Part A and Part B Permit Renewal Application for the

TRIASSIC PARK
WASTE DISPOSAL FACILITY

RCRA Permit No. NM0001002484

Chaves County, New Mexico

Volume 2
Permit Attachments

October 17, 2011
Revision 1 - April 30, 2012

Prepared for:

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Table of Contents

Table of Contents (Continued)

VOLUME 2

Table of Contents (Continued)

VOLUME 3

Attachment

VOLUME 4

Attachment

VOLUME 5

Attachment

Permit Renewal Application
October 17, 2011

Attachment A

General Facility Description and Information

Prepared for:

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Table of Contents

Section **Page**

List of Figures

Figure **Page**

Attachment A. General Facility Description and Information

1. General Facility Standards

This section provides a general description of the Triassic Park Waste Disposal Facility (Facility), including waste management practices, site environment and climate, location information, emergency management, and traffic patterns.

1.1 General Description

The Facility will be a full-service Resource Conservation and Recovery Act (RCRA) Subtitle C waste ~~treatment, storage, and~~ disposal operation. The Facility will be located in Southeastern New Mexico on approximately 480 acres of privately owned land in Chaves County, New Mexico (~~see~~ Figure 1-1 ~~at the end of this section~~). By road, this location is approximately 43 miles east of Roswell and 36 miles west of Tatum, as shown on Figure 1-2.

All waste placed in the Facility will meet land disposal restrictions (LDRs) prior to disposal. The Facility will accept polychlorinated biphenyl (PCB) wastes at concentrations of less than 500 parts per million (ppm) ~~in liquids and~~ in soils~~,~~ and bulk PCB-contaminated remediation waste. The Facility will offer the following RCRA-regulated services, which are described in this permit application.

~~1.1.1 Treatment~~

~~Two treatment processes will be used at the Facility, including an evaporation pond for managing wastewaters that meet LDR standards and a stabilization process for treating liquids, sludges, and solids to ensure that no free liquids are present and that LDR standards are met prior to placing wastes in the landfill. Dilution of restricted waste will not be used as a substitute for adequate treatment. All stabilized wastes will be tested, as a final step in the stabilization process, to ensure that no free liquids are present. The Paint Filter Liquids Test, U.S. Environmental Protection Agency (EPA) Method 9095, will be used to make this evaluation. Prior to treating wastes in the stabilization unit, waste characteristics will be analyzed to ensure that proper measures can be taken to safely manage ignitable, reactive, and incompatible wastes. Procedures for properly identifying and verifying ignitable, reactive, and incompatible wastes are described in Section 4.5 of the Waste Analysis Plan. Once these wastes are identified, they will be managed in accordance with applicable regulatory requirements and permit conditions (see Permit Attachment B, *Procedures to Prevent Hazards*, Section 5.5).~~

~~1.1.2 Solid Waste Storage~~

~~Two container storage areas (roll-off storage area and drum handling unit) will be used to stage waste at the Facility for treatment or disposal. These units will ensure that waste is stored in compliance with RCRA requirements for permitted storage. Neither of the units will be used for long-term storage of waste. All containers being stored will be clearly marked with hazardous waste labels which identify the contents of each container as well as the date of receipt (accumulation date). All labels will be clearly visible while containers are being stored. All containers will remain closed during storage, except when waste is removed or added. Further, container storage and handling procedures will be developed to ensure that containers are not opened, handled, or stored in a manner that may cause them to rupture or leak.~~

1.1.3 Liquid Waste Storage

Four aboveground storage tanks will be utilized to accumulate regulated bulk liquid hazardous wastes prior to stabilization. Handling of reactive materials, tank corrosion, tank assessments, tank inspection and tightness testing, and repair and certification of tank systems is discussed in Section 5.0. Description of contents, quantity of hazardous waste received, and the date each period of accumulation begins will be documented in the facility records and will be included on labels for each storage tank. Design, dimensions, capacity, and other tank specifications are included in Permit Attachments L, *Engineering Report*; L1, Engineering Drawings; L2, *Specifications for the Landfill, Surface Impoundment and Associated Liner and Cover Systems Construction*; and M *Construction Quality Assurance Plan.*

1.1.4 Land Disposal

A landfill will be utilized for the disposal of waste that meets LDRs s standards. Support units and structures include a chemical laboratory, administration building, weigh scale area, maintenance shop, truck wash unit, clay processing area, clay liner material stockpiles, daily cover stockpiles, and a stormwater drretention basin.

Because the Facility has not yet been constructed or operated, there are no solid waste management units (SWMUs) requiring corrective action at this time. Satellite and/or 90-day accumulation areas may possibly be located at the chemical laboratory, the truck wash unit, and the maintenance shop. Other areas at the Facility that may be designated as SWMUs include the untarping, sampling, and weigh scales area, the truck staging area, and the stormwater drretention basin. Detailed information on location, unit type and dimensions, and a structural description of these units is provided in the design of the Facility contained in Permit Attachments L, L1, L2 (Engineering Report and attachments), and M (Construction Quality Assurance Plan), and Volumes IV through VI of the permit application.

The future debris encapsulation area and the future waste processing area identified in the Facility layout are possible future RCRA treatment units envisioned for the Facility that are not being designed at this time. Prior to construction of these units, a RCRA permit modification request will be submitted.

1.1.5 Facility Name

Gandy Marley, Inc. (GMI) owns the Facility. The waste disposal operations covered by this permit will operate under the name of the Triassic Park Waste Disposal Facility.

1.1.6 Facility Contact

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Gandy Marley, Inc.
P.O. Box 1658
RoswellTatum, New Mexico 88202
575-347-0434505/398-4960

1.1.7 Facility Address

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1109 East Broadway
P. O. Box 827
Tatum, New Mexico 88267

1.1.8 Purpose of Facility

The purpose of the Facility will be the treatment and permanent disposal of hazardous wastes in a manner protective of human health and the environment. Wastes that do not meet LDRs standards will not be accepted for placement into the landfill. or evaporation pond until appropriate treatment is performed. Infectious wastes and radioactive wastes will be prohibited at this Facility. The Waste Analysis Plan (Permit Attachment F) contains more details regarding wastes that can be accepted at the Facility and wastes that are prohibited.

1.1.9 Facility Location

The Facility will be located in Southeastern New Mexico on approximately 480 acres of privately owned land in Chaves County, New Mexico, Sections 17 and 18 of R31E, T11S (see Figure 1-1[RF1]). By road, this location is approximately 43 miles east of Roswell and 36 miles west of Tatum, as shown on Figure 1-2[RF2]. The only major road in the vicinity is U.S. Highway 380, which runs east and west approximately 4 miles north of the proposed site. State Highway 172, which runs north and south, is approximately 4 miles east of the proposed site. State Highway 172 is not a major thoroughfare and does not provide access to the proposed site.

1.1.10 Hazardous Waste Generation

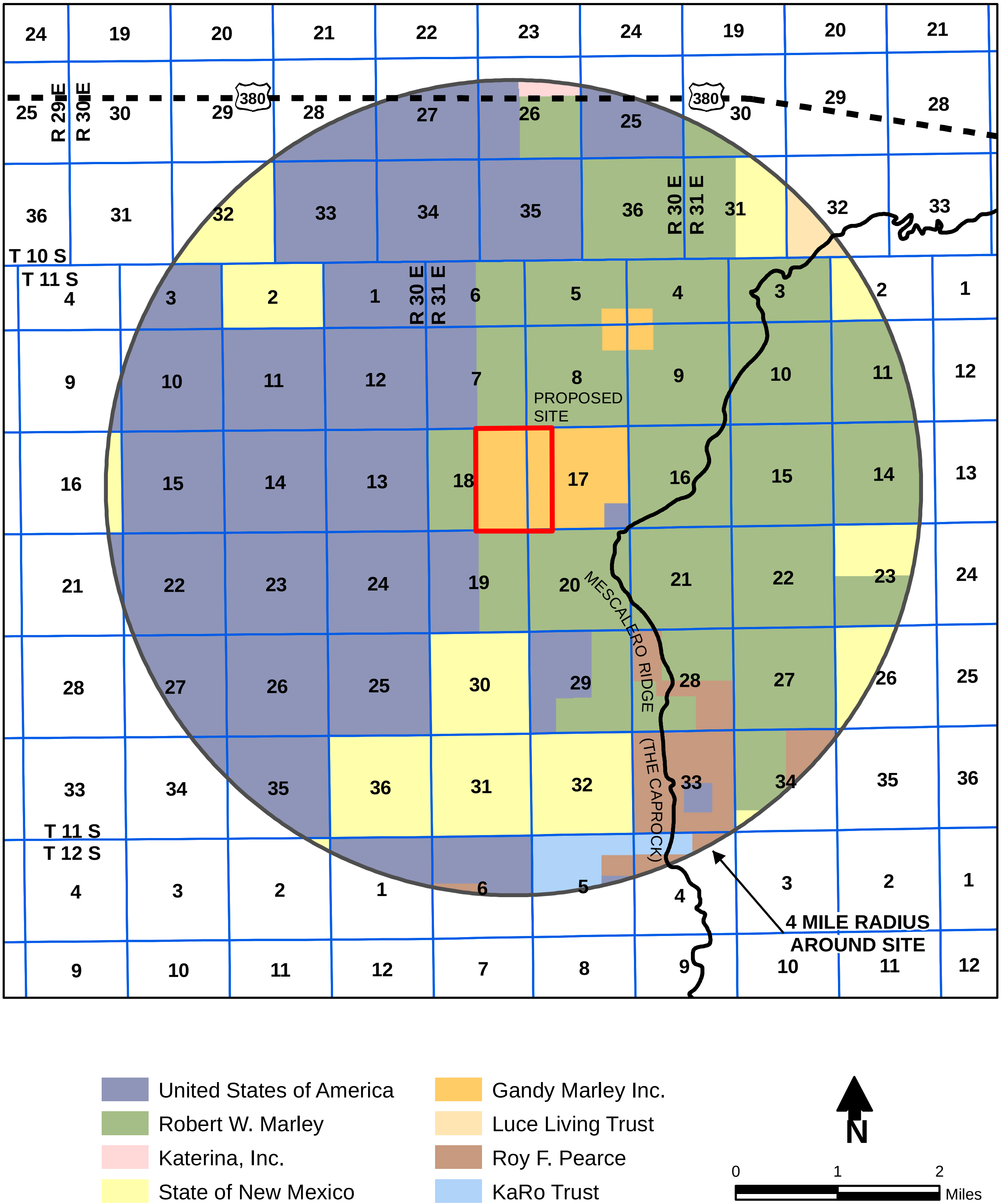
Some hazardous waste will be generated as a result of normal Facility operations. Various treatment and handling processes, support operations and collected leachate will likely generate such wastes. Examples of typical hazardous waste forms likely to be generated during normal Facility operations include solvents, oils, acids and bases, laboratory chemicals and equipment, paint and paint strippers, sludges, solvent contaminated solids, and personal protective equipment. Non-recyclable hazardous wastes, excluding liquids, will be disposed of on-site in accordance with the requirements outlined in Permit Attachment F, Waste Analysis Plan, Section 4.5.6. Any waste not meeting LDRs will be managed through off-site disposal at a facility permitted to accept the material.

1.1.11 Sanitary Waste Generation

Sanitary liquid wastes will be generated in most Facility buildings. This waste form consists primarily of shower water, janitorial wastes, rest room wastes, and liquid wastes generated from cleaning operations. Non-hazardous liquid wastes will be managed as sewage and disposed of off-site.

1.1.12 Non-Hazardous Refuse Generation

Non-hazardous municipal solid waste (MSW) and construction and demolition (C&D) waste will be generated during building and normal operations at the Facility. These wastes will include such things as cardboard packing containers, garbage, paper refuse, and construction debris. Collection, transportation, and disposal of non-recyclable waste will be contracted to a MSW and C&D waste disposal company. Recyclable wastes, such as office paper, will be sent off-site for usable materials recovery. The disposal of non-routine waste materials will be administratively controlled on a case-by-case basis in accordance with applicable regulatory requirements.



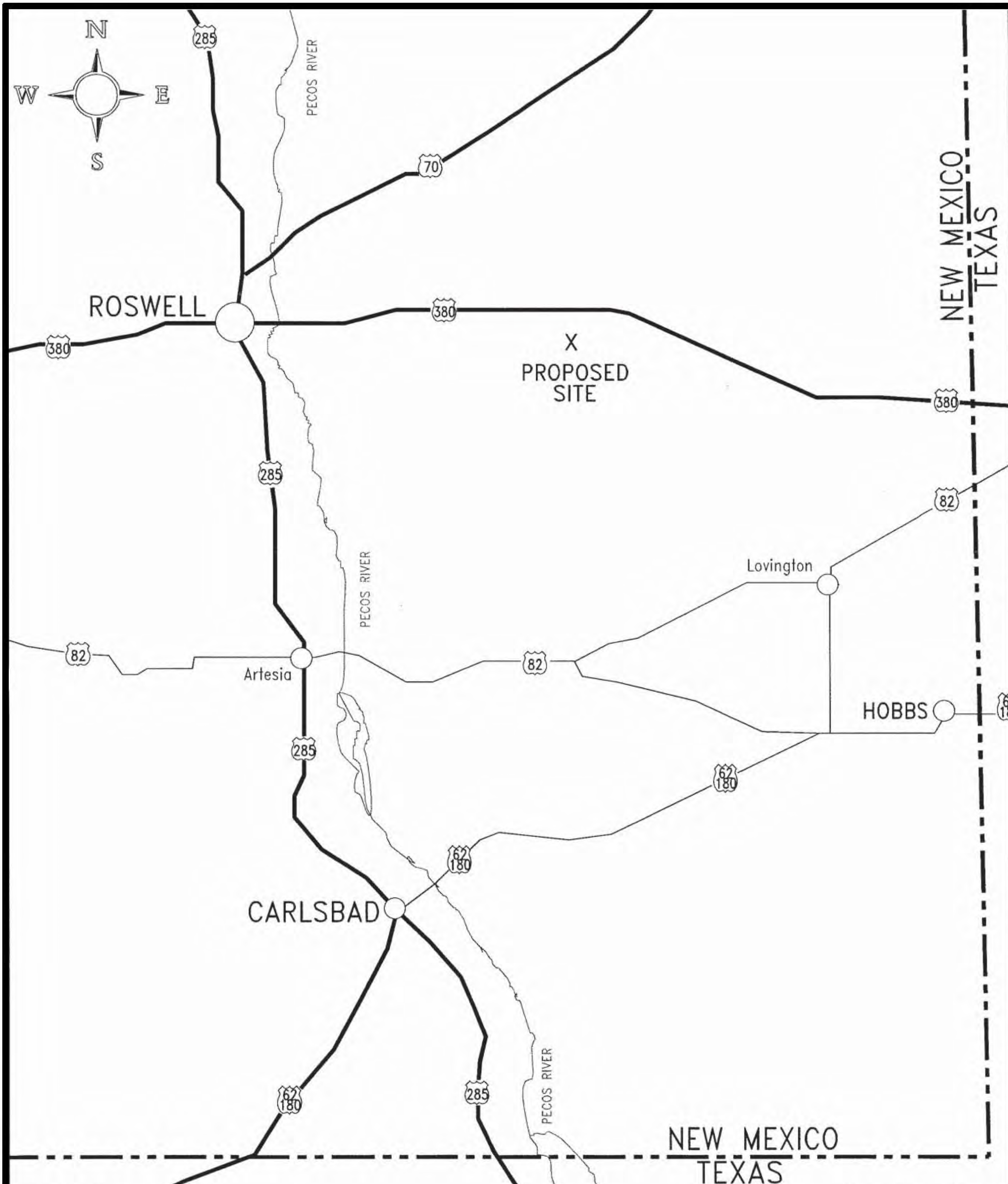
LAND OWNERSHIP WITHIN 4 MILE RADIUS

TRIASSIC PARK WASTE DISPOSAL FACILITY

Figure 1-1

S:/PROJECTS/ES11.0141 TRIASSIC_PARK_PERMIT_RENEWAL/GIS/MXDS/LAND_OWNERSHIP_4_MI.MXD 114101

10/17/2011



Scale: 1"=80 Miles

ONE INCH ~ 16 MILES

SITE LOCATION MAP

TRIASSIC PARK WASTE DISPOSAL FACILITY

Figure 1-2

1.2 Site Environment and Climate

The selected site for the Facility is on the western edge of a geological bench known locally as the Caprock. The Caprock is characterized by rocky terrain which runs north and south. Detailed information about the geologic characteristics of the site is contained in Section 3.0 of the permit application.

The site is approximately 4,150 feet above sea level. Climatic conditions of the area are typical of semiarid regions and are characterized by dry, warm winters with minimal snow cover and hot, somewhat moister summers. The frost-free season averages from 190 to 215 days per year. The mean annual soil temperature ranges from 59 to 65 degrees Fahrenheit (°F). The average annual precipitation rate for Roswell for a 118-year record of data from 1894 to 2011 is 11.6 inches per year~~ranges from 10 to 13 inches~~. Winter precipitation usually consists of occasional snowfall from November through April. Snowfall typically melts within a short period of time. Most precipitation (approximately 80 percent of the annual total) occurs between June and September.

Normally, two-thirds of the summer days reach temperatures in excess of 90°F, with maximum temperatures commonly 100°F or higher. Night temperatures during the winter months commonly fall below freezing, occasionally reaching below 0°F. ~~The average annual temperature is 62°F.~~Moderate temperatures at the ~~Triassic Park~~ Facility are typical throughout the year with annual average high and low temperatures of 75°F and 45°F, respectively

The prevailing wind is from the south. Winds of up to 40 miles per hour are common during the spring and in association with summer thunderstorms.

Area vegetation consists primarily of Tobosa, Buffalo Grass, Vine-Mesquite, Mesquite, Cactus, Sand Dropseed, Little Bluestem, Sand Bluestem, Sandbur, Three-Awn, Shinnery Oak, Yucca, and Sand Sagebrush. According to the New Mexico Forestry and Resources Conservation Division of the State Department of Energy, Minerals, and Natural Resources, there are no rare or endangered plant species located in either Section 17 or 18.

According to the Bureau of Land Management (BLM) - Roswell Resource Area, there are 54 bird species, 33 species of mammals, and 36 species of reptiles and amphibians in what is designated as the Caprock Wildlife Habitat Area. The Facility location is within that wildlife habitat designation.

Pursuant to the U.S. Endangered Species Act, there are 35 listed and sensitive species in Chaves County and 17 species of concern, which are identified for planning purposes only. As of February 28, 1996, the ferruginous hawk (*Buteo regalis*) is no longer listed as a candidate species but does remain a species of management concern.

~~One bird species, the ferruginous hawk (*Buteo regalis*), is classified as a "Category 2" candidate for listing as threatened or endangered by the United States Fish and Wildlife Service of the U.S. Department of Interior. Currently, it is not listed. The Prairie Chicken is a state-listed species and is a candidate for federal listing under the category of Warranted but precluded. No other documented species in the area of the proposed Facility site are federally protected or candidates for federal protection.~~

~~The sand dune sagebrush lizard (*Sceloporus graciosus arenicolous*) is currently listed as a threatened species by the State of New Mexico. Population and habitat studies are ongoing for use by the state in determining whether to give the species protected status. The sand dune sagebrush lizard is not classified for federal protection.~~The sand dune lizard (formerly the sand dune sagebrush lizard) (*Sceloporus graciosus arenicolous*) and the lesser prairie chicken are currently listed as candidate species. In 2008, the U.S. Bureau of Land

Management adopted a Special Status Resource Management Plan for both the sand dune lizard and the lesser prairie chicken.

GMI will continue to monitor the existence of threatened or endangered species in the area. Should any threatened or endangered species be identified within the Facility area, GMI will take measures to ensure that these species are protected. GMI will implement protective measures for the wildlife population in the area,~~.~~ ~~These measures~~ includ~~e~~ing the use of restrictive fencing around the operational portions of the Facility.~~ and the use of protective netting over the evaporation pond.~~

1.3 Location Information

A topographic map of the site has been developed from a 1997 aerial photograph and U.S. Geological Survey (USGS) 7.5 minute series map (Mescalero Point, New Mexico, 1973) and is presented in Permit Attachment L1, Engineering Drawings, Drawing 3. The Facility layout is presented at Drawing 4 in Permit Attachment L1. This drawing illustrates Facility boundaries, access roads, access control locations, internal roads, and site fences.

The site is located in eastern Chaves County, in an area that has historically been utilized primarily as range land for livestock grazing and for limited oil and gas activities. The residence nearest the site is owned by Marley Ranches, Ltd. and is located approximately 2.9 miles to the east-southeast. Land ownership for a 4-mile radius around the site is shown in Figure 1-~~2~~1. All of the residences within a 10-mile radius of the site are listed in Figure 1-3[RF3].

The site will encompass 480 acres and will be enclosed by a 6-foot chain link fence. Gates to the same height as the perimeter fence will be constructed. The area will be secured and monitored so that only authorized personnel or personnel being accompanied and supervised by authorized personnel are allowed on-site. Employees responsible for site security will be present at all times to prevent unauthorized entry and to report unusual events and/or emergencies. Site security personnel will be responsible for conducting regular inspections and routine maintenance of the perimeter area (see Permit Attachment D, Inspection Procedures).

Land use plans and/or zoning maps have not been developed for Chaves County. All areas within the county, except those within municipal boundaries, are designated as Zone A (agricultural). The eastern half of the county is further designated as Area 1 and the western half as Area 2. Area 1 and Area 2 are zoning Land Use Areas, whose boundaries have been determined by a joint-powers agreement between the Board of Chaves County Commissioners and the Roswell City Council. Existing uses in Area 1 are livestock grazing, mineral exploration and production, wildlife habitat, and extensive recreation. Single-family dwellings require permits in Area 1. Area 2 covers an important part of the recharge area of the Roswell Artesian Basin. Existing uses in Area 2 are livestock grazing, mineral exploration and production, extensive recreation, wildlife habitat, and flood control structures and floodways. Any new parcels created in the area must be 5 acres or larger.

Approximately 2 miles northwest of the Facility location, the Mescalero Sands recreational "complex" has been established for use by off-road vehicles. The South Dunes area of Mescalero Sands has been designated as an "Outstanding Natural Area" (ONA) and is utilized by the public primarily for wildlife observation activities.

The land in the area of the Facility is used predominantly for grazing cattle and to a much lesser extent for oil and gas exploration activities. The nearest production well is 3 miles from the site. Additional information about the drilling activities in the area is contained in Section 3.0 of the Permit Application.

OWNER	DISTANCE	DIRECTION
Marley Ranch	Approximately 2.9 Miles	East-Southeast
Bill Kolb, Jr. - KOBR TV Towers	Approximately 4.5 Miles	East
KOBR TV - Two Dwellings (Vacant 20+ Years)	Approximately 4.5 Miles	East
Pearce Ranch	Approximately 4.5 Miles	Southeast
Sand Ranch (Vacant 10+ Years)	Approximately 6.3 Miles	Northeast
Jack Luce Ranch	Approximately 6.5 Miles	Northeast
Pearce Ranch	Approximately 7 Miles	West
Perry Dean Goff Ranch	Approximately 7 Miles	East-Southeast
Sand Ranch	Approximately 7.2 Miles	Northwest
Jackie & Cindy Reynolds	Approximately 7.9 Miles	Southeast
Luce Ranch and Store	Approximately 8 Miles	Northeast
Tivis Ranch	Approximately 8.2 Miles	Southeast
Johnson Ranch	Approximately 9.7 Miles	Northeast

RESIDENCES WITHIN A TEN MILE RADIUS

TRIASSIC PARK WASTE DISPOSAL FACILITY

Figure 1-3

AutoCAD FILE: GANDY-FIG1-3

All abandoned wells in the area have been plugged in accordance with New Mexico Oil Conservation Division (OCD) regulations. These regulations require the use of mud-laden fluids, cement, and plugs in the well "in a way to confine crude petroleum oil, natural gas, or water in the strata in which it is found and to prevent it from escaping into other strata." Surface reclamation of abandoned wells prevents surface water from entering and contaminating subsurface strata.

1.3.1 Flood Plain Information

Sections 17 and 18, T11S, R31E are included on Federal Insurance Rate Map 35005C1775D~~#350125~~. This map has not been printed because this is a non-participating community, a status which generally indicates that the area is an area of minimal flood hazard.~~the National Flood Insurance Program has determined that this is an area of minimal flood hazards.~~ This information was originally provided to GMI by the Director of Planning and Environmental Services, Chaves County, New Mexico, and was confirmed with the National Flood Insurance Program at their website (www.msc.fema.gov) on October 11, 2011.

To confirm that this Facility is an area of minimal flood hazard~~Additionally~~, rainfall runoff calculations were performed to determine whether the site falls within the flood plain of a 100-year, 24-hour storm event. Based on information in the Precipitation Frequency Atlas published by the National Oceanic and Atmospheric Association, a rainfall amount of 5.75~~3~~ inches was used in the calculations. The nearest drainage to the site was determined from the USGS 7.5-minute series topographic map of the Mescalero Point Quadrangle (see Section 3.0 of the permit application). This drainage flows westerly from Mescalero Point, which is approximately 0.75 mile south of the site.

Storm runoff flows were calculated for the area using the Rational Method (see the Surface Water Control Plan in Attachment CC~~Appendix F-3 in Volume VI of the Permit Application dated October 2000~~). A runoff coefficient of 0.3 was used in the calculations. It was determined that the maximum flow could be accommodated in a triangular channel with~~section occupying~~ a width of 78~~6~~ feet at a water depth of 1.2 feet. It may be concluded from this calculation~~omparison~~ that a flood plain does not exist for the drainage and that there are no flood plains within 1 mile of the site. It may be further concluded that flood plain regulations are not applicable to this Facility.

1.3.2 Fire Control and Emergency Response

Fire control and emergency response will be the responsibility of the Emergency Coordinator (EC) who is on call or duty at the time of an incident. Each EC will be trained to handle emergencies and to notify appropriate authorities (see Permit Attachment C, Contingency Plan). Each EC will have the authority to commit resources necessary to implement the site Contingency Plan described in Permit Attachment C.

In addition to on-site emergency response capabilities, cooperative agreements will be established with local emergency response organizations in surrounding communities to respond to and assist in any emergencies that arise at the Facility (see Permit Attachment C).

1.4 Traffic Patterns

The flow of traffic within the Facility boundary will not be significant except during shift changes. The number of employee vehicles will not be substantial enough to require elaborate signage or other traffic control systems. All personnel will be given written instructions that will caution them to be alert to other vehicles and pedestrians. Each vehicle must enter and exit through the security gate at the northeast corner of the perimeter of the Facility boundary. ~~The arrival and departure of trucks transporting waste will not be scheduled during peak traffic times.~~ Drawing 26, Sheet 2 in Permit Attachment L1 illustrates traffic flow patterns for the operations and waste processing area, traffic control signage and truck staging areas.

1.4.1 Traffic Control

Access to the Facility will be gained through the security gate at the northeast corner of the perimeter fence (see Drawing 26, Sheet 2 in Permit Attachment L1). Authorization to enter the Facility will be verified for each vehicle.

Visitors will be required to sign in at the guard shack and will be escorted while on-site unless other arrangements are made with the Facility. Only authorized persons will be allowed past the security gate guard shack.

1.4.2 On-Site Transportation of Wastes

All trucks transporting wastes will be stopped at the security gate prior to entering the Facility. Security personnel will record the license number, transportation company, arrival time, and other pertinent information with regard to the vehicle and driver.

After being granted access to the Facility through the security gate entrance, waste transport vehicles will be directed to the untarping/sampling area. Here, a sample of the waste will be collected for fingerprint testing, along with the shipment manifest and other pertinent documentation. While the sample is being analyzed at the chemical laboratory, the truck will be directed to the weigh scales and finally to the truck staging area. The truck will remain at the staging area until laboratory analysis verifies that the waste meets acceptance criteria and the waste characteristics are consistent with profile information from the shipment manifest.

Following determination that waste acceptance criteria have been met, the truck will be directed ~~either~~ to the landfill, where the waste will be placed in the landfill for permanent disposal~~, in cases where wastes can be directly landfilled (for instance, when all LDR treatment standards are met), or to another station for staging/storage or further processing~~.

1.4.3 Routes

Transporters must use U.S. Highway 380 to reach the Facility. U.S. Highway 380 runs east and west between Roswell and Tatum, New Mexico as shown in Figure 1-2.

2. ~~Treatment, Storage, and~~ Disposal Process

This section provides a general description of the ~~storage, treatment, and~~ disposal process~~es and units~~ for the Facility. ~~For each of the operational units described in this section, d~~Detailed design drawings and associated engineering reports for the Facility are contained in Permit Attachments L, Engineering Report, and L1, Engineering Drawings. The drawings and specifications contained in Permit Attachment L2 present final designs for the RCRA permitted landfill~~facilities~~. Details on the non-RCRA components of the Facility~~facilities~~ will be supplemented during the bidding and construction phase. ~~Gandy Marley~~GMI will supply the additional details on the non-RCRA components of the design to the New Mexico Environment Department (NMED) for review and approval prior to the start of construction.

2.1 Facility Overview

An overview of the Facility layout is provided in Permit Attachment L1, Drawing 4 and identifies areas to be used for waste acceptance, waste receiving, and waste disposal activities. ~~This drawing shows the units used for the five general categories of waste disposal activities at the Facility. These five~~ ~~four~~ ~~waste disposal~~

~~operations are: (1) waste acceptance, (2) waste receiving, (3) waste staging/storage~~, ~~(4) waste treatment, and (5~~4~~) waste disposal.~~ Each activity is described below.

2.1.1 Facility Waste Acceptance

Prior to initiation of a shipment of waste to the Facility, the generator of the waste must provide a full characterization of its waste and receive approval from the Facility to ship the waste. This process is more completely described in Permit Attachment F, Waste Analysis Plan. The Facility will use the waste characterization data to perform the following activities:

- ensure that the waste can be accepted in accordance with the RCRA permit;
- verify that the Facility has the capability to properly ~~treat and/or~~ dispose of the waste;
- identify any safety precautions that must be taken to properly manage the waste;
- use the physical characteristics and chemical composition of the waste to determine whether the waste may be accepted for disposal; ~~the most effective treatment and disposal methods for the waste;~~
- ~~select parameters to be tested to determine the formula for stabilization of appropriate wastes;~~
- select parameters to be tested upon arrival at the Facility to verify that the waste accepted is the waste characterized; and
- develop a cost estimate for ~~treatment and~~ disposal.

2.1.2 Waste Receiving

Once approved for acceptance at the Facility, the waste can be shipped. The Facility can be accessed only from New Mexico State Highway 380, as shown in Figure ~~2-1~~1-2. When a shipment arrives at the Facility, a Facility representative will verify that the shipment was scheduled. If unscheduled shipments arrive at the Facility, the Facility manager will be consulted to determine if the appropriate paperwork has been received and the shipment can be accepted.

The shipment and shipping papers will be inspected to ensure that the correct inventory has been received, that the hazardous waste manifest is properly completed, and that an LDR certification is attached. Any discrepancies will be resolved prior to acceptance of the shipment. If discrepancies cannot be resolved, the shipment will be rejected. Representative samples of the waste will be taken and fingerprint testing will be conducted. Fingerprint testing is described in Section 4.5 of the Waste Analysis Plan in Permit Attachment F. If the fingerprint test results are inconsistent with the generator's information, several actions can be taken (see Section 4.5). Waste will be received~~processed~~ only if fingerprint tests are consistent with information provided by the waste generator. Containers and drums will be inspected for visible cracks, holes or gaps.

~~2.1.3 Waste Staging/Storage~~

~~Containerized wastes will be moved to the drum handling unit or the roll-off storage area. The objectives of these container storage areas are to provide safe storage of waste prior to its introduction into the treatment or disposal system; to ensure that adequate accumulation space is available during intervals when the treatment or disposal system is temporarily unavailable; and to facilitate repackaging as necessary.~~

~~Solid waste will be transferred directly to the landfill for disposal if all applicable LDR requirements are met and, in the case of containerized material, if the container is at least 90 percent full.~~

Restricted waste at the Facility will be stored solely for the purpose of accumulating sufficient quantities to facilitate proper treatment, or disposal. Procedures will be in place at the Facility so that only that waste will be accepted that either (1) meets LDR treatment standards; or (2) is amenable to treatment using existing and available treatment capabilities at the Facility, such that restricted wastes will not be stored for longer than one year.

2.1.4 Waste Treatment

There are two treatment processes: stabilization and evaporation. Low concentration wastewater from off site generators and leachate from the landfill that meet LDR standards will be placed in the evaporation pond. Pond sludge, contaminated leachate from the landfill that does not meet LDR standards, and various wastes from generators will be treated in the stabilization process. Stabilized waste that meets LDR treatment standards and other operational criteria will be placed in the landfill.

Wastes that carry more than one characteristic or listed waste code must be treated to the most stringent treatment requirements for each hazardous waste constituent of concern. When wastes with different treatment standards are combined solely for treatment, the most stringent treatments standard specified will be met.

2.1.5 Waste Disposal

In general, wWastes arriving at the Facility that meet LDRs requirements and contain no free liquids will be directly landfilled. When wastes are unable to be directly landfilled, such as during landfill equipment maintenance periods or extreme weather conditions, the waste will be not be unloaded and will be temporarily stored in the truck stagingwaste storage area. Wastes stabilized at the Facility that meet LDR requirements will be transferred to the landfill from the treatment or storage areas as necessary.

An access ramp will be constructed from the top of the landfill to the bottom of the active portion of the landfill (see Drawings 8 and 14 in Permit Attachment L1). Bulk hazardous wastes will be placed and compacted on the bottom of the landfill in 5-foot to 10-foot layers or lifts. Containers (drums) will be placed upright in the cell using a forklift or barrel snatcher. Sufficient space will be left around the containers for the placement and compaction of compatible bulk hazardous waste.

Materials in roll-off containers will be dumped with the bedliners at preselected locations. Containers or bulk waste can be placed adjacent to the roll-off material. A layer of cover soil sufficient to prevent wind dispersal of waste will be placed over the bulk hazardous wastes and containers following emplacement or before the end of each working day (see Section 2.5.1.7). The soil cover will be deposited on top of the waste placement face and then spread and compacted with a landfill compactor or tracked bulldozer. The minimum cover thickness will be 0.5 foot.

The landfill will be laid out in an engineered grid system consisting of blocks that are 50 feet wide, 50 feet in length, and 10 feet in depth. Grid stakes will be established by survey. A two-dimensional grid system along with lift elevation designation will provide a three-dimensional record of the location of all wastes placed in the landfill. Records of the location, date of placement, waste source, manifest, and profile numbers will be maintained at the Facility.

2.2 Container Storage Areas

The site will employ two container storage areas: a drum handling unit and roll-off storage area. Descriptions and conditions specific to these areas are presented in Section 2.2.1 and Section 2.2.2 for the drum handling unit and roll-off storage area, respectively. Sections 2.2.3 through 2.2.14 describe conditions common to both units. Wastes which are either suspected or known to contain free liquids will be managed accordingly. A description of how these wastes will be managed is included in the following sections. More detailed information on the management of wastes containing free liquids can also be found in the Waste Analysis Plan presented in Section 4.0. Both the drum handling unit and the roll-off storage area will be constructed to meet the minimum requirements identified in the detailed design and associated engineering report (Permit Attachments L and L1).

2.2.1 Drum Handling Unit

Drawings 37, 38, and 39 presented in Permit Attachment L1 show the detailed design for the drum handling unit. The open sided unit will be roofed to prevent run-on from precipitation. The roof of the building is designed to extend over the unloading dock area to ensure that precipitation does not enter the building or impact unloading operations.

The building will be equipped with fire extinguishers, a sprinkler system, telephones, fire alarm system, public address system, eye washes, safety showers, spill control equipment, and first aid equipment. An office for storing record-keeping information and for administrative functions within the drum handling unit will be located in the building.

The base of the drum handling unit will consist of a compacted subgrade of non-swelling soils placed at a moisture content and density capable of supporting projected loads comprised of the building's structural components, stored waste, and mobile equipment traffic inside the building. A 60-mil geomembrane liner, cushion geotextile, and 1 foot of foundation sand will overlie the subgrade. The steel reinforced concrete floor will be constructed on the prepared subgrade. Design details and the associated specifications are presented in Permit Attachments L1 and L2.

2.2.1.1 Containment and Detection of Releases

Wastes stored in the drum handling unit will be placed in individual storage cells segregated by waste type and compatibility. Individual storage cells are defined as groupings of drums as shown on Drawing 37 of Permit Attachment L1. The specific areas to be used for storage will depend on the volume and type of waste being processed at the site. Labels will be added to each section of the drum storage unit to identify the type of waste to be stored. The labels may change depending on the volume and type of waste being received. A chemically resistant epoxy coating (or an equivalent) will be applied to the concrete floor. Chemical resistant water stops and caulking will be installed in all joints. The floor is designed and will be maintained to be free of cracks and gaps and will be inspected regularly to determine if any cracks or gaps have developed or if the epoxy coating has been damaged. Should cracks or gaps develop in the concrete, repairs will be scheduled immediately. The nature of the repair will depend on the extent of the cracking and could range from the application of chemically resistant epoxy fillers or coatings to the replacement of portions of the concrete floor.

Each storage cell will have a concrete floor that slopes toward a trench covered by steel grating. Each trench will lead to a separate secondary containment sump for that cell where any spilled liquids will be accumulated. The trench and sump system design incorporates a double high-density polyethylene (HDPE) geomembrane liner in the leak detection and removal system (LDRS) and leachate collection removal system (LCRS). Both the LDRS and LCRS sumps incorporate drainage material surrounding a perforated pipe. The LCRS sump has been sized to contain at least 10 percent of the volume of the containers stored in the cell. The LCRS and LDRS sumps in the drum handling unit will be checked regularly for the presence of liquid. If liquids are present, samples will be obtained and chemically analyzed to determine the nature and concentration of any waste constituents. An appropriate treatment or disposal method will be selected in accordance with the Waste Analysis Plan presented in Section 4.0. Pumpable quantities of liquids will be removed with a vacuum truck. Leaks and spills will be removed from the sump in as timely a manner as possible. Because the building is covered, precipitation and the consequent accumulation of liquid are not considered in the design or operation of the drum handling unit.

The cells that will contain PCB-contaminated waste will be surrounded by a 6-inch concrete berm, in addition to the floor trench and sump.

2.2.1.2 Dimensions

The drum handling unit is 418 feet long by 118 feet wide (see Drawing 37 in Permit Attachment L1). The building floor and loading dock will be 5 feet above ground level to facilitate the loading and unloading of trucks and prevent run-on from precipitation. An adjustable hydraulic loading platform will align the truck beds with the building floor to allow for the smooth transition of forklifts in and out of the trucks from the floor. An overhang on the front of the building will prevent precipitation from getting on the drums and into the front area.

2.2.1.3 Storage Limits

The drum handling unit will contain seven separate containment areas, each 52 by 63 feet as shown on Drawings 37 and 38 in Permit Attachment L1. Each of the seven areas will have its own floor drain and containment sump, allowing incompatible wastes to be placed in separate cells. Two of the cells will be designed to accommodate only PCB wastes. Aprons on the ends of the cells that store PCB-contaminated waste will be tapered to allow for forklift access over the concrete berms. The total capacity of the drum handling unit will be 1,120 drums (160 drums per containment cell). The drain and sump for each drum cell is dimensioned such that the storage capacity will be a minimum of 118 cubic feet, 10% of the capacity of the drums in each cell. A typical drum layout is shown in Drawing 37 of Permit Attachment L1.

2.2.2 Roll-Off Storage Area

Roll-off containers will be stored on an open pad, as shown in Drawings 41 through 43 presented in Permit Attachment L1. This unit will not be covered or enclosed by walls. The pad will be divided into two sections. One section will hold tarped, U.S. Department of Transportation (DOT) approved, lined, roll-off containers with non-stabilized waste awaiting treatment at the stabilization unit. The other section of the pad is intended as a staging area for roll-off containers containing stabilized waste awaiting Toxicity Characteristic Leaching Procedure (TCLP) test results and landfill-disposal approval.

Waste will be characterized and screened as part of the waste acceptance procedures. This procedure will prevent incompatible waste from being stored in the same roll-off containers that are delivered to the site. After the materials have been stabilized, material from a single stabilization batch will not be mixed with material from a different batch, therefore eliminating the potential for incompatible waste to be stored in the same roll-off bin. The individual steel roll-off bins will be stored in the HDPE-lined roll-off storage unit and physically separated from each other by 4 feet side to side and 2.5 feet end to end. In addition, containers will not be placed within the limits of the roll-off storage area inundated by the rainfall that accumulates for the 25 year, 24 hour storm (see Appendix E-38 in Volume VI of the permit application) or within 4 feet of the edge of the berm.

This area is restricted to wastes that do not contain free liquids. Prior to exiting the stabilization unit, stabilized waste loads will be tested for free liquids using the paint filter test. Stabilized waste loads that do not pass the paint filter test will be reprocessed using a modified treatment mixture and re-tested before being allowed to exit the stabilization unit. Roll-off containers which hold stabilized wastes that pass the paint filter test will be covered before exiting the stabilization unit and will remain covered while they are staged in the roll-off storage area.

Roll-off containers will be inspected for free liquids prior to acceptance at the unit. Containers which are received for disposal, but are found to contain free liquids upon inspection will be managed in accordance with stabilization procedures described in Section 2.4. If the waste generator will not allow the Facility to prioritize handling of the load to eliminate free liquid, the load will not be admitted to the Facility. Otherwise, free liquids will be removed with a vacuum truck, characterized, and managed in accordance with stabilization procedures described in Section 2.4. The volume of free liquids in the roll-off containers is expected to be minimal. Following the removal of free liquids, the waste (in the roll-off container) will either be managed through the stabilization process or landfilled, whichever is appropriate. Section 2.2.12 describes the methods that will be used to separate incompatible wastes. The area will be equipped with fire extinguishers, a telephone, alarm systems, spill control, and first aid kits.

Waste in the roll-off containers that meet the requirements for free liquids (or lack thereof) will be placed in the landfill. Other wastes in roll-off containers that do not pass the appropriate acceptance testing (i.e. paint filler test) will be transferred to the stabilization area for treatment. Upon completion of the stabilization process, the waste will once again be tested to ensure that it meets the landfill criteria.

2.2.2.1 Containment and Detection of Releases

The roll-off storage area is designed to store non-stabilized and stabilized waste. Secondary containment of the roll-off storage area is shown in Drawing 41 through 43 in Permit Attachment L1.

The floor and slopes of the lined cell will consist of, from bottom to top, a prepared subgrade; a geomembrane liner that will be composed of a component material compatible with the anticipated waste; a geocomposite drainage layer; a structural-fill; and a roadbase surface. A sump will be incorporated into the drainage layer. To accommodate this installation, the floor will be sloped to a sump located in the corner of the storage area. Any liquids would collect in the containment sump, which is designed to have the pumping capacity to remove liquids resulting from the 25-year, 24-hour storm event.

The roll-off containment area is surrounded by a berm with a minimum height of 2.0 feet (Drawing 41 of Permit Attachment L1). This berm will divert run-on surface water around the perimeter of the truck roll-off area. Culverts will be placed under each of the access ramps to allow surface water flow to the west towards the run-off detension basin.

The containment sump is designed to collect precipitation falling inside the bermed area of the truck roll-off storage area. During heavy rain events, a portion of the water will drain along the roadbase surface to the sump area located in the corner of the cell. The remaining volume will percolate through the roadbase and structural fill and will be collected in the geocomposite drainage layer. Water collecting on the surface of the sump or in the sump drainage gravel will be removed by vacuum truck. Samples of sump liquids will be chemically analyzed to determine the presence and concentration of any waste constituent. After this determination, an appropriate method of treatment or disposal will be selected in accordance with the criteria prescribed in the Waste Acceptance Plan (see Section 4.0). Leaks, spills, and precipitation will be removed from the sump as soon as possible. The entire roll-off storage area will be surrounded by a berm which ranges in height from 4 feet to 8 feet.

The purpose of the drainage system below the storage area surface is to allow rainfall to be collected and removed from the contained area. This will reduce ponding and mud formation on the storage area surface and will allow the surface to support truck traffic almost immediately following a rainstorm. The presence of free liquids inside the roll-off container/bed liner system can occur if liquids are inadvertently loaded in the container, rainfall enters a hole in the roll-off container cover during transportation, or liquids separate from solids during transport. These free liquids will be identified when the roll-off container is visually inspected at the untarping station.

It is possible, but unlikely, that free liquids could be generated after inspection in the staged roll-off containers. For example, if a faulty roll-off container cover allows rainfall to enter the container and both the plastic and containment fail, a leak can occur on the surface of the roll-off storage area. A leak will appear as a drop or a stain on the storage area surface. In the case of a leak, the liquids in the roll-off container will be handled as described in Section 2.2.2 and the stained soil will be excavated and handled as a potential hazardous waste.

2.2.2.2 Dimensions

The entire roll-off storage area (including both halves) will measure approximately 410 feet by 330 feet from the outer edge of the berms. The berm height surrounding the area will range from 4 feet to 8 feet. The storage areas will be accessed by 35-foot-wide compacted soil ramps at the center of each storage area. The halves will measure approximately 180 feet by 310 feet inside the berms.

2.2.2.3 Storage Limits

The permitted capacity of the incoming waste cell will be 66 roll-off containers. The stabilized waste cell also will have a capacity of 66 roll-off containers, for a total storage capacity of 132 containers. The actual number of roll-off containers placed in the roll-off storage area may vary slightly depending on placement arrangements as determined by operations.

2.2.3 Warning Signs

Signs containing the legend "Danger - Unauthorized Personnel Keep Out" will be conspicuously posted on the outside and at entrances to the storage areas. In the areas where ignitable or reactive wastes will be stored, "No Smoking" signs will be posted. All signs will be in both English and Spanish.

2.2.4 Proper Waste Storage

Compatibility codes established during the initial receipt of waste will be assigned to ensure the proper storage of containers within the Facility (see Permit Attachment F1). Containers which are discovered upon receipt to have free liquids will not be accepted, or will be handled at the stabilization unit as a priority load.

2.2.5 Ignitable/Reactive Wastes

Ignitable or reactive wastes will be protected from any sources of ignition or reaction. All containers storing ignitable or reactive waste will be stored at least 50 feet inside the fence around the Facility shown in Permit Attachment L1, Drawing 4. "No Smoking" rules will be enforced and open flames prohibited where ignitable or reactive waste is being handled.

2.2.6 Precautions to Prevent Reactions

Precautions to prevent reactions are described in Permit Attachment B, Procedures to Prevent Hazards.

2.2.7 Inspection Methods

As required in 40 CFR 164.174, all container storage areas will be visually inspected at least once a week for leaking containers and deterioration of the containers and containment area. Inspectors will enter the area and visually inspect the area and the containers. All inspection information will be recorded, and any problems noted during the inspection will be resolved in a timely manner (see Permit Attachment B). Workers will be instructed and trained on the procedures for identifying and reporting any signs of leaks or

~~deterioration that appear between the weekly inspections. Any identified leaks will be resolved as described in Section 2.2.2.1. Containers with more than 500 ppmw volatile organic compounds will be inspected at least once a month for cracks, holes or gaps in the container, cover or closure devices. Defects detected will be repaired according to CFR 264.1086 (d)(4)(iii).~~

~~2.2.8 Types of Containers~~

~~Hazardous wastes will be stored in 10-gallon, 35-gallon, or 55-gallon drums, in 40 cubic yard or similar roll-off containers, or in other DOT approved containers. Overpack drums will be used as necessary.~~

~~2.2.9 Labels~~

~~All containers of hazardous waste in storage will be labeled with a hazardous waste label identifying the contents of the container. The label will also be clearly marked to indicate the date of accumulation or the date of receipt. The label will not be obstructed from view during storage.~~

~~2.2.10 Condition of Containers~~

~~All containers of hazardous waste will be managed by the following conditions:~~

- ~~containers will be maintained in good condition. If a container is not in good condition (e.g. severe rust, apparent structural defects, or leaks), the hazardous waste will either be transferred to a container that is in good condition or be managed in some other way, such as direct placement in the landfill or stabilization unit;~~
- ~~containers of hazardous waste stored at the drum handling unit will be closed during storage, except when it is necessary to add or remove waste;~~
- ~~the container storage area will be inspected prior to placement of containers to ensure that no conditions exist which could damage the waste containers; and~~
- ~~all containers will be handled in a manner, and with equipment compatible to their design and construction, to minimize the potential for damage to the container.~~

~~The roll-off units to be placed in the roll-off area will be covered with a tarp. The covers will not be removed until the material is placed in the stabilization unit. Roll-off units used to store stabilized material will also be placed on the roll-off unit with covers. It is not expected that the tarps will be removed during storage except for re-sampling of the material, if required.~~

~~2.2.11 Compatibility with the Container~~

~~All hazardous waste will be compatible with the container or liner as defined by the following conditions:~~

- ~~all containers used to store hazardous waste will be made of, or lined with, material that will not react with, or otherwise be incompatible with, the waste being stored so that the ability of the container to hold waste is not impaired; and~~
- ~~hazardous waste will not be placed in an unwashed container that has previously held incompatible waste or material.~~

~~2.2.12 Compatibility with Other Waste~~

~~Incompatible liquid hazardous wastes stored within the units will be separated by a berm, catch pan, or other physical barrier which adequately prevents commingling of incompatible wastes. Incompatible solid hazardous wastes stored within the container storage areas will be separated by a distance of at least 10 feet unless separated by a berm, catch pan, or other physical barrier. Incompatible wastes will not be placed in the same container.~~

~~2.2.13 Aisle Space~~

~~Aisle spacing will be maintained to assure inspectability and accessibility for operational and emergency equipment to containers. The spacing will allow for the unobstructed movement of personnel, fire protection equipment, spill control equipment, and decontamination equipment in the event of an emergency, as required by 40 CFR 264.35.~~

~~A minimum 2.5-foot aisle space will be maintained in the drum handling unit between rows of containers side by side. Containers will be stored in single rows only if they are against a wall or other barrier that prohibits inspection from all sides. Roll-off containers will be spaced 4 feet apart, side-to-side and 4 feet from the edge of the berm.~~

~~2.2.14 Record Keeping~~

~~The results of all container storage waste analyses, trial tests, waste compatibility analyses, and ignitable and reactive waste handling documentation pertaining to compliance will be maintained in the Facility operating record. Inspection records will be maintained in the inspection log for each unit.~~

~~2.3 Storage in Tanks~~

~~The liquid waste receiving and storage unit is shown in Permit Attachment L1, Drawing 40. It will house four aboveground tanks for the storage of regulated bulk liquid hazardous wastes prior to stabilization. The unit will not be covered by a roof or enclosed by walls.~~

~~Each tank will have a capacity of approximately 9,000 gallons. The tanks will be double-walled and constructed of high-density polyethylene materials that are compatible with the wastes to be placed in the tanks. Compatibility of the tanks with different types of waste has been provided by the manufacturer and is presented in Volume VI, Appendix H3, of the permit application. Facility procedures for waste acceptance and the associated criteria in the waste acceptance plan will ensure that wastes incompatible with the tank material are not placed in the storage tanks. The tanks will be placed on an imperviously coated reinforced concrete pad. All piping systems within the facility will comply with API Publication 1615 (November 1979) or ANSI Standard B31.2 and ANSI Standard B31.4. Waste will be transferred from the tanks to the stabilization unit by pumping into transfer tankers.~~

~~Each of the storage tanks will be clearly marked with a description of the contents and records will be kept documenting the quantity of waste received, and the date each period of accumulation begins. This information will be documented in the Facility operating record.~~

~~2.3.1 Containment and Detection of Releases~~

~~The outer tank of the double walled poly tank system will provide secondary containment of sufficient strength and thickness to prevent failure due to pressure gradients, physical contact with waste, climatic~~

conditions, or the stress of daily operations. The tank system will be placed on a concrete base capable of supporting the system, providing resistance to pressure gradients below the system, and preventing failure due to settlement, compression, or uplift. The secondary tank is designed to contain 100 percent of the tank contents.

Each tank will be surrounded by a concrete area which will be sloped to provide drainage to a sump. The floor and berm of the concrete area will be maintained in good condition and free of cracks and gaps, as described in Section 2.2.1.1, in order to protect the effectiveness of the containment.

All ancillary equipment will be provided with secondary containment except aboveground piping (exclusive of flanges, joints, valves, and other connections), welded flanges, welded joints, and welded connections that are visually inspected for leaks each operating day. Secondary containment will be provided by the concrete pad.

Daily visual inspection will be used to detect releases to the secondary containment. Response to releases from tank systems will be initiated immediately upon discovery, and regulations specified in 20 NMAC 4.1 Subpart V, 40 CFR 264.196(d) or 40 CFR 264.56 will be followed as appropriate (see Section 5.0), including notification of the Hazardous Materials Bureau (HMB) of the New Mexico Environment Department (NMED) and National Response Center (NRC). The secondary containment tank will be emptied by pumping fluids from the drainage port located near the base of the tank or by the use of a vacuum truck.

2.3.2 Management of Incompatible Wastes

Only the waste types approved for a tank system will be placed in the tank. No new waste types will be placed into an existing tank system unless: (1) the compatibility of the new waste type with the prior contents of the tank is determined by testing or documentation; or (2) the existing tank system is cleaned or flushed to the extent necessary to ensure compatibility with the new waste type.

2.3.3 Spill and Overfill Prevention

Appropriate controls and practices will be used to prevent spills from and overfills of the tank or containment systems.

Spill prevention is primarily maintained by hard-plumbed piping. When transfer lines are not hard plumbed or when open-ended lines are used, one or more of the following spill prevention controls or an equivalent device will be used:

- *Dry Disconnect Couplings* - a pipe connection designed to cap the flow of liquids as soon as the fitting is disconnected;
- *Direct Monitoring* - the transfer is monitored continuously to prevent spills; and/or,
- *Overfill Prevention* - one or more of the following spill prevention controls or an equivalent device will be used:
  - ◊ *Automatic Feed Cutoff* - a device used to stop flow into a tank when it is filled to operating capacity or another predetermined level;
  - ◊ *High-Level Alarm* - a device used to detect the level in a tank, sounding an audible alarm or displaying a visual alarm when the operating capacity level or another predetermined level is reached;

◊ *Level Indicator* - a device used to visually display the level of material in a tank; if a level indicator is used for overfill prevention, the indicator must be monitored during liquid transfers or checked prior to transfers to ensure that sufficient capacity exists in the receiving tank. Level indicators may include sight gauges, level meters, or graduations placed directly on opaque poly tanks; and/or,

◊ *Bypass* - a device or plumbing arrangement used to divert flow from the tank being filled to a second tank of sufficient capacity after the operating or predetermined level has been reached.

2.3.4 Feed Mechanism, Pressure Controls, and Temperature Controls

The tanks will be operated at ambient pressure and temperature when storing liquids. One of the following feed mechanisms for tank systems or an equivalent transfer mechanism will be used:

- *Pump Transfer* - liquids will be pumped into or out of the tank through permanent or temporary transfer lines; or,

- *Gravity Drain* - liquids will be allowed to drain by gravity through permanent or temporary transfer lines.

2.3.5 Management of Ignitable or Reactive Wastes

Ignitable or reactive wastes will not be placed into any tank system unless the tank system is protected from sources of ignition by measures including, but not limited to, the following: signs prohibiting smoking, open flames or welding; an inert atmosphere blanket; enclosed vents isolated from sources of ignition.

2.3.6 Inspections

A visual inspection of tank systems will be conducted each operating day. Each tank system will be visually inspected, including, but not limited to, the tanks and ancillary equipment, monitoring and leak detection systems, and the construction materials and area immediately surrounding the tank system. The results of each inspection will be documented in the daily operating record. Inspections are further described in Permit Attachment D.

2.3.7 Corrosion Protection

All liquid hazardous waste materials will be stored in double walled poly tanks. Corrosion protection is not required for double walled poly tanks that do not come into contact with soil or water.

2.3.8 Tank Assessments

The tank system proposed has sufficient structural integrity and is acceptable for the storing and treating of hazardous waste. The assessment has been prepared by the engineer of record and is based on the tank design drawings (see Permit Attachment L3, *Tank Integrity Assessment Certification*). After construction of the tank, its integrity will be assessed by an independent New Mexico registered professional engineer in accordance with 20 NMAC 4.1.500 (incorporating 40 CFR 264.192(a)). The engineering report presented with the tank design drawings in Permit Attachments L and L1 includes a list of wastes to be excluded from storage in poly tanks due to their excessive corrosive effects.

2.3.9 Ancillary Equipment

All ancillary equipment will be supported and protected against physical damage and excessive stress due to settlement, vibration, expansion, or contraction, according to API Publication 1615 (November 1979) or ANSI Standard B31.2 and ANSI Standard B31.4.

Hazardous waste will be transferred from the tanks to the tankers through a limited piping system, as shown in Drawing 40 and discussed in Permit Attachment L, Section 8.2.2. This piping system will be considered part of the tanks and will be drained and dismantled as part of the tank closure.

2.3.10 Installation and Tightness Testing

Proper handling procedures will be developed and followed to prevent damage to the system during installation. A qualified installation inspector will inspect the installed system to ensure adequate construction/installation. Any discrepancies will be resolved before the system is placed in service.

The tanks and ancillary equipment will be tested for water tightness, and any necessary repairs will be performed prior to the system being placed in service.

Written statements by those who certify the design and supervise installation will be maintained in the operating record.

2.3.11 Repair and Certification of Tank Systems

If a release occurs from the primary tank system, the tank will be removed from service immediately. Wastes in the tank will be removed within 24 hours to the extent necessary to prevent further release and allow inspection and repair of the tank system. All released materials will be removed from the secondary containment as soon as possible and within 24 hours of detection.

The tank system will be repaired or replaced prior to returning it to service. An independent New Mexico registered professional engineer will certify major repairs. The certification will be submitted to the NMED within seven days after the tank system is returned to service. Major repairs include repair of a ruptured primary containment vessel and replacement of secondary containment.

2.3.12 Transfer of Liquids from Liquid Waste Storage to the Stabilization Unit and to the Evaporation Pond

Transfer of liquids from the liquid waste storage tanks to the stabilization unit will be accomplished by tanker trucks approved for liquid waste transfer. Approved tanker trucks, such as vacuum trucks or DOT approved tankers, will be used to transfer liquids from the storage tanks to the evaporation pond. Tanker trucks will be cleaned following a transfer operation to ensure that subsequent transfers do not result in mixing of incompatible or reactive wastes.

Personnel performing liquid waste transfer operations will comply with all personal protective equipment (PPE) requirements and transfer operation procedures, including spill cleanup. Impervious concrete coatings will be applied to the liquid waste storage tank containment area and the evaporation pond discharge station. Hose and pipe connections will be inside the concrete containment area boundaries.

2.4 Stabilization

Drawings 33 through 36 presented in Permit Attachment L1 show the stabilization building floor plan, a typical bin, and vault sections. The stabilization process will use four in-ground double lined stabilization bins, two dry reagent silos, two liquid reagent tanks, and a water tank. Trucks and other vehicles will access the unit via the gravel aprons. Additionally, there will be a control room from which operations will be directed and coordinated.

Bulk liquids, semi-solids, sludges, and solids that do not meet LDR treatment standards, as well as solids that may contain free liquids, will be treated in the stabilization unit. Dilution of restricted wastes will never be used as a substitute for adequate treatment. If toxic characteristic wastes and listed wastes are amenable to the same type of treatment and aggregation is a part of treatment, the aggregation step does not constitute impermissible dilution.

As discussed in the Waste Analysis Plan in Permit Attachment F, wastes will be tested prior to stabilization to determine the appropriate reagent formula. Both dry and liquid reagents may be used in the stabilization process. Waste may be offloaded directly from trucks into the stabilization bins or transferred from the drum handling unit or roll-off storage area. The bins will be covered while dry reagents are being added to control particulate air emissions. The cover will be removed and a backhoe positioned adjacent to the bin will mix the waste and reagents.

Wastes that are treated on site in the solidification unit will be tested after treatment and before disposal to verify that LDR standards have been met. The stabilized waste will be either transferred to the roll-off area for testing or taken directly to the landfill if testing has been completed. The stabilized waste will be stored temporarily at the roll-off unit while tests are conducted to determine how and if the material can be disposed of in the landfill.

The backhoe bucket and stabilization bin will be thoroughly cleaned before a load of waste which is not compatible with the waste previously stabilized in that bin is mixed. After the last bin load of a specific stabilization mixture has been loaded out, Facility personnel will use a high-pressure water hose located near the bins to rinse the backhoe bucket and the bin walls. This rinsing will cause residual clods of stabilized waste to fall to the bottom of the bin along with the rinse water. Reagents will then be added to the bin at the same mixture proportions and the remaining waste and rinse water will be stabilized, tested for free liquids, and loaded out before a different waste stabilization mixture is processed in that bin.

The nominal dimensions of the bins are 25 feet long by 10 feet wide by 10 feet deep, resulting in an approximate volume of 2,500 cubic feet. The volume of waste to be treated in each batch will be variable but less than 2,500 cubic feet, depending on the addition of stabilization materials. The overall process volume is based on four bins. However, the actual process design will be dependent on the characteristics of the incoming waste (time to mix each batch) and the volume of stabilization materials required. Assuming that 15 batches per bin are processed per day with 4 bins, a total of 150,000 cubic feet of waste are treated per day. The ends of the bins have been shaped to conform to the reach profile of the backhoe selected for mixing in the stabilization unit. The bins will be contained in a concrete vault, which will also provide support. All mixing bins will be equipped with ventilation and air pollution control systems to remove any air pollutants generated during the mixing process. Potential contaminants may include particulates, low concentration volatile organic compounds, or acid fumes.

2.4.1 Contaminant and Detection of Releases

The bins will be of steel construction. Waste which is incompatible with the steel used in construction will not be stabilized in the bins. An assessment of the compatibilities of the bin materials and waste, is contained in the engineering report (Permit Attachment L). The design requirements and limitations will be incorporated into Facility procedures. The waste acceptance plan and associated criteria will ensure that waste which is incompatible with the bin construction material will not be introduced into the bins.

The bins will be double-walled steel tanks with the space between the walls serving as the LDRS. Shock absorbing coiled wire rope isolators will maintain separation between the bins.

The tank secondary containment (the outer shell) will be of sufficient volume to contain the contents of the inner tank, because the inner tank will be completely enclosed within the outer shell. The vault will not be used as secondary containment; therefore, it does not have to be lined or meet other requirements for secondary containment. Its purpose will be to isolate the tank system from the surrounding soil, provide a monitoring and collection point if leakage were to occur from both the primary and secondary systems, and means to inspect and repair the secondary containment.

Releases into the LDRS will be detected within 24 hours by liquid sensing instruments (e.g. a magnehelic gauge) or inspection. Accumulated liquids will be removed within 24 hours of detection. The secondary containment will be emptied by pumping accumulated liquids into a temporary storage tank or into another stabilization bin. Releases to the LDRS could occur if a breach occurred in the primary steel liner. In such a case, the bin will be removed from service and repaired.

All ancillary equipment will be provided with secondary containment unless it is aboveground piping (exclusive of flanges, joints, valves, and other connections), welded flanges, welded joints, and welded connections that can be visually inspected for leaks each operating day. Secondary containment will be provided by a concrete pad.

2.4.2 Management of Incompatible Wastes

New waste will not be placed in the bins unless (1) the compatibility of the new waste type with the prior contents of the bin is determined by testing or process knowledge documented in the operating record or (2) the existing tank system is cleaned or flushed to the extent necessary to ensure compatibility with the new waste type using procedures specified in Section 2.4.

2.4.3 Spill and Overfill Prevention

Spill and overfill prevention will be accomplished by continuous direct monitoring of transfer operations. Additionally, the delivery system will be computerized and will be designed to ensure that the mixture used for stabilization prevents overfilling.

2.4.4 Feed Mechanism, Pressure Controls, and Temperature Controls

The stabilization bins will be operated at ambient temperature and pressure. Reagents will either be pumped from reagent tanks or manually fed. Liquid hazardous wastes will be pumped from the liquid waste receiving and storage unit or from vacuum trucks or tanker trucks. Other wastes may be manually transferred directly from the incoming waste hauler truck or from the container storage areas.

2.4.5 Management of Ignitable or Reactive Waste

The stabilization bins will be protected from sources of ignition through the use of signs and procedures prohibiting smoking, open flames, or welding. If ignitable or reactive wastes are placed in the bins, they will be immediately mixed with sufficient quantities of fly ash and/or cement to render them non-ignitable or non-reactive.

2.4.6 Inspections

Each stabilization bin will be visually inspected once each operating day as described in Permit Attachment D, Inspection Procedures. At least once per month, the daily visual inspection will be conducted on empty bins to ensure the integrity of the bin and welds. An annual sonic test will be conducted to ensure that the thickness of the inner tank and outer shell is maintained.

2.4.7 Corrosion Protection

Corrosion is not anticipated to be a significant problem for the stabilization bins because of low humidity and the fact that the units are located indoors. No corrosion protection will be provided other than cathodic grounding. The thickness of the inner tank and outer shell compensates for the abrasion and impact forces of the backhoe bucket during waste stabilization mixing. The structural steel design of the bins is presented in the engineering report (Permit Attachment L).

Inspection of the bins is discussed in Sections 2.4.6 and 5.2.6. Visual inspection of the empty bins will be accomplished monthly, and sonic testing will be conducted annually. The system has been designed so that the inner tank and outer shell can be easily removed and replaced, if necessary.

2.4.8 Tank Assessments

The stabilization bins proposed have sufficient structural integrity and are acceptable for the storing and treating of hazardous waste. The assessment has been prepared by the engineer of record and is based on the design drawings (see Permit Attachment L3). After construction of the tank, it's its integrity will be assessed by an independent New Mexico registered professional engineer in accordance with 20 NMAC 4.1.500 (incorporating 40 CFR 264.192(a)). The engineering report presented with the tank design drawings in Permit Attachment L includes a discussion of wastes to be excluded from treatment in the bins due to their excessive corrosive effects. The engineering report presented with the tank design drawings in Permit Attachments L and L1 include a discussion of wastes to be excluded from storage or treatment in steel tanks due to their excessive corrosive effects.

2.4.9 Ancillary Equipment

All ancillary equipment will be supported and protected against physical damage and excessive stress due to settlement, vibration, expansion, or contraction; according to API Publication 1615 (November 1979) or ANSI Standard B31.2 and ANSI Standard B31.4.

2.4.10 Installation Inspection and Tightness Testing

Proper handling procedures will be developed and followed to prevent damage to the system during installation. A qualified installation inspector will inspect the installed system to ensure adequate construction/installation. Any discrepancies will be resolved before the system is placed in service. The bins and ancillary equipment will be tested for water tightness, and any necessary repairs will be performed prior to the system being placed in service. Written statements by those who certify the design and supervise installation will be maintained in the operating record.

~~2.4.11 Repair and Certification of Tank Systems~~

~~If a release occurs from a primary tank system, the tank will be removed from service and all materials will be removed from the tank or secondary containment within 24 hours or as soon as reasonably possible. The tank system will be repaired prior to return to service. Major repairs will be certified by an independent New Mexico registered professional engineer. The certification will be submitted to the NMED within seven days after the tank system is returned to service.~~

2.5 Landfill

This section describes the design, construction, and operation of the landfill. ~~As with the Facility units discussed previously in this section, t~~The detailed design for the landfill is contained in Permit Attachments L, Engineering Report, and L1, Engineering Drawings.~~ L.~~ The overall landfill will be constructed in phases, as shown on Drawing 4. The first phase to be considered will be Phase 1A. This permit application refers only to Phase 1A. However, potential expansions of the landfill in future phases have been included in the general layout drawing for completeness. Detailed design drawings are only submitted for Phase 1A. The landfill design is presented on Drawings 6 through 27 in Permit Attachment L1, and a list of these drawings is provided on Drawing 1, Sheet 2 (Permit Attachment L1).

2.5.1 Design of Landfill

The landfill design specifies a double-lined landfill with a leachate collection removal system (LCRS) above the primary liner and a leak detection and removal system (LDRS) between the primary and secondary liners. The detailed design presented in Permit Attachment L specifically describes the relationship between the existing site topography and the landfill subgrade.

2.5.1.1 Nature and Quantity of Waste

As specified in the Waste Analysis Plan in Permit Attachment F, the Facility will accept RCRA hazardous waste and PCB waste, excluding selected waste. The excluded waste is listed in the Waste Analysis Plan (Permit Attachment F).

The wastes which will be accepted for placement in the landfill include all wastes listed in Part A of the application ~~(~~presented in the Part A Permit Application~~Attachment K, *Permit Application - Part A*)~~. All waste to be placed in the landfill must meet LDRs~~ treatment standards~~. Additional details on wastes to be accepted at the Facility can be found in Permit Attachment F1, Section 4.1.1, Waste Analysis Plan.

The total landfill will have an area of approximately 100 acres and a capacity of approximately 10 million cubic yards of waste. The Phase 1A area will include approximately 35 acres (estimated final cover area) and have a capacity of approximately 553,200 cubic yards.

2.5.1.2 Liner Systems

The liner system will be installed to cover all surrounding earth that may come in contact with waste or leachate (see Drawings 9 and 11 in Permit Attachment L1). The primary liner system will consist of, from top to bottom, a 2-foot layer of protective soil, a geocomposite drainage layer, and a high density polyethylene (HDPE) geomembrane liner.

The secondary liner system will consist of a geocomposite drainage layer, HDPE geomembrane liner, geosynthetic clay layer (GCL), and 6 inches of prepared subgrade. Both the primary and secondary liner systems will extend over the floor and slope areas of the landfill.

The primary and secondary geomembrane liners will be constructed of HDPE as defined in the construction specifications presented in Permit Attachment L2. This material will have sufficient strength and thickness to prevent failure as a result of pressure gradients, physical contact with waste or leachate, climatic conditions, stress of installation, and stress of daily operations. The liner systems and geosynthetic drainage layers will rest upon a prepared subgrade capable of providing support to the geosynthetics and preventing failure due to settlement, compression, or uplifting.

Initially, the Phase 1A liner system will be installed. As authorized in future permits, t~~T~~he liner system will be installed in stages as the landfill expands both in the vertical direction up slope and in the horizontal direction by phase. The three horizontal phases of landfill expansion are shown in Drawings 4, 6, and 7 in Permit Attachment L1. The benching technique considered for expansion of the landfill vertically up slope is shown in Drawings 8 through 11 (Permit Attachment L1) for Phase 1A. Geosynthetic liner component tie-ins for the vertical expansion will be made on the access ramps leading into the landfill.

Stresses to the liner system can result from consolidation settlement of the subgrade during waste filling and localized equipment loading during protective soil placement. The subgrade consists of the 6-inch thickness of prepared soil subgrade and the existing ground formations below the landfill (see Drawing 7, Permit Attachment L1). Because the existing ground formations have been prestressed by overburden forces prior to landfill excavation, additional consolidation settlement during waste filling will be minimal.

Consolidation settlement of the 6-inch prepared soil subgrade layer will also be minimal because it is limited by the thickness of this layer and because this material will be compacted during installation. Localized equipment loading to the liner during protective soil placement will be controlled by specifying maximum equipment ground pressures in the construction specifications and by monitoring the placement of this material. Monitoring can be performed by individuals operating the placement equipment or by grade checkers who will observe the material placement to assure that appropriate thicknesses have been installed.

2.5.1.3 Leachate Collection and Removal System (LCRS)

The LCRS will be located above the primary liner system. Drawing 12 in Permit Attachment L1 provides the design details of the LCRS. A filtered LCRS layer consisting of a geocomposite drainage material will be constructed. Within the floor area of the LCRS layer will be the primary leachate collection piping, which is used to remove leachate from the landfill during the active life and post-closure care period. The piping as shown in Drawing 12 (Permit Attachment L1) is nominally 8 inches in diameter.

As demonstrated in the engineering report (Permit Attachment L), the LCRS will be (1) constructed of materials that are chemically resistant to the waste managed in the landfill and the leachate expected to be generated; (2) of sufficient strength and thickness to prevent collapse under pressure exerted by overlying wastes, waste cover material, and equipment used in the landfill; and (3) designed and operated to minimize clogging during the active life and post-closure care period through selection of an appropriate geotextile for the filtration application (see Permit Attachment L, Section 3.1.3).

The LCRS is sloped so that any leachate above the primary liner will drain to ~~one of three~~the sump~~s~~. Phase 1A includes one sump as shown in Drawings 8, 15, 16, and 17 (Permit Attachment L1). The sump~~s~~ and liquid removal methods will be of sufficient size to collect and remove liquids from the sump~~s~~ and prevent liquids from backing up into the drainage layer.

The sump will be lined with the same liner system components as elsewhere in the landfill except that the drainage layer will expand to include gravel and a compacted clay liner material beneath the primary and secondary geomembranes in~~which will fill~~ the sump area. Leachate that collects in the sumps will be pumped through a pipe to the surface of the landfill where it will be collected in temporary storage tanks.

The leachate storage tanks will be chemically resistant, double lined poly tanks anchored to a concrete crest pad as shown in Sheets 1 and 2 of Drawing 19 (Permit Attachment L1). To prevent overfilling of the tanks, an individual tank will be installed for each landfill phase, and each tank will be equipped with high-level control switches, which will automatically shut down the leachate collection or leak detection sump pumps. In addition, an alarm will be activated that will notify personnel that the system requires maintenance. Pumps will be hard piped to the leachate storage tanks, and flow meters will be installed to monitor leachate pumping from the landfill should a catastrophic tank or pipe failure occur. All piping will be located within the concrete tank pad. The pump control panel will be located inside the tank pad with electrical wiring enclosed in waterproof conduits.

~~Because leachate is generated by the landfill, the leachate collection tanks will be used as 90-day storage units and managed accordingly. They are not required to be permitted.~~

The sump system will provide a method for measuring and recording the volume of liquid removed. Drainage materials will meet the minimum drainage requirements per the specifications. Sump design, filter fabric selection, floor pipe design, pump design, disposal system design, and action leakage rate (ALR) calculations involving removal of leachate flow from a 1-mm^2 hole/acre are discussed in the engineering report (Permit Attachment L). All pumpable liquid in the sump will be removed in a timely manner to prevent the head on the primary liner from exceeding 12 inches.

Leachate will be managed by recirculating the liquid and applying it to the landfill soil cover for enhanced evaporation. The leachate collection tanks will be used for temporary storage. A moveable piping and sprinkler system will be used to distribute the water onto the soil cover. Vacuum trucks with spray bars may also be used to apply leachate to the soil cover. Management of leachate has been evaluated through calculations that are provided with the Engineering Report in Attachment L. Calculations show that the leachate generation rate is much less than the potential evaporation rate within the Phase 1A landfill. Management of leachate by recirculation for enhanced evaporation keeps all leachate and potential contaminants within the lined landfill cell.

2.5.1.4 Leak Detection and Removal System (LDRS)

The design of the LDRS is similar to the design of the LCRS. The LDRS will be capable of detecting, collecting, and removing leaks of hazardous constituents through areas of the primary liner during the active life and post-closure care period. A filtered LDRS layer consisting of a geocomposite will be constructed below the primary geomembrane. Within the LDRS layer will be the LDRS piping, which will be used to detect and remove liquid from between the primary and secondary liners. The piping arrangement is shown on Drawing 18 in Permit Attachment L1.

As demonstrated in the engineering report (Permit Attachment L), the LDRS will be (1) constructed with a bottom slope of one percent or more; (2) constructed of a geocomposite with a hydraulic conductivity that exceeds 1 x 10^{-2} centimeters per second (cm/s~~ec~~); (3) constructed of materials that are chemically resistant to the waste managed in the landfill and the leachate expected to be generated; (4) of sufficient strength and thickness to prevent collapse under pressure exerted by overlying wastes, waste cover material, and equipment used at the landfill; and (5) designed and operated to minimize clogging during the active life and post-closure care period.

In addition, the sump and liquid removal methods are designed to be of sufficient size to collect and remove liquid from the sump and prevent liquid from backing up into the drainage layer (see ALR calculations in Permit Attachment J, Action Leakage Rate and Response Action Plan). A method will be provided for measuring and recording the volume of liquid present in the sump and liquid removed. All pumpable liquid in the sump will be removed in a timely manner to maintain the head on the secondary liner at less than

12 inches. The pump for the LDRS sump is located at the sump's low point so that pumpable liquids can be removed to the maximum extent possible.

2.5.1.5 Vadose Zone Monitoring System

The vadose zone monitoring sump serves as a detection system for potential leakage from~~ing in~~ the secondary LDRS system. Located directly beneath the LDRS sump, leakage through the secondary liner system will flow into the vadose sump, allowing it to be detected and removed. The vadose pipe and gravel arrangement is similar to the LCRS and LDRS arrangements. Drawings 16 through 18 in Permit Attachment L1 show the vadose zone monitoring~~in the~~ sump.

2.5.1.6 Run-On/Runoff Control

The run-on/runoff system is designed to be constructed, operated and maintained to control at least the water volume resulting from a 24-hour, 25-year storm. The run-on/runoff control system design is provided in ~~Permit~~the Engineering Report in Attachment~~s~~ L and the Surface Water Control Plan in Attachment CC ~~and L1 and Volume IV of the Permit Application~~. The purpose of the run-on/runoff control system is to prevent any contamination present on-site from migrating off-site by minimizing the volume of liquid entering the landfill and therefore limiting the potential to transport contaminants placed in the landfill.

Run-on/runoff will be collected in one of three different collection basins, depending on the source of the water. The collection basins are listed and discussed in detail below:

- The Facility Stormwater Detention Basin
- The Phase 1A Landfill Stormwater Collection Basin
- The Phase 1A Landfill Contaminated Water Basin

The Facility Stormwater Detention Basin is located northwest of the landfill area, as shown on Drawings 6 and 25 in Permit Attachment L1. Run-on originating from around the landfill will be directed away from the proposed landfill area using unlined landfill perimeter ditches (see Drawing 25, Permit Attachment L1). These ditches will prevent water from outside the landfill from entering the active portion of the landfill. Based on the topography of the site, the run-on is expected to move from the east/southeast to the west/northwest and be diverted to the Stormwater Detention Basin. The Stormwater Detention Basin is also intended to collect runoff from the rest of the Facility (not including the landfill) and will be lined with a single 60-mil HDPE liner as a precaution to prevent infiltration of ponded stormwater. ~~The detention basin will be pumped after rainfall events that result in the accumulation of water in the basin.~~

The Phase 1A Landfill Stormwater Collection Basin is located at the toe of the inter-phase cut slope in the landfill, as shown on Drawings 10 and 13 in Permit Attachment L1. This basin will collect runoff from the inactive portion of the Phase 1A landfill. During the initial stages of the landfill operation, runoff from the landfill side slopes above the liner system will be channeled away from the waste by the slope drainage interceptor ditch. The water in the Stormwater Collection Basin will be handled as clean water because it will not come in contact with the landfill waste. The basin is lined with a single 60 mil HDPE liner.

The Phase 1A Landfill Contaminated Water Basin is located at the bottom of the Phase 1A landfill, as shown on Drawing 10 in Permit Attachment L1. This basin overlies the ~~entire~~ landfill liner system. The contaminated water basin will be maintained to ensure that the adequate amount of protective cover soil (2 feet) is present over the liner system

Runoff from the active portion of the landfill, which does not infiltrate into the LCRS, will be collected in the landfill contaminated water~~is~~ basin. Runoff water collected within the contaminated water basin will be managed by pumping the water to remove the standing water in the basin and applying it to the landfill soil cover for enhanced evaporation. A moveable piping and sprinkler system will be used to distribute the water onto the soil cover. Vacuum trucks with spray bars may also be used to apply water to the soil cover. Management of runoff water within the Phase 1A landfill has been evaluated through calculations that are provided with the Engineering Report in Attachment L. Because evaporation rates greatly exceed precipitation rates at the site, runoff water can be removed from the basin and eliminated by enhanced evaporation. Management of runoff water by recirculation for enhanced evaporation keeps all water that has a potential to contact waste within the lined landfill cell. ~~and will be pumped out of the landfill within 24 hours of a storm event. The water pumped out of the basin will be collected using vacuum trucks and sampled and analyzed for hazardous constituents. Contaminated water will be treated either in the stabilization process or the evaporation pond, and treatment residuals will be disposed of in compliance with appropriate regulations~~~~offsite~~. ~~The contaminated water basin will be maintained to ensure that the adequate amount of protective cover soil (2 feet) is present over the liner system.~~

2.5.1.7 Wind Dispersal Control Procedures

Wind dispersal control will consist of a daily soil cover obtained from excavation. Typically, the daily cover will consist of soil spread on top of the waste placement area to a depth of approximately 0.5 foot.

Depending on the local wind conditions, traffic, and the number of fine particles in the soil cover, dust may be generated from the surface. Typically, this dust generation is reduced by restricting traffic to predetermined haul roads on the surface of the daily cover and applying small amounts of water spray to moisten the soil surface. Water applied for dust control may include clean water supply, leachate, and runoff water collected within the landfill contaminated water basin. The water will be applied ~~with~~ using both a piping and sprinkler system and~~a~~ water trucks equipped with a pump, piping, and an array of nozzles that spray very small water droplets onto the soil cover.

The frequency of the water application depends on the climate and traffic. In areas on the daily cover surface where traffic is not present, an occasional water spray will cause a crust to form on the soil surface, inhibiting dust formation. Sufficient moisture will be applied to all soil surfaces, including roads, on an as needed basis to prevent wind erosion of the daily cover. However, the application of water will be limited so that ponding in the landfill does not occur. Because the water is a topical surface application, the majority of it will evaporate or be absorbed rather than seep through~~into~~ the waste to become leachate.

2.5.1.8 Gas Generation Management

The landfill will not receive MSW or C&D waste, limiting ~~and~~ the gas generated as a result of biological decomposition of organic wastes. Hazardous organic wastes placed in the landfill will meet LDRs, which will limit the organic gas generation potential. The hazardous waste acceptance procedures at the Facility will be designed to limit receipt of wastes with potential for significant gas generation. The waste acceptance program is described in Section 4.3 and outlines the procedures that will be used to test for reactive cyanides and sulfides, other reactive chemical groups, waste compatibility, and biodegradability of sorbents.

During the operational phase of the landfill, periodic checks will be made within the landfill to detect the presence of hazardous gases and volatile organics. Surveys of the active landfill surface area and the riser pipes with an organic vapor meter (OVM) or comparable device will be performed quarterly to detect the presence of organic compounds. PPE levels and respiratory protection levels will be modified accordingly, if necessary. This testing will be conducted in addition to the fingerprint testing conducted on incoming waste. The data from both tests will be evaluated to determine what steps are necessary to reduce the generation and/or release of these gases to levels which meet prescribed regulatory air quality standards.

Prior to closure of the landfill, an assessment will be made of the landfill waste gas generating potential. This assessment will be based on review of fingerprint test data and data gathered in the landfill during operations. Based on this assessment, if it is concluded that gas generation may result in gas build-ups beneath the barrier layer of the cover or releases following closure exceeding regulatory air quality standards, then provisions will be made to collect and monitor gas generation and release during the post-closure period. If this occurs, the latest technology available will be implemented into the construction of the cover system, which may require a modification to the Permit.

2.5.1.9 Cover Design

The design of the final cover is described in Permit Attachment O, Closure ~~and Post-Closure Care~~Plan. Additional details of the final cover design are shown in the Engineering Report in Permit Attachments~~s~~ L and the Engineering Drawings in Permit Attachment L1.

2.5.1.10 Landfill Location Description

The proposed site is in eastern Chaves County, New Mexico.

Geographic Location

The proposed site is located in a remote, unpopulated portion of New Mexico, approximately 43 miles east of the City of Roswell and 36 miles west of~~from~~ the City of Tatum. The primary land use in the surrounding area is ranching, which will not be impacted by landfill operations.

Geologic Setting

The proposed site is to be developed within impermeable, geologically stable sediments of the Dockum Group of Triassic age (see Section 3.4 of the permit application). The base of the proposed landfill will be designed to rest on 600-foot thickness of unsaturated mudstone of the Lower Dockum. This thick sequence acts as a geologic barrier to potential vertical migration of contaminants. Potential lateral migration through unsaturated Upper Dockum sediments will be retarded by the low permeability of the host sediments (siltstones and mudstones) and engineered barriers such as the liner systems.

2.5.2 Construction

Construction activities will consist of site preparation; excavation and preparation of landfill bottoms and subsurface sides; and construction of the liner, LCRS, and LDRS in accordance with the specifications and Permit Attachment M, Construction Quality Assurance Plan.

2.5.2.1 Site Preparation

Existing site drainage will be modified to route any run-on away from the landfill area. Additionally, drainage of the landfill area itself will be modified to route water away from the initial fill area. Access roads and weighing units will be constructed. A fence will also be installed around the Facility. These components and installations are shown in Drawing 4 presented in Permit Attachment L1.

2.5.2.2 Excavation and Preparation of Landfill Bottom and Subsurface Sides

The landfill will be constructed and excavated in sections to allow a smaller portion of the landfill surface to be exposed to precipitation at any one time. The initial working area of the landfill will be excavated to design depth. The excavated material will be stockpiled on unexcavated soil near the active area for use as cover material. The landfill bottom will be sloped toward the central axis of each phase to provide drainage of leachate to the sump. The U.S. Environmental Protection Agency (EPA) minimum required slope of 1 percent has been exceeded in all cases. The upper 6 inches of the subgrade will consist of a soil material ~~which~~ that has been sized, moisture conditioned, compacted, and trimmed to provide a smooth stable surface for geosynthetic material placement.

2.5.2.3 Construction Quality Assurance Plan

Permit Attachment M contains the Construction Quality Assurance (CQA) Plan. Implementation of CQA procedures will result in increased leachate collection efficiency and reduced leakage through the landfill and evaporation pond liners. Additionally, use of CQA will result in fewer costly repairs to the landfill after wastes have been received, fewer occasions of exceeding the ALR, and a decreasing need for corrective action.

The CQA Plan describes the CQA procedures for the installation of the soil and geosynthetic components for the hazardous waste landfill, evaporation pond, and other units requiring subsurface containment systems comprised ofwhich comprise soils and geosynthetic components constructed at the Facility. These procedures apply to construction of the lining systems and final cover systems, including the LCRS and LDRS systems.

The objectives of the CQA program include the following:

- development of a clearly defined organizational structure within which the project can be planned and completed;
- assurance that the methods, techniques, and procedures used to collect, analyze, verify, and report data will produce sound, documented, and defensible results;
- assurance that equipment or instrumentation used in field or laboratory testing activities has been properly maintained and calibrated as required;
- assurance that the required documentation of quality performance is properly generated and that such documentation is adequate and complete for the activity;
- development of permanent project CQA document files identifiable and traceable to each activity;
- systematic control of items, equipment, materials, or activities not in conformity with established requirements or methods, and assurance of prompt and effective corrective action when nonconforming conditions are identified;
- regular evaluation of the adequacy of the CQA program by means of quality audits coupled with the effective action necessary to correct deficiencies and prevent recurrence;
- assurance that technical and CQA personnel are qualified and trained to perform the work activities to which they have been assigned; and
- assurance that subcontractors and consultants used in assisting project activities have an acceptable CQA program or are participating in accordance with the Facility CQA program guidelines.

Upon completion of construction activities, the Facility will submit certification signed by the New Mexico registered professional engineer serving as the CQA certifying engineer, which states that the unit has been constructed in accordance with the design drawings, Construction Quality AssuranceCQA Plan, and Construction Specifications and meets the requirement of 40 CFR 264.19. Documentation supporting the certification will be maintained in the operating record and will be furnished to NMED upon request. Wastes will not be accepted at the constructed portion of the landfill until NMED either approves the certification or waives the approval requirement.

2.5.3 Operation

The landfill will be operated in a safe and proper manner, in accordance with the following requirements.

2.5.3.1 Inspections and Monitoring

Permit Attachment D contains information on inspections and monitoring.

2.5.3.2 Maintenance and Repairs

The landfill structure will be maintained through a routine preventive maintenance program, which will be fully defined in the final site operations plan. ~~Preventative~~ Preventive maintenance will involve regular visual inspections of the landfill liner (where feasible) and review of leachate collection and analysis results. Equipment, such as pumps, generators, electrical lighting, and warning systems, will be subject to manufacturer recommended programs. ~~Preventative~~ Preventive maintenance information will be documented and any deviation from normal conditions will be closely tracked and corrected as necessary.

2.5.3.3 Warning Signs

Permit Attachment B contains information about warning signs.

2.5.3.4 Record Keeping

All documentation pertaining to the results of waste analyses, waste compatibility analyses, and waste handling compliance will be maintained in the Facility operating record. The Facility will be capable of determining exactly where a waste has been placed within a three-dimensional grid system. Landfill inspection records will be maintained on file for at least 3 years, in accordance with 40 CFR 264.15(d) (see Section 5.2.2 of the Part B Permit Application).

2.5.3.5 List of Hazardous Wastes to be Placed in Landfill

The wastes to be placed in the landfill are described in Permit Attachment F.

2.5.3.6 Specific Requirements for Ignitable/Reactive Wastes

Wastes that do not meet LDRs, as defined in Section 4.5 of Permit Attachment F, will not be placed in the landfill. Therefore, untreated ignitable and reactive waste (as defined in 20 NMAC 4.1) will not be placed in the landfill.

~~**Procedures That Render Wastes Nonreactive**~~

~~Reactive waste will be treated or mixed prior to placement in the landfill so that the resulting waste mixture no longer meets the definition of reactive waste.~~

~~**Procedures for Preventing Reactions**~~

~~Reactive waste will be separated from sources of reaction, including but not limited to open flames, smoking, cutting and welding, hot surfaces, frictional heat, sparks, spontaneous ignition, and radiant heat. When reactive waste is being handled, smoking and open flames will not be permitted. "No Smoking" signs written in English and Spanish will be conspicuously placed wherever there is a hazard from ignitable or reactive waste.~~

~~**Procedures that Render Wastes Nonignitable**~~

~~Ignitable waste will be treated or mixed prior to placement in the landfill so that the resulting waste mixture no longer meets the definition of ignitable waste.~~

2.5.3.7 Procedures for Protecting Wastes

Procedures for the handling of incompatible wastes, lab packs, bulk and containerized liquids, and containers that are less than full are discussed below.

Procedures for Ensuring Safe Disposal of Incompatible Wastes

Procedures for identifying incompatible wastes are discussed in Permit Attachment F. At a minimum, incompatible wastes will be spaced a sufficient distance apart in the landfill to prevent commingling. The landfill placement operation will be based on a set of grids along the north end of the landfill and along both the east and west sides of the landfill. Incompatible waste will be placed with a minimum of one grid in between the loads. Grids are normally spaced at approximately 50- to 100-foot intervals. Therefore, the minimum spacing would be 50 feet.

Procedures for Identifying Contents and Ensuring Proper Landfilling of Incoming Lab Packs

Lab packs may be placed in the landfill only if they meet the requirements in 40 CFR 264.316. Containers must be non-leaking and appropriate to the waste being contained. Appropriate non-biodegradable sorbents will be used. The Waste Analysis Plan presented in Section 4.0 will ensure that lab packs meet all of the applicable requirements prior to disposal. As with all other waste, lab packs must be properly characterized prior to acceptance at the Facility and meet the LDR treatment criteria prior to disposal. Lab packs will not be accepted if incompatible wastes are placed within the same lab pack or if reactive wastes have not been treated to render them non-reactive, prior to receipt at the Facility. Lab packs will meet all applicable LDRs (40 CFR 268)~~ requirements~~.

Special Requirements for Bulk and Containerized Liquids

Bulk and containerized wastes will not be placed in the landfill unless they meet the requirements in 40 CFR 264.314. Containers holding bulk~~free~~ liquids will not be received at the Facility or placed in the landfill~~ unless all free liquid has been eliminated by absorption, decanting, solidification, or other method~~. Very small containers, such as ampules or containers designed to hold liquids for use other than storage, may be placed in the landfill (40 CFR 264.314[d]).

Special Requirements for Containers

Containers, except those that are very small such as ampules, will be 90 percent full when placed in tact in the landfill. Containers less than 90 percent full will be crushed~~, shredded, or otherwise reduced in volume~~ to the maximum extent possible though compaction when~~prior to~~ placed~~ment~~ in the landfill.

2.5.3.8 Action Leakage Rate

The ALR proposed for the landfill is 900 gallons per acre per day (gpad). This proposed ALR was selected based on a discussion in the preamble to the January 29, 1992, final rule for Liners and Leak Detection Systems for Hazardous Waste Land Disposal Units (57 FR 3462). A discussion of the proposed ALR and supporting calculations are presented in the Action Leakage Rate and Response Action Plan in Attachment J and the E~~e~~ngineering ~~r~~Report in ~~Permit~~ Attachment L~~-~~.

The average daily flow rate in the LDRS sump will be calculated in accordance with the Action Leakage Rate and Response Action Plan, which is ~~also~~ presented in Permit Attachment J.

2.5.3.9 Response Action Plan

The elements of the response action plan for the landfill ~~and evaporation pond~~ include (1) reducing the head on the liner to the maximum extent possible to aid in the prevention of leaks, (2) determining the failure mechanism of any leaks, and establish procedures to minimize the potential for reoccurrence of this failure mechanism, and (3) responding immediately and appropriately to a leak exceeding the ALR. Each of these elements is described below. ~~The response action plan will apply to both the landfill and the evaporation pond. Activities that apply to the landfill only are specified.~~

Reducing the Head on the Landfill Liner

The head on the liner will be reduced by:

- monitoring the leachate collection system sumps weekly and after all significant precipitation events;
- removing pumpable liquids from the sumps when monitoring indicates the presence of liquid. A reasonable effort will be made to remove as much liquid as possible. As previously described, it is standard landfill design practice to locate a low point or sump box in the base of the landfill sump. The pump for the sump is located at this low point, and it is from here that pumpable liquids are removed to the maximum extent possible; ~~and~~
- waste material and soil cover will be placed in the landfill in a configuration to provide slopes that will prevent ponding and drain to the contaminated water collection basin within the Phase 1A landfill liner; and,
- if water ponds on the surface of the daily cover due to a heavy rain event, vacuum trucks will be utilized to remove as much of the standing water as possible before it can seep into the waste.

Leak Detected Below the Action Leakage Rate

Flow rates less than the ALR are expected under normal operating conditions. However, the following actions will be taken in response to a leak below the ALR:

- determine whether the leak can be attributed to some operational disturbance such as an equipment or power failure;
- verify that the sump pump is working as designed;
- increase the pump rate on the leachate collection system pumps;
- ~~for the landfill only:~~ remove all standing water, if any, from the surface of the landfill;
- assess operations to determine if waste receipt should be temporarily curtailed or waste should be removed for inspection, repair, or controls;
- determine if the flow rate varies with precipitation;
- ~~for the landfill only:~~ repair any damage to the exposed portion of the liner in a manner which conforms to original design specifications and by qualified technicians in accordance with the CQA Plan (see Permit Attachment M);
- document any damage and repairs in the Facility operating record; and
- investigate alternative sources of liquids.

Leak Detected Above Action Leakage Rate

If a leak is detected above the ALR, the following actions will be implemented in response:

- Notify NMED in writing of the exceedance within 7 days of the determination;

- Submit a preliminary written assessment to NMED within 14 days of the exceedance determination, as to the amounts of liquids, likely sources of liquids, possible location, size, and cause of any leaks, and short-term actions taken and planned;
- Determine, to the extent practicable, the location, size, and cause of any leak;
- Determine whether waste receipt should cease or be curtailed, whether any waste should be removed from the unit for inspection, repairs, or controls, and whether or not the unit should be closed;
- Determine any other short-term and long-term actions to be taken to mitigate or stop any leaks;
- Within 30 days after the notification that the action leakage rate has been exceeded, submit to NMED the results of the determinations described above, the results of the actions taken, a description of the actions planned;
- Monthly, as long as the action leakage rate continues to be exceeded, submit a report to NMED summarizing the results of any remedial actions taken and planned; and
- In making the determinations described in this section, either conduct the following investigation or document why such an investigation is not needed:
    - Assess the source and amount of liquid from each source collected in the sump.
    - Conduct a hazardous constituent analysis of the liquid collected in the sump and use the results to help identify the source(s) of the liquid and possible location of any leaks as well as the potential hazard associated with the liquid and its mobility.
    - Assess the seriousness of any leaks in terms of potential for escaping into the environment.

2.5.3.10 Closure

A description of landfill closure is provided in Permit Attachment O, Closure Plan.

~~2.6 Treatment in Evaporation Pond~~

~~Only waste that meets LDR treatment standards will be placed in the evaporation pond. Waste will be received from off site generators and from the leachate collection system associated with the landfill or other site units (i.e. waste storage areas). Evaporation will be the only treatment occurring in the evaporation pond.~~

~~2.6.1 Design of Evaporation Pond~~

~~The Facility is proposing design and operating practices for the evaporation pond in accordance with 40 CFR 264.221. The evaporation pond design is provided on Drawings 28 through 32 in Permit Attachment L1 and will have an approximate operating capacity of 5.2 million gallons over an approximate area of 78,600 square feet.~~

~~The evaporation pond has been designed as a double-lined unit with a LDRS between the primary and secondary liners. The unit is designed and will be constructed, maintained, and operated to prevent overtopping resulting from normal or abnormal operations; overfilling; wind and wave action; rainfall; run-on; malfunctions of level controllers, alarms, and other equipment; and human error.~~

~~2.6.1.1 Liner System~~

~~The liner system, shown in Drawings 29 and 32 of Permit Attachment L1, will include a primary (top) geomembrane liner above a geonet layer and a secondary (bottom) geomembrane liner, supported by 3 feet of compacted clay liner material with a hydraulic conductivity of no more than 1 x 10^{-7} cm/sec. Soil liner~~

leachate compatibility tests (two stage permeability testing using ASTM D 5084) will be conducted prior to construction. In addition, a test fill will be constructed, as per the procedures outlined in the CQA Plan contained in Permit Attachment M. Soil liner compatibility is normally not a problem unless the leachate contains high concentrations of organics (Eklund, 1985; Peterson and Gee, 1985; Mitchell and Madsen, 1987; Finno and Schubert, 1986; Lo et al., 1994; Day, 1994; Shackel ford, 1994). Permit Attachment F1, the Waste Analysis Plan, does not allow the site to accept high concentrations of organics, therefore the soil and leachate compatibility is not expected to be a problem.

The compacted clay surface will provide a stable foundation for the liner and resistance to pressure gradients above and below the liner. The evaporation pond liner system will be located on top of the excavated subgrade which will be located approximately 15 feet below the existing ground surface. At this depth the basal portions of the evaporation pond will lie in either the Quaternary sand or Upper Dockum units. Settlement evaluations presented in the engineering report (see Appendix E in Volume V of the permit application) demonstrate that either of these units will adequately serve as a foundation for the evaporation pond. Near surface evaporation pond slope areas will be located on top of Quaternary soil materials. The engineering report also presents settlement evaluations for the evaporation pond subgrade within the Quaternary soil materials and stability evaluation of any load bearing embankments.

Design and operating practices, together with the geologic setting of the Facility, will prevent the migration of any hazardous constituent to adjacent subsurface soil, surface water, or groundwater. The top liner is designed to minimize the migration of hazardous constituents through the liner system during the active life and closure period of the evaporation pond. A 60-mil HDPE geomembrane material will be used for the primary liner component. HDPE liners have been shown to be chemically resistant to landfill leachates based on operational performance and on EPA 9090 compatibility tests conducted on actual landfill leachates and synthetically generated leachates. Calculations that define the stresses on the evaporation pond liner system due to thermal expansion and contraction are also provided in the engineering report (Appendix E, Volume VI of the permit application).

Drawing 32 in Permit Attachment L1 shows that the bottom liner will be a two-component system, including a geomembrane and a compacted clay liner. The lower component, the 3 feet of compacted clay, will minimize the migration of hazardous constituents if a breach through the upper components occurs.

Material for the evaporation pond compacted clay liner will be siltstone or mudstone obtained during landfill excavation within the Upper Dockum. During landfill excavation, appropriate siltstone and mudstone materials will be stockpiled and if necessary, conditioned such that compacted soil liner specifications are met. The test results presented in Appendices D and E (Volumes V and VI of the permit application) indicate that the unprocessed material has an intact permeability close to 1×10^{-7} cm/sec. Therefore, with processing, the material can be placed and compacted to meet the permeability specification of 1×10^{-7} cm/sec or less.

Additional laboratory tests will be conducted on processed siltstone and mudstone samples during the test fill program to confirm their permeability characteristics.

The liners will be constructed of materials that will be chemically resistant to the waste managed in the evaporation pond and any liquid that has accumulated in the leak detection system. The liner system materials will have appropriate chemical properties and sufficient strength and thickness to prevent failure as a result of pressure gradients, physical contact with the waste or leaked liquid to which they are exposed, climatic conditions, the stress of installation, and the stress of daily operation.

Information pertaining to the chemical properties and physical strength of the liner system materials was supplied by the manufacturer and is included in the construction specifications presented in Volume IV of the permit application.

The geonet drainage system is capable of effectively minimizing the head developing on the secondary evaporation pond liner. Geonet clogging, which reduces the overall drainage capacity, has been incorporated into the design of the drainage system as a factor of safety. This safety factor has been applied in the ALR calculation presented in the engineering report (Permit Attachments L and J). This approach is suggested in EPA guidance for determining the ALR in the preamble to the January 29, 1992, final rule for Liners and Leak Detection System for Hazardous Waste Land Disposal Units (57 FR 3462).

Stresses on geosynthetics during installation are likely to be negligible. The evaporation pond slope lengths will be less than 40 feet, and the slope ratio is relatively shallow, causing little tensile stress to be exerted in the liner. Also, there will be no horizontal seams in the geosynthetic liner material. Traditional anchoring methods will be used. 60-mil HDPE material will be used, which, when properly installed and welded, is of sufficient tensile strength to withstand the stresses of installation.

2.6.1.2 Leak Detection and Removal System/Vadose Monitoring System

The LDRS consists of a geonet layer of cross-linked ribbed HDPE, a sump, and associated detection and liquid removal pipes. A pump located in the LDRS pipe will be used to remove leachate accumulating in the leachate collection systems. When leachate accumulates, it will be pumped to a tanker truck and either returned to the evaporation pond, stabilized in the onsite treatment unit, or stored in one of the liquid waste storage tanks.

The LDRS unit will have the following characteristics:

- be constructed with a bottom slope of 1% or more;
- be constructed of synthetic or geonet drainage materials with a minimum transmissivity of 5×10^{-3} m^2/sec;
- be constructed of materials that are chemically resistant to the waste managed in the evaporation pond and any leachate generated in the landfill;
- of sufficient strength and thickness to prevent collapse under pressure exerted by overlying wastes, and equipment used at the evaporation pond;
- designed and operated to minimize clogging during the active life and closure period of the evaporation pond; and,
- constructed with sump and liquid removal methods.

LDRS details are presented in Drawing 32 in Permit Attachment L1. The LDRS will be sloped so that any leachate below the primary liner will drain to the centrally located sump. The sump pit design is also shown in the drawing.

The collection system has been designed to be of sufficient size to collect and remove liquids from the sump and prevent liquid from backing up into the drainage layer. A sump pump and associated piping will be installed in the lower portion of the sump. The sump system will be covered with gravel to bring the area to the level of the evaporation pond floor. The gravel will serve as an expanded drainage layer providing space for the piping.

The sump system will be provided with a method for measuring and recording the volume of liquids present and the volume of liquid removed. All pumpable liquids in the sump will be removed in a timely manner to maintain the head on the bottom liner below 12 inches.

~~A pump operating level will be established to ensure that backup into the drainage layer does not occur, and the head in the sump is maintained at less than 12 inches.~~

~~Methods and equipment to be used to measure and record liquid handling volumes during evaporation pond operation will include survey monuments and elevation rods, flow meters, and fluid level transducers. Elevation rods will be placed in the evaporation pond following pond construction. The rods will be fixed to a ballasted base, which will rest on the primary geomembrane liner. The rods will have graduated markings from which pond liquid elevations and critical freeboard levels can be observed and pond volumes can be determined. Rod elevations will be checked periodically by survey. Flow meters will be used to record volumes of liquid discharged into the pond and removed from the LDRS drainage system sump. The transducers located in the LDRS sump will provide a reading for the liquid levels in the sump at any time during operation. The evaporation pond vadose monitoring sump serves as a detection system for leakage of the LDRS sump. Leakage through the secondary liner system will flow into the vadose sump. This will allow the leakage to be detected and moved. The vadose pipe and gravel arrangement is similar to the LDRS arrangement.~~

~~2.6.1.3 Separator Berm System~~

~~The evaporation pond design incorporates a separator berm between the two pond sections, Pond 1A and Pond 1B (see Drawing 28 in Permit Attachment L1). This pond design provides two independent treatment areas. Thus, in the event that a leak should occur in one section of the pond, liquids could be pumped into the other section until repairs are completed. Two feet of freeboard will be maintained in the evaporation pond at all times. The evaporation pond design and ongoing proper maintenance of the unit will ensure sufficient structural integrity to prevent massive failure. The evaporation pond will be of sufficient volume and freeboard capacity to contain the 100-year 24-hour storm event. This design capacity, coupled with the management of surface water and routine inspections, will help prevent overtopping (see Section 2.6.4.3).~~

~~2.6.1.4 Run-On/Run-Off Control~~

~~The run-on/run-off system is designed to be constructed, operated and maintained to control at least the water volume resulting from a 24-hour, 25-year storm. Run-on originating off-site will be directed around the proposed evaporation pond into the site wide surface diversion channels shown in Drawing 25 of Permit Attachment L1, using unlined ditches.~~

~~2.6.1.5 Evaporation Pond Location Description~~

~~As indicated in Drawing 4 presented in Permit Attachment L1, the evaporation pond, will be located in the northwest corner of the active portion of the Facility.~~

~~2.6.2 Construction~~

~~Construction activities will consist of site preparation; excavation, and preparation of the bottom and sides of the evaporation pond; construction of dikes; installation of the liners, LDRS and vadose system; and CQA.~~

~~2.6.2.1 Site Preparation~~

~~Existing site drainage will be modified to route any run-on away from the evaporation pond area. Access roads and a truck discharge station will be constructed. These engineered controls and components are shown on Drawings 4, 5, and 31 in Permit Attachment L1.~~

2.6.2.2 Excavation and Preparation of Evaporation Pond Bottom and Subsurface Sides

The evaporation pond will be constructed and excavated to a design depth of approximately 15 feet. The excavated material will be stockpiled for future use. The evaporation pond bottom will be constructed with a 2% (approximate) slope toward the central sump location.

2.6.2.3 Structural Fill Areas

Areas of the evaporation pond requiring structural fill will be constructed according to the specifications presented in Permit Application L2, Section 02110 Site Preparation and Earthwork.

2.6.2.4 Liner, LDRS, and Vadose System Installation

Three feet of clay will be installed directly on the excavated subgrade, forming the lower portion of the secondary liner. The clay will have a permeability of 1 x 10^{-7} cm/sec or less. A geomembrane liner will be placed over the entire clay liner, including the sump area and the separator berm. A geonet layer of cross-linked ribs, which will serve as the LDRS, will be installed next. The sump and associated piping will then be installed, and gravel will be placed in the depression to bring the surface level of the sump area to that of the evaporation pond floor. A filter geotextile will surround the gravel in the sump area to protect the geomembrane liner and to reduce the sediment clogging of the geonet.

The liners will be installed to cover all surrounding soils likely to be in contact with the waste or leachate.

The sump pump and pressure transducers (or other) liquid detection device will be installed next to the LDRS and vadose pipes during construction. These devices will be attached to a control panel. Any time liquids are detected at a specified level, the sump pump will be activated and the liquid will be removed. The pump activation level is related to the sump design and pump type selected. The wastewater will be sampled, analyzed and handled in accordance with the Facility requirements.

2.6.2.5 Construction Quality Assurance Plan

Section 2.5.2.3 contains information detailing the CQA Plan. In addition, the CQA plan is contained in Permit Attachment M.

2.6.3 Nature of Waste

Hazardous wastes which may be placed in the evaporation pond include all wastes listed in Part A of the application (Permit Attachment K), provided that LDR treatment standards are met prior to placement of the wastes. Potential contaminants in the wastewater will include those found in wastes accepted at the landfill and in other wastes as specified in Permit Attachment F1. In general, these wastes include RCRA hazardous wastes and PCB wastes (less than 50 ppm), excluding the waste types listed in Section 2.5.1.1 and the wastes covered by 20 NMAC 4.1.500 (including 40 CFR 264, Subparts BB and CC).

2.6.4 Operation of the Evaporation Pond

Operation of the evaporation pond will involve three main activities: (1) waste acceptance and receiving; (2) placement of wastewater into the evaporation pond; and (3) inspection, monitoring, and repair of the unit. Each of these activities is described below.

2.6.4.1 Waste Acceptance and Receiving

Off site generators must provide a full characterization of their waste to the Facility prior to receiving approval to ship the waste to the Facility. After approval has been received, shipment of waste to the Facility

~~will proceed as described in Section 2.1.2. Tanker trucks will then transport their waste to the tanker discharge pad at the evaporation pond.~~

~~Once the waste is received onsite, it will be sampled and fingerprint tested to verify that it is the same waste that was previously characterized. Landfill leachate waste must also be sampled and analyzed prior to being placed in the evaporation pond. Waste analysis and fingerprint testing are more fully described in Permit Attachment F1. This waste analysis and characterization data will be used to ensure that the waste acceptance criteria specified in the RCRA permit are met and to identify any safety precautions that must be taken to properly manage the waste.~~

~~Following a determination that the leachate from the landfill meets the acceptance criteria, the waste will be pumped from the leachate collection tank to a tanker truck. Approved leachate trucks and off site waste trucks will transport the waste to the tanker discharge pad at the evaporation pond.~~

~~Landfill leachate collection waste and off site waste that is determined not to meet LDR treatment standards will be treated in the stabilization unit or shipped to other appropriate treatment facilities.~~

~~2.6.4.2 Placement of Wastewater into the Evaporation Pond~~

~~Tanker trucks will be unloaded directly into the evaporation pond through a series of hoses, valves and pipes. The tanker discharge pad will be constructed of concrete and will be sloped toward the evaporation pond to drain any spills or leaks into the pond. Details of the tanker discharge pad are provided in Sheets 1 and 2 of Drawing 31 (Permit Attachment L1).~~

~~2.6.4.3 Inspections, Monitoring, and Repairs~~

~~The evaporation pond structure and dikes will be maintained through a routine inspection program. The volume of liquids in the ponds will be dependent on the waste market. Net evaporation (total evaporation minus rainfall) for the site is in the range of 80 inches per year. The freeboard level will be routinely inspected to ensure that approved or acceptable freeboard levels are maintained and that overtopping does not occur. Pond overtopping will be controlled operationally by maintaining evaporation pond fluid levels below the freeboard elevation and by ensuring that any storm water run-on from surrounding areas is diverted around the evaporation pond. Sludge will be removed by vacuum trucks and treated in the stabilization bins. Sludge will be removed on a routine basis to maintain the operational level in the pond. The vacuum trucks will park on a concrete pad during sludge removal. Sludge will be removed by means of pumps and flexible hoses. Vacuum trucks will be washed thoroughly in the truck wash unit after sludge removal and transporation to the stabilization bins. Grading of the surrounding surface area has been included as a part of the surface water management. Inspections will occur on a weekly basis and after storms to detect evidence of deterioration, malfunction, improper operation of overtopping control systems or sudden drops in the liquid level. The liner exposed above the operating pond level will be inspected to make sure that the liner is not damaged.~~

~~The engineering report includes a discussion of the evaporation pond LDRS ALR (see Section 4.0 in Permit Attachment L). LDRS drainage layer flow capacity, LDRS sump capacity, fluid head calculations, and flow rate conversions are included, as well as response actions for ALR exceedance.~~

~~The two evaporation pond sections allow for one section of the pond to be removed from service if the liquid level suddenly drops for an unknown reason. If liquid losses exceed daily evaporation losses and no other reasonable explanation is found, then that section of the evaporation pond will be shut down and authorities at the NMED will be notified immediately. If a section of the evaporation pond must be removed from service, flow of waste to that section will be stopped, leakage will be stopped by draining the pond to below the level of the leak, surface leakage will be contained, and all necessary steps will be taken to repair the~~

liner system and prevent a future failure. Responses to such situations, including NMED notification, are described in Permit Attachment E, Contingency Plan.

Additional inspection and monitoring information is provided in Permit Attachment B, Procedures to Prevent Hazards.

2.6.4.4 Specific Requirements for Ignitable, Reactive, and/or Incompatible Wastes

Wastes that are ignitable, reactive, and/or incompatible will not be placed in the evaporation pond at the same time. Waste acceptance procedures, described in Permit Attachment F1, Waste Analysis Plan, will ensure that such wastes are not inadvertently placed together in the evaporation pond.

2.6.4.5 Warning Signs

Permit Attachment B, Procedures to Prevent Hazards, contains information on warning signs.

2.6.4.6 Record Keeping

All documentation pertaining to the results of waste analyses or waste compatibility analyses will be maintained in the Facility operating record. Inspection records will be maintained in the inspection log for the evaporation pond.

2.6.4.7 Action Leakage Rate

The proposed ALR for the evaporation pond is 1,000 gpad. This ALR was selected based on a discussion in the preamble to the final rule for Liners and Leak Detection Systems for Hazardous Waste Land Disposal Units (57 FR 3462), in which the EPA indicates that an ALR below 1,000 gpad should not be required.

The average daily flow rate to the sump system will be calculated and recorded weekly during the active life and closure period of the evaporation pond to ensure that the ALR is not exceeded.

2.6.4.8 Response Action Plan

The response action plan is described in Section 2.5.3.9 and Permit Attachment J.

2.6.4.9 Closure

A description of how hazardous waste residues will be removed from the evaporation pond at closure is provided in Permit Attachment O, Closure.

2.7 Operations and Maintenance

All of tThe regulated landfill unitfacilities will be constructed in accordance with the Design Drawings, Specifications, and Construction Quality AssuranceCQA Plan presented in Permit Attachments L1, L2, and M, respectively. The operations and maintenance of the landfill units will be in accordance with the Operations and Maintenance Plan presented in Permit Attachment N. In general, all maintenance and repairs to the facilities will be completed to meet the requirements of the original Design Drawings and Specifications and will be monitored in compliance with the Construction Quality AssuranceCQA manual.Plan.

8.8.3 Liability Requirements

As stated in 40 CFR 264.147, an owner or operator of a hazardous waste treatment, storage, or disposal facility must demonstrate financial responsibility for bodily injury and property damage to third parties caused by sudden accidental occurrences which arise from the operation of the facility. This section of the regulations requires that the owner/operator of such a facility provide the administrator one of the following instruments at least 60 days prior to the initial receipt of waste:

1. Liability insurance
2. Financial test
3. Letter of credit
4. Surety bond
5. Trust fund
6. Combination of the above

GMI will submit required documentation demonstrating financial assurance to meet the liability requirements at least 60 days prior to receiving the first hazardous waste at the Facility. The financial assurance mechanism will comply with requirements in 40 CFR Part 264.147.

9. Waste Management

The purpose of this section is to describe the Facility Waste Minimization (WM)/ Pollution Prevention (P2) Program, which will be an organized, comprehensive, and continuous effort to systematically reduce waste generation during the life of the Facility. As such, the program will be ever-changing and expanding to incorporate new or more effective WM/P2 opportunities as they are developed. The level of detail in this description of the WM/P2 Program is commensurate with the level of detail currently available with respect to day-to-day operation of the Facility.

The Facility is committed to the prevention of all forms of pollution and the minimization of all wastes generated at its hazardous waste landfill. Source reduction of waste is the company's highest waste minimization priority, followed by recycling and reuse.

For an industrial facility, such as the Facility, a Waste Minimization Program is an important link to providing increased protection of public health, employee health, and the environment. As part of its WM/P2 Program, the Facility will develop a detailed WM/P2 Program Plan as soon as the intricate details of Facility operation are more clearly defined.

It is anticipated that only insignificant amounts of waste will be generated from site operations. Leachate and wastewater may be generated from the wastes placed in the landfill and from precipitation events. Other wastes that may be generated include waste oils and other maintenance wastes, office wastes, soil and debris from spills, personal protective equipment, excess chemicals, and freon. Not all of these wastes are expected to be hazardous. All site-generated waste will be stored, treated, recycled, reused, and/or disposed of in accordance with applicable regulations. Waste minimization/pollution prevention efforts will be focused on all forms of waste, not just those wastes defined as hazardous in the New Mexico Hazardous Waste Management Regulations.

Waste minimization focuses on reducing the amounts and toxicity of waste materials generated from any process or other plant activity and on reusing, recycling, or reclaiming waste materials for future use and benefit. It should be noted that the terms waste minimization and pollution prevention will be used somewhat interchangeably throughout this section. However, the terms have distinctly different meanings, as defined below:

Waste Minimization

Waste minimization is the reduction, to the extent feasible, of the amounts and toxicity of waste materials after they are generated from any process or other activity. Primary waste minimization techniques include reuse, recycling, or reclamation of waste materials for future use and benefit.

Pollution Prevention

Pollution prevention is the use of any process, practice, or procedure to prevent the generation of waste. Examples of primary pollution prevention techniques include material substitutions (e.g., nonhazardous materials used in place of hazardous materials), process changes, and procedural improvements.

9.1 Brief History of WM/P2 in the United States

Current trends in environmental policy and regulation indicate a move from pollution control to pollution prevention and waste minimization in the private sector. Throughout the 1980s, the United States became increasingly aware of the environmental damage and restoration costs associated with past improper disposal of hazardous wastes. In the 1984 HSWA to RCRA, Congress declared that it is:

> . . . the national policy of the United States that, wherever feasible, the generation of hazardous waste is to be reduced or eliminated as expeditiously as possible. Waste that is nevertheless generated, should be treated, stored, or disposed of so as to minimize present and future threat to human health and the environment. From HSWA, Congress clearly intended a hierarchy of actions for managing the nation's waste problems, with priority given to reduction or elimination of waste over treatment, storage, and disposal of waste after it has been generated.

The Pollution Prevention Act of 1990 expanded this concept to include all forms of environmental pollution. This statute calls pollution prevention a "National Objective" and establishes a hierarchy of environmental protection priorities as national policy. The order of priority is summarized as follows:

1. Reduction or elimination of waste prior to generation (source reduction) is the best option.
2. Recycling and reuse of waste that is generated is the second best option in cases when pollution cannot be prevented.
3. Treatment (reclamation or toxicity reduction) of waste that is generated is the next best option in cases where feasible prevention and recycling opportunities are not available or possible.
4. Disposal of generated waste is the least desirable option.

9.2 Purpose and Objectives of the Facility Waste Minimization/ Pollution Prevention Program

The purpose of this section is to describe the Facility WM/P2 Program. This Program will establish the strategic framework for integrating waste minimization and pollution prevention into all Facility activities. The objectives of the Program are the following:

- raising employee awareness about the reasons for and benefits of a WM/P2 Program and instilling a desire to minimize waste at the lowest organizational levels possible;
- describing planned initiatives that support and promote WM/P2 through various training opportunities, including recycling, reuse, and recovery programs, and good housekeeping practices;
- adapting and implementing existing technologies as rapidly as possible to reduce waste generation at the source and to recycle waste products; and
- reducing all forms and categories of waste to the lowest extent practical.

9.3 Benefits of the Facility Waste Minimization/Pollution

The Facility WM/P2 Program, like all effective waste minimization programs, will yield numerous benefits and advantages, which are either tangible or intangible. Some of these benefits are listed below:

- reduced waste management costs, including labor and disposal costs;
- reduced regulatory compliance costs, including inspection costs and possible fines;
- reduced raw material costs;
- reduced potential for releases of hazardous chemicals and wastes;
- increased worker safety; and
- reduced civil and criminal liabilities under environmental laws.

9.4 Elements and Goals of the Facility WM/P2 Program

As previously mentioned, the Facility will continue to expand and refine its WM/P2 Program during the life of the Facility. The elements of the Program include those methods commonly used to form the baseline, or starting point, for effective WM/P2 Programs. The elements and goals of the Program are listed below as action-items to be completed during the initial phases of Facility operations. Such listings are standard practice in the industry since many of the elements, waste generation levels for example, cannot be determined until after the Facility begins operation. The personnel tasked with oversight of this program will also oversee the planning, development, and implementation of the WM/P2 reduction methods and activities outlined below.

- develop and establish a written policy statement that describes why the WM/P2 Program is being implemented, how it will be implemented, and who will implement it. The policy statement will be issued from the highest level of management. The policy will be provided to each employee at the start of employment and will be reviewed during RCRA training and annual refresher training;
- assign Facility personnel to oversee, plan, develop, and implement the elements of the WM/P2 Program;
- establish support for the program at all levels in the company;
- determine a waste generation baseline at the site and establish a tracking method and waste minimization goals;
- establish a procurement control program to ensure the purchase of environmentally friendly materials and products while preventing the procurement of prohibited items from the site; the Facility will endeavor to reduce or eliminate the use of hazardous materials from its operations;
- ~~minimize the quantities of virgin products and raw materials allowed such as sorbents and other materials used in the stabilization process into the landfill. The Facility will endeavor to utilize other wastes (e.g., fly ash) in the stabilization process rather than virgin materials;~~
- establish reuse, recycling, recovery, and conservation programs to minimize the volume of generated waste requiring disposal or treatment; examples of such programs include paper, aluminum cans, cardboard, scrap metals, oil, batteries, and surplus materials and chemicals;
- establish good-housekeeping practices that promote WM/P2; an example of this type of practice is the requirement to remove packaging materials from chemicals, products, and equipment before they are introduced into the disposal area or contamination-control areas to avoid cross contamination;
- establish a WM/P2 awareness program and train employees, as appropriate;
- prepare a WM/P2 plan and update it annually or as appropriate;
- perform an assessment of waste minimization/pollution prevention opportunities; an example of this type of opportunity is: installation of air conditioning refrigerant reclamation systems; and
- determine the feasibility of implementing the WM/P2 projects and proceed as appropriate with project implementation.

9.5 Proposed Elements of the Facility WM/P2 Program Plan

The Facility will establish a WM/P2 Program Plan when operational details of the Facility, such as the chemical and equipment procurement processes and the actual level of waste generation, are determined. The WM/P2 plan will include the following elements, as appropriate:

- the written policy statement for WM/P2;
- a description of the roles and responsibilities of Facility personnel with respect to WM/P2 and a brief description of how Facility groups will work together to reduce waste generation and energy consumption;
- a plan or method for publicizing and gaining support for the program and communicating the successes and failures of waste minimization efforts (i.e., employee awareness program);
- a description of how employees will be informed about WM/P2 requirements and expectations (possibly within the context of other Facility training courses);
- a description of waste-generating processes, including a clear definition of the types and quantities of materials generated from each process;
- a description of recycling, reclamation, treatment, and disposal programs used by the Facility and the types of wastes and materials that are included in these programs;
- descriptions of other WM/P2 programs and initiatives;
- reporting requirements;
- a description of WM/P2 goals for the Facility;
- a description of the Facility's chemical and material procurement process;
- a review of the costs of waste management and disposal, both onsite and at other facilities;
- criteria for prioritizing candidate WM/P2 processes, activities, and waste streams for future implementation; and
- an evaluation of the effectiveness of the WM/P2 Program and activities.

Permit Renewal Application
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Attachment B

Procedures to Prevent Hazards

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March 2002

~~Permit~~ Attachment B. Procedures to Prevent Hazards

~~Modified from the Permit Application, Volume I, Sections 5.0 through 5.1.2 and 5.3 through 5.5.3~~

5. Procedures to Prevent Hazards

This section provides information on the prevention of hazards to both the public and the environment. Specific procedures for implementing those safeguards will be developed during the construction phase of the project and prior to Facility operations.

The engineered barriers for the mitigation of hazards discussed in this section are shown in design drawings contained in Permit Attachment L1~~Volume III~~.

5.1 Security Procedures to Prevent Hazards

Security at the Facility will be provided by security guards, fences surrounding the Facility and warning signs. Each of these is described in the following sections.

5.1.1 Barrier and Means to Control Entrance

The Facility will be bounded by a barbed-wire fence. The active portion of the Facility (i.e., the processing area) will be bounded by an additional fence with two access gates located in the northern portion of the Facility. The northwest gate will remain locked at all times and will serve as a secondary or emergency entrance/exit. Access into the Facility will be controlled by means of the primary gate, located in the northeast corner of the Facility. The gate will be fitted with a cattle guard to prevent livestock from entering the Facility. A security guard post will be located at this entrance gate and will be attended 24 hours a day. The fence, gates, and guard will provide adequate access control and will prevent unwitting entry of persons or livestock to the active portion of the Facility.

Visitors will be required to sign a visitors log prior to movement in or around the Facility. Each visitor will be issued a security badge, which will be worn while the visitor is onsite. The badge will be worn on the visitor's outermost garment in a clearly visible location above the waist. The security guard will be responsible for ensuring that all visitors comply with these requirements. Visitors will be escorted unless other arrangements are made with Facility personnel.

5.1.2 Warning Signs

Warning signs stating "Danger - Unauthorized Personnel Keep Out" will be posted at the site entrance and every 50 feet along the perimeter fence. The signs will be posted in English and Spanish and will be legible from a distance of at least 25 feet. If ignitable wastes are stored or treated in the area, a "No Smoking" sign will also be posted.

5.2 Inspection Procedures

This section of the permit application provides written inspection guidelines and an inspection schedule for the Facility in accordance with ~~20~~ NMAC 20.4.1.

5.2.1 General Inspection Procedures

Facility personnel will conduct inspections of all equipment and structures as frequently as necessary to prevent, detect, or respond to environmental or human health hazards. Inspection records describing malfunctions, deteriorations, operator errors, and discharges that may cause or contribute to a release of hazardous waste constituents to the environment or that may be a threat to human health will be kept at the Facility administration building for three years from the date of the inspection. Specific inspection procedures are outlined in Sections 5.2.2 through 5.2.10.

Personnel will receive general training about hazardous waste inspections as part of the Facility hazardous waste training program. Personnel responsible for inspecting particular equipment or areas of the Facility will receive classroom and/or on-the-job training in inspection procedures. Inspection procedures will be described in the operating manual, which will be located in the Emergency Coordinator's (EC's) office.

Facility guards will make rounds of the Facility at least once daily to detect any unauthorized entry to the Facility or any other abnormalities. The guards will not use inspection checklists, but they will notify the ~~Emergency Coordinator (~~EC~~)~~ and/or emergency response personnel of any spills or other emergencies. Requirements for the EC and/or emergency response personnel, subsequent to an inspection notification, are outlined in the Contingency Plan in Section 6.0.

5.2.1.1 Inspection Checklist

Inspection checklists and an inspection schedule have been developed to ensure that inspections occur at appropriate frequencies. An inspection schedule matrix is provided in Table ~~5~~B-1. This matrix will be expanded, as necessary, to reflect new equipment or changes to existing equipment inspection frequencies.

Inspection frequencies will vary according to the type and age of the equipment, the frequency of its use, and its importance in preventing environmental incidents. The inspection frequencies provided in Table ~~5~~B-1 show that inspections will occur frequently so that problems can be identified in time to correct them before harm is done to human health or the environment.

Table B-1. Triassic Park Waste Disposal Facility Inspection Schedule

Inspection Item - Problem or Problem Area	Inspection Time
General Facility	
Security equipment – signs, perimeter fences, lights	Daily
Stormwater detention basin – liner	Weekly and after storms
Surface water diversion ditches to stormwater detention basin	Weekly and after storms
Landfill	
Liner and cover systems - uniformity, damage and imperfections	During construction and installation
Liners and cover deterioration and malfunction	During and immediately after construction
Spills, leaks, odors, windblown particulate	Weekly and after storms
Run-on/~~run-off~~runoff control system - uniformity, damage and imperfections	Weekly and after storms
LCRS/LDRS presence of liquid and volume of liquid pumped	Daily and after storms
Leachate collection tank (while holding waste) for condition and proper function	Daily
Hazardous and organic gases	Quarterly
Ancillary equipment	Manufacturer recommended
Sump pumping and instrumentation	Annually

Table B-1. Triassic Park Waste Disposal Facility Inspection Schedule

Inspection Item - Problem or Problem Area	Inspection Time
~~***Evaporation Pond***~~	
~~Liners and cover systems for uniformity, damage, and imperfections~~	~~During construction and installation~~
~~Pond freeboard for level for changes~~	~~Daily and after storms~~
~~Area surrounding pond~~	~~Weekly~~
~~Run-on/run-off control system - uniformity, damage and imperfections~~	~~Weekly and after storms~~
~~LCRS/LDRS for presence of liquid and volume of liquid pumped~~	~~Daily and after storms~~
~~Berms~~	~~Weekly~~
~~Integrity of liners and associated system~~	~~Weekly~~
~~Concrete pad for tanker discharge~~	~~Weekly~~
~~***Container Storage Areas - Drum Handling Unit and Roll-off Unit***~~	
~~Condition of containers, signs, other safety equipment, aisle space~~	~~Weekly~~
~~Secondary containment condition, presence of liquid, and volume of liquid pumped~~	~~Weekly~~
~~Run-off/run-on ditches – uniformity, damage and imperfections~~	~~Weekly and after storms~~
~~Containers with >500ppmw volatile organic compounds~~	~~Monthly~~
~~Ancillary equipment~~	~~Manufacturer recommended~~
~~***Tanks***~~	
~~Condition of tanks, signs, other safety equipment, access routes, overfill control~~	~~Daily (when storing)~~
~~Secondary containment condition~~	~~Daily~~
~~Run-off/run-on ditches – uniformity, damage and imperfections~~	~~Weekly and after storms~~
~~Leak test on ancillary equipment~~	~~Annually~~
~~***Stabilization Unit***~~	
~~Condition of unit when in operation – bins, ancillary equipment, monitoring systems~~	~~Daily~~
~~Condition of unit when empty~~	~~Monthly~~
~~Secondary containment condition, presence of liquid, and volume of liquid removed~~	~~Daily~~
~~Concrete vault area – remove liquids if present~~	~~Monthly~~
~~Run-off/run-on ditches – uniformity, damage and imperfections~~	~~Weekly and after storms~~
~~Sonic test to ensure thickness of tanks~~	~~Annually~~

The inspection checklists will identify the name of the inspector, date and time of the inspection, frequency of inspection, specific items to be checked, any notations or observations of abnormalities, and the nature and date of any corrective actions taken. Checklists are provided in Attachment D1~~Appendix I, Volume II~~. The inspection schedules will be kept in the EC's office.

When new or modified equipment is installed or used at the Facility, the inspection procedures, forms, and schedule will be revised to reflect these changes and submitted to NMED.

5.2.1.2 Remedial Action

Facility personnel or contract personnel will remedy any deterioration or malfunction of equipment or structures encountered during inspections. The remedy will be completed in sufficient time to ensure that the problem does not result in an environmental or human health hazard.

All repairs to permitted portions of the Facility will be made in accordance with the original construction specifications and Construction Quality Assurance (CQA) plan.

If a hazardous or potentially hazardous condition is identified, the EC, as specified in the Contingency Plan (Section 6.0), will be notified immediately to assess the situation and determine how to correct the situation and whether the Contingency Plan should be implemented.

5.2.2 Landfill Inspection Procedures

Landfill liners and the cover will be inspected during and immediately after installation in accordance with the CQA Plan, which is discussed in Section 2.5.2.3.

The landfill and associated equipment will be inspected weekly and after storms unless otherwise specified. Records of the inspections will be maintained in the operating record, which will be kept in the administration building.

If deterioration or any other abnormalities are noted during inspection of the landfill or associated components, the inspector's supervisor will be notified and will determine the appropriate course of action for correction. If the supervisor is not available, the EC will be summoned to make the determination.

The landfill will be inspected by properly-trained personnel weekly and after storms for such items as spills, leaks, odors, wind-blown particulate matter, any evidence of deterioration of the landfill itself, and any malfunction or improper operation of the run-on/~~run-off~~runoff control systems. All inspections will be documented on the landfill inspection checklist, described in Section 5.2.1.1 and found in Attachment D1~~Appendix I (Volume II) of the pplication~~. Inspection checklists will be kept for at least 3 years, in accordance with 40 CFR 264.15(d).

During the active life and during closure of the landfill, the leachate collection and removal system (LCRS) and leak detection and removal system (LDRS) will be checked daily for the presence of liquid. The amount of water in the system can be used to determine if the system is functioning properly. The system will either be inspected through the cleanout pipe, which is connected to the primary collection pipe and the sump riser pipe, or with magnehelic gages or other liquid detection devices, if they are installed. The leachate collection tank will be inspected in accordance with the procedures outlined in Section 5.2.5.

During the operational phase of the landfill, periodic checks will be made within the landfill to detect the presence of hazardous gases and volatile organics. Surveys of the active landfill surface area and the riser pipes with an organic vapor meter (OVM) or comparable device will be performed quarterly to detect the presence of organic compounds.

If it is evident that particulate matter from the landfill is subject to dispersal by the wind, the active portion of the landfill will either be covered or managed to control the dispersal (see Section 2.5.1.7). Adding water to prevent wind erosion will be limited so that ponding in the landfill does not occur. If the dispersion is noted during an inspection, the landfill supervisor will notify the sprayer truck operator to rectify the situation.

The stormwater collection basin within the Phase 1A landfill and ~~holding unit~~ associated with the runoff/run-on control systems will be inspected to following storm event to check whether water~~ensure that liquid~~ has ~~not accidentally~~ accumulated. The collection basin~~system~~ will be emptied as quickly as possible to ensure that the design capacity of the system is not exceeded. Details of the landfill stormwater control system are included in the Engineering Report (Permit Attachment L).

~~5.2.3 Evaporation Pond Inspection Procedures~~

~~Evaporation pond liners will be inspected during and immediately after construction and installation in accordance with the CQA Plan, which is discussed in Section 2.5.2.3.~~

~~While the evaporation pond is in operation, it will be inspected daily to detect any sudden drops in the level of the pond's contents and to measure the volume of and remove any liquid that has accumulated in the leachate collection and leak detection sumps. The daily inspections will also serve to ensure that there is no potential for overtopping by wind or wave action. Since all discharges into the pond will be monitored, visual inspections will be adequate.~~

~~Other inspection items, such as condition of berms, warning signs, and surrounding area, will be checked weekly and after storms. Weekly visual inspections will also be conducted to verify the integrity of the liners and associated systems. Visible portions of the leachate collection pipes and pump will be visually inspected weekly for deterioration. The concrete pad for tanker discharge will be visually inspected weekly for accumulation of liquids. The area around the pond will be inspected weekly for any signs of deterioration, leaks, erosion, etc. The evaporation pond berms will be inspected for any sign of abnormal deterioration, which may include excessive sloughing or the development of significant cracks. All of the above inspections will be used to assess the integrity of the surface impoundments.~~

~~An inspection checklist for the evaporation pond is provided in Appendix I, Volume II.~~

~~5.2.4 Container Storage Area Inspection Procedures~~

~~Weekly visual inspections of container storage areas (drum storage area and roll off storage area) will be performed to identify the status of warning signs, condition of containers and labels, availability and accessibility of spill control and PPE, and the adequacy of aisle space and access/egress routes. Containers will be inspected for any signs of excessive corrosion, buckles, dents, holes, other structural defects or deterioration, and over-pressurization. An inspection checklist for container areas is provided in Appendix I in Volume II.~~

~~If a container is found to be in poor condition, the inspector's supervisor will be notified, who will either arrange to transfer the hazardous waste to a new container, repair the existing container as specified by the manufacturer, or place the container in an overpack drum.~~

~~Containers used for storing liquids will be stored in a secondary containment area described in Section 2.2. These areas will be inspected weekly during the container storage area inspections. The inspections will focus on (1) the condition of sump pits and trenches to ensure that they are free of cracks or gaps and are sufficiently impervious to contain leaks, spills, and accumulated liquids until the collected material is detected and removed; (2) pump operation; and, (3) placement of containers to ensure that designed liquid flow paths are not obstructed. A record of the inspection will be maintained in the operating record, which will be kept in the administration building.~~

~~Spilled or leaked waste or accumulated precipitation that requires removal to prevent overflow of collection systems that is identified during inspection will be removed in a timely manner.~~

~~5.2.5 Tank Inspection Procedures~~

~~Tanks containing or treating waste will be inspected daily. Tanks containing waste include the liquid waste storage tanks and the leachate storage tanks for the landfill. These inspections will focus on~~

~~the status of warning signs, the adequacy and availability of spill control and PPE, the adequacy of access routes, and the condition of the tanks, ancillary equipment, and monitoring and leak detection systems. The inspection will focus on (1) overfill control; (2) equipment condition to detect any signs of corrosion or releases of waste from the tanks or ancillary equipment; (3) data gathered from monitoring and leak detection equipment to ensure that the tank system is being operated in accordance with design specifications; and, (4) the Cathodic Protection Systems, as installed.~~

~~Secondary containment areas in which tanks are located will be inspected daily during the tank inspections. These inspections will focus on the condition of the containment surface to ensure that it is free of cracks or gaps and is sufficiently impervious to contain leaks, spills, or accumulated liquids until the collected material is detected and removed. Inspection records will be maintained in the Facility operating record, which will be kept in the administration building. An inspection checklist for tanks is provided in Appendix I in Volume II.~~

~~5.2.6 Stabilization Unit Inspection Procedures~~

~~Inspection of the stabilization unit will be conducted according to the procedures specified in Section 5.2.5. The inspections will be conducted on days when the unit is operating and daily when waste is in storage. Additional inspection requirements are described in Section 2.4.6. Inspection records will be maintained in the administration building. The concrete vault area will be inspected monthly. If liquids are found they will be removed with a portable pump and transported to the liquid waste unit.~~

5.2.7 Security Equipment Inspection Procedures

Security inspections will be conducted daily and will include the following elements:

- visual inspection of the warning signs at all approaches to the Facility to ensure that the signs are present, legible, and securely attached to the fence;
- inspection of the Facility perimeter to ensure the integrity of the fence and gate by looking for signs of erosion of soil at the fence posts and corrosion or vandalism to the fence, fence posts, or locks;
- inspection and replacement, as necessary, of lights for the purpose of illuminating the Facility at night;
- inspection of structures for signs of erosion, tampering, or vandalism; and
- records of inspections will be maintained in the administration building.

5.2.8 Safety and Emergency Response Equipment Inspection Procedures

Safety and emergency response equipment inspections will occur monthly. This category of equipment includes first aid supplies; respiratory protection equipment (other than personally issued respirators, which will be each employee's responsibility); protective clothing, including hard hats, gloves, and suits; fire extinguishers; eye wash stations; safety showers; empty 55-gallon drums; shovels; and spill cleanup and decontamination kits.

A monthly inventory of safety-related supplies and equipment will be performed to ensure that the items are available, in good condition, and at designated locations. Inadequate or missing items will be replaced or repaired.

Fire protection equipment, including fire extinguishers and fire hoses, will be inspected monthly and after each use to ensure that the equipment is capable of functioning properly and that access to the equipment is not blocked. Each fire extinguisher will be inspected to ensure that the seal around the handle is intact, that the pressure gauge indicates that the unit is adequately charged, and that an Underwriter's Laboratory listing label is attached to each unit. Building sprinkler systems will be inspected according to manufacturer specifications. Chemical fire-suppression systems will be checked to ensure that adequate quantities of the chemical and water exist. The fire-suppression vehicles will also be tuned up at least annually and inspected monthly. Records of inspections will be maintained in the administration building for each unit.

The public address (PA) system will be tested daily to ensure proper operation. In lieu of daily testing, the Facility may opt to broadcast music 24 hours a day, which ensures proper operation of the unit at all times.

Hand-held radios will be tested prior to use each day and periodically throughout the day. The units will be recharged after each shift to ensure that they are operating properly.

5.2.9 Loading and Unloading Area Inspection Procedures

Waste loading and unloading areas will be inspected daily when in use. The inspections will focus on ~~integrity of the containment structure and~~ safety-related issues that could lead to hazards or waste spills. Signs will be located at each loading and unloading area indicating that equipment or materials should not be left unattended as they could be obstructions for the loading and unloading operation.

Onsite roadways and vehicle traffic areas will be inspected on a preventive maintenance order (PMO) schedule to ensure that potential safety hazards, such as road surface deterioration, are minimized or avoided. Records of inspections will be maintained in the administration building for each unit.

~~5.2.10 Truck Wash Area Inspection Procedures~~

~~The sump and sediment bins will be inspected weekly for the accumulation of sediment and liquids in the sump and will be removed to the wash water storage tank. The wash water collected at the truck wash area will be sampled according to the Waste Analysis Plan, Section 4.6 and analyzed according to the Waste Analysis Plan, Section 4.5.6.~~

5.3 Preparedness and Prevention Procedures

Preparedness and prevention encompass a wide range of procedures, from communication to equipment to arrangements with local authorities. These procedures are discussed in the following sections.

5.3.1 Internal Communications

Internal communication will be established to meet the needs for each building and area at the Facility. Three forms of internal communication systems will be implemented; (1) a PA system will be used in the main buildings to alert employees of potential or actual emergencies; (2) in noisy, temporary buildings or remote areas of the Facility, hand-held two-way radios will be used to communicate emergencies; (3) an audible fire alarm will be located in the permanent buildings. The alarm will be used to alert employees of fires but may also be used for alerting them to other emergencies in the event that the two other systems described above are malfunctioning.

Equipment tests will be conducted to assure that internal communication systems are functioning properly according to manufacturer's specifications.

5.3.2 External Communications

A telephone will be available for operations that occur inside the main buildings. For outdoor processing areas without a telephone nearby, hand-held two-way radios capable of summoning emergency assistance from local police departments, fire departments, and state or local emergency response teams will be available.

A map identifying the location of telephones at the Facility will be provided to the NMED prior to acceptance of waste at the Facility.

5.3.3 Emergency Equipment

Emergency response equipment at the Facility includes fire extinguishers and other fire control equipment, spill cleanup kits, and decontamination kits. Each processing area regulated storage unit will be equipped with fire control and spill response equipment. Equipment in the stabilization unit will be used for the tank storage area and roll-off storage area because of their close proximity. A detailed description of this equipment, including the content and type, is included in Attachment C1~~Appendix M in Volume II~~ and is discussed in the Contingency Plan contained in Section 6.0.

A complete list of the contents and location of the various types of kits will be maintained in the EC's office at the Facility.

5.3.4 Water for Fire Control

Permanent buildings at the Facility will be equipped with automatic sprinkler systems and fire extinguishers, as required by the National Fire Protection Association (NFPA) code. The sprinkler systems will be designed according to NFPA guidelines. Water storage to fight fires outside of buildings and the landfill will meet minimum requirements of the New Mexico State Fire Marshal's Office and be transported by water truck(s). It is expected that landfill fires, in the unlikely event that they occur, will be extinguished with a dirt cover. A ready supply of dirt will be available at the excavation stockpile and landfill and general facility equipment (dozers, loaders and scrapers) will be available to load, haul and place dirt.

~~5.3.5 Required Aisle Space~~

~~The aisle between double rows of containers in the drum handling unit will be 30 inches wide, and roll-off containers will be placed 4 feet apart and 4 feet from the edge of the berm. Such spacing will allow for the unobstructed movement of personnel, fire protection equipment, spill control equipment, and decontamination equipment in the event of an emergency. Drums will only be stacked one high.~~

5.3.6 Arrangements with Local Authorities

The Facility will make arrangements with local authorities as described in the Contingency Plan (see Section 6.0).

5.4 Preventive Procedures, Structures, and Equipment

To prevent accidents at the Facility, all individuals responsible for material and waste handling will receive classroom and on-the-job instruction in safety awareness, recognition of potential hazards in the work place, environmental procedures and policies, and fire prevention and control procedures. Individuals who may come in contact with hazardous waste will receive Occupational Safety and Health Administration (OSHA) 40-hour training and annual 8-hour refresher courses. These individuals also will be trained in the operation of the equipment and vehicles they will be using to perform their duties.

Safety meetings will be conducted as necessary to discuss safety issues, fire prevention and control, good housekeeping and any problems relating to specific areas of the site.

5.4.1 Loading, Unloading, and Waste Transfer Operations

To prevent accidents during loading, unloading, and waste transfer, hazardous waste will be handled only by those individuals who have been properly trained in correct handling procedures and proper spill response procedures. The emergency brakes of transport vehicles will be engaged and the wheels chocked during all loading and unloading operations. Inspection of loading and unloading areas is discussed in Section 5.2.9.

Wastes will be transferred in approved vehicles over approved routes and the maximum capacity of the truck will not be exceeded. Waste containers will always remain closed ~~during storage~~, except when it is necessary to add or remove waste (e.g., for sampling). This practice will minimize the potential for accidental releases of waste. ~~Waste containers will only be stacked one high, which will facilitate inspection, handling and storage.~~

~~Wastes will be transferred in approved vehicles over approved routes and the maximum capacity of the truck will not be exceeded. Ramps will be installed where necessary to enable fork lifts, dollies, or hand trucks to move into or out of secondary containment areas surrounded by berms or curbing.~~

~~Transferring waste from drums to tanks will be accomplished as expeditiously as possible to avoid having containers remain open for extended periods of time.~~

If ignitable wastes are handled, special precautions will be instituted, including the use of special non-sparking bung wrenches or other tools for opening drums or otherwise handling the waste containers, grounding waste containers during waste transfer, and other special handling requirements. These precautions, coupled with the procedures for management of ignitable waste contained in Section 2.0, will minimize the hazards associated with ignitable wastes.

5.4.2 Runoff and Run-On

~~Run-off and run-on for the major units are described in the following sections.~~

~~5.4.2.1 Tank Storage, Container Storage, and Treatment Areas~~

~~Run-off and run-on will be prevented in container and tank storage areas and the stabilization unit through exterior drainage systems located at the perimeters of these areas, outside of the containment systems. The layout of the perimeter drainage ditches is shown on Drawing 25.~~

~~All containment areas associated with tanks or containers will be sloped to remove accumulated liquids caused by spills, leaks, or precipitation (for outdoor units). Liquids that accumulate in any secondary containment area will be sampled to determine if the liquid is hazardous waste. If the liquid is hazardous, the waste will be pumped to a drum or tank and handled accordingly. If the liquid is not contaminated, it will be discharged to the storm drainage system.~~

~~Inspection of the run-off and run-on ditches for the above facilities will be made during weekly site inspections and after storms.~~

~~5.4.2.2 The Landfill and Evaporation Pond~~

The landfill run-on control system will be capable of preventing flow onto the active portion of the landfill during peak discharge from at least a 24-hour, 25-year storm. The run-on control system will consist of unlined ditches for diverting run-on from off site around the landfill. Water from outside the landfill will be prevented from entering the active portion of the landfill by the waste processing corridor drainage ditch.

The runoff management system will be capable of collecting the water volume resulting from at least a 24-hour, 25-year storm. Runoff in the active portion of the landfill will be collected in the lined stormwater collection basin within the landfill and the LCRS. The run-on and runoff control system for the landfill is described in greater detail in Section 2.5.1.6.

~~The area surrounding the evaporation pond will be graded to carry stormwater run-off towards the drainage ditch to the south of the evaporation pond area. This ditch will ultimately empty into the site stormwater detention pond. The perimeter of the evaporation pond is elevated to prevent stormwater run-on into the pond from surrounding areas.~~

Inspection of the runoff and run-on ditches ~~for the landfill and evaporation pond~~ will be made during weekly site inspections and after storms. Maintenance and repair of the ditches will be performed as necessary and in accordance with the Operations and Maintenance Manual (~~Volume II, Appendix O~~Permit Attachment N) and the Design Drawings (~~Volume III~~Permit Attachment L1).

5.4.3 Wind Dispersal Control System

The active portion of the landfill will either be covered or managed to control the wind dispersal. In general, dust control will be accomplished by spraying water on the active portion of the landfill and any road or area subject to wind dispersal. Adding water to prevent wind erosion will be limited so that ponding in the landfill does not occur. Additional detail about wind dispersal procedures can be found in Section 2.5.1.7.

5.4.4 Water Protection

There is an existing underground water line from a spring located approximately one mile east of the Facility in the Ogallala formation, which is used for domestic water supply. This water source, and any others in the Caprock area, will not be used for facility operations and will be protected through the following measures: (1) natural means because of its location; (2) the design of the landfill; (3) the type of waste that will be accepted at the Facility; and (4) the method of response to releases to soil. Each is discussed in more detail below.

Natural geologic and hydrologic conditions in the area include the following characteristics:

- the Upper Dockum unit is unsaturated beneath the selected site;

- the Lower Dockum consists of a 600-foot thickness of homogeneous, lacustrine mudstone. This sequence of unsaturated, low permeability mudstones represents a geologic barrier to potential downward migration of contaminants from the landfill (see Section 3.0); and
- the nearest surface water is the Pecos River, approximately 30 miles to the west of the Facility.

The landfill design includes removal of the 10-feet deep layer of alluvial material on the surface of the disposal site prior to construction of the cells, thus eliminating the possibility of hazardous constituents entering the alluvium and migrating away from the Facility.

Free liquid hazardous waste will be placed in the landfill only in accordance with 40 CFR 264.314(d). In addition, no non-hazardous liquid waste will be placed in the landfill. These limitations on the introduction of liquids into the landfill will minimize the generation of leachates and the potential for the migration of any hazardous constituents from the Facility.

Finally, any releases to the soil will be immediately cleaned up to prevent the spread of contamination. The Contingency Plan in Section 6.0 describes the equipment and personnel available to ensure prompt clean up of any spill.

5.4.5 Mitigation of Effects of Equipment Failure and Power Outages

The Facility will use a Preventive Maintenance Order (PMO) schedule, based on manufacturer's recommendations for various pieces of equipment, to ensure proper operation of the equipment. In addition to the items replaced or changed as part of the PMO schedule, any item(s) found to be deficient during the PMO inspection will be replaced or repaired as soon as possible.

Spare parts critical to ensuring continuation of equipment and safety systems may be stored onsite to facilitate immediate repairs. Other items that require long ordering periods also may be stored onsite.

In the event of a power failure, at least one backup generator will be used for emergency backup power. The generator will be started within 30 minutes of a power failure.

On-the-job training will provide personnel with appropriate instruction in emergency response procedures so that proper actions will be taken in the event of equipment or power failure.

The emergency power system is described in Section 6.3.5.4 of the Contingency Plan.

5.4.6 Prevention of Undue Exposure of Personnel to Hazardous Waste

All employees will be trained in the safe operating practices to be used in handling hazardous wastes. All employees will wear steel-toed shoes and safety glasses while in processing or active areas of the landfill. In some cases, additional personal protective equipment (PPE) will be required, such as hearing protection, respiratory protection, and protective clothing. Employees will be trained in, and responsible for, proper inspection and use of their respirator and proper use and care of PPE. If a defect is noted in any of the equipment, the employee will be responsible for replacing or repairing it prior to use, in accordance with the applicable training. As previously stated, PPE, other than respiratory protection, will be located at or near each permitted unit, along with spill response equipment.

Routine tasks will require some PPE, as outlined in the site Health and Safety (HAS) Plan. In many cases, these requirements will include safety glasses, steel-toed shoes, and hard hats. The site HAS plan will be prepared prior to commencement of hazardous waste operations. This plan will be kept at the Facility, but is not considered part of this permit application.

Out-of-the-ordinary hazardous waste activities will be evaluated by the site HAS officer or a member of an emergency response team prior to responding to the incident. After the type of contaminants present has been determined, the HAS officer or the EC will specify the respiratory protection and/or PPE requirements necessary to safely handle the incident. All respiratory protection devices will be maintained in compliance with OSHA requirements and will be issued only to qualified personnel who have received medical approval and training for the proper use of respiratory protection devices.

For emergencies that are beyond the scope of the Facility personnel training program, areas of the Facility or the entire Facility may be evacuated, at the direction of the EC. In such cases, professional emergency response personnel will be notified to respond to the emergency (see Section 6.0).

5.4.7 Special Requirements for Bulk and Containerized Liquids Disposed of in Landfills

As previously stated, bulk or non-containerized liquids will not be disposed of in the landfill. Containers holding free liquids will be placed in the landfill only if (1) all free-standing liquid has been removed by decanting or other methods, mixed with non-biodegradable sorbent, solidified so that free-standing liquid is no longer observed, or otherwise eliminated; (2) the container is very small; (3) the container is designed to hold free liquids for use other than storage (e.g., a battery); or (4) the container is a lab pack disposed in accordance with 40 CFR 264.316.

In the case of number (1) above, prior to placement in the landfill, the absence of free liquids will be verified using a paint filter test. In addition, this waste will be analyzed for other parameters based upon the characterization of the waste before solidification. These requirements are a part of the Waste Analysis Plan presented in Section 4.0.

5.4.8 Special Requirements to Limit Releases to the Atmosphere

Operations at the Facility will be conducted to minimize the potential for releases to the atmosphere as required by 40 CFR 270.14(b)(8)(vi). This objective will be achieved by using a wind dispersal control system to limit or eliminate the dispersal of particulate matter from the landfill, roadways, and other areas of the Facility and by providing control equipment for operations that may produce air emission, if necessary. The dispersal of particulate matter from soil surfaces will be reduced by restricting traffic and applying small amounts of water spray to moisten the soil surface. ~~A structural containment building housing the stabilization unit will be equipped with pollution control systems to minimize the release of particulates to the atmosphere. The bins and stabilization building will be equipped with an exhausting ventilation system which will maintain a negative pressure inside the building. Slotted ducts located around the perimeter of each bin will provide supply and return air in a push-pull arrangement to remove dust during the waste receiving, mixing and load-out operations. During reagent delivery operations, the bin cover, which will also be connected to the exhaust system, will control dust. Dust will be removed from the exhaust air at the bag house located on the west side of the building. Collected dust will be processed in the stabilization unit.~~ Procedures will be developed to ensure that the landfill and associated activities are managed to prevent particulate releases. The Contingency Plan will specify the methods to prevent and control spills and emissions related to spills.

5.5 Precautions to Prevent Ignition or Reaction of Ignitable, Reactive, or Incompatible Wastes

Hazardous wastes will be handled only by properly trained Facility personnel. The Facility training program is outlined in Section 7.0. Individuals will be instructed in identifying incompatible wastes, properly labeling them, and properly handling them. Proper handling includes segregation, avoidance of mixing the wastes, and carefully checking compatibility codes prior to the ~~storage or~~ disposal of any wastes. Personnel also will be specifically trained in the proper handling of ignitable and reactive wastes.

This approach will ensure the proper handling of ignitable and reactive waste and will prevent mixing of incompatible waste. In addition, personnel training and Facility operational procedures will be developed to (1) ensure that wastes are properly identified; (2) ensure that general Facility requirements for the management of ignitable, reactive, and incompatible wastes are adequate; and (3) ensure that ~~unit-specific~~ requirements for the management of these wastes are compatible with operations. The procedures for identifying these wastes are provided in Section 4.5 of the Waste Analysis Plan.

The local fire department or a qualified organization will inspect all of the permitted units on an annual basis to assure continued compliance with all applicable NFPA codes.

Ignitable and reactive waste handling are generally described in Section 5.5.1. More specific requirements for the landfill ~~and stabilization unit~~ are described in Section 5.5.2. Handling of incompatible waste is described in Section 5.5.3.

5.5.1 General Requirements

Precautions will be taken to avoid (1) accidental ignition or reaction of ignitable or reactive wastes; (2) reactions that generate extreme heat or pressure, fire or explosions, or violent reactions; (3) reactions that produce uncontrolled toxic or flammable fumes, dusts or gases, in quantities large enough to threaten human health and the environment; ~~(4) reactions that cause damage to the structural integrity of the container or the unit;~~ and (~~5~~4) any other reactions that threaten human health or the environment.

Ignitable or reactive wastes accepted at the Facility will be separated and protected from any sources of ignition or reaction, including open flames, smoking, cutting and welding, hot surfaces, frictional heat, sparks, spontaneous ignition, and radiant heat. All smoking will be confined to specifically designated areas when ignitable or reactive wastes are being handled. “No Smoking” signs will be conspicuously posted wherever there is a hazard from ignitable or reactive waste. Ignitable or reactive wastes will be located in the active portion of the Facility, which is more than 50 feet from the Facility property line.

5.5.2 Requirements for the Landfill

Ignitable or reactive wastes will not be placed in the landfill unless the waste has been treated and no longer meets the definition of ignitable or reactive waste under 40 CFR 261.21 or 261.23, or unless the general requirements outlined above for ignitable, reactive, or incompatible wastes are complied with. Additional information for the management of these wastes in the landfill is contained in Section 2.5.3.6.

5.5.3 Incompatible Waste Handling

Generator waste profile forms (see Permit Attachment F2~~Appendix H, Volume II~~) will provide Facility waste handlers with the necessary information to avoid mixing containers of incompatible wastes. Facility employees will be trained to recognize incompatible wastes and to prevent the mixing of such wastes. Incompatible wastes will not be placed in the same area of the landfill, but separated adequately to avoid all possibility of commingling in the landfill.

By the time any leachate generated from the landfill reaches the LCRS it will be sufficiently diluted~~,~~; therefore, problems associated with incompatibles in the LCRS sump are not anticipated. Wastes will be solidified and stabilized prior to their placement into the landfill. These processes are performed to bind liquids and prevent leaching of any of the wastes' constituents. Therefore, any leachate generated within the landfill is not expected to contain significant levels of hazardous constituents. Due to the anticipated low concentrations of hazardous constituents in the leachate and the geographic separation of incompatible waste types, incompatibility problems within the landfill will be negligible.

~~Containers of incompatible wastes will be stored in separate containment areas to prevent the potential for mixing. Incompatible wastes will be separated by the walkways and sloping floors towards the sumps that separate each cell. The drum handling unit will utilize seven separate cells for waste placement. Each cell is separated by a concrete berm/walkway and each bay has a separate sump. All incompatible wastes in drums will be stored in separate cells. These physical barriers along with defined operational procedures, will ensure that incompatible wastes will remain segregated. In addition, the design and operational procedures will ensure that incompatible materials will not be placed in the same container, nor will hazardous waste be placed in an unwashed container that previously held an incompatible waste (see Section 2.2.12).~~

Permit Renewal Application
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Attachment C

Contingency Plan

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Permit Attachment C. Contingency Plan

Modified from the Permit Application, Volume I,

Section 6.0

6. Contingency Plan

The purpose of the Contingency Plan is to minimize potential hazards to human health and/or the environment in the event of a fire, explosion, or unplanned sudden or non-sudden release of hazardous waste or hazardous waste constituents to the air, soil, or water. Should any of these unplanned events occur, the procedures in this Contingency Plan will be immediately implemented. When these procedures are followed, the possibility of additional occurrences, recurrences, or spread of the initial emergency in such a way as to require additional emergency response measures will be minimized.

This Contingency Plan was specifically developed for the Triassic Park Waste Disposal Facility (the Facility). A final Contingency Plan will be provided to the New Mexico Environment Department (NMED) and other response agencies 60 days prior to initiation of operations. The plan will be kept at the Facility, and controlled copies will be submitted to and updated at all police and fire departments, hospitals, and state and local emergency response organizations that may be called upon to provide emergency services. A list of these organizations is provided in Permit Attachment C3, Cooperating Local Authorities. Initial site tours with all local emergency response organizations will be conducted to familiarize them with the facility prior to the start of operations.

The plan specifies Facility personnel who will be responsible for implementation of the plan. The plan also specifies the actions these individuals will take in the event of an emergency at the Facility. The plan includes a (1) a description of the Facility layout; (2) the location of possible hazards; (3) the location of emergency and decontamination equipment; (4) evacuation plans and routes; (5) agreements with local emergency personnel; and (6) an up-to-date list of names, addresses, and telephone numbers of Facility personnel qualified to act as Emergency Coordinator (EC).

6.1 General Responsibilities of the Emergency Coordinator

The Facility will train a minimum of five employees to serve as the EC for the Facility. Only one individual at a time will be designated as the primary (on-duty or on-call) EC. Others will be specified as alternate ECs. An updated list of personnel qualified as ECs (see Permit Attachment C2, Emergency Coordinators) will be provided in to the New Mexico Environment DepartmentNMED prior to waste receipt. Individuals will be listed by name, address, and telephone number. The list will also indicate the order in which each will assume responsibility as ECs. In accordance with 40 CFR 264.52(d), which states, "For new facilities, this information must be supplied to the Regional Administrator at the time of certification, rather than at the time of permit application", the list will be provided to the director of the NMED or designee (NMED Director) prior to receipt of waste and will be kept current both at the Facility and with emergency response organizations.

An acting EC will be either physically at the Facility or on call 24 hours a day, 365 days a year. Each EC will have authority to commit resources needed to carry out the provisions of the Contingency Plan. The EC will be responsible for implementing the Contingency Plan, coordinating all emergency response efforts, determining the extent of the emergency, assessing hazards to human health and the environment, and completing necessary reports associated with the incident. Each EC will be thoroughly familiar with (1) the Facility layout and operations; (2) all aspects of the Facility's Contingency Plan; (3) the location and characteristics of hazardous materials, hazardous waste, and waste handling activities at the Facility; (4) the location and operation of emergency response equipment; (5) evacuation plans and routes; and (6) the location of all Facility records.

After an emergency has been brought under control, the EC will assume responsibility for treating, storing, or disposing of recovered waste, contaminated soil or surface water, or any other material that is generated as a result of the release, fire, or explosion at the Facility.

If the EC becomes injured or is otherwise unable to serve as EC during an emergency, a designated operations manager will assume the role of EC until an alternate EC is notified and arrives on the scene.

6.2 Circumstances Dictating Implementation of the Plan

The Contingency Plan must be immediately implemented under any of the following circumstances:

- a fire or explosion occurs resulting in the release of a hazardous waste or involving an active hazardous waste management unit;
- a spill, leak, or other release of hazardous waste or hazardous waste constituents to the air, soil, or surface water occurs that could threaten human health or the environment;
- an indoor spill, leak, or other release of hazardous waste occurs to a secondary containment area that is not removed within 24 hours; and/or
- a hazardous waste incident occurs resulting in an injury requiring more than basic first aid.

The plan will be implemented any time the EC believes that an event occurring at the Facility has the potential to adversely affect human health or the environment. The plan may also be implemented for other reasons at the discretion of the EC.

During the initial discovery and assessment phase of an incident, the EC will obtain information, including the type and quantity of released material and/or injuries that have occurred. At this time, the EC may consult with environmental specialists and other appropriate personnel to determine whether the incident warrants implementation of the Contingency Plan.

6.3 Implementation Procedures

Response procedures for emergencies often vary significantly, depending on the specific details of the incident. However, several response procedures are common to all incidents and include the following elements, which are further detailed in this section:

- discovery of incident and request for assistance from emergency response personnel;
- identification and characterization of released or suspected released material;
- assessment of hazard;
- off-site notification and evacuation criteria;
- response and control procedures;
- measures to prevent recurrence or spread; and
- storage and treatment of released hazardous waste.

6.3.1 Discovery of Incident and Request for Assistance from Emergency Response Personnel

The individual who first discovers an incident or emergency will quickly determine whether the situation is immediately life threatening or non-life threatening. The steps taken in each of these scenarios are briefly described below, although they are likely to vary based on occurrence.

6.3.1.a Life-Threatening Situations

All Facility employees will be instructed and trained on response to a life-threatening situation or life-threatening release of materials. Employees will first relocate to a safe area, if necessary, then immediately notify the EC and/or emergency response personnel as the situation warrants, using the methods described below.

Verbal—In some cases, verbal communication within a building or between buildings will be the fastest way to disseminate emergency information and/or evacuate the area of an emergency.

Telephone—Employees will be instructed to immediately relocate to a safe area, if necessary; appropriate emergency response personnel can be notified by dialing 911 (without first notifying the EC if a particular situation appears to be immediately life-threatening or serious)~~;~~. ~~t~~The EC must be immediately notified of the actions taken.

Fire-Pull Station—The fire-pull station may also be used to alert the fire department and Facility personnel of an emergency. Although this type of alarm does not allow verbal communication with the fire department, it does activate a local fire alarm bell at the Facility and a remote alarm signal at the fire department.

Facility personnel will be trained for initial response to on-site fires. When the alarm is activated, on-site personnel may use fire extinguishers or the application of soil and/or water to suppress fires, when appropriate. The Roswell Fire Department will respond to fires beyond the control of site personnel. Response time for the Roswell Fire Department is approximately 30-45 minutes.

Fire-pull stations will be located at the administration building~~,~~ and the entrance to the landfill~~, the drum handling unit, and the stabilization unit~~. Other possible locations of fire-pull stations may be established.

Automatic Fire Detection/Sprinkler System—All permanent Facility buildings will be equipped with automatic fire detection/sprinkler systems, which, when activated, will transmit an alarm directly to the security gate guard shack and the Roswell Fire Department. The fire department will immediately respond to any alarms.

Public Address (PA) or Paging System—Each of the main buildings will be equipped with a PA or paging system, which will be used to inform employees of adverse conditions at the site and emergency response instructions.

Hand-Held Radios—Hand-held radios will be used to communicate with personnel who are out of range of voice communications, PA, or are working in areas with noise levels such that render the PA system inaudible in emergency situations.

During non-operational hours, the EC will be notified by pager, radio, cellular telephone, or regular telephone. The EC will be at the scene as soon as possible to direct and coordinate emergency response activities.

If the EC determines that additional assistance from an off-site agency or emergency response organization is needed or if immediate action is required to protect a local community population or to protect any visitors using the Mescalero Sands recreation complex and travelers at the rest stop on Highway 380 north of the Facility, the EC will contact the appropriate agencies or organizations. A list of these organizations is provided in Permit Attachment C3. During response activities, two-way radios will be used for communication between responding groups and the EC.

6.3.1.b Non-Life Threatening Situations

Upon discovery of a non-life-threatening release of materials or other non-life-threatening but potentially serious emergency situation, all Facility employees will be instructed and trained to immediately notify the EC or their supervisor. The EC will evaluate the situation, notify appropriate personnel, and if necessary implement the Contingency Plan.

6.3.2 Identification and Characterization of Released or Suspected Released Material

After the emergency situation has been discovered and appropriate response personnel have been contacted for assistance, the EC will immediately obtain the following information by process knowledge (his own or that of another employee): (1) observation; (2) review of Facility records, including material safety data sheets (MSDSs) and manifests; and/or (3) chemical analysis of the material, if this becomes necessary. This information will determine the following:

- the character and amount of released waste;
- the exact source and extent of any released material;
- whether the release could move off-site; if it is determined that the release could move off-site, the EC must determine if any containment procedures have been implemented or whether such procedures should be implemented; and
- any injuries or potential injuries resulting from the incident.

All containers of waste and material at the Facility will be labeled. Therefore, the identification and characterization work generally will be accomplished through visual inspection and process knowledge. Manifests and lists of the waste and locations of waste being stored at the Facility prior to disposal or treatment will be maintained at the Facility. This information will be used in lieu of the visual inspection noted above in cases where the danger of entering the incident area is high or the container labels have been obscured as a result of the incident.

Copies of the MSDSs for raw materials used at the site will be located in the administration building, in the EC's office, and at appropriate operations locations throughout the site. The information in these documents will be used to prepare a course of action.

6.3.3 Assessment of Hazard

Concurrent with the waste identification and characterization phase of the emergency response, the EC will assess possible hazards to human health or the environment that may result from the emergency situation. Indirect and direct effects of the release, fire, or explosion will be considered during this assessment. Examples of direct and indirect effects include the impacts of any toxic, irritating, or asphyxiating gases that are generated or the effects of any hazardous surface water runoff from water or chemical agents used to control a fire.

During this phase of the emergency response, the EC will consider the following information to determine potential risk to human health or the environment:

- the location from which the material or waste is emanating;
- the weather patterns and wind direction at the time of the release; and
- the characteristics of the released material, including physical, reactive, and human or animal toxicity.

The EC may choose to obtain emergency response guidance by contacting one or more of the emergency response organizations listed in Permit Attachment C3 or by utilizing various spill control reference textbooks and MSDSs located in the EC's office.

6.3.4 Off-Site Notification and Evacuation Criteria

If the EC determines that a release, fire, or explosion has occurred at the Facility that poses an immediate threat to on-site or off-site human health and/or the environment, the findings will be reported to appropriate response personnel as follows:

- Local authorities will be immediately notified if an emergency incident at the Facility could affect local areas and if evacuation of these areas is necessary. The EC will be available to assist appropriate officials in deciding whether local areas should be evacuated (evacuation procedures and a site-wide emergency evacuation plan are provided in Permit Attachment C4, *Evacuation Plans*).

- Local authorities will be notified with the following information:
    - the name and telephone number of the reporter;
    - the name and address of the Facility;
    - the time and type of incident that occurred;
    - the name and quantity of material(s) involved, to the extent that this is known;
    - the extent of injuries, if any; and
    - the possible hazards to human health or the environment.

Coordinating agreements will be signed with federal, state, and local emergency response organizations. The agencies with which the Facility will enter these agreements are listed in Permit Attachment C3. The agreements outline the conditions under which the agencies will be contacted and the roles they will assume during various emergency scenarios at the Facility. The agreements establish the EC as the lead coordinator of all emergency response activities at the Facility. The details of these agreements will be located in the EC's office and with each of the participating organizations. The agreements will be considered controlled documents and will be kept current by updating all copies each time a change is made. This ensures a coordinated response to all emergency situations.

The EC may contact one or more of the agencies, such as police, fire departments, or hospitals, as listed in ~~Appendix~~ Attachment C3, if additional assistance is needed at the site to protect community populations.

6.3.5 Response and Control Procedures

Following proper notification of agencies and/or evacuation of the Facility, the EC will initiate response and control procedures. This effort will involve the use of emergency equipment, which is listed in Permit Attachment C1, Emergency Equipment. This list also includes equipment descriptions and locations.

Potential incidents for which response and control procedures are necessary will be grouped into three broad categories: (1) fires and/or explosions; (2) spills, leaks, or other releases; and (3) power failures. A brief discussion of emergency training requirements and the general procedures for handling each of these situations are described in the following sections.

Facility personnel and supervisors will receive safety training to enable them to respond to and handle various emergency situations that are not of a serious nature. In addition to this training, employees will participate in emergency response drills on a periodic basis. These drills will involve both internal responses and those response actions taken in conjunction with external emergency response personnel. Key personnel will be familiar with the use of emergency equipment and fire control structures available to prevent the spread of fires in their areas. To prevent recurrence of an incident, any faulty or defective monitoring equipment, valves, pumps, alarms, or other equipment will be repaired. If repair is not possible, the equipment will be replaced. The unit will not receive hazardous waste until the minimum required equipment for safe operation is fully functional.

Procedures for ensuring that incompatible wastes are not treated, stored, or located in areas where a spill has occurred are addressed in Section 6.3.7.

6.3.5.a Fire and/or Explosion Control Procedure

If a fire or explosion occurs at the Facility that may impact an active hazardous waste management unit or hazardous material storage area, the Contingency Plan will be immediately implemented, as outlined in Section 6.3. The EC will assess the situation and direct the emergency response effort. The EC will also be responsible for advising emergency response personnel of the hazards associated with released materials and other areas that should be protected from the effects of the incident.

In the event that a fire cannot be brought immediately under control and hazardous waste or material are located in the path of the fire or in an otherwise dangerous place, the waste or materials will be relocated to a safer area, if possible. If this is not possible, the material may be sprayed with an appropriate fire suppressant, at the direction of the EC or under the advisement of fire department personnel.

If an explosion is likely to occur, for example because a fire threatens to envelop ignitable waste, the EC may choose to evacuate the area, as described in the Evacuation Plan in Attachment C4~~Appendix L presented in Volume II~~. A site-wide evacuation plan is presented in Drawing L-1 in the Evacuation Plan~~Appendix L, Volume II~~.

Facility employees will be trained and advised to stay in their work areas during emergency situations, unless they are in immediate danger, until they receive further direction via the PA system or other method of communication. If evacuation is necessary, the EC will communicate this via the PA system and by other means, as necessary, and all employees will assemble at the administration building. If anyone is unaccounted for, emergency response personnel will conduct searches.

After the affected areas have been evacuated, re-entry will be authorized by the EC only after the fire has been extinguished and when the emergency has been resolved.

Any equipment used during the incident will be checked for contamination and cleaned and/or replaced prior to resumption of plant operations in the affected area. Any solutions or materials used to decontaminate the equipment will be managed as RCRA-regulated waste.

6.3.5.b Spills, Leaks, or Other Releases Control Procedure

~~All areas in which liquids are stored, managed, or potentially encountered (including tanks, containers, or secondary containment areas) will be inspected regularly for leaks, spills, deterioration, or damage in order to reduce the likelihood of an incident. However, on occasion, such incidents may still occur.~~ This section describes the procedures for responding to spills, leaks, or other releases to containment areas or to the environment.

If Facility employees observe a spill, leak, or other release, whether during a formal inspection or during routine work, they will be instructed to contact the EC immediately and describe the situation in as much detail as possible, giving the following information, at a minimum:

- the location;

- material composition;
- approximate quantity; and
- estimated extent of the release.

Based on this information (and additional investigation by the EC as necessary), the EC will determine whether to evacuate the area and/or implement the Contingency Plan.

As previously stated, if the EC is not available and if the situation is serious or life threatening, employees will be instructed to dial 911 for emergency assistance. In a life threatening situation personnel may call 911 without first notifying the EC. The EC will then be notified of the employee's actions. Upon notification, the EC will conduct a visual inspection of the release and will then implement immediate containment measures.

~~**Releases Within Containment**~~

~~The EC will implement the following procedures for responding to leaks or spills from tank systems or containers into secondary containment areas that are not likely to reach the environment:~~

- ~~the tank system or secondary containment area will be removed from service and the flow of waste stopped;~~
- ~~the unit will be inspected to determine the apparent cause of the leak or spill;~~
- ~~all waste released to a secondary containment area will be removed from the secondary containment systems within 24 hours after detection of the leak, or as timely as possible, to prevent harm to human health and the environment;~~
- ~~leaking containers will be placed in an overpack drum or will have the contents transferred to another container; and,~~
- ~~affected tank systems will be repaired or replaced (if replaced, the old systems will be closed) prior to returning them to service. All released materials will be removed prior to returning the unit(s) to service. Extrusion repairs to geomembrane liners or metal welds to steel containers will be certified by a qualified registered professional engineer. This certification will be submitted to the NMED Secretary.~~

6.3.5.b.i Releases to the Environment

The EC will implement, in addition to the applicable permit conditions of Permit Parts 9 and 10, the following procedures for responding to leaks or spills from units that are likely to reach the environment:

- As previously stated, if uncontrolled releases of ignitable, corrosive, reactive, or toxic materials are involved in the incident, the affected area will be evacuated.

- Response personnel will be directed to the incident location to aid in preventing further migration of the leak or spill to soils or surface water, provided that this can be accomplished safely. This effort will involve the use of industrial absorbents, sorbent dams, or other similar materials. If the release is determined to be beyond the capabilities of Facility personnel, the EC will contact one of the emergency response organizations listed in Permit Attachment C3 for assistance.

- The EC will monitor the status of the incident and direct emergency response personnel until the emergency condition no longer exists.

- When the incident has been brought under control, the EC will coordinate and instruct response personnel to begin cleanup and decontamination operations. These will involve containing and collecting any released material, including liquid releases, contaminated sorbent materials, visibly contaminated soils, and any other waste materials generated during cleanup or decontamination. These items will be removed and properly disposed of, generally by placing the wastes into DOT-approved containers (such as 55-gallon drums), sampling the waste or otherwise determining its constituents, and handling the waste accordingly. All liquids, including the originally released material and any liquids generated during cleanup (unless other circumstances or knowledge preclude this effort) will be pumped into drums and samples taken and analyzed to determine an appropriate course of action.

- If soils or surface water are visibly affected, they will be removed until the contaminant concentration in the remaining soil or water is at or below appropriate levels for the contaminants of concern.

- The EC will then use whatever means are necessary to determine if the released material is a hazardous substance as defined in 40 CFR 302. The EC will then determine whether the amount of released material is a reportable quantity. If the amount is a reportable quantity, the following steps will be taken:
  - ~~waste that could be released to the environment because of a leak in a tank system will be removed from the tank within 24 hours of the detection of the leak, or, if this is not possible (impracticability must be demonstrated to the NMED), it will be removed at the earliest practicable time. In such a case, as much waste as is necessary to prevent further releases to the environment will be removed from the tank system, enabling inspection and repair of the system;~~
  - the EC will report the release to ~~the~~ NMED ~~Director~~ within 24 hours of detection;
  - the National Response Center will be advised of the situation within 24 hours of the incident;
  - an internal report describing the situation and corrective measures necessary to prevent a recurrence will be prepared; and
  - a written report will be filed with ~~the~~ NMED ~~Director~~ within 30 days of detection, as described in Section 6.4.2.

- If the quantity of the spill or leak is less than or equal to 1 pound and is immediately contained and cleaned up or is less than a reportable quantity of material, a Facility employee will be assigned to report on the situation and determine what, if any, follow-up actions are necessary after cleanup.

~~6.3.5.c Evaporation Pond Failure Control Procedure~~

~~The evaporation pond will be removed from service if the level of liquids in the pond suddenly drops and the drop cannot be attributed to known flow rate changes into or out of the pond or if they are exceeded. The major source of volume reduction from the pond is anticipated to result from evaporation. Liquid may also be pumped out of the pond, for example if a heavy rainfall event causes the water level to rise above the required freeboard elevation. Liquid levels in the evaporation pond will be monitored using a measuring staff gauged either in inches or in tenths of a foot. Daily evaporation losses will be compared to daily evaporation rates obtained from the nearest NOAA weather station. Currently this is the Bitter Lakes Wildlife Refuge station, as evaporation rates are not measured at the Roswell and Tatum stations. If liquid losses exceed daily evaporation losses and no other reasonable explanation is found, then the evaporation pond will be shut down and the authorities at NMED will be notified immediately.~~

~~When a pond must be removed from service, the following steps will be taken:~~

- ~~the flow of waste into the pond will be immediately shut off;~~
- ~~any surface leakage that has occurred will be contained;~~
- ~~the leak will be stopped as soon as possible;~~
- ~~any other necessary steps will be taken to stop or prevent a catastrophic failure of the unit; and,~~

- in the event that the leak cannot be stopped by any other means, the pond will be emptied.

Notification will be made to the Chief of the Hazardous Materials Bureau. An oral report will be made within 24 hours. A written report will be submitted within 7 days. An unexplained drop in the level of the evaporation pond would qualify as a noncompliance that may endanger human health or the environment, and 40 CFR 270.30 (l)(6) requires 24-hour notification for such events.

If the evaporation pond is removed from service, it will not be put back into service until it is repaired. If the unit was removed from service as a result of a sudden drop in the liquid level, and the drop in the liquid level was caused by failure of the liner, then either a new liner (in compliance with 264.221[a]) must be installed, or the old liner must be repaired and certified by a qualified engineer that it meets the design specifications approved in the permit. If the pond is not to be repaired, or is not repairable, it will be closed in accordance with the provisions of 264.228 and the approved closure plan.

In the event that the evaporation pond is removed from service due to actual or imminent failure of any portion of the pond dike system, the evaporation pond will not be placed back in service until necessary repairs are completed and inspected, and the structural integrity of the dike is recertified by a New Mexico registered professional engineer. This recertification process will be done in accordance with 40 CFR 264 .226(c) and 40 CFR 264 .227(d)(1).

Several options are available to empty an evaporation pond. Due to the two-sided nature of the single evaporation pond, if a leak occurs in one side, liquid can be transferred to the other side while repairs are being made. Other options, if the leak is on both sides of the pond, include setting up temporary double-lined ponds, temporary double-lined bladders, temporary portable double-lined tanks, or using tanker trucks. These short-term storage measures are intended only to allow storage capacity during a major pond repair effort. The wastes would be transferred into and out of the tanks using existing or temporary pumps.

GM commits to having onsite at all times all required equipment for the emergency storage capability to remove all contents from the evaporation pond. This will include available storage capacity in one side of the pond that is not leaking as well as in temporary storage units (bladders, tanks, or tanker trucks). This equipment will be located at the facility and will be owned by GM. Personnel who notice an impending impoundment failure will notify the Emergency Coordinator immediately following the observation.

The Emergency Coordinator will respond by immediately mobilizing an emergency response team from the maintenance department who will bring in double-liner bladders, tanker trucks, and heavy equipment, if necessary, to the evaporation pond site. The team will endeavor to identify the source of the failure. If it is concluded that the impoundment failure is resulting in a release of water to the ground surface, an interim containment dike will be constructed of soil materials adjacent to the pond. Downstream receiving stream users, groundwater users, and local government authorities will be immediately notified. Bladders, pumps, and tanker trucks will then be mobilized to recover water that is being impounded by the dike. If it is concluded that the impoundment failure is impacting groundwater with no evidence of surface expression, the team will implement immediate drawdown of the pond until the source of the failure is located or until all of the contents have been removed, whichever occurs first.

A program for conducting accelerated water quality monitoring will be immediately instituted by the Emergency Coordinator. Grab samples will be collected by the maintenance department from the surface stream monitoring points and groundwater monitoring well(s) and analyzed according to the facility's environmental monitoring plan. These results will be reported to the local authorities and NMED within 24 hours of receipt of results.

A corrective action plan will be developed by the maintenance department to repair the impoundment. The plan will include provisions for recovery and treatment of soils and released water. If a groundwater pump and treat program is required based on sample results to restore groundwater quality, this program will be designed and

~~implemented by GM and approved by a New Mexico registered professional engineer and NMED prior to implementation.~~

~~A Personnel Decontamination Zone will be set-up near the evaporation pond. Field restoration of the evaporation pond will be conducted by maintenance department personnel who will be fitted with appropriate PPE.~~

~~Restoration activities including required construction quality assurance will be carried out under the supervision of the maintenance department supervisor. A New Mexico registered Professional Engineer will certify the completion of the pond repair. All environmental monitoring and remedial efforts will continue to be conducted until background water quality conditions are restored. All waters captured by containment dikes or tanker trucks will be placed back into the evaporation pond after restoration activities are completed and NMED's concurrence of successful completion of these activities.~~

~~Treatment and/or disposal of contaminated soils will be implemented by the maintenance department. The program for soil treatment/disposal will be developed by GM and approved by NMED prior to it implementation. Decontamination of all equipment used during these remedial activities will be conducted.~~

~~GM will report the results of these corrective action efforts and remedial progress to NMED on a regular basis until the evaporation pond is approved for operation or otherwise directed by NMED. GM will report to local authorities and NMED when all background environmental conditions have been restored.~~

6.3.5.d Power or Equipment Failure Control Procedure

The Facility will be equipped with at least one backup generator for emergency power generation to critical equipment only, which may include the laboratory, stabilization unit and administrative equipment. The generators may also be used to power safety equipment, such as smoke detectors and tank emergency cut-off or bypass mechanisms. The details of this system will be made available as the Facility design is completed. This emergency system will be started within 30 minutes of a power failure.

Equipment that fails but does not result in an emergency incident, such as a fire or explosion, will be promptly repaired or replaced. If emergencies arise as a result of the equipment failure, they will be handled as described in previous sections.

~~In the event of a power failure at the facility affecting the stabilization building, the facility will implement a series of response actions until power is restored. Power is expected to be restored within 30 minutes from the emergency generator which will be installed at the facility. The response actions will address personnel evacuations and waste receiving cessation. The personnel will evacuate to a pre-designated assembly area as outlined by this Contingency Plan in Section 6.3.4. Several of these personnel will be tasked by the Emergency Coordinator to then leave the assembly area and visually monitor the stabilization building from a location specified by him and conduct air quality monitoring. The Emergency Coordinator will notify the Waste Receiving Department to cease the receipt of waste materials from the offsite generator and subsequent transfer of the material to the stabilization building. The Emergency Coordinator will monitor the duration of the power failure and will provide guidance to maintenance personnel who may need to approach the stabilization building to reset electrical systems regarding any chemical and physical hazards. The Emergency Coordinator may elect to request securing of waste containers or other vessels in the stabilization building if the power failure is expected to be prolonged. If this is the case, he will organize a team of stabilization building personnel to re-enter the building while donning appropriate PPE to inspect, then, if necessary, secure any containers or containment vessels to minimize environmental hazards.~~

6.3.6 Measures to Prevent Recurrence or Spread

During an emergency, the EC will take all reasonable measures necessary to ensure that fires, explosions, and releases do not occur, recur, or spread to other hazardous waste areas at the Facility. These measures will include the following, where applicable:

- stopping processes and operations in specific areas of the plant or the entire plant itself; shut-down procedures for processing operations will be maintained in the administration building as well as at specific operating locations;
- collecting and containing released waste as described in Section 6.3.5.2; and
- removing or isolating containers from the emergency at hand, as described in Section 6.3.5.1; if a material cannot be moved because of danger associated with a fire, the material may be sprayed with an appropriate fire suppressant, as directed by the EC or authorized fire official.

If the Facility ceases operations because of an emergency, the EC or a designated individual will monitor for leaks, pressure buildup, gas generation, or ruptures in valves, pipes, or other equipment, wherever this is appropriate.

A preventive maintenance order schedule will be prepared to ensure that monitoring equipment, valves, pumps, alarms, and other equipment will be maintained in good working order. If any of the equipment is found to be faulty or defective, it will be repaired or replaced.

6.3.7 Storage and Treatment of Released Hazardous Waste

Concurrently or immediately after the emergency has been addressed and cleanup procedures have been completed, the EC will make arrangements for the containerization and storage, treatment, or disposal of any waste generated during the incident. The waste will be assumed to be RCRA-regulated until process knowledge or sampling and analysis can be used to determine the actual nature of the waste. Sampling and analysis will be accomplished in accordance with the Waste Analysis Plan in Section 4.0. The material will be placed in DOT-approved containers and stored as RCRA-regulated waste ~~in the drum-handling unit or roll-off container area~~ until a determination is made. If the waste is determined to be RCRA-regulated, it will be labeled and stored accordingly until it is ~~treated or~~ disposed of in accordance with applicable RCRA regulations and permit conditions.

If the waste generated during the cleanup is determined to be incompatible with other wastes stored or treated at the Facility, the incompatible waste will be labeled as such and physically separated from other incompatible waste. In addition, existing waste at the Facility that may be incompatible with the waste generated during cleanup will not be ~~treated, stored, or~~ disposed of until cleanup activities are completed and the cleanup waste is safely containerized and segregated from the existing waste.

6.3.8 Equipment and Personnel Decontamination

A personnel decontamination zone (PDZ) will be set up a safe distance away from the material release area by a team designated the ~~Emergency Coordinator~~EC. The PDZ's location relative to the release area will be determined by the ~~Emergency Coordinator~~EC. The PDZ will be comprised of a support zone, contamination reduction zone, and exclusion zone.

The PDZ will be set up to sequentially decontaminate equipment and personnel. The first level of decontamination will involve equipment or personnel containing the highest level of contamination. Final equipment and personnel decontamination will be verified by visual inspection. The decontamination procedure within the PDZ will generally comprise progressing through the contamination reduction zone and corridor followed by redress of personnel. The Contamination Reduction Corridor will be designed to control access into and out of the exclusion zone and will confine responding personnel to a limited area.

Also included in the Contamination Reduction Corridor will be the decontamination of monitoring devices and waste samples. Non-reusable items such as latex gloves, Tyvek suits and duct tape, and respirators will be properly collected and disposed of at an approved facility. Decontamination of equipment, monitoring devices, and waste samples is presented below in Section 6.3.8.2, Equipment Decontamination. Decontamination efforts regarding personnel will be recorded including personnel identification, emergency response function, and date and time of day entering and leaving the PDZ. The PDZ will be decommissioned when the emergency has been addressed and cleanup measures have been completed.

Sampling equipment including waste sample collection hardware, personal protective equipment, and monitoring devices will be decontaminated in the Contamination Reduction Corridor prior to returning these items to their respective storage locations at the facility. Decontamination will involve scrubbing each item with a biodegradable detergent solution followed by thorough rinsing with deionized water. This process will be repeated at least one time. Additional scrubbing/rinsing will be performed depending on the extent of contamination. The PDZ supervisor will conduct all recordkeeping with regard to decontamination efforts. He will note equipment, waste sample containers, and monitoring devices that were decontaminated. He will also note the number of detergent scrubbing/rinsing steps that were conducted. The PDZ supervisor will verify that all equipment, sample containers, and monitoring devices have been properly decontaminated prior to these items being returned to their respective storage areas for reuse. This verification will be based on a visual inspection of each item prior to its leaving the PDZ. All wastewater that was generated and collected during operation of the PDZ will be properly treated and/or disposed of as directed by the ~~Emergency Coordinator~~EC.

6.4 Post-Implementation Procedures

Following implementation of the Contingency Plan and resolution of the incident, all emergency equipment used during the effort will be made ready for future use. Necessary reports will be prepared and filed at the Facility and with regulatory agencies. These post-implementation procedures are detailed in the following sections.

6.4.1 Post-Emergency Equipment Maintenance

All emergency equipment listed in Permit Attachment C1 will be cleaned, repaired, or replaced so that it is fit to use before plant operations in the affected area are resumed. If the equipment cannot be adequately cleaned, it will be disposed of as hazardous waste. If it cannot be repaired and is not contaminated, it will be disposed of as non-hazardous waste.

Documentation of post-emergency equipment maintenance will be provided to NMED prior to resumption of operations in the affected area of the plant.

6.4.2 Required Reports and Notification

During and after certain emergency situations, as described in previous sections of this plan, specific types of reports or notification will be required. The EC will determine when or if off-site notification and reporting are required for certain scenarios. The various reporting and notification requirements are mentioned in the appropriate sections of the Contingency Plan but are detailed here for purposes of clarity.

After the plan has been implemented, if the EC determines that the Facility has had a release, fire, or explosion that could threaten human health or the environment outside the Facility, the EC must immediately notify either the government official designated as the on-scene coordinator for the geographical area or the National Response Center. The report must include the following information: (1) the name and telephone number of the reporter;

(2) the time and type of incident; (3) the name and quantity of material(s) involved, to the extent that this information is known; (4) the extent of injuries, if any; and (5) the possible hazards to human health, or the environment outside the Facility.

If the EC determines that evacuation of local areas may be advisable, appropriate local authorities will be immediately notified. The EC must be available to help appropriate officials decide whether local areas should be evacuated.

Any release to the environment which threatens human health or the environment must be reported to the NMED Director within 24 hours of detection. If the release is reported pursuant to 40 CFR Part 302, that report will satisfy this requirement. Any release involving a reportable quantity of a hazardous waste as defined in 40 CFR 302.4 will be reported to the National Response Center within 24 hours.

Within 24 hours of implementing the Contingency Plan, the EC must notify NMED. The owner or operator must note in the operating record the time, date, and details of any incident that requires implementation of the Contingency Plan.

As required by 40 CFR 264.56(j), within 15 days of the incident, the EC must submit to the NMED Director a written report on the incident. The report must include the following information: (1) the name, address, and telephone number of the owner or operator; (2) the name, address, and telephone number of the Facility; (3) the date, time, and type of incident; (4) the source and cause of any release to the environment; (5) the name and quantity of material(s) involved; (6) actions taken to mitigate damage due to the release; (7) the extent of injuries, if any; (8) an assessment of actual or potential hazards to human health or the environment, where this is applicable; and (9) the estimated quantity and disposition of recovered material that resulted from the incident.

Within 30 days of detection of a release to the environment, a report containing the following information will be submitted to the NMED Director: (1) the likely route of migration of the release; (2) the characteristics of the surrounding soil (soil composition, geology, hydrogeology, climate); (3) the results of any monitoring or sampling conducted in connection with the release, if available (if sampling or monitoring data relating to the release are not available within 30 days, these data must be submitted to the NMED Director as soon as they become available); (4) the proximity of the incident to downgradient drinking water, surface water, and populated areas; and (5) a description of response actions that were taken or are planned.

The NMED Secretary and state and local authorities will be notified when the Facility is in compliance with 40 CFR 264.56(h), which states that no waste that is incompatible with the released material can be treated, stored, or disposed of until cleanup procedures are completed, and all equipment must be fit for its intended use prior to resuming operations.

6.5 Documents to be Maintained On-Site as Part of the Permit

Following the resolution of emergencies, various documents must be prepared and maintained on-site as part of the operating record. These documents are discussed in previous sections of this plan and are summarized below.

Copies of the Facility- and building-specific evacuation plans will be maintained in the administration building and at each location for which evacuation plans will be prepared. These documents will be submitted to the NMED within 30 days of the effective date of this permit.

An up-to-date list of all satellite and 90-day accumulation areas, if any are utilized at the Facility, will be maintained at the Facility and provided to the NMED inspectors upon request. Prior to accepting waste at a satellite or 90-day accumulation area for the first time, NMED will be provided with a description and location map.

A list of authorized ECs and their home telephone numbers will be maintained in the administration building, in all other buildings and emergency stations at the site, and in all controlled copies of the Contingency Plan.

A list of coordinating agreements that outline the situations and criteria under which outside help is needed will be maintained in the administration building and in all controlled copies of the Contingency Plan. This list will include the role of each emergency response authority in an emergency.

Coordinating Agreements will be put in place with local, state, and federal agencies for responding to emergency incidents that may occur at the Facility. The Facility will formalize Coordinating Agreements with those organizations listed in Permit Attachment C3 no later than 60 days prior to receipt of first waste.

A current evacuation plan will be maintained in the EC's office. Permit Attachment C4 provides a general Evacuation Plan for the Facility. The Facility will finalize this Evacuation Plan with details of building-specific evacuations after the Facility design has received final approval from NMED. It is proposed that the Facility will submit the criteria for determining when site evacuations are necessary within 30 days of the effective date of the permit and that final evacuation plans and procedures be submitted following final NMED approval of the Facility design.

A current version of the emergency and spill response equipment list presented in Permit Attachment C1 will be maintained in the EC's office and in each of the controlled copies of the Contingency Plan.

The operating record for the facility will be updated with the time, date, and details of any incidents that require implementation of the Contingency Plan.

6.6 Amendment of Contingency Plan

If the Contingency Plan is implemented, the circumstances under which it was implemented will be thoroughly reviewed to investigate the following:

- why the incident occurred and the cause for the occurrence;
- what measures were taken to prevent a recurrence; and
- what measures will be taken to reduce the risk of having a similar occurrence in the future.

The Contingency Plan itself will be reviewed by the EC and/or the Facility owner and immediately amended, if necessary, whenever any of the following events occur:

- the Facility permit is revised;
- the plan fails in an emergency;
- changes occur to the Facility design, construction, operation, maintenance, or other circumstance that materially increase the potential for fires, explosions, or releases of hazardous waste or hazardous waste constituents, or that change the response necessary in an emergency;
- the list of ECs changes; or
- the list of emergency equipment changes.

Because the Contingency Plan is a controlled document, any changes will be made in the following manner: (1) inaccurate or out-of-date pages will be directly replaced with new pages containing the modified or additional information; (2) the corrected pages will be issued to all agencies and organizations that have controlled copies of the plan; and (3) old pages will be removed from copies of the plan and discarded. These steps will ensure that each organization has a current version of the plan.

Attachment C1. Location, Description, and Capabilities of Emergency Equipment

Details pertaining to the specific locations, physical descriptions, and capabilities of the emergency response equipment listed in this Permit Attachment will be provided to the New Mexico Environment Department (NMED) and other response agencies prior to the initiation of operations at the facility.

This preliminary list provides the types and locations for emergency response equipment for the facility. Equipment changes that occur at the facility will be provided to each agency and organization on controlled distribution for the Contingency Plan.

Diagrams will be posted at various locations throughout the facility with "You Are Here" references at each location. These diagrams will show the locations of safety equipment, alarms, and primary and alternative execution routes.

Emergency equipment for the facility includes:

Fire Control Equipment sprinkler systems buildings fire extinguishers buildings – 20 lbs. dry chemical landfill emergency station – 20 lbs. Dry chemical equipment – 10 lbs. dry chemical trucks – 10 lbs. dry chemical building fire hoses landfill bulldozer landfill (Caterpillar D5 to D8 or equal) mobile fire suppression water/foam truck all areas (approximately 1,000 gal tank)	*Spill Control/Decontamination Equipment - All buildings except administration and landfill emergency station* site heavy equipment industrial absorbents (55 gal drums) sorbent dam 55-gallon recovery drums 85 gallon overpack drums Portland cement (pallet) bung wrench to remove 55 gal drum plugs (2) shovels (6 min) rakes (6 min) decontamination equipment personnel and areas wash basins soap scrub brushes plastic sheeting trash bags
Personal Protective Equipment - All buildings except administration and landfill emergency station tyvek suits and hoods saranex suits and hoods boot covers duct tape plastic tape respiratory protection SCBAs (as necessary) respirators with assorted cartridges rubber gloves	*Communications Equipment* public address or paging system all buildings telephones all buildings hand-held radios (as needed) fire-pull stations (to be determined)

Personal Protective Equipment - All buildings except administration and landfill emergency station (Continued)	*Alarm Systems - All alarms will be indicated in guard shack and have local audible alarms*
splash shields hard hats various type of gloves goggles safety glasses	onsite fire bell system buildings landfill area treatment or tank alarms spill alarms accident or emergency alarm (non-fire alarm)
Safety Equipment - All buildings except administration and landfill emergency station	*Truck Equipment*
Eyewashes safety showers first aid kit	10 lbs. dry chemical fire extinguisher chock block spare tire/jack/wrench emergency triangle flashlight first aid kit towing strap

Attachment C2. List of Emergency Coordinators

Since the Triassic Park Facility is not operational at this time only one Emergency Coordinator (EC) is proposed. Details of the EC are listed below:

Mr. Larry Gandy,
Vice President
Gandy Marley, Inc.
P.O. Box 1658
Roswell, New Mexico 88202
575-347-0434~~1109 E. Broadway~~
~~Tatum, NM 88267~~
~~(505) 398-4960~~

The names, addresses, and telephone numbers (office and home) of the additional Triassic Park Waste Disposal facility personnel who are qualified to act as emergency coordinators (EC) will be provided in this appendix prior to receipt of hazardous waste at the facility. The list will specify the primary EC and alternates in the order they will assume responsibility. This list will be provided to the Director at the time of certification. Copies of this list will also be distributed for inclusion in all controlled copies of the Contingency Plan. Controlled copies will be considered the most current operating Permit, and the official version of the Permit will always reside, at a minimum, in the Administrative Record at the Hazardous Waste Bureau of the NMED in Santa Fe.

Attachment C3. Coordinating Agreements

Arrangements will be made with local, state, and federal agencies for responding to emergencies that might occur at the Triassic Park Waste Disposal Facility. These will be detailed and provided to New Mexico Environment Department (NMED) and all organizations with controlled copies of the contingency plan prior to acceptance of waste at the facility. Coordinating agreements and emergency arrangements are planned with the following organizations:

Eastern New Mexico Medical Center
405 W. Country Club Road
Roswell, NM 88201
(575) 622-8170

County Health Department
Lovington Public Health Office
302 N. Fifth Street
Lovington, NM 88260
(575) 396-2853

Roswell Fire Department
City of Roswell, New Mexico
425 N. Richardson
Roswell, New Mexico 88202
(575) 624-6805

Roswell Ambulance Service
Superior Ambulance Service
108 W. Deming Street
Roswell, NM 88203
(575) 247-8840
911

Tatum Volunteer Fire Department
126 N. Avenue A
Tatum, NM 88267
(575) 398-3473

Tatum Ambulance Service
(575) 398-3223

NM Department of Public Safety
4491 Cerrillos Road
Santa Fe, NM 87507
(505) 827-9000

Lea County Emergency Management
100 N. Main
Lovington, NM 88260
(575) 396-8602

New Mexico Department of Homeland Security & Emergency Management
PO Box 27111
Santa Fe, New Mexico 87502
(505) 476-9600

U.S. EPA/National Response Division
2100 2nd Street SW
Washington, DC 20593
(800) 424-8802
(202) 267-8802

Attachment C4. Evacuation Plan

Evacuation plans are pre-established procedures designed to direct employees to safe assembly areas to ensure their personal safety. Evacuation plans are also designed to enhance the response effort in the event of an emergency. Emergencies that could threaten human health or the environment may require the evacuation of areas, buildings, the entire facility, or local areas surrounding the facility. A site wide evacuation plan is presented on Drawing L-1. This indicates primary assembly areas that are located upwind of the prevailing wind direction for the site. Specific building and area evacuation plans and maps will be prepared as appropriate. These specific plans and maps will be maintained and updated as necessary. The evacuation plans and routes will be addressed in area-specific training courses. A master copy of all evacuation plans for the facility will be maintained and updated by the Emergency Coordinator (EC).

Upon notification of an incident the EC will determine if the incident poses a potential threat to human health or the environment and will evacuate area(s) based upon his/her determination. Employees will assemble in pre-determined areas, outside buildings and away from processing areas as indicated in the evacuation plan.

The evacuation plans will describe the signals to be used to begin evacuations, evacuation routes, and alternate routes for various scenarios. Some of the scenarios included are:

- fires and/or explosions
- spills, leaks, or other releases
- power or equipment failures

Four types of evacuation plans, outlined below, will be prepared prior to acceptance of waste at the facility. In each case, the plans will address the proper response of employees for (1) public address (PA) announcements; (2) various types of alarms and their associated sounds; (3) the evacuation routes available to them from a specific area; (4) assembly areas; and (5) other safety-related issues. The four types of plans are:

1. Process Area Shutdowns and Evacuations

   Emergency shutdown procedures will be prepared for each area and maintained at the specific processing location. These procedures will be used during on-the-job training to instruct and inform operations employees of the evacuation procedures for their specific area.

2. Building Evacuation

   Building specific procedures will be developed prior to the receipt of waste at the facility. These procedures will be maintained in the building for which they are prepared and in the EC's office. The procedures will be used during on-the-job training to instruct employees on the proper response to a building evacuation.

   The evacuation of a building will be initiated in one or more of the following ways:

   - PA announcement from the EC, an emergency responder, or other operations personnel;
   - an evacuation or emergency alarm; and
   - the employee's decision to evacuate for personal protection.

   When an evacuation is announced all employees will immediately leave their work area and assemble at the designated assembly areas. Supervisors will account for all facility personnel and the sign-in log will be used to account for non-facility personnel.

3. Facility Evacuation

   Evacuation of the entire facility will proceed in a fashion similar to that of a building evacuation. If necessary additional means of communication will be used to ensure all personnel are aware of the site evacuation. Means of communication other than PA announcements might include:

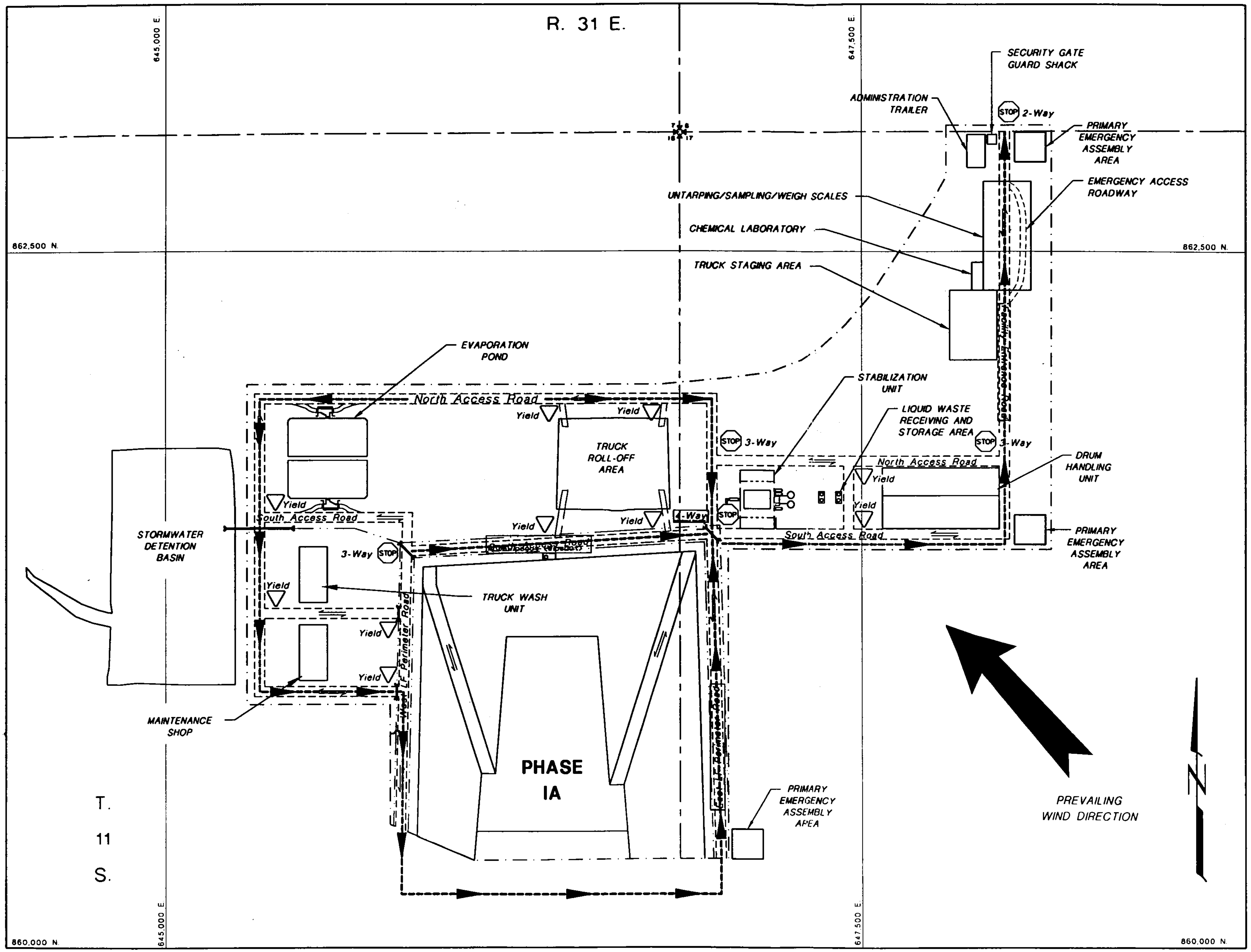
   - hand-held radio for personnel in areas of high noise or areas without PA capability;
   - telephone;
   - area alarms; and/or
   - messengers.

   If the incident site is upwind of the current building location employees and visitors will evacuate in a direction perpendicular to the wind direction. If the incident is downwind from the current location visitors and employees will evacuate in an upwind direction. Windsocks will be placed at strategic locations throughout the facility to ensure their visibility.

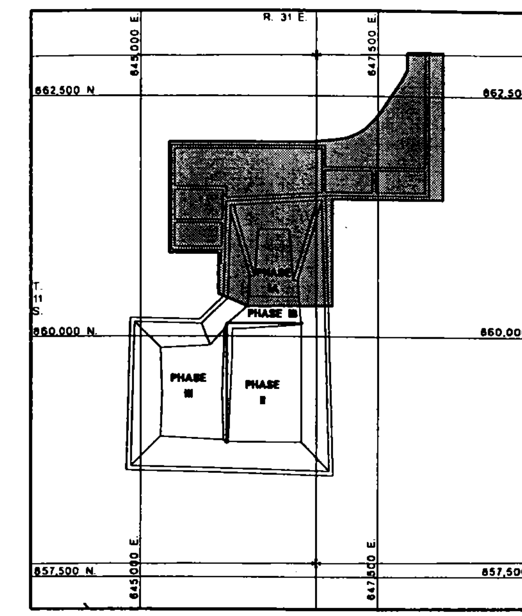
   If possible employees and visitors will relocate to the entrance gate of the facility and await further instructions. If this is not possible, or if routes leading to the facility entrance are unsafe, then personnel will be instructed to assemble in a safe location so that all personnel and visitors may be accounted for.

4. Evacuation of Local Areas

   If the EC's assessment indicates that evacuation of local areas may be necessary, the appropriate local authorities will be notified immediately. The EC will provide assistance, as necessary, to the appropriate officials in making area evacuation decisions and notifications. Notifications by the EC might include the government official designated as the on-scene coordinator for the geographical area or the National Response Center (1-800-424-8802).



MAP KEY



NOTES:
1. FOR GENERAL NOTES AND LEGEND INFORMATION SEE DRAWING No. 2, "INDEX, LEGEND AND GENERAL NOTES".
2. UNIMPROVED ROADS AND CONSTRUCTION HAUL ROADS NOT SHOWN. GRAVEL LINED ACCESS ROADS ARE 2 WAY TRAFFIC. ALL SITE ACCESS ROADS SPEED LIMIT IS 15 MPH, CONSTRUCTION HAUL ROAD SPEED LIMIT IS 35 MPH.

PATRICK G. CORSER — NEW MEXICO — 12236 — REGISTERED PROFESSIONAL ENGINEER

PROFESSIONAL ENGINEER'S STATEMENT

I, Patrick G. Corser, state that this drawing was prepared under my supervision and all the information presented hereon is true and correct to the best of my knowledge and information.

Date — Patrick G. Corser, NM P.E. 12236

Not For Construction

REV No	REVISIONS	DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	Issued for Review	12/28/00	P.Corser	K.Conrath	P.Corser

TRIASSIC PARK WASTE DISPOSAL FACILITY

DRAWING TITLE:

EMERGENCY EVACUATION PLAN

TerraMatrix
MONTGOMERY WATSON
Mining Group

Sheet 1 Of 1 Sheets
SCALE: As noted
DRAWING No. L-1

SCALE 0 200 400 Feet

AutoCAD FILE: /AC.DWG PROJECT NUMBER: 2450192.02180200

Permit Renewal Application
October 17, 2011

Attachment D

Inspection Procedures

Prepared for:
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Modified by:
The New Mexico Environment Department
March 2002

~~Permit~~ Attachment D. Inspection Procedures

~~Modified from the Permit Application, Volume I,~~

~~Section 5.2~~

5.2 Inspection Procedures

This section of the permit application provides written inspection guidelines and an inspection schedule for the Facility in accordance with ~~20~~ NMAC 20.4.1.

5.2.1 General Inspection Procedures

Facility personnel will conduct inspections of all equipment and structures as frequently as necessary to prevent, detect, or respond to environmental or human health hazards. Inspection records describing malfunctions, deteriorations, operator errors, and discharges that may cause or contribute to a release of hazardous waste constituents to the environment or that may be a threat to human health will be kept at the Facility administration building for three years from the date of the inspection. Specific inspection procedures are outlined in Sections 5.2.2 through 5.2.10.

Personnel will receive general training about hazardous waste inspections as part of the Facility hazardous waste training program. Personnel responsible for inspecting particular equipment or areas of the Facility will receive classroom and/or on-the-job training in inspection procedures. Inspection procedures will be described in the operating manual, which will be located in the Emergency Coordinator's~~EC's~~ office.

Facility guards will make rounds of the Facility at least once daily to detect any unauthorized entry to the Facility or any other abnormalities. The guards will not use inspection checklists, but they will notify the Emergency Coordinator (EC) and/or emergency response personnel of any spills or other emergencies. Requirements for the EC and/or emergency response personnel, subsequent to an inspection notification, are outlined in Permit Attachment C, Contingency Plan.

5.2.1.1 Inspection Checklist

Inspection checklists and an inspection schedule have been developed to ensure that inspections occur at appropriate frequencies. An inspection schedule matrix is provided as Table 5-1 in Permit Attachment D1, Inspection Schedules and Checklists~~, Table 5-1~~. This matrix will be expanded, as necessary, to reflect new equipment or changes to existing equipment inspection frequencies.

Inspection frequencies will vary according to the type and age of the equipment, the frequency of its use, and its importance in preventing environmental incidents. The inspection frequencies provided in Table 5-1 show that inspections will occur frequently so that problems can be identified in time to correct them before harm is done to human health or the environment.

The inspection checklists will identify the name of the inspector, date and time of the inspection, frequency of inspection, specific items to be checked, any notations or observations of abnormalities, and the nature and date of any corrective actions taken. Checklists are also provided in Permit Attachment D1. The inspection schedules will be kept in the office of the ~~Emergency Coordinator (~~EC~~)~~.

When new or modified equipment is installed or used at the Facility, the inspection procedures, forms, and schedule will be revised to reflect these changes and will be submitted to NMED.

5.2.1.2 Remedial Action

Facility personnel or contract personnel will remedy any deterioration or malfunction of equipment or structures encountered during inspections. The remedy will be completed in sufficient time to ensure that the problem does not result in an environmental or human health hazard.

All repairs to permitted portions of the Facility will be made in accordance with the original construction specifications and Construction Quality Assurance (CQA) Plan.

If a hazardous or potentially hazardous condition is identified, the EC, as specified in the Contingency Plan, will be notified immediately to assess the situation and determine how to correct the situation and whether the Contingency Plan should be implemented.

5.2.2 Landfill Inspection Procedures

Landfill liners and the cover will be inspected during and immediately after installation in accordance with the CQA Plan, which is discussed in Permit Attachment A, General Facility Description and Information, Section 2.5.2.3, and contained in Permit Attachment M, Construction Quality Assurance Plan.

The landfill and associated equipment will be inspected weekly and after storms unless otherwise specified. Records of the inspections will be maintained in the operating record, which will be kept in the administration building.

If deterioration or any other abnormalities are noted during inspection of the landfill or associated components, the inspector's supervisor will be notified and will determine the appropriate course of action for correction. If the supervisor is not available, the EC will be summoned to make the determination.

The landfill will be inspected by properly trained personnel weekly and after storms for such items as spills, leaks, odors, wind-blown particulate matter, any evidence of deterioration of the landfill itself, and any malfunction or improper operation of the run-on/runoff control systems. All inspections will be documented on the landfill inspection checklist, described in Section 5.2.1.1 and contained in Permit Attachment D1. Inspection checklists will be kept for at least 3 years, in accordance with 40 CFR 264.15(d).

During the active life and during closure of the landfill, the leachate collection and recovery system (LCRS) and leak detection and removal system (LDRS) will be checked daily for the presence of liquid. The amount of water in the system can be used to determine if the system is functioning properly. The system will either be inspected through the cleanout pipe, which is connected to the primary collection pipe and the sump riser pipe, or with magnehelic gages or other liquid detection devices, if they are installed. The leachate collection tank will be inspected in accordance with the procedures outlined in Section 5.2.5.

During the operational phase of the landfill, periodic checks will be made within the landfill to detect the presence of hazardous gases and volatile organics. Surveys of the active landfill surface area and the riser pipes with an organic vapor meter (OVM) or comparable device will be performed quarterly to detect the presence of organic compounds.

If it is evident that particulate matter from the landfill is subject to dispersal by the wind, the active portion of the landfill will either be covered or managed to control the dispersal (see Permit Attachment A, Section 2.5.1.7). Adding water to prevent wind erosion will be limited so that ponding in the landfill does not occur. If the dispersion is noted during an inspection, the landfill supervisor will notify the sprayer truck operator to rectify the situation.

The stormwater collection basin within the landfill~~and holding unit~~ associated with the runoff/run-on control systems will be inspected to monitor whether stormwater~~ensure that liquid has not accidentally~~ accumulated following storm events. Stormwater collected within the landfill that has the potential to have contacted waste with be managed by enhanced evaporation through recirculation on the landfill soil cover. The recirculation system is described in the Engineering Report in Permit Attachment L. The collection collection basin~~system~~ will be emptied as quickly as possible to ensure that the design capacity of the system is not exceeded.

~~5.2.3 Evaporation Pond Inspection Procedures~~

~~Evaporation pond liners will be inspected during and immediately after construction and installation in accordance with the CQA Plan, which is discussed in Permit Attachment A, Section 2.5.2.3, and contained in Permit Attachment M.~~

~~While the evaporation pond is in operation, it will be inspected daily to detect any sudden drops in the level of the pond's contents and to measure the volume of and remove any liquid that has accumulated in the leachate collection and leak detection sumps. The daily inspections will also serve to ensure that there is no potential for overtopping by wind or wave action. Since all discharges into the pond will be monitored, visual inspections will be adequate.~~

~~Other inspection items, such as condition of berms, warning signs, and surrounding area, will be checked weekly and after storms. Weekly visual inspections will also be conducted to verify the integrity of the liners and associated systems. Visible portions of the leachate collection pipes and pump will be visually inspected weekly for deterioration. The concrete pad for tanker discharge will be visually inspected weekly for accumulation of liquids. The area around the pond will be inspected weekly for any signs of deterioration, leaks, erosion, etc. The evaporation pond berms will be inspected for any sign of abnormal deterioration, which may include excessive sloughing or the development of significant cracks. All of the above inspections will be used to assess the integrity of the surface impoundments.~~

~~An inspection checklist for the evaporation pond is provided in Permit Attachment D1.~~

~~5.2.4 Container Storage Area Inspection Procedures~~

~~Weekly visual inspections of container storage areas (drum storage area and roll off storage area) will be performed to identify the status of warning signs, condition of containers and labels, availability and accessibility of spill control and PPE, and the adequacy of aisle space and access/egress routes. Containers will be inspected for any signs of excessive corrosion, buckles, dents, holes, other structural defects or deterioration, and over-pressurization. An inspection checklist for container areas is provided in Permit Attachment D1.~~

~~If a container is found to be in poor condition, the inspector's supervisor will be notified, who will either arrange to transfer the hazardous waste to a new container, repair the existing container as specified by the manufacturer, or place the container in an overpack drum.~~

~~Containers used for storing liquids will be stored in a secondary containment area described in Permit Attachment A, Section 2.2. These areas will be inspected weekly during the container storage area inspections. The inspections will focus on (1) the condition of sump pits and trenches to ensure that they are free of cracks or gaps and are sufficiently impervious to contain leaks, spills, and accumulated liquids until the collected material is detected and removed; (2) pump operation; and, (3) placement of containers to ensure that designed liquid flow paths are not obstructed. A record of the inspection will be maintained in the operating record, which will be kept in the administration building.~~

Spilled or leaked waste or accumulated precipitation that requires removal to prevent overflow of collection systems that is identified during inspection will be removed in a timely manner.

5.2.5 Tank Inspection Procedures

The leachate storage tankTanks containing or treating waste will be inspected daily along with the daily inspection to check for leachate in the LCRS and LDRS. Tanks containing stored waste include the liquid waste storage tanks and the leachate storage tanks for the landfill. These inspections will focus on the status of warning signs, the adequacy and availability of spill control and personal protective equipment (PPE), the adequacy of access routes, and the condition of the tanks, ancillary equipment, and monitoring and leak detection systems. The inspection will focus on (1) overfill control; (2) equipment condition to detect any signs of corrosion or releases of waste from the tanks or ancillary equipment; (3) data gathered from monitoring and leak detection equipment to ensure that the tank system is being operated in accordance with design specifications; and (4) the Cathodic Protection Systems, as installed.

Secondary containment areas in which tanks are located will be inspected daily during the tank inspections. These inspections will focus on the condition of the containment surface to ensure that it is free of cracks or gaps and is sufficiently impervious to contain leaks, spills, or accumulated liquids until the collected material is detected and removed. Inspection records will be maintained in the Facility operating record, which will be kept in the administration building. An inspection checklist for tanks is provided in Permit Attachment D1.

5.2.6 Stabilization Unit Inspection Procedures

Inspection of the stabilization unit will be conducted according to the procedures specified in Section 5.2.5. The inspections will be conducted on days when the unit is operating and daily when waste is in storage. Additional inspection requirements are described in Section 2.4.6. Inspection records will be maintained in the administration building. The concrete vault area will be inspected monthly. If liquids are found they will be removed with a portable pump and transported to the liquid waste unit.

5.2.7 Security Equipment Inspection Procedures

Security inspections will be conducted daily and will include the following elements:

- visual inspection of the warning signs at all approaches to the Facility to ensure that the signs are present, legible, and securely attached to the fence;
- inspection of the Facility perimeter to ensure the integrity of the fence and gate by looking for signs of erosion of soil at the fence posts and corrosion or vandalism to the fence, fence posts, or locks;
- inspection and replacement, as necessary, of lights for the purpose of illuminating the Facility at night;
- inspection of structures for signs of erosion, tampering, or vandalism; and
- records of inspections will be maintained in the administration building.

5.2.8 Safety and Emergency Response Equipment Inspection Procedures

Safety and emergency response equipment inspections will occur monthly. This category of equipment includes first aid supplies; respiratory protection equipment (other than personally issued respirators, which will be each employee's responsibility); protective clothing, including hard hats, gloves, and suits; fire extinguishers; eye wash stations; safety showers; empty 55-gallon drums; shovels; and spill cleanup and decontamination kits.

A monthly inventory of safety-related supplies and equipment will be performed to ensure that the items are available, in good condition, and at designated locations. Inadequate or missing items will be replaced or repaired.

Fire protection equipment, including fire extinguishers and fire hoses, will be inspected monthly and after each use to ensure that the equipment is capable of functioning properly and that access to the equipment is not blocked. Each fire extinguisher will be inspected to ensure that the seal around the handle is intact, that the pressure gauge indicates that the unit is adequately charged, and that an Underwriter's Laboratory listing label is attached to each unit. Building sprinkler systems will be inspected according to manufacturer specifications. Chemical fire-suppression systems will be checked to ensure that adequate quantities of the chemical and water exist. The fire-suppression vehicles will also be tuned up at least annually and inspected monthly. Records of inspections will be maintained in the administration building for each unit.

The public address (PA) system will be tested daily to ensure proper operation. In lieu of daily testing, the Facility may opt to broadcast music 24 hours a day, which ensures proper operation of the unit at all times.

Hand-held radios will be tested prior to use each day and periodically throughout the day. The units will be recharged after each shift to ensure that they are operating properly.

5.2.9 Loading and Unloading Area Inspection Procedures

Waste loading and unloading areas will be inspected daily when in use. The inspections will focus on integrity of the containment structure and safety-related issues that could lead to hazards or waste spills. Signs will be located at each loading and unloading area indicating that equipment or materials should not be left unattended as they could be obstructions for the loading and unloading operation.

On-site roadways and vehicle traffic areas will be inspected on a preventive maintenance order (PMO) schedule to ensure that potential safety hazards, such as road surface deterioration, are minimized or avoided. Records of inspections will be maintained in the administration building for each unit.

~~5.2.10 Truck Wash Area Inspection Procedures~~

~~The sump and sediment bins will be inspected weekly for the accumulation of sediment and liquids in the sump and will be removed to the wash water storage tank. The wash water collected at the truck wash area will be sampled according to Permit Attachment F, *Waste Analysis Plan*, Section 4.6, and analyzed according to Permit Attachment F, Section 4.5.6.~~

Permit Attachment D1. Inspection Schedules and Checklists

**Modified from the Permit Application,
Volume I, Section 5.2, Table 5-1, and Volume II, Appendix I**

Table 5-1. Triassic Park Waste Disposal Facility Inspection Schedule

Inspection Item - Problem or Problem Area	Inspection Time
General Facility	
Security equipment – signs, perimeter fences, lights	Daily
Stormwater detention basin – liner	Weekly and after storms
Surface water diversion ditches to stormwater detention basin	Weekly and after storms
Landfill	
Liner and cover systems - uniformity, damage and imperfections	During construction and installation
Liners and cover deterioration and malfunction	During and immediately after construction
Spills, leaks, odors, windblown particulate	Weekly and after storms
Run-on/run-off control system - uniformity, damage and imperfections	Weekly and after storms
LCRS/LDRS presence of liquid and volume of liquid pumped	Daily and after storms
Leachate collection tank (while holding waste) for condition and proper function	Daily
Hazardous and organic gases	Quarterly
Ancillary equipment	Manufacturer recommended
Sump pumping and instrumentation	Annually
Evaporation Pond	
Liners and cover systems for uniformity, damage, and imperfections	During construction and installation
Pond freeboard for level for changes	Daily and after storms
Area surrounding pond	Weekly
Run-on/run-off control system - uniformity, damage and imperfections	Weekly and after storms
LCRS/LDRS for presence of liquid and volume of liquid pumped	Daily and after storms
Berms	Weekly
Integrity of liners and associated system	Weekly
Concrete pad for tanker discharge	Weekly
Container Storage Areas - Drum Handling Unit and Roll-off Unit	
Condition of containers, signs, other safety equipment, aisle space	Weekly
Secondary containment condition, presence of liquid, and volume of liquid pumped	Weekly
Run-off/run-on ditches – uniformity, damage and imperfections	Weekly and after storms
Containers with >500ppmw volatile organic compounds	Monthly
Ancillary equipment	Manufacturer recommended
Leachate Storage Tanks	
Condition of tanks, signs, other safety equipment, access routes,	Daily (when storing)

overfill control	
Secondary containment condition	Daily
Runoff/run-on ditches – uniformity, damage and imperfections	Weekly and after storms
Leak test on ancillary equipment	Annually
~~***Stabilization Unit***~~	
~~Condition of unit when in operation – bins, ancillary equipment, monitoring systems~~	~~Daily~~
~~Condition of unit when empty~~	~~Monthly~~
~~Secondary containment condition, presence of liquid, and volume of liquid removed~~	~~Daily~~
~~Concrete vault area – remove liquids if present~~	~~Monthly~~
~~Run-off/run-on ditches – uniformity, damage and imperfections~~	~~Weekly and after storms~~
~~Sonic test to ensure thickness of tanks~~	~~Annually~~

Inspection Checklist – Operational Days

Inspections shall be conducted once every operational day (except as noted). An operational day is defined as a day in which waste management activities occur at the site. For purposes of this definition, laboratory operations do not constitute an operational day.

The recording of liquid level readings for Leak Detection Systems, Leachate Collection Systems, collection tanks, and freeboard shall be maintained in Facility log books. Only the indication of a problem for each system shall be noted and recorded on the inspection checklist.

Inspectors are required to date and record the time of the inspection and sign their names on the Inspection Checklist that they complete. All items shall be responded to by indicating that an item is either a problem or is not a problem. If a problem is observed, a description of the problem will be recorded. If an item is not inspected, the Inspector shall respond by writing "NI" in the Problem column with an explanation of why it was not inspected. In the event the Inspector cannot complete a checklist, the new Inspector shall continue with the same inspection and shall date and sign his/her name to that checklist.

An Inspection Corrective Action Report, which will include the date and time of repairs and remedial actions taken shall be initiated and distributed by the Inspector. The remediator will retain the original copy until the item has been corrected. A second copy will be given to management and the third copy will remain with the Inspector. The signed original will then be filed with the originating checklist upon completion.

Inspection Corrective Action Report

Current Items	New Items	Corrected Items	Comments
1	1	1	Reference Corrective Action Report, (Title and Date) for any corrections.
2	2	2	
3	3	3	
4	4	4	
Reviewed by Manager of Environmental Affairs and Regulatory Compliance:			***Date:***

Precipitation and Wind Readings

1. **Precipitation**

Date and time recorded:__________________

Amount and type since last daily inspection to the nearest 0.1 inch:________________

Gauge working: Yes____ No____

2. **Wind Readings**

Date and time recorded:__________________

Wind Direction:_________________

Wind speed in mph:__________________

Recorder working: Yes____ No____

GENERAL SITE

1. **Drainage Ditches**
   Date and time inspected:____________________

Ditches Checked	**Description and General Condition**
1.	
2.	
3.	
4.	
5.	
6.	
7.	

Inspection Item	**Problem Yes/-No**	**If Yes, Description and Ditch No.**
Erosion	______	______________________________
Obstructions	______	______________________________
Overflow or Imminent overflow	______	______________________________
Runoff Present	______	______________________________
Windblown Debris	______	______________________________
Spill Present	______	______________________________

2. **Security Fencing and Gates**
   Date and time inspected:____________________

a. Any unauthorized entry noted.	______	______________________________
b. Repairs required	______	______________________________

Inspection Item		Problem Yes/-No		If Yes, Description
3.	**Sampling Station** Time Inspected: ___________			
a.	Spills, Leaks or unauthorized discharges	______		______________________
b.	Obstructions in floor collection trenches	______		______________________
c.	Spills or Ponding			
•	On roadways	______		______________________
•	On access ramps	______		______________________
•	On loading and Unloading areas	______		______________________

4. ~~Tanker and~~ **Truck Parking Area**
Date and time Inspected:___________

Inspection Item		Problem Yes No	If Yes, Description
a.	Entry areas:		
•	Deterioration	______	______________________
•	Cracking	______	______________________
•	Corrosion	______	______________________
b.	Spills or Ponding		
•	On roadways	______	______________________
•	On loading and Unloading areas	______	______________________

~~HAZARDOUS WASTE MANAGEMENT UNITS~~

1. ~~DRUM HANDLING UNIT (WEEKLY)~~

~~Date and time inspected:~~ ________________

Inspection Item	Problem Yes No	If Yes, Description
Drums:		
• Leaks	______	______
• Corrosion	______	______
• Deterioration	______	______
• Incompatibility with content.	______	______
• Rows more than 2 drums wide	______	______
• Lack of pallets for	______	______
• Aisle space less than 2.5 feet	______	______
•		

Inspection Item	Problem Yes No	If Yes, Description
c. Compatibility group designation not visible on drums	______	______
d. Spills or Ponding		
• On roadways	______	______
• On access ramps	______	______
• On loading and Unloading areas	______	______
e. Presence of liquids or solids in:		
• Spill containment trenches	______	______
• Sump System 1	______	______
• Sump System 2	______	______
• Sump System 3	______	______
• Sump System 4	______	______
• Sump System 5	______	______
• Sump System 6	______	______
• Sump System 7	______	______
f. Incompatible waste in same segregation area.	______	______

~~g. Unreadable or no signs posting PPE requirements at entry doors.~~ ______ ____________________

~~h. Does waste contain VO concentrations greater than 500 ppmw~~ ______ ____________________

~~(If yes, see inspection forms for Volatile organic waste.)~~

~~i. No cracks on concrete floor and epoxy coating not damaged.~~ ______ ____________________

1A. DRUM HANDLING UNIT (VOLATILE ORGANIC WASTES) (WEEKLY)

Date and time inspected:____________________

Inspection Item	Problem Yes No	If Yes, Description
a. Cover and closure devices such as lids, bungs, caps etc. are secure	______	______

- If coverage closure device is not properly secured, then secure, repair or replace.
- If volume is less then 0.1 m^3, no additional inspection required.
- If volume is between 0.1 m^3 and 0.46 m^3, then confirm requirements for air monitoring for level 1 containers (40 CFR 264.1086)
- If volume is greater then 0.46 m^3, then confirm requirements for air monitoring for level 1 or level 2 containers, depending on container type (40 CFR 264.1086).

~~2. Roll-Off Storage Unit – Non-Stabilized (Weekly)~~

~~Date and time inspected:~~ ____________________

~~Inspection Item~~	~~Problem Yes No~~	~~If Yes, Description~~
~~a. Containers:~~		
~~• Spills~~	______	______
~~• Corrosion which affects structural integrity or Containment capability~~	______	______
~~• Deterioration~~	______	______
~~• Incompatibility with contents~~	______	______
~~b. Open containers at time of inspection while not involved in sampling~~	______	______
~~c. Compatibility group designation not visible on containers~~	______	______
~~d. Incompatible waste in same segregation area.~~	______	______
~~e. Spills or Ponding~~		
~~• On roadways~~	______	______
~~• On access ramps~~	______	______
~~• On loading and Unloading areas~~	______	______
~~f. Presence of liquids in sump.~~	______	______
~~g. Roll-off units within exclusion zone for storm water storage.~~	______	______
~~h. Deterioration or leaks in containment berms.~~	______	______
~~i. Columns less than 4 feet wide, rows less than 2.5 feet wide.~~	______	______

Roll Off Unit Stabilized (Weekly)

Date and time inspected: ____________________

Inspection Item	Problem Yes No	If Yes, Description
a. Containers:		
• Spills	______	______
• Corrosion which affects structural integrity or Containment capability	______	______
• Deterioration	______	______
• Incompatibility with contents	______	______
b. Open containers at time of inspection while not involved in sampling	______	______
c. Compatibility group designation on containers.	______	______
d. Incompatible waste in same segregation area	______	______
e. Spills or Ponding		
• On roadways	______	______
• On access ramps	______	______
• On loading and Unloading areas	______	______
f. Presence of liquids in sump.	______	______
g. Roll-off units within exclusion zone for storm water storage.	______	______
h. Deterioration or leaks in containment berms.	______	______

3. Liquid Waste Receiving and Storage Unit (Daily)[1]

Date and time inspected: ________________

Inspection Item	Problem Yes No	If Yes, Description
a. Leaks or spills in area surrounding tanks.		
•Tank #1	______	______
•Tank #2	______	______
b. Evidence of excessive corrosion		
•Tank #1	______	______
•Tank #2	______	______
c. Leaks in above grade piping, hoses, valves and pumps	______	______
d. Readings compared with operating log		
•Tank #1	______	______
•Tank #2	______	______
e. Proper operation: of tank vents of level indicators		
•Tank #1	______	______
•Tank #2	______	______
f. Liquids in concrete basin. .	______	______
g. Liquid in secondary containment. .	______	______
h. Spills or Ponding		
•On roadways	______	______
•On access ramps	______	______
•On loading and Unloading areas	______	______

[1] Leak Test on Ancillary Equipment is Required Annually.

☐ 4. Stabilization Unit (Daily)

Date and time inspected:________________

Inspection Item	Problem Yes No	If Yes, Description
a. Presence of unknown materials, fume or gas-producing reactions or excessive dust generation.	______	______
b. Posted sign to the Stabilized Unit that denotes the protection level are unreadable or missing	______	______
c. Spills or ponding on process area floor.	______	______
d. Treatment Mixing Basin has a freeboard less than 2 feet	______	______
e. Dust Suppression System:		
•Worn hoses or pipes	______	______
•Loose fitting Hydraulic leaks	______	______
f. Mechanical Mixing System:		
•Worn hoses or pipes	______	______
•Loose fitting Hydraulic leaks	______	______
•Conveyor belts not operating properly	______	______
•Electric cutoff not functioning	______	______
g. Steel Bins:		
•Cracks or dents	______	______
•Punctures	______	______
•Excessive wear	______	______
h. Fluids in leak detection system	______	______
i.. Damages to surface within concrete vault. system	______	______

Stabilization Unit (Monthly)

Date and time inspected:____________________

Inspection Item	Problem Yes No	If Yes, Description
a. Steel bins (when empty)		
•Cracks	______	______
•Punctures	______	______
•Excessive wear	______	______
b. Concrete frames for bins:		
•Spills or ponding on floor	______	______
•Cracks in concrete	______	______

5. Evaporation Pond Unit (Daily)

Date and time inspected:____________________

Average Daily flow rate __________ gallons/day
Daily Liquid Level ________________ ft.

Inspection Item	Problem Yes No	If Yes, Description
a. Spills, discharges, leaks around perimeter.	______	______
b. Staff gauge not visible.	______	______
c. Liquid levels above max fill line	______	______
d. Liquid levels above pumping levels in LDRS.	______	______
e. Liquids levels above pumping levels in Vadose Zone System.	______	______
f. Liquids present in secondary containment system.	______	______
g. Liquid levels above max storage capacity in the pond.	______	______

~~Evaporation Pond Unit (Weekly and after storms)~~

~~Date and time inspected:~~ ____________________

~~Inspection Item~~	~~Problem Yes No~~	~~If Yes, Description~~
~~a. Seeps around Pond perimeter.~~	______	______
~~b. Sloughing or Damage to Berms.~~	______	______
~~c. Damage to exposed liner system.~~	______	______
~~d. Damage to protective netting.~~	______	______
~~e. Sudden drop in impoundment contents.~~	______	______
~~f. Amount of liquid removed from leak detection system.~~	______ ~~gallons~~	

~~6. Truck Wash Facility~~

~~Date and time inspected:~~ ____________________

~~Inspection Item~~	~~Problem Yes No~~	~~If Yes, Description~~
~~a. Spills or leaks in or around surrounding area~~	______	______
~~b. Tank leaking~~	______	______
~~(Note which tank)~~	______	
~~c. Ancillary equipment leaking~~	______	______
~~d. Collection trench overflowing~~	______	______
~~e. Obstructions in drainage system~~	______	______

~~f. Liquids above high level point in collection tank~~ _____ ____________________________

~~Note liquid levels~~ _____ ____________________________

~~g. Deterioration, leaks or corrosion of the water recycling system~~ _____ ____________________________

~~Note solid levels~~ _____ ____________________________

~~h. Recycling System Not Operating Properly~~ _____ ____________________________

~~7.~~ Landfill (Daily)

Date and time inspected:______________________

Inspection Item		**Problem Yes/-No**	**If Yes, Description**
a.	Ponding or liquids inside cell	______	______________________________
b.	Erosion of protective soil level	______	______________________________
c.	Liquid above pumping level in LCRS	______	______________________________
d.	Liquid above pumping level in LDRS	______	______________________________
e.	Liquid above pumping level in Vadose Zone Monitoring Sump	______	______________________________
f.	Spills, discharge, leaks, around leachate storage tank	______	______________________________
g.	Liquids in secondary containment for leachate storage tank	______	______________________________
h.	Liquid levels above max storage capacity in leachate storage tanks	______	______________________________
i.	Spills or Ponding		
•	On roadways	______	______________________________
•	On access ramps	______	______________________________
•	On loading and Unloading areas	______	______________________________

Landfill (Weekly)

Date and time inspected:______________________

Inspection Item	Problem Yes/-No	If Yes, Description
a. Spills, discharge leaks, and/or wind blown debris around perimeter	______	____
b. Excess dust generation on haul roads	______	____
c. Blockage or damage to runoff/run-on control systems	____	____
d. Amount of liquid removed from the sump	______	____
LCRS System #1	______gallons	
LDRS System #2	______gallons	
Vadose System #3	______gallons	
e. Depth of water in landfill contaminatedined water collection basin	_____ft	
f. Depth of water in landfill stormwater collection basin	______ft	

Landfill (Quarterly)

Date and time inspected:______________________

Inspection Item	Problem Yes No	If Yes, Description
a. Organic gas present and need for air quality permit (above background)	______	____

Permit Renewal Application
October 17, 2011

Attachment E

Personnel Training

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~~Permit~~ Attachment E. Personnel Training

~~Modified from the Permit Application, Volume I,~~

~~Section 7.0~~

7. Personnel Training

The personnel training program for the Facility will be developed in accordance with 40 CFR 264.16 as adopted by the State of New Mexico in the New Mexico Hazardous Waste Management Regulations, Part V. This plan documents training procedures to be used by the Facility for all new employees and refresher training for experienced workers to ensure that all employees perform their work in full compliance with 40 CFR 264.16.

As illustrated in Figure 7-1[RF1], personnel will be divided into three categories for the purposes of the Resource Conservation and Recovery Act (RCRA) training: Facility personnel, visitors, and off-site emergency response personnel. Facility personnel will be further categorized based on whether or not they will handle hazardous waste. Personnel will receive training appropriate to their specific job responsibilities. All Facility personnel will be required to complete classroom training within six months of employment and annually according to the requirements of ~~the~~40 CFR 264.16. Employees who will handle hazardous waste and supervisors of employees who will handle hazardous waste will be required to complete on-the-job training (OJT) and OSHA 40-hour training and annual refreshers. Employees assigned to the Facility will not be allowed to work without direct supervision until completing the training program relevant to the positions in which they are employed. New personnel will be required to complete their training program as soon as practicable, but no later than six months, following their effective date of employment at the Facility.

Section 7.1 describes job titles, qualifications, and duties; Section 7.2 describes training content and frequency; and Section 7.3 describes record keeping procedures.

7.1 Job Titles and Duties

To facilitate safe and effective Facility operation, the training program is designed to provide training commensurate with job responsibilities. A list of qualifications, duties, and special training required for appropriate personnel will be developed and maintained on-site prior to commencement of operations. This section includes a description of the qualifications and responsibilities of the RCRA training officer, the Emergency Coordinator (EC), waste handlers, the site security officer, laboratory specialists, and maintenance personnel. Although other categories of personnel may work at the site, these six categories include key personnel with respect to ensuring safety and compliance and therefore are included in this section. It is important to note that one person may fulfill the responsibilities of more than one of the job categories outlined below.

7.1.1 RCRA Training Officer

The RCRA training officer will be responsible for developing and implementing a RCRA training program that is in compliance with 40 CFR 264.16, Personnel Training.

The RCRA training officer will possess the following qualifications:

- a four-year science or engineering degree or sufficient experience in hazardous waste management to oversee the training program;

Facility Personnel

- Those who handle hazardous waste
  - classroom training
  - on-the-job training
  - OSHA 40-hour
- Those who do not handle hazardous waste
  - classroom training

Visitors

- Expected to be onsite briefly of infrequently
  - basic training on actions to be taken during an emergency; does not allow visitors to attempt to respond to emergencies except in very limited circumstances

Offsite Emergency Responders

- May be different for different organizations
  - training tailored to their role
  - familiarization with site

FACILITY RCRA TRAINING PROGRAM

TRIASSIC PARK WASTE DISPOSAL FACILITY

Figure 7-1

- working knowledge of the New Mexico Hazardous Waste Act and the New Mexico Hazardous Waste Management Regulations;
- knowledge of site-specific hazardous waste management procedures;
- a thorough understanding of the purpose of the Contingency Plan and emergency procedures and the ability to implement them; and
- 40-hour OSHA and annual refresher training.

The RCRA training officer will have the following responsibilities:

- developing and implementing the RCRA training program, including classroom training development and revision;
- establishing course curricula;
- conducting training;
- maintaining and updating, as needed, a list of all employees requiring training; this list will provide a personalized training history for each employee, which includes job title, training schedule, course attendance, and test results;
- reviewing any new job classifications to determine if ~~on-the-job-training (~~OJT~~)~~ is required (supervisors may also request that employees receive OJT);
- scheduling training;
- ensuring that all personnel with RCRA responsibilities are trained as soon as practicable following the effective date in a position and are annually updated; and
- conducting an annual review to determine which personnel require OJT.

7.1.2 Emergency Coordinator

The EC will coordinate all emergency response activities and will have the authority to commit the resources necessary to implement the Contingency Plan contained in Section 6.0. The Facility will appoint a primary EC as well as secondary ECs to ensure that someone is always available to serve as the EC. The secondary ECs must meet the same qualifications and responsibilities, outlined below, as the primary coordinator.

The EC will possess the following qualifications:

- a four-year science or engineering degree or sufficient experience in hazardous waste management and emergency response to coordinate all aspects of emergency response;
- working knowledge of the New Mexico Hazardous Waste Act and the New Mexico Hazardous Waste Regulations;
- familiarity with all aspects of the Contingency Plan and emergency procedures, all operations and activities at the Facility, the location and characteristics of waste handled, the location of records within the Facility, and the Facility layout prior to acting as EC; and
- 40-hour OSHA training, annual refreshers, and OSHA supervisor training.

The EC will have the following responsibilities:

- either being on the Facility premises or being available to respond to an emergency by reaching the Facility within a short period of time;
- notifying all appropriate Facility personnel upon awareness of an emergency situation;
- notifying all appropriate state or local agencies with designated response roles;
- identifying the character, exact source, amount, and extent of any released materials;
- assessing possible hazards to human health and the environment that may result from a release, fire, or explosion;
- notifying local authorities if a release, fire, or explosion has occurred that could threaten human health or the environment;
- notifying the National Response Center if a release, fire, or explosion occurs that could threaten human health or the environment;
- taking all reasonable measures during an emergency to ensure that fires, explosions, and releases do not occur, recur, or spread to other hazardous waste at the Facility;
- if appropriate, when the Facility ceases operations in response to a release, fire, or explosion, monitoring for leaks, pressure build-up, gas generation, or ruptures in equipment;
- providing for the treating, storing, or disposing of recovered waste, contaminated soil or surface water, or any other material that results from a release, fire, or explosion at the Facility;
- ensuring that no waste that may be incompatible with the released material is treated, stored, or disposed until cleanup procedures are completed and that emergency equipment is cleaned and fit for its intended use prior to resumption of operations;
- notifying NMED and appropriate local authorities before operations are resumed;
- noting in the operating record the time, date, and details of any incident that requires implementing the Contingency Plan; and
- submitting a written report to the NMED within 15 days of implementing the Contingency Plan.

7.1.3 Waste Handlers

Waste handlers will perform sampling, screening, unloading, transfer, ~~storage,~~ and loading of material.

The waste handlers will possess the following qualifications:

- high school diploma or equivalent; and
- two years of experience in hazardous waste operations.

The waste handlers will have the following responsibilities:

- verifying waste received;
- testing emergency equipment;
- inspecting Facility and emergency equipment;
- managing containers in such a way as to prevent leaks, spills, and ruptures;

- inspecting ~~container storage areas, tanks, the evaporation pond, and~~ the landfill;
- inspecting roll-off containers and drums for cracks or holes;
- repair of defects on roll-off containers and drums;
- inspection of non-regulated but potential SWMU units;
- maintaining runoff management system, control wind dispersal, and ensuring compliance with other operational requirements specific to the RCRA permit;
- assisting in maintaining the operating record; and
- preparing biennial reports, unmanifested waste reports, and other reports as necessary.

7.1.4 Site Security Officers

The site security officers will control access to the Facility, ensure site security, and possess high school diplomas or equivalent.

The site security officers will have the following responsibilities:

- controlling entry, at all times, through gates or other entrances to the active portion of the Facility;
- ensuring site security;
- inspecting the perimeter fence to prevent unknowing entry and prevent the unauthorized entry of persons or livestock onto the active portion of the Facility; and
- initially locating and then maintaining warning signs that indicate "Danger - Unauthorized Personnel Keep Out" in both English and Spanish, which will be posted on the perimeter fence and will be legible from a distance of 25 feet.

7.1.5 Laboratory Specialist

The laboratory specialist will help to assure that wastes received at the Facility are consistent with waste profiles supplied by generators.

The laboratory specialist will possess the following qualifications:

- a four-year science degree or sufficient experience to adequately perform acceptance testing;
- working knowledge of the New Mexico Hazardous Waste Act and the New Mexico Hazardous Waste Regulations; and
- familiarity with the Waste Analysis Plan and waste analysis practices and procedures.

The laboratory specialist will have the following responsibilities:

- developing sampling, characterization, and testing procedures for waste received and generated at the Facility;
- directing or performing sampling, characterization, and testing for the Facility;
- determining if waste is acceptable for ~~treatment, storage, and~~ disposal according to waste profile information submitted by the generator;

- determining if the initial and annual full chemical analysis and fingerprint analysis confirm generator information provided on the waste profile and manifest; and
- implementing the laboratory QA/QC program.

7.1.6 Maintenance Personnel

Maintenance personnel will maintain all equipment, buildings, roads and ditches.

Maintenance personnel will possess the following qualifications:

- high school diploma or equivalent; and
- two years experience in an industrial setting.

Maintenance personnel will have the following responsibilities:

- developing maintenance procedures; and
- performing maintenance-type activities, including repairs, preventive maintenance, and corrective actions associated with RCRA inspections.

7.2 Training Content and Frequency

Section 7.2.1 describes the training program for Facility personnel, Section 7.2.2 describes training for visitors, and Section 7.2.3 describes training for off-site emergency response organizations.

7.2.1 Training Program for Facility Personnel

All new employees will be required to successfully complete the training program related to their position. Training programs will include RCRA classroom training, job-specific training, OSHA 40-hour training, and annual refresher training for all three programs. OJT and OSHA 40-hour training sessions will be required only for those personnel who will handle hazardous waste and the supervisors of personnel who will handle hazardous waste. Employees will not be permitted to assume unsupervised job duties until successful completion of all the required elements of their training program. As soon as practicable following a new employee's hire date, successful completion of the training program specific to his or her position must be accomplished, and certification of the completion will be recorded and kept on file by the RCRA training officer.

7.2.1.1 Classroom Training

The initial classroom training will consist of at least one 8-hour session. Annual refresher training will consist of at least one 4-hour session. The outline of the annual refresher is the same as the outline for the initial classroom training; however, the refresher training will be an abbreviated version of the initial training at an accelerated pace. The RCRA classroom training will include the following goals:

- developing a basic understanding of the regulatory requirements for a treatment, storage, and disposal facility;
- promoting understanding of policies and procedures necessary to protect human health and the environment;
- ensuring proper management of hazardous waste; and

- educating employees regarding response to emergencies.

The outline for the RCRA training class will consist of the following elements:

- an introduction to RCRA, including a general description of RCRA and Hazardous and Solid Waste Amendments (HSWA); the definition of hazardous waste; waste generator requirements; ~~treatment, storage, and~~ disposal requirements; and labeling, inspection, record keeping, and reporting requirements;
- requirements associated with the RCRA permit for the Facility;
- Facility-specific waste management, including general procedures for receipt and handling of waste from off-site as well as management of waste generated on-site;
- decontamination procedures;
- emergency procedures, including response to fires, explosions, and releases, and shutdown of operations;
- emergency equipment location and use;
- emergency systems, such as the communication and alarm systems and the fire suppression system;
- Contingency Plan;
- evacuation plan;
- waste minimization;
- occupational health and safety, including items such as personal protective clothing and equipment, general industrial safety, and employee right-to-know (the Hazard Communication Standard);
- transportation of hazardous waste, including marking, labeling, placarding, loading, use of shipping papers, record keeping, and other DOT requirements; and
- maintenance of documentation.

Facility tours and audio-visual aids in conjunction with lectures and procedure manuals will be utilized in the classroom training. A written test will be administered at the completion of classroom training. A grade of 80 percent or better will be required to demonstrate mastery of the course material. The course curriculum will be reviewed at least annually by the RCRA training officer to ensure that it is current and appropriate.

7.2.1.2 Job-Specific Training

The RCRA classroom training will be supplemented with job-specific training tailored to each employee's actual job responsibilities. Job-specific training may include additional classroom training and/or OJT. All employees who handle hazardous waste and supervisors of personnel who handle hazardous waste will be required to complete OJT. The purpose of OJT is not to demonstrate to personnel how to perform their duties, but rather to demonstrate how to perform their duties safely and in compliance with RCRA. OJT will be conducted in the work area by the line supervisor or foreman subsequent to classroom training. The length and complexity of the OJT will vary according to the employee's responsibilities. These minimum OJT sessions will be documented by both the employee and the supervisor by signing and dating a form. The form will also indicate the length of time spent on OJT training. The signed forms will be maintained as part of the Operating Record as discussed in Section 7.3.

A checklist developed by the work area supervisor will be used for job-specific training. Prior to initial use of the checklist, it must be reviewed and approved by the RCRA training officer. All employees performing similar duties will have consistent job-specific training. The job-specific training checklist will be reviewed at least annually to ensure that it is current and appropriate for the subject job classification.

The job-specific training checklist will include the following elements:

- information about procedures relevant to the individual's position, where these procedures are located, and which personnel have the authority to implement the procedures, key operating parameters, and waste feed cut-off systems;
- location and use of communications or alarm systems;
- response to releases;
- emergency and routine shutdown of operations;
- Facility Contingency Plan and emergency procedures;
- evacuation procedures and location of emergency exits;
- response to leaks, spills, and overflows;
- Waste Analysis Plan procedures; and
- inspection and maintenance procedures.

Based on the checklist, Gandy Marley, Inc. (GMI) will develop a training outline specifically for each job-specific training program. The training programs specific to incident response positions, laboratory positions, waste handling positions, maintenance positions, emergency coordinators and site security officers are discussed below.

Incident Response Personnel

Specific classroom training and OJT for on-site individuals involved in incident response will focus on the emergency response equipment present at the facility. The training will address the use, maintenance, operation, purpose and limitations of the following specific equipment:

- fire-specific control equipment,
- personal protective equipment (PPE),
- spill control and decontamination equipment,
- emergency equipment,
- monitoring and communications equipment,
- shutdown operations,
- safety equipment,
- lock out/tag out program, and
- continuous air monitors.

Laboratory Personnel

Specific classroom training and OJT elements for laboratory personnel involved in analysis of hazardous waste will include:

- waste tracking procedures and profile forms,
- laboratory waste acceptance procedures,
- laboratory recordkeeping,
- waste pre-acceptance,

- waste discrepancy and rejection procedures,
- operation of on-site laboratory,
- proper analytical methods,
- laboratory quality assurance and quality control,
- laboratory safety and waste handling within the laboratory,
- laboratory and environmental monitoring equipment calibration,
- basic chemical concepts, and
- toxicology overview and exposure pathways.

Waste Handlers and Maintenance Personnel

Specific classroom training and OJT elements received by waste handlers and maintenance personnel will include:

- proper field sampling and testing procedures (waste handlers only),
- heavy equipment operations,
- waste handling precautions including chemical and physical hazards associated with each waste that will be handled on-site,
- drum and roll-off container handling,
- safety equipment,
- basic chemical concepts,
- hand and power tool safety and operation (maintenance personnel only),
- lock out/tag out procedures,
- waste compatibility issues,
- ~~waste segregation procedures in storage and during treatment,~~
- ~~storage area operations,~~
- ~~waste treatment selection procedures,~~
- waste tracking procedures and profile forms, and
- sampling recordkeeping procedure., ~~andtreatment data form procedure.~~

Emergency Coordinator

Specific classroom training and OJT elements for emergency coordinators will include:

- site emergency communications procedures,
- federal, state, and local agency emergency and all-clear notification procedures,
- qualitative and quantitative assessment of released materials,
- human health and environmental hazard recognition,
- release containment procedures,
- Facility-wide fire, explosion, and leak detection procedures during emergency responses and normal operations,

- procedures for recovering, treating, storing, and disposing of recovered waste, soil, organic liquid, and water resulting from an emergency response,
- emergency equipment decontamination and reuse procedures,
- emergency response recordkeeping plan, and
- written reporting requirements to the agencies.

Site Security Officers

Specific classroom training and OJT elements for site security officers will include:

- procedures for controlling entry to the facility,
- maintaining overall facility security including perimeter fence inspections, and
- maintenance of all warning signs.

7.2.1.3 OSHA 40-Hour Training

All personnel who handle hazardous waste and the supervisors of personnel who handle hazardous waste will complete OSHA 40-hour training as required by 29 CFR 1910.120. It is anticipated that, at least initially, the OSHA 40-hour training will be provided by an outside vendor. Personnel who have documentation of course completion for the 40-hour and refresher training will not be required to retake the 40-hour training.

7.2.2 Training for Visitors

Visitors who are expected to be in the Facility for only a short period of time and who will not be handling hazardous waste will be provided a short briefing on basic emergency procedures such as decontamination, emergency signals and alarms, and evacuation routes. Visitors will not be allowed on-site unless they are escorted by Facility personnel or unless other arrangements have been made with Facility personnel. The briefing will include the following information:

- what hazards that may be encountered at the Facility;
- how emergencies are signaled or announced, how help is summoned , what information is to be given, and to whom the information is given;
- where to report during an emergency;
- how to safely evacuate from the Facility;
- what standard operating procedures for visitors are;
- where check-in/check out locations are; and
- what safety equipment is required.

7.2.3 Training for Off-Site Emergency Response Organizations

Training will be established for off-site emergency response organizations through agreements with local agencies and contracts with vendors. This training will include, as appropriate, the following:

- site layout and site-specific hazards;
- the Contingency Plan;
- Facility emergency procedures;

- Facility decontamination procedures; and
- appropriate response techniques.

7.3 Record Keeping

In accordance with 40 CFR 264.16, records regarding job title, job description, training, and other appropriate documentation will be kept by the RCRA training officer.

7.3.1 Job Titles, Descriptions, and Duties

Job titles will be designated for each position at the Facility related to hazardous waste management and the name of each employee filling each job. Job descriptions will detail job duties and responsibilities for that position. The description will include the skills, education, and qualifications required for each position. A written description for each position will be maintained to determine the types and amounts of both introductory and continuing training to be given to each employee at the Facility.

7.3.2 Training Documentation

Records that document RCRA classroom training and OJT given to and completed by Facility personnel will be kept by the RCRA training officer. Training records on current employees will be kept until closure of the Facility. Training records on former employees will be kept for at least three years from the date the employee last worked at the Facility.

7.3.3 Other Documentation

Other documentation to be maintained at the Facility includes the following:

- documentation of the annual review of the curriculum for RCRA classroom training;
- documentation of the annual review of the OJT checklists; and
- RCRA classroom training test results.

Permit Renewal Application
October 17, 2011

Attachment F

Waste Analysis Plan

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Table of Contents

Section **Page**

List of Figures

Figure **Page**

List of Tables

Table **Page**

Permit Attachment F. Waste Analysis Plan

Modified from the Permit Application, Volume I,

Sections 4.0 through 4.5 and 4.5.2 through 4.9

4. Waste Analysis Plan

The Triassic Park Hazardous Waste Disposal Facility (the Facility) is a commercial facility that receives hazardous waste generated off-site for treatment, storage, and disposal. This Waste Analysis Plan (WAP) establishes Facility requirements for accepting and characterizing hazardous waste generated both off-site and on-site. The waste analysis planWAP requirements are established in the 1995 New Mexico Hazardous Waste Management Regulations at 20 NMAC 4.1.500 incorporating 40 CFR 264.13, 20 NMAC 4.1.800 incorporating 40 CFR 268.7, and 20 NMAC 4.1.900 incorporating 40 CFR 270.14(b)(3). The most recent revision of this Waste Analysis PlanWAP will be maintained at the Facility as part of the Facility Operating Record. The Facility will continually upgrade the waste analysis planWAP with regard to the land disposal restrictions (LDR) regulations contained in 40 CFR 268.

Section 4.1 identifies wastes which that will be accepted at the Facility and wastes which that are prohibited. Section 4.2 lists criteria for waste acceptance and management. Sections 4.3 and 4.4 contain pre-acceptance procedures for initial acceptance of hazardous waste received from off-site generators and management procedures for incoming shipments of waste. The various waste analysis protocols that will be required at the Facility are contained in Section 4.5. Sampling and analytical methods and protocols for quality assurance/quality control (QA/QC) are discussed in Sections 4.6 and 4.7. Section 4.8 explains the Facility's waste tracking system. Section 4.9 summarizes notification, certification, and recordkeeping requirements related to waste analysis.

4.1 Permitted and Prohibited Waste

Section 4.1.1 identifies hazardous waste permitted for acceptance at the Facility. Hazardous waste prohibited at the Facility is identified in Section 4.1.2.

4.1.1 Permitted Waste

The Facility will treat, store, and/or dispose of only those hazardous wastes listed in Part A of the Facility Permit Application. Only hazardous waste which meets the Land Disposal Restrictions (LDR) treatment standards identified in 40 CFR 268, Subpart D, or can be treated at the facility to meet these standards, will be accepted. These treatment standards are applicable to both primary contaminants and underlying constituents.

4.1.2 Prohibited Waste

The Facility will not accept the following wastes from off-site generators:

- *Dioxin-contaminated wastes:* Wastes listed in 40 CFR 268.31 as adopted by 20 NMAC 4.1.800.

- *Certain PCB-contaminated liquids:* Ignitable polychlorinated biphenyl (PCB)- contaminated liquids or liquids with PCB concentrations greater than or equal to 50 parts per million (ppm).

- *Certain PCB-contaminated soils:* Soils with PCB concentrations greater than or equal to 500 ppm will not be accepted at the Facility, except for those soils (or other wastes) ~~which~~ that are PCB bulk product waste or PCB remediation waste (40 CFR 761). The Facility may obtain a permit from the U.S. Environmental Protection Agency (EPA) for management of Toxic Substances Control Act (TSCA) wastes in order to accept other wastes containing PCB concentrations greater than 500 ppm. A copy of this permit will be transmitted to the New Mexico Environment Department (NMED) before such waste is accepted.

- *Organic liquids/sludges:* Liquids/sludges with organic concentrations at levels that make them subject to the treatment, storage, and disposal requirements described in 40 CFR 264 Subpart AA or CC; and that have not been treated, prior to receipt at the Facility, to applicable LDR treatment standards (40 CFR 264 Subpart AA and CC as adopted by 20 NMAC 4.1.500).

- *Explosives:* Any substance or article, including a device, ~~which~~ that is designed to function by explosion (i.e., an extremely rapid release of gas and heat) or ~~which~~that, by chemical reaction within itself, is able to function in a similar manner even if not designed to function by explosion.

- *Radioactive/nuclear materials:* Materials regulated by NMED or the New Mexico Oil Conservation Division and defined in 20 NMAC 3.1 Subpart 14, or materials regulated under the Atomic Energy Act of 1954, as amended (including source, special nuclear materials and byproduct materials as defined in 10 CFR 20.1003).

- *Medical waste:* Waste including infectious/biologic/pathogenic solid waste generated in the diagnosis, treatment, or immunization of human beings or animals, in research pertaining thereto, or in the production or testing of biologicals. This also includes infectious waste as defined in NMAC 9.1.105.AL.

- *Packing house and killing plant offal:* Defined as a special waste by 20 NMAC 9.1.105. BZ.

- *Certain hazardous debris:* Hazardous debris ~~which~~ that has not been treated, prior to receipt at the Facility, to meet the LDR treatment standards.

- *Certain lab packs:* Lab packs ~~which~~ that contain wastes [identified in 40 CFR 268, Appendix IV (adopted by reference in 20 NMAC 4.1.800)] excluded from lab packs under the alternative treatment standards of 40 CFR 268.42(c) (adopted by reference in 20 NMAC 4.1.800).

- *Compressed gases:* Gases stored at pressures higher than atmospheric.

- *Unknown or unidentified waste:* These wastes cannot be accepted at the Facility except by special provision and direction from the NMED Secretary (e.g., emergency clean-up operations) or until full characterization has been performed.

4.2. Criteria for Waste Management at the Facility

Waste managed at the Facility must meet the Facility's criteria for acceptance and management. Waste analysis (or, in some cases, acceptable process knowledge ~~(~~[AK~~)~~]) will be used to ensure determination of:

- Complete characterization of the waste.

- Compliance with LDR treatment standards, including, where applicable, underlying constituents. If the waste stream does not meet the LDR treatment standards, the waste will be rejected ~~if the Facility does not have the appropriate treatment capability to bring it into compliance~~.
- Compliance with the Facility's regulatory and operational limits (e.g., the waste is not included in the permitted wastes listed in Part A of this application or the waste does not meet other operational boundaries established by this WAP).

The criteria to be used to evaluate ~~acceptable knowledge (~~AK~~)~~ validity, appropriateness, and adequateness will include the following:

- Relationship of wastes generated to process information;
- Availability of supporting analytical data and results;
- Correlation of waste material with processes/product chemistry;
- Process line variability with respect to waste generation;
- Waste alteration/treatment activities and resulting waste characterization; and
- Any other relevant information to assess acceptability of information.

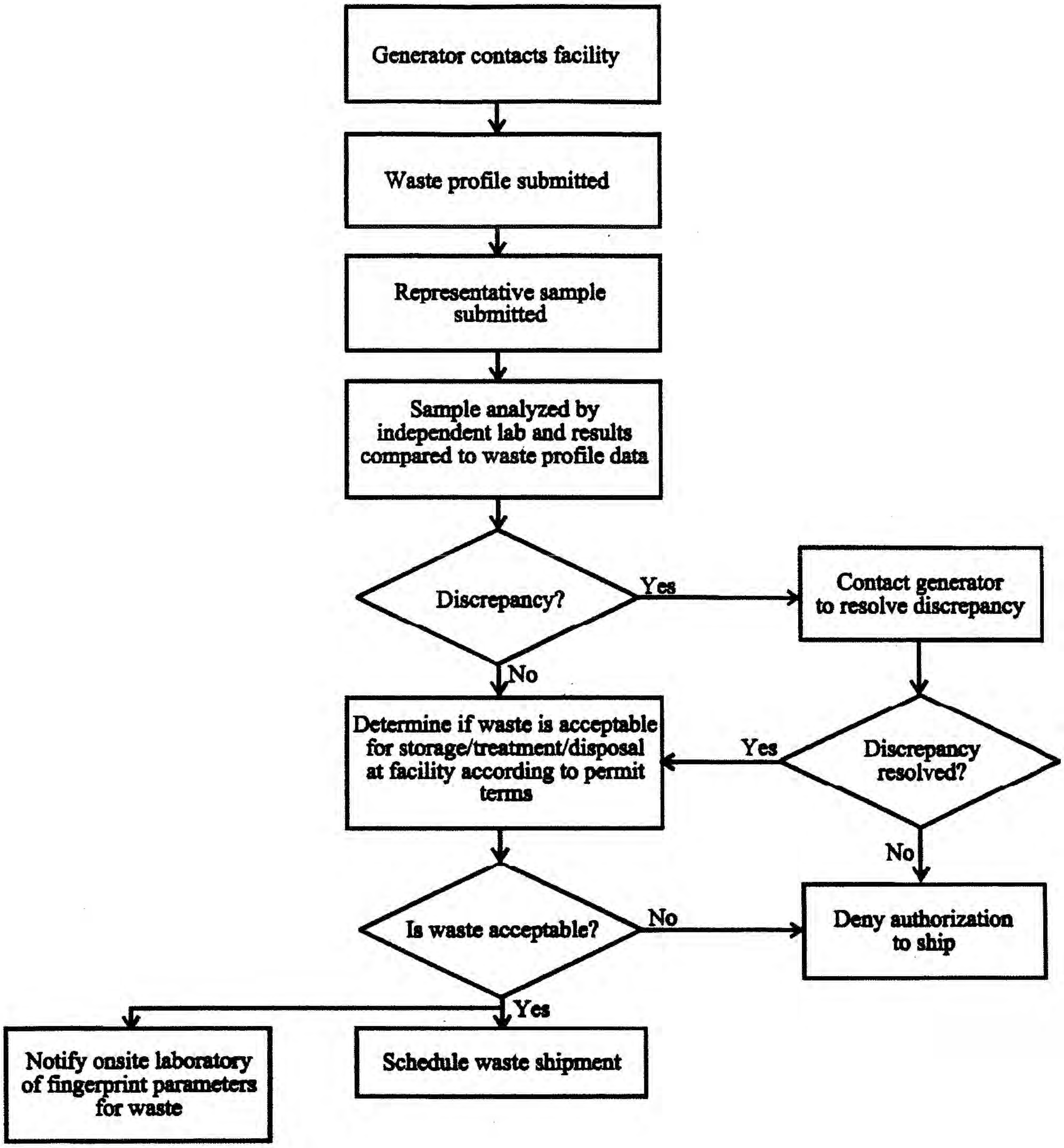
4.3 Pre-Acceptance Procedures for Off-Site Waste

Before a waste stream is accepted, all off-site generators will be required to provide a complete waste characterization (Section 4.3.1). After evaluating the paperwork supplied by the generator (Section 4.3.2), the Facility will send a representative sample of the waste to a laboratory for analysis and will evaluate the analytical results (Section 4.3.3). Finally, the Facility will notify the generator that the Facility will accept the waste stream (Section 4.3.4).

4.3.1 Waste Characterization Information Provided by the Generator

The activities associated with pre-acceptance of off-site waste streams are shown in Figure 4-1[RF1]. The generator must provide the following waste characterization information for each waste stream:

- A completed Waste Profile Form signed by an authorized agent of the generator. An example of a Waste Profile Form is contained in Permit Attachment F2. This form may be changed if the Facility believes that more information is warranted or if there are changes in regulations governing the Facility.
- Other documentation that supports the information presented on the Waste Profile Form (e.g., material safety data sheets [MSDSs]).
- A description of the process that generated the waste.
- A completed Land Disposal Restriction Notification.
- All other supporting data required by 40 CFR 268.7.
- All required certifications.
- Waste analysis data used to characterize the waste and/or process knowledge documentation.
- A representative sample of the waste, of adequate volume for analysis.



PRE-ACCEPTANCE PROCEDURE FOR FIRST TIME WASTE

TRIASSIC PARK WASTE DISPOSAL FACILITY

Figure 4-1

Insert Figure 4-1, Pre-Acceptance Procedure for First Time Waste

If waste analysis is used to characterize the waste, the generator must supply, at a minimum, the following waste analysis data for each representative sample:

- identification of the sample medium (e.g., aqueous, sludge, soil);
- information about waste stratification;
- brief description of the sampling strategy, including
  - a description of the sampling technique (i.e., biased or random);
  - rationale for selection of the number and location of samples;
  - a description of the statistical approach, if any; and
  - the sample type (i.e., grab or composite);
- identification of the analytical methods that were used and the rationale for the selection of these parameters;
- final laboratory reports including case narratives, waste analyses, and quality assurance/quality controlQA/QC analyses; and
- identification of the laboratory whichthat performed the waste analyses.

The Facility will evaluate the way each representative sample was obtained in order to determine whether it is truly representative of the waste stream. The Facility will evaluate the information provided by the supplier and will use the documents listed below for guidance.

- The Sampling Plan, Section 4.6 of this document
- Standard Practice for Sampling Waste and Soil for Volatile Organics (American Society for Testing and Materials (ASTM) D4547-91)
- Test Methods for the Evaluation of Solid Waste, Physical/Chemical Methods, Part III (US Environmental Protection Agency Publication SW-846, latest edition)
- RCRA Sampling Procedures Handbook (EPA Region VI)

In certain cases, generators may meet waste analysis requirements by supplying "acceptable knowledge". Acceptable knowledgeAK, includinges process knowledge and waste analysis (Permit Attachment F4 identifies acceptable knowledge requirements for foreign generators). Process knowledge includes detailed information of a waste obtained from existing published or documented waste analysis data or studies on hazardous wastes generated by processes similar to that which generated the waste, or industry or trade association hazardous waste profile studies, or EPA documents. Examples of waste streams where process knowledge may be adequate for characterization are K-listed wastes (hazardous wastes from specific sources), which are identified by comparing the specific process that generated the waste to those processes listed in 40 CFR 261.32. The application of process knowledge is appropriate where the physical/chemical make-up of the waste is well known and consistent. Process knowledge is often used in conjunction with physical and analytical analysis.

Foreign Generators shall, in addition to all of the above requirements, analysis analyze wastes at an accredited laboratory in accordance with Section 4.7.4, Laboratory Requirements for Foreign Generators, and shall characterize all waste streams in accordance with Permit Attachment F4, Waste Characterization Using Acceptable Knowledge.

4.3.2 Paperwork Evaluation

The Facility will evaluate all of the waste characterization paperwork to determine if it adequately represents the physical and chemical characteristics of the waste stream and whether the waste stream is appropriate for management at the Facility. As part of the pre-shipment process, the Facility will work with the off-site waste generator to ensure that all necessary waste analyses and waste characterization information are provided to meet the applicable requirements for acceptance.

If waste analysis was used to characterize the waste, the Facility will evaluate the data to determine that:

- appropriate extraction and preservation techniques were used;
- appropriate sampling strategies were used;
- appropriate sample types were collected~~ (e.g., to demonstrate compliance with the LDR treatment standards, hazardous waste regulations require that grab samples be collected for non-wastewaters and composite samples be collected for wastewaters)~~;
- appropriate parameters were selected for analysis;
- appropriate analytical methods were used;
- recommended holding times were met;
- detection limits were below applicable standards (e.g., the LDR standards); and
- the quality of the analytical data is adequate for making a waste determination based on an evaluation of the final laboratory reports.

If the data supplied are not adequate to provide a complete characterization of the waste stream, the Facility will either require additional information from the generator or will not agree to accept the waste.

All of the waste characterization information supplied by the generator will be maintained in the Facility's Operating Record. In addition, the Facility's evaluation of this information and the results of the independent analysis will be maintained in the Operating Record.

4.3.3 Representative Sample Assessment

After evaluation and approval of the sample representativeness and waste characterization data paperwork, the representative sample submitted by the generator will be analyzed by a qualified laboratory other than the one used by the generator. Based upon the Facility evaluation of the information supplied by the generator, the Facility will inform the laboratory of the medium type (e.g., ~~liquid, ~~aqueous or~~,~~ solid) and appropriate parameters for analysis. The rationale for selection will be maintained in the Facility Operating Record.

The generator's Waste Profile Form will be compared with the results of the laboratory analysis of the representative sample and with the Facility's permit to ensure that the waste is acceptable for ~~storage, treatment, and/or ~~disposal at the Facility. Should there be a discrepancy between the analytical results and the generator information, the Facility will contact the generator to resolve the discrepancy. The generator will not be authorized to ship the waste until all discrepancies are resolved. If the discrepancies cannot be resolved with the information provided by the generator, the Facility will request a new Waste Profile Form and any additional information that may be required to characterize the waste adequately. In addition, the Facility may require the generator to submit additional samples of the waste for analysis. If the generator cannot supply adequate information to provide a complete characterization of the waste stream, the Facility will not accept the waste. The generator will submit a new Waste Profile Form for each new waste stream and for an existing waste stream if it is modified significantly.

4.3.3.1 Major Discrepancies

Major discrepancies include the following:

- analytical results indicating that the generator applied an incomplete or wrong waste code to the waste stream;
- analytical results indicating that the generator submitted incomplete or wrong information on the LDR Notification Form;
- analytical results including constituents or underlying hazardous characteristics that are not explained by a description of the process; and
- other information indicating that the waste stream is not characterized properly.

In the event of a major discrepancy, the Facility will reject the paperwork and require the generator to analyze the waste in accordance with a sampling plan that is consistent with the guidance in EPA document SW-846, *Test Methods for the Evaluation of Solid Waste, Physical/Chemical Methods*, Chapter 9. The Facility will require the generator to resubmit the waste characterization information listed in Section 4.3.1 and one or more additional representative samples for analysis.

4.3.3.2 Minor Discrepancies

Minor discrepancies include any other waste characterization discrepancy (e.g., discrepancies ~~which~~ that do not question hazardous waste code assignments, waste treatment, or the presence of prohibited items). In the event of a minor discrepancy, the Facility will work with the generator to resolve the discrepancy. For example, uncertainties regarding whether sorbents are present will be handled as minor discrepancies. The Facility will contact the generator if the Waste Profile Form does not indicate whether a sorbent was added to the waste, or if it indicates that a sorbent was added but does not specify the name and type of sorbent and whether it is biodegradable. If the generator cannot provide this documentation, the waste must be tested to determine ~~if~~ whether it contains a biodegradable sorbent. If the waste is determined to contain a biodegradable sorbent, it will be ~~stabilized prior to disposal or~~ rejected.

4.3.3.3 Additional Waste Acceptance Conditions

In addition to complete characterization of the waste, the Facility will also evaluate the waste to ensure that it can be managed at the Facility. Waste analysis will be conducted where necessary to ensure that:

- the waste is not prohibited (e.g., the waste is included in Part A of this application, is not listed in Section 4.1 as a prohibited waste, or does not exceed allowable PCB concentrations or include dioxins);
- the LDR treatment standards contained in 40 CFR~~,~~ 268, Subpart D, including the standards for underlying hazardous constituents, are met;
- the general requirements contained in 40 CFR 264.17 for ignitable, reactive, and/or incompatible waste are met; and
- ~~the special requirements for bulk and containerized liquids contained in 40 CFR 264.314 are met; and~~
- the waste does not contain biodegradable sorbents, as required in 40 CFR 264.314(e).

All major and minor discrepancies, discrepancy resolutions, and compliance with the additional waste acceptance conditions listed above will be documented in writing and maintained in the Facility Operating Record.

4.3.4 Notification and Approval of Waste Shipment

After the Facility determines that the waste stream meets the pre-acceptance requirements, the Facility will send a written notification to the generator. This notification will include the following:

- a statement that the waste is acceptable for shipment;
- a unique identifier number for the waste stream, assigned by the Facility (see Section 4.10);
- instructions to put the unique identifier number on all shipment paperwork and all future waste characterization data that are submitted for the waste stream;
- a requirement to notify the Facility at least 24 hours before shipping, so that the Facility can ensure that there are sufficient resources and capacity to manage the shipment when it arrives;
- a statement that the Facility reserves the right to delay shipments beyond the 24-hour time frame;
- instructions to ensure safe management of the waste (e.g., packaging or labeling requirements not otherwise required by regulations);
- if the generator has treated the waste prior to shipment to meet applicable LDR treatment standards, a requirement that the generator develop and follow a written ~~waste analysis plan~~WAP that describes the procedures used; and
- a requirement that the generator retain on-site a copy of all notices, certifications, demonstrations, waste analysis data, and other documentation produced pursuant to characterization of the waste stream for five years from the date that the waste was last sent to the Facility.

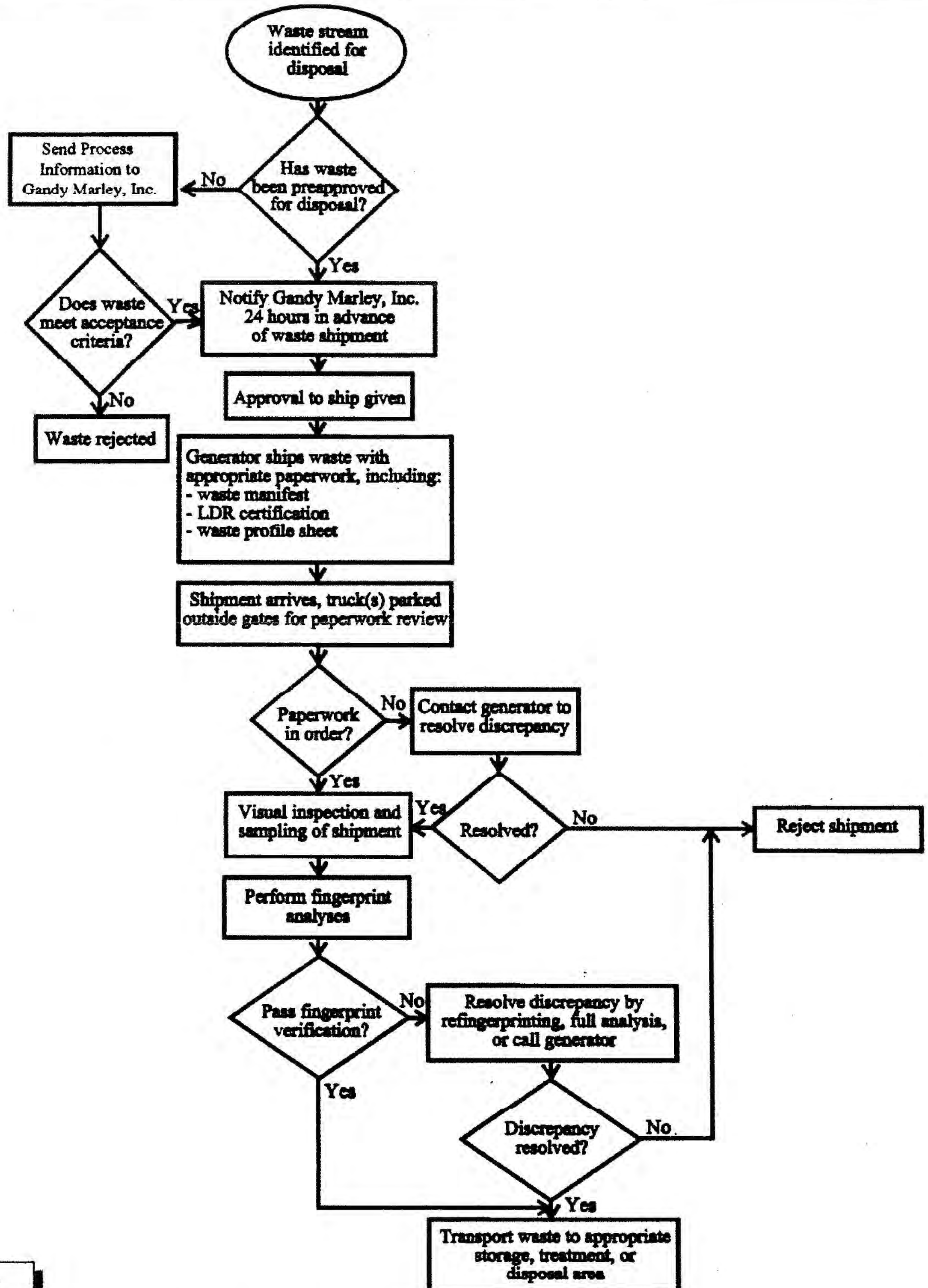
Once the Facility has completed pre-acceptance requirements and has determined that a waste stream is acceptable for shipment, the on-site laboratory will be notified in writing. The notification will include the waste type, waste stream identifier, physical form, packaging, and how the waste is to be managed. This information will be used by the laboratory as follows:

- the waste stream identifier will be used to track the samples in relation to the waste stream;
- the waste type ~~and management methods (storage, solidification, evaporation, and/or disposal)~~ will be used to help determine the analytical methods that will be employed for fingerprint analysis; and
- the physical form and packaging will determine the most applicable sampling methods.

Using this information, the on-site laboratory will designate a sampling and analytical protocol specific to each waste stream as described in Section 4.6. The unique identifier number for the waste stream will be used to track all activities for the waste stream. Individual shipments from within the waste stream will receive an additional identifier to enable the Facility to tie information back to the specific shipment as well as to the waste stream.

4.4 Procedures for Incoming Waste Acceptance

The activities associated with incoming waste shipment~~s (typically in drums, roll-off boxes, vacuum trucks, and tanker trucks)~~ are shown in Figure 4-2[RF2]. These procedures will be used for both initial shipment of a



INCOMING WASTE SHIPMENT PROCEDURES

TRIASSIC PARK WASTE DISPOSAL FACILITY

Figure 4-2

waste stream and for waste streams that have previously been accepted by the Facility from the same generator and process. The Facility will review the waste shipment paperwork and resolve paperwork discrepancies (Section 4.4.1), and visually inspect the waste inside the containers and roll-off boxes (Section 4.4.2). Waste analyses for incoming shipments consist of fingerprint analysis and an annual analysis to update characterization of the waste stream (Section 4.4.3). Based on the Facility's evaluation of the waste stream, a determination to accept or reject the waste will be made (Section 4.4.4).

4.4.1 Paperwork Review

Upon receipt of a waste shipment, the truck will be routed to a parking area outside the Facility gate while documents are reviewed. The Facility will:

- review all paperwork for completeness to verify that all required documentation is present and signed as necessary;
- compare the information in the manifest, the Waste Profile Form, the LDR Notification Form, and pre-acceptance waste characterization information for consistency;
- compare the number of containers, the volume or weight of the waste, and the waste labels on each container with the manifest for consistency; and
- review all paperwork to verify that the unique identifier number for the waste stream is on all the waste shipment paperwork and all accompanying waste characterization data.

If the Facility determines that the paperwork is complete and consistent, the waste shipment will be routed to the truck sampling station, a staging area inside the Facility gate.

~~Insert Figure 4-2, Incoming Waste Shipment Procedures~~

If the Facility determines that the paperwork is incomplete or inconsistent, the waste shipment will be routed to a segregated, secure area inside the Facility gate pending resolution of the discrepancies. An attempt will be made to resolve discrepancies with the waste generator or transporter within 24 hours. In those instances where a discrepancy with the manifest cannot be resolved within 15 days of receiving the waste, a letter will be submitted to NMED describing the discrepancy and the attempts made to reconcile it. A copy of the manifest or shipping paper at issue also will be provided to NMED, as specified in 40 CFR 264.72(b). If the Facility is unable to resolve the manifest discrepancies, the waste will not be accepted.

The Facility will resolve significant manifest discrepancies in accordance with 40 CFR 264.72. Manifest discrepancies are differences between the quantity or type of hazardous waste designated on the manifest and the quantity or type of hazardous waste contained in the shipment received at the Facility.

Significant discrepancies in quantity are:

- *Bulk waste:* Variations greater than 10 percent in weight.
- *Batch waste:* Any variation in piece count, such as a discrepancy of one drum in a truckload.

Significant discrepancies in type are obvious differences which can be discovered by inspection or waste analysis, such as waste solvent substituted for waste acid, or toxic constituents not reported on the manifest or shipping paper.

All discrepancy resolutions will be documented in writing and maintained in the Facility Operating Record. If manifest discrepancies are not resolved within 90 days of identifying the discrepancy, waste will not be accepted for ~~storage or~~ disposal, and the waste will either be returned to the sender or disposed at an appropriate off-site facility.

4.4.2 Visual Inspection

After all paperwork discrepancies have been resolved, the Facility will physically open and inspect the waste inside drums and roll-off boxes for color, similar physical appearance (e.g., single phase, bi-layer, multi-layer), and physical state (e.g., solid or~~,~~ semi-solid~~, or liquid~~). This information will be compared with the waste characterization information provided by the generator and the physical appearance of the representative sample. If the color and/or viscosity of bulk wastes (solids and sludges) appear inconsistent, the Facility may elect to perform additional chemical tests (i.e., composite samples would be taken from within the different areas of coloration or viscosity).

The Facility will inspect a minimum of 10 percent of all drums of each waste stream per shipment (but not less than one drum per waste stream) and each roll-off container~~ or tanker truck~~.

The Facility will physically open all containers of hazardous debris and inspect the contents to ensure that the waste shipment matches the waste that is expected. Prior to acceptance of hazardous debris, the Facility will require the generator to provide a certification that the waste has been treated in accordance with the requirements defined for the treatment of hazardous debris in 40 CFR 268. Hazardous debris is visually inspected because it is exempted from the representative sample waste analysis requirements discussed in Section 4.7.2. This visual inspection will ensure that the waste stream matches the description provided by the generator.

Certain loads may not be sampled, at the discretion of the Facility manager or laboratory supervisor, for environmental and safety reasons (e.g., severe weather which causes unsafe working conditions). In these cases, the generator or his agent will be required to provide a signed certification that the load conforms to the Waste Profile Form. This variance from established procedure will be documented in the Facility Operating Record.

If a discrepancy is found, the Facility will contact the waste generator for resolution (see Section 4.4.1). The results of visual inspections and all discrepancy resolutions will be documented in writing and maintained in the Facility Operation Record. If discrepancies noted during visual examination are not resolved within 90 days of identifying the discrepancy, waste will not be accepted for ~~storage or~~ disposal, and the waste will either be returned to the sender or disposed off-site at an appropriate facility.

4.4.3 Waste Analysis for Incoming Shipments

Waste analysis for incoming shipments consists of fingerprint tests (Section 4.5.4) and an annual analysis to ensure correct characterization of each waste stream (Section 4.5.3).

4.4.3.1 Fingerprint Test Procedure

Fingerprint testing is an abbreviated analysis and is used to confirm that an incoming shipment of waste received at the Facility is the actual waste expected and that it matches the expected chemical content for that waste. Fingerprint analysis will be conducted on each waste stream in each shipment prior to shipment acceptance. Fingerprint analysis will be conducted generally for parameters that will give information that can be used to help verify that a waste stream received from off-site matches the expected characteristics of the waste.

While the incoming shipment is staged at the sampling station, laboratory personnel or other trained personnel will review the sampling and laboratory requirements for the specific waste stream. After completion of this review, sampling personnel will obtain the necessary samples in the manner prescribed by the Sampling Plan and applicable laboratory requirements. Sampling will be conducted in accordance with approved site operating procedures. These procedures will detail the sampling requirements, sample labeling, chain-of-custody requirements, any necessary sample preservation requirements, and other sampling components (see Section 4.6).

Each waste stream in each shipment will be sampled in accordance with the following sampling rate, at a minimum:

- *Bulk waste:* One sample will be collected from each shipment of bulk waste (one shipment of bulk waste is considered to be one truck load or one roll-off box). If, upon visual inspection, the color and viscosity of solids or sludges appear inconsistent, the Facility may elect to obtain additional samples. These samples would be composites from within the different areas of color or viscosity.
- *Batch waste:* One sample will be collected from each 10 waste drums in each waste stream in each shipment. If there are less than 10 waste drums in the waste stream, one drum will be sampled. One sample will be collected from each drum if the waste appears to be inconsistent with the pre-acceptance waste characterization data.

The Facility can increase this sampling rate for any reason. For example, the Facility may decide to collect additional samples if the waste appears to be inconsistent with the pre-acceptance characterization data. In some instances, the Facility may elect to waive one or more analyses under the following conditions:

- The transported waste is a portion of a continuously shipped, well documented waste stream, such as waste produced from a consistent, non-variable process or contaminated soils from a specific remedial action.
- The waste has been approved for receipt by NMED on an emergency basis.
- Facility personnel at the point of generation sampled, or oversaw the sampling of, the waste, and the fingerprint test/supplemental analyses have been conducted. (In cases where a generator is sending very large or continual shipments, the Facility may elect to station personnel at the point of generation to obtain samples prior to or during loading of the waste).

Prior to waiving sampling and analysis requirements, however, the Facility will request a variance from NMED and will not dispose of the waste until NMED approval is received.

4.4.3.2 Annual Analysis Procedure

As part of the Facility's QA/QC procedures (see Section 4.7), the representative sample analysis for each waste stream from each generator will be repeated annually. Repeating this pre-acceptance procedure will ensure that the analysis is accurate and up-to-date and that the waste stream has remained within the operational bounds of the Facility. This annual analysis will be performed by an independent laboratory. This analysis will be repeated more frequently if the Facility believes, or has been informed by the generator, that the process generating the waste stream has changed. In the case of a change in the waste generation process the waste stream will be managed as a new waste stream in accordance with the requirements of this ~~waste analysis plan~~WAP.

4.4.4 Acceptance/Rejection Determination

4.4.4.1 Discrepancy Resolution

Upon completion of the fingerprint analysis, a determination will be made as to whether or not the wastes are consistent with the pre-acceptance waste characterization information and within acceptance limits of the Facility ~~and specific management units~~. If any of the analyses determine the waste is not within the operational acceptance limits for disposal, ~~a specific management unit,~~ the waste will not be accepted by the Facility. ~~for that unit.~~ If the results of the analysis conflict with the waste profile information, the Facility may take any or all of the following actions:

- Resample the waste, if necessary, and perform a second fingerprint test. The Facility manager has discretion to accept the waste if the second fingerprint results match those on the waste profile sheet. The discrepancy between results will be explained and included in the Facility Operating Record for that waste stream or shipment.
- Perform further characterization as necessary to verify the composition of the waste by sending a sample to a qualified independent analytical laboratory.
- Reject the entire waste shipment or the nonconforming portion of the shipment.

If discrepancies between fingerprint analysis and waste stream characterization information exist upon completion of discrepancy resolution, the waste will be rejected by the Facility. The Facility will return the rejected waste to the generator or ensure proper disposal of the waste at an appropriate off-site facility within 30 days of the waste rejection.

4.4.4.2 Shipment Acceptance Procedures

Once the decision has been made to accept a waste shipment, the appropriate papers will be signed for the generator, and the waste stream will be transported by truck to the landfill. ~~an appropriate management unit.~~

4.5 Waste Analysis

Tables 4F-1 through 4F-3 specify parameters which will be analyzed to ensure that all criteria for waste acceptance and management are met. The Facility will use approved SW-846 or ASTM analytical methods, or other approved method. If an alternative method not contained in SW-846 is to be used, the Facility will demonstrate that such alternative method is equivalent to the approved method contained in SW-846 or this ~~waste analysis plan~~WAP. Alternative methods will be submitted to the NMED Secretary at least 15 days prior to the sample collection event.

Permit Attachment F1, Section 4.5.1, identifies the rationale for selecting parameters and analytical methods which will be used to test hazardous waste managed at the Facility. Requirements for the pre-acceptance analysis of a representative sample of waste generated off-site and for the annual analysis are discussed in Sections 4.5.2 and 4.5.3, respectively. Section 4.5.4 contains requirements for fingerprint testing. Section 4.5.5 contains waste analysis requirements specific for the landfill.~~to storage, treatment, and disposal units.~~ Section 4.5.6 contains requirements for ~~waste~~ analysis of waste generated on-site.

Table 4F-1. Parameters and Methods for Pre-Acceptance Representative Sample Analysis

Waste Parameters	Extraction/Sample Preparation	Method[a]
Volatile organic compounds	5021 5031 5032 5035	8260
Semivolatile organic compounds	3510 3520	8270
Organochlorine pesticides	3510 3520	8081/8270
PCBs	3520	8082/8080
TCLP: Organics	1311	8260/8270/8080/8150
Chlorinated herbicides	8151[b]	8151
Reactive cyanide		9014
Reactive sulfide		9034
~~Water~~		~~ASTM C566~~
Ignitability		1010/1030
Flashpoint		1010/1020A
Corrosivity to metals		1110 pH paper pH electrometer 9040A/9041A/9045A
pH		9040A/9041A9045A
Dioxins		8280
Total metals	3000 1311	6000 series 7000 series
Liner compatibility tests		9090A
Extractable volatiles	3500	8260
Extractable semivolatiles	3500	8270
Physical appearance		ASTM D4979
Radioactivity		Industry standard survey technique (e.g., scintillation detector)

[a] Most current revision of SW-846 will be used.

[b] Method 8151 contains the extraction, cleanup, and determinative procedures for these analytes.

Table 4F-2. Tests and Analytical Methods for Fingerprint Samples

Test	Method and Description	Qualitative or Quantitative
Flammability potential screen	ASTM D4982	Qualitative
Free liquids	Paint filter test, penetrometer, or visual/9095	Qualitative
Ignitability	Match test, Pansky-Martens closed cup or Set-a-flash 1010/1020A	Qualitative

Test	Method and Description	Qualitative or Quantitative
Miscibility	50/50 mixture with water	Qualitative
~~Water mix~~	~~ASTM D5058 Test Method C~~	~~Qualitative~~
Chlorinated solvents	Colorimetric test or Beilsten test	Quantitative
Cyanide	Electrode or colorimetric test (ASTM D5049 Test Method B)	Quantitative
PCBs	Colorimetric test/8080	Quantitative
Specific gravity	Hydrometer/Method dependent on material composition and physical state	Quantitative
Sulfide screen	ASTM 4978	Quantitative

Table 4F-3. Additional Tests and Analytical Methods

Test	Reference	Description
Paint filter test	EPA 9095	This test will determine the free liquids that are contained within the waste matrix and will be used as a control parameter for wastes that are to be landfilled.
Heavy metals	6010A/7470	This test determines the concentration of heavy metals.
Free cyanides	APHA 412G, H	This test determines if cyanides could potentially be reactive under acidic conditions.
Toxicity characteristic leaching procedure[a]	Extraction Method 1311/3010A	Determines if waste, or stabilized waste, contains level of restricted constituents above BDAT treatment standards.
Total organic halogens	EPA 9020	Determines if the waste potentially contains LDR constituents above BDAT standards for California List wastes.
PCBs	Colorimetric test/EPA 8080	Determines if PCBs are contained in the waste matrix and determines the concentration.
IR scan	ASTM D2621, D4053	Determines the presence of organics and provides a rough estimate of their concentration.

[a]Analytical method chosen is dependent upon constituent being determined (i.e., Organics 8260, 8270, 8080).

4.5.2 Representative Sample Analysis

The Facility will select parameters for analysis to ensure that the criteria for waste acceptance identified in Section 4.2 are met. The analysis will include, at a minimum, testing for each hazardous waste contained in the waste stream, as identified by EPA hazardous waste code, and for each underlying hazardous constituent, as identified in 40 CFR 268.48, Table 4-1, Parameters and Methods for Representative Sample Analysis. Additionally, parameters on Tables 4-2, Tests and Analytical Methods for Fingerprint Analysis, and 4-3, Additional Tests and Analytical Methods, will be included, as applicable.

For foreign wastes, in addition to the conditions specified above, representative sample analysis for each waste stream shall include testing for all constituents listed in 40 CFR 268.48 using practical quantitation limits capable of measuring the standards specified in 268.48. The results of this test will be used to perform the comparison with the generator's Waste Profile Form specified in the Representative Sample Assessment Section (Waste Analysis Plan Condition 4.3.3). Testing for all constituents listed in 40 CFR 268.48 shall not be required for the annual analyses.

Hazardous debris, as defined in 40 CFR 268.2(g), that has already been treated to meet the LDR treatment standards as described in 40 CFR 268.45 does not have to meet the representative sample analysis requirements if the Facility determines that the generator provided waste characterization information that demonstrates that the proper EPA Hazardous Waste Numbers were applied and indicates whether or not the LDR treatment standards have been met.

4.5.3 Annual Analysis

The representative sample analysis for each waste stream from each generator will be repeated annually at an independent laboratory not used by the generator (see Section 4.4.3.2).

4.5.4 Fingerprint Analysis

Fingerprint samples will be analyzed for all parameters listed on Table 4F-2, and may include tests for physical appearance, pH, and radioactivity. Additional fingerprint parameters will be selected based on the pre-acceptance waste characterization data, shipment paperwork, physical form of the waste, and the visual inspection of the contents of containers and bulk waste. The Facility will follow the additional parameter selection process described in Section 2.2 of the EPA guidance document, *Waste Analysis at Facilities That Generate, Treat, Store, and Dispose of Hazardous Wastes* (EPA, OSWER 9938.4-03, April 1994).

Because the Facility already knows the detailed chemical and physical properties of a waste, additional necessary and appropriate fingerprint or spot check parameters can be chosen easily, as the purpose of the fingerprint is only to verify that the waste fingerprint analysis will include, at a minimum, the parameters received is the waste expected. These parameters will be analyzed at the on-site laboratory. Analyses which are not within the on-site laboratory's capability will be sent to an independent laboratory for analysis.

Fingerprint analysis will also include parameters as necessary to ensure that the waste is within the Facility regulatory and operational acceptance limits (see Table 4F-3). To select these additional sample parameters, the Facility will consider:

- compliance with applicable regulatory and permit requirements. (This may require selection of parameters not reported by the generator);
- identification of incompatible and inappropriate wastes; and
- process and design considerations.

As noted, fingerprint analysis helps the Facility minimize the potential to receive waste that is unacceptable. Therefore, the level of additional analysis required for a waste shipment is a function of Facility knowledge about the waste generation process and the waste generator. The Facility may elect to perform additional fingerprint tests to achieve a higher level of confidence that a full waste characterization is achieved. If discrepancies are noted between the received waste and the Waste Profile Form, the waste will be further analyzed using additional fingerprint parameters. Discrepancies that can result in the Facility requiring additional analysis include non-conformance with the results of required testing or a change in color, texture, liquid content, or other characteristics that can be observed upon receipt.

The Facility will follow the additional parameter selection process described in Section 2.2 of the EPA guidance document, *Waste Analysis at Facilities That Generate, Treat, Store, and Dispose of Hazardous Wastes* (EPA, OSWER 9938.4-03, April 1994).

4.5.5 Additional Analysis for the Landfill Specific Management Units

4.5.5.1 Overview of Waste Management Procedures in the Permitted Hazardous Waste Management Units

Upon completion of the fingerprint analysis, and supplemental analyses if conducted, waste will be transferred to the appropriate staging area. Prior to interim or final disposition of the waste, however, additional analyses may be required to ensure that requirements for the landfill permitted hazardous waste management units are met.

Analysis necessary for disposal specific management units is generally conducted as part of the pre-acceptance procedure (see Section 4.7.2). Appropriate parameters will be selected from Tables 4F-2 and 4F-3. The Facility will use a combination of process knowledge and analytical results to obtain the information needed prior to placing waste in the landfillone of the management units. The Facility may elect to use other EPA--approved analytical methods if it is felt that information other than that obtainable by these methods is needed to manage the waste safely.

All hazardous waste management units will haveThe landfill has specific ignitability, reactivity, and compatibility requirements which that must be met. Acceptable knowledge or waste analysis will be used to determine whether a waste stream is ignitable, reactive, or incompatible with other wastes to be placed in the landfill. when stored or mingled. In addition, acceptable knowledge or waste analysis will be used to determine whether the waste stream is compatible with the container or tank in which it is placed, or with the liner of the evaporation pond or landfill. Specific ignitability, reactivity, and compatibility tests will be conducted as part of the representative sample analysis, and may be repeated in the fingerprint test, for wastes assigned to specific management units. Management of these wastes is discussed in Vol. I, Section 5.5Permit Attachment B, Section 5.5 of this application. Ignitability, reactivity, and compatibility determination is discussed in Section 4.5.1.2.

The Facility will conduct compatibility tests as part of the representative sample analysis procedure on an incoming waste stream specific to each management unit and specific to other waste streams with which it may be combined. Special requirements for specific management units are discussed in Sections 4.5.5.2 through 4.5.5.5.

4.5.5.2 Waste Analysis Requirements Specific to Storage Units.

Wastes will be stored in the drum storage building, the roll-off container storage area, and the liquid waste storage tanks. Waste characterization is accomplished through the representative sample analysis, the yearly update of the representative sample analysis, and on-going fingerprint analysis. The ignitability, reactivity, and incompatibility of each waste stream will be determined using procedures listed in Table 4-2 to ensure that stored waste is compatible with other wastes and with the container or tank in which it is placed. Spills or releases of hazardous waste and/or fluids removed from the leak detection systems will be tested to determine if the recovered material is hazardous.

~~Procedures from Table 4-3 will be used to determine whether a hazardous waste stored in containers must comply with the requirements of 40 CFR 264, Subpart CC. If it must comply, the container will be managed to meet Container Level 1 and Level 2 standards as appropriate. Waste which must comply with the requirements of 40 CFR 264, Subpart CC, will not be placed in storage tanks.~~

~~The facility will ensure that containers are either at least 90 percent full when placed in the landfill, or are crushed, shredded, or similarly reduced in volume to the maximum practical extent.~~

~~4.5.5.3 Waste Analysis Requirements Specific to the Evaporation Pond~~

~~Liquid waste streams may be placed in the evaporation pond for drying before they are sent to the stabilization tanks for solidification. Following evaporation of the pond liquids, sludge will be removed from the bottom with trash pumps or hand excavation equipment.~~

~~Waste will be characterized by representative sample analyses and fingerprint analyses, using the parameters listed on Tables 4-1 through 4-3, as applicable, before it is placed in the evaporation pond. A determination of ignitability, reactivity, and incompatibility with other wastes with which the waste may be combined and with the pond liner will be made. It will also be tested to ensure that the LDR standards are met and that the waste placed in the pond does not contain volatile organic concentrations equal to or greater than 500 ppmw.~~

~~Because evaporation in the pond may change the chemical composition of the waste, or different waste streams may be combined in the pond, analysis to ensure that the LDR standards are met will be conducted on a waste stream after it leaves the pond. Applicable knowledge will be used to determine appropriate parameters for analysis. If, after treatment, a waste displays a characteristic for the first time, the characteristic waste code will be added to the LDR Notification Form and facility records. The waste will be retreated, if necessary, to meet the characteristic treatment standard before land disposal.~~

~~Dilution of restricted wastes will not be used as a substitute for adequate treatment for non-toxic hazardous characteristic waste. If toxic characteristic wastes and listed wastes are amenable to the same type of treatment and aggregation is a part of treatment, then the aggregation step does not constitute impermissible dilution.~~

~~4.5.5.4 Waste Analysis Requirements Specific to the Stabilization Tanks~~

~~Waste treated in the stabilization tanks is characterized to determine the hazardous constituents contained in the waste and to ensure that waste placed in the stabilization tank is compatible with the tank liner and with the previous waste type treated. Acidic or caustic material may be neutralized by the stabilization process.~~

~~In addition to the representative sample provided by the generator during the pre-acceptance period, a second representative sample of any waste requiring stabilization prior to placement in the landfill (or a sample of waste coming from the evaporation pond for stabilization) must be supplied. This sample will be used for bench-scale testing to determine regulated constituent leaching based on varying admixtures and ratios (i.e., to determine treatability of wastes). The stabilization process will result in a dry and structurally stable material that is suitable for compaction and landfilling.~~

~~Bench-scale tests will be conducted as part of the representative sample analysis for incoming waste streams which will go directly to the stabilization tanks, or for a waste stream from the evaporation pond. Selection of treatment reagents and quantities will be established according to the waste profile and the post-treatment LDR requirements. Stabilization agents that will be tested include, but are not limited to, lime, fly ash, and Portland cement.~~

~~The waste will also be treated to ensure that it does not contain volatile organic concentrations equal to or greater than 500 ppmw.~~

~~The EPA universal treatment standard (see 40 CFR 268.48) will be met for wastes treated on-site. Waste streams that carry more than one characteristic or listed EPA Hazardous Waste Number will be treated to the most stringent treatment requirements for each hazardous waste constituent, including underlying hazardous constituents. When wastes with different treatment standards are combined solely for the purpose of treatment, the most stringent treatment specified will be met for each hazardous constituent in the combined waste.~~

~~After stabilization, wastes will be retested prior to placement in the landfill to determine whether they meet LDR requirements. If LDR requirements are not met, the waste will be retreated. After testing, stabilized waste will be placed in roll-off containers and placed on the roll-off pad until cured.~~

4.5.5.5 Waste Analysis Requirements Specific to the Landfill.

~~The stabilized waste will be retested p~~Prior to placement of waste in the landfill, it must be determined that the waste ~~to determine whether it~~ meets LDR standards as set forth in 40 CFR 268, Subpart D. 40 CFR 268.40 states that a waste identified in the table "Treatment Standards for Hazardous Wastes" may be land disposed only if it meets the requirements found in the table. For each waste, the table identifies one of three types of treatment standard requirements:

- All hazardous constituents in the waste or in the treatment residue must be at or below the values found in the table for that waste ("total waste standards"); or
- The hazardous constituents in the extract of the waste or in the extract of the treatment residue must be at or below the values found in the table ("waste extract standards"); or
- The waste must be treated using the technology specified in the table ("technology standard") which are described in detail in 40 CFR 268.42, Table 4-1.

In cases where treatment standards are based on concentrations in the waste extract, the generator ~~facility~~ will use toxicity characteristic leaching procedures (TCLP, see 40 CFR 261, Appendix II) to determine if the waste meets the standards. The sampling and analysis protocols outlined in Sections 4.5 through 4. 7 of this permit application will apply to all wastes to ensure compliance with LDR standards. Parameters for analysis will be determined by the characterization of the waste before analysis. All information obtained to document LDR compliance will be maintained in the Facility Operating Record.

In addition to other required procedures and analyses, on an annual basis the Facility will randomly sample and analyze a minimum of 10 percent of incoming waste streams that are to be directly landfilled to verify conformance with the LDR requirements. These additional samples will be analyzed for the specific regulated hazardous constituents contained in the hazardous waste stream. The data generated from these samples, in conjunction with the generator-supplied data, will be used to verify conformance with the LDR requirements.

Facility personnel, either at the Facility or at the point of generation, will collect these samples. The samples will be split into a minimum of two aliquots. One will be retained and the other analyzed for conformance with the applicable LDR requirements. If the results of the analysis indicate that the waste does not conform with the applicable LDR requirements, the retained sample will be analyzed, generator-supplied information re-evaluated, and an evaluation made of the potential for the waste's variability based on the process that generates the waste stream.

The retained sample will subsequently be analyzed, the generator-supplied information re-evaluated, and an evaluation made of the potential for the waste's variability based on the process that generated the waste stream. These factors, along with an evaluation of the QA/QC data from the laboratory (both the generator's and the Facility's), will be used to determine if the subject waste stream is eligible for continued disposal at the Facility or if additional treatment is necessary prior to disposal. Disposal of the waste stream will be discontinued until the discrepancy regarding compliance with the LDR requirements has been resolved and the generator has demonstrated that its on-going program for compliance with LDR requirements is adequate.

Procedures to meet LDR standards for specific wastes include the following:

- *Lab packs:* Prior to acceptance by the Facility for disposal, hazardous wastes contained in lab packs will be treated to meet applicable treatment standards for each waste type identified. ~~Procedures to determine applicable treatment requirements, and the subsequent treatment of lab wastes to applicable standards, will be consistent with procedures implemented for other waste types.~~ Lab packs will also be analyzed to ensure that they do not contain hazardous wastes listed in 40 CFR 264, Appendix IV. In cases where hazardous lab pack wastes are combined with non--hazardous lab pack wastes prior to or during treatment, the entire mixture will be treated to meet the most stringent treatment standard for each hazardous constituent before being disposed of in the landfill.

- *Ignitable or reactive wastes:* Ignitable or reactive hazardous waste will be tested to ensure that it will not be placed in the landfill until the waste has been rendered non-ignitable or non-reactive by treatment.

- *Characteristic wastes.* Generator process knowledge and/or analytical data will be used to determine whether characteristic wastes meet the applicable treatment standards or to demonstrate that the waste has been treated by the appropriate specified treatment technology. In accordance with 40 CFR 268.41, where treatment standards are based on concentrations in the waste extract, generators shipping waste to the Facility will determine if their wastes meet treatment standards.

- ~~*Bulk liquids:* All hazardous wastes will be tested for the presence of free liquids (paint filter test) to ensure that no free liquids are placed in the landfill. No containers holding free liquids will be placed in the landfill unless the container is in a lab pack, or the container was designed to hold liquid for use other than storage, such as a battery or capicitor, or the container is very small, such as an ampule.~~

- *Reactive wastes:* Reactive wastes will not be placed in the landfill until they have been rendered nonreactive by treatment.

- *Incompatible wastes:* Incompatible wastes will be sufficiently separated when placed in the landfill to ensure that they do not combine to cause adverse reactions. These wastes will be managed to ensure that they meet the requirements specified in 40 CFR 264.313 and 274.17. This management includes placing incompatible wastes in non-adjacent landfill grids and treatment of potentially noncompatible wastes prior to shipment of the waste to the Facility. ~~landfilling~~.

- *Hazardous debris:* ~~Hazardous debris will not be treated at the facility. Therefore, t~~The Facility will only accept hazardous debris that has been treated and certified to meet the LDR treatment standards specified in 40 CFR 268.45(b) or (c) by the generator prior to shipment to the Facility.

- *Listed waste:* Listed waste will not be placed in the landfill until it has been shown to meet the requirements of 40 CFR 268.40.

4.5.6 Waste Analysis Requirements for Waste Generated On-Site

4.5.6.1 Overview of Waste Generated On-Site

The Facility is expected to generate some waste on-site through ~~waste treatment,~~ day-to-day Facility operations, leachate, or releases of hazardous waste to the environment (see Table 4F-4).

Table 4F-4. Potential On-Site Waste Generation Areas/Activities

Area	Method of Generation	Waste Form [a]
Landfill	Leachate collected in the leachate collection system	L, SL
~~Evaporation Pond~~	~~Leachate collected in the leachate collection system~~	~~L, SL~~
~~Evaporation Pond~~	~~Sludges generated as a result of the cleaning and repair of the liner system~~	~~L, SL~~
~~Truck Wash~~	~~Decontamination rinse water~~	~~L, SL~~
Stormwater Retention Basin	Contaminated rain water	L, SL
~~Liquid Waste Storage Area~~	~~Decontamination rinse water~~	~~L~~
~~Stabilization Area~~	~~Decontamination rinse water~~	~~L, SL~~
Operations	Personal protective equipment (PPE) contaminated during routine and non-routine operations	S
Site Operations	Spill residues primarily from waste handling operations. Sampling activities.	L, SL, S

[a] L = Liquid, SL = Sludge, S = Solid

Waste generated on-site will be assumed to be RCRA-regulated until process knowledge and/or sampling and analysis can be used to determine the actual nature of the waste. Sampling and analysis will be accomplished in accordance with the requirements this ~~waste analysis plan~~WAP.

The Facility will select waste analysis parameters to confirm the identity of waste streams generated at the Facility. The selection of waste analysis parameters will typically be based on knowledge of the physical and chemical processes that produced the waste stream. If there is doubt as to the specific source, the Facility will use the waste tracking system to identify all possible sources and to develop a list of specific parameters for laboratory analysis. Acceptable knowledge and analytical testing as necessary will be used to ensure compliance with LDR requirements and provide waste compatibility and other information to determine appropriate waste management activities.

~~After analysis, the waste will be returned to the unit from which it came or sent to another appropriate unit.~~ The Facility will ensure that all on-site generated waste sent to the landfill meets all LDR treatment standards.

~~**Treated waste** is considered newly generated waste because hazardous waste treatment at the facility will result in a change in the physical and/or chemical character or composition of the waste. Treated waste will be recharacterized, using waste analysis or acceptable knowledge as appropriate and it will be tested to ensure that LDR treatment standards are met before disposal in the landfill. Waste analysis requirements are discussed in Section 4.5.5.5.~~

Day-to-day operations at the Facility will produce some waste on-site from day-to-day operations (e.g., paint and paint strippers, laboratory chemicals and equipment, vehicle maintenance). This waste will be characterized using acceptable knowledge, or waste analysis if the source cannot be definitively determined. If it is hazardous waste and meets all disposal requirements, it may be ~~sent to the evaporation pond or stabilization tanks for treatment as appropriate, and~~ disposed in the landfill. If it does not meet the requirements for disposal in the landfill or if it is not hazardous waste, it will be sent off-site for disposal.

A **release** is defined as "any spilling, leaking, pouring, emitting, emptying, discharging, injecting, pumping, escaping, leaching, dumping, or disposing of hazardous waste (including hazardous constituents) into the environment (including the abandonment or discarding of barrels, containers, and other closed receptacles containing hazardous wastes or hazardous constituents)". Management protocols for releases generated on-site are discussed below:

- *Spills and leaks:* Spills and leaks may occur during ordinary Facility operations (e.g., release of fluid from a leaking drum to the cell trench and sump in the drum handling unit, a spill at any loading or unloading area~~, or overtopping at the evaporation pond~~).

Provisions for the detection, characterization, and management of spills and leaks are discussed in ~~Vol. I,~~ Sections 2.0, 5.4.2, 6.3.5.2, and 6.3.7 of this Permit Application. If spills and/or leaks are identified during inspections, the materials will typically be removed from the system, characterized, and managed appropriately. If necessary, the contaminated area will be sampled to ensure that all contaminated materials are removed.

- *Decontamination rinse water:* Personal ~~protection~~ protective equipment (PPE), as well as other equipment (e.g., trucks, sampling equipment, industrial absorbents used during spill or leak clean-up, emergency equipment), may become contaminated during the course of site operations such as the handling of wastes, the transfer of waste to another unit, or emergency operations. The water used to rinse this equipment will be analyzed to determine if it is a hazardous waste and if the equipment has been adequately decontaminated. Provisions for the detection, characterization, and management of decontamination rinse water are discussed in ~~Vol. I,~~ Sections 5.2.5~~, and~~ 5.2.10, and ~~Vol III, Section~~ 9.1.2~~,~~ of this Permit Application. ~~Rinse water will be removed to the truck wash area.~~ Rinse water and residues will be chemically analyzed and handled in an appropriate manner.

- *Run-on/run-off:* Facility stormwater control is provided by a network of surface run-on and run-off diversion channels and collection and detention basins (see ~~Vol III,~~ Drawing 25 of the Facility design drawings in Permit Attachment L1~~of this Permit Application~~). To control the runoff from the Facility, several collection channels and culverts will be built to divert discharges from storm events to a stormwater retention basin (see Section 2.7 of the Operations and Maintenance Plan, submitted separately). Procedures for management of run-on/runoff are discussed in ~~Volume I,~~ Sections 2.5.1.6, 2.6.1.4, and 5.4.2 of this Permit Application. ~~Contaminated water will be characterized, treated in the evaporation pond and/or stabilization bins, and disposed of in the landfill in compliance with appropriate regulations.~~ Sampling will be conducted upstream of the stormwater d~~r~~etention basin to determine the source of any~~the point where~~ hazardous constituents that could be~~were~~ introduced into the stormwater. Appropriate corrective actions will be implemented to prevent further contamination during future stormwater events.

- *Investigation derived wastes (IDW):* IDW may include drill muds and~~,~~ cuttings from~~, and~~ well installation ~~purge waters~~ associated with the investigation of spills and releases; ~~purge waters,~~ soils and other materials from regularly scheduled sampling activities associated with waste management units and the vadose zone monitoring system; and contaminated PPE. All IDW will be assumed to be hazardous waste until site or material specific information becomes available. IDW will be stored near the point of generation in appropriately labeled containers for no greater than 90 days and will be appropriately analyzed to determine whether it is either a characteristic or listed hazardous waste. Analysis of materials associated with the IDW may be used also to characterize the IDW. An example of associated analysis for urge waters from the vadose zone monitoring system would be the final analytical results for the samples collected to satisfy regularly scheduled monitoring requirements.

- *Contaminated soil:* Soil means unconsolidated earthen material consisting of clay, silt, sand or gravel size particles as classified by the US Natural Resource Conservation Service, or a mixture of such materials with liquids, sludges or solids which is inseparable by simple mechanical removal processes and is made primarily of soil by volume based on visual inspection. Contaminated soil is soil impacted by a hazardous constituent release. Soil may become impacted by a release either at the surface or subsurface. If the contaminated soil exists at the surface, the appropriate response is described in the Contingency Plan in the Permit Application. If the contaminated soil exists subsurface, the appropriate response will be developed by NMED as permit conditions. Contaminated soils that are managed as hazardous wastes will be analyzed and managed in accordance with the alternative LDR treatment standards for contaminated soil contained in 40 CFR 268.49.

- *Air emissions:* Procedures for detection of hazardous gases and volatile organic at the landfill are discussed in ~~Vol. I,~~ Sections 2.5.1.8 and 6.2.2 of this Permit Application. Procedures to minimize wind dispersal of dust throughout the Facility are identified in Section 5.4.8. This section also discusses pollution control systems in the stabilization unit to minimize the release of particulate to the atmosphere. The Facility will apply to NMED for a new source air emissions permit before start-up of operations.

- *Leachate:* ~~Leachate collected from the storage units or the stabilization building is treated as a spill or release.~~ Leachate~~s,~~ as used here refers to landfill ~~and evaporation pond~~ fluids. The definition of leachate is in 40 CFR 260.10, collected from the leachate collection and removal system (LCRS), the leak detection and removal system (LCRS), or the vadose zone monitoring system (VZMS) sump~~s~~.

~~Leak detection and removal/vadose zone monitoring for evaporation pond leachate is discussed in Vol. 1, Sections 2.6.1.2 and 2.6.4.3 of this application. Procedures for the removal of evaporation pond leachate are discussed in Section 2.5.4.3. Leachate will be removed by vacuum truck on a regular basis, combined with leachate from the landfill and treated in the stabilization tanks to remove free liquids and to ensure that LDR treatment standards are met.~~

Leak detection and removal/vadose zone monitoring for landfill leachate is discussed in ~~Vol. 1,~~ Sections 2.5.1.3, 2.5.1.4, and 2.5.1.5 and in the Engineering Report in Permit Attachment L. Leachate generated from the landfill will be managed and removed by enhanced evaporation through leachate recirculation within the landfill~~pumped out of the unit sumps into the temporary leachate storage tank. It will then be tested to assure compliance with LDR requirements defined in 40 CFR 268 for F039 listed wastes~~. All leachate will be contained within the lined landfill unit.

~~Leachate will be transferred daily from both the landfill and the surface impoundment sumps and combined in temporary storage tanks for management purposes. The combined leachate will be analyzed monthly for the F039 underlying hazardous constituents to determine whether it meets LDR treatment standards and can undergo evaporation in the surface impoundment prior to stabilization.~~

Leachate may also be collected from the vadose zone monitoring wells, but only in the unlikely event of a leachate release from the landfill. These wells will be monitored monthly; if any fluids are present, they will be sampled and analyzed for all F039 constituents. Biennially, the wells will be analyzed for all the Ground Waste Monitoring List constituents identified in 40 CFR 264, Appendix IX, if water is present.

Leachate sampling and analysis will follow the sampling and analytical procedures and recordkeeping requirements contained in the Vadose Zone Monitoring SystemVZMS Work Plan (Attachment I) and this section.

4.6 Sampling Plan

The Sampling Plan is based upon the guidance provided in Chapter 9 of SW-846. The overall plan takes into account the regulatory and scientific objectives identified in this waste analysis planWAP. Based upon these objectives, the sampling strategy ensures that the data collected will minimize the potential for accepting waste that is unsuitable for management at the Facility. Modifications to the Sampling Plan to include detailed sampling protocols specific to the site activities will likely be required to reflect the sampling to be performed during operation of the Facility.

The sampling program will take into account the different types of waste constituents and the various waste matrices that may be encountered. By taking these variables into account, the Facility will identify the protocols by which sample locations will be selected and the methods most appropriate for collecting samples from the different waste streams.

The latest revision of SW-846 methods (ASTM) or other approved methods will be used, and site procedures will be revised as necessary to incorporate new requirements.

General sampling methods and collection techniques are discussed in section 4.6.1. Section 4.6.2 contains specific sampling procedures. Section 4.6.3 and 4.6.4 provide information on sample location and sample type, respectively. Section 4.6.5 discusses sampling quality assurance/quality control (QA/QC) procedures. Sections 4.6.6 and 4.6.7 present requirements regarding sample preservation, volume and holding times, and for equipment decontamination, respectively.

4.6.1 Sampling Methods

Sampling methods will follow Appendix I of 40 CFR, Part 261 unless a more appropriate method is identified. Table 4F-5, Sampling Methods, lists general waste matrices and appropriate sampling methods that will be used at the Facility.

Matrices that will be sampled include containerized liquid, viscous liquids/sludges, crushed/powdered material, rock/rock-like material, soil, and fly-ash-like material. The methods and equipment used for sampling wastes will vary with the form and consistency of the material to be sampled. Also, these matrices will be sampled using a variety of sampling tools (see Table 4F-5), including the Coliwasa (containerized liquid/viscous liquid), dipper (containerized liquid/viscous liquid), thief (containerized liquid/viscous liquid), weighted bottle (containerized liquid), scoop (sludge, powdered material, rock/soil material, fly-ash material), shovel (powdered material, rock/soil material), auger (soil/fly-ash-like material) and tube sampler (fly-ash like material and liquids). The Facility will select the appropriate sampling method from Table 4F-5 based upon the sample matrices, chemical constituents within the sample, and sampling conditions. If a sampling method not presented on Table 4F-5 would be more appropriate for the specific matrices to be sampled given site-specific conditions or if the procedures presented below must be modified, an alternative method will be used. If an alternative method is used, the sampling method will be well documented, justified, placed in the Operating Record, and approved by NMED prior to implementation.

Table 4F-5. Sampling Methods

Waste Matrix	Sampling Method	Sampling Equipment
~~Extremely viscous liquid or s~~Sludge	ASTM D140-70	~~Coliwasa, d~~Dipper, scoop, thief
Crushed or powdered material	ASTM D346-75	Scoop, shovel, tube sampler
Soil or rock-like material	ASTM D420-69	Scoop, shovel, auger
Soil-like material	ASTM D1452-65	Scoop, shovel, tube sampler
Fly ash-like material	ASTM D2234-76	Tube sampler, trier, auger, scoop, shovel
~~Containerized liquids~~	~~SW-846~~	~~Coliwasa, tube sampler, weighted bottle, dipper, thief~~

Sampling equipment will be compatible with waste, and are generally made of glass, steel, or Teflon. Stainless steel is more suitable for sampling solids and soils, while glass and Teflon are more suitable for liquids.

~~4.6.1.1 Sampling with a Coliwasa~~

~~The Coliwasa is used to collect extremely viscous liquid or sludge samples, as well as containerized liquid samples. The Coliwasa provides a representative sample of layered and homogenous liquid materials, and the sampler consists of glass, plastic, or metal tube with an end closure that can be opened and closed while the tube is submerged in the sample material. The following general process will be used to sample with the Coliwasa:~~

~~1.Clean/decontaminate Coliwasa.~~

~~2.Adjust sampler's mechanisms to ensure that the stopper provides tight closure. Open sampler.~~

~~3.Lower sampler into waste so that liquid level inside and outside the sampler remain the same.~~

~~4.When sampler hits the base of the material to be sampled, the sample tube is pushed down to close the sampler and lock the stopper.~~

~~5.Withdraw the Coliwasa from the waste and place sample into the appropriate sample container.~~

~~Note that only plastic Coliwasas constructed of Teflon should be used to sample organics. Glass coliwasas are not used to sample hydrofluoric acid liquids, and if solids are present at the base of the sampled matrix, an alternative sample device will be used to obtain a representative sample of the solid phase.~~

4.6.1.2 Sampling with a Dipper

Dippers are used to collect liquid samples and free-flowing slurries. The dipper consists of a glass, plastic, or stainless steel beaker or similar container typically clamped, as necessary, to the end of a pole which serves as a handle. The following process will be used to sample with the dipper:

1. Clean/decontaminate the dipper.

2. Insert dipper into the liquid to be sampled, preferably through the entire sample container, if possible.

3. Remove dipper and place sample into the appropriate sample container.

4.6.1.3 Sampling with a Thief Sampler

A thief sampler may be used to collect ~~viscous liquid/~~sludge samples or to sample small dry granules. Thief samplers typically consist of two slotted concentric tubes of stainless steel; the outer tub has a conical tip allowing the sampler to penetrate the sample material, while the inner tube is rotated to open/close the sampler. The following general process will be used to sample with a thief sampler:

1. Clean/decontaminate the sampler.

2. Insert closed thief into material to be sampled. Rotate the inner tube to open the thief; collect sample.

3. Withdraw the thief, and remove inner tube, transferring sample to sampler container.

~~4.6.1.4 Sampling with a Weighted Bottle~~

~~The weighted bottle is used to sample liquids and free-flowing slurries that are relatively homogeneous. The sampler consists of a glass or plastic bottle with a sinker, stopper, and line that is used to lower/raise the bottle within the sampler matrix. The following general process will be used to sample with a weighted bottle:~~

~~1.Clean/decontaminate the sampler.~~

~~2.Assemble weighted bottle sampler.~~

~~3.Lower the sampler to the desired depth and remove stopper.~~

~~4.Allow bottle to fill.~~

~~5.Raise sampler and cap (sampler can serve as the sample container).~~

~~Non-fluorocarbon plastic bottles should not be used to sample organics. Before sampling, ensure that sample line, sinker, and other equipment are compatible with waste materials (i.e. waste will not corrode sampling equipment).~~

4.6.1.5 Sampling with a Scoop/Shovel

Scoops/shovels are used to sample rock/soil-like, solid or powdered matrices. The following general process will be used to sample with scoops/shovels:

1. Clean/decontaminate the sampler.

2. Obtain a full cross section of the waste material using the scoop or shovel that is large enough to contain the waste collected in one cross sectional sweep.

4.6.1.6 Sampling with an Auger

Augers are used to sample relatively hard packed solid waste material or soils. Augers are spiral drilling blades attached to metal shafts which are “turned” downward through sample material, allowing sample to exit the sample matrix by moving upward along the auger spirals. The following general process will be used to sample with an auger:

1. Clean/decontaminate the sampler.

2. Drill downward, using the auger, into the waste material, capturing waste moving upward along the auger blades in the appropriate sample container.

4.6.1.7 Sampling with a Tube Sampler

Tube samplers are used to collect soil/solid samples, and are generally glass or steel tubing that can be inserted into relatively compact matrix. (Modified tube samplers, however, can be used for liquid sampling.) Following insertion of the tube, and tube is extracted with the sample contained in the inserted tube. The following general process will be used to sample with the tube sampler:

1. Clean/decontaminate the sampler.

2. Lower/insert the tube into the waste to the desired depth.

3. When the desired depth is reached, slowly withdraw the tube, taking care to retain as much sample with the tube as possible.

4. Extract sample into the appropriate sample container.

4.6.2. Sample Collection Procedures

This section discusses the general sampling procedures for each type of sample to be collected at the Facility, as presented in Table 4F-6. It is recognized that the specific sampling that will take place at the Facility may differ from general procedures included herein, and approval by NMED is required before revisions are implemented. Additionally, selection of sample locations (Section 4.6.2.8) and sample types (Section 4.6.2.9) for on-site samples to be collected are addressed.

Table 4F-6. On-Site Sample Collection Activities

Sample Type	Matrix	Collection frequency	Comments
Fingerprint sample	All incoming ~~liquid,~~ sludge and solid; debris waste will not be fingerprinted	One/shipment for bulk shipments 1/10 drums for drummed waste	Table F4-2 defines base fingerprint analysis required
Annual sample	All incoming ~~liquid,~~ sludge and solid; debris waste will not be fingerprinted	One sample annually for each waste that underwent representative sampling prior to initial shipment	Table F4-1 defines base representative analysis required. Sampling will be performed at the generator site.
Spills/releases	Spilled waste and contaminated material (sludge, liquid, soil)	Each release	For Hazardous Waste determination
~~Evaporation pond output~~	~~Waste sludge and liquid as it is removed from pond~~	~~Each waste transferral~~	~~To determine LDR status~~
~~Stabilization tank input~~	~~Evaporation pond and offsite sludge and liquid leachate.~~	~~Each input~~	~~For bench scale testing to determine stabilization~~
~~Stabilization tank~~	~~All tank output (sludge, liquid~~	~~Each output~~	~~To determine LDR status~~

Sample Type	Matrix	Collection frequency	Comments
output	and solidified solid)		
Landfill input	All incoming sludge and solidified solid waste to landfill except debris	Each input to landfill from Stabilization Tank and Evaporation Pond Random sampling of waste directly landfilled.	To determine LDR status. May use results from Stabilization Tank Output/Evaporation pond analysis.
On-site waste	1. Treated waste 2. Day-to-day (Truck Wash, etc.) operations 3. Releases 4. Run-on/runoff 5. Investigation-derived waste 6. Soil 7. Air 8. Leachate/sludges from Evaporation Pond and Llandfill	1,2. When acceptable knowledge is not available 3,4. See Vol. II Appendices (Permit Application October 2000) 5. Each container 6. Contingency Plan 7. See Vol. II Appendices (Permit Application October 2000) 8. Placed in temporary leachate storing tanks; sSampled monthly	To determine hazardous/LDR status. See Table 4F-5 for specific waste matrices generated by on-site activities

4.6.2.1 Fingerprint Sampling

Fingerprint sampling will be conducted for all in-coming waste, except for debris waste. E (each container of debris waste will be visually inspected, however, as will each drum and roll-off, regardless of waste matrix). Matrices that will undergo fingerprint sampling include sludges and, solids, and liquids, arriving in containers such as tanker trucks, roll-offs, and drums/containers. Refer to Table 4F-6 and Section 4.4.3.1 for sampling frequency and waste analysis.

Tanker trucks delivering bulk liquids will be sampled through an access hatch, with a vertical sample collected using a Coliwasa or other appropriate sampling devise (see Section 4.6.1). Trucks delivering bulk solid material (e.g. in roll-offs) will be sampled using solid sampling equipment, such as a scoop (see Section 4.6.1). A surface sample will be collected from the front one-third area of the truck, middle one-third area, and rear one-third area of the bulk; samples will then be composited (see Section 4.6.4). Vertical waste composition will be determined, as possible, by collecting an additional sample from more than approximately 2 feet below the surface of the waste at each of the three sample locations using the appropriate sample collection tool (e.g., auger); these three samples will be composited with the first three samples. All loads will be visually inspected during unloading. If the load exhibits different color, texture, or wetness, samples from these areas will also be collected and included in the composite sample.

Sample methodology for drummed waste will depend on the sample matrix, but will likely include liquid sample collection using a Coliwasa and solid sampling using a scoop or auger. A single sample, collected through as much depth of the drummed waste as possible, will be collected. The location of samples collected is discussed in Section 4.6.3.

The Facility will detail the sampling method used for fingerprint waste sample collection, including but not limited to sample collection technique, sample type, sample representativeness, sample volume, sample containers, sample preservation, chain-of-custody, etc., and will place this information in the Operating Record.

4.6.2.2 Annual Sampling

Wastes that underwent representative sampling prior to initial waste shipment will undergo annual sampling to confirm waste composition. The Facility will assess the representative sampling procedure prior to initial waste acceptance, and this same representative sampling procedure will be used for annual sampling. Annual sampling will follow the representative sampling process performed prior to initial waste shipment; if the process is modified, the Facility will assess the sampling process to ensure collection of a representative sample, and place this assessment in the Operating Record.

4.6.2.3 Spills/Releases

See Section 4.6.2.7

~~4.6.2.4 Evaporation Pond Output~~

~~Evaporation Pond output will consist of liquids and sludges/solids of varying viscosity/degree of solidification. This waste is then transferred, as appropriate, to stabilization tanks, and/or the landfill. Each waste transfer will be sampled with a single grab sample selected from the waste transferred at the midpoint/middle of sample transfer, if the waste is homogenous. Alternatively, if the waste is heterogeneous, a composite sample may be collected in the transfer vessel using a tube sampler or other appropriate sample devise, with the extracted sample then composited. If modification to these sampling methods to meet waste/site-specific requirements occurs, all information pertaining to the modified method will be detailed in the Operating Record. Samples will be analyzed to assess continued waste LDR compliance. The facility will detail the sampling method used for each output waste, including but not limited to sample collection technique, sample type, sample representativeness, sample volume, sample containers, sample preservation, chain of custody, etc., and will place this information in the Operating Record. Note that leachate and waste sludge may be generated within/below the Evaporation Pond, however, these are considered "on-site" generated waste and are discussed in Section 4.6.2.7.~~

~~4.6.2.5 Stabilization Tank Input/Output~~

~~Stabilization Tank input wastes include liquid (e.g. leachate) and sludges. Output includes sludges, liquid, and solidified sludge. Input samples are to be sampled primarily for bench-scale testing to assess solidification techniques. Sampling methodology will be dependent upon the matrix sampled, but must include at least one grab sample from the input waste container/stream of sufficient volume to perform bench-scale assessments (assuming a homogenous waste stream). A composite sample will be collected if the stream is heterogeneous in nature. Output waste must be sampled to ensure continued compliance with LDR requirements; see Section 4.6.2.4 for output sampling methodologies. The facility will detail the sampling method used for each input/output waste, including but not limited to sample collection technique, sample type, sample representativeness, sample volume, sample containers, sample preservation, chain of custody, etc., and will place this information in the Operating Record.~~

4.6.2.6 Landfill Input

All incoming waste to the landfill will be sampled to ensure continued compliance with LDR requirements. ~~For waste originating from the stabilization tank or evaporation pond, output sampling will fulfill this requirement. For wastes directly placed in the Landfill from off-site sources, and o~~On an annual basis, the Facility will randomly sample and analyze a minimum of 10 percent of incoming waste streams that are to be directly landfilled to verify conformance with the LDR requirements. These additional samples will be analyzed for the specific regulated hazardous constituents contained in the hazardous waste stream. The data generated from these samples, in conjunction with the generator-supplied data, will be used to verify conformance with the LDR requirements. Sampling procedures will follow those presented in Sections 4.6.2.1 and 4.6.2.4, as applicable.

4.6.2.7 On-Site Generated Waste

Several wastes may be generated on-site that require sampling and analysis (see Table 4F-4). Specifically, treated waste, day-to-day generated waste (e.g. truck wash, liquid waste storage area, and stabilization area decontamination rinse, personal protective equipment), releases of wastes, run-on/run-off, investigation-derived waste, contaminated soil, air emissions, and leachate/sludges from the evaporation pond/ landfill are considered on-site generated waste.

Leachate/sludges from the evaporation pond and landfill will be placed in temporary storage tanks and/or the stabilization tank. Sampling of leachate/sludges must occur prior to emplacement in the stabilization tanks and/or evaporation pond, and will entail either sampling required of input to these units, or collection of a representative sample from the temporary holding tank using the appropriate sampling device (e.g. Coliwasa, weighted sampling bottle). Also see Sections 4.6.2.5 and 4.6.2.6.

4.6.3 Selection of Sample Locations

The Facility will collect samples from containers and roll-off boxes using either random (i.e., probability) or biased (i.e., authoritative) sampling methods. Random sampling methods will be used to select drummed containers for fingerprint analysis. All other on-site sampling, except for annual sampling of waste directly landfilled (i.e., 10 percent of the waste) requires sampling of each load, bulk container, or waste transfer, and random selection of waste containers to be sampled is therefore not applicable. However, the Facility will collect random samples from within the waste to be sampled for non-fingerprint or annual analysis (e.g., leachate, landfill input) if the wastes are expected to be fairly homogeneous waste streams. A biased sampling method will be used to select roll-off/tanker waste sample locations. (Biased samples will be collected if the wastes are expected to be or are found to be heterogeneous.) For some waste streams, the Facility may use both sampling techniques, as determined appropriate by the facility and justified in the Operating Record.

With random sampling, every unit in a population (e.g., every drum from a given waste stream in a shipment) has a theoretically equal chance of being selected for sampling. Consequently, data generated by these samples are unbiased estimators of the range of concentrations in a population. If a sufficient number of samples are taken, they would be representative of the average concentrations within the entire population. For example, in the case of drums, those drums to be fingerprint sampled will be numbered, and numbers will be randomly drawn to determine those containers that will be sampled.

With biased sampling, a preference is given to selecting only certain units in a population. This technique requires the sampler to use discretion and to have knowledge of the waste. The sampler selects the sample locations from areas where contamination is known or suspected (e.g., the sampler could collect a biased sample from areas where there is layering or differences in color or consistency). Also, the Facility may use a field screening instrument to bias the sample location, (e.g., a photoionization detector could be used to select locations having higher volatile organic concentrations). EPA-approved ASTM method D140-70 identifies the procedure for estimating the number of containers that should be sampled. Samples collected from roll-offs, for example, may include biased sampling if areas of obvious discoloration, and other pertinent information, are noted.

The Facility will document the sampling technique that is used to locate each waste sample collected pursuant to this waste analysis planWAP. The Facility will maintain this information in the Facility Operating Record.

4.6.4 Sample Types

Samples of the waste will be collected as either composite or grab samples. It is possible that the Facility may modify or augment the procedures discussed below for the collection of composite and grab samples before the Facility becomes operational; if so, these revisions will be approved by NMED prior to implementation.

In composite sampling, a number of samples are initially collected from a waste and combined into a single sample which is then analyzed for the constituents of concern. Composite sampling is a valid method for homogeneous samples and tends to minimize the between-sample variation, much like the maximization of the physical size of a sample. This has the effect of reducing the number of samples that must be analyzed to verify the contents of a waste shipment. Composite samples can also be obtained from a waste that has stratified; however, a composite would only be made from samples obtained from the same strata within the waste. Composite samples will be taken with clean sampling equipment and samples will be blended before analysis. ~~Composite sampling will be used to obtain samples of wastewaters.~~ Grab sampling will be used to obtain samples of ~~non-wastewaters and~~ heterogeneous wastes.

4.6.5 Sampling QA/QC

QA sampling procedures will be conducted in accordance with the guidance provided in the EPA document SW-846 and EPA's waste analysis plan guidance manual, *Waste Analysis at Facilities that Generate, Treat, Store and Dispose of Hazardous Waste*. The QA requirements will be applicable to on-site sampling (e.g., leachate collection system samples~~, truck rinsate, waste removed from the evaporation pond~~) as well as to the sampling of incoming waste shipments. This program is necessary to ensure that decisions regarding the acceptance and disposition of waste are based on sound, statistically valid, and documented data. Additional QA procedures associated with sampling and analysis determined prior to initiation of on-site sampling will be included in the Operating Record.

The sampling QA program will include the following:

- training requirements for personnel responsible for sample collection;
- chain-of-custody protocols for tracking samples;
- QA review of procedures to ensure proper use of equipment;
- protocols for equipment maintenance;
- identification of required sampling techniques for specific media;
- field sampling QC procedures; and
- documentation of sampling locations.

Deviations from the approved sampling program, sampling methods, or chemical analytical methods will be documented and reviewed by personnel responsible for site QA. NMED will be notified in writing of the QA exceptions within seven days of the occurrence and measures will be taken to correct the problems as soon as practicable.

4.6.5.1 Training Requirements for Personnel Responsible for Sample Collection

All personnel and supervisory staff responsible for collecting waste samples for screening and chemical analysis will be trained in the use of all sampling methods and equipment used at the site.

4.6.5.2 Chain-of-Custody Protocols for Tracking Samples

The integrity of the sampling/analytical scheme will be maintained by following chain-of-custody procedures from the point of sample collection through analytical data reporting to sample disposal. The possession and handling of samples will be traceable from the time of collection through analysis and final disposition.

A sample is considered to be in a person's custody if it is:

- in a person's physical possession;
- in view of the person after taking possession; or
- secured in a container sealed by the responsible person so that it cannot be tampered with during transport to the designated destination or during storage after being secured by that person in an area of restricted access.

The sampler will place a sample label on each sample container. The label will include the following information:

- sample number, a unique identifier that is traceable to the waste stream and shipment;
- name of collector (sampler);
- date and time of collection; and
- place of collection.

Labels will be affixed to sample containers prior to or at the time of sampling and will be filled out at the time of collection.

Sample chain-of-custody seals will be required if the sample is designated to leave the possession of Facility personnel for transport to an analytical laboratory. The seal will include the same information as the sample label. The seal will be attached in such a way that it is necessary to break it in order to open the sample container. In addition, chain-of-custody seals will be affixed to sample storage containers in a similar manner in order to prevent tampering prior to shipment from the Facility to off-site analytical laboratories. Samples and storage containers which require seals must be sealed prior to leaving the possession of Facility personnel.

To establish the documentation necessary to trace sample possession from the time of collection, a chain of custody record will be filled out and will accompany every sample. A sample chain of custody record is provided in Permit Attachment F3~~Vol. II of this application~~.

If the sample is to be shipped off-site for analysis, it will be accompanied by a sample analysis request sheet. The sample analysis request sheet will include the information necessary to identify the sample and the analyses requested by the Facility. Samples shipped off-site for analysis will be packaged and shipped in accordance with DOT transportation requirements.

Laboratory samples will be maintained in a secure area and retained until holding times expire, as listed in SW-846, or three months, whichever comes earlier. After the holding time or three month holding period has expired, samples will be disposed at the Facility with compatible waste batches. Records of the date the samples are removed from storage and the date and method of disposal will be maintained at the Facility until completion of post-closure care. In cases where samples are not analyzed within their holding times, the Facility will resample.

4.6.5.3 QA Review of Procedures to Ensure Proper Use of Equipment

Standard operating procedures will be developed for the use, decontamination, and storage of sampling equipment used to characterize waste shipped to the Facility. The standard operating procedures will include the sampling equipment to be used, instructions for use, and the applications for use of the equipment for collection of samples from specific media and types of shipping containers. The procedures and QA standards for waste sample collection will be included in the standard operating procedures.

4.6.5.4 Protocols for Equipment Maintenance

The protocols for equipment maintenance will be included in the standard operating procedures. Protocols will be developed, as described in the preceding paragraph, for use, decontamination, and storage of equipment. Protocols for equipment maintenance will be included in the standard operating procedures (See Section 4.6.7 for general decontamination requirements).

4.6.5.5 Identification of Required Sampling Techniques For Specific Media

The sampling methods and equipment used for collecting samples from specific media will be selected in accordance with the guidelines included in 40 CFR, Part 261, Appendix I, and in the EPA guidance manual, *Waste Analysis at Facilities That Generate, Treat, Store, and Dispose of Hazardous Waste*, Chapter 2. Alternative sampling methods may be used with prior approval of NMED.

4.6.5.6 Field Sampling QC Procedures

Blank and duplicate samples will be obtained during waste characterization sampling to confirm that sample collection and handling procedures meet the QA/QC standards outlined in the standard operating procedures and data quality objectives included in the Facility sampling manual. Duplicate samples will be collected at a minimum frequency of 10 percent (1 for every 10 samples). Field blanks and equipment blanks will be collected at a minimum frequency of 5 percent (1 for every 20 samples). Trip blanks will be included with all sample kits where samples are sent to off-site laboratories for chemical analysis. The field QA samples are described below:

- *Field blanks:* Field blanks are prepared in the field by filling a clean container with pure de-ionized water and appropriate preservative (if required for a specific activity). Contaminants found may indicate airborne contamination, contaminated equipment, or cross-contamination during sampling. A minimum of one field blank will be collected for every 20 waste samples collected.

- *Trip blanks:* Trip blanks are sample containers that are prepared with an inert material such as de-ionized water and carried into and out of the field, but not opened at any time during the sampling event. Contaminants detected in the trip blank may indicate that the source where the sample was prepared or the container that transported the trip blank was contaminated. A trip blank will accompany all sample shipping containers sent from and to off-site laboratories.

- *Equipment blanks:* Equipment blanks are prepared in the field prior to sampling by running de-ionized water over sampling equipment and placing it into a clean sample container. Contamination in this type of sample will indicate that the sampling equipment is contaminated. A minimum of one equipment blank will be collected for every 20 waste samples collected.

- *Field duplicates:* Field duplicates are independent samples that are taken from the same location at the same time and are used to measure the effectiveness of obtaining representative samples. A minimum of one field duplicate will be collected for every 10 waste samples collected.

4.6.5.7 Documentation of Sampling Activities

Sampling activities, including observations and field procedures, will be recorded on appropriate forms and kept on file at the Facility. Copies of the completed forms will be maintained in a bound and sequentially numbered file. The record of waste stream sampling activities will include:

- the date;
- the time of arrival and departure;
- weather conditions (including estimated temperature and wind direction);
- the name of the sample collector;
- daily activities and times sampling was conducted;
- observations;
- a record of samples collected, with sample designations and locations specified;
- field monitoring data, including health and safety monitoring;
- a list of equipment used and calibration records, if appropriate;
- a list of additional data sheets completed; and
- the signature of personnel completing the field record.

Each sample collected during waste stream sampling activities will be identified by a unique sample designation. The sample designation will be included on the sample label. QA samples will be designated with a "Q" (QA/QC samples) at the end of the sample designation, followed by one of the following to indicate the type of QA sample:

- "D" will be used for a duplicate sample;
- "E" will be used for equipment rinsate blanks;
- "F" will be used for field blank samples; or
- "TB" will be used for field trip blanks.

This coding will be used to assure that duplicates and blanks are submitted "blind" to the laboratory, but can still be easily tracked by the Facility for QA purposes.

4.6.6 Sample Preservation, Volumes, and Holding

Table 4F-7 presents general preservation, container, and holding time information for samples collected. SW-846 guidelines have been used to determine these general requirements, although these may be modified or augmented to account for waste-specific requirements, waste-container compatibility considerations, or additional waste parameters for analysis. Specific sample volumes and containers appropriate for the sampling event will be determined by the Facility. Prior to any sampling event, sample container labels will be prepared and affixed to sample containers, and all sample containers will be certified clean by the supplying laboratory. Sample labels will identify, at a minimum, sample number, date, sampler, matrix, analyses to be performed, and sample preservation. Once collected, samples will be placed immediately into the shipping container (i.e., cooler), and chain-of-custody documentation will be filled out (see Section 4.6.5.2).\

4.6.7 Equipment Decontamination

Sampling equipment will be decontaminated prior to use. Decontamination of sampling equipment typically includes initial scrubbing with a biodegradeable commercial detergent, followed by a de-ionized water rinse. The decontamination process will include wiping down of sampling equipment to remove surface residue, followed by detergent wash, rinse, a second detergent wash, and second rinse. Modifications to this process may be required to account for site/contaminant conditions, and may take place so long as the decontamination procedure is well documented and appropriate supporting information is placed in the Operating Record.

Table 4F-7. General Container, Holding Time, and Preservative Requirements by Sample Matrix

Sample Matrix	Concentration	Fraction	Volume	Container Type [a]	Preservative	Holding Times
Inorganics						
~~Water~~	~~Low~~	~~Total metals~~	~~1 liter~~	~~C, H, or L~~	~~Cool to 4°C~~	~~6 months~~
		~~Dissolved metals~~	~~1 liter~~	~~C or L~~	~~Filter on-site; HNO_3 to pH<2~~	~~6 months~~
	~~Medium~~	~~Total metals~~	~~1 liter~~	~~C or L~~	~~Cool to 4°C~~	~~6 months~~
		~~Dissolved metals~~	~~1 liter~~	~~C or L~~	~~Filter on-site; HNO_3 to pH<2~~	~~6 months~~
Soil, Sediment, and Residue	Low/Medium Medium	Total metals	6 oz	F or G	Cool to 4°C	6 months
Organics						
~~Water~~	~~Low~~	~~VOCs~~	~~80 mL~~	~~B~~	~~HCl to pH <2, Cool to 4°C~~	~~14 if preserved~~
		~~SVOCs~~	~~2 liters~~	~~A,K, or H~~	~~HCl to pH <2, Cool to 4°C~~	~~7 days for extraction; 40 days after extraction to analysis~~
		~~Petroleum hydro-carbons~~	~~2 liters~~	~~A, K, or H~~	~~HCl to pH <2, Cool to 4°C~~	~~7 days for extraction, 40 days after extraction to analysis~~
Soil, Sediment, and Residue	Low/Medium	VOCs	240 mL	D	Cool to 4°C	14 days
		SVOCS	3 oz	F or G	Cool to 4°C	14 days for extraction, 40 days after extraction to analysis
		Petroleum hydro-carbons	3 oz	F or G	Cool to 4°C	15 days for extraction, 40 days after extraction to analysis

Note: The above table is general in nature and may be modified or augmented, so long as the requirements are congruent with SW-846 requirements.

[a] Container types are as follows:

~~A = 80-oz amber glass bottle with teflon-lined black phenolic cap~~

~~B = 40-mL glass vial with teflon-backed silicon septum cap~~
~~C = 1-L high-density polyethylene bottle with poly-lined, poly cap~~
D = 120-mL glass vial with teflon lined, white poly cap
~~E = 16-oz wide-mouthed glass jar with teflon-lined, black poly cap Water~~
F = 8-oz wide-mouthed glass jar with teflon-lined black poly cap Water
G = 4-oz wide-mouthed glass jar with teflon-lined, black poly cap Water
~~H = 1-L amber glass bottle with teflon-lined, black poly cap~~
~~K = 4-L amber glass bottle with teflon-lined, black phenolic cap~~
~~L = 500-mL high-density polyethylene bottle with poly-lined, black poly cap~~

4.7 Analytical Methods

Analytical methods which the Facility will use for specific tests are identified in the waste analysis tables (Tables 4F-1 through 4F-3). All analytical methods used in conjunction with this ~~waste analysis plan~~WAP must be EPA-approved methods or methods required by hazardous waste regulations. If there is no equivalent EPA-approved method, an ASTM method or other approved method may be used. If the Facility or a generator wishes to use alternate test methods, the Facility or generator will first demonstrate to the NMED Secretary that the proposed method is equal or superior to the corresponding methods prescribed in 40 CFR 261 or 264, in accordance with 40 CFR 260.21.

An example of a non-EPA method required by hazardous waste regulations are the ASTM tests specified in 40 CFR 264.314(e)(2) to determine the presence of non-biodegradable sorbents.

Section 4.7.1 identifies the duties of the laboratory manager. Section 4.7.2 identifies the contents of the laboratory QA/QC plan. Requirements for off-site laboratories used by the Facility are contained in Section 4.7.3.

4.7.1 Duties of the Laboratory Manager

The on-site laboratory manager will have the following responsibilities to ensure an effective quality assurance program:

- ensuring that laboratory personnel are adequately trained to perform sampling and analytical procedures and in safety procedures;
- ensuring that equipment and instrumentation under his or her control are calibrated and functioning properly;
- coordinating internal and external assurance audits;
- reviewing procedures and QA plans of outside laboratories used. QA/QC practices will be considered during the selection of independent analytical laboratories. QA/QC practices that will be reviewed include written procedures, certification, internal and external audits, personnel training, and chain-of-custody procedures; and
- development, updating, and implementation of the laboratory QA plan.

4.7.2 Facility Laboratory QA/QC Plan

Prior to beginning operations, the Facility will develop procedures which will comprise the laboratory QA/QC plan. The Facility will develop a QA manual for operation of the on-site laboratory. The manual will be submitted to NMED for review.

The results of chemical analysis of waste samples generated by the on-site laboratory will not be used as part of the waste acceptance evaluation process prior to NMED's review of the QA manual.

The overall QA objective for measurement data is to ensure that data of known and acceptable quality are provided. All measurements will be made to yield accurate and precise results representative of the media and conditions measured. QA objectives for precision, accuracy, and completeness will be established for each measurement variable, where possible, and will be included in the QA manuals of the on-site and off-site laboratories where waste samples will be submitted for chemical analysis. The laboratory procedures, practices, and qualifications will be included in the QA manual for each laboratory.

The laboratory QA/QC plan will be based on guidance provided in EPA's *Requirements for Quality Assurance Project Plans for Environmental Data Operations* (EPA QA/R-5). As such, the plan will address the following key elements in compliance with EPA QA/R-5: project organization; laboratory quality assurance organization; data quality objectives and criteria; employee training and certification requirements; laboratory analytical methods; quality control requirements; laboratory equipment and instrumentation calibration, testing, inspection, and maintenance; QA/QC of suppliers and vendors; data acquisition requirements; data management; data review, validation and verification; and, reconciliation with quality objectives and criteria. These elements and other procedures which will be included in this plan are discussed in the following sections:

- laboratory quality assurance;
- equipment calibration;
- laboratory QA/QC samples;
- laboratory QC;
- analytical procedures; and
- laboratory maintenance.

4.7.2.1 Laboratory Quality Assurance

The Facility laboratory and each off-site laboratory will maintain an internal quality assurance program, as documented in its laboratory quality assurance manual. The laboratories will use a combination of blanks, surrogates, duplicates, MS/MSD (matrix spike/matrix spike duplicate) and laboratory control samples, BS/BSD (blank spike/blank spike duplicate), to demonstrate analytical QA/QC. Control limits will be established for individual chemicals or groups of chemicals based on the long-term performance of the test methods. The specific procedures to be completed and the laboratory control limits will be included in the QA manual for each laboratory.

4.7.2.2 Equipment Calibration

The laboratory equipment calibration procedures, calibration frequency, and calibration standards will be in accordance with EPA (or equivalent method) specified test methodology requirements and will be documented in the laboratory's QA manual. All instruments and equipment used by the laboratory will be operated, calibrated, and maintained according to manufacturers' guidelines and recommendations. Operation, calibration, and maintenance will be performed by personnel who have been properly trained in these procedures. A routine schedule and record of instrument calibration and maintenance will be kept on file at the laboratory.

4.7.2.3 Laboratory QA/QC samples

Analytical procedures will be evaluated by analyzing reagent or method blanks, surrogates, MS/MSDs, BS/BSDs, and/or laboratory duplicates, as required or appropriate for each method. The laboratory QA/QC samples and frequency of analysis to be completed will be in accordance with EPA or equivalent method protocols and will be included in the QA manual for each laboratory.

The laboratory QA manuals and procedures will incorporate data quality objectives (DQOs) to verify that waste characterization data obtained by the methods established in this ~~waste analysis plan~~WAP meet regulatory requirements with regard to regulatory compliance and Facility waste management requirements. The following DQOs are established for the sampling and analysis of waste managed by the Facility:

- Identify and quantify the hazardous constituents in the waste to ensure compliance with 40 CFR 264 and the requirements of the Facility permit, and
- Compare the contaminant concentrations in the waste with the specified characteristics of 40 CFR 261 in order that the waste may be managed in accordance with Facility requirements.

To ensure that the laboratory data quality objectives are met, the following analyses will be completed in the laboratory to monitor the analytical process:

- *Laboratory duplicate samples:* Laboratory duplicate samples will be analyzed to monitor for intralaboratory precision of data generated. These samples will be analyzed at a rate of no less than 5 percent (1 for every 20 samples) of the total samples with at least one replicate if fewer than 20 samples are analyzed for any particular parameter.

- *Spiked samples (MS/BS):* Spiked samples will be analyzed to monitor analytical precision. Spiked samples will be tested on no less than a five percent (1 for every 20 samples) basis for any particular parameter. At least one spiked sample will be run if fewer than 20 samples are analyzed.

- *Control charts:* Control charts will be utilized to establish laboratory control limits to monitor and review the accuracy of the data generated as a result of spike analyses. Control limits reflect long-term data accuracy trends and will be modified as new data are acquired.

- *Method/reagent blanks:* Method/reagent blanks will be prepared using samples of purified water or reagents which will then subjected to the entire sample analytical procedure to monitor potential contamination of samples due to contamination in the laboratory or laboratory equipment. Method or reagent blanks will be included with each set of samples.

- *Laboratory equipment blanks:* Laboratory equipment blanks will be analyzed to monitor potential contamination of samples due to improper or ineffective cleaning of equipment. These samples will be analyzed at a rate of no less than 5 percent (1 for every 20 samples) of the total samples.

- *Quality control samples:* QC samples will be analyzed to monitor for accuracy of data generated. EPA QC samples or samples purchased from a reputable independent source will be submitted to off-site laboratories as blind samples for chemical analysis of a set of selected analytes approved by NMED at the beginning of the Facility operation and also at regular intervals during the Facility operating life.

- *Surrogates:* Surrogates will be analyzed in accordance with EPA guidelines for organics analysis. Surrogate recovery is a measure of the effectiveness of the analytical process. Surrogates will be tested on no less than a 5 percent (1 for every 20 samples) basis for any analysis of organic compounds.

- *Calibration standards and devices:* Calibration standards and devices will be used in accordance with the manufacturers' recommended guidelines to calibrate laboratory instrumentation.

- *Internal standards:* Internal standards prepared in the laboratory will be referenced against external standards to measure accuracy.

Laboratory QC procedures will be included in the laboratory QA manuals prepared by each laboratory.

4.7.2.4 Laboratory Quality Control

QC objectives for the analytical data are a means of checking and controlling the sources of error in analytical data results. The criteria for data evaluation include assessing the data accuracy, precision, completeness, representativeness, and comparability. The criteria are described below:

- *Accuracy:* Accuracy is a measure of the error between chemical analytical results and the true sample concentrations. Accuracy is a measure of the bias in a system and will be expressed as the percent recovery of spiked samples. Accuracy will be presented as percent recovery and will be calculated as follows:

$$\%R - (S\text{-}U) \text{ X } 100\%C_{sa}$$

where %R = percent recovery
S = spike sample analytical result
U = sample analytical result
C_{sa} = known spike concentration

The data quality objectives (DQOs) for accuracy for each analytical method will be presented in the laboratory QA manual.

- *Precision:* Precision is a measure of data variability. Variability can be attributed to sampling activities and/or chemical analysis. Relative percent difference (RPD) will be used to assess the precision of the sampling and analytical method and will be calculated as follows:

$$RPD = [*C_1 - C_2*/(C_1 + C_2)/2)] \text{ x } 100$$

where RPD = relative percent difference
C1 = larger of the two concentrations
C_2 = smaller of the two concentrations

The DQOs for precision for each analytical method will be presented in the laboratory QA manual.

- *Completeness:* Completeness will be evaluated to assess whether a sufficient amount of valid data is obtained. Completeness is described as the ratio of acceptable measurements. Completeness will be calculated as follows:

C = (Number of samples having acceptable data)/(total number of samples analyzed) x 100%

where C = completeness

The DQOs for completeness will be presented in the laboratory QA manual.

- *Representativeness:* Representativeness is a qualitative parameter related to the degree to which the sample data represent the specific characteristics of concern. Procedures in sample collection will be implemented to assure representative samples, such as repeated measurements of the same parameter from the same waste stream in the same shipping container over several distinct sampling events. Any procedures or variations that may affect the collection or analysis of representative samples will be noted and the data qualified as appropriate.

- *Comparability:* Comparability is a qualitative parameter related to whether similar sample data can be prepared. To assure comparability, analytical results will be reported in appropriate units for comparison with other data (such as past studies or clean-up standards), and the standard collection and analytical procedures included in this ~~waste analysis plan~~WAP will be implemented. Any procedures or variations that may affect comparability will be noted, and the data will be qualified as appropriate.

4.7.2.5 Analytical Procedures

Specific QA/QC procedures to be used for sampling, chain-of-custody, calibration, analytical methods, reporting, internal QC, audits, and preventative maintenance will be included in the laboratory QA manual.

Laboratory procedures and methods to be used will contain all of the information presented in the EPA document, SW-846, for each method. The format for each method will be similar to that used in SW-846. If there is no appropriate SW-846 method ASTM or other approved methods will be employed. The laboratory procedures and methods also will include the following:

- *Scope:* A description of the scope of applicability of the procedure.

- *Principal:* A brief description of the steps to be taken and/or the theory involved in the laboratory analysis.

- *Interference:* A description of known interfering agents that would cause difficulty in the laboratory analysis.

- *Apparatus:* A listing or description of equipment required to perform the laboratory analysis.

- *Reagents:* A listing of the reagents required, a description of the steps involved in preparing the reagents, and instructions on storage requirements and retention times.

- *Procedures (instructions):* An enumeration of the sequence of activities to be followed. The topics include sample preparation or pretreatment, sample storage requirements, instrument set-up, standardization or calibration, sample analysis, calculations, and glassware-cleaning procedures. The procedure includes any precautions, explanation, or clarifications needed to properly perform the analysis. These include safety precautions, the frequency of standardization required, the acceptance criteria or procedures for determining the acceptability of standard curves, clarification or special techniques critical to the analysis, and the procedure the analyst uses to determine the reliability of sample results based on the standard curves.

- *Quality control requirements:* A listing of the QC checks to be performed and the acceptance criteria used to evaluate the QC data.

- *Reference:* A listing of the publications from which the information was derived in preparing the laboratory method. All references pertain to these documents. As a rule, laboratory methods are derived from the following publications:
    - Standard Methods for the Examination of Water and Wastewater, American Public Health Association;
    - Annual Book of Standards, American Society for Testing and Materials;
    - Methods for Chemical Analysis of Water and Waste, US Environmental Protection Agency;
    - Test Methods for Evaluating Solid Waste, SW-846, US Environmental Protection Agency;
    - National Functional Guidelines for Organics Data Review; and
    - Laboratory Data Validation Functional Guidelines for Evaluating Inorganic Analyses.

    Editions used will be those currently specified in 40 CFR, as updated.

4.7.2.6 Laboratory Maintenance

The analytical laboratory will have in place a procedure that details the steps to be taken to calibrate and standardize instruments to ensure that analytical data produced are accurate. Records of all calibrations, preventative maintenance, and service calls will be readily available from the laboratory files. Calibration procedures will follow the method procedures outlined in the EPA document, SW-846, or the *Annual Book of ASTM Standards*.

A procurement procedure that identifies methods to be used to document and control the purchase of materials, parts, and services will be implemented by the laboratory and will be presented in the laboratory QA manual. The procedure will include identifying the quality of laboratory chemicals and equipment, management approval of procedure items, inspection of shipments for compliance with requirements, and isolation of nonconforming items to be returned to vendors. The quality of all equipment will conform to the requirements specified in the most current edition of the EPA document, *Handbook of Analytical Quality Control in Water and Wastewater Laboratories*, the Federal Register, or other regulatory agency publications. This procurement procedure will serve to ensure that spare parts routinely required will be readily available.

4.7.3 Requirements for Off-Site Laboratories

The Facility will document that the following conditions are met for each off-site laboratory performing waste analyses for the Facility:

- the laboratory will not be the same laboratory that was used by the generator;
- the laboratory must be approved by the Facility;
- the laboratory must use the analytical methods identified in Section 4.5;
- if there is more than one analytical method for a specific test identified in Section 4.5, the laboratory must follow the guidance in Chapter Two of the current version of EPA document SW-846 to determine the appropriate analytical method; and
- the laboratory must follow the QA/QC requirements described in this ~~waste analysis plan~~WAP.

4.7.4 Laboratory Requirements for Foreign Generators

The Facility will ensure and document that laboratory analysis provided by foreign generators is performed by a laboratory accredited or certified for the appropriate hazardous waste field of testing (FOT) by an authority using the EPA's National Environmental Laboratory Accreditation Conference standards.

4.8 Waste Tracking

To identify and track the waste managed at the Facility, a Facility-specific number will be assigned to each waste stream and to each shipment within that waste stream. Each waste shipment will be tracked using a unique alphanumeric designation. This designation will identify the generator, a sequential number specific to the shipment, substance and source and the delivery date (or, in the case of site-generated waste, the date the waste entered the system). An example is presented below:

ABC-0001-043099

where ABC identifies the generator
0001 identifies the waste stream, source, and shipment
043099 is the date the waste was delivered

The waste numbering system will assist in the tracking of waste as it moves through the Facility. The number will be recorded on:

- all incoming paperwork from the generator;
- samples received from the generator;
- samples taken on-site; and
- site-generated records.

The date will not be recorded until the waste actually arrives on-site. This numbering system will allow the Facility to track a specific waste with regard to ~~analyses conducted, necessary treatment, and~~ the final disposition of the waste. In addition, assigning a unique designation to each generator and a unique number to each waste stream from that generator will make possible determining the amount of waste from a given waste stream that has been received by the Facility. Individual shipments from within the waste stream will receive an additional identifier to enable the Facility to tie information back to the specific shipment as well as to the waste stream. The system will allow the Facility to locate the current position of the waste at the Facility, including the location of the waste in the landfill.

Tracking waste in this manner will allow the Facility to determine the efficiency and accuracy of a generator's profiling efforts and the rejection rate for incoming waste. This information will be used to assist Facility operations in determining the rate of fingerprint analysis required for a given generator.

The Facility number will designate waste generated on-site. All other numbering and tracking will be the same for all waste managed at the Facility. The tracking system will be maintained in the Facility records as either hard copy or electronically (computer database).

4.9 Notification, Certification, and Recordkeeping

The Facility will maintain a Facility Operating Record in accordance with 40 CFR 264.73. The Operating Record will include:

- all analytical results;
- all chain-of-custody forms;
- generator notices of restricted wastes not meeting treatment standards or exceeding levels specified in RCRA Section 30049(d), including the information listed in 40 CFR 268.7(a)(1); and
- generator notices of restricted wastes meeting applicable treatment standards and prohibition levels, including the information in 40 CFR 268.7(a)(2).
- all final disposition records;
- all manifest and waste discrepancy resolution documentation; and
- all other information (e.g., notifications, certifications, waste analysis reports, waste movements) which will be maintained in the Operating Record as noted in this waste analysis planWAP.

As required in 40 CFR 268.7, the following records will be maintained at the Facility for wastes generated on-site, and/or documentation of treating restricted wastes:

- Where on-site generated wastes are characterized to determine compliance with LDR standards using only process knowledge, all data used to make any such determination. This These data will be maintained by site personnel.
- Where a representative sample of waste is analyzed to determine compliance with LDR standards, all waste analysis information. This These data will be retained on-site in Facility files.
- All notifications and/or certifications submitted by waste generators. These records will be maintained until Facility closure as required in 40 CFR 264.73.

In addition, relevant inspection forms and monitoring data will be maintained on file at the Facility. Files will be maintained for a minimum of three years (for inspection records and LDR notification), or until approval of Facility closure (for inventory records).

Permit Attachment F1. Rationale for Analytical Parameter Selection

Modified from the Permit Application, Volume I,

Section 4.5.1

4.5.1 Analytical Parameters

The analytical parameter lists for pre-acceptance waste characterization, fingerprint analysis, and additional unit-specific analysis are presented in Permit Attachment F, Waste Analysis Plan, Tables 4F-1, Parameters and Methods for Pre-Acceptance Representative Sample Analysis, 4F-2, Tests and Analytical Methods for Fingerprint Samples, and 4F-3, Additional Tests and Analytical Methods. The Facility will augment these lists as necessary, to ensure that additional considerations pertaining to waste-stream–-specific pre-acceptance characteristics, LDR standards analysis, and other Facility operational limits are met. The rationale used to determine pre-acceptance characterization is specified in Section 4.5.1.1. The rationale for selecting additional parameters to ensure compliance with the LDR standards is specified in Section 4.5.1.2. The rationale for selecting parameters to ensure compliance with other facility regulatory and operational limits is contained in Section 4.5.1.3. For each waste stream accepted, treated, and disposed of at the facility, appropriate parameters will be selected to ensure that each of the facility acceptance criteria (see Permit Attachment F, Section 4.2, Criteria for Waste Management at the Facility,) is met.

4.5.1.1 Parameters for Waste Characterization

Permit Attachment F, Table 4F-1 specifies parameters to confirm that a waste stream agrees with the information provided by the generator. The rationale for the selection of these parameters is as follows:

- *Total volatile organic compounds (VOCs):* This test will determine the presence and concentration of individual VOCs.

- *Total semivolatile organic compounds (SVOCs):* This test will determine the presence and concentration of individual SVOCs.

- *Metals and inorganic constituents:* These tests will determine the presence and concentrations of individual metals and other inorganic constituents.

- *Physical appearance:* This test determines the general identity of the waste and establishes baseline characteristics that can then be subjectively compared with the waste shipment when it arrives at the facility. The waste is visually inspected and the physical appearance of the waste is recorded, including, at a minimum, the following properties: Color, physical state (solid or, semi-solid, or liquid), texture, viscosity, layering (single phase, bi-layer, multi-layer), and presence of free liquids.

- *pH:* This test indicates the corrosive nature of the waste. It also determines compatibility with other wastes and with containers or liners, and treatment requirements. The tolerance range for pH is plus or minus 2.5 pH units.

- *Radioactivity screen:* This test screens each load using a gamma ray scintillation detector or other appropriate equipment. This test will be used to ensure that the level of radioactivity observed in NORM waste or equipment from oil, gas, and water production containing hazardous constituents, or other naturally occurring radioactive materials not regulated under 20.3.1.14 NMAC, is not above regulated limits as defined in 20 NMAC 3.1, Subpart 14 (i.e., the maximum radiation exposure reading at any accessible point does not exceed 50 microroentgens per hour ~~(~~[ΦR/hr~~)~~]~~,~~ and the maximum radiation reading for sludges and scales contained in oil, gas, and water production equipment does not exceed 50 ΦR/hr, or, if the radiation readings for removable sludges and scales exceed 50 ΦR/hr, the concentration of radium 226, in a representative sample, does not exceed 30 picocuries per gram ~~(30~~[pCi/g~~)~~]). ~~(~~Material regulated under the Atomic Energy Act of 1954, as amended, is not permitted for waste management~~)~~.

4.5.1.2 Additional Analysis to Ensure Compliance with the LDR Treatment Standards

The facility will ensure that LDR treatment standards are met by identifying the appropriate treatment standard requirements as follows:

- *Total waste standards:* All hazardous constituents in the waste or in the treatment residue must be at or below the values for these constituents contained in the table in 40 CFR 268.40.
- *Waste extract standards:* The hazardous constituents in the extract of the waste or in the extract of treatment residue must be at or below the values found in the table in 40 CFR 268.40.
- *Technology standards:* The waste must be treated using the technology specified in the table in 40 CFR 268.40.

Identification of parameters to demonstrate compliance with LDR standards will be conducted as follows:

- identification of all hazardous applicable characteristic and listed EPA Hazardous Waste Numbers;
- identification of the appropriate subcategory for each applicable EPA Hazardous Waste Number (from the most current version of the Table in 40 CFR 268.40);
- ~~determination of wastewater/non-wastewater status for the waste stream;~~
- identification of all underlying hazardous constituents for each applicable EPA Hazardous Waste Number (from the most current version of the Tables in 40 CFR 268.40 and 268.48; and
- selection of the most current versions of the analytical methods associated with all identified hazardous wastes, underlying hazardous constituents, and subcategories~~, and wastewater/non-wastewater status~~ (from Table 4-2, SW-846, or equivalent).

The rationale for the selection of additional parameters to ensure compliance with the LDR standards is as follows:

- ~~*Total organic carbon (TOC):* This test determines the total organic carbon concentration of the waste and is needed to determine whether the waste is a wastewater or non-wastewater.~~
- ~~*Total suspended solids (TSS):* This test determines the total suspended solids concentration of the waste and is needed to determine whether the waste is a wastewater or non-wastewater.~~
- *Ignitability:* This is a qualitative test to determine the ignitable nature of the waste and~~,~~ indicate if the waste is prohibited~~, and determine treatment requirements~~. It also helps to determine whether the waste is compatible with ~~containers, tanks,~~ liners, piping, structures, equipment, and other waste streams.

- *Explosive meter vapor test (TLV sniff test):* This test determines the fire-producing potential of the waste and whether it is regulated as flammable or combustible by the US Department of Transportation. If liquid waste exceeds 200 ppm, the waste will also be tested for ignitability using the flash point test. The tolerance range for the TLV sniff test is plus or minus 200 ppm.

- *Flash point test:* This test determines the flash point of the waste and determines whether the waste is ignitable**.**

- *pH:* This test indicates the corrosive nature of the waste. It also determines compatibility with other wastes and with ~~containers or~~ liners~~, and treatment requirements~~. The tolerance range for pH is plus or minus 2.5 pH units.

- *Reactive sulfide:* This test determines the reactive nature of the waste and~~,~~ indicates if the waste is prohibited~~, and determines treatment requirements~~. It is also used to determine whether the waste is compatible with ~~containers, tanks,~~ liners, piping, structures, equipment, and other waste streams. Wastes containing total releasable sulfide with concentrations less than 500 ppm are considered non-reactive.

- *Reactive cyanide:* This test determines if cyanide could potentially be reactive under acidic conditions, indicates if the waste is prohibited~~, and determines treatment requirements~~. It also determines whether the waste is compatible with ~~containers, tanks,~~ liners, piping, structures, equipment, and other waste streams. Wastes containing total releaseable cyanide with concentrations less than 250 ppm are considered non-reactive.

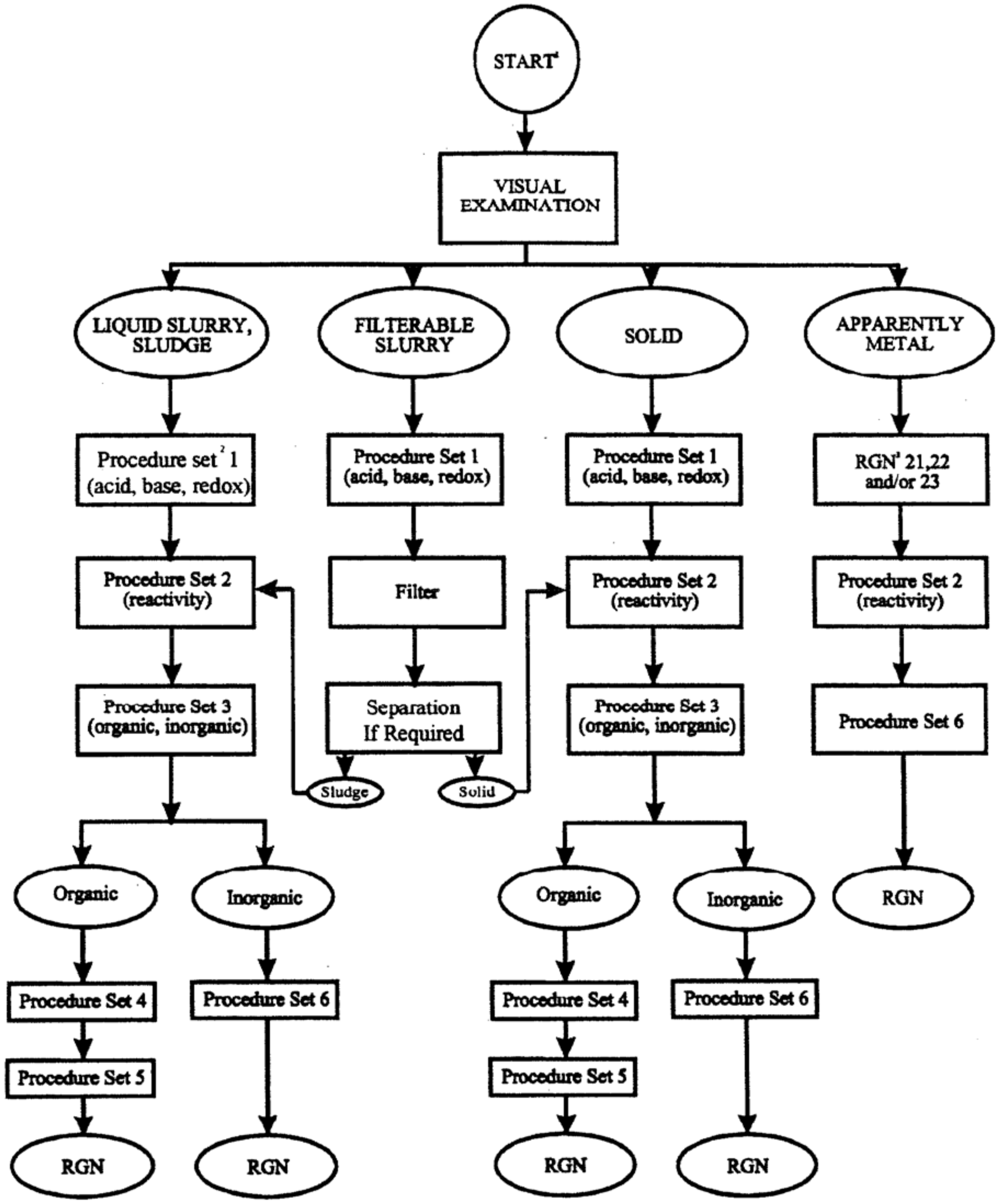
- *Reactivity (compatibility):* This test determines the compatibility between the waste and the liner~~, tank, container,~~ or equipment which the waste may contact.

  The Facility will ensure that potentially incompatible wastes will not be ~~stored, treated, or~~ disposed of in the same location. The facility will perform a compatibility determination based on the pre-acceptance waste characterization information. Acceptable knowledge or assessment information provided on the Waste Profile Form may be used to assign compatibility codes to each waste type form based on 40 CFR 264, Appendix V. ~~For wastes that will be mixed with other waste streams for the purpose of treatment, chemical analysis will be required to ensure the compatibility of the waste streams.~~

  Chemical analysis will be accomplished in three steps, as appropriate for the waste being analyzed:

  - An analysis of the waste for reactive cyanide and sulfide. This analysis will be used to determine the waste's potential to release dangerous levels of hydrogen cyanide or hydrogen sulfide gases in acidic conditions (i.e., pH less than 2).

  - An evaluation of the reactivity characteristics of the waste through process knowledge and a series of analytical procedures that will test for the presence of reactive chemical groups. The procedures in the EPA document, *Design and Development of a Hazardous Waste Reactivity Testing Protocol,* EPA-600/2-84-057, February 1984, will be followed and the results used to assign the waste a reactivity group designation. Figure 4-3[RF1], Sequence of Procedure Sets for Determining Reactivity Group, summarizes the reactivity testing protocol.



[1] Based upon its knowledge of the waste, a generator may only need to use parts of the following sequence to confirm the generator's knowledge of the material.
[2] Procedure sets are identified in EPA's "Design Development of a Hazardous Waste Reactivity Testing Protocol" (EPA 600/2-84-057, February 1984).
[3] RGN = Reactivity Group Number

○ Start, Stop, Continue
▭ Procedure
⬭ Result

SEQUENCE OF PROCEDURE SETS FOR DETERMINING REACTIVITY GROUP

Figure 4-3

TRIASSIC PARK WASTE DISPOSAL FACILITY

- ○ Use of the reactivity group designation contained in Figure 4-3 to evaluate compatibility of the waste with other wastes by comparing it to the compatibility matrix shown in Figure 4-4[RF2], Reactivity Group Designation. (Refer to EPA document, A Method for Determining the Compatibility of Hazardous Wastes, EPA-600/2-80-076, April 1980, and 40 CFR Part 264, Appendix V, for additional information on waste compatibility).

- *Total ~~volatile organic compounds (~~VOCs~~)~~:* This test will determine the presence and concentration of individual VOCs.

- *Total ~~semi-volatile organic compounds (~~SVOCs~~)~~:* This test will determine the presence and concentration of individual SVOCs.

- *Metals:* These tests will determine the presence and concentrations of individual metals and other inorganic constituents.

- *Organochlorine pesticides:* This test determines the pesticide concentration of the waste.

- *Chlorinated herbicides:* This test determines the herbicide concentration of the waste.

- *PCBs:* This is a quantitative test to determine whether PCBs are contained in oil-bearing and other types of waste and to determine the concentration.

- *Leachate:* Leachate must be tested for all leachate constituents listed in the table in 40 CFR 268.40.

4.5.1.3 Additional Analysis to Ensure Compliance with Regulatory and Operational Limits

The rationale for the selection of additional parameters to ensure compliance with the facility's regulatory and operational limits is as follows:

- *Radioactivity screen:* See Section 4.5.1.1. This test will determine if the waste is prohibited from acceptance at the facility (see Section 4.1.2 for a list of prohibited wastes).

- *PCBs:* See Section 4.5.1.2. This test will determine if the waste contains a prohibited concentration of PCBs.

- *VOCs (Subpart BB):* These tests are conducted as required by 40 CFR 264.1063(d) to determine, for each piece of equipment subject to the requirements of 40 CFR~~,~~ 264, Subpart BB, whether the equipment contains or exceeds 10 percent VOCs by weight. Applicable process knowledge may be used to make this determination.

- ~~*VOCs (Subpart CC).* - These tests are conducted as required by 40 CFR 264.1084(a)(3)(iii) to determine, if wastes placed in tanks, the evaporation pond, and the stabilization bins are subject to the requirements of Subpart CC. A hazardous waste with a volatile organic concentration equal to or greater than 500 ppmw will be accepted only for storage in approved containers and direct disposal in the landfill;~~

- *Dioxins and dibenzofurans:* This test is conducted to ensure that the waste stream does not contain dioxins and/or dibenzofurans.

REACTIVITY GROUP DESIGNATION AND WASTE COMPATIBILITY MATRIX (1)

TRIASSIC PARK WASTE DISPOSAL FACILITY — **Figure 4-4**

Reactivity Group No.	Reactivity Group Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	101	102	103	104	105	106	107
1	Acids, Mineral, Nonoxidizing	1																																								
2	Acids, Mineral, Oxidizing		2																																							
3	Acids, Organic		G H	3																																						
4	Alcohols and Glycols	H	HF	HP	4																																					
5	Aldehydes	HP	HF	HP		5																																				
6	Amides	H	H GT				6																																			
7	Amines, Aliphatic and Aromatic	H	H GT	H		H		7																																		
8	Azo Compounds, Diazo Compounds, and Hydrazines	H G	H GT	H G	H G	H			8																																	
9	Carbamates	H G	H GT						G H	9																																
10	Caustics	H	H	H		H				H G	10																															
11	Cyanides	GT GF	GT GF	GT GF					G			11																														
12	Dithiocarbamates	H GF F	H GF F	H GF F		GF GT		U	H G				12																													
13	Esters	H	H F						H G		H			13																												
14	Ethers	H	H F												14																											
15	Fluorides, Inorganic	GT	GT	GT												15																										
16	Hydrocarbons, Aromatic		H F														16																									
17	Halogenated Organics	H GT	H F GT					H GT	H G		H GF	H						17																								
18	Isocyanates	H G	H F GT	H G	H P			H P	H G		H F G	H G	U						18																							
19	Keytones	H	H F						H G		H	H								19																						
20	Mercaptans and Other Organic Sulfides	GT GF	H F GT						H G									H	H	H	20																					
21	Metals, Alkali and Alkaline Earth, Elemental	GT H GF	GT H GF	GT H GF	GT H GF	GT H GF	GF H	GF H	GF H	GF H	GF H	GF H	GF GT H	GF H				H E	GF H	GF H	GF H	21																				
22	Metals, Other Elemental & Alloys as Powders, Vapors or Sponges	GF H F	GF H F	GF					H F GT	U	GF H							H E	GF H		H GF F		22																			
23	Metals, Other Elemental & Alloys as Sheets, Rods, Moldings, etc.	GF H GF	GF H GF						H F G									H F						23																		
24	Metals and Metal Compounds, Toxic	S	S	S			S	S			S														24																	
25	Nitrides	GF H F	H F F	H GF	GF H E	GF H			U	H G	U	GF H	GF H	GF H				GF H	U	GF H	GF H	E				25																
26	Nitriles	H GT GF	H F GT	H							U											H F			S	GF H	26															
27	Nitro Compounds, Organic		H F GT			H					H E											H GF F				H GF F		27														
28	Hydrocarbons, Aliphatic Unsaturated	H	H F			H																	H E						28													
29	Hydrocarbons, Aliphatic Saturated		H F																											29												
30	Peroxides and Hydroperoxides, Organic	H HG	H E		H P	H G		H GT	H F E	H F GT		H E GT	H F GT					H E	H	E	H F GT	H E	H G		H G	H GF F	H F GT		H F		30											
31	Phenols and Creosols	H	H F						H G										H F			GF H				GF H					H	31										
32	Organophosphates, Phosphothioates, Phosphodithioates	H GT	H GT						U		H E											H									U		32									
33	Sulfides, Inorganic	GT GF	HF GT	GT		H			E										H												H GT			33								
34	Epoxides	H P	H P	H P	H P	U		H P	H P		H P	H P	U								H F	H F	H F		H F	H F					H F	H F	U	H F	34							
101	Combustibles and Flammable Materials, Miscellaneous	H G	H F GT																			H G F				H GF F					H F GT					101						
102	Explosives	H E	H E	H E				H E		H E			H E									H E	H E	H E	E	E					H E	H E		H E	H E	H E	102					
103	Polymerizable Compounds	P H	P H					P H		P H	P H	U										F H	F H	F H	F H	F H					F H	F H		F H			H E	103				
104	Oxidizing Agents, Strong	H GT		H GT	H F	H F	H F GT	H F GT	H E	H F GT		H F GT	H F GT	H F	H F		H F	H GT	H F GT	H F	H F GT	H F E	H F E	H F		H F E	H F GT	H E	H F	H F	H G	H F	H F GT	H F GT	H F G	H F G	H E	H P GT	104			
105	Reducing Agents, Strong	H GF	H F GF	H F GF	H F GF	H F GF	G H	H GF	H G				H GT	H F				H E	GF H	GF H	GF H						H GF	H E			H E	GF H	GT GE H		H	GF H	H E	H P GT	H F E	105		
106	Water and Mixtures Containing Water	H	H						G										H G			GF H	GF H		S	GF H								GT GF							106	
107	Water Reactive Substances	EXTREMELY REACTIVE! DO NOT MIX WITH ANY CHEMICAL OR WASTE MATERIAL! EXTREMELY REACTIVE!																																								107

Reactivity Code	Consequences
H	Heat Generation
F	Fire
G	Innocuous
GT	Toxic gas generation
GF	Flammable gas generation
E	Explosive
P	Violent polymerization
S	Solubilization of toxic substances
U	May be hazardous but unknown

Example:

H F GT	Heat generation, fire, and toxic gas generation

[1] Determine the reactivity group numbers of the waste being evaluated. Locate the higher number using the left column "Reactivity Group No." and locate the other number on the stair-stepped columns on the right.

Locate the square at the intersection of the two group numbers, then consult the legend to match the reactivity code(s) with the consequences.

- *Non-biodegradable sorbent test:* This test is performed as required by 40 CFR 264.314 (prohibition of liquids in landfills). This test is required if the facility determines that the generator did not indicate whether a sorbent was added to the waste or indicates that a sorbent was added but did not specify the name and type of sorbent and whether it is nonbiodegradable. If any of this information is not present, the generator will be contacted for clarification. If uncertainty remains, 40 CFR 264.314(e)(1)(i-iii) will be reviewed. If the sorbent's biodegradability cannot be determined from the list or if the name of the sorbent is unknown, the material will be analyzed following one of the tests referenced in 40 CFR 264.314(e)(2). The facility will select one of the following tests:
  - ASTM Method G21-70 (1984a) - Standard Practice for Determining Resistance of Synthetic Polymer Materials to Fungi;
  - ASTM Method G22-76 (1984b) - Standard Practice for Determining Resistance of Plastics to Bacteria;
  - OECD Test 301B - CO_2 Evolution (Modified Sturm Test) ASTM Method G21-70 (1984a) - Standard Practice for Determining Resistance of Synthetic Polymer Materials to Fungi; or
  - Other approved test method.

- *Total organic halogens (TOX):* This test determines if concentrations of halogens in the waste are in compliance with the LDR treatment standards. It also determines if the waste contains constituents that could degrade a liner. Wastes containing TOX greater than 1,000 mg/l (based on TCLP extract) will not be placed in the ~~evaporation pond or the~~ landfill.

- *Free liquid content test (paint filter liquids test):* This test is a qualitative test to determine the free liquids concentration contained within the waste matrix and will be used as a control parameter for wastes that are to be landfilled.

- *Toxicity characteristic leaching procedure (TCLP):* This test must be used to obtain an extract of the waste where treatment standards are based on concentrations in the waste extract:
  - major ions and metals in non-leachate (sulfides and sulfates, radionuclides, VOCs, SVOCs, pesticides, PCBs, perchlorate, and TPH).

Attachment F2. Example Waste Profile Form

Example Waste Profile Sheet *

1. WASTE PROFILE #:__________

EPA Facility ID #: ____________________

DO NOT LEAVE BLANK SPACES. PLEASE SUBMIT THIS FORM TYPE-WRITTEN.

I. GENERATOR INFORMATION

2. Generator Name: ____________________ 3. EPA ID #: __________
4. Mailing Address: ____________________
5. Plant Address: ____________________
6. Business Contact: ____________________ Phone #: __________
7. Technical Contact: ____________________ Phone #: __________

The following information is required to comply with RCRA 40 CFR §§264/265.13 (O.A.C. 3745-65-13) General Waste Analysis.

II. GENERAL WASTE INFORMATION

8. Waste Material Name: ____________________ ___ 9. Generator Code: __________ (Optional)
10. Describe process that generates waste: ____________________ 11. SIC Code: __________
12. Is your company the original generator of the waste? ☐ No ☐ Yes If not, provide the name of the original generator:

____

13. If this waste is a still bottom, are you the original generator of the feed stock? ☐ No ☐ Yes
14. Rate of Generation: ____________________ Current accumulation: Drums __________ Bulk ______ (Gal.)
15. Check all types of containerization for which you request quotation.

______ 55-Gallon Steel Drum (SC)
______ 30-Gallon Steel Drum
______ 85-Gallon Steel Drum (Without inside container)
______ 85-Gallon Salvage Drum (With fiber or steel drums inside)
______ 55-Gallon Fiber Drum
______ 5-Gallon Pail
______ Bulk (For bulk shipments, waste viscosity must be < 5000 cps)
______ Other (Specify)

______ Palletized small containers
Overall dimensions of material on pallet: ______ x ______ x ______ (High)
Dimensions of pallet only: ______ x ______ x ______ (High)
What are the small containers on the pallet? ______________(1 qt. Bottles, 8 oz. Aerosol Cans, etc.)

III. WASTE STREAM CHEMICAL COMPOSITION**

16.

COMPONENTS INCLUDING 40 CFR 261 APPENDIX VII HAZARDOUS CONSTITUENTS	CONCENTRATION RANGE (UNITS)	AVERAGE % MUST TOTAL 100%	TLV (IF PUBLISHED) ACGIH	OSHA
______	___ to ___	______	______	______
______	___ to ___	______	______	______
______	___ to ___	______	______	______
______	___ to ___	______	______	______
______	___ to ___	______	______	______
______	___ to ___	______	______	______
______	___ to ___	______	______	______

* If applicable, this Waste Profile Sheet is a new revision of a previously submitted Waste Profile Sheet dated__________. Attach to this Form any additional information which must be known to treat, store, or dispose of the waste in accordance with RCRA §§264/265.13, including but not limited to data developed under RCRA Part 261, Laboratory Analysis Technical Publications or Material Safety Data Sheets.

** 40 CFR 261 Appendix VIII constituents should be identified for combustion facilities, even if not present in high enough concentrations to significantly contribute to the 100% composition.

WASTE PROFILE #:____________

IV. SPECIFIC ANALYSIS OF WASTE

17. Method used to obtain a representative sample of the analyzed waste (i.e., grab, composite, etc.) Sampling methods are described in RCRA 40 CFR 261 Appendix 1.

Generator's Knowledge & MSDS

In completing the next two items, do not leave blanks. If the specific element is not present, indicate "None".

18. Organic Bound

Organic Bound	CONCENTRATION RANGE			AVERAGE
Sulfur	______	to	______	______
Chlorine	______	to	______	______
Fluorine	______	to	______	______
Bromine	______	to	______	______
Iodine	______	to	______	______
Nitrogen	______	to	______	______
Phosphorus	______	to	______	______

(Base % WT on Molecular Structure)

19. Metals (Actual Content)

Arsenic	______	ppm	Mercury	______	ppm
Barium	______	ppm	Nickel	______	ppm
Cadmium	______	ppm	Selenium	______	ppm
Chromium	______	ppm	Silver	______	ppm
Lead	______	ppm	Thallium	______	ppm
Aluminum	______	%	Silicon	______	%
Magnesium	______	%	Sodium	______	%

20. Does this waste contain PCBs?
☐ No ☐ Yes. If yes, give the concentration regardless of amount and attach supporting documentation:
________________ ppm

21. Does this waste contain insecticides, pesticides, herbicides, or rodenticides?
☐ No ☐ Yes. If yes, identify each in the space below and the concentrations:
________________ ppm
________________ ppm
(Include Safety Data Sheets for each)

22. Does this waste contain Dioxin? ☐ No ☐ Yes

23. Does this waste contain free cyanide> 250 ppm?
☐ No ☐ Yes

24. Does this waste contain free sulfide > 250 ppm?
☐ No ☐ Yes

V. TOXICITY

25. Check Applicable Data

______ Eye Explain ____________
______ Inhalation Explain ____________
______ Dermal Explain ____________
______ Ingestion Explain ____________
______ Other Explain ____________
______ Carcinogen (suspected or known) Explain
____
____

VI. PHYSICAL PROPERTIES

26. Physical state at 70° F (Circle)

Liquid	Semisolid	Solid
Slurry	Sludge	Gas

Viscosity at 70° F ____________ CPS

27. Is material pumpable? ☐ No ☐ Yes
Varies (Explain): ____________

28. Is waste multi-layered? ☐ No ☐ Yes
If yes, please describe and quantify each layer:
1. (Top) ____________ %
2. ____________ %
3. ____________ %

29. Dissolved Solids: ____________ % WT
30. Suspended Solids: ____________ % WT
31. BTU Value/lbs: ____________
32. Ash Content (% by WT): ____________
33. Flash Point: ____________ °F
34. Vapor Pressure at 70° F: ____________
35. Specific Gravity: ____________
36. pH: ____________
37. Corrosivity: ____________ mpy
38. Color: ____________

VII. REACTIVITY AND STABILITY

39. What is the Reactivity Group Number(s) for this waste?
____

In accordance with **"Design and Development of Hazardous Waste Reactivity Testing Protocol,"** EPA Document No. EPA-600/2-84-057, February 1984.

40. Is this material stable? ☐ No ☐ Yes
If no, explain: ____________
____
____
____
____

41. Is this material shock sensitive? ☐ No ☐ Yes
If yes, explain: ____________
____
____
____
____

WASTE PROFILE #:____________

VIII. EPA INFORMATION

42. Is this waste hazardous as defined by RCRA 40 CFR Part 261? ☐ No ☐ Yes

If yes, list the applicable EPA Hazardous Waste Number(s) and explain why you have assigned the number(s). For example, if you assign D001, the reason for selection is that the flash point is less than 140° F. If you assign F002, the reason for selection may be that the waste is the still bottom from the recovery of methylene chloride:

EPA Hazardous Waste Number(s) ____________ Reason for Selection ____________

43. If the answer to #42 is yes, list CERCLA reportable quantities, found in 40 CFR §302.4:

____

44. If the waste is not hazardous as defined by federal regulations but is hazardous as defined by state regulations in which the waste was generated, please provide the state hazardous waste number(s). Also provide any state hazardous numbers that are not included in the federal regulations:

State Hazardous Waste Number(s) ____________ Reason for Selection ____________

IX. SAMPLING INFORMATION

45. Sample source (e.g., drum, lagoon, pond, tank, vat, etc.): ____________

Date Sampled: ____________ Sampler's Name/Company: ____________

46. Generator's Agent Supervising Sampling: ____________ 47. ☐ No sample required (Provide rationale)

X. LAND DISPOSAL RESTRICTIONS INFORMATION

48. Identify ALL characteristic and listed EPA hazardous waste numbers that apply (as defined by 40 CFR 261). For each waste number, identify the subcategory (as applicable, check none, or write in the description from 40 CFR 268.41, 268.42, and 268.43).

REF #	A. EPA HAZARDOUS WASTE CODE(S)	B. SUBCATEGORY ENTER THE SUBCATEGORY DESCRIPTION IF NOT APPLICABLE CHECK NONE		C. APPLICABLE TREATMENT STANDARDS			D. HOW MUST THE WASTE BE MANAGED?
				PERFORMANCE-BASED (CHECK AS APPLICABLE)		SPECIFIED TECHNOLOGY IF APPLICABLE ENTER THE CFR 268.42 TABLE 1 TREATMENT CODE(S)	ENTER THE APPROPRIATE LETTER (A-D) FROM BELOW
		DESCRIPTION	NONE	268.41(a)	268.43(a)	268.42	
1							
2							
3							
4							
5							
6							

WASTE PROFILE #:____________

To list additional EPA waste numbers and categories, use additional page and check here: ________

Management under the land disposal restrictions:

A. RESTRICTED WASTE REQUIRES TREATMENT? ☐ No ☐ Yes

B.1. RESTRICTED WASTE TREATED TO PERFORMANCE STANDARDS? ☐ NO ☐ Yes Method ___________

B.2. RESTRICTED WASTES FOR WHICH THE TREATMENT STANDARD IS EXPRESSED AS A SPECIFIED TECHNOLOGY (AND THE WASTE HAS BEEN TREATED BY THAT TECHNOLOGY) ☐ NO ☐ Yes Method ____

B.3. GOOD FAITH ANALYTICAL CERTIFICATION FOR INCINERATED ORGANICS? ☐ NO ☐ Yes Method _____

C. RESTRICTED WASTE SUBJECT TO A VARIANCE? ☐ No ☐ Yes Date/Type ____________________

D. RESTRICTED WASTE CAN BE LAND DISPOSED WITHOUT FURTHER TREATMENT? ☐ No ☐ Yes

XI. DOT INFORMATION

In accordance with the Department of Transportation 49 CFR Parts 171 through 177, complete the following:

49. DOT Proper Shipping Name: ____________________

50. DOT Hazard Class: ____________________

51. DOT UN or NA Number: ____________________

52. Container Label(s): ____________________
(For containers of 110 gallons or less)

Additional Description ____________________

53. Placards: ____________________

Generator's hazardous waste shipments must also comply with the labeling requirements of RCRA 40 CFR Part 262.

54. Is this waste a soil and/or debris? No: ___ Yes, Soil: ___ Yes, Debris: ___ Yes, Both: ___

55. COMPLETE ONLY FOR WASTES INTENDED FOR FUELS OR INCINERATION

TOTAL

Antimony as Sb	____________	ppm
Beryllium as Be	____________	ppm
Potassium as K	____________	ppm
Sodium as Na	____________	ppm
Bromine as Br	____________	*ppm/%
Chlorine as Cl	____________	*ppm/%
Fluorine as F	____________	*ppm/%
Sulfur as S	____________	*ppm/%

* Indicate ppm or %.

56. RECLAMATION, FUELS OR INCINERATION PARAMETERS (Provide if information is available)

RANGE

A. Heat Value (BTU/lb.) _________ _________

B. Water: ____________________

C. Viscosity (cps): ___________ @_____°F ____100°F ______150°F

D. Ash: ______________%

E. Settleable solids: _______________%

F. Vapor Pressure @ STP (mm/Hg): ______________

G. Is this waste a pumpable liquid? ☐ No ☐ Yes

H. Can this waste be heated to improve flow? ☐ No ☐ Yes

I. Is this waste soluble in water? ☐ No ☐ Yes

J. Particle size: Will the solid portion of this waste pass through a 1/8-inch screen: ☐ No ☐ Yes

57. Special Handling Information ____________________
____

WASTE PROFILE #:___________

ACCOUNTABILITY STATEMENT

58. I hereby certify that all information submitted in this and all attached documents contains true and accurate descriptions of this waste. Any sample submitted is representative as defined in 40 CFR 261 Appendix I or by using an equivalent method. All relevant information regarding known or suspected hazards in the possession of the generator has been disclosed. I authorize (_____) to obtain a sample from any waste shipment for purposes of recertification.

______________________	______________________	______________
Authorized Signature	Printed (or typed) Name and Title	Date

PERMIT ATTACHMENT F3

EXAMPLE CHAIN-OF-CUSTODY FORM

Example Chain-Of-Custody Record

PROJECT NO.	PROJECT NAME					NO. OF CONTAINERS	PARAMETERS	INDUSTRIAL HYGIENE SAMPLE Y / N
SAMPLERS: (Signature)					(Printed)			REMARKS
FIELD SAMPLE NUMBER	DATE	TIME	COMP	GRAB	STATION LOCATION			

Relinquished by: (Signature)	DATE / TIME	Received by: (Signature)	Relinquished by: (Signature)	DATE / TIME	Received by: (Signature)
(Printed)		(Printed)	(Printed)		(Printed)

Relinquished by: (Signature)	DATE / TIME	Received for Laboratory by: (Signature)	DATE / TIME	Remarks
(Printed)		(Printed)		

ATTACHMENT F4

WASTE CHARACTERIZATION USING ACCEPTABLE KNOWLEDGE

F4-1 Introduction

Generators of solid waste are required by New Mexico Hazardous Waste Management Regulations in Title 20 New Mexico Administrative Code, Chapter 4, Part 1, Subpart 300 (20.4.1.300 NMAC), incorporating 40 CFR 262.11, to determine if the waste is a listed or characteristic hazardous waste, either by analyzing the waste or by applying knowledge of the waste in light of the materials or process used. The New Mexico Environment Department's (**NMED**) preferred method to meet waste analysis requirements is to conduct sampling and laboratory analysis because it is more accurate and defensible than other options. However, 40 CFR Parts 260 through 265, 268, and 270, and the Subparts I through VI, Subpart VIII, and Subpart IX, authorize the use of acceptable knowledge (**AK**) in appropriate circumstances by waste generators, or treatment, storage, or disposal facilities to characterize hazardous waste.

AK is described in *Waste Analysis: EPA Guidance Manual for Facilities That Generate, Treat, Store and Dispose of Hazardous Waste* (**EPA, 1994**). AK, as an alternative to sampling and analysis, can be used to meet all or part of the waste characterization requirements under the RCRA (EPA, 1994).

AK includes a number of techniques used to characterize waste, such as process knowledge, records of analysis acquired prior to RCRA, and other supplemental sampling and analysis data (EPA, 1994). Process knowledge includes information regarding the physical form of the waste, the base materials composing the waste, and the process that generates the waste. Examples of supplemental sampling and analysis data are provided in Section F4-2c.

AK is used in waste characterization activities in the following ways:

- To identify hazardous constituents in wastes from specific processes, such as F-listed and K-listed wastes identified at 20.4.1.200 NMAC (incorporating 40 CFR '261.31)

- As the sole characterization for wastes that are unused commercial chemical products or reagents, such as several of the P-listed and U-listed wastes identified at 20.4.1.200 NMAC (incorporating 40 CFR '261.33)

- To assess if underlying hazardous constituents exist in wastes that are determined to be characteristically hazardous (20.4.1.800 NMAC, incorporating 40 CFR '268.9).

- To assess waste characteristics when the physical nature of the waste does not lend itself to taking a laboratory sample, such as heterogeneous debris wastes exhibiting a toxicity characteristic (20.4.1.200 NMAC, incorporating 40 CFR '261.24)

- To delineate waste streams

F4-1a Permit-Specific Waste Characterization Requirements and the Use of Acceptable Knowledge

Permit Attachment 4, Section 4.3.1, specifies waste characterization information that must be provided by the waste generator, including but not limited to "waste analysis data used to characterize the waste and/or process knowledge documentation". Section 4.3.1 also states that waste analysis requirements may sometimes be met by providing "acceptable knowledge" documentation. As such, the Permit specifies that generator sites may choose to use acceptable knowledge in lieu of sampling to obtain waste characterization information.

In a March 18, 2002 Final Order issuing the Permit, the Secretary of Environment Department (**Secretary**) required that for wastes received from foreign generators, the Permittee require additional information and verify that information through increased auditing. To comply with the Secretary's Order, all foreign waste streams shall undergo the applicable provisions of this AK process prior to management at Triassic Park. The Permittee shall obtain AK documentation from each waste generator for each waste stream as specified in Section F4-2. And the Permittee shall assess generator's collection and use of AK documentation during audits as specified in Section F4-5.

Permit Attachment F, Section 4.3.1 also specifies that representative samples must also be collected for each waste stream in addition to waste analysis information. The Permit also requires fingerprint analysis at Triassic Park (**Facility**). The Permittee may not accept AK waste characterization information as a substitute for representative sampling (except in the case of debris waste as specified in section 4.4.2) or in lieu of performing on-site fingerprint analysis.

F4-2 AK Documentation

The following Sections include the information the Permittee will require from each foreign generator to characterize waste using AK. The required AK information must be supported by additional information (see Section F4-2c, Supporting AK Information).

If the required information is not available for a particular waste (e.g., a drum of unlabeled waste), the Permittee shall require the generator to obtain supplemental data (e.g., sampling/analysis data) to augment existing AK, but must petition the Secretary for a determination whether sufficient waste characterization documentation exists in the form of AK documentation and supplemental analytical data, or the waste will not be accepted for storage, treatment, or disposal at the Facility. NMED will evaluate whether sufficient documentation exists to justify all missing hazardous waste codes.

All specific, relevant AK documentation, including supporting AK documentation, assembled and used in the AK process, whether it supports or contradicts any required AK documentation, shall be identified by the generator and an explanation provided for its use (e.g., identification of a toxicity characteristic) in an Acceptable Knowledge Waste Characterization Documentation Summary.

F4-2a Required Generator Waste Management Program Information

Generator waste management program information shall describe how waste intended for management at the Facility is generated, tracked, and managed at the generator facility. The following information shall be included as part of the AK written record:

1. Map of the generator facility with the areas involved in waste generation and treatment identified

2. Identification of waste(s) intended for management at the Facility

3. Description of the operations that generate the above identified waste(s)

4. Waste identification or categorization schemes used at the facility

5. Quantities of waste(s) generated

6. Identity of the person(s) responsible for compliance with administrative controls of wastes

The generator must obtain this information through implementation of written procedures (perhaps provided by the Permittee) that address, at a minimum:

- Procedures for delineating waste stream(s)

- Procedures to identify hazardous waste(s) and assign the appropriate hazardous waste code(s) to each waste stream. The following are minimum baseline requirements/standards that procedures shall include to ensure comparable and consistent characterization of hazardous waste:

    - Review the required information to determine if the waste is listed under 20.4.1.200 NMAC (incorporating 40 CFR '261, Subpart D). Assign all appropriate and applicable listed hazardous waste codes unless the generator chooses to justify an alternative assignment and document the justification.

    - Review the required information to determine if the waste may contain hazardous constituents included in the toxicity characteristics specified in 20.4.1.200 NMAC (incorporating 40 CFR '261, Subpart C). If a toxicity characteristic constituent is identified and is not included as a listed waste, assign the toxicity characteristic code unless appropriate AK documentation or supplemental analytical data are available that demonstrate that the concentration of the constituent in the waste is less than the toxicity characteristic regulatory level. When analytical data are not available, the toxicity characteristic hazardous waste code for the identified hazardous constituent shall be applied to the waste stream.

    - Review the required information to determine if the waste may exhibit ignitable, reactive or corrosive hazardous characteristics specified in 20.4.1.200 NMAC (incorporating 40 CFR '261, Subpart C). Without appropriate AK documentation or supplemental analytical data, the ignitable, reactive and corrosive characteristic hazardous waste codes shall be applied to the waste stream.

- If the waste stream is identified as characteristically hazardous, review the required information to identify underlying hazardous constituents as required by 20.4.1.800 NMAC (incorporating 40 CFR '268.9)

- Procedures the generator will use to ensure prohibited wastes are not present in each container of waste (e.g., see Permit Condition 2.4.2, *Prohibited Waste Streams*)

- Procedures for assigning the appropriate physical waste form of the waste(s)

- Procedures to document how changes to waste stream assignment and associated EPA hazardous waste numbers based on material composition are documented for any waste

- Procedures for waste certification to be sent to the Facility

- Procedures for resolving inconsistencies in AK documentation

F4-2b <u>Required Generator Waste Stream Information</u>

For each waste stream, the Permittee shall require generators to compile all data used to characterize that waste stream. The type and quantity of documentation will vary by waste stream, depending on the process generating the waste. At a minimum, the waste stream information shall include the following written information:

1. Area(s) and/or building(s) from which the waste stream was or is generated

2. Material inputs or other information that identifies the chemical content of the waste stream and the physical waste form

3. Waste generating process described for each waste stream

4. Waste stream volume and time period of generation

5. Waste process flow diagrams (e.g., a diagram illustrating how the waste stream moves from a specific building to a size reduction facility to a container storage area)

Assumptions made in delineating each waste stream also shall be identified and justified. If discrepancies exist between required information, then generators shall apply all hazardous waste codes indicated by the information to the subject waste stream unless the generators choose to justify an alternative assignment and document the justification.

F4-2c AK Supporting Information

Generators shall make all AK supporting information part of the AK documentation. The amount and type of supporting information is generator-specific and cannot be mandated, but generators shall collect information as appropriate to support required information. The Permittee shall assess adequacy of supporting information during audits (Section B4-3f). AK supporting documentation includes, but is not limited to, the following:

- Process design documents
- Preliminary and final safety analysis reports and technical safety requirements
- Waste packaging logs
- Test plans or research project reports that describe reagents and other raw materials used in experiments
- Generator databases (e.g., chemical inventory database)
- Information from generator personnel (e.g., documented interviews)
- Standard industry documents (e.g., vendor information)
- Analytical data relevant to the waste stream, including results from representative sample analysis, fingerprint analyses, spot checks, or routine verification sampling.
- Material Safety Data Sheets, product labels, or other product package information
- Sampling and analysis data from comparable or surrogate waste streams
- Laboratory notebooks that detail the research processes and raw materials used in an experiment

Supporting documentation may be used to further document the rationale for the hazardous characterization results. Similar to required information, if discrepancies exist between supporting information and the required information, generators shall apply all hazardous waste codes indicated by the supporting information to the subject waste stream unless the generators choose to justify an alternative assignment and document the justification.

F4-3 Qualifications and Training Requirements

Generator personnel responsible for compiling AK, assessing AK, and resolving discrepancies associated with AK shall be qualified and trained in the following areas at a minimum:

- New Mexico and U.S. Federal RCRA regulations associated with solid and hazardous waste characterization

- WAP requirements as specified in Permit Part 2, Permit Conditions 2.3.1, 2.4.2, 2.5.2, and 2.5.3; Permit Attachment F, Sections 4.3 and 4.4; and Permit Attachment F4.

F4-4 AK Data Quality Requirements

Permittee shall require generators to comply with the following data quality requirements for AK documentation:

- Accuracy - Accuracy is the degree of agreement between an observed sample result and the true value. The percentage of waste containers that require re-designation of hazardous waste codes based on representative sampling and analysis data will be determined as a measure of AK accuracy.
- Completeness - The AK record shall contain 100 percent of the information specified in Section F4-2. The usability of the AK information will be assessed for completeness during audits.

- Comparability - Data are considered comparable when one set of data can be compared to another set of data. Comparability is ensured through generators meeting the training requirements and complying with the minimum standards outlined for procedures that are used to implement the AK process.

- Representativeness - Representativeness expresses the degree to which sample data accurately and precisely represent characteristics of a population. Representativeness is a qualitative parameter that will be satisfied by ensuring that the process of obtaining, evaluating, and documenting AK information is performed in accordance with the minimum standards established in Section F4-2. Generators also shall assess and document the limitations of the AK information used to assign hazardous waste codes (e.g., purpose and scope of information, date of publication, type and extent to which waste parameters are addressed and limitations of information in identifying hazardous wastes).

F4-5 Audits of AK

The Permittee will conduct document audits to verify compliance with the compilation, application, and interpretation requirements of AK information specified in this Section at all foreign generator facilities. This audit does not require the Permittee visit foreign generator facilities. The audit will evaluate the completeness and defensibility of generator-specific AK documentation related to hazardous waste characterization. The audit will result in a Waste Steam Audit Report to be maintained in the Facility's Operating Record.

Members of the Permittee's audit team will be knowledgeable regarding the WAP-required AK information and RCRA hazardous waste characterization. Audit team members will be independent of all waste management operations at the foreign generator being audited.

The Permittee will conduct an audit of each foreign generator prior to allowing waste transport to the Facility. This initial audit will establish an approved baseline that will be reassessed annually by the Permittee. Generator waste management programs and waste stream-specific audit checklists identifying all required documentation will be developed, used and evaluated by the Permittee prior to acceptance of a waste stream. Auditors will assess AK for correlation to specific waste streams, evaluate the generator process of compiling AK documentation; assigning hazardous waste codes; and identifying, resolving, and documenting discrepancies in AK records. Auditors will review documentation for logic, completeness, and defensibility, clarity of presentation, and degree of compliance with this Permit Attachment. Auditors shall ensure that generators appropriately include all potential hazardous waste codes indicated by the AK records. Any deficiencies in procedures shall be documented in the Waste Steam Audit Report.

A Waste Steam Audit Report will be completed and maintained the Facility's Operating Record. The Audit Report will include all observations and findings identified during the audit. The Audit Report will be provided to the Generator and the Generator shall respond to all audit findings and identify corrective actions. If the required AK information is not available, the Permittee will not manage the waste for the subject waste stream. Permittee's acceptance of the subject waste stream will not resume until the Permittee determines that the generator complies with all applicable requirements of the WAP.

F4-6 AK Re-evaluation and Corrective Action

The Permittee shall require generators to establish procedures for reevaluating AK if representative waste sampling and analysis results in the assignment of a different hazardous waste code. Generator procedures shall describe how AK is reevaluated and how appropriate hazardous waste codes are assigned. If a waste must be assigned to a different waste code, the following minimum steps shall be taken to reevaluate AK:

- Review existing information based on the container identification number and document all differences in hazardous waste code assignments
- If differences exist in the hazardous waste codes that were assigned, reassess and document all required AK information (Section B4-3b) associated with the new designation
- Reassess and document all sampling and analytical data associated with the waste
- Verify and document that the process material inputs are consistent with the waste characterization
- Define the actions necessary to fully characterize the waste

Permit Renewal Application
October 17, 2011

Attachment G

Air Quality

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The New Mexico Environment Department
March 2002

~~Permit~~ Attachment G. Air Quality

~~**Modified from the Permit Application, Volume I, Section 11.0.**~~

11. 40 CFR 264 Subparts AA~~,~~ and BB ~~& CC~~ Regulations

This section provides a brief summary of the air requirements, as presented in 40 CFR 264 subparts AA and BB. In addition, this section provides a brief summary of other regulations which may be applicable to the Facility.

11.1 40 CFR 264 Subpart AA - Air Emissions for Progress Units

The Facility will not be subject to the 40 CFR 264 Subpart AA regulations because the Facility will not utilize distillation, fractionation, thin-film evaporation, solvent extraction, air or steam stripping operations.

11.2 40 CFR 264 Subpart BB – Air Emission Standards for Equipment Leaks

No wastes with organic concentrations greater than 10 percent by weight shall be ~~accepted for storage in the liquid waste storage unit, treated in the evaporation pond or treated in the stabilization unit stored in containers, or~~ placed in the landfill. Units in compliance with this provision will not be subject to 40 CFR 264 Subpart BB regulations. Equipment such as pumps, compressors, pressure relief devices, sampling equipment, connecting system, and valves shall not contain or contact hazardous wastes with organic concentrations of 10 percent or greater by weight.

~~11.3 40 CFR 264 Subpart CC – Air Emissions Standards for Tanks, Suface Impoundments and Containers~~

~~Tanks and evaporation ponds shall not be used to manage hazardous wastes containing volatile organic concentrations of equal to or greater than 500 parts per million by weight (ppmw). Units in compliance with this provision will not be subject to 40 CFR 264 Subpart CC regulations.~~

~~Drums and roll-off containers may hold hazardous waste that contains greater than 500 ppmw volatile organic compounds. These wastes shall be stored in containers with appropriate covers (see Section 11.3.2).~~

~~11.3.1 Waste Determination~~

~~A waste determination will only be conducted for each waste stream to be placed in a unit that is exempt from the Subpart CC requirements for air emission controls (e.g. the evaporation pond). The waste determination shall be made at the point of waste origination. In general, the Facility will use generator-supplied information (manifests, shipping papers, certification notices etc.) prepared in accordance with 40 CFR 264.1083 to make this determination, however, the Facility may choose to test a representative sample of the waste. For waste to be placed in units that comply with Subpart CC requirements for air emission controls, no formal waste determination is required.~~

11.3.2 Applicability to Containers

There are two types of containers expected to be used at the Facility to store wastes: (1) drums and (2) roll-off containers. These containers may hold hazardous waste that contains greater than 500 ppmw volatile organic compounds. These drums and roll-off containers stored at the Facility will have covers and meet DOT requirements for packaging of hazardous waste for transport under 49 CFR 178. Potential air pollution, from containers that hold hazardous waste with greater then 500 ppmw volatile organic compounds, will be controlled in accordance with the standards specified in CFR 264.1086(d).

11.3.3 Applicability to the Evaporation Pond

The Facility will not accept waste to be placed in the evaporation pond that contains greater than 500 ppmw volatile organics. Therefore, the evaporation pond is exempt from air emission control requirements specified in Subpart CC.

11.3.4 Applicability to Tanks

The waste storage tanks will not be subject to the Subpart CC requirements for inspection, monitoring, and emission controls because this unit will not be used to manage wastes containing volatile organic concentrations greater than 500 parts per million by weight (ppmw)

11.3.5 Applicability to the Stabilization Process

The concentration of volatile organics in the waste to be stabilized will be limited to less than 500 ppmw. Final design documentation will be included as part of the operating record for the Facility.

11.3.6 Inspection and Monitoring

A written plan and schedule will be developed and implemented to perform all inspection and monitoring in accordance with 40 CFR 264.1088(b).

11.3.7 Recordkeeping and Reporting

Recordkeeping and reporting will be conducted in accordance with 40 CFR 264.1089 and 264.1090, respectively.

11.3.7.1 Recordkeeping

The following records will be kept:

- waste determinations;
- inspection and monitoring results;
- design specifications for closed vent systems and control devices;
- control device exceedances and corrective action; and,
- leak repair information.

~~11.3.7.2 Reporting~~

~~If the Facility becomes aware that an exempt unit has received hazardous waste containing greater than 500 ppmw volatile organic compounds, the regulatory agency will be notified within 15 days. In accordance with 40 CFR 270.30, if continuous emission monitoring is used at the exempt unit holding hazardous waste with greater than 500 ppmw volatile organic compounds, a semi-annual report will be provided that indicates each time the unit is operated in non-compliance over a 24 hour (or more) period of time. This report will not be provided if the unit remains in compliance during the entire 6-month reporting period.~~

11.4 Other Applicable Regulations

There are a number of other federal regulations which will apply to the Facility. Once the Facility has received a final permit and the configuration and operational aspects are finalized (it is possible that some minor changes to the Facility configuration and operation will occur as a result of the final permit), other regulations will be evaluated. Some of the regulations that will be evaluated are:

- National Pollution Discharge ~~and~~ Elimination System;
- Clean Water Act;
- Clean Air Act; and
- Occupational Safety and Health Administration regulations.

The regulations listed above will be evaluated for their applicability to the Facility. In addition to these federal regulations, the Facility will evaluate numerous state, county, and local regulations. GMI will ensure that the Facility is designed, constructed, and operated in compliance with all applicable regulations.

Permit Renewal Application
October 17, 2011

Attachment H

Ground Water Monitoring Waiver Request ~~and Approval~~

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March 2002

Table of Contents

Section **Page**

List of Figures

Figure **Page**

List of Tables

Table **Page**

List of Appendices

Appendix

Attachment H. Ground Water Monitoring Waiver Request and Approval

1. Introduction

On January 12, 2000, the Hazardous Waste Bureau (HWB) of the New Mexico Environment Department (NMED) granted Gandy Marley, Inc. (GMI) a Groundwater Monitoring Waiver for its proposed Triassic Park Waste Disposal Facility. Approval was based on site-specific hydrogeologic conditions and engineering safeguards that were documented in the report titled *Groundwater Monitoring Waiver Request, Triassic Park Waste Disposal Facility* (Montgomery Watson, January 2000). The Groundwater Monitoring Waiver and a Vadose Zone Monitoring System (VZMS) Work Plan for liquid detection and water quality monitoring were part of the permit approval for the Triassic Park Waste Disposal Facility authorized by NMED in a Final Order on March 18, 2002.

For this Permit Renewal Application, tThe Gandy-Marley CorporationGMI is again requesting that the Hazardous and Radioactive Materials Bureau (HRMB) of the New Mexico Environment Department (NMED)HWB grant a Groundwater Monitoring Waiver for theits proposed Triassic Park Waste Disposal Facility. This request is based on a demonstration that the site-specific geologic and hydrologic conditions at the site combined with the engineered barriers in the regulated units at the Facility will prevent migration of liquids from the unitscontaminants to the uppermost aquifer.

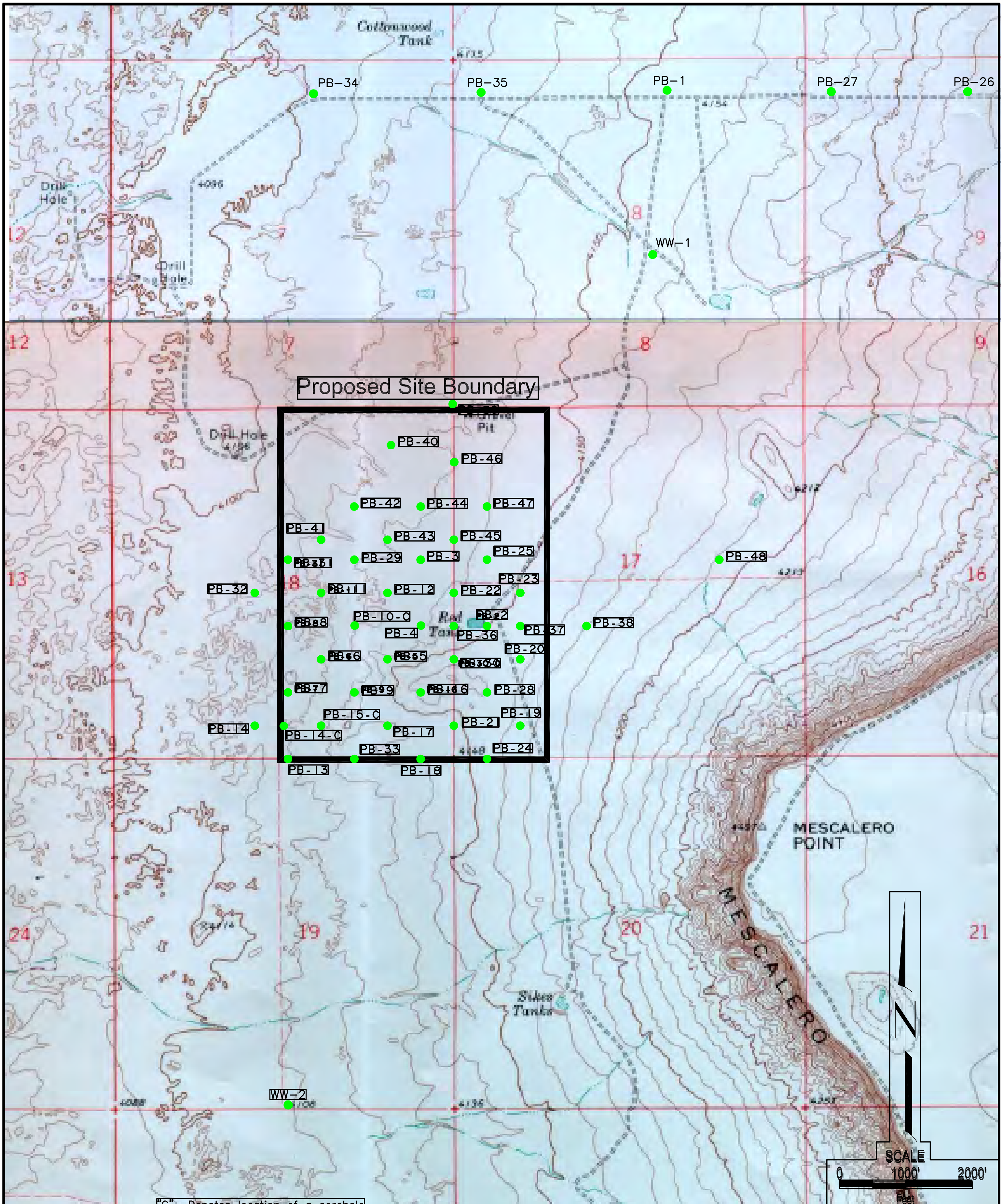
An alternative to groundwater monitoring is also presented in this document and in the VZMS Work Plan in Attachment I. The proposed alternative monitoring system is a Vadose Zone Monitoring System (VZMS) that will be superior to traditional groundwater monitoring for detecting potential leaks from the facility in a timely manner. The VZMS is proposed because it will be more protective of human health and the environment than groundwater monitoring of the uppermost aquifer.

Triassic sediments in eastern Chaves County, New Mexico were identified as host rocks for this proposed Facility because they (1) contain thick sequences of low permeability clays; (2) occur in remote, unpopulated areas; and (3) locally produce no groundwater. These sediments have been characterized by drilling programs in 1993, 1994, 1995 and 1999. Fifty (50) drill holes have been completed on the proposed site (Figure 1-1, Drill Hole Locations[AK1]), with lithologic and geophysical logs recorded for each of these holes. Data obtained from these drilling programs have been incorporated into this demonstration.

This demonstration or justification will evaluate the potential for migration of hazardous waste or hazardous waste constituents from the facility to the uppermost aquifer, through:

- A geologic and hydrologic characterization of host sediments,
- A water balance of precipitation, evapotranspiration, runoff, and infiltration; and
- Unsaturated zone contaminant transport modeling

The following sections provide a summary of the regulatory authority to allow modification of the groundwater monitoring requirements and the technical justifications required to support the groundwater monitoring waiver.



DRILL HOLE LOCATIONS

TRIASSIC PARK WASTE DISPOSAL FACILITY

Figure 1-1

AutoCAD FILE: GAN-DHLOC.DWG

2. Regulatory Requirements

NMED's authority to grant a groundwater monitoring waiver lies in the New Mexico Hazardous Waste Management Regulations (204.1.500 NMAC 4.1.500), which adopts by reference 40 CFR § 264.90(b)(4). The relevant regulation states that the owner or operator of regulated units is not subject to regulations of 40 CFR 264.90 for releases into the uppermost aquifer under this part if:

> The Regional Administrator finds that there is no potential for migration of liquid from a regulated unit to the uppermost aquifer during the active life of the regulated unit (including the closure period) and the post-closure care period specified under § 264.117. This demonstration must be certified by a qualified geologist or geotechnical engineer. In order to provide an adequate margin of safety in the prediction of potential migration of liquid, the owner or operator must base any predictions made under this paragraph on assumptions that maximize the rate of liquid migration.

3. Geology

This section describes the regional and geologic setting of the proposed facilities. The proposed facilities will be founded in unsaturated materials consisting of Quaternary alluvial sediments, Upper Dockum interbedded siltstones and mudstones, and Lower Dockum mudstone and thinly interbedded siltstone.

3.1 Regional Stratigraphy

The geologic formations present within the region range in age from Quaternary through Triassic. Those include Quaternary alluvium, Tertiary Ogallala Formation, and the Triassic Dockum Group. Permian sediments do not outcrop in this region but, because they underlie the proposed host sediments, they are also discussed in this section. The stratigraphic relationship of the formations discussed in this section is illustrated in Figure 3-1, Stratigraphic Column[AK2]. Information concerning formation tops and thicknesses was obtained from well logs from the New Mexico Oil Conservation Division (OCD) office in Hobbs, New Mexico.

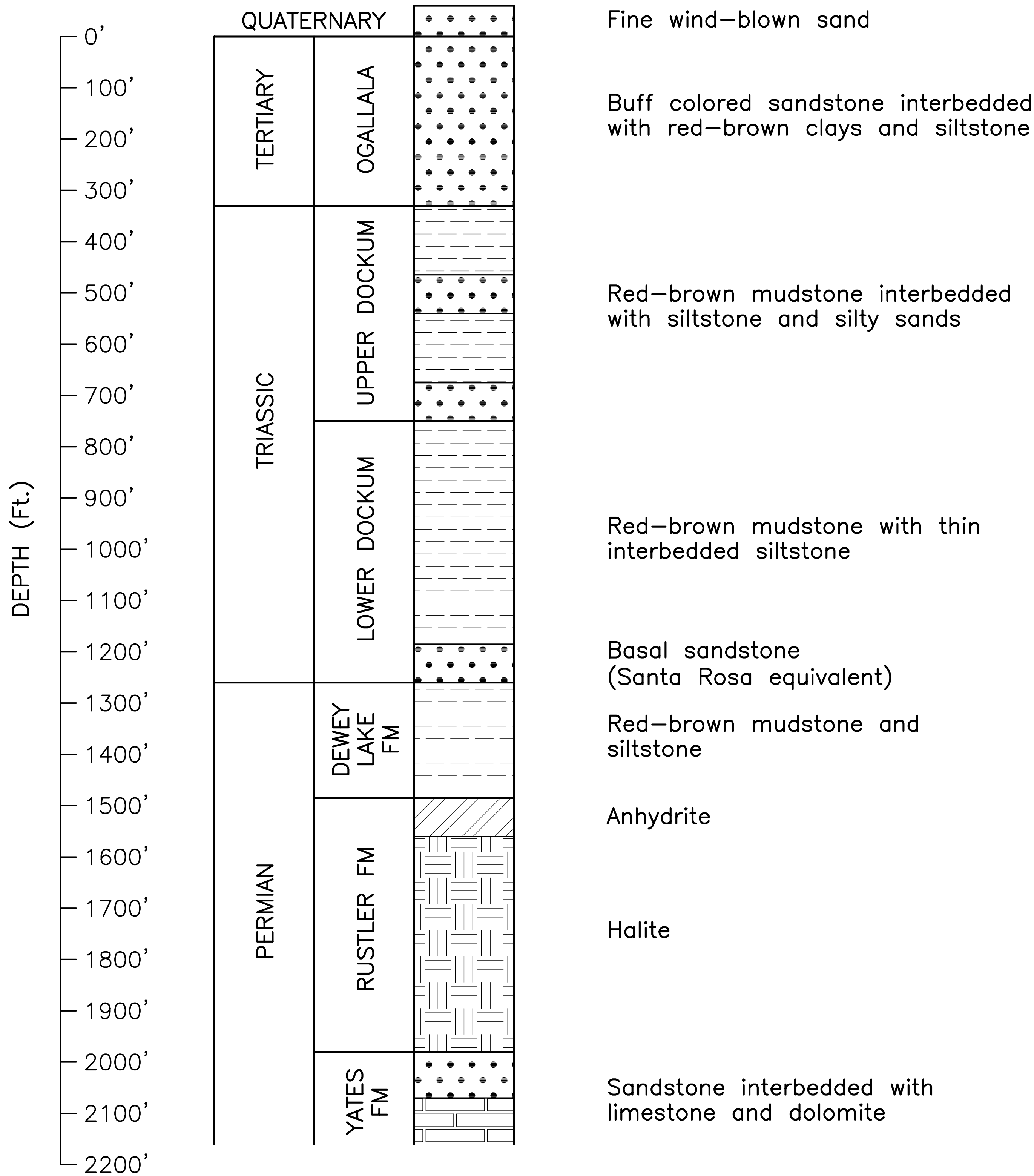
3.1.1 Quaternary

The surface throughout the project area is covered by alluvial deposits of Quaternary age. These deposits are composed of fine-grained, red-brown sands, interbedded with red-brown silts and clays. A major source of these sediments was the topographically higher Ogallala Formation, as evidenced by the abundant granitic cobbles, chert pebbles, and fragments of petrified wood found throughout this unit. The thickness of these alluvial deposits along the eastern flank of the Pecos River Basin in Chaves County varies from a few feet to as much as 50 feet.

3.1.2 Tertiary

The "Caprock," which is the surface expression of the Tertiary Ogallala Formation, unconformably overlies Triassic sediments in southeastern New Mexico. This flat-lying sandstone and conglomeritic unit is approximately 300 to 400 feet thick. It consists of fluviatile sand, silt, clay, and gravel capped by caliche. The sand deposits of the Ogallala Formation consist of fine- to medium-grained quartz grains, which are silty and calcareous. Bedding features range from indistinctly bedded to massive to crossbedded. The formation varies from unconsolidated to weakly cohesive and contains local quartzite lenses. The sand intervals of the Ogallala Formation occur in various shades of gray and red.

Ogallala Formation silt and clay deposits are reddish brown, dusky red, and pink and contain caliche nodules. Gravels occur as basal conglomerates in intra-formational channel deposits and consist primarily of quartz,



STRATIGRAPHIC COLUMN

TRIASSIC PARK WASTE DISPOSAL FACILITY

Figure 3-1

AutoCAD FILE: GANDY-FIG3-1

quartzite, sandstone, limestone, chert, igneous rock, and metamorphic rock. There are abundant petrified wood fragments throughout this unit.

3.1.3 Triassic

Triassic sediments are the potential host rocks for the proposed Facility and, as such, are described in more detail than the other formations. The Depositional Framework of the Lower Dockum Group (Triassic), Texas Bureau of Economic Geology, No. 97, 1979, by McGowen was used as a major reference for gathering information on the characteristics of Triassic sediments.

Triassic sediments unconformably overlie Permian sequences in Texas and New Mexico and have been classified as the Triassic Dockum Group. The Dockum Group is composed of a complexly interrelated series of fluvial and lacustrine mudstone, siltstone, sandstone, and silty dolomite deposits that can be as much as 2,000 feet thick in this part of the Permian Basin. These sediments accumulated in a variety of continental depositional settings, including braided and meandering streams, alluvial fan deltas, lacustrine deltas, lacustrine systems, and mud flats.

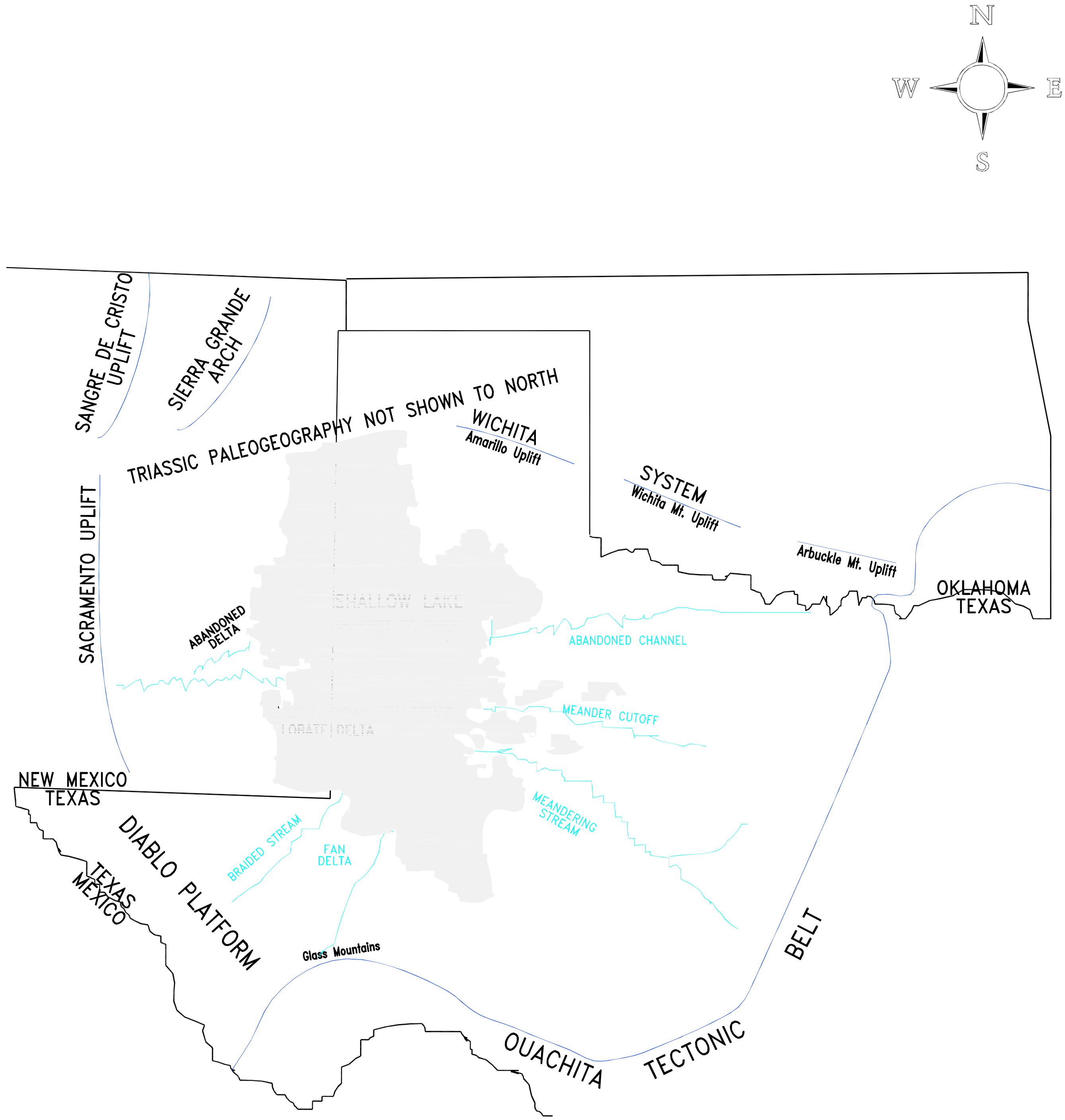
The Triassic Dockum Group is divided into an Upper and Lower Unit. The Upper Dockum Unit is very near the surface within the project boundary, covered only by a thin veneer of Quaternary sediments. The character of this unit, also know as the Chinle Formation, is a series of fluvial sediments. These sediments conformably overlie the Lower Dockum Unit and consist of red-green micaceous mudstones, interbedded with thin, discontinuous lenses of siltstone and silty sandstones. A continental fluvial depositional environment predominated during Upper Dockum time, when the Triassic basin was filled with lacustrine sediments. The Chinle Formation is widespread in the southwestern United States.

The Lower Dockum accumulated in a fluvial lacustrine basin defined by the Amarillo Uplift on the north and the Glass Mountains on the south (Figure 3-2, Basin Paleomap for Triassic Period[AK3]). These former tectonic belts were more than 200 miles away, and the regional slopes were relatively low. As presented in this basin map, the Lower Dockum represents sediments from a large, regional depositional system. For any given portion of this basin, these sediments tend to be very homogeneous and not subject to abrupt local changes. This basin was peripherally filled, receiving sediment from the east, south, and west. Chief sediment sources were Paleozoic sedimentary rocks. Lowlands to the east and west were traversed chiefly by meandering streams. Higher gradient streams with flashy discharge existed at northern and southern ends of the basin. The large shallow lake (or lakes) was the last portion of the basin to be filled. The lacustrine sediments that accumulated here consist primarily of low-energy mudstone. Surface exposures today in these areas consist of thick sequences of maroon-red-purple variegated mudstones with thin discontinuous layers of siltstones and silty sandstones.

The stratigraphy of the basal Lower Dockum varies significantly throughout eastern New Mexico. Figure 3-3, Triassic Period Sand Accumulation in Paleobasin[AK4], a subsurface sand percent map of this unit, was compiled from drill hole data from more than 1,500 oil wells throughout the basin. Thick sequences of sandstones at the northern and southern portions of the basin are shown projecting inward toward the center of the basin. In the New Mexico portion of this basin, these sand accumulations are related to the occurrence of the Santa Rosa Sandstones. This medium- to coarse-grained, white to buff sandstone represents the lowermost Triassic depositional unit and is a major aquifer in many portions of New Mexico.

3.1.4 Permian

Permian sediments are important to the geologic setting because they are immediately below the proposed Triassic host rocks. The deeper formations of Permian age were deposited in a restricted-marine



Scale: 1"=80 Miles

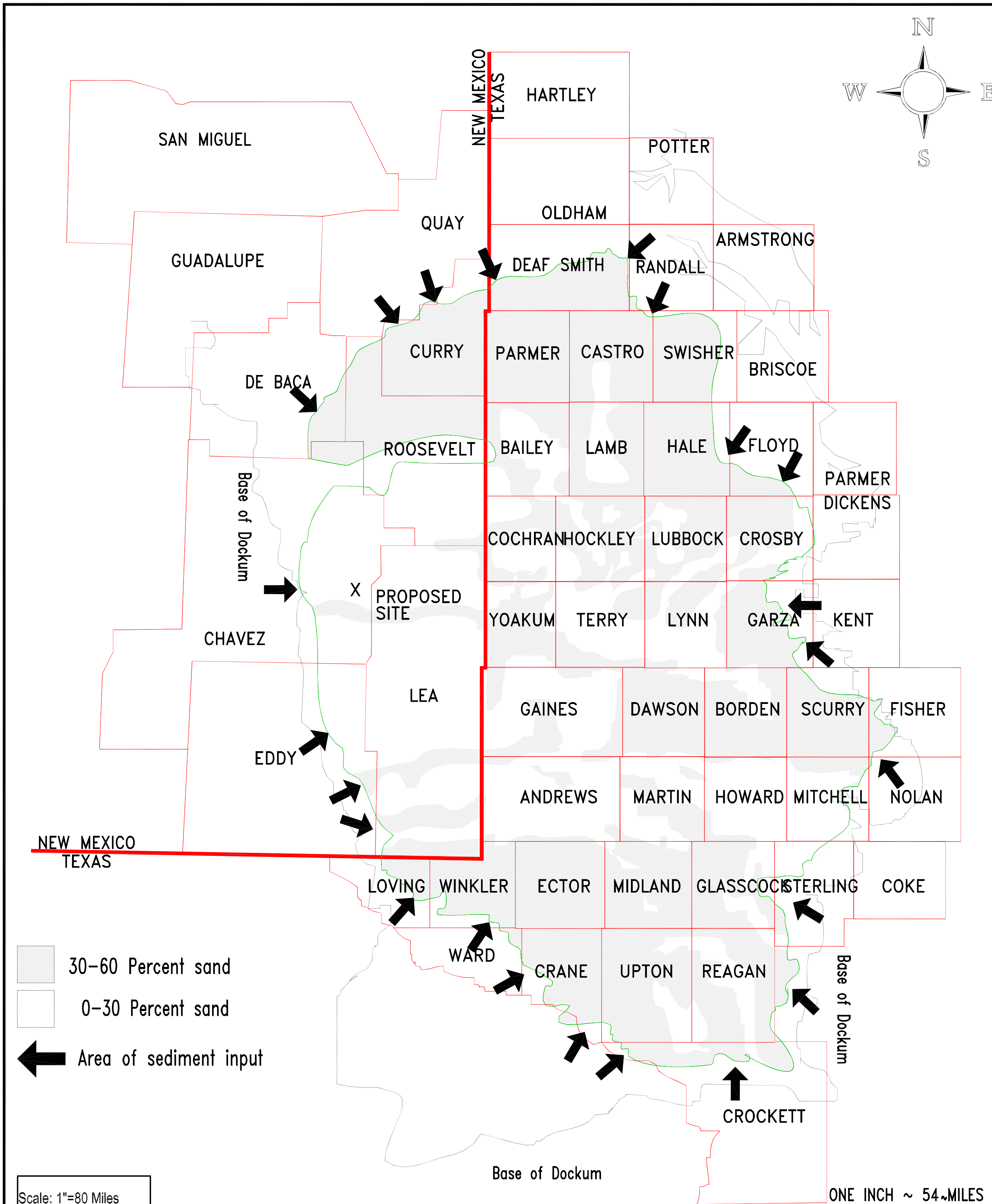
ONE INCH ~ 100 MILES

BASIN PALEOMAP FOR TRIASSIC PERIOD

TRIASSIC PARK WASTE DISPOSAL FACILITY

Figure 3-2

AutoCAD FILE: *GANDY-FIG3-2*



TRIASSIC PERIOD SAND ACCUMULATION IN PALEOBASIN

TRIASSIC PARK WASTE DISPOSAL FACILITY

Figure 3-3

AutoCAD FILE: GANDY-FIG3-3

environment and thus contain salt deposits, which make the groundwater produced from them too brackish for use.

Permian sediments underlying the Triassic units in the project area are assigned to the Artesia Group. Oil well logs from the New Mexico OCD in Hobbs, New Mexico, have provided sufficient data to identify the Dewey Lake Formation, Rustler Formation, and Yates Formation from the upper portion of this group. Geologic literature describes these Permian sediments to be gently dipping to the east. This fact was confirmed by using oil well log data to construct a graphic 3-point solution. These calculations indicate a north-south strike and a dip of less than 1° to the east, ~~. C~~consistent with the reported regional dip for Permian (and Triassic) sediments along the western flank of the Permian Basin.

Dewey Lake Formation - The uppermost Permian sediments underlying the Triassic sequence in the project area correlate to the Dewey Lake Formation. These sediments are predominately red to red-brown mudstones and siltstones and are virtually indistinguishable from the overlying Triassic sediments. Geologic literature reports a conformable relationship between these sediments and the overlying Triassic sediments. There are approximately 240 feet of Permian redbeds in this section.

Rustler Formation - The top of the Rustler Formation was identified on OCD well logs and corresponds to the top of a 40-foot bed of anhydrite. These anhydrites are visible in outcrop on the hills immediately east of the Pecos River drainage east of Roswell, New Mexico. Underlying the anhydrite are approximately 500 feet of halite (salt). The Rustler Formation represents the youngest anhydrite sequence in the Permian Basin.

Yates Formation - Unconformably underlying the Rustler, the Yates Formation is composed primarily of interbedded sandstone with minor dolostone and limestone. The sands are light gray and fine to very fine grained. Limestone is white to very light gray microcrystalline lime mudstone with a chalky texture. Dolostone is pink to light gray and microcrystalline.

3.2 Site Stratigraphy

This section ~~will~~ provides detailed descriptions of the proposed Triassic host sediments and the Quaternary alluvium that overlies these sediments. Figure 3-4, Surface Geology – Project Area[AK5], illustrates the surficial geology on and adjacent to the proposed site. Figure 3-5, Stratigraphic Cross Section[AK6], is a stratigraphic cross-section based on site drilling, illustrating relationships between the proposed Triassic host sediments and adjacent formations.

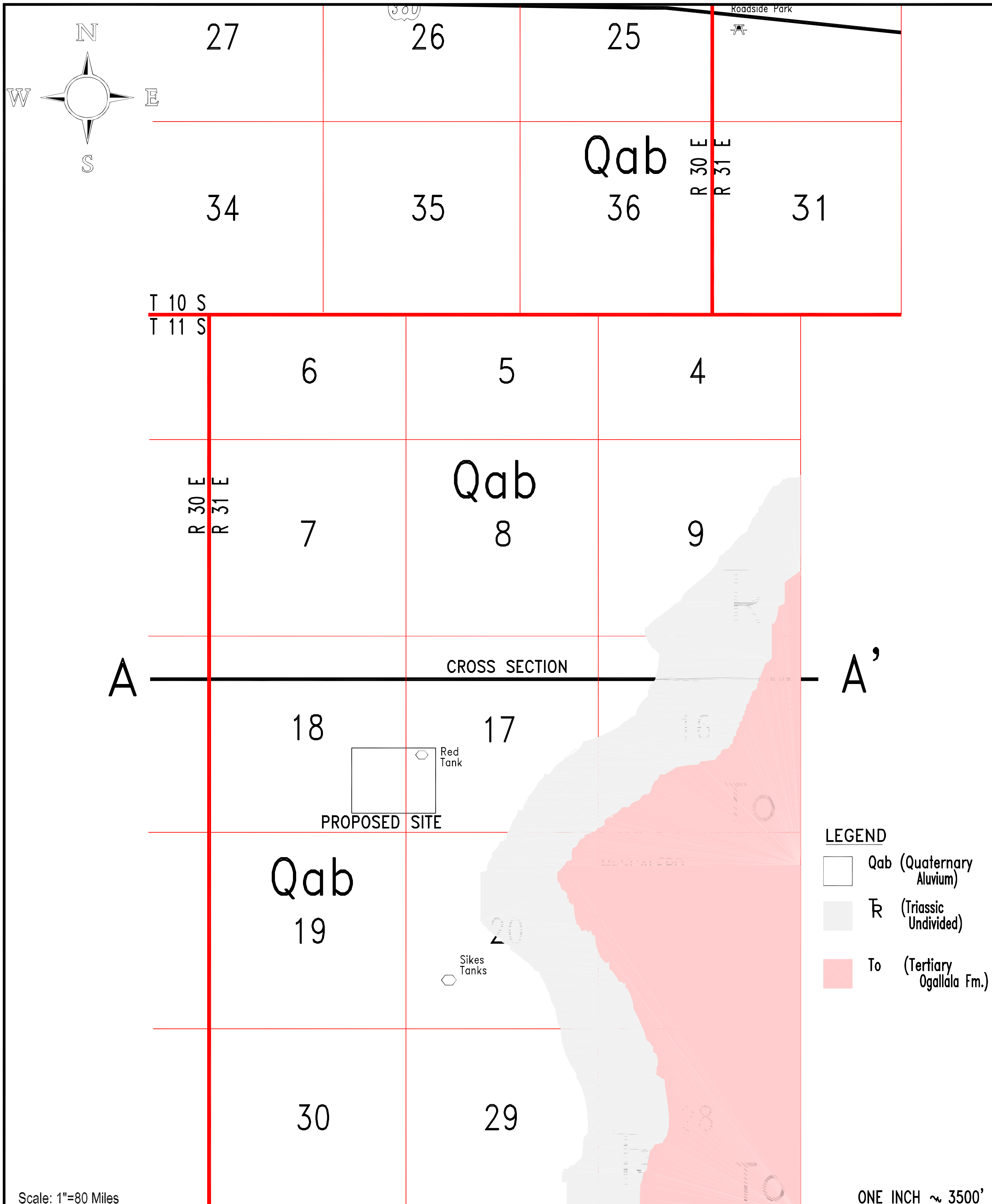
3.2.1 Quaternary

The thickness of Quaternary alluvial deposits at the site varies from less than 10 feet to 35 feet. The upper portion of these sediments consists of fine to very fine, wind-blown yellow-brown sands. Below this sand are varying thicknesses of red-brown to yellow-brown siltstones and silty mudstones. Scattered throughout these sediments are small chert pebbles and granitic cobbles derived from the Tertiary Ogallala Formation.

A caliche zone (Mescalero Caliche) is present in most of this unit. The caliche is found immediately under the top wind-blown sands and coats and fills fractures within the more consolidated siltstones. Where the Quaternary alluvium is quite thin, this caliche is found coating Triassic sediments.

3.2.2 Triassic

Drilling at the site has delineated 1,175 feet of Dockum sediments. Two distinct units can be identified in these sediments: the Upper Dockum (475 feet thick) and the Lower Dockum (700 feet thick). Within the



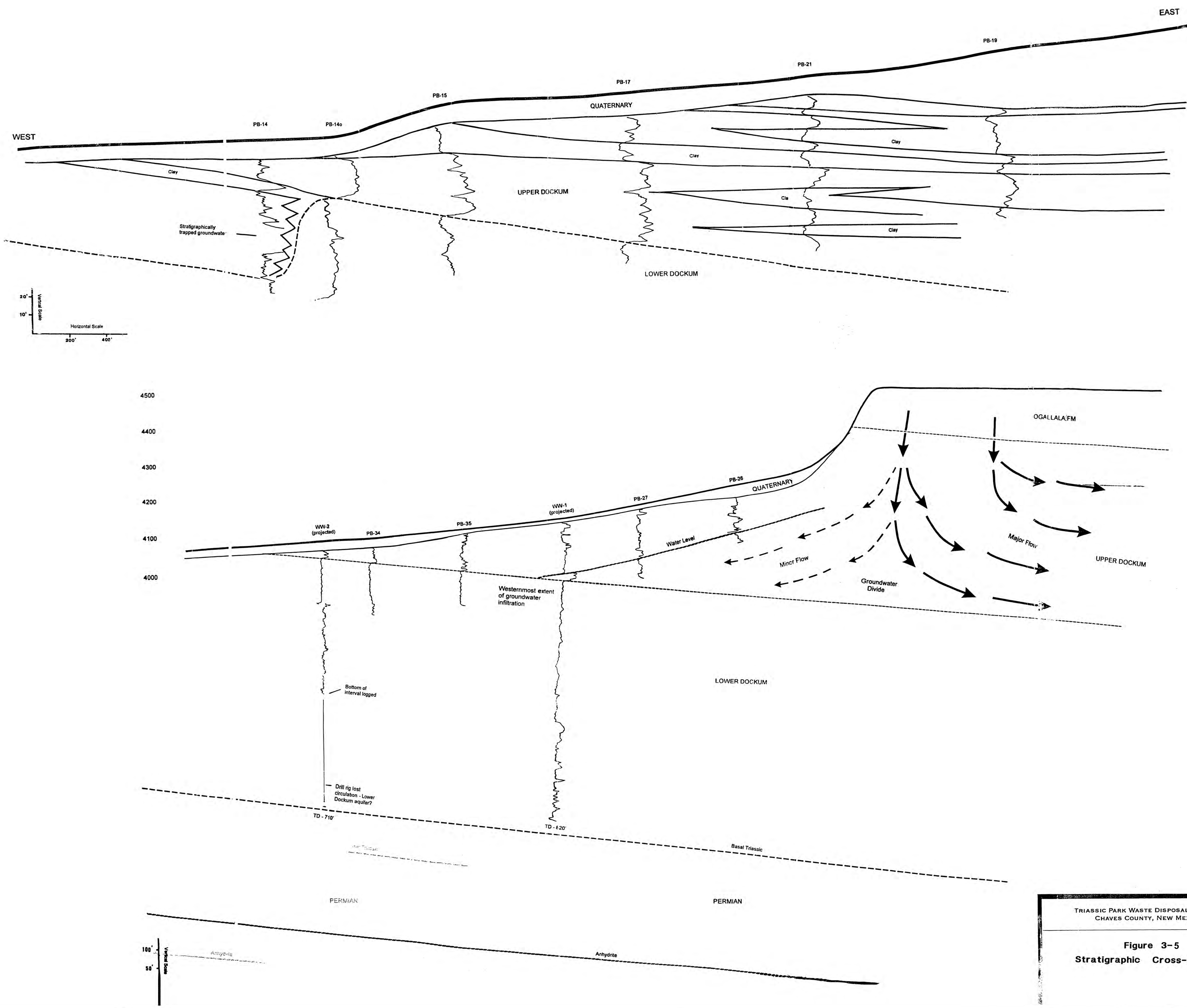
SURFACE GEOLOGY - PROJECT AREA

TRIASSIC PARK WASTE DISPOSAL FACILITY

Figure 3-4

AutoCAD FILE: *GANDY-FIG3-4*

GANDY MARLEY PROJECT



Triassic Park Waste Disposal Facility
Chaves County, New Mexico

Figure 3-5
Stratigraphic Cross-Section

proposed Facility boundary the thickness of the Upper Dockum unit never exceeds 100 feet. Upper Dockum sediments are in contact with the overlying Quaternary alluvium throughout the project area.

Upper Dockum - This unit consists of variegated (red-brown-green) mudstones interbedded with reddish gray siltstones and reddish-gray-green sandy siltstones. The siltstones are micaceous (predominantly muscovite), indicating they were part of a relatively active fluvial system capable of transporting material into the basin from distant source rocks. From examination of lithology and down-hole electric logs, it is estimated that 30 percent of the unit is composed of mudstones. Lithologies of the remainder of the unit are evenly divided between siltstones and sandy siltstones. However, as the geotechnical properties of these two lithologies are very similar, this geologic discussion will simply refer to them both as siltstone. Mudstones were found to have an average permeability of 2.5 x 10^{-7} cm/s, and the siltstones average 1.2 x 10^{-5} cm/s.

These sediments were deposited in a fluvial environment. Mudstone and siltstone bodies are very lenticular and are found to pinch out abruptly. Accordingly, individual lithologies are not correlatable over significant distances (thousands of feet). The fluvial nature of the Upper Dockum Unit has led to the scouring of channels into the underlying Lower Dockum Unit. This scouring and the pinching-out of fluvial sediments have resulted in the local development of an undulatory surface on top of the Lower Dockum Unit (Figure 3-6, Structure Contour - Top of Lower Dockum[AK7]).

Lower Dockum - The Lower Dockum Unit has a completely different character from the upper unit. The lower unit represents a time of relatively quiet lacustrine deposition, which resulted in the accumulation of thick sequences of predominantly mudstones interbedded with thin siltstones. These sediments are very homogeneous, in contrast with the abrupt facies changes present in the more active Upper Dockum depositional system.

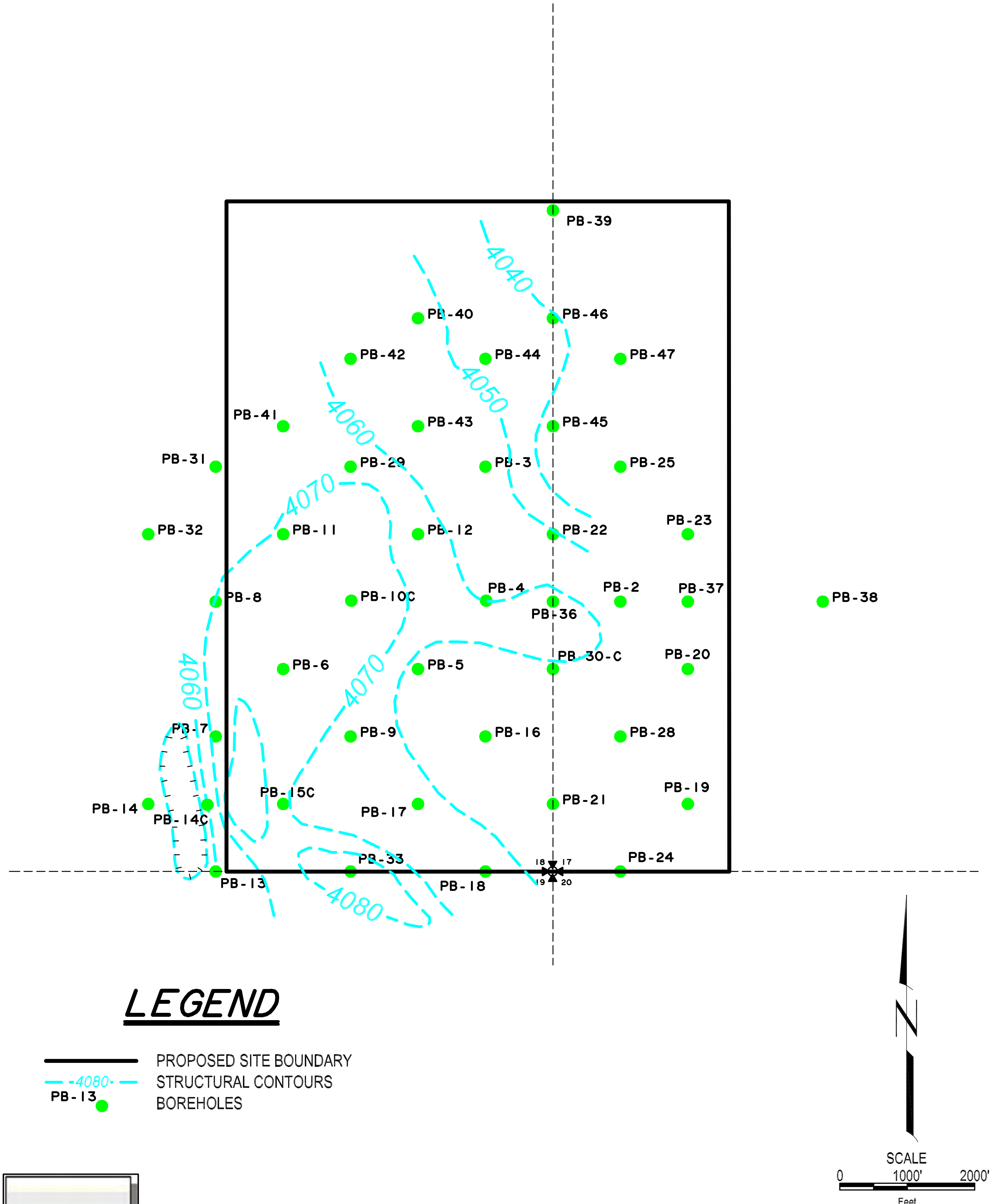
Most of the close-spaced drilling within the proposed Facility boundary "bottomed" in Lower Dockum mudstones. These mudstones were consistently a moderate reddish brown color, which according to McGowen (1979), is associated with low stand lacustrine and mud flat deposition. Two deep holes (WW-1 and WW-2) were drilled adjacent to the proposed site to examine the total extent of the Lower Dockum mudstones. Results of this drilling, along with the examination of several oil well logs, demonstrated a consistent thickness of 600-650 feet of these sediments. Representative core samples of this material were sent for permeability analyses. The results of these analyses confirm the Lower Dockum to have a very low permeability (average permeability of 5.7 x 10^{-8} cm/s), capable of performing as a geologic barrier to downward migration of fluids from the proposed facilities.

Underlying the thick sequence of mudstones, there is a basal sand unit in the Lower Dockum below the site. As illustrated in Figure 3-3, this sand unit is roughly equivalent to the Santa Rosa Formation. However, the major accumulation of Santa Rosa Sands that fills the northern portion of the Triassic paleobasin pinches out before reaching the Facility site. During the Lower Dockum time, the Facility site was part of a low-relief area with little fluvial deposition. The McGowen (1979) report specifies sand percentages of the Lower Dockum group in the Facility site area to be in the 10-20% range.

3.3 Structural Setting

The proposed Facility site is located on the western flank of the Permian Basin of west Texas. Because of the distance from tectonic centers and the minimal seismic activity, this is considered one of the more geologically stable regions within the United States. Data obtained from the National Geophysical Data Center of NOAA indicate a total of 102 observed earthquakes within a 250-km (155-mile) radius of the proposed site. These data reflect observations made from 1930 to 1993.

As shown in Figure 3-7, Seismic Activity Map[AK8], there were no recorded earthquakes with a magnitude greater than 3.9 within 70 miles of the proposed site and no recorded seismic activity within a radius of 45

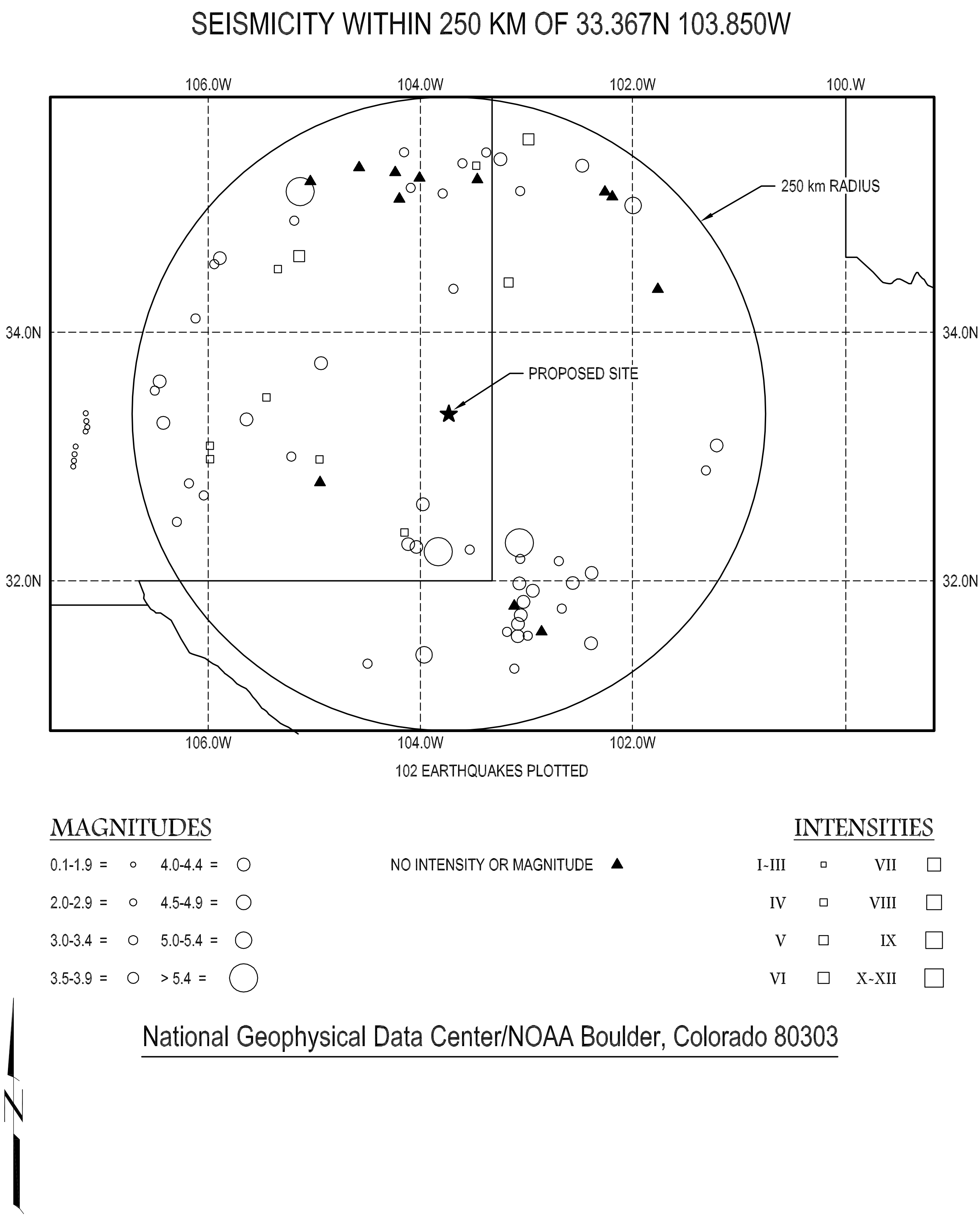


STRUCTURE CONTOUR
TOP OF LOWER DOCKUM

TRIASSIC PARK WASTE DISPOSAL FACILITY

Figure 3-6

AutoCAD FILE: GANDY-FIG-3-6



SEISMIC ACTIVITY MAP

TRIASSIC PARK WASTE DISPOSAL FACILITY

Figure 3-7

AutoCAD FILE: GANDY-FIG3-7

miles. The distance from any tectonic centers and the low-recorded seismic activity suggest that the proposed site is located in an extremely stable environment where activity is not expected. Consequently, little damage from earthquake activity is not anticipated.

There are no identified faults within the project area. As previously discussed, the proposed site is located in a geologically stable area. There are no mapped or otherwise identified faults on or adjacent to the project area. Color air photos of the area were examined for surface lineations, which can reflect faulting in the subsurface. All surface lineations observed on these photos were attributed to man-made features (i.e., fences, roads, etc.).

Subsurface drilling did not encounter displacement or repeating of geologic sequences that would be indicative of faulting. In the Upper Dockum Unit, there are abrupt changes in lithologies, but these are attributed to depositional processes associated with an active fluvial system. Due to the stable structural setting and the plasticity exhibited in Lower Dockum mudstones, the development of secondary porosity due to fracturingpermeabilities within this unit is not expected.

4. Hydrology

4.1 Surface Water

There are no perennial stream drainages on or near the proposed site. The nearest surface drainage is the Pecos River, approximately 30 miles to the west.

There is one small stock tank (Red Tank) within the proposed Facility boundary and several additional tanks on adjacent lands. These tanks are approximately 200 feet by 200 feet and contain water for livestock. The tanks are clay-lined and retain water from run-off or receive water from an underground pipeline. Water in the underground pipeline is supplied from three water wells on the Marley Ranch located in Section 10, T11S, R31E. These wells are east of the Mescalero Rim and produce water from the Ogallala Formation. In the past, water from the springs along the Caprock escarpment was used in this pipeline, but now water is pumped from the Ogallala Formation. The pipeline is personally owned and maintained by the Marley Ranch to provide water to cattle operations below the Caprock.

It was observed in the 1999 drilling that "pooled" surface waters have the potential of migrating through the surface alluvial sediments. Once the site is designated as a disposal area, cattle operations on this property will cease and the Marley Ranch will stop using Red Tank. They will also re-route their personal pipeline, as appropriate, to avoid waste disposal facility operations and continue to supply water to their cattle operations below the Caprock. It should be noted that pits that could pool surface water over the alluvium will be backfilled and graded to drain as part of the initial construction activities prior to operations.

4.2 Groundwater

This section describes regional and local aquifers.

4.2.1 Regional Aquifers

In the region surrounding the proposed site, there are two geologic units that have produced groundwater, the Triassic and the Tertiary Ogallala Formation. Very minor amounts of groundwater have been produced from Triassic sediments; but the Tertiary Ogallala Formation is a major aquifer in southeastern New Mexico, west Texas, and several other western states.

Figure 4-1[AK9] is a map of 33 water wells developed within a 10-mile radius of the proposed site. This information was obtained from the New Mexico Office of the State Engineer (OSE) in October 2011 and represents the results of a records search of registered wells in the OSE WATERS database. A total of 33 water wells were reported, 17 from the Ogallala Formation and 16 from the Triassic.

4.2.1.1 Ogallala Aquifer

The Ogallala Aquifer is the primary freshwater aquifer within the regional study area and serves as the principal source of groundwater in the Southern High Plains. The saturated thickness of the Ogallala Aquifer ranges from a few feet to approximately 300 feet in the Southern High Plains. Groundwater within the Ogallala Aquifer is typically under water table conditions, with a regional hydraulic gradient toward the southeast ranging from approximately 10 feet/mile to 15 feet/mile. The average hydraulic conductivity of the Ogallala Aquifer ranges from 1 foot/day to 27 feet/day.

The Ogallala Aquifer is recharged primarily through the infiltration of precipitation. The rate of recharge is believed to be less than 1 inch/year. Groundwater discharge from the Ogallala Aquifer occurs naturally through springs, underflow, evaporation, and transpiration, but groundwater is also removed artificially through pumpage and catchment. Currently, the rate of withdrawal exceeds the rate of recharge for much of the Ogallala Aquifer.

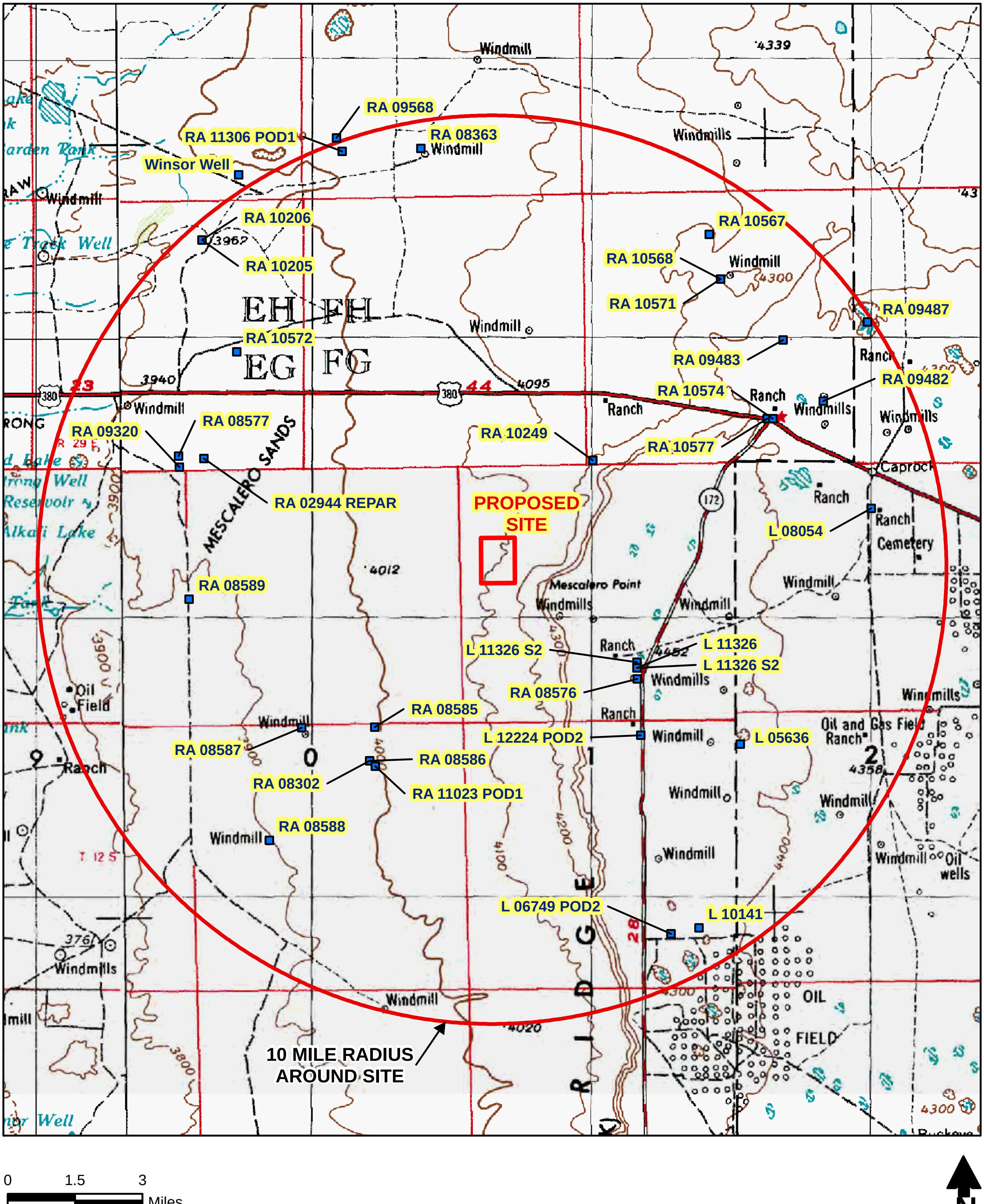
Seventeen of the wells identified are located above the Mescalero ridge, east of the proposed site, and are likely completed within the Ogalalla aquifer. Most of the wells are completed to depths between 140 and 285 ft bgs. Three of the wells are shallower, completed to depths between 60 and 100 feet bgs. These wells are used to supply water for domestic use (3), commercial use (3), for livestock and wildlife (8), and for other uses including oil and gas and prospecting (3).

4.2.1.2 Lower Dockum Aquifer

The major aquifer within the Lower Dockum is the Santa Rosa Sandstone. This sandstone is present along the northern and southern flanks of the Permian Basin and is a principal source of groundwater in Roosevelt and Curry Counties, New Mexico. The Santa Rosa Sandstone is not mapped along the western flank of the Permian Basin, which includes the proposed site. Where the Santa Rosa Aquifer has been studied, hydrochemical analyses and groundwater oxygen isotopes indicate that it is distinctly different from the Ogallala Aquifer. The thick, impermeable clays within the Triassic section have been sufficiently impermeable to prevent hydraulic communication between these aquifers.

~~Figure 4-1 is a map of ten water wells developed in Triassic sediments within a 10-mile radius of the proposed site. This information was obtained from the New Mexico State Engineer's office and represents the results of a records search of six townships surrounding the proposed site (T11S - T13S, R29E & R30E). Six of these wells are shallow completions (100 feet or less) from the 1910s and 1940s and are used with windmills to supply water to livestock and wildlife. The numbers of these wells are RA-8585 through RA-8589 and RA-8363.~~

Sixteen of the identified wells are located in the area of Triassic sediments around and to the west of the Facility site. These wells are used for livestock and wildlife (11), domestic (4), and irrigation (1). The nearest ~~Triassic~~ well to the site is located approximately 3 miles to the northeast (domestic well RA 10249). This well is located at the base of the Mescalero Escarpment and is 100 feet deep. The well appears to be located where it would penetrate Triassic sediments; however, its proximity to the western edge of the Ogallala Formation suggests that the Ogallala may be the water source. Completion depths and details were not available for all of the Triassic wells. For the nine wells for which data were available, eight of these wells range in depth from 218 to 650 ft bgs. These wells likely penetrate the Lower Dockum sediments (including the Santa Rosa Sandstone equivalent). One well (RA 11023 POD1) was completed at a shallow depth of 101 ft bgs and is used for irrigation. ~~These are included as~~This wells~~s~~ penetrates~~ing~~ Triassic sediments ~~because of~~



AREA TOPOGRAPHY AND WATER WELLS - 10 MILE RADIUS

TRIASSIC PARK WASTE DISPOSAL FACILITY

Figure 4-1

S:/PROJECTS/ES11.0141 TRIASSIC PARK PERMIT RENEWAL/GIS/MXDS/FIGURES/FIG 4-1 WELLS 10 MI.MXD

04/26/2012

theirbased on its surface location; s. Hhowever, due to their shallow depths, the source of water could be from surface surficial alluvial sediments.

The four other wells range in depth from 560 to 640 feet and have been completed within the past seven years. These wells would have penetrated the Lower Dockum sediments (including the Santa Rosa Sandstone equivalent). Following is a description of these wells:

The following description of selected wells was included in the October 2000 permit application; this information was not available through the OSE WATERS database.

- RA-_8577 was drilled to a depth of 614 feet in 1992. Its initial production was 4 gallons per minute.
- RA-_9320 was drilled in 1996 to a depth of 560650. The estimated yield was 6 gallons per minute; however, the water was determined to be not potable. The well was plugged and abandoned on 11/25/96November 25, 1996.
- RA-_9568 was drilled to a depth of 640 550 feet in 1998. It was a dry hole and was plugged and abandoned on 08/14/98August 14, 1998.
- RA-_9670 was drilled in 1998 to a depth of 587. The estimated initial yield was 2 gallons per minute.

4.2.2 Site Groundwater

Potential Triassic host sediments within the proposed Facility boundary are unsaturated. Detailed drilling within this boundary has encountered no groundwater. Drilling outside the proposed Facility boundary has identified saturated zones in both the Upper and Lower Dockum Units. The following subsections contain descriptions of these saturated zones.

4.2.2.1 Ogallala Aquifer

The western boundary of the Ogallala Aquifer, represented by the Caprock escarpment, is located topographically/stratigraphically above and 2 miles east of the proposed site. The Ogallala Aquifer is not present at the Facility site. At the base of the escarpment, along the contact of the Ogallala Formation and the underlying Upper Dockum, are numerous springs, which are a result of downward-migrating Ogallala groundwater coming into contact with low permeability zones within the Upper Dockum and being diverted to the surface. Because of its stratigraphic and physical location, it is highly unlikely that the proposed disposal facility will have any impact on this aquifer.

4.2.2.2 Lower Dockum - "Uppermost Aquifer"

For the purpose of this application, the uppermost aquifer is considered to be the basal sand unit of the Lower Dockum because the Ogallala Aquifer is not present at the site. The EPA has defined the uppermost aquifer as the geologic formation, group of formations, or part of a formation that is the aquifer nearest to the ground surface capable of yielding a significant amount of groundwater to wells or springs. The Lower Dockum does not currently yield a significant amount of groundwater. However, preliminary drilling in the site area has found the basal portion of this unit to be water-bearing and to possess consistent hydrologic characteristics.

The identification of a confining layer is an essential factor in the identification of the uppermost aquifer. The 600 to 650 feet of Lower Dockum mudstones, which overly the basal sand unit, represent a high-integrity aquitard, effectively confining the aquifer. This thick sequence of mudstones is of sufficient low permeability to prevent hydraulic communication between the Upper and Lower Dockum Units.

The basal sandstone of the Lower Dockum Unit is the water-bearing portion of this unit. The recharge area for the Lower Dockum Aquifer is the Pecos River drainage to the west. Groundwater flow direction is easterly, along the regional dip of this unit.

Most of the shallow drilling in the site area has "bottomed" in the upper portion of the aquitard. Two holes (WW-1 and WW-2) were drilled to approximately the base of the Triassic section and encountered water from the Lower Dockum Aquifer (Figure 4-2, Upper Dockum - Perched Water[AK10]).

Hole WW-1 also penetrated a saturated zone in the Upper Dockum Unit, resulting in a mixing of these groundwaters in this drill hole.

Both holes were drilled with an air rotary rig and drill-cutting samples were collected. WW-1 was completed to a depth of 820 feet and, at the time of drilling, no water saturation was apparent in the drill cuttings. WW-2 was completed to a depth of 710 feet; however, circulation was lost at a depth of 645 feet. Loss of circulation commonly occurs when drill cuttings are too wet for the air pressure of the rig to remove the cuttings from the hole. It is likely that the basal sandstone of the Lower Dockum Unit was penetrated at this depth.

Water Level Measurements - Temporary plastic casing was placed in each of the two holes immediately after completion. In July 1994, geophysical logs were run for each hole, and water levels were identified. WW-1 had a water level of 155 feet. This level is 20 feet above the Upper/Lower Dockum contact, and it is likely that groundwater~~s~~ from both units is~~are~~ present in this drill hole. A water level of 467 feet was observed for WW-2. This finding indicates that there is a hydrostatic head pressure within the Lower Dockum Aquifer of 178 feet.

Both of these cased holes were pumped and allowed to recover. After a sufficient recovery period, a static water level (155 feet for WW-1 and 467 feet for WW-2) was maintained.

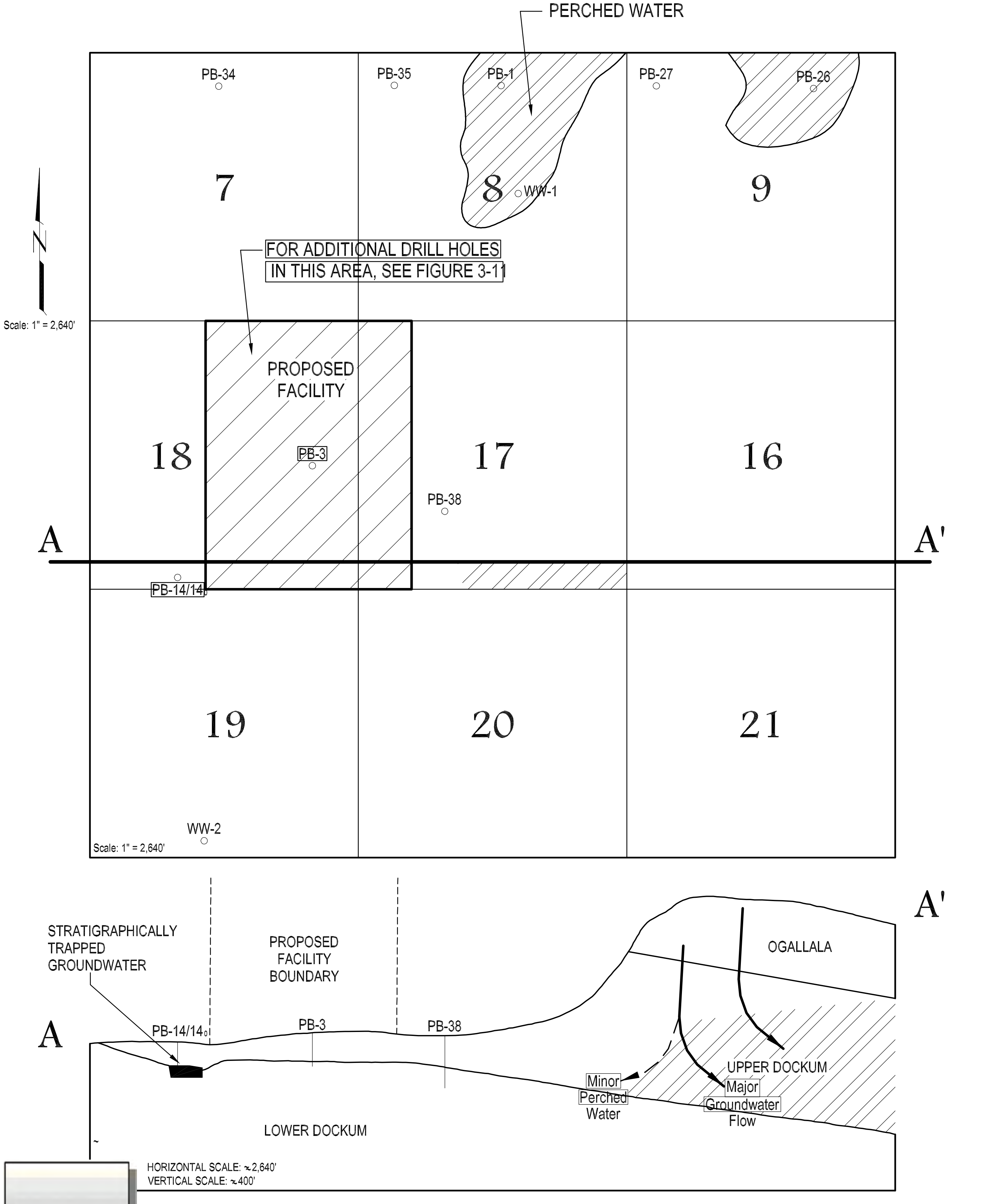
Water Quality - Two sources of data have been used to evaluate water quality data for the Lower Dockum:~~;~~ (1) United States Geological Survey (USGS) Multistation Analyses, and (2) site-specific analyses.

The USGS works in conjunction with the State of New Mexico to ~~establish~~ sample and analyze ground water from monitoring wells throughout the state. A request for data was made to the USGS on water quality information from wells within 12 townships surrounding the proposed site. This request was made for data from wells below the Caprock (Ogallala Aquifer). The search area consisted of T9S through T12S and R29E through R31E.

Data from a total of nine USGS monitoring wells within the search area were received. Of these nine wells, only two could be confirmed as being within Dockum sediments. The depths of these two wells were 258 feet (Beadle well) and 14 feet (Winsor well). The Winsor well is shown on Figure 4-1, while the Beadle well is an additional two miles to the northwest, outside the 10-mile search radius.

The Beadle and Winsor wells, as ~~are~~ with many of the USGS monitor wells, are not registered with the OSE~~State Engineer's office~~. Any existing water wells drilled in this region prior to 1993, when the OSE extended the declared ~~closing of the~~ Roswell ~~Extended~~ Basin boundaries, ~~in 1993~~ were not required to file well permit applications.

Ten separate analyses were conducted on samples from these wells. Total results can be reviewed in Appendix A. For this section, to be consistent with results of site-specific analyses, only values for Total Dissolved Solids, Magnesium and Sodium are presented.



UPPER DOCKUM - PERCHED WATER

TRIASSIC PARK WASTE DISPOSAL FACILITY

Figure 4-2

AutoCAD FILE: GANDY-FIG4-2

	Beadle well	Winsor well
Total Dissolved Solids	38,400 mg/L	14,000 mg/L
Sodium	11,000 mg/L	3,200 mg/L
Magnesium	625 mg/L	519 mg/L

Site-specific analyses are presented only for WW-2. This drill hole encountered groundwater from the Lower Dockum. Because groundwater from the Upper Dockum and Lower Dockum was mixed in drill hole WW-1, preliminary water quality data from WW-1 do not accurately characterize either aquifer and are not presented. The results from WW-2 include the following:

Total Dissolved Solids	18,800 mg/L
Alkalinity	83 mg/L
Sodium	7,030 mg/L
Magnesium	87 mg/L

The extremely high TDS values are indicative of long formation retention times, which reflect~~s~~ low groundwater flow and low permeability conditions within the Lower Dockum aquifer. Water with TDS values of greater than ~~5~~1,000 mg/L is considered to be unfit for human consumption. These available data, along with the documented abandonment of other water wells due to encountering non-potable water within Lower Dockum sediments, indicate that the water quality of this unit is very low.

4.2.2.3 Upper Dockum - Perched Water

Several springs are present where the Ogallala Formation crops out, two miles east of the Facility site, along the 200-foot high Caprock escarpment. None of these springs occur near the proposed facility. These springs are present where the Ogallala sands unconformably overlie impermeable Dockum mudstones and claystones and the groundwater moves laterally to the surface. Where these water-bearing Ogallala sands are in contact with more permeable units of the Upper Dockum, saturation of these underlying sediments may occur. The result is sporadic accumulation of perched water within some Upper Dockum siltstones. As shown in Figure 4-2~~1~~, three holes to the northeast of the proposed site (PB-1, PB-26 and WW-1) have~~n~~ encountered this perched water. Due to the great variability in lithologies of the fluvial Upper Dockum sediments and the need for permeable sediments to be in contact with Ogallala source rocks, the occurrence of saturation within these sediments is ~~extremely~~ unpredictable.

It is ~~extremely~~ significant that this saturation does not extend beneath the Facility site. All 40 drill holes within the site boundary, as shown on Figure 1-1, have been unsaturated. For this reason, there were no groundwater production tests conducted.

Exploratory drilling west of the proposed Facility boundary (updip), near the outcrop of the Upper Dockum Unit~~,~~ in the small sandy hills located along the section line between Section 18, T11S, R31E and Section 13, T11S, R30E, encountered an isolated occurrence of groundwater (Figure 4-2~~1F~~). In a single drill hole (PB-14), at a depth of 42 feet, a small accumulation of groundwater was found in a depression developed on the surface of the underlying Lower Dockum mudstones. This depression is consistent with the "scouring" of the Upper Dockum fluvial sediments into the Lower Dockum mudstones. Closer spaced drilling in the vicinity of this occurrence encountered no other such accumulations. This isolated "pooling" is most likely a result of surface run-off entering the subsurface from the nearby outcrop and being caught in a small "stratigraphic trap."

Water Quality - Preliminary wWater quality data were obtained from limited chemical analyses on a sample of the stratigraphically trapped groundwater from drill hole PB-14. These results include the following measurements:

Total Dissolved Solids	4,920 mg/Ll
Alkalinity	396 mg/Ll
Sodium	1,640 mg/Ll
Magnesium	103 mg/Ll

Although this represents only one sampling point, these preliminary data suggest that water from the Upper Dockum, has a different geochemical character than does water from the Lower Dockum.

4.3 General Description

The Triassic Park facility will be a Resource Conservation and Recovery Act (RCRA) Subtitle C waste disposal operation. The Facility will offer the following RCRA-regulated services, which are described in this permit application.

Two treatment processes will be used at the Facility. The first is an evaporation pond for managing wastewater that meet LDR standards and a stabilization process for treating liquids, sludges, and solids to ensure that no free liquids are present. In addition, the stabilization process will ensure that LDR standards are met prior to placing wastes in the landfill. Both treatment units will be clean closed as part of the closure operations.

Two container storage areas (roll-off storage area and drum handling unit) will be used to stage waste at the Facility for treatment or disposal. These units will ensure that waste is stored in compliance with RCRA requirements for permitted storage. Neither of the units will be used for long-term storage of waste and will be clean closed during closure operations.

Four aboveground storage tanks will be utilized to accumulate regulated bulk liquid hazardous wastes prior to stabilization. Both of these units will be clean closed during closure operations.

A landfill will be utilized for final disposal of waste that meets LDR standards. The landfill will be the only unit that will remain after closure and will contain hazardous waste.

Support units and structures include a chemical laboratory, administration building, weigh scale area, maintenance shop, truck wash unit, clay processing area, clay liner material stockpiles, daily cover stockpiles, and a stormwater retention basin.

The facilities that pose the largest threat to release of large volumes of liquids to the subsurface are the evaporation ponds and the landfill. The evaporation ponds will store free liquids during operation of the facility. However, after operations have been completed the ponds will be removed and closed as clean facilities. The landfill is the only disposal facility that will include the permanent disposal of hazardous materials. The landfill will not accept any free liquids and will be covered after closure. However, since hazardous waste will remain in place after closure, it is a potential long-term source of release from the facility. All other facilities will be clean closed as part of the closure operations.

4.44.3 Containment Systems

The Triassic Park facility will be a Resource Conservation and Recovery Act (RCRA) Subtitle C waste disposal operation. The Facility will utilize a landfill for final disposal of waste that meets land disposal restriction (LDR) standards. The landfill will permanently disposeal of hazardous materials. The landfill will not accept any free liquids and will be covered after closure. However, since hazardous waste will remain in place after closure, it is a potential long-term source of release from the facility. Landfill containment systems include primary and secondary liners, a liner leak detection system, and a final cover.

Support units and structures at the Facility include a chemical laboratory, administration building, weigh scale area, maintenance shop, clay processing area, clay liner material stockpiles, daily cover stockpiles, and a stormwater retention basin.

Since these two facilities pose the largest threat for release of hazardous material to the surface, we have described the engineered containment systems and leachate collection and removal systems for both facilities. These include the landfill and evaporation ponds.

4.4.14.3.1 Landfill

4.4.1.14.3.1.1 Liner Systems for Landfill

The liner system will be installed to cover all surrounding earth that may come in contact with waste or leachate. The primary system will consist of, from top to bottom, a 2-foot layer of protective soil, a geocomposite drainage layer, and a high density polyethylene (HDPE) geomembrane liner. The secondary system will consist of a geocomposite drainage layer, HDPE geomembrane liner, geosynthetic clay layer (GCL), and 6 inches of prepared subgrade. Between the primary and secondary liners, a leak detection system will monitor any leakage from the primary liner and provide capability to remove any fluids. Both the primary and secondary systems will extend over the floor and slope areas of the landfill.

The primary and secondary geomembrane liners will be constructed of HDPE. This material will have sufficient strength and thickness to prevent failure as a result of pressure gradients, physical contact with waste or leachate, climatic conditions, stress of installation, and stress of daily operations. The liner systems and geosynthetic drainage layers will rest upon a prepared subgrade capable of providing support to the geosynthetics and preventing failure due to settlement, compression, or uplifting.

4.4.1.24.3.1.2 Landfill Leachate Collection and Removal System (LCRS)

The leachate collection and removal system (LCRS) will be located above the primary liner system. A filtered LCRS layer consisting of a geocomposite drainage material will be constructed. Within the floor area of the LCRS layer will be the primary leachate collection piping, which is used to remove leachate from the landfill during the active life and post-closure care period.

The LCRS is sloped so that any leachate above the primary liner will drain to one of three sumps. The sumps and liquid removal methods will be of sufficient size to collect and remove liquids from the sumps and prevent liquids from backing up into the drainage layer.

The sumps will be lined with the same liner system components as elsewhere in the landfill except that the drainage layer will expand to include gravel and a compacted clay liner material beneath the primary and secondary geomembranes which will fill the sump area. Leachate that collects in the sumps will be pumped through a pipe to the surface of the landfill where it will be collected in temporary storage tanks.

4.4.1.34.3.1.3 Landfill Leak Detection and Removal System (LDRS)

The design of the leak detection and removal system (LDRS) is similar to the design of the LCRS. The LDRS will be capable of detecting, collecting, and removing leaks of hazardous constituents through areas of the primary liner during the active life and post-closure care period. A filtered LDRS layer consisting of a geocomposite will be constructed below the primary geomembrane. Within the LDRS layer will be the LDRS piping, which will be used to detect and remove liquid from between the primary and secondary liners.

4.3.2Evaporation Pond

4.3.2.1Evaporation Pond Liner System

The liner system will include a primary (top) geomembrane liner above a geonet layer and a secondary (bottom) geomembrane liner, supported by 3 feet of compacted clay liner material with a hydraulic conductivity of no more than 1 x 10-7 cm/sec. Soil liner leachate compatibility tests (EPA 9090) will be conducted prior to construction. In addition, a test fill will be constructed, as per the procedures outlined in the CQA Plan.

Design and operating practices, together with the geologic setting of the Facility, will prevent the migration of any hazardous constituent to adjacent subsurface soil, surface water, or groundwater. The top liner is designed to minimize the migration of hazardous constituents through the liner system during the active life. A 60-mil HDPE geomembrane material will be used for the primary liner component. HDPE liners have been shown to be chemically resistant to landfill leachates based on operational performance and on EPA 9090 compatibility tests conducted on actual landfill leachates and synthetically generated leachates.

4.3.2.2Leak Detection and Removal System

The LDRS consists of a geonet layer of cross-linked ribbed HDPE, a sump, and associated detection and liquid removal pipes. A pump located in the LDRS pipe will be used to remove leachate accumulating in the leachate collection systems. When leachate accumulates, it will be pumped to a tanker truck and either returned to the evaporation pond, stabilized in the onsite treatment unit, or stored in one of the liquid waste storage tanks.

The LDRS unit will have the following characteristics:

- be constructed with a bottom slope of 1% or more;
- be constructed of synthetic or geonet drainage materials with a minimum transmissivity of 5 x 10-3 m2/sec;
- be constructed of materials that are chemically resistant to the waste managed in the evaporation pond and any leachate generated in the landfill;
- of sufficient strength and thickness to prevent collapse under pressure exerted by overlying wastes, and equipment used at the evaporation pond;
- designed and operated to minimize clogging during the active life and closure period of the evaporation pond; and,
- constructed with sump and liquid removal methods.

The collection system has been designed to be of sufficient size to collect and remove liquids from the sump and prevent liquid from backing up into the drainage layer. A sump pump and associated piping will be

~~installed in the lower portion of the sump. The sump system will be covered with gravel to bring the area to the level of the evaporation pond floor. The gravel will serve as an expanded drainage layer providing space for the piping. In addition, the sump system will be provided with a method for measuring and recording the volume of liquids present and the volume of liquid removed. All pumpable liquids in the sump will be removed in a timely manner to maintain the head on the bottom liner below 12 inches.~~

~~4.5~~4.4 Monitoring System~~s~~

~~4.5.1~~4.4.1 General

The monitoring system~~s~~ proposed for the Triassic Park facility has been developed to provide early detection for any release from the site. In addition, the system~~s~~ is~~are~~ focused on the facilities that have the largest potential for releases to the subsurface. The monitoring system~~s~~ includes vadose zone sumps in the landfill ~~and the evaporation pond~~ and a series of vadose zone/perched groundwater monitoring wells ~~that will be installed along the east side of the facility~~. Each of these system components~~s~~ is described in more detail below.

~~4.5.2~~4.4.2 Vadose Zone Sumps

The vadose zone monitoring sumps serve~~s~~ as a detection system for leakage in the secondary LDRS system. Located directly beneath the LDRS sumps, leakage through the secondary liner system will flow into the vadose sump, allowing it to be detected and removed. The vadose pipe and gravel arrangement is similar to the LCRS and LDRS arrangements.

~~The evaporation pond vadose monitoring sump serves as a detection system for leakage of the LDRS sump. Leakage through the secondary liner system will flow into the vadose sump. This will allow the leakage to be detected and moved. The vadose pipe and gravel arrangement is similar to the LDRS arrangement.~~

~~4.5.3~~4.4.3 Vadose Zone/Perched Groundwater Monitoring Holes

~~In the unlikely event that the release of liquids from any of the facilities is not detected by the leak detection systems or the vadose zone sumps, a~~A series of vadose zone/perched groundwater monitoring wells will be installed as described in the VZMS Plan in Attachment I. These monitoring wells will provide early detection capabilities, in the unlikely event that a release of liquids from the landfill is not detected by the leak detection system or the vadose zone sumps. The vadose zone monitoring wells will be installed along the landfill perimeter, within the facility boundary northeast of the landfill, and outside the facility at locations to the northeast where previous investigation borings have encountered perched groundwater~~eastern site boundary~~. The vadose zone/perched groundwater monitoring wells will include shallow wells installed at the contact between the alluvium and Upper Dockum, and deep wells~~be~~ installed at ~~or just below~~ the contact between the Upper and Lower Dockum units. The intent of these wells is to detect any liquids that would be migrating down dip along these contacts.

5. Technical Justification

This section presents technical data to support the ~~Gandy Marley~~ request for a Groundwater Monitoring Waiver. This data consists of water balance calculations for the region to establish hydrologic components and the results of contaminant transport modeling.

The Triassic Park facility will use~~Gandy Marley recognizes the need for~~ an effective release monitoring system for the protection of human health and the environment. Due to the unique geologic setting of the proposed

Triassic Park ~~Disposal F~~facility site, an alternative release monitoring system is recommended. Because of the unsaturated nature of the proposed host rocks, technical data supports the implementation of a VZMS~~vadose zone monitoring system~~ in lieu of traditional groundwater monitoring. For this environment, a VZMS~~vadose zone monitoring system~~ is superior for detecting and characterizing potential releases.

5.1 Water Balance

The purpose of this water balance is to provide a conceptual understanding of the hydrologic components at the site. This water balance analysis estimates groundwater recharge from direct precipitation and~~,~~ surface water bodies~~, and irrigation~~ at the proposed landfill site. This information is useful for assessing the potential migration of contaminants released at or near the surface to groundwater. Groundwater recharge rate is directly related to the potential for contaminants spilled or leaked at the surface to reach groundwater. In areas with little or no groundwater recharge, there is less potential for groundwater contamination from releases of hazardous substances than in high recharge areas, because the mechanisms to transport potential contamination are limited.

A water balance requires quantification of the hydrologic components, which can result in changes in the amount of water stored in the area of interest. Often, water balances are calculated for an entire watershed to understand the relative importance of the hydrologic components within that area. For this analysis, the water balance was performed to estimate groundwater recharge at the proposed landfill site.

Groundwater recharge at the proposed site can be estimated by summing precipitation and~~,~~ infiltration from surface water bodies~~, and irrigation~~ at the site and subtracting evapotranspiration and surface run-off. As no natural surface water bodies ~~or irrigation occur~~exist at the site, groundwater recharge is estimated as the difference between direct precipitation and evapotranspiration. This assumes no surface run-off at the site.

Precipitation data collected at the Roswell weather station indicate that mean annual precipitation is 10.61 inches. This annual mean is used as the average precipitation at the proposed site.

Evapotranspiration refers to the processes that return water to the atmosphere by a combination of direct evaporation and transpiration by plants~~ and animals~~. It is the largest item in the water budget because most of the precipitation that falls in the area returns almost immediately to the atmosphere without becoming part of the surface water or groundwater systems. On semi-arid~~unirrigated~~ rangeland, much of the precipitation that does not evaporate immediately is taken up fairly rapidly by plants and transpired. In a regional water balance conducted in southeastern New Mexico, it was estimated that approximately 96 percent of total precipitation is lost to evapotranspiration (Hunter, 1985). This number corresponds to data presented for the Rio Grande Basin by Todd (1983) that estimated that 95.4 percent of total precipitation was being lost to evapotranspiration.

Assuming a mean annual precipitation rate of 10.61 inches, of which 96 percent is lost to evapotranspiration, the net recharge to groundwater is estimated as 0.42 inch per year. This low groundwater recharge rate significantly reduces the potential for groundwater contamination from spills or leaks at the proposed Facility.

The amount of groundwater recharge is a reflection of the arid climate of the region. The net recharge estimate of 0.42 inch per year (based on average hydrologic components) represents the expected long-term annual conditions at the site. The relatively low recharge rate appears to be reasonable given the unsaturated conditions of the Upper Dockum within the site boundaries. Using the highest recorded annual precipitation value of 32.92 inches yields only a slightly higher recharge rate of 1.32 inches (assuming an evapotranspiration rate of 0.96). This short-term (1 year) increase in recharge is unlikely to have a significant impact on the unsaturated flow regime at the proposed site.

5.2 Contaminant Transport Modeling

The geologic and hydrologic characteristics of the Lower Dockum sediments, as described in Sections 3.0 and 4.0, were used to estimate potential contaminant transport rates to the basal sand unit of the Lower Dockum; referred to as the Santa Rosa Formation (i.e. the upper most aquifer). Two different assessments of potential contaminant transport rates through the Lower Dockum are presented in this section.

5.2.1 Previous Unsaturated Flow Modeling

Previous unsaturated flow modeling for the site was reported in TerraMatrix/Montgomery Watson (1997). These calculations used a steady-state solution for unsaturated flow as reported in Bumb and McKee (1988). The modeling was based on the following steps.

- Estimate effective saturation using the Bumb and McKee model and HELP model predictions of leakage rates
- Determine unsaturated hydraulic conductivities using the Brooks-Corey model
- Estimate flow rates using Darcy's Law with a unit hydraulic gradient
- Calculate travel times using the interstitial velocity

The results from these calculations indicated that travel times from a hypothetical leak through the Lower Dockum would be on the order of millions of years. A more complete summary of this model analysis is presented in Appendix B.

5.2.2 Alternative Modeling Approach

Numerous discussions were held with NMED regarding the modeling requirements for a waiver demonstration. Based on these discussions, the following criteria for the modeling effort were developed.

- A one-dimensional flow and transport model, MULTIMED, should be used to evaluate the potential travel times through the Lower Dockum.
- A travel time of 800 years should be considered as a minimum to justify a waiver from groundwater monitoring.
- Conservative input parameters should be utilized for all modeling runs. During this discussion, the most conservative assumptions and parameters will be highlighted in the text using the initials MCA (Most Conservative Assumption).

Based on the criteria discussed above, a one-dimensional flow and transport model, MULTIMED, was used to evaluate potential travel times through the lower Dockum as well as travel times along the Upper Dockum/Lower Dockum contact to an assumed perched aquifer 3600 feet east of the landfill. The approach presented in this ~~sections~~ section differs from the previous model in several areas and was developed to be as conservative as possible (i.e. to predict the maximum transport rate and the minimum transport time through the Lower Dockum). Because of the different approach used in the current calculations, the results are not directly comparable to those reported in Section 5.2.1. Several important assumptions were changed in the current model as shown below in Table ~~5.~~H-1.

Table ~~5.~~H-1. Assumptions Used to Develop Alternative Modeling Approach

Assumption	Current Model	Previous Model	Justification
Flow dimensionality	1-dimensional flow	3-dimensional flow	A one dimensional flow simulation will require less water to reach a given depth and is therefore more conservative although the 3-dimensional approach is more physically correct **(MCA)**.
Saturated hydraulic conductivity	6.8 x 10^{-8} cm/s	5.7 x 10^{-8} cm/s	The hydraulic conductivity value used in the previous model was the average value based on core measurements. The value used in the current model was obtained by taking the maximum measured value (6.8 x 10^{-8} cm/s) from core measurements **(MCA)**.
Saturation	Based on MULTIMED modeling	Based on Bumb and McKee model (1988) and HELP model predictions	The previous model used an exact steady-state solution to estimate saturation. The current model used a completely saturated system **(MCA)**. Completely saturated conditions are considered highly unlikely given the arid conditions at the site but were used to present a maximum bound on the calculations.
Unsaturated hydraulic conductivity	Van Genuchten Model	Brooks-Corey Model	The Van Genuchten and Brooks-Corey Model are commonly used to estimate unsaturated conductivity.
Hydraulic gradient	Assumed to be unity	Assumed to be unity	This assumption ignores artesian conditions in the Santa Rosa Formation, which would result in a lower gradient and is therefore conservative.

The computer transport model MULTIMED was used to analyze the hypothetical leak into the subsurface below the landfill. The semi-analytical model consists of a number of modules, which predict contaminant transport through the Lower Dockum. A steady state, one-dimensional, semi-analytical module simulates flow in the unsaturated zone. The output from the unsaturated zone model is expressed as water saturation as a function of depth. This output is then used as input for the one-dimensional, unsaturated transport module, which can calculate transient and steady state contaminant concentrations. The results from both of these models are input into the one-dimensional flow and transport saturated zone module. The boundary conditions, input parameters, and MULTIMED output for each simulation are~~is~~ located in Appendix C.

Two MULTIMED simulations calculated the travel times through the Lower Dockum using different infiltration rates as boundary conditions:

- Assumes an infiltration rate equal to the saturated hydraulic conductivity of 0.84 in/yr (MCA). This approach is considered the most conservative and assumes that the formation has access to as much leachate as it can physically accept.

- Assumes as infiltration rate equal to the net recharge of 0.42 in/yr for this site. This is based on a regional water balance assessment that does not account for any of the liner or cover barrier layers in the landfill. This approach more accurately models the long-term annual conditions at the site, but is still considered conservative.

A MULTIMED simulation also calculated the travel time to the east along the Upper Dockum/Lower Dockum contact to a perched aquifer approximately 3,600 feet downgradient of the proposed landfill. This simulation assumed an infiltration rate of 0.60 in/yr. Note that the MULTIMED output from this simulation reported a warning that the amount of infiltration input into the model was slightly more than the system could accept. This supports that the most conservative approach would require a slightly smaller infiltration rate and would generate a greater travel time.

The results from these simulations are shown below in Table ~~5.~~H-2.

Table ~~5.~~H-2 Simulation Results

Infiltration Rate in/yr (cm/s)	Travel Time (years)	Description
0.84 (6.8 x 10^{-8}) – Trial 1	1606	Assumes vertical migration through the entire section of Lower Dockum sediments. Utilizes maximum infiltration rate in Lower Dockum sediments **(MCA)**. This is considered very conservative.
0.42 (3.4 x 10^{-8}) – Trial 2	3211	Assumes vertical migration through the entire section of Lower Dockum sediments. Utilizes realistic but still conservative infiltration rate.
0.60 (4.76 x 10^{-8}) – Trial 3	3600[1]	Assumes lateral migration to nearest potential aquifer to the east. Permeability is representative of Upper Dockum sediments.

Note: [1]Travel time to receptor well 3600 feet east of the landfill.

5.2.3 Discussion of Modeling Results

Two different approaches have been presented for evaluating the potential for releases from the landfill to impact groundwater. Both of these evaluations have concluded that it would require an extremely long time for potential leaks to reach groundwater (over a thousand years). Extremely conservative assumptions were used in the most recent evaluation of transport time to groundwater and these are assumptions that are not likely to occur during the lifetime of the facility or the extended future (greater than 1,000 years). The factors contributing to the long periods of time for a potential release from the facility to reach the Santa Rosa Formation include the low permeability of the Lower Dockum, the thickness of the unit (600 feet) and the arid conditions at the site. These conditions combine to make the ~~Gandy Marley~~Triassic Park facility an ideal location for the proposed landfill activities.

5.3 Vadose Zone Monitoring

Due to the extremely long travel times in the Lower Dockum and along the Upper Dockum/Lower Dockum contact, groundwater monitoring data from the Santa Rosa formation or the perched aquifer downgradient of the site will not provide meaningful information concerning potential releases from the proposed facility. It is therefore recommended that a ~~Vadose Zone Monitoring System (~~VZMS~~)~~ be used to detect potential releases from the facility. The VZMS will provide the most effective method for detecting potential releases from the facility in a timely manner. Before potential contaminants can reach the uppermost aquifer, these systems can detect leaks and help to initiate corrective actions for preventing impacts to the environment.

6. Summary and Conclusions

Site drilling has established the basal sand of the Lower Dockum (Santa Rosa Sandstone equivalent) to be the uppermost aquifer for the proposed Triassic Park Disposal Facility. Within a four-mile radius of the Facility, there is no water currently being produced from this unit. Water quality from this aquifer is considered to be poor, with water analyses at the site showing Total Dissolved Solids to be 18,800 mg/Ll.

Overlying this aquifer are 600-650 feet of unsaturated, low-permeability mudstones. Analyses of site core samples indicate that the average permeability of these mudstones isare 5.7 x 10^{-8} cm/s. The base of the hazardous waste landfill is designed to rest on the top of this thick mudstone sequence. The low-permeability mudstone provides over 600 feet of excellent protection against potential transport of leakage from the facility to groundwater. The combination of the thick mudstone sequence and the lack of potable water resources make the proposed facility an excellent location for the safe disposal of hazardous waste. Conservative unsaturated transport modeling indicates that it would take thousands to millions of years for contaminants to travel from the base of the landfill to this aquifer.

The Gandy Marley CorporationGMI considers the monitoring of the Lower Dockum aquifer not to be protective of human health and the environment and requests a waiver from these monitoring requirements for the following reasons:

- A VZMS will be implemented to detect potential leaks more effectively and in a more timely manner than monitoring wells installed in the Lower Dockum Formation.
- The thick sequence (600-650 feet) of unsaturated, low permeability Lower Dockum mudstones provides an excellent geologic barrier to the downward migration of contaminants.
- The installation of monitoring wells in the Lower Dockum aquifer would potentially violate the integrity of the geologic barrier provided by the thick sequence of mudstones and possibly create an avenue for contaminant migration.
- The Lower Dockum aquifer has artesian characteristics as demonstrated through a site-specific investigation.
- A commitment exists from Gandy MarleyGMI to construct a hazardous waste landfillmanagement units (HWMU) with leachate collection and leak detectionrelease monitoring and retrieval systems.

This groundwater monitoring wavier waiver has been prepared by qualified individuals and the proper certification is included in Appendix D.

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APPENDIX A
WATER QUALITY DATA

UNITED STATES DEPARTMENT OF INTERIOR – GEOLOG MULTIPLE STATION ANALYSES			
Local Identifier	Station Number	Date	Time
09S.29E.22. Bozart Well	333132103574701	07/15/40	--09S.29E.22.
09S.29E.22. Jess Beadle	333133103574801	06/19/40	--09S.29E.22
09S.29E.35. Winsor Well	332857103564501	07/15/40	--09S.29E.35.
09S.29E.36. J Beadle WL	332857103554301	03/11/40	--09S.29E.36.
09S.30E.36. J Beadle	332868103554401	07/13/38	--09S.30E.36 J
09S.31E.26. Camino Well	333014103442201	08/13/82	1415 09S.31E.26.
09S.31E.26.440	333000103442401	05/25/70	1400 09S.31E.26.4
12S.30E.07. Culp Ranch	331706103574801	08/13/82	1015 12S.30E.07.
12S.30E.31. Culp Ranch Well	331803103542101	08/46/82	1210 12S.30E.31.C

UNITED STATES DEPARTMENT OF INTERIOR – GEOLOG MULTIPLE STATION ANALYSES						
Local Identifier	Date	Site	Geological Unit	Tempera ture Water (Deg C) (00010)	Agency Collecting Sample (Code Number) (00027)	Agency Analyzing Sample (Code Number) (00028)
09S.29E.22. Bozart	07/15/40	GW	--	--	1028	1028
09S.29E.22. Jess B	06/19/40	GW	231DCKM	--	1028	1028
09S.29E.35 Winsor	07/15/40	GW	231DCKM	--	1028	1028
09S.29E.36. J Beadle	03/11/40	GW	--	--	1028	1028
09S.30E.36. J Beadle	07/13/38	GW	--	--	1028	1028
09S.31E.26. Camino	08/13/82	GW	--	19.0	80020	80020
09S.31E.26.440	05/25/70	GW	231SNRS	--	--	--
12S.30E.07. Culp Ranch	08/13/82	GW	--	20.0	80020	80020
12S.30E.31. Culp Ranch Well	08/13/82	GW	--	18.5	80020	80020

UNITED STATES DEPARTMENT OF INTERIOR – GEOLOG MULTIPLE STATION ANALYSES						
Local Identifier	Date	PH Water Whole Lab (Standard Units) (00403)	Carbon Dioxide Dissolved (MG/L as CO2) (00405)	ANC Water Unfltrd Fet Field MG/L as CACO3 (00410)	ANC Water Unfltrd Fet Field MG/L as HCO3 (00440)	ANC Unfltrd Carb. Fet Field MG/L as CO3 (00445)
09S.29E.22. Bozart	07/15/40	--	--	--	380	28
09S.29E.22. Jess Beadle	06/19/40	--	--	--	160	0
09S.29E.35 Winsor	07/15/40	--	--	--	220	0
09S.29E.36. J Beadle	03/11/40	--	--	--	300	27
09S.30E.36. J Beadle	07/13/38	--	--	--	370	104
09S.31E.26. Camino	08/13/82	8.3	5.7	--	--	--
09S.31E.26.440	05/25/70	--	2.3	189	230	0
12S.30E.07. Culp Ranch	08/13/82	8.1	12	--	--	--
12S.30E.31. Culp Ranch Well	08/13/82	8.3	8.6	--	--	--

APPENDIX A

Figure APP-A

AutoCAD FILE: APPA-FIG

APPENDIX B
PREVIOUS UNSATURATED FLOW MODELING RESULTS

B-1 Unsaturated Flow Modeling

Unsaturated flow modeling was performed to simulate potential leakage or infiltration from the proposed hazardous waste facilities. Site characterization data indicate unsaturated conditions in the strata underlying the proposed facilities. The unsaturated flow model developed by McKee and Bumb (1988) predicts the extent of wetting fronts emanating from leakage sources on the base of the landfill. Leakage rates were based on preliminary HELP (Hydrologic Evaluation of Landfill Performance) modeling results presented in Tables B-1, Triassic Park HELP Model Results Summary for Cell Floor and B-2, Triassic Park HELP Model Results Summary for Cell Slope. The modeling results help illustrate how the natural hydrological conditions at the site inhibit subsurface fluid flow. [Note: These HELP modeling results should not be confused with those presented in the engineering report in Volumes III and VI, which support the current landfill design.] The following simulation was performed to account for the heterogeneities at the site. The simulation predicts the soil moisture distribution in the Lower Dockum from leakage sources at the base of the landfill. The predicted wetting fronts led to the estimation of unsaturated hydraulic conductivities, darcy flux rates, interstitial water velocities and approximate contaminant travel times to the nearest aquifers. The primary modeling objectives include the following:

- prediction of the effective saturation distribution (wetting front) emanating from the landfill source; and,

- determination of the unsaturated hydraulic conductivity and advective transport rates.

TABLE B-1
TRIASSIC PARK HELP MODEL RESULT SUMMARY FOR CELL FLOOR

Time (years)	LCRS Operational Beyond 30 Years Post Closure			LCRS Not Operational Beyond 30 Years Post Closure		
	Liner Leakage (gal/acre/day)	Cap Leakage (gal/acre/day)	Final Waste Moisture Content (vol/vol)	Liner Leakage (gal/acre/day)	Cap Leakage (gal/acre/day)	Final Waste Moisture Content (vol/vol)
0	1.3781	NA	0.1410	1.3781	NA	0.1410
20	0.9400	0.0454	0.1222	.9400	0.0454	0.1222
30	0.2735	0.0430	0.1181	0.2735	0.0430	0.1181
50	0.1927	0.0450	0.1125	3.4579	0.0450	0.1125
70	0.1329	0.0450	0.1087	8.0071	0.0450	0.1098
90	0.1007	0.0439	0.1059	9.1465	0.0439	0.1083
100	0.0775	0.0442	0.1049	8.5811	0.0442	0.1076
120	0.0744	0.0453	0.1029	8.8612	0.0453	0.1062
140	0.0629	0.0461	0.1013	8.6989	0.0461	0.1048
160	0.0547	0.0442	0.0999	8.5494	0.0442	0.1034
180	0.0482	0.0442	0.0987	8.4178	0.0442	0.1021
200	0.0431	0.0431	0.0976	8.2818	0.0442	0.1008

NA - Not Applicable
LCRS= Leakage collection and recovery system

TABLE B-2
TRIASSIC PARK HELP MODEL RESULT SUMMARY FOR CELL SLOPE[1]

Time (years)	LCRS Operational Beyond 30 Years Post Closure			LCRS Not Operational Beyond 30 Years Post Closure		
	Liner Leakage (gal/acre/day)	Cap Leakage (gal/acre/day)	Final Waste Moisture Content (vol/vol)	Liner Leakage (gal/acre/day)	Cap Leakage (gal/acre/day)	Final Waste Moisture Content (vol/vol)
0	173.0000	NA	0.1410	173.0000	NA	0.1414
20	123.0000	0.0453	0.1221	123.0000	0.0453	0.1223
30	53.5373	0.0442	0.1182	53.5373	0.0442	0.1182
50	37.0011	0.0453	0.1152	37.0282	0.0453	0.1152
70	24.5001	0.0461	0.1087	24.5114	0.0452	0.1087
90	18.0529	0.0442	0.1059	18.0583	0.0449	0.1059
100	13.6143	0.0425	0.1049	13.6174	0.0430	0.1049
120	12.9000	0.0443	0.1029	12.9032	0.0450	0.1029
140	10.7627	0.0439	0.1013	10.7642	0.0450	0.1013
160	9.2002	0.0457	0.0999	9.2030	0.0439	0.0999
180	8.0161	0.0462	0.0987	8.0178	0.0457	0.0987
200	7.0994	0.0461	0.0976	7.1002	0.0462	0.0976

Notes: [1]Initial HELP Modeling Results were based on landfill liner system without double liner system on side slopes. These should not be confused with HELP results presented in the Engineering Report.
NA - Not Applicable
LCRS = Leakage collection and recovery system.

B-2 Modeling Methodology

Unsaturated flow modeling was performed using the exact steady state solution developed by McKee and Bumb (1988) and Bump and McKee et al. (1988). The steady state solution derived from the Richards equation (1931) of unsaturated flow provides more conservative results in lieu of transient based solutions. The McKee and Bumb (1988) and Bumb and McKee et al. (1988) steady state solution for a continuous point source in an infinite isotropic medium is governed by the following equations.

(EQ. 1)

$$\Delta\eta_\infty = \frac{Q^{\exp\left[\frac{\alpha}{2}\left(z-z'-\sqrt{r^2+(z-z')^2}\right)\right]}}{4\pi\sqrt{r^2+(z-z')^2}}$$

(EQ. 2)

where

$$r = \sqrt{(x-x')-(y-y')^2}$$

(EQ. 3)

$\Delta\eta$ = hydraulic potential

$$S = S_r + (S_m - S_r)(\alpha\eta / K_o)^{1/n}$$

(EQ. 4)

or

$$S_e = (a\eta / K_o)^{1/n}$$

At the Facility site, the evapotranspiration rate is high with respect to precipitation (TerraMatrix/Montgomery Watson, 1997). According to McKee and Bumb (1988), the soils in semi-arid regions of the western United States are at or below residual saturation (Sr). Therefore, the observed initial moisture contents are probably at or near the residual moisture content. Generally, fluid flow is inhibited at soil moisture contents at or below the residual moisture content. The amount of saturation above the residual moisture content is referred to as the effective saturation. Unsaturated hydraulic conductivity is a function of the effective saturation and is expressed in the following equation (McKee and Bumb, 1988; Bumb and McKee et al., 1988):

(EQ. 5)

$$K(\theta) = K_0 S_e^n$$

Brooks and Corey (1964) correlated the *n* exponent with the pore size distribution index α. McKee and Bumb (1988) by confirmation of theoretical derivations by Irmay (1954) suggest an optimal value of 3 for η .

Under steady state conditions flow is driven by the force of gravity as the matric potential approaches unity (Hillel, 1980). Therefore, under steady state conditions the unsaturated hydraulic conductivity is equal to the darcy flux which in turn is multiplied by the unit area to obtain a leakage or discharge rate (Q). The following equations express these relationships:

(EQ. 6)

$$q(\theta) = K(\theta);$$

(EQ. 7)

$$Q = \frac{q(\theta)}{A}$$

The average interstitial water velocity (*v*) was used to estimate advective transport rates of non-reactive conservative solutes. Approximate travel times to the nearest aquifers can be estimated from the interstitial water velocity using the following expression:

$$v = q / \theta$$ (EQ. 8)

In summary, modeling assumptions include steady state unsaturated flow in an infinite domain, a continuous leakage source, flow through porous medium, complete saturation of the soil beneath the source, and initial uniform saturation of the medium. The modeling does not account for secondary permeability features such as faults, fractures and macropores.

B-3 Input Parameters

Input parameters and initial boundary conditions were based on observed field conditions, landfill design specification, and preliminary HELP modeling results [Note: These preliminary HELP modeling results were based on a landfill liner design which did not incorporate a double liner system on the side slope areas. These results should not be confused with the HELP modeling results presented in the engineering report in Volume III and VI. The results presented in the engineering report support the currently proposed landfill design which incorporates a double liner in all areas and does not indicate any leakage from the landfill.] Average hydraulic parameters for the Lower Dockum and landfill design specifications are presented in this section. Input parameters used for the unsaturated flow modeling are presented in Table B-3, Input Parameters for Unsaturated Flow Modeling.

Modeled source coordinates correspond to the basal dimensions of the proposed landfill. Conservative average leakage rates from the preliminary HELP modeling were used as source terms along the base (8.58 gpd) of the landfill to provide conservative “worst case” estimate of unsaturated flow. The leakage rate for the floor of the landfill was based on HELP modeling simulations between 70 and 200 years. The initial leakage rates for the first 50 years of HELP modeling were excluded from the average because these rates were extremely low and probably not representative of steady state conditions. These simulated leakage

TABLE B-3
INPUT PARAMETERS FOR UNSATURATED FLOW MODELING

	β	Ko			Q		α	Source Coordinates (m)		
Unit	**(m)**	**(m/day)**	**Sr**	**Sm**	**(m^3/day)**	**n**	**1/m**	**x[1]**	**y[1]**	**z[1]**
Lower Dockum	0.373	4.90E-05	0.279	1	8.00E-05	3	8.042	0, 33, 66, 99, 132, 165, 193, 231, 264, 297, 330, 363, 396, 429, 462	0	0
Upper Dockum	0.2076	1.05E-02	0.161	1	3.80E-05	3	14.45	5.5, 11, 16.5, 22, 27.5, 33, 38.5, 44, 49.5, 55, 60.5, 66, 71.5, 77	0	24.5, 22.6, 20.72, 18.84, 16.96, 15.07, 13.19, 11.31, 9.42, 7.54, 5.65, 3.77, 1.88, 0
Clay Berm	0.37	8.64E-05	0.126[a]	1	3.80E-05	3	8.108	0, 5.5, 11	0	3.77, 1.88, 0
Quaternary Alluvium	0.0726[a]	8.64E-02	0.0458[a]	1	3.80E-05	3	41.32	0, 5.5, 11	0	3.77, 1.88, 0

Key:

β = bubbling pressure; typical values reported by Bumb and Mckee et al. (1988)
Ko = saturated hydraulic conductivity; site-specific means values
Sm = maximum saturation; assumed
Sr = residual saturation; site-specific mean values
Q = leakage rate; based on HELP modeling results
n = curve fitting parameter based on pre size index (Mckee and Bumb, 1988)
α = n/β
1 = Typical values reported by Bumb and Mckee et al (1988)
a = typical values reported by Bumb and Mckee et al. (1988)
b = assumed values

rates are based on extreme conditions such as waste moisture content conditions which exceed the field capacity of the waste and a termination of leachate pumping following the 30-year post-closure period.

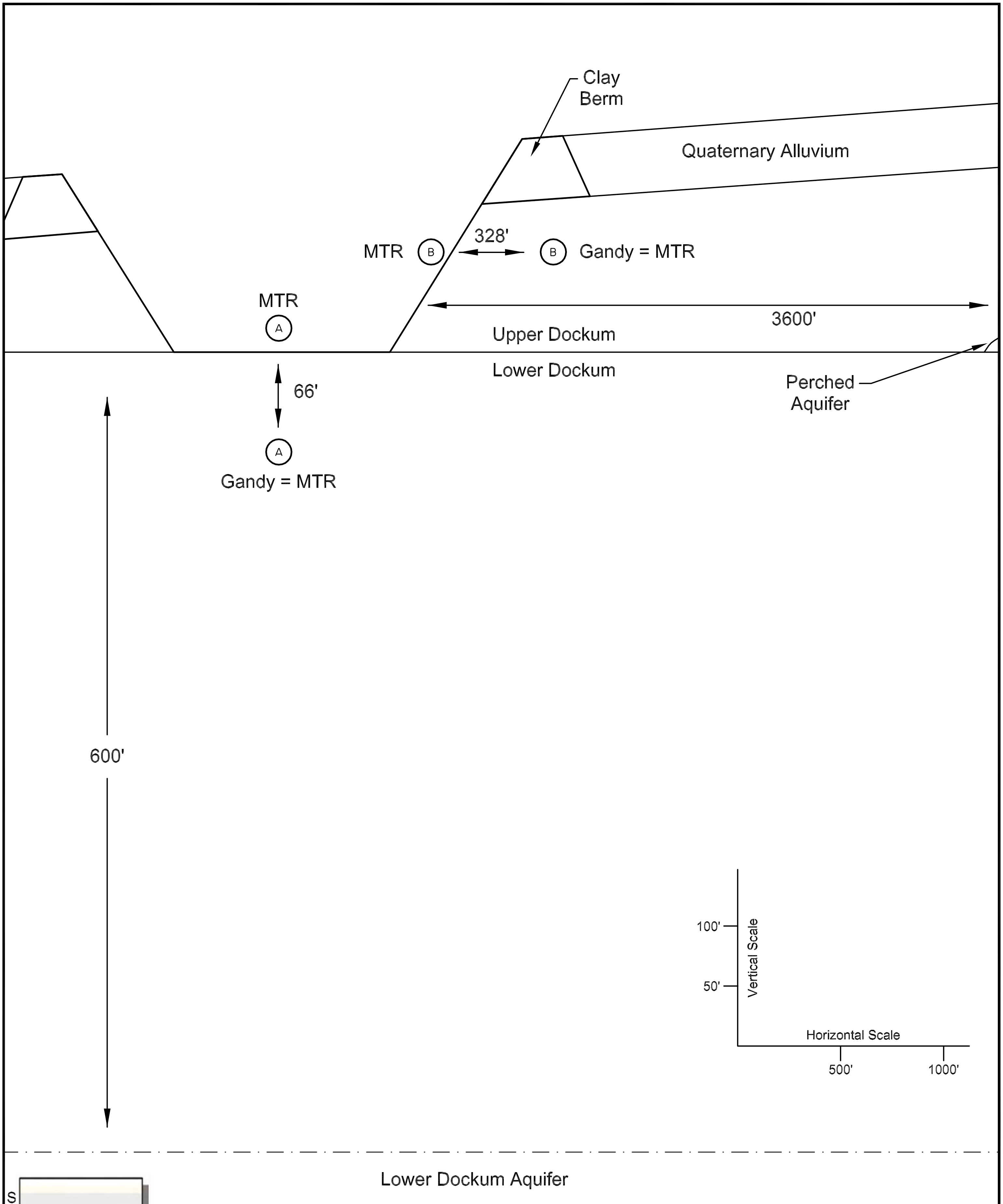
Average site-specific saturated hydraulic conductivity values for the Lower Dockum (5.68×10^{-8} cm/s) were used as initial conditions for the modeling simulations. The effective saturation values for the Lower Dockum simulation was based on site-specific average initial moisture contents (TerraMatrix/Montgomery Watson, 1997). The bubbling pressures for the Lower Dockum simulation was based on average values of similar types of geologic materials reported by Bumb and McKee et al. (1988). Initial boundary conditions are presented in Figure B-1, which shows a schematic of the proposed landfill and surrounding hydrostratigraphy. As displayed in Figure B-2, the Lower Dockum Aquifer is approximately 600 feet (200 meters) below the site.

B-4 Modeling Results

The steady state unsaturated flow modeling results are presented in Figures B-2 through B-5. The Lower Dockum results are presented as a function of depth from the source. The results of the modeling simulations are in reference to the landfill source.

Figure B-2 displays the effective saturation at various distances from the source. As the wetting front disperses from the landfill source the chart shows abrupt decreases in saturation. Although the effective saturation dissipates less rapidly in the Lower Dockum, moisture contents decrease by nearly one order of magnitude at approximately 200 meters from the landfill source. The modeling results indicate that the Lower Dockum maintains saturation because fluid movement is driven primarily by gravitational forces; therefore fluid migration is greatest in the vertical direction.

Figures B-3 and B-4 display the unsaturated hydraulic conductivity and interstitial water velocity results, respectively. Comparison of these data to the effective saturation distributions (Figure B-2) show the high degree of correlation between unsaturated flow and soil moisture content. Figures B-3 and B-4 show abrupt decreases in unsaturated hydraulic conductivity and interstitial water velocity, respectively, at relatively short distances from the source. Although Figure B-4 shows that the interstitial water velocities decrease exponentially over distance, gross travel times may be estimated. The simulated interstitial water velocities were used to compute the contaminant travel time for a non-reactive solute from the base of the landfill to the Lower Dockum Aquifer, located approximately 200 meters (600 feet) below the site, as at 4,084,674 years.

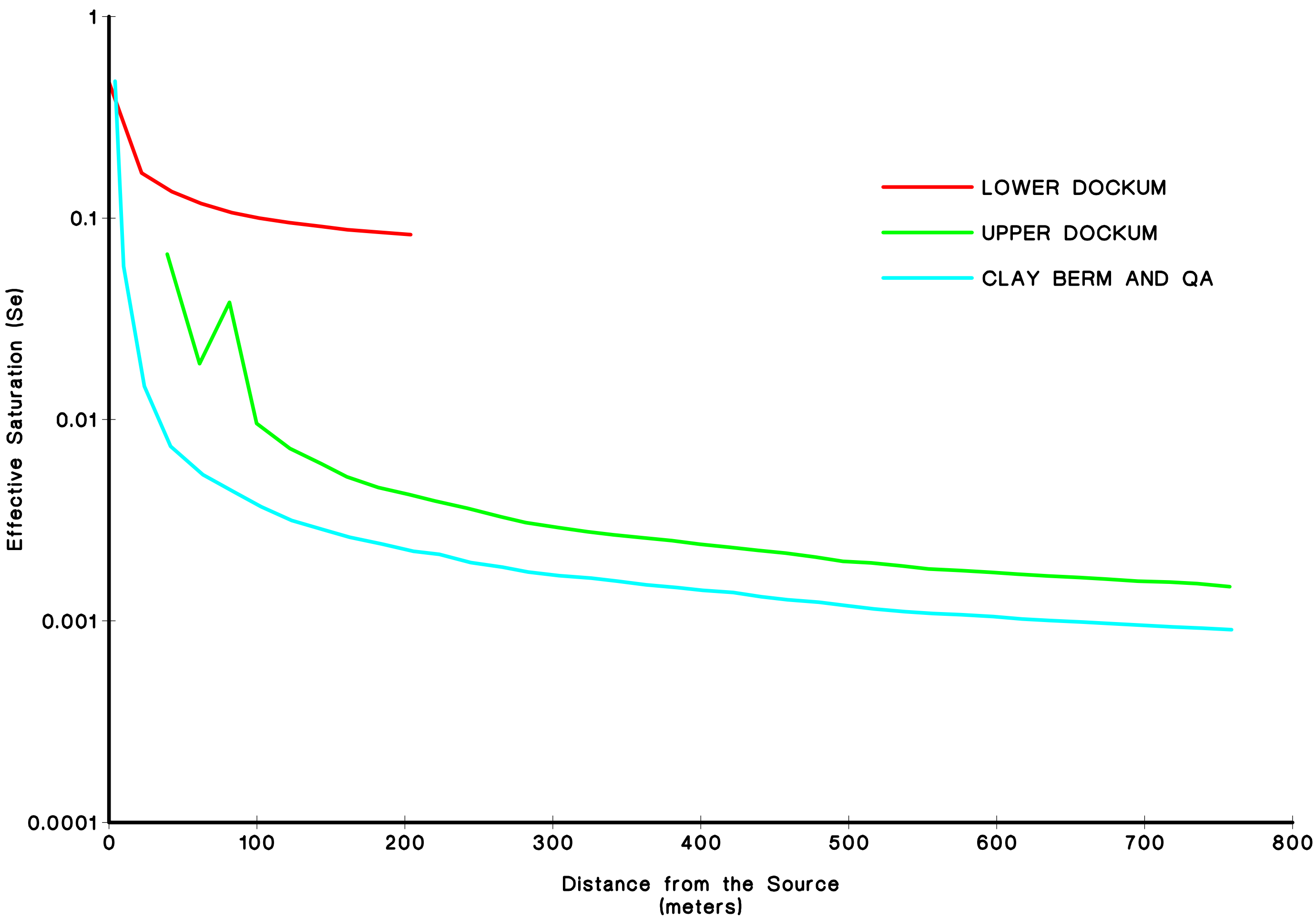


LANDFILL PROFILE

TRIASSIC PARK WASTE DISPOSAL FACILITY

Figure B-1

AutoCAD FILE: *GANDY-FIGB-1*

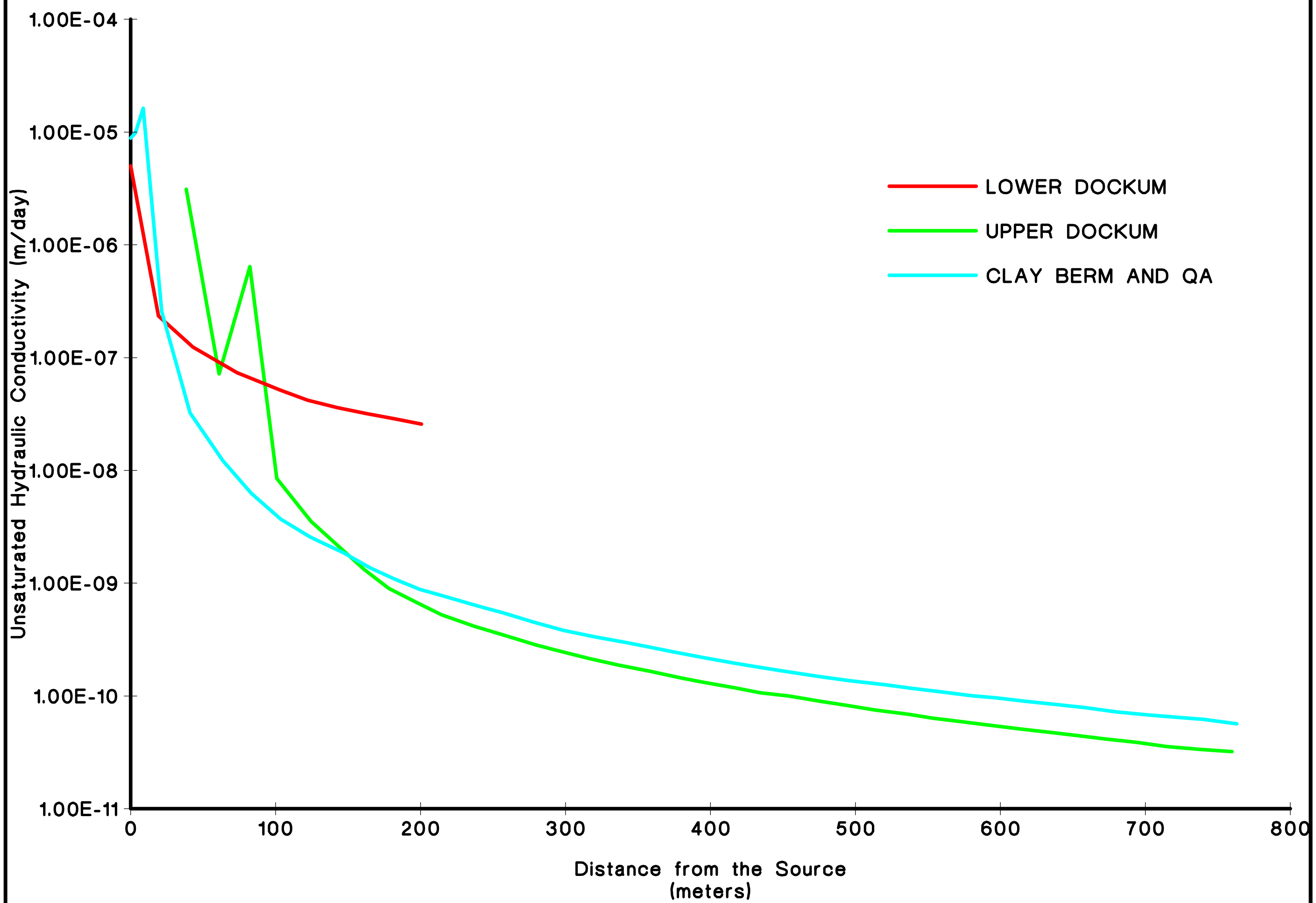


STEADY STATE EFFECTIVE SATURATION vs. DISTANCE FROM SOURCE

Figure B-2

TRIASSIC PARK WASTE DISPOSAL FACILITY

AutoCAD FILE: GANDY-FIGB-2

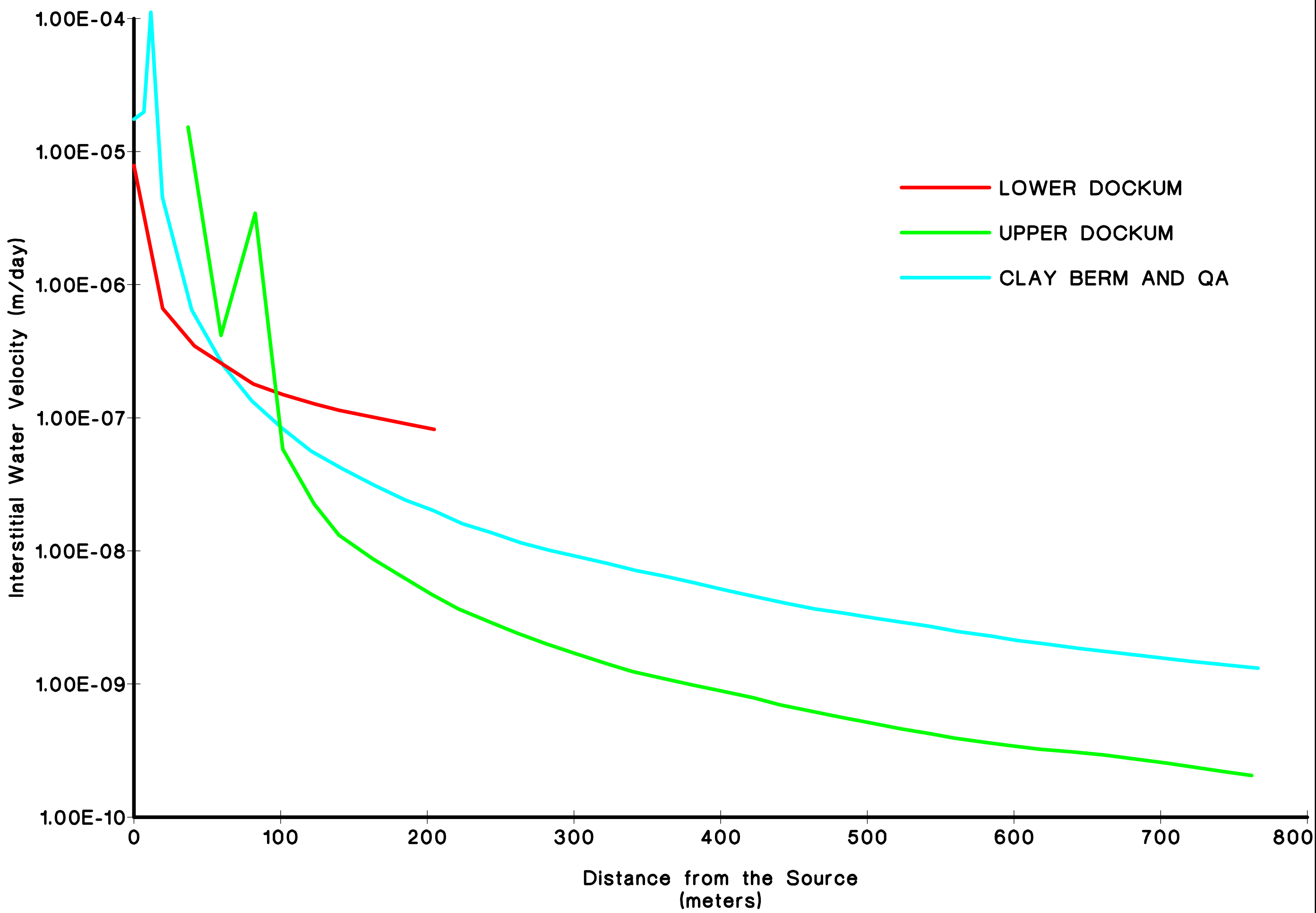


STEADY STATE UNSATURATED HYDRAULIC CONDUCTIVITY vs. DISTANCE FROM SOURCE

TRIASSIC PARK WASTE DISPOSAL FACILITY

Figure B-3

AutoCAD FILE: GANDY-FIGB-3

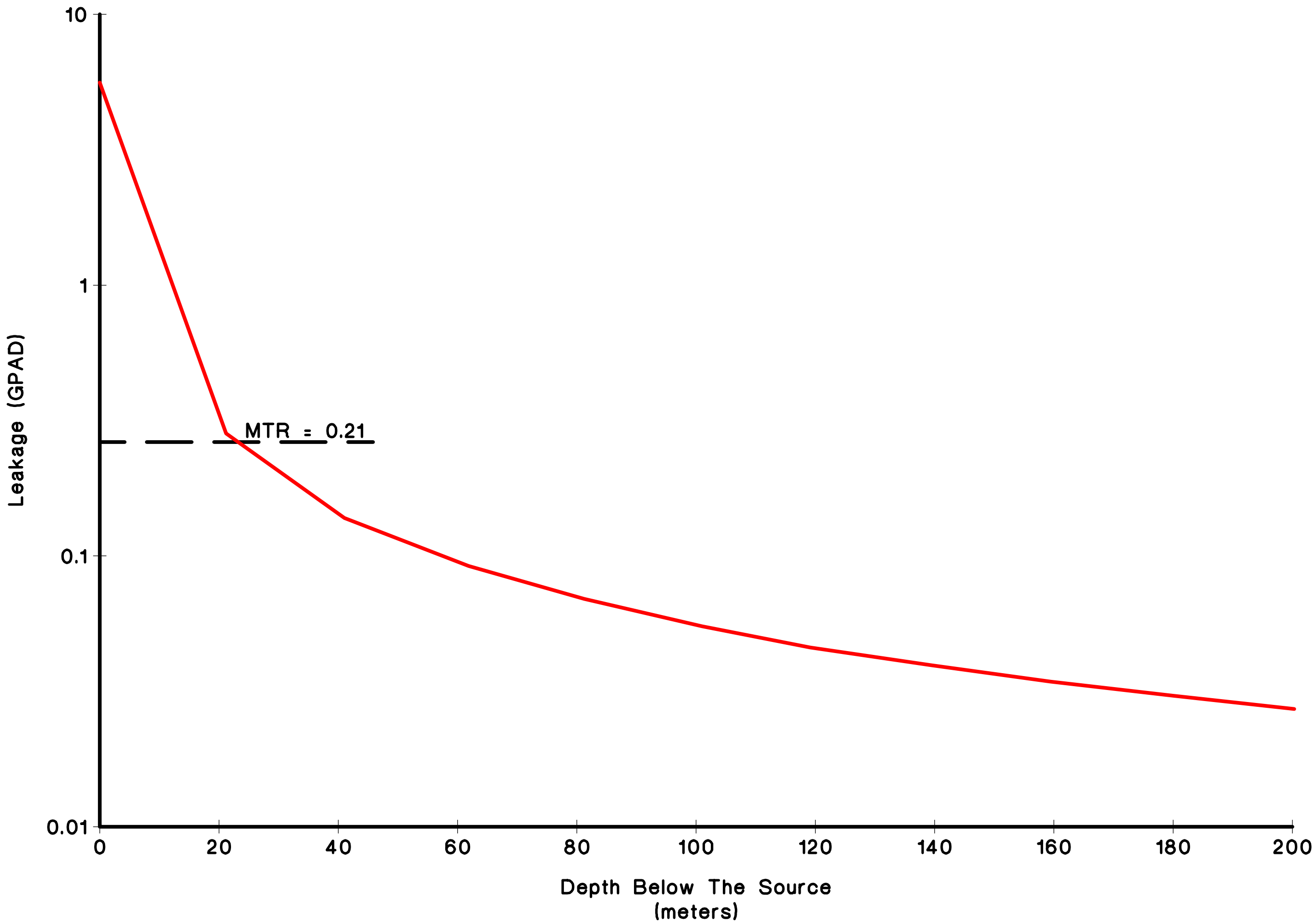


INTERSTITIAL WATER VELOCITY vs. DISTANCE FROM SOURCE

TRIASSIC PARK WASTE DISPOSAL FACILITY

Figure B-4

AutoCAD FILE: GANDY-FIGB-4



STEADY STATE LEAKAGE INTO LOWER DOCKUM vs.DISTANCE FROM SOURCE

Figure B-5

TRIASSIC PARK WASTE DISPOSAL FACILITY

AutoCAD FILE: GANDY-FIGB-5

APPENDIX C
MULTIMED FLOW MODELING RESULTS

C-1 MULTIMED Boundary Conditions

Model boundary condition are important for successful simulations since they define the theoretical constraints of the model and reflect inherent assumptions necessary to translate a real physical system into the virtual mathematical system of the computer model. The boundary conditions used for the model are described below in Table C-1, Triassic Park MULTIMED Model Boundary Conditions.

TABLE C-1
TRIASSIC PARK MULTIMED MODEL BOUNDARY CONDITIONS

Parameter	Parameter Value	Justification
Recharge	0.0 m/yr – all Trials	To keep infiltrating contaminants over the area outside the landfill from being diluted by rainfall **(MCA)**. This condition will result in more conservative contaminant concentrations at the receptor well
Leachate Infiltration Rate	0.84 in/yr – Trial 1 0.42 in/yr – Trial 2 0.60 in/yr – Trial 3	Equal to the unsaturated hydraulic conductivity **(MCA)** – Trial 1 Equal to the net recharge rate – Trial 2 Maximum infiltration rate that model will accept – Trial 3
Area of Waste Disposal Unit	9.00 m^2 – all Trials	This is the size of the hypothetical liner flaw in the vicinity of the leachate sump. Due to construction quality assurance programs, a liner flaw of this magnitude is highly improbable **(MCA)**.
Contaminant Concentration	1.0 ppm – all Trials	This condition implies that the contaminant mass in the system will not be depleted by setting it to a constant 1.0 ppm during the entire transport simulation period
Contaminant Decay	0.00 – all Trials	To allow the maximum concentration of leachate to travel through the subsurface **(MCA)**
Retardation	0.00 – all Trials	To allow the fastest possible contaminant transport through the subsurface **(MCA)**
Groundwater Table Mixing Zone	0.1 m – all Trials	To reduce the dilution effects of the untainted groundwater on the contaminant concentration

C-2 MULTIMED Unsaturated and Saturated Zone Input Parameters

Since the model simulates flow and transport in the unsaturated and saturated zones, geologic characteristics of the subsurface are necessary as input to the model. These variables, derived from published literature and the site-specific geologic investigation are discussed below in Table C-2, Triassic Park MULTIMED Unsaturated Zone Input Parameters and Table C-3, Triassic Park MULTIMED Saturated Zone Input Parameters.

TABLE C-2
TRIASSIC PARK MULTIMED UNSATURATED ZONE INPUT PARAMETERS

Parameter	Parameter Value	Justification
Saturated Hydraulic Conductivity	6.8×10^{-8} cm/s – Trial 1 6.8×10^{-8} cm/s – Trial 2 1.0×10^{-5} cm/s - Trial 3	Maximum value obtained from core samples of Lower Dockum tested in the lab **(MCA)** – Trials 1 & 2 Maximum value obtained from core samples of Upper Dockum tested in the lab – Trial 3
Effective Porosity	0.23 – Trial 1 0.23 – Trial 2 0.30 – Trial 3	50% of literature value for siltstones (Dean et al. 1989) for the most conservative value– Trials 1 & 2 Estimated literature value for aquifer-type materials –Trial 3
Residual Water Content	0.116– all Trials	Average in-situ moisture content of the Chinle Formation claystones as measured in 10 core samples (Weaver et al, 1997)
Air Entry Pressure	1.00 m – all Trials	Selected from published literature value for siltstone (Weaver et al., 1997)
Van Genuchten Alpha (α) coefficient	0.005 – all Trials	Selected from published literature value for silty clays and clayey silts (Weaver et al., 1997)
Van Genuchten Beta (β) coefficient	1.09 – all Trials	Selected from published literature value for silty clays and clayey silts (Weaver et al., 1997)
Thickness of Layer	183 m – Trial 1 183 m – Trial 2 1.0 m – Trial 3	Thickness of vadose zone in Lower Dockum – Trial 1 Thickness of vadose zone in Lower Dockum – Trial 1 To create a lateral simulation to a perched water table along the Upper Dockum/Lower Dockum contact
Longitudinal Dispersivity	1.00 – all Trials	To avoid excessively high dispersion as suggested in the MULTIMED program documentation

TABLE C-3
TRIASSIC PARK MULTIMED SATURATED ZONE INPUT PARAMETERS

Parameter	Parameter Value	Justification
Saturated Hydraulic Conductivity	30.0 m/yr – Trial 1 30.0 m/yr – Trial 2 3.15 m/yr - Trial 3	Estimated value for Lower Dockum aquifer – Trial 1 Estimated value for Lower Dockum aquifer – Trial 2 Estimated value for lateral travel along Upper/Lower Dockum contact – Trial 3
Aquifer Thickness	30.0 – Trial 1 30.0 – Trial 2 3.00 – Trial 3	Estimated value for Lower Dockum aquifer – Trial 1 Estimated value for Lower Dockum aquifer – Trial 2 Estimated value for perched aquifer along Upper/Lower Dockum contact – Trial 3
Hydraulic Gradient	.01 – all	Estimated value for site
Distance to Receptor Well	1.00 m – Trial 1 1.00 m – Trial 2 1120 m – Trial 3	To obtain point of compliance for upper aquifer – Trial 1 To obtain point of compliance for upper aquifer – Trial 2 To perched aquifer approx. 1120 m from the landfill

Vtrnapt

```
CONCENTRATION AT BOTTOM OF VADOSE ZONE
 RUN NO.     1
      AT TIME = 0.1385E-04  CONC = -.4778E-01
      AT TIME = 0.1505E+04  CONC = -.5529E-02
      AT TIME = 0.1606E+04  CONC = 0.7461E-01
      AT TIME = 0.1689E+04  CONC = 0.1696E+00
      AT TIME = 0.1759E+04  CONC = 0.2580E+00
      AT TIME = 0.1817E+04  CONC = 0.3311E+00
      AT TIME = 0.1865E+04  CONC = 0.3897E+00
      AT TIME = 0.1905E+04  CONC = 0.4373E+00
      AT TIME = 0.1939E+04  CONC = 0.4767E+00
      AT TIME = 0.1967E+04  CONC = 0.5097E+00
      AT TIME = 0.2017E+04  CONC = 0.5701E+00
      AT TIME = 0.2067E+04  CONC = 0.6326E+00
      AT TIME = 0.2117E+04  CONC = 0.6964E+00
      AT TIME = 0.2167E+04  CONC = 0.7598E+00
      AT TIME = 0.2217E+04  CONC = 0.8200E+00
      AT TIME = 0.2267E+04  CONC = 0.8739E+00
      AT TIME = 0.2317E+04  CONC = 0.9196E+00
      AT TIME = 0.2367E-04  CONC = 0.9517E+00
      AT TIME = 0.2417E+04  CONC = 0.9715E+00
      AT TIME = 0.2467E+04  CONC = 0.9773E+00
      AT TIME = 0.2517E+04  CONC = 0.9692E+00
      AT TIME = 0.2567E+04  CONC = 0.9477E+00
      AT TIME = 0.2617E+04  CONC = 0.9145E+00
      AT TIME = 0.2667E+04  CONC = 0.8710E+00
      AT TIME = 0.2717E+04  CONC = 0.8194E+00
      AT TIME = 0.2767E+04  CONC = 0.7617E+00
      AT TIME = 0.2817E+04  CONC = 0.6998E+00
      AT TIME = 0.2867E+04  CONC = 0.6358E+00
      AT TIME = 0.2917E+04  CONC = 0.5708E+00
      AT TIME = 0.2967E+04  CONC = 0.5067E+00
      AT TIME = 0.2995E+04  CONC = 0.4717E+00
      AT TIME = 0.3028E+04  CONC = 0.4307E+00
      AT TIME = 0.3069E+04  CONC = 0.3834E+00
      AT TIME = 0.3117E+04  CONC = 0.3297E+00
      AT TIME = 0.3175E+04  CONC = 0.2703E+00
      AT TIME = 0.3244E+04  CONC = 0.2069E+00
      AT TIME = 0.3328E+04  CONC = 0.1424E+00
      AT TIME = 0.3428E+04  CONC = 0.8091E-01
      AT TIME = 0.3548E+04  CONC = 0.2785E-01
      AT TIME = 0.5804E+04  CONC = 0.6340E-02

1                        UNSATURATED ZONE TRANSPORT RESULTS


                                                                  NORMALIZED
SERIAL NUMBER        TIME           DEPTH       CONCENTRATION    CONCENTRATION
```

TRAIL1-VTRN

Figure TRAIL-1

AutoCAD FILE: TRAIL1-VTRN

Vtrospt

```
CONCENTRATION AT BOTTOM OF VADOSE ZONE
 RUN NO.      1
      AT TIME = 0.2771E+04  CONC = -.5497E-01
      AT TIME = 0.3011E+04  CONC = -.2357E-01
      AT TIME = 0.3211E+04  CONC = 0.6788E-01
      AT TIME = 0.3378E+04  CONC = 0.1819E+00
      AT TIME = 0.3517E+04  CONC = 0.2889E+00
      AT TIME = 0.3633E+04  CONC = 0.3765E+00
      AT TIME = 0.3730E+04  CONC = 0.4432E+00
      AT TIME = 0.3811E+04  CONC = 0.4921E+00
      AT TIME = 0.3878E+04  CONC = 0.5272E+00
      AT TIME = 0.3934E+04  CONC = 0.5522E+00
      AT TIME = 0.3984E+04  CONC = 0.5710E+00
      AT TIME = 0.4034E+04  CONC = 0.5864E+00
      AT TIME = 0.4084E+04  CONC = 0.5984E+00
      AT TIME = 0.4134E+04  CONC = 0.6072E+00
      AT TIME = 0.4184E+04  CONC = 0.6126E+00
      AT TIME = 0.4234E+04  CONC = 0.6149E+00
      AT TIME = 0.4284E+04  CONC = 0.6142E+00
      AT TIME = 0.4334E+04  CONC = 0.6107E+00
      AT TIME = 0.4384E+04  CONC = 0.6046E+00
      AT TIME = 0.4434E+04  CONC = 0.5960E+00
      AT TIME = 0.4484E+04  CONC = 0.5853E+00
      AT TIME = 0.4534E+04  CONC = 0.5725E+00
      AT TIME = 0.4584E+04  CONC = 0.5580E+00
      AT TIME = 0.4634E+04  CONC = 0.5420E+00
      AT TIME = 0.4684E+04  CONC = 0.5246E+00
      AT TIME = 0.4734E+04  CONC = 0.5062E+00
      AT TIME = 0.4784E+04  CONC = 0.4868E+00
      AT TIME = 0.4834E+04  CONC = 0.4667E+00
      AT TIME = 0.4884E+04  CONC = 0.4461E+00
      AT TIME = 0.4934E+04  CONC = 0.4252E+00
      AT TIME = 0.4990E+04  CONC = 0.4015E+00
      AT TIME = 0.5057E+04  CONC = 0.3730E+00
      AT TIME = 0.5137E+04  CONC = 0.3391E+00
      AT TIME = 0.5234E+04  CONC = 0.2995E+00
      AT TIME = 0.5350E+04  CONC = 0.2542E+00
      AT TIME = 0.5489E+04  CONC = 0.2041E+00
      AT TIME = 0.5656E+04  CONC = 0.1512E+00
      AT TIME = 0.5856E+04  CONC = 0.9867E-01
      AT TIME = 0.6097E+04  CONC = 0.5080E-01
      AT TIME = 0.1036E+05  CONC = 0.3151E-02
```

1

UNSATURATED ZONE TRANSPORT RESULTS

TRAIL2-VTRN

Figure TRAIL-2

AutoCAD FILE: TRAIL2-VTRN

TRIAL 1
MULTIMED INPUT AND OUTPUT FILES

```
DEFAULT
CASE


GENERAL DATA

***  CHEMICAL NAME FORMAT(80A1)
DEFAULT CHEMICAL

***    ISOURC                        ROUTE      NT       IYCHK   PALPH      APPTYP
***OPTION   OPTAIR  RUN             MONTE    ISTEAD     IOPEN     IZCHK     LANDF   COMPLETE
    2    0    0     DETERMINISTIC    500    1    0   25    1    0    0 90.0    0    1    1


***   XST


*** TIME STEPPING PARAMETERS FOR SATURATED ZONE MODEL
 1600.00   1625.00   1650.00   1675.00   1700.00   1725.00   1750.00   1775.00   1800.00   1825.00
 1850.00   1875.00   1900.00   1925.00   1950.00   1975.00   2000.00   2025.00   2050.00   2075.00
 2100.00   2125.00   2150.00   2175.00   2200.00

END GENERAL

CHEMICAL SPECIFIC VARIABLE DATA
ARRAY VALUES
***      CHEMICAL SPECIFIC VARIABLES

***           VARIABLE NAME                UNITS               DISTRIBUTION   PARAMETERS           LIMITS
***                                                                          MEAN      STD DEV    MIN      MAX

************************************************************************************************************************
 1 Solid phase decay coeff (1/yr)                                 -1      -999.     -999.     0.000E+00 0.100E+11
 2 Diss phase decay coeff (1/yr)                                  -1      -999.     -999.     0.000E+00 0.100E+11
 3 Overall chem dcy coeff (1/yr)                                  -1      -999.     -999.     0.000E+00 0.100E+11
 4 Acid cataly hydrol rte(l/M-yr)                                  0      0.000E+00 -999.     0.000E+00 -999.
 5 Neutral hydrol rate cons(1/yr)                                  0      0.000E+00 -999.     0.000E+00 -999.
 6 Base cataly hydrol rte(l/M-yr)                                  0      0.000E+00 -999.     0.000E+00 -999.
 7 Reference temperature (C)                                       0       20.0     -999.     0.000E+00  100.
 8 Normalized distrib coeff(ml/g)                                  0      0.000E+00 -999.     0.000E+00 -999.
 9 Distribution coefficient                                       -1      -999.     -999.     0.000E+00 0.100E+11
10 Biodegrad coef(sat zone)(1/yr)                                  0      0.000E+00 -999.     0.000E+00 -999.
11 Air diffusion coeff (cm2/s)                                     0      0.000E+00 -999.     0.000E+00  10.0
12 Ref temp for air diffusion (C)                                  0       20.0     -999.     0.000E+00  100.
13 Molecular weight (g/mole)                                       0      0.000E+00 -999.     0.000E+00 -999.
14 Mole fraction of solute                                         0      0.000E+00 -999.     0.100E-08  1.00
15 Solute vapor pressure (mm Hg)                                   0      0.000E+00 -999.     0.000E+00  100.
16 Henry`s law cons (atm-m^3/M)                                    0      0.000E+00 -999.     0.100E-09  1.00
17 Not in use                                                      0      -999.     -999.     0.000E+00  1.00
18 Not in use                                                      0      -999.     -999.     0.000E+00  1.00
19 Not in use                                                      0      -999.     -999.     0.000E+00  1.00
END ARRAY

END CHEMICAL SPECIFIC VARIABLE DATA



SOURCE SPECIFIC VARIABLE DATA
ARRAY VALUES
***        SOURCE SPECIFIC VARIABLES

***           VARIABLE NAME                UNITS               DISTRIBUTION   PARAMETERS           LIMITS
***                                                                          MEAN      STD DEV    MIN      MAX

************************************************************************************************************************
 1 Infiltration rate (m/yr)                                        0      0.214E-01 -999.     0.100E-09 0.100E+11
 2 Area of waste disp unit (m^2)                                   0       9.00     -999.     0.100E-01 -999.
 3 Duration of pulse (yr)                                          0      0.100E+04 -999.     0.100E-08 -999.
 4 Spread of contaminant srce (m)                                 -1      -999.     -999.     0.100E-08 0.100E+11
 5 Recharge rate (m/yr)                                            0      0.000E+00 -999.     0.000E+00 0.100E+11
 6 Source decay constant (1/yr)                                    0      0.000E+00 -999.     0.000E+00 -999.
 7 Init conc at landfill (mg/l)                                    0       1.00     -999.     0.000E+00 -999.
 8 Length scale of facility (m)                                   -1      -999.     -999.     0.100E-08 0.100E+11
 9 Width scale of facility (m)                                    -1      -999.     -999.     0.100E-08 0.100E+11
END ARRAY

END SOURCE SPECIFIC VARIABLE DATA



VFL   UNSATURATED FLOW MODEL PARAMETERS


CONTROL PARAMETERS
***    DUMMY     NMAT      KPROP     DUMMY    NVFLAY
         7         1         1         1         1


END CONTROL PARAMETERS
SATURATED MATERIAL PROPERTY PARAMETERS
ARRAY VALUES
***   SATURATED MATERIAL   VARIABLES

***           VARIABLE NAME                UNITS               DISTRIBUTION   PARAMETERS           LIMITS
***                                                                          MEAN      STD DEV    MIN      MAX

************************************************************************************************************************
 1 Sat hydraulic conduct (cm/hr)                                   0      0.245E-03 -999.     0.100E-10 0.100E+05
```

```
 2 Unsaturated zone porosity                                  0      0.230     -999.     0.100E-08 0.990
 3 Air entry pressure head (m)                                0      0.100     -999.     0.000E+00 -999.
 4 Depth of the unsat zone (m)                                0       183.     -999.     0.100E-08 -999.
END ARRAY

END MATERIAL  1
END
SOIL MOISTURE PARAMETERS
***   FUNCTIONAL COEFFICIENTS
ARRAY VALUES
***   FUNCTIONAL COEFFICIE VARIABLES

***           VARIABLE NAME                UNITS             DISTRIBUTION   PARAMETERS             LIMITS
***                                                                          MEAN      STD DEV    MIN      MAX

************************************************************************************************************************
 1 Residual water content                                     0      0.116     -999.     0.100E-08  1.00
 2 Brooks and Corey exponent, EN                              0      -999.     -999.     0.000E+00  10.0
 3 ALFA van Genuchten coefficient                             0      0.500E-02 -999.     0.000E+00  1.00
 4 BETA Van Genuchten coefficient                             0       1.09     -999.      1.00      5.00
END ARRAY

END MATERIAL  1
END
END UNSATURATED FLOW



VTP    UNSATURATED TRANSPORT MODEL
CONTROL PARAMETERS
***   NLAY     DUMMY      IADU      ISOL         N      NTEL     NGPTS       NIT     DUMMY     DUMMY
         1        20         1         1        18         3       104         2         1         1
***  WTFUN
     1.200


END CONTROL PARAMETERS
TRANSPORT PARAMETER
ARRAY VALUES
***   UNSATURATED TRANSPOR VARIABLES

***           VARIABLE NAME                UNITS             DISTRIBUTION   PARAMETERS             LIMITS
***                                                                          MEAN      STD DEV    MIN      MAX

************************************************************************************************************************
 1 Thickness of layer (m)                                     0       183.     -999.     0.100E-08 -999.
 2 Longit disper of layer (m)                                -1       1.00     -999.     0.100E-02 0.100E+05
 3 Percent organic matter                                     0      0.000E+00 -999.     0.000E+00  100.
 4 Bulk dens of soil layer (g/cc)                             0       1.83     -999.     0.100E-01  5.00
 5 Biological decay coeff (1/yr)                              0      0.000E+00 -999.     0.000E+00 -999.
END ARRAY

END LAYER  1
END UNSATURATED TRANSPORT PARAMETERS
END TRANSPORT MODEL
AQUIFER SPECIFIC VARIABLE DATA
ARRAY VALUES
***       AQUIFER SPECIFIC VARIABLES

***           VARIABLE NAME                UNITS             DISTRIBUTION   PARAMETERS             LIMITS
***                                                                          MEAN      STD DEV    MIN      MAX

************************************************************************************************************************
 1 Particle diameter (cm)                                     0      0.500E-01 -999.     0.100E-08  100.
 2 Aquifer porosity                                           0      0.300     -999.     0.100E-08 0.990
 3 Bulk density (g/cc)                                        0       1.70     -999.     0.100E-01  5.00
 4 Aquifer thickness (m)                                      0       30.0     -999.     0.100E-08 0.100E+06
 5 Mixing zone depth (m)                                     -1      0.100     -999.     0.100E-08 0.100E+06
 6 Hydraulic conductivity (m/yr)                              0       30.0     -999.     0.100E-06 0.100E+09
 7 Hydraulic Gradient                                         0      0.100E-01 -999.     0.100E-07 -999.
 8 Grndwater seep velocity (m/yr)                            -1      -999.     -999.     0.100E-09 0.100E+09
 9 Retardation coefficient                                   -1       1.00     -999.      1.00     0.100E+09
10 Longitudinal dispersivity (m)                             10       1.00     -999.     -999.     -999.
11 Transverse dispersivity (m)                               10      -999.     -999.     0.100E-02 0.100E+05
12 Vertical dispersivity (m)                                 10      -999.     -999.     -999.     -999.
13 Temperature of aquifer (C)                                 0       20.0     -999.     0.000E+00  100.
14 pH                                                         0       7.00     -999.     0.300      14.0
15 Organic carbon content (fract)                             0      0.000E+00 -999.     0.100E-05  1.00
16 Receptor distance from site(m)                             0       1.00     -999.      1.00     -999.
17 Angle off center (degree)                                  0      0.000E+00 -999.     0.000E+00  360.
18 Z-dist from watertable (fract)                             0      0.000E+00 -999.     0.000E+00  1.00
END ARRAY

END AQUIFER SPECIFIC VARIABLE DATA


END ALL DATA
```

1

U. S. E N V I R O N M E N T A L P R O T E C T I O N A G E N C Y

E X P O S U R E A S S E S S M E N T

M U L T I M E D I A M O D E L

MULTIMED (Version 1.01, June 1991)

1

Run options
--- -------

DEFAULT

CASE
Chemical simulated is DEFAULT CHEMICAL

```
Option Chosen                        Saturated and unsaturated zone models
Run was                              DETERMIN
Infiltration input by user
Run was transient
Reject runs if Y coordinate outside plume
Reject runs if Z coordinate outside plume
Gaussian source used in saturated zone model
```

1
1

```
UNSATURATED ZONE FLOW MODEL PARAMETERS
(input parameter description and value)
NP      - Total number of nodal points                 240
NMAT    - Number of different porous materials           1
KPROP   - Van Genuchten or Brooks and Corey              1
IMSHGN  - Spatial discretization option                  1
NVFLAYR - Number of layers in flow model                 1
```

OPTIONS CHOSEN
------- ------
Van Genuchten functional coefficients
User defined coordinate system

1

Layer information

LAYER NO.	LAYER THICKNESS	MATERIAL PROPERTY
1	183.00	1

DATA FOR MATERIAL 1
---- --- --------
VADOSE ZONE MATERIAL VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Saturated hydraulic conductivity	cm/hr	CONSTANT	0.245E-03	-999.	0.100E-10	0.100E+05
Unsaturated zone porosity	--	CONSTANT	0.230	-999.	0.100E-08	0.990
Air entry pressure head	m	CONSTANT	0.100	-999.	0.000E+00	-999.
Depth of the unsaturated zone	m	CONSTANT	183.	-999.	0.100E-08	-999.

```
                                                DATA FOR MATERIAL  1
                                                ---- --- --------
                                            VADOSE ZONE FUNCTION VARIABLES


           ----------------------------------------------------------------------------------------------------------
----------
                       VARIABLE NAME               UNITS      DISTRIBUTION         PARAMETERS            LIMITS
                                                                                 MEAN     STD DEV      MIN         MAX
           ----------------------------------------------------------------------------------------------------------
----------
           Residual water content                   --         CONSTANT       0.116     -999.      0.100E-08   1.00
           Brook and Corey exponent,EN              --         CONSTANT       -999.     -999.      0.000E+00   10.0
           ALFA coefficient                        1/cm        CONSTANT       0.500E-02 -999.      0.000E+00   1.00
           Van Genuchten exponent, ENN              --         CONSTANT        1.09     -999.       1.00       5.00
1

 UNSATURATED ZONE TRANSPORT MODEL PARAMETERS

 NLAY   - Number of different layers used              1
 NTSTPS - Number of time values concentration calc    40
 DUMMY  - Not presently used                           1
 ISOL   - Type of scheme used in unsaturated zone      1
 N      - Stehfest terms or number of increments      18
 NTEL   - Points in Lagrangian interpolation           3
 NGPTS  - Number of Gauss points                     104
 NIT    - Convolution integral segments                2
 IBOUND - Type of boundary condition                   2
 ITSGEN - Time values generated or input               1
 TMAX   - Max simulation time            --           0.0
 WTFUN  - Weighting factor               --           1.2


 OPTIONS CHOSEN
 ------- ------
 Stehfest numerical inversion algorithm
 Nondecaying pulse source
 Computer generated times for computing concentrations
1

                                                DATA FOR LAYER   1
                                                ---- --- -----
                                                VADOSE TRANSPORT VARIABLES


           ----------------------------------------------------------------------------------------------------------
----------
                       VARIABLE NAME               UNITS      DISTRIBUTION         PARAMETERS            LIMITS
                                                                                 MEAN     STD DEV      MIN         MAX
           ----------------------------------------------------------------------------------------------------------
----------
           Thickness of layer                       m          CONSTANT        183.     -999.      0.100E-08  -999.
           Longitudinal dispersivity of layer       m          DERIVED         1.00     -999.      0.100E-02
0.100E+05
           Percent organic matter                   --         CONSTANT       0.000E+00 -999.      0.000E+00   100.
           Bulk density of soil for layer          g/cc        CONSTANT        1.83     -999.      0.100E-01   5.00
           Biological decay coefficient           1/yr         CONSTANT       0.000E+00 -999.      0.000E+00  -999.
1
                                               CHEMICAL SPECIFIC VARIABLES


           ----------------------------------------------------------------------------------------------------------
----------
                       VARIABLE NAME               UNITS      DISTRIBUTION         PARAMETERS            LIMITS
                                                                                 MEAN     STD DEV      MIN         MAX
           ----------------------------------------------------------------------------------------------------------
----------
           Solid phase decay coefficient            1/yr       DERIVED        -999.     -999.      0.000E+00
0.100E+11
           Dissolved phase decay coefficient        1/yr       DERIVED        -999.     -999.      0.000E+00
0.100E+11
           Overall chemical decay coefficient       1/yr       DERIVED        -999.     -999.      0.000E+00
0.100E+11
           Acid catalyzed hydrolysis rate          l/M-yr      CONSTANT       0.000E+00 -999.      0.000E+00  -999.
           Neutral hydrolysis rate constant        1/yr        CONSTANT       0.000E+00 -999.      0.000E+00  -999.
           Base catalyzed hydrolysis rate          l/M-yr      CONSTANT       0.000E+00 -999.      0.000E+00  -999.
           Reference temperature                   C           CONSTANT        20.0     -999.      0.000E+00   100.
           Normalized distribution coefficient     ml/g        CONSTANT       0.000E+00 -999.      0.000E+00  -999.
           Distribution coefficient                 --         DERIVED        -999.     -999.      0.000E+00
0.100E+11
           Biodegradation coefficient (sat. zone)   1/yr       CONSTANT       0.000E+00 -999.      0.000E+00  -999.
           Air diffusion coefficient               cm2/s       CONSTANT       0.000E+00 -999.      0.000E+00   10.0
           Reference temperature for air diffusion  C          CONSTANT        20.0     -999.      0.000E+00   100.
           Molecular weight                        g/M         CONSTANT       0.000E+00 -999.      0.000E+00  -999.
           Mole fraction of solute                  --         CONSTANT       0.000E+00 -999.      0.100E-08   1.00
           Vapor pressure of solute                 mm Hg      CONSTANT       0.000E+00 -999.      0.000E+00   100.
           Henry`s law constant                  atm-m^3/M     CONSTANT       0.000E+00 -999.      0.100E-09   1.00
           Overall 1st order decay sat. zone        1/yr       DERIVED        0.000E+00 0.000E+00  0.000E+00   1.00
           Not currently used                                  CONSTANT       -999.     -999.      0.000E+00   1.00
           Not currently used                                  CONSTANT       -999.     -999.      0.000E+00   1.00
1
                                                 SOURCE SPECIFIC VARIABLES


           ----------------------------------------------------------------------------------------------------------
----------
```

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	STD DEV	LIMITS MIN	MAX
Infiltration rate	m/yr	CONSTANT	0.214E-01	-999.	0.100E-09	0.100E+11
Area of waste disposal unit	m^2	CONSTANT	9.00	-999.	0.100E-01	-999.
Duration of pulse	yr	CONSTANT	0.100E+04	-999.	0.100E-08	-999.
Spread of contaminant source	m	DERIVED	-999.	-999.	0.100E-08	0.100E+11
Recharge rate	m/yr	CONSTANT	0.000E+00	-999.	0.000E+00	0.100E+11
Source decay constant	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Initial concentration at landfill	mg/l	CONSTANT	1.00	-999.	0.000E+00	-999.
Length scale of facility	m	DERIVED	-999.	-999.	0.100E-08	0.100E+11
Width scale of facility	m	DERIVED	-999.	-999.	0.100E-08	0.100E+11
Near field dilution		DERIVED	1.00	0.000E+00	0.000E+00	1.00

1

AQUIFER SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	STD DEV	LIMITS MIN	MAX
Particle diameter	cm	CONSTANT	0.500E-01	-999.	0.100E-08	100.
Aquifer porosity	--	CONSTANT	0.300	-999.	0.100E-08	0.990
Bulk density	g/cc	CONSTANT	1.70	-999.	0.100E-01	5.00
Aquifer thickness	m	CONSTANT	30.0	-999.	0.100E-08	0.100E+06
Source thickness (mixing zone depth)	m	DERIVED	0.100	-999.	0.100E-08	0.100E+06
Conductivity (hydraulic)	m/yr	CONSTANT	30.0	-999.	0.100E-06	0.100E+09
Gradient (hydraulic)		CONSTANT	0.100E-01	-999.	0.100E-07	-999.
Groundwater seepage velocity	m/yr	DERIVED	-999.	-999.	0.100E-09	0.100E+09
Retardation coefficient	--	DERIVED	1.00	-999.	1.00	0.100E+09
Longitudinal dispersivity	m	FUNCTION OF X	1.00	-999.	-999.	-999.
Transverse dispersivity	m	FUNCTION OF X	-999.	-999.	0.100E-02	0.100E+05
Vertical dispersivity	m	FUNCTION OF X	-999.	-999.	-999.	-999.
Temperature of aquifer	C	CONSTANT	20.0	-999.	0.000E+00	100.
pH	--	CONSTANT	7.00	-999.	0.300	14.0
Organic carbon content (fraction)		CONSTANT	0.000E+00	-999.	0.100E-05	1.00
Well distance from site	m	CONSTANT	1.00	-999.	1.00	-999.
Angle off center	degree	CONSTANT	0.000E+00	-999.	0.000E+00	360.
Well vertical distance	m	CONSTANT	0.000E+00	-999.	0.000E+00	1.00

1

TIME	CONCENTRATION
0.160E+04	0.00000E+00
0.162E+04	0.18903E-01
0.165E+04	0.43355E-01
0.167E+04	0.67807E-01
0.170E+04	0.93490E-01
0.172E+04	0.12078E+00
0.175E+04	0.14807E+00
0.177E+04	0.17521E+00
0.180E+04	0.20227E+00
0.182E+04	0.22900E+00
0.185E+04	0.25506E+00
0.187E+04	0.28085E+00
0.190E+04	0.30624E+00
0.192E+04	0.33150E+00
0.195E+04	0.35680E+00
0.197E+04	0.38238E+00
0.200E+04	0.40832E+00
0.202E+04	0.43455E+00
0.205E+04	0.46138E+00
0.207E+04	0.48841E+00
0.210E+04	0.51584E+00
0.212E+04	0.54321E+00
0.215E+04	0.57044E+00
0.217E+04	0.59721E+00
0.220E+04	0.62307E+00

TRIAL 2
MULTIMED INPUT AND OUTPUT FILES

DEFAULT
CASE

```
GENERAL DATA

***  CHEMICAL NAME FORMAT(80A1)
DEFAULT CHEMICAL

***    ISOURC                        ROUTE      NT        IYCHK   PALPH      APPTYP
***OPTION   OPTAIR  RUN             MONTE    ISTEAD     IOPEN     IZCHK     LANDF   COMPLETE
    2    0    0     DETERMINISTIC    500    1    0    25    1    0    0 90.0    0    1    1


***   XST


*** TIME STEPPING PARAMETERS FOR SATURATED ZONE MODEL
 2000.00   2100.00   2200.00   2300.00   2400.00   2500.00   2600.00   2700.00   2800.00   2900.00
 3000.00   3100.00   3200.00   3300.00   3400.00   3500.00   3600.00   3700.00   3800.00   3900.00
 4000.00   4100.00   4200.00   4300.00   4400.00

END GENERAL

CHEMICAL SPECIFIC VARIABLE DATA
ARRAY VALUES
***      CHEMICAL SPECIFIC VARIABLES

***            VARIABLE NAME                UNITS                DISTRIBUTION   PARAMETERS            LIMITS
***                                                                            MEAN      STD DEV    MIN       MAX

************************************************************************************************************************
 1 Solid phase decay coeff (1/yr)                                   -1      -999.     -999.     0.000E+00 0.100E+11
 2 Diss phase decay coeff (1/yr)                                    -1      -999.     -999.     0.000E+00 0.100E+11
 3 Overall chem dcy coeff (1/yr)                                    -1      -999.     -999.     0.000E+00 0.100E+11
 4 Acid cataly hydrol rte(l/M-yr)                                    0      0.000E+00 -999.     0.000E+00 -999.
 5 Neutral hydrol rate cons(1/yr)                                    0      0.000E+00 -999.     0.000E+00 -999.
 6 Base cataly hydrol rte(l/M-yr)                                    0      0.000E+00 -999.     0.000E+00 -999.
 7 Reference temperature (C)                                         0       20.0     -999.     0.000E+00  100.
 8 Normalized distrib coeff(ml/g)                                    0      0.000E+00 -999.     0.000E+00 -999.
 9 Distribution coefficient                                         -1      -999.     -999.     0.000E+00 0.100E+11
10 Biodegrad coef(sat zone)(1/yr)                                    0      0.000E+00 -999.     0.000E+00 -999.
11 Air diffusion coeff (cm2/s)                                       0      0.000E+00 -999.     0.000E+00  10.0
12 Ref temp for air diffusion (C)                                    0       20.0     -999.     0.000E+00  100.
13 Molecular weight (g/mole)                                         0      0.000E+00 -999.     0.000E+00 -999.
14 Mole fraction of solute                                           0      0.000E+00 -999.     0.100E-08  1.00
15 Solute vapor pressure (mm Hg)                                     0      0.000E+00 -999.     0.000E+00  100.
16 Henry`s law cons (atm-m^3/M)                                      0      0.000E+00 -999.     0.100E-09  1.00
17 Not in use                                                        0      -999.     -999.     0.000E+00  1.00
18 Not in use                                                        0      -999.     -999.     0.000E+00  1.00
19 Not in use                                                        0      -999.     -999.     0.000E+00  1.00
END ARRAY

END CHEMICAL SPECIFIC VARIABLE DATA



SOURCE SPECIFIC VARIABLE DATA
ARRAY VALUES
***        SOURCE SPECIFIC VARIABLES

***            VARIABLE NAME                UNITS                DISTRIBUTION   PARAMETERS            LIMITS
***                                                                            MEAN      STD DEV    MIN       MAX

************************************************************************************************************************
 1 Infiltration rate (m/yr)                                          0      0.107E-01 -999.     0.100E-09 0.100E+11
 2 Area of waste disp unit (m^2)                                     0       9.00     -999.     0.100E-01 -999.
 3 Duration of pulse (yr)                                            0      0.100E+04 -999.     0.100E-08 -999.
 4 Spread of contaminant srce (m)                                   -1      -999.     -999.     0.100E-08 0.100E+11
 5 Recharge rate (m/yr)                                              0      0.000E+00 -999.     0.000E+00 0.100E+11
 6 Source decay constant (1/yr)                                      0      0.000E+00 -999.     0.000E+00 -999.
 7 Init conc at landfill (mg/l)                                      0       1.00     -999.     0.000E+00 -999.
 8 Length scale of facility (m)                                     -1      -999.     -999.     0.100E-08 0.100E+11
 9 Width scale of facility (m)                                      -1      -999.     -999.     0.100E-08 0.100E+11
END ARRAY

END SOURCE SPECIFIC VARIABLE DATA



VFL   UNSATURATED FLOW MODEL PARAMETERS


CONTROL PARAMETERS
***    DUMMY     NMAT      KPROP     DUMMY    NVFLAY
         7         1         1         1         1


END CONTROL PARAMETERS
SATURATED MATERIAL PROPERTY PARAMETERS
ARRAY VALUES
***   SATURATED MATERIAL   VARIABLES

***            VARIABLE NAME                UNITS                DISTRIBUTION   PARAMETERS            LIMITS
***                                                                            MEAN      STD DEV    MIN       MAX

************************************************************************************************************************
 1 Sat hydraulic conduct (cm/hr)                                     0      0.170E-03 -999.     0.100E-10 0.100E+05
 2 Unsaturated zone porosity                                         0      0.230     -999.     0.100E-08 0.990
 3 Air entry pressure head (m)                                       0      0.100     -999.     0.000E+00 -999.
 4 Depth of the unsat zone (m)                                       0       183.     -999.     0.100E-08 -999.
```

```
END ARRAY

END MATERIAL  1
END
SOIL MOISTURE PARAMETERS
***   FUNCTIONAL COEFFICIENTS
ARRAY VALUES
***   FUNCTIONAL COEFFICIE VARIABLES

***           VARIABLE NAME                UNITS               DISTRIBUTION   PARAMETERS            LIMITS
***                                                                           MEAN      STD DEV    MIN       MAX

*************************************************************************************************************************
 1 Residual water content                                          0      0.116     -999.     0.100E-08  1.00
 2 Brooks and Corey exponent, EN                                   0     -999.      -999.     0.000E+00  10.0
 3 ALFA van Genuchten coefficient                                  0      0.500E-02 -999.     0.000E+00  1.00
 4 BETA Van Genuchten coefficient                                  0       1.09     -999.      1.00      5.00
END ARRAY

END MATERIAL  1
END
END UNSATURATED FLOW



VTP    UNSATURATED TRANSPORT MODEL
CONTROL PARAMETERS
***   NLAY     DUMMY      IADU      ISOL         N       NTEL      NGPTS       NIT     DUMMY     DUMMY
         1        20         1         1        18         3       104         2         1         1
***  WTFUN
     1.200


END CONTROL PARAMETERS
TRANSPORT PARAMETER
ARRAY VALUES
***   UNSATURATED TRANSPOR VARIABLES

***           VARIABLE NAME                UNITS               DISTRIBUTION   PARAMETERS            LIMITS
***                                                                           MEAN      STD DEV    MIN       MAX

*************************************************************************************************************************
 1 Thickness of layer (m)                                          0       183.     -999.     0.100E-08 -999.
 2 Longit disper of layer (m)                                     -1       1.00     -999.     0.100E-02 0.100E+05
 3 Percent organic matter                                          0      0.000E+00 -999.     0.000E+00  100.
 4 Bulk dens of soil layer (g/cc)                                  0       1.83     -999.     0.100E-01  5.00
 5 Biological decay coeff (1/yr)                                   0      0.000E+00 -999.     0.000E+00 -999.
END ARRAY

END LAYER  1
END UNSATURATED TRANSPORT PARAMETERS
END TRANSPORT MODEL
AQUIFER SPECIFIC VARIABLE DATA
ARRAY VALUES
***       AQUIFER SPECIFIC VARIABLES

***           VARIABLE NAME                UNITS               DISTRIBUTION   PARAMETERS            LIMITS
***                                                                           MEAN      STD DEV    MIN       MAX

*************************************************************************************************************************
 1 Particle diameter (cm)                                          0      0.500E-01 -999.     0.100E-08  100.
 2 Aquifer porosity                                                0      0.300     -999.     0.100E-08 0.990
 3 Bulk density (g/cc)                                             0       1.70     -999.     0.100E-01  5.00
 4 Aquifer thickness (m)                                           0       30.0     -999.     0.100E-08 0.100E+06
 5 Mixing zone depth (m)                                          -1      0.100     -999.     0.100E-08 0.100E+06
 6 Hydraulic conductivity (m/yr)                                   0       30.0     -999.     0.100E-06 0.100E+09
 7 Hydraulic Gradient                                              0      0.100E-01 -999.     0.100E-07 -999.
 8 Grndwater seep velocity (m/yr)                                 -1     -999.      -999.     0.100E-09 0.100E+09
 9 Retardation coefficient                                        -1       1.00     -999.      1.00     0.100E+09
10 Longitudinal dispersivity (m)                                  10       1.00     -999.     -999.     -999.
11 Transverse dispersivity (m)                                    10     -999.      -999.     0.100E-02 0.100E+05
12 Vertical dispersivity (m)                                      10     -999.      -999.     -999.     -999.
13 Temperature of aquifer (C)                                      0       20.0     -999.     0.000E+00  100.
14 pH                                                              0       7.00     -999.     0.300      14.0
15 Organic carbon content (fract)                                  0      0.000E+00 -999.     0.100E-05  1.00
16 Receptor distance from site(m)                                  0       1.00     -999.      1.00     -999.
17 Angle off center (degree)                                       0      0.000E+00 -999.     0.000E+00  360.
18 Z-dist from watertable (fract)                                  0      0.000E+00 -999.     0.000E+00  1.00
END ARRAY

END AQUIFER SPECIFIC VARIABLE DATA


END ALL DATA
```

1

U. S. E N V I R O N M E N T A L P R O T E C T I O N A G E N C Y

E X P O S U R E A S S E S S M E N T

M U L T I M E D I A M O D E L

MULTIMED (Version 1.01, June 1991)

1

Run options
--- -------

DEFAULT

CASE
Chemical simulated is DEFAULT CHEMICAL

```
Option Chosen                        Saturated and unsaturated zone models
Run was                              DETERMIN
Infiltration input by user
Run was transient
Reject runs if Y coordinate outside plume
Reject runs if Z coordinate outside plume
Gaussian source used in saturated zone model
```

1
1

```
UNSATURATED ZONE FLOW MODEL PARAMETERS
(input parameter description and value)
NP      - Total number of nodal points                 240
NMAT    - Number of different porous materials           1
KPROP   - Van Genuchten or Brooks and Corey              1
IMSHGN  - Spatial discretization option                  1
NVFLAYR - Number of layers in flow model                 1
```

OPTIONS CHOSEN
------- ------
Van Genuchten functional coefficients
User defined coordinate system

1

Layer information

LAYER NO.	LAYER THICKNESS	MATERIAL PROPERTY
1	183.00	1

DATA FOR MATERIAL 1
---- --- --------
VADOSE ZONE MATERIAL VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Saturated hydraulic conductivity	cm/hr	CONSTANT	0.170E-03	-999.	0.100E-10	0.100E+05
Unsaturated zone porosity	--	CONSTANT	0.230	-999.	0.100E-08	0.990
Air entry pressure head	m	CONSTANT	0.100	-999.	0.000E+00	-999.
Depth of the unsaturated zone	m	CONSTANT	183.	-999.	0.100E-08	-999.

DATA FOR MATERIAL 1
---- --- --------
VADOSE ZONE FUNCTION VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Residual water content	--	CONSTANT	0.116	-999.	0.100E-08	1.00
Brook and Corey exponent,EN	--	CONSTANT	-999.	-999.	0.000E+00	10.0
ALFA coefficient	1/cm	CONSTANT	0.500E-02	-999.	0.000E+00	1.00
Van Genuchten exponent, ENN	--	CONSTANT	1.09	-999.	1.00	5.00

1

UNSATURATED ZONE TRANSPORT MODEL PARAMETERS

```
NLAY   - Number of different layers used              1
NTSTPS - Number of time values concentration calc    40
DUMMY  - Not presently used                           1
ISOL   - Type of scheme used in unsaturated zone      1
N      - Stehfest terms or number of increments      18
NTEL   - Points in Lagrangian interpolation           3
NGPTS  - Number of Gauss points                     104
NIT    - Convolution integral segments                2
IBOUND - Type of boundary condition                   2
ITSGEN - Time values generated or input               1
TMAX   - Max simulation time          --            0.0
WTFUN  - Weighting factor             --            1.2
```

OPTIONS CHOSEN
------- ------
Stehfest numerical inversion algorithm
Nondecaying pulse source
Computer generated times for computing concentrations
1

DATA FOR LAYER 1
---- --- -----
VADOSE TRANSPORT VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Thickness of layer	m	CONSTANT	183.	-999.	0.100E-08	-999.
Longitudinal dispersivity of layer	m	DERIVED	1.00	-999.	0.100E-02	0.100E+05
Percent organic matter	--	CONSTANT	0.000E+00	-999.	0.000E+00	100.
Bulk density of soil for layer	g/cc	CONSTANT	1.83	-999.	0.100E-01	5.00
Biological decay coefficient	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.

1

CHEMICAL SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Solid phase decay coefficient	1/yr	DERIVED	-999.	-999.	0.000E+00	0.100E+11
Dissolved phase decay coefficient	1/yr	DERIVED	-999.	-999.	0.000E+00	0.100E+11
Overall chemical decay coefficient	1/yr	DERIVED	-999.	-999.	0.000E+00	0.100E+11
Acid catalyzed hydrolysis rate	l/M-yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Neutral hydrolysis rate constant	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Base catalyzed hydrolysis rate	l/M-yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Reference temperature	C	CONSTANT	20.0	-999.	0.000E+00	100.
Normalized distribution coefficient	ml/g	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Distribution coefficient	--	DERIVED	-999.	-999.	0.000E+00	0.100E+11
Biodegradation coefficient (sat. zone)	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Air diffusion coefficient	cm2/s	CONSTANT	0.000E+00	-999.	0.000E+00	10.0
Reference temperature for air diffusion	C	CONSTANT	20.0	-999.	0.000E+00	100.
Molecular weight	g/M	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Mole fraction of solute	--	CONSTANT	0.000E+00	-999.	0.100E-08	1.00
Vapor pressure of solute	mm Hg	CONSTANT	0.000E+00	-999.	0.000E+00	100.
Henry`s law constant	atm-m^3/M	CONSTANT	0.000E+00	-999.	0.100E-09	1.00
Overall 1st order decay sat. zone	1/yr	DERIVED	0.000E+00	0.000E+00	0.000E+00	1.00
Not currently used		CONSTANT	-999.	-999.	0.000E+00	1.00
Not currently used		CONSTANT	-999.	-999.	0.000E+00	1.00

1

SOURCE SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	STD DEV	LIMITS MIN	MAX
Infiltration rate	m/yr	CONSTANT	0.107E-01	-999.	0.100E-09	0.100E+11
Area of waste disposal unit	m^2	CONSTANT	9.00	-999.	0.100E-01	-999.
Duration of pulse	yr	CONSTANT	0.100E+04	-999.	0.100E-08	-999.
Spread of contaminant source	m	DERIVED	-999.	-999.	0.100E-08	0.100E+11
Recharge rate	m/yr	CONSTANT	0.000E+00	-999.	0.000E+00	0.100E+11
Source decay constant	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Initial concentration at landfill	mg/l	CONSTANT	1.00	-999.	0.000E+00	-999.
Length scale of facility	m	DERIVED	-999.	-999.	0.100E-08	0.100E+11
Width scale of facility	m	DERIVED	-999.	-999.	0.100E-08	0.100E+11
Near field dilution		DERIVED	1.00	0.000E+00	0.000E+00	1.00

1

AQUIFER SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	STD DEV	LIMITS MIN	MAX
Particle diameter	cm	CONSTANT	0.500E-01	-999.	0.100E-08	100.
Aquifer porosity	--	CONSTANT	0.300	-999.	0.100E-08	0.990
Bulk density	g/cc	CONSTANT	1.70	-999.	0.100E-01	5.00
Aquifer thickness	m	CONSTANT	30.0	-999.	0.100E-08	0.100E+06
Source thickness (mixing zone depth)	m	DERIVED	0.100	-999.	0.100E-08	0.100E+06
Conductivity (hydraulic)	m/yr	CONSTANT	30.0	-999.	0.100E-06	0.100E+09
Gradient (hydraulic)		CONSTANT	0.100E-01	-999.	0.100E-07	-999.
Groundwater seepage velocity	m/yr	DERIVED	-999.	-999.	0.100E-09	0.100E+09
Retardation coefficient	--	DERIVED	1.00	-999.	1.00	0.100E+09
Longitudinal dispersivity	m	FUNCTION OF X	1.00	-999.	-999.	-999.
Transverse dispersivity	m	FUNCTION OF X	-999.	-999.	0.100E-02	0.100E+05
Vertical dispersivity	m	FUNCTION OF X	-999.	-999.	-999.	-999.
Temperature of aquifer	C	CONSTANT	20.0	-999.	0.000E+00	100.
pH	--	CONSTANT	7.00	-999.	0.300	14.0
Organic carbon content (fraction)		CONSTANT	0.000E+00	-999.	0.100E-05	1.00
Well distance from site	m	CONSTANT	1.00	-999.	1.00	-999.
Angle off center	degree	CONSTANT	0.000E+00	-999.	0.000E+00	360.
Well vertical distance	m	CONSTANT	0.000E+00	-999.	0.000E+00	1.00

1

TIME	CONCENTRATION
0.200E+04	0.00000E+00
0.210E+04	0.00000E+00
0.220E+04	0.00000E+00
0.230E+04	0.00000E+00
0.240E+04	0.00000E+00
0.250E+04	0.00000E+00
0.260E+04	0.00000E+00
0.270E+04	0.00000E+00
0.280E+04	0.00000E+00
0.290E+04	0.00000E+00
0.300E+04	0.00000E+00
0.310E+04	0.00000E+00
0.320E+04	0.00000E+00
0.330E+04	0.32510E-01
0.340E+04	0.70180E-01
0.350E+04	0.11146E+00
0.360E+04	0.15214E+00
0.370E+04	0.19039E+00
0.380E+04	0.22435E+00
0.390E+04	0.25200E+00
0.400E+04	0.27285E+00
0.410E+04	0.28643E+00
0.420E+04	0.29290E+00
0.430E+04	0.29275E+00
0.440E+04	0.28668E+00

TRIAL 3
MULTIMED INPUT AND OUTPUT FILES

```
DEFAULT
CASE


GENERAL DATA

***  CHEMICAL NAME FORMAT(80A1)
DEFAULT CHEMICAL

***    ISOURC                            ROUTE      NT        IYCHK   PALPH      APPTYP
***OPTION   OPTAIR  RUN              MONTE    ISTEAD     IOPEN     IZCHK     LANDF   COMPLETE
    2    0    0     DETERMINISTIC    500    1    0   25    1    0    0 90.0    0    1    1


***   XST


*** TIME STEPPING PARAMETERS FOR SATURATED ZONE MODEL
 2500.00   2550.00   2600.00   2650.00   2700.00   2750.00   2800.00   2850.00   2900.00   2950.00
 3000.00   3050.00   3100.00   3150.00   3200.00   3250.00   3300.00   3350.00   3400.00   3450.00
 3500.00   3550.00   3600.00   3650.00   3700.00

END GENERAL

CHEMICAL SPECIFIC VARIABLE DATA
ARRAY VALUES
***      CHEMICAL SPECIFIC VARIABLES

***            VARIABLE NAME                UNITS               DISTRIBUTION   PARAMETERS           LIMITS
***                                                                           MEAN      STD DEV    MIN      MAX

***********************************************************************************************************************
 1 Solid phase decay coeff (1/yr)                                  -1      -999.     -999.     0.000E+00 0.100E+11
 2 Diss phase decay coeff (1/yr)                                   -1      -999.     -999.     0.000E+00 0.100E+11
 3 Overall chem dcy coeff (1/yr)                                   -1      -999.     -999.     0.000E+00 0.100E+11
 4 Acid cataly hydrol rte(l/M-yr)                                   0      0.000E+00 -999.     0.000E+00 -999.
 5 Neutral hydrol rate cons(1/yr)                                   0      0.000E+00 -999.     0.000E+00 -999.
 6 Base cataly hydrol rte(l/M-yr)                                   0      0.000E+00 -999.     0.000E+00 -999.
 7 Reference temperature (C)                                        0       20.0     -999.     0.000E+00  100.
 8 Normalized distrib coeff(ml/g)                                   0      0.000E+00 -999.     0.000E+00 -999.
 9 Distribution coefficient                                        -1      -999.     -999.     0.000E+00 0.100E+11
10 Biodegrad coef(sat zone)(1/yr)                                   0      0.000E+00 -999.     0.000E+00 -999.
11 Air diffusion coeff (cm2/s)                                      0      0.000E+00 -999.     0.000E+00  10.0
12 Ref temp for air diffusion (C)                                   0       20.0     -999.     0.000E+00  100.
13 Molecular weight (g/mole)                                        0      0.000E+00 -999.     0.000E+00 -999.
14 Mole fraction of solute                                          0      0.000E+00 -999.     0.100E-08  1.00
15 Solute vapor pressure (mm Hg)                                    0      0.000E+00 -999.     0.000E+00  100.
16 Henry`s law cons (atm-m^3/M)                                     0      0.000E+00 -999.     0.100E-09  1.00
17 Not in use                                                       0      -999.     -999.     0.000E+00  1.00
18 Not in use                                                       0      -999.     -999.     0.000E+00  1.00
19 Not in use                                                       0      -999.     -999.     0.000E+00  1.00
END ARRAY

END CHEMICAL SPECIFIC VARIABLE DATA



SOURCE SPECIFIC VARIABLE DATA
ARRAY VALUES
***        SOURCE SPECIFIC VARIABLES

***            VARIABLE NAME                UNITS               DISTRIBUTION   PARAMETERS           LIMITS
***                                                                           MEAN      STD DEV    MIN      MAX

***********************************************************************************************************************
 1 Infiltration rate (m/yr)                                         0      0.150E-01 -999.     0.100E-09 0.100E+11
 2 Area of waste disp unit (m^2)                                    0       9.00     -999.     0.100E-01 -999.
 3 Duration of pulse (yr)                                           0      0.100E+04 -999.     0.100E-08 -999.
 4 Spread of contaminant srce (m)                                  -1      -999.     -999.     0.100E-08 0.100E+11
 5 Recharge rate (m/yr)                                             0      0.000E+00 -999.     0.000E+00 0.100E+11
 6 Source decay constant (1/yr)                                     0      0.000E+00 -999.     0.000E+00 -999.
 7 Init conc at landfill (mg/l)                                     0       1.00     -999.     0.000E+00 -999.
 8 Length scale of facility (m)                                    -1      -999.     -999.     0.100E-08 0.100E+11
 9 Width scale of facility (m)                                     -1      -999.     -999.     0.100E-08 0.100E+11
END ARRAY

END SOURCE SPECIFIC VARIABLE DATA



VFL   UNSATURATED FLOW MODEL PARAMETERS


CONTROL PARAMETERS
***    DUMMY     NMAT      KPROP     DUMMY    NVFLAY
         7         1         1         1         1


END CONTROL PARAMETERS
SATURATED MATERIAL PROPERTY PARAMETERS
ARRAY VALUES
***   SATURATED MATERIAL   VARIABLES

***            VARIABLE NAME                UNITS               DISTRIBUTION   PARAMETERS           LIMITS
***                                                                           MEAN      STD DEV    MIN      MAX

***********************************************************************************************************************
 1 Sat hydraulic conduct (cm/hr)                                    0      0.360E-01 -999.     0.100E-10 0.100E+05
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 2 Unsaturated zone porosity                                         0      0.300     -999.     0.100E-08 0.990
 3 Air entry pressure head (m)                                       0      0.100     -999.     0.000E+00 -999.
 4 Depth of the unsat zone (m)                                       0       1.00     -999.     0.100E-08 -999.
END ARRAY

END MATERIAL  1
END
SOIL MOISTURE PARAMETERS
***   FUNCTIONAL COEFFICIENTS
ARRAY VALUES
***   FUNCTIONAL COEFFICIE VARIABLES

***           VARIABLE NAME                UNITS               DISTRIBUTION   PARAMETERS            LIMITS
***                                                                          MEAN      STD DEV    MIN      MAX

************************************************************************************************************************
 1 Residual water content                                            0      0.116     -999.     0.100E-08  1.00
 2 Brooks and Corey exponent, EN                                     0      -999.     -999.     0.000E+00  10.0
 3 ALFA van Genuchten coefficient                                    0      0.500E-02 -999.     0.000E+00  1.00
 4 BETA Van Genuchten coefficient                                    0       1.09     -999.      1.00      5.00
END ARRAY

END MATERIAL  1
END
END UNSATURATED FLOW



VTP    UNSATURATED TRANSPORT MODEL
CONTROL PARAMETERS
***   NLAY     DUMMY      IADU      ISOL         N      NTEL     NGPTS       NIT     DUMMY     DUMMY
         1        20         1         1        18         3       104         2         1         1
***  WTFUN
     1.200


END CONTROL PARAMETERS
TRANSPORT PARAMETER
ARRAY VALUES
***   UNSATURATED TRANSPOR VARIABLES

***           VARIABLE NAME                UNITS               DISTRIBUTION   PARAMETERS            LIMITS
***                                                                          MEAN      STD DEV    MIN      MAX

************************************************************************************************************************
 1 Thickness of layer (m)                                            0       1.00     -999.     0.100E-08 -999.
 2 Longit disper of layer (m)                                       -1       1.00     -999.     0.100E-02 0.100E+05
 3 Percent organic matter                                            0      0.000E+00 -999.     0.000E+00  100.
 4 Bulk dens of soil layer (g/cc)                                    0       1.70     -999.     0.100E-01  5.00
 5 Biological decay coeff (1/yr)                                     0      0.000E+00 -999.     0.000E+00 -999.
END ARRAY

END LAYER  1
END UNSATURATED TRANSPORT PARAMETERS
END TRANSPORT MODEL
AQUIFER SPECIFIC VARIABLE DATA
ARRAY VALUES
***       AQUIFER SPECIFIC VARIABLES

***           VARIABLE NAME                UNITS               DISTRIBUTION   PARAMETERS            LIMITS
***                                                                          MEAN      STD DEV    MIN      MAX

************************************************************************************************************************
 1 Particle diameter (cm)                                            0      0.500E-01 -999.     0.100E-08  100.
 2 Aquifer porosity                                                  0      0.300     -999.     0.100E-08 0.990
 3 Bulk density (g/cc)                                               0       1.70     -999.     0.100E-01  5.00
 4 Aquifer thickness (m)                                             0       3.00     -999.     0.100E-08 0.100E+06
 5 Mixing zone depth (m)                                            -1      0.100     -999.     0.100E-08 0.100E+06
 6 Hydraulic conductivity (m/yr)                                     0       3.15     -999.     0.100E-06 0.100E+09
 7 Hydraulic Gradient                                                0      0.100E-01 -999.     0.100E-07 -999.
 8 Grndwater seep velocity (m/yr)                                   -1      -999.     -999.     0.100E-09 0.100E+09
 9 Retardation coefficient                                          -1       1.00     -999.      1.00     0.100E+09
10 Longitudinal dispersivity (m)                                    10       1.00     -999.     -999.     -999.
11 Transverse dispersivity (m)                                      10      -999.     -999.     0.100E-02 0.100E+05
12 Vertical dispersivity (m)                                        10      -999.     -999.     -999.     -999.
13 Temperature of aquifer (C)                                        0       20.0     -999.     0.000E+00  100.
14 pH                                                                0       7.00     -999.     0.300      14.0
15 Organic carbon content (fract)                                    0      0.000E+00 -999.     0.100E-05  1.00
16 Receptor distance from site(m)                                    0      0.112E+04 -999.      1.00     -999.
17 Angle off center (degree)                                         0      0.000E+00 -999.     0.000E+00  360.
18 Z-dist from watertable (fract)                                    0      0.000E+00 -999.     0.000E+00  1.00
END ARRAY

END AQUIFER SPECIFIC VARIABLE DATA


END ALL DATA
```

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1

                      U. S.   E N V I R O N M E N T A L   P R O T E C T I O N   A G E N C Y

                                      E X P O S U R E   A S S E S S M E N T

                                         M U L T I M E D I A   M O D E L

                                       MULTIMED  (Version 1.01, June 1991)
1
 Run options
 --- -------



 DEFAULT


 CASE
 Chemical simulated is DEFAULT CHEMICAL


 Option Chosen                        Saturated and unsaturated zone models
 Run was                              DETERMIN
 Infiltration input by user
 Run was transient
 Reject runs if Y coordinate outside plume
 Reject runs if Z coordinate outside plume
 Gaussian source used in saturated zone model
1
1
 UNSATURATED ZONE FLOW MODEL PARAMETERS
 (input parameter description and value)
 NP      - Total number of nodal points                240
 NMAT    - Number of different porous materials          1
 KPROP   - Van Genuchten or Brooks and Corey             1
 IMSHGN  - Spatial discretization option                 1
 NVFLAYR - Number of layers in flow model                1


 OPTIONS CHOSEN
 ------- ------
 Van Genuchten functional coefficients
 User defined coordinate system
1


 Layer information
 -----------------
 LAYER NO.    LAYER THICKNESS     MATERIAL PROPERTY
 ---------    ---------------     -----------------
     1                 1.00            1

                                                DATA FOR MATERIAL  1
                                                ---- --- --------
                                            VADOSE ZONE MATERIAL VARIABLES
```

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Saturated hydraulic conductivity	cm/hr	CONSTANT	0.360E-01	-999.	0.100E-10	0.100E+05
Unsaturated zone porosity	--	CONSTANT	0.300	-999.	0.100E-08	0.990
Air entry pressure head	m	CONSTANT	0.100	-999.	0.000E+00	-999.
Depth of the unsaturated zone	m	CONSTANT	1.00	-999.	0.100E-08	-999.

DATA FOR MATERIAL 1
---- --- --------
VADOSE ZONE FUNCTION VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Residual water content	--	CONSTANT	0.116	-999.	0.100E-08	1.00
Brook and Corey exponent,EN	--	CONSTANT	-999.	-999.	0.000E+00	10.0
ALFA coefficient	1/cm	CONSTANT	0.500E-02	-999.	0.000E+00	1.00
Van Genuchten exponent, ENN	--	CONSTANT	1.09	-999.	1.00	5.00

1

UNSATURATED ZONE TRANSPORT MODEL PARAMETERS

NLAY	- Number of different layers used		1
NTSTPS	- Number of time values concentration calc		40
DUMMY	- Not presently used		1
ISOL	- Type of scheme used in unsaturated zone		1
N	- Stehfest terms or number of increments		18
NTEL	- Points in Lagrangian interpolation		3
NGPTS	- Number of Gauss points		104
NIT	- Convolution integral segments		2
IBOUND	- Type of boundary condition		2
ITSGEN	- Time values generated or input		1
TMAX	- Max simulation time	--	0.0
WTFUN	- Weighting factor	--	1.2

OPTIONS CHOSEN
------- ------
Stehfest numerical inversion algorithm
Nondecaying pulse source
Computer generated times for computing concentrations
1

DATA FOR LAYER 1
---- --- -----
VADOSE TRANSPORT VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Thickness of layer	m	CONSTANT	1.00	-999.	0.100E-08	-999.
Longitudinal dispersivity of layer	m	DERIVED	1.00	-999.	0.100E-02	0.100E+05
Percent organic matter	--	CONSTANT	0.000E+00	-999.	0.000E+00	100.
Bulk density of soil for layer	g/cc	CONSTANT	1.70	-999.	0.100E-01	5.00
Biological decay coefficient	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.

1

CHEMICAL SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Solid phase decay coefficient	1/yr	DERIVED	-999.	-999.	0.000E+00	0.100E+11
Dissolved phase decay coefficient	1/yr	DERIVED	-999.	-999.	0.000E+00	0.100E+11
Overall chemical decay coefficient	1/yr	DERIVED	-999.	-999.	0.000E+00	0.100E+11
Acid catalyzed hydrolysis rate	l/M-yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Neutral hydrolysis rate constant	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Base catalyzed hydrolysis rate	l/M-yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Reference temperature	C	CONSTANT	20.0	-999.	0.000E+00	100.
Normalized distribution coefficient	ml/g	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Distribution coefficient	--	DERIVED	-999.	-999.	0.000E+00	0.100E+11
Biodegradation coefficient (sat. zone)	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Air diffusion coefficient	cm2/s	CONSTANT	0.000E+00	-999.	0.000E+00	10.0
Reference temperature for air diffusion	C	CONSTANT	20.0	-999.	0.000E+00	100.
Molecular weight	g/M	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Mole fraction of solute	--	CONSTANT	0.000E+00	-999.	0.100E-08	1.00
Vapor pressure of solute	mm Hg	CONSTANT	0.000E+00	-999.	0.000E+00	100.
Henry`s law constant	atm-m^3/M	CONSTANT	0.000E+00	-999.	0.100E-09	1.00
Overall 1st order decay sat. zone	1/yr	DERIVED	0.000E+00	0.000E+00	0.000E+00	1.00
Not currently used		CONSTANT	-999.	-999.	0.000E+00	1.00
Not currently used		CONSTANT	-999.	-999.	0.000E+00	1.00

1

SOURCE SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Infiltration rate	m/yr	CONSTANT	0.150E-01	-999.	0.100E-09	0.100E+11
Area of waste disposal unit	m^2	CONSTANT	9.00	-999.	0.100E-01	-999.
Duration of pulse	yr	CONSTANT	0.100E+04	-999.	0.100E-08	-999.
Spread of contaminant source	m	DERIVED	-999.	-999.	0.100E-08	0.100E+11
Recharge rate	m/yr	CONSTANT	0.000E+00	-999.	0.000E+00	0.100E+11
Source decay constant	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Initial concentration at landfill	mg/l	CONSTANT	1.00	-999.	0.000E+00	-999.
Length scale of facility	m	DERIVED	-999.	-999.	0.100E-08	0.100E+11
Width scale of facility	m	DERIVED	-999.	-999.	0.100E-08	0.100E+11
Near field dilution		DERIVED	1.00	0.000E+00	0.000E+00	1.00

1

AQUIFER SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Particle diameter	cm	CONSTANT	0.500E-01	-999.	0.100E-08	100.
Aquifer porosity	--	CONSTANT	0.300	-999.	0.100E-08	0.990
Bulk density	g/cc	CONSTANT	1.70	-999.	0.100E-01	5.00
Aquifer thickness	m	CONSTANT	3.00	-999.	0.100E-08	0.100E+06
Source thickness (mixing zone depth)	m	DERIVED	0.100	-999.	0.100E-08	0.100E+06
Conductivity (hydraulic)	m/yr	CONSTANT	3.15	-999.	0.100E-06	0.100E+09
Gradient (hydraulic)		CONSTANT	0.100E-01	-999.	0.100E-07	-999.
Groundwater seepage velocity	m/yr	DERIVED	-999.	-999.	0.100E-09	0.100E+09
Retardation coefficient	--	DERIVED	1.00	-999.	1.00	0.100E+09
Longitudinal dispersivity	m	FUNCTION OF X	1.00	-999.	-999.	-999.
Transverse dispersivity	m	FUNCTION OF X	-999.	-999.	0.100E-02	0.100E+05
Vertical dispersivity	m	FUNCTION OF X	-999.	-999.	-999.	-999.
Temperature of aquifer	C	CONSTANT	20.0	-999.	0.000E+00	100.
pH	--	CONSTANT	7.00	-999.	0.300	14.0
Organic carbon content (fraction)		CONSTANT	0.000E+00	-999.	0.100E-05	1.00
Well distance from site	m	CONSTANT	0.112E+04	-999.	1.00	-999.
Angle off center	degree	CONSTANT	0.000E+00	-999.	0.000E+00	360.
Well vertical distance	m	CONSTANT	0.000E+00	-999.	0.000E+00	1.00

1

TIME	CONCENTRATION
0.250E+04	0.12624E-05
0.255E+04	0.15473E-05
0.260E+04	0.18805E-05
0.265E+04	0.22674E-05
0.270E+04	0.27134E-05
0.275E+04	0.32238E-05
0.280E+04	0.38042E-05
0.285E+04	0.44601E-05
0.290E+04	0.51968E-05
0.295E+04	0.60195E-05
0.300E+04	0.69333E-05
0.305E+04	0.79430E-05
0.310E+04	0.90529E-05
0.315E+04	0.10267E-04
0.320E+04	0.11589E-04
0.325E+04	0.13023E-04
0.330E+04	0.14571E-04
0.335E+04	0.16234E-04
0.340E+04	0.18016E-04
0.345E+04	0.19917E-04
0.350E+04	0.21938E-04
0.355E+04	0.24079E-04
0.360E+04	0.26340E-04
0.365E+04	0.28719E-04
0.370E+04	0.31216E-04

*** WARNING *** Near field mixing factor is greater than 1.
Mixing factor = 1.14

APPENDIX D
CERTIFICATION OF SUSPENSION
REQUEST DEMONSTRATION

Certification of suspension request demonstration:

I hereby state that, to the best of my professional judgement, the information provided in this request for suspension of groundwater monitoring requirements for Triassic Park Facility landfill is accurate and complete and the request includes a demonstration that there is limited potential for migration of hazardous constituents from the landfill to the uppermost aquifer during the active life of the landfill and the post-closure care period and the demonstration is based upon:

1. site-specific field measurements, sampling, and analysis of physical, chemical, and biological processes affecting contaminant fate and transport; and,

2. contaminant fate and transport predictions that maximize contaminant migration and consider impacts on public health, welfare and environment.

____

____________Signed____________

1/25/2000_____
Date

Signature of qualified* groundwater scientist

___David_Ellerbroek_________________

____

Printed Name

____

__________Signed______________

1/24/2000_____
Date

Signature of qualified* groundwater scientist

_____Patrick_Corser_________________

____

Printed Name

*Resumes are attached that demonstrates conformity with §105.AG

DAVID A. ELLERBROEK, Ph.D
SENIOR HYDROGEOLOGIST/GEOCHEMIST

EDUCATION:

Ph.D., Environmental Engineering, Colorado State University
M.S., Environmental Science, Colorado School of Mines
B.S., Geophysics, University of Colorado

SUMMARY:

Dr. Ellerbroek is responsible for conducting hydrological and geochemical investigations in support of mining, environmental and engineering projects. His background includes 14 years experience in mining and multidisciplinary environmental projects. Particular areas of expertise include groundwater hydrology, geochemistry, analysis of acid rock drainage (ARD) potential in tailings and waste rock, unsaturated flow modeling, reactive transport modeling, geostatistics and investigation of water and solute movement through constructed landforms such as tailings dams, waste rock dumps and mine pit lakes. Dr. Ellerbroek has conducted several large environmental programs for mining clients including evaluation of saturation and sulfide oxidation rates in partially-saturated tailings, predicting long-term water quality in seepage from tailings dams, developing cover systems to limit ARD from tailings and evaluating waste rock geochemistry. He has presented several papers on these subjects at conferences and in referred journals. International project experience includes Australia, Chile, China, Indonesia, Peru, Romania and the United Kingdom.

MINING EXPERIENCE

Senior Geochemist, Thompson Creek Mining, Supplemental Environmental Impact Statement, USA
Performed numeric modeling to predict long-term water quality in seepage from the tailing impoundment and embankment. Reviewed data from static and kinetic geochemical testing to predict the potential for the development of ARD. Modeled potential impacts to surface water quality from ARD for the No-Action and Proposed-Action Alternatives. Reviewed all geochemical information for the EIS and developed sections of the EIS concerned with geochemistry and water quality.

Project Manager/Senior Geochemist and Hydrogeologist, Southern Peru Limited, Torata Flood Control Project, Peru
Managed production of the Environmental Impact Assessment for the Torata Flood Control Project. Developed geochemical and hydrogeologic programs in support of the Torata Flood Control Project. Developed a geochemical testing program for waste rock at the site that was presented to and approved by the Ministry of Energy and Mines. Performed water balance and unsaturated flow modeling to estimate infiltration rates through waste rock. Investigated hydrologic and geochemical issues associated with pit expansion, river diversion and storage of mine waste. Developed a groundwater characterization program in support of the river diversion and pit expansions studies.

Project Manager/ Senior Geochemist and Hydrogeologist, Southern Peru Copper, Toquepala Baseline and Environmental Impact Studies, Peru
Managed production of two environmental impact assessments for expansion of the SX/EW facility and waste dump leaching at the Toquepala Mine. Developed a geochemical testing program for characterizing ARD potential from waste rock. Data generated from of these studies were used to evaluate potential impacts from ARD and waste rock seepage to downgradient water quality. Evaluated mitigation strategies for ARD at the site.

Senior Geochemist, Third Party EIS, McDonald Gold Project, Montana, USA
Reviewed data predicting waste rock seepage rates and acid rock drainage potential from waste rock and tailings. Evaluated geochemical issues associated with disposal of pit water, land application areas and pit lake water quality. Assisted in production of reports detailing background geochemistry, water quality and ARD potential at the site.

Senior Hydrogeologist/Geochemist, Renison Bell Tin Mine, Evaluation of Close-out Options for Sulfidic Tailings, Tasmania, Australia.
Investigated close-out options for three sulfidic tailings dams. Responsibilities included design and performance of hydrochemical studies to evaluate sulfide oxidation rates, water balance and factors determining water quality in the tailings dam system. Conducted unsaturated flow modeling to evaluate the effectiveness of a wet cover to minimize oxygen diffusion and sulfide oxidation in the tailings. Modeled oxygen diffusion and sulfide oxidation in the tailings for a range of climatic conditions and different cover designs. This site represents the first attempt to design a wet cover for mitigation of sulfidic tailings in Australia.

Senior Geochemist, CDE Chilean Mining Corporation, Furioso Geochemical Studies, Chile (in progress)
Developed a geochemical testing program for the Furioso Environmental Impact Statement. Developed a testing program based on static and kinetic geochemical testing to meet Chilean requirements. Reviewed geochemical and geologic data to predict the potential for development of ARD from tailings and waste rock at the site.

Senior Hydrogeologist/Geochemist, BHP Coal, Hydrology of Final Voids, Queensland, Australia.
Investigated water and solute movement in coal spoil to develop strategies for long term management of water (both quantity and quality) in final voids created by coal mining. Developed a groundwater flow model for the coal spoil and final void system. Performed unsaturated flow modeling for coal spoil to evaluate recharge rates to the final void. Evaluated solute mobilization and transport in the spoil using results from column and batch leach tests. Assessed the potential mobility of selenium, arsenic and molybdenum in the subsurface based on groundwater modeling and column leach test results.

Senior Hydrologist/Geochemist, Western Mining Company, Tailings Dam Close-out Options, Western Australia.
Provided technical review and support to evaluate close-out options for sulfidic tailings. Provided third party review of the site characterization program and results. Evaluated

alternative mitigation strategies with respect to hydrochemical impacts and water quality. Assisted in design of a revised characterization study.

Project Manager/Senior Hydrologist, Hamersley Iron Pty, Ltd., Pit Lake Hydrology and Water Quality, Western Australia.
Developed a program to review pit lake modeling practices in the United States and performed numeric modeling to estimate water quality in the Yandi Pit in the Pilbara region of Western Australia. Reviewed several studies of pit lake modeling including Gold Quarry, Goldstrike and Twin Creek Mines. These studies were used to assist Hamersley in design of their pit lake modeling program. Meet with regulators to discuss regulations pertaining to pit lake quality and re-injection of water from pit dewatering.

Project Manager/Senior Hydrogeologist, Jabiluka Uranium Mine, Boyweg Groundwater Investigation, Northern Territory, Australia.
Performed a hydrogeologic characterization and groundwater modeling study to investigate potential impacts from dewatering of the Jabiluka Mine on the Boyweg Site which is an aboriginal sacred site. Developed a conceptual hydrogeologic model for the region based on hydraulic and geochemical data and used this model to estimate potential impacts from dewatering at the mine.

Project Manager/Senior Hydrologist, Ranger Uranium Mine, Hydrogeologic Characterization, Northern Territory, Australia.
Developed a program to investigate the hydrologic and geochemical consequences of tailings storage in mine pits. Reviewed all previous hydrologic investigations and designed a program for hydrologic characterization of the overall site. Investigated surface water and groundwater interaction in support of the hydrologic characterization and tailings storage programs. Assisted in writing sections of the Environmental Impact Statement for the Jabiluka project concerning tailings disposal and hydrogeologic issues.

Research Scientist, Australian Centre for Minesite Rehabilitation Research. Brisbane, Australia.
Presented a lecture discussing management options and factors controlling water quality in mine pit lakes to mining industry representatives. Issues which were discussed included predicting long term water quality and the water balance of mine pit lakes. The lecture also covered relevant examples from Australia and factors for consideration during design of field monitoring studies.

Senior Hydrologist, Worsley Aluminum Company. Western Australia.
Designed a study to evaluate sources of water in underground mine workings using groundwater dating techniques.

Senior Hydrologist, P.T. Freeport Indonesia, Irian Jaya, Indonesia.
Designed and performed hydrologic and geochemical studies of tailings transport in a river system. Assisted in preparation of the ANDAL. Designed, operated, and maintained automated data collection stations for collection of hydrologic and meteorological data. Evaluated environmental impacts from riverine disposal of tailings including the fate and transport of metals in the river system and performed geochemical modeling.

Research Scientist, Chinese Academy of Science, Peoples Republic of China.
Participated in a scientific exchange between the Peoples Republic of China and Australia to evaluate the long term hydrologic consequences of coal mining. Developed a research program to investigate issues associated with subsidence and impacts to groundwater from coal mining.

Project Hydrologist, Bureau of Land Management, Circle Mining District,. Alaska.
Performed field studies evaluating the geomorphology and water quality of placer mined streams. Measured and compared geomorphologic and water quality parameters in watersheds with and without mining. Developed hydrologic criteria for rehabilitation of placer mined streams.

Research Assistant, United States Geological Survey, Tennessee Park, Colorado.
Assisted in development of a groundwater and water quality monitoring program to characterize hydrochemical processes in a natural wetland receiving acid mine drainage. Installed piezometers and collected water quality samples.

Research Assistant, Colorado School of Mines, Golden, Colorado.
Assisted with various projects evaluating the ability of natural and man-made wetlands to attenuate metals and acidity associated with acid mine drainage. Worked on field surveys, collected and analyzed water quality samples, and performed microbiological testing.

ENVIRONMENTAL EXPERIENCE

Project Manager/Geostatistian, Rocky Flats Soils Program, Golden, Colorado.
Managed the Soils Program at Rocky Flats and performed geostatistical studies to evaluate the spatial distribution of plutonium in soils surrounding the site. Performed probability kriging to determine probability of exceeding background and regulatory levels for plutonium in soils in and near the Rocky Flats Site. The probability kriging provided a risk-based approach for evaluating remediation options and potential exposure levels.

Project Manager, Hydrogeologic Characterization Report, Rocky Flats, Golden, Colorado.
Managed production of the Hydrogeologic Characterization Report for Rocky Flats including technical oversight of all work. Activities included description of the hydrogeologic setting, analyzing surface water and groundwater interaction, defining hydrostratigraphic units, and reviewing hydraulic data. The report incorporated all existing information to construct a conceptual hydrogeologic model that is used for remedial investigations and regulatory activities at the site.

Senior Hydrologist, Well Evaluation Report, Rocky Flats, Golden, Colorado.
Reviewed and assisted in writing chapters of the well evaluation report dealing with hydrology and geochemistry. The well evaluation report evaluated the groundwater monitoring network at Rocky Flats.

Senior Hydrologist/Statistician, RCRA Groundwater Monitoring Report, Rocky Flats, Golden, Colorado.
Developed statistical programs and supervised statistical analysis for the 1993 RCRA Groundwater Monitoring Report at Rocky Flats.

Senior Hydrogeologist, Hazardous Waste Landfill, New Mexico.
Assisted in evaluation of potential solute migration rates through a constructed liner and natural materials as part of a permit application for a hazardous waste landfill.

Project Manager/Senior Hydrogeologist, DNAPL Assessment, Confidential Client.
Evaluated historic waste management practices and monitored levels of Dense Non-Aqueous Liquids in groundwater in support of a property transfer. Presented results of the investigation to the legal department and Board of Directors.

Project Hydrologist, OU7 Hydrogeology, Rocky Flats, Golden, Colorado.
Characterized hydrogeologic conditions at the landfill at Rocky Flats (OU7) in support of the remedial investigation.

Project Hydrologist, OU11 Hydrogeology, Rocky Flats, Golden, Colorado.
Assisted in evaluation of hydrogeologic conditions at OU11 (Rocky Flats) in support of the remedial investigation.

Senior Hydrologist, Los Alamos NPDES Permit Application, Los Alamos, New Mexico.
Performed hydrologic and water quality assessments in support of the NPDES permit application including field characterization and modeling.

Project Hydrologist, Baseline Environmental Assessment, Romania.
Characterized and documented baseline hydrogeologic conditions and water quality in an exploration area for an international oil firm.

Project Manager, Contaminated Sites Assessment Program, United Kingdom.
Developed a contaminated sites assessment program for a client in the United Kingdom including soil and water sampling protocols.

Project Hydrologist, Glacier National Park Flood Assessment, Montana.
Performed field work, HEC2 modeling, and sediment transport analysis to support flood plain mapping.

Project Hydrologist, Gulkana National Wild and Scenic River, Alaska.
Performed field work and hydrologic modeling to support the application of the first instream flow water right in Alaska.

Project Hydrologist, Delat National Wild and Scenic River, Alaska.
Performed field work and hydrologic modeling to support the application for an instream flow water right.

Research Assistant, Agricultural Chemical in Groundwater, San Luis Valley, Colorado.
Conducted a two year study as part of dissertation research evaluating the occurrence of pesticides and nitrates in groundwater. Performed detailed unsaturated flow modeling describing the movement of pesticides in soil and the role of preferential flow processes. Conducted a stochastic analysis using Monte Carlo techniques to evaluate the relative importance of intrinsic and extrinsic sources of variability on pesticide transport. Evaluated the impact of best management practices on pesticide migration through the soil.

PUBLICATIONS / PRESENTATIONS:

Ellerbroek D.A., and D.R. Jones, 1997, Hydrochemical Characterization to Support Decommissioning of Sulfidic Tailings, Tailings and Mine Waste 97, Fort Collins, Colorado.

Ellerbroek, D.A., D.S. Durnford, and J.C. Loftis, 1998, Modeling Pesticide Transport in an Irrigated Field Soil with Varying Water Application and Hydraulic Conductivity, Journal of Environmental Quality, Vol.27 p. 796-825.

Jones, D.R., Ellerbroek, D.A., and L.R. Townley, 1997, The Hydrology and Water Quality of Final Mining Voids, 22nd Annual Minerals Council of Australia Environmental Workshop. Adelaide, S.A., Australia

Jones, D.R., Ellerbroek, D.A., Hajinakitas J., and D. Blowes, 1997, Coupled Hydrological and Geochemical Modeling to Assess the Performance of a Wet Cover for Tailings Close-Out, 22nd Annual Minerals Council of Australia Environmental Workshop. Adelaide, S.A., Australia

Jones, D.R., Ellerbroek, D.A., and H. Laszczyk, 1997, Evaluating Close-Out Options for Acid Generating, Tailings, Fourth International Conference on Acid Rock Drainage, Vancouver, Canada.

Ellerbroek D.A., D.R. Jones, and L.R. Townley, 1996, Managing the Hydrology and Water Quality of Final Voids After Mining, Workshop on Post-Mining Landform Stability and Design, Australian Centre for Minesite Rehabilitation Research, Brisbane, Australia.

Ellerbroek D.A., D.R. Jones, L.R. Townley, and J.C Eames, 1996, Hydrology and Geochemistry of Coal Spoil and Final Voids, <u>in</u> Subsurface Hydrologic Responses to Land Cover and Land Use Changes, edited by Makoto Taniguchi, Kluwer Academic Press.

Ellerbroek D.A., D.R. Jones, and L.R. Townley, 1996, Water and Solute Movement in Coal Spoil, Western Pacific Geophysics Meeting, Brisbane, Australia.

Ellerbroek, D.A., 1996 Review of Ranger Minesite Hydrology in Relation to Contaminant Transport (Technical Report for Energy Resources of Australia, Ltd.).

Litaor, M.I., D.A. Ellerbroek, and L.E. Allen, 1995, Comprehensive Appraisal of Plutonium-239+240 in Soils of Colorado: A Basis for Risk Analysis, Health Physics (69) 923-935

Ellerbroek, D.A., M.I. Litaor, and L.E. Allen, 1995 Assessment of Plutonium-239+240 Contamination in Soils near the former Rocky Flats Site using Nonparametric Geostatistics, International Conference on Modelling and Simulation, Newcastle, NSW, Australia.

Ellerbroek, D.A. and L.R. Townley, 1995, A review of processes affecting the water and solute balance of final voids, CSIRO Minesite Rehabilitation Research Program, Perth, Australia.

Townley L.R. and D.A. Ellerbroek, 1995, Review of Hydrologic Data at Possum Pit, CSIRO Minesite Rehabilitation Research Program, Perth, Australia.

Townley L.R. and D.A. Ellerbroek, 1995 Water Movement in the Possum Pit Transect, CSIRO Minesite Rehabilitation Research Program, Perth, Australia.

Department of Energy, 1995, Hydrogeologic Characterization Report for the Rocky Flats Site, Golden, Colorado (Project Manager).

Department of Energy, 1994, Well Evaluation Report for the Rocky Flats Site, Golden, Colorado (Chapters 3 and 4, Hydrogeology and Geochemistry).

Ellerbroek, D.A., D.S. Durnford, and C. Pearson, 1992 Monitoring Groundwater Quality in the San Luis Valley. Proceedings: Colorado Water Engineering and Management Conference. Published by the Colorado Water Resources Research Institute, Fort Collins, Colorado.

Ellerbroek, D.A., K.R. Thompson, D.S. Durnford, and S. Davies, 1991, Groundwater Pollution in the San Luis Valley. Proceedings: Colorado Water Engineering and Management Conference. Published by the Colorado Water Resources Research Institute, Fort Collins, Colorado.

PATRICK CORSER, P.E.
VICE PRESIDENT/DIRECTOR OF ENGINEERING

EDUCATION:

M.S., Civil Engineering, Northwestern University
B.S., Civil Engineering, University of Minnesota
Graduate Studies Cold Regions Engineering, University of Alaska, Anchorage, Alaska
Graduate Studies Construction Management, University of Washington, Seattle, Washington

REGISTRATION:

Professional Engineer: Alaska, Arizona, California, Colorado, Nevada, New Mexico, North Dakota, Oregon, Washington, Utah, and Wyoming

SUMMARY:

Mr. Corser is Vice President of Montgomery Watson and is responsible for all engineering studies performed for the Mining Division. Mr. Corser has over 20 years of practical engineering experience servicing the civil, environmental and mining business in the western United States and South America.

EXPERIENCE:

MINING

Project Manager, Cyprus Minerals Cerro Verde Mine, Peru.
Remedial investigation and re-design for leaking PLS Pond for Copper heap leach pad

Project Manager, Newmont Gold South Area Non-Property Heap Leach Pad Deformation Study, Nevada.
Remedial investigation into cause and mechanism for the slope deformation at the Phase II heap leach pad.

Project Director, BHP Old Dominion Mine, Arizona.
Site characterization, design, permitting and construction management for remediation of historic mine facilities. Impacts on surface water quality from tailings piles, waste rock piles, and abandon processing facilities was major issue at the site. Designs were required to preserve the historic character of the site and site address surface water quality issues.

Project Director, Addwest's Gold Road Mine Tailings Facility Expansion, Arizona.
Design, permitting, and construction monitoring for expansion of existing lined tailings facility.

Technical Reviewer, Vista Gold's Amayapampa Mine, Bolivia.
Design and permitting of water supply embankment and tailings facility. Embankment is 65 meters high and includes a concrete lined upstream face.

Technical Specialist, Southeast Idaho Phosphate Mine's Selenium Subcommittee, Idaho.
Site characterization, sampling, analysis and assessment of Se contamination in surface water, groundwater, soil and air from phosphate mining and processing activities. Facilities owned and/or operated by FMC, Monsanto, Agrium, Rhone-Poulenc, and Simplot.

Technical Reviewer, Minera Yanacocha Norte Waste Dump, Peru.
Stability investigation and conceptual designs for stabilization of waste dump over soft peats and clay. Work included field investigation, sampling and testing of foundation materials, stability evaluation and remedial and expansion design recommendations.

Project Manager, Coeur Alaska Inc. - Kensington Dry Tailings Facility, Alaska
Design review and development of cost estimates for alternative construction methods for dry tailings facility for Gold mine in SE Alaska.

Project Director, Various Coal Mines in Rocky Mountains, Colorado.
Reclamation and drainage and sediment control designs and permitting for various coalmines (Kerr, Raton Creek, Southfield, and Colowyo).

Project Manager, Rhone-Poulenc's Rasmussen Ridge Mine, Idaho.
Highwall stability evaluation in limestone hanging wall of Phosphate mine in SE Idaho

Project Manager, Rio Tinto Working Group, Rio Tinto Mine Remediation Project, Nevada.
Comprehensive, five year project to characterize and design remediation for and abandoned mine in northern Nevada. Four previous owners of the property (Cleveland-cliffs, DuPont, ARCO, Cominco) form the Rio Tinto Working Group. Tasks included site characterization, sampling and analysis of surface water and groundwater design, permitting and agency negotiations for remediation of the site and complete construction management services to implement the remediation.

Lead Engineer, Cyprus Mineral Park Application, Arizona.
Lead engineer in the BADCT design of sediment ponds and closure systems for waste rock stockpiles, tailings impoundment for the Cyprus Mineral Park facility located in northwest Arizona. Experience in completing both prescriptive and non-prescriptive BADCT designs.

Technical Reviewer and Resource Specialist, Barrick Gold, Tambo Project, Chile.
Design, Permitting, Construction Management and CQA work performed for multiple lined tailings embankments and impoundments in upper reaches of the Andes Mountains.

Construction Manager, Newmont Gold, Resurrection Project, Colorado.
Construction manager and design reviewer for all remedial construction associated with abandon mining facilities in Leadville, Colorado. Projects included tailings removal actions, tailings regrading and covering, portal discharged collection, piping and infiltration systems and surface water diversion structures and groundwater cutoff structures.

Program Manager, Newmont Gold, Idarado Project, Colorado.
Program Manager for the Idarado Mine Remediation Project in southern Colorado. Provided overall technical project management for this four year project including the removal of hazardous mine tailing, the design of surface water diversion structures, groundwater interceptor systems, portal plugs, portal discharge collection and infiltration systems, tailings remediation, including regrading and revegetation and the design and construction of closure and barrier layer systems. Provided complete construction designs, permitting, regulatory interaction, construction manpower loading, and cost control and provided overall technical oversight and budget management.

Project Manager, Choquelimpie Mine, Chile.
Project Manager for an assessment of remedial design alternatives for a leaking heap leach pad in central Chile. A risk-based analysis was used to evaluate the effectiveness of each alternative. In addition, probabilistic cost estimates were prepared for each alternative to determine the most cost-effective solution. Selected method consisted of groundwater collection and treatment system below pad in combination with surface water control structures.

Project Manager, Monticello Remedial Action Plan OU-1 Millsite Remediation, Utah.
Construction quality assurance and design assistance related to all geosynthetic components of the liner and cover systems for uranium tailings disposal facility. A staff of five to seven engineers were onsite for the duration of construction to perform engineering and construction monitoring tasks.

Project Manager, Cambior Alaska, Valdez Creek Mine, Alaska.
Field investigation, design and construction monitoring for 40-foot high geosynthetically lined tailings Pond Embankment.

Task Manager, Beartrack Heap Leach Project, Idaho.
Prepared final grading plan and cover design for heap leach facility. Analysis included stability erosion, surface water drainages, cover infiltration and overall water balance.

Project Engineer, Washington Irrigation and Development Company, Washington.
Perform investigations and designs for new reuse retention facilities for coal processing plant. Designs completed for new facilities as well as reclamation of completed facilities.

Project Manager, Usibelli Coal Mine, Alaska.
Project Manager for a risk based analysis that was used to evaluate the stability of in-pit spoil piles that were impacting current mining operations. Analyses were conducted to determine the risk of failure and the associated costs for remediation and impacts to the

ongoing operations. The model was also applied to the failing of excess spoil piles that required substantial remediation prior to satisfying regulatory criteria.

Project Engineer, Diamond Chuitna, Alaska.
Surface coalmine permit completeness review.

Project Engineer, State of Alaska, Alaska.
Coal mining reclamation program for seven sites within the Nenana Coal Field.

Project Manager, Usibelli Coal Mine, Alaska.
Poker Flats and Runaway Ridge highwall and spoil stability investigation and dewatering investigation.

Project Engineer, Bering River Coal, Alaska.
Geotechnical investigation and foundation design recommendation.

Project Engineer, Washington Irrigation Development Company, Washington.
Spoil pile stability study.

Project Engineer, Carter Coal, Wyoming.
Highwall and spoil pile stability study at surface coalmines.

Project Engineer, Getty Diatomite Mine, California.
Geotechnical and hydrological investigations and slope stability analysis.

Project Engineer, New Hope Prospect, Arkansas.
Highwall stability study.

Project Engineer, Los Bronces Expansion Project, Chile.
Field investigation for tailings dam design.

WASTE DISPOSAL AND WASTE CONTAINMENT DESIGN PROJECTS

Project Manager, Highway 36 Hazardous Waste Facility, Colorado.
Project manager for design and permitting of five new ten acre landfills, construction quality assurance monitoring for Secure Cell No. 2, closure design Secure Cell No. 1, Class 2 Permit Modification drawings, test fill design and construction monitoring.

Project Manager, Gandy-Marley Hazardous Waste Landfill, New Mexico.
Complete design and permitting services for new hazardous waste landfill and processing facilities in site in New Mexico.

Project Manager, Tower Road Landfill, Colorado.
Project Manager for the landfill expansion design study, site characterization and groundwater monitoring program, Subtitle D compliance demonstration study, and construction quality assurance monitoring.

Project Manager, Kettleman Hills Landfill B-18, California.
Project Manager for CQA program for 36 acres hazardous waste landfill including over 3 million square feet of geosynthetic liner.

Project Manager, Hidronor Industrial Hazardous Waste Landfill, Chile.
Design review, construction management and CQA of the first fully lined hazardous waste facility in Chile.

Project Manager, United Waste System's Jahner Landfill, North Dakota.
Site design and operations plan to expand and updated liner and leachate collection and removal system to meet Subtitle D standards.

Project Manager, Jackson County Landfill, Colorado.
Investigation and characterization of borrow sources to be used for liner and cover construction on MSW landfill.

Project Manager, Chemical Waste Management Inc.
Project Manager for a detailed risk based study to evaluate the most cost effective cover system to meet regulatory criteria, long term performance criteria, minimize capital costs, and minimize maintenance costs. The study included engineering evaluation from TerraMatrix as well as direct input from CWMI regulatory, operations, and financial staff.

Project Manager, Mesa County Orchard Mesa Landfill, Colorado.
Project Manager for a preliminary site compatibility study for a proposed expansion of the Orchard Mesa Landfill located in Grand Junction, Colorado.

Principal-In-Charge, Rio Blanco County, Colorado.
Siting study for a new MSW landfill, expansion of existing facility and closure of historic site.

Project Manager, Rocky Flats OU-7 Landfill, Colorado.
Project Manager for the closure design for existing hazardous and municipal waste landfill (OU-7) including final grading plan, gas collection and venting system design, cover design and slurry wall design. Construction level design drawings, specifications and CQA Plan were prepared.

Project Manager, Rocky Flats Low Level Mixed Waste Facility, Colorado.
Project Manager for the complete construction level design drawings for new five acre double lined landfill.

Project Manager, Kettleman Hills Facility, California.
Project Manager for a 2-year study of a failed landfill. Tasks included; development of immediate remedial measures to stabilize the waste and limit additional movement, design and implementation of a field and laboratory investigation program to determine the cause and mechanism of failures and the design of all final remedial measures for the failed cell.

- Project Manager for cover design for 70 acres of hazardous waste disposal area
- Project Manager for design for 46 acre hazardous waste landfill
- Project Manager. CQA services for 45 acre and 25-acre hazardous waste landfills.

Project Manager, Hanford Nuclear Reservation, Washington.
Project Manager for construction quality assurance observation and testing for lining of 2 two million-gallon purge tanks.

Project Manager, Marsh Canyon Landfill, California.
Project Manager for final design of 90 million cubic yard municipal landfill.

Project Manager, Hanford Nuclear Reservation, W-025 Landfill, Washington.
Project Manager, for design of first RCRA compliant radioactive mixed waste landfill.

Project Engineer, Merrill Field Landfill, Anchorage.
Geotechnical evaluation and closure design.

Project Manager, INEL, Idaho.
Cover design and remedial measures for mixed waste landfills.

Project Engineer, Anchorage Regional Landfill, Alaska.
Geotechnical evaluation of subsurface conditions, development of excavation plan and lining and leachate collection system options. Design and installation of groundwater monitoring wells.

Project Engineer, Arlington RCRA Landfill, Oregon.
Design for covers for RCRA landfills and review of construction quality assurance testing for construction of a new landfill cell and various covers.

Project Manager, Kodiak Island Landfill, Alaska.
Closure design and new cell design.

Project Engineer, Midway Landfill, Washington.
Geotechnical evaluation and conceptual closure design.

Construction Manager, Newmont Gold, Resurrection Project, Colorado.
Construction manager and design reviewer for all remedial construction associated with abandon mining facilities in Leadville, Colorado. Projects included tailings removal actions, tailings regrading and covering, portal discharged collection, piping and infiltration systems and surface water diversion structures and groundwater cutoff structures. Remedial construction valued at over $7 million.

Program Manager, Newmont Gold, CERCLA Idarado Project, Colorado.
Program Manager for the Idarado CERCLA mine remediation Project in southern Colorado. Provided overall technical project management for this four year project including the removal of hazardous mine tailing, the design of surface water diversion structures, groundwater interceptor systems, portal plugs, portal discharge collection and infiltration systems, tailings remediation, including regrading and revegetation and the design and construction of closure and barrier layer systems. Provided complete construction designs, permitting, regulatory interaction, construction manpower loading, and cost control and provided overall technical oversight and budget management. Total construction valued at over $20 million.

Project Manager and Geosynthetic Design Consultant, DOE Monticello Uranium Tailings Disposal Facility, Utah.
Provide design recommendations for geosynthetic aspects of liner and cover system for uranium tailings disposal facility at DOE site in Utah. In addition, supervised the construction quality assurance observation and testing program for installation of liner and cover system. Project involved mobilization of project team to the DOE facility for nine-month duration during construction of the liner system. Designs included triple lined evaporation pond with multiple GCL layers and double lined repository liner with a GCL in both the primary and secondary liner system.

Project Manager, Mesa County Landfill Alternative Cover Studies, Colorado.
Designed and conducted a program to assess the performance of alternative cover design on water movement in the unsaturated zone. The objective of this study is to provide information that can be used by the regulatory community to approve cover designs based on output from simulations of unsaturated flow. The study will define and provide performance criteria for model calibration that will describe the use of unsaturated flow models (e.g. SoilCover) to validate cover designs in terms of environmental performance. Two sets of criteria will be developed during this study: 1) performance criteria describing the ability of the model to predict net infiltration rates through a cover; and 2) data criteria describing the minimum amount and types of data necessary to achieve the performance criteria. The criteria will be evaluated to determine the ability of the model to meet the performance objective using more generalized information (e.g. regional values for climate or text book values for hydraulic parameters). This information will provide an assessment of the minimum level of characterization necessary to support modeling and design studies. An automated data collection system will be used to collect information (e.g. water contents and soil suctions) describing the performance of the cover systems.

CIVIL/GEOTECHNICAL

Project Manager, Arco Cherry Point Refinery, Washington.
Geotechnical Foundations Study for sulfur recovery unit.

Project Manager, Oakland Quarry, California.
Geotechnical Investigation for Siting Rock Quarry Storage and Processing Facilities.

Project Manager, Lake Washington, Washington.
Geotechnical Investigations, Design Report, Construction Observation for 40 acre multi-facility housing development.

Project Manager, Westside Reservoir, Washington.
Remedial designs for slope failure.

Project Manager, Bradley Lake Hydroelectric Project.
Foundation design for 20 miles of transmission lines.

Project Manager, St. Hermans; Breakwater, Alaska.
Field investigation through design for rubble mount breakwater.

Project Manager, Fish Creek Sewer, Alaska.
Geotechnical investigation and design recommendations for five miles of force main and gravity sewer lines through tide flats.

Project Engineer, Alaska Railroad, Alaska.
Tunnel slope stability analysis blasting design for the removal of Tunnel No. 5.

Project Engineer, Kings Cove Dam, Alaska.
Rock abutment stability analysis and rock anchor design and installation program.

Project Engineer, Seward Shiplift Facility, Alaska.
Field investigation for remedial design of failing sheet pile cofferdam.

Project Engineer, Pacwest Tower, Oregon.
Field investigation and foundation design using 200-ton pile.

ORGANIZATIONS:

American Society of Civil Engineers (ASCE), Solid Waste Association of North America (SWANA)

ADDITIONAL COURSES AND WORKSHOPS:

MSHA and OSHA Health and Safety Training Seminar, 1989 to present

PUBLICATIONS AND PRESENTATIONS

"Uranium Millsite Remediation at Monticello, Utah" Tailings and Mine Waste 98 Conference Proceedings, Fort Collins, Colorado.

"Rio Tinto Mine Remediation: An Alternative Approach to the CERCLA Process," Tailings and Mine Waste 98 Conference Proceedings, Fort Collins, Colorado.

"Evaluation of Impacts to Productivity and Quality During Construction of a Lined Tailings Impoundment for a Grinding and Cyanide Leaching Mill Process" Tailings and Mine Waste 98 Conference Proceedings, Fort Collins, Colorado.

"Observations on Long-Term Performance of Composite Clay Liners and Covers", Geosynthetics: Design and Performance, 6th Annual Symposium Vancouver Geotechnical Society, 1991.

"Current Design and Construction Methods for Municipal and Hazardous Waste Landfills, Washington Engineers Club, 1991.

"Costs of RCRA Design and Construction Methods", Environmental Compliance - Solutions That Work, Society of Mining Engineers Conference, Denver, Colorado, 1990.

"RCRA Requirements for Mining Wastes", Society of American Foresters Conference, Spokane, Washington, 1989.

"Construction Quality Assurance Methods for Municipal and Hazardous Waste Facilities" Instructor for 2-day seminar for California Department of Health Services, 1988.

"Geotechnical Constraints on Mining in Alaska's Interior - A Case Study", Society of Mining Engineers Annual Conference, Tucson, Arizona, 1988.

"Coal Mining in Alaska's Interior: Problems and Solutions", Cold Regions Engineering - Proceedings of the Fourth International Conference, Anchorage, Alaska 1986.

"Cracking and Construction Blasting" ASCE Journal of Construction Division, March 1991.

January 12, 2000

Larry Gandy
Vice President
Gandy-Marley Corporation
1109 E. Broadway
Tatum, New Mexico

RE: GROUNDWATER MONITORING WAIVER REQUEST

Dear Mr. Gandy:

The New Mexico Environment Department Hazardous and Radioactive Materials Bureau has reviewed Gandy-Marley Corporation's (GMC) *Groundwater Monitoring Waiver Request* for the proposed Triassic Park waste disposal facility. The Department has determined that the request meets the requirements of the regulations (20 NMAC 4.1.500) by conservatively demonstrating that there is no potential for migration of liquid from any of the proposed regulated units to the uppermost aquifer during the life of the units. Furthermore, GMC has committed to developing a vadose-zone monitoring system that will be protective of human health and the environment. The Department therefore agrees that groundwater characteristics in the Santa Rosa Sandstone aquifer below the proposed facility need not be monitored. GMC should proceed with incorporating an approved groundwater monitoring waiver in their final permit application. This agreement will be finalized through the vadose-zone monitoring requirements expected to be set forth in the permit. Please contact Steve Pullen at 827-1558 (ext.1020) should you have any questions.

Sincerely,

Signed

James P. Bearzi
Chief
Hazardous and Radioactive Materials Bureau

cc: Stephanie Kruse, NMED
David Neleigh, EPA R6

Permit Renewal Application
October 17, 2011

Attachment I

Vadose Zone Monitoring System Work Plan

Prepared for:
TRIASSIC PARK WASTE DISPOSAL FACILITY
Gandy Marley, Inc.
Post Office Box 1658
Roswell, New Mexico 88202

Prepared by:
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320 Gold Ave. SW, Suite # 1000
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Original Prepared by:
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(970) 879-6260

Modified by:
The New Mexico Environment Department
March 2002

Table of Contents

List of Figures

Figure **Page**

List of Tables

Table **Page**

List of Appendices

Appendix

Attachment I. Vadose Zone Monitoring System Work Plan

1. Introduction

1.1 Background

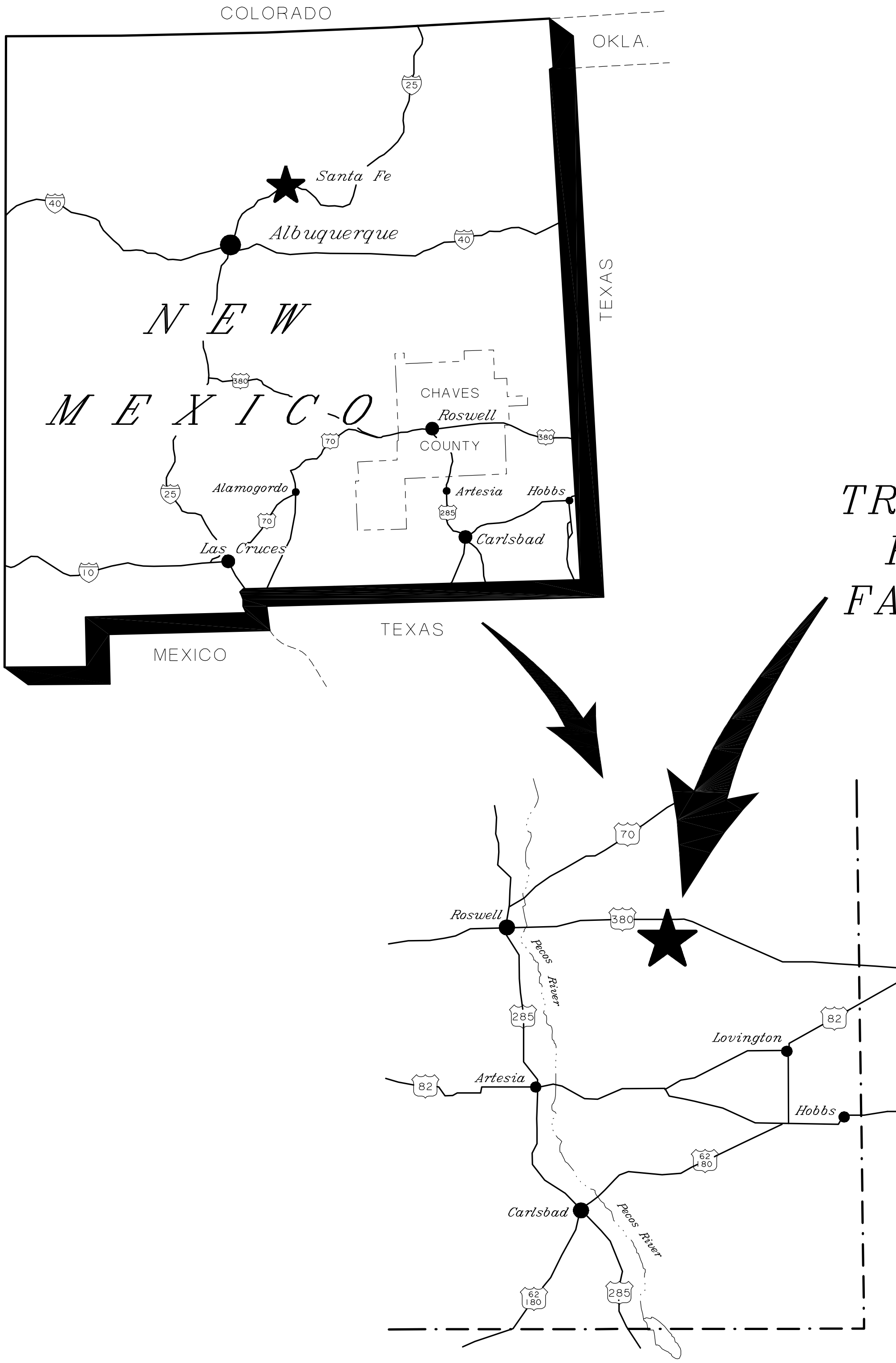
On January 12, 2000, the Hazardous Waste Bureau (HWB) of the New Mexico Environment Department (NMED) granted ~~the~~ Gandy Marley, Inc. ~~Corporation~~ (GMI) ~~was granted~~ a Groundwater Monitoring Waiver for its proposed Triassic Park Waste Disposal Facility ~~by the Hazardous and WasteRadioactive Materials Bureau (HWRMB) of the New Mexico Environmental Department (NMED) on January 12, 2000~~. The Groundwater Monitoring Waiver and a Vadose Zone Monitoring System (VZMS) Work Plan for liquid detection and water quality monitoring were part of the permit approval for the Triassic Park Waste Disposal Facility authorized by NMED in a Final Order on March 18, 2002.

The Triassic Park Waste Disposal Facility will be located in Chaves County, New Mexico, east of Roswell (Figure 1, Site Location Map[rpf1]). The facility will be a full-service Resource Conservation and Recovery Act (RCRA) Subtitle C waste ~~treatment, storage and~~ disposal operation. The facility will provide landfill disposal only. Two treatment processes authorized under the original permit are no longer planned; therefore, the VZMS work plan has been updated to reflect elimination of certain operations from the facility design. Previously planned operations that will no longer need monitoring include ~~will be used at the facility. E~~evaporation ponds ~~will be used~~ for managing ~~leachate~~ fluids that meet~~s~~ land~~fill~~ disposal restriction standards and a stabilization process ~~will be used~~ for treating fluids, sludge, and solids ~~prior to final disposal in the on-site landfill~~. Under the permit renewal, the landfill will be the only regulated unit for waste disposal.

Site-specific hydrogeologic conditions and engineering safeguards for the landfill~~regulated units~~ were documented in the report titled *Groundwater Monitoring Waiver Request, Triassic Park Waste Disposal Facility* (Montgomery Watson, January 2000). The *Groundwater Monitoring Waiver Request* report indicated that hydrogeologic conditions at the site will minimize migration of potential leachate fluids from the facility to the uppermost aquifer. The conservative modeling calculations presented in the *Groundwater Monitoring Waiver Request* report estimated that the migration time for potential leaks from the disposal facility to the uppermost aquifer would be greater than 1000 years. As an alternative to conventional groundwater monitoring, the *Groundwater Monitoring Waiver Request* report recommended installation of a ~~vadose zone monitoring system (~~VZMS~~)~~ as a superior means for protecting human health and the environment because of its ability to detect potential leaks in a more timely manner.

This Work Plan presents the design of a VZMS at the site and will be an ~~appendix~~ attachment to the Permit Application. It includes a discussion of the location and design of the vadose zone monitoring wells and methodologies for characterizing fluids that may accumulate in vadose zone wells and sumps from various sources. This Work Plan also discusses how data will be collected to select chemical parameters indicative of fluids (waste or non-waste) that may occur at the site. A summary of monitoring frequency, sampling procedures, laboratory analyses, and data reporting associated with the monitoring system are also provided. Figure 2, Location of Sumps and Monitoring Wells[rpf2], presents a map of the proposed facility showing significant site features, including the locations of the waste management units, vadose zone monitoring wells, and sumps.

~~(NOTE)~~ The VZMS Work Plan in the 2002 permit approval noted that Permit Part 7, Vadose Zone Monitoring, supersede~~d~~s th~~e~~ ~~is~~ Work Plan in the Permit Application. ~~Any conflict or contradiction between Permit Part 7 and this Work Plan shall cause the Permittee to abide by the conditions in the Permit Part~~This



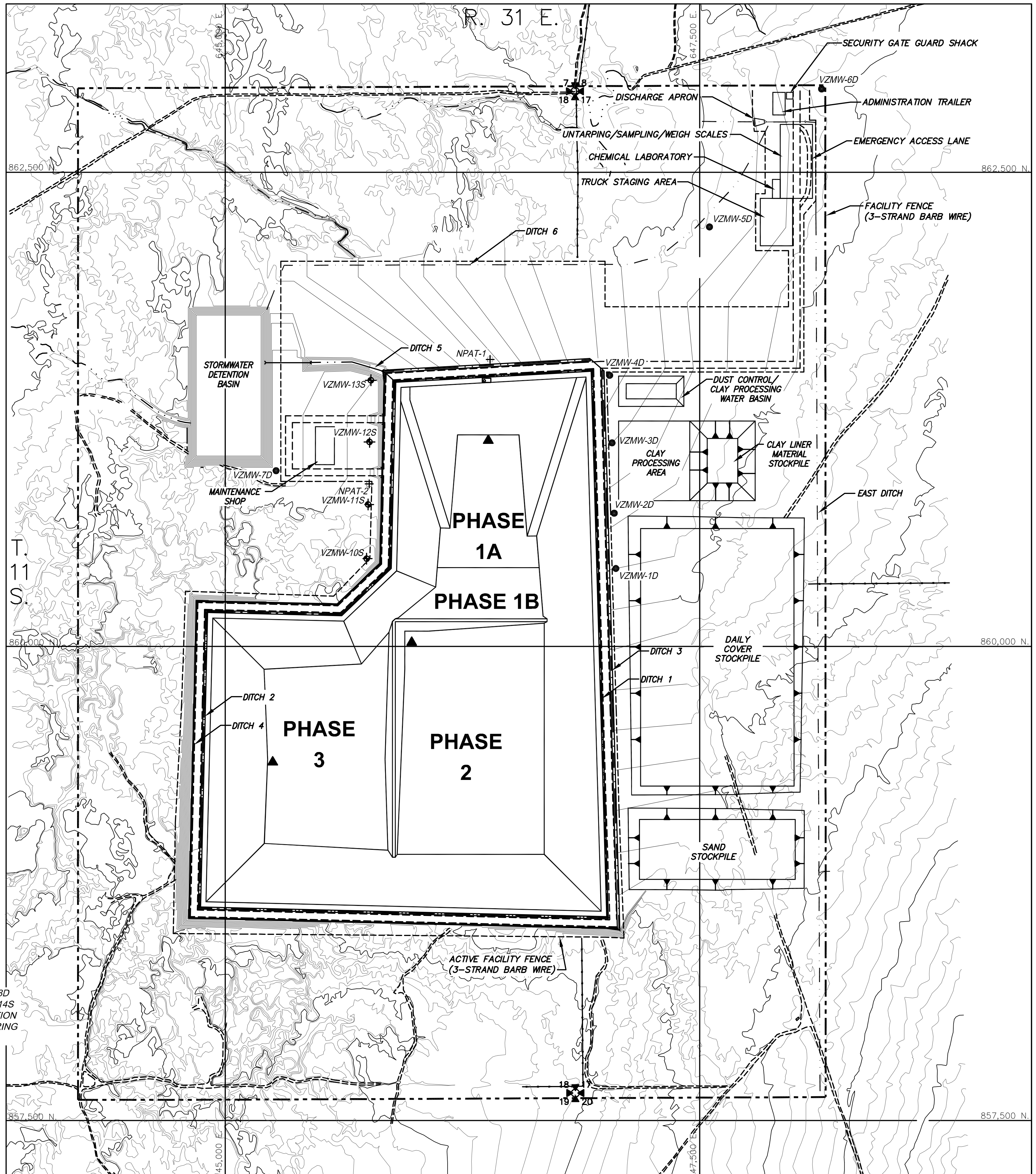
REV. No.	REVISIONS	REV. DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
1	Reissue	7/6/00	T.Leeson	K.Conrath	T.Leeson
	Issued for Report	2/11/00	T.Leeson	K.Conrath	T.Leeson

TRIASSIC PARK
WASTE DISPOSAL FACILITY

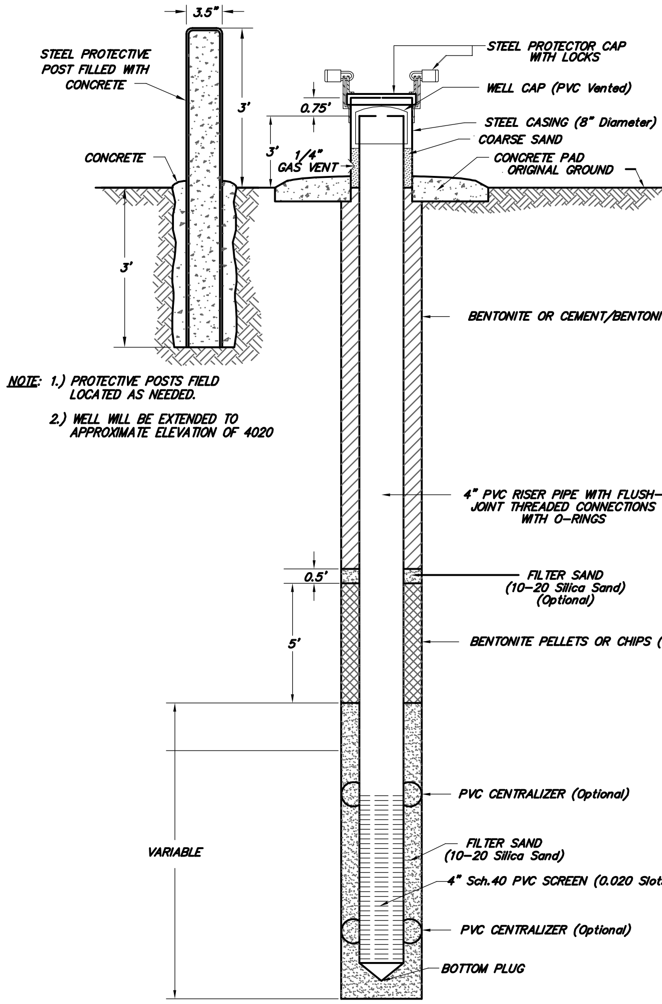
MONTGOMERY WATSON

PROJECT No.: 1342602.02190200
AutoCAD FILE: SITELOC.DWG
SCALE: N/A
FIGURE No: 1

SITE LOCATION

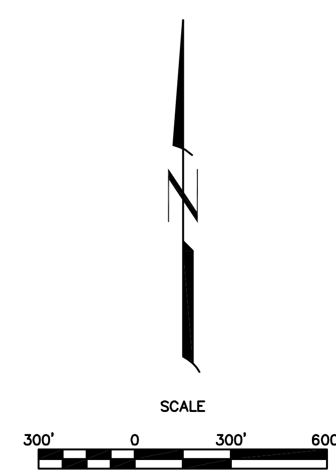


VZMW-8D
VZMW-14S
(LOCATION OF BORING PB-14)



NOTE: 1.) PROTECTIVE POSTS FIELD LOCATED AS NEEDED.
2.) WELL WILL BE EXTENDED TO APPROXIMATE ELEVATION OF 4020

TYPICAL VADOSE ZONE MONITORING WELL INSTALLATION DETAIL



LEGEND
- Existing contour
- Regraded contour
- Deep monitoring well
- Shallow monitoring well
- Vadose zone sump
- Neutron probe access tube
- Facility and active facility fences (3-strand barb wire)

NOTES:
1. VADOS ZONE MONITOR WELLS VZMW-9D AND VZMW-15S ARE LOCATED APPROXIMATELY 3,300 FEET NORTHEAST OF THE FACILITY BOUNDARY WITHIN 15 FEET OF THE LOCATION OF BORING WW-1.

PRELIMINARY - NOT FOR CONSTRUCTION

NO	DATE	BY	REVISION MADE
0	10/18/11	GDP	PART B PERMIT APPLICATION RENEWAL

FILE NAME: S:\Projects\ES11.0141_Triassic_Park_Permit_Renewal\VR_Drawings\ES11_0141_008_loc_sumps_wells_02.dwg

Daniel B. Stephens & Associates, Inc.
ENVIRONMENTAL SCIENTISTS & ENGINEERS
6020 ACADEMY NE, SUITE 100
ALBUQUERQUE, NM 87109
(505) 822-9400

DESIGNED BY: TG
DRAWN BY: KDB
CHECKED BY: GDP
DATE: 10/13/2011

TRIASSIC PARK WASTE DISPOSAL FACILITY
CHAVEZ COUNTY, NEW MEXICO

LOCATION OF SUMPS AND MONITORING WELLS

JOB NO. ES11.0141

FIGURE 2

XREF: S:\PROJECTS\ES11.0141_TRIASSIC_PARK_PERMIT_RENEWAL\VR_DRAWINGS\TITLEBLOCK\TB_22X34 updated VZMS Work Plan has been modified to be consistent with Permit Part 7 along with additional updates reflecting the Facility design changes.

1.2 Project Scope and Objectives

This Work Plan presents recommendations for a VZMS at the site. The vadose zone monitoring program for the facility allows collection of fluids beneath or downgradient of the facility and identification of the potential source(s) associated with these fluids. The following items are included as part of this Work Plan. References to the Part B Permit Application or the permit are presented where additional detail is required.

- A description of the methodology for installing a VZMS capable of detecting fluids migrating from the waste management units
- A description of the methodology for developing baseline data characterizing the chemical characteristics of non-leachate fluids that may accumulate in sumps or vadose zone wells
- A methodology for selection of appropriate indicator parameters that could be used to identify leachate fluids during future monitoring at the site
- A description of the methodology to be used for collecting field and analytical data as part of the vadose zone monitoring program at the site
- A description of the contingencies to the monitoring program if fluids are detected in the monitoring system~~. References to the Part B Permit Application or actual permit are presented where additional detail is required.~~

The primary VZMS consists of a vadose zone monitoring sump~~s~~ located beneath the landfill ~~Phase IA~~Phase 1A cell~~ and beneath each of two evaporation ponds~~. A secondary system consists of a series of vadose zone monitoring wells located adjacent to the landfill ~~Phase IA~~Phase 1A cell and~~ the evaporation ponds, and~~ on the periphery of the facility. Neutron access probe tubes ~~and lysimeters ~~are also located adjacent to the landfill ~~Phase IA~~Phase 1A cell~~ and the evaporation ponds~~.

This Work Plan also describes how the chemical characteristics of non-leachate fluids from various sources (i.e., stormwater evaporation ponds, rainwater, consolidation water, and water supply) are characterized. These data are used to develop a list of indicator parameters and/or water profiles that enable distinguishing between non-leachate fluids and leachate fluids.

Additional components of the vadose zone monitoring system presented in this Work Plan include the following~~are listed below~~~~as follow.~~:

- Monitoring frequency
- Sampling procedures
- Laboratory analyses
- Data management
- Data reporting
- Health and safety

The methods described within this Work Plan include the necessary elements for a Quality Assurance Project Plan (QAPP). The QAPP objectives are designed to assure that sampling, chain of custody, laboratory analysis, data measurements, and reporting activities provide quality data that ~~is~~are representative of conditions at the site and legally defensible.

1.3 Project Organization

~~HRMB/~~The NMED HWB is the lead regulatory agency for this portion of the hazardous waste management p~~P~~ermit renewal a~~A~~pplication. ~~Gandy Marley~~GMI is the permittee and will review project documents prior to their submittal to the HW~~RM~~B. When the work plan is implemented, GMI will use a qualified engineering and environmental~~Montgomery Watson, in conjunction with their sub-consultants, is the~~ oversight contractor ~~and~~ responsible for coordination of field activities, subcontractors, data management, review, and reporting of information concerning site characteristics and interpretation of data developed during the studies. Additional contractors or subcontractors ~~to Montgomery Watson will~~are expected to conduct monitoring well construction and laboratory analyses.

1.4 Geology and Hydrology

A detailed discussion of regional and site-specific geology and hydrology is provided in the *Groundwater Monitoring Waiver Request*~~,~~ ~~Triassic Park Waste Disposal Facility~~ (Montgomery Watson, ~~January~~ 2000) and Section 3 ~~(Volume I)~~ of the Part B Permit Application. A brief summary of the site-specific geology and hydrology is presented below.

1.4.1 Site-Specific Geology

The thickness of Quaternary alluvial deposits (fine to very fine wind-blown sands) at the site varies from less than 10 to 35 feet. Two distinct Tertiary units, the Upper and Lower Dockum, exist beneath the alluvial deposits at the site. Within the proposed facility boundary, the Upper Dockum unit never exceeds 100 feet in thickness and the Lower Dockum is approximately 700 feet thick. The Upper Dockum consists of mudstones interbedded with siltstones and sandy siltstones. The Upper Dockum mudstones have an average permeability of 2.5×10^{-7} centimeters per second (cm/s) and the siltstones have an average permeability of 1.2×10^{-5} cm/s. The Upper Dockum sediments were deposited in a fluvial environment and individual lithologies may pinch out and not correlate over long distances.

The Lower Dockum was deposited in a lacustrine environment resulting in a thick accumulation of predominantly mudstones interbedded with thin siltstones. This unit is very homogeneous compared to the Upper Dockum. The Lower Dockum has an average permeability of 5.7×10^{-8} cm/s and represents a significant geologic barrier to downward migration of potential leachate from the proposed facility.

The site is located in a geologically stable region of the United States based upon its distance from tectonic centers and historically low seismic activity. There are no identified faults in the immediate area of the site.

1.4.2 Site-Specific Hydrology

There are no perennial stream drainages on or near the site. The nearest surface drainage is the Pecos River, ~~that~~which is located approximately 30 miles to the west.

The basal sand unit (Santa Rosa Sandstone) within the Lower Dockum is considered the "uppermost aquifer" in the region. Previous exploratory drilling, consisting of approximately 50 boreholes within the site boundary, did not encounter groundwater within potential Triassic host sediments. There is no water being produced from the Triassic sediments within a ~~four~~4-mile radius of the site. Beyond the site boundary, groundwater flow in the uppermost aquifer is generally easterly in the direction of the regional dip of the unit.

Based on drilling information, the western boundary of the Quaternary Ogallala Aquifer is located topographically between ~~one-half~~0.5 and ~~two~~2 miles east and stratigraphically above the site. Because of its stratigraphic and physical location, it is highly unlikely that the proposed disposal facility will have any impact on this aquifer.

Groundwater was encountered in several wells during subsurface characterization for the Part B Permit Application. Brackish groundwater was identified in a perched zone (~42 feet below ground surface [bgs]) borehole PB-14, which is located to the southwest outside of the site footprint and appeared to be due to a lithologic depression on the surface of the Lower Dockum unit. Groundwater was also encountered in wells WW-1, WW-2, PB-1, and PB-26, which are located 2,000 feet or more to the north and south of the site. Additional detail on the results of this drilling can be found in Section 3.0 of the Permit Application.

1.4.3 Site Model

In order to justify the design of the VZMS, potential contaminant pathways, should there ever be a release from one of the waste management units, are shown in Figure 3, Schematic Site Model[rpf3]. There are several types of potential conduits for fluid movement through bedrock, including those listed below.the following:

- Primary permeability (i.e., connected interstitial voids) in either bedrock or alluvial material
- Bedding planes (i.e., between interbeds within the Upper Dockum unit or along the contact between the Upper and Lower Dockum units)
- Secondary permeability (i.e., faults and fractures), although there is no evidence of faults in the area

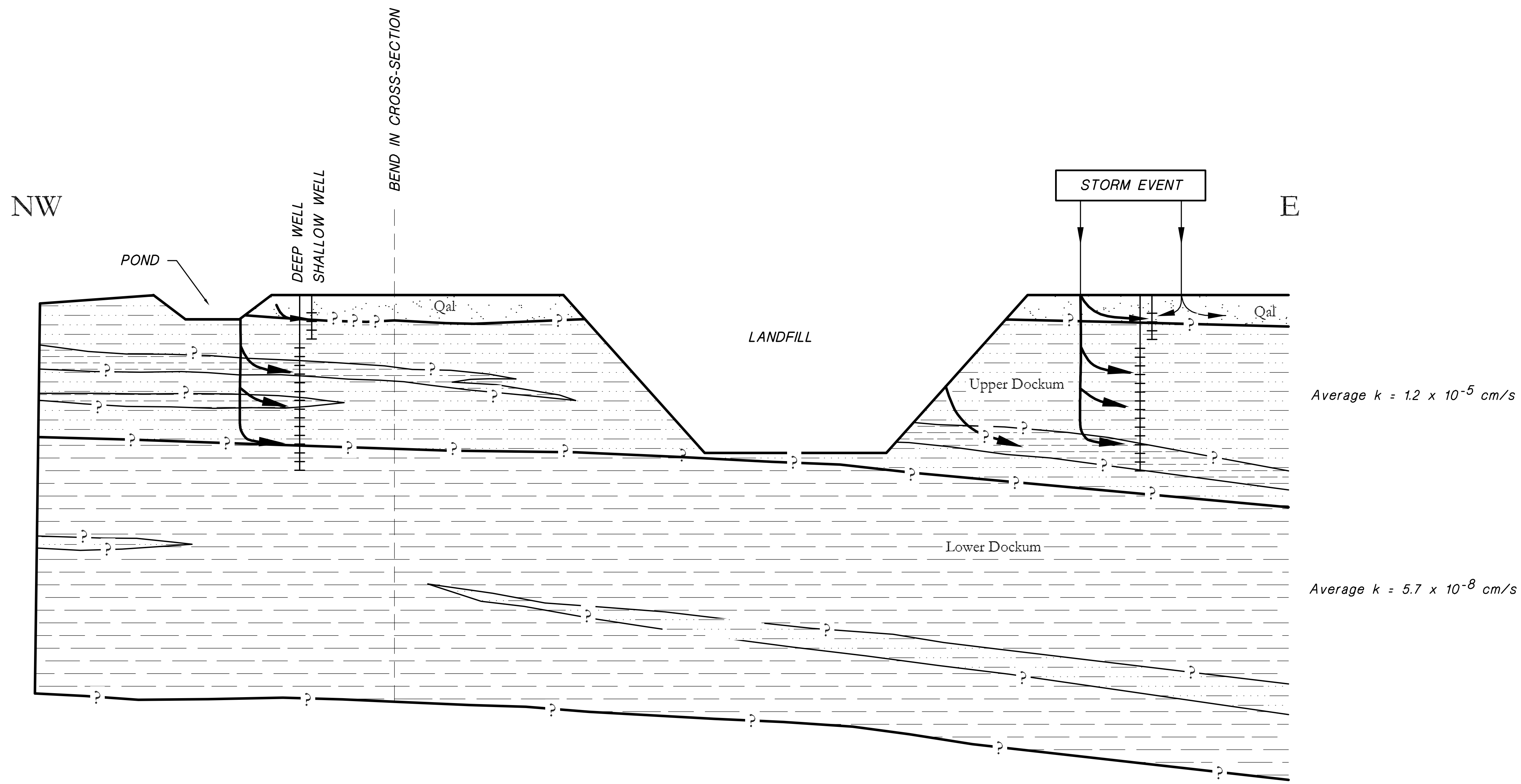
Consequently, if there were a release of fluids from one of the landfillregulated units, fluid could migrate vertically and/or laterally via one of the above-mentioned conduits. It is likely that lateral migration of the fluids along the dip of the units (i.e., along bedding planes) would dominate the flow regime. Therefore, a monitoring well located down dip of the facility and screened across the Upper Dockum/Lower Dockum contact and up into the Upper Dockum unit (i.e., across the silty and sandy silty interbeds) would be the most likely locations to observe these fluids if they ever were to occur.

Additionally, fluids that may have been released from the landfilla regulated unit, such as the evaporation ponds, could migrate through alluvium and along the alluvium/Upper Dockum contact, such that a shallow well located down-dip of the unit and screened across the contact and up into the alluvium would be the most likely place to observe these fluids. Furthermore, all non-leachate fluids, except consolidation water, would be expected to appear first in the shallow wells.

2. Vadose Zone Monitoring System Installation

The landfill cells and evaporation ponds will be constructed in phases. The Phase IAPhase 1A landfill cell will be completed first and will include a single central sump system. The Phase 2II and Phase 3III cells will be completed at a much later date and will also include individual sump systems. Evaporation Ponds 1A and 1B will be constructed first and each will have its own central monitoring sump system. Evaporation Ponds 2A and 2B will be completed at a later date. The VZMS will be installed prior to the initial acceptance of waste at the facility.

This Work Plan only addresses the vadose zone monitoring sumps and vadose zone monitoring wells associated with the Phase IAPhase 1A landfill cell and Evaporation Ponds 1A and 1B. Additional monitoring sumps and vadose zone monitoring wells will be addressed in a permit modification request for the remaining landfill cells and evaporation ponds. Construction details for the vadose zone monitoring sumps are provided in the design document *Design Drawings, Triassic Park Waste Disposal Facility, Chaves County, New Mexico* (Montgomery Watson *December 1997* , (Revised October 2000).



LEGEND

POTENTIAL CONTAMINANT TRANSPORT PATHWAY

MONITORING WELL

Screened Interval

NOTE:
THIS FIGURE IS STRICTLY SCHEMATIC, NOT TO SCALE, AND NOT MEANT TO PRESENT THE ACTUAL STRATIGRAPHY OR CONSTRUCTION OF TRUE REGULATED UNITS.

Not to Scale

REV. No.	REVISIONS	DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	Issued for Review	6/14/00	T.Leeson	K.Conrath	T.Leeson

TRIASSIC PARK WASTE DISPOSAL FACILITY

PROJECT:
VADOSE ZONE MONITORING SYSTEM WORK PLAN

DRAWING TITLE:
SCHEMATIC SITE MODEL

MONTGOMERY WATSON

Sheet 1 Of 1 Sheets

SCALE: Not to Scale

Figure No.: 3

AutoCAD FILE: schematic-site2.dwg PROJECT NUMBER: 1342602.02190200

2.1 Vadose Zone Sumps

Each landfill cell will have a triple leachate detection/removal sump system. Figure 4, Typical Landfill Sump Detail Cross-Section[rpf4], provides a cross-_section of the landfill sump system. The uppermost leachate collection and removal system (LCRS) consists of collection piping located above a primary liner system. The LCRS is sloped so any leachate above the primary liner drains to the sump within the landfill cell. A secondary landfill leak detection and removal system (LDRS), similar in design to the LCRS, will be located below the LCRS and primary liner. Beneath the LDRS and its secondary liner will be a vadose zone monitoring sump fitted with a transducer that will serve as a detection and removal system in the event of leakage through the primary and secondary liners. The vadose zone sump piping and gravel arrangement will be similar to the LCRS and LDRS arrangements.

The evaporation pond vadose zone monitoring sumps will serve as a detection system for possible leakage from the LDRS sump associated with the ponds. Figure 5, *Evaporation Pond LDRS and Vadose Plan and Details*[rpf5], provides a cross-section of the evaporation pond sump system. Leakage through the secondary liner system will flow into vadose zone monitoring sumps. This will allow the leakage to be detected, contained and properly treated and disposed. The vadose zone monitoring sump piping and gravel arrangement is similar to the LDRS arrangement. The Permit Application provides additional details on the sump transducers. Operation and maintenance of the sumps and transducer is covered in the Operation and Maintenance Manual included in the Permit Application.

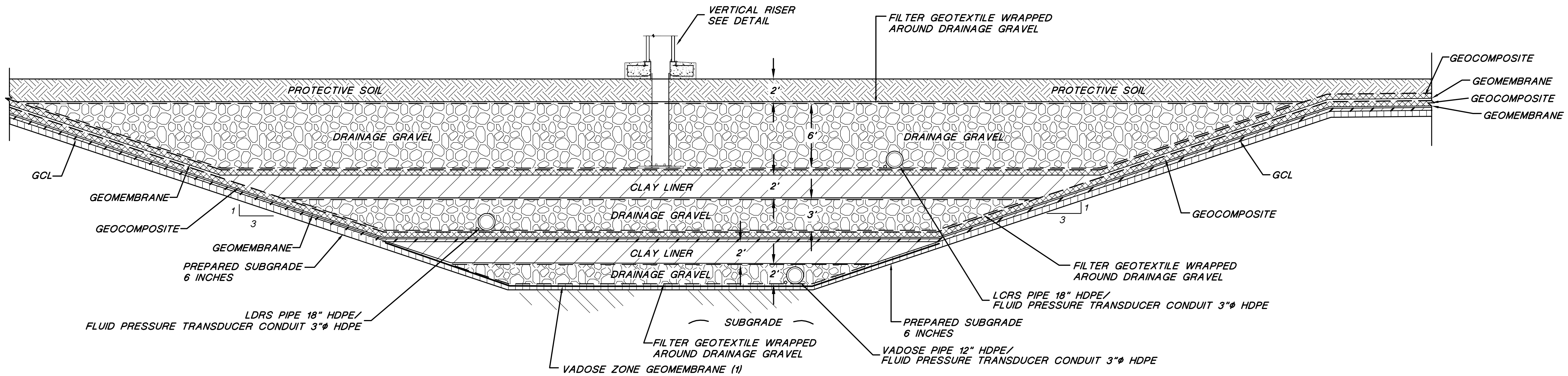
2.2 Vadose Zone Monitoring Wells

2.2.1 Well Locations

Vadose zone monitoring wells will be constructed and maintained to yield sufficient fluid samples that are representative of the various fluid sources, as required by 20.4.1.500 (incorporating 40 CFR 264.95(a) and 40 CFR 264.97(a)(2)). A total of 15Seventeen vadose zone monitoring wells and 2 neutron probe access tubes will be installed to detect potential migration of fluids from the landfill (Phase IAPhase 1A cell) and evaporation ponds (1A and 1B), as shown in Figure 2. The vadose zone monitoring wells include 6 shallow wells, 8 deep wells, and 1 very deep well. Of the 15 vadose zone monitoring wells, 11 are located within the facility boundary at locations shown in Figure 2. The other 4 vadose zone monitoring wells will be installed outside the facility at locations where previous investigation borings have encountered perched groundwater. The 2 neutron access probes are located on the north and west sides of the Phase 1A landfill, as shown in Figure 2. Ten of these wells will be deep (installed across the Lower Dockum/Upper Dockum contact and up into the Upper Dockum), six will be shallow (screened across the Upper Dockum/alluvium contact), as detailed in Section 2.2.2, and one will be very deep as described in Permit Part 7. Two of the shallow wells will be nested with a deep well and will be located 8 to 15 feet from the deep well.

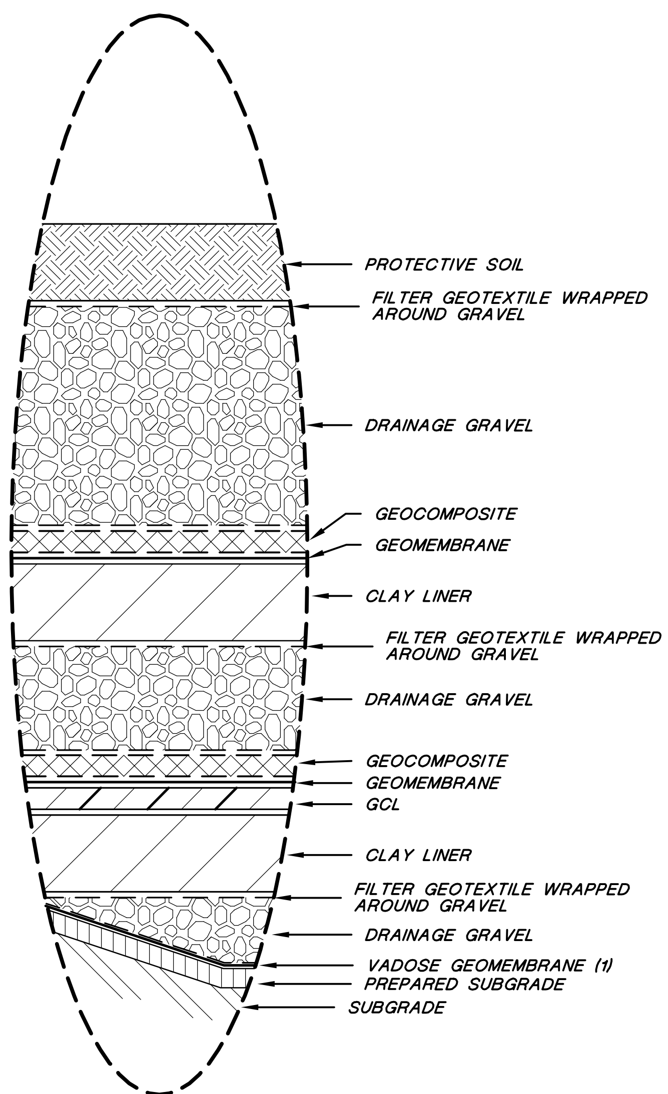
2.2.2 Vadose Zone Monitoring Well Construction

A utility clearance will be conducted at all drill locations to insureensure that no subsurface utilities or obstacles exist in the area. This will be conducted using methods appropriate to the conditions of each location (e.g., geophysics, utility maps, or facility personnel knowledge). The vadose zone monitoring wells will be installed using an air-rotary drill rig with no drive casing. Soil samples from cuttings will be logged and collected for use in characterizing fluids that may accumulate in the sumps and vadose zone monitoring wells, as described in see Section 3.0. These samples will also be collected for baseline chemical analyses. For additional well construction requirements, see Permit Part 7.



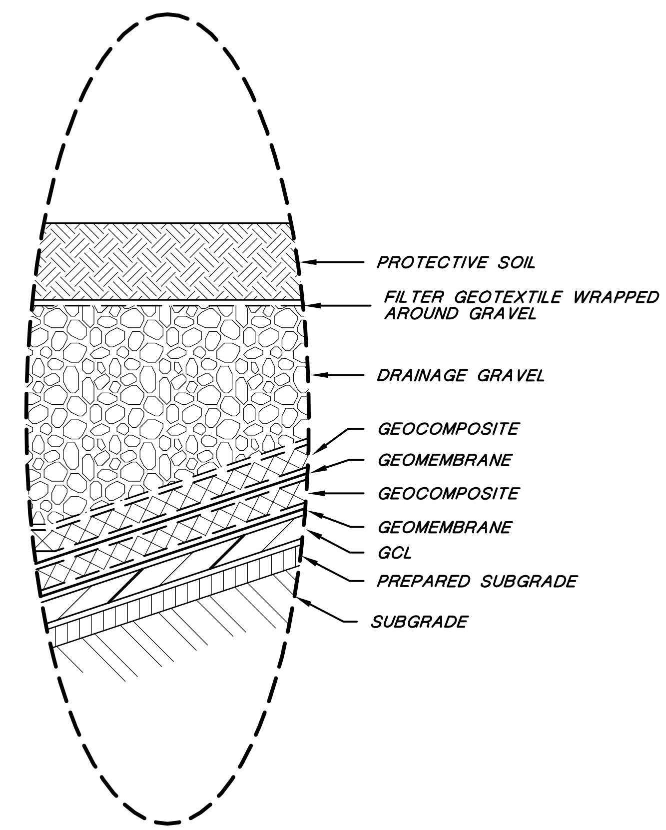
TYPICAL SUMP DETAIL

SCALE
0 5.0' 10.0'
Feet



EXAGGERATED GEOSYNTHETIC COMPONENT DETAIL

Not To Scale



EXAGGERATED GEOSYNTHETIC COMPONENT DETAIL

Not To Scale

NOTE:
THE VADOSE GEOMEMBRANE EXTENDS TO LIMITS OF THE SECONDARY CLAY LINER.

Not For Construction

REV. No.	REVISIONS	DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	Issued for Report	6/14/00	T.Leeson	K.Conrath	T.Leeson

TRIASSIC PARK

WASTE DISPOSAL FACILITY

PROJECT:
VADOSE ZONE MONITORING SYSTEM WORK PLAN

DRAWING TITLE:
TYPICAL LANDFILL SUMP DETAIL
CROSS-SECTION

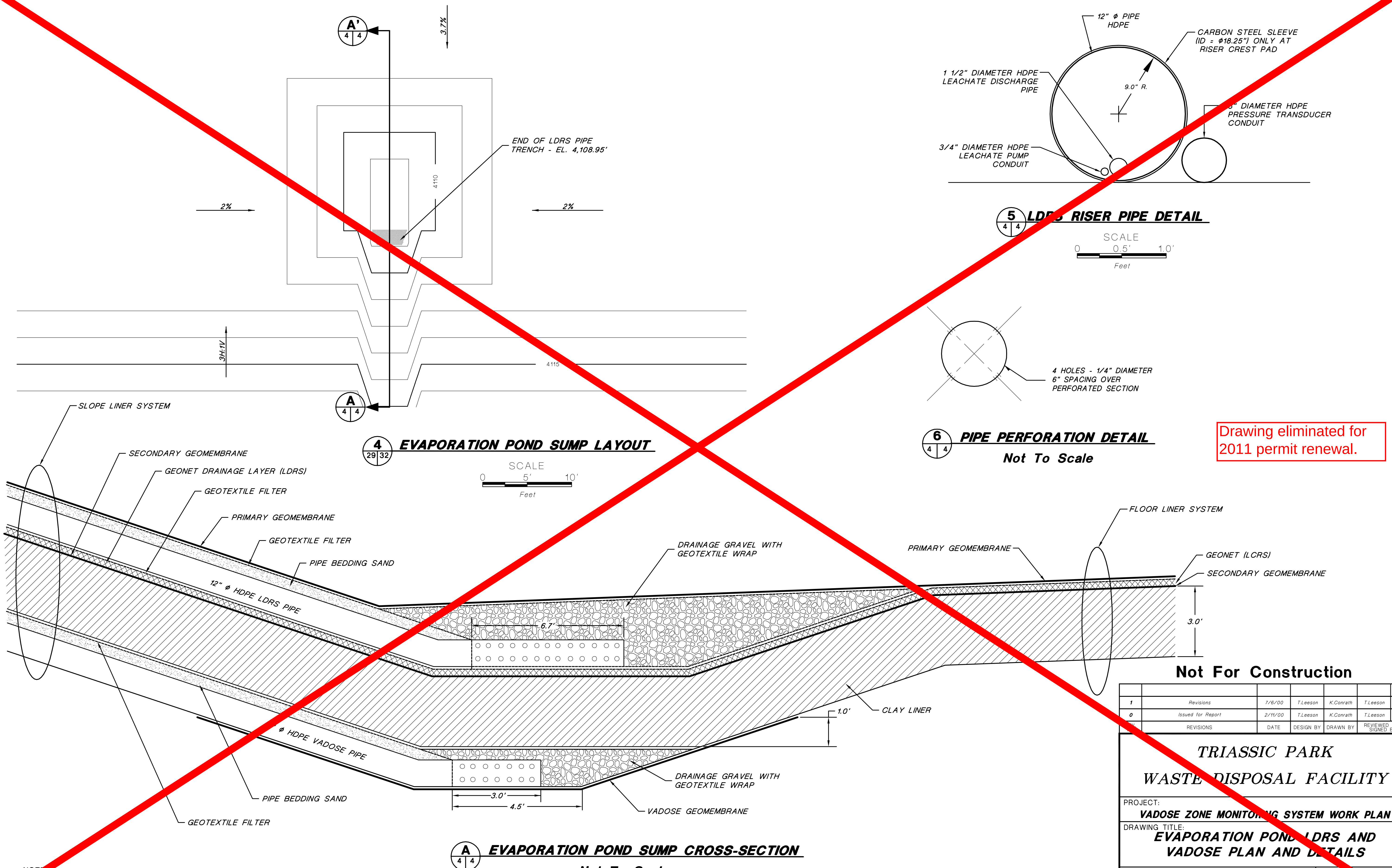
MONTGOMERY WATSON

Sheet 1 Of 1 Sheets

SCALE: As Shown

Figure No: 4

AutoCAD FILE: WP-TYPXS.DWG PROJECT NUMBER: 1342602.02190200



Drawing eliminated for 2011 permit renewal.

NOTE:
FOR GENERAL NOTES AND LEGEND INFORMATION SEE DRAWING No. 2, "INDEX, LEGEND AND GENERAL NOTES".

Not For Construction

1	Revisions	7/6/00	T.Leeson	K.Conrath	T.Leeson
0	Issued for Report	2/11/00	T.Leeson	K.Conrath	T.Leeson
	REVISIONS	DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY

TRIASSIC PARK
WASTE DISPOSAL FACILITY

PROJECT:
VADOSE ZONE MONITORING SYSTEM WORK PLAN

DRAWING TITLE:
EVAPORATION POND LDRS AND VADOSE PLAN AND DETAILS

MONTGOMERY WATSON

Sheet 1 Sheets
SCALE: As Shown
Figure No. 5

AutoCAD FILE: WP-LDRSPLAN.DWG PROJECT NUMBER: 1342602

2.2.2.1 Deep Monitoring Wells

The deep monitoring wells will be installed primarily to monitor for the possible detection of saturation above the Upper Dockum/Lower Dockum contact. Of the 8 deep monitoring wells, 7 wells will be installed with well screens across the Upper Dockum/Lower Dockum contact and up into the Upper Dockum. The one very deep vadose zone monitoring well will be installed within the Lower Dockum Unit above the lower sandstone formation (Santa Rosa Sandstone). The very deep well will be screened from 50 feet below the top of the Lower Dockum Unit, down to 100 feet above the top of the Santa Rosa Sandstone.

The 9 deep and very deep vadose zone monitoring wells will be installed at the following locations:

- 4 deep monitoring wells will be located in a line along the eastern boundary of the Phase 1A landfill, spaced at approximately 350-foot intervals.
- 1 deep monitoring well will be located at the northeast corner of the facility.
- 1 deep monitoring well will be located at the midpoint between the northeast corner of the Phase 1A landfill and the northeast corner of the facility.
- 1 off-site deep monitoring well will be installed approximately 3,300 feet northeast of the facility, within 15 feet of the location of boring WW-1.
- 1 off-site monitoring wells will be installed approximately 550 feet west of the facility, near the southwest facility corner, within 15 feet of the location of boring PB-14.
- The very deep monitoring well will be installed at the southeast corner of the stormwater detention basin.

The on-site geologist will log the boring and confer with the driller regarding lithology changes that identify the Upper Dockum/Lower Dockum contact. Drilling will use continuous coring to log the lithology in detail at deep borings VZMW-1 and VZMW-4 and very deep boring VZMW-9. All geologic core will be labeled as to depth, photographed, boxed, stored, and be available for inspection for the operating life of the facility. The location of the contact will be confirmed using a down-hole geophysical tool –(i.e., gamma ray and neutron logging methods). Monitoring wells that will continually undergo neutron logging shall have baseline logs created in both open and cased boreholes. It is estimated that the total depths for the deep landfill monitoring wells will range between 140 and 185 feet based on well location, and final grading at the site,. andT the anticipated depth offor the deep evaporation pond monitoring wells will be approximately 70 feet, assuming the wells are drilled ten feet below the Upper Dockum/Lower Dockum contact.

The deep vadose zone monitoring wells will be screened from 20 feet beneath the alluvium/Upper Dockum contact to 10 feet below the contact between the Upper Dockum/ and Lower Dockum contact, with the screened interval extending five5 feet below the contact and a five5-foot--long sump below that. A detail of the well construction is shown on Figure 2.

Five feet of solid 4-inch-diameter Schedule 80 PVC casing will be placed at the bottom of the borehole to serve as a liquid collection sump. Above this casing, 4-inch-diameter Schedule 80 PVC flush-threaded 0.010-inch well screen will extend to 20 feet below the top of the alluvium/Upper Dockum/alluvium contact. The top of the screened interval will extend to a depth that enables a minimum 20-foot seal below the alluvium/Upper Dockum/alluvium contact and a minimum of 10 feet from the bottom of the adjacent shallow well's screened interval, if applicable. This will result in 80- to 100-foot screened intervals in the deep wells. Solid 4-inch-diameter Schedule 80 PVC casing will then be installed to the surface. Bottom caps will be attached with stainless steel rivets. Additionally, in order to minimize the chances of the bottom of the well being inadvertently broken out, extra care will be taken to ensure that the filterpack is filled in, while still hanging the well casing under tension, with maximum density around the end of the well casing for added stability.

The casing will be lowered into the borehole a section at a time by hanging the casing from the drill rig. The casing will be left hanging from the drill rig after all the well casing has been attached and during the emplacement of filterpack material and grout to ensure that the casing remains straight. Centralizers will also be used to ensure that the well is straight. It will be important for the well to be plumb (i.e., vertical) to allow adequate visual monitoring of the wells. This will be accomplished by drilling the borehole straight, which will be the responsibility of the driller, as well as using the methods described above.

Following placement of the well casing, fine-grained sand (e.g., 20/40 silica sand) will be placed in the annulus to form a filter pack. Sand will be placed approximately 3 feet above the top of the well screen. Above the sand pack, ~~Three~~3 feet of transitional sand (i.e., 100-mesh sand) will be placed ~~above the sand pack~~ to prevent migration of the grout seal into the filterpack during emplacement. The main advantage of using transitional sand versus bentonite pellets is that it does not require hydration and will prevent any confusion of the source of the water if it were to enter into the well sump. The wells will be completed by pumping a grout mixture to form a seal from the top of the transitional sand to the top of the borehole using a tremie pipe. The grout mixture will consist of a high solids (~20 to 30%) bentonite grout ~~(e.g., Aquaguard or equivalent)~~ mixed to the manufacturer's specifications. The top of the well will be cemented with concrete and set with aboveground well protection. No water will be used in the construction of the well, except in the grout mixture, which will be pre-mixed above ground prior to emplacement in the annulus to avoid any free water entering the well or annulus during well construction.

2.2.2.2 Shallow Monitoring Wells

The shallow monitoring wells will be installed to monitor for the possible detection of saturation above the alluvium/Upper Dockum contact. The 6 shallow monitoring wells will be screened across the alluvium/Upper Dockum contact.

The shallow vadose zone monitoring wells will be installed at the following locations:

- 4 shallow monitoring wells will be located in a line along the western boundary of the Phase 1A landfill, spaced at approximately 330--foot intervals.
- 1 off-site shallow monitoring well will be installed approximately 3,300 feet northeast of the facility, within 15 feet of the deep vadose zone monitoring well near the location of borehole WW-1.
- 1 off-site monitoring well~~s~~ will be installed approximately 550 feet west of the facility, near the southwest facility corner, within 15 feet of the deep vadose zone monitoring well near the location of boring PB-14.

If there is greater than 4 feet of alluvium present, the shallow vadose zone monitoring wells will be drilled to approximately 3 feet below the alluvium/Upper Dockum contact, ~~between the Upper Dockum and alluvium~~ with a 5-foot screened interval extending 2 feet below the contact and with a 1-foot-long sump below that. If less than 4 feet of alluvium is encountered, no monitoring well will be installed at that location. A detail of the well construction is shown on Figure 2. The on-site geologist will log the boring and confer with the driller regarding lithology changes that identify the alluvium/Upper Dockum~~/alluvium~~ contact.

The thickness of the alluvium averages around 10 feet across the site. A minimum 3-foot seal or 4 feet of alluvium will be necessary to install a properly constructed monitoring well. 1 foot of solid 4-inch-diameter Schedule 80 PVC casing will be placed at the bottom of the borehole to serve as a liquid collection sump. Above this casing, 5 feet of 4-inch-diameter Schedule 80 PVC flush-threaded 0.010-inch well screen will extend to 3 feet above the alluvium/Upper Dockum~~/alluvium~~ contact.

Following placement of the well casing, fine-grained sand (e.g., 20/40 silica sand) will be placed in the annulus to form a filter pack. Sand will be placed between ½ 0.5 and 1 foot above the top of the well screen followed by ½ 0.5 to 1 foot of transitional sand. The actual thicknesses will be determined by the depth of the contact and a minimum 3-foot surface seal. The wells will be completed by emplacing a grout mixture to form the surface seal from the top of the bentonite to the top of the borehole. The grout mixture will be gravity emplaced if the wells are less than 50 feet deep and contain no formation water; if they are greater than 50 feet deep or contain formation water, the grout will be emplaced using the same procedures as the deep wells. The grout mixture will consist of a high solids (~20 to 30%) bentonite grout (e.g., Aquaguard or equivalent) mixed to the manufacturer's specification. The top of the well will be cemented with concrete and set with aboveground well protection. No water will be used in the construction of the well, except in the grout mixture, which will be pre-mixed above ground prior to emplacement in the annulus to avoid any free water entering the well or annulus during well construction.

2.2.2.3 Neutron Probe Access Tubes

Neutron probe access tubes will also be installed at two locations near the Phase 1A landfill liner to allow moisture content monitoring in the vadose zone and enable collection of a representative sample of any fluid that may accumulate at or above the stratigraphic boundary between the Upper and Lower Dockum stratigraphic units and below the stratigraphic boundary between the alluvium and the Upper Dockum. The locations of the two neutron probe access tubes are shown in Figure 2.

Neutron probe access tubes will be constructed with the same care as monitoring wells to ensure functionality and to prevent fluid contamination. Details are provided in Permit Part 7. Because the neutron probe access tubes will be located near stormwater runoff channels, the access tubes will be installed in a way to distinguish moisture changes that may occur due to infiltration of clean stormwater from moisture possibly caused by landfill leakage. The portion of the access tubes located close to the channels will be isolated from the deeper portion of the access tubes by sealing an interval of the borehole with cement grout containing 5 percent bentonite.

Neutron probe access tubes will be constructed using either PVC, low carbon steel, or stainless steel casing. Flush-threaded or welded tubing is preferred to coupled tubing, to minimize wall thickness for better transmission of neutrons. To allow use of various models of neutron probes, 2.5- to 3.0-inch tubing diameter will be used. The borehole annulus outside the casing will be backfilled with soil cuttings or silica sand to allow transmission of neutrons to the surrounding formation materials, with the exception of the sealed interval between the upper and lower intervals. If possible, cuttings from each major hydrostratigraphic interval should be segregated on plastic and kept covered so the material can be used to backfill the boring annulus. During installation, a dummy probe will be used to check the access tubes for bends or dents before and after installation is complete.

The neutron probe access tube is used to collect representative moisture content information with the neutron probe. Therefore, the access hole diameter and disturbance to the surrounding soil should be minimized. Working with the drilling contractor, a final borehole diameter will be selected that is the minimum necessary for successful completion of the access tube installation. A borehole diameter of approximately 5 to 6 inches is expected.

The top of the well will be cemented with concrete and set with aboveground well protection. No water will be used in the construction of the well, except in the grout mixture, which will be pre-mixed above ground prior to emplacement in the annulus to avoid any free water entering the well or annulus during well construction. Finally, a desiccant should be suspended beneath the well cap to keep the access tube free of moisture.

To determine the moisture content of soil surrounding the neutron probe access tubes, a calibration is needed between instrument counts and soil moisture. During installation of the neutron probe access tubes, the neutron moisture meter will be used to profile the moisture content. Moisture profile measurements will be made before and after the cement grout is emplaced, so the moisture introduced by the grout can be distinguished from background conditions. The moisture profile will be compared with laboratory soil moisture data from samples collected during drilling, so a correlation can be made between neutron counts and moisture content for each major lithology type encountered. Thus, an accurate geologic log is needed for the calibration.

2.2.2.4Suction Lysimeters

Suction lysimeters will be constructed with the same care as monitoring wells to ensure functionality and to prevent fluid contamination. Details are provided in Permit Part 7.

2.2.2.4 VZMS Construction Information

Vadose zone monitoring wells will be drilled using air-rotary drilling methods. During drilling, VZMS construction information will be recorded on boring logs and well construction forms by the field geologist for each well and will contain the following information. The information will also be provided on final detailed well construction drawings presenting depth of well construction material emplacement and well dimensions.

- Name of geologist, site location, and date of activity
- Description and identification of drilling and sampling equipment
- Name of drilling contractor
- Soils description using the Unified Soil Classification System
- Description of soil texture, color, density, odors, and other appropriate descriptions
- Description of rock type
- Depth and thickness of groundwater (if encountered)
- Total depth of the boring and well to within 0.1 foot with respect to ground surface, and well depth to within 0.01 foot with respect to top of casing (marked)
- All applicable well construction details
    - Casing material specifications and size, and reference material certifications
    - Screen slot size and depth to both top and bottom of screen interval
    - Casing and screen joint type
    - Filterpack material source and grain size analysis
    - Filterpack placement methodology
    - Sealant material sources, types, and mix design
    - Surface seal and protective casing design
    - Well location horizontal and vertical coordinates
- Explanation of any introduced water and a reference to its source and its chemical analysis
- Reference to any non-anthropogenic fluids encountered during construction
- Well development procedures, should they be required
    - Equipment and methods used
    - Total daily amounts of fluids removed
    - Recovery rates
    - Turbidity
    - Static fluid surface elevation measurements

- Aquifer test results, including hydraulic conductivity, for any well encountering groundwater during installation

Three borings drilled for deep vadose zone monitoring wells will be continuously cored. Core will be collected during drilling of VZMW-1D and VZMW-4D located on the east side of the Phase 1A landfill and VZMW-7D located west of the Phase 1A landfill as the southeast corner of the stormwater detention basin. VZMW-7D is the very deep boring drilled into the Lower Dockum. The primary purpose of the coring is to evaluate the possible existence of paleofractures or faults beneath the facility. Should these borings yield insufficient core to accurately determine the lithology and geologic structure, additional core may be collected from other borings. All geologic core will be labeled as to depth, photographed, boxed, stored, and be stored for possible inspection for the operating life of the Facility. The core samples will be maintained as part of the Operating Record.

Following monitoring well installation, a licensed surveyor using a benchmark of known elevation as a reference point will survey each vadose zone monitoring well and neutron probe access tube. A reference mark will be made at the top of each well casing and surveyed for horizontal coordinates (±0.1 foot) and height above mean seal level (±0.01 foot). Then the depth of the well will be measured and recorded to 0.01 foot below the top of casing, as well as below the well pad and ground surface. Any deviations from this Work Plan will be documented and justified.

2.2.3 Decontamination

The drill rig and equipment used for installing the vadose zone monitoring wells for the landfill ~~Phase 1A~~Phase 1A cell ~~and evaporation ponds~~ will be decontaminated prior to drilling and between boreholes. Decontamination procedures are described below.

Drilling equipment ~~which~~ that comes into direct contact with subsurface soils or groundwater will be decontaminated between each boring by removing adherent soil, steam cleaning and/or scrubbing with an anionic detergent in potable water followed by a double rinse with purified (deionized) water.

Investigation derived waste (IDW) will be handled in accordance with the waste analysis plan (WAP).

2.2.4 Well Development

Based upon previous investigations, groundwater is not anticipated in many of the vadose zone monitoring wells; therefore, well development should not be necessary. Isolated zones of perched groundwater may be encountered in the two deep vadose zone monitoring wells drilled at the locations of borings WW-1 and PB-14. ~~However, a description of~~The protocols for well development ~~is~~ provided below will be followed for all vadose zone monitoring wells where ~~in the unlikely event~~ groundwater is encountered. In the ~~unlikely~~ event that groundwater is encountered during the installation of monitoring wells, NMED will be contacted within 24 hours of the event.

If groundwater is encountered, wells will be developed to remove fine material from the formation and filterpack surrounding the well. Following well construction, the cement grout will be allowed to cure for approximately one week, after which development will consist of bailing and surging until relatively clear water (i.e., groundwater with low turbidity) is produced. Each well will be surged and bailed using a development rig equipped with a winch and a 3-inch-diameter steel bailer. Surging and bailing of fines is anticipated to take up to 4 hours per well to complete. The volume of water removed may ~~vary between~~range from ~~one~~ 1 casing volume for low-recharge wells (i.e., those that do ~~n't~~ not fully recharge within 12 hours) ~~and~~ to 6 casing volumes.

3. Baseline Liquid Characterization

Potential sources for water detected in the vadose zone monitoring wells and sumps may include those shown belowthe following:.

- Non-leachate fluids
  - Rainwater
  - Stormwater detention pond fluids
  - Consolidation water from prepared subgrade or geosynthetic clay liner (GCL)
  - Pipeline leaks from facility water supply

- Leachate fluids (originating within the regulated unit)
  - Fluids that have migrated through waste from the landfill
  - Stormwater runoff collected in the landfill-contaminated water basin
  - Evaporation pond fluids

A baseline liquid characterization program will be conducted within three months of activating the facility, and through ongoing monitoring during facility operations, water supply system to evaluate the water quality characteristics of sources of non-leachate fluids that could accumulate in sumps or vadose zone monitoring wells. Additionally, leachate fluids will be evaluated as part of the WAP and will include sampling and analysis of each of the leachate fluids types listed above. The potential characteristics of leachate fluids will be evaluated after a sufficient amount of waste materials have been placed in the landfill and landfill leachate has been collected, if it occurs. These data will be used to distinguish leachate fluids from non-leachate fluids that could accumulate in sumps or vadose zone monitoring wells during operation, according to the methods discussed in Section 6.4.

The baseline characterization program will be conducted on samples of non-leachate fluids to produce preliminary chemical profiles for these waters. Samples of non-leachate fluids will be analyzed according to the program described in Table I-1. These data will be used to develop a water quality profile representative of each potential non-leachate fluid source.

Table I-1. Baseline Chemical Analyses

Analytes	Analytical Method	Sample Container(s)	Preservation Method/ Holding Time
General Water Quality			
Bicarbonate/carbonate	EPA 310.1SM 2320B	250-mL HDPE	4°C / 14 days48 hours
Chloride	EPA 300.0	250125-mL HDPE	4°C / 28 days
Dissolved major cations (Na, K, Mg, Ca, Fe)	EPA 6010B	500-mL HDPE	4°C; pH < 2 with HNO_3 / 6 months
Total dissolved solids	EPA 160.1SM 2540C	250125-mL HDPE	4°C / 7 days
Sulfate	EPA 300	250500-mL HDPE	4°C / 28 days
Heavy Metals			
Dissolved and total metals (Sb, As, Ba, Be, Cd, Cr, Cu, Pb, Hg, Ni, Se, Ag, Tl, Zn)	EPA 6010B/70006020	1-L125-mL HDPE	4°C; pH < 2 with HNO_3 / 6 months; 28 days for Hg
Total metals (Sb, As, Ba, Be, Cd, Cr, Cu, Pb, Ni, Se, Ag, Tl, Zn)	EPA 6010B/6020	500-mL HDPE	4°C; pH < 2 with HNO_3 / 6 months

Analytes	Analytical Method	Sample Container(s)	Preservation Method/ Holding Time
Total mercury (Hg)	EPA 7470/7471/ 245.2	500-mL HDPE	4°C; pH < 2 with HNO_3 / 28 days
Radionuclides			
Gross alpha, gross beta, gamma emitters	EPA E900.0/ 901.~~1~~0	~~250-mL CWM glass jar~~1-L HDPE	4°C; pH < 2 with HNO_3 / 6 months
Uranium, total	EPA ~~200.8~~6020	~~250-mL CWM glass jar~~500-mL HDPE	4°C; pH < 2 with HNO_3 / 6 months
Radium 226/228	EPA 903.1/904.0/ 600/~~9320~~	~~250-mL CWM glass jar~~1-L HDPE	4°C; pH < 2 with HNO_3 / 6 months
Radon	EPA 913.0	~~250-mL CWM glass jar~~2 x 40-mL VOA vial	4°C / ~~6 months~~4 days
Organics			
Volatile organic compounds	EPA ~~624~~8260B	3 x 40-mL VOA vial	4°C; pH < 2 with HCl / 14 days
Semivolatile organic~~s~~ compounds	EPA ~~625~~8270C	1-L ~~HDPE~~glass amber	4°C / 7 days extraction~~, 40 days analysis~~
Pesticides	EPA ~~608~~8081/8141B	1-L ~~HDPE~~glass amber	4°C / 7 days extraction~~, 40 days~~
Polychlorinated biphenyls	EPA 8082~~608~~	1-L ~~HDPE~~glass amber	4°C / 7 days extraction~~, 40 days~~
Perchlorate	EPA 300.11/314.1	~~1-L~~125-mL wide-mouth HDPE	4°C / ~~2~~ 28 days
Cyanide	EPA 335.3	1-L HDPE	4°C / ~~2~~ 14 days
~~Sulfide, reactive~~	~~EPA 376.2~~	~~1-L HDPE~~	~~4°C / 14 days~~
TPH-gasoline	EPA ~~8015M~~418.1	~~3 x 40-mL VOA vial~~500-mL glass amber	4°C; pH <2 with HCl / 7 days extraction~~, 40 days analysis~~
TPH-diesel	EPA ~~8015M~~418.1	~~1-L glass~~500-mL glass amber	4°C; pH < 2 with HCl / ~~14 days~~7 days extraction
Oil & grease	EPA 9071/413.2	~~1-L HDPE~~500-mL glass amber	4°C; ~~H_2SO_4~~ pH < 2 with HCl / ~~28 days~~7 days extraction
Soil Analyses			
Metals	EPA 200.7/6010C	125-mL CWM glass jar	4°C / 6 months
Radiochemistry	HASL-300 / Gamma spec	500-mL CWM glass jar	4°C / 6 months

VOA = Volatile organic analysis
CWM = Clear wide-mouth jar
HDPE = High density polyethyrene bottles
HCl = Hydrochloric acid

A sample of the potential consolidation water will be analyzed as part of the baseline characterization program. The sample will be obtained by running a permeability test (ASTM D 5084~~-90~~) on a representative sample of the clay liner and/or GCL. The extract from that test will then be analyzed according to Table I-1.

Water representative of the potential non-leachate fluid sources will be used in conjunction with drill cuttings from both the Upper and Lower Dockum Units to establish a chemical baseline using the Synthetic Precipitation Leaching Procedure (SPLP)~~,~~ (U.S. EPA SW-846 method 1312; ~~Meteoric Water Mobility Procedure (~~see Appendix A). The ~~MWMP~~SPLP will be used to test three samples representative of the lithologies (e.g., mudstone, siltstone, and sandy siltstone) of both the Upper and Lower Dockum Units using each distinct non-leachate fluid type. If the water profiling discussed in the previous paragraph reveals that the different non-leachate fluids each have distinct profiles, each water type will be used to conduct the ~~MWMP~~SPLP tests; otherwise, water representative of all the non-leachate fluids combined will be used.

Cuttings will be collected for use in these tests during installation of the vadose zone monitoring wells. The extract from these tests will be analyzed according to the program described in Table I-1. ~~If it is determined that the solids are too fine to conduct the standard extraction method (column leaching) for the MWMP test (see Appendix A), an alternative method will be used (i.e., bottle roll).~~ These data will provide an indication of the chemical profile (in terms of major ion chemistry, radiochemistry and trace metals) of water that would occur as a result of Dockum sediments being subjected to non-leachate fluid sources. Certain constituents listed in Table I-1, such as volatile organic compounds, are not expected to be detected during these tests~~,~~; however, their absence will be confirmed in case any natural organic materials (e.g., hydrocarbons) exist in the geologic materials.

Additionally, the samples of the Dockum cuttings collected ~~of the Dockum cuttings~~ during drilling will be used to analyze the material (solid) for background determination. These samples will be analyzed for heavy metals and radionuclides, as listed in Table I-1~~, Baseline Chemical Analyses~~.

After initial vadose zone fluids are sampled and tested, an assessment will be completed to determine whether the vadose zone fluids may be adversely affected by well construction materials. The compatibility assessment will consider both non-leachate and leachate fluids. The compatibility demonstration will be completed within six months of monitoring well construction, provided that sufficient vadose zone fluids are available to perform the assessment.

4. Monitoring Procedures

4.1 Monitoring Frequency

Following installation, monitoring for the presence of fluids will be performed daily for the vadose zone sump~~s~~ below the LCRS and LDRS sumps ~~will be monitored for the presence of fluids daily~~ and monthly for the vadose zone monitoring wells ~~monthly~~. The total depth of the vadose zone wells will also be measured each time the wells are monitored. Table I-2~~, *Monitoring Frequency*,~~ presents a summary of the monitoring program for the facility.

Table I-2. Monitoring Frequency

Time Period	Landfill		~~Evaporation Ponds~~	
	Sumps	Vadose Wells	~~Sumps~~	~~Vadose Wells~~
Operation	Daily	Monthly	~~Daily~~	~~Monthly~~
Closure	Daily	Monthly	~~Daily~~	~~Monthly~~
Post-Closure	Semiannually	Semiannually	~~Semiannually~~	~~Semiannually~~

During the operating life of the Facility, ~~The Permittee shall inspect~~ each vadose zone monitoring well and neutron probe access tube and the landfill vadose zone sump will be inspected according to the schedule in Table I-2. ~~, plus Vadose Zone Monitoring Wells 1, 2 and 3, every six months.~~ During the post-closure care period, monitoring wells VZMW-1D, -2D, -3D, and -4D and the landfill vadose zone sump will be inspected and sampled semiannually.

4.2 Response Actions

The following response actions~~, plus those identified in Permit Part 7,~~ will be conducted based on the outcome of each monitoring event.

- Liquid not present: no further action.
- Liquid present: the fluids will be sampled and analyzed. All remaining fluids will be removed and properly disposed of.

If the source of water in the sumps or vadose monitoring well is determined to be non-leachate fluids, no further action will be conducted other than removing the liquid and mitigating the source, if possible (e.g., a break in the water supply system). As part of the source mitigation, ~~the applicant will submit~~ a written plan for determining and mitigating the source of the fluids will be submitted to NMED for ~~their~~ approval within one week of its occurrence. If the source of the water is determined to be leachate fluids, corrective action steps will be taken, as described in the applicable permit module. Additionally, if the action leakage rate (ALR) is exceeded, corrective action or contingency steps will be taken, as described in the applicable permit modules, to include an increase in the monitoring frequency to weekly for one month or until the ALR is reduced, whichever occurs first. All response actions will be assessed by an independent New Mexico Professional Engineer. Reporting commitments are described in Section 6.4.

If fluids are detected in one of the shallow wells, the depth of the fluids will be compared to the depth of the waste. This comparison will aid in evaluating whether the source of the fluids could be from the waste disposal units.

4.3 Monitoring Method

The sumps are fitted with a dedicated transducer ~~fitted~~ with a manual readout. Consequently, the readout will be recorded and documented manually at the frequency indicated in Table I-2.

The wells will not be fitted with transducers and so will be monitored visually and manually, as listed below.

- ~~A light source, such as a flashlight or mirror, will be directed down the well and used to inspect for a reflection off fluids.~~
- A water level sounder capable of detecting and measuring the depth to water, if water is present.
- If water is detected, ~~A~~an interface probe~~,~~ capable of detecting water as well as petroleum hydrocarbons, will be lowered down the well and used to measure the depth of any water and/or the thickness of any petroleum hydrocarbons present.
- If fluids or petroleum hydrocarbons are suspected, a clean disposable bailer will be lowered into the well to collect a sample of the fluid for visual inspection and confirmation of its presence prior to collecting any for laboratory analysis.

The water level sounder and interface probe will be decontaminated prior to ~~using it~~use at each well. The results of this monitoring will be documented.

The procedures and schedule for inspection and maintenance of the VZMS sumps are described in the operations and maintenance manual included in the permit application. The wells will be visually inspected for damage or malfunction at the time of each monitoring event. Any problems will be communicated to the NMED and fixed in a timely manner.

4.4 Sample Collection

Consolidation water from prepared subgrade or GCL will be sampled for baseline characterization if and when it occurs. The most likely locations for consolidation water to collect are in the LDRS and VZMS sumps, as shown on Figure 4~~5~~. As such, if it occurs prior to initial placement of waste in the landfill, it likely will represent consolidation water, provided there is no other significant source of fluids in the LDRS sump, like rainwater. If it is observed after initial placement of waste in the landfill, it will still be sampled, but may not represent consolidation water. The exact nature of that water will be determined at the time of occurrence.

If fluids are encountered in the sumps or vadose zone monitoring wells, samples will be collected as described below. The vadose zone monitoring sumps will each be equipped with a bladder pump. Samples will be collected from the pump using the minimal flow rate if sufficient volume exists in the sump. Laboratory analyses of samples will be completed by a chemical laboratory, as described in the WAP.

Groundwater is not anticipated in the on-site vadose zone monitoring wells based on results from previous hydrogeologic investigations at the site. Perched groundwater may be encountered at the two off-site locations where VZMS wells will be installed at the locations of borings WW-1 and PB-14. In the ~~unlikely~~ event groundwater is encountered following well installation, the wells will be initially sampled approximately one week after installation and development, or whenever water shows up.

Static water level measurements will be taken in the wells using an interface probe prior to sampling. Measurements will be taken to the nearest 0.01 foot from the surveyed reference point on the well casing. The interface probe will be cleaned between each well using a non-phosphate biodegradable detergent and fresh tap water followed by a distilled or de~~-~~ionized water rinse. New chemical-resistant disposable sample gloves will be used while collecting samples at each sump or well.

Following water~~-~~ level measurement, well purging will commence and field measurements of pH, conductivity, temperature, and turbidity will be recorded every 2 to 5 minutes to demonstrate parameter stabilization prior to sampling. Purging will be discontinued once the parameters have stabilized or when three well volumes of water have been purged from the well, whichever occurs first. If there is insufficient recharge for the well to fully recover within 12 hours~~-~~, the well will only be purged once and sampled as soon as sufficient volume is recharged to the well, as per the guidelines in the Technical Enforcement Guidance Document (U.S. EPA, 1989). Groundwater samples will be collected using a disposable polyethylene bailer attached to a nylon rope. However, groundwater may also be collected from a submersible pump under a reduced flow to prevent volatilization if sufficient water exists.

Groundwater samples will be placed in appropriate containers provided by the laboratory. Table I-1 indicates the appropriate sample containers, volumes, and preservation required for each analyte. Samples will then be labeled and immediately placed in a refrigerated cooler for transport to the laboratory. Sample information will also be recorded in the field log book.

4.5 Sample Preservation and Transportation

After sealing the sample container, samples will be placed into a cooler as soon as possible and maintained at a temperature of approximately 4 degrees Celsius (°C). Samples will be transported to the analytical laboratory at the end of each sampling event. Samples in breakable containers will be packed in such a way as to prevent breakage during transportation. Table I-1 provides a summary of sample preservation and holding times required for each analyte.

4.6 Quality Assurance Samples

Duplicate samples will be collected in order to check the precision of laboratory analyses. Duplicates will be included for each parameter requested with samples sent to the laboratory and labeled so that the samples are not identified as quality assurance samples. Approximately one duplicate sample will be collected for each ten samples sent to the laboratory or one per sample batch, whichever is less.

One trip blank sample will also be sent with each cooler containing samples for volatile organics analysis. Blank samples will be labeled so that the samples are not identified as quality assurance samples.

4.7 Chain of Custody Procedures

Chain of custody documentation will be used to ensure the integrity of samples from the time of collection to reporting of analytical results. This documentation will permit tracing of the possession and handling of samples from the time of collection through analysis and final disposition. Copies of the chain of custody forms will be kept in the facility operating record.

Sample custody will be initiated at the time of sample collection by placing a label on the sample container and filling out a chain of custody form. Each sample collected will be identified in the chain of custody form. Each person handling the sample will be identified on the form.

4.8 Field Equipment

Field equipment required for collecting samples will include: sample containers; gloves; refrigerated cooler; sample labels; physical parameter meter; log book; and miscellaneous equipment.

Calibration of field equipment (e.g., pH meter or organic vapor meter) will be conducted at the beginning and end of each work day.

4.9 Decontamination

In order to prevent cross contamination between sampling sites, sampling equipment will be decontaminated according to the following procedures.

- Remove excess soil or other adhering substances
- Wash with a solution of non-phosphate detergent in tap water
- Rinse with tap water
- Double rinse with distilled water

Decontamination of all equipment that comes into direct contact with sampled media will be carried out between samples and prior to equipment leaving the site. If a pump and hose system is used, the system will be cleaned prior to each groundwater sampling event by pumping a non-phosphate detergent dissolved in fresh tap water followed by a double rinse with de-ionized water. Should bailers be necessary, an unused, disposable bailer will be used at each well to prevent cross-contamination.

5. Laboratory Analysis

5.1 Analytical Methods

Table I-1 summarizes -the analytical program for the baseline liquid characterization program, as well as for water detected in vadose zone monitoring wells and sumps. ~~Detection limits will be below drinking water~~

~~standards for applicable parameters.~~ Analytical detection limits will meet the most stringent of the following three criteria:

- Applicable state or federal drinking water standards
- Universal treatment standards (UTS) contained at 20.4.1.800 NMAC (incorporating 40 CFR 268, Subpart D)
- Lowest detection limits specified at EPA publication SW-846 (most recent edition)

This analytical program is designed to "fingerprint" fluids associated with the landfill operations so that if water is detected in the vadose zone sumps or monitoring wells, the source of that water can be determined. As such, it may become justifiable to revise the vadose zone sump and monitoring well analytical program based on the results of the baseline liquid characterization program. NMED approval will be obtained prior to making any changes to the program.

5.2 Laboratory Quality Assurance/Quality Control

Internal laboratory quality assurance/quality control procedures will include the following:

- Laboratory chain-of-custody tracking of samples
- Instrument calibration using calibration check standards and laboratory blanks
- Use of reagent and method blanks
- QC spike samples (approximately 1 every 20 samples)
- Matrix spike samples (approximately 1 every 20 samples)
- Laboratory split sample duplicates (approximately 1 every 20 samples)
- Laboratory check standards (approximately 1 every 20 samples)

5.3 Data Review, Validation, and Verification Requirements

All analytical laboratory data will be presented in accordance with~~as~~ SW-846 [i.e., EPA SW-846, *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*~~, *Third Edition*~~ (most recent edition, e.g., U.S. EPA, 2011a~~EPA, 1986~~)] documentation packages that provide the same level of detail as EPA Contract Laboratory Program (CLP) protocol ~~Level IV [see OLM02.1, *USEPA Contract Laboratory Program Statement of Work for Organics Analysis, Multi-Media, Multi-Concentration* (EPA, 1990a) and OLM03.0, *USEPA Contract Laboratory Program Statement of Work for Organics Analysis, Multi-Media, Multi-Concentration* (EPA, 1990b)].~~ (U.S. EPA, 2011b).

A tabular key will be provided with the package that relates field/laboratory sample numbers to: (1) QA and QC samples; (2) cooler receipt form(s); (3) reporting requirements for organic and inorganic analyses; (4) reporting of internal QC results (e.g., laboratory blanks, surrogate spike samples, matrix spike samples, laboratory duplicates and/or matrix spike duplicate pairs, and laboratory control standards); and (5) identification of field duplicates and all types of blanks. Actual chromatograms will be provided for all samples analyzed by gas chromatography (GC) methods.

At a minimum, data package verification will include evaluation of sampling documentation and representativeness, technical holding time, instrument calibration and tuning, field and lab blank sample analyses, method QC sample results, field duplicates, compound identification and quantification, the presence of any elevated detection limits, and a summary of qualified data. All data will be flagged with appropriate qualifiers.

The data validation and verification procedures will include: (1) an initial review or verification of the completeness of individual data packages for each sample delivery group; (2) validation of the data using guidelines tailored to the type of analyses performed (i.e., organics, inorganics, or radiochemical); (3) resolution of data discrepancies, where possible, by liaison with the responsible laboratory; (4) qualification of data by flagging with appropriate codes, with emphasis on data usability for decision-making purposes; and (5) preparation of sample delivery group specific data assessment summaries and a narrative report.

6. Data Management

6.1 Field Documentation

Records of all field activities will be kept in the facility operating record and the following items will be used to document field activities:

- Field log book
- Boring logs and well construction diagrams
- Well or sump sampling logs
- Chain of custody forms

Field log books will be maintained during the operating and post-closure period of the facility and used to record details of work including daily activities, any deviations from sampling or quality assurance plans, and equipment calibration.

Geologic boring logs will be produced by the field geologist during drilling activities. The logs will be prepared under the direct supervision of a qualified geologist or geotechnical engineer. Field logs will also be reviewed by the supervising geologist or engineer prior to finalization.

6.2 Laboratory Documentation

Once custody of a sample has been relinquished to the laboratory, complete documentation of the progress of the sample through the analytical process will be carried out by the laboratory. This will include a description of sample condition upon receipt, recording of sample receipt in the laboratory log book, documentation of steps in the analytical process, and recording of the results of analysis.

6.3 Laboratory Reporting

The laboratory reports (Level IV Data Validation Packages) will include the following information: ~~listed below.~~

- Sample number (as recorded on sample label and in field log book)
- Date sample received by laboratory
- Date of analysis
- Analysis performed
- Results of analysis
- Detection limits
- Reporting units

- Signatures of persons responsible for analysis

In addition, laboratory reports will include the raw data (e.g., chromatograms), copies of chain of custody forms, and results of laboratory QC procedures indicating accuracy and precision of analytical results.

6.4 Data Analysis

Data analysis will include tabular and graphical representation, graphical comparison between various parameters, and statistical analysis,if appropriate, to determine whether fluids detected in the VZMS during the monitoring period are from leachate fluids sources or not. Statistical procedures will follow the methods described in Permit Attachment Q, Statistics for Release Determination. The application of data analysis methods is dependent on the data -reported during monitoring of the VZMS, if any.

Using primarily the baseline characterizations and the leachate fluid analyses (WAP), chemical profiles of the water types as well as a suite of appropriate analytical indicator parameters will be selected to be incorporated into the vadose zone monitoring program for leak detection during facility operation. The indicator parameters will be based primarily on the leachate fluid analyses, while the non-leachate fluids profiles will be based primarily on major ion chemistry established in the baseline, if available. Therefore, the indicator parameter list is expected to evolve as varying waste streams are accepted by the facility. In addition, all hazardous chemicals ever received at the facility will be considered as indicator parameters.

Analytical data from samples of fluids detected in the VZMS -will be compared to the non-leachate fluids baseline characterizations and leachate fluids evaluations discussed in Section 3.0. These comparisons will be based on evaluating trilinear plots of major ion chemistry characterization for non-leachate parameters: (bicarbonate, chloride, dissolved major cations [Na, K, Mg, Ca, Fe], total dissolved solids [TDS], and sulfate) (e.g., calcium, magnesium, potassium, sodium, bicarbonate, sulfate and chloride) and tabular and graphical summaries of metals/nonmetals, radionuclides, hydrocarbons, and other constituents. Through these evaluations, an obvious correlation between the water types and concentration ranges of the monitoring sample to either the leachate fluids or non-leachate fluids characterization may be observed. If the monitoring sample data cannot be easily characterized as leachate fluid or non-leachate fluid, or if concentrations fall outside the ranges established during baseline characterization, the monitoring sample will be characterized using statistical methods. Statistical analysis will be used to determine statistically significant changes in the following non-leachate parameters: dissolved and total metals (Sb, As, Ba, Be, Cd, Cr, Cu, Pb, Hg, Ni, Se, Ag, Ti, Zn) and radionuclides (gross alpha, gross beta, gamma emitters, total uranium, radium 226/228, radon). In this case, a tolerance or prediction interval statistical procedure will be applied, unless a more appropriate statistical method is identified.

In order to apply these statistics, it may become necessary to collect additional baseline data for non-leachate fluids to establish a more concrete background profile. The need for additional baseline sampling and analysis will be evaluated at the time of occurrence and evaluation of fluids in the VZMS.

Solid and liquid wastes accepted by the facility, as well as leachate fluids, will be sampled and analyzed separately and individually as per the WAP. These data will be used to develop a list of indicator parameters (i.e., waste constituents) to monitor for in the VZMS and will be used to determine if fluids detected in the VZMS are in fact leachate fluids. Additionally, if based on these data it is not clear whether the fluids detected in the VZMS are leachate fluids or not, additional samples of any fluids present in the LCRSs and the evaporation ponds will be collected and analyzed for major ions and metals, as per Table I-1. These data will then be used to develop a chemical profile of these waters at the time of occurrence of fluids in the VZMS and used to compare to the baseline non-leachate fluid profile(s) to aid in determining the source of fluids in the VZMS.

6.5 Data Reporting

Data will be summarized and presented to NMED on a quarterly basis. All reports will be prepared under the supervision of a qualified geologist or professional engineer. The report will include an executive summary that highlights any significant findings during the reporting period.

The first quarterly report will contain the following information:

- Well completion and lithologic logs
- List of indicator parameters for non-leachate fluids and associated computations
- List of indicator parameters for initial leachate ~~based on F-039 and the first Appendix IX analysis; and~~
- VZMS analytical results collected during the first quarter
- Well inspection logs
- Monitoring field logs with sampling information

The main body of quarterly ~~the~~ reports will include discussions or summaries of the following topics ~~listed below.~~:

- Monitoring and sampling methodology
- Sample collection and preservation procedures
- Indicator parameter list, including non-leachate and leachate parameters indicating any revisions and evaluations used to derive the indicator parameters
- Current and historical analytical results
- Monthly leachate chemistry results
- Current and historical fluid levels~~, if applicable~~
- VZMS inspection and maintenance results
- Volumes of fluids removed from all monitoring points, including the LCRS~~s~~ and LDRS~~s~~
- Release assessment information in the form of a summary of the data reports
- Significant historical changes in fluid levels or fluid chemistry (e.g., leachate fluids)
- Summary of 40 CFR 264 Appendix IX results included in the previous biennial sampling event
- A cumulative list of chemicals managed in the landfill~~regulated units~~, as identified in the WAP

~~The report will also include the items listed below.~~

- Maps illustrating facility waste management units and monitoring sump and well locations
- Maps illustrating groundwater depth, gradient and flow direction (if appropriate)
- Map (plan view or cross-section) illustrating groundwater pathways (if appropriate)
- Graphs and/or tables depicting water quality
- Laboratory documentation, chain of custody and QA/QC documentation
- Copies of well and sump sampling logs and other pertinent documentation
- Operation and maintenance report
- Conclusions and recommendations

Biennial reports will also be submitted that contain the following information:

- 40 CFR 264 Appendix IX analysis
- Any modification to the indicator parameter list based on 40 CFR 264 Appendix IX analysis, including evaluations used to derive the indicator parameters

If needed, special reports will be submitted that contain the following information:

- Release information
- Monthly reports, as long as there are leachate fluids in the VZMS
- Non-leachate parameter list, including evaluations used to derive the indicator parameters

If fluids are detected in either the sumps or wells, NMED will be notified within 24 hours. Subsequently, an additional report (i.e., not a regularly scheduled quarterly report) will then be submitted to NMED within 14 days of fluid appearance. This report will include an assessment of the amount and source of the fluids; the possible size, location, and cause of the leak; and the seriousness of the any leak in terms of potential releases to the environment. It will also include a summary of any immediate short or long term response actions to be taken. The report will also include ~~those items listed below~~the following items~~.~~:

- Monitoring results from the sumps and wells (volumes/fluid levels and analytical results)
- A comparison to the baseline characterization results
- Analytical results for all fluids

Within 30 days of fluid appearance, a report will be submitted to NMED describing the effectiveness of the response actions. Monthly reports will be submitted to NMED as long as fluids are present in the VZMS.

6.6 Data Storage

All completed data analyses and reports from this project will be stored electronically. Copies of the electronic data and hard copies of the data and laboratory reports will be placed in the facility record during the operating and post-closure periods.

7. Health and Safety

If there is reasonable potential for exposure to toxic compounds, field personnel will be required to have current certification of 40-hour health and safety training per OSHA 29 CFR 1910.120(e). Personnel will adhere to proper health and safety protocols as described in a separate health and safety plan that will be submitted to NMED for review and approval prior to initiation of work plan activities. The selected contractor will also provide a health and safety plan relating to their operation (e.g., drilling equipment).

A Health and Safety Officer (HSO) will be designated that will be responsible for monitoring potentially hazardous situations during all field activities, ensuring that all personnel know the potential physical and chemical hazards and are trained in the proper use of personal protective equipment (PPE). It is anticipated that safety Level D will be the highest level of PPE necessary (i.e., work clothes, hard hats, steel-toed boots and safety glasses). The HSO will make the decision when it is necessary to upgrade to a higher level of PPE. The HSO will also conduct periodic air monitoring (documented following Rule 1166-type requirements [SCAQMD, 2001]) and determine if conditions require an immediate termination of work.

References[rpf6][rpf7]

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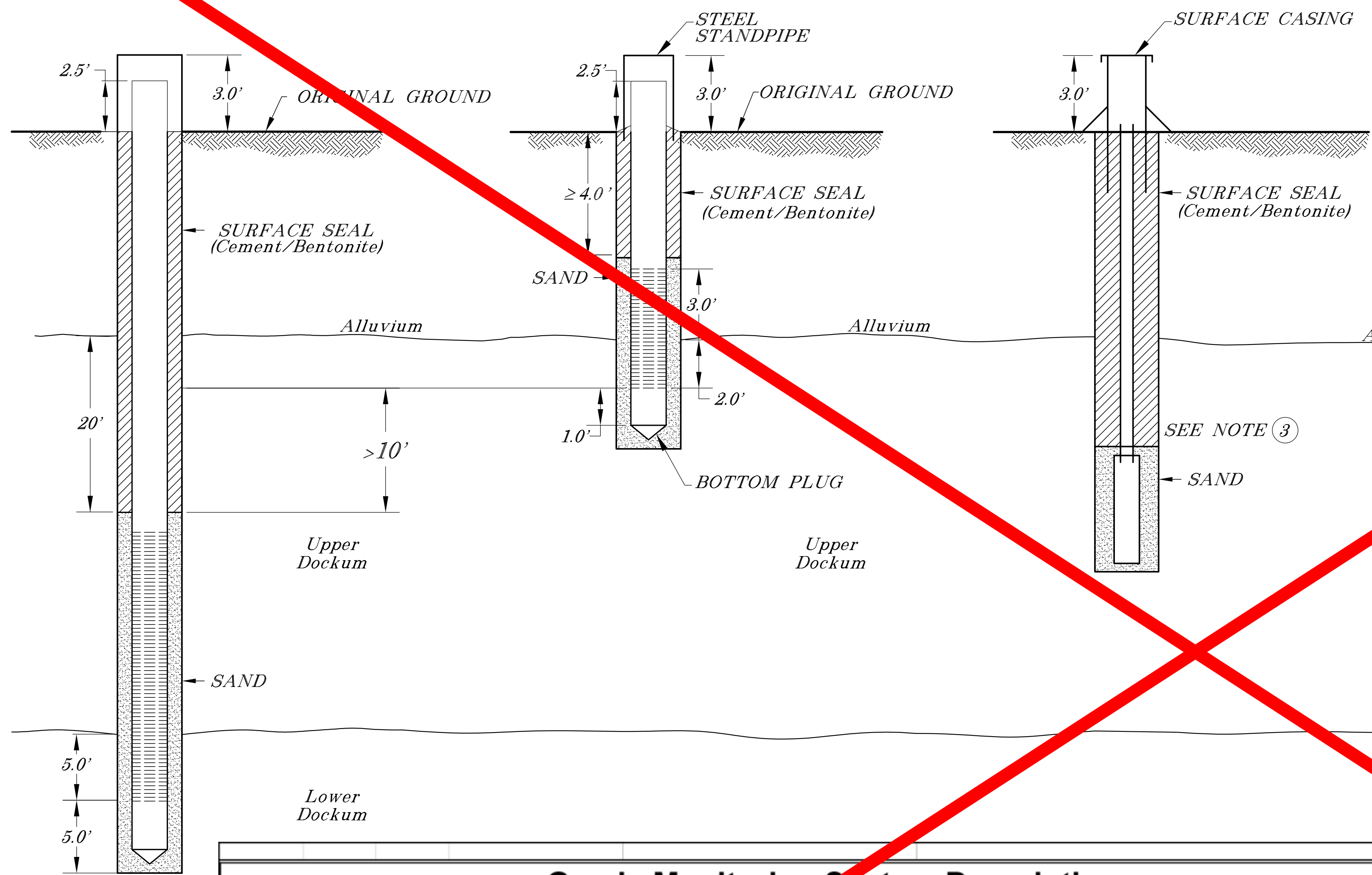
Drawing eliminated for 2011 permit renewal.

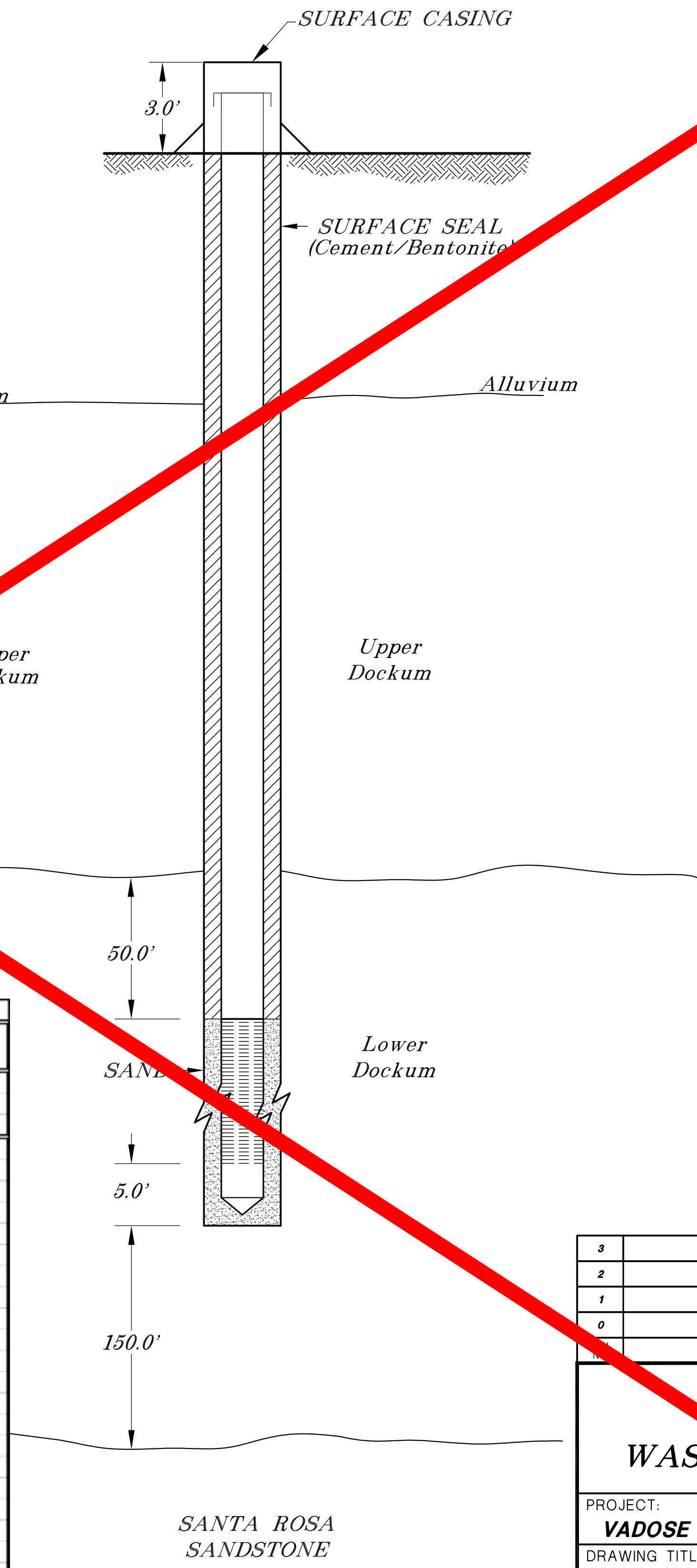
DEEP MONITORING WELL AND NEUTRON PROBES INSTALLATION DETAILS (2)
NTS

SHALLOW MONITORING WELL INSTALLATION DETAIL (2)
NTS

PRESSURE-VACUUM SOIL-WATER SAMPLER INSTALLATION DETAIL (2)
NTS



VERY DEEP MONITORING WELL INSTALLATION DETAIL (2)
NTS



NOTES:

(2) INSTALLATION DETAILS ARE CONCEPTUAL TO INDICATE APPROXIMATE DEPTH OF INSTALLATION AND SCREENED OR MONITORED INTERVALS. ACTUAL DETAILS TO BE DETERMINED IN THE FIELD.

(3) SAMPLER TO BE LOCATED AT DEPTH OF FIVE FEET BELOW VADOSE ZONE SUMPS FOR SURFACE IMPOUNDMENT.

Gandy Monitoring System Description

Name	Number	Depth	Contact/Zone to Be Monitored	Installation Description	General Location (1)
VZMW- D	1	Deep	Upper/Lower Dockum	4-inch diameter Sch 80, PVC Pipe	East side of north evaporation pond
VZMW- D	2	Deep	Upper/Lower Dockum	4-inch diameter Sch 80, PVC Pipe	East side of south evaporation pond
VZMW- D	3	Deep	Upper/Lower Dockum	4-inch diameter Sch 80, PVC Pipe	East side of Phase IA, 400 feet south of NE corner of landfill
VZMW- D	4	Deep	Upper/Lower Dockum	4-inch diameter Sch 80, PVC Pipe	East side of Phase IA, 750 feet south of NE corner of landfill
VZMW- D	5	Deep	Upper/Lower Dockum	4-inch diameter Sch 80, PVC Pipe	East side of Phase IA, 1050 feet south of NE corner of landfill
VZMW- D	6	Deep	Upper/Lower Dockum	4-inch diameter Sch 80, PVC Pipe	At NE corner of Phase IA of landfill
VZMW- D	7	Deep	Upper/Lower Dockum	4-inch diameter Sch 80, PVC Pipe	At NE corner of Facility boundary
VZMW- D	8	Deep	Upper/Lower Dockum	4-inch diameter Sch 80, PVC Pipe	Halfway along a straight line extended between VZMW-D6 and D7
VZMW- D	9	Deep	Upper/Lower Dockum	4-inch diameter Sch 80, PVC Pipe	Next to WW1
VZMW- D	10	Deep	Upper/Lower Dockum	4-inch diameter Sch 80, PVC Pipe	Next to PB14
VZMW- S	11	Shallow	Upper Dockum	Vacuum-pressure Suction Cup Sampler	NW Corner of north evaporation pond (next to VSMW-D23)
VZMW- S	12	Shallow	Upper Dockum	Vacuum-pressure Suction Cup Sampler	East side of north evaporation pond (next to VZMW-D1)
VZMW- S	13	Shallow	Upper Dockum	Vacuum-pressure Suction Cup Sampler	East side of south evaporation pond (next to VZMW-D2)
VZMW- S	14	Shallow	Alluvial/Upper Dockum	4-inch diameter Sch 80, PVC Pipe	NE corner of Stormwater Detention Basin
VZMW- S	15	Shallow	Alluvial/Upper Dockum	4-inch diameter Sch 80, PVC Pipe	East side of Stormwater Detention Basin, one-third distance between 14 and 17
VZMW- S	16	Shallow	Alluvial/Upper Dockum	4-inch diameter Sch 80, PVC Pipe	East side of Stormwater Detention Basin, two-thirds distance between 14 and 17
VZMW- S	17	Shallow	Alluvial/Upper Dockum	4-inch diameter Sch 80, PVC Pipe	SE corner of Stormwater Detention Basin
VZMW- S	18	Shallow	Alluvial/Upper Dockum	4-inch diameter Sch 80, PVC Pipe	Next to WW1
VZMW- S	19	Shallow	Alluvial/Upper Dockum	4-inch diameter Sch 80, PVC Pipe	Next to PB14
VZMW- VD	20	Very Deep	Lower Dockum	4-inch diameter Sch 80, PVC Pipe	SE corner of Stormwater Detention Basin (next to VZMW-S17)
VZMW- D	21	Deep	Upper/Lower Dockum	2-inch dia. Sch 80, PVC Pipe, Neutron Probe	North side, center, Phase 1A Landfill
VZMW- D	22	Deep	Upper/Lower Dockum	2-inch dia. Sch 80, PVC Pipe, Neutron Probe	West side, center, Phase 1A Landfill
VZMW- D	23	Deep	Upper/Lower Dockum	2-inch dia. Sch 80, PVC Pipe, Neutron Probe	NW Corner of north evaporation pond (next to VSMW-S11)

Note 1 - See Sheet 1 of 2 for approximate locations on site facility map.

Not For Construction

No.	REVISIONS	DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
3	Revisions	4/15/02	P.Corser	J.Gates	P.Corser
2	Revisions	7/6/00	T.Leeson	K.Conrath	T.Leeson
1	Revisions	5/9/00	T.Leeson	K.Conrath	T.Leeson
0	Issued for Report	2/11/00	T.Leeson	K.Conrath	T.Leeson

TRIASSIC PARK

WASTE DISPOSAL FACILITY

PROJECT: **VADOSE ZONE MONITORING SYSTEM WORK PLAN**

DRAWING TITLE: **WELL INSTALLATION DETAILS**

MWH
MONTGOMERY WATSON HARZA

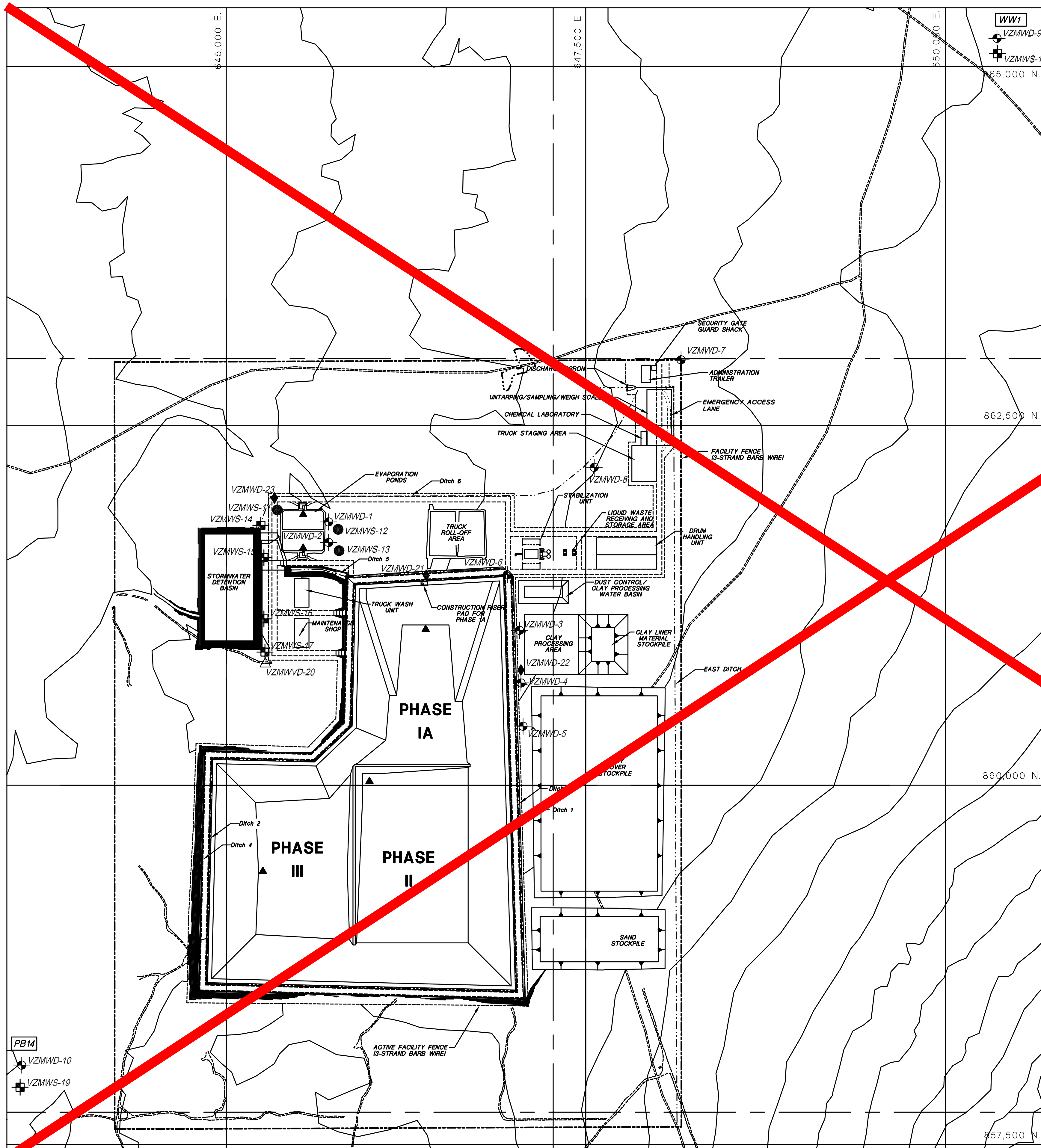
Sheet 2 of 2 Sheets

SCALE: As Shown

DRAWING No. 2

AutoCAD FILE: Well Install Details

PROJECT NUMBER: 2450192



LEGEND

- EXISTING CONTOUR
- REGRADED CONTOUR
- FACILITY AND ACTIVE FACILITY FENCES
- VADOSE ZONE SUMP
- VZMWS-11 SHALLOW WELL AT UPPER DOCKUM WITH LYSIMETER
- VZMWD- DEEP WELL AT UPPER/ LOWER DOCKUM
- VZMWVD-20 VERY DEEP - LOWER DOCKUM
- VZMWS-15 SHALLOW WELL AT UPPER DOCKUM ALLUVIAL
- VZMWD-22 NEUTRON PROBES

Drawing eliminated for 2011 permit renewal.

SCALE

500' 0 500' 1000'

Not For Construction

No.	REVISIONS	DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
3	Revisions	4/15/02	P.Corser	J.Gates	P.Corser
2	Revisions	7/6/00	T.Leeson	K.Conrath	T.Leeson
1	Revisions	5/9/00	T.Leeson	K.Conrath	T.Leeson
0	Issued for Report	2/11/00	T.Leeson	K.Conrath	T.Leeson

TRIASSIC PARK WASTE DISPOSAL FACILITY

PROJECT: **VADOSE ZONE MONITORING SYSTEM WORK PLAN**

DRAWING TITLE: **MONITORING WELL LOCATIONS**

MWH
MONTGOMERY WATSON HARZA

Sheet 1 of 2 Sheets
SCALE: As Shown
DRAWING No. 2

AutoCAD FILE: Monitoring Locations   PROJECT NUMBER: 2450192

Appendix A

~~Meteoric Water Mobility~~Synthetic Precipitation Leaching Procedure

ABSTRACT

Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (SW-846) provides test procedures and guidance which are recommended for use in conducting the evaluations and measurements needed to comply with the Resource Conservation and Recovery Act (RCRA), Public Law 94-580, as amended. These methods are approved by the U.S. Environmental Protection Agency for obtaining data to satisfy the requirements of 40 **CFR** Parts 122 through 270 promulgated under RCRA, as amended. This manual presents the state-of-the-art in routine analytical tested adapted for the RCRA program. It contains procedures for field and laboratory quality control, sampling, determining hazardous constituents in wastes, determining the hazardous characteristics of wastes (toxicity, ignitability, reactivity, and corrosivity), and for determining physical properties of wastes. It also contains guidance on how to select appropriate methods.

Several of the hazardous waste regulations under Subtitle C of RCRA require that specific testing methods described in SW-846 be employed for certain applications. Refer to 40 *Code of Federal Regulations* (CFR), Parts 260 through 270, for those specific requirements. Any reliable analytical method may be used to meet other requirements under Subtitle C of RCRA.

CHAPTER SIX

PROPERTIES

This chapter addresses procedures for "method-defined parameters," where the analytical result is wholly dependant on the process used to make the measurement. Changes to the specific methods may change the end result and incorrectly identify a waste as nonhazardous. Therefore, when the measurement of such method-defined parameters is required by regulation, those methods are **not** subject to the flexibility afforded in other SW-846 methods (such as described in the Disclaimer and Chapter Two of this manual).

The following methods are found in Chapter Six:

Method 1030:	Ignitability of Solids
Method 1040:	Test Method for Oxidizing Solids
Method 1050:	Test Methods to Determine Substances Likely to Spontaneously Combust
Method 1120:	Dermal Corrosion
Method 1312:	Synthetic Precipitation Leaching Procedure
Method 1320:	Multiple Extraction Procedure
Method 1330A:	Extraction Procedure for Oily Wastes
Method 9041A:	pH Paper Method
Method 9045D:	Soil and Waste pH
Method 9050A:	Specific Conductance
Method 9080:	Cation-Exchange Capacity of Soils (Ammonium Acetate)
Method 9081:	Cation-Exchange Capacity of Soils (Sodium Acetate)
Method 9090A:	Compatibility Test for Wastes and Membrane Liners
Method 9095B:	Paint Filter Liquids Test
Method 9096:	Liquid Release Test (LRT) Procedure
	Appendix A: Liquid Release Test Pre-Test
Method 9100:	Saturated Hydraulic Conductivity, Saturated Leachate Conductivity, and Intrinsic Permeability
Method 9310:	Gross Alpha and Gross Beta
Method 9315:	Alpha-Emitting Radium Isotopes

METHOD 1312

SYNTHETIC PRECIPITATION LEACHING PROCEDURE

1.0 SCOPE AND APPLICATION

1.1 Method 1312 is designed to determine the mobility of both organic and inorganic analytes present in liquids, soils, and wastes.

2.0 SUMMARY OF METHOD

2.1 For liquid samples (i.e., those containing less than 0.5 % dry solid material), the sample, after filtration through a 0.6 to 0.8 µm glass fiber filter, is defined as the 1312 extract.

2.2 For samples containing greater than 0.5 % solids, the liquid phase, if any, is separated from the solid phase and stored for later analysis; the particle size of the solid phase is reduced, if necessary. The solid phase is extracted with an amount of extraction fluid equal to 20 times the weight of the solid phase. The extraction fluid employed is a function of the region of the country where the sample site is located if the sample is a soil. If the sample is a waste or wastewater, the extraction fluid employed is a pH 4.2 solution. A special extractor vessel is used when testing for volatile analytes (see Table 1 for a list of volatile compounds). Following extraction, the liquid extract is separated from the solid phase by filtration through a 0.6 to 0.8 µm glass fiber filter.

2.3 If compatible (i.e., multiple phases will not form on combination), the initial liquid phase of the waste is added to the liquid extract, and these are analyzed together. If incompatible, the liquids are analyzed separately and the results are mathematically combined to yield a volume-weighted average concentration.

3.0 INTERFERENCES

3.1 Potential interferences that may be encountered during analysis are discussed in the individual analytical methods.

4.0 APPARATUS AND MATERIALS

4.1 Agitation apparatus: The agitation apparatus must be capable of rotating the extraction vessel in an end-over-end fashion (see Figure 1) at 30 ± 2 rpm. Suitable devices known to EPA are identified in Table 2.

4.2 Extraction Vessels

4.2.1 Zero Headspace Extraction Vessel (ZHE). This device is for use only when the sample is being tested for the mobility of volatile analytes (i.e., those listed in Table 1). The ZHE (depicted in Figure 2) allows for liquid/solid separation within the device and effectively precludes headspace. This type of vessel allows for initial liquid/solid separation, extraction, and final extract filtration without opening the vessel (see Step 4.3.1). These vessels shall have an internal volume of 500-600 mL and be equipped to accommodate a 90-110 mm filter. The devices contain VITON®[1] O-rings which should be replaced frequently. Suitable ZHE devices known to EPA are identified in Table 3.

For the ZHE to be acceptable for use, the piston within the ZHE should be able to be moved with approximately 15 psig or less. If it takes more pressure to move the piston, the O-rings in the device should be replaced. If this does not solve the problem, the ZHE is unacceptable for 1312 analyses and the manufacturer should be contacted.

The ZHE should be checked for leaks after every extraction. If the device contains a built-in pressure gauge, pressurize the device to 50 psig, allow it to stand unattended for 1 hour, and recheck the pressure. If the device does not have a built-in pressure gauge, pressurize the device to 50 psig, submerge it in water, and check for the presence of air bubbles escaping from any of the fittings. If pressure is lost, check all fittings and inspect and replace O-rings, if necessary. Retest the device. If leakage problems cannot be solved, the manufacturer should be contacted.

Some ZHEs use gas pressure to actuate the ZHE piston, while others use mechanical pressure (see Table 3). Whereas the volatiles procedure (see Step 7.3) refers to pounds-per-square-inch (psig), for the mechanically actuated piston, the pressure applied is measured in torque-inch-pounds. Refer to the manufacturer's instructions as to the proper conversion.

4.2.2 Bottle Extraction Vessel. When the sample is being evaluated using the nonvolatile extraction, a jar with sufficient capacity to hold the sample and the extraction fluid is needed. Headspace is allowed in this vessel.

The extraction bottles may be constructed from various materials, depending on the analytes to be analyzed and the nature of the waste (see Step 4.3.3). It is recommended that borosilicate glass bottles be used instead of other types of glass, especially when inorganics are of concern. Plastic bottles, other than polytetrafluoroethylene, shall not be used if organics are to be investigated. Bottles are available from a number of laboratory suppliers. When this type of extraction vessel is used, the filtration device discussed in Step 4.3.2 is used for initial liquid/solid separation and final extract filtration.

4.3 Filtration Devices: It is recommended that all filtrations be performed in a hood.

4.3.1 Zero-Headspace Extraction Vessel (ZHE): When the sample is evaluated for volatiles, the zero-headspace extraction vessel described

[1]VITON® is a trademark of Du Pont.

in Step 4.2.1 is used for filtration. The device shall be capable of supporting and keeping in place the glass fiber filter and be able to withstand the pressure needed to accomplish separation (50 psig).

NOTE: When it is suspected that the glass fiber filter has been ruptured, an in-line glass fiber filter may be used to filter the material within the ZHE.

4.3.2 Filter Holder: When the sample is evaluated for other than volatile analytes, a filter holder capable of supporting a glass fiber filter and able to withstand the pressure needed to accomplish separation may be used. Suitable filter holders range from simple vacuum units to relatively complex systems capable of exerting pressures of up to 50 psig or more. The type of filter holder used depends on the properties of the material to be filtered (see Step 4.3.3). These devices shall have a minimum internal volume of 300 mL and be equipped to accommodate a minimum filter size of 47 mm (filter holders having an internal capacity of 1.5 L or greater, and equipped to accommodate a 142 mm diameter filter, are recommended). Vacuum filtration can only be used for wastes with low solids content (<10 %) and for highly granular, liquid-containing wastes. All other types of wastes should be filtered using positive pressure filtration. Suitable filter holders known to EPA are listed in Table 4.

4.3.3 Materials of Construction: Extraction vessels and filtration devices shall be made of inert materials which will not leach or absorb sample components of interest. Glass, polytetrafluoroethylene (PTFE), or type 316 stainless steel equipment may be used when evaluating the mobility of both organic and inorganic components. Devices made of high-density polyethylene (HDPE), polypropylene (PP), or polyvinyl chloride (PVC) may be used only when evaluating the mobility of metals. Borosilicate glass bottles are recommended for use over other types of glass bottles, especially when inorganics are analytes of concern.

4.4 Filters: Filters shall be made of borosilicate glass fiber, shall contain no binder materials, and shall have an effective pore size of 0.6 to 0.8-µm . Filters known to EPA which meet these specifications are identified in Table 5. Pre-filters must not be used. When evaluating the mobility of metals, filters shall be acid-washed prior to use by rinsing with 1N nitric acid followed by three consecutive rinses with reagent water (a minimum of 1-L per rinse is recommended). Glass fiber filters are fragile and should be handled with care.

4.5 pH Meters: The meter should be accurate to ± 0.05 units at 25°C.

4.6 ZHE Extract Collection Devices: TEDLAR®[2] bags or glass, stainless steel or PTFE gas-tight syringes are used to collect the initial liquid phase and the final extract when using the ZHE device. These devices listed are recommended for use under the following conditions:

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[2]TEDLAR® is a registered trademark of Du Pont.

4.6.1 If a waste contains an aqueous liquid phase or if a waste does not contain a significant amount of nonaqueous liquid (i.e., <1 % of total waste), the TEDLAR® bag or a 600 mL syringe should be used to collect and combine the initial liquid and solid extract.

4.6.2 If a waste contains a significant amount of nonaqueous liquid in the initial liquid phase (i.e., >1 % of total waste), the syringe or the TEDLAR® bag may be used for both the initial solid/liquid separation and the final extract filtration. However, analysts should use one or the other, not both.

4.6.3 If the waste contains no initial liquid phase (is 100 % solid) or has no significant solid phase (is <0.5% solid) , either the TEDLAR® bag or the syringe may be used. If the syringe is used, discard the first 5 mL of liquid expressed from the device. The remaining aliquots are used for analysis.

4.7 ZHE Extraction Fluid Transfer Devices: Any device capable of transferring the extraction fluid into the ZHE without changing the nature of the extraction fluid is acceptable (e.g., a positive displacement or peristaltic pump, a gas-tight syringe, pressure filtration unit (see Step 4.3.2), or other ZHE device).

4.8 Laboratory Balance: Any laboratory balance accurate to within ± 0.01 grams may be used (all weight measurements are to be within ± 0.1 grams).

4.9 Beaker or Erlenmeyer flask, glass, 500 mL.

4.10 Watchglass, appropriate diameter to cover beaker or Erlenmeyer flask.

4.11 Magnetic stirrer.

5.0 REAGENTS

5.1 Reagent grade chemicals shall be used in all tests. Unless otherwise indicated, it is intended that all reagents shall conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society, where such specifications are available. Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination.

5.2 Reagent Water. Reagent water is defined as water in which an interferant is not observed at or above the method's detection limit of the analyte(s) of interest. For nonvolatile extractions, ASTM Type II water or equivalent meets the definition of reagent water. For volatile extractions, it is recommended that reagent water be generated by any of the following methods. Reagent water should be monitored periodically for impurities.

5.2.1 Reagent water for volatile extractions may be generated by passing tap water through a carbon filter bed containing about 500 grams of activated carbon (Calgon Corp., Filtrasorb-300 or equivalent).

5.2.2 A water purification system (Millipore Super-Q or equivalent) may also be used to generate reagent water for volatile extractions.

5.2.3 Reagent water for volatile extractions may also be prepared by boiling water for 15 minutes. Subsequently, while maintaining the water temperature at 90 $\pm$ 5 degrees C, bubble a contaminant-free inert gas (e.g. nitrogen) through the water for 1 hour. While still hot, transfer the water to a narrow mouth screw-cap bottle under zero-headspace and seal with a Teflon-lined septum and cap.

5.3 Sulfuric acid/nitric acid (60/40 weight percent mixture) H_2SO_4/HNO_3. Cautiously mix 60 g of concentrated sulfuric acid with 40 g of concentrated nitric acid. If preferred, a more dilute H_2SO_4/HNO_3 acid mixture may be prepared and used in steps 5.4.1 and 5.4.2 making it easier to adjust the pH of the extraction fluids.

5.4 Extraction fluids.

5.4.1 Extraction fluid #1: This fluid is made by adding the 60/40 weight percent mixture of sulfuric and nitric acids (or a suitable dilution) to reagent water (Step 5.2) until the pH is 4.20 $\pm$ 0.05. The fluid is used to determine the leachability of soil from a site that is east of the Mississippi River, and the leachability of wastes and wastewaters.

NOTE: Solutions are unbuffered and exact pH may not be attained.

5.4.2 Extraction fluid #2: This fluid is made by adding the 60/40 weight percent mixture of sulfuric and nitric acids (or a suitable dilution) to reagent water (Step 5.2) until the pH is 5.00 $\pm$ 0.05. The fluid is used to determine the leachability of soil from a site that is west of the Mississippi River.

5.4.3 Extraction fluid #3: This fluid is reagent water (Step 5.2) and is used to determine cyanide and volatiles leachability.

NOTE: These extraction fluids should be monitored frequently for impurities. The pH should be checked prior to use to ensure that these fluids are made up accurately. If impurities are found or the pH is not within the above specifications, the fluid shall be discarded and fresh extraction fluid prepared.

5.5 Analytical standards shall be prepared according to the appropriate analytical method.

6.0 SAMPLE COLLECTION, PRESERVATION, AND HANDLING

6.1 All samples shall be collected using an appropriate sampling plan.

6.2 There may be requirements on the minimal size of the field sample depending upon the physical state or states of the waste and the analytes of concern. An aliquot is needed for the preliminary evaluations of the percent solids and the particle size. An aliquot may be needed to conduct the nonvolatile analyte extraction procedure. If volatile organics are of concern, another aliquot may be needed. Quality control measures may require additional aliquots. Further, it is always wise to collect more sample just in case something goes wrong with the initial attempt to conduct the test.

6.3 Preservatives shall not be added to samples before extraction.

6.4 Samples may be refrigerated unless refrigeration results in irreversible physical change to the waste. If precipitation occurs, the entire sample (including precipitate) should be extracted.

6.5 When the sample is to be evaluated for volatile analytes, care shall be taken to minimize the loss of volatiles. Samples shall be collected and stored in a manner intended to prevent the loss of volatile analytes (e.g., samples should be collected in Teflon-lined septum capped vials and stored at 4°C. Samples should be opened only immediately prior to extraction).

6.6 1312 extracts should be prepared for analysis and analyzed as soon as possible following extraction. Extracts or portions of extracts for metallic analyte determinations must be acidified with nitric acid to a pH < 2, unless precipitation occurs (see Step 7.2.14 if precipitation occurs). Extracts should be preserved for other analytes according to the guidance given in the individual analysis methods. Extracts or portions of extracts for organic analyte determinations shall not be allowed to come into contact with the atmosphere (i.e., no headspace) to prevent losses. See Step 8.0 (Quality Control) for acceptable sample and extract holding times.

7.0 PROCEDURE

7.1 Preliminary Evaluations

Perform preliminary 1312 evaluations on a minimum 100 gram aliquot of sample. This aliquot may not actually undergo 1312 extraction. These preliminary evaluations include: (1) determination of the percent solids (Step 7.1.1); (2) determination of whether the waste contains insignificant solids and is, therefore, its own extract after filtration (Step 7.1.2); and (3) determination of whether the solid portion of the waste requires particle size reduction (Step 7.1.3).

7.1.1 Preliminary determination of percent solids: Percent solids is defined as that fraction of a waste sample (as a percentage of the total sample) from which no liquid may be forced out by an applied pressure, as described below.

7.1.1.1 If the sample will obviously yield no free liquid when subjected to pressure filtration (i.e., is 100% solid), weigh out a representative subsample (100 g minimum) and proceed to Step 7.1.3.

7.1.1.2 If the sample is liquid or multiphasic, liquid/solid separation to make a preliminary determination of percent solids is required. This involves the filtration device discussed in Step 4.3.2, and is outlined in Steps 7.1.1.3 through 7.1.1.9.

7.1.1.3 Pre-weigh the filter and the container that will receive the filtrate.

7.1.1.4 Assemble filter holder and filter following the manufacturer's instructions. Place the filter on the support screen and secure.

7.1.1.5 Weigh out a subsample of the waste (100 gram minimum) and record the weight.

7.1.1.6 Allow slurries to stand to permit the solid phase to settle. Samples that settle slowly may be centrifuged prior to filtration. Centrifugation is to be used only as an aid to filtration. If used, the liquid should be decanted and filtered followed by filtration of the solid portion of the waste through the same filtration system.

7.1.1.7 Quantitatively transfer the sample to the filter holder (liquid and solid phases). Spread the sample evenly over the surface of the filter. If filtration of the waste at 4°C reduces the amount of expressed liquid over what would be expressed at room temperature, then allow the sample to warm up to room temperature in the device before filtering.

Gradually apply vacuum or gentle pressure of 1-10 psig, until air or pressurizing gas moves through the filter. If this point is not reached under 10 psig, and if no additional liquid has passed through the filter in any 2-minute interval, slowly increase the pressure in 10 psig increments to a maximum of 50 psig. After each incremental increase of 10 psig, if the pressurizing gas has not moved through the filter, and if no additional liquid has passed through the filter in any 2-minute interval, proceed to the next 10-psig increment. When the pressurizing gas begins to move through the filter, or when liquid flow has ceased at 50 psig (i.e., filtration does not result in any additional filtrate within any 2-minute period), stop the filtration.

NOTE: If sample material (>1 % of original sample weight) has obviously adhered to the container used to transfer the sample to the filtration apparatus, determine the weight of this residue and subtract it from the sample weight determined in Step 7.1.1.5 to determine the weight of the sample that will be filtered.

NOTE: Instantaneous application of high pressure can degrade the glass fiber filter and may cause premature plugging.

7.1.1.8 The material in the filter holder is defined as the solid phase of the sample, and the filtrate is defined as the liquid phase.

NOTE: Some samples, such as oily wastes and some paint wastes, will obviously contain some material that appears to be a liquid, but even after applying vacuum or pressure filtration, as outlined in Step 7.1.1.7, this material may not filter. If this is the case, the material within the filtration device is defined as a solid. Do not replace the original filter with a fresh filter under any circumstances. Use only one filter.

7.1.1.9 Determine the weight of the liquid phase by subtracting the weight of the filtrate container (see Step 7.1.1.3) from the total weight of the filtrate-filled container. Determine the weight of the solid phase of the sample by subtracting the weight of the liquid phase from the weight of the total sample, as determined in Step 7.1.1.5 or 7.1.1.7.

Record the weight of the liquid and solid phases. Calculate the percent solids as follows:

$$\text{Percent solids} = \frac{\text{Weight of solid (Step 7.1.1.9)}}{\text{Total weight of waste (Step 7.1.1.5 or 7.1.1.7)}} \times 100$$

7.1.2 If the percent solids determined in Step 7.1.1.9 is equal to or greater than 0.5%, then proceed either to Step 7.1.3 to determine whether the solid material requires particle size reduction or to Step 7.1.2.1 if it is noticed that a small amount of the filtrate is entrained in wetting of the filter. If the percent solids determined in Step 7.1.1.9 is less than 0.5%, then proceed to Step 7.2.9 if the nonvolatile 1312 analysis is to be performed, and to Step 7.3 with a fresh portion of the waste if the volatile 1312 analysis is to be performed.

7.1.2.1 Remove the solid phase and filter from the filtration apparatus.

7.1.2.2 Dry the filter and solid phase at 100 $\pm$ 20°C until two successive weighings yield the same value within $\pm$ 1 %. Record the final weight.

Caution: The drying oven should be vented to a hood or other appropriate device to eliminate the possibility of fumes from the sample escaping into the laboratory. Care should be taken to ensure that the sample will not flash or violently react upon heating.

7.1.2.3 Calculate the percent dry solids as follows:

$$\text{Percent dry solids} = \frac{\text{(Weight of dry sample + filter) - tared weight of filter}}{\text{Initial weight of sample (Step 7.1.1.5 or 7.1.1.7)}} \times 100$$

7.1.2.4 If the percent dry solids is less than 0.5%, then proceed to Step 7.2.9 if the nonvolatile 1312 analysis is to be performed, and to Step 7.3 if the volatile 1312 analysis is to be performed. If the percent dry solids is greater than or equal to 0.5%, and if the nonvolatile 1312 analysis is to be performed, return to the beginning of this Step (7.1) and, with a fresh portion of sample, determine whether particle size reduction is necessary (Step 7.1.3).

7.1.3 Determination of whether the sample requires particle-size reduction (particle-size is reduced during this step): Using the solid portion of the sample, evaluate the solid for particle size. Particle-size reduction is required, unless the solid has a surface area per gram of material equal to or greater than 3.1 cm^2, or is smaller than 1 cm in its narrowest dimension (i.e., is capable of passing through a 9.5 mm (0.375 inch) standard sieve). If the surface area is smaller or the particle size larger than described above, prepare the solid portion of the sample for extraction by crushing, cutting, or grinding the waste to a surface area or particle size as described above. If the solids are prepared for organic volatiles extraction, special precautions must be taken (see Step 7.3.6).

NOTE: Surface area criteria are meant for filamentous (e.g., paper, cloth, and similar) waste materials. Actual measurement of surface area is not required, nor is it recommended. For materials that do not obviously meet the criteria, sample-specific methods would need to be developed and employed to measure the surface area. Such methodology is currently not available.

7.1.4 Determination of appropriate extraction fluid:

7.1.4.1 For soils, if the sample is from a site that is east of the Mississippi River, extraction fluid #1 should be used. If the sample is from a site that is west of the Mississippi River, extraction fluid #2 should be used.

7.1.4.2 For wastes and wastewater, extraction fluid #1 should be used.

7.1.4.3 For cyanide-containing wastes and/or soils, extraction fluid #3 (reagent water) must be used because leaching of cyanide-containing samples under acidic conditions may result in the formation of hydrogen cyanide gas.

7.1.5 If the aliquot of the sample used for the preliminary evaluation (Steps 7.1.1 - 7.1.4) was determined to be 100% solid at Step 7.1.1.1, then it can be used for the Step 7.2 extraction (assuming at least 100 grams remain), and the Step 7.3 extraction (assuming at least 25 grams remain). If the aliquot was subjected to the procedure in Step 7.1.1.7, then another aliquot shall be used for the volatile extraction procedure in Step 7.3. The aliquot of the waste subjected to the procedure in Step 7.1.1.7 might be appropriate for use for the Step 7.2 extraction if an adequate amount of solid (as determined by Step 7.1.1.9) was obtained. The amount of solid necessary is dependent upon whether a sufficient amount of extract will be produced to support the analyses. If an adequate amount of solid remains, proceed to Step 7.2.10 of the nonvolatile 1312 extraction.

7.2 Procedure When Volatiles Are Not Involved

A minimum sample size of 100 grams (solid and liquid phases) is recommended. In some cases, a larger sample size may be appropriate, depending on the solids content of the waste sample (percent solids, See Step 7.1.1), whether the initial liquid phase of the waste will be miscible with the aqueous extract of the solid, and whether inorganics, semivolatile organics, pesticides, and herbicides are all analytes of concern. Enough solids should be generated for extraction such that the volume of 1312 extract will be sufficient to support all of the analyses required. If the amount of extract generated by a single 1312 extraction will not be sufficient to perform all of the analyses, more than one extraction may be performed and the extracts from each combined and aliquoted for analysis.

7.2.1 If the sample will obviously yield no liquid when subjected to pressure filtration (i.e., is 100 % solid, see Step 7.1.1), weigh out a subsample of the sample (100 gram minimum) and proceed to Step 7.2.9.

7.2.2 If the sample is liquid or multiphasic, liquid/solid separation is required. This involves the filtration device described in Step 4.3.2 and is outlined in Steps 7.2.3 to 7.2.8.

7.2.3 Pre-weigh the container that will receive the filtrate.

7.2.4 Assemble the filter holder and filter following the manufacturer's instructions. Place the filter on the support screen and secure. Acid wash the filter if evaluating the mobility of metals (see Step 4.4).

NOTE: Acid washed filters may be used for all nonvolatile extractions even when metals are not of concern.

7.2.5 Weigh out a subsample of the sample (100 gram minimum) and record the weight. If the waste contains <0.5 % dry solids (Step 7.1.2), the liquid portion of the waste, after filtration, is defined as the 1312 extract. Therefore, enough of the sample should be filtered so that the amount of filtered liquid will support all of the analyses required of the 1312 extract. For wastes containing >0.5 % dry solids (Steps 7.1.1 or 7.1.2), use the percent solids information obtained in Step 7.1.1 to determine the optimum sample size (100 gram minimum) for filtration. Enough solids should be generated by filtration to support the analyses to be performed on the 1312 extract.

7.2.6 Allow slurries to stand to permit the solid phase to settle. Samples that settle slowly may be centrifuged prior to filtration. Use centrifugation only as an aid to filtration. If the sample is centrifuged, the liquid should be decanted and filtered followed by filtration of the solid portion of the waste through the same filtration system.

7.2.7 Quantitatively transfer the sample (liquid and solid phases) to the filter holder (see Step 4.3.2). Spread the waste sample evenly over the surface of the filter. If filtration of the waste at 4°C reduces the amount of expressed liquid over what would be expressed at room temperature, then allow the sample to warm up to room temperature in the device before filtering.

Gradually apply vacuum or gentle pressure of 1-10 psig, until air or pressurizing gas moves through the filter. If this point if not reached under 10 psig, and if no additional liquid has passed through the filter in any 2-minute interval, slowly increase the pressure in 10-psig increments to maximum of 50 psig. After each incremental increase of 10 psig, if the pressurizing gas has not moved through the filter, and if no additional liquid has passed through the filter in any 2-minute interval, proceed to the next 10-psig increment. When the pressurizing gas begins to move through the filter, or when the liquid flow has ceased at 50 psig (i.e., filtration does not result in any additional filtrate within a 2-minute period), stop the filtration.

> NOTE: If waste material (>1 % of the original sample weight) has obviously adhered to the container used to transfer the sample to the filtration apparatus, determine the weight of this residue and subtract it from the sample weight determined in Step 7.2.5, to determine the weight of the waste sample that will be filtered.

> NOTE: Instantaneous application of high pressure can degrade the glass fiber filter and may cause premature plugging.

7.2.8 The material in the filter holder is defined as the solid phase of the sample, and the filtrate is defined as the liquid phase. Weigh the filtrate. The liquid phase may now be either analyzed (see Step 7.2.12) or stored at 4°C until time of analysis.

> NOTE: Some wastes, such as oily wastes and some paint wastes, will obviously contain some material which appears to be a liquid. Even after applying vacuum or pressure filtration, as outlined in Step 7.2.7, this material may not filter. If this is the case, the material within the filtration device is defined as a solid, and is carried through the extraction as a solid. Do not replace the original filter with a fresh filter under any circumstances. Use only one filter.

7.2.9 If the sample contains <0.5% dry solids (see Step 7.1.2), proceed to Step 7.2.13. If the sample contains >0.5 % dry solids (see Step 7.1.1 or 7.1.2), and if particle-size reduction of the solid was needed in Step 7.1.3, proceed to Step 7.2.10. If the sample as received passes a 9.5 mm sieve, quantitatively transfer the solid material into the extractor bottle along with the filter used to separate the initial liquid from the solid phase, and proceed to Step 7.2.11.

7.2.10 Prepare the solid portion of the sample for extraction by crushing, cutting, or grinding the waste to a surface area or particle-size as described in Step 7.1.3. When the surface area or particle-size has been appropriately altered, quantitatively transfer the solid material into an extractor bottle. Include the filter used to separate the initial liquid from the solid phase.

NOTE: Sieving of the waste is not normally required. Surface area requirements are meant for filamentous (e.g., paper, cloth) and similar waste materials. Actual measurement of surface area is not recommended. If sieving is necessary, a Teflon-coated sieve should be used to avoid contamination of the sample.

7.2.11 Determine the amount of extraction fluid to add to the extractor vessel as follows:

$$\text{Weight of extraction fluid} = \frac{20 \times \%\ \text{solids (Step 7.1.1)} \times \text{weight of waste filtered (Step 7.2.5 or 7.2.7)}}{100}$$

Slowly add this amount of appropriate extraction fluid (see Step 7.1.4) to the extractor vessel. Close the extractor bottle tightly (it is recommended that Teflon tape be used to ensure a tight seal), secure in rotary extractor device, and rotate at 30 $\pm$ 2 rpm for 18 $\pm$ 2 hours. Ambient temperature (i.e., temperature of room in which extraction takes place) shall be maintained at 23 $\pm$ 2°C during the extraction period.

NOTE: As agitation continues, pressure may build up within the extractor bottle for some types of sample (e.g., limed or calcium carbonate-containing sample may evolve gases such as carbon dioxide). To relieve excess pressure, the extractor bottle may be periodically opened (e.g., after 15 minutes, 30 minutes, and 1 hour) and vented into a hood.

7.2.12 Following the 18 $\pm$ 2 hour extraction, separate the material in the extractor vessel into its component liquid and solid phases by filtering through a new glass fiber filter, as outlined in Step 7.2.7. For final filtration of the 1312 extract, the glass fiber filter may be changed, if necessary, to facilitate filtration. Filter(s) shall be acid-washed (see Step 4.4) if evaluating the mobility of metals.

7.2.13 Prepare the 1312 extract as follows:

7.2.13.1 If the sample contained no initial liquid phase, the filtered liquid material obtained from Step 7.2.12 is defined as the 1312 extract. Proceed to Step 7.2.14.

7.2.13.2 If compatible (e.g., multiple phases will not result on combination), combine the filtered liquid resulting from Step 7.2.12 with the initial liquid phase of the sample obtained in Step 7.2.7. This combined liquid is defined as the 1312 extract. Proceed to Step 7.2.14.

7.2.13.3 If the initial liquid phase of the waste, as obtained from Step 7.2.7, is not or may not be compatible with the filtered liquid resulting from Step 7.2.12, do not combine these liquids. Analyze these liquids, collectively defined as the 1312 extract, and combine the results mathematically, as described in Step 7.2.14.

7.2.14 Following collection of the 1312 extract, the pH of the extract should be recorded. Immediately aliquot and preserve the extract for analysis. Metals aliquots must be acidified with nitric acid to pH < 2. If precipitation is observed upon addition of nitric acid to a small aliquot of the extract, then the remaining portion of the extract for metals analyses shall not be acidified and the extract shall be analyzed as soon as possible. All other aliquots must be stored under refrigeration (4°C) until analyzed. The 1312 extract shall be prepared and analyzed according to appropriate analytical methods. 1312 extracts to be analyzed for metals shall be acid digested except in those instances where digestion causes loss of metallic analytes. If an analysis of the undigested extract shows that the concentration of any regulated metallic analyte exceeds the regulatory level, then the waste is hazardous and digestion of the extract is not necessary. However, data on undigested extracts alone cannot be used to demonstrate that the waste is not hazardous. If the individual phases are to be analyzed separately, determine the volume of the individual phases (to $\pm$ 0.5 %), conduct the appropriate analyses, and combine the results mathematically by using a simple volume-weighted average:

$$\text{Final Analyte Concentration} = \frac{(V_1)\,(C_1) + (V_2)\,(C_2)}{V_1 + V_2}$$

where:

V_1 = The volume of the first phase (L).
C_1 = The concentration of the analyte of concern in the first phase (mg/L).
V_2 = The volume of the second phase (L).
C_2 = The concentration of the analyte of concern in the second phase (mg/L).

7.2.15 Compare the analyte concentrations in the 1312 extract with the levels identified in the appropriate regulations. Refer to Section 8.0 for quality assurance requirements.

7.3 Procedure When Volatiles Are Involved

Use the ZHE device to obtain 1312 extract for analysis of volatile compounds only. Extract resulting from the use of the ZHE shall not be used to evaluate the mobility of non-volatile analytes (e.g., metals, pesticides, etc.).

The ZHE device has approximately a 500 mL internal capacity. The ZHE can thus accommodate a maximum of 25 grams of solid (defined as that fraction of a sample from which no additional liquid may be forced out by an applied pressure of 50 psig), due to the need to add an amount of extraction fluid equal to 20 times the weight of the solid phase.

Charge the ZHE with sample only once and do not open the device until the final extract (of the solid) has been collected. Repeated filling of the ZHE to obtain 25 grams of solid is not permitted.

Do not allow the sample, the initial liquid phase, or the extract to be exposed to the atmosphere for any more time than is absolutely necessary. Any manipulation of these materials should be done when cold (4°C) to minimize loss of volatiles.

7.3.1 Pre-weigh the (evacuated) filtrate collection container (see Step 4.6) and set aside. If using a TEDLAR® bag, express all liquid from the ZHE device into the bag, whether for the initial or final liquid/solid separation, and take an aliquot from the liquid in the bag for analysis. The containers listed in Step 4.6 are recommended for use under the conditions stated in Steps 4.6.1-4.6.3.

7.3.2 Place the ZHE piston within the body of the ZHE (it may be helpful first to moisten the piston O-rings slightly with extraction fluid). Adjust the piston within the ZHE body to a height that will minimize the distance the piston will have to move once the ZHE is charged with sample (based upon sample size requirements determined from Step 7.3, Step 7.1.1 and/or 7.1.2). Secure the gas inlet/outlet flange (bottom flange) onto the ZHE body in accordance with the manufacturer's instructions. Secure the glass fiber filter between the support screens and set aside. Set liquid inlet/outlet flange (top flange) aside.

7.3.3 If the sample is 100% solid (see Step 7.1.1), weigh out a subsample (25 gram maximum) of the waste, record weight, and proceed to Step 7.3.5.

7.3.4 If the sample contains <0.5% dry solids (Step 7.1.2), the liquid portion of waste, after filtration, is defined as the 1312 extract. Filter enough of the sample so that the amount of filtered liquid will support all of the volatile analyses required. For samples containing $\geq$0.5% dry solids (Steps 7.1.1 and/or 7.1.2), use the percent solids information obtained in Step 7.1.1 to determine the optimum sample size to charge into the ZHE. The recommended sample size is as follows:

7.3.4.1 For samples containing <5% solids (see Step 7.1.1), weigh out a 500 gram subsample of waste and record the weight.

7.3.4.2 For wastes containing >5% solids (see Step 7.1.1), determine the amount of waste to charge into the ZHE as follows:

$$\text{Weight of waste to charge ZHE} = \frac{25}{\text{percent solids (Step 7.1.1)}} \times 100$$

Weigh out a subsample of the waste of the appropriate size and record the weight.

7.3.5 If particle-size reduction of the solid portion of the sample was required in Step 7.1.3, proceed to Step 7.3.6. If particle-size reduction was not required in Step 7.1.3, proceed to Step 7.3.7.

7.3.6 Prepare the sample for extraction by crushing, cutting, or grinding the solid portion of the waste to a surface area or particle size as described in Step 7.1.3.1. Wastes and appropriate reduction equipment should be refrigerated, if possible, to 4°C prior to particle-size reduction. The means used to effect particle-size reduction must not generate heat in and of itself. If reduction of the solid phase of the waste is necessary, exposure of the waste to the atmosphere should be avoided to the extent possible.

> NOTE: Sieving of the waste is not recommended due to the possibility that volatiles may be lost. The use of an appropriately graduated ruler is recommended as an acceptable alternative. Surface area requirements are meant for filamentous (e.g., paper, cloth) and similar waste materials. Actual measurement of surface area is not recommended.

When the surface area or particle-size has been appropriately altered, proceed to Step 7.3.7.

7.3.7 Waste slurries need not be allowed to stand to permit the solid phase to settle. Do not centrifuge samples prior to filtration.

7.3.8 Quantitatively transfer the entire sample (liquid and solid phases) quickly to the ZHE. Secure the filter and support screens into the top flange of the device and secure the top flange to the ZHE body in accordance with the manufacturer's instructions. Tighten all ZHE fittings and place the device in the vertical position (gas inlet/outlet flange on the bottom). Do not attach the extraction collection device to the top plate.

> Note: If sample material (>1% of original sample weight) has obviously adhered to the container used to transfer the sample to the ZHE, determine the weight of this residue and subtract it from the sample weight determined in Step 7.3.4 to determine the weight of the waste sample that will be filtered.

Attach a gas line to the gas inlet/outlet valve (bottom flange) and, with the liquid inlet/outlet valve (top flange) open, begin applying gentle pressure of 1-10 psig (or more if necessary) to force all headspace slowly out of the ZHE device into a hood. At the first appearance of liquid from the liquid inlet/outlet valve, quickly close the valve and discontinue pressure. If filtration of the waste at 4°C reduces the amount of expressed liquid over what would be expressed at room temperature, then allow the sample to warm up to room temperature in the device before filtering. If the waste is 100 % solid (see Step 7.1.1), slowly increase the pressure to a maximum of 50 psig to force most of the headspace out of the device and proceed to Step 7.3.12.

7.3.9 Attach the evacuated pre-weighed filtrate collection container to the liquid inlet/outlet valve and open the valve. Begin applying gentle pressure of 1-10 psig to force the liquid phase of the sample into the filtrate collection container. If no additional liquid has passed through the filter in any 2-minute interval, slowly increase the pressure in 10-psig increments to a maximum of 50 psig. After each incremental increase of 10 psig, if no additional liquid has passed through the filter in any 2-minute interval, proceed to the next 10-psig increment. When liquid flow has ceased such that continued pressure filtration at 50 psig does not result in any additional filtrate within a 2-minute period, stop the filtration. Close the liquid inlet/outlet valve, discontinue pressure to the piston, and disconnect and weigh the filtrate collection container.

NOTE: Instantaneous application of high pressure can degrade the glass fiber filter and may cause premature plugging.

7.3.10 The material in the ZHE is defined as the solid phase of the sample and the filtrate is defined as the liquid phase.

NOTE: Some samples, such as oily wastes and some paint wastes, will obviously contain some material which appears to be a liquid. Even after applying pressure filtration, this material will not filter. If this is the case, the material within the filtration device is defined as a solid, and is carried through the 1312 extraction as a solid.

If the original waste contained <0.5 % dry solids (see Step 7.1.2), this filtrate is defined as the 1312 extract and is analyzed directly. Proceed to Step 7.3.15.

7.3.11 The liquid phase may now be either analyzed immediately (see Steps 7.3.13 through 7.3.15) or stored at 4°C under minimal headspace conditions until time of analysis. Determine the weight of extraction fluid #3 to add to the ZHE as follows:

$$\text{Weight of extraction fluid} = \frac{20 \times \%\ \text{solids (Step 7.1.1)} \times \text{weight of waste filtered (Step 7.3.4 or 7.3.8)}}{100}$$

7.3.12 The following steps detail how to add the appropriate amount of extraction fluid to the solid material within the ZHE and agitation of the ZHE vessel. Extraction fluid #3 is used in all cases (see Step 5.4.3).

7.3.12.1 With the ZHE in the vertical position, attach a line from the extraction fluid reservoir to the liquid inlet/outlet valve. The line used shall contain fresh extraction fluid and should be preflushed with fluid to eliminate any air pockets in the line. Release gas pressure on the ZHE piston (from the gas inlet/outlet valve), open the liquid inlet/outlet valve, and begin transferring extraction fluid (by pumping or similar means) into the ZHE. Continue pumping extraction fluid into the ZHE until the appropriate amount of fluid has been introduced into the device.

7.3.12.2 After the extraction fluid has been added, immediately close the liquid inlet/outlet valve and disconnect the extraction fluid line. Check the ZHE to ensure that all valves are in their closed positions. Manually rotate the device in an end-over-end fashion 2 or 3 times. Reposition the ZHE in the vertical position with the liquid inlet/outlet valve on top. Pressurize the ZHE to 5-10 psig (if necessary) and slowly open the liquid inlet/outlet valve to bleed out any headspace (into a hood) that may have been introduced due to the addition of extraction fluid. This bleeding shall be done quickly and shall be stopped at the first appearance of liquid from the valve. Re-pressurize the ZHE with 5-10 psig and check all ZHE fittings to ensure that they are closed.

7.3.12.3 Place the ZHE in the rotary extractor apparatus (if it is not already there) and rotate at 30 $\pm$ 2 rpm for 18 $\pm$ 2 hours. Ambient temperature (i.e., temperature of room in which extraction occurs) shall be maintained at 23 $\pm$ 2°C during agitation.

7.3.13 Following the 18 $\pm$ 2 hour agitation period, check the pressure behind the ZHE piston by quickly opening and closing the gas inlet/outlet valve and noting the escape of gas. If the pressure has not been maintained (i.e., no gas release observed), the ZHE is leaking. Check the ZHE for leaking as specified in Step 4.2.1, and perform the extraction again with a new sample of waste. If the pressure within the device has been maintained, the material in the extractor vessel is once again separated into its component liquid and solid phases. If the waste contained an initial liquid phase, the liquid may be filtered directly into the same filtrate collection container (i.e., TEDLAR® bag) holding the initial liquid phase of the waste. A separate filtrate collection container must be used if combining would create multiple phases, or there is not enough volume left within the filtrate collection container. Filter through the glass fiber filter, using the ZHE device as discussed in Step 7.3.9. All extracts shall be filtered and collected if the TEDLAR® bag is used, if the extract is multiphasic, or if the waste contained an initial liquid phase (see Steps 4.6 and 7.3.1).

NOTE: An in-line glass fiber filter may be used to filter the material within the ZHE if it is suspected that the glass fiber filter has been ruptured

7.3.14 If the original sample contained no initial liquid phase, the filtered liquid material obtained from Step 7.3.13 is defined as the 1312 extract. If the sample contained an initial liquid phase, the filtered liquid material obtained from Step 7.3.13 and the initial liquid phase (Step 7.3.9) are collectively defined as the 1312 extract.

7.3.15 Following collection of the 1312 extract, immediately prepare the extract for analysis and store with minimal headspace at 4°C until analyzed. Analyze the 1312 extract according to the appropriate analytical methods. If the individual phases are to be analyzed separately (i.e., are not miscible), determine the volume of the individual phases (to 0.5%), conduct the appropriate analyses, and combine the results mathematically by using a simple volume- weighted average:

$$\text{Final Analyte Concentration} = \frac{(V_1)\ (C_1) + (V_2)\ (C_2)}{V_1 + V_2}$$

where:

V_1 = The volume of the first phases (L).
C_1 = The concentration of the analyte of concern in the first phase (mg/L).
V_2 = The volume of the second phase (L).
C_2 = The concentration of the analyte of concern in the second phase (mg/L).

7.3.16 Compare the analyte concentrations in the 1312 extract with the levels identified in the appropriate regulations. Refer to Step 8.0 for quality assurance requirements.

8.0 QUALITY CONTROL

8.1 A minimum of one blank (using the same extraction fluid as used for the samples) for every 20 extractions that have been conducted in an extraction vessel. Refer to Chapter One for additional quality control protocols.

8.2 A matrix spike shall be performed for each waste type (e.g., wastewater treatment sludge, contaminated soil, etc.) unless the result exceeds the regulatory level and the data is being used solely to demonstrate that the waste property exceeds the regulatory level. A minimum of one matrix spike must be analyzed for each analytical batch. As a minimum, follow the matrix spike addition guidance provided in each analytical method.

8.2.1 Matrix spikes are to be added after filtration of the 1312 extract and before preservation. Matrix spikes should not be added prior to 1312 extraction of the sample.

8.2.2 In most cases, matrix spike levels should be added at a concentration equivalent to the corresponding regulatory level. If the analyte concentration is less than one half the regulatory level, the spike concentration may be as low as one half of the analyte concentration, but may not be less than five times the method detection limit. In order to avoid differences in matrix effects, the matrix spikes must be added to the same nominal volume of 1312 extract as that which was analyzed for the unspiked sample.

8.2.3 The purpose of the matrix spike is to monitor the performance of the analytical methods used, and to determine whether matrix interferences exist. Use of other internal calibration methods, modification of the analytical methods, or use of alternate analytical methods may be needed to accurately measure the analyte concentration in the 1312 extract when the recovery of the matrix spike is below the expected analytical method performance.

8.2.4 Matrix spike recoveries are calculated by the following formula:

$$\%R\ (\%\ Recovery) = 100\ (X_s - X_u)\ /\ K$$

where:

X_s = measured value for the spiked sample

X_u = measured value for the unspiked sample, and

K = known value of the spike in the sample.

8.3 All quality control measures described in the appropriate analytical methods shall be followed.

8.4 The use of internal calibration quantitation methods shall be employed for a metallic contaminant if: (1) Recovery of the contaminant from the 1312 extract is not at least 50% and the concentration does not exceed the appropriate regulatory level, and (2) The concentration of the contaminant measured in the extract is within 20% of the appropriate regulatory level.

8.4.1. The method of standard additions shall be employed as the internal calibration quantitation method for each metallic contaminant.

8.4.2 The method of standard additions requires preparing calibration standards in the sample matrix rather than reagent water or blank solution. It requires taking four identical aliquots of the solution and adding known amounts of standard to three of these aliquots. The forth aliquot is the unknown. Preferably, the first addition should be prepared so that the resulting concentration is approximately 50% of the expected concentration of the sample. The second and third additions should be prepared so that the concentrations are approximately 100% and 150% of the expected concentration of the sample. All four aliquots are maintained at the same final volume by adding reagent water or a blank solution, and may need dilution adjustment to maintain the signals in the linear range of the instrument technique. All four aliquots are analyzed.

8.4.3 Prepare a plot, or subject data to linear regression, of instrument signals or external-calibration-derived concentrations as the dependant variable (y-axis) versus concentrations of the additions of standards as the independent variable (x-axis). Solve for the intercept of the abscissa (the independent variable, x-axis) which is the concentration in the unknown.

8.4.4 Alternately, subtract the instrumental signal or external-calibration-derived concentration of the unknown (unspiked) sample from the instrumental signals or external-calibration-derived concentrations of the standard additions. Plot or subject to linear regression of the corrected instrument signals or external-calibration-derived concentrations as the dependant variable versus the independent variable. Derive concentrations for the unknowns using the internal calibration curve as if it were an external calibration curve.

8.5 Samples must undergo 1312 extraction within the following time periods:

SAMPLE MAXIMUM HOLDING TIMES (days)

	From: Field Collection To: 1312 extraction	From: 1312 extraction To: Preparative extraction	From: Preparative extraction To: Determinative analysis	Total Elapsed Time
Volatiles	14	NA	14	28
Semi-volatiles	14	7	40	61
Mercury	28	NA	28	56
Metals, except mercury	180	NA	180	360
NA = Not Applicable				

If sample holding times are exceeded, the values obtained will be considered minimal concentrations. Exceeding the holding time is not acceptable in establishing that a waste does not exceed the regulatory level. Exceeding the holding time will not invalidate characterization if the waste exceeds the regulatory level.

9.0 METHOD PERFORMANCE

9.1 Precision results for semi-volatiles and metals: An eastern soil with high organic content and a western soil with low organic content were used for the semi-volatile and metal leaching experiments. Both types of soil were analyzed prior to contaminant spiking. The results are shown in Table 6. The concentration of contaminants leached from the soils were reproducible, as shown by the moderate relative standard deviations (RSDs) of the recoveries (averaging 29% for the compounds and elements analyzed).

9.2 Precision results for volatiles: Four different soils were spiked and tested for the extraction of volatiles. Soils One and Two were from western and eastern Superfund sites. Soils Three and Four were mixtures of a western soil with low organic content and two different municipal sludges. The results are shown in Table 7. Extract concentrations of volatile organics from the eastern soil were lower than from the western soil. Replicate leachings of Soils Three and Four showed lower precision than the leachates from the Superfund soils.

10.0 REFERENCES

1. Environmental Monitoring Systems Laboratory, "Performance Testing of Method 1312; QA Support for RCRA Testing: Project Report". EPA/600/4-89/022. EPA Contract 68-03-3249 to Lockheed Engineering and Sciences Company, June 1989.

2. Research Triangle Institute, "Interlaboratory Comparison of Methods 1310, 1311, and 1312 for Lead in Soil". U.S. EPA Contract 68-01-7075, November 1988.

Table 1. Volatile Analytes[1]

Compound	CAS No.
Acetone	67-64-1
Benzene	71-43-2
n-Butyl alcohol	71-36-3
Carbon disulfide	75-15-0
Carbon tetrachloride	56-23-5
Chlorobenzene	108-90-7
Chloroform	67-66-3
1,2-Dichloroethane	107-06-2
1,1-Dichloroethylene	75-35-4
Ethyl acetate	141-78-6
Ethyl benzene	100-41-4
Ethyl ether	60-29-7
Isobutanol	78-83-1
Methanol	67-56-1
Methylene chloride	75-09-2
Methyl ethyl ketone	78-93-3
Methyl isobutyl ketone	108-10-1
Tetrachloroethylene	127-18-4
Toluene	108-88-3
1,1,1,-Trichloroethane	71-55-6
Trichloroethylene	79-01-6
Trichlorofluoromethane	75-69-4
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1
Vinyl chloride	75-01-4
Xylene	1330-20-7

[1] When testing for any or all of these analytes, the zero-headspace extractor vessel shall be used instead of the bottle extractor.

Table 2. Suitable Rotary Agitation Apparatus[1]

Company	Location	Model No.
Analytical Testing and Consulting Services, Inc.	Warrington, PA (215) 343-4490	4-vessel extractor (DC20S); 8-vessel extractor (DC20); 12-vessel extractor (DC20B)
Associated Design and Manufacturing Company	Alexandria, VA (703) 549-5999	2-vessel (3740-2); 4-vessel (3740-4); 6-vessel (3740-6); 8-vessel (3740-8); 12-vessel (3740-12); 24-vessel (3740-24)
Environmental Machine and Design, Inc.	Lynchburg, VA (804) 845-6424	8-vessel (08-00-00) 4-vessel (04-00-00)
IRA Machine Shop and Laboratory	Santurce, PR (809) 752-4004	8-vessel (011001)
Lars Lande Manufacturing	Whitmore Lake, MI (313) 449-4116	10-vessel (10VRE) 5-vessel (5VRE)
Millipore Corp.	Bedford, MA (800) 225-3384	4-ZHE or 4 1-liter bottle extractor (YT30ORAHW)

[1] Any device that rotates the extraction vessel in an end-over-end fashion at 30 $\pm$2 rpm is acceptable.

Table 3. Suitable Zero-Headspace Extractor Vessels[1]

Company	Location	Model No.
Analytical Testing & Consulting Services, Inc.	Warrington, PA (215) 343-4490	C102, Mechanical Pressure Device
Associated Design and Manufacturing Company	Alexandria, VA (703) 549-5999	3745-ZHE, Gas Pressure Device
Lars Lande Manufacturing[2]	Whitmore Lake, MI (313) 449-4116	ZHE-11, Gas Pressure Device
Millipore Corporation	Bedford, MA (800) 225-3384	YT30090HW, Gas Pressure Device
Environmental Machine and Design, Inc.	Lynchburg, VA (804) 845-6424	VOLA-TOX1, Gas Pressure Device

[1] Any device that meets the specifications listed in Step 4.2.1 of the method is suitable.

[2] This device uses a 110 mm filter.

Table 4. Suitable Filter Holders[1]

Company	Location	Model/ Catalogue #	Size
Nucleopore Corporation	Pleasanton, CA (800) 882-7711	425910 410400	142 mm 47 mm
Micro Filtration Systems	Dublin, CA (800) 334-7132 (415) 828-6010	302400 311400	142 mm 47 mm
Millipore Corporation	Bedford, MA (800) 225-3384	YT30142HW XX1004700	142 mm 47 mm

[1] Any device capable of separating the liquid from the solid phase of the waste is suitable, providing that it is chemically compatible with the waste and the constituents to be analyzed. Plastic devices (not listed above) may be used when only inorganic analytes are of concern. The 142 mm size filter holder is recommended.

Table 5. Suitable Filter Media[1]

Company	Location	Model	Pore Size (μm)
Millipore Corporation	Bedford, MA (800) 225-3384	AP40	0.7
Nucleopore Corporation	Pleasanton, CA (415) 463-2530	211625	0.7
Whatman Laboratory Products, Inc.	Clifton, NJ (201) 773-5800	GFF	0.7
Micro Filtration Systems	Dublin, CA (800) 334-7132 (415) 828-6010	GF75	0.7

[1] Any filter that meets the specifications in Step 4.4 of the Method is suitable.

TABLE 6 - METHOD 1312 PRECISION RESULTS FOR SEMI-VOLATILES AND METALS

	Amount Spiked (µg)	Eastern Soil (pH 4.2) Amount Recovered* (µg)	Eastern Soil (pH 4.2) % RSD	Western Soil (pH 5.0) Amount Recovered* (µg)	Western Soil (pH 5.0) % RSD
FORTIFIED ANALYTES					
bis(2-chloroethyl)-ether	1040	834	12.5	616	14.2
2-Chlorophenol	1620	1010	6.8	525	54.9
1,4-Dichlorobenzene	2000	344	12.3	272	34.6
1,2-Dichlorobenzene	8920	1010	8.0	1520	28.4
2-Methylphenol	3940	1860	7.7	1130	32.6
Nitrobenzene	1010	812	10.0	457	21.3
2,4-Dimethylphenol	1460	200	18.4	18	87.6
Hexachlorobutadiene	6300	95	12.9	280	22.8
Acenaphthene	3640	210	8.1	310**	7.7
2,4-Dinitrophenol	1300	896**	6.1	23**	15.7
2,4-Dinitrotoluene	1900	1150	5.4	585	54.4
Hexachlorobenzene	1840	3.7	12.0	10	173.2
gamma BHC (Lindane)	7440	230	16.3	1240	55.2
beta BHC	640	35	13.3	65.3	51.7
METALS					
Lead	5000	70	4.3	10	51.7
Cadmium	1000	387	2.3	91	71.3

* = Triplicate analyses.
** = Duplicate analyses; one value was rejected as an outlier at the 90% confidence level using the Dixon Q test.

TABLE 7 - METHOD 1312 PRECISION RESULTS FOR VOLATILES

	Soil No. 1 (Western)		Soil No. 2 (Eastern)		Soil No. 3 (Western and Sludge)		Soil No. 4 (Western and Sludge)	
Compound Name	Avg. %Rec.*	%RSD	Avg. %Rec.*	%RSD	Avg. %Rec.**	%RSD	Avg. %Rec.***	%RSD
Acetone	44.0	12.4	43.8	2.25	116.0	11.5	21.3	71.4
Acrylonitrile	52.5	68.4	50.5	70.0	49.3	44.9	51.8	4.6
Benzene	47.8	8.29	34.8	16.3	49.8	36.7	33.4	41.1
n-Butyl Alcohol (1-Butanol)	55.5	2.91	49.2	14.6	65.5	37.2	73.0	13.9
Carbon disulfide	21.4	16.4	12.9	49.5	36.5	51.5	21.3	31.5
Carbon tetrachloride	40.6	18.6	22.3	29.1	36.2	41.4	24.0	34.0
Chlorobenzene	64.4	6.76	41.5	13.1	44.2	32.0	33.0	24.9
Chloroform	61.3	8.04	54.8	16.4	61.8	29.1	45.8	38.6
1,2-Dichloroethane	73.4	4.59	68.7	11.3	58.3	33.3	41.2	37.8
1,1-Dichloroethane	31.4	14.5	22.9	39.3	32.0	54.4	16.8	26.4
Ethyl acetate	76.4	9.65	75.4	4.02	23.0	119.8	11.0	115.5
Ethylbenzene	56.2	9.22	23.2	11.5	37.5	36.1	27.2	28.6
Ethyl ether	48.0	16.4	55.1	9.72	37.3	31.2	42.0	17.6
Isobutanol (4-Methyl -1-propanol)	0.0	ND	0.0	ND	61.8	37.7	76.0	12.2
Methylene chloride	47.5	30.3	42.2	42.9	52.0	37.4	37.3	16.6
Methyl ethyl ketone (2-Butanone)	56.7	5.94	61.9	3.94	73.7	31.3	40.6	39.0
Methyl isobutyl ketone	81.1	10.3	88.9	2.99	58.3	32.6	39.8	40.3
1,1,1,2-Tetrachloro-ethane	69.0	6.73	41.1	11.3	50.8	31.5	36.8	23.8
1,1,2,2-Tetrachloro-ethane	85.3	7.04	58.9	4.15	64.0	25.7	53.6	15.8
Tetrachloroethene	45.1	12.7	15.2	17.4	26.2	44.0	18.6	24.2
Toluene	59.2	8.06	49.3	10.5	45.7	35.2	31.4	37.2
1,1,1-Trichloro-ethane	47.2	16.0	33.8	22.8	40.7	40.6	26.2	38.8
1,1,2-Trichloro-ethane	76.2	5.72	67.3	8.43	61.7	28.0	46.4	25.4
Trichloroethene	54.5	11.1	39.4	19.5	38.8	40.9	25.6	34.1
Trichloro-fluoromethane	20.7	24.5	12.6	60.1	28.5	34.0	19.8	33.9
1,1,2-Trichloro-trifluoroethane	18.1	26.7	6.95	58.0	21.5	67.8	15.3	24.8
Vinyl chloride	10.2	20.3	7.17	72.8	25.0	61.0	11.8	25.4

* Triplicate analyses
** Six replicate analyses
*** Five replicate analyses

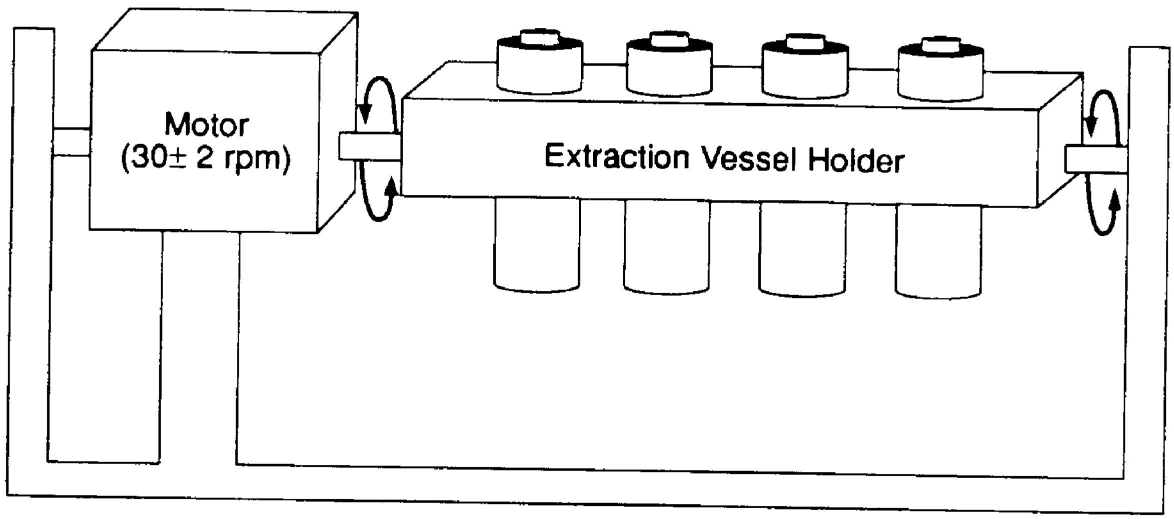


Figure 1. Rotary Agitation Apparatus

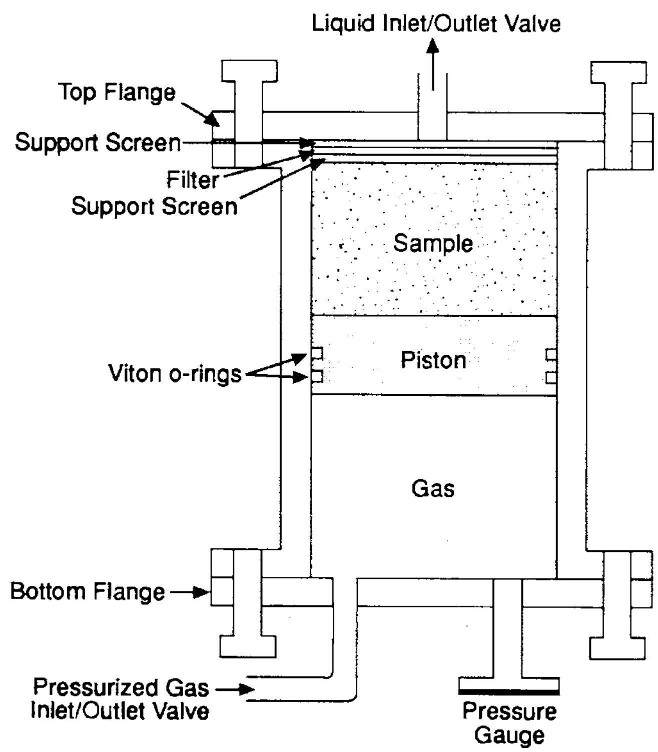
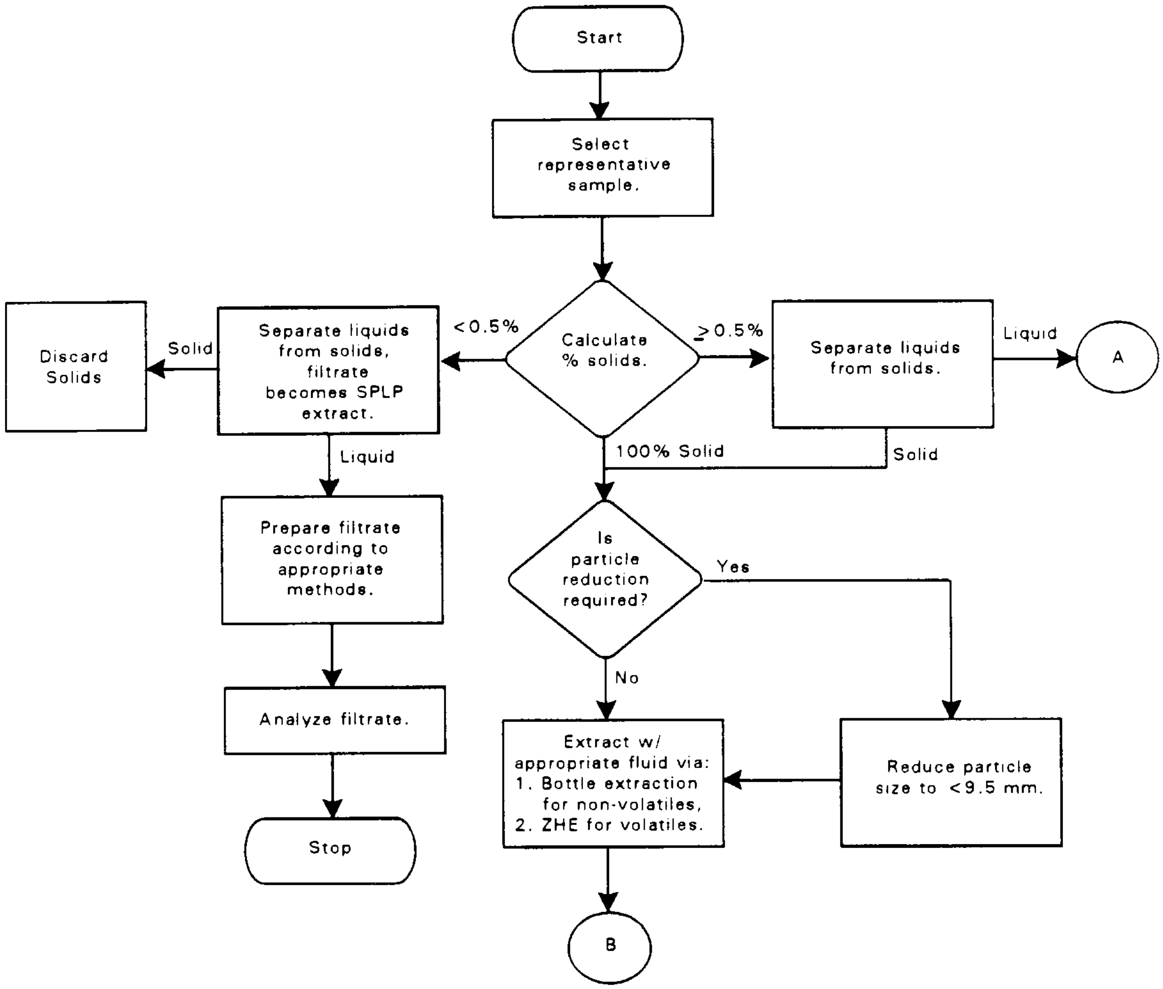
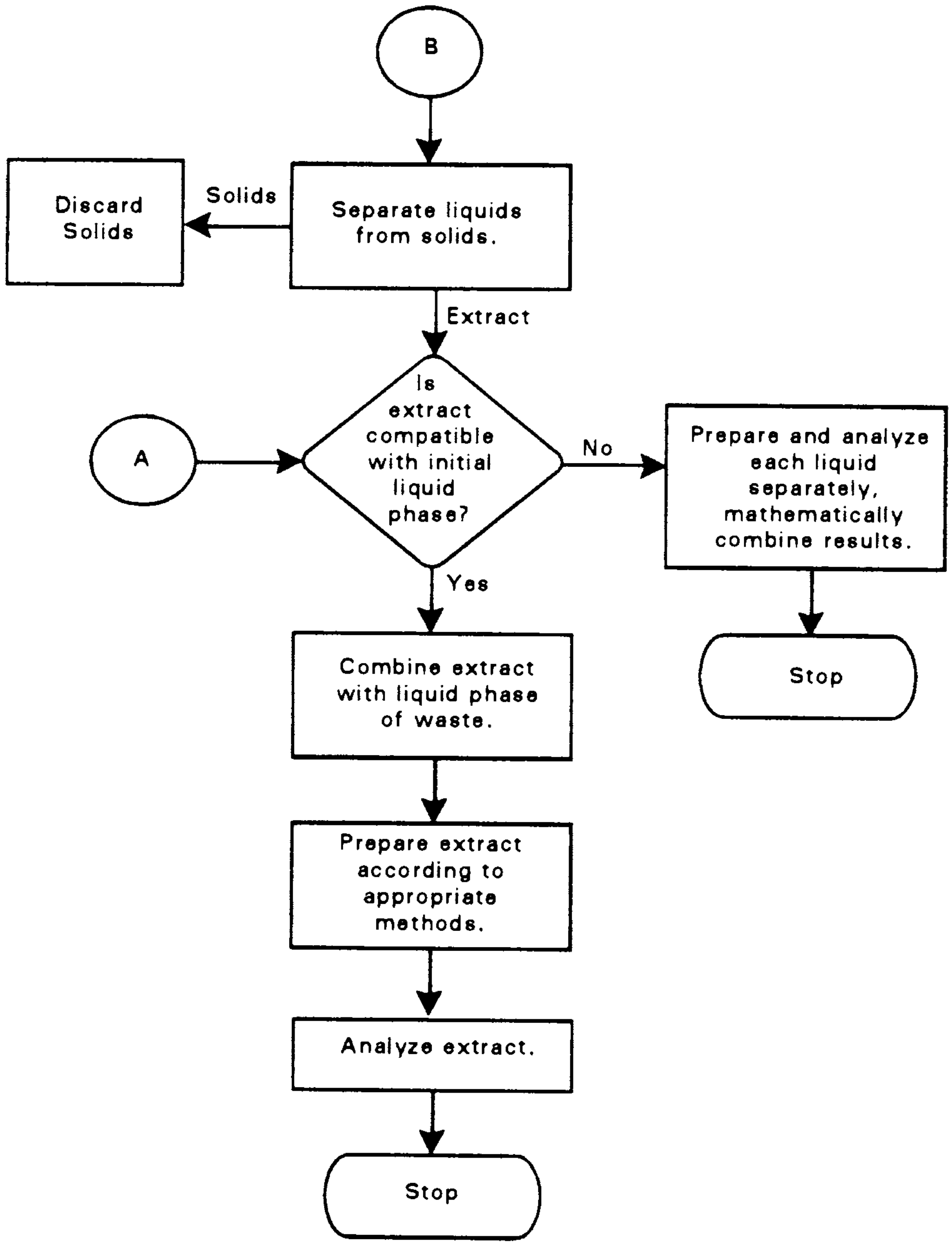


Figure 2. Zero-Headspace Extractor (ZHE)

SYNTHETIC PRECIPITATION LEACHING PROCEDURE



SYNTHETIC PRECIPITATION LEACHING PROCEDURE (continued)



Permit Renewal Application
October 17, 2011

Attachment J

Action Leakage Rate and Response Action Plan

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Modified by:
The New Mexico Environment Department
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Table of Contents

List of Appendices

Attachment J. Action Leakage Rate and Response Action Plan

1. Introduction

An Action Leakage Rate (ALR) and Response Action Plan (RAP) for the proposed Triassic Park Hazardous Waste Facility landfill ~~and evaporation pond is~~are required under 40 CFR Parts 264.302 and 304. A three-phased landfill ~~and a two phased evaporation pond have~~has been proposed as part of this~~a~~ Resource Conservation and Recovery Act (RCRA) Part B Permit Renewal Application dated October 17, 2011 ~~November 1997~~. This report presents a proposed ALR~~s~~ based on the landfill~~- and evaporation pond~~ specific design~~s~~ and calculation methodologies recommended by the U.S. Environmental Protection Agency (EPA). The ALR, as defined in the final rule published in January 29, 1992 (U.S. EPA, 1992a), is the maximum design flow rate that the leak detection and removal system (LDRS) may remove without the fluid head on the bottom liner exceeding one foot. The RAP describes the steps to be taken in the event the ALR is exceeded in the landfill~~ or the evaporation pond~~. The RAP specifies the initial notifications, steps to be taken in response to the leakage rate being exceeded, and follow-up reports.

2. Proposed Landfill Design

This section briefly describes aspects of the landfill design~~s~~ relevant to the ALR and the RAP. Engineering drawings and technical specifications are included in ~~the~~ Attachment L to the ~~Revised~~ Part B Permit Renewal Application~~ dated November 1997~~.

2.1 Liner Design

The landfill liner system consists of a single and composite liner. The liner system which applies to the base and slopes of the landfill is described below (from top to bottom).

- A minimum 2-foot-thick protective soil layer.
- A leachate collection system consisting of:
  - a double sided geocomposite (geonet with a layer of geotextile bonded to both sides, transmissivity $\geq 2 \times 10^{-4}$ square meters per second [m^2/s]).
- A primary liner consisting of:
  - 60-mil high density polyethylene (HDPE) geomembrane.
- A leak detection and removal system consisting of:
  - a double-sided geocomposite (geonet with a layer of geotextile bonded to both sides, transmissivity $\geq 1.2 \times 10^{-4}$ m^2/s).
- A secondary composite liner consisting of:
  - 60-mil HDPE geomembrane
  - a geosynthetic clay liner (GCL) with $k \leq 5 \times 10^{-9}$ centimeters per second (cm/s) (bentonite sandwiched between two layers of geotextile).
- 6 inches of prepared subgrade.

The liner system in the sump area differs from the liner system in the landfill base and slope areas due to the inclusion of drainage gravel (k $\geq$ 1.0 cm/s) and compacted clay (k $\leq$1 x 10^{-7} cm/s) in the base area of the leachate collection and removal system (LCRS) sump and the leak detection and removalLDRS sump. The liner system in the landfill sump area is illustrated on Drawing No. 16, Sump Cross-Sections - Phase 1A, and Drawing No. 18, Vadose, LDRS, LCRS Cross-Sections and Details – phase 1A.

2.2 Leachate Collection and Removal System, Leak Detection and Removal Systems, and Vadose Monitoring System

The geocomposite leachate collection and removal system (LCRS) installed above the primary geomembrane will collect liquid above the geomembrane and transmit it to the LCRS collection sump.

The leak detection and removal system (LDRS) installed above the secondary geomembrane will detect and collect liquid above the geomembrane and transmit it to the LDRS sump. The vadose monitoring sump will detect and collect fluid leakage from the LDRS sump.

2.2.1 Leachate Collection and Removal System

Liquid entering the LCRS will come from rainfall which percolates through the waste thereby generating leachate. The function of the LCRS is to transport this liquid to the sump where it can be removed so that hydraulic head on the primary liner is minimized.

Components of this system, in addition to those described above, include a lateral 8-inch-diameter drainage pipe located along the minimum grade line in the floor of the landfill, an 18-inch-diameter HDPE sump collection and slope riser pipe, and a 24-inch-diameter steel vertical riser pipe. The floor pipe and slope riser pipe will be surrounded by a gravel envelope, separated from the surrounding soil by an 8-oz. non-woven geotextile filter. The vertical riser pipe system, which will extend from the center of the LCRS sump vertically through the waste and cover system, provides a second access to the LCRS from which leachate can be removed. Accumulated liquids will be removed from the leachate collection sump by pumping either through the slope riser pipe or through the vertical riser pipe. A submersible pump will be used for leachate removal.

2.2.2 Leak Detection and Removal System

The potential sources of liquid entering the LDRS include primary liner leakage and consolidation water from the primary sump's clay liner. To meet the design requirements, the leak detection system must be able to collect and transmit liquid to the leak detection sump so that it can be removed.

The LDRS will be installed above the secondary composite liner on the landfill base and sideslopes. Should liquid enter the detection system, it will drain toward the collection sump via the LDRS drainage geocomposite and drainage pipe. Once in the sump, the liquid can be detected and removed via a riser pipe which extends up the slope of the landfill to the surface. The liquid will be pumped to the surface by a submersible pump.

2.2.3 Vadose Monitoring Sump

Sources of liquid entering the vadose sump include secondary liner leakage and consolidation water from the secondary sump's clay liner. The purpose of the vadose monitoring sump is to detect and remove leakage passing through both the primary and secondary liner systems. As with the LCRS sump and LDRS sump described above, liquid in the vadose sump will be pumped to the surface by a submersible pump.

3. Proposed Evaporation Pond Design

This section briefly describes aspects of the evaporation pond design relevant to the ALR and the RAP. Engineering drawings and technical specifications are included in the Revised Part B Permit dated November 1997.

3.1 Liner Design

The evaporation pond liner system consists of a single and a composite liner. The liner system which applies to the base and slopes of the evaporation pond is described below (from top to bottom).

- A primary liner consisting of:
  - 60-mil HDPE geomembrane.

- A leak detection system and removal system consisting of:
  - a geonet drainage layer (transmissivity $\geq 5 \times 10^{-3}$ m^2/s).

- A secondary composite liner consisting of :
  - a 60-mil HDPE geomembrane
  - a 3 foot thick compacted clay liner (CCL) with $k \leq 1 \times 10^{-7}$ cm/s.

The liner system in the sump area differs from the liner system elsewhere in the pond due to the inclusion of drainage gravel and geotextile cushion layers in the LDRS layer. Drawing No. 32, Evaporation Pond LDRS Plan and Details illustrates the liner sump liner system arrangement.

3.2 Leak Detection and Removal System and Vadose Monitoring System

3.2.1 Leak Detection and Removal System

Liquid entering the LDRS will be the result of primary liner leakage. To meet design requirements, the LDRS must be able to collect and transmit liquid to the leak detection sump so that it can be removed.

The LDRS will be installed above the secondary composite liner on the evaporation pond floor and sideslopes. Should liquid enter the LDRS, it will drain toward the collection sump where it can be detected and removed via a slope riser pipe which extends up the side slope of the evaporation pond to the surface. The liquid will be pumped to the surface by a submersible pump.

3.2.2 Vadose Monitoring System

Sources of liquid entering the vadose sump include secondary liner leakage and consolidation water from the secondary clay liner. The purpose of the vadose monitoring sump is to detect and remove leakage passing through the secondary liner systems. As with the LDRS sump described above, liquid in the vadose sump will be pumped to the surface by a submersible pump.

4. Potential Sources of Flow from the Leak Detection and Removal System

Before an ALRs and a RAP can be established, for the potential sources of flow from the landfill LDRS of the landfill and evaporation pond must be understood, and the magnitudes of flow from the potential sources should be estimated. This understanding of the potential sources and magnitudes of flow is also useful in planning for the potential flow quantities and in identifying unusual flow conditions.

4.1 Potential Sources of Flow from the Landfill LDRS

Potential sources of flow from the landfill LDRS are:

- Precipitation that enters the leak detection layer during construction (hereafter referred to as construction water).
- Water expelled from consolidation of the clay components of the composite primary liner during landfill operations (hereafter referred to as consolidation water).
- Leakage through the primary liner.

These potential sources of liquid have been discussed in detail in the technical papers by Gross et al. (1990) and Bonaparte and Gross (1990). An evaluation of potential sources and magnitudes of flow from each of the sources discussed above is presented below:

Substantial flow rates of construction water are possible; however, since because geocomposites do not exhibit significant capillarity, it is likely that the flow of construction water from the geocomposite and sump drainage gravel will be complete before waste placement begins.

The average consolidation water flow rate is dependent on the area, thickness, and degree of saturation of the primary clay component in the sump area; and the rate of waste filling. Because the sump primary clay component is very small (limited to the sump area), consolidation water volumes are not expected to be significant.

The potential for leakage through the primary liner is the basis for the ALR and is discussed in Section 5.0.

4.2 Potential Sources of Flow from the Evaporation Pond LDRS

The source of flow from the evaporation pond LDRS is restricted to leakage through the primary geomembrane. Similar to the landfill, construction water will likely be removed from the LDRS prior to placement of waste liquids in the pond. Since there is no primary clay component in the pond liner system, consolidation water is not a potential source of liquids in the LDRS.

5. Action Leakage Rate Determination

5.1 Introduction

As presented in Code of Federal Regulations, Title 40, Part 264, Rule 264.302 (40 CFR Rule 264.302):

> The action leakage rate is the maximum design flow rate that the leak detection and removal system (LDRS) can remove without the fluid head on the bottom liner exceeding 1 foot. The action leakage rate must include

an adequate safety margin to allow for uncertainties in the design (e.g., slope, hydraulic conductivity, thickness of drainage material), construction, operation, and location of the LDRS, waste and leachate characteristics, likelihood and amount of other sources of liquids in the LDRS and proposed response actions (e.g., the action leakage rate must consider decreases in the flow capacity of the system over time resulting from siltation and clogging, rib layover and creep of synthetic components of the system, overburden pressures, etc.).

In other words, the ALR is the maximum design flow rate, including a safety factor, that the leak detection system can remove without the head on the bottom liner exceeding 1 foot.

5.2 Determination of Action Leakage Rate: Landfill

5.2.1 Equation for Geocomposite Flow Capacity

The leak detection drainage layer consists of a double sided geocomposite (geotextile/geocomposite/geotextile). The maximum flow rate from a single hole in the primary HDPE liner that a geocomposite drainage layer can convey without the fluid head on the secondary liner exceeding a predetermined level is given by the following equation (U.S. EPA 1992b)

$$Q = k*D*(2h-D) \qquad \text{(Equation 1)}$$

where Q = the flow rate through a single hole in the primary liner;
k = the hydraulic conductivity of the leakage detection geocomposite drainage layer;
h = the head on the secondary liner; and
D = thickness of leak detection drain layer (geocomposite).

5.2.2 Design Parameters

5.2.2.1 Hydraulic Conductivity

The technical specifications require that over the base and side slopes of the landfill the geocomposite of the LDRS have a hydraulic transmissivity of at least 2.2×10^{-4} m^2/s when subjected to testing conditions which include stress, hydraulic gradient, and boundary conditions similar to those anticipated in the field. The thickness of the geocomposite of the LDRS is 0.2 inch. Using the specified hydraulic transmissivity of 2.2×10^{-4} m^2/s (and adjusting the transmissivity by a total factor of safety of 3.3 to account for creep, chemical clogging, and sediment clogging) and geocomposite thickness of 0.2 inch results in a calculated hydraulic conductivity of 1.3 cm/s for the LDRS geocomposite drainage layer over the base of the landfill. Hydraulic transmissivity test results confirming that the specified geocomposite has this calculated hydraulic conductivity are required in the specifications and CQA Plan.

5.2.2.2 Head on Secondary Liner

The current federal regulations require that the head on the liner should not exceed one foot. Therefore, 1 foot will be used for the calculated maximum head build-up on the secondary liner and the calculation of the ALR.

5.2.2.3 Geocomposite Thickness

A 1-foot head on the secondary liner does not mean that the flow thickness in the geocomposite is 1 foot (the geocomposite thickness is only 0.2 inch); it only means that the fluid pressure in the geocomposite directly beneath the hole in the primary liner could be equivalent to 1 foot of fluid head.

5.2.3 Discussion of Proposed Action Leakage Rates

The proposed ALR of 900 gallons per acre per day (gpad) is greater than the 100 gpad suggested by the U.S. EPA (U.S. EPA, 1992b) for landfill units that are built to meet the minimum design specifications presented in 40 CFR Part 264 for the LDRS. This ALR (100 gpad) was developed by U.S. EPA using calculations similar to those presented in this document. However, the proposed LDRS design for the Triassic Park landfill includes a geocomposite drainage layer with a hydraulic transmissivity at least two orders of magnitude greater than that required to meet the minimum design specifications (granular drainage layer) presented in 40 CFR Part 264. With this greater hydraulic transmissivity, the geocomposite drainage layer is capable of conveying much greater flow rates without the fluid head on the secondary liner exceeding 1 foot. As a result, the proposed ALRs calculated using the equation given in U.S.by EPA (U.S. EPA, 1992b) are is substantially greater than 100 gpad. However, consistent with 40 CFR Part 264, the proposed ALRs hasve been established to ensure that the maximum fluid head on the secondary liner is not in excess of 1 foot. This is demonstrated by the calculations presented in Appendix G-1A. Therefore, the proposed ALRs isare consistent with the requirements of 40 CFR Part 264, and the designs for the landfill are appropriate.

5.3 Determination of Action Leakage Rate: Evaporation Pond

5.3.1 Equation for Geocomposite Flow Capacity

The leak detection drainage layer consists of a geonet. The maximum flow rate from a single hole in the primary liner that a geonet drainage layer can convey without the fluid head on the secondary liner exceeding a predetermined level is given by Equation 1 presented in Section 5.2.1.

5.3.2 Design Parameters

5.3.2.1 Hydraulic Conductivity

The technical specifications for the evaporation pond geonet require that over the base and the side slopes of the evaporation pond the geonet of the LDRS have a hydraulic transmissivity of at least 5×10^{-3} m^2/s when subjected to testing conditions which include stresses, and hydraulic gradient and boundary conditions similar to those anticipated in the field. Using the specified hydraulic transmissivity of 5×10^{-3} m^2/s and (and adjusting the transmissivity by a total factor of safety of 5.1 to account for intrusion, chemical slogging, biological clogging, and sediment clogging) geonet thickness of 0.2 inch, the calculated hydraulic conductivity is 20 cm/s. Hydraulic transmissivity test results confirming that the specified geonet has this calculated conductivity are required in the specifications and the CQA plan.

5.3.2.2 Head on Secondary Liner

Similar to the landfill LDRS regulations, the head on the evaporation pump liner should not exceed 1 foot. Therefore, 1 foot will be used for the calculated maximum head build-up on the secondary liner and the calculation of the ALR. Also, as with the landfill LDRS, 1 foot of head is interpreted to mean an equivalent fluid pressure of 1 foot rather than a 1-foot increase in fluid elevation.

5.3.3 Action Leakage Rate

5.3.3.1 Action Leakage Rate Calculation

Using Equation 1 and the design parameters listed above the maximum flow rate that the LDRS geocomposite drainage layer at the base of the evaporation pump can convey from a single hole in the primary layer is calculated to be approximately 13,000 gallons per acre per day (gpad). For the pond area this is approximately 9,000 gpd. The calculations are attached as Appendix G-1.

~~5.3.3.2 Design LDRS Sump Flow Capacity~~

~~The flow rate listed above is for the case of flow entering the drainage layer from a single hole in the primary liner. In order to determine if the LDRS sump has sufficient capacity to remove and therefore to detect the flow from a single hole in the primary liner, an analysis was carried out for the LDRS sump capacity.~~

~~The construction materials and layout for the LDRS sump are shown on Drawings 28 to 32. The calculations for the capacity of the LDRS sump presented in Appendix G-2 and indicate that the sumps can safely remove flows of approximately 75,600 gpd. This exceeds the expected flow capacity of LDRS geonet layer from a single hole in the primary liner; therefore, the sump could detect a leak of this magnitude.~~

~~5.3.4 Discussion of Proposed Action Leakage Rates~~

~~The proposed ALR of 1000 gpad is equivalent to the EPA recommended maximum and is substantially less then the calculated maximum. The ALR, as proposed by EPA, generally refers to values with units of gallons per acre per day (gpad). The calculated flow rates for the LDRS net layer for a single hole in the primary liner system are presented in units of gallons per day. However, if the value is divided by the pond area, the flows are reported in gallons per acre per day.~~

5.4 Determination if the Action Leakage Rate is Exceeded

Determination if the ALR is exceeded in ~~either~~ the landfill ~~or evaporation pond~~ will be conducted in accordance with 40 CFR 264.302(b). Each week during the active life and closure period of the landfill ~~and each week during the active life of the evaporation pond~~, the weekly flow rates into each LDRS sump (based on the results of the LDRS monitoring) will be converted to average daily flow rates per unit area (gpad). Each month during the landfill post-closure care period (i.e., after the final cover is installed), the monthly flow rates into each LDRS sump will be converted to average daily flow rates per unit area. The ALR is exceeded~~,~~ if the average daily flow rate into a LDRS sump is greater than the ALR assigned to that sump. If the ALR is exceeded, the response actions described in Section 7.0 will be implemented by the Triassic Park facility.

6. Leak Detection and Removal System Monitoring

The flow of liquid removed from the~~each~~ leak detection sump will be monitored either with a flow meter or using a container of known volume and a stop watch.

In accordance with 40 CFR 264.303 and 40 CFR 264.222, the volume of liquid removed from ~~each~~ the leak detection system sump in the landfill ~~and evaporation pond~~ will be recorded at least once each week during the active life. Liquid volumes will also be recorded once each week for the landfill LDRS sump~~s~~ during the closure period.

During the landfill post-closure care period, the volume of liquid removed from ~~each~~ the leak detection system sump will be recorded at least monthly. If the liquid level in the sump stays below the pump operating level, (i.e., 1 foot above the bottom liner)~~,~~ for two consecutive months, the level of liquid in the sump must be recorded at least quarterly. If the liquid level in the sump stays below the pump operating level for two consecutive quarters, the level of liquid in the sump will be recorded at least semiannually. However, if at any time during the post-closure care period the pump operating level is exceeded ~~for a sump~~ on quarterly or semiannual recording schedules, monthly recording of the volume of liquid removed from the sump will be reinstated. This will continue until such time that the liquid level in the sump again remains below the pump operating level for two consecutive months.

7. Response Actions

In accordance with 40 CFR 264.223 and 40 CFR 264.304, if the ALR is exceeded for the landfill LDRS sump ~~in either the landfill or evaporation pond~~, the Triassic Park Facility will:

- Notify the NMED in writing of the exceedance within 7 days of the determination;
- Submit a preliminary written assessment to NMED within 14 days of the exceedance determination, as to the amounts of liquids, likely sources of liquids, possible location, size, and cause of any leaks, and short term actions taken and planned;
- Determine, to the extent practicable, the location, size, and cause of any leak;
- Determine whether waste receipt should cease or be curtailed, whether any waste should be removed from the unit for inspection, repairs, or controls, and whether or not the unit should be closed;
- Determine any other short term and long term actions to be taken to mitigate or stop any leaks;
- Within 30 days after the notification that the action leakage rate has been exceeded, submit to NMED the results of the determinations described above, the results of the actions taken, a description of the actions planned;
- Monthly, as long as the action leakage rate continues to be exceeded, submit a report to NMED summarizing the results of any remedial actions taken and planned; and
- In making the determinations described in this section, either conduct the following investigation or document why such an investigation is not needed:
  - Assess the source and amount of liquid from each source collected in the sump.
  - Conduct a hazardous constituent analysis of the liquid collected in the sump, and use the results to help identify the source(s) of the liquid and possible location of any leaks as well as the potential hazard associated with the liquid and its mobility.
  - Assess the seriousness of any leaks in terms of potential for escaping into the environment.~~Closure of the pond per 40 CFR 264.223(b)(4).~~

8. References

Bonaparte, R. and B.A. Gross. Field behavior of double liner systems. Waste Containment Systems Construction, Regulation, and Performance, ASCE Geotechnical Special Publication No. 26, Nov 1990, pp. 52 83.

~~Giroud, J.P., Gross, B.A., and Darrasse, J., "Flow in Leachate Collection Layers" to be published, 1993.~~

Gross, B.A., R. Bonaparte, and J.P. Giroud. Evaluation of flow from landfill leakage detection layers. Proceedings, Fourth International Conference on Geotextiles, Vol. 2, The Hague, June 1990, pp. 481-486.

~~USEPA, "Action Leakage Rates for Leak Detection Systems", EPA/580 R 92¬004, Jan 1992, 69 p.~~

U.S. Environmental Protection Agency (EPA). 1992a. Federal Register, Volume 57, No. 19, Wednesday, January 29, 1992 Rules and Regulations, pp. 3462 - 3482.

U.S. EPA. 1992b. *Action leakage rates for leak detection systems*. EPA/580 R 92¬004, Jan 1992, 69 p.

Appendix ~~G-1~~A

~~Landfill ALR~~ Calculations

TERRAMATRIX INC.

Calculation Cover Sheet

Sheet 1 of 1

Project Title: Triassic Park

Project No. 602-0200

Calculation Title: Landfill Action Leakage Rate

	Name	Date
Prepared By:	J. Kendall	10/6/97
Checked By:	J. Pellicer	13-Nov-97
Reviewed By:	P. Corser	14 Nov 97
QA Review:		

Revisions	Date	By	Checked By	Reviewed By	QA Review

TerraMatrix
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Phone 970.879.6260 Fax 970.879.9048

Project Name: TRIASSIC PARK HW FACILITY - LF ALR
Project Number: 602-0200
Prepared By: K
Checked By: J. Pellicer

Date: 10/6/97
Date: 3-Nov-97

TITLE: TRIASSIC PARK LANDFILL ACTION LEAKAGE RATE

OBJECTIVE: DETERMINE ACTION LEAKAGE RATE (ALR) FOR THE TRIASSIC PARK HAZARDOUS WASTE FACILITY LANDFILL

REFERENCES:

1. USEPA, FEDERAL REGISTER, VOL 57 NO 19, WEDNESDAY JANUARY 29, 1992, RULES AND REGULATIONS, PP 3462-3477
2. USEPA, "ACTION LEAKAGE RATES FOR LEAK DETECTION SYSTEMS", EPA/530-R-92004, JANUARY 1992.
3. CODE OF FEDERAL REGULATIONS, TITLE 40, PART 264.302
4. BEAR, JACOB, "HYDRAULICS OF GROUNDWATER", McGRAW-HILL, 1979. PP 74-89.
5. TERRAMATRIX/MONTGOMERY WATSON, TRIASSIC PARK HAZARDOUS WASTE FACILITY DRAWINGS AS FOLLOWS:

DRAWING NO.	DRAWING TITLE	DATE
6	ULTIMATE LANDFILL EXCAVATION PLAN	NOV 97
12	LINER DETAILS	↓
15	SUMP PLAN VIEW	↓
16	SUMP CROSS-SECTIONS	↓
17	TYP. SUMP DETAILS	↓
18	CROSS-SECTION + DETAILS	↓

6. TERRAMATRIX/MONTGOMERY WATSON, TRIASSIC PARK HAZARDOUS WASTE FACILITY SPECIFICATIONS AS FOLLOWS:

SPEC NO	SPEC TITLE	DATE
02224	DRAINAGE GRAVEL	NOV 97
02710	GEOCOMPOSITE	NOV 97

7. MANUFACTURER'S PRODUCT SPECIFICATIONS AND TEST DATA AS FOLLOWS:

A. NSC, "TEX-NET TRANSMISSIVITY CHARTS", TEX-NET TN3002/1125 (PLATE/FRICTION SEAL/TN3002CN/1125/FRICTION SEAL/PLATE)

B. ADS, "TECHNICAL NOTE 2.109 RE: FLOW CAPACITY", 3/1/95.

8. MINIMUM EPA REQUIREMENTS FOR GEOSYNTHETIC DRAINAGE LAYERS IN LANDFILLS: 3×10^{-5} m^2/sec (REF 1. p 3468)

9. KOERNER, ROBERT M., "DESIGNING WITH GEOSYNTHETICS" 3rd ED., PRENTICE HALL, ENGLEWOOD CLIFFS, NJ, 1994.

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METHOD:

1. ALR IS DEFINED BY FEDERAL LAW AS:

REF 3.) 40CFR PART 264.302

§ 264.302 Action leakage rate.

(a) The Department shall approve an action leakage rate for landfill units subject to § 264.301(c) or (d). The action leakage rate is the maximum design flow rate that the leak detection system (LDS) can remove without the fluid head on the bottom liner exceeding 1 foot. The action leakage rate must include an adequate safety margin to allow for uncertainties in the design (e.g., slope, hydraulic conductivity, thickness of drainage material), construction, operation, and location of the LDS, waste and leachate characteristics, likelihood and amounts of other sources of liquids in the LDS, and proposed response actions (e.g., the action leakage rate must consider decreases in the flow capacity of the system over time resulting from siltation and clogging, rib layover and creep of synthetic components of the system, overburden pressures, etc.).

(b) To determine if the action leakage rate has been exceeded, the owner or operator must convert the weekly or monthly flow rate from the monitoring data obtained under § 264.303(c), to an average daily flow rate (gallons per acre per day) for each sump. Unless the Department approves a different calculation, the average daily flow rate for each sump must be calculated weekly during the active life and closure period, and monthly during the post-closure care period when monthly monitoring is required under § 264.303(c).

2. FLOW RATE INTO LEAK DETECTION SYSTEM CAN BE DETERMINED FROM THE FOLLOWING EQN CITED IN REF 1, p. 3474 AND DEVELOPED FOR GEONET DRAINAGE LAYERS CITED IN REF 2, p 12, (EQN 3).

$Q = K \cdot D(2h - D)$ WHERE

Q = FLOW RATE IN LEAK DETECTION SYSTEM RESULTING FROM 1 HOLE PER ACRE (GPAD)

K = HYDRAULIC CONDUCTIVITY OF DRAINAGE LAYER (FT/SEC)

FOR GEONET: $K = T/t$

WHERE T = TRANSMISSIVITY OF GEONET (FT^2/SEC)

t = THICKNESS (FT)

h = HEAD ON LINER (FT)

D = LEAK DETECTION LAYER THICKNESS (FT)

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METHOD (CONTINUED)

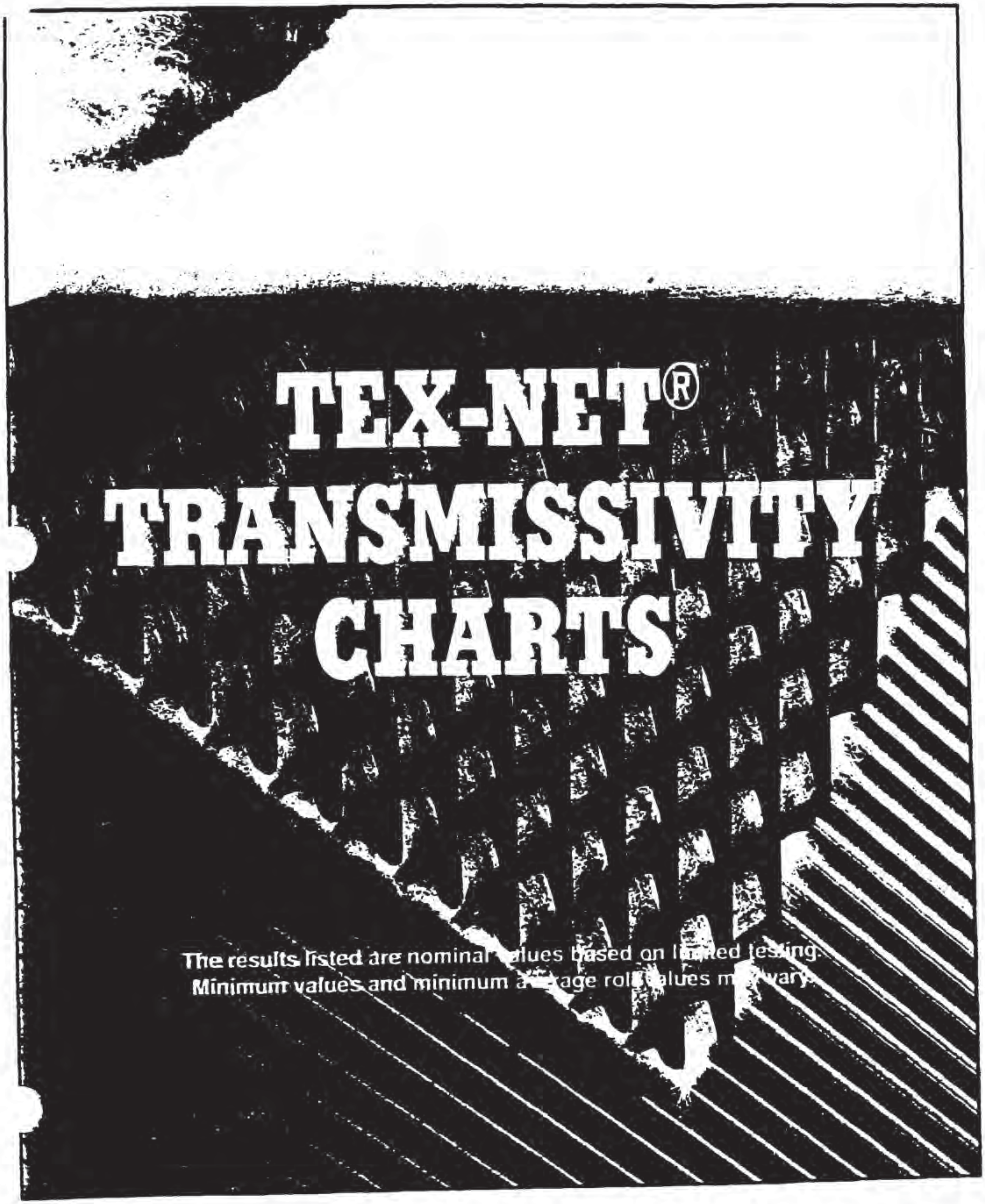
3. GEOCOMPOSITE TRANSMISSIVITY (OR FLOW RATE) CORRECTIONS FOR INTRUSION OF ADJAC MATERIALS (REF 9. PP 402-423)

GEOCOMPOSITE MANUFACTURERS TYPICALLY REPORT TRANSMISSIVITY (OR FLOW RATE) DA BASED ON ASTM 4716-87 TEST PROCEDURES CONDUCTED AT VARIOUS RANGES OF OVERBURDEN PRESSURES (NORMAL LOADS), HYDRAULIC GRADIENTS, AND MATERIAL LAYER ARRANGEMENTS. FOR THIS DATA TO BE APPLICABLE, THE TEST CONDITIONS MUST BE REPRESENTATIVE OF ACTUAL DESIGN AND OPERATING CONDITIONS. THEREFORE, APPROPRIATE FACTORS OF SAFETY MUST BE APPLIED TO MANUFACTURER'S DATA TO ACCOUNT FOR TEST PROCEDURE DIFFERENCES. FURTHER, HYDRAULIC TESTING OF THE SELECTED GEOCOMPOSITE SHOULD BE CONDUCTED UNDER ACTUAL DESIGN AND OPERATING CONDITIONS TO CONFIRM THAT THE FACTORS OF SAFETY APPLIED TO MANUFACTURER'S DATA ARE ADEQUATE.

4. CHECK LDRS PIPE FLOW CAPACITY VS LDRS INFLOW
CHECK LDRS SUMP FLOW CAPACITY VS LDRS INFLOW

NSC

National Seal Company



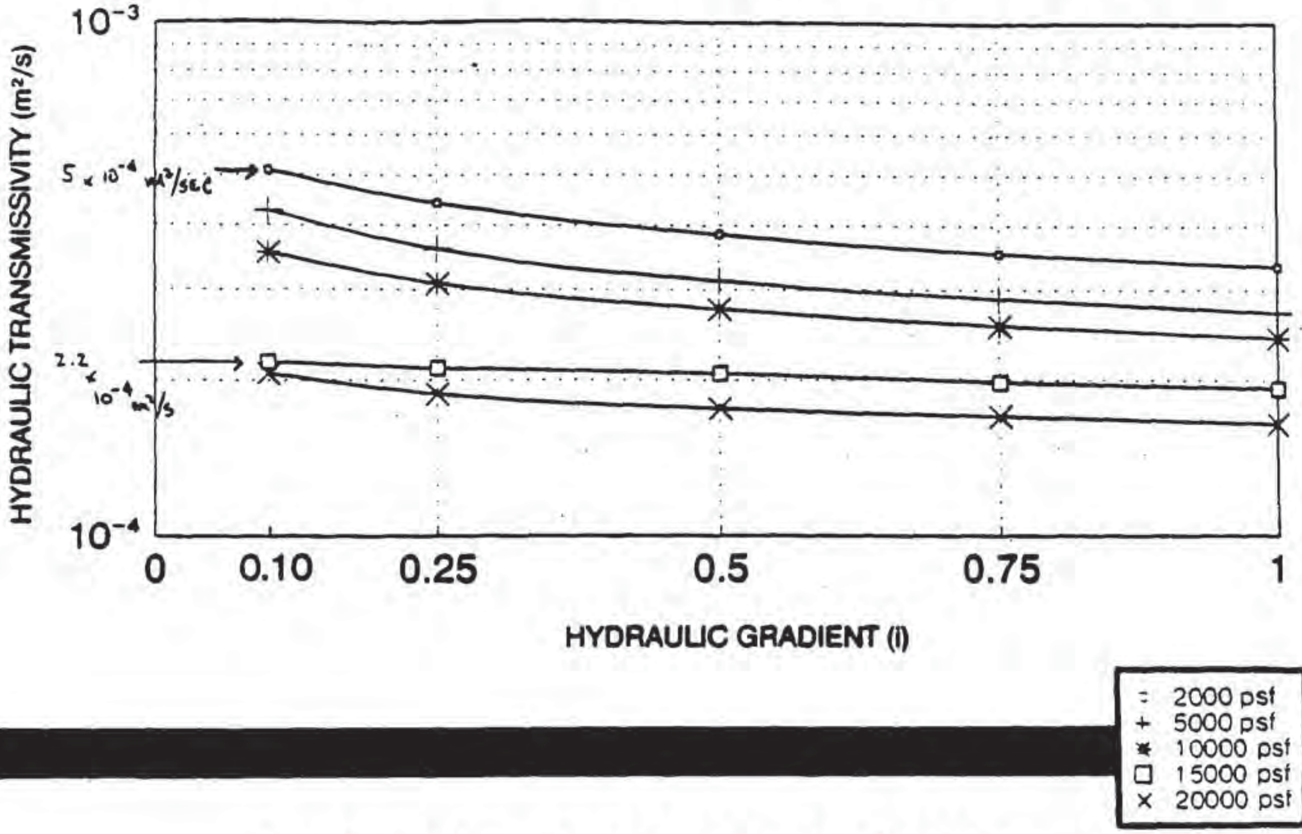
TEX-NET®
TRANSMISSIVITY CHARTS

The results listed are nominal values based on limited testing.
Minimum values and minimum average roll values may vary.

REF 7A
602-0200
JK
10/6/97

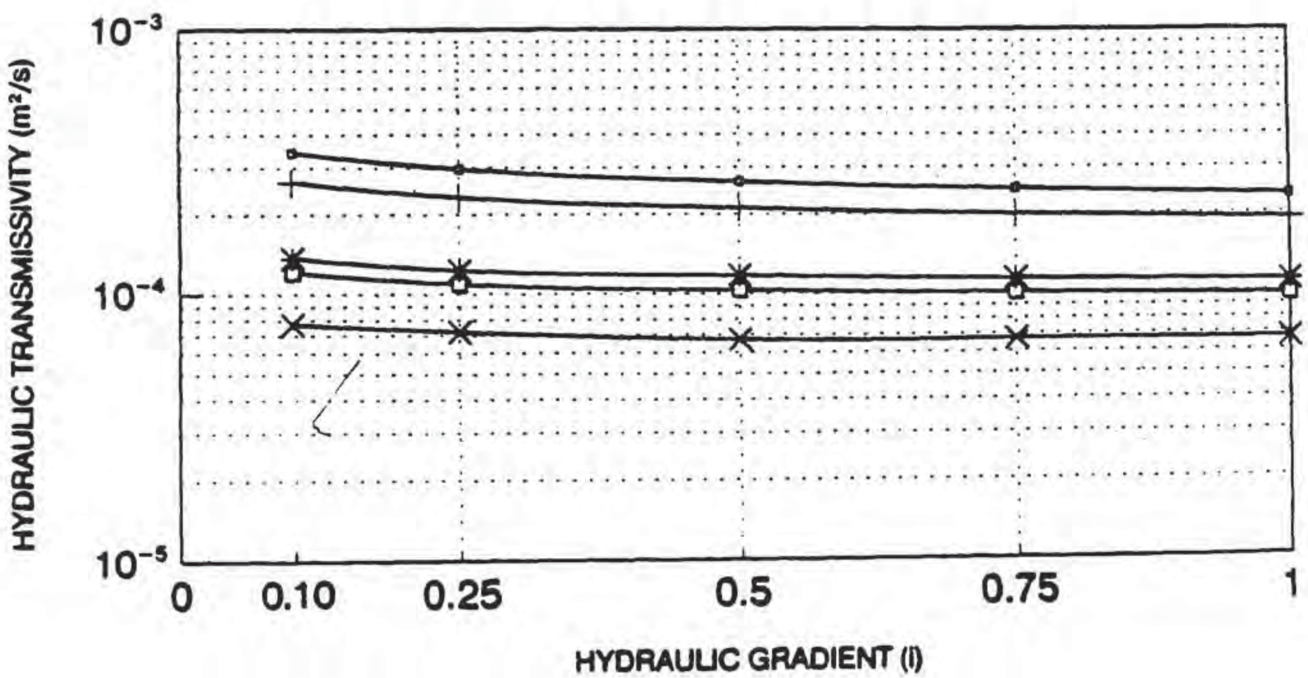
TEX-NET TN3002/1125

plate/FRICTION SEAL/TN3002/1125/FRICTION SEAL/plate



TEX-NET TN3002CN/1125

plate/FRICTION SEAL/TN3002CN/1125/FRICTION SEAL/plate



REF. 7A 6

602-32W
12/6/97

SPECIFICATION – Minimum Average Roll Values

Raw material	PN2000 polyethylene	PN3000 polyethylene	PN3000CN polyethylene
Weight (lbs/ft²) ASTM D5261	0.100	0.162	0.140
Thickness (inches) ASTM D5199	0.160	0.200	0.200
Density (g/cm³) ASTM D1505	0.940	0.940	0.940
Tensile strength (lb/in) ASTM D5035	30	45	32
Carbon black (%) ASTM D4218	2	2	2
Porosity (%), Nom.	83	80	76
Roll with (feet), Nom.	7.54 & 14.5	7.54 & 14.5	7.54 & 14.5
Standard roll length (feet), Nom.	300	300	300
Area per roll (ft²), Nom.	2262 & 4350	2262 & 4350	2262 & 4350

The transmissivity results listed on the preceding pages were determined in compliance with ASTM D4716-87 test procedure. The transmissivity was measured using water @ 20°C (68°F) with a seat time of one hour. Values may vary, based on dimensions of the transmissivity specimen and specific laboratory.

CONVERSION FACTORS FOR TRANSMISSIVITY UNITS

$1 m^2/s$ = 1 cubic meter/second/meter width/unit gradient
$1 m^2/s = 10^3$ liters/second/meter width/unit gradient
$1 m^2/s = 6 \times 10^4$ liters/minute/meter width/unit gradient
$1 m^2/s = 10.76 ft^2/second$
$1 m^2/s = 646 ft^2/minute$
$1 m^2/s$ = 4830 gallons/minute/foot width/unit gradient

$1 ft^2/second$ = 1 cubic foot/second/foot width/unit gradient
$1 ft^2/second = 9.3 \times 10^{-2} m^2/s$
$1 ft^2/minute$ = 1 cubic foot/minute/foot width/unit gradient
$1 ft^2/minute = 1.55 \times 10^{-3} m^2/s$
1 gpm/foot width/unit gradient $= 2.07 \times 10^{-4} m^2/s$
1 liter/minute/meter width/unit gradient $= 1.66 \times 10^{-5} m^2/s$
100 liters/minute/meter width/unit gradient $= 1.07 ft^2/min.$

NSC

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ASSUMPTIONS

1. GEOCOMPOSITE TRANSMISSIVITY

FROM REF 7A, CHART FOR TEX-NET TN 3002./1125. MINIMUM TRANSMISSIVITY REPORTED IS 2.2 x 10^-4 / M²/SEC @ NORMAL PRESSURE = 15,000 PSF AND HYDRAULIC GRADIENT OF 0.1, TEST SECTION WAS PLATE/FRICTION SEAL/TN 3002 CN/1125/FRICTION SEAL/PLATE.

ADJUST TRANSMISSIVITY CITED ABOVE FOR DIFFERENCES BETWEEN MANUFACTURER'S TEST CONDITIONS AND ACTUAL DESIGN CONDITIONS. APPLY FS IN A MANNER SIMILAR TO APPROACH SUGGEST BY KOERNER (REF. 9, PP. 413-414)

$FS_{INTRUSION}$: SINCE TEST CONDITIONS ALLOW FOR INTRUSION OF GEOTEXTILE FROM ABOVE AND BELOW THE GEONET AND NORMAL PRESSURES ARE CONSISTENT WITH DESIGN (120 FT WASTE & 110 lb/CFT = 13,200 PSF), USE $FS_{IN} = 1$.

FS_{CREEP} : SINCE TEST CONDITIONS MAY REPRESENT SHORT DURATIONS, USE $FS_{CR} = 1.5$

$FS_{CHEMICAL\ CLOGGING}$: SINCE LEACHATE FROM WASTES OF A WIDE CHEMICAL VARIETY MAY BE PRESENT, USE $FS_{CC} = 1.5$.

$FS_{BIOLOGICAL\ CLOGGING}$: SINCE MUNICIPAL WASTES WILL NOT BE ACCEPTED IN THE LANDFILL, THE PERCENTAGE OF BIODEGRADABLE MATERIAL PRESENT WILL BE SMALL, USE $FS_{BC} = 1$.

$FS_{SEDIMENT\ CLOGGING}$: SINCE FINE GRAINED SOILS MAY BE PRESENT IN THE PROTECTIVE COVER MATERIAL (SM CLASSIFICATION), USE $FS_{SC} = 1.5$

$$TOTAL\ FS = FS_{IN} \times FS_{CR} \times FS_{CC} \times FS_{BC} \times FS_{SC} = 1 \times 1.5 \times 1.5 \times 1 \times 1.5$$

$$= 3.375$$

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ASSUMPTIONS (CONTINUED)

1. GEOCOMPOSITE TRANSMISSIVITY (CONTINUED)

ALLOWABLE GEOCOMPOSITE FLOW RATE $(q) = q\,(\text{MANUF. TEST}) \times \frac{1}{FS_{TOTAL}}$

$$q_{ALLOW} = \frac{2.2 \times 10^{-4}}{3.375} = 6.52 \times 10^{-5}\ m^2/sec \quad \text{SAY } 6.5 \times 10^{-5}\ m^2/sec$$

CHECK q_{ALLOW} VS EPA MINIMUM (REF 1, p 3468)

$6.5 \times 10^{-5} > 3.0 \times 10^{-5}$ ∴ OK

(NOTE: ALTHOUGH THE ASSUMPTIONS LEADING TO $q_{ALLOW} = 6.5 \times 10^{-5}\ m^2/sec$ ARE CONSERVATIVE, CONFIRMATORY TESTING OF GEOCOMPOSITE TRANSMISSIVITY WILL BE REQUIRED. TESTING WILL BE CONDUCTED ON ACTUAL GEOCOMPOSITE SELECTED AT DESIGN CONDITIONS)

2. MAXIMUM HEAD ON LINER

USE 1.0 ft PER EPA 40 CFR 264.302

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CALCULATION

DETERMINE ALR

$$ALR = Q_{ALLOWABLE} = KD(2h - D) \quad (GPAD)$$

WHERE

$K_{GEOCOMPOSITE} = T/t$ $\quad$ T = TRANSMISSIVITY = 6.5×10^{-5} m²/s
t = THICKNESS = 5 mm

$$K_{GEOCOMPOSITE} = \frac{6.5 \times 10^{-5}\ m^2/sec}{.005\ m} = 0.013\ m/sec$$

= 1.3 cm/sec

= 0.043 FT/sec

h = 1.0 ft

D = 5 mm = 0.0164 FT

$$ALR = Q_{ALLOWABLE} = 0.043\ \frac{FT}{sec} \times 0.0164\ FT \times (2 \times 1.0\ FT - 0.0164\ FT)$$

= 0.00140 CFT/Ac/sec

= 120.9 CFT/Ac/DAY

= 904 GPAD

RECOMMENDED ALR IS 900 GPAD ⟵

NOTE: THE RECOMMEND ALR VALUE OF 900 GPAD IS ABOVE THE EPA RECOMMENDED VALUE OF 100 GPAD (REF 1, p. 3474). THE PRIMARY REASON FOR THIS DIFFERENCE IS THE EPA VALUE IS BASED ON SAND PERMEABILITY (1×10^{-2} cm/sec) COMPARED TO THE GEOCOMPOSITE PERMEABILITY ASSUMED ABOVE (1.3 cm/sec).

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CALCULATION (CONTINUED)

CHECK LDRS FLOOR PIPE CAPACITY

USE FLOOR LAYOUT AND CROSS SECTIONS (REF.

USE ADS N-12 PIPE FLOW CAPACITY CHART FOR 8" DIAM. PIPE (REF. 7B)

FLOW = 2.07 CFT/SEC
= 929 GPM ✓
= 1.337 MGPD ✓

USE EPA FLOW RATE EQN TO DETERMINE FLOW INTO LDRS WITH $T = 5 \times 10^{-4}$ m/sec (REF. 7A) (most transmissive value, conservative)

NOTE: TRANSMISSIVITY VALUE USED HERE IS GREATER THAN THAT USED FOR ALR CALC BECAUSE WE ARE CHECKING MAXIMUM FLOW CAPACITIES FOR THE LDRS PIPE AND SUMP GRAVEL. THE HIGH TRANSMISSIVITY VALUE HERE IS MORE REPRESENTATIVE OF A SCENARIO EARLY IN THE LIFE OF THE LANDFILL WHEN WASTE FILL HEIGHTS ARE RELATIVELY LOW.

$Q = K \cdot D(2h - D)$ (REF 2, P12, EQN 3)

$K = T/t = \dfrac{5 \times 10^{-4}\ m^2/sec}{0.005\ m} = 0.1\ m/sec$ ✓
$= 10\ cm/sec$ ✓
$= 0.328\ ft/sec$ ✓

$h = 1.0$ ft
$D = 5\ mm = 0.0164$ FT ✓

$Q = 0.328 \times 0.0164 \times ((2 \times 1.0) - 0.0164)$
= 0.0106 CFT/AC/SEC ✓
= 922 CFT/AC/DAY ✓
= 6898 GAL/AC/DAY (GAPD) ✓

FLOW INTO PHASE 1 LDRS = 6898 GAPD × 7AC = 48,286 GPD ✓

FLOW INTO PHASE 1 LDRS << PIPE FLOW CAPACITY
48,286 GPD << 1.34 MGPD So PIPE CAPACITY OK ✓

Technical Notes

ADS

Technical Note 2.109

Re: Flow Capacity
Date: March 1 1995

It is the intent of this Technical Note to provide current hydraulic performance data for use by the engineering community. A bibliography is included for the engineer's use if further information or guidance is needed.

Manning's "n" values are offered for design purposes based on the best available data assembled from a variety of sources as indicated. Table 1 presents the Manning's "n" values recommended by the A.D.S. engineering staff for use in design.

REF 7B

Table 1
Manning's "n" Value For Design
(Storm & Sanitary Sewer and Culverts)

Pipe Type	"n"
A.D.S. Corrugated Polyethylene Pipe	
3" - 6" Diameter	0.015
8" Diameter	0.016
10" Diameter	0.017
12" - 15" Diameter	0.018
18" - 36" Diameter	0.020
A.D.S. N-12	0.012 ←
Concrete Pipe	0.013
Corrugated Metal Pipe (2 2/3" x 1/2" corrugation)	
Annular	
Plain	0.024
Paved Invert	0.020
Fully Paved (smooth lined)	0.013
Helical	
Plain 15" Diameter	0.013
Plain 18" Diameter	0.015
Plain 24" Diameter	0.018
Plain 36" Diameter	0.021
Spiral-Rib	0.012
Plastic Pipe (SDR, S&D, Etc.)	0.011
Vitrified Clay	0.013

REF. 7B

TABLE 4

PIPE SLOPE = 2.5%

CIRCULAR PIPE FLOW CAPACITY
Full Flow (cubic feet per second)

Mannings "n"= 0.012

Dia. (in.)	*Conv. Factor	0.02	0.05	0.10	0.20	0.35	0.50	0.75	1.00	1.25	1.50	1.75	2.0	2.5	5.0	10.0	20.0
		% Slope (feet per 100 feet) (c.f.s.)															
3	0.957	0.014	0.021	0.030	0.043	0.057	0.068	0.083	0.096	0.107	0.12	0.13	0.14	0.16	0.21	0.30	0.43
4	2.062	0.029	0.046	0.065	0.092	0.122	0.146	0.179	0.206	0.231	0.25	0.27	0.29	0.33	0.46	0.66	0.92
5	3.738	0.053	0.084	0.118	0.167	0.221	0.264	0.324	0.374	0.418	0.46	0.49	0.53	0.59	0.84	1.18	1.67
6	6.079	0.086	0.136	0.192	0.272	0.360	0.430	0.526	0.608	0.680	0.74	0.80	0.86	0.96	1.36	1.92	2.72
8	13.091	0.185	0.293	0.414	0.585	0.774	0.926	1.134	1.309	1.464	1.60	1.73	1.85	2.07	2.93	4.14	5.85
10	23.74	0.34	0.53	0.75	1.06	1.40	1.68	2.06	2.37	2.65	2.91	3.14	3.36	3.75	5.31	7.51	10.61
12	38.60	0.55	0.86	1.22	1.73	2.28	2.73	3.34	3.86	4.32	4.73	5.11	5.46	6.10	8.63	12.21	17.26
15	69.98	0.99	1.56	2.21	3.13	4.14	4.95	6.06	7.00	7.82	8.57	9.26	9.90	11.06	15.65	22.13	31.30
18	113.80	1.61	2.54	3.60	5.09	6.73	8.05	9.86	11.38	12.72	13.94	15.05	16.09	17.99	25.45	35.99	50.89
21	171.65	2.43	3.84	5.43	7.68	10.16	12.14	14.87	17.17	19.19	21.02	22.71	24.28	27.14	38.38	54.28	76.77
24	245.08	3.47	5.48	7.75	10.96	14.50	17.33	21.22	24.51	27.40	30.02	32.42	34.66	38.75	54.80	77.50	109.60
27	335.51	4.74	7.50	10.61	15.00	19.85	23.72	29.06	33.55	37.51	41.09	44.38	47.45	53.06	75.0	106.1	150.0
30	444.35	6.28	9.94	14.05	19.87	26.29	31.42	38.48	44.44	49.68	54.42	58.78	62.84	70.26	99.4	140.5	198.7
36	722.57	10.22	16.16	22.85	32.31	42.75	51.09	62.58	72.26	80.79	88.50	95.59	102.19	114.25	161.6	228.5	323.1
42	1089.9	15.41	24.37	34.47	48.74	64.5	77.1	94.4	109.0	121.9	133.5	144.2	154.1	172.3	243.7	344.7	487.4
48	1556.1	22.01	34.80	49.21	69.59	92.1	110.0	134.8	155.6	174.0	190.6	205.9	220.1	246.0	348.0	492.1	695.9

* Conveyance Factor = (1.486 x R2/3 x A) / n

602-020

JK 10/6/97

12/41

CALCULATION (CONTINUED)

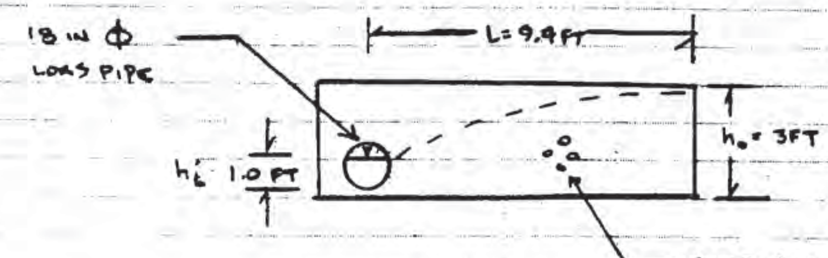
CHECK LDRS SUMP PUMPING CAPACITY

USE LDRS CROSS-SECTIONS (REF
USE METHOD DESCRIBED IN "HYDRAULICS OF GROUNDWATER" (REF 4)

USE DUPUIT-FORCHHEIMER EQN

$$Q = K/2L\,(h_o^2 - h_L^2)$$

WHERE: Q = FLOW RATE PER FT OF PIPE LENGTH
L = DISTANCE TO MAXIMUM FLUID ELEVATION
h_o = MAXIMUM FLUID ELEVATION
h_L = FLUID ELEVATION IN PIPE
K = PERMEABILITY OF LDRS SUMP GRAVEL



$$Q = \frac{1.969\ \text{FT/MIN}}{2 \times 9.4\ \text{FT}} \times (3^2\ \text{FT} - 1^2\ \text{FT})$$

= 0.837 CFT/MIN/FT PIPE LENGTH ✓

PIPE LENGTH = 15 FT (REF.

Q_{TOTAL} = 0.837 CFT/MIN/FT PIPE LENGTH × 15 FT = 12.57 CFT/MIN
= 135,403 GPD

FLOW INTO LDRS < FLOW CAPACITY OF SUMP

48,286 GPD < 135,403 GPD ∴ SUMP CAPACITY OK

Attachment K. Part A Permit Application

The Part A permit application is included in Volume 1 of this application. Attachment K is maintained as a placeholder, following the order of attachments in the 2002 approved permit.

Permit Renewal Application
October 17, 2011

Attachment L

Engineering Report

Prepared for:
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Prepared by:
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Modified by:
The New Mexico Environment Department
March 2002

Table of Contents

Section **Page**

Table of Contents (Continued)

Section **Page**

List of Tables

Table **Page**

~~List of Appendices~~

~~Appendix~~

List of Appendices (Continued)

Appendix

Attachment L. Engineering Report

1. General

1.1 Introduction

Gandy Marley Inc. (GMI) is submitting a Resource Conservation and Recovery Act (RCRA) Part B Permit Application to construct and operate the proposed Triassic Park Waste Disposal Facility (EPA ID NO. NM0001002484) to be located in Chaves County, New Mexico. This Engineering Report was updated by Daniel B. Stephens & Associates, Inc. (DBS&A) based on the original Engineering Report prepared for the Triassic Park Permit Application by TerraMatrix/Montgomery Watson (TerraMatrix). This Engineering Report presents the detailed design of the Triassic Park Waste Disposal Facility submitted in support of the Triassic Park Waste Disposal Facility RCRA Part B Application.

1.1.1 Background

In 1994, ~~Gandy Marley Inc.~~GMI contracted the S.M. Stoller Corporation to perform site characterization work and to prepare RCRA Part A and Part B Permit Applications for location of a hazardous waste treatment, storage and disposal facility on a 480 acre parcel of privately owned land located in Chaves County, New Mexico. The proposed site is located in Section 17 and 18 of R31E, T11S which lies approximately 42 miles east of Roswell, New Mexico and 36 miles west of Tatum, New Mexico.

In August 1994, ~~Gandy Marley Inc.~~GMI contracted with TerraMatrix to prepare preliminary designs for the various site facilities and to assist S.M. Stoller in the preparation of the RCRA Part B Permit submittals. ~~Since that time,~~ S.M. Stoller and TerraMatrix ~~have been~~ workeding jointly to respond to comments and requests for additional information made by the New Mexico Environmental Department (NMED).

The Facility design as presented herein is a product of several design iterations which incorporated additional information and design modifications as suggested by the NMED. The Facility permit was approved by NMED in 2002.

In 2011, GMI contracted DBS&A to update the engineering design for the Triassic Park Facility, which is yet to be constructed. The design updates include elimination of some operations and waste types planned under the original design and permit. Details of the changes are described in this Engineering Report.

1.1.2 Objective and Scope

The primary objective of this report is to present the detailed design and engineering analyses required under Title 40, Code of Regulations (40 CFR), Part 264 and Title 20, New Mexico Administrative Code ~~(20 NMAC)~~ 4.1 (20 4.1 NMAC) in support of the Triassic Park Waste Disposal Facility RCRA Part B Permit Application. This engineering report presents ~~detailed design drawings, construction specifications, construction quality assurance plan, surface water control plan, and supporting engineering analyses and laboratory studies~~information applicable to the following site features and facilities:

- Site arrangement
- Landfill

Updates to the engineering design for the renewal of the Triassic Park permit include elimination of the following facilities that were part of the original permitted design.

- Evaporation Pond
- Truck Roll-Off Area
- Stabilization Facility
- Drum Handling Facility
- Liquid Waste Storage Facility
- Truck Wash Facility

The report also presents the landfill and evaporation pond action leakage rate and response action plan along with its supporting engineering analyses.

1.1.3 Report Organization

This report is organized into ten sections including this Section 1.0, Introduction. Sections 2.0 and 3.0 of this report through 9.0 describe the design elements and engineering analyses for the general facility arrangement and, the landfill, the evaporation pond, the truck roll-off area, the stabilization facility, the drum handling facility, the liquid waste storage facility and the truck wash facility. Sections 4 through 9 describing facilities that have been eliminated from the 2002 Engineering Report have been removed. Section 10.0 presents aA list of references used in the report follows the removed sectionsfollowed by the report appendices. Detailed design drawings are provided as Permit Attachment L1. The Construction Quality Assurance (CQA) Plan is provided as Permit Attachment M. The landfill action leakage rate and response action plan and its supporting engineering analyses are provided as Permit Attachment J. See the attachments Appendices A-C through F and H, presented in Volumes 4III through VI of the Permit Application dated October 2000 for present, respectively, the detailed design drawings, construction quality assurance plan, construction specifications (Attachment Z), laboratory test results (Attachment AA), engineering calculations (Attachment BB), surface water control plan (Attachment CC), and action leakage rate and response action plan, and manufacturer information (Attachment DD).

The drawings in Appendix APermit Attachment L1 present final designs for the RCRA--permitted facilities. Details on the non-RCRA components of the facilities may be supplemented during the bidding and construction phase. Gandy MarleyGMI will supply the additional details on the non-RCRA components of the design to NMED for review and approval prior to the start of construction.

1.2 Regulatory Criteria and Guidance

The following federal and state regulations, as well as federal guidance documents were used in the design:

- New Mexico Hazardous Waste Regulations, 20.4.1 NMAC20.4.1.
- Title 40 -- Code of Federal Regulations (Federal Hazardous Waste Regulations, 40 CFR), Part 264.
- U.S. Environmental Protection Agency (US EPA), 1984. Permit Applicants Guide Manual for Hazardous Waste Land Treatment Storage and Disposal Facilities.
- U.S. Environmental Protection Agency, 1988. Lining of Waste Containment and Other Impoundment Facilities, Part 1 of 2 and Part 2 of 2.
- U.S. Environmental Protection Agency, 1988. Seminar Presentations - Requirements for Hazardous Waste Landfill Design, Construction and Closure.
- U.S. Environmental Protection Agency, 1996. Technical Guidance Document. Construction Quality Assurance for Hazardous Waste Land Disposal Facilities.

- United States Environmental Protection Agency, July, 1990. Seminars - Design and Construction of RCRA/Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Final Covers, Washington, DC

Additional supporting reference documents are presented in Section 10.0.the reference list.

1.3 Review of NMED Comment Responses

In March 1997 comments on the GMI Triassic Park Waste Disposal Facility RCRA Part B Permit Application were prepared for NMED by A.T. Kearny. In June 1997, Montgomery Watson prepared a response to each comment and indicated how the comment would be addressed with revised information or submittal of additional information. In that submittal, we indicated that it was the intention of GMI to meet all relevant requirements stipulated under 40 CFR 264, 40 CFR 268, 40 CFR 270 and corresponding NMED requirements in 20 NMAC necessary to obtain a RCRA Part B Permit for the Triassic Park Waste Disposal Facility. In addition, GMI would provide the requested supporting technical information for each waste management unit proposed for the facility. Finally, GMI would also provide detailed design drawings, engineering reports, and specifications signed and stamped by a professional engineer registered in the State of New Mexico (Patrick G. Corser, P.E., Registration Number 12236) prior to NMED issuing a Draft RCRA Permit for the Triassic Park Waste Disposal Facility.

1.4 Summary of Geologic and Hydrologic Conditions

Regional and site geologic and hydrologic conditions are discussed in the Triassic Park Waste Disposal Facility Part B Permit Application (5245). This site characterization work was performed by the S.M. Stoller Corporation and is based on a series of exploration drilling and test pit programs conducted at the site and review of New Mexico Oil Conservation Division well logs. One of the results of primary importance to this engineering report stemming from the site characterization report is the identification of the "most favorable area" for the location of the landfill. A brief summary of the site geologic and hydrologic conditions based on the Part B Permit Application is presented below.

1.4.1 Regional Conditions

The geologic formations present within the region where the Triassic Park Treatment, Storage, and Disposal Facility (TSDF) is situated range from Quaternary through Triassic in age. These include Quaternary alluvium, Tertiary Ogallala Formation, and the Triassic Dockum Group. Permian sediments do not outcrop in this region.

1.4.2 Site Geology

Site stratigraphy generally consists of, from top down, 2- to 20-foot thicknesses of Quaternary alluvial materials; 30- to 100-foot thicknesses of Upper Dockum mudstones, siltstones, and sandy siltstones; and up to 600-foot thicknesses of Lower Dockum mudstones. Permeability testing of mudstones core samples were was found to average 2.2 x 10^{-7} centimeters per second (cm/s) and siltstones averaged 1 x 10^{-4} cm/s (5245).

Based on the regional geologic features, the potential for subsurface subsidence and the occurrence of sinkholes is considered negligible. In addition, there are no identified faults within the project area. The proposed site is located in a geologically stable area with low seismic activity potential. Design ground accelerations of 0.04 g were used in engineering evaluations presented in this report (1).

1.4.3 Site Hydrogeology

The Part B Permit Application Section 3.~~0~~, Ground Water Protection, provides a detailed discussion of the site geology and supporting investigation activities, as well as site groundwater characteristics and supporting groundwater flow modeling. Based on these assessments, the "most favorable" area for the landfill construction was identified (see Figure 3-12 of Section 3.~~0~~). The footprint for the proposed landfill generally conforms to the "most favorable" area. Cross sections shown on Drawing No. 7 show the landfill base and geologic foundation intercepts.

1.5 Additional Field and Laboratory Studies

In addition to the site characterization drilling and test pitting programs described above, a test pit program to characterize near surface soil conditions and laboratory studies to identify geotechnical properties of the soils and proposed liner components was conducted. Attachments W and X~~Appendix D provided in Volume V of the Permit Application dated October 2000~~ present~~s~~ the results of the test pit program, soil index tests, and interface shear tests performed on the soil and geosynthetic liner materials.

1.6 Summary of Climatological Data

Site climatological data, including temperature and precipitation, ~~was~~ were obtained from the National Oceanic and Atmospheric Administration (NOAA) Class A recording station in Roswell, New Mexico. Climate conditions of the area are typical of semi-arid regions characterized by dry, warm winters with minimal snow cover and hot, somewhat moister summers (52). Other climatological data required for modeling were obtained from Weather Underground and the National Solar Radiation Database.

Moderate temperatures at the Triassic Park ~~Site~~ Facility are typical throughout the year, with annual average high and low temperatures ~~near~~ of 75 degrees Fahrenheit (°F) and 45°F, respectively~~60°F~~. Temperatures ~~in December~~ throughout ~~February~~ the year often exhibit ~~show~~ a large diurnal variation~~, averaging 36°F at~~ in Roswell. ~~On approximately 75 percent of the~~ While winter mornings~~s,~~ temperatures ~~are~~ below freezing~~, and afternoon maximum temperatures in the high fifties. Afternoon winter temperatures of 70°F or more are common. Night time lows average near 23°F, occasionally dipping as low as 14°F.~~ are possible, ~~There are perhaps two or three winter~~ days when the temperature fails to rise above freezing are rare. ~~Avergae~~Average temperatures in the months of June, July, and August exceed 90°F and often exceed 100°F.

Precipitation is light and unevenly distributed throughout the year~~, averaging 10 to 13 inches~~. Winter is the season of least precipitation, averaging less than 0.6 inch~~es~~ of rainfall per month for the months of November through March. Snow averages about 5 inches per year, but often melts withing 24 hours of each snowfall event. ~~at the site and seldom remains on the ground for more than a day at a time because of the typically above freezing temperatures in the afternoon. Approximately~~ More than half of the annual precipitation ~~comes~~ in Roswell is the result of monsoonal moisture associated with the months of ~~from frequent thunderstorms in~~ June through September. ~~Rains~~ Storm events are usually brief but ~~occasionally~~ often intense~~ when moisture from the Gulf of Mexico spreads over the region~~.

Precipitation for the project area varies greatly from year to year. For example, Roswell's record low and high annual precipitation values ~~is~~are, respectively, ~~4.35~~2.9 inches in 2003 and 32.9 inches in 1941. The maximum 24-hour rainfall was 5.65 inches in October 1901. ~~The record annual high is 32.92 inches. Most years are either "wet" or "dry"; few are "average". An~~ The average annual precipitation rate for Roswell for a 1~~80~~18~~7~~-year period from 18~~47~~94~~8~~ to 2011~~1982,~~ is ~~10.61~~11.655 inches~~ per year~~.

The prevailing wind direction is from the south with a normal mean wind speed of 9.6 miles per hour (mph) at Roswell.

2. General Facility Design Elements

2.1 General Facility Design Elements

2.1.1 General

General facility design elements include the overall facility layout, traffic plan, and site wide storm~~-~~water control design. This permit application refers only to Phase 1A. However, potential expansions of the landfill to future phases have been included in the general layout drawings for completeness. This section describes the site layout and provides rationale for the individual facility locations and roadway network. In addition, the site wide storm~~-~~water control feature system is described.

2.1.2 Facility Layout

Drawing No. 4, Facility Layout, illustrates the proposed locations of all site facilities, including the site waste receiving, treatment, disposal, and storage facilities; the site maintenance area; soil stockpiles; surface water control features; water storage basins; and interconnecting access roadways. The locations of these facilities ~~is~~ are governed by the landfill layout and construction sequencing, existing roads leading to the facility, and existing topography and surface water drainage~~, and operational interactions between the waste storage, treatment, and disposal facilities~~. Additional rationale for the facility layout is~~individual facility locations are~~ discussed below.

Facility entrance and receiving areas, including the security gate, administration trailer, truck untarping and sampling stations, chemical laboratory, and truck staging area, are located near the facility entrance in the northeast corner of the site. This arrangement facilitates site access security; incoming waste load inspection, sampling, testing, and weighing; and provides vehicle parking, truck staging, and emergency vehicle access.

~~Waste processing and storage areas including the drum handling facility, stabilization facility, liquid waste storage area, and truck roll-off area are located north of the landfill access. This arrangement will minimize traffic interference between waste processing facility operations, landfill operations, and landfill construction activities. The drum handling facility and liquid waste storage area are located closest to the facility entrance because delivery vehicles to these units will not be required to access the landfill or other site facilities. The stabilization facility is located in close proximity to the liquid waste storage area, drum handling facility, truck roll-off area, and landfill entrance to facilitate waste transfer operations between these units.~~

~~The evaporation pond and truck wash facility are located to the northwest of the landfill. This arrangement allows trucks leaving the landfill, which need to be cleaned, to pass through the truck wash and exit the facility via the northernmost roadway. The evaporation pond location provides space for future evaporation pond development and is located near the truck wash and the landfill leachate tank locations to reduce leachate haul distances.~~

The facility maintenance shop area is located next to the Phase 1A landfill~~truck wash facility because landfill operations equipment is typically cleaned prior to being serviced by the maintenance personnel. As the last facility~~ along the western perimeter haul road.~~;~~ ~~e~~Earthmoving and construction equipment will be able to access the maintenance shop from the south, thus reducing interference with site operations traffic and minimizing ~~ware~~ wear to the perimeter road surface. The stormwater detention basin is located in the northwest corner of the site because this is a natural low point to which clean runoff from the facility will be directed.

Stockpile and clay processing areas are located along the east side of the facility. These areas provide adequate soil storage space and allow construction equipment to operate separately from other site operations. The landfill location is governed by subsurface geologic and hydrogeologic characterization discussed in Section 1.4.3.

2.1.3 Facility Traffic Plan

Drawing No. 26, Traffic Plan, illustrates the site roadway locations and grades, traffic flow directions, traffic control features, and emergency vehicle access lanes at the facility entrance. Roadway locations are governed by facility locations and operations requirements. Expected vehicle types and volumes, proposed road types and their intended uses, traffic control features, and individual facility traffic patterns are discussed below. Road design analyses are discussed in Section 2.2.1.

Table L-1 lists the types of vehicles, their gross vehicle weight, and estimated traffic volume per day which will travel on the site roadways. The traffic volumes shown in Table L-1 are estimated based on an assumed waste receipt volume. Actual traffic volumes may vary.

Table L-1. Expected Vehicle Types

Vehicle Type	Off Highway/ On Highway	Gross Vehicle Weight (lb)	Estimated Traffic Volume (units/day)
Waste Haulers			
Roll-off trucks	On highway	<100,000	30–70
End dump trucks (bulk waste)	On highway	<100,000	30–70
~~Tanker trucks (liquid waste)~~	~~On highway~~	~~<100,000~~	~~0–5~~
~~Semi trailer trucks (drums)~~	~~On highway~~	~~<100,000~~	~~0–5~~
Other miscellaneous trucks	On highway	<100,000	0–5
Site Operations Vehicles			
Vacuum trucks	On highway	<100,000	0–5
Tanker trucks	On highway	<100,000	0–5
Roll-off trucks	On highway	<100,000	10–30
Flat-bed trucks	On highway	<100,000	0–5
Maintenance vehicles	On highway	<100,000	0–5
LF waste compactors	Off highway	<100,000	0–2
Excavators	Off highway	>100,000	0–2
Backhoes	Off highway	<100,000	0–2
Landfill~~F~~ scrapers	Off highway	>100,000	0–2
Water trucks	On highway	<100,000	0–20
Front end loaders	Off highway	<100,000	0–2
Fork lifts	Off highway	<100,000	0–2
Construction Vehicles (restricted to construction roads)			
End dump trucks	Off highway	<100,000	NA
Water trucks	On highway	<100,000	NA
Compactors	Off highway	<100,000	NA
Graders	Off highway	<100,000	NA

Vehicle Type	Off Highway/ On Highway	Gross Vehicle Weight (lb)	Estimated Traffic Volume (units/day)
Dozers	Off highway	<100,000	NA
Excavators	Off highway	<100,000	NA
Other			
Employee vehicles	On highway	<100,000	30–50

Main Facility Roads

Drawing No. 26, Traffic Plan, identifies the extent of the main facility roadways. These roads include the facility entrance road, north landfill access road, south access road, and east and west landfill perimeter roads. Drawing No. 27, Perimeter Road Detail, illustrates the road dimensions, drainage slope, and road surface and subbase material types and thicknesses to be used in construction. The main facility road network will serve the majority of site traffic into and out of the landfill and the waste processing facilities. Construction equipment will typically be restricted to construction haul roads and the cut slope access ramp into the landfill.

Unimproved Access Roads and Temporary Construction Haul Roads

Unimproved access roads and temporary construction haul roads (not shown on the drawings) will be constructed as required by site operations and construction contractors. Access roads to the stormwater detention basin, soil stock pile areas, and along the site perimeter fence or along power lines are typical locations for these roads. In general, these roads will be constructed by removing loose materials and vegetation and compacting the underlying soils. No road surface gravels will be placed; however, provisions for surface water drainage, such as culverts and ditches, as well as, erosion control features will be included.

The truck staging area located at the south end of the facility entrance will provide space for waste haul trucks awaiting disposal approval. This area will be surfaced with gravel and will drain to the surface stormwater detention basin. Any localized spills will be cleaned up as required by the Contingency Plan presented in Volume Ias Permit Attachment C.

Parking areas for site personnel vehicles will be designated near the administration trailer, chemical laboratory, drum handling facility, stabilization facility, and maintenance shop area. These areas are also likely be gravel-surfaced.

Traffic Control Features

Traffic control features incorporated in the site traffic plan include the main facility entrance gate, stop signs, posted speed limits, and warning and informational signs. Temporary road dividers such as K-rails (also known as California rails) are also often used to separate two-way traffic in high volume areas. Stop sign locations, as shown on Drawing No. 26, Traffic Plan, will serve to control traffic at main roadway intersections and at the various waste processing unit entrances. Speed limits will be posted on all roadways. The main facility road and unimproved access roads will be posted at 15 mph. Temporary construction haul roads will be posted at 35 mph. Additional signage will be posted to identify restricted areas, facility personal protection protective equipment (PPE) requirements, truck entrance areas, and facility names and access driveways.

Also shown on Drawing No. 26, Traffic Plan, are the emergency vehicle access lanes at the facility entrance. These lanes will remain clear at all times.

~~Individual Facility~~Landfill Traffic Patterns

~~The Drum Handling Facility entrance faces the north access road. Incoming trucks will enter the gravel lined apron and will back up to the loading dock areas. Once the truck unloading (or loading) operation is complete, the trucks will exit the facility via the same north access road. Parking areas for site personnel vehicles will be designated near the Drum Handling Facility Office. The gravel apron in front of the facility will not be used to stage waste haul trucks.~~

~~The Stabilization Facility has entrances for incoming trucks on both the north and south access roads. These accesses will be used for incoming waste trucks loaded with unstabilized waste for processing. Incoming trucks will enter the gravel lined apron on the north or south side of the facility and back into the stabilization building. Once the load has been dumped into the bin and the truck bed washed out, the truck will exit the facility via its entrance route. The east and west building entrances will be used by stabilized waste loadout trucks that will cycle between the truck roll-off area or the landfill. The gravel lined areas surrounding the stabilization facility will not be used to stage waste haul trucks. Parking areas for site personnel vehicles will be designated near the stabilization facility office.~~

~~Access to the liquid waste storage area is provided on the east, west, and north sides of concrete tank pads. Tanker trucks can use either the north access road or the road to the east of the liquid waste storage area.~~

~~The truck roll-off area can be accessed via the north or south access roads.~~

The landfill design incorporates three access ramps. The two northern ramps will be used by waste haul trucks and landfill operations equipment. These 30-foot-wide ramps will accommodate 2-way traffic when necessary; however, in general, the east ramp will be used for incoming traffic and the west ramp for exiting traffic. The third ramp located on the southern cut slope will provide access for earthmoving equipment involved with landfill expansion construction activities. Incoming waste haul trucks will be released from the truck staging area and use the south access road and northeast ramp to enter the landfill. Empty haul trucks will exit the landfill via the northwest ramp~~, pass through the truck wash facility, if necessary,~~ and exit the site via the north access road.

~~Evaporation Pond 1A and 1B truck discharge stations are accessible via the north and south access roads, respectively. Pond 1B will be used predominantly for day to day operations for incoming waste. However, the liquid levels in both ponds will be maintained at approximately the same level to maximize evaporation. Tanker trucks will enter Pond 1B discharge station turnout from the west, discharge their load, and can exit the site via the north or south access roads.~~

2.1.4 Facility Stormwater Control

Facility stormwater control is provided in the design by a network of surface water run-on and runoff diversion channels and collection and detention basins. These facilities ~~have~~ were~~been~~ designed to collect and contain the required 25-year, 24-hour storm event of 4.30 inches. Since the original permit was approved, the 25-year, 24-hour storm event increased from 4.30 to 4.39 inches. The rainfall-runoff analysis was recalculated with the new storm event and new peak discharges were calculated. The stormwater channels as previously designed can accommodate the increase in flow. The original ~~D~~diversion ditch calculations are provided~~resented~~ in Attachment BB~~Appendix F (Volume VI of the Permit Application dated October 2000)~~; the new analysis is provided in ~~Permit~~ Attachment L4.

Site Vicinity Drainage Pattern

The proposed site is located on the far eastern flank of the Pecos River Basin. The land surface gently slopes to the west at approximately 40 to 50 feet per mile toward the river. The sloping plain is characterized by low relief hummocky wind-blown deposits, sand ridges, and dunes. The Caprock escarpment (or Mescalero Rim) is one of the most prominent topographic features in southeastern New Mexico. East of the proposed site, the escarpment has approximately 200 feet of relief. Upgradient sources of surface water flow are bounded by the Caprock escarpment. The U.S. Geological Survey (USGS) Topographic Maps (7.5 minute series) for Mescalero and Mescalero N.E. in the Surface Water Control Plan in Attachment CCAppendix F (Volume VI of the Permit Application dated October 2000) illustrate the topographic features and contributing surface water drainage areas pertinent to the site. The watershed associated with the east diversion channel encompasses an area of approximately 378 acres beginning at the Caprock escarpment and continuing down to the site's east property line.

Surface Water Run-On Diversion Channels

The east diversion channel located on the eastern edge of the landfill property line provides run-on control from the east watershed area. The remaining topography surrounding the site grades away from the site. The discharge location for this channel coincides with existing natural drainages to the north of the site as indicated on Drawing No. 25. The east diversion channel will remain in place after the landfill cover system is constructed.

Surface Water Run-Off Channels

To control the runoff from the facilities area, several collection channels and culverts were designed to divert the peak discharge from the 25-year, 24-hour storm event to a storm-water detention basin. The locations of the collection channels (Ditch 1 through 6), culverts, and detention pond are shown on Drawing 25. Channels 1 and 2 are located along the inside of the perimeter road at the toe of the final cover slope. The channels divert runoff from the final cover to channel 5 located at the northwest corner of the landfill. Channels 3 and 4 run along the outside edge of the perimeter road. Channel 3 collects the majority of runoff from the disturbed facilities areas immediately to the east and north of the landfill footprint. Channel 4 collects runoff from the west and south perimeter road. Both channels also discharge to channel 5 at the northwest corner of the landfill. Channel 5 collects the runoff from ditches 1, 2, 3, and 4 and conveys it to the detention pond. Channel 6 collects runoff from the facilities located near the entrance to the site and routes it to the detention pond.

Two ditches, Ditches 7 and 8, are located in the Phase 1AI landfill. These channels are designed to divert runoff from unlined areas of the landfill to the clean water collection basin located in the south end of the landfill.

~~Two additional ditches (9 and 10) will be located around the evaporation ponds.~~

Surface Water Detention Basins

There will be three lined detention basins located on the site. The ~~surface~~ stormwater detention basin located in the northwest corner of the site is shown on Drawing No. 25. The clean stormwater collection basin located in the toe of the Phase 1A cut slope and ~~the~~ a ~~third~~ contaminated water basin, ~~which will be~~ located within the lined portion of Phase 1A ~~and will~~ extending from the waste fill slope to the clean stormwater collection basin berm, are shown on Drawings No. 10 ~~and 13~~.

A berm has been included at the base of the access road to the stormwater collection~~retention~~ basin of Phase 1A to prevent access road runoff into the contaminated water basin.

Final Cover

The landfill Final Cover Grading Plan is shown on Drawings No. 21 and 22. An access road to the top of the landfill is located along the western side of the landfill. The surface water control ditch adjacent to the road will reduce erosion and control surface runoff of the cover. The ditch dimensions and details are shown on Drawings No. 25 and 27.

2.2 General Facility Design Analyses

2.2.1 Road Designs

Drawing No. 27, Main Facility Road Detail, illustrates the road dimensions, drainage slope, and road surface and subbase material types and thicknesses to be used in construction. Construction Specification Section 02225, Road Base, provides details regarding road construction materials and placement execution. Calculations presented in Attachment BB~~Appendix E (Volume V of the Permit Application dated October 2000)~~ evaluate the main facility road design and specification relative to the expected traffic conditions identified in Table L-1. As described in the calculations, the main facility bearing capacity of 2,000 pounds per square foot (psf) is suitable for the expected traffic loading.

2.2.2 Facility Surface Water Control Design Analyses

All surface water calculations were conducted utilizing the SEDCAD+ computer model developed by Civil Software Design (~~63~~70). Channels were sized based on ~~the~~ Manning's equation for open channel flow. The methodology and assumptions used in the design of the surface water control system are presented in the Surface Water Control Plan in Attachment CC~~Appendix F (Volume VI of the Permit Application dated October 2000)~~. Drawing No. 25 presents a layout of the surface water control plan and a schedule of channel and culvert dimensions and installation criteria.

Detention Basin Design Analyses

The ~~surface~~ stormwater detention basin is designed to contain the storm-water discharge from the entire active site area given flows from a 25-year, 24-hour storm event. In order to assess the required size of the surface water d~~r~~etention basin, a worst-case storm-water volume discharge area was identified. The worst-case scenario assumed that the final cover was in place and the runoff from the entire landfill footprint along with the runoff from the surrounding facilities area are all diverted to the basin. The total drainage area is approximately 265.5 acres. Of the 265.5 acres, 44 percent is assumed to be reclaimed and revegetated and the remaining 56 percent is considered to be disturbed. The total runoff was computed to be approximately 51.4 acre-feet (ac-ft). Total volume of the detention pond at the invert of the spillway is 66.1 ac-ft.

Erosion Control

Channels with flow velocities less than 5 feet per second (fps) from a 25-year event will not require erosion protection. Channels with peak flow velocities greater than 5 fps from a 25-year event but less than 5 fps from an average storm (2-year event) will also not utilize erosion protection. During average storm events these channels should be stable; however, during major storm events the channels may show signs of erosion in some areas. These areas will be repaired as required following all major storm events. Channels with peak flow velocities greater than 5 fps from an average storm will be lined with gravel or riprap, as required. ~~All c~~Channels are designed with 1 foot of freeboard.

To minimize sediment transport to receiving streams, the east diversion channel will be lined with gravel. ~~The channel was designed with 1 foot of freeboard.~~ A riprap apron will be constructed at the end of the ~~E~~east diversion channel to dissipate the flow before entering the natural channel ~~to help reduces~~ and mitigate erosion. The location and details of the discharge apron ~~is~~ are shown on Drawing No. 25. ~~Details of the apron are shown on Drawing No. 25.~~ Design calculations are shown in Attachments L4 and BB~~Appendix F (Volume VI of the Permit Application dated October 2000)~~. Channels 7 and 8, which direct clean water runoff on the side slope of the landfill into the clean water collection~~detention~~ basin, will be lined with a high density polyethylene (HDPE) liner.

2.2.3 Operations and Maintenance

All of the regulated facilities will be constructed in accordance with the Design Drawings (Permit Attachment L1), Specifications (Permit Attachment L2), and Construction Quality Assurance Plan (Permit Attachment M).~~presented in Volume II, Appendix O of the Permit Application dated October 2000~~. In general, all maintenance and repairs to the facilities will be completed to meet the requirements of the original Design Drawings and Specifications and will be monitored in compliance with the ~~Construction Quality Assurance manual~~CQA Plan and Operations and Maintenance Plan (Permit Attachment N~~M~~).

3. Landfill

3.1 Landfill Design

3.1.1 General

Landfill design elements include ultimate and interim landfill layout and phasing; subgrade design; liner system design; and leachate collection system, leak detection system, and vadose monitoring sump design. ~~–~~This section describes each of these design elements. This permit application refers only to Phase 1A. However, potential expansions of the landfill to future phases have been included in the general layout drawings for completeness.

3.1.2 Landfill Layout and Phasing

The proposed landfill footprint illustrated on Drawing No. 4~~,~~ generally conforms to the most favorable area as previously described. The landfill footprint is divided into three phases (Phase 1, Phase 2, and Phase 3) with each phase having a separate leachate collection, leak detection, and vadose detection system. These phases will be further subdivided based on development sequencing and landfill waste receipt rates. The limits of Phase 1A~~-~~, the first area of the landfill to be developed, are shown on Drawings ~~Numbers~~ No. 8, 9, and 10. Details of the ultimate landfill configuration and the Phase 1A configuration are discussed below.

Ultimate Landfill Configuration

Drawings No~~s~~. 6, 7, and 22~~,~~ illustrate the ultimate configuration of the landfill for Phases ~~I~~1, ~~II~~ 2 and ~~III~~3. The landfill footprint defined by the crest line encompasses approximately 101 acres. The final cover area, which will extend~~s~~ 20 feet beyond the crest line, is approximately 107 acres. The final cover ~~area~~ for Phase 1A, including revegetation, is ~~approximately as~~ shown ~~i~~on Drawing No. 22.~~;~~ ~~n~~No waste will be placed outside of the crest line of the landfill, and leachate percolating vertically through the waste mass will be contained by the slope and floor liner systems.

The subsurface, or basal, portion of the landfill will be excavated to a depth of approximately 100 feet. At this depth, the floor and sumps of the landfill will be located in the Lower Dockum Unit (Drawing No. 7). All side slope angles are 3 horizontal: 1 vertical (3H:1V) and the base in each landfill phase grades approximately 3 percent with a minimum of 2 percent towards its respective sump area. The basal liner system anchor trench is located approximately 4 feet beyond the crest of the landfill (Drawing No. 12). Sumps are located at convenient locations in each phase to allow for subphase landfill development, to provide space for access ramps, and to maintain leachate collection system flow lengths capable of detecting a leak in a timely manner.

As shown on Drawings No. 7 and 22, the final cover system will reach a maximum elevation of approximately 4,205 feet. The cover system will crest at the mid-point of the landfill and will slope at 6 percent outwards. Slopes around the perimeter of the landfill will be 4H:1V.

Phase 1A Landfill Configuration

Phase 1A landfill development is illustrated on Drawings No. 8, 9, 10, and 11. The basal liner system will cover the entire north 3H:1V slope, the slopes below the access ramps, and most of the Phase 1A floor. Waste placement will occur only on lined areas as shown on Drawing No. 10.

Landfill access ramps located on the east and west sides of Phase 1A grade at 10 percent from the crest to the floor surface. The 30-foot-wide ramps can facilitate two-way traffic. Drawing No. 14, illustrates the access ramp cross sections when waste placement takes place below the ramps and when waste placement takes place above the ramps.

Drawing No. 13, shows slope runoff diversion ditches located along the access ramps that discharge into a collection basin positioned at the toe of the cut slope. This temporary stormwater control feature will collect runoff from unlined slope areas above the access ramp and from the cut slope area during Phase 1A waste filling. Clean water collected in the basin may be used for dust control within the landfill or may be pumped out of the basin and discharged into the site surface water control system.

3.1.3 Subgrade Excavation, Liner System, LCRS, LDRS, and Vadose Zone Monitoring System Sump Design

Subgrade Excavation

Drawing No. 6 shows the landfill excavation and structural fill contours. The crest of the landfill generally follows the site's surface topography which grades from the southeast to the northwest. Fill areas along the south and west sides of the landfill combined with cut areas along the landfill's north side provide sufficient grade differences for perimeter drainage ditches to move stormwater runoff to the detention basin located in the northwest corner of the site. Drawing No. 5 indicates the initial cut and fill areas that would be required for the initial site development. This would require grading around the perimeter of the landfill and in the waste processing areas.

Specification Section ~~No.~~ 02110, Site Preparation and Earthwork, describes site preparation, excavated soil classification and stockpiling, subgrade surface preparation and inspection, structural fill placement and compaction requirements, survey and quality control, and erosion control features.

Liner System

Drawing No. 12 shows the landfill basal liner components intended for the floor, slopes, and anchor trench areas. The landfill liner system is a double lined system consisting of (from bottom up) a prepared subgrade, a composite (geosynthetic clay liner and geomembrane) secondary liner, a geocomposite leak detection drainage layer, a primary geomembrane liner, a geocomposite leachate collection drainage layer, and a protective soil layer. Details of each liner component are discussed below:

- *6-inch thickness of prepared subgrade*

  The prepared subgrade component will provide a smooth stable surface suitable for placement of overlying geosynthetic materials. Specification Section 02119, Prepared Subgrade, presents subgrade material requirements including particle size and moisture content, placement and compaction requirements, and survey and field quality control requirements.

- *16-foot compacted clay liner (CCL) around landfill perimeter*

  During excavation, Quaternary Sands will be exposed around the perimeter of the landfill to depths ranging from 2 to 10 feet. As shown on Drawing No. 23, 16 feet of ~~horizontal thickness of this~~ sand material, measured laterally, will be removed and replaced with a compacted CCL component. The purpose of the CCL is to provide the liner with enhanced water barrier qualities in the Quaternary Sand areas. The CCL will be extended into the Upper Dockum Unit to a depth of at least 2 feet. The CCL (permeability, ~~k~~K ~~≤~~less than or equal to 1 x 10^{-7} cm/s) in combination with the overlying GCL described below will serve as a low permeability barrier layer to restrict infiltration of leachate into the subgrade. The CCL will consist of clay material (soils classified as CL or CH by the Unified Soil Classification System [USCS]) obtained during excavation of the landfill and surface impoundment. Specification Section 02221, Clay Liner, describes clay material requirements, including particle size and moisture content, placement and compaction requirements, and survey and field quality control requirements. Soil liner leachate compatibility tests (ASTM D5084) will be conducted prior to construction. In addition, a test fill will be constructed, as per the procedures outlined in the CQA Plan (Permit Attachment M). The results of the permeability testing performed in compacted samples are shown in the appendices.

- *Geosynthetic clay liner (GCL)*

  The GCL will serve as a low permeability (~~k~~K ~~≤~~less than or equal to 5 x 10^{-9} cm/s) barrier layer to restrict infiltration of leachate into the subgrade. The GCL type used will consist of bentonite granules sandwiched between two layers of geotextile. The upper geotextile will be a non-woven 6-ounce~~z.~~ material and the lower geotextile will be a woven 4 ounce~~z.~~ material. Specification Section 02780, Geosynthetic Clay Liners, describes minimum GCL properties required, subgrade preparation and inspection, material transportation and handling procedures, deployment and seaming requirements, and material construction quality assurance (CQA).

  Site specific compatibility tests (ASTM D5084) will be conducted prior to operations.

  Manufacturer published information on the compatibility of the GCL with typical leachate materials is provided in Attachment DD~~Appendix H-5 (Volume VI of the Permit Application dated October 2000)~~.

- *60-mil-thick ~~high density polyethylene (~~HDPE~~)~~ geomembrane liner (textured on both sides)*

  The 60-mil HDPE liner placed on top of the GCL is the second component of the composite secondary liner. Together, the GCL and HDPE liner form a highly efficient barrier layer to restrict percolation of leachate into the subgrade (see Section 3.2.7, HELP Modeling). HDPE texturing increases the friction angle between the geomembrane and the underlying and overlying geotextile liner elements. Specification Section 02775, Geomembrane Liners, describes minimum geomembrane properties required, subgrade preparation and inspection, material transportation and handling procedures, deployment and seaming requirements, and material construction quality assurance. Section 3.2.1~~,~~ discusses slope stability analyses for the landfill liner system.

  Site-specific compatibility tests will be conducted on a synthetic leachate and the proposed liner prior to operation of the facility. Manufacturers' Published Information on the compatibility of the HDPE with typical leachate materials is provided in Attachment DD~~Appendix H-4 (Volume VI of the Permit Application dated October 2000)~~.

- *Geocomposite leak detection drainage layer (transmissivity ~~≥~~greater than or equal to 2.2 x 10^{-4} square meters per second [m^2/s] as tested under actual field conditions) consisting of:*
  - A 7 ounce~~z.~~ geotextile (non-woven)
  - A geonet
  - A 7 ounce~~z.~~ geotextile (non-woven)

The high-transmissivity geocomposite leak detection drainage layer provides a means to transmit and remove leachate percolating through any leaks in the primary geomembrane layer above. The upper and lower geotextiles serve to filter sediments from the leachate and cushion the geomembranes, respectively. Flow calculations discussed in Section 3.2.8 and presented in Appendix G Permit Attachment J indicate that the geocomposite, in combination with the centrally located 8-inch-diameter drain pipe, are capable of removing leachate in a timely manner such that head on the underlying geomembrane will remain less than 1 foot. Specification Section 02710, Geocomposite, describes minimum geocomposite properties required, material transportation and handling procedures, deployment and seaming requirements, and material construction quality assurance (CQA).

The arrangement for the 8-inch-diameter drain pipes and surrounding drainage gravel and filtration geotextile, which are located in the floor of the leak detection layer and the leachate collection layer, are illustrated on Drawing No. 12. Specification Section 02714, Filter or Cushion Geotextile, describes minimum geotextile properties required, material transportation and handling procedures, deployment and seaming requirements, and material CQA.

Calculations demonstrating the leak detection system performance capabilities are presented in Section 3.2.7, HELP Modeling and Section 3.2.8, Leachate Collection and Removal, Leak Detection and Removal, and Vadose Monitoring System Hydraulic Analyses.

- *60-mil-thick HDPE geomembrane liner (textured on both sides)*

  This HDPE geomembrane serves as the primary barrier layer of the double liner system. Specification Section 02775, Geomembrane Liners, discussed above also applies to this geomembrane layer.

  Site specific compatibility tests will be conducted on a synthetic leachate and the proposed liner prior to operation of the facility. Manufacturers' published information on the compatibility of the HDPE with typical leachate materials is provided in Attachment DDAppendix H-4 (Volume VI of the Permit Application dated October 2000).

- *Geocomposite leachate collection and removal drainage layer (transmissivity ≥greater than or equal to 2.2 x 10^{-4} m^2/s as tested under actual field conditions) consisting of :*
  - A 7 ouncez. geotextile (non-woven)
  - A geonet
  - A 7 ouncez. geotextile (non-woven)

  This geocomposite layer serves as the primary leachate collection and removal system. Leachate percolating through the overlying waste fill will drain through the geocomposite to the central drain pipe and then flow to the leachate collection sump where it will be removed via the slope riser pipes. This material is the same used in secondary leak detection layer. The floor drain pipe arrangement is also the same.

  Primary geocomposite flow calculations are presented in Attachment BBAppendices E and G (Volume VI of the Permit Application dated October 2000), and the performance demonstrations are provided in the HELP Modeling discussed in Section 3.2.7.

- *2-foot-thick protective soil layer*

  A 2-foot-thick protective soil layer will be placed above the primary leachate collection geocomposite. The protective soil layer will extend over all lined floor and side slope areas. The purpose of the soil layer is to protect the underlying geosynthetics from damage due to vehicle traffic or from waste debris settlement. Specification Section 02716, Protective Soil Layer, describes material requirements including particle size, placement requirements, and survey and field quality control requirements. This soil layer will be placed during construction of the liner system.

3.1.4 ~~Leachate Collection and Removal~~LCRS, ~~Leak Detection and Removal~~LDRS, and ~~Vadose Monitoring~~VZMS Sumps ~~Systems~~

The leachate collection and removal system (LCRS), leak detection and removal system (LDRS), and vadose zone monitoring system~~s~~ (VZMS) each have a separate sump from which fluids can be collected and removed. The liner systems on the landfill floor continue into the sumps, however, in order to provide adequate volume to efficiently operate removal pumps, gravel thicknesses are incorporated into the drainage systems. Also, because liquids may be present, clay soil liner components have been added below the primary geomembrane liner and below the secondary GCL liner. These clay soil liner elements are not required by the regulations but are added to enhance the barrier qualities of the liner elements in the sump. Drawings describing the sump arrangements in Phase 1A include Drawings No~~s~~. 15, 16, 17, and, 18. As shown on the drawings, the sumps are square pyramidal shapes which lie concentrically above one another. The slope riser pipes enter their respective sumps at the sump base and are horizontally offset to provide adequate space for slope riser trenches. The slope riser trench arrangement enables the vadose and leak detection slope riser pipes to penetrate overlying geosynthetic liner elements at the crest of the landfill rather than in the sump area. The leachate collection riser pipe lies on top of the primary geomembrane and therefore no liner penetration is required. Table L-2~~, Landfill Sump Arrangement Summary, below~~ lists the dimensions, volumes, flow capacity, slope riser pipe dimensions, pump type and capacity, and fluid level instrumentation included in each of the sumps. Performing curves for the proposed pumps are shown in Attachment DD~~Appendix H-1 (Volume VI of the Permit Application dated October 2000)~~.

Table L-2. Landfill Sump Arrangement Summary

	LCRS	LDRS	~~Vadose~~VZMS
Fluid capacity [a] (gallons)	102,900	16,840	1,965
Pipe dimensions (length/diameter)	30 ft/18 in	15 ft/18 in	10 ft/12 in
Flow capacity [b] (gallons per day)	618,480	135,400	For detection
Pump type/capacity [c] (gallons per minute [gpm])	Grundfos/50 gpm	Grundfos/50 gpm	Grundfos/25 gpm
Fluid level instrumentation	Yes	Yes	Yes

[a] 0.3 x net volume accounts for gravel space.

[b] Determined from Dupuit-Forcheimer equation for flow from the sump gravel to collection pipe.

[c] Expected pump type and flow capacity for side slope riser.

LCRS Vertical Riser

In addition to its side slope riser, the LCRS sump also has a vertical riser which will extend from the LCRS through the waste fill and final cover system to the surface. The vertical riser is a redundant design feature ~~which~~ that provides ~~an~~ additional access to the LCRS sump whereby a second pump can be added to rapidly increase leachate removal rates. As shown on Drawings No. 17 and 20, the vertical riser arrangement consists of three pipes and three vertical riser pipe pads. The innermost pipe is an 18-inch-diameter stainless steel pipe that rests on an HDPE flatstock and extends from the bottom of the LCRS sump through an opening in the concrete vertical riser pad above. Because this pipe is not attached to the concrete pad, any settlement that the concrete pad incurs will not be transferred to the pipe. The concrete vertical riser pad rests on the LCRS gravel and provides support for the second pipe which will extend through the waste fill to the surface. This pipe is wrapped with a double layer of HDPE. This arrangement isolates the pipes from the surrounding wastesoils, which reduces downdrag forces resulting from waste settlement. Calculations that evaluate the downdrag forces and structural design of the concrete vertical riser pad are included in Attachment BBAppendix E (Volume VI of the Permit Application dated October 2000).

Crest Riser Pad Arrangement

Drawing No. 19 illustrates the slope riser piping and valving, the double-lined 9,000-gallon polyethylene tank (poly tank) system for leachate storage, and the concrete containment pad. Also indicated are high and low level tank cutoff switches, flexible piping connections between the inner and outer poly tanks, the fluid level sight gauge, 50 gallons per minute (gpm) leachate discharge pump and control panel locations.

The double-lined poly tank consists of two tanks, one inside of the other. The inner tank will have a capacity of 9,000 gallons and the outer tank will have a minimum capacity of 15,500 gallons. Liquids containing solvents such as MEK, toluene, xylene, diesel, or gasoline in concentrations greater than 15 percent will not be placed in the tanks. Tank tie-down details have been provided by the manufacturer and are included in Attachment DDAppendix H-2 (Volume VI of the Permit Application dated October 2000). A chemical resistance chart for the tanks is provided in Attachment DDAppendix H-3 (Volume VI of the Permit Application dated October 2000).

The concrete containment pad will slope towards the landfill crest. The leachate storage tank and containment pad are a connected, integral component of the landfill and are considered part of the regulated unit. A concrete pad will be placed in the loading/unloading areas for the tanker trucks. This pad will be sloped providing drainage toward the sump areas. Calculations on the bearing capacity of the concrete pad are detailed in Attachment BBAppendix E-35 (Volume VI of the Permit Application dated October 2000). Should a catastrophic failure of the tank or piping system occur, leachate will flow back into the landfill leachate collection system rather than be released to unlined areas. The landfill liner system anchor trench will completely encompass the pad so that any leakage through the pad will also drain back into the landfill leachate collection system. Construction details for the concrete containment pad are called out in Specification Section 03100, Concrete Formwork, Section 03200, Reinforcement Steel, Section 03290, Joints in Concrete, and Section 03300, Cast-in-Place Concrete.

3.1.5 Waste Filling Sequence

As mentioned previously in Section 3.1.2, landfill development will begin in Phase 1A, proceed southward into Phase 2, and then finish in Phase 3. The extent of landfill subphases will be based on waste receipt rates.

Liner installation in Phase 1A will take place in two stages: the slope and floor area below the access ramps and the slope area above the access ramps. The initial stage of the Phase 1A liner installation will consist of liner placement below the access ramps and is the only portion relevant to this permit application. The approximate area that will be lined during the Phase 1A construction is 14.9 acres which is delineated on Drawing No. 10.

Detailed planning for Phase 1B, Phase 2, and Phase 3 liner installation, access ramp location, and waste fill sequencing will be determined and permitted in the future; however, the ultimate landfill configuration will be developed as follows. Once the waste fill approaches the Phase 1A limits defined in Drawing No. 10, the cut slope will be advanced southward into Phase 2 and the remaining floor and slope areas of Phase 1 will be lined. At this time, the stormwater collection basin in the landfill will be removed from Phase 1 and reestablished in Phase 2. Waste filling in Phase 1 will continue during this liner expansion. As the waste fill extends beyond and above the access ramps, a ramp will be established in the south waste fill slope to provide access to the newly lined floor areas of Phase 1. Waste filling will take place in 5- to 10-foot-thick horizontal lifts. Waste will be covered with daily cover soil as soon as practicable following waste placement (and minimally at the end of each operating shift). Daily cover soil thicknesses will be at least 0.5 foot.

3.1.6 Final Cover

Drawings No. 21, 22, and 23 illustrate the landfill's ultimate waste fill configuration and final cover design. The final cover system is a composite cover consisting of (from top down) a vegetative cover, a geocomposite drainage layer, a geomembrane layer, a geosynthetic clay layer, a prepared subgrade layer, and a cover soil layer. -Details of each component of this 4.5-foot-thick cover system are discussed below.

- *2.5-foot-thick vegetative cover*

  The vegetative cover will provide a substrate for plant growth on the cover surface and protect the underlying geosynthetics from frost and sun exposure damage. Establishment of plant growth will enhance evapotranspiration of precipitation that soaks into the vegetative cover and will reduce soil erosion due to rainwater runoff. Specification Section 02227, Vegetative Cover, discusses vegetative cover material requirements including particle size and moisture content, placement and compaction requirements, and survey and field quality control requirements. Specification Section 02900, Vegetation and Seeding, identifies seed mixtures, site preparation, and planting requirements for cover vegetation.

- *Geocomposite drainage layer (transmissivity $\geq 2 \times 10^{-4}$ m²/s) consisting of :*
  - A 7 ~~oz.~~ounce geotextile (non-woven)
  - A geonet
  - A 7 ~~oz.~~ounce geotextile (non-woven)

  The high-transmissivity geocomposite drainage layer provides a means to transmit and remove precipitation percolating through the vegetative cover above. The upper and lower geotextiles serve to filter sediments from the rainwater and cushion the geomembrane below. Flow calculations discussed in Section 3.2.7 and presented in Attachment BB~~Appendix E (Volumes V and VI of the Permit Application dated October 2000)~~ indicate that the geocomposite, in combination with the vegetative cover above, is capable of removing 99 percent of the precipitation falling on the cover. Specification Section 02710, Geocomposite, describes minimum geocomposite properties required, material transportation and handling procedures, deployment and seaming requirements, and material CQA.

- *60-mil-thick HDPE geomembrane (textured on both sides)*

  The 60-mil HDPE liner placed below the geocomposite drainage layer and on top of the GCL is the primary barrier layer of the cover system. Together with the underlying GCL, the HDPE geomembrane forms a highly efficient barrier layer to restrict percolation of rainwater into the waste fill (see Section 3.2.7, HELP Modeling). HDPE texturing serves to increase the geocomposite/geomembrane/GCL friction angles to enhance slope stability. Specification Section 02775, Geomembrane Liners, describes minimum geomembrane properties required, subgrade preparation and inspection, material transportation and handling procedures, deployment and seaming requirements, and material CQA.

  Site-specific compatibility tests will be conducted on a synthetic leachate and the proposed liner prior to operation of the facility. Manufacturers' published information on the compatibility of the HDPE is presented in Attachment DD~~Appendix H (Volume VI of the Permit Application dated October 2000)~~.

- *Geosynthetic clay liner (GCL)*

  In conjunction with the overlying HDPE geomembrane, the GCL will serve as a low permeability (kK ≤less than or equal to 5 x 10^{-9} cm/s) barrier layer to restrict infiltration of precipitation runoff into the waste fill. The GCL type used will consist of bentonite granules sandwiched between two layers of geotextile. The upper geotextile will be a non-woven 6 oz.ounce material and the lower geotextile will be a woven 4-oz.ounce material. Specification Section 02780, Geosynthetic Clay Liners, describes the minimum GCL properties required, subgrade preparation and inspection, material transportation and handling procedures, deployment and seaming requirements, material construction quality assurance.

  Manufacturer published information on the compatibility of the GCL with typical leachate materials is provided in Attachment DDAppendix H-5 (Volume VI of the Permit Application dated October 2000).

- *6-inch-thick prepared subgrade layer*

  The prepared subgrade component will provide a smooth stable surface suitable for placement of overlying geosynthetic materials. Specification Section 02119, Prepared Subgrade, presents subgrade material requirements including particle size and moisture content, placement and compaction requirements, and survey and field quality control requirements.

- *2-foot-thick cover soil layer*

  The cover soil layer placed on the surface of the waste fill serves to isolate the waste and any near surface debris from the overlying cover elements and also provides a base for the prepared subgrade layer. Specification Section 02226, Cover Soil, presents material requirements including particle size and moisture content, placement and compaction requirements, and survey and field quality control requirements.

As shown on Drawing No. 23 the final cover system will extend 24 20 feet outside the crest of the landfill. In addition, the waste fill terminates inboard of the crest line. Rainwater that percolates through the vegetative cover will flow in the cover system's geocomposite layer to the drainage pipe located in the cover anchor trench. The water will then be discharged to the landfill perimeter drainage ditch system. Rainwater that percolates through the cover system and comes in contact with the waste will flow vertically downward and be captured in the LCRS.

Prior to closure of the landfill, an assessment will be made of the landfill waste gas generating potential. If it is concluded that gas generation may result in gas build-ups beneath the barrier layer of the cover or releases following closure exceeding regulator air quality standards, then provisions will be made to collect and monitor gas generation and release during the post-closure period. If this occurs, the latest technology available will be implemented into the construction of the cover system.

Drawing No. 22 indicates the location of the cover access road and surface water diversion ditches. Traffic on the cover access road will be limited to light vehicles such as pick up trucks. Surface water drainage ditches on the cover are included to reduce runoff flow lengths and thereby reduce surface soil erosion. Sections 3.2.10 and 3.2.11 discuss ditch sizing and cover soil erosion, respectively.

Waste settlement impacts on the 6 percent and 4H:1V cover slopes are discussed in Section 3.2.2.

3.1.7 Landfill Clean Stormwater Control Features

Drawings No. 8 through~~13,~~ 14, 22, 24, and 25 illustrate the landfill's clean stormwater control features designed to contain and control rainwater runoff and run-on for the required 25-year, 24-hour storm event. These features include the landfill's stormwater collection basin and slope runoff drainage ditches, cover system drainage ditches, perimeter drainage ditch, and the culverts and drainage ditches leading to the stormwater detention pond. The clean stormwater control features are designed to minimize the quantity of water that contacts or potentially contacts waste material in the landfill. Clean stormwater collected within the Phase 1A landfill excavation, but not within the lined waste disposal cell, will be discharged to the site-wide surface water control system. The systems designed to contain and manage contaminated stormwater and leachate within the Phase 1A landfill are described in Sections 3.1.8 and 3.1.9.

During the Phase 1A waste filling, runoff from the slope areas above the access ramps and from the cut slope area will be diverted to the HDPE lined collection basin located near the toe of the cut slope on the floor of the landfill. HDPE lined diversion ditches located on the side of the access ramps will carry slope runoff to the stormwater collection basin. The landfill perimeter ditches located on either side of the perimeter road will intercept runoff from areas outside of the landfill and divert this water to the stormwater detention basin. ~~. Runoff from active waste filling area will drain to the contaminated water basin at the south end of the landfill. The contaminated water basin is not its own separate entity, but is a part of the Phase 1A landfill that will not initially receive waste. The layout of the contaminated water basin is shown on Drawing Nos.: 10, 11, 13, and 24. Since the contaminated water basin is only a portion of the landfill set aside to store stormwater, it will not be removed as the landfill is expanded to the south. Rather waste will be placed over the top of the contaminated water basin.~~

During the operational period of future Phases 2 and 3, when the final cover system is partially installed in some areas and waste filling continues to take place in other areas, runoff from the final cover will be diverted to the ~~surface~~ stormwater detention basin. Following the post-closure period, after the effectiveness of the landfill cover has been demonstrated, the ~~surface~~ stormwater detention basin will be removed from service and the area will be regraded to its approximate predisturbance state. Runoff from the landfill cover will be allowed to flow into the natural drainages which existed prior to construction.

Section 3.2.10~~4.2.8~~ summarizes surface water calculations performed to size the landfill's stormwater control features. The calculations are presented in Attachments L4 and L5~~Appendix F (Volume VI of the Permit Application dated October 2000)~~.

3.1.8 Landfill Contaminated Stormwater Control Features

Drawings No. 8 through 14 and 24 illustrate the landfill's stormwater control features designed to contain and control ~~rainwater~~ stormwater runoff and run-on and isolate potentially contaminated runoff from clean runoff for the required 25-year, 24-hour storm event. Contaminated or potentially contaminated stormwater within the Phase 1A landfill is collected within the lined contaminated water basin. Runoff from the active waste filling area will drain to the contaminated water basin at the south end of the landfill. When the Phase 1A landfill has been filled to the maximum extent, the contaminated water basin has a minimum storage capacity of 17 acre-feet. At earlier stages of filling, the basin is larger, providing greater storage capacity.

The contaminated water basin is not its own separate entity, but is a part of the Phase 1A landfill that will not initially receive waste. The layout of the contaminated water basin is shown on Drawings No. 10, 11, 13, and 24. Because the contaminated water basin is only a portion of the landfill set aside to store stormwater, it will not be removed as the landfill is expanded to the south; rather, waste will be placed over the top of the contaminated water basin.

Section 3.2.10 summarizes surface water calculations performed to size the landfill's stormwater control features. The calculations are presented in Attachments L4 and L5 (Volume VI of the Permit Application dated October 2000).

3.1.9 Leachate and Contaminated Stormwater Recirculation Evaporation System

Leachate and contaminated stormwater generated from precipitation falling within the Phase 1A landfill waste disposal area will be managed by recirculation and enhanced evaporation within the regulated unit. The stormwater will be applied to the protective soil cover through a piping and sprinkler network. Tanker trucks may also be used to apply water for dust control on the landfill roads and cover soil.

Modeling of recirculation rates was performed to determine the viability of recirculation of contaminated stormwater and possible effects on the volume of stormwater entering the leachate collection system. Model approach, assumptions, input files, and results are presented in Permit Attachment L5. The UNSAT-H model was used to evaluate potential for stormwater recirculation, specifically to estimate the increase in water percolation through the daily cover and waste. UNSAT-H uses daily climate data, including the added application of recirculation water, and soil and water hydraulic properties to compute evaporation, runoff, moisture storage, and percolation through the waste and soil profile. The model used several conservative conditions, including only one layer of waste and daily cover and use of climate data for the second wettest precipitation year on record. In the model, stormwater application rates are limited to 0.5 inch per day. The recirculation of stormwater adds approximately 50 percent additional water application to the precipitation rate in a given year.

The modeling results show that during average years, with annual precipitation around 11.7 inches, no increase in leachate is expected. For extremely wet years, the model results indicate that there is an increase in stormwater movement through the daily cover and waste to the leachate collection, but well within the design flow capacity of the LCRS. Leachate generation rates in arid climate landfills typically decrease as the thickness of waste placement increases. The modeling results show that the recirculation system can be used effectively to manage stormwater runoff and leachate within the lined landfill cell during the early portion of waste placement under conditions of either average or extremely wet precipitation conditions.

3.2 Landfill Design Analyses

3.2.1 Slope Stability

Cut Slope Stability

Prior to filling, unsupported cut slopes will exist on all sides of the landfill. These slopes were analyzed for static and dynamic stability using the Janbu Simplified Method. A computerized slope stability program (XSTABL) was used to analyze the cut slopes (5144). Strength parameters used for soil and rock materials were estimated using design overburden pressures and plasticity index data gathered from laboratory testing of site soil materials correlated to published data (5346). The material properties used in the analyses are summarized in Calculation No. E-1, presented in Attachment BBAppendix E (Volume V of the Permit Application dated October 2000).

The site grading plans (Drawings No. 5 and 6) indicate that the maximum cut slopes will be 3H:1V and maximum height will be approximately 100 feet. Results for the critical 3H:1V slope indicate a static factor of safety of 1.4 for the critical short term (undrained) condition. Stability during seismic loading was estimated by applying a pseudo-static earthquake force in the Janbu analysis. Results based on the 0.04 g design acceleration indicate a dynamic factor of safety of 1.2 for the short term (undrained) condition.

The stability of the outward slopes was also evaluated. Results indicate a static factor of safety of 1.3 and a dynamic factor of safety of 1.1. These slopes were analyzed using Bishop's Method (Appendix E-34).

The temporary cut slope along the south side of Phase 1A was analyzed using Bishop's Method giving a static factor of safety of 1.1 (CalculationAppendix E-37 in Attachment BB[Volume VI of the Permit Application dated October 2000]).

Waste Fill Stability

Waste fill stability was considered for both the Phase 1A and ultimate landfill configurations. In both cases, a face failure through the waste and along the lining system, and a basal failure along the lining system was considered. The analysis assumed a 4H:1V waste fill slope and floor at design base grades. The Sarma analysis method was used to calculate factor of safety and acceleration coefficient (Kc). Kc is the net acceleration that would have to be applied to a slide mass to initiate movement.

Phase 1A Waste Fill Stability

Critical inputs for the Phase 1A stability analysis were as follows:

- *GCL, saturated undrained condition: friction angle = 2° and C=440 psf*

  Based on testing performed by Geosyntec Inc. using actual site soils and a needle punched GCL, the critical failure interface under saturated conditions occurs in bentonite layer between the geotextile components of the GCL. It should be noted that this value is highly conservative since the GCL is most likely to remain in an unsaturated state during the life of the landfill. Additionally, the type of GCL tested was the needle punched variety. Other types of GCLs with stitching between the geotextile components offer substantially greater interface shear strengths.

- *Design ground acceleration = 0.04 g*
- *Waste friction angle ϕ = 29° (29)*
- *Design fill configuration shown on Drawing No. 10*

Results of the Phase 1A analyses presented in Calculation No. E-3, Phase 1A Filling Plan Stability, indicated a static factor of safety of 1.5 and a dynamic factor of safety of 1.0. These factors of safety are considered acceptable for the interim fill configuration of Phase 1A.

Ultimate Landfill Configuration Waste Fill Stability

The ultimate landfill configuration analyses used same liner interface strength inputs as the Phase 1A evaluation and the final waste configuration shown on Drawing No. 22. Results of the ultimate configuration waste fill stability analyses presented in Calculation No. E-4, Ultimate Filling Plan Waste Stability, indicated a static factor of safety of 3.7 and a dynamic factor of safety of 1.5. These factors of safety are considered acceptable for the ultimate waste fill configuration.

Protective Soil Layer Stability

An infinite slope model approach was used to evaluate the stability of the protective soil layer on the 3H:1V landfill slopes which considered the loading scenario of the protective soil layer only, and a loading scenario with a D6 dozer (9.8 pounds per square inch [psi] track loading [1617]) on top of the protective soil. The analysis considered saturated and undrained soil conditions. The soil/geotextile interface shear strength was based on a friction angle of 31° and an adhesion of 15 psf obtained from interface shear tests. Results of the analyses indicated a static factor of safety of 2.0 for the soil only case and a static factor of safety of 1.8 for the case with the dozer loading. Both factors of safety are considered acceptable. Calculation No. E-2, Protective

Soil Layer Stability, is presented in Attachment BBAppendix E (Volume V of the Permit Application dated October 2000).

Cover Stability

The cover system stability analysis focused on two potential failure mechanisms: a deep block failure through the waste and along the basal liner system, and an infinite slope failure within the cover system. Both stability analyses were conducted for static and dynamic conditions assuming undrained soil conditions. The block failure analysis assumed a zero head condition on the liner system while the infinite slope failure analyses considered a zero head condition and a head condition of 2.5 feet in the cover. As with other stability analyses, a design ground acceleration of 0.04 g, waste friction angle of 29°, and liner interface strength of $\phi = 2°$ and c = 440 psf was assumed.

Results of the analyses indicated a static factor of safety of 2.8 and dynamic factor of safety of 1.5 for the deep block failure. The infinite slope analyses indicated a static factor of safety of 10.9 and dynamic factor of safety of 6.5 for the zero head condition and a static factor of safety of 5.2 and dynamic factor of safety of 3.1 for the 2.5 feet head condition. All of these factors of safety are considered acceptable. Calculation E-5, Cover Stability, is presented in Attachment BBAppendix E (Volume V of the Permit Application dated October 2000).

3.2.2 Settlement

Subgrade Settlement

Total settlement of the landfill base due to settlement of the subgrade and prepared subgrade layers was calculated to ensure that the base liner grades did not fall below EPA's recommended minimum of 2 percent.

Subgrade settlement was modeled assuming the subgrade behaves as an elastic medium (3330). This assumption implies that any settlement occurs during placement of a given load. Therefore, settlement in the subgrade should occur during the operating life of the landfill and post-closure settlement should be negligibly small. The most important parameter used in this analysis is the elastic modulus of the subgrade. The elastic modulus used was 72,000 kips per square foot (ksf) which was obtained from conservative estimates for unweathered mudstone (3532). The maximum calculated settlements near the center of the landfill are expected to be on the order of 5 inches. Settlement should progressively decrease towards the toe of the sideslopes. These settlements are not expected to result in any excessive stress in the liner system. Details of the subgrade settlement analysis are presented in Calculation E-9 in Attachment BBAppendix E (Volume V of the Permit Application dated October 2000).

Final Cover Grades Due to Waste Settlement

As previously mentioned, waste placed at the Facility will consist of hazardous waste which contains no free liquids. All drummed solid material and lab packs will be stacked horizontally in rows within the landfill and the voids between drums filled with compacted bulk wastes. Bulk waste filling will take place in 5- to 10-foot-thick horizontal lifts. Waste will be covered with daily cover soil as soon as practicable following waste placement (and minimally at the end of each operating shift). Daily cover soil thicknesses will be at leastrange from 0.2 to 0.5 foot.

EPA guidelines (61 and 6254 and 55) suggest a minimum of 3 percent for final cover grades on hazardous waste landfills. The proposed 6 percent initial design cover grade was analyzed to determine the maximum settlement factor to maintain the final 3 percent grade after settlement. The calculated maximum settlement factor was 7 percent. The analysis assumed that the waste settlement is uniform. Calculation E-11, Waste Settlement, presents waste settlement computations in Attachment BBAppendix E (Volume V of the Permit Application dated October 2000).

EPA estimates, based on finite element modeling, indicate that settlement factors of 11.5 percent are appropriate for hazardous waste landfills (4338). This model considered that the most significant portion of the waste would be solidified material buried in steel drums, with the drums having a maximum allowable void space of ten10 percent. This model may not be applicable to the Triassic Park Facility because there should be less void space in the waste than that assumed for the model.

In order to mitigate this potential discrepancy between the suggested 11.5 percent and calculated 7 percent, the post-closure waste settlement of Phase 1A should be monitored. The monitoring results will be compared to the estimated settlement factor of 7 percent. If settlement is greater than 7 percent, cover grades of subsequent phases will be steepened to accommodate the settlement and maintain the minimum 3 percent final grade.

3.2.3 Geosynthetics Strength and Performance Analyses

Geomembranes

Settlement Induced Stress

The maximum settlement will occur at the base of the cell slopes where the waste load is highest. The subgrade settlement is estimated to be approximately 0.5 foot. This settlement will vary from this calculated maximum at the slope toe to zero at the slope crest. Resulting stresses of 65 psi in the geomembrane are much lower than the 2200 psi geomembrane yield stress. Differential settlement is therefore not expected to damage the liner (38 34). Details of the liner stress analysis are presented in Calculation E-12, Settlement Induced Stress, in Attachment BB(Volume V of the Permit Application dated October 2000).

Thermal Induced Stress

Due to the 2-foot-thick protective soil layer above the liner, the 60-mil HDPE geomembrane liner will not be subject to extended periods of contraction and expansion from daily temperature differentials. Temperature restrictions for installation of geomembrane are discussed in Specification Section 02775.

Tear and Puncture

All geomembranes in the landfill liner and cover system are overlain by at least one layer of geotextile. Review of the puncture resistance of the geotextiles indicates a worst case factor of safety of 3.5 (see Calculation E-17, Geomembrane Puncture Resistance in Landfill and Calculation E-21, Puncture Resistance of Geotextile/Geocomposite [3337]). Therefore, the proposed 60-mil HDPE is adequate to resist puncture stresses.

Geocomposites

The geocomposite is intended to act as a lateral drainage layer in both the LCRS and the LDRS. The geonet in the core of the geocomposite is the drainage media and the overlying and underlying geotextile act as filters. The primary design criteriona of the geocomposite is the transmissivity. As part of the design process the typical transmissivity values reported in the literature and by manufacturers have been reduced to account for clogging of the geotextile, penetration of the geotextile in to the geonet, and creep of the geonet.

In order to confirm the actual transmissivity of the material that arrives on the site, the specifications require that the material be tested as part of the conformance testing program. The specific test methods, including backing materials, normal loads, seating times, gradients, and test durations, are detailed in the specifications and meet actual design conditions (5755).

Geotextiles

Geotextile Filtration

Geotextiles are used in a number of locations in both the liner and cover sections for filtration. Specifically, the geotextiles act as filters between the clay liners and drainage layers or between the granular leachate collection material, protective soil cover or general fill and a drainage layer. All of the soil materials expected to be used for either the liners, covers, protective soil cover or general fill are conservatively expected to be fine grained with more than 50 percent of the material passing the Number 200 sieve.

The design criteria outlined by Task Force 25 (3431) indicated that for soil material with more than 50 percent passing the #200 sieve, the apparent opening size (AOS) of the geotextile should be less than 0.297 mm. The current geotextile specifications require that the AOS is less than 0.212 mm. Therefore, the geotextile should adequately retain any of the on-site soils. Calculation E-20, Geotextile/Geocomposite filtration, compares specified material AOS values to site soil analyses results.

Geotextile Cushion

The puncture resistance during installation of the proposed geotextile materials was analyzed. The analysis, which used standard design equations (3337), was based on the maximum ground pressure exerted by construction equipment, the largest average aggregate size that will be in contact with the geotextile, and the minimum puncture strength properties specified in the General Specifications. Based on these parameters the calculated safety factor for puncture is 3.6, which is acceptable (see Calculation No. E-21, Puncture Resistance of Geotextile/Geocomposite, in Attachment BB[Volume V of the Permit Application dated October 2000]).

Geosynthetic Clay Liner

No specific design analyses were conducted on the GCL other than determining the interface friction angle of the material in the liner and cover section. The GCL has a specified permeability of 5 x 10^{-9} cm/s which exceeds EPA's criteria of 1 x 10^{-7} cm/s. Detailed specifications for the GCL are presented in the specifications. The critical parameters for the GCL will be confirmed through a conformance testing program on the material that is delivered to the site.

Geosynthetics Leachate Compatibility

Specific leachate compatibility tests have not been conducted on the soil or geosynthetic liner components for the Triassic Park facility. These tests have not been conducted at this time, because the specific manufacture of the liner components has not been selected and there is not a representative leachate available for testing. EPA (5557) recommends that compatibility testing be done on the specific (manufacturer and resin type) liner materials selected for use in a facility and a representative leachate for the facility. Therefore, it is proposed that testing be completed prior to construction once the geosynthetic materials have been selected. Because the facility will not be in operation, a representative leachate will not be available. However, as recommended by EPA (5557), market studies can be used to characterize expected waste streams and a synthetic leachate can be developed for use in compatibility testing.

Although compatibility has not been completed, it is expected that the geosynthetic materials selected for the liner and leachate collection system for the Triassic Park Facility have a long track record of successful use at a variety of waste disposal facilities (both municipal waste and hazardous waste) across the U.S. Therefore, it is not expected that there will be any compatibility issues that would impact the current design. However, as mentioned above, site specific testing will be completed and the results submitted to NMED for approval prior to construction. Supporting information on the compatibility of the HDPE and GCL components of the lining system with various leachates is presented in Attachment DDAppendix H (Volume VI of the Permit Application dated October 2000).

3.2.4 Sump Compacted Clay Liner

In the sump base a compacted clay liner (CCL) will be placed in addition to a GCL layer. The ~~compacted clay liner (~~CCL~~)~~ will provide an added thickness to the liner in the area of the sump where leachate is expected to have the longest resident time and the largest head. The specifications for processing, placement, and compaction are detailed in the specifications. The placement criteria in terms of moisture content and dry density is defined by a window with limits defined by the zero air voids curve, a percent saturation line, a minimum dry density and a minimum moisture content. A graph indicating these specific limits is presented in the specifications which were based on actual laboratory testing conducted as part of this study (Appendix Z~~D~~ ~~[Volume V of the Permit Application dated October 2000]~~). This method of specifying a compaction window for a CCL is recommended by EPA and is detailed in a series of articles by Prof. Craig Benson (12).

As part of the CQA program samples of the material to be used as the compacted clay liner will be obtained and tested to confirm the permeability criteria (1 x 10^{-7} cm/s) can be met. In addition, samples will be taken from the in-place liner to confirm the permeability.

3.2.5 Anchor Trench Design

The pullout capacity of the primary and secondary geosynthetics from the landfill anchor trench was determined. It was assumed the geosynthetics will pull out of the trench with single-sided shear. Single-sided shear is believed to occur rather than double-sided shear because there is less shearing resistance for single-sided shear. Assumed interface friction angles were based on previous laboratory testing for similar materials at low normal stresses. Based on the trench geometry, critical HDPE geomembrane properties, and assumed interface friction angles, both the secondary and primary liners will pull out prior to tearing. Stability calculations for both the secondary and primary liner systems indicate that there are no net downslope forces on the anchor trench because the liner systems are held in place by friction (see Calculation E-15, Anchor Trench Pullout Capacity, in Attachment BB~~[Volume V of the Permit Application dated October 2000]~~).

3.2.6 Access Ramp Design

Calculation E-24, Wheel Loading on Access Ramp, presented in Appendix E in Attachment BB~~(Volume V of the Permit Application dated October 2000)~~, evaluated the puncture resistance of the geomembrane on the landfill access ramps. The ramps grade at 10 percent from the crest of the landfill to the floor. Drawing No. 14 shows the access ramp configuration during initial Phase 1A filling below the ramps and the final configuration after the slope areas above the ramp are lined.

The ramp section consists of the following components (from top down):

- 1-foot thickness of roadbase material
- 12-ounce cushion geotextile (enveloping the top and sides of the underlying subbase)
- 2-foot thickness of subbase material
- Basal liner geosynthetics (geocomposite/60-mil ~~T~~HDPE/geocomposite/60-mil ~~T~~HDPE/GCL/ prepared subgrade)

The calculation considered a Caterpillar 631 scraper which weighs approximately 168,000 pounds when fully loaded (17~~16~~). A factor of safety of 4.6 against puncture of the HDPE is considered acceptable for this loading condition.

An assessment of the stability of the Ramp Liner System under breaking forces from a loaded scraper was also analyzed (~~34~~38). This analysis utilized the strength parameters from the interface shear testing program. The results presented in Calculation~~Appendix~~ E-6 in Attachment BB~~(Volume V of the Permit Application dated October 2000)~~ indicate a factor of safety of 4.3 against sliding on the ramp.

3.2.7 HELP Modeling

Hydrologic Evaluation of Landfill Performance (HELP) (48~~41~~) modeling was performed to demonstrate equivalency of the proposed Triassic Park landfill liner and cover system with EPA's Minimum Technology Requirement (MTR) systems. This demonstration was submitted to NMED for review and was subsequently approved by NMED on March 11, 1996 and EPA on March 14, 1996. The report entitled, Triassic Park Hazardous Waste Landfill Alternative Liner System Analyses (Revision 1), dated March 1996 presents the HELP modeling performed and is reproduced in Appendix E.

The HELP modeling approach used to evaluate the hydrologic performance of the proposed landfill liner and cover alternative follows the NMED's Draft Guidance Document for Performance Demonstration for an Alternative Liner Design Using the HELP Modeling Program Under the New Mexico Solid Waste Management Regulations (20 NMAC 9.1). This approach was selected because it allows a direct comparison between MTR liner system and an alternative liner system. The results can be used to demonstrate performance equivalency required under 40 CFR 264.301(d).

The conclusions of the HELP modeling as stated in the report are as follows:

- There is little difference between the proposed alternative and MTR in terms of percolation rates through the bottom liner over the life of the facility. The differences that exist in Years 0 through 10 are insignificantly small. The proposed alternate liner performance can therefore be considered equivalent to the MTR liner performance.

- Hydraulic pressure on the primary and secondary liners of both the MTR and proposed alternate liner system is well below the regulatory maximum of 12 inches.

- The cover system leakage is less than or equal to the leakage of the liner system. It effectively reduces precipitation infiltration which will allow the waste to drain once the cover is in place.

3.2.8 ~~Leachate Collection and Removal~~LCRS, ~~Leak Detection and Removal~~LDRS, and ~~Vadose Monitoring System~~VZMS Hydraulic Analyses

Analyses performed to evaluate the effectiveness of the LCRS, LDRS, and ~~Vadose Monitoring Systems~~VZMS are discussed below. Also discussed are slope and vertical riser pipe strength evaluations and the concrete crest riser pad structural analyses.

Leachate Collection and Removal System Analyses

Based on HELP modeling data presented in Triassic Park Hazardous Waste Landfill Alternative Liner System Analyses (Revision 1), dated March 1996, maximum LCRS flow rates of 116.8 gallons per acre per day (gpad) for slope areas and 50.9 gpad for floor areas occur during year 11 of the simulated Facility life. For Phase 1A, which has a slope surface area of 7.9 acres and floor surface area of approximately 3.4 acres, this totals to approximately 1,100 gallons per day (gpd). Calculation E-31, LCRS Pumping Capacity (Attachment BB~~Volume VI of the Permit Application dated October 2000~~), estimates the flow capacity of the LCRS sump design to be approximately 618,000 gpd (based on Dupuit-Forchniemer Equation [11]).

The flow capacity of the LCRS sump far exceeds the flow rates delivered from the LCRS as determined from the HELP modeling. A Grundfos 50-gpm pump, which has the capacity to remove 72,000 gpd, is recommended for the LCRS sump. In addition, should flow rates into the LCRS increase beyond those predicted by the HELP modeling or the capacity of the 50-gpm pump, a second leachate removal pump can quickly be added via the vertical riser system, thus increasing the leachate removal rates.

Leak Detection and Removal System Analyses

Adequacy of the leak detection and removal system for Phase 1A is addressed in the landfill action leakage rate (ALR) calculation presented in the Action Leakage Rate and Response Action Plan (~~see Appendix G~~Permit Attachment J). In this calculation, leakage rates into the LDRS, as determined by EPA's recommended method (~~60~~66), were compared to flow capacities of the LDRS geocomposite drainage layer and the LDRS sump. Based on these calculations, the flow capacity of the LDRS sump exceeds the flow capacity of the LDRS geocomposite drainage layer and the flow capacity of the LDRS geocomposite drainage layer exceeds the leakage rate into the LDRS. A Grundfos 50-gpm pump, which has the capacity to remove 72,000 gpd, is recommended for the LDRS ~~system~~ sump.

Vadose Monitoring System Analyses

The ~~vadose monitoring~~VZMS sump serves as a detection system for leakage of the secondary LDRS~~ system~~. A Grundfos 25-gpm pump is recommended for vadose monitoring sump. In the unlikely event that a leak develops in the LDRS sump, leachate will flow to the ~~vadose monitoring~~VZMS sump where it can be collected and removed.

Evaluation of Slope Riser Pipe and Vertical Riser Pipe Strengths

Calculation E-26, Pipe Crushing, presented in Attachment BB~~Appendix E (Volume V of the Permit Application dated October 2000)~~, considers the stresses and deflections to the slope riser pipes. Based on this calculation, the 18-inch-diameter HDPE SDR 11 slope riser pipe ring deflection at maximum burial depths of 160 feet is 0.4 percent. This is less than the manufacturer's recommended ring deflection limit of 2.7 percent (45~~39~~).

The downdrag loads on the vertical riser pipe were evaluated in Calculation ~~G~~E-30 (Attachment BB~~Volume VI of the Permit Application dated October 2000)~~ to determine if the vertical riser pipe could damage the liner. The vertical downdrag loads are developed as a result of waste settlement around the vertical pipe. In order to limit the downdrag loads acting on the liner, the lower portion of the vertical riser was de-coupled from the upper portion. The upper portion was founded on a large concrete pad that is located on top of the sump gravel. In addition, a friction break consisting of a double wrap of HDPE was included around the steel vertical riser pipe.

3.2.9 Action Leakage Rate and Response Action Plan

The~~Because of the similar~~ landfill liner components were used~~ in the landfill and the evaporation pond a single~~ to develop an Action Leakage Rate (ALR) and Response Action Plan (RAP)~~ was developed which includes both facilities~~. This plan and its supporting calculations are presented in their entirety ~~in Appendix G~~as Permit Attachment J. The results are summarized below.

An ~~Action Leakage Rate (~~ALR~~)~~ and RAP for the proposed Triassic Park Waste Disposal Facility landfill ~~is~~are required under 40 CFR Part~~s~~ 302. The ALR, as defined in the final rule published in January 29, 1992, is the maximum design flow rate that the LDRS may remove without the fluid head on the bottom liner exceeding ~~one~~ 1 foot (~~60~~54). The RAP describes the steps to be taken in the event the ALR is exceeded in landfill. The RAP specifies the initial notifications, steps to be taken in response to the leakage rate being exceeded, and follow-up reports.

The EPA–-recommended method for determining the landfill ALR presented in Federal Register Vol. 57, No. 19 (67) and in references No. 65 and 6659 were used to calculate the ALR for the landfill facility. Using the flow equation for geonets and applying field representative geocomposite transmissivities and appropriate factors of safety for geonet creep and sediment clogging, the recommended ALR for the landfill was determined to be 900 gpad.

The ALR value of 900 gpad is above the EPA--recommended value of 100 gpad. The primary reason for this difference is that the EPA value is based on a sand drainage layer with a permeability of 1 x 10^{-2} cm/s compared to the geocomposite drainage layer transmissivity of 2.2 x 10^{-4} m^2/s proposed for the Triassic Park Facility landfill.

Additional computations to check the LDRS sump capacity and LDRS drain pipe capacity are also presented in the Appendix GPermit Attachment J.

Response Action Plan sSteps outlined in the Action Leakage Rate and Response Action PlanRAP closely follow the recommended actions presented in Federal Register Volume 57, No. 19 (67).

3.2.10 Surface Water Drainage Analyses

Design parameters for HDPE lined Channels 7 and 8 located above the landfill access ramps are presented on Drawing No. 25 (Sheet 2 of 2). The methodology, assumptions, and runoff calculations for these channels and the collection basins discussed below and are presented in Appendix FPermit Attachment L4.

The clean stormwater collection basin located at the toe of the 2H:1V cut slope in the south end of the landfill will contain the runoff from the 15 acres of unlined area of Phase 1A (above the access ramps). The total runoff from the 25-year, 24-hour event is approximately 4.5 4.6 ac-ft. Total volume of the detention pond assuming 1 foot of freeboard is 5.2 ac-ft.

The contaminated water basin at the toe of the Phase 1A waste fill slope is designed to contain the runoff from the entire 15.6-acre fill area of Phase 1A. The total runoff from the 25-year, 24-hour event is approximately 4.34 ac-ft. The contaminated water basin is approximately 560 feet by 200 feet and can store approximately 10.417.0 ac-ft assuming 1 foot of freeboard. This is the minimum capacity of the basin, which occurs when the landfill Phase IA has reached capacity. Prior to the landfill reaching capacity, the basin will have more than 17.0 ac-ft of storage space. The contaminated water basin will be constructed at the same time as the rest of the Phase 1A landfill so it can accommodate runoff from waste placed in Phase 1A.

3.2.11 Soil Erosion Analyses

Due to the temporary nature of the 2H:1V cut slope and the 3H:1V subgrade slopes above the access ramps, severe soil erosion of these slope areas is not anticipated. The 2H:1V cut slope will be excavated during future landfill construction and the 3H:1V subgrade areas above the access roads will be conditioned prior to liner placement as required in the specifications.

Erosional features such as rills and localized slumping in exposed areas of the protective soils layer on the 3H:1V slope areas will be repaired following rain events.

3.2.12 Frost Protection

The maximum frost depths in the Roswell area, indicates that frost may reach 23 inches during the winter months. In addition, site-specific frost penetration modeling for the site indicated a maximum design freezing depth of 2.3 feet for this cover. Recent sStudies by Kraus (3936) evaluating the effects of frost on geosynthetic clay liners indicate that there is little change in the permeability of the GCLs due to frost. Because the landfill utilizes GCLs in combination with HDPE as barrier elements for both the liner system and the cover system, frost damage to these layers is not expected. However, the 2.5-foot-thick vegetative layer on the cover system will also provide frost protection for underlying geosynthetics and soil components in the cover section;, 2 feet of protective soil is specified on the side slopes of the landfill. Due to the relatively short time period that the side slopes will be exposed without waste placement, the 2-foot cover thickness is considered adequate.

3.2.13 Earthwork Volumetrics

Table L-3 lists the material quantities for subgrade excavation, structural fill, cover and liner soil components, and the net waste airspace available for Phase 1A development. Table L-3 also lists material quantities for the final landfill configuration.

Table L-3. Landfill Phase 1A Material Balance and Ultimate Landfill Material Balance

	Loose or Compacted Cubic Yards	Bank Cubic Yards
Material Balance Phase 1A		
Design Capacity		
Total Airspace		691,540 bcy
Liner Area		14.5 acres
Cover Area (Top of Waste)		11.9 acres
Volume of cover (NOT included in airspace)		0 bcy
Volume of Liner (NOT included in airspace)		0 bcy
Remaining Airspace		691,540 bcy
Volume of Daily Cover (20% of total)		138,308 bcy
Total Waste Capacity		553,232 bcy
Total Soil Requirements		
Volume of Daily Cover (20% of total)	170,119 lcy	138,308 bcy
Volume of Liner Material (0.5 foot)	92,194 ccy	83,813 bcy
Volume of Cover (4 feet)	718,385 ccy	653,077 bcy
Total Volume of Soil Required		875,198 bcy
Total Cut Volume		2,797,921 bcy
Cut/Fill Balance Difference		1,922,723 bcy
Material Balance Ultimate Landfill		
Design Capacity		
Total Airspace		13,997,654 bcy
Liner Area		103.9 acres
Cover Area (Top of Waste)		101.2 acres
Volume of cover (NOT included in airspace)		0 bcy
Volume of Liner (NOT included in airspace)		419,063 bcy
Remaining Airspace		13,578,591 bcy
Volume of Daily Cover (20% of total)		2,715,718 bcy
Total Waste Capacity		10,862,873 bcy
Total Soil Requirements		
Volume of Daily Cover (20% of total)	3,340,333 lcy	2,715,718 bcy
Volume of Liner Material (0.5 foot)	92,194 ccy	88,813 bcy
Volume of Cover (4 feet)	718,385 ccy	653,077 bcy
Total Volume of Soil Required		3,452,608 bcy
Total Cut Volume		10,281,466 bcy
Cut/Fill Balance Difference		6,828,858 bcy

lcy = 1.23 bcy
ccy = 1.1 bcy

4.Evaporation Pond

4.1Evaporation Pond Design

4.1.1General

The purpose of the evaporation pond is to treat liquid wastes which meet land ban restrictions. The majority of these liquid wastes will be leachates collected from the landfill LCRS or other containment sump systems on site. The pond may receive leachates from other off-site sources. This unit will not be used to manage wastes containing volatile organic concentrations greater than 500 parts per million by weight (ppmw).

The volume of liquids in the pond will be dependent on the waste market. Net evaporation (total evaporation minus rainfall) for the site is in the range of 80 inches per year.

Evaporation pond design elements include pond layouts and phasing; subgrade design; liner system design; and leak detection system, and vadose monitoring sump design. This section describes each of these design elements.

4.1.2Evaporation Pond Layout and Phasing

The proposed evaporation pond area layout and phasing is illustrated on Drawing No. 28. Pond 1 will be constructed initially and will service site operations during waste filling of landfill Phase 1A. A future Pond 2 would be located east of Pond 1 and would provide additional pond treatment capacity as the landfill expands into Phases 2 and 3. Space has been allocated in the site layout to the east of Future Pond 2 should demand for pond storage capacity increase beyond that currently provided in the design.

Ponds 1 and 2 are each divided into two separate ponds, A and B. This arrangement provides separate pond units which can be placed into service independently. For example, in the event of a major rain event or should the Pond 1A primary liner begin to leak, additional pond storage capacity available in Pond 1B could immediately be brought on line. Each pond unit is equipped with its own discharge station. An inter-pond transfer pump will be located on separation berm between the A and B pond units. Provisions to curtail placement of liquid wastes into an impoundment that has exceeded its ALR are discussed in Appendix G.

Pond units 1A and 1B are each 135 feet wide by 290 feet long by 12 feet deep and each will contain approximately 2.62 million gallons. Sideslope angles are 3H:1V except for the interpond berms, which have 2H:1V sideslopes. Leak detection and vadose monitoring sumps are located centrally on the long side of the pond units. Pond floor grades are a minimum 2 percent towards the sumps.

Pond overtopping will be controlled manually through the use of liquid elevation indicators placed in the pond. These indicators will be graduated vertical rods fixed to a stable base. The rods will be placed such that graduated markings can be easily read from the discharge station. The rods will be surveyed when placed and checked by survey periodically to ensure accuracy. Correlation charts between elevation and pond volume will be maintained at the discharge station of each pond. Pond discharge pipes will also be equipped with flow meters so that liquid volumes placed in the pond can be continuously tracked and documented. Filling of the ponds above the 2-foot freeboard limit will not be permitted. Site personnel will be present during all fluid discharge and transfer operations to ensure that pond overtopping does not occur in the event of equipment malfunction or other human error.

Due to the small aerial extent of the evaporation ponds and limited fetch distance, wave action developed in the pond fluid surface will also be limited. The 2-ft freeboard distance will accommodate minimal wave action without overtopping. At closure, the pond will be backfilled to surrounding ground and revegetation.

4.1.3.1Subgrade Excavation, Liner System, LDS Sump Design and Vadose Monitoring Sump Design

Subgrade Excavation

Drawing No. 28 shows the evaporation pond excavation contours. The crest of the evaporation pond is essentially flat. Fill areas around the perimeter of the ponds along with site grading outside of the pond area provide sufficient grade differences for storm water run-off to flow to the perimeter road ditches and ultimately to the storm water detention basin located in the northwest corner of the site.

Specification Section No. 02110, Site Preparation and Earthwork, describes site preparation, excavated soil classification and stockpiling, subgrade surface preparation and inspection, structural fill placement and compaction requirements, survey and quality control, and erosion control features.

Liner System

Drawing Nos. 30, 31 and 32 show the evaporation pond liner components covering the floor and slopes, and extending into the anchor trench areas. The liner system will be continuous over the berm between the A and B units. The evaporation pond liner system is a double lined system consisting of (from bottom up) a composite (compacted clay and geomembrane) secondary liner, a geonet leak detection drainage layer, and a primary geomembrane liner. Details of each liner component are discussed below:

- *3-foot-thick compacted clay liner (CCL)*

  The CCL ($k \leq 1 \times 10^{-7}$ cm/s) in combination with the overlying HDPE geomembrane will serve as a low permeability barrier layer to restrict infiltration of leachate into the subgrade. The CCL will consist of clay material (CL, CH) obtained during excavation of the landfill and surface impoundment. Specification Section 02221, Clay Liner, describes clay material requirements including particle size and moisture content, placement and compaction requirements, and survey and field quality control requirements. Soil under leachate compatibility tests (two stage permeability testing using ASTM D 5084) will be conducted prior to construction. In addition, a test fill will be constructed, as per the procedures outlined in the CQA plan. The results of the permeability testing performed compacted samples are shown in the appendices.

  Soil liner compatibility is normally not a problem unless the leachate contains high concentrations of organics (Eklund, 1985; Peterson and Gee, 1985; Mitchell and Madsen, 1987; Finno and Schubert, 1986). Additional supporting information on the compatibility of the GCL with various leachate is presented in Appendix E-40.

- *60-mil thick high density polyethylene (HDPE) geomembrane liner (smooth)*

  The 60-mil HDPE liner placed on top of the CCL is the second component of the composite secondary liner. Together, the CCL and HDPE liner form a highly efficient barrier layer to restrict percolation of leachate into the subgrade (see Section 3.2.7, HELP Modeling). Specification Section 02775, Geomembrane Liners, describes minimum geomembrane properties required, subgrade preparation and inspection, material transportation and handling procedures, deployment and seaming requirements, and material CQA.

Site specific compatibility tests will be conducted on a synthetic leachate and the proposed liner prior to operation of the facility.

- *Geonet leak detection drainage layer (transmissivity ≥ 5×10^{-3} m^2/s as tested under actual field conditions)*

  The high transmissivity geonet leak detection drainage layer provides a means to transmit and remove leachate percolating through any leaks in the primary geomembrane layer above. Flow calculations discussed in Section 4.2.7 and presented in Appendix G indicate that the geonet is capable of removing leachate in a timely manner such that head on the underlying geomembrane will remain less than 1 foot. Specification Section 02712, Geonet, describes minimum geonet properties required, material transportation and handling procedures, deployment and seaming requirements, and material construction quality assurance.

- *60-mil thick high density polyethylene (HDPE) geomembrane liner (smooth)*

  This HDPE geomembrane serves as the liner systems primary barrier layer of the double liner system. Specification Section 02775, Geomembrane Liners, discussed above also applies to this geomembrane layer.

  Site specific compatibility tests will be conducted on a synthetic leachate and the proposed liner prior to operation of the facility.

Since portions of this liner component will be permanently exposed to sunlight and UV radiation, it may be necessary to replace it prior to the end of the facility life. The lifetime of exposed geomembrane liners varies, however, it is generally limited to the warranty period of the product which may be as long as 20 years (33). The staged approach to pond development will help alleviate this concern, as will maintain fluid levels near capacity in the primary use pond unit. Periodically alternating pond units for primary use will also reduce exposure time.

Leak Detection and Removal and Vadose Monitoring Sump Systems

The leak detection and vadose monitoring systems each have a separate sump from which fluids can be collected and removed. The liner systems on the evaporation pond floor continue into the sumps, however, in order to provide adequate volume to efficiently operate removal pumps, gravel thicknesses are incorporated into the drainage systems. Drawing No. 32 illustrates the sump layout and cross section. As shown on the drawings, the sumps are square pyramidal shapes which lie concentrically above one another. The slope riser pipe trenches enter their respective sumps at the sump base. The slope riser trench arrangement enables the vadose and leak detection slope riser pipes to penetrate overlying geosynthetic liner elements at the crest of the evaporation pond rather than in the sump area. The leak detection sump has a total fluid capacity of 1,790 gallons (after accounting for gravel). Similar to the landfill leak detection sump, the evaporation pond sump will be equipped with fluid level instrumentation and a 50 gpm fluid removal pump. The vadose monitoring sump has a total fluid capacity of 95 gallons (after accounting for gravel).

4.1.4 Evaporation Pond Discharge Pad Arrangement

Drawing No. 31 illustrates the slope riser piping and valving, the discharge pipe arrangement, and the layout for the concrete containment pad. Tanker trucks will pull up next to the concrete pad and hook up to the desired piping system. Hose connections at the pipes are located within the concrete pad area to contain any leakage. A concrete pad will be placed in the loading/unloading area for the tanker trucks. This pad will be sloped providing drainage toward the sump area. The concrete containment pad slopes towards the evaporation pond crest. Should a catastrophic failure of the piping system occur, leachate will flow back into the evaporation pond rather than be released to unlined areas. The evaporation pond liner system anchor trench will completely encompass the pad so that any leakage through the pad will also drain back into the

~~evaporation pond. Construction details for the concrete containment pad are called out in Specification Section 03100, Concrete Formwork, Section 03200, Reinforcement Steel, Section 03290, Joints in Concrete, and Section 03300, Cast-in-Place Concrete.~~

~~Storm Water Control Features~~

~~Drawing No. 5 depicts the surface grades around the perimeter of the pond area. Surface water run off from these areas will flow to the roadway ditch system and ultimately to the surface water detention pond.~~

~~4.2Evaporation Pond Design Analyses~~

~~4.2.1 Slope Stability~~

~~Cut Slope Stability~~

~~Prior to filling, unsupported cut slopes will exist on all sides of the evaporation pond. These slopes were analyzed for static and dynamic stability using the Bishop method of slices. A computerized slope stability program (XSTABL) (44) was used to analyze the cut slopes. Strength parameters used for soil and rock materials were estimated using pocket penetrometer data gathered during test pitting of the site soil materials. The material properties used in the analyses are summarized in Appendix E.~~

~~The site grading plans (Drawing Nos. 28 and 29) indicate that the maximum cut slopes will be 3H:1V and 2H:1V and maximum height will be approximately 12 feet. Results for the critical 2H:1V slope as presented in Calculation E-7, indicate a static factor of safety of 19.8 for the critical short term (undrained) condition. Stability during seismic loading was estimated by applying a pseudo-static earthquake force in the Bishop analysis. Results based on the 0.04 g design acceleration indicate a dynamic factor of safety of 15.7 for the short term (undrained) condition.~~

~~Slope stability was not considered for the filled evaporation pond configurations. Filling the pond with fluid does not place any stresses on the liner system which could cause instability.~~

~~4.2.2Settlement~~

~~The evaporation pond will experience relatively low overburden pressures due to its shallow depth and liquid fill density in comparison to pressures previously imparted to the clay during placement compaction. Clay liner consolidation will therefore be negligible.~~

~~4.2.3Geosynthetics Strength and Performance Analyses~~

~~As discussed in Sections 4.2.1 and 4.2.2 above geosynthetics components of the evaporation pond will not experience significant stresses related to slope stability or settlement. Settlement induced stresses to evaporation pond geosynthetics were, therefore, not considered.~~

~~Geomembranes~~

~~The general use of geomembranes in the evaporation pond is similar to that described for the landfill. Thermal induced stress and tear and puncture evaluations are discussed below.~~

~~Thermal Induced Stress~~

~~The 60-mil HDPE geomembrane liner will be subject to contraction and expansion from daily temperature differentials. The contraction/expansion potential of the HDPE liner was determined, and the maximum induced stress was determined. Calculation No. E-27, Thermal Induced Stress in Evaporation Pond Liner,~~

indicates the maximum induced thermal stress in the liner would be 560 psi. This value is far below the 2200 psi minimum yield strength of liner, which yields a design safety factor of 3.9.

Tear and Puncture

The evaluation of geomembrane tear and puncture in the landfill liner system was presented in Section 3.2.1.2 . The results of that analyses indicated that the 60-mil HDPE geomembranes were adequate for loading conditions which were much more severe than those expected for the evaporation pond. Since similar HDPE products will be used in the evaporation pond and the same subgrade surface preparation methods are required by the specifications, separate calculations for evaporation pond geomembrane tear and puncture are not necessary.

Geonets

The geonet is intended to act as a lateral drainage layer in the evaporation pond LDRS. The primary design criterion of the geonet is the transmissivity. Calculations presented in Appendix G-2 evaluate the typical transmissivity values reported in the literature and by manufactures. These values have been reduced to account for clogging of the geotextile, penetration of the geotextile in to the geonet and creep of the geonet.

In order to confirm the actual transmissivity of the material that arrives on the site, the specifications require that the geonet be tested as part of the conformance testing program. The specific test methods, including backing materials, normal loads, seating times, gradients, and test durations are detailed in the specifications.

Geotextiles

Geotextile Filtration

Geotextiles are used in a number of locations in both the liner and sump sections for filtration. Specifically, the geotextiles act as filters between the pipe bedding material or between the granular leachate collection materials. Similar to the landfill evaluation, if these soil materials are conservatively estimated to be fine grained with more than 50 percent of the material passing the Number 200 sieve, then the specified geotextile with a AOS of less than 0.212 mm should adequately retain these soils.

Geotextile Cushion

The puncture resistance during installation of the proposed geotextile materials was analyzed for more severe conditions in the landfill design. Therefore, these calculations are not repeated for the evaporation pond application.

4.2.4Compacted Clay Liner

As previously discussed for the sump CCL, the criteria for the CCL materials characteristics and the placement and compaction criteria are presented in the specifications.

4.2.5Anchor Trench Design

The pullout capacity of the primary and secondary geosynthetics from the evaporation pond anchor trench was determined. It was assumed the geosynthetics will pull out of the trench with single-sided shear. Single-sided shear is believed to occur rather than double-sided shear because there is less shearing resistance for single-sided shear. Assumed interface friction angles were based on previous laboratory testing for similar materials at low normal stresses. Based on the trench geometry, critical HDPE geomembrane properties, and assumed interface friction angles, pullout resistance calculations for both the secondary and primary liner anchor trenches indicate that the HDPE geomembranes will pull out prior to tearing (see Calculation No. E-15).

4.2.6Leak Detection and Vadose System Hydraulic Analyses

The leak detection system design and performance is very similar to the landfill system. Therefore, design analyses for the following criteria are not discussed. Rather the reader is referred to Appendix E for the detail of the calculations.

Adequacy of the leak detection and removal system for the evaporation pond is addressed in the Action Leakage Rate calculation presented in Action Leakage Rate and Response Action Plan (see Section 4.2.7 below and Appendix G). In this calculation, leakage rates into the LDRS, as determined by EPA's recommended method, were compared to flow capacities of the LDRS geonet drainage layer and the LDRS sump. Based on these calculations, the flow capacity of the LDRS sump exceeds the flow capacity of the LDRS geonet drainage layer and the estimated leakage rate into the LDRS. A Grundfos 50 gpm pump which has the capacity to remove 72,000 gpd is recommended for the LDRS system sump.

Vadose Monitoring System Analyses

The vadose monitoring sump serves as a detection system for leakage of the secondary LDRS system. A Grundfos 25 gpm pump is recommended for vadose monitoring sump. In the unlikely event that a leak develops in the LDRS sump, leachate will flow to the vadose monitoring sump where it can be detected and removed.

4.2.7Action Leak Rate and Response Action Plan

Because of the similar liner components used in the landfill and the evaporation pond a single ALR and RAP was developed which includes both facilities. This plan and its supporting calculations are presented in its entirety in Appendix G. The results are summarized below.

An ALR and RAP for the proposed Triassic Park Waste Disposal Facility evaporation pond is required under 40 CFR Parts 302. The ALR, as defined in the final rule published in January 29, 1992, is the maximum design flow rate that the LDRS may remove without the fluid head on the bottom liner exceeding one foot. The RAP describes the steps to be taken in the event the ALR is exceeded in the evaporation pond. The RAP specifies the initial notifications, steps to be taken in response to the leakage rate being exceeded, and follow-up reports.

The EPA recommended method for determining the landfill ALR was used to calculate the ALR for the evaporation pond. Using the flow equation for geonets and applying field representative geonet transmissivities and appropriate factors of safety for geonet creep and sediment clogging, the recommended ALR for the evaporation pond was determined to be 1000 gpad.

Although computations indicated a much higher ALR value could be justified, the ALR value of 1000 gpad, which is equal to the maximum EPA recommended value of 1000 gpad, was selected because this value adequately represented a "large and rapid" leak considering the small size of the evaporation ponds.

Additional computations to check the LDRS sump capacity and LDRS drain pipe capacity are also presented in the Appendix G.

Response Action Plan steps outlined in the ALR and RAP closely follow the recommended actions presented in the Federal Regulations.

4.2.8Frost Protection

Based on the landfill design, the design depth of frost at the site could be in the range of 2.3 feet (see Calculation No. E-25, Frost Penetration). Review of the evaporation pond design indicates that portions of the clay liner above the pond fluid level may be exposed to frost action. The following paragraph discusses resulting effects this may have on leakage to the environment.

Unlike the landfill, the evaporation pond is a temporary facility to be removed from service during the facility's post closure period. Increased permeability of the clay liner and any resulting leakage is therefore, not as critical as with a permanent landfill installation. Further, due to the insulating effects of the pond liquids, only portions of the clay liner above the fluid level in the pond will reach freezing temperatures. Finally, the evaporation pond design incorporates a vadose detection system and a leak detection system. Any leakage detected will be removed and if large enough, based on the action leakage rate, will cause remedial steps to be taken to locate and repair damage to the geomembrane, thus limiting exposure of fluids to the clay liner. Therefore, in our judgment, any increase in permeability of the clay liner due to potential damaging effects of frost will not result in significant increases of liquids released to the environment.

4.2.9Earthwork and Pond Volumetrics

Approximately 62,500 cy of soil materials will be excavated to construct evaporation Pond 1. Clay liner construction will require placement of 22,150 cy of compacted clay liner material. The resulting pond volume available for liquid evaporation (not including 2 ft of freeboard) is approximately 5.2 million gallons.

5.Truck Roll-Off Area

5.1Truck Roll-off Area Design

5.1.1General

It should be noted that the incoming trucks containing unstabilized waste will be Department of Transportation (DOT) approved roll off vehicles (17). These trucks are required by DOT to be covered. Additionally, the roll-off bin must be free of leaks and the waste must be contained with a plastic bed liner. Together, the roll-off bin and the plastic bed liner are considered a double lined system. This containment system will remain in place the entire period the roll-off bin is staged in the truck roll-off area. The liner system incorporated in the waste roll-off area is included as a precautionary measure.

It should also be noted that some roll-off containers staged in the area will contain stabilized waste which has met the paint filter tests for free liquids. Additionally, these roll-off bins will be lined using a plastic bed liner and will be covered in a manner similar to DOT approved roll-off containers.

The purpose of the truck roll-off area is to provide a staging area for incoming roll-off bins containing unstabilized waste destined for the stabilization facility and a second staging area for roll-off bins containing post treatment stabilized waste awaiting landfill disposal approval.

The truck roll-off area is surrounded by a berm with a minimum height of 2.0 feet (see Drawing 41). This berm will divert run-on surface water around the perimeter of the truck roll-off area. Culverts are proposed under each of the access ramps to allow surface water flow to the west towards the run-off detention basin. The interior depth of the berms is also a minimum of 2.0 feet. The 25-year, 24-hour storm for the site is 4.3 inches. This is expected to result in ponding inside the roll-off area to a depth of approximately 2 feet in the sump area and in the range of 1-foot or less in the central area. Incoming waste roll-off containers are not expected to contain free liquids. The sumps will be pumped to remove any accumulated water after any rainfall event.

Truck roll-off area design elements include truck roll-off area layout, subgrade design; liner design; and drainage sump design. This section describes each of these design elements.

5.1.2Truck Roll-Off Area Layout

Drawing Nos. 41 and 42 illustrate the layout of the Truck Roll-Off Facility. Each is approximately 310 ft long by 180 ft wide roll-off cell can stage approximately 66 roll-off bins. The floor of each cell grades at 2 percent towards its respective sump and the surrounding soil berms have side slopes of 1.5H:1V and range in elevation from 4 ft to 8 ft. Cell access is provided by four ramps which grade at 10 percent.

The west cell will be used for unstabilized waste, and the east cell will be used for stabilized waste

5.1.3 Subgrade Excavation, Liner System, Drainage Sump Design, and Leak Detection System Design

Subgrade Excavation

Drawing No. 41 shows the truck roll-off area excavation and fill contours. Cut areas in the central portion of the facility are made to achieve the required floor grades. The berms and fill areas around the perimeter of the truck roll-off area and surrounding site grading provide sufficient grade differences for storm water run-off to flow to the perimeter road ditches and ultimately to the storm water detention basin.

Specification Section No. 02110, Site Preparation and Earthwork, describes site preparation, excavated soil classification and stockpiling, subgrade surface preparation and inspection, structural fill placement and compaction requirements, survey and quality control, and erosion control features.

Liner System

Drawing No. 43 shows the liner components on the floor, berm, and anchor trench areas. The truck roll-off area for roll-off bins is a single lined system consisting of (from bottom up) a prepared subgrade, a geomembrane underliner, a geonet drainage layer, a geotextile filter layer, a soil subbase layer, and a surface gravel layer. This design should accommodate the limited truck traffic that will be required to load and unload the roll-off boxes. Details of each liner component are discussed below.

- *6-inch thickness of prepared subgrade*

  The prepared subgrade component will provide a smooth stable surface suitable for placement of overlying geosynthetic materials. Specification Section 02119, Prepared Subgrade, presents subgrade material requirements including particle size and moisture content, placement and compaction requirements, and survey and field quality control requirements.

- *60-mil thick high density polyethylene (HDPE) geomembrane underliner (smooth)*

  The 60-mil HDPE liner placed on top of the prepared subgrade liner form a highly efficient barrier layer to restrict percolation of rain water into the subgrade. Specification Section 02775, Geomembrane Liners, describes minimum geomembrane properties required, subgrade preparation and inspection, material transportation and handling procedures, deployment and seaming requirements, and material construction quality assurance.

  Site specific compatibility tests will be conducted on a synthetic leachate and the proposed liner prior to operation of the facility.

- *Geocomposite leak detection drainage layer (transmissivity $\geq 2.2 \times 10^{-4}$ m^2/s) as tested under actual field conditions*

The high transmissivity geocomposite drainage layer provides a means to transmit and remove rainwater falling within the unstabilized waste roll-off bin area. Flow calculations discussed in Appendix E indicate that the geocomposite is capable of removing rainwater so that ponding can be minimized and trafficability of the upper gravel surface can be maintained. Specification Section 02710, Geocomposite, describes minimum geocomposite properties required, material transportation and handling procedures, deployment and seaming requirements, and material CQA.

- *18-inch thickness of soil subbase layer*

The soil subbase will consist of free draining soils classified as SM, SW, GM, or GW. Specification Section 02230, Subbase, presents material requirements including particle size and moisture content, placement and compaction requirements, and survey and field quality control requirements.

- *6-inch thick road base gravel surface*

The road base gravel surface will allow storm water to drain from the surface while providing sufficient bearing capacity for truck traffic. Any disturbance of the road base surface as a result of loading and unloading the roll-off trailers will be observed during the weekly inspections of the unit and repaired by placement of new material or re-grading of the raising material. In the case of severe rutting (greater than 6 inches) the area will be excavated and the geosynthetic materials will be inspected for damage. Repairs will be made if required. Specification Section 02225, Road Base, presents material requirements including particle size and moisture content, placement and compaction requirements, and survey and field quality control requirements.

Potential leakages from the containers would be very limited and are not expected to react with the road-base aggregate.

Drainage Sump System

The drainage sump will collect storm water run off from the floor of the truck roll-off area. The liner systems on the truck roll-off area continue into the sump, however, in order to provide adequate volume to efficiently operate the removal pump, a gravel thickness has been incorporated into the drainage systems. Drawing No. 43 illustrates the sump layout and cross section. As shown on the drawings, the sump is a triangular pyramidal shape. The slope riser pipe enters the sump at the sump base. The slope riser trench arrangement enables the leak detection slope riser pipe to penetrate the overlying geomembrane liner elements at the crest of the truck roll-off area berm rather than in the sump area. The sump has a total fluid capacity of 1,406 gallons (after accounting for gravel). The truck roll-off area drainage sump will be monitored visually to determine whether pumping is required. Fluid removal will be performed by a vacuum truck.

5.2Truck Roll-off Area Design Analyses

5.2.1 Geosynthetics Strength and Performance Analyses

Geomembranes

The evaluation of geomembrane puncture in the truck roll-off liner system is presented in Calculation No. 18, Geomembrane Puncture Resistance. The results of the calculation indicate that the 6-inch road base and 18 inch subbase materials will adequately dissipate truck wheel loads and, in conjunction with the subgrade preparation specifications, which call for a 1 inch maximum particle size, will adequately protect the geomembrane from puncture. A calculated factor of safety of 60 to 1 against puncture was computed.

Geocomposite

Low overburden pressures due to the overlying roadbase and subbase are not high enough to adversely affect transmissivity of the geocomposite. Review of the texnet transmissivity charts presented in Calculation No. G-1, Landfill Action Leakage Rate supports this.

Geotextiles

Geotextile filtration and puncture resistance are evaluated in Calculation No. E-20, Geotextile/Geocomposite Filtration, and Calculation No. E-21, Puncture Resistance of Geotextile/Geocomposites, respectively. Based on these calculations, the geotextiles specified for the truck roll-off area will adequately filter the sites fine grained materials and resist puncture.

5.2.2Anchor Trench Design

The purpose of the truck roll-off facility anchor trench is to hold the geosynthetic liner components in place during placement of the overlying subbase and roadbase materials. Pull out considerations due to settlement are not a relevant concern for this facility.

5.2.3Storm Water Collection Sump and Leak Detection Sump Containment Hydraulic Analyses

Calculation No. E-32, Truck Roll-Off LDRS Pumping Capacity, evaluates the capacity of the storm water collection sump in the lined portion of the truck roll-off facility to remove water from the geonet drainage layer. Based on this calculation, the geonet flow capacity is estimated to be 161,000 gpd and the sump capacity is estimated to be 199,000 gpd. The sump will, therefore, provide adequate water removal capabilities.

6.Stabilization Facility

6.1Stabilization Facility Design

6.1.1General

The purpose of the stabilization facility is to treat waste streams using a chemical stabilization process which will chemically alter hazardous waste constituents such that their leachability is reduced to levels allowing landfill disposal. The stabilization treatment process involves combining chemical reagents with waste materials according to a specific treatment recipe and mixing until the waste/reagent reactions are complete. The batch stabilization mixing method to be used in the Triassic Park Stabilization Facility requires a backhoe excavator to mix waste with reagents in a large double lined steel bin. The materials treated will be in the bins for a limited amount of time, therefore only concentrated acids will not be allowed in the bins.

Stabilization facility design elements presented here include stabilization facility layout; stabilization bin, bin vault, and floor design; and stabilization process design. This section describes each of these design elements. It should be noted that certain components of the stabilization building, process control and delivery systems, ventilation systems and steel bins will be completed under future design/build contracts.

6.1.2Facility Layout

Drawing No. 3 illustrates the layout of the stabilization building and the surrounding area. As previously discussed, the Stabilization Facility has entrances for incoming trucks on both the north and south access

~~roads. These accesses will be used for incoming waste trucks loaded with unstabilized waste for processing in the bins. Incoming trucks will enter the gravel lined apron on the north or south side of the facility and back into the stabilization building. Once the load has been dumped into the bin and the truck bed washed out, the truck will exit the facility via the entrance route. The east and west building entrances will be used by stabilized waste loadout trucks, which will cycle between the truck roll-off area or the landfill. The gravel lined areas surrounding the stabilization facility will not be used to stage waste hauler trucks. Parking areas for site personnel vehicles will be designated near the stabilization facility control room.~~

~~The control room is positioned centrally along the east wall of the stabilization building. From this vantage point operations personnel will be able to monitor all activities taking place inside the building. Reagent storage tanks and silos are also located on the eastside of the building which permits operations personnel to view reagent delivery activities.~~

~~The stabilization building's internal arrangement is centered around the four waste mixing bins. The mixing bins are orientated such that delivery, mixing and loadout operations can take place from either the north or the south sides of the building. Stabilization unit operations are depicted on Drawing No. 34. The 25 ft long by 10 ft wide by 10 ft deep bins can hold a maximum of approximately 100 cy of waste and reagent material. The double lined steel bins are located within a 38 ft wide by 79 ft long by 12 ft deep concrete vault which has a total volume of 1,330 cy. The bin and vault arrangement provides three levels of waste containment with the inner bin liner serving as primary containment, the outer bin as secondary containment, and the vault as final or tertiary containment.~~

~~The 118-foot-wide by 123-foot-long concrete floor is sized to accommodate the backhoe mixer and load out truck operations with adequate clearances. Section 6.2.3 discusses working point distance and clearance radius requirements for this operation.~~

~~The vertical dimensions for the stabilization building will be established during the building design/build phase when locations and sizing of the reagent delivery system and ventilation system are finalized.~~

~~6.1.3Bin Liner, Bin Vault, and Floor Design~~

~~The stabilization bin arrangement is a double lined system consisting of two concentric steel bins separated by a network of wire rope isolators. The bins must be able to withstand the impacts from mixing with a backhoe bucket and also be relatively compatible with the waste that will be placed in the bins. Since the bins are concentric, the outer bin (secondary containment) can hold 100% of the volume of the inner bin. The wire rope isolators act as shock absorbers to dissipate impact loading to the bins by the mixing action of the backhoe. The wire rope isolators also serve to reduce impact loading transferred to the concrete vault floor and walls. Drawing No. 35 illustrates the inner and outer bin arrangements, bin dimensions, plate thicknesses, reinforcing rib arrangements, and locations of the wire rope isolators. The inner bin is not attached to the outer bin and therefore, can be removed for repair or replacement. The space between the bins provides access for leak detection instrumentation and fluid removal piping. Should a leak in the inner bin occur such that fluids escape into the inter-bin space, the leak detection instrumentation will trigger alarms in the control room immediately notifying the operators. The bin can then be taken out of service, inter-bin fluids removed, bin walls inspected, and repairs made if necessary. The outer bin is attached to the floor of the concrete vault. Drawing No. 33 shows the location of the leak detection and fluid removal piping. Liquid in the leak detection and fluid removal pipes may be monitored using a probe and removed by pumping, if necessary. The design of the bin has been based on a rational assumption of the design mixing and has selected a design thickness based on a reasonable curve of risk for damage. It is fully realized that if a worst case loading condition arose and the bins were cracked or otherwise damaged to the point of not providing containment than the bin would be taken out of service and repaired or replaced. Outline Specification for Proposed Hazardous Waste Mixing Bins at the Triassic Park Facility, presented in Appendix E, describes the steel plate, reinforcing members, and energy absorbing devices intended for the stabilization bin system.~~

~~The 1,330 cy concrete vault which will contain the stabilization bins has the capacity to easily contain the volume of all 4 100 cy bins (400 cy total capacity). As mentioned above, the vault serves as a tertiary containment feature should a catastrophic bin failure occur. In addition, the vault also provides access to the bins for inspection purposes and for ancillary reagent delivery piping and ventilation ducts. Construction details will be prepared for the concrete containment vault similar to those provided in Specification Section 03100, Concrete Formwork, Section 03200, Reinforcement Steel, Section 03290, Joints in Concrete, and Section 03300, Cast-in-Place Concrete.~~

~~The concrete floor will be steel reinforced cast-in-place concrete. All joints in the concrete floor will be constructed with chemical resistant water stops and caulking sealer. Drawing No. 44 shows the rebar types and concrete details for the floor. Construction details for the floor will be prepared similar to those provided in Specification Section 03100, Concrete Formwork, Section 03200, Reinforcement Steel, Section 03290, Joints in Concrete, and Section 03300, Cast-in-Place Concrete. Specification Section 07970, Sealants and Caulking, describes the concrete epoxy coating requirements.~~

~~6.1.4Stabilization Process Design~~

~~Drawing No. 34 summarizes the major waste processing unit operations and illustrates typical waste and reagent stream flows. Also shown are reagent tank and silo capacities, delivery piping, and control valve and flow meter locations.~~

~~Waste processing unit operations include waste receiving, reagent addition, stabilization mixing, and stabilized waste loadout. Waste receiving involves positioning loaded waste hauler at the end of the bin, dumping the waste load, and washing out any residue left in the truck bed into the bin. Reagent addition involves placing a cover on top of the bin, connecting ventilation and dry reagent delivery ducts, and injecting reagents into the bin. Reagent delivery to the bins will be controlled by a process controller (computer) system which will automatically sequence and deliver the necessary quantities of reagent based on a predetermined waste processing recipe. The bin cover will then be removed and a backhoe type excavator will mix the reagents with the waste. Following mixing, the waste will be sampled and a paint filter test will be conducted to ensure that no free liquids are present. Also, if necessary, samples will be gathered for toxicity characteristic leachate procedure (TCLP) testing. If the paint filter test is passed, the backhoe will load the stabilized waste into a waste hauler (roll-off truck) and the truck's roll-off cover will be positioned over the waste. The truck will either proceed to the landfill for disposal or will stage the roll-off bin in the Truck Roll-Off Area. The stabilized waste will need to be stored temporarily at the roll-off unit while tests are completed to determine how and if the material can be disposed of in the landfill.~~

~~Reagent usage will vary with the waste type and the prescribed stabilization recipe. It should be noted that both waste receipt rates and stabilization recipes will vary considerably. Stabilization process flows are discussed further in Section 6.2.4.~~

~~Reagent storage and delivery systems for two types of dry reagent and three types of liquid reagent (one being water) are incorporated into the design. Dry reagents including cement and fly will be stored in 25,000 and 50,000 cft silos, respectively, and delivered to the bins by a pneumatic delivery system. Liquid reagents including calcium polysulfate and ferrous sulfide will be batch mixed in individual 10,000 gal reagent tanks and pumped into the bins. Water will also be pumped to the stabilization bins.~~

~~For design purposes, a CAT 213B LC type excavator was selected as the backhoe mixer, however, other equipment manufacturer's offer excavators with similar reach, power, and weight characteristics.~~

~~In order to ensure no visible fugitive dust emissions during stabilization processing, the bins and the stabilization building will be equipped with an exhausting ventilation system which will maintain a negative pressure inside the building. Slotted ducts located around the perimeter of each bin will provide supply and~~

return air in a push-pull arrangement to remove dust during the waste receiving, mixing, and loadout operations. During reagent delivery operations, the bin cover, which will also be connected to the exhaust system, will control dust. Dust will be removed from the exhaust air in the bag house located on the west side of the building. Collected dust will be processed in the stabilization facility.

Wastes containing VOCs greater than 500 parts per million per weight (ppmw) will not be accepted for stabilization processing.

6.2 Stabilization Facility Design Analyses

6.2.1 Stabilization Bin Structural Analyses

Basic engineering principles in conjunction with finite plate analyses were used to address the preliminary structural design of the steel stabilization bins. Principles of impulse - momentum and conservation of energy were used to establish the mass, velocity and displacement relationships. Then plated stresses were approximated through the use of Sap 90. Finally force and displacement results were scaled up/down to limiting displacements (controlled by the wire rope isolators) and stresses (controlled by the grade of steel).

The fundamental design inputs for the bin analysis are the forces generated by the backhoe mixing action. For the purposes of this design a CAT 213B LC type backhoe was assumed. Critical velocities of the backhoe movements to prevent damage to the bins were determined as a percentage of maximum velocities achievable by the backhoe. These limiting velocities will be implemented in the actual backhoe unit by adjusting the hydraulic system flows. Calculations are presented in Appendix E and summarized in the overview below.

Overview Structural Analysis

- Calculations establish the structural capacity required to support the static loads from hazardous waste material plus the stabilizing materials. The worst case scenario for the static load case is 80 cubic yards of material weighing 110 lbs/cubic foot.

- Dynamic analyses for vertical impact loads due to the material dropping into the bin indicate that this is not a significant problem. However, impact from the bucket dropping freely due to a total and instantaneous hydraulic failure from a height of 15 feet would cause stresses in a 1 inch thick inner liner which would far exceed the yield stress of the steel and cause a permanent “dent” in the steel. It does not appear cost effective to design the inner liner for this possibility.

- Dynamic analyses established a side impact load from the backhoe bucket with contributions from the stick and boom based upon their relative velocity and percent of load transferred to the bucket when it impacts the sidewall of the mixing bin.

  - Static loads were applied to the wall of the inner liner to establish the relative deflections of points surrounding the point of impact. Then the effectiveness of the inner liner which would act to reduce the momentum of the bucket was established and the conservation of momentum principle was used to determine the reduction in velocity immediately after impact.

  - After impact the moving bucket plus the effective plate mass has a kinetic energy equal to one half of the total mass times the square of the velocity. That kinetic energy is “gradually” transferred into potential energy from force times displacement (or bending moment times angle change) in the inner liner, the energy absorbing springs and the outer plate support system. When the bucket has been stopped all of the energy has been transferred from the kinetic state to the potential state. It appears that 80 to 90 percent of the energy absorption occurs in the springs.

- ~~Through a trial and error process, approximate relationships between initial velocity, displacements and stresses in the structural systems were established. It appears that the controlling factor in the system is the stress in the inner liner when subjected to impact loads.~~

- ~~The impact loads from the weight of the bucket plus contributions from the stick and boom totaling approximately 3,290 pounds results in a kinetic energy in excess of 800,000 lb-inches for the condition where a swing angle of 180 degrees can occur in 3 seconds (approximately 440 inches per second at the outer end of the bin).~~

- ~~In order to limit the stresses in the high strength inner liner plate to an acceptable allowable value, it will be necessary to reduce the side to side velocity of the bucket to 15 percent of the present velocity with a ¾ inch thick plate, 19 percent for a 7/8 inch plate and 23 percent for a 1-inch plate.~~

- ~~Preliminary analysis of the dominantly in and out impact loads caused by movement of the boom, stick and bucket were also made. Combinations of circular velocities (Boom + Stick + Bucket) could easily result in velocities and resulting impact loads greater than the capacity of the inner plate to resist. Some of these velocities will probably need to be reduced to limit damage to the inner liner but this will require significantly more detailed calculations. Note that the effective mass at impact varies with each of these elements and the addition of these circular velocities and tributary masses in any particular direction and at any particular point is far from linear. The maximum reduction in velocity for any of these elements appears to be in the order of 50 percent.~~

~~Bin steel plate thickness is dependent on the grade of steel selected. The final bin design will determine the optimal steel plate to be used.~~

~~Corrosion protection for the bins will be provided by installing grounded cathodes to the inner and outer bins.~~

~~6.2.2Facility Stabilization Concrete Vault~~

~~The Stabilization Facility concrete vault is not a secondary containment feature; therefore, regulations pertaining to secondary containment do not apply. However, all joints in the concrete vault of the stabilization building will be constructed with chemical resistant water stops. In addition, a chemical resistant epoxy coating will be placed on the surface of the vault floor and walls to further restrict potential liquid penetration into the concrete.~~

~~The concrete vault area will be inspected monthly. If liquids are found, then will be removed with a portable pump and transported to the liquid waste storage unit.~~

~~6.2.3Stabilization Facility Concrete Floor~~

~~Waste entering the stabilization building will be contained in the DOT approved waste trucks. Stabilized waste, having undergone treatment, will either be contained in roll-off trucks fashioned with DOT approved truck bed liners or, if treatment standards are met, according to approved testing protocols, the stabilized waste will be transferred directly to the landfill. The floor of the stabilization building will not be exposed to untreated waste material and is not required to serve as a containment system. However, all joints in the concrete floor of the stabilization building will be constructed with chemical resistant water stops. In addition, a chemical resistant epoxy coating will be placed on the surface of the floor to further restrict potential liquid penetration into the concrete.~~

~~As shown on Drawing No. 33, stabilization bins are located on 19 ft centers in the middle of the stabilization building. The bins are situated such that adjacent bins alternate mixing and receiving ends allowing for reagent addition operations to take place simultaneously with mixing or loadout operations in two adjacent bins.~~

~~During mixing and loadout operations, the center point (rotational axis) of the backhoe unit will be located 8 to 9 feet from the mixing end of the bin. Load out trucks, which can access the building through one of four doorways, will be positioned 15 to 20 feet from the backhoe center point within the 20-foot-wide load out truck lane. A 6.5-foot clearance is provided between the load out truck lane and the north and south building walls. A 27-foot clearance is provided between the outer bins and the east and west building walls. At this distance the backhoe unit will be able to make a full 180° swing angle in the direction of the wall with minimal reach adjustments.~~

~~The backhoe unit will be equipped with synthetic rubber track pads covering the steel track ribs. The track pads will allow the backhoe unit to move over the concrete floor without damaging the floor surface.~~

~~6.2.4Stabilization Process Analyses~~

~~Solid waste throughputs in the order of 400 tons per day and liquid waste throughputs in the order of 1000 gpd were assumed based on experience at similar operating facilities. Similarly, a typical waste recipe for stabilization of solid and liquid waste was developed.~~

~~The 25,000 and 50,000 cft dry reagent storage silos and 10,000 gal tank capacities are based on providing sufficient reagent quantities for one week of normal stabilization operations. Reagent delivery piping sizes shown on Drawing No. 34 are preliminary and will be finalized when selection of the pumps and dry reagent pneumatic system are determined, however, these piping sizes are capable of meeting the daily reagent delivery requirements.~~

~~Ventilation system requirements will be determined in conjunction with the final design of the stabilization building. As previously mentioned, the building will be maintained under negative pressure during processing operations to ensure no visible dust is emitted. Additionally, each bin will have its own push-pull ventilation system to control dust inside the building during waste receiving, mixing, and loadout operations.~~

~~6.2.5Compatibility~~

~~The steel bins of the stabilization unit will not be completely compatible with all possible wastes. However, steel bins are considered to be the best material to withstand the impacts of the mixing operations. In addition, the bins are accessible and can be inspected for corrosion that could impact their containment capabilities. If excessive corrosion or wear is noted during the inspections the tanks could be prepared or replaced.~~

~~7.Drum Handling Facility~~

~~7.1Drum Handling Facility Design~~

~~7.1.1General~~

~~The purpose of the drum handling facility is to provide storage capacity for drummed waste streams which will either be processed in the stabilization facility, placed in the landfill, or shipped to other waste processing centers such as incinerators or solvent recovery plants.~~

Drum handling facility design elements include drum facility layout, subgrade design; liner design; concrete floor design, and drainage sump design. This section describes each of these design elements.

7.1.2Facility Layout

Drawing No. 37 shows the layout of the drum handling facility floor and surrounding area. Additional details for the floor and floor drains are illustrated on Drawing No. 38.

As previously discussed, the drum handling facility entrance faces the north access road. Incoming trucks will enter the gravel lined apron and will back up to the loading dock areas. Once the truck unloading (or loading) operation is complete, the trucks will exit the facility via the same north access road. Parking areas for site personnel vehicles will be designated near the Drum Handling Facility Office. The gravel apron in front of the facility will not be used to stage waste haul trucks.

The drum handling building will be an open walled building with a roof which extends over the entire floor and truck docking areas. The roof structure will eliminate rain water from entering the drum handling area. The open walls will provide ample ventilation inside the building, however, personnel involved with drum sampling and decanting activities will still be required to use supplied air respiratory systems. As discussed in Section 1.6, during winter months the site will experience temperatures as low as 14°F, with average daily temperatures of 36°F. Under the most severe conditions, freezing of liquids in the drums may be possible. Therefore, during periods of extended low temperatures, drums will be monitored for any sign of leakage or damage due to freezing. Damaged drums will be immediately placed in over pack units to ensure containment.

The 49,265 sf total floor area is divided into 7 drum storage cells with each cell having a separate drain, collection sump, and leak detection sump. Each 63-ft long by 52-ft wide cell is capable of storing 160 drums. Two of the cells are designated as TSCA-PCB cells and as such are required to be isolated from other drum storage cells. The 6-inch high by 41 inch wide berm walkway which surrounds the TSCA –PCB cell provides the necessary isolation. The remaining five cells are also separated by berm walkways. As shown on Drawing No. 38, drums will be placed in four rows, two drums deep. Two 12-ft wide aisles will provide access for the forklift to place and remove drums. Any drum spills or leakage will flow to the deep drain located along the center line of the cell. The drain bottom slopes at 2 percent to the sumps located on the south side (rear) of the building. The berms in combination with the sloping floors to the sumps for each cell will provide separation of the incompatible wastes. Any fluids in the sump will be removed though the sump riser pipes using a vacuum truck which can access the pipes from the rear of the building.

The perimeter of the drum storage unit will be graded to drain away from the facility foundation.

7.1.3 Subgrade Excavation, Liner System, Leachate Collection Sump, and Leak Detection Sump Design

Subgrade Excavation

The subgrade surface will be compacted to provide a suitable foundation for overlying drainage soils, geosynthetics, and the concrete floor and building foundation. Soft areas will be over excavated and replaced with compacted structural fill. Specification Section No. 02110, Site Preparation and Earthwork, describes site preparation, excavated soil classification and stockpiling, subgrade surface preparation and inspection, structural fill placement and compaction requirements, survey and quality control, and erosion control features.

~~Liner System~~

~~Drawing No. 37 indicates the area extent of the liner system and the basal liner components intended for the floor, drainage trenches and sumps, and anchor trench areas. In the floor area of the drum handling facility, the liner system is a double lined system consisting of (from bottom up), a prepared subgrade, a geomembrane secondary liner, a composite geotextile and sand leachate collection drainage layer, and the epoxy coated concrete floor which serves as the primary containment element. In the drainage trench areas, the liner system is a double lined system consisting of (from bottom up), a prepared subgrade, a secondary geomembrane liner, a geonet leak detection and removal layer, and a primary geomembrane liner. Details of each liner component of the floor and drainage trench areas (from bottom up) are discussed below.~~

~~Floor Liner System~~

- ~~*6-inch thickness of prepared subgrade*~~

  ~~The prepared subgrade component will provide a smooth stable surface suitable for placement of overlying geosynthetic materials. Specification Section 02119, Prepared Subgrade, presents subgrade material requirements including particle size and moisture content, placement and compaction requirements, and survey and field quality control requirements.~~

- ~~*60-mil thick high density polyethylene (HDPE) geomembrane liner (smooth)*~~

  ~~The 60-mil HDPE liner placed on top of the prepared subgrade is the secondary liner component. The HDPE liner is a highly efficient barrier layer to restrict percolation of leachate into the subgrade. Specification Section 02775, Geomembrane Liners, describes minimum geomembrane properties required, subgrade preparation and inspection, material transportation and handling procedures, deployment and seaming requirements, and material CQA.~~

  ~~Site specific compatibility tests will be conducted on a synthetic leachate and the proposed liner prior to operation of the facility.~~

- ~~*12-oz non-woven cushion geotextile*~~

  ~~The 12-oz non-woven geotextile layer placed on top of the geomembrane will provide cushion, as well as filtration qualities to protect the geomembrane from puncture and allow liquids percolating through the concrete floor and select subbase to drain to the sump area. Specification Section 02714, Filter or Cushion Geotextile, describes minimum geotextile properties required, material transportation and handling procedures, deployment and seaming requirements, and material CQA.~~

- ~~*1-foot-thick select subbase*~~

  ~~The select subbase will provide a stable foundation for the overlying concrete floor while allowing liquids for the overlying concrete floor while allowing liquids percolating through the concrete to drain to the sump area. Specification Section 02229, Select Subbase, presents material requirements including particle size and moisture content, placement and compaction requirements, and survey and field quality control requirements.~~

- ~~*6-inch thick epoxy coated concrete floor*~~

  ~~The concrete drum handling facility concrete floor slopes towards one of the seven drainage trenches located within each cell. The drum handling facility secondary liner system completely encompasses the floor so that any leakage through the pad will also drain back into one of the drainage trenches. The concrete floor will be steel reinforced cast-in-place concrete. All joints in the concrete floor will be constructed with chemical resistant water stops and caulking sealer. Drawing No. 45 shows the rebar types and concrete details for the floor. Construction details for the floor are also called out in~~

~~Specification Section 03100, Concrete Formwork, Section 03200, Reinforcement Steel, Section 03290, Joints in Concrete, and Section 03300, Cast-in-Place Concrete. Specification Section 07920, Sealants and Caulking, describes the concrete epoxy coating requirements.~~

~~Drainage Trench Liner System~~

- ~~*6-inch thickness of prepared subgrade*~~

~~The prepared subgrade component will provide a smooth stable surface suitable for placement of overlying geosynthetic materials. Specification Section 02119, Prepared Subgrade, presents subgrade material requirements including particle size and moisture content, placement and compaction requirements, and survey and field quality control requirements.~~

- ~~*60-mil thick high density polyethylene (HDPE) secondary geomembrane liner (smooth)*~~

~~The 60-mil HDPE liner placed on top of the prepared subgrade is the secondary liner component. The HDPE liner is a highly efficient barrier layer to restrict percolation of leachate into the subgrade. Specification Section 02775, Geomembrane Liners, describes minimum geomembrane properties required, subgrade preparation and inspection, material transportation and handling procedures, deployment and seaming requirements, and material and CQA.~~

~~Site specific compatibility tests will be conducted on a synthetic leachate and the proposed liner prior to operation of the facility.~~

- ~~*Geonet leak detection drainage layer (transmissivity ≥ 5 x 10^{-3} m^2/s)*~~

~~The high transmissivity geonet drainage layer provides a means to transmit and remove fluids percolating through the primary geomembrane layer. Flow calculations discussed in Section 7.2.1 and presented in Appendix E indicate that the geonet is capable of removing fluids such that ponding on the secondary liner can be avoided. Specification Section 02712, Geonet, describes minimum geonet properties required, material transportation and handling procedures, deployment and seaming requirements, and material and construction quality assurance.~~

- ~~*60-mil thick high density polyethylene (HDPE) primary geomembrane liner (smooth)*~~

~~The 60-mil HDPE liner placed on top of the geonet layer serves as the primary liner component in the drainage trench area. The HDPE liner is a highly efficient barrier layer to restrict percolation of fluids from entering the into the geosynthetic layers below. Specification Section 02775, Geomembrane Liners, describes minimum geomembrane properties required, subgrade preparation and inspection, material transportation and handling procedures, deployment and seaming requirements, and material and CQA.~~

~~Site specific compatibility tests will be conducted on a synthetic leachate and the proposed liner prior to operation of the facility.~~

~~Leachate Collection Sump and Leak Detection Sump Design~~

~~The leachate collection system and leak detection system each have a separate sump from which fluids can be collected and removed. The liner components in the drainage trench system continue into the sumps, however, in order to provide adequate volume to efficiently operate removal pumps, gravel thicknesses are incorporated in the sumps. Drawing No. 39 illustrates the sump layout and cross-sections and the geosynthetic component arrangements. As shown on the drawings, the sumps are rectangular pyramidal shapes which lie concentrically above one another. The slope riser pipes enter their respective sumps at the sump base and are in the same vertical plane. The slope riser trench arrangement enables the leachate collection and leak detection slope riser pipes to penetrate overlying geosynthetic liner elements at the crest of~~

the sump rather than at its base. The leachate collection sump and drain has a total fluid capacity of 2,110 gallons (after accounting for gravel). Ten percent of the cell water volume is 880 gallons based on a storage capacity of 160 55-gallon drums. The leak detection sump and drain has a total fluid capacity of 41 gallons (after accounting for gravel). Because theses sumps are close to the surface and any fluids in the sump can be observed by looking down the riser pipes, fluid level instrumentation is not required.

7.2Drum Handling Facility Design Analyses

7.2.1Geosynthetics Strength and Performance Analyses

7.2.1.1Geomembranes

The 60 mil geomembrane located beneath the concrete floor area of the drum handling building is protected by a an overlying geotextile and fine grained foundation sand. Below this geomembrane is a 6-inch thickness of prepared subgrade. Specification No. 02119, Prepared Subgrade, requires this subgrade material to have a maximum particle size of 1 inch. Specification No. 02775, Geomembrane

Liners, requires that the surface of the prepared subgrade be smooth drum compacted and free of any foreign objects which might damage the overlying geomembrane. Considering that the loading conditions of the geomembrane in this arrangement due to the overlying sand, concrete floor, drums, and forklift wheeling loading do not approach the loading conditions evaluated in Calculation No. E-18, Geomembrane Puncture Resistance, the geomembrane will be adequately protected against puncture.

The geomembranes located in the drain areas and the drain sumps will not be subjected to significant overburden pressures. Gravel in the sump will not be compacted.

Geonet

The geonet layer in the drain areas and the drain sumps will not be subjected to significant overburden pressures which might reduce flow capacity. Additionally, the 2 percent slope of the drain system provides adequate relief to cause fluid flow to the sumps.

Geotextiles

Calculation No. E-20, Geotextile/Geocomposite Filtration, evaluates the AOS of several available geotextile products with respect to the silty sands and Upper Dockum materials found at the site. Based on this calculation, the 7 oz non woven geotextile called for in the specifications will adequately filter fines from the foundation sand material (SM) .

Anchor Trench Design

The purpose of the anchor trench in the drum handling facility is to restrict movement of the geosynthetics during installation of the sand and concrete layers. Pullout capacity due to settlement is not a relevant concern for this facility.

7.2.2Drum Handling Facility Concrete Floor

The floor of the drum handling building may be exposed to untreated waste material and is required to serve as the primary containment system. All joints in the concrete floor of the stabilization building will be constructed with chemical resistant water stops. In addition, a chemical resistant epoxy coating will be placed on the surface of the floor to further restrict potential liquid penetration into the concrete.

~~Drawing No. 45 shows the rebar types and concrete details for the floor. Construction details for the floor are also called out in Specification Section 03100, Concrete Formwork, Section 03200, Reinforcement Steel, Section 03290, Joints in Concrete, and Section 03300, Cast-in-Place Concrete. Specification Section 07920, Sealants and Caulking, describes the concrete epoxy coating requirements.~~

~~8.Liquid Waste Storage Facility~~

~~8.1Liquid Storage Facility Design~~

~~8.1.1General~~

~~The purpose of the liquid waste storage facility is to provide storage capacity for bulk liquid wastes which will either be processed in the stabilization facility or be placed in the evaporation pond. The tanks will not be used to manage wastes containing volatile organic concentrations greater than 500 parts per million by weight (ppmw).~~

~~Liquid waste storage facility design elements include liquid storage facility layout, storage tank leak containment design; piping and pumping design; and concrete tank pad. This section describes each of these design elements.~~

~~8.1.2Facility Layout~~

~~Drawing No. 40 shows the arrangement of the liquid waste storage tanks, piping , and tank containment pad and surrounding area. The four double lined HDPE poly tanks (9,000 gallon capacity) will each have its own concrete pad area, discharge and intake pump, and piping and control system.~~

~~As previously discussed, access to the liquid waste storage area is provided on the east, west, and north sides of concrete tank pads. Tanker trucks can use either the north access road or the road to the east of the liquid waste storage area.~~

~~The concrete pad is included to prevent the spread of fluid should leaks or spills occur at discharge piping connections and pumps located within the pad.~~

~~A concrete pad will be placed in the loading/unloading areas for the tanker trucks. This pad will be sloped providing drainage toward the sump areas.~~

~~8.1.3Tank Leakage Containment Design~~

~~Drawing No. 40 illustrates the double walled poly tank system. The outer tank will be covered to prevent the precipitation infiltration. The inner tank will not be covered. The tanks will be equipped with flexible connections at pipe penetrations between the inner and outer tanks and drainage ports in the outer tank. Chemical resistant gaskets will be used at all tank flanges. Liquids containing solvents such as MEK, toluene, xylene, diesel, or gasoline in concentrations greater than 15% will not be placed in the tanks. Tank tie down details will be developed from manufacturer's shop drawings when the tank is purchased.~~

~~The 15,500 gallon outer tank will contain the total volume of the 9,000 gallon inner tank should a leak in the inner tank occur. Each tank system will be equipped with graduated sight gauges allowing visual determination of fluid volume in the inner tank. In addition, to prevent tank overfilling or unnecessary pumping, high level and low level cutoff switches are included.~~

The tanks will be vented to the atmosphere to prevent internal pressure buildup. Protected ladders running up the outside of the outer tank will provide access to openings in the top tank.

Specification Section 13205, Polyethylene Tank (see Volume IV, Appendix C for Construction Specifications), discusses the tank material and installation requirements. Construction details for the concrete tank pad are called out in Specification Section 03100, Concrete Formwork, Section 03200, Reinforcement Steel, Section 03290, Joints in Concrete, and Section 03300, Cast-in-Place Concrete.

8.2Liquid Waste Storage Facility Design Analyses

8.2.1Tank Design, Testing, and Quality Control Standards

The liquid waste storage facility poly tanks will be manufactured by Central California Container Inc. Performance tests, material property tests, and design standards provided by the manufacturer include the following:

- Performance Requirement Tests
  - Low Temperature Dart Impact Test (ASTM D-1998)
  - o-xylene-Insoluble Faction (Gel Test) (ASTM D-1998)
  - Ultrasonic Gauge Wall Thickness Test (ASTM D-1998)
  - Hydrostatic Pressure Test (ASTM D1998)
- Material Properties Tests
  - Environmental Stress Crack Resistance (ASTM D-1693)
  - Elongation @ Break, Tensile Strength (ASTM D-638)
  - UV Stabilizer Compounded into Resin (ASTM D-1998)
- Design Standards
  - Wall Thickness Calculations (ASTM D01998)
  - Seismic & Wind Restrain (UBC)
  - Finite Element Analysis (ADE-92)

The tank manufacturer has provided recommended tank tie down details. The details should be reviewed and approved by a registered professional engineer prior to tank installation.

The manufacturer information on the tank compatibility is provided in Appendix H-3. This assessment indicates that the tanks are compatible with a wide variety of waste liquids.

8.2.2Pumping and Piping

Drawing No. 40 illustrates the pumping, piping, and control feature arrangement for the liquid waste receiving and storage area. High and low level cutoffs will prevent tank overfilling and pump burnout. The flow meter will record fluid volumes pumped into and out of the tank.

The Piping system will be installed according to API publication 1625 (November 1979) or ANSI standard B31.2 and ANSI standard B31.4.

~~All piping installed at the liquid waste storage facility will be double walled.~~

~~8.2.3Tank Concrete Pad~~

~~The concrete pad will provide secondary containment for the ancillary facilities.~~

~~Drawing Nos. 40 and 45 show the rebar types and concrete details for the floor. Construction details for the floor are also called out in Specification Section 03100, Concrete Formwork, Section 03200, Reinforcement Steel, Section 03290, Joints in Concrete, and Section 03300, Cast-in-Place Concrete. Specification Section 07920, Sealants and Caulking, describes the concrete epoxy coating requirements.~~

~~9.Truck Wash Facility~~

~~9.1Truck Wash Facility Design~~

~~9.1.1General~~

~~DOT approved roll-off trucks delivering bulk solid waste for landfill disposal will have plastic bed liners which will isolate the waste from the roll-off bin interior. As waste loads are dumped, these bed liners can become damaged exposing the roll-off bin to the waste material. If this material cannot be removed from the roll-off bin at the landfill waste placement face, then the truck will be required to proceed to the truck wash facility, where the bin will be washed out. Also, during rainy periods, mud from access roads or daily cover soil can collect on the wheels and undercarriages of waste haul trucks exiting the landfill. Similarly, if this material cannot be removed from the truck while in the landfill, then the truck will be required to proceed to the truck wash facility for cleanup prior to exiting the site. Landfill operations equipment such as waste compactors, scrapers, water trucks, and other vehicles may also require similar cleanup upon exiting the landfill. Because potentially contaminated materials may be washed from the roll-off bin or from undercarriage recesses while at the truck wash facility, a double liner containment system has been designed to contain wash water and wash residues.~~

~~The truck wash facility design elements presented here include the facility layout, liner system, and sump and leak detection system.~~

~~9.1.2Facility Layout~~

~~Drawing No. 44 illustrates the truck wash facility layout. As previously discussed, access to the truck wash facility is from the west landfill perimeter road. Exiting traffic will proceed to the north access road. The facility is designed with two wash bays: a heavy equipment bay and a roll-off truck bay; and a water storage area. Both wash bays drain to a common sump area which will collect wash water and residue. Poly tanks and pumps, located in the water storage area provide storage and pumping capacity for clean and used wash water.~~

~~The truck wash sump drains to a collection point at its north end where water will be pumped from the sump into a clarifier. The sump and sediment bins will be inspected weekly for the accumulation of sediment and liquids and will be removed to the wash water storage tanks. Residues remaining in the sump can be removed using a front-end-loader which has access from the heavy equipment wash bay. Oils, grease, and fine sediments will be removed from the wash water in the clarifier before being pumped to a double lined poly tank. Wash water and residues will be chemically analyzed and handled in an appropriate manner.~~

~~The entire extent of the truck wash facility concrete, which acts as primary containment, is designed with a geosynthetic secondary liner and leak detection system. The concrete will be coated with epoxy similar to the drum handling facility.~~

~~The roll-off truck bay is equipped with a truck barrier, tail gate lift, moveable wash platforms, and three high pressure hose reel and nozzle assemblies. The high pressure pump and delivery system can either be a single fixed installation or be made up of several portable units. Roll-off trucks will back into the bay to the truck barrier and lift the truck bed as if to dump. The tailgate lift will be attached and the tailgate raised to expose the inside of the roll-off bin. Truck wash personnel will then wash out the inside of the bin using the high pressure wash system. Wash water and residue will then be washed from the concrete floor into the sump area. If necessary, moveable platforms can be positioned next to the truck and the truck bed can be washed from openings in its top surface.~~

~~The heavy equipment wash bay will be constructed with steel rail or I-beams incorporated into the concrete floor of this bay to resist damage by heavy equipment tracks. Wash water and residue will flow to the sump area and will be removed as discussed above.~~

~~A concrete pad will be placed in the loading/unloading areas for the tanker trucks. This pad will be sloped, providing drainage towards the sump areas.~~

~~9.1.3Subgrade Excavation, Liner System, Sump and Leak Detection System Design~~

- ~~Subgrade Excavation~~

  ~~The subgrade surface will be compacted to provide a suitable foundation for overlying drainage soils, geosynthetics, and the concrete floor and building foundation. Soft areas will be overexcavated and replaced with compacted structural fill. Specification Section No. 02110, Site Preparation and Earthwork, describes site preparation, excavated soil classification and stockpiling, subgrade surface preparation and inspection, structural fill placement and compaction requirements, survey and quality control, and erosion control features.~~

- ~~Liner System~~

  ~~Drawing No. 44 indicates the aerial extent of the liners system and the basal liner components intended for the floor, drainage trenches and sumps, and anchor trench areas. In the floor areas, the liner system consists of (from bottom up), a prepared subgrade, a geomembrane secondary liner, a geocomposite drainage layer, a foundation sand layer, and the epoxy coated concrete floor which serves as the primary containment element. Details of each liner component are discussed below.~~

~~Floor Liner System~~

- ~~6-inch thickness of prepared subgrade~~

  ~~The prepared subgrade component will provide a smooth stable surface suitable for placement of overlying geosynthetic materials. Specification Section 02119, Prepared Subgrade, presents subgrade material requirements including particle size and moisture content, placement and compaction requirements, and survey and field quality control requirements.~~

- ~~60-mil thick high density polyethylene (HDPE) geomembrane liner (textured)~~

~~The 60-mil HDPE liner placed on top of the prepared subgrade is the secondary liner component. The HDPE liner is a highly efficient barrier layer to restrict percolation of leachate into the subgrade. Specification Section 02775, Geomembrane Liners, describes minimum geomembrane properties required, subgrade preparation and inspection, material transportation and handling procedures, deployment and seaming requirements, and material construction quality assurance.~~

~~Site specific compatibility tests will be conducted on a synthetic leachate and the proposed liner prior to operation of the facility.~~

- ~~Geocomposite: A geocomposite drainage layer (transmissivity ≥ 2.2 x 10^{-4} m^2/s) consisting of:~~
  - ~~A 7 oz. geotextile (non-woven)~~
  - ~~A geonet~~
  - ~~A 7 oz. geotextile (non-woven)~~

~~The high transmissivity geocomposite drainage layer provides a means to transmit and remove fluids percolating through the epoxy coated concrete floor. Flow calculations discussed in Section 3.2.8 and presented in Appendix E indicate that the geocomposite is capable of removing fluids such that ponding on the geomembrane liner can be avoided. Specification Section 02712, Geocomposites, describes minimum geonet properties required, material transportation and handling procedures, deployment and seaming requirements, and material and construction quality assurance.~~

- ~~A 12-inch thick foundation sand layer~~

~~Specification Section 02231, Foundation Sand, presents foundation sand material requirements including particle size and moisture content, placement and compaction requirements, and survey and field quality control requirements.~~

- ~~1-foot-thick epoxy coated concrete floor~~

~~The truck wash facility floor slopes towards sump located between the two bay areas. The truck wash facility secondary liner system completely encompasses the floor so that any leakage through the floor will be captured in the leak detection system. The concrete floor will be steel reinforced cast-in-place concrete. All joints in the concrete floor will be constructed with chemical resistant water stops and caulking sealer. Construction details for the floor will be provided similar to those presented in Specification Section 03100, Concrete Formwork, Section 03200, Reinforcement Steel, Section 03290, Joints in Concrete, and Section 03300, Cast-in-Place Concrete. Specification Section 07920, Sealants and Caulking, describes the concrete epoxy coating requirements.~~

~~Leak Detection Sump (LDRS) Design~~

~~The leak detection system geocomposite drains to a separate sump from which fluids can be detected and removed. In order to provide adequate volume to efficiently operate removal pumps, a gravel thickness has been incorporated in the sump. Drawing No. 44 illustrates the sump layout and cross sections and the geosynthetic component arrangements. A vertical riser pipe is located in the center of the sump and provides space for the fluid removal pump. The leak detection sump has a total fluid capacity of 72 gallons (after accounting for gravel). Because this sump is close to the surface and any fluids in the sump can be observed by looking down the riser pipe, fluid level instrumentation is not required. Fluids in the sump will be removed by pumping into the clarified or by vacuum truck.~~

~~9.2 Truck Wash Facility Design Analyses~~

~~9.2.1 Geosynthetics Strength and Performance~~

~~Geomembrane, geocomposite, and geotextile material installation in the truck wash facility is similar to the installations in the drum pad facility. Rationale and computations pertaining to geomembrane puncture and tearing, geocomposite flow capability, and geotextile cushioning and filtration performed for the drum pad, which are applicable to the truck wash facility, are not repeated.~~

~~9.2.2 Tank Design, Testing, and Quality Control Standards~~

~~Tanks and piping intended to store and convey potentially contaminated wash water will be double lined installations similar to the liquid waste storage area tanks. Section 8.2 presents a discussion of this equipment which also applies to the truck wash facility. Control features for this system are identified on Drawing No. 44.~~

~~Piping system will be installed according to API publication 1615 (November 1979) or ANSI B31.2 and ANSI standard B31.4. The clean water supply tank and piping will be single walled installations.~~

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Attachment L1

**Engineering Drawings
(Volume 3)**

Part A and Part B Permit Renewal Application for the

TRIASSIC PARK
WASTE DISPOSAL FACILITY

RCRA Permit No. NM0001002484

Chaves County, New Mexico

Volume 3
Permit Attachment L1 - Engineering Drawings

October 17, 2011
Revision 1 - April 30, 2012

Prepared for:

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Attachment L1, Design Drawings, is provided as Volume 3.

Attachment L2

Specifications for Landfill, Surface Impoundment and Associated Facilities Liner and Cover System Construction

Attachment L2. Specification for Landfill Liner and Cover System and Associated Facilities Construction

Provided in Attachment Z

Attachment L3

Tank Integrity
Assessment Certification

Attachment L3. Tank Integrity Assessment Certification

No longer applicable.

Attachment L4

New Landfill
Engineering Calculation

Permit Renewal Application
October 17, 2011

Attachment L4

New Landfill Engineering Calculations

Prepared for:

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Calculation Cover Sheet

Daniel B. Stephens & Associates, Inc.

Project Name Triassic Park Landfill Permit Renewal Project Number ES11.0141

Calculation Number ES11.0141-001 Discipline Hydrology No. of Sheets ____

PROJECT: Triassic Park Waste Disposal Facility Permit Renewal

SITE: Triassic Park Waste Disposal Facility, Roswell, NM

SUBJECT: Calculate surface water runoff to assess existing channel and culvert sizing.

SOURCES OF DATA:

A. Part A and Part B Permit Application for the Triassic Park Waste Disposal Facility, Chaves County, New Mexico, Appendix F-3. October 2000.

SOURCES OF FORMULAE & REFERENCES:

1. W.R. Viessman, G.L. Lewis, J.W. Knapp, Introduction to Hydrology, 3rd Edition, 1989. P.310.
2. Part A and Part B Permit Application for the Triassic Park Waste Disposal Facility, Chaves County, New Mexico, October 2000.

[x] Preliminary Calculation [ ] Final Calculation Supersedes Calculation No. ____

Rev. No.	Revision	Calculation By	Date	Checked By	Date	Approved By	Date
0		KI	9/21/11	[signature]	10/14/11	[signature]	10/14/11

Calculation Sheet

Daniel B. Stephens & Associates, Inc.

Project No. ES11.0141 | Date 09/21/11
Subject Surface water runoff and channel sizing | Sheet 1 of 1
By K Isaacson | Checked By ______ | Calculation No. ES11.0141-001

1.0 OBJECTIVE

The purpose of this calculation is to calculate a channel size for the 100 year storm event and compare this to the drainage nearest the landfill to see if there is any possibility of the runoff reaching the Triassic Park Waste Disposal Facility. The nearest drainage is approximately 3/4 of a mile southwest of the site (reference A).

2.0 GIVEN

The 100-year, 24-hour design storm for the site is 5.75 inches.[A] In the 2002 permit application, the area of 1937.6 acres and a runoff coefficient of 0.3 were used.

3.0 METHOD

This calculation utilizes the rational method:

Q = C.I.A
where:
Q = Peak runoff rate (cfs)
C = Maximum runoff coefficient
I = Rainfall rate (in./hr)
A = Drainage area (acres)

4.0 RESULTS

Storm Intensity was calculated by dividing the rainfall by its duration:
I = 5.75 in/24hr = 0.24 in/hr

Based on the topography of the area, the runoff coefficient is as follows:
C = 0.3

The drainage area:
A = 1937.6 acres

Peak runoff rate estimated by formula noted above in the method section (see reference 1):
$Q = 0.3*((0.24 in/hr*0.08333 ft/in/3600 s/hr) ft/s*(1937.6 ac.*43560 ft^3/ac.) ft^3) cfs$
Q = 139.26 cfs

A flow of 140 cfs was used to size a channel in the Bentley FlowMaster software. The Manning equation was used to solve for normal depth of the channel. Inputs and results are in the attached FlowMaster report. For a flow of 140 cfs the normal depth is 1.2 ft and the channel width is approximately 80 feet. Given the distance to the drainage of 3/4 of a mile the facility is not in a flood plain.

Triassic - Surface Water Runoff and Channel Sizing

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.060	
Channel Slope	0.03000	ft/ft
Left Side Slope	33.00	ft/ft (H:V)
Right Side Slope	33.00	ft/ft (H:V)
Discharge	140.00	ft^3/s

Results

Normal Depth	1.18	ft
Flow Area	46.30	ft^2
Wetted Perimeter	78.21	ft
Hydraulic Radius	0.59	ft
Top Width	78.17	ft
Critical Depth	1.02	ft
Critical Slope	0.06564	ft/ft
Velocity	3.02	ft/s
Velocity Head	0.14	ft
Specific Energy	1.33	ft
Froude Number	0.69	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.18	ft
Critical Depth	1.02	ft
Channel Slope	0.03000	ft/ft
Critical Slope	0.06564	ft/ft

2

Permit Renewal Application
October 17, 2011

Attachment A

General Facility Description and Information

Prepared for:

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The New Mexico Environment Department
March 2002

The site is located in eastern Chaves County, in an area that has historically been utilized primarily as range land for livestock grazing and for limited oil and gas activities. The residence nearest the site is owned by Marley Ranches, Ltd. and is located approximately 2.9 miles to the east-southeast. Land ownership for a 4-mile radius around the site is shown in Figure 1-2. All of the residences within a ten-mile radius of the site are listed in Figure 1-3.

The site will encompass 480 acres and will be enclosed by a 6-foot chain link fence. Gates to the same height as the perimeter fence will be constructed. The area will be secured and monitored so that only authorized personnel or personnel being accompanied and supervised by authorized personnel are allowed onsite. Employees responsible for site security will be present at all times to prevent unauthorized entry and to report unusual events and/or emergencies. Site security personnel will be responsible for conducting regular inspections and routine maintenance of the perimeter area (see Permit Attachment D, *Inspection Procedures*).

Land use plans and/or zoning maps have not been developed for Chaves County. All areas within the county, except those within municipal boundaries, are designated as Zone A (agricultural). The eastern half of the county is further designated as Area 1 and the western half as Area 2. Area 1 and Area 2 are zoning Land Use Areas, whose boundaries have been determined by a joint-powers agreement between the Board of Chaves County Commissioners and the Roswell City Council. Existing uses in Area 1 are livestock grazing, mineral exploration and production, wildlife habitat, and extensive recreation. Single-family dwellings require permits in Area 1. Area 2 covers an important part of the recharge area of the Roswell Artesian Basin. Existing uses in Area 2 are livestock grazing, mineral exploration and production, extensive recreation, wildlife habitat, and flood control structures and floodways. Any new parcels created in the area must be five acres or larger.

Approximately 2 miles northwest of the Facility location, the Mescalero Sands recreational "complex" has been established for use by off-road vehicles. The South Dunes area of Mescalero Sands has been designated as an "Outstanding Natural Area" (ONA) and is utilized by the public primarily for wildlife observation activities.

The land in the area of the Facility is used predominantly for grazing cattle and to a much lesser extent for oil and gas exploration activities. The nearest production well is 3 miles from the site. Additional information about the drilling activities in the area is contained in Section 3.0 of the permit application.

All abandoned wells in the area have been plugged in accordance with New Mexico Oil Conservation Division (OCD) regulations. These regulations require the use of mud-laden fluids, cement and plugs in the well "in a way to confine crude petroleum oil, natural gas, or water in the strata in which it is found and to prevent it from escaping into other strata." Surface reclamation of abandoned wells prevents surface water from entering and contaminating subsurface strata.

1.3.1 Flood Plain Information

Sections 17 and 18, T11S, R31E are included on Federal Insurance Rate Map #~~350125~~35005C1775D. This map has not been printed because this is a non-participating community, a status which generally indicates that the area is an area of minimal flood hazards.~~e National Flood Insurance Program has determined that this is an area of minimal flood hazards.~~ This information was provided to GMI by the Director of Planning and Environmental Services, Chaves County, New Mexico, and was confirmed with the National Flood Insurance Program at their website, www.msc.fema.gov.

~~Additionally~~To confirm that this Facility is an area of minimal flood hazards, rainfall run-off calculations were performed to determine whether the site falls within the flood plain of a 100-year, 24-hour storm event. Based on information in the Precipitation Frequency Atlas published by the National Oceanic and

Atmospheric Association, a rainfall amount of 5.~~3~~75 inches was used in the calculations. The nearest drainage to the site was determined from the USGS 7.5-minute series topographic map of the Mescalero Point Quadrangle (see Section 3.0 of the permit application). This drainage flows westerly from Mescalero Point, which is approximately three-quarters of a mile south of the site.

Storm run-off flows were calculated for the area using the Rational Method (see Appendix F-3 in Volume VI of the permit application). A run-off coefficient of 0.3 was used in the calculations. It was determined that the maximum flow could be accommodated in a triangular section occupying a width of ~~76~~ 78 feet. It may be concluded from this comparison that a flood plain does not exist for the drainage and that there are no flood plains within 1 mile of the site. It may be further concluded that flood plain regulations are not applicable to this Facility.

1.3.2 Fire Control and Emergency Response

Fire control and emergency response will be the responsibility of the Emergency Coordinator (EC) who is on call or duty at the time of an incident. Each EC will be trained to handle emergencies and to notify appropriate authorities (see Permit Attachment C, *Contingency Plan*). Each EC will have the authority to commit resources necessary to implement the site Contingency Plan described in Permit Attachment C.

In addition to onsite emergency response capabilities, cooperative agreements will be established with local emergency response organizations in surrounding communities to respond to and assist in any emergencies that arise at the Facility (see Permit Attachment C).

1.4 Traffic Patterns

The flow of traffic within the Facility boundary will not be significant except during shift changes. The number of employee vehicles will not be substantial enough to require elaborate signage or other traffic control systems. All personnel will be given written instructions that will caution them to be alert to other vehicles and pedestrians. Each vehicle must enter and exit through the security gate at the northeast corner of the perimeter of the Facility boundary. ~~The arrival and departure of trucks transporting waste will not be scheduled during peak traffic times.~~ Drawing 26, Sheet 2 in Permit Attachment L1 illustrates traffic flow patterns for the operations and waste processing area, traffic control signage and truck staging areas.

1.4.1 Traffic Control

Access to the Facility will be gained through the security gate at the northeast corner of the perimeter fence (see Drawing 26, Sheet 2 in Permit Attachment L1). Authorization to enter the Facility will be verified for each vehicle.

Visitors will be required to sign in at the guard shack and will be escorted while onsite unless other arrangements are made with the Facility. Only authorized persons will be allowed past the security gate guard shack.

1.4.2 Onsite Transportation of Wastes

All trucks transporting wastes will be stopped at the security gate prior to entering the Facility. Security personnel will record the license number, transportation company, arrival time, and other pertinent information with regard to the vehicle and driver.

INTRODUCTION TO HYDROLOGY

THIRD EDITION

WARREN VIESSMAN, JR.
University of Florida

GARY L. LEWIS
Consulting Engineer

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Virginia Military Institute

HarperCollins*Publishers*

models incorporating all fundamental hydrologic processes. The mechanics of all these processes are not completely known and some empiricism remains. In fact, small watershed modeling is still part art and part science, but as more data become available and modeling technology improves, a greater degree of sophistication and reliability will result. Perhaps the greatest underlying need is for more data characterizing the water cycle on urban areas. Information on both the quantity and quality of urban runoff is in critically short supply.

15.2 PEAK FLOW FORMULAS FOR URBAN AND SMALL WATERSHEDS

Numerous methods are available for estimating the peak rates of runoff required for design applications in small urban and rural watersheds. Some incorporate a rational analysis of the rainfall–runoff process whereas others are completely empiric or correlative in that they predict peak runoff rates by correlating the flow rates with simple drainage basin characteristics such as area or slope.

Both categories of peak flow determination are easily adapted and have had wide application; however, two relatively major difficulties are normally encountered in applying the techniques. First, the rainfall–runoff formulas, such as the *rational formula*, are difficult to apply unless the return periods for rainfall and runoff are assumed to be equal. Also, estimates of coefficients required by these formulas are subjective and have received considerable criticism. The empiric and correlative methods are limited in application because they are derived from localized data and are not valid when extrapolated to other regions.

The most fundamental peak flow formulas and empiric-correlative methods, due to their simplicity, persist in dominating the urban design scene, and several of the most popular forms are briefly described to acquaint the reader with methods and assumptions. Urban runoff simulation techniques are described in Chapter 26, and Chapter 16 gives a discussion of the effects of urbanization on the hydrologic cycle.

Rational Formula

The rational formula for estimating peak runoff rates was introduced in the United States by Emil Kuichling in 1889.[18] Since then it has become the most widely used method for designing drainage facilities for small urban and rural watersheds. Peak flow is found from

$$Q_p = CIA \tag{15.1}$$

where Q_p = the peak runoff rate (cfs)

C = the runoff coefficient (assumed to be dimensionless)

I = the *average* rainfall intensity (in./hr), lasting for a critical period of time t_c

t_c = the time of concentration

A = the size of the drainage area (acres)

CI = the net rain intensity (in./hr) at $t = t_c$

The runoff coefficient can be assumed to be dimensionless because 1.0 acre-in./hr is equivalent to 1.008 ft^3/sec. Typical C values for storms of 5–10-year return periods are provided in Table 15.1.

The rationale for the method lies in the concept that application of a steady, uniform rainfall intensity will cause runoff to reach its maximum rate when all parts of the watershed are contributing to the outflow at the point of design. That condition is met after the elapsed time t_c, the time of concentration, which usually is taken as the time for a wave to flow from the most remote part of the watershed. At this time, the runoff rate matches the net rain rate.

Figure 15.1 graphically illustrates the relation. The IDF curve is the rainfall intensity–duration–frequency relation for the area and the peak intensity of the runoff is $Q/A = q$, which is proportional to the value of I defined at t_c. The constant of proportionality is thus the runoff coefficient, $C = (Q/A)/I$. Note that Q/A is a point value and that the relation, as it stands, yields nothing of the nature of the rest of the hydrograph.

TABLE 15.1 TYPICAL *C* COEFFICIENTS FOR 5- TO 10-YEAR FREQUENCY DESIGN

Description of area	Runoff coefficients
Business	
Downtown areas	0.70–0.95
Neighborhood areas	0.50–0.70
Residential	
Single-family areas	0.30–0.50
Multiunits, detached	0.40–0.60
Multiunits, attached	0.60–0.75
Residential (suburban)	0.25–0.40
Apartment dwelling areas	0.50–0.70
Industrial	
Light areas	0.50–0.80
Heavy areas	0.60–0.90
Parks, cemeteries	0.10–0.25
Playgrounds	0.20–0.35
Railroad yard areas	0.20–0.40
Unimproved areas	0.10–0.30
Streets	
Asphaltic	0.70–0.95
Concrete	0.80–0.95
Brick	0.70–0.85
Drives and walks	0.75–0.85
Roofs	0.75–0.95
Lawns; sandy soil:	
Flat, 2%	0.05–0.10
Average, 2–7%	0.10–0.15
Steep, 7%	0.15–0.20
Lawns; heavy soil:	
Flat, 2%	0.13–0.17
Average, 2–7%	0.18–0.22
Steep, 7%	0.25–0.35

Daniel B. Stephens & Associates, Inc.

Calculation Cover Sheet

Project Name: Triassic Park Landfill Permit Renewal   Project Number: ES11.0141

Calculation Number: ES11.0141-002   Discipline: Hydrology   No. of Sheets: ____

PROJECT: Triassic Park Waste Disposal Facility Permit Renewal

SITE: Triassic Park Waste Disposal Facility, Roswell, NM

SUBJECT: Calculate precipitation file for use in UNSAT-H Model.

SOURCES OF DATA:

A. Part A and Part B Permit Application for the Triassic Park Waste Disposal Facility, Chaves County, New Mexico, Appendix F- Surface Water Control System Design and Appendix E-28 - HELP Modeling Report. October 2000.

B. National Oceanic and Atmospheric Association (NOAA). www.ncdc.noaa.gov/oa/ncdc.html

C. Western Regional Climate Center. www.wrcc.dri.edu/htmlfiles/westernevap.final.html

D. Weather Underground. www.wunderground.com

SOURCES OF FORMULAE & REFERENCES:

1. USDA NRCS Urban Hydrology for Small Watersheds (TR55). June 1986.
2. Playan et. al. Day and Night Wind Drift and Evaporation Losses in Sprinkler Solid-Sets and Moving Laterals. *Agricultural Water Management*. Volume 76, Issue 3, 10 August 2005, Pages 139-159

[x] Preliminary Calculation   [ ] Final Calculation   Supersedes Calculation No. ____

Rev. No.	Revision	Calculation By	Date	Checked By	Date	Approved By	Date
0		KI	10/11/11	TG	10/14/11	[signature]	10/14/11

1.0 OBJECTIVE

The purpose of this calculation is to generate a new precipitation file for use in an UNSAT-H model of the Triassic Park Waste Disposal Facility during active filling that accounts for measured precipitation as well as recirculation of potentially contaminated stormwater and leachate.

2.0 GIVEN

In the 2002 permit application[A] Appendix F, a Curve Number of 91 was used for the active filling area (with daily soil cover). The area contributing to the contaminated stormwater pond (CSWP) is 15.6 acres[A]. The CSWP in the bottom of Phase IA has an area of 2.5 acres[A]. The area of the bottom of the landfill that could be covered by the initial layer of waste is 6 acres[A] – this is the area to which recirculation water is applied.

3.0 METHOD

UNSAT-H allows use of daily records of precipitation and temperature, among other variables, to assess the evaporation from, infiltration into, and runoff from user-specified layers. This calculation describes the generation of the hourly precipitation file that will be used in UNSAT-H that accounts for measured precipitation and stormwater recirculation back onto the waste. For this analysis, the second wettest year on record in Roswell is used, 1986.

A complete hourly precipitation record for Roswell, NM is not available; however, daily precipitation data are available from the National Oceanic and Atmospheric Association (NOAA)[B]. To convert the daily precipitation record to hourly data, all precipitation events are set to begin at 6pm. Precipitation is assigned a rate of 1.0 inch/hour until all the precipitation has fallen. This precipitation rate was assigned due to the nature of most precipitation events in Roswell, NM, which are predominately short duration and intense. This hourly data is applied to the active filling area to determine runoff, using the United States Department of Agriculture's Natural Resource Conservation Service's TR55 method[1]. Specific equations utilized are summarized below.

The runoff resulting from each daily precipitation event is calculated using the curve number method:

$$Q_{depth} = \frac{(P - 0.2S)^2}{P + 0.8S} \qquad \text{Eq 1}$$

where
- Q_{depth} = runoff (inches)
- P = rainfall (inches)
- S = potential maximum retention after runoff begins (inches)

In this equation, it is assumed that $S = I_a/0.2$, where I_a is the initial abstraction.

S is related to the soil and cover conditions of the watershed by the curve number (CN):

$$S = \frac{1000}{CN} - 10 \qquad \text{Eq 2}$$

The depth of runoff obtained with Equations 1 and 2 is converted to a volume by multiplying by the area of the watershed (A_{ws}):

$$Q_{runoff} = Q_{depth} * A_{ws} \qquad \text{Eq 3}$$

Q_{runoff} enters the contaminated stormwater pond each hour that there is precipitation that generates runoff. Evaporation losses from the pond are estimated from the surface of the CSWP by utilizing monthly pan evaporation data for Roswell, NM[C]. A standard reduction factor of 0.7 is applied to the pan evaporation data for evaporation from the pond[C]. If the evaporative losses are greater than the water in the pond, then the pond is empty. If the water in the pond has not evaporated by 8AM the following morning, stormwater recirculation begins. Up to 0.29 acre-ft of water is applied per day, from 8AM to 4PM with an assumed stationary sprinkler system. The percent evaporative losses from spraying are calculated[2] using average wind speed[D] and relative humidity[D]:

$$\%Loss = 20.7 + 0.185 * AWS - 2.14x10^{-3} * RH^2 \qquad \text{Eq 4}$$

where

AWS = average wind speed (meters/sec)

RH = relative humidity (%)

Equation 4 was selected due to its validation performance, and because recirculation only occurs during the daytime.

The volume of water in the pond is tracked on an hourly basis, and incorporates any water left in the pond from the day before and evaporation losses from the pond to determine how much water is sprayed back each hour. Water recirculation only occurs from 8AM-4PM, regardless of whether measured precipitation occurs that day.

This calculation is performed in Excel for the entirety of 1986, but the steps and equations described above are illustrated below for a few days in October from the 1986 record. Once hourly precipitation and recirculation values were determined in Excel, Microsoft Access was used to process the data for input into UNSAT-H.

4.0 SOLUTION

The measured rainfall on October 9, 1986 is 0.59 inches. The measured precipitation is applied at a rate of 1.0 inches/hour beginning at 6PM until all the precipitation is applied, resulting in the following precipitation record for these two days.

Month	Day	Hour	Precipitation (in)	Month	Day	Hour	Precipitation (in)
10	9	0	0	10	10	0	0
10	9	1	0	10	10	1	0
10	9	2	0	10	10	2	0
10	9	3	0	10	10	3	0
10	9	4	0	10	10	4	0
10	9	5	0	10	10	5	0
10	9	6	0	10	10	6	0
10	9	7	0	10	10	7	0
10	9	8	0	10	10	8	0
10	9	9	0	10	10	9	0
10	9	10	0	10	10	10	0
10	9	11	0	10	10	11	0
10	9	12	0	10	10	12	0
10	9	13	0	10	10	13	0
10	9	14	0	10	10	14	0
10	9	15	0	10	10	15	0
10	9	16	0	10	10	16	0
10	9	17	0	10	10	17	0
10	9	18	0.59	10	10	18	1
10	9	19	0	10	10	19	1
10	9	20	0	10	10	20	1
10	9	21	0	10	10	21	0.46
10	9	22	0	10	10	22	0
10	9	23	0	10	10	23	0

The potential maximum runoff from the active landfill waste is determined assuming a curve number of 91[A] and Equation 2:

$$S = \frac{1000}{91} - 10 = 0.99$$

For the first 17 hours of October 9, there is no precipitation, so no runoff is calculated. At 6pm, I_a over the precipitation is calculated to ensure that there is more precipitation than the initial abstractions:

$$\frac{I_a}{P} = \frac{0.2 * S}{P} = \frac{0.2 * 0.99}{0.56} = 0.34$$

If the value of I_a/P is greater than one, then there is no runoff as initial abstractions exceed precipitation. If I_a/P is less than one, Equation 1 is used to calculate the runoff depth in inches from the precipitation:

$$Q_{depth} = \frac{(0.59 - 0.2 * 0.99)^2}{0.59 + 0.8 * 0.99} = 0.11 inches$$

The volume of runoff is determined with Equation 3:

$$Q_{runoff} = 0.11 in * 15.6\ acres * \frac{1 ft}{12 in} = 0.145\ acre - ft$$

This volume enters the CSWP. The pan evaporation losses for the month of October are 6.97 inches, which is multiplied by the pan evaporation coefficient of 0.7. The resultant losses are converted to an evaporation loss per hour:

$$\frac{6.97 inch}{mo} * 0.7 * \frac{mo}{31 day} * \frac{day}{24 hour} = \frac{0.007 inch}{hour}$$

From 7PM (it only rains from 6pm to 7pm) until 8AM (13 hours), Q_{runoff} sits in the pond and evaporates at a rate of 0.007inch/hour, over 2.5 acres:

$$\frac{0.007 inch}{hour} * 2.5 acres * \frac{ft}{12 inch} = \frac{0.0014 acre - ft}{hour}$$

Therefore, at 8AM on October 10, there is

$$0.145\ acre - ft - \frac{0.0014 acre - ft}{hour} * 13 hours = 0.126 acre - ft$$

in the CSWP. Sprayback at a rate of 0.0357 acre-ft per hour (0.29 acre-ft per day if applied for 8 hours) then occurs. At 8AM, 0.0357 acre-ft of water is taken from the pond, and evaporative losses from this recirculation are estimated with Equation 4:

$$\% Loss = 20.7 + 0.185 * (4.02)^2 - 2.14 x 10^{-3} * (89)^2 = 6.74\%$$

$$0.0357 acre - ft * 6.74\% = 0.0024 acre - ft$$

Since 0.024 acre-ft is lost to evaporation during spraying, only

0.0357 acre-ft – 0.0024 acre-ft = 0.033 acre-ft

of water is recirculated over the waste, resulting in an application of water at 8AM of

$$\frac{0.033 acre-ft}{6 acres} * \frac{12 inches}{ft} = 0.067 inches$$

At 9AM on October 9, there is

0.124 acre-ft – 0.0357 acre-ft = 0.089 acre-ft

of water in the pond. The evaporative losses from the pond are the same, 0.0014 acre-ft of water per hour, leaving

0.089 acre-ft - 0.0014 acre-ft = 0.087 acre-ft

in the CSWP. Then, 0.0357 acre-ft per hour is taken from the pond to recirculate over the waste, and water losses from spraying the water are estimated as above. This continues until 11AM, at which time there is 0.0144 acre-ft of water in the pond. After evaporation losses of 0.007inch/hour are applied, the pond volume is less than the maximum application rate of 0.0357 acre-ft per hour; thus, the pond is emptied and the remaining water (0.013 acre-ft) is sprayed onto the waste. Evaporative losses from the pond are accounted for as above, and the evaporative losses from spraying are calculated:

$$\%Loss = 20.7 + 0.185 * (4.02)^2 - 2.14x10^{-3} * (89)^2 = 6.74\%$$
$$0.013 acre - ft * 6.74\% = 0.00088 acre - ft$$

Since 0.00088 acre-ft of water are lost to evaporation, only

0.013 acre-ft – 0.00088 acre-ft = 0.012 acre-ft

of water is recirculated over the waste, resulting in an application of water at 11AM of

$$\frac{0.012 acre - ft}{6 acres} * \frac{12 inches}{ft} = 0.024 inches$$

At this time, the pond is empty thus stormwater recirculation ceases. At 6PM, measured precipitation is applied as described above and the process detailed is repeated. The steps of this calculation are included in the attached table for all days of 1986.

The measured precipitation for 1986 is 24.8 inches. The resultant precipitation in 1986 for input into UNSAT-H is 34.6 inches, indicating that 9.8 additional inches of water are applied to the waste from stormwater recirculation.

A

The hydrologic properties of hazardous waste have not been studied to the same extent that municipal waste has been studied and therefore literature information is limited. The HELP model does not provide specific default values for hazardous waste and it is left to the program user to define these characteristics.

The waste was assigned soil texture numbers, initial moisture contents, and hydraulic conductivities which reflect expected actual conditions. The soil texture number of 7 corresponds to a silty sand material (SM) with default porosity of 0.473, field capacity of 0.222, wilting point of 0.104, and hydraulic conductivity of 5.4 x 10^{-4}cm/sec. The initial moisture content was set at 0.2055.

5.2

The hydraulic properties of the waste fill will depend on the characteristics of the incoming waste and the nature of the daily cover soil used. The physical characteristics of landfilled hazardous waste can vary widely from sludges to solids and debris. Contaminated soils and bulk solid materials, however, will make up a major proportion of these materials. Typically, the waste material is placed and compacted and covered with daily cover soil material. Since the surface of the waste fill must be trafficable to waste hauler trucks and other heavy earthmoving equipment, it is not an uncommon practice to increase the amount of daily cover soil placed when softer or sludgy type wastes are received. At the Triassic Park site sand and siltstone will be predominantly used as daily cover materials and incoming contaminated soils are also likely to have a high sand content. Bulk solid wastes such as filter cake material, bag house wastes, and other process wastes are fine grained with particle sizes in the silt range. Based on this, the soil texture corresponding to a sandy silt was selected for the waste material.

Based on previous experience at hazardous waste sites, the initial moisture contents of the waste for Years 0 through 1 were set at 0.2055 which corresponds to a moisture content of 15 percent.

4.2.2 Protective Soil

0.105

The protective soil layer placed on top of the liner prior to waste filling will be the same material used for daily soil cover with the exception that it will be screened to remove oversize rocks and cobbles. Based on evaluation of bulk samples taken at the site from the upper sand unit, a soil texture number of 4 corresponding to a silty sand was selected to model the protective soil layer. This soil texture has the following defaults: porosity of 0.473, field capacity of 0.0105, wilting point of 0.047, and hydraulic conductivity of 1.7 x 10^{-3}cm/sec. The initial moisture content for this layer was set at 0.0863 which is consistent with the average moisture contents of 5.9 percent for the site's silty sand samples.

4.2.3 Lateral Drainage (Sand)

The lateral drainage sand material considered for use at the site will have to meet minimum hydraulic conductivities of 1 x 10^{-2}cm/sec. Although no hydraulic testing of candidate site materials has been conducted, it is believed that this performance standard can be met with available material sources either in their natural state or with a minimal amount of screening and washing. The soil texture number of 1 which corresponds to a poorly graded sand was selected for this layer. This soil texture has the following defaults: porosity of 0.417, field capacity of 0.045, wilting point of 0.018, and hydraulic conductivity of 1 x 10^{-2}cm/sec. Initial moisture content for this layer was set at 0.045 which equals the field capacity and therefore does not allow for water storage in the lateral drainage layer. It should be noted that the geotextile components of the sand drainage layer were not included in the this evaluation. Transmissities of this material exceeds those of the sand material and therefore this assumption is conservative.

4.2.4 Lateral Drainage (Geocomposite)

The geocomposite drainage material used in this analysis was a geotextile bonded to a geonet. The HELP model does not have a specific default for geocomposites so the default for the geonet was selected for this layer. The added capacity of the geotextile in this case is ignored and, as above, this assumption is conservative. The soil

4

specifies the initial notifications, steps to be taken in response to the leakage rate being exceeded, and follow-up reports.

The EPA recommended method for determining the landfill ALR presented in Federal Register Vol. 57, No. 19 and in reference No. 59 were used to calculate the ALR for the landfill facility. Using the flow equation for geonets and applying field representative geocomposite transmissivities and appropriate factors of safety for geonet creep and sediment clogging, the recommended ALR for the landfill was determined to be 900 gpad.

The ALR value of 900 gpad is above the EPA recommended value of 100 gpad. The primary reason for this difference is that the EPA value is based on a sand drainage layer with a permeability of 1 x 10^{-2} cm/sec compared to the geocomposite drainage layer transmissivity of 2.2x10^{-4} m^2/sec proposed for the Triassic Park Landfill.

Additional computations to check the LDRS sump capacity and LDRS drain pipe capacity are also presented in the Appendix G.

Response Action Plan steps outlined in the Action Leakage Rate and Response Action Plan closely follow the recommended actions presented in Federal Register Volume 57, No. 19.

3.2.10 Surface Water Drainage Analyses

Design parameters for HDPE lined Channels 7 and 8 located above the landfill access ramps are presented on Drawing No. 25 (Sheet 2 of 2). The methodology, assumptions, and run-off calculations for these channels and the collection basins discussed below and are presented in Appendix F.

The clean stormwater collection basin located at the toe of the 2H:1V cut slope in the south end of landfill will contain the run-off from the 15 acres of unlined area of Phase 1A (above the access ramps). The total run-off from the 25-year, 24-hour event is approximately 4.5 ac-ft. Total volume of the detention pond assuming 1 foot of freeboard is 5.2 ac-ft.

The contaminated water basin at the toe of the Phase 1A waste fill slope is designed to contain the run-off from the entire 15.6 acre fill area of Phase 1A. The total run-off from the 25-year, 24-hour event is approximately 4.3 ac-ft. The contaminated water basin is approximately 560 feet by 200 feet and can store approximately 10.4 ac-ft assuming 1 foot of freeboard. The contaminated water basin will be constructed at the same time as the rest of the Phase 1A landfill so it can accommodate runoff from waste placed in Phase 1A.

$560 ft \times 200 ft = 112000 ft^2 \times \frac{1 acre}{43560 ft^2} = 2.57$ acres

3.2.11 Soil Erosion Analyses

Due to the temporary nature of the 2H:1V cut slope and the 3H:1V subgrade slopes above the access ramps, severe soil erosion of these slope areas is not anticipated. The 2H:1V cut slope will be excavated during future landfill construction and the 3H:1V subgrade areas above the access roads will be conditioned prior to liner placement as required in the specifications.

Erosional features such as rills and localized slumping in exposed areas of the protective soils layer on the 3H:1V slope areas will be repaired following rain events.

3.2.12 Frost Protection

The maximum frost depths in the Roswell area, indicates that frost may reach 23 inches during the winter months. In addition, site-specific frost penetration modeling for the site indicated a maximum design freezing

(A)

Appendix H-2. A chemical resistance chart for the tanks is provided in Appendix H-3.

The concrete containment pad will slope towards the landfill crest. A concrete pad will be placed in the loading/unloading areas for the tanker trucks. This pad will be sloped providing drainage toward the sump areas. Calculations on the bearing capacity of the concrete pad are detailed in Appendix E-35. Should a catastrophic failure of the tank or piping system occur, leachate will flow back into the landfill leachate collection system rather than be released to unlined areas. The landfill liner system anchor trench will completely encompass the pad so that any leakage through the pad will also drain back into the landfill leachate collection system. Construction details for the concrete containment pad are called out in Specification Section 03100, Concrete Formwork, Section 03200, Reinforcement Steel, Section 03290, Joints in Concrete, and Section 03300, Cast-in-Place Concrete.

3.1.4 Waste Filling Sequence

As mentioned previously in Section 3.1.2, landfill development will begin in Phase 1A, proceed southward into Phase 2, and then finish in Phase 3. The extent of landfill subphases will be based on waste receipt rates.

Liner installation in Phase 1A will take place in two stages: the slope and floor area below the access ramps and the slope area above the access ramps. The initial stage of the Phase 1A liner installation will consist of liner placement below the access ramps and is the only portion relevant to this permit application. The approximate area that will be lined during the Phase 1A construction is 14.9 acres which is delineated on Drawing No. 10.

Detailed planning for Phase 1B, Phase 2 and Phase 3 liner installation, access ramp location, and waste fill sequencing will be determined and permitted in the future, however, the ultimate landfill configuration will be developed as follows. Once the waste fill approaches the Phase 1A limits defined in Drawing No. 10, the cut slope will be advanced southward into Phase 2 and the remaining floor and slope areas of Phase 1 will be lined. At this time, the stormwater collection basin in the landfill will be removed from Phase 1 and re-established in Phase 2. Waste filling in Phase 1 will continue during this liner expansion. As the waste fill extends beyond and above the access ramps, a ramp will be established in the south waste fill slope to provide access to the newly lined floor areas of Phase 1.

Waste filling will take place in 5 to 10 foot thick horizontal lifts. Waste will be covered with daily cover soil as soon as practicable following waste placement (and minimally at the end of each operating shift). Daily cover soil thicknesses will be at least 0.5 ft.

B

Data Downloaded from www.ncdc.noaa.gov/oa/ncdc.html

DSET	COOPID	WBNID	ELEM	UN	YEARMO	DAY01	DAY02	DAY03	DAY04	DAY05	DAY06	DAY07	DAY08	DAY09	DAY10	DAY11	DAY12	DAY13
3210	297610	23009	PRCP	HI	198601	0	0	0	0	0	20	47	0	0	0	0	0	0
3210	297610	23009	PRCP	HI	198602	0	0	0	4	0	0	3	4	31	8	0	0	0
3210	297610	23009	PRCP	HI	198603	0	0	0	0	0	0	0	0	0	0	0	0	0
3210	297610	23009	PRCP	HI	198604	0	0	0	0	0	0	0	31	0	0	0	0	0
3210	297610	23009	PRCP	HI	198605	0	0	0	0	0	0	0	0	0	0	0	0	0
3210	297610	23009	PRCP	HI	198606	2	0	0	1	0	0	0	36	0	0	0	0	0
3210	297610	23009	PRCP	HI	198607	66	22	2	0	0	0	0	0	10	1	0	0	0
3210	297610	23009	PRCP	HI	198608	0	8	16	12	0	4	0	0	0	0	0	0	1
3210	297610	23009	PRCP	HI	198609	74	171	0	93	0	0	2	0	0	0	0	0	4
3210	297610	23009	PRCP	HI	198610	0	7	0	0	13	7	0	0	59	346	0	0	0
3210	297610	23009	PRCP	HI	198611	0	70	79	14	0	0	0	0	0	0	0	0	13
3210	297610	23009	PRCP	HI	198612	0	0	0	0	0	0	0	15	0	18	0	0	0
3210	297610	23009	TMAX	F	198601	65	67	57	51	49	67	41	33	38	56	59	58	60
3210	297610	23009	TMAX	F	198602	71	65	68	54	43	49	41	28	29	25	28	29	46
3210	297610	23009	TMAX	F	198603	81	77	67	69	72	78	68	81	76	72	63	63	59
3210	297610	23009	TMAX	F	198604	72	80	68	74	79	85	92	82	68	79	81	85	86
3210	297610	23009	TMAX	F	198605	85	83	85	92	90	89	87	75	82	85	92	93	88
3210	297610	23009	TMAX	F	198606	77	79	79	89	89	97	100	87	90	90	83	92	93
3210	297610	23009	TMAX	F	198607	92	78	85	92	93	89	89	90	90	91	97	98	93
3210	297610	23009	TMAX	F	198608	98	98	89	91	94	95	96	91	92	90	90	92	95
3210	297610	23009	TMAX	F	198609	84	82	80	87	82	84	79	77	87	89	81	85	83
3210	297610	23009	TMAX	F	198610	88	76	82	77	62	61	74	83	75	70	64	43	66
3210	297610	23009	TMAX	F	198611	69	41	47	50	63	72	62	65	57	61	50	43	29
3210	297610	23009	TMAX	F	198612	58	66	58	42	53	53	67	58	38	32	42	51	54
3210	297610	23009	TMIN	F	198601	33	25	28	27	22	28	18	13	13	23	25	31	27
3210	297610	23009	TMIN	F	198602	36	43	34	30	24	18	23	21	19	14	21	19	26
3210	297610	23009	TMIN	F	198603	31	44	49	36	38	34	43	35	51	39	47	44	35
3210	297610	23009	TMIN	F	198604	51	47	46	40	41	49	57	51	46	40	51	50	57
3210	297610	23009	TMIN	F	198605	54	62	59	59	51	52	56	51	43	50	49	63	52
3210	297610	23009	TMIN	F	198606	53	60	59	62	60	63	64	61	61	58	58	60	62
3210	297610	23009	TMIN	F	198607	66	66	68	68	68	66	69	66	66	68	66	66	67
3210	297610	23009	TMIN	F	198608	66	67	65	64	65	67	68	68	64	67	65	66	71

B

DSET	COOPID	WBNID	ELEM	UN	YEARMO	DAY01	DAY02	DAY03	DAY04	DAY05	DAY06	DAY07	DAY08	DAY09	DAY10	DAY11	DAY12	DAY13
3210	297610	23009	TMIN	F	198609	63	60	63	61	57	62	62	61	63	68	56	54	61
3210	297610	23009	TMIN	F	198610	47	59	56	52	54	51	50	47	53	54	43	37	38
3210	297610	23009	TMIN	F	198611	41	38	39	36	30	34	38	33	31	27	25	26	24
3210	297610	23009	TMIN	F	198612	25	23	28	27	40	44	39	36	32	25	23	20	22
3210	297610	23009	PRCP	HI	199801	0	0	0	0	0	0	0	0	0	0	0	0	0
3210	297610	23009	PRCP	HI	199802	0	0	0	5	4	0	0	0	0	0	0	0	0
3210	297610	23009	PRCP	HI	199803	0	0	0	0	0	0	5	0	0	0	0	0	0
3210	297610	23009	PRCP	HI	199804	0	0	0	0	0	0	0	0	0	0	0	0	0
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3210	297610	23009	PRCP	HI	199806	0	0	0	0	0	0	0	0	0	18	0	0	0
3210	297610	23009	PRCP	HI	199807	0	17	0	62	2	0	0	20	1	0	0	0	0
3210	297610	23009	PRCP	HI	199808	0	21	0	0	10	0	0	0	0	0	1	69	4
3210	297610	23009	PRCP	HI	199809	0	0	0	0	0	0	0	0	0	0	0	0	0
3210	297610	23009	PRCP	HI	199810	154	0	0	0	0	0	0	0	0	0	0	0	0
3210	297610	23009	PRCP	HI	199811	0	0	0	1	2	0	0	0	0	0	0	0	0
3210	297610	23009	PRCP	HI	199812	10	55	0	0	0	0	0	0	0	5	0	0	0
3210	297610	23009	TMAX	F	199801	37	40	43	38	43	43	42	49	49	39	51	52	33
3210	297610	23009	TMAX	F	199802	55	66	63	39	47	55	62	68	64	59	56	48	62
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3210	297610	23009	TMAX	F	199805	87	88	84	92	86	88	85	86	84	92	91	91	93
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3210	297610	23009	TMAX	F	199811	61	62	62	49	47	52	64	75	73	57	68	60	63
3210	297610	23009	TMAX	F	199812	66	56	61	70	74	54	46	48	48	41	46	56	60
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3210	297610	23009	TMIN	F	199802	32	22	32	34	34	35	28	40	36	34	25	26	21
3210	297610	23009	TMIN	F	199803	25	23	24	32	35	39	30	28	21	20	25	21	26
3210	297610	23009	TMIN	F	199804	28	44	38	35	36	39	37	41	34	37	43	44	41
3210	297610	23009	TMIN	F	199805	48	51	53	47	59	51	51	52	53	49	52	45	44

B

DSET	COOPID	WBNID	ELEM	UN	YEARMO	DAY01	DAY02	DAY03	DAY04	DAY05	DAY06	DAY07	DAY08	DAY09	DAY10	DAY11	DAY12	DAY13
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3210	297610	23009	TMIN	F	199807	72	66	65	67	70	72	76	70	65	66	71	69	70
3210	297610	23009	TMIN	F	199808	68	70	66	64	63	60	61	63	61	66	68	65	65
3210	297610	23009	TMIN	F	199809	62	65	64	64	64	64	62	61	59	65	59	62	61
3210	297610	23009	TMIN	F	199810	61	58	53	62	48	43	44	42	46	48	48	51	54
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3210	297610	23009	TMIN	F	199812	35	43	41	35	38	35	28	20	24	32	28	23	28

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YEARMO	DAY14	DAY15	DAY16	DAY17	DAY18	DAY19	DAY20	DAY21	DAY22	DAY23	DAY24	DAY25	DAY26	DAY27	DAY28	DAY29	DAY30
198601	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
198602	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-99999	-99999
198603	4	0	0	0	2	5	1	0	0	0	0	0	0	0	0	0	0
198604	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
198605	0	0	0	27	0	0	0	0	0	0	0	2	7	1	0	6	51
198606	0	0	0	0	94	8	0	0	0	104	144	109	4	0	0	0	0
198607	0	0	0	2	0	0	0	2	0	6	0	0	0	0	0	0	0
198608	0	0	0	0	0	0	0	0	59	17	0	0	85	40	26	3	11
198609	0	0	0	0	0	0	0	0	12	29	0	0	0	0	0	8	0
198610	0	0	0	18	0	0	11	87	0	0	0	0	0	0	0	0	0
198611	0	0	0	0	0	6	0	0	0	7	0	0	0	0	0	0	0
198612	0	0	8	26	10	0	0	26	44	0	0	0	0	0	0	0	0
198601	60	68	67	71	62	74	77	72	52	64	70	53	55	60	77	61	71
198602	68	78	72	77	82	84	79	61	69	78	77	85	85	61	65	-99999	-99999
198603	52	68	74	68	57	56	59	72	80	81	82	83	77	78	82	80	85
198604	76	79	83	82	77	62	77	81	87	87	88	84	85	76	88	86	91
198605	89	92	89	57	74	86	94	97	94	84	93	79	77	73	82	80	77
198606	96	99	102	92	93	89	90	91	90	68	74	78	82	87	94	94	96
198607	86	88	92	91	91	94	92	86	86	91	94	98	100	101	100	99	100
198608	92	94	96	98	97	98	103	94	92	82	85	86	89	80	68	78	85
198609	85	88	85	91	93	93	91	90	85	84	79	83	85	86	85	86	82
198610	72	72	70	76	80	63	61	78	70	66	69	70	72	77	82	66	75
198611	53	60	71	76	64	74	61	66	74	48	52	61	48	61	67	70	63
198612	58	63	49	45	41	52	55	43	37	47	49	48	53	52	51	55	59
198601	28	29	37	30	37	29	30	36	30	24	31	25	21	24	26	39	27
198602	37	39	46	40	42	42	47	33	34	32	42	39	45	43	34	-99999	-99999
198603	35	34	31	40	32	39	34	30	35	36	40	42	45	45	44	50	48
198604	39	47	48	54	42	41	37	44	48	50	51	59	57	49	45	58	60
198605	57	55	54	43	38	47	53	56	61	56	62	59	57	55	52	55	54
198606	65	65	67	66	63	65	65	63	66	63	63	64	65	65	66	68	69
198607	67	65	66	64	65	62	64	67	67	65	65	65	64	68	67	65	65
198608	70	71	67	69	67	67	66	73	66	66	64	61	65	66	62	63	65

B

YEARMO	DAY14	DAY15	DAY16	DAY17	DAY18	DAY19	DAY20	DAY21	DAY22	DAY23	DAY24	DAY25	DAY26	DAY27	DAY28	DAY29	DAY30
198609	62	59	63	58	59	65	63	63	65	61	53	51	51	49	56	59	48
198610	36	39	43	44	46	57	56	50	43	46	49	46	44	43	40	45	42
198611	26	35	40	43	49	42	39	32	36	30	24	22	30	24	26	28	33
198612	26	26	34	33	32	24	27	37	33	29	29	30	27	25	29	26	22
199801	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
199802	0	1	0	0	3	0	0	0	0	0	0	0	0	0	0	-99999	-99999
199803	0	21	43	8	1	0	0	0	0	0	0	0	0	0	0	0	4
199804	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0
199805	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
199806	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
199807	0	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	70
199808	0	0	0	0	0	12	4	0	0	0	0	0	12	0	11	0	0
199809	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	5
199810	0	0	0	0	0	11	78	4	1	1	0	0	0	148	0	0	179
199811	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	19	0
199812	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0
199801	52	53	62	66	63	60	63	52	53	55	59	66	60	69	67	60	67
199802	69	56	57	58	56	56	54	61	70	72	81	60	55	52	51	-99999	-99999
199803	70	63	53	57	67	56	53	68	82	88	87	90	84	76	80	79	59
199804	82	75	66	55	63	71	70	69	76	89	91	84	70	64	67	75	84
199805	87	82	93	94	97	99	98	92	95	93	95	85	90	97	98	101	101
199806	95	89	101	100	96	105	106	104	104	105	108	108	108	108	110	106	101
199807	100	100	92	93	97	102	101	99	97	96	98	95	91	90	97	100	102
199808	90	92	95	93	92	90	84	89	92	93	96	94	92	96	90	91	93
199809	94	88	87	89	90	95	95	97	85	90	96	96	96	96	92	91	87
199810	90	91	82	74	70	69	55	53	57	62	70	77	79	64	72	73	78
199811	74	74	74	74	76	70	48	69	76	72	76	72	74	73	77	57	65
199812	60	56	61	56	71	46	71	50	27	32	39	61	64	69	70	65	63
199801	23	19	30	27	33	26	34	33	24	25	24	26	28	25	25	24	27
199802	39	37	26	28	37	35	27	36	29	34	33	38	34	29	16	-99999	-99999
199803	38	47	42	37	35	30	31	30	33	40	44	45	51	44	39	51	38
199804	40	41	38	33	28	34	42	37	40	40	47	51	45	44	38	39	45
199805	51	48	45	54	58	62	61	63	59	54	50	59	53	52	55	58	57

B

YEARMO	DAY14	DAY15	DAY16	DAY17	DAY18	DAY19	DAY20	DAY21	DAY22	DAY23	DAY24	DAY25	DAY26	DAY27	DAY28	DAY29	DAY30
199806	62	59	56	60	61	57	62	63	63	64	65	65	69	65	65	65	66
199807	67	67	66	70	69	66	69	68	68	66	72	69	71	70	71	72	66
199808	61	63	61	60	65	68	66	65	64	63	64	67	66	68	71	67	57
199809	64	65	61	62	61	64	64	68	59	61	63	62	61	61	66	64	65
199810	56	59	51	43	40	53	49	49	50	50	47	50	58	48	42	42	56
199811	34	39	37	34	40	42	35	30	31	34	31	36	31	35	38	40	33
199812	22	28	25	27	35	30	39	17	11	14	19	15	20	31	26	34	27

B

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YEARMO	DAY31
198601	0
198602	-99999
198603	0
198604	-99999
198605	25
198606	-99999
198607	0
198608	29
198609	-99999
198610	0
198611	-99999
198612	0
198601	70
198602	-99999
198603	88
198604	-99999
198605	69
198606	-99999
198607	98
198608	89
198609	-99999
198610	80
198611	-99999
198612	52
198601	32
198602	-99999
198603	49
198604	-99999
198605	57
198606	-99999
198607	64
198608	65

B

YEARMO	DAY31
198609	-99999
198610	47
198611	-99999
198612	22
199801	0
199802	-99999
199803	0
199804	-99999
199805	0
199806	-99999
199807	0
199808	0
199809	-99999
199810	15
199811	-99999
199812	0
199801	64
199802	-99999
199803	66
199804	-99999
199805	99
199806	-99999
199807	86
199808	93
199809	-99999
199810	62
199811	-99999
199812	52
199801	31
199802	-99999
199803	32
199804	-99999
199805	55

B

YEARMO	DAY31
199806	-99999
199807	66
199808	60
199809	-99999
199810	46
199811	-99999
199812	36

C

Evaporation Stations

Standard daily pan evaporation is measured using the four-foot diameter Class A evaporation pan.
The pan water level reading is adjusted when precipitation is measure to obtain the actual evaporation.
Most Class A pans are installed above ground, allowing effects such as radiation on the side walls and heat exchnges with the pan material. These effects ~~tend to increase~~ the evaporation totals. The amounts can then be adjusted by multiplying the totals b 0.70 or 0.80 to more closely estimate the evaporation from naturally existing urfaces such as a shallow lake, wet soil or other moist natural surfaces.

0.7 CONSERVATIVE

Many stations do not measure pan evaportation during winter months. A "0.00" total indicates no measuement is taken.

Stations marked with an asterisk (*) have estimated totals computed from meteorological measurements using a form of the Penman equation.

Click on a State: Arizona <#ARIZONA>, California <#CALIFORNIA>, Colorado <#COLORADO>, Hawaii & Pacific Islands <#HAWAII/PACIFIC ISLANDS>, Idaho <#IDAHO>, Montana <#MONTANA>, Nevada <#N
EVADA>,
New Mexico <#NEW MEXICO>, Oregon <#OREGON>, Utah <#UTAH>, Washington <#WASHINGTON>, Wyoming <#WYOMING>

NEW MEXICO

MONTHLY AVERAGE PAN EVAPORATION (INCHES)

	PERIOD OF RECORD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
ABIQUIU DAM	1957-2005	0.00	0.00	6.06	7.43	9.95	11.39	10.52	8.90	7.23	5.30	3.13	2.22	72.13
AGRICULTURAL COLLEGE	1892-1959	3.01	4.00	7.89	10.20	8.65	13.99	12.33	11.16	8.31	6.28	4.35	2.89	93.06
ALAMOGORDO DAM	1939-1975	3.73	4.35	8.21	11.30	12.88	14.43	13.66	11.59	9.17	7.19	4.89	3.46	104.86
ANIMAS	1923-2005	3.87	4.91	8.29	10.78	12.36	14.25	11.60	11.07	8.54	6.71	4.69	3.61	100.68
ARTESIA 6 S	1914-2005	4.38	3.03	7.25	7.66	12.11	13.13	10.86	10.44	9.36	6.34	3.12	0.00	87.68
BITTER LAKES WL REFUGE	1950-2005	2.67	3.93	6.82	9.60	11.31	12.62	11.88	10.16	8.02	5.85	3.53	2.50	88.89
BOSQUE DEL APACHE	1914-2005	3.21	4.20	7.76	10.20	11.61	13.13	11.56	10.36	8.03	6.25	3.66	2.54	92.51
BRANTLEY DAM	1987-2005	4.65	0.00	8.62	11.77	14.61	15.46	14.19	12.22	9.88	7.97	5.77	4.34	109.48
CABALLO DAM	1938-2005	4.42	5.10	8.56	11.37	13.59	14.80	13.08	11.35	9.26	7.27	4.78	3.48	107.06
CAPULIN NATL MONUMENT	1966-1979	0.00	0.00	0.00	0.00	9.08	10.57	9.71	9.18	7.65	0.00	0.00	0.00	46.19
CLOVIS 13 N	1929-2005	3.83	4.12	6.63	8.72	10.15	11.45	11.65	9.55	7.64	5.78	3.95	3.21	86.68
COCHITI DAM	1975-2005	0.00	4.14	6.44	8.48	11.07	12.95	12.38	10.62	8.91	6.29	3.94	2.79	88.01

D

History for Roswell, NM

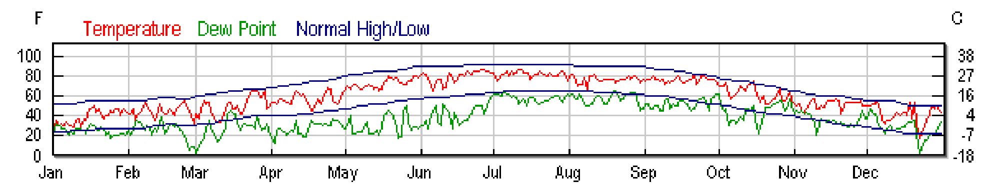
January 1, 1998 through December 31, 1998 — View Current Conditions

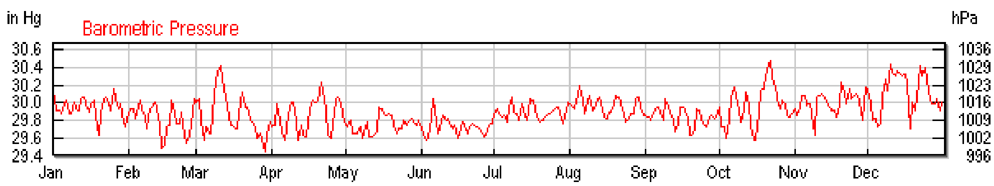
January 1, 1998 through December 31, 1998

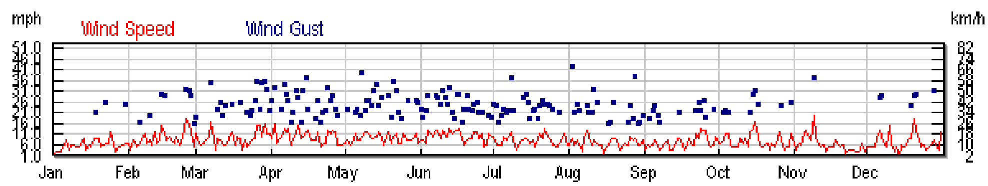
January 1 1998 - TO - December 31 1998 Go

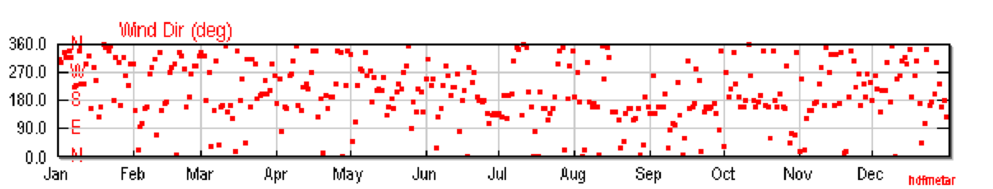
Daily | Weekly | Monthly | **Custom**

	Max	Avg	Min	Sum
Temperature				
Max Temperature	**111** °F	**76** °F	**26** °F	
Mean Temperature	**88** °F	**61** °F	**18** °F	
Min Temperature	**79** °F	**47** °F	**10** °F	
Degree Days				
Heating Degree Days (base 65)	47	9	0	3349
Cooling Degree Days (base 65)	24	6	0	2085
Growing Degree Days (base 50)	38	14	0	5136
Dew Point				
Dew Point	**72** °F	**38** °F	**-6** °F	
Precipitation				
Precipitation	**1.78** in	**0.03** in	**0.00** in	**10.93** in
Snowdepth	-	-	-	-
Wind				
Wind	**45** mph	**8** mph	**0** mph	
Gust Wind	**56** mph	**25** mph	**16** mph	
Sea Level Pressure				
Sea Level Pressure	**30.62** in	**29.89** in	**29.33** in	









Certify This Report

Observations

1998	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
Jan	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	high	sum	
1	36	24	12	30	19	10	100	91	79	30.25	30.16	30.09	10	4	0	5	2	-	0.00	Fog
2	39	29	19	33	26	18	96	88	73	30.09	30.03	29.95	10	9	5	8	2	-	0.00	Snow
3	42	36	27	36	33	25	100	92	79	29.97	29.92	29.83	10	5	0	8	3	-	0.00	Fog
4	37	30	24	36	30	21	100	97	86	30.00	29.91	29.88	10	2	0	12	3	21	0.00	Fog
5	42	32	23	35	28	21	100	95	62	29.92	29.88	29.82	10	3	0	12	3	-	0.00	Fog
6	42	30	19	31	27	17	100	88	51	30.15	29.99	29.91	10	6	0	26	6	31	0.00	Fog , Snow
7	41	34	24	31	26	19	100	75	49	30.11	30.02	29.92	10	9	2	17	8	-	0.00	Snow
8	48	30	12	29	21	9	92	72	39	29.93	29.87	29.81	10	10	10	14	4	-	0.00	Rain
9	39	30	21	30	24	19	89	72	53	29.99	29.87	29.79	10	10	10	12	6	-	0.00	
10	37	29	21	29	23	20	100	88	68	30.08	30.01	29.91	10	5	0	10	6	-	0.00	
11	50	36	23	35	27	20	89	74	52	30.01	29.93	29.87	10	8	5	12	5	-	0.00	
12	50	37	24	32	27	21	88	68	43	30.00	29.91	29.86	10	10	10	8	5	-	0.00	
13	33	29	25	32	28	24	100	95	85	30.14	30.05	29.98	10	1	0	10	6	-	0.00	Fog
14	51	38	24	32	26	22	100	75	38	30.19	30.07	30.00	10	8	0	15	9	-	0.00	Fog
15	53	36	19	31	23	15	88	63	38	30.13	29.98	29.81	10	10	10	13	4	-	0.00	
16	62	47	32	36	30	23	86	58	32	30.04	29.89	29.78	10	10	10	21	6	29	0.00	
17	66	47	28	41	32	25	89	62	36	30.11	29.98	29.85	10	10	10	17	5	-	0.00	
18	63	50	33	32	30	23	79	52	22	30.12	30.03	29.90	10	10	10	22	9	16	0.00	
19	60	44	28	33	28	21	81	55	36	30.08	29.83	29.57	10	10	10	20	9	21	0.00	
20	63	48	34	30	26	21	75	43	23	29.78	29.64	29.54	10	10	10	16	9	-	0.00	
21	50	42	33	34	29	24	79	61	46	29.96	29.87	29.76	10	10	10	8	5	-	0.00	
22	52	38	24	31	27	23	100	75	34	30.11	30.02	29.95	10	9	1	16	6	21	0.00	
23	54	40	26	26	20	12	85	55	20	30.17	30.07	29.93	10	10	10	21	7	28	0.00	
24	57	40	24	30	24	20	84	58	28	30.12	29.99	29.85	10	10	10	16	7	-	0.00	
25	66	46	27	31	18	6	85	40	10	30.13	29.92	29.84	10	10	10	32	12	39	0.00	
26	59	44	28	23	20	17	69	44	20	30.24	30.16	30.06	10	10	10	9	6	-	0.00	
27	69	48	27	25	21	14	75	44	14	30.16	30.04	29.90	10	10	10	12	3	-	0.00	
28	66	47	28	25	20	15	69	42	14	30.00	29.93	29.84	10	10	10	9	5	-	0.00	
29	57	40	24	28	22	17	75	47	24	30.12	29.98	29.86	10	10	10	8	5	-	0.00	
30	66	47	28	27	22	17	78	47	15	29.85	29.76	29.64	10	10	10	21	6	20	0.00	
31	63	46	30	29	21	12	76	41	14	29.79	29.73	29.66	10	10	10	23	7	28	0.00	
1998	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
Feb	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	high	sum	
1	54	43	32	30	25	22	73	54	30	29.94	29.88	29.75	10	10	10	10	7	-	0.00	
2	64	42	21	25	21	16	78	46	16	30.02	29.93	29.83	10	10	10	12	4	17	0.00	
3	62	48	35	33	25	19	79	46	20	30.04	29.94	29.86	10	10	10	13	8	-	0.00	

Comma Delimited File

1998	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
4	39	36	33	37	34	29	100	91	76	29.92	29.82	29.72	10	7	2	13	7	-	0.05	Rain
5	46	40	35	39	36	32	100	91	63	30.07	29.87	29.77	10	5	0	20	5	25	0.04	Fog , Rain
6	54	44	35	34	34	32	96	75	43	30.13	30.03	29.93	10	10	7	12	7	17	0.00	
7	62	46	30	36	31	23	100	73	28	30.02	29.92	29.75	10	6	0	17	8	-	0.00	
8	66	54	42	37	26	21	66	37	17	29.96	29.83	29.71	10	10	10	20	11	-	0.00	
9	62	50	39	37	31	19	79	53	19	29.77	29.71	29.62	10	10	10	18	7	29	0.00	
10	55	45	35	37	28	22	83	53	27	30.05	29.94	29.76	10	10	9	17	8	22	0.00	Rain
11	55	42	28	24	21	16	72	47	23	30.09	29.96	29.84	10	10	10	13	6	-	0.00	
12	46	36	27	32	27	21	89	60	43	30.12	30.01	29.84	10	10	10	30	12	38	0.00	
13	61	41	21	32	24	18	100	61	19	30.09	29.94	29.81	10	8	0	15	7	-	0.00	Fog
14	64	52	41	45	32	26	93	52	26	29.88	29.75	29.63	10	10	10	22	8	25	0.00	
15	54	46	37	45	39	31	96	77	41	29.69	29.49	29.37	10	9	5	24	15	33	0.01	Rain
16	57	42	26	32	22	16	89	47	21	29.69	29.52	29.44	10	10	10	25	11	38	0.01	
17	57	42	28	32	24	15	82	47	26	29.83	29.73	29.66	10	10	10	15	8	-	0.00	
18	55	47	39	39	33	21	82	63	38	29.92	29.74	29.63	10	10	9	20	10	25	0.03	Rain
19	55	46	35	34	32	26	87	62	34	30.14	30.03	29.93	10	10	10	13	8	-	0.00	
20	52	40	27	35	29	23	85	64	38	29.99	29.87	29.78	10	10	10	15	7	-	0.00	
21	60	48	36	37	32	26	86	58	31	29.84	29.77	29.72	10	10	10	17	10	-	0.00	
22	70	50	30	30	25	20	82	43	16	29.84	29.76	29.67	10	10	10	22	6	30	0.00	
23	71	53	35	33	25	18	73	38	15	29.99	29.90	29.83	10	10	10	14	7	-	0.00	
24	79	56	34	30	21	12	67	29	8	29.88	29.64	29.43	10	10	6	32	14	41	0.00	
25	60	50	39	23	15	7	45	27	15	29.60	29.54	29.48	10	10	10	29	18	41	0.00	
26	54	44	35	19	6	-3	50	24	10	29.71	29.63	29.58	10	10	10	29	16	41	0.00	
27	50	40	30	19	9	2	38	30	15	29.92	29.77	29.69	10	10	10	28	12	32	0.00	
28	50	33	16	23	9	-6	74	40	10	30.13	30.04	29.94	10	10	10	17	5	16	0.00	
1998	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
Mar	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	high	sum	
1	55	42	28	7	3	-1	38	23	11	30.10	30.00	29.86	10	10	10	18	11	21	0.00	
2	51	38	24	13	9	2	53	35	21	30.16	30.05	29.99	10	10	10	14	7	-	0.00	
3	71	48	25	17	14	9	58	30	12	30.01	29.79	29.59	10	10	10	14	6	18	0.00	
4	75	55	35	20	17	11	44	25	11	29.65	29.58	29.50	10	10	10	16	7	-	0.00	
5	71	53	35	33	27	20	78	42	15	29.88	29.73	29.61	10	9	5	17	8	-	0.00	
6	68	54	39	39	36	32	82	57	30	29.83	29.65	29.48	10	10	10	25	10	39	0.00	
7	57	44	30	41	29	8	100	75	16	29.96	29.66	29.42	10	7	2	32	17	47	0.05	Snow
8	46	37	28	25	21	16	82	56	39	30.16	30.08	29.95	10	10	10	14	9	-	0.00	
9	50	36	23	19	17	14	77	49	27	30.35	30.24	30.14	10	10	10	12	4	17	0.00	
10	50	34	19	16	14	9	63	46	26	30.50	30.34	30.21	10	10	10	20	9	25	0.00	
11	42	34	26	23	18	14	69	53	38	30.56	30.41	30.25	10	10	10	25	8	31	0.00	
12	54	38	21	26	22	16	80	59	34	30.46	30.27	30.10	10	10	9	17	7	21	0.00	

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1998	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
13	69	48	26	35	28	21	85	54	22	30.20	30.06	29.94	10	10	10	17	6	24	0.00	
14	68	52	37	49	42	35	93	74	37	30.13	29.96	29.83	10	10	4	18	7	-	0.00	
15	61	54	46	54	46	39	100	80	46	29.90	29.75	29.65	10	9	2	20	11	24	0.21	Rain
16	52	47	42	48	44	41	100	91	77	29.81	29.75	29.65	10	8	2	18	12	28	0.43	Rain
17	57	47	37	48	43	38	100	86	62	29.77	29.71	29.63	10	10	10	13	6	-	0.08	Rain
18	66	51	36	46	32	17	100	60	30	29.84	29.70	29.58	10	10	10	31	10	44	0.01	
19	55	42	30	33	26	21	79	52	31	30.09	30.02	29.89	10	10	10	22	9	26	0.00	
20	52	42	32	34	31	27	92	68	45	30.21	30.11	30.04	10	10	10	8	4	-	0.00	
21	68	49	30	35	32	29	96	59	26	30.05	29.96	29.84	10	10	10	20	8	22	0.00	
22	80	56	33	35	31	25	92	46	13	30.04	29.95	29.86	10	10	10	14	5	21	0.00	
23	86	64	42	35	31	27	76	34	13	29.90	29.81	29.72	10	10	10	16	7	22	0.00	
24	87	66	45	36	30	21	63	31	11	29.89	29.79	29.66	10	10	10	22	8	25	0.00	
25	88	66	45	41	28	23	63	27	11	29.83	29.73	29.66	10	10	10	24	9	32	0.00	Rain
26	82	67	52	54	40	21	93	50	10	29.70	29.60	29.41	10	9	2	36	15	44	0.00	Rain
27	73	59	45	32	29	26	51	32	17	29.81	29.65	29.60	10	10	10	22	15	33	0.00	Rain
28	79	59	39	34	26	19	68	32	11	29.78	29.57	29.44	10	10	10	31	10	40	0.00	
29	79	66	54	35	27	20	47	26	12	29.55	29.45	29.33	10	10	9	34	16	44	0.00	Rain
30	55	47	39	39	32	21	85	59	29	29.78	29.63	29.49	10	10	6	34	11	45	0.04	Rain
31	64	50	35	24	20	17	57	33	16	29.83	29.78	29.71	10	10	10	18	11	22	0.00	

1998	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
Apr	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	high	sum	
1	77	54	32	24	18	10	66	28	10	29.87	29.72	29.55	10	10	10	25	9	32	0.00	
2	62	54	44	28	13	5	41	22	10	29.89	29.74	29.56	10	10	10	36	16	40	0.00	
3	66	52	39	30	26	19	60	36	20	30.08	29.98	29.91	10	10	10	18	7	-	0.00	
4	77	57	37	35	27	21	62	34	15	29.94	29.81	29.65	10	10	10	23	9	31	0.00	
5	78	58	37	35	25	18	73	32	12	29.79	29.67	29.56	10	10	10	23	10	28	0.00	
6	72	56	42	32	24	21	47	26	15	29.71	29.58	29.51	10	10	10	32	14	44	0.00	
7	70	54	39	27	21	16	53	30	14	29.81	29.70	29.61	10	10	10	26	12	34	0.00	
8	68	54	42	26	22	15	49	30	15	29.98	29.87	29.75	10	10	10	23	14	31	0.00	
9	71	52	34	35	26	20	79	41	16	30.07	30.00	29.93	10	10	10	12	6	17	0.00	
10	79	59	39	29	24	22	53	29	12	30.11	30.00	29.91	10	10	10	16	9	24	0.00	
11	86	65	44	42	36	27	58	37	17	29.99	29.78	29.55	10	10	10	29	11	37	0.00	
12	82	64	46	40	23	18	55	21	12	29.78	29.58	29.46	10	10	10	31	15	36	0.00	
13	75	60	46	27	22	14	44	25	12	29.84	29.75	29.66	10	10	10	15	9	17	0.00	
14	82	62	42	26	19	10	47	21	11	29.78	29.64	29.54	10	10	10	29	10	37	0.00	
15	75	58	42	28	19	12	44	23	11	29.70	29.61	29.47	10	10	10	34	12	45	0.00	
16	66	52	39	33	25	20	60	36	20	29.96	29.78	29.66	10	10	10	28	13	31	0.00	
17	55	45	35	43	36	31	100	74	45	30.08	30.01	29.96	10	10	5	22	8	-	0.05	Rain
18	63	45	28	42	34	27	100	64	28	30.11	30.02	29.93	10	10	7	26	8	17	0.00	

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1998	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
19	71	52	34	36	33	26	92	52	22	30.14	30.01	29.86	10	10	10	16	8	22	0.00	
20	70	57	45	36	32	25	66	42	27	30.21	30.02	29.86	10	10	10	23	12	31	0.00	
21	69	52	37	37	32	27	83	49	25	30.32	30.23	30.13	10	10	10	10	5	17	0.00	
22	75	57	39	33	30	26	65	36	19	30.27	30.14	30.01	10	10	5	18	6	23	0.00	
23	89	64	42	38	33	27	58	32	16	30.04	29.91	29.76	10	10	10	14	7	24	0.00	Rain
24	91	69	48	38	30	22	52	24	12	29.75	29.63	29.52	10	10	10	33	13	40	0.00	
25	84	67	52	34	30	24	37	22	15	29.80	29.60	29.48	10	10	10	24	11	39	0.00	
26	70	56	44	42	37	30	77	53	26	30.11	29.76	29.56	10	10	10	30	13	38	0.00	Rain
27	64	54	45	40	35	30	80	51	31	30.08	30.03	29.99	10	10	10	21	12	26	0.00	
28	66	52	39	43	35	27	82	55	31	30.21	30.07	29.96	10	10	10	10	6	28	0.00	
29	75	57	39	36	32	28	79	42	20	30.10	30.00	29.90	10	10	10	14	6	-	0.00	
30	84	64	45	37	29	19	68	32	11	29.96	29.86	29.76	10	10	10	15	6	-	0.00	
1998	**Temp.** (°F)			**Dew Point** (°F)			**Humidity** (%)			**Sea Level Press.** (in)			**Visibility** (mi)			**Wind** (mph)			**Precip.** (in)	**Events**
May	**high**	**avg**	**low**	**high**	**avg**	**low**	**high**	**avg**	**low**	**high**	**avg**	**low**	**high**	**avg**	**low**	**high**	**avg**	**high**	**sum**	
1	86	68	50	34	28	23	43	23	11	29.82	29.74	29.66	10	10	10	12	7	21	0.00	
2	88	70	52	35	31	28	49	25	13	29.81	29.72	29.65	10	10	10	13	8	23	0.00	
3	84	68	55	54	41	27	77	44	13	30.07	29.81	29.71	10	10	10	12	6	-	0.00	
4	91	71	51	33	23	14	50	20	8	29.76	29.65	29.53	10	10	10	24	7	33	0.00	
5	86	72	61	32	23	16	24	16	10	29.76	29.65	29.55	10	10	10	20	11	24	0.00	
6	88	70	53	32	24	17	34	18	9	29.73	29.66	29.60	10	10	10	17	8	29	0.00	
7	84	68	53	31	24	18	37	19	12	29.86	29.72	29.64	10	10	5	16	8	23	0.00	
8	86	68	53	32	24	14	41	24	8	29.68	29.59	29.47	10	10	10	34	10	51	0.00	
9	84	70	55	34	30	26	42	25	13	29.92	29.73	29.64	10	10	10	20	12	24	0.00	
10	91	71	51	47	34	15	68	34	10	29.95	29.79	29.64	10	10	10	24	12	32	0.00	
11	91	72	54	30	23	16	26	15	10	29.78	29.61	29.49	10	10	10	22	11	32	0.00	
12	91	70	50	29	22	17	33	18	10	29.70	29.61	29.54	10	10	10	26	9	32	0.00	
13	93	68	45	27	22	16	34	17	10	29.70	29.63	29.56	10	10	10	24	9	34	0.00	
14	87	69	54	40	25	18	37	21	10	29.77	29.68	29.59	10	10	10	36	10	47	0.00	
15	82	65	48	29	21	10	41	20	10	30.17	29.95	29.83	10	10	10	21	12	26	0.00	
16	93	68	46	52	27	11	48	20	11	30.05	29.94	29.81	10	10	7	25	9	32	0.00	
17	93	74	55	53	40	33	77	32	12	29.95	29.88	29.81	10	9	6	16	6	-	0.00	
18	97	76	57	46	42	38	51	28	14	29.93	29.85	29.75	10	9	5	26	9	33	0.00	Rain
19	99	80	64	51	45	35	56	31	13	30.02	29.88	29.78	10	10	8	25	12	39	0.00	
20	98	79	61	54	42	34	67	31	13	29.95	29.86	29.79	10	10	6	14	7	22	0.00	
21	91	77	63	47	39	31	46	28	12	29.84	29.75	29.64	10	9	5	33	10	41	0.00	
22	95	79	63	42	29	17	39	20	7	29.88	29.65	29.54	10	10	7	29	11	40	0.00	
23	93	75	59	26	18	10	24	13	7	29.80	29.70	29.62	10	10	10	14	7	21	0.00	
24	95	74	55	27	19	12	29	13	7	29.80	29.71	29.62	10	10	10	16	7	20	0.00	
25	84	72	60	50	44	16	60	41	11	29.88	29.80	29.68	10	10	10	18	11	-	0.00	

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1998	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
26	90	72	54	60	51	43	69	50	29	29.84	29.75	29.58	10	9	6	26	8	39	0.00	
27	97	76	57	53	34	17	81	31	7	29.90	29.78	29.69	10	10	7	21	8	38	0.00	
28	98	76	55	33	25	18	23	15	8	29.93	29.82	29.74	10	10	7	14	8	-	0.00	
29	100	80	60	48	29	19	28	15	8	29.90	29.79	29.68	10	10	10	20	9	26	0.00	
30	100	80	61	43	29	21	32	17	9	29.81	29.75	29.68	10	10	10	25	11	32	0.00	
31	99	79	60	35	27	18	30	15	9	29.93	29.80	29.72	10	10	10	20	7	26	0.00	
1998	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
Jun	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	high	sum	
1	108	82	59	40	30	18	27	15	10	29.80	29.71	29.60	10	10	10	16	8	26	0.00	
2	106	84	62	41	31	22	29	14	9	29.76	29.63	29.53	10	10	10	16	8	25	0.00	
3	102	83	64	40	35	27	28	17	11	29.77	29.58	29.47	10	10	10	22	7	23	0.00	
4	93	78	64	37	27	17	26	15	10	29.76	29.59	29.53	10	10	10	31	13	34	0.00	
5	84	70	57	51	41	20	72	39	15	30.09	29.84	29.67	10	10	10	20	11	-	0.00	
6	79	66	55	48	46	43	69	52	34	30.19	30.05	29.94	10	10	10	16	10	22	0.00	
7	95	75	57	66	50	27	79	49	10	30.06	29.79	29.53	10	10	8	28	13	37	0.00	
8	93	78	61	67	34	17	97	28	10	29.82	29.66	29.58	10	9	6	25	13	33	0.00	
9	96	78	61	42	30	18	29	18	13	29.88	29.78	29.70	10	10	10	21	9	28	0.00	
10	81	68	55	61	52	41	100	66	26	30.04	29.85	29.75	10	9	3	24	13	31	0.17	Rain
11	88	69	51	55	48	40	100	51	19	29.96	29.80	29.71	10	10	10	30	10	38	0.01	
12	97	79	62	51	46	39	65	35	14	29.94	29.82	29.74	10	10	10	22	10	28	0.00	
13	100	84	68	57	43	25	63	27	12	29.94	29.76	29.64	10	10	10	30	14	40	0.00	
14	95	78	63	36	28	21	22	15	12	29.84	29.70	29.60	10	10	10	18	11	24	0.00	
15	89	74	60	49	44	24	64	38	16	29.90	29.74	29.62	10	10	10	17	12	18	0.00	
16	100	78	55	42	36	22	49	21	12	29.79	29.59	29.46	10	10	10	25	13	37	0.00	
17	100	83	66	39	31	21	26	15	11	29.84	29.64	29.52	10	10	10	26	14	34	0.00	
18	96	82	66	43	34	25	26	19	14	29.90	29.79	29.71	10	10	10	15	9	17	0.00	
19	105	81	57	47	36	25	36	19	14	29.87	29.75	29.64	10	10	10	20	6	26	0.00	
20	106	85	66	48	36	27	24	17	14	29.75	29.66	29.58	10	10	10	16	8	29	0.00	
21	104	84	66	50	40	29	51	22	13	29.91	29.73	29.64	10	10	10	17	9	26	0.00	
22	104	83	64	59	42	28	44	23	15	29.86	29.77	29.69	10	10	10	18	9	28	0.00	
23	105	85	66	60	49	34	70	32	13	29.85	29.74	29.62	10	10	10	25	12	36	0.00	
24	108	86	66	59	50	38	66	30	14	29.91	29.72	29.59	10	10	10	21	12	37	0.00	
25	108	86	66	58	50	40	59	31	14	29.88	29.71	29.61	10	10	10	24	9	29	0.00	
26	108	88	70	58	50	32	61	30	15	29.74	29.65	29.55	10	10	10	18	11	22	0.00	
27	108	88	68	50	42	33	30	20	15	29.70	29.62	29.56	10	10	10	14	5	-	0.00	
28	109	86	64	59	49	36	40	27	15	29.75	29.68	29.62	10	10	10	20	6	22	0.00	
29	106	86	66	63	55	50	68	35	18	29.94	29.74	29.65	10	10	10	17	11	22	0.00	
30	100	84	69	68	60	54	69	44	21	29.83	29.77	29.72	10	10	10	16	10	22	0.00	
1998	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events

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1998	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
Jul	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	high	sum	
1	97	84	73	66	62	57	73	49	28	30.06	29.88	29.76	10	10	10	21	10	33	0.00	
2	84	75	66	71	63	57	91	73	49	30.11	29.94	29.88	10	9	2	25	6	31	0.17	Rain
3	91	78	66	67	62	56	96	62	30	29.95	29.87	29.78	10	10	10	20	6	17	0.00	Rain
4	98	82	68	68	61	55	88	54	24	30.06	29.83	29.73	10	9	2	15	6	28	0.32	Rain
5	98	82	69	69	65	59	88	62	30	30.09	29.86	29.74	10	9	2	22	10	25	0.32	Rain
6	100	86	72	68	62	56	82	49	23	29.96	29.79	29.71	10	10	10	24	8	25	0.00	
7	81	80	75	62	62	61	62	56	50	30.08	29.96	29.77	10	10	10	25	10	30	0.00	
8	100	86	72	63	59	55	73	47	22	30.13	30.06	29.94	10	9	2	36	12	55	0.17	Rain
9	98	82	66	65	60	47	87	58	18	29.96	29.90	29.81	10	10	10	20	8	23	0.01	Rain
10	99	84	68	66	59	52	87	49	21	29.95	29.87	29.77	10	10	10	8	4	-	0.00	
11	104	88	73	61	53	42	64	34	13	29.86	29.80	29.73	10	10	10	9	6	-	0.00	
12	93	88	79	61	56	44	54	39	18	30.05	29.98	29.89	10	10	10	23	8	29	0.00	
13	100	84	70	63	57	45	76	45	17	30.11	29.91	29.74	10	10	10	25	8	36	0.00	
14	100	84	68	56	51	43	63	33	14	29.95	29.80	29.72	10	10	10	24	9	32	0.00	
15	100	84	68	66	55	47	87	45	18	30.26	29.90	29.77	10	9	3	20	8	31	0.24	Rain
16	91	78	66	67	59	50	93	56	25	30.14	30.05	29.97	10	10	10	14	7	18	0.01	
17	93	80	70	64	59	53	78	54	27	30.15	30.02	29.92	10	10	10	21	8	25	0.00	Rain
18	97	83	70	63	56	50	78	45	22	30.00	29.91	29.81	10	10	10	18	5	25	0.00	Rain
19	102	83	66	56	52	47	68	37	17	29.87	29.80	29.72	10	10	10	16	8	20	0.00	
20	100	86	71	55	53	51	51	34	19	29.85	29.79	29.73	10	10	10	23	11	30	0.00	
21	99	83	68	60	54	44	65	41	16	29.87	29.81	29.71	10	10	10	24	9	32	0.00	
22	97	82	69	60	55	50	65	39	20	29.98	29.84	29.74	10	10	9	28	14	34	0.00	
23	96	80	66	59	56	51	73	43	22	30.01	29.87	29.78	10	10	10	24	10	31	0.00	Rain
24	98	84	72	60	57	53	64	42	25	30.00	29.87	29.78	10	10	10	26	9	31	0.00	
25	95	81	69	63	59	52	68	49	26	29.97	29.91	29.87	10	10	10	21	6	26	0.00	
26	91	80	72	62	60	57	66	55	34	30.12	29.94	29.88	10	10	10	17	6	-	0.00	Rain
27	90	80	71	64	61	57	76	58	33	30.01	29.95	29.86	10	10	10	12	5	16	0.00	
28	97	84	72	65	58	50	78	47	22	29.94	29.87	29.77	10	10	10	14	7	21	0.00	
29	111	86	73	57	54	48	53	34	18	29.95	29.77	29.69	10	10	10	21	9	-	0.00	
30	102	84	66	66	59	51	90	52	20	30.03	29.84	29.67	10	8	0	45	11	56	0.68	Rain
31	86	75	66	66	62	59	90	70	44	30.08	30.00	29.92	10	10	10	12	6	-	0.00	
1998	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
Aug	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	high	sum	
1	93	81	69	67	61	55	87	51	28	30.16	29.98	29.91	10	10	10	17	6	20	0.00	
2	93	82	71	69	63	55	84	66	28	30.12	29.96	29.88	10	10	4	37	9	43	0.21	Rain , Thunderstorm
3	91	80	68	65	59	49	90	58	24	30.01	29.94	29.87	10	10	10	18	6	23	0.00	
4	79	70	64	60	58	53	81	64	45	30.15	30.09	30.01	10	10	10	21	8	26	0.00	
5	79	72	64	64	62	58	94	79	58	30.36	30.19	30.10	10	9	3	17	6	22	0.10	Rain ,

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1998	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
																				Thunderstorm
6	86	73	60	61	57	49	100	63	29	30.14	30.03	29.90	10	10	9	9	3	-	0.00	
7	97	79	62	58	53	48	84	44	20	30.03	29.87	29.77	10	10	10	17	9	21	0.00	
8	75	68	66	53	51	50	57	52	46	30.13	30.01	29.84	10	10	10	21	13	25	0.00	
9	98	80	62	60	50	43	65	35	17	30.21	30.08	29.89	10	10	10	17	10	24	0.00	
10	97	81	66	59	53	47	66	39	19	29.99	29.92	29.82	10	10	10	14	6	22	0.00	
11	97	83	70	63	58	47	76	51	19	30.02	29.94	29.85	10	10	10	24	8	32	0.01	Rain
12	90	78	64	64	61	55	97	66	31	30.29	30.05	29.94	10	9	2	23	7	28	0.64	Rain
13	84	75	66	65	61	53	93	70	34	30.14	30.06	29.96	10	10	10	12	6	-	0.09	Rain
14	90	76	62	61	57	49	90	55	25	30.02	29.94	29.83	10	10	10	10	6	17	0.00	
15	91	77	63	59	52	37	75	45	15	29.92	29.84	29.76	10	10	10	8	2	-	0.00	
16	95	78	64	57	52	47	73	42	21	29.88	29.82	29.77	10	10	10	13	5	21	0.00	
17	93	78	64	63	55	50	75	47	23	29.95	29.89	29.82	10	10	10	12	6	16	0.00	
18	91	78	64	65	61	55	87	57	30	29.96	29.90	29.81	10	10	10	15	8	17	0.00	
19	90	78	68	72	66	61	94	70	40	30.16	29.97	29.87	10	9	2	16	9	28	0.12	Rain
20	84	74	66	67	65	61	97	78	47	30.27	30.08	29.99	10	10	7	21	9	-	0.04	Rain
21	89	76	64	66	61	55	97	63	32	30.14	30.07	29.98	10	10	10	13	6	18	0.00	
22	91	78	64	61	56	51	87	50	25	30.05	29.98	29.89	10	10	8	15	4	-	0.00	
23	93	78	64	62	57	50	84	51	24	29.94	29.87	29.78	10	10	10	13	6	-	0.00	
24	96	78	64	65	60	55	90	55	29	29.84	29.78	29.69	10	10	10	13	7	21	0.00	
25	93	80	66	67	63	57	94	62	30	30.07	29.82	29.71	10	10	10	14	6	17	0.00	
26	91	78	66	66	64	61	97	67	38	30.08	29.88	29.76	10	10	6	21	10	31	0.12	Rain
27	96	80	68	68	64	57	90	60	29	30.09	29.87	29.79	10	10	8	13	8	18	0.00	
28	90	80	71	70	64	60	88	68	39	30.31	30.05	29.87	10	9	2	34	9	38	0.11	Rain
29	91	78	66	64	53	36	87	51	15	30.16	30.06	29.96	10	10	10	10	6	16	0.00	
30	93	74	57	51	45	36	75	40	15	30.04	29.96	29.86	10	10	10	13	6	18	0.00	
31	93	78	62	55	48	41	70	38	16	29.93	29.86	29.79	10	10	10	14	8	20	0.00	
1998	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
Sep	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	high	sum	
1	91	76	63	61	52	48	66	45	27	29.91	29.86	29.80	10	10	10	18	4	-	0.00	Rain
2	93	78	64	58	53	47	70	46	21	29.91	29.83	29.74	10	10	4	14	6	21	0.00	
3	91	78	64	53	48	42	63	38	18	29.86	29.81	29.76	10	10	9	16	5	18	0.00	
4	96	80	64	52	48	46	58	38	19	29.94	29.87	29.82	10	10	10	14	6	26	0.00	
5	93	78	64	57	51	48	61	40	23	30.08	29.94	29.87	10	10	10	21	8	26	0.00	
6	93	78	64	57	50	44	63	40	20	30.15	29.95	29.86	10	10	10	16	5	22	0.00	
7	93	76	62	54	46	41	58	36	20	29.97	29.89	29.80	10	10	10	13	4	17	0.00	
8	93	77	61	50	46	43	62	35	18	29.89	29.81	29.73	10	10	10	12	5	-	0.00	
9	75	72	70	62	56	49	66	56	44	30.11	30.04	29.81	10	10	10	20	7	30	0.00	
10	91	76	64	60	57	54	76	53	31	30.13	29.95	29.81	10	10	10	12	8	-	0.00	

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1998	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
11	88	74	61	53	48	45	60	41	25	30.08	29.88	29.81	10	10	7	10	4	-	0.00	
12	89	75	62	57	53	47	73	49	27	29.91	29.81	29.71	10	10	10	9	4	-	0.00	
13	95	78	62	57	51	48	67	42	23	29.76	29.67	29.58	10	10	10	9	5	-	0.00	
14	93	80	66	62	51	43	78	40	21	29.97	29.74	29.62	10	10	7	24	9	41	0.06	Rain
15	88	77	66	62	57	51	84	56	29	30.01	29.95	29.87	10	10	10	16	9	21	0.00	Rain
16	87	74	62	59	55	50	84	56	30	30.04	29.96	29.89	10	10	10	15	6	-	0.00	
17	89	74	62	57	54	49	80	51	27	30.03	29.92	29.84	10	10	10	14	4	-	0.00	
18	90	76	61	55	52	50	72	47	26	29.93	29.82	29.70	10	10	10	15	6	22	0.00	
19	95	78	64	56	47	40	67	38	17	29.70	29.63	29.54	10	10	10	16	9	-	0.00	
20	95	78	64	50	45	38	56	31	14	29.69	29.64	29.57	10	10	10	14	7	-	0.00	
21	97	82	68	53	48	42	56	32	19	29.75	29.69	29.62	10	10	10	16	6	23	0.00	
22	84	72	59	61	51	43	81	51	33	30.20	29.94	29.75	10	10	9	21	11	25	0.00	
23	90	76	62	59	57	55	78	58	35	30.01	29.91	29.78	10	10	10	24	9	30	0.00	
24	96	80	64	62	57	46	87	49	20	29.96	29.81	29.72	10	10	7	20	14	26	0.00	
25	96	80	64	64	59	48	87	53	19	29.99	29.74	29.62	10	10	6	23	13	31	0.00	
26	96	79	62	62	52	37	90	44	15	29.85	29.72	29.63	10	10	6	18	13	22	0.00	
27	96	78	61	58	45	36	59	33	15	29.91	29.83	29.75	10	10	10	13	6	-	0.00	
28	91	78	66	64	58	53	73	53	31	29.92	29.85	29.77	10	10	10	14	5	16	0.00	
29	91	77	64	66	59	52	87	61	29	29.96	29.82	29.72	10	9	4	22	6	34	0.13	Rain , Thunderstorm
30	87	75	66	65	62	59	90	75	48	29.89	29.83	29.77	10	10	10	18	10	-	0.05	Rain
1998	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
Oct	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	high	sum	
1	79	70	62	64	62	59	100	87	58	30.14	29.95	29.70	10	7	1	13	7	-	1.54	Rain
2	84	70	57	62	50	38	93	55	21	29.78	29.72	29.66	10	10	10	14	7	21	0.01	
3	90	71	53	52	46	38	86	48	16	29.83	29.72	29.62	10	10	10	21	8	21	0.00	
4	87	74	62	54	47	41	65	43	20	29.79	29.60	29.51	10	10	10	16	11	24	0.00	
5	71	61	51	50	31	14	58	33	12	29.98	29.80	29.54	10	10	10	21	11	26	0.00	
6	72	58	44	39	35	27	79	49	19	30.15	30.07	29.96	10	10	10	9	6	-	0.00	
7	77	60	44	40	35	27	79	47	16	30.26	30.17	30.10	10	10	10	13	5	-	0.00	
8	82	62	44	40	33	28	76	40	15	30.17	30.07	29.98	10	10	10	18	5	23	0.00	
9	86	66	46	39	36	32	68	39	17	30.01	29.92	29.81	10	10	10	12	5	-	0.00	
10	91	70	48	46	39	36	74	41	14	29.88	29.78	29.66	10	10	10	23	9	32	0.00	
11	88	68	48	48	35	20	74	37	8	30.06	29.92	29.74	10	10	10	13	7	-	0.00	
12	80	66	52	57	47	37	81	54	44	30.22	30.11	30.05	10	10	10	13	9	-	0.00	
13	90	72	54	55	48	36	90	53	15	30.08	29.97	29.84	10	10	5	16	5	20	0.00	
14	90	72	55	57	46	35	93	47	15	29.86	29.74	29.60	10	10	6	16	12	21	0.00	
15	91	75	59	59	51	38	93	54	15	29.69	29.57	29.46	10	9	5	25	14	33	0.00	
16	82	67	52	60	36	24	93	39	12	29.66	29.57	29.49	10	10	9	32	17	39	0.00	
17	73	58	43	31	23	15	53	29	11	30.04	29.89	29.74	10	10	10	18	10	25	0.00	

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1998	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
18	70	54	39	33	29	25	63	40	21	30.23	30.13	30.05	10	10	10	13	6	-	0.00	
19	69	61	53	55	41	30	93	53	35	30.24	30.15	30.09	10	10	10	14	5	-	0.09	Rain
20	55	52	48	50	49	48	100	93	80	30.42	30.31	30.15	10	8	1	12	6	-	0.78	Rain
21	53	52	50	50	49	47	100	93	83	30.54	30.44	30.33	10	5	2	12	7	-	0.18	Rain
22	57	54	50	50	49	46	100	88	67	30.57	30.47	30.36	10	6	1	9	4	-	0.01	Rain
23	62	56	50	54	50	46	100	88	75	30.42	30.28	30.14	10	8	2	13	7	-	0.01	Rain
24	70	58	46	56	52	46	100	91	57	30.28	30.17	30.03	10	6	0	10	5	-	0.01	Fog
25	77	64	50	57	54	49	97	77	45	30.06	29.97	29.86	10	8	4	20	9	-	0.01	
26	79	68	57	59	56	53	93	75	40	30.11	29.93	29.83	10	9	5	16	12	24	0.00	
27	63	56	48	61	56	48	100	93	87	30.15	30.03	29.90	10	6	1	17	8	24	1.39	Rain
28	71	56	42	52	46	42	100	88	36	30.09	29.99	29.81	10	5	0	7	4	-	0.01	Fog
29	73	58	44	54	47	41	90	70	36	29.96	29.86	29.78	10	10	10	8	5	-	0.00	
30	77	66	55	62	57	52	100	87	56	29.95	29.83	29.63	10	6	0	40	5	46	1.78	Fog , Rain
31	62	55	46	56	51	42	96	86	60	30.05	29.87	29.71	10	10	2	23	11	32	0.04	Rain
1998	**Temp.** (°F)			**Dew Point** (°F)			**Humidity** (%)			**Sea Level Press.** (in)			**Visibility** (mi)			**Wind** (mph)			**Precip.** (in)	**Events**
Nov	**high**	**avg**	**low**	**high**	**avg**	**low**	**high**	**avg**	**low**	**high**	**avg**	**low**	**high**	**avg**	**low**	**high**	**avg**	**high**	**sum**	
1	60	52	43	49	42	38	90	73	53	30.04	29.94	29.83	10	10	10	13	7	-	0.00	
2	61	51	41	50	45	39	96	79	62	29.93	29.85	29.75	10	10	8	9	4	-	0.00	
3	61	52	43	46	44	40	96	81	56	30.05	29.93	29.83	10	9	3	15	7	-	0.01	
4	48	46	44	46	45	43	100	94	86	30.18	30.09	29.96	10	4	2	10	6	-	0.01	Rain
5	46	44	42	43	42	41	100	94	81	30.19	30.08	29.98	10	6	2	16	11	-	0.02	Rain
6	52	47	42	48	44	41	100	93	80	30.05	29.97	29.86	10	5	0	20	13	21	0.00	Fog
7	64	53	42	45	43	38	100	85	40	30.11	29.99	29.88	10	6	0	20	9	-	0.01	Fog
8	73	55	37	44	39	36	96	61	27	30.06	29.88	29.67	10	10	9	25	8	29	0.00	
9	72	58	44	40	34	18	66	47	23	29.85	29.63	29.39	10	10	8	38	20	51	0.00	
10	57	47	34	28	21	13	79	41	18	30.14	30.06	29.88	10	10	10	17	10	-	0.00	
11	66	47	28	38	31	25	88	59	26	30.21	30.09	29.97	10	10	10	13	6	-	0.00	
12	60	50	39	41	38	36	89	70	47	30.19	30.10	30.01	10	10	10	10	5	-	0.00	
13	63	49	35	39	36	33	92	66	37	30.17	30.07	29.97	10	10	10	9	6	-	0.00	
14	73	54	35	38	34	28	93	56	19	30.07	30.00	29.94	10	10	10	12	3	-	0.00	
15	73	56	39	38	36	34	79	56	24	30.10	29.96	29.84	10	10	10	16	5	-	0.00	
16	73	55	37	39	34	28	83	53	18	30.00	29.92	29.84	10	10	10	15	5	-	0.00	
17	73	55	37	39	36	32	83	57	27	30.05	29.92	29.78	10	10	10	14	5	-	0.00	
18	75	58	42	37	34	28	73	46	18	29.92	29.83	29.78	10	10	10	12	8	-	0.00	
19	70	56	42	37	33	28	71	49	22	30.16	29.97	29.81	10	10	10	14	6	-	0.00	
20	48	42	36	36	34	30	89	72	56	30.31	30.23	30.17	10	10	10	8	5	-	0.00	
21	68	50	32	37	32	27	92	63	21	30.22	30.11	29.99	10	10	9	14	6	-	0.00	
22	75	54	34	35	31	26	82	50	18	30.06	29.99	29.88	10	10	10	9	2	-	0.00	
23	72	54	37	32	29	25	70	45	18	30.24	30.16	30.00	10	10	10	9	4	-	0.00	

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1998	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
24	75	54	33	39	32	27	78	49	24	30.17	30.04	29.89	10	10	8	13	4	-	0.00	
25	71	54	37	34	29	24	79	47	17	30.16	30.09	30.00	10	10	10	9	4	-	0.00	
26	73	54	34	33	31	28	79	50	21	30.20	30.10	30.01	10	10	10	8	3	-	0.00	
27	72	54	36	42	35	28	80	58	29	30.12	30.02	29.94	10	10	10	12	3	-	0.00	
28	75	56	37	47	40	33	83	61	29	30.00	29.88	29.75	10	10	10	16	4	-	0.00	
29	55	50	39	54	46	33	100	83	52	29.94	29.81	29.70	10	7	0	25	7	36	0.19	Fog , Rain
30	64	50	35	41	37	32	89	67	38	30.28	30.17	29.97	10	10	10	8	3	-	0.00	
1998	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
Dec	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	high	sum	
1	64	50	37	41	38	33	89	69	38	30.27	30.16	30.05	10	10	10	15	5	-	0.02	Rain
2	55	50	44	52	47	40	100	89	77	30.10	29.98	29.84	10	7	0	25	5	31	0.00	Fog , Rain
3	60	52	42	49	44	40	100	87	53	29.87	29.80	29.70	10	7	0	17	5	-	0.00	Fog , Rain
4	68	52	36	49	42	36	100	76	40	29.88	29.82	29.76	10	10	5	12	5	-	0.00	
5	73	56	39	43	35	26	89	55	18	29.83	29.72	29.59	10	10	10	22	9	30	0.00	
6	54	46	37	36	28	23	81	53	32	29.84	29.76	29.59	10	10	10	22	13	28	0.00	
7	45	36	28	31	27	24	100	71	44	30.32	30.08	29.81	10	10	7	24	10	31	0.00	
8	46	32	19	25	22	18	92	69	34	30.37	30.26	30.15	10	10	10	14	6	-	0.00	
9	46	35	24	34	27	20	85	68	50	30.27	30.14	30.05	10	10	10	14	5	-	0.00	
10	41	36	32	35	31	25	100	85	60	30.52	30.44	30.28	10	7	0	20	15	29	0.02	Fog , Rain , Snow
11	46	37	28	31	28	25	92	76	46	30.47	30.35	30.25	10	10	9	9	6	-	0.00	
12	55	40	24	30	25	20	92	67	26	30.37	30.30	30.22	10	10	10	7	3	-	0.00	Rain
13	59	44	28	30	27	22	85	62	24	30.46	30.37	30.31	10	10	10	9	5	-	0.00	
14	59	41	23	30	27	20	88	70	31	30.38	30.32	30.19	10	10	10	9	1	-	0.00	
15	55	42	28	32	29	26	92	72	37	30.39	30.31	30.25	10	10	10	10	6	-	0.00	
16	61	44	26	35	29	24	92	66	27	30.45	30.33	30.25	10	10	10	13	5	-	0.00	
17	55	41	27	38	32	25	97	75	47	30.44	30.21	29.88	10	10	10	17	6	-	0.00	
18	71	54	37	43	34	22	100	68	16	29.83	29.70	29.54	10	8	2	32	9	40	0.00	Rain
19	45	38	30	39	34	30	100	87	71	30.11	30.01	29.82	10	8	1	18	9	24	0.00	
20	69	54	39	41	35	19	100	72	15	30.02	29.92	29.76	10	6	0	29	18	38	0.00	Fog
21	48	33	17	34	20	3	82	55	33	30.60	30.07	29.74	10	10	10	25	13	34	0.00	
22	26	18	10	7	3	-1	67	52	37	30.62	30.42	30.19	10	10	10	12	8	-	0.00	
23	30	22	15	9	8	6	71	54	38	30.41	30.31	30.18	10	10	10	10	5	-	0.00	
24	39	29	19	18	15	9	82	62	39	30.49	30.39	30.31	10	10	10	15	6	-	0.00	
25	60	38	15	21	16	12	89	54	20	30.37	30.25	30.13	10	10	10	12	4	-	0.00	
26	63	41	19	27	20	14	78	46	21	30.17	30.03	29.90	10	10	10	13	5	-	0.00	
27	69	51	33	28	22	14	70	40	14	30.14	29.99	29.88	10	10	10	22	6	28	0.00	
28	69	48	28	29	23	19	79	44	16	30.12	29.99	29.83	10	10	10	24	8	39	0.00	
29	64	50	36	27	24	21	60	40	22	30.11	30.05	29.93	10	10	10	12	6	-	0.00	
30	63	46	30	34	30	24	82	59	34	30.04	29.91	29.77	10	10	10	16	4	-	0.00	

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1998	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
31	51	44	37	37	34	32	93	69	54	30.20	30.00	29.78	10	10	10	18	12	-	0.00	

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History for Roswell, NM

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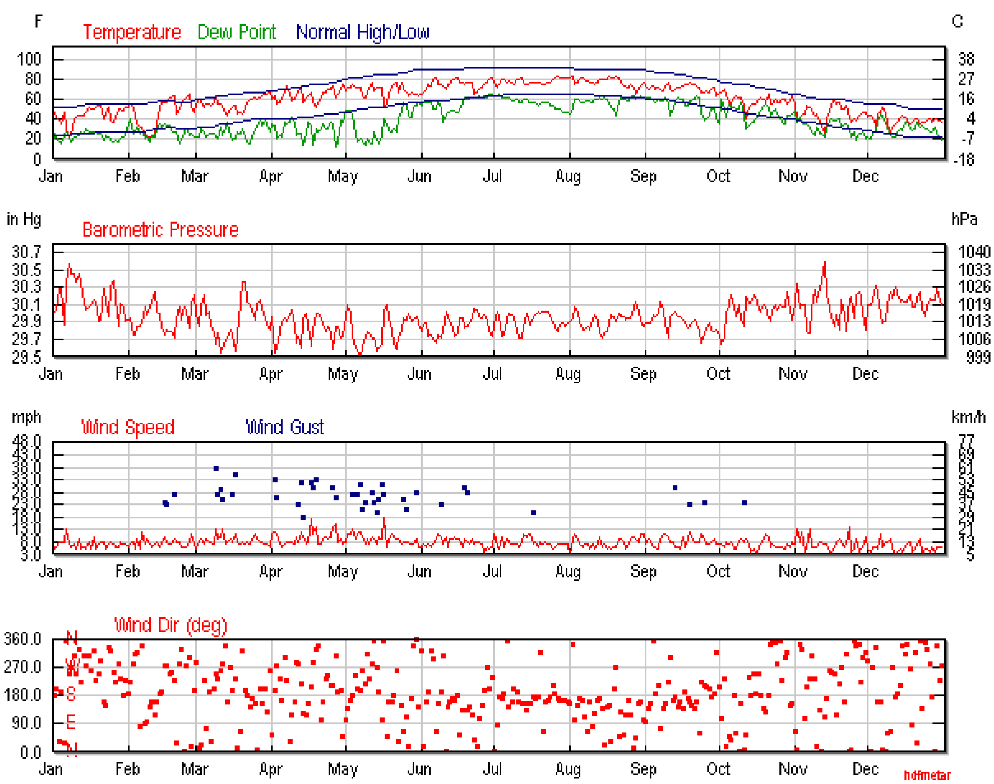
January 1, 1986 through December 31, 1986 — View Current Conditions

January 1, 1986 through December 31, 1986

January 1 1986 - TO - December 31 1986 Go

Daily Weekly Monthly **Custom**

	Max	Avg	Min	Sum
Temperature				
Max Temperature	**102** °F	**74** °F	**24** °F	
Mean Temperature	**84** °F	**61** °F	**20** °F	
Min Temperature	**73** °F	**48** °F	**12** °F	
Degree Days				
Heating Degree Days (base 65)	45	8	0	3091
Cooling Degree Days (base 65)	20	4	0	1596
Growing Degree Days (base 50)	34	13	0	4909
Dew Point				
Dew Point	**69** °F	**40** °F	**4** °F	
Precipitation				
Precipitation	**2.90** in	**0.06** in	**0.00** in	**23.68** in
Snowdepth	**5.0** in	**3.0** in	**1.0** in	-
Wind				
Wind	**53** mph	**8** mph	**0** mph	
Gust Wind	**47** mph	**26** mph	**16** mph	
Sea Level Pressure				
Sea Level Pressure	**30.72** in	**29.96** in	**29.31** in	



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Observations

1986	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
Jan	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	high	sum	
1	64	50	36	37	32	24	73	55	34	30.08	29.98	29.87	15	10	7	12	7	-	0.00	Rain
2	66	46	27	32	21	9	100	49	11	30.14	30.02	29.90	20	9	7	10	5	-	0.00	
3	55	42	28	29	23	14	64	47	33	30.14	30.04	29.92	10	8	7	14	6	-	0.22	
4	50	39	28	25	18	15	59	42	26	30.48	30.29	29.99	10	10	7	17	8	-	0.00	
5	48	36	23	18	16	12	72	47	24	30.48	30.28	30.04	20	11	10	16	8	-	0.00	
6	66	47	28	36	24	15	79	43	23	30.02	29.87	29.71	20	9	7	18	8	26	0.00	Rain
7	41	31	19	37	28	18	100	94	79	30.62	30.37	29.87	10	5	0	17	13	-	0.30	Fog , Rain , Snow
8	33	22	12	30	20	13	100	94	69	30.63	30.58	30.51	15	10	7	9	7	-	0.10	
9	37	24	12	21	17	12	100	75	48	30.56	30.46	30.34	10	9	4	8	6	-	0.00	Fog
10	55	40	24	26	23	19	81	59	32	30.53	30.45	30.38	20	8	6	12	7	-	0.00	Fog
11	59	42	26	26	22	18	81	53	28	30.44	30.36	30.26	15	9	7	9	5	-	0.00	
12	57	44	32	36	24	20	100	53	25	30.53	30.45	30.30	20	10	7	14	9	-	0.00	
13	60	44	27	35	27	20	100	64	32	30.49	30.34	30.15	20	11	10	10	5	-	0.00	
14	60	44	28	33	26	19	89	61	21	30.19	30.12	30.06	10	9	7	9	6	-	0.00	
15	66	47	28	34	30	25	85	59	25	30.11	30.04	29.93	10	10	10	12	5	-	0.00	
16	66	52	37	32	28	19	76	48	17	30.14	30.07	30.00	20	11	7	16	8	26	0.00	
17	70	50	30	31	28	25	82	49	22	30.18	30.09	29.98	10	8	7	14	5	-	0.00	
18	61	51	37	31	28	24	73	43	24	30.29	30.16	29.98	20	9	7	16	10	18	0.00	
19	73	52	30	31	28	24	82	52	16	30.23	30.13	30.00	15	10	7	8	5	-	0.00	
20	77	54	30	30	26	21	79	44	14	30.02	29.90	29.77	20	10	7	12	7	-	0.00	
21	70	54	37	27	25	20	62	35	15	30.19	29.92	29.76	15	9	7	12	8	21	0.00	
22	51	40	30	22	19	16	59	40	25	30.39	30.29	30.21	20	12	10	14	8	-	0.00	
23	64	45	26	28	24	18	78	51	24	30.27	30.11	29.92	10	9	7	13	5	-	0.00	
24	70	52	33	29	23	18	72	42	14	30.11	29.97	29.86	15	11	7	20	7	-	0.00	
25	52	39	26	22	19	17	69	47	26	30.45	30.31	30.10	20	11	10	21	8	23	0.00	
26	54	38	21	18	17	14	72	48	24	30.50	30.39	30.26	20	14	10	16	7	-	0.00	
27	60	42	25	22	19	14	71	47	21	30.33	30.17	29.94	20	10	7	12	6	-	0.00	
28	75	51	27	23	17	9	72	37	8	29.93	29.85	29.75	15	10	10	21	6	24	0.00	
29	61	50	39	24	20	14	55	35	22	30.30	30.12	29.83	20	11	10	16	8	-	0.00	
30	71	49	27	26	23	18	69	43	17	30.20	30.08	29.92	20	11	7	9	7	-	0.00	
31	70	52	33	28	24	22	66	40	18	29.99	29.91	29.83	20	12	7	12	7	-	0.00	
1986	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
Feb	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	high	sum	
1	69	53	37	43	36	29	76	51	33	30.01	29.93	29.86	20	11	10	14	6	-	0.00	
2	64	56	46	46	41	36	77	60	42	30.04	29.94	29.85	20	11	10	15	7	-	0.00	
3	68	52	35	36	25	12	86	45	12	29.90	29.76	29.63	20	11	10	18	8	-	0.00	

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1986	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
4	53	42	30	37	27	20	87	60	31	29.84	29.75	29.67	20	10	7	7	5	-	0.04	Rain
5	43	36	25	36	32	21	96	85	73	29.98	29.86	29.77	20	11	7	21	9	-	0.00	Rain
6	48	33	18	39	25	17	100	74	40	29.98	29.85	29.73	20	7	0	7	5	-	0.00	Fog
7	39	32	25	35	27	19	96	78	61	30.14	29.89	29.70	20	10	6	25	12	33	0.03	Rain , Snow
8	28	24	21	25	21	17	96	86	75	30.15	30.07	29.96	10	6	1	10	7	-	0.10	Fog , Snow
9	28	24	19	27	23	18	100	93	81	30.07	29.99	29.92	7	2	0	14	9	-	0.10	Fog , Snow
10	24	20	16	23	17	12	100	87	74	30.13	30.08	30.02	20	6	0	10	7	-	0.10	Fog , Snow
11	27	24	21	25	24	20	100	95	88	30.22	30.14	30.08	2	1	0	14	6	-	0.00	Fog
12	28	24	19	27	23	17	96	93	85	30.33	30.25	30.16	10	2	0	13	7	-	0.00	Fog
13	46	36	27	37	31	26	96	86	66	30.17	30.02	29.84	7	3	0	12	8	-	0.00	Fog
14	66	52	37	41	35	30	86	57	29	30.10	30.00	29.94	20	9	5	12	6	-	0.00	Fog
15	75	57	39	40	33	23	89	47	14	29.95	29.84	29.71	15	9	7	17	8	25	0.00	
16	71	58	46	40	35	30	71	45	22	29.82	29.76	29.69	20	10	7	18	10	25	0.00	
17	77	58	39	38	32	27	73	41	16	29.94	29.82	29.72	20	10	7	17	8	23	0.00	
18	81	62	43	40	34	28	74	45	14	29.86	29.79	29.73	15	11	7	15	7	-	0.00	
19	82	62	43	37	29	15	74	37	8	29.90	29.80	29.70	15	10	10	16	7	25	0.00	
20	79	64	48	33	27	18	52	29	10	29.79	29.72	29.65	10	10	10	23	9	33	0.00	
21	60	46	33	33	27	19	70	48	26	30.06	29.95	29.80	20	12	7	14	8	-	0.00	
22	68	51	34	24	16	6	56	29	9	30.19	30.07	29.99	7	7	7	13	8	-	0.00	
23	78	56	33	23	19	16	59	30	10	30.03	29.93	29.83	10	10	7	21	6	24	0.00	
24	75	60	45	31	27	23	52	33	15	30.15	30.07	29.94	15	10	10	9	6	-	0.00	
25	84	62	39	33	30	25	68	35	12	30.13	30.02	29.90	20	13	7	12	6	-	0.00	
26	84	65	46	32	24	14	47	26	7	29.93	29.83	29.69	20	12	7	14	8	-	0.00	
27	61	52	44	34	25	21	47	36	24	30.24	30.11	29.80	15	10	10	21	11	31	0.00	
28	64	48	33	25	22	20	65	37	19	30.38	30.21	30.10	20	14	10	14	7	-	0.00	
1986	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
Mar	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	high	sum	
1	81	56	30	27	22	17	76	34	10	30.11	29.98	29.83	10	10	10	10	5	-	0.00	
2	77	60	44	28	23	18	42	24	11	29.92	29.86	29.81	20	11	10	14	8	-	0.00	
3	66	58	50	34	30	26	52	38	24	30.31	30.10	29.92	20	11	7	13	9	-	0.00	Rain
4	68	52	36	32	28	24	79	42	19	30.35	30.21	30.03	20	9	7	14	7	-	0.00	
5	71	55	39	27	23	18	49	33	13	30.14	29.99	29.90	20	11	7	17	9	24	0.00	
6	77	56	35	30	25	16	59	33	15	30.17	30.02	29.86	15	11	7	16	8	-	0.00	
7	66	54	43	27	25	21	49	34	22	29.93	29.86	29.80	20	11	10	17	8	-	0.00	
8	81	58	35	30	26	22	64	34	12	29.92	29.79	29.64	10	10	10	16	7	21	0.00	
9	75	64	52	30	22	12	35	21	11	29.81	29.64	29.54	10	8	5	38	13	46	0.00	
10	71	55	39	26	21	12	38	25	17	29.94	29.78	29.65	10	8	7	21	9	29	0.00	
11	62	55	48	36	32	29	56	44	29	29.65	29.55	29.45	20	11	7	23	10	34	0.00	Rain , Thunderstorm
12	62	54	45	28	24	19	48	34	19	29.67	29.59	29.52	20	12	10	22	13	30	0.00	

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1986	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
13	57	46	36	36	30	21	82	56	36	29.80	29.70	29.62	20	10	7	14	7	-	0.00	
14	52	44	35	45	37	21	89	78	51	29.81	29.72	29.62	20	12	7	18	8	-	0.04	Rain
15	66	50	35	34	23	13	89	41	12	29.88	29.81	29.75	20	11	10	14	9	25	0.00	
16	73	52	30	26	19	13	59	31	10	29.90	29.75	29.59	10	10	10	20	8	30	0.00	
17	66	54	42	30	20	14	55	29	14	29.61	29.57	29.49	20	13	10	29	11	40	0.00	
18	57	46	34	38	28	22	76	53	29	29.99	29.74	29.58	15	10	10	17	8	-	0.02	Rain
19	55	47	39	37	25	17	83	48	23	30.29	30.14	29.99	15	10	7	23	7	34	0.10	Rain
20	57	46	34	37	30	22	93	61	25	30.48	30.36	30.22	20	11	7	14	8	-	0.01	Rain
21	71	50	30	27	23	18	79	40	14	30.49	30.36	30.24	15	10	10	13	7	-	0.00	
22	79	58	37	25	18	12	59	25	8	30.25	30.13	30.01	20	11	10	17	8	-	0.00	
23	81	60	39	22	15	9	43	20	8	30.25	30.10	30.01	10	9	7	10	7	-	0.00	
24	81	61	41	34	23	12	57	28	8	30.17	30.05	29.93	15	11	7	21	9	23	0.00	
25	82	63	44	39	30	14	73	36	10	30.05	29.92	29.81	20	9	7	16	11	-	0.00	
26	75	60	45	41	33	20	58	38	21	30.24	30.12	29.93	20	11	10	16	9	-	0.00	
27	78	62	46	46	41	33	86	50	21	30.26	30.16	30.06	20	11	7	13	8	-	0.00	
28	82	64	46	45	34	21	76	40	13	30.15	30.06	29.97	20	11	10	13	8	-	0.44	
29	79	65	51	45	39	27	69	44	21	30.00	29.94	29.88	20	11	10	23	7	31	0.00	
30	84	66	48	41	35	25	68	36	14	29.96	29.87	29.78	15	10	10	12	7	-	0.00	
31	88	69	50	33	28	23	43	23	10	29.88	29.81	29.74	15	9	7	14	6	-	0.00	
1986	**Temp.** (°F)			**Dew Point** (°F)			**Humidity** (%)			**Sea Level Press.** (in)			**Visibility** (mi)			**Wind** (mph)			**Precip.** (in)	**Events**
Apr	**high**	**avg**	**low**	**high**	**avg**	**low**	**high**	**avg**	**low**	**high**	**avg**	**low**	**high**	**avg**	**low**	**high**	**avg**	**high**	**sum**	
1	71	61	51	42	36	28	57	39	23	30.16	29.97	29.80	15	10	7	18	11	30	0.00	
2	80	64	46	46	34	20	86	43	12	29.79	29.54	29.31	20	12	7	32	12	47	0.00	
3	66	56	46	33	21	12	54	29	15	29.75	29.60	29.52	20	11	10	20	11	26	0.00	
4	73	57	41	29	24	18	51	30	15	29.85	29.79	29.73	20	12	7	12	7	-	0.00	
5	79	60	41	29	22	17	48	26	10	29.97	29.90	29.84	20	11	10	12	6	-	0.00	
6	84	67	50	56	37	19	57	34	21	30.15	29.94	29.83	20	13	10	12	7	-	0.00	
7	91	74	57	45	35	28	58	28	12	29.99	29.90	29.80	10	9	7	21	8	30	0.00	
8	81	66	51	51	38	28	78	37	17	30.20	29.98	29.90	20	12	7	17	8	-	0.30	Rain , Thunderstorm
9	66	59	50	47	42	38	77	58	37	30.21	30.04	29.91	20	11	7	12	8	-	0.01	
10	78	60	41	45	37	27	89	51	15	30.03	29.86	29.70	20	11	7	10	7	-	0.00	
11	80	66	53	36	24	19	41	20	11	29.72	29.66	29.60	15	11	7	17	10	28	0.00	
12	84	67	50	30	26	21	36	23	12	29.82	29.73	29.67	20	13	10	16	8	23	0.00	
13	86	74	61	31	26	11	31	19	12	29.75	29.60	29.48	15	9	5	23	12	39	0.00	
14	75	58	42	21	14	5	27	16	12	30.03	29.92	29.76	10	9	7	15	10	18	0.00	
15	78	63	48	32	25	17	34	24	17	30.12	30.00	29.92	15	11	7	14	7	-	0.00	
16	80	64	48	53	38	28	65	37	23	29.99	29.85	29.71	20	11	5	20	8	36	0.00	Fog , Rain
17	81	68	55	56	34	9	97	40	11	29.80	29.63	29.52	20	9	0	29	17	40	0.00	Fog
18	75	58	42	18	14	10	31	17	11	29.87	29.81	29.71	15	11	7	18	11	30	0.00	

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1986	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
19	61	53	43	36	30	12	65	43	18	30.12	30.00	29.86	20	13	10	25	14	36	0.00	
20	77	57	37	32	28	25	73	37	16	30.09	30.00	29.89	15	10	10	13	7	-	0.00	
21	81	63	45	36	31	23	46	30	17	30.03	29.95	29.90	10	10	10	12	7	-	0.00	
22	87	68	48	43	36	30	59	34	13	29.98	29.87	29.74	15	11	7	18	9	25	0.00	
23	84	68	52	38	31	27	47	26	13	29.92	29.80	29.72	20	11	7	18	10	-	0.00	Rain , Thunderstorm
24	87	70	52	37	31	24	41	24	10	29.96	29.85	29.75	20	11	10	16	9	-	0.00	
25	82	71	60	48	38	32	64	33	16	29.89	29.77	29.67	20	11	7	20	10	29	0.00	
26	84	74	63	40	35	31	38	26	15	29.67	29.58	29.49	20	12	7	28	14	34	0.00	
27	75	62	48	30	13	7	36	17	7	29.91	29.85	29.70	15	11	7	23	15	29	0.00	
28	87	66	46	25	17	9	24	15	8	29.95	29.85	29.71	15	10	10	17	8	-	0.00	
29	84	70	57	48	39	26	49	32	21	29.88	29.72	29.64	10	10	10	17	9	-	0.00	Rain , Thunderstorm
30	90	76	61	53	38	22	72	34	9	29.83	29.73	29.65	20	13	7	14	7	23	0.00	
1986	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
May	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	high	sum	
1	84	69	54	53	49	45	72	47	26	30.04	29.96	29.85	20	12	7	17	8	-	0.00	
2	82	72	62	55	49	40	78	50	25	30.21	30.10	30.01	20	12	10	17	11	-	0.00	
3	84	72	59	54	49	45	78	49	26	30.13	30.01	29.85	20	10	7	21	11	30	0.00	
4	91	75	59	54	44	21	81	41	12	29.93	29.74	29.55	20	10	7	23	13	30	0.00	
5	90	72	53	49	24	7	67	22	7	29.70	29.61	29.56	15	10	10	18	9	29	0.00	
6	89	72	54	22	18	10	28	13	7	29.68	29.59	29.52	10	10	10	23	11	34	0.00	
7	86	72	57	32	20	12	26	14	8	29.58	29.50	29.39	20	10	7	24	12	37	0.00	
8	75	64	52	30	17	5	40	18	8	29.76	29.62	29.47	10	9	7	18	10	23	0.00	
9	81	62	43	21	14	6	30	17	8	29.83	29.74	29.63	10	10	10	18	7	28	0.00	
10	84	68	53	27	20	5	37	18	9	29.86	29.79	29.73	15	10	7	17	9	-	0.00	
11	91	70	48	25	17	11	29	14	7	29.88	29.77	29.67	15	9	7	16	7	28	0.00	
12	91	77	63	20	15	7	16	9	6	29.78	29.70	29.60	15	10	10	21	10	28	0.00	
13	86	69	52	48	27	8	47	20	10	29.85	29.71	29.62	10	10	10	18	9	25	0.00	
14	88	72	57	29	19	4	32	15	7	29.62	29.56	29.49	10	9	7	18	7	21	0.00	
15	90	72	55	21	15	7	19	10	7	29.70	29.60	29.52	20	11	10	18	10	26	0.00	
16	89	72	55	46	24	9	48	20	8	29.90	29.64	29.55	15	10	2	23	9	37	0.00	Fog
17	62	52	43	45	40	37	89	74	53	30.22	30.04	29.74	20	8	1	23	18	32	0.30	Fog , Rain
18	73	56	39	40	36	32	93	52	22	30.20	30.09	29.98	20	11	10	10	6	-	0.00	
19	86	67	48	39	29	22	54	29	11	30.03	29.95	29.84	10	10	10	17	9	25	0.00	
20	93	73	53	32	28	22	43	21	9	29.89	29.80	29.67	20	11	10	15	11	-	0.00	
21	97	76	55	37	31	24	40	20	9	29.73	29.65	29.55	20	10	7	14	10	-	0.00	
22	93	78	63	37	28	20	32	17	9	29.63	29.58	29.55	20	11	7	16	9	24	0.63	
23	82	68	55	52	40	21	59	33	17	29.84	29.74	29.59	20	11	7	18	9	-	0.00	
24	91	78	64	60	48	35	71	41	15	29.98	29.79	29.68	20	15	5	21	7	34	0.00	

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1986	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
25	79	70	59	61	57	55	90	69	47	30.14	29.95	29.84	20	12	7	17	8	28	0.00	Rain , Thunderstorm
26	77	67	57	58	54	51	93	70	45	30.13	29.93	29.72	20	10	7	14	8	21	0.02	Rain , Thunderstorm
27	72	64	55	52	44	37	83	55	29	30.12	30.00	29.91	20	14	10	12	8	-	0.10	
28	81	67	53	47	43	40	69	42	24	29.99	29.90	29.78	20	12	10	17	7	-	0.00	
29	78	66	55	58	53	48	90	66	36	30.10	29.93	29.83	15	10	7	25	7	30	0.00	Rain , Thunderstorm
30	77	66	55	58	54	50	96	72	42	30.07	29.97	29.85	20	12	1	25	9	28	0.40	Fog , Rain , Thunderstorm
31	69	64	59	59	57	54	96	83	61	30.01	29.88	29.79	20	11	4	14	6	-	0.20	Fog , Rain , Thunderstorm

1986	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
Jun	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	high	sum	
1	77	66	54	59	54	50	93	70	45	29.92	29.80	29.75	20	13	10	14	6	-	0.10	Rain , Thunderstorm
2	77	68	60	59	57	53	90	73	43	30.05	29.87	29.81	20	11	7	13	7	-	0.00	
3	79	70	60	60	58	50	96	72	36	30.06	29.88	29.76	10	5	0	10	6	-	0.00	Fog
4	89	76	63	62	57	51	90	59	30	29.83	29.73	29.64	20	12	10	14	7	-	0.01	Rain , Thunderstorm
5	87	74	61	62	57	52	90	58	31	29.82	29.75	29.67	10	9	7	12	6	-	0.00	
6	95	80	64	58	51	44	75	40	17	29.76	29.69	29.62	10	10	7	12	7	-	0.00	
7	98	82	66	57	50	42	61	37	15	29.88	29.67	29.62	20	10	7	16	9	-	0.00	
8	86	76	64	63	59	51	78	59	40	29.93	29.75	29.60	15	10	7	23	11	34	0.20	Rain , Thunderstorm
9	90	76	61	62	51	27	93	56	11	29.90	29.71	29.58	15	9	7	14	10	23	0.00	Rain , Thunderstorm
10	89	74	59	46	37	29	51	27	12	29.89	29.80	29.68	10	10	10	9	7	-	0.00	
11	82	70	57	52	46	43	62	41	25	30.09	30.03	29.95	10	10	10	17	10	-	0.00	
12	91	76	60	56	48	35	72	41	14	30.01	29.95	29.86	15	10	10	13	6	-	0.00	
13	91	76	62	59	48	39	72	39	17	29.99	29.92	29.85	20	13	10	14	9	20	0.00	
14	93	80	66	61	49	34	76	38	12	29.93	29.84	29.74	20	12	10	13	9	-	0.00	
15	98	81	64	62	49	40	68	37	17	29.82	29.74	29.66	20	11	10	14	10	-	0.00	
16	100	83	66	58	47	36	68	34	12	30.09	29.78	29.70	10	9	4	17	9	28	0.00	
17	91	78	66	53	49	42	61	38	19	30.01	29.94	29.88	20	12	7	15	9	-	0.00	
18	91	78	63	63	57	51	87	52	27	30.17	29.94	29.78	20	12	5	17	6	29	0.30	Rain , Thunderstorm
19	87	76	64	66	62	58	90	69	37	29.99	29.84	29.77	20	13	7	18	9	30	0.10	Rain , Thunderstorm
20	88	77	66	64	60	50	87	60	33	29.91	29.86	29.81	20	12	10	18	8	28	0.00	
21	90	77	64	64	60	53	87	58	28	29.98	29.89	29.81	20	14	10	14	7	-	0.00	
22	89	78	66	65	63	58	93	69	35	30.10	29.94	29.86	20	14	10	17	9	-	0.00	Rain , Thunderstorm
23	69	66	63	65	62	58	96	88	70	30.20	30.06	29.99	10	8	1	14	7	-	0.70	Fog , Rain
24	73	68	63	66	63	61	97	90	71	30.20	30.04	29.96	15	6	0	17	8	-	1.60	Fog , Rain , Thunderstorm

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1986	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
25	78	71	64	66	64	63	97	86	62	30.11	29.97	29.88	20	8	0	16	8	-	1.80	Fog , Rain , Thunderstorm
26	81	72	64	65	63	60	96	76	54	30.09	29.94	29.88	20	11	5	15	7	-	0.04	Fog , Rain
27	87	76	64	69	64	59	93	69	39	30.04	29.98	29.94	10	9	7	12	4	-	0.00	
28	91	78	66	68	63	55	93	62	29	29.98	29.90	29.80	20	11	7	9	6	-	0.00	
29	93	80	68	69	65	62	90	63	37	30.03	29.80	29.71	15	11	10	10	5	-	0.00	
30	95	83	71	69	65	60	87	61	34	29.92	29.73	29.66	20	14	10	12	6	-	0.00	
1986	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
Jul	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	high	sum	
1	91	78	66	67	64	60	97	66	38	30.14	29.87	29.70	20	10	5	23	11	22	0.50	Fog , Rain , Thunderstorm
2	77	72	66	66	64	61	96	80	58	30.14	30.02	29.97	20	10	5	12	6	-	0.30	Fog , Rain , Thunderstorm
3	82	75	68	68	66	64	96	79	58	30.16	29.97	29.83	20	10	5	12	5	-	0.02	Fog , Rain , Thunderstorm
4	91	80	68	67	63	59	96	62	33	29.83	29.73	29.60	15	10	7	21	10	28	0.00	
5	91	80	70	66	63	58	81	57	32	29.98	29.75	29.68	20	12	7	17	6	-	0.00	
6	89	78	66	65	62	59	87	59	39	30.00	29.93	29.82	20	13	10	13	9	-	0.00	
7	89	79	69	66	62	55	84	60	32	30.06	30.00	29.94	20	14	10	14	8	-	0.00	
8	90	78	66	63	59	52	81	55	28	30.06	29.99	29.91	20	11	7	12	7	-	0.00	
9	87	76	66	61	59	53	76	57	36	30.10	29.94	29.85	20	14	7	17	7	28	0.08	Rain , Thunderstorm
10	91	80	68	64	60	55	87	56	29	29.93	29.80	29.71	20	10	7	13	7	-	0.10	Rain , Thunderstorm
11	95	80	66	63	58	49	84	50	21	29.76	29.71	29.64	10	9	7	14	6	-	0.00	
12	98	82	66	64	58	49	81	47	19	29.76	29.71	29.68	10	8	7	13	8	-	0.00	
13	91	78	66	64	60	54	87	54	27	29.95	29.84	29.77	10	9	7	17	11	-	0.00	
14	84	76	68	63	61	57	81	61	38	30.22	30.00	29.91	20	11	7	15	10	-	0.00	
15	88	76	64	60	58	54	73	53	37	30.00	29.94	29.86	20	12	7	17	11	-	0.00	
16	91	78	66	61	57	52	73	49	27	30.06	29.87	29.78	20	11	10	17	11	25	0.00	
17	90	77	64	59	57	53	78	49	29	30.16	29.94	29.87	15	12	10	18	7	21	0.00	Rain , Thunderstorm
18	91	78	64	60	57	52	81	50	27	30.21	29.99	29.94	15	10	7	14	8	-	0.00	
19	93	78	63	59	54	43	81	47	18	30.08	30.02	29.94	20	11	7	12	6	-	0.00	
20	91	78	64	58	55	51	78	46	26	30.09	30.00	29.88	20	11	10	14	8	-	0.00	
21	84	75	66	62	58	53	76	58	41	30.24	30.02	29.90	20	15	10	14	7	-	0.02	Rain
22	86	76	66	59	57	54	76	53	35	30.17	30.03	29.98	10	8	7	14	8	-	0.00	
23	90	77	64	64	58	51	93	54	28	30.21	30.02	29.92	20	10	7	16	7	-	0.10	Rain , Thunderstorm
24	93	78	64	57	54	49	68	43	22	30.03	29.96	29.89	10	10	10	12	7	-	0.00	
25	98	81	64	59	54	49	78	44	19	29.96	29.90	29.83	15	10	10	18	5	28	0.00	
26	99	82	66	59	51	42	68	38	14	29.93	29.84	29.77	15	12	7	12	6	-	0.00	
27	100	84	69	54	50	42	58	32	14	29.86	29.80	29.76	20	13	7	9	7	-	0.00	

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1986	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
28	99	82	66	53	51	47	61	34	17	30.13	29.87	29.81	10	10	10	10	7	-	0.00	
29	99	82	66	51	47	42	56	31	15	29.95	29.88	29.82	20	11	10	12	7	-	0.00	
30	99	82	66	52	47	38	52	30	13	29.90	29.85	29.78	20	10	7	10	7	-	0.00	
31	97	82	66	54	47	36	56	32	12	29.93	29.88	29.83	15	10	10	14	7	-	0.00	

1986	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
Aug	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	high	sum	
1	98	83	68	51	46	42	47	29	15	29.99	29.91	29.83	20	11	10	13	3	-	0.00	
2	97	84	71	57	51	40	49	33	21	30.25	29.94	29.85	15	12	7	25	9	32	0.00	Rain , Thunderstorm
3	88	76	64	64	60	55	90	60	32	30.30	30.07	29.94	20	10	7	17	11	-	0.10	Rain , Thunderstorm
4	90	77	64	64	61	57	93	63	33	30.27	30.01	29.85	20	11	7	26	9	34	0.10	Rain , Thunderstorm
5	93	80	66	64	59	48	87	56	21	30.20	29.89	29.78	10	10	5	9	7	-	0.00	Fog , Rain , Thunderstorm
6	95	82	69	61	57	53	73	45	26	29.85	29.81	29.75	20	11	7	13	6	-	0.04	
7	93	81	69	63	58	55	71	47	27	29.86	29.82	29.79	10	9	7	14	7	-	0.00	
8	90	79	68	61	59	56	76	55	34	30.10	29.86	29.79	20	11	7	17	7	-	0.00	
9	91	78	66	61	59	53	81	53	33	30.00	29.81	29.73	15	12	7	18	5	-	0.00	
10	89	78	66	61	58	54	81	55	31	30.00	29.93	29.83	20	13	7	10	7	-	0.00	
11	89	76	64	63	61	58	84	59	35	30.24	29.99	29.90	20	14	10	10	5	-	0.00	
12	91	78	66	64	60	57	81	54	31	29.99	29.90	29.79	20	12	10	12	7	-	0.00	
13	91	81	71	66	62	59	73	54	33	29.92	29.78	29.67	20	12	7	16	10	23	0.01	Rain , Thunderstorm
14	91	80	70	65	61	55	81	54	30	29.78	29.71	29.65	20	11	10	10	6	-	0.10	
15	91	81	71	66	62	57	84	56	32	30.01	29.78	29.67	20	12	10	17	7	-	0.00	Rain , Thunderstorm
16	96	81	66	66	61	49	90	56	21	29.85	29.79	29.73	10	9	7	13	5	-	0.00	
17	97	84	70	61	55	48	68	41	19	29.94	29.88	29.81	20	10	7	14	6	-	0.00	
18	97	82	66	57	52	49	59	37	20	30.06	29.99	29.92	20	14	7	12	5	-	0.00	
19	98	82	66	56	50	43	61	35	16	30.08	29.97	29.90	15	11	10	13	6	-	0.00	
20	102	84	66	51	44	34	49	27	10	29.97	29.90	29.82	20	12	10	8	6	-	0.00	
21	91	82	73	62	58	39	62	45	20	30.32	30.00	29.88	20	14	7	14	9	-	0.00	
22	88	77	66	67	63	60	90	66	39	30.21	29.96	29.85	20	10	7	21	9	32	0.50	Rain , Thunderstorm
23	81	74	66	66	61	55	93	69	41	30.02	29.97	29.91	10	8	3	22	8	-	0.10	Rain
24	84	74	64	64	61	55	96	71	37	30.00	29.93	29.86	10	6	2	18	5	-	0.00	Fog
25	84	72	61	63	59	54	97	68	37	30.13	29.95	29.84	20	9	3	14	7	-	0.00	Fog
26	88	76	64	66	62	57	93	70	35	30.18	29.95	29.83	20	9	1	17	9	-	0.90	Fog , Rain , Thunderstorm
27	79	72	66	66	64	61	93	79	54	30.24	30.06	29.98	20	8	2	16	10	-	0.40	Fog , Rain
28	68	66	63	64	61	59	97	89	81	30.25	30.13	30.08	10	5	2	14	9	-	0.20	Fog , Rain
29	78	71	64	65	63	61	96	82	60	30.22	30.02	29.87	15	7	3	14	8	-	0.03	Fog

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1986	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
30	84	74	64	66	64	62	97	75	51	30.10	29.91	29.79	20	10	2	17	11	-	0.10	Fog , Rain , Thunderstorm
31	88	77	64	66	63	53	100	70	38	30.04	29.86	29.74	20	10	1	16	11	23	0.10	Fog , Rain , Thunderstorm

1986	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
Sep	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	high	sum	
1	84	74	63	65	62	58	97	71	46	30.06	29.88	29.76	20	11	7	20	7	-	0.60	Rain , Thunderstorm
2	81	70	60	65	62	57	97	78	55	30.07	29.89	29.78	20	9	3	15	9	-	1.60	Fog , Rain , Thunderstorm
3	80	72	63	65	62	59	93	75	54	29.95	29.89	29.85	20	9	7	12	8	-	0.00	
4	86	74	62	63	59	54	97	70	38	30.18	29.99	29.86	20	8	0	28	6	41	1.00	Fog , Rain , Thunderstorm
5	82	70	57	63	58	55	97	71	42	30.09	29.97	29.88	15	11	0	9	6	-	0.00	Fog
6	84	73	62	64	61	57	90	71	41	30.16	30.00	29.90	20	11	0	8	5	-	0.00	Fog , Rain , Thunderstorm
7	79	70	62	61	59	47	93	74	34	30.32	30.14	30.04	20	11	4	15	9	-	0.02	Fog , Rain
8	77	69	61	60	59	56	93	76	52	30.25	30.05	29.90	20	7	3	16	11	-	0.00	Fog
9	86	74	63	64	62	57	93	72	40	30.08	29.87	29.69	20	7	2	17	11	-	0.00	Fog , Rain , Thunderstorm
10	88	78	69	64	55	47	78	51	25	29.79	29.71	29.64	20	10	7	16	10	21	0.00	
11	81	70	59	49	44	38	60	40	22	30.06	29.96	29.80	15	10	7	12	8	-	0.00	
12	84	69	54	65	51	47	81	55	31	30.07	30.00	29.92	15	11	10	17	8	23	0.00	
13	81	71	61	64	59	53	87	73	56	30.19	30.02	29.95	20	11	10	18	6	30	0.04	Rain , Thunderstorm
14	82	72	63	64	62	60	97	75	49	30.04	29.97	29.88	15	9	7	12	6	-	0.00	
15	87	73	59	64	60	51	97	70	29	30.12	29.96	29.86	20	10	3	13	5	-	0.00	Fog
16	84	74	63	63	60	53	93	68	43	30.04	29.93	29.85	15	11	7	14	10	-	0.00	Rain , Thunderstorm
17	91	75	59	60	54	45	93	57	22	30.08	29.88	29.77	20	11	7	10	6	-	0.00	
18	91	76	61	62	54	45	84	51	20	29.95	29.83	29.74	20	12	10	21	9	25	0.00	Rain , Thunderstorm
19	93	78	64	65	59	50	97	60	23	30.07	29.86	29.78	15	7	1	16	12	23	0.00	Fog
20	90	76	63	62	59	54	90	61	30	29.95	29.88	29.82	15	10	10	17	10	-	0.00	
21	89	76	63	64	61	54	93	66	30	30.14	29.93	29.82	20	10	3	14	8	-	0.00	Fog
22	84	74	64	66	64	60	93	74	47	30.08	29.89	29.80	20	10	5	10	8	-	0.10	Fog , Rain , Thunderstorm
23	82	72	62	66	63	58	93	81	49	29.98	29.80	29.70	20	9	4	41	8	-	0.30	Fog , Rain , Thunderstorm
24	79	67	55	59	45	20	96	57	11	29.74	29.66	29.60	20	10	6	28	11	38	0.00	Fog , Rain
25	82	67	52	49	39	27	67	42	14	29.82	29.77	29.71	20	12	10	18	9	25	0.00	
26	84	69	54	48	41	35	72	43	18	29.91	29.84	29.77	20	11	7	12	7	-	0.00	
27	86	68	50	49	44	39	80	47	20	30.05	29.89	29.80	15	10	10	14	7	23	0.00	
28	84	70	57	62	53	44	93	61	25	30.02	29.81	29.68	15	11	10	23	8	-	0.00	
29	84	72	60	65	51	33	97	56	18	29.99	29.79	29.66	10	4	1	18	9	25	0.10	Fog , Rain , Thunderstorm

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1986	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
30	81	64	48	49	41	34	68	43	21	29.91	29.81	29.71	10	9	7	12	7	-	0.00	
1986	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
Oct	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	high	sum	
1	87	68	48	40	36	25	71	37	10	29.83	29.75	29.64	20	11	7	18	7	24	0.00	
2	72	68	63	66	61	45	93	84	45	29.79	29.64	29.57	20	14	10	9	7	-	0.07	Rain
3	82	70	57	60	50	43	97	61	25	29.88	29.74	29.64	20	11	7	21	6	29	0.00	
4	75	64	53	52	42	37	75	48	28	30.08	30.00	29.89	20	12	10	12	8	-	0.00	
5	62	58	55	58	56	51	97	91	75	30.28	30.10	29.96	10	4	1	12	7	-	0.10	Fog , Rain
6	60	56	51	54	52	50	97	87	72	30.34	30.22	30.16	20	6	1	53	8	-	0.10	Fog , Rain
7	73	62	50	55	52	50	100	75	46	30.21	30.07	29.92	15	6	0	12	5	-	0.00	Fog
8	82	64	46	54	49	41	100	68	26	30.11	29.96	29.86	10	5	0	8	5	-	0.00	Fog
9	73	63	53	56	51	46	93	67	45	30.26	30.09	29.93	20	11	3	16	8	-	0.20	Fog , Rain , Thunderstorm
10	68	62	57	61	58	53	97	89	70	30.18	29.92	29.72	15	6	0	23	9	34	2.90	Fog , Rain , Thunderstorm
11	64	54	44	53	45	33	100	78	60	30.10	29.86	29.70	20	6	0	17	8	25	0.00	Fog , Rain , Thunderstorm
12	43	40	37	33	31	29	76	72	65	30.26	30.19	30.13	10	7	3	12	9	-	0.00	Fog
13	66	52	37	37	34	26	89	59	22	30.22	30.11	29.98	10	8	7	14	7	-	0.00	
14	72	54	36	40	35	29	86	56	20	30.18	30.11	30.05	15	10	10	9	4	-	0.00	
15	71	55	39	43	38	36	89	59	29	30.30	30.22	30.14	15	9	7	12	5	-	0.00	
16	68	56	45	46	41	37	83	61	32	30.28	30.19	30.11	20	10	7	9	3	-	0.00	
17	75	60	44	52	46	41	90	68	34	30.11	30.04	29.93	20	12	10	12	6	-	0.18	Rain , Thunderstorm
18	79	62	46	54	49	45	100	73	30	30.16	30.02	29.91	15	8	0	16	7	-	0.00	Fog
19	63	60	57	56	54	52	96	82	67	30.23	30.10	30.01	15	6	1	14	9	-	0.00	Fog , Rain , Thunderstorm
20	61	58	55	57	55	53	97	90	81	30.20	30.08	30.00	10	6	1	15	11	-	0.07	Fog , Rain
21	77	66	53	57	53	37	100	77	24	30.08	29.94	29.75	20	6	0	15	10	23	0.87	Fog , Rain , Thunderstorm
22	69	56	44	49	42	34	90	63	29	30.01	29.91	29.85	15	8	1	8	6	-	0.00	Fog
23	66	56	46	53	47	40	86	71	54	30.22	30.03	29.90	20	10	7	13	7	-	0.00	Rain , Thunderstorm
24	68	60	51	52	50	48	93	77	50	30.24	30.09	29.99	20	12	7	8	6	-	0.00	
25	69	58	46	50	46	43	97	71	40	30.15	30.05	29.99	20	13	6	9	6	-	0.00	Fog
26	71	58	45	45	42	37	93	65	31	30.17	30.10	30.05	15	9	7	8	6	-	0.00	
27	75	60	44	43	38	30	85	55	19	30.17	30.08	30.00	10	10	10	9	6	-	0.00	
28	82	60	39	41	35	25	86	50	12	30.18	30.08	29.99	10	10	10	14	5	-	0.00	
29	64	55	46	48	44	39	83	65	48	30.32	30.24	30.18	15	11	7	9	7	-	0.00	
30	75	59	43	47	44	40	93	65	32	30.18	30.05	29.91	15	12	7	13	6	-	0.00	
31	79	64	48	50	46	39	100	64	24	30.07	29.93	29.82	20	8	0	14	8	-	0.00	Fog
1986	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
Nov	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	high	sum	

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1986	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
1	68	56	42	62	49	37	97	77	55	30.33	30.12	29.96	15	8	4	17	7	23	0.00	Fog
2	41	39	37	40	38	36	100	95	89	30.44	30.35	30.25	10	3	1	17	13	-	0.51	Fog , Rain
3	46	42	39	46	42	39	100	95	89	30.25	30.06	29.93	15	5	1	14	8	-	0.98	Fog , Rain , Thunderstorm
4	50	44	36	41	37	33	93	81	61	30.15	30.10	30.06	15	8	5	21	12	-	0.14	Fog , Rain
5	62	46	30	40	35	30	96	72	41	30.19	30.09	29.97	15	8	1	7	4	-	0.00	Fog
6	72	54	35	43	36	30	93	64	21	29.96	29.79	29.65	10	10	7	14	6	-	0.10	
7	62	52	41	40	32	21	74	48	21	29.95	29.77	29.63	20	12	10	25	13	38	0.00	
8	64	49	34	31	27	22	73	50	21	30.20	30.05	29.96	20	11	10	12	6	-	0.00	
9	55	44	32	30	24	14	75	51	19	30.40	30.26	30.15	20	13	10	12	6	-	0.00	
10	60	45	28	39	32	19	89	67	46	30.40	30.13	30.01	20	11	10	14	6	-	0.00	
11	50	38	26	34	26	17	92	67	50	30.41	30.29	30.14	10	10	10	12	8	-	0.00	
12	41	34	26	33	25	18	96	77	57	30.71	30.39	30.09	10	8	0	23	8	36	0.00	Fog
13	28	26	24	24	22	19	91	84	75	30.72	30.59	30.34	10	5	1	12	7	-	0.13	Fog , Rain , Snow
14	53	40	27	37	30	24	96	82	55	30.37	30.22	30.09	20	7	0	8	7	-	0.00	Fog
15	59	48	36	44	39	34	93	77	53	30.14	30.06	29.99	20	11	3	7	4	-	0.00	Fog
16	71	55	39	45	40	35	97	66	27	30.01	29.96	29.91	20	12	7	9	4	-	0.00	
17	75	60	45	42	39	33	80	51	22	29.94	29.86	29.78	20	10	7	12	6	-	0.00	
18	63	56	50	43	39	34	74	55	34	30.11	29.99	29.84	10	10	10	14	8	-	0.00	
19	73	58	43	48	41	36	93	60	26	29.91	29.82	29.67	15	11	5	14	9	-	0.06	Fog , Rain
20	61	50	39	38	33	26	80	54	31	30.25	30.15	29.92	15	12	7	14	8	24	0.00	
21	66	50	33	42	36	30	89	67	36	30.14	29.99	29.83	20	10	7	12	6	-	0.00	
22	73	54	36	43	35	24	93	58	17	29.86	29.79	29.69	20	11	10	16	7	-	0.00	
23	48	40	30	37	31	25	93	77	57	30.33	30.17	29.83	15	9	2	20	14	23	0.10	Fog , Rain , Snow
24	52	38	25	26	23	18	89	63	28	30.33	30.20	30.04	15	9	7	8	4	-	0.00	
25	61	41	21	34	27	19	91	64	33	30.11	29.95	29.80	20	10	7	16	5	23	0.00	
26	48	39	30	27	19	14	69	48	27	30.28	30.21	30.12	20	11	7	12	9	-	0.00	
27	61	44	26	31	26	20	82	61	30	30.32	30.25	30.17	15	11	7	8	4	-	0.00	
28	66	46	27	32	26	19	85	56	18	30.27	30.18	30.09	20	11	7	8	5	-	0.00	
29	69	48	28	32	27	21	85	55	17	30.15	30.00	29.82	20	10	7	13	6	-	0.00	
30	62	48	34	28	21	11	79	39	15	29.99	29.82	29.72	20	9	7	23	10	31	0.00	
1986	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
Dec	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	high	sum	
1	57	42	27	28	22	17	85	53	22	30.20	30.09	29.99	20	10	7	16	5	-	0.00	
2	66	44	23	25	20	16	85	48	16	30.17	30.10	30.04	10	10	10	9	4	-	0.00	
3	55	42	28	28	26	22	81	58	30	30.23	30.15	30.06	20	11	10	9	6	-	0.00	
4	42	34	27	34	29	23	85	77	70	30.40	30.32	30.15	15	10	5	12	6	-	0.00	Fog
5	52	46	39	41	37	34	100	78	59	30.37	30.23	30.10	10	6	0	13	5	-	0.00	Fog
6	52	48	44	48	45	43	100	89	74	30.11	29.99	29.87	15	4	0	20	11	-	0.00	Fog , Rain

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1986	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
7	64	52	39	45	42	38	100	74	41	30.04	29.89	29.80	20	7	0	16	6	-	0.00	Fog
8	57	47	36	40	36	25	96	78	28	29.99	29.91	29.78	20	7	0	13	8	-	0.10	Fog , Rain
9	37	35	33	35	33	31	96	89	79	30.20	30.09	29.99	10	4	1	13	8	-	0.00	Fog
10	32	28	25	31	24	21	96	87	72	30.34	30.24	30.18	15	4	1	14	9	-	0.10	Fog , Rain , Snow
11	41	32	24	27	23	19	96	75	53	30.30	30.18	30.10	10	8	5	9	5	-	0.00	Fog
12	50	36	21	31	23	17	96	67	33	30.38	30.30	30.24	15	8	6	12	3	-	0.00	
13	53	38	24	32	28	21	92	73	41	30.31	30.23	30.14	20	10	7	8	4	-	0.00	
14	57	42	26	35	31	23	96	76	37	30.20	30.14	30.04	20	9	0	8	5	-	0.00	Fog
15	62	44	26	33	29	22	86	66	31	30.21	30.15	30.09	20	12	7	8	4	-	0.00	
16	48	42	35	46	38	31	100	86	68	30.21	30.13	30.08	20	9	3	10	6	-	0.10	Fog , Rain
17	45	39	33	43	38	32	100	96	89	30.25	30.14	30.04	10	3	0	16	7	-	0.20	Fog , Rain , Snow
18	39	36	33	32	31	30	96	86	68	30.30	30.22	30.15	20	9	2	12	8	-	0.10	Fog , Snow
19	52	38	24	38	29	23	100	82	48	30.14	30.07	29.99	20	7	0	9	4	-	0.00	Fog
20	54	41	28	36	31	25	92	72	43	30.15	30.08	30.02	20	12	7	8	5	-	0.00	
21	43	40	37	38	37	36	97	90	76	30.23	30.18	30.13	10	6	1	14	7	-	0.20	Fog , Rain
22	37	35	33	35	33	32	96	95	92	30.31	30.25	30.21	10	3	0	12	9	-	0.40	Fog , Rain , Snow
23	46	37	28	38	34	28	100	94	73	30.20	30.05	29.93	10	2	0	8	3	-	0.00	Fog
24	48	38	28	35	31	27	100	78	43	30.02	29.97	29.93	10	4	0	16	5	-	0.00	Fog
25	48	39	30	33	31	28	92	71	50	30.15	30.07	30.01	20	11	10	8	5	-	0.00	
26	52	40	27	31	27	24	92	70	35	30.26	30.18	30.11	15	9	7	9	4	-	0.00	
27	51	38	26	31	28	22	89	73	41	30.22	30.15	30.09	20	11	7	12	6	-	0.00	
28	50	40	30	37	32	26	92	80	57	30.23	30.15	30.08	20	12	10	8	4	-	0.00	
29	55	40	26	32	25	21	96	63	27	30.37	30.29	30.22	20	11	6	12	6	-	0.00	Fog
30	57	39	21	26	23	17	84	59	22	30.29	30.13	30.00	15	11	7	12	6	-	0.00	
31	51	38	26	23	19	14	78	52	23	30.17	30.09	29.97	15	10	10	17	6	-	0.00	

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Chapter 2 Estimating Runoff

SCS runoff curve number method

The SCS Runoff Curve Number (CN) method is described in detail in NEH-4 (SCS 1985). The SCS runoff equation is

$$Q = \frac{(P - I_a)^2}{(P - I_a) + S} \qquad \text{[eq. 2-1]}$$

where

Q = runoff (in)
P = rainfall (in)
S = potential maximum retention after runoff begins (in) and
I_a = initial abstraction (in)

Initial abstraction (I_a) is all losses before runoff begins. It includes water retained in surface depressions, water intercepted by vegetation, evaporation, and infiltration. I_a is highly variable but generally is correlated with soil and cover parameters. Through studies of many small agricultural watersheds, I_a was found to be approximated by the following empirical equation:

$$I_a = 0.2S \qquad \text{[eq. 2-2]}$$

By removing I_a as an independent parameter, this approximation allows use of a combination of S and P to produce a unique runoff amount. Substituting equation 2-2 into equation 2-1 gives:

$$Q = \frac{(P - 0.2S)^2}{(P + 0.8S)} \qquad \text{[eq. 2-3]}$$

S is related to the soil and cover conditions of the watershed through the CN. CN has a range of 0 to 100, and S is related to CN by:

$$S = \frac{1000}{CN} - 10 \qquad \text{[eq. 2-4]}$$

Figure 2-1 and table 2-1 solve equations 2-3 and 2-4 for a range of CN's and rainfall.

Factors considered in determining runoff curve numbers

The major factors that determine CN are the hydrologic soil group (HSG), cover type, treatment, hydrologic condition, and antecedent runoff condition (ARC). Another factor considered is whether impervious areas outlet directly to the drainage system (connected) or whether the flow spreads over pervious areas before entering the drainage system (unconnected). Figure 2-2 is provided to aid in selecting the appropriate figure or table for determining curve numbers.

CN's in table 2-2 (*a* to *d*) represent average antecedent runoff condition for urban, cultivated agricultural, other agricultural, and arid and semiarid rangeland uses. Table 2-2 assumes impervious areas are directly connected. The following sections explain how to determine CN's and how to modify them for urban conditions.

Hydrologic soil groups

Infiltration rates of soils vary widely and are affected by subsurface permeability as well as surface intake rates. Soils are classified into four HSG's (A, B, C, and D) according to their minimum infiltration rate, which is obtained for bare soil after prolonged wetting. Appendix A defines the four groups and provides a list of most of the soils in the United States and their group classification. The soils in the area of interest may be identified from a soil survey report, which can be obtained from local SCS offices or soil and water conservation district offices.

Most urban areas are only partially covered by impervious surfaces: the soil remains an important factor in runoff estimates. Urbanization has a greater effect on runoff in watersheds with soils having high infiltration rates (sands and gravels) than in watersheds predominantly of silts and clays, which generally have low infiltration rates.

Any disturbance of a soil profile can significantly change its infiltration characteristics. With urbanization, native soil profiles may be mixed or removed or fill material from other areas may be introduced. Therefore, a method based on soil texture is given in appendix A for determining the HSG classification for disturbed soils.

Chapter 3 Time of Concentration and Travel Time

Travel time (T_t) is the time it takes water to travel from one location to another in a watershed. T_t is a component of time of concentration (T_c), which is the time for runoff to travel from the hydraulically most distant point of the watershed to a point of interest within the watershed. T_c is computed by summing all the travel times for consecutive components of the drainage conveyance system.

T_c influences the shape and peak of the runoff hydrograph. Urbanization usually decreases T_c, thereby increasing the peak discharge. But T_c can be increased as a result of (a) ponding behind small or inadequate drainage systems, including storm drain inlets and road culverts, or (b) reduction of land slope through grading.

Factors affecting time of concentration and travel time

Surface roughness

One of the most significant effects of urban development on flow velocity is less retardance to flow. That is, undeveloped areas with very slow and shallow overland flow through vegetation become modified by urban development: the flow is then delivered to streets, gutters, and storm sewers that transport runoff downstream more rapidly. Travel time through the watershed is generally decreased.

Channel shape and flow patterns

In small non-urban watersheds, much of the travel time results from overland flow in upstream areas. Typically, urbanization reduces overland flow lengths by conveying storm runoff into a channel as soon as possible. Since channel designs have efficient hydraulic characteristics, runoff flow velocity increases and travel time decreases.

Slope

Slopes may be increased or decreased by urbanization, depending on the extent of site grading or the extent to which storm sewers and street ditches are used in the design of the water management system. Slope will tend to increase when channels are straightened and decrease when overland flow is directed through storm sewers, street gutters, and diversions.

Computation of travel time and time of concentration

Water moves through a watershed as sheet flow, shallow concentrated flow, open channel flow, or some combination of these. The type that occurs is a function of the conveyance system and is best determined by field inspection.

Travel time (T_t) is the ratio of flow length to flow velocity:

$$T_t = \frac{L}{3600V} \qquad \text{[eq. 3-1]}$$

where:

T_t = travel time (hr)
L = flow length (ft)
V = average velocity (ft/s)
3600 = conversion factor from seconds to hours.

Time of concentration (T_c) is the sum of T_t values for the various consecutive flow segments:

$$T_c = T_{t_1} + T_{t_2} + \dots T_{t_m} \qquad \text{[eq. 3-2]}$$

where:

T_c = time of concentration (hr)
m = number of flow segments

Day and Night Wind Drift and Evaporation Losses in Sprinkler Solid-Sets and Moving Laterals

by

Playán, E. [1], Salvador, R. [2], Faci, J. M. [2], Zapata, N. [2], Martínez-Cob, A. [1] and Sánchez, I. [2]

Abstract

Wind drift and evaporation losses (*WDEL*) represent a relevant water sink in sprinkler irrigation, particularly in areas with strong winds and high evaporative demand. The objectives of this paper include: 1) Characterize *WDEL* under day and night operation conditions for solid-set and moving lateral configurations; 2) Propose adequate predictive equations; and 3) Prospect the effect of sprinkler irrigation on the meteorological variables and on the estimates of reference evapotranspiration. A total of 89 catch can irrigation evaluations were performed in both irrigation systems and

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Table 5. *Selected predictive equations for WDEL. Equations are presented for solid-sets, moving laterals and both irrigation systems; and for day, night and both conditions. Quality indicators are supplied for each equation: R^2 (Determination Coefficient), AMRE (Average Magnitude of the Relative Error) and Pred[0.25] (Prediction level 25 %). Three dependent variables are used in the equations: Wind Speed at an elevation of 2 m (U, m s^{-1}), Relative Humidity (RH, %), and Air Temperature (T, °C).*

Irrigation System	Day or Night	Eq. #	WDEL =	R^2 (%)	SE (%)	AMRE (%)	Pred[0.25] (-)
Solid-Set	All	E15	$20.3 + 0.214\ U^2 - 2.29\ 10^{-3}\ RH^2$	0.80	3.1	0.31	62
		E14	$26.1 + 1.64\ U - 0.274\ RH$	0.79	3.2	0.31	59
		E5	$38.6 - 0.407\ RH$	0.67	3.9	0.37	49
		E23	$4.4 + 3.60\ U^{0.9}$	0.60	4.3	0.51	43
		E4	$5.2 + 2.90\ U$	0.60	4.3	0.51	43
	Day	E13	$20.7 + 0.185\ U^2 - 2.14\ 10^{-3}\ RH^2$	0.75	2.8	0.11	89
		E12	$24.1 + 1.41\ U - 0.216\ RH$	0.69	3.1	0.13	79
		E21	$12.3 + 0.552\ U^{1.6}$	0.59	3.5	0.17	79
		E1	$13.0 + 0.246\ U^2$	0.58	3.5	0.18	79
		E20	$10.5 + 1.89\ U$	0.57	3.5	0.17	74
	Night	E22	$3.2 + 1.84\ U^{1.7}$	0.55	3.2	0.43	56
		E2	$3.7 + 1.31\ U^2$	0.55	3.2	0.42	61
		E3	$29.9 - 0.300\ RH$	0.39	3.7	0.53	28
Moving Lateral	All	E18	$-2.1 + 1.91\ U + 0.231\ T$	0.74	1.8	0.33	58
		E7	$2.7 + 2.31\ U$	0.60	2.2	0.42	54
		E27	$2.4 + 2.70\ U^{0.9}$	0.60	2.2	0.42	56
	Day	E17	$7.0 + 1.65\ U - 1.16\ 10^{-3}\ RH^2$	0.51	1.8	0.17	81
		E16	$8.9 + 1.67\ U - 0.097\ RH$	0.50	1.8	0.17	81
		E25	$5.1 + 1.78\ U^{0.9}$	0.38	2.0	0.20	77
		E24	$5.4 + 1.48\ U$	0.38	2.0	0.20	77
	Night	E26	$3.1 + 0.00600\ U^{9.2}$	0.28	1.2	0.40	43
		E6	$239 / RH$	0.11	1.3	0.45	38
Both Irrigation Systems	All	E11	$3.1 + 2.95\ U$	0.58	3.7	0.49	51
	Day	E8	$8.6 + 0.337\ U^2$	0.51	3.8	0.28	62
		E28	$8.4 + 0.409\ U^{1.9}$	0.51	3.8	0.28	64
		E19	$5.7 + 2.29\ U$	0.51	3.8	0.29	56
	Night	E29	$3.2 + 0.761\ U^{2.6}$	0.59	2.5	0.48	46
		E9	$3.4 + 0.512\ U^3$	0.59	2.5	0.47	46
		E10	$10.3 - 8.97\ 10^{-4}\ RH^2$	0.12	3.7	0.70	36

Calculation Cover Sheet

Daniel B. Stephens & Associates, Inc.

Project Name Triassic Park Landfill Permit Renewal   Project Number ES11.0141

Calculation Number ES11.0141-001   Discipline Hydrology   No. of Sheets ____

PROJECT: Triassic Park Waste Disposal Facility Permit Renewal

SITE: Triassic Park Waste Disposal Facility, Roswell, NM

SUBJECT: Calculate surface water runoff to assess existing channel and culvert sizing.

SOURCES OF DATA:

A. National Oceanic and Atmospheric Association Precipitation Frequency Atlas 14, Volume 1, Version 5.

B. Part A and Part B Permit Application for the Triassic Park Waste Disposal Facility, Chaves County, New Mexico, Appendix F- Surface Water Control System Design and Drawing 25 (Sheet 1 of 2 and Sheet 2 of 2). October 2000.

SOURCES OF FORMULAE & REFERENCES:

1. USDA NRCS Urban Hydrology for Small Watersheds (TR55). June 1986.
2. Hydraulic Engineering, Roberson Cassidy, and Chaudhry, 1998.

[x] Preliminary Calculation   [ ] Final Calculation   Supersedes Calculation No. ____

Rev. No.	Revision	Calculation By	Date	Checked By	Date	Approved By	Date
0		KI	9/21/11	7A	9/27/11	JP	10/2/11

S:\Projects\ES11.0141_Triassic_Park_Permit_Renewal\Engineering\Calculations\Runoff and Channel Sizing\Stormwater Runoff.docx

1.0 OBJECTIVE

The purpose of this calculation is to assess the stormwater conveyance system designed as part of the 2002 permit application for Triassic Park landfill. The design storm for the area has increased from the design storm used in the previous permit (4.3 inches)[B]. This calculation evaluates whether the previously designed channels and culverts can convey the increased runoff resulting from the increase in precipitation.

2.0 GIVEN

The 25-year, 24-hour design storm for the site is 4.39 inches.[A] In the 2002 permit application, the area, curve numbers, and time of concentration of the sub-watersheds associated with the site were determined[B] (Table 1).

Table 1. Characteristics of sub-watershed in Triassic Park storm water calculations

Site	Area (acres)	Curve Number	Time of Concentration (hrs)
Offsite east	377.8	71	0.709
East landfill	32.8	71	0.348
West landfill	77.8	71	0.595
East site	104.1	86	0.852
Very west side/road	4.4	86	0.563
Near evap pond	4.5	86	0.099
North site	15.6	86	0.330
Inside landfill W	2.3	94	0.026
Inside landfill E	6.1	94	0.071
West site	8.3	86	0.166
West site	8.2	71	0.561
West site	9.8	98	0.001
Pond inside landfill	6.6	94	0.046
Roadside ditch	27	71	0.258
Landfill waste	15.6	91	0.070

3.0 METHOD

This calculation utilizes the United States Department of Agriculture's Natural Resource Conservation Service's TR55 method[1]. Specific equations utilized are summarized below.

The runoff resulting from a precipitation event can be calculated using the curve number method:

$$Q_{depth} = \frac{(P - 0.2S)^2}{P + 0.8S} \qquad \text{Eq 1}$$

where

Q_{depth} = runoff (inches)

P = rainfall (inches)

S = potential maximum retention after runoff begins (inches)

In this equation, it is assumed that $S = I_a/0.2$, where I_a is the initial abstraction.

S is related to the soil and cover conditions of the watershed by the curve number (CN):

$$S = \frac{1000}{CN} - 10 \qquad \text{Eq 2}$$

The depth of runoff obtained with Equations 1 and 2 is converted to a volume by multiplying by the area of the watershed (A_{ws}):

$$Q_{runoff} = Q_{depth} * A_{ws} \qquad \text{Eq 3}$$

The 2002 permit application used proprietary software to determine peak discharge. Several industry standard methods, including the one outlined in TR55, were used by DBS&A to attempt to duplicate the peak discharge calculated in the 2002 permit application, without success. Therefore, as peak discharge is linearly related to runoff volume in most methods, the percent increase in runoff volume (Q_{runoff}) for each sub-watershed was applied to the peak discharge calculated in the 2002 permit application to generate the updated peak discharge.

The new peak discharge, along with the channel dimensions, armoring, and slopes from Drawing 25 and Appendix F in the 2002 permit application[B] were entered into Bentley's FlowMaster software. Calculations in FlowMaster for normal depth are based on Manning's equation[2]:

$$Q = \frac{C_m}{n} A R^{2/3} S_O^{1/2} \qquad \text{Eq 4}$$

where:

C_m = unit conversion coefficient, 1.486 for English units (unitless)

n = Manning's roughness coefficient (unitless)

A = cross-sectional area (ft^2)

R = hydraulic radius (ft.) = A/P

S_O = longitudinal slope (ft./ft.)

Q = channel discharge (ft^3/s)

The Manning's roughness coefficient is taken from the 2002 permit application for the material types indicated in the previous design.

4.0 SOLUTION

The runoff and peak discharge were calculated for the 25-year, 24-hour storm following the method presented above. The 25-year, 24 hour storm calculation for the area east of the site is presented in detail; results of calculations from all the sub-watersheds are summarized below.

The NOAA Precipitation Frequency Atlas for Roswell, NM gives the 25-year, 24-hour precipitation event as 4.39 inches[A]. The east ditch captures and routes offsite runoff from an area, A_{ws}, of 377.8 acres, with a curve number of 71. The potential maximum retention after runoff begins is calculated with Equation 2:

$$S = \frac{1000}{71} - 10 = 4.08$$

Equation 1 is used to calculate the runoff depth in inches from the design storm:

$$Q_{depth} = \frac{(4.39 - 0.2 * 4.08)^2}{4.39 + 0.8 * 4.08} = 1.67\ inches$$

The volume of runoff is determined with Equation 3:

$$Q_{runoff} = 1.67 in * 377.8\ acres * \frac{1 ft}{12 in} = 52.49\ acre - ft$$

The runoff volume of 50.47 acre-ft was calculated in the 2002 permit application[B]. The percent increase in runoff is:

$$\frac{52.49 - 50.47}{50.47} = 4\%$$

The peak discharge calculated in the 2002 permit application was 272.8 cubic feet per second (cfs); therefore the peak discharge is now:

272.8 cfs * 1.04% = 283.7 cfs

The percent increase in runoff volume for each sub-watershed was applied to the previous peak discharge to generate the new peak discharge (Table 2). Only channelized runoff peak discharge results are shown.

Table 2. Peak discharge comparison between previous permit and new calculation

Basin	Conveyance Channel	Previous Peak Discharge (cfs)	New Peak Discharge (cfs)
Offsite east	East	272.8	283.7
East landfill	Ditch 1	34.2	35.6
West landfill	Ditch 2	62.2	64.7
East site	Ditch 3	126.6	130.3
Very west side/road	Ditch 4	6.8	7.0
Near evap pond	Ditch 5	217.3	223.1
North site	Ditch 6	30.1	30.9
Inside landfill W	Ditch 7	7.3	7.5
Inside landfill E	Ditch 8	19.3	19.8
Roadside ditch	Final Cover Road Side	31.5	32.7
Spillway	Spillway	358	372

The calculated peak discharge is then used to evaluate whether any modifications are required to the planned drainage network. The new peak discharge, along with the channel dimensions, armoring, and slopes from the previous permit[B] were entered into Bentley's FlowMaster software. Calculations in FlowMaster for normal depth are based on Equation 4.

The Manning's roughness coefficient, *n*, for each channel lining type was taken from the calculations in the 2002 permit application. In the original permit the flow depth was calculated with the minimum grade of the channel (which produces the largest depth of flow); the velocity was calculated with the maximum grade of the channel (giving the fastest velocities). The same technique was used to evaluate the existing channels with the new peak discharge: for the given discharge the depth was calculated with the minimum slope given on Drawing 25 Sheet 2 of 2[B] and the velocity was calculated with the maximum slope given on Drawing 25 Sheet 2 of 2[B]. The resultant depths and velocities calculated by FlowMaster are summarized in Tables 3 and 4.

Table 3. Flow depth associated with 25-yr, 24 hour storm, calculated with minimum channel slope.

Basin	Conveyance Channel	Peak Discharge (cfs)	Slope (ft/ft)	Flow Depth (ft)
Offsite east	East	283.7	0.005	2.6
East landfill	Ditch 1	35.6	0.005	2.1
West landfill	Ditch 2	64.7	0.005	2.6
East site	Ditch 3 - Part 1	130.3	0.005	2.2
	Ditch 3 - Part 2	130.3	0.011	2.1
Very west side/road	Ditch 4	7.0	0.005	1.1
Near evap pond	Ditch 5	223.1	0.005	2.3
North site	Ditch 6	30.9	0.005	2.0
Inside landfill W	Ditch 7 - Lower	7.5	0.010	0.9
	Ditch 7 - Upper	7.5	0.100	0.6
Inside landfill E	Ditch 8 - Lower	19.8	0.010	1.3
	Ditch 8 - Upper	19.8	0.100	0.9
Roadside ditch	Final Cover Road Side	32.7	0.005	1.8
Detention Basin Overflow	Spillway	372	0.005	2.7

Table 4. Velocity associated with 25-yr, 24 hour storm, calculated with maximum channel slope.

Conveyance Channel	Peak Discharge (cfs)	Slope (ft/ft)	Velocity (ft/sec)
East	283.7	0.008	5.6
Ditch 1	35.6	0.020	6.7
Ditch 2	64.7	0.010	6.1
Ditch 3 - Part 1	130.3	0.010	6.6
Ditch 3 - Part 2	130.3	0.020	6.7
Ditch 4	35.6	0.010	3.5
Ditch 5	64.7	0.010	7.3
Ditch 6	30.9	0.010	5.1
Ditch 7 - Lower	7.5	0.010	6.0
Ditch 7 - Upper	7.5	0.100	14.2
Ditch 8 - Lower	19.8	0.010	7.6
Ditch 8 - Upper	19.8	0.100	18.1
Final Cover Road Side	32.7	0.024	5.8
Spillway	372	0.005	5.0

Project No. ES11.0141 Date 09/21/11

Subject Surface water runoff and channel sizing Sheet 6 of 6

By K Isaacson Checked By Calculation No. ES11.0141-001

Based on the new depths and velocities, the planned channels as designed in the 2002 permit application will convey the increase in runoff. All but one channel has freeboard of one foot; in one channel the freeboard is less than one foot but greater than 0.5 foot.

All new peak discharges are below the capacity of the culverts (Table 5) as designed in the 2002 permit application. Therefore, no modifications are required to the culverts.

Table 5. Culvert capacity and peak discharge comparison

Conveyance Channel	Culvert Capacity (cfs)	New Peak Discharge (cfs)
East	310	283.7
Ditch 1	100	35.6
Ditch 2	100	64.7
Ditch 3	150	130.3
Ditch 4	9	35.6
Ditch 5	270	64.7
Ditch 8	50	19.8

Triassic Park Triangular Channels - Shallow Slope Report

Label	Roughness Coefficient	Channel Slope (ft/ft)	Discharge (ft^3/s)
Ditch 1	0.025	0.00500	34.20
Ditch 2	0.025	0.00500	64.70
Ditch 4	0.025	0.00500	7.00
Ditch 6	0.025	0.00500	30.90
Ditch 7 - Lower	0.013	0.01000	7.50
Ditch 7 - Upper	0.013	0.10000	7.50
Ditch 8 - Lower	0.013	0.01000	19.80
Ditch 8 - Upper	0.013	0.10000	19.80
Roadside	0.030	0.00500	32.70

	Normal Depth (ft)	Velocity (ft/s)	Left Side Slope (ft/ft (H:V))	Right Side Slope (ft/ft (H:V))
DITCH 1	2.07	3.99	2.00	2.00
2	2.63	4.68	2.00	2.00
4	1.14	2.68	2.00	2.00
6	1.99	3.89	2.00	2.00
7L	0.91	5.99	1.50	1.50
7U	0.59	14.22	1.50	1.50
8L	1.31	7.64	1.50	1.50
8U	0.85	18.13	1.50	1.50
ROAD	1.84	3.20	3.00	3.00

Triassic Park Triangular Channel - Steep Slope Report

Label	Roughness Coefficient	Channel Slope (ft/ft)	Discharge (ft³/s)
Ditch 1	0.025	0.02000	34.20
Ditch 2	0.025	0.01000	64.70
Ditch 4	0.025	0.01000	7.00
Ditch 6	0.025	0.01000	30.90
Ditch 7 - Lower	0.013	0.01000	7.50
Ditch 7 - Upper	0.013	0.10000	7.50
Ditch 8 - Lower	0.013	0.01000	19.80
Ditch 8 - Upper	0.013	0.10000	19.80
Roadside	0.030	0.02400	32.70

Normal Depth (ft)		Velocity (ft/s)	Left Side Slope (ft/ft (H:V))	Right Side Slope (ft/ft (H:V))
1.60	DITCH 1	6.71	2.00	2.00
2.31	2	6.07	2.00	2.00
1.00	4	3.48	2.00	2.00
1.75	6	5.05	2.00	2.00
0.91	7L	5.99	1.50	1.50
0.59	7U	14.22	1.50	1.50
1.31	8L	7.64	1.50	1.50
0.85	8U	18.13	1.50	1.50
1.37	ROAD	5.77	3.00	3.00

Triassic Park Trapezoidal Channels - Shallow Slope Report

Label	Roughness Coefficient	Channel Slope (ft/ft)	Discharge (ft^3/s)
Ditch 3 - Part 1	0.025	0.00500	130.30
Ditch 3 - Part 2	0.035	0.01100	130.30
Ditch 5	0.025	0.00500	223.10
East	0.034	0.00500	283.70
Spillway	0.034	0.00500	372.00

	Normal Depth (ft)	Velocity (ft/s)	Left Side Slope (ft/ft (H:V))	Right Side Slope (ft/ft (H:V))
DITCH 3	2.19	5.13	3.00	3.00
3	2.14	5.35	3.00	3.00
5	2.31	5.72	3.00	3.00
EAST	2.55	4.70	3.00	3.00
SPILL	2.68	4.96	3.00	3.00

Bottom Width (ft)
5.00
5.00
10.00
16.00
20.00

Triassic Park Trapezoidal Channels - Steep Slope Report

Label	Roughness Coefficient	Channel Slope (ft/ft)	Discharge (ft^3/s)
Ditch 3 - Part 1	0.025	0.01000	130.30
Ditch 3 - Part 2	0.035	0.02000	130.30
Ditch 5	0.025	0.01000	223.10
East	0.034	0.00800	283.70
Spillway	0.034	0.00500	372.00

Normal Depth (ft)		Velocity (ft/s)	Left Side Slope (ft/ft (H:V))	Right Side Slope (ft/ft (H:V))
1.86	DITCH 3	6.62	3.00	3.00
1.85	3	6.67	3.00	3.00
1.93	5	7.33	3.00	3.00
2.25	EAST	5.55	3.00	3.00
2.68	SPILL	4.96	3.00	3.00

Bottom Width (ft)
5.00
5.00
10.00
16.00
20.00

A

NOAA Atlas 14, Volume 1, Version 5
Location name: New Mexico, US*
Coordinates: 33.3531, -103.8753
Elevation: 4081 ft*
* source: Google Maps

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.307 (0.265-0.357)	0.397 (0.343-0.461)	0.527 (0.454-0.612)	0.629 (0.540-0.728)	0.766 (0.654-0.884)	0.873 (0.743-1.01)	0.986 (0.834-1.14)	1.10 (0.927-1.27)	1.26 (1.05-1.45)	1.38 (1.14-1.59)
10-min	0.468 (0.403-0.544)	0.604 (0.522-0.702)	0.802 (0.691-0.932)	0.957 (0.822-1.11)	1.17 (0.996-1.34)	1.33 (1.13-1.53)	1.50 (1.27-1.73)	1.68 (1.41-1.93)	1.92 (1.60-2.21)	2.11 (1.74-2.42)
15-min	0.580 (0.500-0.674)	0.748 (0.647-0.870)	0.995 (0.857-1.16)	1.19 (1.02-1.37)	1.45 (1.23-1.67)	1.65 (1.40-1.90)	1.86 (1.57-2.14)	2.08 (1.75-2.39)	2.38 (1.98-2.73)	2.61 (2.16-3.01)
30-min	0.781 (0.673-0.908)	1.01 (0.871-1.17)	1.34 (1.15-1.56)	1.60 (1.37-1.85)	1.95 (1.66-2.25)	2.22 (1.89-2.56)	2.50 (2.12-2.89)	2.80 (2.36-3.22)	3.20 (2.67-3.68)	3.52 (2.91-4.05)
60-min	0.966 (0.833-1.12)	1.25 (1.08-1.45)	1.66 (1.43-1.93)	1.98 (1.70-2.29)	2.41 (2.06-2.78)	2.75 (2.33-3.17)	3.10 (2.62-3.57)	3.46 (2.92-3.99)	3.96 (3.30-4.56)	4.35 (3.60-5.01)
2-hr	1.10 (0.948-1.28)	1.42 (1.23-1.66)	1.91 (1.64-2.23)	2.29 (1.96-2.66)	2.83 (2.40-3.27)	3.25 (2.74-3.74)	3.70 (3.10-4.25)	4.16 (3.46-4.78)	4.80 (3.96-5.52)	5.32 (4.35-6.13)
3-hr	1.18 (1.02-1.36)	1.53 (1.32-1.76)	2.04 (1.76-2.34)	2.45 (2.11-2.80)	3.01 (2.58-3.45)	3.47 (2.95-3.96)	3.95 (3.33-4.50)	4.45 (3.73-5.07)	5.16 (4.27-5.88)	5.73 (4.70-6.53)
6-hr	1.39 (1.22-1.59)	1.78 (1.55-2.04)	2.36 (2.06-2.69)	2.82 (2.45-3.21)	3.47 (3.00-3.94)	4.00 (3.43-4.53)	4.55 (3.88-5.15)	5.14 (4.35-5.81)	5.97 (4.99-6.74)	6.64 (5.50-7.51)
12-hr	1.57 (1.36-1.80)	2.00 (1.75-2.29)	2.64 (2.29-3.02)	3.15 (2.73-3.60)	3.87 (3.33-4.40)	4.45 (3.81-5.05)	5.07 (4.31-5.74)	5.72 (4.83-6.48)	6.63 (5.54-7.52)	7.37 (6.09-8.37)
24-hr	1.78 (1.57-2.00)	2.27 (2.01-2.56)	2.99 (2.64-3.35)	3.57 (3.14-4.00)	4.39 (3.84-4.90)	5.05 (4.39-5.63)	5.75 (4.98-6.41)	6.50 (5.58-7.25)	7.55 (6.41-8.44)	8.40 (7.07-9.40)
2-day	1.96 (1.71-2.25)	2.51 (2.19-2.88)	3.33 (2.89-3.81)	4.00 (3.47-4.56)	4.97 (4.28-5.66)	5.76 (4.95-6.56)	6.63 (5.64-7.53)	7.56 (6.38-8.60)	8.90 (7.42-10.1)	10.0 (8.25-11.4)
3-day	2.12 (1.88-2.40)	2.71 (2.40-3.08)	3.62 (3.19-4.09)	4.36 (3.83-4.91)	5.43 (4.75-6.11)	6.31 (5.49-7.10)	7.26 (6.27-8.17)	8.29 (7.10-9.34)	9.77 (8.26-11.0)	11.0 (9.19-12.5)
4-day	2.28 (2.04-2.55)	2.92 (2.62-3.27)	3.90 (3.49-4.37)	4.71 (4.20-5.26)	5.89 (5.21-6.57)	6.85 (6.03-7.64)	7.90 (6.90-8.80)	9.02 (7.82-10.1)	10.6 (9.11-11.9)	12.0 (10.1-13.5)
7-day	2.57 (2.31-2.87)	3.30 (2.96-3.68)	4.39 (3.93-4.89)	5.27 (4.71-5.87)	6.52 (5.78-7.26)	7.53 (6.64-8.38)	8.62 (7.55-9.59)	9.76 (8.49-10.9)	11.4 (9.81-12.8)	12.7 (10.9-14.3)
10-day	2.87 (2.56-3.20)	3.68 (3.29-4.11)	4.88 (4.35-5.44)	5.84 (5.20-6.51)	7.20 (6.37-8.01)	8.30 (7.30-9.23)	9.46 (8.28-10.5)	10.7 (9.30-11.9)	12.4 (10.7-13.9)	13.9 (11.8-15.5)
20-day	3.65 (3.30-4.03)	4.65 (4.20-5.13)	6.03 (5.44-6.65)	7.10 (6.40-7.83)	8.56 (7.67-9.43)	9.69 (8.65-10.7)	10.8 (9.64-12.0)	12.0 (10.6-13.3)	13.7 (12.0-15.1)	14.9 (13.0-16.6)
30-day	4.25 (3.84-4.68)	5.40 (4.88-5.95)	6.93 (6.25-7.64)	8.10 (7.29-8.92)	9.64 (8.65-10.6)	10.8 (9.67-11.9)	12.0 (10.7-13.2)	13.2 (11.7-14.6)	14.8 (13.0-16.4)	16.0 (14.0-17.8)
45-day	5.04 (4.57-5.55)	6.41 (5.80-7.05)	8.20 (7.41-9.01)	9.57 (8.63-10.5)	11.4 (10.2-12.5)	12.8 (11.4-14.0)	14.2 (12.7-15.6)	15.6 (13.9-17.2)	17.5 (15.4-19.4)	19.0 (16.6-21.1)
60-day	5.81 (5.28-6.38)	7.36 (6.70-8.09)	9.32 (8.46-10.2)	10.8 (9.76-11.8)	12.7 (11.4-13.9)	14.1 (12.7-15.5)	15.5 (13.9-17.0)	16.9 (15.1-18.6)	18.6 (16.5-20.6)	20.0 (17.6-22.1)

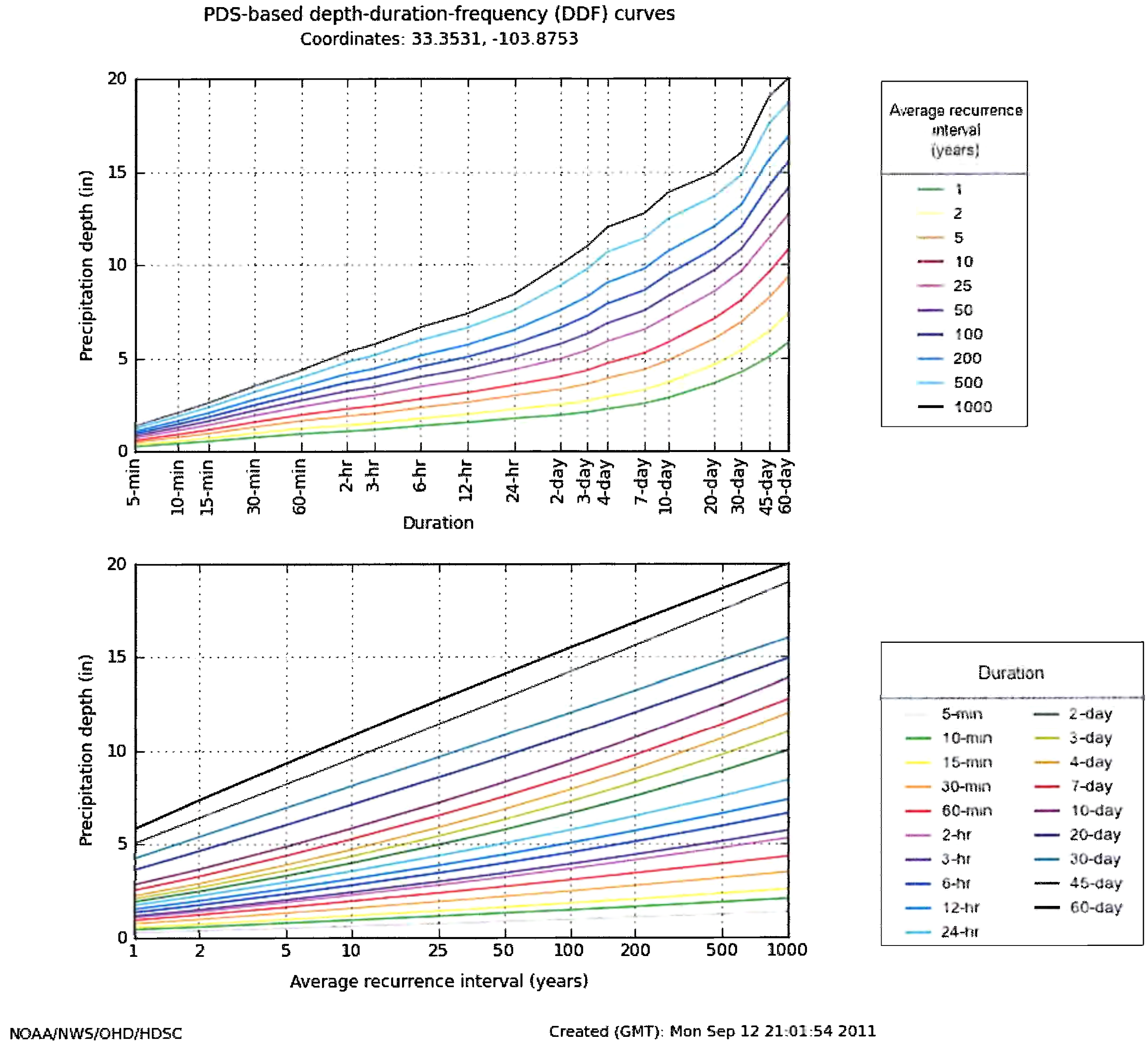
[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

Back to Top

PF graphical



Back to Top

Maps & aerials

Small scale terrain

Civil Software Design -- SEDCAD+ Version 3.1

Company Name: ACZ, INC.
Filename: J:\602\SEDCAD\LANDFILL User: TEL
Date: 11-08-1997 Time: 16:23:38
GANDY : LANDFILL PHASE 1 RUN-OFF
Storm: 4.30 inches, 25 year-24 hour, SCS Type II
Hydrograph Convolution Interval: 0.1 hr

B

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Pea Disch (cf
111	1	15.60	91	M	0.070	0.000	0.000	0.0	4.30	4
		Type: Null			Label: PHASE 1 LANDFILL					
111	Structure	15.60							4.30	
111	Total IN/OUT	15.60							4.30	4

Civil Software Design -- SEDCAD+ Version 3.1

Company Name: ACZ, INC.
Filename: J:\602\SEDCAD\ROADSIDE User: DGG
Date: 11-07-1997 Time: 15:14:00
GANDY TRIASSIC PARK LANDFILL : FINAL COVER ROADSIDE DITCH
Storm: 4.30 inches, 25 year-24 hour, SCS Type II
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Pea Disch (cf
111	1	27.00	71	M	0.258	0.000	0.000	0.0	3.61	31
		Type: Null			Label: ROADSIDE DITCH					
111	Structure	27.00							3.61	
111	Total IN/OUT	27.00							3.61	31

Civil Software Design -- SEDCAD+ Version 3.1

Company Name: ACZ, INC.
Filename: J:\602\SEDCAD\OFFSITE User: DGG
Date: 11-08-1997 Time: 13:07:58
GANDY TRIASSIC PARK LANDFILL : SITE PERIMETER DITCH
Storm: 4.30 inches, 25 year-24 hour, SCS Type II
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Pe Disc (c
111	1	377.80	71	M	0.709	0.000	0.000	0.0	50.47	27
			Type: Null		Label: EAST DITCH					
111	Structure	377.80							50.47	
111	Total IN/OUT	377.80							50.47	27

Civil Software Design -- SEDCAD+ Version 3.1

Company Name: ACZ, INC.
Filename: J:\602\SEDCAD\COLBASIN User: TEL
Date: 11-14-1997 Time: 13:22:41
TRIASSIC PARK LANDFILL: RAMP DITCHES & CLAENWATER COLLECTION POND
Storm: 4.30 inches, 25 year-24 hour, SCS Type II
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Pe Disc (c
111	1	2.30	94	F	0.026	0.000	0.000	0.0	0.69	
		Type: Null			Label: DITCH 7					
111	Structure	2.30							0.69	
111	Total IN/OUT	2.30							0.69	
121	1	6.10	94	F	0.071	0.000	0.000	0.0	1.84	1
		Type: Null			Label: DITCH 8					
121	Structure	6.10							1.84	
1	Total IN/OUT	6.10							1.84	1
211	1	6.60	94	F	0.046	0.000	0.000	0.0	1.99	2
		Type: Null			Label: COLLECTION POND					
211	Structure	6.60							4.52	
211	Total IN/OUT	15.00							4.52	4
111 to 211	Routing					0.000	0.486			

Civil Software Design -- SEDCAD+ Version 3.1

Company Name: ACZ, INC.
Filename: J:\602\SEDCAD\FACPOND User: TEL
Date: 11-13-1997 Time: 16:28:43
TRIASSIC PARK LANDFILL: FACILITIES DITCHES AND POND
Storm: 4.30 inches, 25 year-24 hour, SCS Type II
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

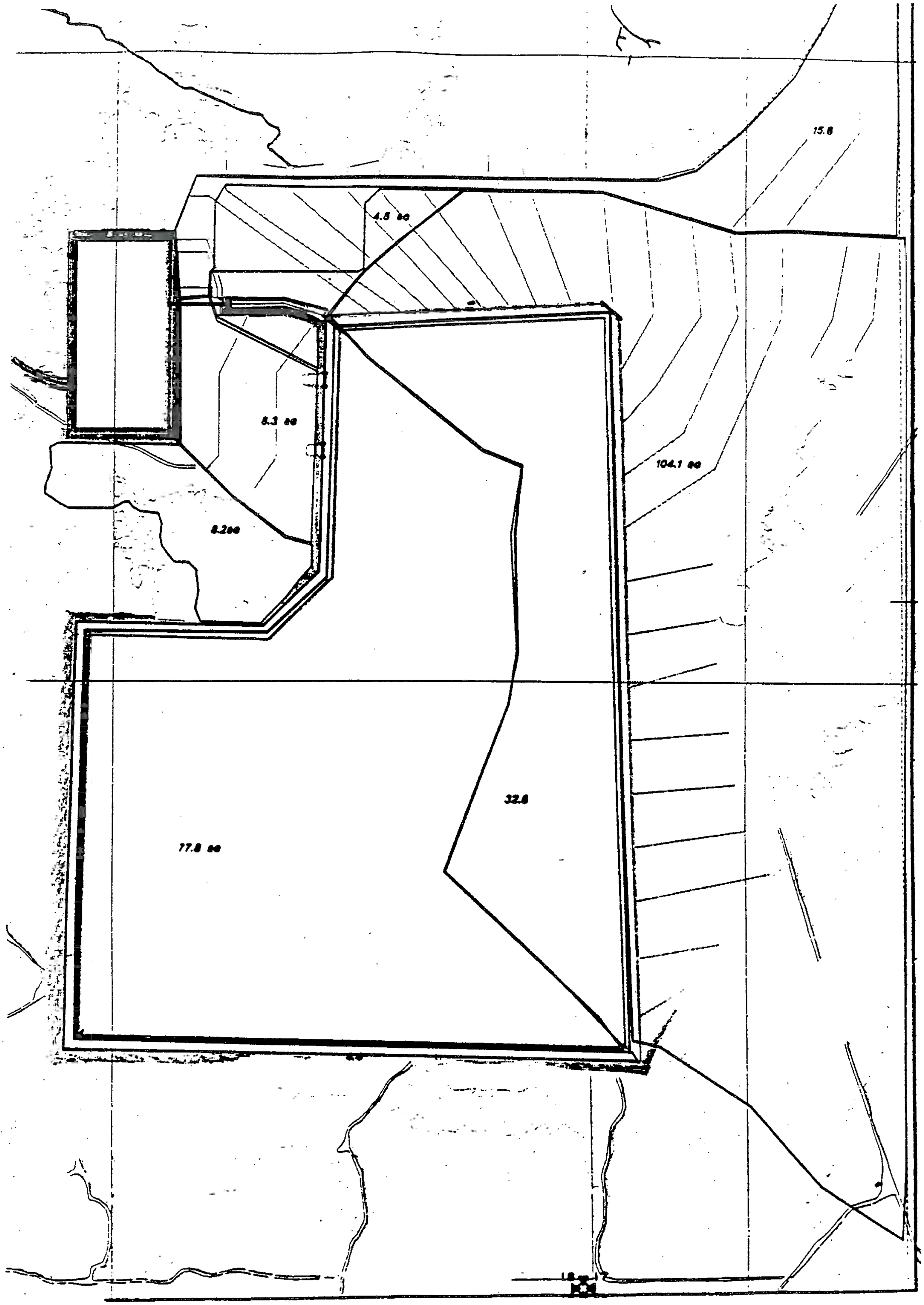
-Hydrology-

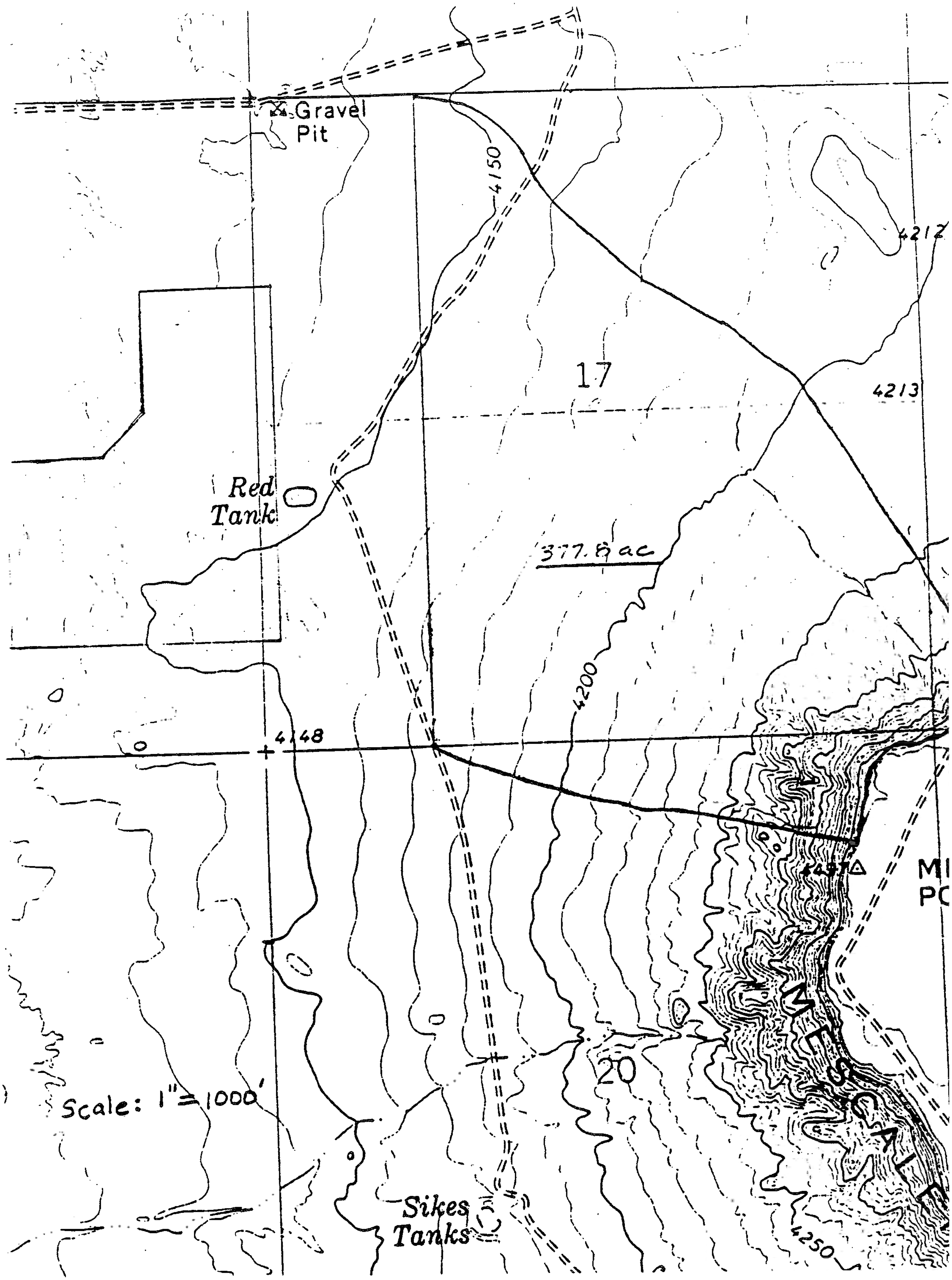
JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Pe Disc (c
111	1	32.80	71	M	0.348	0.000	0.000	0.0	4.38	1
			Type: Null		Label: DITCH 1					
111	Structure	32.80							4.38	
111	Total IN/OUT	32.80							4.38	1
121	1	77.80	71	M	0.595	0.000	0.000	0.0	10.39	6
			Type: Null		Label: DITCH 2					
121	Structure	77.80							10.39	
21	Total IN/OUT	77.80							10.39	6
211	1	104.10	86	M	0.852	0.000	0.000	0.0	24.46	12
			Type: Null		Label: DITCH 3					
211	Structure	104.10							39.24	
211	Total IN/OUT	214.70							39.24	2
111 to 211	Routing					0.009	0.277			
221	1	4.40	86	M	0.563	0.000	0.000	0.0	1.03	
			Type: Null		Label: DITCH 4					
221	Structure	4.40							1.03	
221	Total IN/OUT	4.40							1.03	
311	1	4.50	86	M	0.099	0.000	0.000	0.0	1.06	
			Type: Null		Label: DITCH 5					
311	Structure	4.50							41.33	
311	Total IN/OUT	223.60							41.33	2
211 to 311	Routing					0.078	0.277			
321	1	15.60	86	M	0.330	0.000	0.000	0.0	3.67	
			Type: Null		Label: DITCH 6					
21	Structure	15.60							3.67	
321	Total IN/OUT	15.60							3.67	

411	1	8.30	86	M	0.166	0.000	0.000	0.0	1.95	1
411	2	8.20	71	M	0.561	0.000	0.000	0.0	1.10	
411	3	9.80	98	F	0.001	0.000	0.000	0.0	3.32	3

Type: Null Label: STORMWATER POND

411 Structure	26.30		51.36	
411 Total IN/OUT	265.50		51.36	25
311 to 411 Routing		0.000 0.486		


15.6
4.5 ac
8.3 ac
8.2ac
104.1 ac
32.8
77.8 ac



Gravel Pit
4150
4212
17
4213
Red Tank
377.8 ac
4200
4148
MI
PC
20
MESCAL
Scale: 1" = 1000'
Sikes Tanks
4250

SEDCAD+ NONERODIBLE CHANNEL DESIGN

DITCH 1

INPUT VALUES:

Shape	TRIANGULAR	
Discharge	34.20 cfs	
Slope	0.50 %	
Sideslopes	2.00:1 (L)	2.00:1 (R)
Manning's n	0.025	
Material	STIFF CLAY	
Freeboard	.3 ft	

RESULTS:

Depth	**2.07 ft**
with Freeboard	**2.37 ft**
Top Width	**8.27 ft**
with Freeboard	**9.47 ft**
Velocity	**4.00 fps**
Cross Sectional Area	**8.55 sq ft**
Hydraulic Radius	**0.92 ft**
Froude Number	**0.69**

SEDCAD+ NONERODIBLE CHANNEL DESIGN

DITCH 2

INPUT VALUES:

Shape	TRIANGULAR	
Discharge	62.20 cfs	
Slope	0.50 %	
Sideslopes	2.00:1 (L)	2.00:1 (R)
Manning's n	0.025	
Material	STIFF CLAY	
Freeboard	.3 ft	

RESULTS:

Depth	2.59 ft
with Freeboard	2.89 ft
Top Width	10.35 ft
with Freeboard	11.55 ft
Velocity	4.65 fps
Cross Sectional Area	13.39 sq ft
Hydraulic Radius	1.16 ft
Froude Number	0.72

SEDCAD+ NONERODIBLE CHANNEL DESIGN

DITCH 3

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	40.00 cfs	
Slope	1.00 %	
Sideslopes	3.00:1 (L)	3.00:1 (R)
Bottom Width	5.00 ft	
Manning's n	0.025	
Material	STIFF CLAY	
Freeboard	.3 ft	

RESULTS:

Depth	1.03 ft
with Freeboard	1.33 ft
Top Width	11.18 ft
with Freeboard	12.98 ft
Velocity	4.80 fps
Cross Sectional Area	8.33 sq ft
Hydraulic Radius	0.72 ft
Froude Number	0.98

SEDCAD+ NONERODIBLE CHANNEL DESIGN

DITCH 3

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	126.60 cfs	
Slope	1.10 %	
Sideslopes	3.00:1 (L)	3.00:1 (R)
Bottom Width	5.00 ft	
Manning's n	0.035	
Material	6" RIPRAP	
Freeboard	.3 ft	

RESULTS:

Depth	2.10 ft
with Freeboard	2.40 ft
Top Width	17.62 ft
with Freeboard	19.42 ft
Velocity	5.32 fps
Cross Sectional Area	23.80 sq ft
Hydraulic Radius	1.30 ft
Froude Number	0.81

SEDCAD+ NONERODIBLE CHANNEL DESIGN

DITCH 4

INPUT VALUES:

Shape	TRIANGULAR	
Discharge	6.80 cfs	
Slope	1.00 %	
Sideslopes	2.00:1 (L)	2.00:1 (R)
Manning's n	0.025	
Material	.STIFF CLAY	
Freeboard	.3 ft	

RESULTS:

Depth	0.99 ft
with Freeboard	1.29 ft
Top Width	3.96 ft
with Freeboard	5.16 ft
Velocity	3.46 fps
Cross Sectional Area	1.96 sq ft
Hydraulic Radius	0.44 ft
Froude Number	0.87

SEDCAD+ NONERODIBLE CHANNEL DESIGN

DITCH 5

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	217.30 cfs	
Slope	0.50 %	
Sideslopes	3.00:1 (L)	3.00:1 (R)
Bottom Width	10.00 ft	
Manning's n	0.025	
Material	.STIFF CLAY	
Freeboard	.3 ft	

RESULTS:

Depth	**2.27 ft**
with Freeboard	**2.57 ft**
Top Width	**23.63 ft**
with Freeboard	**25.43 ft**
Velocity	**5.69 fps**
Cross Sectional Area	**38.21 sq ft**
Hydraulic Radius	**1.57 ft**
Froude Number	**0.79**

SEDCAD+ NONERODIBLE CHANNEL DESIGN

DITCH 6

INPUT VALUES:

Shape	TRIANGULAR	
Discharge	30.10 cfs	
Slope	1.00 %	
Sideslopes	2.00:1 (L)	2.00:1 (R)
Manning's n	0.025	
Material	STIFF CLAY	
Freeboard	.3 ft	

RESULTS:

Depth	1.73 ft
with Freeboard	2.03 ft
Top Width	6.92 ft
with Freeboard	8.12 ft
Velocity	5.02 fps
Cross Sectional Area	5.99 sq ft
Hydraulic Radius	0.77 ft
Froude Number	0.95

SEDCAD+ NONERODIBLE CHANNEL DESIGN

DITCH 7 LOWER

INPUT VALUES:

Shape		TRIANGULAR	
Discharge		7.30 cfs	
Slope		1.00 %	
Sideslopes		1.50:1 (L)	1.50:1 (R)
Manning's n		0.013	
Material	HDPE		
Freeboard		.3 ft	

RESULTS:

Depth	0.90 ft
with Freeboard	1.20 ft
Top Width	2.71 ft
with Freeboard	3.61 ft
Velocity	5.97 fps
Cross Sectional Area	1.22 sq ft
Hydraulic Radius	0.38 ft
Froude Number	1.57

SEDCAD+ NONERODIBLE CHANNEL DESIGN

DITCH 8 LOWER

INPUT VALUES:

Shape	TRIANGULAR	
Discharge	19.30 cfs	
Slope	1.00 %	
Sideslopes	1.50:1 (L)	1.50:1 (R)
Manning's n	0.013	
Material	HDPE	
Freeboard	.3 ft	

RESULTS:

Depth	1.30 ft
with Freeboard	1.60 ft
Top Width	3.90 ft
with Freeboard	4.80 ft
Velocity	7.61 fps
Cross Sectional Area	2.54 sq ft
Hydraulic Radius	0.54 ft
Froude Number	1.66

Material: Riprap

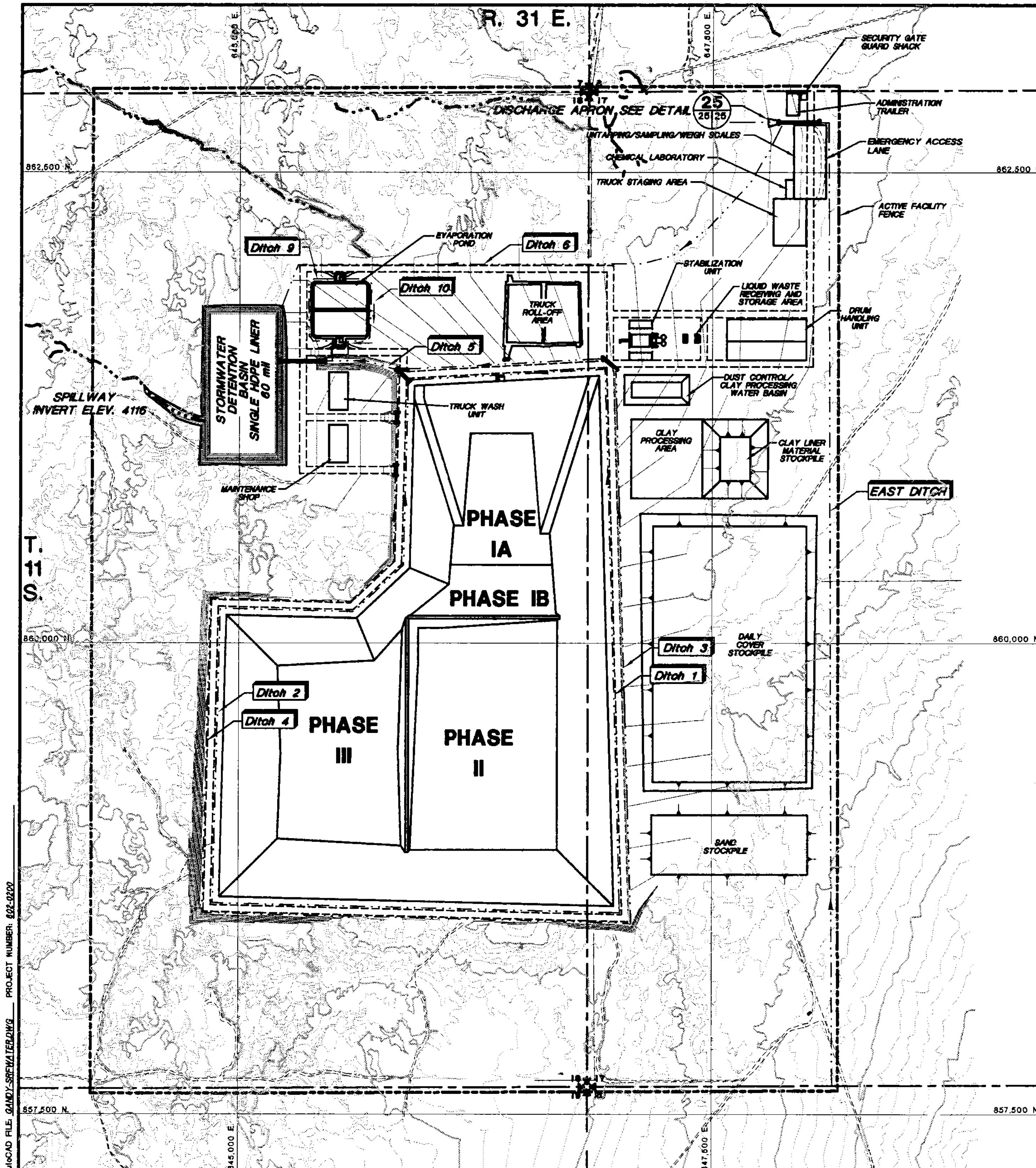
Trapezoidal Channel

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
16.00	3.0:1	3.0:1	0.8			

PADER Method - Mild Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	272.80 cfs	
Depth:	2.20 ft	
Top Width:	29.18 ft	
Velocity:	5.50 fps	
X-Section Area:	49.64 sq ft	
Hydraulic Radius:	1.660	
Froude Number:	0.74	
Manning's n:	0.0340	
Dmin:	2.00 in	
D50:	3.00 in	
Dmax:	4.50 in	

EAST CHANNEL



NOTES:
1. FOR GENERAL NOTES AND LEGEND INFORMATION SEE DRAWING No. 2, "INDEX, LEGEND AND GENERAL NOTES".
2. DITCHES 7 & 8 ARE SHOWN ON DRAWING 13.

SCALE
300' 0 300' 600'

Not For Construction

REV. No.	REVISIONS	DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY	
4	October 2000 Revision	10/4/00	J.Pellicer	K.Conrath	P.Corser	
3	NOVEMBER 1999 UPDATES	11/02/99	J.Troncoso	M.Mortensen	P.Corser	
2	SEPTEMBER 1999 REVISION	9/21/99	P.Corser	K.Conrath	P.Corser	
1	NOVEMBER 1998 REVISION	10/29/98	J.Pellicer	T.Smith	P.Corser	
0	PART B PERMIT APPLICATION	12/12/97	PGC/JFP	T.Smith	P.Corser	

PATRICK G. CORSER NEW MEXICO 12236 REGISTERED PROFESSIONAL ENGINEER

PROFESSIONAL ENGINEER'S STATEMENT

I, Patrick G. Corser, state that this drawing was prepared under my supervision and all the information presented hereon is true and correct to the best of my knowledge and information.

Date *Patrick G. Corser, NM P.E. 12236*

TRIASSIC PARK WASTE DISPOSAL FACILITY

DRAWING TITLE:

SURFACE WATER CONTROL FEATURES

TerraMatrix
MONTGOMERY WATSON
Mining Group

Sheet 1 Of 2 Sheets

SCALE: AS NOTED

DRAWING No. 25

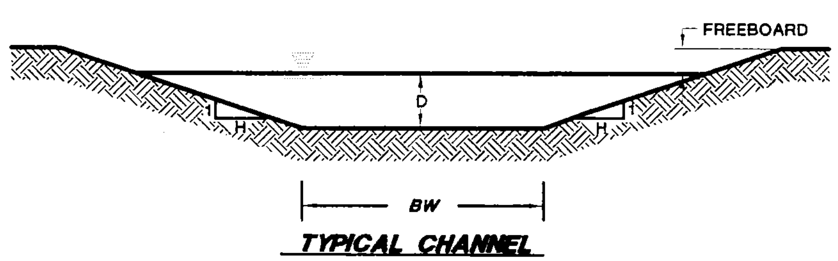
CHANNEL DESIGNS											
Ditch	25-yr,24-hr Flow Q (cfs)	Slope (%)	Bottom Width (BW) (ft)	Sideslope H:1V	Depth of Flow (D) (ft) 1	Velocity (fps) 2	Freeboard (ft)	Maximum Total Depth (ft)	Erosion Protection	2-yr,24-hr Flow Q (cfs)	Velocity (fps)
1	34.2	0.5–2.0	0	2	2.1	6.7	1.0	3.1	None	4.8	4.1
2	62.2	0.5–1.0	0	2	2.6	6.0	1.0	3.6	None	8.3	3.6
3	126.6	0.5–1.0	5.0	3	2.4	5.8	1.0	3.4	None	40.0	4.8
		1.1–2.0	5.0	3	2.1	6.6	1.0	3.1	Riprap D50=6"		
4	6.8	0.5–1.0	0	2	1.1	3.5	1.0	2.1	None	7	7
5	217.3	0.5–1.0	10.0	3	2.3	7.3	1.0	3.3	None	53.6	4.8
6	30.1	0.5–1.0	0	2	2.0	5.0	1.0	3.0	None	7	7
7 Lower	7.3	1.0	0	1.5	0.9	6.0	1.0	1.9	HDPE	7	7
7 Upper	7.3	10	0	1.5	0.6	14.2	1.0	1.6	HDPE	7	7
8 Lower	19.3	1.0	0	1.5	1.3	7.6	1.0	2.3	HDPE	7	7
8 Upper	19.3	10	0	1.5	0.8	18	1.0	1.8	HDPE	7	7
East	272.8	0.5–0.8	16.0	3	2.5	5.5	1.0	3.5	Gravel D50=3"	7	7
Final Cover Road Side	31.5	0.5–2.4	0	3	1.8	5.5	1.0	2.8	Gravel D50=3"	7	7
Spillway	358 (6)	0.5	20.0	3	2.6	4.9	1.0	3.4	Gravel D50=3"	7	7
9,10	90.4	0.5	3.0	3	2.1	4.7	1.0	3.1	NONE	7	7

NOTES:
(1) Maximum allowable velocity for channels without erosion protection 5 fps
(2) Channels with velocities greater than 5 fps for the 25-yr event and less than the 5 fps for the 2 year storm will not be lined.
(3) Maximum allowable velocity for gravel lined channels is 6 fps.
(4) Depth of Flow determined from minimum grade of Channel.
(5) Flow Velocity determined from maximum grade of Channel.
(6) Design Flow for Spillway is 100YR – 24 HR.
(7) The velocity calculations were not required for the 2-year storm because the 25YR-24HR rain event flow velocity was less than 5 fps, so the 2YR-24HR rain event flow event flow velocity would also be less than 5 fps, or because erosion protection had already been specifed.

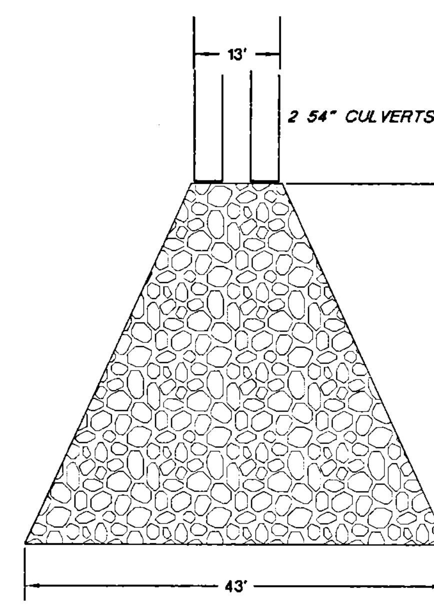
GENERAL NOTES:
1. STORM WATER DETENTION BASIN TO BE LINED WITH SINGLE 60 mil HDPE LINER.

CULVERT DESIGNS					
Culvert On Ditch	Flow (cfs)	Culvert Capacity (cfs)	No. Of Culverts	Culvert Diameter (in)	Total Capacity (cfs)
East	272.8	155	2	54	310
3	126.6	50	3	36	150
4	6.8	9	1	18	9
5	217.3	135	2	54	270
1 and 2	96.4	50	2	36	100
8	19.3	50	1	36	50
9 and 10	90.4	50	2	36	100

NOTES: (1) Culverts were sized assuming a Headwater/Culvert Diameter= 1.5.



TYPICAL CHANNEL



NOTE:
RIP RAP D_{50} = 2', DEPTH OF ROCK 3'

25 RIP RAP OUTLET APRON DETAIL
Not To Scale

PATRICK G. CORSER NEW MEXICO 12236 REGISTERED PROFESSIONAL ENGINEER

PROFESSIONAL ENGINEER'S STATEMENT
I, Patrick G. Corser, state that this drawing was prepared under my supervision and all the information presented hereon is true and correct to the best of my knowledge and information.

Date — Patrick G. Corser, NM P.E. 12236

Not For Construction

REV. No.	REVISIONS	DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
3	October 2000 Revision	10/4/00	J.Pelltier	K.Conrath	P.Corser
2	NOVEMBER 1999 UPDATES	11/02/99	J.Trevenosso	M.Matthews	P.Corser
1	NOVEMBER 1998 REVISION	10/28/98	J.Pelltier	T.Smith	P.Corser
0	PART B PERMIT APPLICATION	12/12/97	PGC/JPP	K.Conrath	P.Corser

TRIASSIC PARK WASTE DISPOSAL FACILITY

DRAWING TITLE:
SURFACE WATER CONTROL DETAILS

TerraMatrix
MONTGOMERY WATSON
Mining Group

Sheet 2 Of 2 Sheets
SCALE: Not to Scale
DRAWING No. 25

NOTE:
FOR GENERAL NOTES AND LEGEND INFORMATION SEE DRAWING No. 2, "INDEX, LEGEND AND GENERAL NOTES".

AutoCAD FILE: GANDY-SRFWTRDTLS.DWG PROJECT NUMBER: 802-0200

30

United States Department of Agriculture

Natural Resources Conservation Service

Conservation Engineering Division

Technical Release 55

June 1986

Urban Hydrology for Small Watersheds

TR-55

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Click the show/hide navigation pane button , and then

click the bookmarks tab. It will navigate you to the contents,

chapters, rainfall maps, and printable forms.

Chapter 2 Estimating Runoff

SCS runoff curve number method

The SCS Runoff Curve Number (CN) method is described in detail in NEH-4 (SCS 1985). The SCS runoff equation is

$$Q = \frac{(P - I_a)^2}{(P - I_a) + S} \qquad \text{[eq. 2-1]}$$

where

- Q = runoff (in)
- P = rainfall (in)
- S = potential maximum retention after runoff begins (in) and
- I_a = initial abstraction (in)

Initial abstraction (I_a) is all losses before runoff begins. It includes water retained in surface depressions, water intercepted by vegetation, evaporation, and infiltration. I_a is highly variable but generally is correlated with soil and cover parameters. Through studies of many small agricultural watersheds, I_a was found to be approximated by the following empirical equation:

$$I_a = 0.2S \qquad \text{[eq. 2-2]}$$

By removing I_a as an independent parameter, this approximation allows use of a combination of S and P to produce a unique runoff amount. Substituting equation 2-2 into equation 2-1 gives:

$$Q = \frac{(P - 0.2S)^2}{(P + 0.8S)} \qquad \text{[eq. 2-3]}$$

S is related to the soil and cover conditions of the watershed through the CN. CN has a range of 0 to 100, and S is related to CN by:

$$S = \frac{1000}{CN} - 10 \qquad \text{[eq. 2-4]}$$

Figure 2-1 and table 2-1 solve equations 2-3 and 2-4 for a range of CN's and rainfall.

Factors considered in determining runoff curve numbers

The major factors that determine CN are the hydrologic soil group (HSG), cover type, treatment, hydrologic condition, and antecedent runoff condition (ARC). Another factor considered is whether impervious areas outlet directly to the drainage system (connected) or whether the flow spreads over pervious areas before entering the drainage system (unconnected). Figure 2-2 is provided to aid in selecting the appropriate figure or table for determining curve numbers.

CN's in table 2-2 (*a* to *d*) represent average antecedent runoff condition for urban, cultivated agricultural, other agricultural, and arid and semiarid rangeland uses. Table 2-2 assumes impervious areas are directly connected. The following sections explain how to determine CN's and how to modify them for urban conditions.

Hydrologic soil groups

Infiltration rates of soils vary widely and are affected by subsurface permeability as well as surface intake rates. Soils are classified into four HSG's (A, B, C, and D) according to their minimum infiltration rate, which is obtained for bare soil after prolonged wetting. Appendix A defines the four groups and provides a list of most of the soils in the United States and their group classification. The soils in the area of interest may be identified from a soil survey report, which can be obtained from local SCS offices or soil and water conservation district offices.

Most urban areas are only partially covered by impervious surfaces: the soil remains an important factor in runoff estimates. Urbanization has a greater effect on runoff in watersheds with soils having high infiltration rates (sands and gravels) than in watersheds predominantly of silts and clays, which generally have low infiltration rates.

Any disturbance of a soil profile can significantly change its infiltration characteristics. With urbanization, native soil profiles may be mixed or removed or fill material from other areas may be introduced. Therefore, a method based on soil texture is given in appendix A for determining the HSG classification for disturbed soils.

Chapter 3 Time of Concentration and Travel Time

Travel time (T_t) is the time it takes water to travel from one location to another in a watershed. T_t is a component of time of concentration (T_c), which is the time for runoff to travel from the hydraulically most distant point of the watershed to a point of interest within the watershed. T_c is computed by summing all the travel times for consecutive components of the drainage conveyance system.

T_c influences the shape and peak of the runoff hydrograph. Urbanization usually decreases T_c, thereby increasing the peak discharge. But T_c can be increased as a result of (a) ponding behind small or inadequate drainage systems, including storm drain inlets and road culverts, or (b) reduction of land slope through grading.

Factors affecting time of concentration and travel time

Surface roughness

One of the most significant effects of urban development on flow velocity is less retardance to flow. That is, undeveloped areas with very slow and shallow overland flow through vegetation become modified by urban development: the flow is then delivered to streets, gutters, and storm sewers that transport runoff downstream more rapidly. Travel time through the watershed is generally decreased.

Channel shape and flow patterns

In small non-urban watersheds, much of the travel time results from overland flow in upstream areas. Typically, urbanization reduces overland flow lengths by conveying storm runoff into a channel as soon as possible. Since channel designs have efficient hydraulic characteristics, runoff flow velocity increases and travel time decreases.

Slope

Slopes may be increased or decreased by urbanization, depending on the extent of site grading or the extent to which storm sewers and street ditches are used in the design of the water management system. Slope will tend to increase when channels are straightened and decrease when overland flow is directed through storm sewers, street gutters, and diversions.

Computation of travel time and time of concentration

Water moves through a watershed as sheet flow, shallow concentrated flow, open channel flow, or some combination of these. The type that occurs is a function of the conveyance system and is best determined by field inspection.

Travel time (T_t) is the ratio of flow length to flow velocity:

$$T_t = \frac{L}{3600V} \qquad \text{[eq. 3-1]}$$

where:

T_t = travel time (hr)
L = flow length (ft)
V = average velocity (ft/s)
3600 = conversion factor from seconds to hours.

Time of concentration (T_c) is the sum of T_t values for the various consecutive flow segments:

$$T_c = T_{t_1} + T_{t_2} + \dots T_{t_m} \qquad \text{[eq. 3-2]}$$

where:

T_c = time of concentration (hr)
m = number of flow segments

HYDRAULIC ENGINEERING

ROBERSON · CASSIDY · CHAUDHRY

SECOND EDITION

Using the Moody diagram (see Fig. 5-5), the f value is found to be about 0.020 for a Reynolds number of about 10^6. Use this f for the first computation of Q:

$$Q = \sqrt{\frac{8 \times 32.2}{0.020}} \times (2 \times 5) \times \sqrt{1.11 \times 0.002}$$

$$Q = 53.5 \text{ cfs} \qquad V = Q/A = 5.35 \text{ ft/s}$$

Assume the water temperature is 60°F, then, the kinematic viscosity will be 1.22×10^{-5} ft²/s, and the Reynolds number $V \times 4R/\nu$ will be found to be 1.95×10^6. On checking the Moody diagram with the Reynolds number of 1.95×10^6, we find that f is indeed 0.020; therefore, with the given assumptions, the discharge will be 53.5 cfs.

The Manning Equation

The discharge equation most often used by hydraulic engineers is the Manning equation, named after an Irish engineer of the nineteenth century. In the Manning equation, using the traditional system of units, the Chezy coefficient of Eq. (4-3) is given as $C = (1.49/n) \times R^{1/6}$, where n is a resistance factor. Thus, the Manning discharge equation is

$$Q = \frac{1.49}{n} AR^{2/3}S_0^{1/2} \tag{4-7a}$$

In the SI system of units,

$$Q = \frac{1}{n} AR^{2/3}S_0^{1/2} \tag{4-7b}$$

The resistance factor, n, is a function of a number of variables, the primary one being the roughness of the channel.* To assist the engineer in choosing n, Table 4-1 gives n values for various types and conditions of channels. Figures 4-2, 4-3, and 4-4 are photos of actual channels along with measured n values.

Flow in Channels of Circular Cross Section

Highway culverts and city sewers are common examples of open channel conduits of circular cross section. For a given slope and resistance coefficient (n = constant), the discharge will be proportional to $AR^{2/3}$, as can be seen by inspecting Eqs. (4-7a and 4-7b). Since $V = Q/A$, it can also be deduced that the velocity will be proportional to $R^{2/3}$. Therefore, one can easily determine $Q/Q_0 = (AR^{2/3})/(A_0R_0^{2/3})$, where Q is the discharge for a given depth of flow, and Q_0 is the discharge for the completely full conduit. Figure 4-5 is a plot of the relative discharge (Q/Q_0) versus relative depth

*For a more complete discussion of n values, see Chow (4) and Yen (24).

acteristics of Critical Flow

We have already seen that critical flow occurs when the specific energy is minimum for a given discharge. The depth for this condition may be determined if we solve for dE/dy from $E = y + Q^2/2gA^2$ and set dE/dy equal to zero:

$$\frac{dE}{dy} = 1 - \frac{Q^2}{gA^3} \cdot \frac{dA}{dy} \qquad \textbf{(4-15)}$$

However, $dA = T\,dy$, where T is the width of the channel at the water surface as shown in Fig. 4-14. Then Eq. (4-15), with $dE/dy = 0$ (the critical flow condition), will reduce to

$$\frac{Q^2 T_c}{gA_c^3} = 1 \qquad \textbf{(4-16)}$$

or

$$\frac{A_c}{T_c} = \frac{Q^2}{gA_c^2} \qquad \textbf{(4-17)}$$

$$\frac{A_c}{T_c} = \frac{V_c^2}{g} \qquad \textbf{(4-18)}$$

Determine the critical depth in a trapezoidal channel for a discharge of 500 cfs. The width of the channel bottom is 20 ft, and the sides slope upward at an angle of 45°.

LUTION

Starting with Eq. (4-16),

$$\frac{Q^2 T_c}{gA_c^3} = 1$$

or

$$\frac{A_c^3}{T_c} = \frac{Q^2}{g}$$

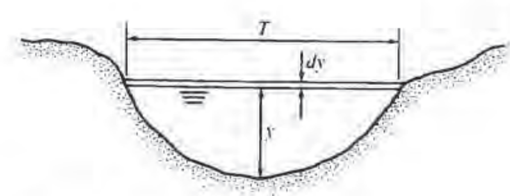


Figure 4-14 Open channel relations

Then, for $Q = 500$ cfs

$$\frac{A_c^3}{T_c} = \frac{500^2}{32.2} = 7764 \text{ ft}^2$$

For this channel, $A = y(b + y)$ and $T = b + 2y$. Then by iteration (choose y and compute A^3/T), we can find y that will yield an A^3/T equal to 7764 ft^2. Such a solution yields $y_c = 2.57$ ft.

If the channel is of rectangular cross section, then A_c/T_c is the critical depth, and $Q^2/A_c^2 = q^2/y_c^2$, so the formula for critical depth (Eq. 4-17) becomes

$$y_c = \left(\frac{q^2}{g}\right)^{1/3} \tag{4-19}$$

where q is the discharge per unit width of channel.

If we apply Eq. (4-18) to a rectangular channel, divide it by $A_c/T_c = y_c$, and then take the square root of both sides, we obtain

$$\frac{V_c}{\sqrt{gy_c}} = 1 \tag{4-20}$$

The left side of Eq. (4-20) is the Froude number; therefore, the Froude number is equal to unity when the flow is critical.

Originally, the term *critical flow* probably related to the unstable character of the flow for the condition. If we refer to Fig. 4-12, we see that only a slight change in specific energy will cause the depth to increase or decrease a significant amount; this is a very unstable condition. In fact, observations of critical flow in open channels show that the water surface consists of a series of standing waves. Because of the unstable nature of the depth in critical flow, designing canals so that normal depth is either well above or well below critical depth is usually best. The flow in canals and rivers is usually subcritical; however, the flow in steep chutes or over spillways is supercritical.

If we take the square root of Eq. 4-17 and do some rearranging, we obtain $Q/\sqrt{g} = A^{3/2}/T^{1/2}$. The right-hand side of the above equation is called the section factor. Note that for a given value of $Q/\sqrt{g}$ and a given conduit shape (circular or trapezoidal, etc.) there is only one depth (critical depth) that will satisfy the equation. Critical depth solutions have been made for both circular and trapezoidal channels for a wide range of section factors and the results have been given in graphical form as shown in Fig. 4-15.

SOLUTION

The solution is done in tabular form as shown below:

Section	Depth (ft)	Width (ft)	ΔA (ft^2)	Avg. V (ft/s)	ΔQ (ft/s)
1	5.5	12.5	68.8	6.85	471
2	7.3	15.0	109.5	7.30	799
3	8.5	15.0	127.5	7.45	950
4	8.0	17.5	140.0	7.55	1057
5	7.9	15.0	118.5	7.45	883
6	7.9	12.5	98.8	7.45	736
7	7.8	15.0	117.0	7.20	842
8	6.3	15.0	94.5	6.75	638
9	3.2	12.5	40.0	4.90	196
					Q = 6572 cfs

Weirs, Flumes, Spillways, and Gates

Sharp-Crested Weirs

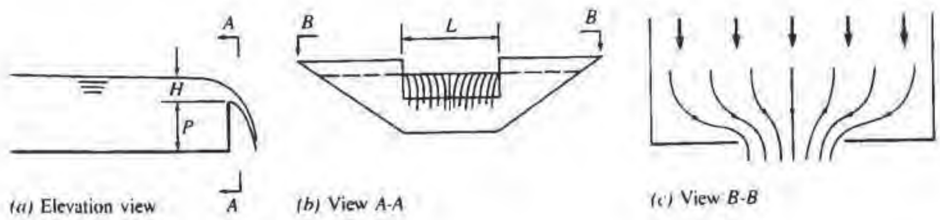
A simple device for discharge measurement in canals and flumes is the *sharp-crested weir* (Fig. 4-34). When atmospheric pressure prevails above and below the nappe, it is said to be well ventilated. The discharge equation for a *rectangular weir* (a weir that spans a rectangular flume) is given as

$$Q = K\sqrt{2g}LH^{3/2} \tag{4-38}$$

In Eq. (4-38), K is the flow coefficient of the weir and is given as

$$K = 0.40 + 0.05\frac{H}{P} \tag{4-39}$$

Based on experimental work by Kindsvater (10), this is valid up to an H/P value of about 10.



(a) Elevation view (b) View A-A (c) View B-B

Figure 4-34 Rectangular weir

Often the weir section does not span the entire width of the channel (Fig. 4-34). Therefore, there will be a contraction of the flow section just downstream of the weir so that the effective length of the weir will be somewhat less than L. Experiments show that this effective reduction in length is approximately equal to $0.20H$ when $L/H > 3$. Thus the formula for a *contracted weir* (one with flow contraction due to end walls) is given as

$$Q = K\sqrt{2g}(L - 0.20H)H^{3/2} \qquad \textbf{(4-40)}$$

The formula for the *suppressed weir* (a weir without end walls; suppressed contractions) may also be used for the contracted weir if the sides of the weir are inclined as shown in Fig. 4-35. The degree of inclination is made so that the reduction of flow caused by the end contractions is counterbalanced by the increased flow in the "notches" (regions *ABC* of Fig. 4-35) at either end of the weir. The Cipolletti weir (often used in irrigation canals in the western United States) has an angle of wall inclination of 28° to effect the desired result.

With low flow rates, it is common to use a triangular weir (Fig. 4-36). The basic weir equation is given as

$$Q = \frac{8}{15}K\sqrt{2g}\tan\left(\frac{\theta}{2}\right)H^{5/2} \qquad \textbf{(4-41)}$$

where K is the flow coefficient that is primarily a function of the head H. For weirs with θ values of 60° and 90°, Lenz (11) showed that the flow coefficient values varied from 0.60 to 0.57 as the head varied from 0.20 to 2.0 ft.

Broad-Crested Weirs

If the weir is long in the direction of flow so that the flow leaves the weir in essentially a horizontal direction, the weir is a *broad-crested weir* (see Fig. 4-16, page 178). The basic theoretical equation for the broad-crested weir is shown on page 178 (Eq. 4-23). However, to account for head loss and shape of weir, a discharge coefficient should be applied to Eq. (4-23). If the ratio of the actual discharge, Q, to the theoretical discharge, Q_{theor}, is given by C, then

$$Q = 0.385CL\sqrt{2g}H^{3/2} \qquad \textbf{(4-42)}$$

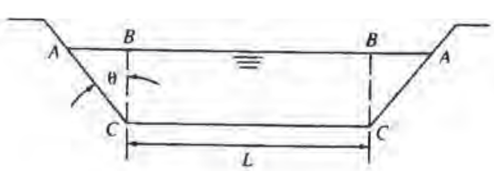


Figure 4-35 Trapezoidal weir

Attachment L5

Landfill Stormwater and Leachate Recirculation Modeling

Permit Renewal Application
October 17, 2011

Attachment L5

Landfill Stormwater and Leachate Recirculation Modeling

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Table of Contents

List of Tables

List of Appendices

Attachment L5. Landfill Stormwater and Leachate Recirculation Modeling

1. Introduction

The permit renewal application seeks to use recirculation of stormwater and leachate within the lined Phase 1A landfill to manage water by enhanced evaporation. The recirculation operation will replace the use of a lined evaporation pond that was approved for original Triassic Park Waste Disposal Facility permit. Under the 2002 permit, the evaporation pond was to serve various purposes, including liquid waste disposal and management of contaminated or potentially contaminated water from other facilities, including the landfill. Daniel B. Stephens & Associates, Inc. (DBS&A) evaluated the potential to eliminate the evaporation pond for the 2011 permit renewal. DBS&A has evaluated alternatives for management of water generated during the landfill operation.

The UNSAT-H model was used to evaluate potential contaminated stormwater recirculation, specifically to model any potential increase in liquid percolation through the waste and daily cover. The UNSAT-H model (version 3.01) uses a one-dimensional finite element version of Richard's equation to simulate infiltration in variably saturated media as a function of environmental conditions such as climate, soil type, and vegetation. The model was developed at Pacific Northwest National Laboratory (PNNL) and has been verified against analytical solutions and validated against lysimeter data by Fayer et al. (1992). More information about UNSAT-H is available from the PNNL's website (http://hydrology.pnl.gov/resources/unsath/unsath.asp). It is commonly used to model the infiltration rates of landfill soil evapotranspiration final covers (Dwyer, 2003).

UNSAT-H was selected to model recirculation due to its ability to account for precipitation events and evaporation at an hourly time scale, which is an important consideration in arid environments where precipitation events are frequently short and intense. The model simulates water flow in unsaturated media and provides a robust consideration of evaporative losses and moisture storage and seepage through the waste and soil profile. Evaporative losses from the waste and soil profile are a very important component of a water budget. In addition, because evaporation removes water from the soil profile, it is the primary mechanism responsible for reducing seepage.

This document summarizes UNSAT-H modeling performed in support of the RCRA Part B renewal application for the Triassic Park Waste Disposal Facility. It outlines assumptions and sources of data used in the model and presents model results.

2. UNSAT-H Model

2.1 Approach

UNSAT-H was used to assess a variety of precipitation years to study contaminated stormwater infiltration into the daily soil cover and waste. The primary inputs to the model include weather data, waste characteristics, and soil characteristics. Conservative assumptions for these inputs were used, resulting in a conservative estimate of moisture infiltration and percolation through the waste. This percolation will be collected by the leachate collection and removal system (LCRS).

Model composition used for this analysis includes three layers. From top to bottom, these layers include: (1) 0.5 foot of daily soil cover, (2) a 10-foot layer of waste, and (3) a 2-foot layer of protective soil. The protective soil layer covers the LCRS. The model represents the earliest placement of the first waste lift, initially covering a 6-acre area of the floor of the Phase 1A liner. When more layers of waste and daily cover are added in a thicker waste profile, there would be more internal moisture storage and transitions between materials. These transitions slow downward water movement; thus, the current modeling approach represents the scenario most conducive to water movement. As waste placement increases, the acreage for water application increases, thereby reducing the rates of water application per acre. Therefore, analyzing only one layer of waste and daily cover is a conservative approach. Stormwater recirculation will only occur on areas that have a soil cover, never directly onto waste.

Data from two years (1986 and 1998) were selected for analysis with the UNSAT-H model. 1986 was modeled to conservatively represent precipitation, as it is the wettest year on record for which a sufficient record of all parameters required to run UNSAT-H are available. 1986 is the second wettest year on record, with a precipitation of 24.8 inches; the wettest year on record, 1941, does not have sufficient available data. The 1998 data were modeled to represent an "average" year; the total precipitation in 1998 is 11.75 inches, slightly higher than the average annual precipitation for the entire record (1894-2010) of 11.6 inches. The sources of all weather data are described in detail in Section 2.2.1. Soil parameters were used from previous modeling conducted during the original permitting process, described in Section 2.2.2.

2.2 Model Inputs

Sections 2.2.1 and 2.2.2 detail the soil and meteorological model inputs. Section 2.2.3 describes other assumptions used in the model.

2.2.1 Climate Data

UNSATH requires the following data:

- Maximum air temperature (degrees Farenheit [°F])
- Minimum air temperature (°F)
- Dew point temperature (°F)
- Solar radiation (langleys)
- Average wind speed (miles per hour)
- Average cloud cover (tenths)
- Precipitation (inches)

The nearest town to the Triassic Park Waste Disposal Facility with a sufficient weather record is Roswell, New Mexico. Available data, including maximum temperature, minimum temperature, and precipitation data for Roswell, New Mexico were obtained from the National Oceanic Atmospheric Association (NOAA) for the period of January 1894 through June 2011. Dew point temperature, average wind speed, and average cloud cover were not available from NOAA; therefore, these data were downloaded from Weather Underground (www.wunderground.com). Solar radiation data were obtained from the National Solar Radiation Database (NSRDB) for Tucumcari, New Mexico, the closest town to the site with a similar climate for which these data were available for 1986. The NSRDB is currently available at the following website: http://rredc.nrel.gov/solar/old_data/nsrdb/. Solar radiation data for 1991 onward is available from the NSRDB at the same website. Solar radiation, dew point, wind speed, and cloud cover for 1986 and 1998 were obtained from each organization's website. There were no data gaps in any of the measurements for 1986 or 1998.

Measured precipitation data from NOAA comes in measurements of hundredths of an inch. Minimum and maximum temperature measurements were provided by NOAA in °F. The mean dew point data from Weather Underground, provided in °F, was used as the dew point temperature. Mean wind speed data were provided in miles per hour. Cloud cover data provided in daily summaries in percentages (e.g., 26% cloud cover), and all values downloaded were less than 10. Solar radiation data provided were hourly and were averaged by day. Unit conversions of solar radiation data from Wh/m^2 to langleys were applied.

The precipitation data used for this model incorporate measured precipitation plus stormwater runoff and leachate that is applied to the daily cover during periods in which recirculation is performed. The leachate component is minor in relation to the stormwater quantity. When recirculation is considered, evaporative losses from the stormwater collection basin and from spraying are calculated. Incorporation of these losses is described in detail in the attached calculation (Appendix A).

2.2.2 Soil Data

In the previous 2000 permit application, modeling was performed to assess water movement through the landfill during operation. Various parameters used in the previous work were used directly in the UNSAT-H model or were used to generate parameters used in the UNSAT-H model. These parameters are summarized in Table L5-1.

Table L5-1. Parameters from Previous Model Used for UNSAT-H Model

Parameter	Daily Cover Soil	Waste	Protective Soil	Units
Layer thickness	0.5	10	2.0	feet
HELP soil texture number	4	7	4	N/A
HELP soil material	Silty sand	Silty sand	Silty sand	N/A
Porosity	0.473	0.473	0.473	cm^3/cm^3
Field capacity	0.0105	0.222	0.0105	cm^3/cm^3
Wilting point	0.047	0.104	0.047	cm^3/cm^3
Hydraulic conductivity	1.7×10^{-3}	5.4×10^{-4}	1.7×10^{-3}	cm/s
Initial moisture content	0.0863	0.2055	0.0863	cm^3/cm^3

cm^3/cm^3 = Cubic centimeters per cubic centimeter   cm/s = Centimeters per second

The hydraulic parameters used for the daily cover soil are not specifically given in the previous modeling report (Appendix E-28 to the Engineering Report, Volume VI of the Permit Application dated October 2000); however, elsewhere in the Engineering Report (Attachment L), the daily cover material and protective soil material are stated to be the same material. Therefore, the parameters given for the protective soil cover are also used to describe the daily cover.

To obtain necessary input for the current modeling exercise, parameters for the daily cover, waste, and protection layer were developed based on the previous characteristics used in the 2002 permit application and engineering judgment. The characteristics used in the previous permit application for the waste and the soil protection layer are provided in Table L5-2.

Table L5-2. Soil Texture Characteristics for Input to the Rosetta Model

Material	Sand %	Silt %	Clay%	Bulk Density (g/cm^3)	TH33 (cm^3/cm^3)	TH1500 (cm^3/cm^3)
Soil	80	15	5	1.69	0.105	0.047
Waste	60	35	5	1.65	0.222	0.104

g/cm^3 = Grams per cubic centimeter cm^3/cm^3 = Cubic centimeters per cubic centimeter

The percentages of sand, silt, and clay for each soil are based on typical soil properties and engineering judgment to match the soil type and characteristics used in previous work. The TH33 (field capacity) and TH1500 properties (wilting point) were verified prior to use in UNSAT-H.

To obtain input parameters for the van Genuchten equations used in the UNSAT-H model, the Rosetta computer program was used to estimate the following hydraulic parameters:

- θ_r
- θ_s
- α
- N
- Saturated hydraulic conductivity

Rosetta V1.2 (Schaap, 2000) is a Windows program that estimates unsaturated hydraulic properties from soil texture, bulk density, and the field capacity and wilting point moisture tension values. The software can be downloaded from the website http://www.cals.arizona.edu/research/rosetta/download/ROSETTA.EXE. The inputs given in Table L5-2 produced the output from Rosetta listed in Table L5-3.

Table L5-3. Rosetta Output Parameters

Material	θ_r (cm^3/cm^3)	θ_s (cm^3/cm^3)	α (1/cm)	N	Saturated Hydraulic Conductivity (cm/s)
Soil	0.0277	0.3270	0.0526	1.49	9.4×10^{-4}
Waste	0.0319	0.3354	0.0181	1.32	2.0×10^{-4}

Note: The outputs for α, N, and saturated hydraulic conductivity have been converted from log format. The conductivity has been converted from centimeters per day (cm/d) to centimeters per second (cm/s).

cm^3/cm^3 = Cubic centimeters per cubic centimeter

2.2.3 Model Assumptions

UNSAT-H allows the user to control many aspects of the model. Many parameters that ensure numerical stability and timely calculations are used that are not detailed here. This section describes parameters that directly impact model results and outlines the methods used to calculate elements such as soil moisture wetting curves.

Specifics regarding the parameters described in this paragraph are available in the UNSAT-H Version 3.0 User's Manual (Fayer, 2000). Soil hydraulic properties are described with the van Genuchten equation (van Genuchten, 1980). A unit gradient is assumed at the bottom of the protective soil, which mathematically permits the water to flow to the leachate collection system. Daily precipitation is applied at a rate of 1.0 inch per hour until all precipitation is applied. This precipitation rate reflects the nature of precipitation events in semiarid regions, which tend to be of short duration and intense. The recirculation rate in the model was set to limit recirculation water application to 0.5 inch per day after spray application evaporative losses are taken into account. The moisture applied to the soil surface in the UNSAT-H model is the sum of the measured daily precipitation and the stormwater recirculation onto the daily cover when recirculation is considered.

The initial moisture content of the waste and soil was set in accordance with the New Mexico Environment Department Solid Waste Bureau's guidance on performance demonstration of alternative covers (NMED SWB, 1998) by adding 25 percent of the difference between the wilting point and field capacity to the wilting point.

The input files are included as Appendix B to this report.

2.3 Results

UNSAT-H was initially run with the measured precipitation for 1998. 1998 had a total precipitation of 11.75 inches, very near the record average of 11.6 inches, and had a maximum daily precipitation of 1.8 inches. It also contained eight days with total precipitation greater than 0.5 inch. A precipitation record that includes measured precipitation and calculated recirculation was used in UNSAT-H to analyze recirculation performance for the expected recirculation water management scenario. The cumulative annual results are provided in Table L5-4.

Table L5-4. Summary of Cumulative Results of 1998 Model With Stormwater Recirculation

Model Output	With Recirculation (inches)	With Recirculation (gallons)
Total Precipitation	16.2	2,635,000
Runoff	0.3	52,000
Evaporation	7.8	1,271,000
Storage	8.1	1,313,000
Drainage	0.0	0

Note: The number provided for storage is the increased volume of water in storage. Initially, there is some water in storage as a result of initial moisture content (e.g., construction water used while installing the protective soil and daily cover, and assuming the waste is not completely devoid of water when it arrives at the landfill).

As stated above, the measured annual precipitation is 11.75 inches; thus, the model result of 16.2 inches total precipitation indicates that 4.45 inches of recirculated water was applied. The drainage value of 0 inches indicates that the use of stormwater recirculation does not result in an increase in percolation through the waste to the LCRS. This suggests that for "average" years, contaminated stormwater recirculation is a viable option for contaminated stormwater management with little impact to the leachate collection system.

To analyze the impact of stormwater recirculation if a very high precipitation year occurred during the first year of waste placement, UNSAT-H was run with the measured precipitation for 1986. Other climatological data from 1986 (e.g., maximum and minimum temperature) were incorporated, while all soil parameters were equivalent to the 1998 scenario. The total precipitation in 1986 was 24.8 inches, with a maximum daily precipitation of 3.46 inches. First, 1986 was modeled without recirculation to verify UNSAT-H model results with previous modeling, as well as to allow comparison of the no recirculation/recirculation scenarios. The cumulative results of this model are provided in Table L5-5. The results show no stormwater percolation through the waste with one layer of waste and daily cover, which is consistent with previous work.

UNSAT-H was then used to analyze recirculation scenarios. The 1986 precipitation data were used with the inclusion of any accumulated stormwater being recirculated each day until all water in the stormwater pond is removed. The maximum time to empty the pond after the 3.46-inch storm event is 6 days. The results of this model are provided in Table L5-6 with the results from the no recirculation scenario for comparison.

Table L5-5. Summary of Cumulative Results of 1986 Model Without Stormwater Recirculation

Model Output	No Recirculation (inches)	No Recirculation (gallons)
Total Precipitation	24.8	4,041,000
Runoff	1.4	229,000
Evaporation	10.3	1,680,000
Storage	13.1	2,134,000
Drainage	0.0	0

Table L5-6. Comparison of Cumulative 1986 UNSAT-H Model Results Without Recirculation vs. Daily Recirculation

Model Output	No Recirculation (inches)	No Recirculation (acre-feet)	Daily Recirculation (inches)	Daily Recirculation (acre-feet)	Increase (inches)
Total Precipitation	24.8	4,041,000	34.6	5,646,000	9.8
Runoff	1.4	229,000	2.5	415,000	1.1
Evaporation	10.3	1,680,000	11.6	1,886,000	1.3
Storage	13.1	2,134,000	20.5	3,345,000	7.4
Drainage	0.0	0	3.0	487,000	3.0

The results listed in Table L5-6 are annual totals for each output. Dividing the drainage by 365 days per year gives an approximate additional 1,340 gallons per day (gpd) of water that will need to be handled by the LCRS.

A second 1986 scenario with stormwater recirculation was analyzed. In this scenario, recirculation was only permitted on alternating days until the pond was emptied. This provides some time for water in the daily cover soil to evaporate prior to additional stormwater recirculation application, although it increases the amount of time water is in the contaminated stormwater pond from 6 consecutive days to 11 consecutive days. Table L5-7 summarizes this second scenario with the results of the previous two scenarios.

Table L5-7. Comparison of Cumulative 1986 UNSAT-H Model Results

Model Output	No Recirculation (inches)	No Recirculation (acre-feet)	Recirculation Every Day (inches)	Recirculation Every Day (acre-feet)	Recirculation Alternating Days (inches)	Recirculation Alternating Day (acre-feet)	Increase from No Recirculation (inches)
Total Precipitation	24.8	4,041,000	34.6	5,646,000	34.4	5,605,000	9.6
Runoff	1.4	229,000	2.5	415,000	2.2	363,000	0.8
Evaporation	10.3	1,680,000	11.6	1,886,000	12.3	2,012,000	2.0
Storage	13.1	2,134,000	20.5	3,345,000	19.8	3,231,000	6.7
Drainage	0.0	0	3.0	487,000	2.3	367,000	2.3

In this scenario, dividing the drainage by 365 days per year gives an approximate additional 1,010 gpd of water that will need to be handled by the leachate collection system, which is 120,000 gallons per year less than if recirculation is done each day following a storm event. The reduction in applied water, 34.4 inches versus 34.6 inches, results from higher net evaporative losses from the stormwater collection basin as the runoff resides in the pond longer prior to recirculation. This analysis demonstrates that different management scenarios of the stormwater runoff can be used to minimize stormwater percolation to the LCRS.

3. Conclusions

UNSAT-H was used to evaluate potential for stormwater recirculation, specifically to calculate the change in water percolation through the daily cover and waste. The model used several conservative conditions, including only one layer of waste and daily cover and use of climate data for the second wettest precipitation year on record. The model results indicate that if precipitation rates are near average during the first year of placing an initial lift of waste, the use of recirculation to manage stormwater and leachate results in no increase in seepage through the daily cover and waste. The model results indicate that if a very high precipitation year is experienced during placement of the first list of waste, there is an increase in stormwater movement through the daily cover and waste to the LCRS. The increase in leachate generation from the previously estimated 35 gpd to an estimated 1,485 gpd is a minor change that will not affect the LCRS, which is designed for a capacity to remove leachate of 72,000 gpd (see Engineering Report in Permit Attachment L). It should be noted that the 35 gpd leachate generation is based only on the first year of operations, with a coinciding small volume of waste. Additionally, dependent on recirculation frequency, only 24 to 30 percent of the recirculated water passes through the daily cover and waste to the LCRS, indicating that this is a viable option for stormwater and leachate management. This increase in leachate will need to be managed through additional recirculation to provide adequate evaporative loss of water.

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Appendix A

Precipitation Calculation

Daniel B. Stephens & Associates, Inc.

Calculation Cover Sheet

Project Name: Triassic Park Landfill Permit Renewal   Project Number: ES11.0141

Calculation Number: ES11.0141-002   Discipline: Hydrology   No. of Sheets: ____

PROJECT: Triassic Park Waste Disposal Facility Permit Renewal

SITE: Triassic Park Waste Disposal Facility, Roswell, NM

SUBJECT: Calculate precipitation file for use in UNSAT-H Model.

SOURCES OF DATA:

A. Part A and Part B Permit Application for the Triassic Park Waste Disposal Facility, Chaves County, New Mexico, Appendix F- Surface Water Control System Design and Appendix E-28 - HELP Modeling Report. October 2000.

B. National Oceanic and Atmospheric Association (NOAA). www.ncdc.noaa.gov/oa/ncdc.html

C. Western Regional Climate Center. www.wrcc.dri.edu/htmlfiles/westernevap.final.html

D. Weather Underground. www.wunderground.com

SOURCES OF FORMULAE & REFERENCES:

1. USDA NRCS Urban Hydrology for Small Watersheds (TR55). June 1986.
2. Playan et. al. Day and Night Wind Drift and Evaporation Losses in Sprinkler Solid-Sets and Moving Laterals. *Agricultural Water Management*. Volume 76, Issue 3, 10 August 2005, Pages 139-159

[x] Preliminary Calculation   [ ] Final Calculation   Supersedes Calculation No. ____

Rev. No.	Revision	Calculation By	Date	Checked By	Date	Approved By	Date
0		KI	10/11/11	TG	10/14/11	WA	10/14/11

S:\Projects\ES11.0141_Triassic_Park_Permit_Renewal\Engineering\Calculations\New Precip Generation\New Precip Generation.docx

1.0 OBJECTIVE

The purpose of this calculation is to generate a new precipitation file for use in an UNSAT-H model of the Triassic Park Waste Disposal Facility during active filling that accounts for measured precipitation as well as recirculation of potentially contaminated stormwater and leachate.

2.0 GIVEN

In the 2002 permit application[A] Appendix F, a Curve Number of 91 was used for the active filling area (with daily soil cover). The area contributing to the contaminated stormwater pond (CSWP) is 15.6 acres[A]. The CSWP in the bottom of Phase IA has an area of 2.5 acres[A]. The area of the bottom of the landfill that could be covered by the initial layer of waste is 6 acres[A] – this is the area to which recirculation water is applied.

3.0 METHOD

UNSAT-H allows use of daily records of precipitation and temperature, among other variables, to assess the evaporation from, infiltration into, and runoff from user-specified layers. This calculation describes the generation of the hourly precipitation file that will be used in UNSAT-H that accounts for measured precipitation and stormwater recirculation back onto the waste. For this analysis, the second wettest year on record in Roswell is used, 1986.

A complete hourly precipitation record for Roswell, NM is not available; however, daily precipitation data are available from the National Oceanic and Atmospheric Association (NOAA)[B]. To convert the daily precipitation record to hourly data, all precipitation events are set to begin at 6pm. Precipitation is assigned a rate of 1.0 inch/hour until all the precipitation has fallen. This precipitation rate was assigned due to the nature of most precipitation events in Roswell, NM, which are predominately short duration and intense. This hourly data is applied to the active filling area to determine runoff, using the United States Department of Agriculture's Natural Resource Conservation Service's TR55 method[1]. Specific equations utilized are summarized below.

The runoff resulting from each daily precipitation event is calculated using the curve number method:

$$Q_{depth} = \frac{(P - 0.2S)^2}{P + 0.8S} \qquad \text{Eq 1}$$

where

- Q_{depth} = runoff (inches)
- P = rainfall (inches)
- S = potential maximum retention after runoff begins (inches)

In this equation, it is assumed that $S = I_a/0.2$, where I_a is the initial abstraction.

S is related to the soil and cover conditions of the watershed by the curve number (CN):

$$S = \frac{1000}{CN} - 10 \qquad \text{Eq 2}$$

The depth of runoff obtained with Equations 1 and 2 is converted to a volume by multiplying by the area of the watershed (A_{ws}):

$$Q_{runoff} = Q_{depth} * A_{ws} \qquad \text{Eq 3}$$

Q_{runoff} enters the contaminated stormwater pond each hour that there is precipitation that generates runoff. Evaporation losses from the pond are estimated from the surface of the CSWP by utilizing monthly pan evaporation data for Roswell, NM[C]. A standard reduction factor of 0.7 is applied to the pan evaporation data for evaporation from the pond[C]. If the evaporative losses are greater than the water in the pond, then the pond is empty. If the water in the pond has not evaporated by 8AM the following morning, stormwater recirculation begins. Up to 0.29 acre-ft of water is applied per day, from 8AM to 4PM with an assumed stationary sprinkler system. The percent evaporative losses from spraying are calculated[2] using average wind speed[D] and relative humidity[D]:

$$\%Loss = 20.7 + 0.185 * AWS - 2.14x10^{-3} * RH^2 \qquad \text{Eq 4}$$

where

AWS = average wind speed (meters/sec)

RH = relative humidity (%)

Equation 4 was selected due to its validation performance, and because recirculation only occurs during the daytime.

The volume of water in the pond is tracked on an hourly basis, and incorporates any water left in the pond from the day before and evaporation losses from the pond to determine how much water is sprayed back each hour. Water recirculation only occurs from 8AM-4PM, regardless of whether measured precipitation occurs that day.

This calculation is performed in Excel for the entirety of 1986, but the steps and equations described above are illustrated below for a few days in October from the 1986 record. Once hourly precipitation and recirculation values were determined in Excel, Microsoft Access was used to process the data for input into UNSAT-H.

4.0 SOLUTION

The measured rainfall on October 9, 1986 is 0.59 inches. The measured precipitation is applied at a rate of 1.0 inches/hour beginning at 6PM until all the precipitation is applied, resulting in the following precipitation record for these two days.

Month	Day	Hour	Precipitation (in)	Month	Day	Hour	Precipitation (in)
10	9	0	0	10	10	0	0
10	9	1	0	10	10	1	0
10	9	2	0	10	10	2	0
10	9	3	0	10	10	3	0
10	9	4	0	10	10	4	0
10	9	5	0	10	10	5	0
10	9	6	0	10	10	6	0
10	9	7	0	10	10	7	0
10	9	8	0	10	10	8	0
10	9	9	0	10	10	9	0
10	9	10	0	10	10	10	0
10	9	11	0	10	10	11	0
10	9	12	0	10	10	12	0
10	9	13	0	10	10	13	0
10	9	14	0	10	10	14	0
10	9	15	0	10	10	15	0
10	9	16	0	10	10	16	0
10	9	17	0	10	10	17	0
10	9	18	0.59	10	10	18	1
10	9	19	0	10	10	19	1
10	9	20	0	10	10	20	1
10	9	21	0	10	10	21	0.46
10	9	22	0	10	10	22	0
10	9	23	0	10	10	23	0

The potential maximum runoff from the active landfill waste is determined assuming a curve number of 91[A] and Equation 2:

$$S = \frac{1000}{91} - 10 = 0.99$$

For the first 17 hours of October 9, there is no precipitation, so no runoff is calculated. At 6pm, I_a over the precipitation is calculated to ensure that there is more precipitation than the initial abstractions:

$$\frac{I_a}{P} = \frac{0.2*S}{P} = \frac{0.2*0.99}{0.56} = 0.34$$

If the value of I_a/P is greater than one, then there is no runoff as initial abstractions exceed precipitation. If I_a/P is less than one, Equation 1 is used to calculate the runoff depth in inches from the precipitation:

$$Q_{depth} = \frac{(0.59 - 0.2*0.99)^2}{0.59 + 0.8*0.99} = 0.11 inches$$

The volume of runoff is determined with Equation 3:

$$Q_{runoff} = 0.11in*15.6\ acres*\frac{1ft}{12in} = 0.145\ acre - ft$$

This volume enters the CSWP. The pan evaporation losses for the month of October are 6.97 inches, which is multiplied by the pan evaporation coefficient of 0.7. The resultant losses are converted to an evaporation loss per hour:

$$\frac{6.97inch}{mo}*0.7*\frac{mo}{31day}*\frac{day}{24hour} = \frac{0.007inch}{hour}$$

From 7PM (it only rains from 6pm to 7pm) until 8AM (13 hours), Q_{runoff} sits in the pond and evaporates at a rate of 0.007inch/hour, over 2.5 acres:

$$\frac{0.007inch}{hour}*2.5acres*\frac{ft}{12inch} = \frac{0.0014acre-ft}{hour}$$

Therefore, at 8AM on October 10, there is

$$0.145\ acre - ft - \frac{0.0014acre - ft}{hour}*13hours = 0.126acre - ft$$

in the CSWP. Sprayback at a rate of 0.0357 acre-ft per hour (0.29 acre-ft per day if applied for 8 hours) then occurs. At 8AM, 0.0357 acre-ft of water is taken from the pond, and evaporative losses from this recirculation are estimated with Equation 4:

$$\%Loss = 20.7 + 0.185*(4.02)^2 - 2.14x10^{-3}*(89)^2 = 6.74\%$$

$$0.0357acre - ft*6.74\% = 0.0024acre - ft$$

Since 0.024 acre-ft is lost to evaporation during spraying, only

0.0357 acre-ft – 0.0024 acre-ft = 0.033 acre-ft

of water is recirculated over the waste, resulting in an application of water at 8AM of

$$\frac{0.033 acre-ft}{6 acres} * \frac{12 inches}{ft} = 0.067 inches$$

At 9AM on October 9, there is

0.124 acre-ft – 0.0357 acre-ft = 0.089 acre-ft

of water in the pond. The evaporative losses from the pond are the same, 0.0014 acre-ft of water per hour, leaving

0.089 acre-ft - 0.0014 acre-ft = 0.087 acre-ft

in the CSWP. Then, 0.0357 acre-ft per hour is taken from the pond to recirculate over the waste, and water losses from spraying the water are estimated as above. This continues until 11AM, at which time there is 0.0144 acre-ft of water in the pond. After evaporation losses of 0.007inch/hour are applied, the pond volume is less than the maximum application rate of 0.0357 acre-ft per hour; thus, the pond is emptied and the remaining water (0.013 acre-ft) is sprayed onto the waste. Evaporative losses from the pond are accounted for as above, and the evaporative losses from spraying are calculated:

$$\%Loss = 20.7 + 0.185 * (4.02)^2 - 2.14x10^{-3} * (89)^2 = 6.74\%$$

$$0.013 acre - ft * 6.74\% = 0.00088 acre - ft$$

Since 0.00088 acre-ft of water are lost to evaporation, only

0.013 acre-ft – 0.00088 acre-ft = 0.012 acre-ft

of water is recirculated over the waste, resulting in an application of water at 11AM of

$$\frac{0.012 acre - ft}{6 acres} * \frac{12 inches}{ft} = 0.024 inches$$

At this time, the pond is empty thus stormwater recirculation ceases. At 6PM, measured precipitation is applied as described above and the process detailed is repeated. The steps of this calculation are included in the attached table for all days of 1986.

The measured precipitation for 1986 is 24.8 inches. The resultant precipitation in 1986 for input into UNSAT-H is 34.6 inches, indicating that 9.8 additional inches of water are applied to the waste from stormwater recirculation.

A

The hydrologic properties of hazardous waste have not been studied to the same extent that municipal waste has been studied and therefore literature information is limited. The HELP model does not provide specific default values for hazardous waste and it is left to the program user to define these characteristics.

The waste was assigned soil texture numbers, initial moisture contents, and hydraulic conductivities which reflect expected actual conditions. The soil texture number of 7 corresponds to a silty sand material (SM) with default porosity of 0.473, field capacity of 0.222, wilting point of 0.104, and hydraulic conductivity of 5.4 x 10^{-4}cm/sec. The initial moisture content was set at 0.2055.

5.2

The hydraulic properties of the waste fill will depend on the characteristics of the incoming waste and the nature of the daily cover soil used. The physical characteristics of landfilled hazardous waste can vary widely from sludges to solids and debris. Contaminated soils and bulk solid materials, however, will make up a major proportion of these materials. Typically, the waste material is placed and compacted and covered with daily cover soil material. Since the surface of the waste fill must be trafficable to waste hauler trucks and other heavy earthmoving equipment, it is not an uncommon practice to increase the amount of daily cover soil placed when softer or sludgy type wastes are received. At the Triassic Park site sand and siltstone will be predominantly used as daily cover materials and incoming contaminated soils are also likely to have a high sand content. Bulk solid wastes such as filter cake material, bag house wastes, and other process wastes are fine grained with particle sizes in the silt range. Based on this, the soil texture corresponding to a sandy silt was selected for the waste material.

Based on previous experience at hazardous waste sites, the initial moisture contents of the waste for Years 0 through 1 were set at 0.2055 which corresponds to a moisture content of 15 percent.

4.2.2 Protective Soil

0.105

The protective soil layer placed on top of the liner prior to waste filling will be the same material used for daily soil cover with the exception that it will be screened to remove oversize rocks and cobbles. Based on evaluation of bulk samples taken at the site from the upper sand unit, a soil texture number of 4 corresponding to a silty sand was selected to model the protective soil layer. This soil texture has the following defaults: porosity of 0.473, field capacity of 0.0105, wilting point of 0.047, and hydraulic conductivity of 1.7 x 10^{-3}cm/sec. The initial moisture content for this layer was set at 0.0863 which is consistent with the average moisture contents of 5.9 percent for the site's silty sand samples.

4.2.3 Lateral Drainage (Sand)

The lateral drainage sand material considered for use at the site will have to meet minimum hydraulic conductivities of 1 x 10^{-2}cm/sec. Although no hydraulic testing of candidate site materials has been conducted, it is believed that this performance standard can be met with available material sources either in their natural state or with a minimal amount of screening and washing. The soil texture number of 1 which corresponds to a poorly graded sand was selected for this layer. This soil texture has the following defaults: porosity of 0.417, field capacity of 0.045, wilting point of 0.018, and hydraulic conductivity of 1 x 10^{-2}cm/sec. Initial moisture content for this layer was set at 0.045 which equals the field capacity and therefore does not allow for water storage in the lateral drainage layer. It should be noted that the geotextile components of the sand drainage layer were not included in the this evaluation. Transmissities of this material exceeds those of the sand material and therefore this assumption is conservative.

4.2.4 Lateral Drainage (Geocomposite)

The geocomposite drainage material used in this analysis was a geotextile bonded to a geonet. The HELP model does not have a specific default for geocomposites so the default for the geonet was selected for this layer. The added capacity of the geotextile in this case is ignored and, as above, this assumption is conservative. The soil specifies the initial notifications, steps to be taken in response to the leakage rate being exceeded, and follow-up reports.

The EPA recommended method for determining the landfill ALR presented in Federal Register Vol. 57, No. 19 and in reference No. 59 were used to calculate the ALR for the landfill facility. Using the flow equation for geonets and applying field representative geocomposite transmissivities and appropriate factors of safety for geonet creep and sediment clogging, the recommended ALR for the landfill was determined to be 900 gpad.

The ALR value of 900 gpad is above the EPA recommended value of 100 gpad. The primary reason for this difference is that the EPA value is based on a sand drainage layer with a permeability of 1 x 10^{-2} cm/sec compared to the geocomposite drainage layer transmissivity of 2.2x10^{-4} m^2/sec proposed for the Triassic Park Landfill.

Additional computations to check the LDRS sump capacity and LDRS drain pipe capacity are also presented in the Appendix G.

Response Action Plan steps outlined in the Action Leakage Rate and Response Action Plan closely follow the recommended actions presented in Federal Register Volume 57, No. 19.

3.2.10 Surface Water Drainage Analyses

Design parameters for HDPE lined Channels 7 and 8 located above the landfill access ramps are presented on Drawing No. 25 (Sheet 2 of 2). The methodology, assumptions, and run-off calculations for these channels and the collection basins discussed below and are presented in Appendix F.

The clean stormwater collection basin located at the toe of the 2H:1V cut slope in the south end of landfill will contain the run-off from the 15 acres of unlined area of Phase 1A (above the access ramps). The total run-off from the 25-year, 24-hour event is approximately 4.5 ac-ft. Total volume of the detention pond assuming 1 foot of freeboard is 5.2 ac-ft.

The contaminated water basin at the toe of the Phase 1A waste fill slope is designed to contain the run-off from the entire 15.6 acre fill area of Phase 1A. The total run-off from the 25-year, 24-hour event is approximately 4.3 ac-ft. The contaminated water basin is approximately 560 feet by 200 feet and can store approximately 10.4 ac-ft assuming 1 foot of freeboard. The contaminated water basin will be constructed at the same time as the rest of the Phase 1A landfill so it can accommodate runoff from waste placed in Phase 1A.

560ft x 200 ft = 112000ft² * 1 acre / 43560ft² = 2.57 acres

3.2.11 Soil Erosion Analyses

Due to the temporary nature of the 2H:1V cut slope and the 3H:1V subgrade slopes above the access ramps, severe soil erosion of these slope areas is not anticipated. The 2H:1V cut slope will be excavated during future landfill construction and the 3H:1V subgrade areas above the access roads will be conditioned prior to liner placement as required in the specifications.

Erosional features such as rills and localized slumping in exposed areas of the protective soils layer on the 3H:1V slope areas will be repaired following rain events.

3.2.12 Frost Protection

The maximum frost depths in the Roswell area, indicates that frost may reach 23 inches during the winter months. In addition, site-specific frost penetration modeling for the site indicated a maximum design freezing

Appendix H-2. A chemical resistance chart for the tanks is provided in Appendix H-3.

The concrete containment pad will slope towards the landfill crest. A concrete pad will be placed in the loading/unloading areas for the tanker trucks. This pad will be sloped providing drainage toward the sump areas. Calculations on the bearing capacity of the concrete pad are detailed in Appendix E-35. Should a catastrophic failure of the tank or piping system occur, leachate will flow back into the landfill leachate collection system rather than be released to unlined areas. The landfill liner system anchor trench will completely encompass the pad so that any leakage through the pad will also drain back into the landfill leachate collection system. Construction details for the concrete containment pad are called out in Specification Section 03100, Concrete Formwork, Section 03200, Reinforcement Steel, Section 03290, Joints in Concrete, and Section 03300, Cast-in-Place Concrete.

3.1.4 Waste Filling Sequence

As mentioned previously in Section 3.1.2, landfill development will begin in Phase 1A, proceed southward into Phase 2, and then finish in Phase 3. The extent of landfill subphases will be based on waste receipt rates.

Liner installation in Phase 1A will take place in two stages: the slope and floor area below the access ramps and the slope area above the access ramps. The initial stage of the Phase 1A liner installation will consist of liner placement below the access ramps and is the only portion relevant to this permit application. The approximate area that will be lined during the Phase 1A construction is 14.9 acres which is delineated on Drawing No. 10.

Detailed planning for Phase 1B, Phase 2 and Phase 3 liner installation, access ramp location, and waste fill sequencing will be determined and permitted in the future, however, the ultimate landfill configuration will be developed as follows. Once the waste fill approaches the Phase 1A limits defined in Drawing No. 10, the cut slope will be advanced southward into Phase 2 and the remaining floor and slope areas of Phase 1 will be lined. At this time, the stormwater collection basin in the landfill will be removed from Phase 1 and re-established in Phase 2. Waste filling in Phase 1 will continue during this liner expansion. As the waste fill extends beyond and above the access ramps, a ramp will be established in the south waste fill slope to provide access to the newly lined floor areas of Phase 1.
Waste filling will take place in 5 to 10 foot thick horizontal lifts. Waste will be covered with daily cover soil as soon as practicable following waste placement (and minimally at the end of each operating shift). Daily cover soil thicknesses will be at least 0.5 ft.

B

Data Downloaded from www.ncdc.noaa.gov/oa/ncdc.html

DSET	COOPID	WBNID	ELEM	UN	YEARMO	DAY01	DAY02	DAY03	DAY04	DAY05	DAY06	DAY07	DAY08	DAY09	DAY10	DAY11	DAY12	DAY13
3210	297610	23009	PRCP	HI	198601	0	0	0	0	0	20	47	0	0	0	0	0	0
3210	297610	23009	PRCP	HI	198602	0	0	0	4	0	0	3	4	31	8	0	0	0
3210	297610	23009	PRCP	HI	198603	0	0	0	0	0	0	0	0	0	0	0	0	0
3210	297610	23009	PRCP	HI	198604	0	0	0	0	0	0	0	31	0	0	0	0	0
3210	297610	23009	PRCP	HI	198605	0	0	0	0	0	0	0	0	0	0	0	0	0
3210	297610	23009	PRCP	HI	198606	2	0	0	1	0	0	0	36	0	0	0	0	0
3210	297610	23009	PRCP	HI	198607	66	22	2	0	0	0	0	0	10	1	0	0	0
3210	297610	23009	PRCP	HI	198608	0	8	16	12	0	4	0	0	0	0	0	0	1
3210	297610	23009	PRCP	HI	198609	74	171	0	93	0	0	2	0	0	0	0	0	4
3210	297610	23009	PRCP	HI	198610	0	7	0	0	13	7	0	0	59	346	0	0	0
3210	297610	23009	PRCP	HI	198611	0	70	79	14	0	0	0	0	0	0	0	0	13
3210	297610	23009	PRCP	HI	198612	0	0	0	0	0	0	0	15	0	18	0	0	0
3210	297610	23009	TMAX	F	198601	65	67	57	51	49	67	41	33	38	56	59	58	60
3210	297610	23009	TMAX	F	198602	71	65	68	54	43	49	41	28	29	25	28	29	46
3210	297610	23009	TMAX	F	198603	81	77	67	69	72	78	68	81	76	72	63	63	59
3210	297610	23009	TMAX	F	198604	72	80	68	74	79	85	92	82	68	79	81	85	86
3210	297610	23009	TMAX	F	198605	85	83	85	92	90	89	87	75	82	85	92	93	88
3210	297610	23009	TMAX	F	198606	77	79	79	89	89	97	100	87	90	90	83	92	93
3210	297610	23009	TMAX	F	198607	92	78	85	92	93	89	89	90	90	91	97	98	93
3210	297610	23009	TMAX	F	198608	98	98	89	91	94	95	96	91	92	90	90	92	95
3210	297610	23009	TMAX	F	198609	84	82	80	87	82	84	79	77	87	89	81	85	83
3210	297610	23009	TMAX	F	198610	88	76	82	77	62	61	74	83	75	70	64	43	66
3210	297610	23009	TMAX	F	198611	69	41	47	50	63	72	62	65	57	61	50	43	29
3210	297610	23009	TMAX	F	198612	58	66	58	42	53	53	67	58	38	32	42	51	54
3210	297610	23009	TMIN	F	198601	33	25	28	27	22	28	18	13	13	23	25	31	27
3210	297610	23009	TMIN	F	198602	36	43	34	30	24	18	23	21	19	14	21	19	26
3210	297610	23009	TMIN	F	198603	31	44	49	36	38	34	43	35	51	39	47	44	35
3210	297610	23009	TMIN	F	198604	51	47	46	40	41	49	57	51	46	40	51	50	57
3210	297610	23009	TMIN	F	198605	54	62	59	59	51	52	56	51	43	50	49	63	52
3210	297610	23009	TMIN	F	198606	53	60	59	62	60	63	64	61	61	58	58	60	62
3210	297610	23009	TMIN	F	198607	66	66	68	68	68	66	69	66	66	68	66	66	67
3210	297610	23009	TMIN	F	198608	66	67	65	64	65	67	68	68	64	67	65	66	71

B

DSET	COOPID	WBNID	ELEM	UN	YEARMO	DAY01	DAY02	DAY03	DAY04	DAY05	DAY06	DAY07	DAY08	DAY09	DAY10	DAY11	DAY12	DAY13
3210	297610	23009	TMIN	F	198609	63	60	63	61	57	62	62	61	63	68	56	54	61
3210	297610	23009	TMIN	F	198610	47	59	56	52	54	51	50	47	53	54	43	37	38
3210	297610	23009	TMIN	F	198611	41	38	39	36	30	34	38	33	31	27	25	26	24
3210	297610	23009	TMIN	F	198612	25	23	28	27	40	44	39	36	32	25	23	20	22
3210	297610	23009	PRCP	HI	199801	0	0	0	0	0	0	0	0	0	0	0	0	0
3210	297610	23009	PRCP	HI	199802	0	0	0	5	4	0	0	0	0	0	0	0	0
3210	297610	23009	PRCP	HI	199803	0	0	0	0	0	0	5	0	0	0	0	0	0
3210	297610	23009	PRCP	HI	199804	0	0	0	0	0	0	0	0	0	0	0	0	0
3210	297610	23009	PRCP	HI	199805	0	0	0	0	0	0	0	0	0	0	0	0	0
3210	297610	23009	PRCP	HI	199806	0	0	0	0	0	0	0	0	0	18	0	0	0
3210	297610	23009	PRCP	HI	199807	0	17	0	62	2	0	0	20	1	0	0	0	0
3210	297610	23009	PRCP	HI	199808	0	21	0	0	10	0	0	0	0	0	1	69	4
3210	297610	23009	PRCP	HI	199809	0	0	0	0	0	0	0	0	0	0	0	0	0
3210	297610	23009	PRCP	HI	199810	154	0	0	0	0	0	0	0	0	0	0	0	0
3210	297610	23009	PRCP	HI	199811	0	0	0	1	2	0	0	0	0	0	0	0	0
3210	297610	23009	PRCP	HI	199812	10	55	0	0	0	0	0	0	0	5	0	0	0
3210	297610	23009	TMAX	F	199801	37	40	43	38	43	43	42	49	49	39	51	52	33
3210	297610	23009	TMAX	F	199802	55	66	63	39	47	55	62	68	64	59	56	48	62
3210	297610	23009	TMAX	F	199803	56	52	72	76	72	69	59	46	51	51	43	54	69
3210	297610	23009	TMAX	F	199804	77	64	68	77	79	72	70	68	71	79	86	82	76
3210	297610	23009	TMAX	F	199805	87	88	84	92	86	88	85	86	84	92	91	91	93
3210	297610	23009	TMAX	F	199806	108	106	103	94	85	79	95	93	96	81	88	97	100
3210	297610	23009	TMAX	F	199807	97	85	92	98	98	101	99	100	98	99	104	107	100
3210	297610	23009	TMAX	F	199808	93	93	92	79	79	86	97	99	98	97	97	90	85
3210	297610	23009	TMAX	F	199809	91	93	92	96	94	94	93	94	89	91	88	89	95
3210	297610	23009	TMAX	F	199810	79	84	90	87	71	72	77	83	86	92	88	80	90
3210	297610	23009	TMAX	F	199811	61	62	62	49	47	52	64	75	73	57	68	60	63
3210	297610	23009	TMAX	F	199812	66	56	61	70	74	54	46	48	48	41	46	56	60
3210	297610	23009	TMIN	F	199801	12	15	27	22	23	20	25	13	18	22	22	21	25
3210	297610	23009	TMIN	F	199802	32	22	32	34	34	35	28	40	36	34	25	26	21
3210	297610	23009	TMIN	F	199803	25	23	24	32	35	39	30	28	21	20	25	21	26
3210	297610	23009	TMIN	F	199804	28	44	38	35	36	39	37	41	34	37	43	44	41
3210	297610	23009	TMIN	F	199805	48	51	53	47	59	51	51	52	53	49	52	45	44

B

DSET	COOPID	WBNID	ELEM	UN	YEARMO	DAY01	DAY02	DAY03	DAY04	DAY05	DAY06	DAY07	DAY08	DAY09	DAY10	DAY11	DAY12	DAY13
3210	297610	23009	TMIN	F	199806	57	60	64	63	57	55	57	60	60	54	51	62	67
3210	297610	23009	TMIN	F	199807	72	66	65	67	70	72	76	70	65	66	71	69	70
3210	297610	23009	TMIN	F	199808	68	70	66	64	63	60	61	63	61	66	68	65	65
3210	297610	23009	TMIN	F	199809	62	65	64	64	64	64	62	61	59	65	59	62	61
3210	297610	23009	TMIN	F	199810	61	58	53	62	48	43	44	42	46	48	48	51	54
3210	297610	23009	TMIN	F	199811	43	40	43	44	42	42	41	36	44	34	27	38	35
3210	297610	23009	TMIN	F	199812	35	43	41	35	38	35	28	20	24	32	28	23	28

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YEARMO	DAY14	DAY15	DAY16	DAY17	DAY18	DAY19	DAY20	DAY21	DAY22	DAY23	DAY24	DAY25	DAY26	DAY27	DAY28	DAY29	DAY30
198601	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
198602	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-99999	-99999
198603	4	0	0	0	2	5	1	0	0	0	0	0	0	0	0	0	0
198604	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
198605	0	0	0	27	0	0	0	0	0	0	0	2	7	1	0	6	51
198606	0	0	0	0	94	8	0	0	0	104	144	109	4	0	0	0	0
198607	0	0	0	2	0	0	0	2	0	6	0	0	0	0	0	0	0
198608	0	0	0	0	0	0	0	0	59	17	0	0	85	40	26	3	11
198609	0	0	0	0	0	0	0	0	12	29	0	0	0	0	0	8	0
198610	0	0	0	18	0	0	11	87	0	0	0	0	0	0	0	0	0
198611	0	0	0	0	0	6	0	0	0	7	0	0	0	0	0	0	0
198612	0	0	8	26	10	0	0	26	44	0	0	0	0	0	0	0	0
198601	60	68	67	71	62	74	77	72	52	64	70	53	55	60	77	61	71
198602	68	78	72	77	82	84	79	61	69	78	77	85	85	61	65	-99999	-99999
198603	52	68	74	68	57	56	59	72	80	81	82	83	77	78	82	80	85
198604	76	79	83	82	77	62	77	81	87	87	88	84	85	76	88	86	91
198605	89	92	89	57	74	86	94	97	94	84	93	79	77	73	82	80	77
198606	96	99	102	92	93	89	90	91	90	68	74	78	82	87	94	94	96
198607	86	88	92	91	91	94	92	86	86	91	94	98	100	101	100	99	100
198608	92	94	96	98	97	98	103	94	92	82	85	86	89	80	68	78	85
198609	85	88	85	91	93	93	91	90	85	84	79	83	85	86	85	86	82
198610	72	72	70	76	80	63	61	78	70	66	69	70	72	77	82	66	75
198611	53	60	71	76	64	74	61	66	74	48	52	61	48	61	67	70	63
198612	58	63	49	45	41	52	55	43	37	47	49	48	53	52	51	55	59
198601	28	29	37	30	37	29	30	36	30	24	31	25	21	24	26	39	27
198602	37	39	46	40	42	42	47	33	34	32	42	39	45	43	34	-99999	-99999
198603	35	34	31	40	32	39	34	30	35	36	40	42	45	45	44	50	48
198604	39	47	48	54	42	41	37	44	48	50	51	59	57	49	45	58	60
198605	57	55	54	43	38	47	53	56	61	56	62	59	57	55	52	55	54
198606	65	65	67	66	63	65	65	63	66	63	63	64	65	65	66	68	69
198607	67	65	66	64	65	62	64	67	67	65	65	65	64	68	67	65	65
198608	70	71	67	69	67	67	66	73	66	66	64	61	65	66	62	63	65

B

YEARMO	DAY14	DAY15	DAY16	DAY17	DAY18	DAY19	DAY20	DAY21	DAY22	DAY23	DAY24	DAY25	DAY26	DAY27	DAY28	DAY29	DAY30
198609	62	59	63	58	59	65	63	63	65	61	53	51	51	49	56	59	48
198610	36	39	43	44	46	57	56	50	43	46	49	46	44	43	40	45	42
198611	26	35	40	43	49	42	39	32	36	30	24	22	30	24	26	28	33
198612	26	26	34	33	32	24	27	37	33	29	29	30	27	25	29	26	22
199801	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
199802	0	1	0	0	3	0	0	0	0	0	0	0	0	0	0	-99999	-99999
199803	0	21	43	8	1	0	0	0	0	0	0	0	0	0	0	0	4
199804	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0
199805	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
199806	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
199807	0	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	70
199808	0	0	0	0	0	12	4	0	0	0	0	0	12	0	11	0	0
199809	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	5
199810	0	0	0	0	0	11	78	4	1	1	0	0	0	148	0	0	179
199811	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	19	0
199812	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0
199801	52	53	62	66	63	60	63	52	53	55	59	66	60	69	67	60	67
199802	69	56	57	58	56	56	54	61	70	72	81	60	55	52	51	-99999	-99999
199803	70	63	53	57	67	56	53	68	82	88	87	90	84	76	80	79	59
199804	82	75	66	55	63	71	70	69	76	89	91	84	70	64	67	75	84
199805	87	82	93	94	97	99	98	92	95	93	95	85	90	97	98	101	101
199806	95	89	101	100	96	105	106	104	104	105	108	108	108	108	110	106	101
199807	100	100	92	93	97	102	101	99	97	96	98	95	91	90	97	100	102
199808	90	92	95	93	92	90	84	89	92	93	96	94	92	96	90	91	93
199809	94	88	87	89	90	95	95	97	85	90	96	96	96	96	92	91	87
199810	90	91	82	74	70	69	55	53	57	62	70	77	79	64	72	73	78
199811	74	74	74	74	76	70	48	69	76	72	76	72	74	73	77	57	65
199812	60	56	61	56	71	46	71	50	27	32	39	61	64	69	70	65	63
199801	23	19	30	27	33	26	34	33	24	25	24	26	28	25	25	24	27
199802	39	37	26	28	37	35	27	36	29	34	33	38	34	29	16	-99999	-99999
199803	38	47	42	37	35	30	31	30	33	40	44	45	51	44	39	51	38
199804	40	41	38	33	28	34	42	37	40	40	47	51	45	44	38	39	45
199805	51	48	45	54	58	62	61	63	59	54	50	59	53	52	55	58	57

B

YEARMO	DAY14	DAY15	DAY16	DAY17	DAY18	DAY19	DAY20	DAY21	DAY22	DAY23	DAY24	DAY25	DAY26	DAY27	DAY28	DAY29	DAY30
199806	62	59	56	60	61	57	62	63	63	64	65	65	69	65	65	65	66
199807	67	67	66	70	69	66	69	68	68	66	72	69	71	70	71	72	66
199808	61	63	61	60	65	68	66	65	64	63	64	67	66	68	71	67	57
199809	64	65	61	62	61	64	64	68	59	61	63	62	61	61	66	64	65
199810	56	59	51	43	40	53	49	49	50	50	47	50	58	48	42	42	56
199811	34	39	37	34	40	42	35	30	31	34	31	36	31	35	38	40	33
199812	22	28	25	27	35	30	39	17	11	14	19	15	20	31	26	34	27

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YEARMO	DAY31
198601	0
198602	-99999
198603	0
198604	-99999
198605	25
198606	-99999
198607	0
198608	29
198609	-99999
198610	0
198611	-99999
198612	0
198601	70
198602	-99999
198603	88
198604	-99999
198605	69
198606	-99999
198607	98
198608	89
198609	-99999
198610	80
198611	-99999
198612	52
198601	32
198602	-99999
198603	49
198604	-99999
198605	57
198606	-99999
198607	64
198608	65

YEARMO	DAY31
198609	-99999
198610	47
198611	-99999
198612	22
199801	0
199802	-99999
199803	0
199804	-99999
199805	0
199806	-99999
199807	0
199808	0
199809	-99999
199810	15
199811	-99999
199812	0
199801	64
199802	-99999
199803	66
199804	-99999
199805	99
199806	-99999
199807	86
199808	93
199809	-99999
199810	62
199811	-99999
199812	52
199801	31
199802	-99999
199803	32
199804	-99999
199805	55

YEARMO	DAY31
199806	-99999
199807	66
199808	60
199809	-99999
199810	46
199811	-99999
199812	36

(C)

Evaporation Stations

Standard daily pan evaporation is measured using the four-foot diameter Class A evaporation pan.
The pan water level reading is adjusted when precipitation is measure to obtain the actual evaporation.
Most Class A pans are installed above ground, allowing effects such as radiation on the side walls and
heat exchnges with the pan material. These effects ~~tend to increase~~ the evaporation totals. The amounts
can then be adjusted by multiplying the totals b 0.70 or 0.80 to more closely estimate the evaporation
from naturally existing urfaces such as a shallow lake, wet soil or other moist natural surfaces.

0.7 CONSERVATIVE

Many stations do not measure pan evaportation during winter months. A "0.00" total indicates no measuement is taken.

Stations marked with an asterisk (*) have estimated totals computed from meteorological measurements using a
form of the Penman equation.

Click on a State: Arizona <#ARIZONA>, California <#CALIFORNIA>, Colorado <#COLORADO>, Hawaii & Pacific Islands <#HAWAII/PACIFIC ISLANDS>, Idaho <#IDAHO>, Montana <#MONTANA>, Nevada <#N
EVADA>,
New Mexico <#NEW MEXICO>, Oregon <#OREGON>, Utah <#UTAH>, Washington <#WASHINGTON>, Wyoming <#WYOMING>

NEW MEXICO

MONTHLY AVERAGE PAN EVAPORATION (INCHES)

	PERIOD OF RECORD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
ABIQUIU DAM	1957-2005	0.00	0.00	6.06	7.43	9.95	11.39	10.52	8.90	7.23	5.30	3.13	2.22	72.13
AGRICULTURAL COLLEGE	1892-1959	3.01	4.00	7.89	10.20	8.65	13.99	12.33	11.16	8.31	6.28	4.35	2.89	93.06
ALAMOGORDO DAM	1939-1975	3.73	4.35	8.21	11.30	12.88	14.43	13.66	11.59	9.17	7.19	4.89	3.46	104.86
ANIMAS	1923-2005	3.87	4.91	8.29	10.78	12.36	14.25	11.60	11.07	8.54	6.71	4.69	3.61	100.68
ARTESIA 6 S	1914-2005	4.38	3.03	7.25	7.66	12.11	13.13	10.86	10.44	9.36	6.34	3.12	0.00	87.68
BITTER LAKES WL REFUGE	1950-2005	2.67	3.93	6.82	9.60	11.31	12.62	11.88	10.16	8.02	5.85	3.53	2.50	88.89
BOSQUE DEL APACHE	1914-2005	3.21	4.20	7.76	10.20	11.61	13.13	11.56	10.36	8.03	6.25	3.66	2.54	92.51
BRANTLEY DAM	1987-2005	4.65	0.00	8.62	11.77	14.61	15.46	14.19	12.22	9.88	7.97	5.77	4.34	109.48
CABALLO DAM	1938-2005	4.42	5.10	8.56	11.37	13.59	14.80	13.08	11.35	9.26	7.27	4.78	3.48	107.06
CAPULIN NATL MONUMENT	1966-1979	0.00	0.00	0.00	0.00	9.08	10.57	9.71	9.18	7.65	0.00	0.00	0.00	46.19
CLOVIS 13 N	1929-2005	3.83	4.12	6.63	8.72	10.15	11.45	11.65	9.55	7.64	5.78	3.95	3.21	86.68
COCHITI DAM	1975-2005	0.00	4.14	6.44	8.48	11.07	12.95	12.38	10.62	8.91	6.29	3.94	2.79	88.01

D

History for Roswell, NM

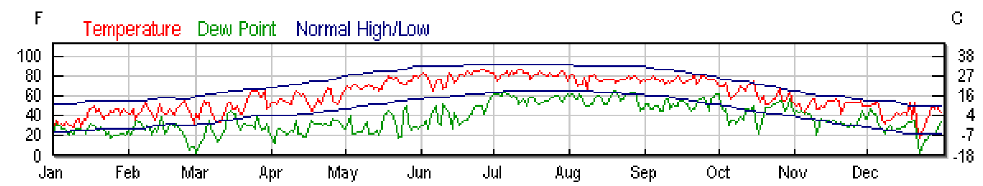
January 1, 1998 through December 31, 1998 — View Current Conditions

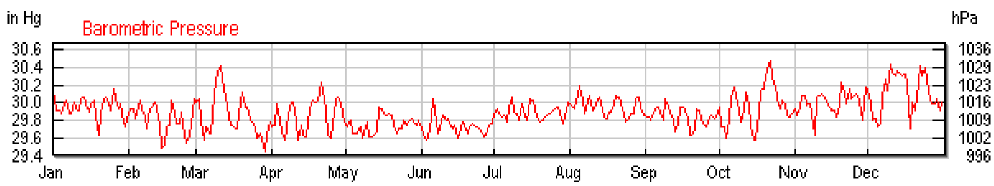
January 1, 1998 through December 31, 1998

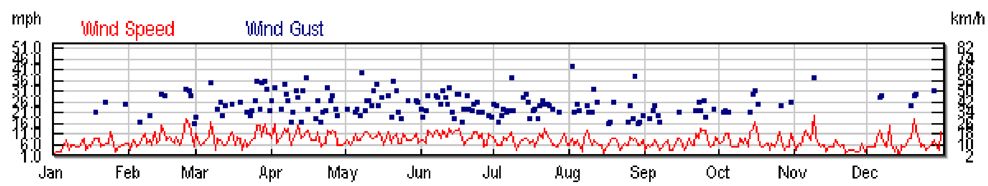
January | 1 | 1998 - TO - December | 31 | 1998 | Go

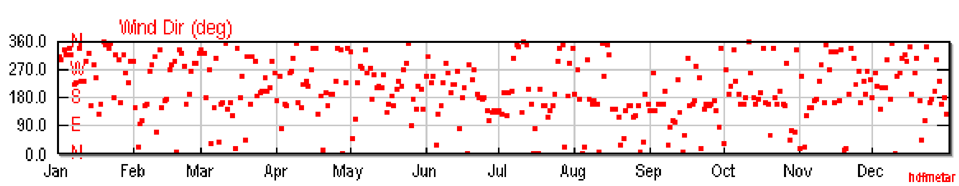
Daily | Weekly | Monthly | **Custom**

	Max	Avg	Min	Sum
Temperature				
Max Temperature	**111** °F	**76** °F	**26** °F	
Mean Temperature	**88** °F	**61** °F	**18** °F	
Min Temperature	**79** °F	**47** °F	**10** °F	
Degree Days				
Heating Degree Days (base 65)	47	9	0	3349
Cooling Degree Days (base 65)	24	6	0	2085
Growing Degree Days (base 50)	38	14	0	5136
Dew Point				
Dew Point	**72** °F	**38** °F	**-6** °F	
Precipitation				
Precipitation	**1.78** in	**0.03** in	**0.00** in	**10.93** in
Snowdepth	-	-	-	-
Wind				
Wind	**45** mph	**8** mph	**0** mph	
Gust Wind	**56** mph	**25** mph	**16** mph	
Sea Level Pressure				
Sea Level Pressure	**30.62** in	**29.89** in	**29.33** in	









Certify This Report

Observations

1998	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
Jan	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	high	sum	
1	36	24	12	30	19	10	100	91	79	30.25	30.16	30.09	10	4	0	5	2	-	0.00	Fog
2	39	29	19	33	26	18	96	88	73	30.09	30.03	29.95	10	9	5	8	2	-	0.00	Snow
3	42	36	27	36	33	25	100	92	79	29.97	29.92	29.83	10	5	0	8	3	-	0.00	Fog
4	37	30	24	36	30	21	100	97	86	30.00	29.91	29.88	10	2	0	12	3	21	0.00	Fog
5	42	32	23	35	28	21	100	95	62	29.92	29.88	29.82	10	3	0	12	3	-	0.00	Fog
6	42	30	19	31	27	17	100	88	51	30.15	29.99	29.91	10	6	0	26	6	31	0.00	Fog , Snow
7	41	34	24	31	26	19	100	75	49	30.11	30.02	29.92	10	9	2	17	8	-	0.00	Snow
8	48	30	12	29	21	9	92	72	39	29.93	29.87	29.81	10	10	10	14	4	-	0.00	Rain
9	39	30	21	30	24	19	89	72	53	29.99	29.87	29.79	10	10	10	12	6	-	0.00	
10	37	29	21	29	23	20	100	88	68	30.08	30.01	29.91	10	5	0	10	6	-	0.00	
11	50	36	23	35	27	20	89	74	52	30.01	29.93	29.87	10	8	5	12	5	-	0.00	
12	50	37	24	32	27	21	88	68	43	30.00	29.91	29.86	10	10	10	8	5	-	0.00	
13	33	29	25	32	28	24	100	95	85	30.14	30.05	29.98	10	1	0	10	6	-	0.00	Fog
14	51	38	24	32	26	22	100	75	38	30.19	30.07	30.00	10	8	0	15	9	-	0.00	Fog
15	53	36	19	31	23	15	88	63	38	30.13	29.98	29.81	10	10	10	13	4	-	0.00	
16	62	47	32	36	30	23	86	58	32	30.04	29.89	29.78	10	10	10	21	6	29	0.00	
17	66	47	28	41	32	25	89	62	36	30.11	29.98	29.85	10	10	10	17	5	-	0.00	
18	63	50	33	32	30	23	79	52	22	30.12	30.03	29.90	10	10	10	22	9	16	0.00	
19	60	44	28	33	28	21	81	55	36	30.08	29.83	29.57	10	10	10	20	9	21	0.00	
20	63	48	34	30	26	21	75	43	23	29.78	29.64	29.54	10	10	10	16	9	-	0.00	
21	50	42	33	34	29	24	79	61	46	29.96	29.87	29.76	10	10	10	8	5	-	0.00	
22	52	38	24	31	27	23	100	75	34	30.11	30.02	29.95	10	9	1	16	6	21	0.00	
23	54	40	26	26	20	12	85	55	20	30.17	30.07	29.93	10	10	10	21	7	28	0.00	
24	57	40	24	30	24	20	84	58	28	30.12	29.99	29.85	10	10	10	16	7	-	0.00	
25	66	46	27	31	18	6	85	40	10	30.13	29.92	29.84	10	10	10	32	12	39	0.00	
26	59	44	28	23	20	17	69	44	20	30.24	30.16	30.06	10	10	10	9	6	-	0.00	
27	69	48	27	25	21	14	75	44	14	30.16	30.04	29.90	10	10	10	12	3	-	0.00	
28	66	47	28	25	20	15	69	42	14	30.00	29.93	29.84	10	10	10	9	5	-	0.00	
29	57	40	24	28	22	17	75	47	24	30.12	29.98	29.86	10	10	10	8	5	-	0.00	
30	66	47	28	27	22	17	78	47	15	29.85	29.76	29.64	10	10	10	21	6	20	0.00	
31	63	46	30	29	21	12	76	41	14	29.79	29.73	29.66	10	10	10	23	7	28	0.00	
1998	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
Feb	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	high	sum	
1	54	43	32	30	25	22	73	54	30	29.94	29.88	29.75	10	10	10	10	7	-	0.00	
2	64	42	21	25	21	16	78	46	16	30.02	29.93	29.83	10	10	10	12	4	17	0.00	
3	62	48	35	33	25	19	79	46	20	30.04	29.94	29.86	10	10	10	13	8	-	0.00	

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1998	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
4	39	36	33	37	34	29	100	91	76	29.92	29.82	29.72	10	7	2	13	7	-	0.05	Rain
5	46	40	35	39	36	32	100	91	63	30.07	29.87	29.77	10	5	0	20	5	25	0.04	Fog , Rain
6	54	44	35	34	34	32	96	75	43	30.13	30.03	29.93	10	10	7	12	7	17	0.00	
7	62	46	30	36	31	23	100	73	28	30.02	29.92	29.75	10	6	0	17	8	-	0.00	
8	66	54	42	37	26	21	66	37	17	29.96	29.83	29.71	10	10	10	20	11	-	0.00	
9	62	50	39	37	31	19	79	53	19	29.77	29.71	29.62	10	10	10	18	7	29	0.00	
10	55	45	35	37	28	22	83	53	27	30.05	29.94	29.76	10	10	9	17	8	22	0.00	Rain
11	55	42	28	24	21	16	72	47	23	30.09	29.96	29.84	10	10	10	13	6	-	0.00	
12	46	36	27	32	27	21	89	60	43	30.12	30.01	29.84	10	10	10	30	12	38	0.00	
13	61	41	21	32	24	18	100	61	19	30.09	29.94	29.81	10	8	0	15	7	-	0.00	Fog
14	64	52	41	45	32	26	93	52	26	29.88	29.75	29.63	10	10	10	22	8	25	0.00	
15	54	46	37	45	39	31	96	77	41	29.69	29.49	29.37	10	9	5	24	15	33	0.01	Rain
16	57	42	26	32	22	16	89	47	21	29.69	29.52	29.44	10	10	10	25	11	38	0.01	
17	57	42	28	32	24	15	82	47	26	29.83	29.73	29.66	10	10	10	15	8	-	0.00	
18	55	47	39	39	33	21	82	63	38	29.92	29.74	29.63	10	10	9	20	10	25	0.03	Rain
19	55	46	35	34	32	26	87	62	34	30.14	30.03	29.93	10	10	10	13	8	-	0.00	
20	52	40	27	35	29	23	85	64	38	29.99	29.87	29.78	10	10	10	15	7	-	0.00	
21	60	48	36	37	32	26	86	58	31	29.84	29.77	29.72	10	10	10	17	10	-	0.00	
22	70	50	30	30	25	20	82	43	16	29.84	29.76	29.67	10	10	10	22	6	30	0.00	
23	71	53	35	33	25	18	73	38	15	29.99	29.90	29.83	10	10	10	14	7	-	0.00	
24	79	56	34	30	21	12	67	29	8	29.88	29.64	29.43	10	10	6	32	14	41	0.00	
25	60	50	39	23	15	7	45	27	15	29.60	29.54	29.48	10	10	10	29	18	41	0.00	
26	54	44	35	19	6	-3	50	24	10	29.71	29.63	29.58	10	10	10	29	16	41	0.00	
27	50	40	30	19	9	2	38	30	15	29.92	29.77	29.69	10	10	10	28	12	32	0.00	
28	50	33	16	23	9	-6	74	40	10	30.13	30.04	29.94	10	10	10	17	5	16	0.00	

1998	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
Mar	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	high	sum	
1	55	42	28	7	3	-1	38	23	11	30.10	30.00	29.86	10	10	10	18	11	21	0.00	
2	51	38	24	13	9	2	53	35	21	30.16	30.05	29.99	10	10	10	14	7	-	0.00	
3	71	48	25	17	14	9	58	30	12	30.01	29.79	29.59	10	10	10	14	6	18	0.00	
4	75	55	35	20	17	11	44	25	11	29.65	29.58	29.50	10	10	10	16	7	-	0.00	
5	71	53	35	33	27	20	78	42	15	29.88	29.73	29.61	10	9	5	17	8	-	0.00	
6	68	54	39	39	36	32	82	57	30	29.83	29.65	29.48	10	10	10	25	10	39	0.00	
7	57	44	30	41	29	8	100	75	16	29.96	29.66	29.42	10	7	2	32	17	47	0.05	Snow
8	46	37	28	25	21	16	82	56	39	30.16	30.08	29.95	10	10	10	14	9	-	0.00	
9	50	36	23	19	17	14	77	49	27	30.35	30.24	30.14	10	10	10	12	4	17	0.00	
10	50	34	19	16	14	9	63	46	26	30.50	30.34	30.21	10	10	10	20	9	25	0.00	
11	42	34	26	23	18	14	69	53	38	30.56	30.41	30.25	10	10	10	25	8	31	0.00	
12	54	38	21	26	22	16	80	59	34	30.46	30.27	30.10	10	10	9	17	7	21	0.00	

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1998	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
13	69	48	26	35	28	21	85	54	22	30.20	30.06	29.94	10	10	10	17	6	24	0.00	
14	68	52	37	49	42	35	93	74	37	30.13	29.96	29.83	10	10	4	18	7	-	0.00	
15	61	54	46	54	46	39	100	80	46	29.90	29.75	29.65	10	9	2	20	11	24	0.21	Rain
16	52	47	42	48	44	41	100	91	77	29.81	29.75	29.65	10	8	2	18	12	28	0.43	Rain
17	57	47	37	48	43	38	100	86	62	29.77	29.71	29.63	10	10	10	13	6	-	0.08	Rain
18	66	51	36	46	32	17	100	60	30	29.84	29.70	29.58	10	10	10	31	10	44	0.01	
19	55	42	30	33	26	21	79	52	31	30.09	30.02	29.89	10	10	10	22	9	26	0.00	
20	52	42	32	34	31	27	92	68	45	30.21	30.11	30.04	10	10	10	8	4	-	0.00	
21	68	49	30	35	32	29	96	59	26	30.05	29.96	29.84	10	10	10	20	8	22	0.00	
22	80	56	33	35	31	25	92	46	13	30.04	29.95	29.86	10	10	10	14	5	21	0.00	
23	86	64	42	35	31	27	76	34	13	29.90	29.81	29.72	10	10	10	16	7	22	0.00	
24	87	66	45	36	30	21	63	31	11	29.89	29.79	29.66	10	10	10	22	8	25	0.00	
25	88	66	45	41	28	23	63	27	11	29.83	29.73	29.66	10	10	10	24	9	32	0.00	Rain
26	82	67	52	54	40	21	93	50	10	29.70	29.60	29.41	10	9	2	36	15	44	0.00	Rain
27	73	59	45	32	29	26	51	32	17	29.81	29.65	29.60	10	10	10	22	15	33	0.00	Rain
28	79	59	39	34	26	19	68	32	11	29.78	29.57	29.44	10	10	10	31	10	40	0.00	
29	79	66	54	35	27	20	47	26	12	29.55	29.45	29.33	10	10	9	34	16	44	0.00	Rain
30	55	47	39	39	32	21	85	59	29	29.78	29.63	29.49	10	10	6	34	11	45	0.04	Rain
31	64	50	35	24	20	17	57	33	16	29.83	29.78	29.71	10	10	10	18	11	22	0.00	
1998	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
Apr	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	high	sum	
1	77	54	32	24	18	10	66	28	10	29.87	29.72	29.55	10	10	10	25	9	32	0.00	
2	62	54	44	28	13	5	41	22	10	29.89	29.74	29.56	10	10	10	36	16	40	0.00	
3	66	52	39	30	26	19	60	36	20	30.08	29.98	29.91	10	10	10	18	7	-	0.00	
4	77	57	37	35	27	21	62	34	15	29.94	29.81	29.65	10	10	10	23	9	31	0.00	
5	78	58	37	35	25	18	73	32	12	29.79	29.67	29.56	10	10	10	23	10	28	0.00	
6	72	56	42	32	24	21	47	26	15	29.71	29.58	29.51	10	10	10	32	14	44	0.00	
7	70	54	39	27	21	16	53	30	14	29.81	29.70	29.61	10	10	10	26	12	34	0.00	
8	68	54	42	26	22	15	49	30	15	29.98	29.87	29.75	10	10	10	23	14	31	0.00	
9	71	52	34	35	26	20	79	41	16	30.07	30.00	29.93	10	10	10	12	6	17	0.00	
10	79	59	39	29	24	22	53	29	12	30.11	30.00	29.91	10	10	10	16	9	24	0.00	
11	86	65	44	42	36	27	58	37	17	29.99	29.78	29.55	10	10	10	29	11	37	0.00	
12	82	64	46	40	23	18	55	21	12	29.78	29.58	29.46	10	10	10	31	15	36	0.00	
13	75	60	46	27	22	14	44	25	12	29.84	29.75	29.66	10	10	10	15	9	17	0.00	
14	82	62	42	26	19	10	47	21	11	29.78	29.64	29.54	10	10	10	29	10	37	0.00	
15	75	58	42	28	19	12	44	23	11	29.70	29.61	29.47	10	10	10	34	12	45	0.00	
16	66	52	39	33	25	20	60	36	20	29.96	29.78	29.66	10	10	10	28	13	31	0.00	
17	55	45	35	43	36	31	100	74	45	30.08	30.01	29.96	10	10	5	22	8	-	0.05	Rain
18	63	45	28	42	34	27	100	64	28	30.11	30.02	29.93	10	10	7	26	8	17	0.00	

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1998	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
19	71	52	34	36	33	26	92	52	22	30.14	30.01	29.86	10	10	10	16	8	22	0.00	
20	70	57	45	36	32	25	66	42	27	30.21	30.02	29.86	10	10	10	23	12	31	0.00	
21	69	52	37	37	32	27	83	49	25	30.32	30.23	30.13	10	10	10	10	5	17	0.00	
22	75	57	39	33	30	26	65	36	19	30.27	30.14	30.01	10	10	5	18	6	23	0.00	
23	89	64	42	38	33	27	58	32	16	30.04	29.91	29.76	10	10	10	14	7	24	0.00	Rain
24	91	69	48	38	30	22	52	24	12	29.75	29.63	29.52	10	10	10	33	13	40	0.00	
25	84	67	52	34	30	24	37	22	15	29.80	29.60	29.48	10	10	10	24	11	39	0.00	
26	70	56	44	42	37	30	77	53	26	30.11	29.76	29.56	10	10	10	30	13	38	0.00	Rain
27	64	54	45	40	35	30	80	51	31	30.08	30.03	29.99	10	10	10	21	12	26	0.00	
28	66	52	39	43	35	27	82	55	31	30.21	30.07	29.96	10	10	10	10	6	28	0.00	
29	75	57	39	36	32	28	79	42	20	30.10	30.00	29.90	10	10	10	14	6	-	0.00	
30	84	64	45	37	29	19	68	32	11	29.96	29.86	29.76	10	10	10	15	6	-	0.00	
1998	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
May	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	high	sum	
1	86	68	50	34	28	23	43	23	11	29.82	29.74	29.66	10	10	10	12	7	21	0.00	
2	88	70	52	35	31	28	49	25	13	29.81	29.72	29.65	10	10	10	13	8	23	0.00	
3	84	68	55	54	41	27	77	44	13	30.07	29.81	29.71	10	10	10	12	6	-	0.00	
4	91	71	51	33	23	14	50	20	8	29.76	29.65	29.53	10	10	10	24	7	33	0.00	
5	86	72	61	32	23	16	24	16	10	29.76	29.65	29.55	10	10	10	20	11	24	0.00	
6	88	70	53	32	24	17	34	18	9	29.73	29.66	29.60	10	10	10	17	8	29	0.00	
7	84	68	53	31	24	18	37	19	12	29.86	29.72	29.64	10	10	5	16	8	23	0.00	
8	86	68	53	32	24	14	41	24	8	29.68	29.59	29.47	10	10	10	34	10	51	0.00	
9	84	70	55	34	30	26	42	25	13	29.92	29.73	29.64	10	10	10	20	12	24	0.00	
10	91	71	51	47	34	15	68	34	10	29.95	29.79	29.64	10	10	10	24	12	32	0.00	
11	91	72	54	30	23	16	26	15	10	29.78	29.61	29.49	10	10	10	22	11	32	0.00	
12	91	70	50	29	22	17	33	18	10	29.70	29.61	29.54	10	10	10	26	9	32	0.00	
13	93	68	45	27	22	16	34	17	10	29.70	29.63	29.56	10	10	10	24	9	34	0.00	
14	87	69	54	40	25	18	37	21	10	29.77	29.68	29.59	10	10	10	36	10	47	0.00	
15	82	65	48	29	21	10	41	20	10	30.17	29.95	29.83	10	10	10	21	12	26	0.00	
16	93	68	46	52	27	11	48	20	11	30.05	29.94	29.81	10	10	7	25	9	32	0.00	
17	93	74	55	53	40	33	77	32	12	29.95	29.88	29.81	10	9	6	16	6	-	0.00	
18	97	76	57	46	42	38	51	28	14	29.93	29.85	29.75	10	9	5	26	9	33	0.00	Rain
19	99	80	64	51	45	35	56	31	13	30.02	29.88	29.78	10	10	8	25	12	39	0.00	
20	98	79	61	54	42	34	67	31	13	29.95	29.86	29.79	10	10	6	14	7	22	0.00	
21	91	77	63	47	39	31	46	28	12	29.84	29.75	29.64	10	9	5	33	10	41	0.00	
22	95	79	63	42	29	17	39	20	7	29.88	29.65	29.54	10	10	7	29	11	40	0.00	
23	93	75	59	26	18	10	24	13	7	29.80	29.70	29.62	10	10	10	14	7	21	0.00	
24	95	74	55	27	19	12	29	13	7	29.80	29.71	29.62	10	10	10	16	7	20	0.00	
25	84	72	60	50	44	16	60	41	11	29.88	29.80	29.68	10	10	10	18	11	-	0.00	

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1998	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
26	90	72	54	60	51	43	69	50	29	29.84	29.75	29.58	10	9	6	26	8	39	0.00	
27	97	76	57	53	34	17	81	31	7	29.90	29.78	29.69	10	10	7	21	8	38	0.00	
28	98	76	55	33	25	18	23	15	8	29.93	29.82	29.74	10	10	7	14	8	-	0.00	
29	100	80	60	48	29	19	28	15	8	29.90	29.79	29.68	10	10	10	20	9	26	0.00	
30	100	80	61	43	29	21	32	17	9	29.81	29.75	29.68	10	10	10	25	11	32	0.00	
31	99	79	60	35	27	18	30	15	9	29.93	29.80	29.72	10	10	10	20	7	26	0.00	
1998	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
Jun	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	high	sum	
1	108	82	59	40	30	18	27	15	10	29.80	29.71	29.60	10	10	10	16	8	26	0.00	
2	106	84	62	41	31	22	29	14	9	29.76	29.63	29.53	10	10	10	16	8	25	0.00	
3	102	83	64	40	35	27	28	17	11	29.77	29.58	29.47	10	10	10	22	7	23	0.00	
4	93	78	64	37	27	17	26	15	10	29.76	29.59	29.53	10	10	10	31	13	34	0.00	
5	84	70	57	51	41	20	72	39	15	30.09	29.84	29.67	10	10	10	20	11	-	0.00	
6	79	66	55	48	46	43	69	52	34	30.19	30.05	29.94	10	10	10	16	10	22	0.00	
7	95	75	57	66	50	27	79	49	10	30.06	29.79	29.53	10	10	8	28	13	37	0.00	
8	93	78	61	67	34	17	97	28	10	29.82	29.66	29.58	10	9	6	25	13	33	0.00	
9	96	78	61	42	30	18	29	18	13	29.88	29.78	29.70	10	10	10	21	9	28	0.00	
10	81	68	55	61	52	41	100	66	26	30.04	29.85	29.75	10	9	3	24	13	31	0.17	Rain
11	88	69	51	55	48	40	100	51	19	29.96	29.80	29.71	10	10	10	30	10	38	0.01	
12	97	79	62	51	46	39	65	35	14	29.94	29.82	29.74	10	10	10	22	10	28	0.00	
13	100	84	68	57	43	25	63	27	12	29.94	29.76	29.64	10	10	10	30	14	40	0.00	
14	95	78	63	36	28	21	22	15	12	29.84	29.70	29.60	10	10	10	18	11	24	0.00	
15	89	74	60	49	44	24	64	38	16	29.90	29.74	29.62	10	10	10	17	12	18	0.00	
16	100	78	55	42	36	22	49	21	12	29.79	29.59	29.46	10	10	10	25	13	37	0.00	
17	100	83	66	39	31	21	26	15	11	29.84	29.64	29.52	10	10	10	26	14	34	0.00	
18	96	82	66	43	34	25	26	19	14	29.90	29.79	29.71	10	10	10	15	9	17	0.00	
19	105	81	57	47	36	25	36	19	14	29.87	29.75	29.64	10	10	10	20	6	26	0.00	
20	106	85	66	48	36	27	24	17	14	29.75	29.66	29.58	10	10	10	16	8	29	0.00	
21	104	84	66	50	40	29	51	22	13	29.91	29.73	29.64	10	10	10	17	9	26	0.00	
22	104	83	64	59	42	28	44	23	15	29.86	29.77	29.69	10	10	10	18	9	28	0.00	
23	105	85	66	60	49	34	70	32	13	29.85	29.74	29.62	10	10	10	25	12	36	0.00	
24	108	86	66	59	50	38	66	30	14	29.91	29.72	29.59	10	10	10	21	12	37	0.00	
25	108	86	66	58	50	40	59	31	14	29.88	29.71	29.61	10	10	10	24	9	29	0.00	
26	108	88	70	58	50	32	61	30	15	29.74	29.65	29.55	10	10	10	18	11	22	0.00	
27	108	88	68	50	42	33	30	20	15	29.70	29.62	29.56	10	10	10	14	5	-	0.00	
28	109	86	64	59	49	36	40	27	15	29.75	29.68	29.62	10	10	10	20	6	22	0.00	
29	106	86	66	63	55	50	68	35	18	29.94	29.74	29.65	10	10	10	17	11	22	0.00	
30	100	84	69	68	60	54	69	44	21	29.83	29.77	29.72	10	10	10	16	10	22	0.00	
1998	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events

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1998	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
Jul	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	high	sum	
1	97	84	73	66	62	57	73	49	28	30.06	29.88	29.76	10	10	10	21	10	33	0.00	
2	84	75	66	71	63	57	91	73	49	30.11	29.94	29.88	10	9	2	25	6	31	0.17	Rain
3	91	78	66	67	62	56	96	62	30	29.95	29.87	29.78	10	10	10	20	6	17	0.00	Rain
4	98	82	68	68	61	55	88	54	24	30.06	29.83	29.73	10	9	2	15	6	28	0.32	Rain
5	98	82	69	69	65	59	88	62	30	30.09	29.86	29.74	10	9	2	22	10	25	0.32	Rain
6	100	86	72	68	62	56	82	49	23	29.96	29.79	29.71	10	10	10	24	8	25	0.00	
7	81	80	75	62	62	61	62	56	50	30.08	29.96	29.77	10	10	10	25	10	30	0.00	
8	100	86	72	63	59	55	73	47	22	30.13	30.06	29.94	10	9	2	36	12	55	0.17	Rain
9	98	82	66	65	60	47	87	58	18	29.96	29.90	29.81	10	10	10	20	8	23	0.01	Rain
10	99	84	68	66	59	52	87	49	21	29.95	29.87	29.77	10	10	10	8	4	-	0.00	
11	104	88	73	61	53	42	64	34	13	29.86	29.80	29.73	10	10	10	9	6	-	0.00	
12	93	88	79	61	56	44	54	39	18	30.05	29.98	29.89	10	10	10	23	8	29	0.00	
13	100	84	70	63	57	45	76	45	17	30.11	29.91	29.74	10	10	10	25	8	36	0.00	
14	100	84	68	56	51	43	63	33	14	29.95	29.80	29.72	10	10	10	24	9	32	0.00	
15	100	84	68	66	55	47	87	45	18	30.26	29.90	29.77	10	9	3	20	8	31	0.24	Rain
16	91	78	66	67	59	50	93	56	25	30.14	30.05	29.97	10	10	10	14	7	18	0.01	
17	93	80	70	64	59	53	78	54	27	30.15	30.02	29.92	10	10	10	21	8	25	0.00	Rain
18	97	83	70	63	56	50	78	45	22	30.00	29.91	29.81	10	10	10	18	5	25	0.00	Rain
19	102	83	66	56	52	47	68	37	17	29.87	29.80	29.72	10	10	10	16	8	20	0.00	
20	100	86	71	55	53	51	51	34	19	29.85	29.79	29.73	10	10	10	23	11	30	0.00	
21	99	83	68	60	54	44	65	41	16	29.87	29.81	29.71	10	10	10	24	9	32	0.00	
22	97	82	69	60	55	50	65	39	20	29.98	29.84	29.74	10	10	9	28	14	34	0.00	
23	96	80	66	59	56	51	73	43	22	30.01	29.87	29.78	10	10	10	24	10	31	0.00	Rain
24	98	84	72	60	57	53	64	42	25	30.00	29.87	29.78	10	10	10	26	9	31	0.00	
25	95	81	69	63	59	52	68	49	26	29.97	29.91	29.87	10	10	10	21	6	26	0.00	
26	91	80	72	62	60	57	66	55	34	30.12	29.94	29.88	10	10	10	17	6	-	0.00	Rain
27	90	80	71	64	61	57	76	58	33	30.01	29.95	29.86	10	10	10	12	5	16	0.00	
28	97	84	72	65	58	50	78	47	22	29.94	29.87	29.77	10	10	10	14	7	21	0.00	
29	111	86	73	57	54	48	53	34	18	29.95	29.77	29.69	10	10	10	21	9	-	0.00	
30	102	84	66	66	59	51	90	52	20	30.03	29.84	29.67	10	8	0	45	11	56	0.68	Rain
31	86	75	66	66	62	59	90	70	44	30.08	30.00	29.92	10	10	10	12	6	-	0.00	
1998	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
Aug	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	high	sum	
1	93	81	69	67	61	55	87	51	28	30.16	29.98	29.91	10	10	10	17	6	20	0.00	
2	93	82	71	69	63	55	84	66	28	30.12	29.96	29.88	10	10	4	37	9	43	0.21	Rain , Thunderstorm
3	91	80	68	65	59	49	90	58	24	30.01	29.94	29.87	10	10	10	18	6	23	0.00	
4	79	70	64	60	58	53	81	64	45	30.15	30.09	30.01	10	10	10	21	8	26	0.00	
5	79	72	64	64	62	58	94	79	58	30.36	30.19	30.10	10	9	3	17	6	22	0.10	Rain ,

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1998	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
																				Thunderstorm
6	86	73	60	61	57	49	100	63	29	30.14	30.03	29.90	10	10	9	9	3	-	0.00	
7	97	79	62	58	53	48	84	44	20	30.03	29.87	29.77	10	10	10	17	9	21	0.00	
8	75	68	66	53	51	50	57	52	46	30.13	30.01	29.84	10	10	10	21	13	25	0.00	
9	98	80	62	60	50	43	65	35	17	30.21	30.08	29.89	10	10	10	17	10	24	0.00	
10	97	81	66	59	53	47	66	39	19	29.99	29.92	29.82	10	10	10	14	6	22	0.00	
11	97	83	70	63	58	47	76	51	19	30.02	29.94	29.85	10	10	10	24	8	32	0.01	Rain
12	90	78	64	64	61	55	97	66	31	30.29	30.05	29.94	10	9	2	23	7	28	0.64	Rain
13	84	75	66	65	61	53	93	70	34	30.14	30.06	29.96	10	10	10	12	6	-	0.09	Rain
14	90	76	62	61	57	49	90	55	25	30.02	29.94	29.83	10	10	10	10	6	17	0.00	
15	91	77	63	59	52	37	75	45	15	29.92	29.84	29.76	10	10	10	8	2	-	0.00	
16	95	78	64	57	52	47	73	42	21	29.88	29.82	29.77	10	10	10	13	5	21	0.00	
17	93	78	64	63	55	50	75	47	23	29.95	29.89	29.82	10	10	10	12	6	16	0.00	
18	91	78	64	65	61	55	87	57	30	29.96	29.90	29.81	10	10	10	15	8	17	0.00	
19	90	78	68	72	66	61	94	70	40	30.16	29.97	29.87	10	9	2	16	9	28	0.12	Rain
20	84	74	66	67	65	61	97	78	47	30.27	30.08	29.99	10	10	7	21	9	-	0.04	Rain
21	89	76	64	66	61	55	97	63	32	30.14	30.07	29.98	10	10	10	13	6	18	0.00	
22	91	78	64	61	56	51	87	50	25	30.05	29.98	29.89	10	10	8	15	4	-	0.00	
23	93	78	64	62	57	50	84	51	24	29.94	29.87	29.78	10	10	10	13	6	-	0.00	
24	96	78	64	65	60	55	90	55	29	29.84	29.78	29.69	10	10	10	13	7	21	0.00	
25	93	80	66	67	63	57	94	62	30	30.07	29.82	29.71	10	10	10	14	6	17	0.00	
26	91	78	66	66	64	61	97	67	38	30.08	29.88	29.76	10	10	6	21	10	31	0.12	Rain
27	96	80	68	68	64	57	90	60	29	30.09	29.87	29.79	10	10	8	13	8	18	0.00	
28	90	80	71	70	64	60	88	68	39	30.31	30.05	29.87	10	9	2	34	9	38	0.11	Rain
29	91	78	66	64	53	36	87	51	15	30.16	30.06	29.96	10	10	10	10	6	16	0.00	
30	93	74	57	51	45	36	75	40	15	30.04	29.96	29.86	10	10	10	13	6	18	0.00	
31	93	78	62	55	48	41	70	38	16	29.93	29.86	29.79	10	10	10	14	8	20	0.00	
1998	**Temp.** (°F)			**Dew Point** (°F)			**Humidity** (%)			**Sea Level Press.** (in)			**Visibility** (mi)			**Wind** (mph)			**Precip.** (in)	**Events**
Sep	**high**	**avg**	**low**	**high**	**avg**	**low**	**high**	**avg**	**low**	**high**	**avg**	**low**	**high**	**avg**	**low**	**high**	**avg**	**high**	**sum**	
1	91	76	63	61	52	48	66	45	27	29.91	29.86	29.80	10	10	10	18	4	-	0.00	Rain
2	93	78	64	58	53	47	70	46	21	29.91	29.83	29.74	10	10	4	14	6	21	0.00	
3	91	78	64	53	48	42	63	38	18	29.86	29.81	29.76	10	10	9	16	5	18	0.00	
4	96	80	64	52	48	46	58	38	19	29.94	29.87	29.82	10	10	10	14	6	26	0.00	
5	93	78	64	57	51	48	61	40	23	30.08	29.94	29.87	10	10	10	21	8	26	0.00	
6	93	78	64	57	50	44	63	40	20	30.15	29.95	29.86	10	10	10	16	5	22	0.00	
7	93	76	62	54	46	41	58	36	20	29.97	29.89	29.80	10	10	10	13	4	17	0.00	
8	93	77	61	50	46	43	62	35	18	29.89	29.81	29.73	10	10	10	12	5	-	0.00	
9	75	72	70	62	56	49	66	56	44	30.11	30.04	29.81	10	10	10	20	7	30	0.00	
10	91	76	64	60	57	54	76	53	31	30.13	29.95	29.81	10	10	10	12	8	-	0.00	

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1998	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
11	88	74	61	53	48	45	60	41	25	30.08	29.88	29.81	10	10	7	10	4	-	0.00	
12	89	75	62	57	53	47	73	49	27	29.91	29.81	29.71	10	10	10	9	4	-	0.00	
13	95	78	62	57	51	48	67	42	23	29.76	29.67	29.58	10	10	10	9	5	-	0.00	
14	93	80	66	62	51	43	78	40	21	29.97	29.74	29.62	10	10	7	24	9	41	0.06	Rain
15	88	77	66	62	57	51	84	56	29	30.01	29.95	29.87	10	10	10	16	9	21	0.00	Rain
16	87	74	62	59	55	50	84	56	30	30.04	29.96	29.89	10	10	10	15	6	-	0.00	
17	89	74	62	57	54	49	80	51	27	30.03	29.92	29.84	10	10	10	14	4	-	0.00	
18	90	76	61	55	52	50	72	47	26	29.93	29.82	29.70	10	10	10	15	6	22	0.00	
19	95	78	64	56	47	40	67	38	17	29.70	29.63	29.54	10	10	10	16	9	-	0.00	
20	95	78	64	50	45	38	56	31	14	29.69	29.64	29.57	10	10	10	14	7	-	0.00	
21	97	82	68	53	48	42	56	32	19	29.75	29.69	29.62	10	10	10	16	6	23	0.00	
22	84	72	59	61	51	43	81	51	33	30.20	29.94	29.75	10	10	9	21	11	25	0.00	
23	90	76	62	59	57	55	78	58	35	30.01	29.91	29.78	10	10	10	24	9	30	0.00	
24	96	80	64	62	57	46	87	49	20	29.96	29.81	29.72	10	10	7	20	14	26	0.00	
25	96	80	64	64	59	48	87	53	19	29.99	29.74	29.62	10	10	6	23	13	31	0.00	
26	96	79	62	62	52	37	90	44	15	29.85	29.72	29.63	10	10	6	18	13	22	0.00	
27	96	78	61	58	45	36	59	33	15	29.91	29.83	29.75	10	10	10	13	6	-	0.00	
28	91	78	66	64	58	53	73	53	31	29.92	29.85	29.77	10	10	10	14	5	16	0.00	
29	91	77	64	66	59	52	87	61	29	29.96	29.82	29.72	10	9	4	22	6	34	0.13	Rain , Thunderstorm
30	87	75	66	65	62	59	90	75	48	29.89	29.83	29.77	10	10	10	18	10	-	0.05	Rain
1998	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
Oct	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	high	sum	
1	79	70	62	64	62	59	100	87	58	30.14	29.95	29.70	10	7	1	13	7	-	1.54	Rain
2	84	70	57	62	50	38	93	55	21	29.78	29.72	29.66	10	10	10	14	7	21	0.01	
3	90	71	53	52	46	38	86	48	16	29.83	29.72	29.62	10	10	10	21	8	21	0.00	
4	87	74	62	54	47	41	65	43	20	29.79	29.60	29.51	10	10	10	16	11	24	0.00	
5	71	61	51	50	31	14	58	33	12	29.98	29.80	29.54	10	10	10	21	11	26	0.00	
6	72	58	44	39	35	27	79	49	19	30.15	30.07	29.96	10	10	10	9	6	-	0.00	
7	77	60	44	40	35	27	79	47	16	30.26	30.17	30.10	10	10	10	13	5	-	0.00	
8	82	62	44	40	33	28	76	40	15	30.17	30.07	29.98	10	10	10	18	5	23	0.00	
9	86	66	46	39	36	32	68	39	17	30.01	29.92	29.81	10	10	10	12	5	-	0.00	
10	91	70	48	46	39	36	74	41	14	29.88	29.78	29.66	10	10	10	23	9	32	0.00	
11	88	68	48	48	35	20	74	37	8	30.06	29.92	29.74	10	10	10	13	7	-	0.00	
12	80	66	52	57	47	37	81	54	44	30.22	30.11	30.05	10	10	10	13	9	-	0.00	
13	90	72	54	55	48	36	90	53	15	30.08	29.97	29.84	10	10	5	16	5	20	0.00	
14	90	72	55	57	46	35	93	47	15	29.86	29.74	29.60	10	10	6	16	12	21	0.00	
15	91	75	59	59	51	38	93	54	15	29.69	29.57	29.46	10	9	5	25	14	33	0.00	
16	82	67	52	60	36	24	93	39	12	29.66	29.57	29.49	10	10	9	32	17	39	0.00	
17	73	58	43	31	23	15	53	29	11	30.04	29.89	29.74	10	10	10	18	10	25	0.00	

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1998	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
18	70	54	39	33	29	25	63	40	21	30.23	30.13	30.05	10	10	10	13	6	-	0.00	
19	69	61	53	55	41	30	93	53	35	30.24	30.15	30.09	10	10	10	14	5	-	0.09	Rain
20	55	52	48	50	49	48	100	93	80	30.42	30.31	30.15	10	8	1	12	6	-	0.78	Rain
21	53	52	50	50	49	47	100	93	83	30.54	30.44	30.33	10	5	2	12	7	-	0.18	Rain
22	57	54	50	50	49	46	100	88	67	30.57	30.47	30.36	10	6	1	9	4	-	0.01	Rain
23	62	56	50	54	50	46	100	88	75	30.42	30.28	30.14	10	8	2	13	7	-	0.01	Rain
24	70	58	46	56	52	46	100	91	57	30.28	30.17	30.03	10	6	0	10	5	-	0.01	Fog
25	77	64	50	57	54	49	97	77	45	30.06	29.97	29.86	10	8	4	20	9	-	0.01	
26	79	68	57	59	56	53	93	75	40	30.11	29.93	29.83	10	9	5	16	12	24	0.00	
27	63	56	48	61	56	48	100	93	87	30.15	30.03	29.90	10	6	1	17	8	24	1.39	Rain
28	71	56	42	52	46	42	100	88	36	30.09	29.99	29.81	10	5	0	7	4	-	0.01	Fog
29	73	58	44	54	47	41	90	70	36	29.96	29.86	29.78	10	10	10	8	5	-	0.00	
30	77	66	55	62	57	52	100	87	56	29.95	29.83	29.63	10	6	0	40	5	46	1.78	Fog , Rain
31	62	55	46	56	51	42	96	86	60	30.05	29.87	29.71	10	10	2	23	11	32	0.04	Rain
1998	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
Nov	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	high	sum	
1	60	52	43	49	42	38	90	73	53	30.04	29.94	29.83	10	10	10	13	7	-	0.00	
2	61	51	41	50	45	39	96	79	62	29.93	29.85	29.75	10	10	8	9	4	-	0.00	
3	61	52	43	46	44	40	96	81	56	30.05	29.93	29.83	10	9	3	15	7	-	0.01	
4	48	46	44	46	45	43	100	94	86	30.18	30.09	29.96	10	4	2	10	6	-	0.01	Rain
5	46	44	42	43	42	41	100	94	81	30.19	30.08	29.98	10	6	2	16	11	-	0.02	Rain
6	52	47	42	48	44	41	100	93	80	30.05	29.97	29.86	10	5	0	20	13	21	0.00	Fog
7	64	53	42	45	43	38	100	85	40	30.11	29.99	29.88	10	6	0	20	9	-	0.01	Fog
8	73	55	37	44	39	36	96	61	27	30.06	29.88	29.67	10	10	9	25	8	29	0.00	
9	72	58	44	40	34	18	66	47	23	29.85	29.63	29.39	10	10	8	38	20	51	0.00	
10	57	47	34	28	21	13	79	41	18	30.14	30.06	29.88	10	10	10	17	10	-	0.00	
11	66	47	28	38	31	25	88	59	26	30.21	30.09	29.97	10	10	10	13	6	-	0.00	
12	60	50	39	41	38	36	89	70	47	30.19	30.10	30.01	10	10	10	10	5	-	0.00	
13	63	49	35	39	36	33	92	66	37	30.17	30.07	29.97	10	10	10	9	6	-	0.00	
14	73	54	35	38	34	28	93	56	19	30.07	30.00	29.94	10	10	10	12	3	-	0.00	
15	73	56	39	38	36	34	79	56	24	30.10	29.96	29.84	10	10	10	16	5	-	0.00	
16	73	55	37	39	34	28	83	53	18	30.00	29.92	29.84	10	10	10	15	5	-	0.00	
17	73	55	37	39	36	32	83	57	27	30.05	29.92	29.78	10	10	10	14	5	-	0.00	
18	75	58	42	37	34	28	73	46	18	29.92	29.83	29.78	10	10	10	12	8	-	0.00	
19	70	56	42	37	33	28	71	49	22	30.16	29.97	29.81	10	10	10	14	6	-	0.00	
20	48	42	36	36	34	30	89	72	56	30.31	30.23	30.17	10	10	10	8	5	-	0.00	
21	68	50	32	37	32	27	92	63	21	30.22	30.11	29.99	10	10	9	14	6	-	0.00	
22	75	54	34	35	31	26	82	50	18	30.06	29.99	29.88	10	10	10	9	2	-	0.00	
23	72	54	37	32	29	25	70	45	18	30.24	30.16	30.00	10	10	10	9	4	-	0.00	

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1998	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
24	75	54	33	39	32	27	78	49	24	30.17	30.04	29.89	10	10	8	13	4	-	0.00	
25	71	54	37	34	29	24	79	47	17	30.16	30.09	30.00	10	10	10	9	4	-	0.00	
26	73	54	34	33	31	28	79	50	21	30.20	30.10	30.01	10	10	10	8	3	-	0.00	
27	72	54	36	42	35	28	80	58	29	30.12	30.02	29.94	10	10	10	12	3	-	0.00	
28	75	56	37	47	40	33	83	61	29	30.00	29.88	29.75	10	10	10	16	4	-	0.00	
29	55	50	39	54	46	33	100	83	52	29.94	29.81	29.70	10	7	0	25	7	36	0.19	Fog , Rain
30	64	50	35	41	37	32	89	67	38	30.28	30.17	29.97	10	10	10	8	3	-	0.00	
1998	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
Dec	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	high	sum	
1	64	50	37	41	38	33	89	69	38	30.27	30.16	30.05	10	10	10	15	5	-	0.02	Rain
2	55	50	44	52	47	40	100	89	77	30.10	29.98	29.84	10	7	0	25	5	31	0.00	Fog , Rain
3	60	52	42	49	44	40	100	87	53	29.87	29.80	29.70	10	7	0	17	5	-	0.00	Fog , Rain
4	68	52	36	49	42	36	100	76	40	29.88	29.82	29.76	10	10	5	12	5	-	0.00	
5	73	56	39	43	35	26	89	55	18	29.83	29.72	29.59	10	10	10	22	9	30	0.00	
6	54	46	37	36	28	23	81	53	32	29.84	29.76	29.59	10	10	10	22	13	28	0.00	
7	45	36	28	31	27	24	100	71	44	30.32	30.08	29.81	10	10	7	24	10	31	0.00	
8	46	32	19	25	22	18	92	69	34	30.37	30.26	30.15	10	10	10	14	6	-	0.00	
9	46	35	24	34	27	20	85	68	50	30.27	30.14	30.05	10	10	10	14	5	-	0.00	
10	41	36	32	35	31	25	100	85	60	30.52	30.44	30.28	10	7	0	20	15	29	0.02	Fog , Rain , Snow
11	46	37	28	31	28	25	92	76	46	30.47	30.35	30.25	10	10	9	9	6	-	0.00	
12	55	40	24	30	25	20	92	67	26	30.37	30.30	30.22	10	10	10	7	3	-	0.00	Rain
13	59	44	28	30	27	22	85	62	24	30.46	30.37	30.31	10	10	10	9	5	-	0.00	
14	59	41	23	30	27	20	88	70	31	30.38	30.32	30.19	10	10	10	9	1	-	0.00	
15	55	42	28	32	29	26	92	72	37	30.39	30.31	30.25	10	10	10	10	6	-	0.00	
16	61	44	26	35	29	24	92	66	27	30.45	30.33	30.25	10	10	10	13	5	-	0.00	
17	55	41	27	38	32	25	97	75	47	30.44	30.21	29.88	10	10	10	17	6	-	0.00	
18	71	54	37	43	34	22	100	68	16	29.83	29.70	29.54	10	8	2	32	9	40	0.00	Rain
19	45	38	30	39	34	30	100	87	71	30.11	30.01	29.82	10	8	1	18	9	24	0.00	
20	69	54	39	41	35	19	100	72	15	30.02	29.92	29.76	10	6	0	29	18	38	0.00	Fog
21	48	33	17	34	20	3	82	55	33	30.60	30.07	29.74	10	10	10	25	13	34	0.00	
22	26	18	10	7	3	-1	67	52	37	30.62	30.42	30.19	10	10	10	12	8	-	0.00	
23	30	22	15	9	8	6	71	54	38	30.41	30.31	30.18	10	10	10	10	5	-	0.00	
24	39	29	19	18	15	9	82	62	39	30.49	30.39	30.31	10	10	10	15	6	-	0.00	
25	60	38	15	21	16	12	89	54	20	30.37	30.25	30.13	10	10	10	12	4	-	0.00	
26	63	41	19	27	20	14	78	46	21	30.17	30.03	29.90	10	10	10	13	5	-	0.00	
27	69	51	33	28	22	14	70	40	14	30.14	29.99	29.88	10	10	10	22	6	28	0.00	
28	69	48	28	29	23	19	79	44	16	30.12	29.99	29.83	10	10	10	24	8	39	0.00	
29	64	50	36	27	24	21	60	40	22	30.11	30.05	29.93	10	10	10	12	6	-	0.00	
30	63	46	30	34	30	24	82	59	34	30.04	29.91	29.77	10	10	10	16	4	-	0.00	

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1998	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
31	51	44	37	37	34	32	93	69	54	30.20	30.00	29.78	10	10	10	18	12	-	0.00	

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History for Roswell, NM

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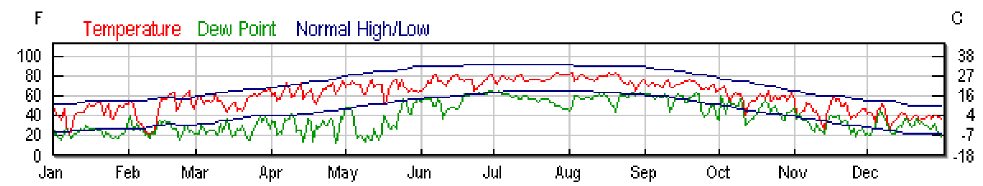
January 1, 1986 through December 31, 1986 — View Current Conditions

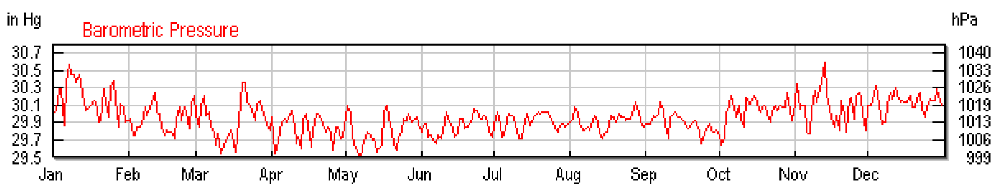
January 1, 1986 through December 31, 1986

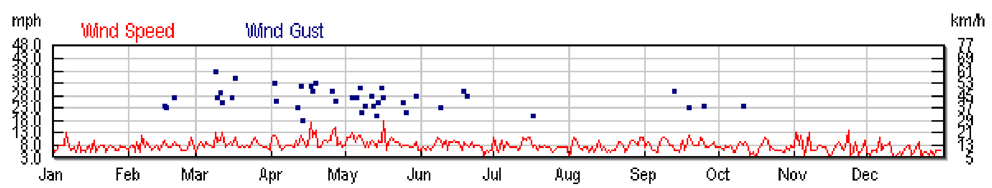
January | 1 | 1986 - TO - December | 31 | 1986 | Go

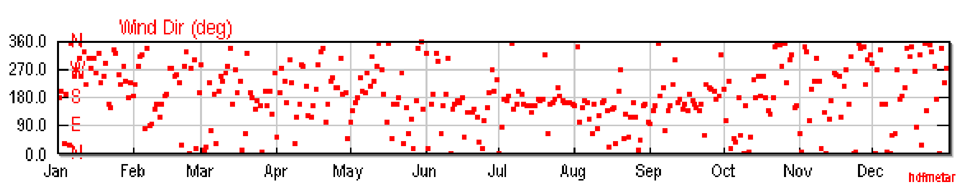
Daily | Weekly | Monthly | **Custom**

	Max	Avg	Min	Sum
Temperature				
Max Temperature	**102** °F	**74** °F	**24** °F	
Mean Temperature	**84** °F	**61** °F	**20** °F	
Min Temperature	**73** °F	**48** °F	**12** °F	
Degree Days				
Heating Degree Days (base 65)	45	8	0	3091
Cooling Degree Days (base 65)	20	4	0	1596
Growing Degree Days (base 50)	34	13	0	4909
Dew Point				
Dew Point	**69** °F	**40** °F	**4** °F	
Precipitation				
Precipitation	**2.90** in	**0.06** in	**0.00** in	**23.68** in
Snowdepth	**5.0** in	**3.0** in	**1.0** in	-
Wind				
Wind	**53** mph	**8** mph	**0** mph	
Gust Wind	**47** mph	**26** mph	**16** mph	
Sea Level Pressure				
Sea Level Pressure	**30.72** in	**29.96** in	**29.31** in	









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Observations

1986	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
Jan	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	high	sum	
1	64	50	36	37	32	24	73	55	34	30.08	29.98	29.87	15	10	7	12	7	-	0.00	Rain
2	66	46	27	32	21	9	100	49	11	30.14	30.02	29.90	20	9	7	10	5	-	0.00	
3	55	42	28	29	23	14	64	47	33	30.14	30.04	29.92	10	8	7	14	6	-	0.22	
4	50	39	28	25	18	15	59	42	26	30.48	30.29	29.99	10	10	7	17	8	-	0.00	
5	48	36	23	18	16	12	72	47	24	30.48	30.28	30.04	20	11	10	16	8	-	0.00	
6	66	47	28	36	24	15	79	43	23	30.02	29.87	29.71	20	9	7	18	8	26	0.00	Rain
7	41	31	19	37	28	18	100	94	79	30.62	30.37	29.87	10	5	0	17	13	-	0.30	Fog , Rain , Snow
8	33	22	12	30	20	13	100	94	69	30.63	30.58	30.51	15	10	7	9	7	-	0.10	
9	37	24	12	21	17	12	100	75	48	30.56	30.46	30.34	10	9	4	8	6	-	0.00	Fog
10	55	40	24	26	23	19	81	59	32	30.53	30.45	30.38	20	8	6	12	7	-	0.00	Fog
11	59	42	26	26	22	18	81	53	28	30.44	30.36	30.26	15	9	7	9	5	-	0.00	
12	57	44	32	36	24	20	100	53	25	30.53	30.45	30.30	20	10	7	14	9	-	0.00	
13	60	44	27	35	27	20	100	64	32	30.49	30.34	30.15	20	11	10	10	5	-	0.00	
14	60	44	28	33	26	19	89	61	21	30.19	30.12	30.06	10	9	7	9	6	-	0.00	
15	66	47	28	34	30	25	85	59	25	30.11	30.04	29.93	10	10	10	12	5	-	0.00	
16	66	52	37	32	28	19	76	48	17	30.14	30.07	30.00	20	11	7	16	8	26	0.00	
17	70	50	30	31	28	25	82	49	22	30.18	30.09	29.98	10	8	7	14	5	-	0.00	
18	61	51	37	31	28	24	73	43	24	30.29	30.16	29.98	20	9	7	16	10	18	0.00	
19	73	52	30	31	28	24	82	52	16	30.23	30.13	30.00	15	10	7	8	5	-	0.00	
20	77	54	30	30	26	21	79	44	14	30.02	29.90	29.77	20	10	7	12	7	-	0.00	
21	70	54	37	27	25	20	62	35	15	30.19	29.92	29.76	15	9	7	12	8	21	0.00	
22	51	40	30	22	19	16	59	40	25	30.39	30.29	30.21	20	12	10	14	8	-	0.00	
23	64	45	26	28	24	18	78	51	24	30.27	30.11	29.92	10	9	7	13	5	-	0.00	
24	70	52	33	29	23	18	72	42	14	30.11	29.97	29.86	15	11	7	20	7	-	0.00	
25	52	39	26	22	19	17	69	47	26	30.45	30.31	30.10	20	11	10	21	8	23	0.00	
26	54	38	21	18	17	14	72	48	24	30.50	30.39	30.26	20	14	10	16	7	-	0.00	
27	60	42	25	22	19	14	71	47	21	30.33	30.17	29.94	20	10	7	12	6	-	0.00	
28	75	51	27	23	17	9	72	37	8	29.93	29.85	29.75	15	10	10	21	6	24	0.00	
29	61	50	39	24	20	14	55	35	22	30.30	30.12	29.83	20	11	10	16	8	-	0.00	
30	71	49	27	26	23	18	69	43	17	30.20	30.08	29.92	20	11	7	9	7	-	0.00	
31	70	52	33	28	24	22	66	40	18	29.99	29.91	29.83	20	12	7	12	7	-	0.00	
1986	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
Feb	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	high	sum	
1	69	53	37	43	36	29	76	51	33	30.01	29.93	29.86	20	11	10	14	6	-	0.00	
2	64	56	46	46	41	36	77	60	42	30.04	29.94	29.85	20	11	10	15	7	-	0.00	
3	68	52	35	36	25	12	86	45	12	29.90	29.76	29.63	20	11	10	18	8	-	0.00	

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1986	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
4	53	42	30	37	27	20	87	60	31	29.84	29.75	29.67	20	10	7	7	5	-	0.04	Rain
5	43	36	25	36	32	21	96	85	73	29.98	29.86	29.77	20	11	7	21	9	-	0.00	Rain
6	48	33	18	39	25	17	100	74	40	29.98	29.85	29.73	20	7	0	7	5	-	0.00	Fog
7	39	32	25	35	27	19	96	78	61	30.14	29.89	29.70	20	10	6	25	12	33	0.03	Rain , Snow
8	28	24	21	25	21	17	96	86	75	30.15	30.07	29.96	10	6	1	10	7	-	0.10	Fog , Snow
9	28	24	19	27	23	18	100	93	81	30.07	29.99	29.92	7	2	0	14	9	-	0.10	Fog , Snow
10	24	20	16	23	17	12	100	87	74	30.13	30.08	30.02	20	6	0	10	7	-	0.10	Fog , Snow
11	27	24	21	25	24	20	100	95	88	30.22	30.14	30.08	2	1	0	14	6	-	0.00	Fog
12	28	24	19	27	23	17	96	93	85	30.33	30.25	30.16	10	2	0	13	7	-	0.00	Fog
13	46	36	27	37	31	26	96	86	66	30.17	30.02	29.84	7	3	0	12	8	-	0.00	Fog
14	66	52	37	41	35	30	86	57	29	30.10	30.00	29.94	20	9	5	12	6	-	0.00	Fog
15	75	57	39	40	33	23	89	47	14	29.95	29.84	29.71	15	9	7	17	8	25	0.00	
16	71	58	46	40	35	30	71	45	22	29.82	29.76	29.69	20	10	7	18	10	25	0.00	
17	77	58	39	38	32	27	73	41	16	29.94	29.82	29.72	20	10	7	17	8	23	0.00	
18	81	62	43	40	34	28	74	45	14	29.86	29.79	29.73	15	11	7	15	7	-	0.00	
19	82	62	43	37	29	15	74	37	8	29.90	29.80	29.70	15	10	10	16	7	25	0.00	
20	79	64	48	33	27	18	52	29	10	29.79	29.72	29.65	10	10	10	23	9	33	0.00	
21	60	46	33	33	27	19	70	48	26	30.06	29.95	29.80	20	12	7	14	8	-	0.00	
22	68	51	34	24	16	6	56	29	9	30.19	30.07	29.99	7	7	7	13	8	-	0.00	
23	78	56	33	23	19	16	59	30	10	30.03	29.93	29.83	10	10	7	21	6	24	0.00	
24	75	60	45	31	27	23	52	33	15	30.15	30.07	29.94	15	10	10	9	6	-	0.00	
25	84	62	39	33	30	25	68	35	12	30.13	30.02	29.90	20	13	7	12	6	-	0.00	
26	84	65	46	32	24	14	47	26	7	29.93	29.83	29.69	20	12	7	14	8	-	0.00	
27	61	52	44	34	25	21	47	36	24	30.24	30.11	29.80	15	10	10	21	11	31	0.00	
28	64	48	33	25	22	20	65	37	19	30.38	30.21	30.10	20	14	10	14	7	-	0.00	
1986	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
Mar	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	high	sum	
1	81	56	30	27	22	17	76	34	10	30.11	29.98	29.83	10	10	10	10	5	-	0.00	
2	77	60	44	28	23	18	42	24	11	29.92	29.86	29.81	20	11	10	14	8	-	0.00	
3	66	58	50	34	30	26	52	38	24	30.31	30.10	29.92	20	11	7	13	9	-	0.00	Rain
4	68	52	36	32	28	24	79	42	19	30.35	30.21	30.03	20	9	7	14	7	-	0.00	
5	71	55	39	27	23	18	49	33	13	30.14	29.99	29.90	20	11	7	17	9	24	0.00	
6	77	56	35	30	25	16	59	33	15	30.17	30.02	29.86	15	11	7	16	8	-	0.00	
7	66	54	43	27	25	21	49	34	22	29.93	29.86	29.80	20	11	10	17	8	-	0.00	
8	81	58	35	30	26	22	64	34	12	29.92	29.79	29.64	10	10	10	16	7	21	0.00	
9	75	64	52	30	22	12	35	21	11	29.81	29.64	29.54	10	8	5	38	13	46	0.00	
10	71	55	39	26	21	12	38	25	17	29.94	29.78	29.65	10	8	7	21	9	29	0.00	
11	62	55	48	36	32	29	56	44	29	29.65	29.55	29.45	20	11	7	23	10	34	0.00	Rain , Thunderstorm
12	62	54	45	28	24	19	48	34	19	29.67	29.59	29.52	20	12	10	22	13	30	0.00	

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1986	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
13	57	46	36	36	30	21	82	56	36	29.80	29.70	29.62	20	10	7	14	7	-	0.00	
14	52	44	35	45	37	21	89	78	51	29.81	29.72	29.62	20	12	7	18	8	-	0.04	Rain
15	66	50	35	34	23	13	89	41	12	29.88	29.81	29.75	20	11	10	14	9	25	0.00	
16	73	52	30	26	19	13	59	31	10	29.90	29.75	29.59	10	10	10	20	8	30	0.00	
17	66	54	42	30	20	14	55	29	14	29.61	29.57	29.49	20	13	10	29	11	40	0.00	
18	57	46	34	38	28	22	76	53	29	29.99	29.74	29.58	15	10	10	17	8	-	0.02	Rain
19	55	47	39	37	25	17	83	48	23	30.29	30.14	29.99	15	10	7	23	7	34	0.10	Rain
20	57	46	34	37	30	22	93	61	25	30.48	30.36	30.22	20	11	7	14	8	-	0.01	Rain
21	71	50	30	27	23	18	79	40	14	30.49	30.36	30.24	15	10	10	13	7	-	0.00	
22	79	58	37	25	18	12	59	25	8	30.25	30.13	30.01	20	11	10	17	8	-	0.00	
23	81	60	39	22	15	9	43	20	8	30.25	30.10	30.01	10	9	7	10	7	-	0.00	
24	81	61	41	34	23	12	57	28	8	30.17	30.05	29.93	15	11	7	21	9	23	0.00	
25	82	63	44	39	30	14	73	36	10	30.05	29.92	29.81	20	9	7	16	11	-	0.00	
26	75	60	45	41	33	20	58	38	21	30.24	30.12	29.93	20	11	10	16	9	-	0.00	
27	78	62	46	46	41	33	86	50	21	30.26	30.16	30.06	20	11	7	13	8	-	0.00	
28	82	64	46	45	34	21	76	40	13	30.15	30.06	29.97	20	11	10	13	8	-	0.44	
29	79	65	51	45	39	27	69	44	21	30.00	29.94	29.88	20	11	10	23	7	31	0.00	
30	84	66	48	41	35	25	68	36	14	29.96	29.87	29.78	15	10	10	12	7	-	0.00	
31	88	69	50	33	28	23	43	23	10	29.88	29.81	29.74	15	9	7	14	6	-	0.00	
1986	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
Apr	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	high	sum	
1	71	61	51	42	36	28	57	39	23	30.16	29.97	29.80	15	10	7	18	11	30	0.00	
2	80	64	46	46	34	20	86	43	12	29.79	29.54	29.31	20	12	7	32	12	47	0.00	
3	66	56	46	33	21	12	54	29	15	29.75	29.60	29.52	20	11	10	20	11	26	0.00	
4	73	57	41	29	24	18	51	30	15	29.85	29.79	29.73	20	12	7	12	7	-	0.00	
5	79	60	41	29	22	17	48	26	10	29.97	29.90	29.84	20	11	10	12	6	-	0.00	
6	84	67	50	56	37	19	57	34	21	30.15	29.94	29.83	20	13	10	12	7	-	0.00	
7	91	74	57	45	35	28	58	28	12	29.99	29.90	29.80	10	9	7	21	8	30	0.00	
8	81	66	51	51	38	28	78	37	17	30.20	29.98	29.90	20	12	7	17	8	-	0.30	Rain , Thunderstorm
9	66	59	50	47	42	38	77	58	37	30.21	30.04	29.91	20	11	7	12	8	-	0.01	
10	78	60	41	45	37	27	89	51	15	30.03	29.86	29.70	20	11	7	10	7	-	0.00	
11	80	66	53	36	24	19	41	20	11	29.72	29.66	29.60	15	11	7	17	10	28	0.00	
12	84	67	50	30	26	21	36	23	12	29.82	29.73	29.67	20	13	10	16	8	23	0.00	
13	86	74	61	31	26	11	31	19	12	29.75	29.60	29.48	15	9	5	23	12	39	0.00	
14	75	58	42	21	14	5	27	16	12	30.03	29.92	29.76	10	9	7	15	10	18	0.00	
15	78	63	48	32	25	17	34	24	17	30.12	30.00	29.92	15	11	7	14	7	-	0.00	
16	80	64	48	53	38	28	65	37	23	29.99	29.85	29.71	20	11	5	20	8	36	0.00	Fog , Rain
17	81	68	55	56	34	9	97	40	11	29.80	29.63	29.52	20	9	0	29	17	40	0.00	Fog
18	75	58	42	18	14	10	31	17	11	29.87	29.81	29.71	15	11	7	18	11	30	0.00	

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1986	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
19	61	53	43	36	30	12	65	43	18	30.12	30.00	29.86	20	13	10	25	14	36	0.00	
20	77	57	37	32	28	25	73	37	16	30.09	30.00	29.89	15	10	10	13	7	-	0.00	
21	81	63	45	36	31	23	46	30	17	30.03	29.95	29.90	10	10	10	12	7	-	0.00	
22	87	68	48	43	36	30	59	34	13	29.98	29.87	29.74	15	11	7	18	9	25	0.00	
23	84	68	52	38	31	27	47	26	13	29.92	29.80	29.72	20	11	7	18	10	-	0.00	Rain , Thunderstorm
24	87	70	52	37	31	24	41	24	10	29.96	29.85	29.75	20	11	10	16	9	-	0.00	
25	82	71	60	48	38	32	64	33	16	29.89	29.77	29.67	20	11	7	20	10	29	0.00	
26	84	74	63	40	35	31	38	26	15	29.67	29.58	29.49	20	12	7	28	14	34	0.00	
27	75	62	48	30	13	7	36	17	7	29.91	29.85	29.70	15	11	7	23	15	29	0.00	
28	87	66	46	25	17	9	24	15	8	29.95	29.85	29.71	15	10	10	17	8	-	0.00	
29	84	70	57	48	39	26	49	32	21	29.88	29.72	29.64	10	10	10	17	9	-	0.00	Rain , Thunderstorm
30	90	76	61	53	38	22	72	34	9	29.83	29.73	29.65	20	13	7	14	7	23	0.00	
1986	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
May	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	high	sum	
1	84	69	54	53	49	45	72	47	26	30.04	29.96	29.85	20	12	7	17	8	-	0.00	
2	82	72	62	55	49	40	78	50	25	30.21	30.10	30.01	20	12	10	17	11	-	0.00	
3	84	72	59	54	49	45	78	49	26	30.13	30.01	29.85	20	10	7	21	11	30	0.00	
4	91	75	59	54	44	21	81	41	12	29.93	29.74	29.55	20	10	7	23	13	30	0.00	
5	90	72	53	49	24	7	67	22	7	29.70	29.61	29.56	15	10	10	18	9	29	0.00	
6	89	72	54	22	18	10	28	13	7	29.68	29.59	29.52	10	10	10	23	11	34	0.00	
7	86	72	57	32	20	12	26	14	8	29.58	29.50	29.39	20	10	7	24	12	37	0.00	
8	75	64	52	30	17	5	40	18	8	29.76	29.62	29.47	10	9	7	18	10	23	0.00	
9	81	62	43	21	14	6	30	17	8	29.83	29.74	29.63	10	10	10	18	7	28	0.00	
10	84	68	53	27	20	5	37	18	9	29.86	29.79	29.73	15	10	7	17	9	-	0.00	
11	91	70	48	25	17	11	29	14	7	29.88	29.77	29.67	15	9	7	16	7	28	0.00	
12	91	77	63	20	15	7	16	9	6	29.78	29.70	29.60	15	10	10	21	10	28	0.00	
13	86	69	52	48	27	8	47	20	10	29.85	29.71	29.62	10	10	10	18	9	25	0.00	
14	88	72	57	29	19	4	32	15	7	29.62	29.56	29.49	10	9	7	18	7	21	0.00	
15	90	72	55	21	15	7	19	10	7	29.70	29.60	29.52	20	11	10	18	10	26	0.00	
16	89	72	55	46	24	9	48	20	8	29.90	29.64	29.55	15	10	2	23	9	37	0.00	Fog
17	62	52	43	45	40	37	89	74	53	30.22	30.04	29.74	20	8	1	23	18	32	0.30	Fog , Rain
18	73	56	39	40	36	32	93	52	22	30.20	30.09	29.98	20	11	10	10	6	-	0.00	
19	86	67	48	39	29	22	54	29	11	30.03	29.95	29.84	10	10	10	17	9	25	0.00	
20	93	73	53	32	28	22	43	21	9	29.89	29.80	29.67	20	11	10	15	11	-	0.00	
21	97	76	55	37	31	24	40	20	9	29.73	29.65	29.55	20	10	7	14	10	-	0.00	
22	93	78	63	37	28	20	32	17	9	29.63	29.58	29.55	20	11	7	16	9	24	0.63	
23	82	68	55	52	40	21	59	33	17	29.84	29.74	29.59	20	11	7	18	9	-	0.00	
24	91	78	64	60	48	35	71	41	15	29.98	29.79	29.68	20	15	5	21	7	34	0.00	

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1986	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
25	79	70	59	61	57	55	90	69	47	30.14	29.95	29.84	20	12	7	17	8	28	0.00	Rain , Thunderstorm
26	77	67	57	58	54	51	93	70	45	30.13	29.93	29.72	20	10	7	14	8	21	0.02	Rain , Thunderstorm
27	72	64	55	52	44	37	83	55	29	30.12	30.00	29.91	20	14	10	12	8	-	0.10	
28	81	67	53	47	43	40	69	42	24	29.99	29.90	29.78	20	12	10	17	7	-	0.00	
29	78	66	55	58	53	48	90	66	36	30.10	29.93	29.83	15	10	7	25	7	30	0.00	Rain , Thunderstorm
30	77	66	55	58	54	50	96	72	42	30.07	29.97	29.85	20	12	1	25	9	28	0.40	Fog , Rain , Thunderstorm
31	69	64	59	59	57	54	96	83	61	30.01	29.88	29.79	20	11	4	14	6	-	0.20	Fog , Rain , Thunderstorm
1986	**Temp.** (°F)			**Dew Point** (°F)			**Humidity** (%)			**Sea Level Press.** (in)			**Visibility** (mi)			**Wind** (mph)			**Precip.** (in)	**Events**
Jun	**high**	**avg**	**low**	**high**	**avg**	**low**	**high**	**avg**	**low**	**high**	**avg**	**low**	**high**	**avg**	**low**	**high**	**avg**	**high**	**sum**	
1	77	66	54	59	54	50	93	70	45	29.92	29.80	29.75	20	13	10	14	6	-	0.10	Rain , Thunderstorm
2	77	68	60	59	57	53	90	73	43	30.05	29.87	29.81	20	11	7	13	7	-	0.00	
3	79	70	60	60	58	50	96	72	36	30.06	29.88	29.76	10	5	0	10	6	-	0.00	Fog
4	89	76	63	62	57	51	90	59	30	29.83	29.73	29.64	20	12	10	14	7	-	0.01	Rain , Thunderstorm
5	87	74	61	62	57	52	90	58	31	29.82	29.75	29.67	10	9	7	12	6	-	0.00	
6	95	80	64	58	51	44	75	40	17	29.76	29.69	29.62	10	10	7	12	7	-	0.00	
7	98	82	66	57	50	42	61	37	15	29.88	29.67	29.62	20	10	7	16	9	-	0.00	
8	86	76	64	63	59	51	78	59	40	29.93	29.75	29.60	15	10	7	23	11	34	0.20	Rain , Thunderstorm
9	90	76	61	62	51	27	93	56	11	29.90	29.71	29.58	15	9	7	14	10	23	0.00	Rain , Thunderstorm
10	89	74	59	46	37	29	51	27	12	29.89	29.80	29.68	10	10	10	9	7	-	0.00	
11	82	70	57	52	46	43	62	41	25	30.09	30.03	29.95	10	10	10	17	10	-	0.00	
12	91	76	60	56	48	35	72	41	14	30.01	29.95	29.86	15	10	10	13	6	-	0.00	
13	91	76	62	59	48	39	72	39	17	29.99	29.92	29.85	20	13	10	14	9	20	0.00	
14	93	80	66	61	49	34	76	38	12	29.93	29.84	29.74	20	12	10	13	9	-	0.00	
15	98	81	64	62	49	40	68	37	17	29.82	29.74	29.66	20	11	10	14	10	-	0.00	
16	100	83	66	58	47	36	68	34	12	30.09	29.78	29.70	10	9	4	17	9	28	0.00	
17	91	78	66	53	49	42	61	38	19	30.01	29.94	29.88	20	12	7	15	9	-	0.00	
18	91	78	63	63	57	51	87	52	27	30.17	29.94	29.78	20	12	5	17	6	29	0.30	Rain , Thunderstorm
19	87	76	64	66	62	58	90	69	37	29.99	29.84	29.77	20	13	7	18	9	30	0.10	Rain , Thunderstorm
20	88	77	66	64	60	50	87	60	33	29.91	29.86	29.81	20	12	10	18	8	28	0.00	
21	90	77	64	64	60	53	87	58	28	29.98	29.89	29.81	20	14	10	14	7	-	0.00	
22	89	78	66	65	63	58	93	69	35	30.10	29.94	29.86	20	14	10	17	9	-	0.00	Rain , Thunderstorm
23	69	66	63	65	62	58	96	88	70	30.20	30.06	29.99	10	8	1	14	7	-	0.70	Fog , Rain
24	73	68	63	66	63	61	97	90	71	30.20	30.04	29.96	15	6	0	17	8	-	1.60	Fog , Rain , Thunderstorm

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1986	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
25	78	71	64	66	64	63	97	86	62	30.11	29.97	29.88	20	8	0	16	8	-	1.80	Fog , Rain , Thunderstorm
26	81	72	64	65	63	60	96	76	54	30.09	29.94	29.88	20	11	5	15	7	-	0.04	Fog , Rain
27	87	76	64	69	64	59	93	69	39	30.04	29.98	29.94	10	9	7	12	4	-	0.00	
28	91	78	66	68	63	55	93	62	29	29.98	29.90	29.80	20	11	7	9	6	-	0.00	
29	93	80	68	69	65	62	90	63	37	30.03	29.80	29.71	15	11	10	10	5	-	0.00	
30	95	83	71	69	65	60	87	61	34	29.92	29.73	29.66	20	14	10	12	6	-	0.00	

1986	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
Jul	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	high	sum	
1	91	78	66	67	64	60	97	66	38	30.14	29.87	29.70	20	10	5	23	11	22	0.50	Fog , Rain , Thunderstorm
2	77	72	66	66	64	61	96	80	58	30.14	30.02	29.97	20	10	5	12	6	-	0.30	Fog , Rain , Thunderstorm
3	82	75	68	68	66	64	96	79	58	30.16	29.97	29.83	20	10	5	12	5	-	0.02	Fog , Rain , Thunderstorm
4	91	80	68	67	63	59	96	62	33	29.83	29.73	29.60	15	10	7	21	10	28	0.00	
5	91	80	70	66	63	58	81	57	32	29.98	29.75	29.68	20	12	7	17	6	-	0.00	
6	89	78	66	65	62	59	87	59	39	30.00	29.93	29.82	20	13	10	13	9	-	0.00	
7	89	79	69	66	62	55	84	60	32	30.06	30.00	29.94	20	14	10	14	8	-	0.00	
8	90	78	66	63	59	52	81	55	28	30.06	29.99	29.91	20	11	7	12	7	-	0.00	
9	87	76	66	61	59	53	76	57	36	30.10	29.94	29.85	20	14	7	17	7	28	0.08	Rain , Thunderstorm
10	91	80	68	64	60	55	87	56	29	29.93	29.80	29.71	20	10	7	13	7	-	0.10	Rain , Thunderstorm
11	95	80	66	63	58	49	84	50	21	29.76	29.71	29.64	10	9	7	14	6	-	0.00	
12	98	82	66	64	58	49	81	47	19	29.76	29.71	29.68	10	8	7	13	8	-	0.00	
13	91	78	66	64	60	54	87	54	27	29.95	29.84	29.77	10	9	7	17	11	-	0.00	
14	84	76	68	63	61	57	81	61	38	30.22	30.00	29.91	20	11	7	15	10	-	0.00	
15	88	76	64	60	58	54	73	53	37	30.00	29.94	29.86	20	12	7	17	11	-	0.00	
16	91	78	66	61	57	52	73	49	27	30.06	29.87	29.78	20	11	10	17	11	25	0.00	
17	90	77	64	59	57	53	78	49	29	30.16	29.94	29.87	15	12	10	18	7	21	0.00	Rain , Thunderstorm
18	91	78	64	60	57	52	81	50	27	30.21	29.99	29.94	15	10	7	14	8	-	0.00	
19	93	78	63	59	54	43	81	47	18	30.08	30.02	29.94	20	11	7	12	6	-	0.00	
20	91	78	64	58	55	51	78	46	26	30.09	30.00	29.88	20	11	10	14	8	-	0.00	
21	84	75	66	62	58	53	76	58	41	30.24	30.02	29.90	20	15	10	14	7	-	0.02	Rain
22	86	76	66	59	57	54	76	53	35	30.17	30.03	29.98	10	8	7	14	8	-	0.00	
23	90	77	64	64	58	51	93	54	28	30.21	30.02	29.92	20	10	7	16	7	-	0.10	Rain , Thunderstorm
24	93	78	64	57	54	49	68	43	22	30.03	29.96	29.89	10	10	10	12	7	-	0.00	
25	98	81	64	59	54	49	78	44	19	29.96	29.90	29.83	15	10	10	18	5	28	0.00	
26	99	82	66	59	51	42	68	38	14	29.93	29.84	29.77	15	12	7	12	6	-	0.00	
27	100	84	69	54	50	42	58	32	14	29.86	29.80	29.76	20	13	7	9	7	-	0.00	

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1986	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
28	99	82	66	53	51	47	61	34	17	30.13	29.87	29.81	10	10	10	10	7	-	0.00	
29	99	82	66	51	47	42	56	31	15	29.95	29.88	29.82	20	11	10	12	7	-	0.00	
30	99	82	66	52	47	38	52	30	13	29.90	29.85	29.78	20	10	7	10	7	-	0.00	
31	97	82	66	54	47	36	56	32	12	29.93	29.88	29.83	15	10	10	14	7	-	0.00	
1986	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
Aug	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	high	sum	
1	98	83	68	51	46	42	47	29	15	29.99	29.91	29.83	20	11	10	13	3	-	0.00	
2	97	84	71	57	51	40	49	33	21	30.25	29.94	29.85	15	12	7	25	9	32	0.00	Rain , Thunderstorm
3	88	76	64	64	60	55	90	60	32	30.30	30.07	29.94	20	10	7	17	11	-	0.10	Rain , Thunderstorm
4	90	77	64	64	61	57	93	63	33	30.27	30.01	29.85	20	11	7	26	9	34	0.10	Rain , Thunderstorm
5	93	80	66	64	59	48	87	56	21	30.20	29.89	29.78	10	10	5	9	7	-	0.00	Fog , Rain , Thunderstorm
6	95	82	69	61	57	53	73	45	26	29.85	29.81	29.75	20	11	7	13	6	-	0.04	
7	93	81	69	63	58	55	71	47	27	29.86	29.82	29.79	10	9	7	14	7	-	0.00	
8	90	79	68	61	59	56	76	55	34	30.10	29.86	29.79	20	11	7	17	7	-	0.00	
9	91	78	66	61	59	53	81	53	33	30.00	29.81	29.73	15	12	7	18	5	-	0.00	
10	89	78	66	61	58	54	81	55	31	30.00	29.93	29.83	20	13	7	10	7	-	0.00	
11	89	76	64	63	61	58	84	59	35	30.24	29.99	29.90	20	14	10	10	5	-	0.00	
12	91	78	66	64	60	57	81	54	31	29.99	29.90	29.79	20	12	10	12	7	-	0.00	
13	91	81	71	66	62	59	73	54	33	29.92	29.78	29.67	20	12	7	16	10	23	0.01	Rain , Thunderstorm
14	91	80	70	65	61	55	81	54	30	29.78	29.71	29.65	20	11	10	10	6	-	0.10	
15	91	81	71	66	62	57	84	56	32	30.01	29.78	29.67	20	12	10	17	7	-	0.00	Rain , Thunderstorm
16	96	81	66	66	61	49	90	56	21	29.85	29.79	29.73	10	9	7	13	5	-	0.00	
17	97	84	70	61	55	48	68	41	19	29.94	29.88	29.81	20	10	7	14	6	-	0.00	
18	97	82	66	57	52	49	59	37	20	30.06	29.99	29.92	20	14	7	12	5	-	0.00	
19	98	82	66	56	50	43	61	35	16	30.08	29.97	29.90	15	11	10	13	6	-	0.00	
20	102	84	66	51	44	34	49	27	10	29.97	29.90	29.82	20	12	10	8	6	-	0.00	
21	91	82	73	62	58	39	62	45	20	30.32	30.00	29.88	20	14	7	14	9	-	0.00	
22	88	77	66	67	63	60	90	66	39	30.21	29.96	29.85	20	10	7	21	9	32	0.50	Rain , Thunderstorm
23	81	74	66	66	61	55	93	69	41	30.02	29.97	29.91	10	8	3	22	8	-	0.10	Rain
24	84	74	64	64	61	55	96	71	37	30.00	29.93	29.86	10	6	2	18	5	-	0.00	Fog
25	84	72	61	63	59	54	97	68	37	30.13	29.95	29.84	20	9	3	14	7	-	0.00	Fog
26	88	76	64	66	62	57	93	70	35	30.18	29.95	29.83	20	9	1	17	9	-	0.90	Fog , Rain , Thunderstorm
27	79	72	66	66	64	61	93	79	54	30.24	30.06	29.98	20	8	2	16	10	-	0.40	Fog , Rain
28	68	66	63	64	61	59	97	89	81	30.25	30.13	30.08	10	5	2	14	9	-	0.20	Fog , Rain
29	78	71	64	65	63	61	96	82	60	30.22	30.02	29.87	15	7	3	14	8	-	0.03	Fog

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1986	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
30	84	74	64	66	64	62	97	75	51	30.10	29.91	29.79	20	10	2	17	11	-	0.10	Fog , Rain , Thunderstorm
31	88	77	64	66	63	53	100	70	38	30.04	29.86	29.74	20	10	1	16	11	23	0.10	Fog , Rain , Thunderstorm
1986	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
Sep	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	high	sum	
1	84	74	63	65	62	58	97	71	46	30.06	29.88	29.76	20	11	7	20	7	-	0.60	Rain , Thunderstorm
2	81	70	60	65	62	57	97	78	55	30.07	29.89	29.78	20	9	3	15	9	-	1.60	Fog , Rain , Thunderstorm
3	80	72	63	65	62	59	93	75	54	29.95	29.89	29.85	20	9	7	12	8	-	0.00	
4	86	74	62	63	59	54	97	70	38	30.18	29.99	29.86	20	8	0	28	6	41	1.00	Fog , Rain , Thunderstorm
5	82	70	57	63	58	55	97	71	42	30.09	29.97	29.88	15	11	0	9	6	-	0.00	Fog
6	84	73	62	64	61	57	90	71	41	30.16	30.00	29.90	20	11	0	8	5	-	0.00	Fog , Rain , Thunderstorm
7	79	70	62	61	59	47	93	74	34	30.32	30.14	30.04	20	11	4	15	9	-	0.02	Fog , Rain
8	77	69	61	60	59	56	93	76	52	30.25	30.05	29.90	20	7	3	16	11	-	0.00	Fog
9	86	74	63	64	62	57	93	72	40	30.08	29.87	29.69	20	7	2	17	11	-	0.00	Fog , Rain , Thunderstorm
10	88	78	69	64	55	47	78	51	25	29.79	29.71	29.64	20	10	7	16	10	21	0.00	
11	81	70	59	49	44	38	60	40	22	30.06	29.96	29.80	15	10	7	12	8	-	0.00	
12	84	69	54	65	51	47	81	55	31	30.07	30.00	29.92	15	11	10	17	8	23	0.00	
13	81	71	61	64	59	53	87	73	56	30.19	30.02	29.95	20	11	10	18	6	30	0.04	Rain , Thunderstorm
14	82	72	63	64	62	60	97	75	49	30.04	29.97	29.88	15	9	7	12	6	-	0.00	
15	87	73	59	64	60	51	97	70	29	30.12	29.96	29.86	20	10	3	13	5	-	0.00	Fog
16	84	74	63	63	60	53	93	68	43	30.04	29.93	29.85	15	11	7	14	10	-	0.00	Rain , Thunderstorm
17	91	75	59	60	54	45	93	57	22	30.08	29.88	29.77	20	11	7	10	6	-	0.00	
18	91	76	61	62	54	45	84	51	20	29.95	29.83	29.74	20	12	10	21	9	25	0.00	Rain , Thunderstorm
19	93	78	64	65	59	50	97	60	23	30.07	29.86	29.78	15	7	1	16	12	23	0.00	Fog
20	90	76	63	62	59	54	90	61	30	29.95	29.88	29.82	15	10	10	17	10	-	0.00	
21	89	76	63	64	61	54	93	66	30	30.14	29.93	29.82	20	10	3	14	8	-	0.00	Fog
22	84	74	64	66	64	60	93	74	47	30.08	29.89	29.80	20	10	5	10	8	-	0.10	Fog , Rain , Thunderstorm
23	82	72	62	66	63	58	93	81	49	29.98	29.80	29.70	20	9	4	41	8	-	0.30	Fog , Rain , Thunderstorm
24	79	67	55	59	45	20	96	57	11	29.74	29.66	29.60	20	10	6	28	11	38	0.00	Fog , Rain
25	82	67	52	49	39	27	67	42	14	29.82	29.77	29.71	20	12	10	18	9	25	0.00	
26	84	69	54	48	41	35	72	43	18	29.91	29.84	29.77	20	11	7	12	7	-	0.00	
27	86	68	50	49	44	39	80	47	20	30.05	29.89	29.80	15	10	10	14	7	23	0.00	
28	84	70	57	62	53	44	93	61	25	30.02	29.81	29.68	15	11	10	23	8	-	0.00	
29	84	72	60	65	51	33	97	56	18	29.99	29.79	29.66	10	4	1	18	9	25	0.10	Fog , Rain , Thunderstorm

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1986	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
30	81	64	48	49	41	34	68	43	21	29.91	29.81	29.71	10	9	7	12	7	-	0.00	
1986	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
Oct	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	high	sum	
1	87	68	48	40	36	25	71	37	10	29.83	29.75	29.64	20	11	7	18	7	24	0.00	
2	72	68	63	66	61	45	93	84	45	29.79	29.64	29.57	20	14	10	9	7	-	0.07	Rain
3	82	70	57	60	50	43	97	61	25	29.88	29.74	29.64	20	11	7	21	6	29	0.00	
4	75	64	53	52	42	37	75	48	28	30.08	30.00	29.89	20	12	10	12	8	-	0.00	
5	62	58	55	58	56	51	97	91	75	30.28	30.10	29.96	10	4	1	12	7	-	0.10	Fog , Rain
6	60	56	51	54	52	50	97	87	72	30.34	30.22	30.16	20	6	1	53	8	-	0.10	Fog , Rain
7	73	62	50	55	52	50	100	75	46	30.21	30.07	29.92	15	6	0	12	5	-	0.00	Fog
8	82	64	46	54	49	41	100	68	26	30.11	29.96	29.86	10	5	0	8	5	-	0.00	Fog
9	73	63	53	56	51	46	93	67	45	30.26	30.09	29.93	20	11	3	16	8	-	0.20	Fog , Rain , Thunderstorm
10	68	62	57	61	58	53	97	89	70	30.18	29.92	29.72	15	6	0	23	9	34	2.90	Fog , Rain , Thunderstorm
11	64	54	44	53	45	33	100	78	60	30.10	29.86	29.70	20	6	0	17	8	25	0.00	Fog , Rain , Thunderstorm
12	43	40	37	33	31	29	76	72	65	30.26	30.19	30.13	10	7	3	12	9	-	0.00	Fog
13	66	52	37	37	34	26	89	59	22	30.22	30.11	29.98	10	8	7	14	7	-	0.00	
14	72	54	36	40	35	29	86	56	20	30.18	30.11	30.05	15	10	10	9	4	-	0.00	
15	71	55	39	43	38	36	89	59	29	30.30	30.22	30.14	15	9	7	12	5	-	0.00	
16	68	56	45	46	41	37	83	61	32	30.28	30.19	30.11	20	10	7	9	3	-	0.00	
17	75	60	44	52	46	41	90	68	34	30.11	30.04	29.93	20	12	10	12	6	-	0.18	Rain , Thunderstorm
18	79	62	46	54	49	45	100	73	30	30.16	30.02	29.91	15	8	0	16	7	-	0.00	Fog
19	63	60	57	56	54	52	96	82	67	30.23	30.10	30.01	15	6	1	14	9	-	0.00	Fog , Rain , Thunderstorm
20	61	58	55	57	55	53	97	90	81	30.20	30.08	30.00	10	6	1	15	11	-	0.07	Fog , Rain
21	77	66	53	57	53	37	100	77	24	30.08	29.94	29.75	20	6	0	15	10	23	0.87	Fog , Rain , Thunderstorm
22	69	56	44	49	42	34	90	63	29	30.01	29.91	29.85	15	8	1	8	6	-	0.00	Fog
23	66	56	46	53	47	40	86	71	54	30.22	30.03	29.90	20	10	7	13	7	-	0.00	Rain , Thunderstorm
24	68	60	51	52	50	48	93	77	50	30.24	30.09	29.99	20	12	7	8	6	-	0.00	
25	69	58	46	50	46	43	97	71	40	30.15	30.05	29.99	20	13	6	9	6	-	0.00	Fog
26	71	58	45	45	42	37	93	65	31	30.17	30.10	30.05	15	9	7	8	6	-	0.00	
27	75	60	44	43	38	30	85	55	19	30.17	30.08	30.00	10	10	10	9	6	-	0.00	
28	82	60	39	41	35	25	86	50	12	30.18	30.08	29.99	10	10	10	14	5	-	0.00	
29	64	55	46	48	44	39	83	65	48	30.32	30.24	30.18	15	11	7	9	7	-	0.00	
30	75	59	43	47	44	40	93	65	32	30.18	30.05	29.91	15	12	7	13	6	-	0.00	
31	79	64	48	50	46	39	100	64	24	30.07	29.93	29.82	20	8	0	14	8	-	0.00	Fog
1986	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
Nov	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	high	sum	

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1986	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
1	68	56	42	62	49	37	97	77	55	30.33	30.12	29.96	15	8	4	17	7	23	0.00	Fog
2	41	39	37	40	38	36	100	95	89	30.44	30.35	30.25	10	3	1	17	13	-	0.51	Fog , Rain
3	46	42	39	46	42	39	100	95	89	30.25	30.06	29.93	15	5	1	14	8	-	0.98	Fog , Rain , Thunderstorm
4	50	44	36	41	37	33	93	81	61	30.15	30.10	30.06	15	8	5	21	12	-	0.14	Fog , Rain
5	62	46	30	40	35	30	96	72	41	30.19	30.09	29.97	15	8	1	7	4	-	0.00	Fog
6	72	54	35	43	36	30	93	64	21	29.96	29.79	29.65	10	10	7	14	6	-	0.10	
7	62	52	41	40	32	21	74	48	21	29.95	29.77	29.63	20	12	10	25	13	38	0.00	
8	64	49	34	31	27	22	73	50	21	30.20	30.05	29.96	20	11	10	12	6	-	0.00	
9	55	44	32	30	24	14	75	51	19	30.40	30.26	30.15	20	13	10	12	6	-	0.00	
10	60	45	28	39	32	19	89	67	46	30.40	30.13	30.01	20	11	10	14	6	-	0.00	
11	50	38	26	34	26	17	92	67	50	30.41	30.29	30.14	10	10	10	12	8	-	0.00	
12	41	34	26	33	25	18	96	77	57	30.71	30.39	30.09	10	8	0	23	8	36	0.00	Fog
13	28	26	24	24	22	19	91	84	75	30.72	30.59	30.34	10	5	1	12	7	-	0.13	Fog , Rain , Snow
14	53	40	27	37	30	24	96	82	55	30.37	30.22	30.09	20	7	0	8	7	-	0.00	Fog
15	59	48	36	44	39	34	93	77	53	30.14	30.06	29.99	20	11	3	7	4	-	0.00	Fog
16	71	55	39	45	40	35	97	66	27	30.01	29.96	29.91	20	12	7	9	4	-	0.00	
17	75	60	45	42	39	33	80	51	22	29.94	29.86	29.78	20	10	7	12	6	-	0.00	
18	63	56	50	43	39	34	74	55	34	30.11	29.99	29.84	10	10	10	14	8	-	0.00	
19	73	58	43	48	41	36	93	60	26	29.91	29.82	29.67	15	11	5	14	9	-	0.06	Fog , Rain
20	61	50	39	38	33	26	80	54	31	30.25	30.15	29.92	15	12	7	14	8	24	0.00	
21	66	50	33	42	36	30	89	67	36	30.14	29.99	29.83	20	10	7	12	6	-	0.00	
22	73	54	36	43	35	24	93	58	17	29.86	29.79	29.69	20	11	10	16	7	-	0.00	
23	48	40	30	37	31	25	93	77	57	30.33	30.17	29.83	15	9	2	20	14	23	0.10	Fog , Rain , Snow
24	52	38	25	26	23	18	89	63	28	30.33	30.20	30.04	15	9	7	8	4	-	0.00	
25	61	41	21	34	27	19	91	64	33	30.11	29.95	29.80	20	10	7	16	5	23	0.00	
26	48	39	30	27	19	14	69	48	27	30.28	30.21	30.12	20	11	7	12	9	-	0.00	
27	61	44	26	31	26	20	82	61	30	30.32	30.25	30.17	15	11	7	8	4	-	0.00	
28	66	46	27	32	26	19	85	56	18	30.27	30.18	30.09	20	11	7	8	5	-	0.00	
29	69	48	28	32	27	21	85	55	17	30.15	30.00	29.82	20	10	7	13	6	-	0.00	
30	62	48	34	28	21	11	79	39	15	29.99	29.82	29.72	20	9	7	23	10	31	0.00	
1986	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
Dec	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	low	high	avg	high	sum	
1	57	42	27	28	22	17	85	53	22	30.20	30.09	29.99	20	10	7	16	5	-	0.00	
2	66	44	23	25	20	16	85	48	16	30.17	30.10	30.04	10	10	10	9	4	-	0.00	
3	55	42	28	28	26	22	81	58	30	30.23	30.15	30.06	20	11	10	9	6	-	0.00	
4	42	34	27	34	29	23	85	77	70	30.40	30.32	30.15	15	10	5	12	6	-	0.00	Fog
5	52	46	39	41	37	34	100	78	59	30.37	30.23	30.10	10	6	0	13	5	-	0.00	Fog
6	52	48	44	48	45	43	100	89	74	30.11	29.99	29.87	15	4	0	20	11	-	0.00	Fog , Rain

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1986	Temp. (°F)			Dew Point (°F)			Humidity (%)			Sea Level Press. (in)			Visibility (mi)			Wind (mph)			Precip. (in)	Events
7	64	52	39	45	42	38	100	74	41	30.04	29.89	29.80	20	7	0	16	6	-	0.00	Fog
8	57	47	36	40	36	25	96	78	28	29.99	29.91	29.78	20	7	0	13	8	-	0.10	Fog , Rain
9	37	35	33	35	33	31	96	89	79	30.20	30.09	29.99	10	4	1	13	8	-	0.00	Fog
10	32	28	25	31	24	21	96	87	72	30.34	30.24	30.18	15	4	1	14	9	-	0.10	Fog , Rain , Snow
11	41	32	24	27	23	19	96	75	53	30.30	30.18	30.10	10	8	5	9	5	-	0.00	Fog
12	50	36	21	31	23	17	96	67	33	30.38	30.30	30.24	15	8	6	12	3	-	0.00	
13	53	38	24	32	28	21	92	73	41	30.31	30.23	30.14	20	10	7	8	4	-	0.00	
14	57	42	26	35	31	23	96	76	37	30.20	30.14	30.04	20	9	0	8	5	-	0.00	Fog
15	62	44	26	33	29	22	86	66	31	30.21	30.15	30.09	20	12	7	8	4	-	0.00	
16	48	42	35	46	38	31	100	86	68	30.21	30.13	30.08	20	9	3	10	6	-	0.10	Fog , Rain
17	45	39	33	43	38	32	100	96	89	30.25	30.14	30.04	10	3	0	16	7	-	0.20	Fog , Rain , Snow
18	39	36	33	32	31	30	96	86	68	30.30	30.22	30.15	20	9	2	12	8	-	0.10	Fog , Snow
19	52	38	24	38	29	23	100	82	48	30.14	30.07	29.99	20	7	0	9	4	-	0.00	Fog
20	54	41	28	36	31	25	92	72	43	30.15	30.08	30.02	20	12	7	8	5	-	0.00	
21	43	40	37	38	37	36	97	90	76	30.23	30.18	30.13	10	6	1	14	7	-	0.20	Fog , Rain
22	37	35	33	35	33	32	96	95	92	30.31	30.25	30.21	10	3	0	12	9	-	0.40	Fog , Rain , Snow
23	46	37	28	38	34	28	100	94	73	30.20	30.05	29.93	10	2	0	8	3	-	0.00	Fog
24	48	38	28	35	31	27	100	78	43	30.02	29.97	29.93	10	4	0	16	5	-	0.00	Fog
25	48	39	30	33	31	28	92	71	50	30.15	30.07	30.01	20	11	10	8	5	-	0.00	
26	52	40	27	31	27	24	92	70	35	30.26	30.18	30.11	15	9	7	9	4	-	0.00	
27	51	38	26	31	28	22	89	73	41	30.22	30.15	30.09	20	11	7	12	6	-	0.00	
28	50	40	30	37	32	26	92	80	57	30.23	30.15	30.08	20	12	10	8	4	-	0.00	
29	55	40	26	32	25	21	96	63	27	30.37	30.29	30.22	20	11	6	12	6	-	0.00	Fog
30	57	39	21	26	23	17	84	59	22	30.29	30.13	30.00	15	11	7	12	6	-	0.00	
31	51	38	26	23	19	14	78	52	23	30.17	30.09	29.97	15	10	10	17	6	-	0.00	

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Urban Hydrology for Small Watersheds

TR-55

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Chapter 2 Estimating Runoff

SCS runoff curve number method

The SCS Runoff Curve Number (CN) method is described in detail in NEH-4 (SCS 1985). The SCS runoff equation is

$$Q = \frac{(P - I_a)^2}{(P - I_a) + S} \qquad \text{[eq. 2-1]}$$

where

- Q = runoff (in)
- P = rainfall (in)
- S = potential maximum retention after runoff begins (in) and
- I_a = initial abstraction (in)

Initial abstraction (I_a) is all losses before runoff begins. It includes water retained in surface depressions, water intercepted by vegetation, evaporation, and infiltration. I_a is highly variable but generally is correlated with soil and cover parameters. Through studies of many small agricultural watersheds, I_a was found to be approximated by the following empirical equation:

$$I_a = 0.2S \qquad \text{[eq. 2-2]}$$

By removing I_a as an independent parameter, this approximation allows use of a combination of S and P to produce a unique runoff amount. Substituting equation 2-2 into equation 2-1 gives:

$$Q = \frac{(P - 0.2S)^2}{(P + 0.8S)} \qquad \text{[eq. 2-3]}$$

S is related to the soil and cover conditions of the watershed through the CN. CN has a range of 0 to 100, and S is related to CN by:

$$S = \frac{1000}{CN} - 10 \qquad \text{[eq. 2-4]}$$

Figure 2-1 and table 2-1 solve equations 2-3 and 2-4 for a range of CN's and rainfall.

Factors considered in determining runoff curve numbers

The major factors that determine CN are the hydrologic soil group (HSG), cover type, treatment, hydrologic condition, and antecedent runoff condition (ARC). Another factor considered is whether impervious areas outlet directly to the drainage system (connected) or whether the flow spreads over pervious areas before entering the drainage system (unconnected). Figure 2-2 is provided to aid in selecting the appropriate figure or table for determining curve numbers.

CN's in table 2-2 (*a* to *d*) represent average antecedent runoff condition for urban, cultivated agricultural, other agricultural, and arid and semiarid rangeland uses. Table 2-2 assumes impervious areas are directly connected. The following sections explain how to determine CN's and how to modify them for urban conditions.

Hydrologic soil groups

Infiltration rates of soils vary widely and are affected by subsurface permeability as well as surface intake rates. Soils are classified into four HSG's (A, B, C, and D) according to their minimum infiltration rate, which is obtained for bare soil after prolonged wetting. Appendix A defines the four groups and provides a list of most of the soils in the United States and their group classification. The soils in the area of interest may be identified from a soil survey report, which can be obtained from local SCS offices or soil and water conservation district offices.

Most urban areas are only partially covered by impervious surfaces: the soil remains an important factor in runoff estimates. Urbanization has a greater effect on runoff in watersheds with soils having high infiltration rates (sands and gravels) than in watersheds predominantly of silts and clays, which generally have low infiltration rates.

Any disturbance of a soil profile can significantly change its infiltration characteristics. With urbanization, native soil profiles may be mixed or removed or fill material from other areas may be introduced. Therefore, a method based on soil texture is given in appendix A for determining the HSG classification for disturbed soils.

Chapter 3 Time of Concentration and Travel Time

Travel time (T_t) is the time it takes water to travel from one location to another in a watershed. T_t is a component of time of concentration (T_c), which is the time for runoff to travel from the hydraulically most distant point of the watershed to a point of interest within the watershed. T_c is computed by summing all the travel times for consecutive components of the drainage conveyance system.

T_c influences the shape and peak of the runoff hydrograph. Urbanization usually decreases T_c, thereby increasing the peak discharge. But T_c can be increased as a result of (a) ponding behind small or inadequate drainage systems, including storm drain inlets and road culverts, or (b) reduction of land slope through grading.

Factors affecting time of concentration and travel time

Surface roughness

One of the most significant effects of urban development on flow velocity is less retardance to flow. That is, undeveloped areas with very slow and shallow overland flow through vegetation become modified by urban development: the flow is then delivered to streets, gutters, and storm sewers that transport runoff downstream more rapidly. Travel time through the watershed is generally decreased.

Channel shape and flow patterns

In small non-urban watersheds, much of the travel time results from overland flow in upstream areas. Typically, urbanization reduces overland flow lengths by conveying storm runoff into a channel as soon as possible. Since channel designs have efficient hydraulic characteristics, runoff flow velocity increases and travel time decreases.

Slope

Slopes may be increased or decreased by urbanization, depending on the extent of site grading or the extent to which storm sewers and street ditches are used in the design of the water management system. Slope will tend to increase when channels are straightened and decrease when overland flow is directed through storm sewers, street gutters, and diversions.

Computation of travel time and time of concentration

Water moves through a watershed as sheet flow, shallow concentrated flow, open channel flow, or some combination of these. The type that occurs is a function of the conveyance system and is best determined by field inspection.

Travel time (T_t) is the ratio of flow length to flow velocity:

$$T_t = \frac{L}{3600V} \qquad \text{[eq. 3-1]}$$

where:

T_t = travel time (hr)
L = flow length (ft)
V = average velocity (ft/s)
3600 = conversion factor from seconds to hours.

Time of concentration (T_c) is the sum of T_t values for the various consecutive flow segments:

$$T_c = T_{t_1} + T_{t_2} + \ldots T_{t_m} \qquad \text{[eq. 3-2]}$$

where:

T_c = time of concentration (hr)
m = number of flow segments

Day and Night Wind Drift and Evaporation Losses in Sprinkler Solid-Sets and Moving Laterals

by

Playán, E. [1], Salvador, R. [2], Faci, J. M. [2], Zapata, N. [2], Martínez-Cob, A. [1] and Sánchez, I. [2]

Abstract

Wind drift and evaporation losses (*WDEL*) represent a relevant water sink in sprinkler irrigation, particularly in areas with strong winds and high evaporative demand. The objectives of this paper include: 1) Characterize *WDEL* under day and night operation conditions for solid-set and moving lateral configurations; 2) Propose adequate predictive equations; and 3) Prospect the effect of sprinkler irrigation on the meteorological variables and on the estimates of reference evapotranspiration. A total of 89 catch can irrigation evaluations were performed in both irrigation systems and

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Table 5. *Selected predictive equations for WDEL. Equations are presented for solid-sets, moving laterals and both irrigation systems; and for day, night and both conditions. Quality indicators are supplied for each equation: R^2 (Determination Coefficient), AMRE (Average Magnitude of the Relative Error) and Pred[0.25] (Prediction level 25 %). Three dependent variables are used in the equations: Wind Speed at an elevation of 2 m (U, m s^{-1}), Relative Humidity (RH, %), and Air Temperature (T, °C).*

Irrigation System	Day or Night	Eq. #	WDEL =	R^2 (%)	SE (%)	AMRE (%)	Pred[0.25] (-)
Solid-Set	All	E15	$20.3 + 0.214\ U^2 - 2.29\ 10^{-3}\ RH^2$	0.80	3.1	0.31	62
		E14	$26.1 + 1.64\ U - 0.274\ RH$	0.79	3.2	0.31	59
		E5	$38.6 - 0.407\ RH$	0.67	3.9	0.37	49
		E23	$4.4 + 3.60\ U^{0.9}$	0.60	4.3	0.51	43
		E4	$5.2 + 2.90\ U$	0.60	4.3	0.51	43
	Day	E13	$20.7 + 0.185\ U^2 - 2.14\ 10^{-3}\ RH^2$	0.75	2.8	0.11	89
		E12	$24.1 + 1.41\ U - 0.216\ RH$	0.69	3.1	0.13	79
		E21	$12.3 + 0.552\ U^{1.6}$	0.59	3.5	0.17	79
		E1	$13.0 + 0.246\ U^2$	0.58	3.5	0.18	79
		E20	$10.5 + 1.89\ U$	0.57	3.5	0.17	74
	Night	E22	$3.2 + 1.84\ U^{1.7}$	0.55	3.2	0.43	56
		E2	$3.7 + 1.31\ U^2$	0.55	3.2	0.42	61
		E3	$29.9 - 0.300\ RH$	0.39	3.7	0.53	28
Moving Lateral	All	E18	$-2.1 + 1.91\ U + 0.231\ T$	0.74	1.8	0.33	58
		E7	$2.7 + 2.31\ U$	0.60	2.2	0.42	54
		E27	$2.4 + 2.70\ U^{0.9}$	0.60	2.2	0.42	56
	Day	E17	$7.0 + 1.65\ U - 1.16\ 10^{-3}\ RH^2$	0.51	1.8	0.17	81
		E16	$8.9 + 1.67\ U - 0.097\ RH$	0.50	1.8	0.17	81
		E25	$5.1 + 1.78\ U^{0.9}$	0.38	2.0	0.20	77
		E24	$5.4 + 1.48\ U$	0.38	2.0	0.20	77
	Night	E26	$3.1 + 0.00600\ U^{9.2}$	0.28	1.2	0.40	43
		E6	$239 / RH$	0.11	1.3	0.45	38
Both Irrigation Systems	All	E11	$3.1 + 2.95\ U$	0.58	3.7	0.49	51
	Day	E8	$8.6 + 0.337\ U^2$	0.51	3.8	0.28	62
		E28	$8.4 + 0.409\ U^{1.9}$	0.51	3.8	0.28	64
		E19	$5.7 + 2.29\ U$	0.51	3.8	0.29	56
	Night	E29	$3.2 + 0.761\ U^{2.6}$	0.59	2.5	0.48	46
		E9	$3.4 + 0.512\ U^3$	0.59	2.5	0.47	46
		E10	$10.3 - 8.97\ 10^{-4}\ RH^2$	0.12	3.7	0.70	36

Appendix B

Model Input Files

Scenario:

1998

Stormwater Recirculation Every Day

```
Supplemental Cover Modeling: 36-inch cover - First test with Australia weather data
1,1,                             IPLANT,NGRAV
365,1,365,                       IFDEND,IDTBEG,IDTEND
1,1,0,0,1,                       IYS,NYEARS,ISTEAD,IFLIST,NFLIST
0,24.0,                          NPRINT,STOPHR
0,2,1,1.E-6,                     ISMETH,INMAX,ISWDIF,DMAXBA
1.0,1.0E-40,0.0,                 DELMAX,DELMIN,OUTTIM
1.2,1.0E-06,0.0,0.0,0.0,         RFACT,RAINIF,DHTOL,DHMAX,DHFACT
4,3,0.0,                         KOPT,KEST,WTF
0,1,1,1,                         ITOPBC,IEVOPT,NFHOUR,LOWER
0.0,1.5E+04,0.0,0.40,            HIRRI,HDRY,HTOP,RHA
1,1,1,                           IETOPT,ICLOUD,ISHOPT
0,0.0,                           IRAIN,HPR
0,0,0,0,0,                       IHYS,AIRTOL,HYSTOL,HYSMXH,HYFILE
0,0,0,                           IHEAT,ICONVH,DMAXHE
0,0,0,0,                         UPPERH,TSMEAN,TSAMP,QHCTOP
0,0.0,0.0,                       LOWERH,QHLEAK,TGRAD
1,0.66,294.0,0.24,               IVAPOR,TORT,TSOIL,VAPDIF
2,   116,                        MATN,NPT
1,0.0, 1,0.5, 1,1.0, 1,1.5,
1,2.0, 1,2.5, 1,3.0, 1,3.5,
1,4.0, 1,4.5, 1,5.0, 1,6.0,
1,7.0, 1,8.0, 1,9.0, 1,10.0,
1,10.5, 1,11.0, 1,11.5, 1,12.0,
1,12.5, 1,13.0, 1,13.5, 1,14.0,
1,14.5, 1,15.0, 2,15.5, 2,16.0,
2,16.5, 2,17.0, 2,17.5, 2,18.0,
2,18.5, 2,19.0, 2,19.5, 2,20.0,
2,21.0, 2,22.0, 2,23.0, 2,24.0,
2,25.0, 2,30.0, 2,35.0, 2,40.0,
2,45.0, 2,50.0, 2,60.0, 2,70.0,
2,80.0, 2,90.0, 2,100.0, 2,125.0,
2,150.0, 2,175.0, 2,200.0, 2,225.0,
2,250.0, 2,260.0, 2,270.0, 2,280.0,
2,290.0, 2,295.0, 2,300.0, 2,305.0,
2,310.0, 2,311.0, 2,312.0, 2,313.0,
2,314.0, 2,315.0, 2,315.5, 2,316.0,
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2,318.5, 2,319.0, 2,319.5, 1,320.0,
1,320.5, 1,321.0, 1,321.5, 1,322.0,
1,322.5, 1,323.0, 1,323.5, 1,324.0,
1,324.5, 1,325.0, 1,330.0, 1,335.0,
1,340.0, 1,345.0, 1,350.0, 1,355.0,
1,360.0, 1,365.0, 1,370.0, 1,371.0,
1,372.0, 1,373.0, 1,374.0, 1,375.0,
1,375.5, 1,376.0, 1,376.5, 1,377.0,
1,377.5, 1,378.0, 1,378.5, 1,379.0,
1,379.5, 1,380.0, 1,380.5, 1,381.0,
MAT#1: Daily cover/protective soil
0.327, 0.0277, 0.0526, 1.49,            THES,THER,ALPHA,N
SOIL CONDUCTIVITY DATA
2, 3.31, 0.0526, 1.49, 0.5,           KMOD,KSAT,ALPHA,N,EPIT
MAT#2: Waste
0.3354, 0.0319, 0.018, 1.3200,            THES,THER,ALPHA,N
SOIL CONDUCTIVITY DATA
2, 0.7367, 0.018, 1.3200, 0.5,           KMOD,KSAT,ALPHA,N,EPIT
    0,    (TOSS.OUT file for day  3.65000E+02)              NDAY
   1.62600E+03, 1.62600E+03, 1.62600E+03, 1.62600E+03,   Head Values
   1.62600E+03, 1.62600E+03, 1.62600E+03, 1.62600E+03,
   1.62600E+03, 1.62600E+03, 1.62600E+03, 1.62600E+03,
   1.62600E+03, 1.62600E+03, 1.62600E+03, 1.62600E+03,
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   1.62600E+03, 1.62600E+03, 1.62600E+03, 1.62600E+03,
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   1.62600E+03, 1.62600E+03, 1.62600E+03, 1.62600E+03,
   1, 1, 1, 1, 364, 365,       LEAF,NFROOT,NUPTAK,NFPET,NSOW,NHRVST
   1.0,                       BARE
    4,                        NDLAI
    95, 0., 125, 1.5, 271, 1.5, 301, 0.,            IDLAI,VLAI
 8.705E-01, 6.108E-02, 0.0144E+0,                   AA,B1,B2
    1, 1, 1, 1, 1, 1, 1, 1, 1, 1,                   NTROOT
    1, 1, 1, 1, 1, 1, 1, 1, 1, 1,                   NTROOT
    1, 1, 1, 1, 1, 1, 1, 1, 1, 1,                   NTROOT
    1, 1, 1, 1, 1, 1, 1, 1, 1, 1,                   NTROOT
    1, 1, 1, 1, 1, 1, 1, 1, 1, 1,                   NTROOT
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    1, 1, 1, 1, 1, 1, 1, 1, 1, 1,                   NTROOT
    1, 1, 1, 1, 1, 1, 1, 1, 1, 1,                   NTROOT
    1, 1, 1, 1, 1, 1, 1, 1, 1, 1,                   NTROOT
    1, 1, 1, 1, 1, 1, 1, 1, 1, 1,                   NTROOT
    1, 1, 1, 1, 1, 1, 1, 1, 1, 1,                   NTROOT
    1, 1, 1, 1, 1, 1,                               NTROOT
 1.500E+04, 3.000E+03, 1.000E+0,          HW,HD,HN
 1.500E+04, 3.000E+03, 1.000E+0,          HW,HD,HN
   0.0, 0.52, 0.5, 0.1, 2.7,              PETPC(1:5)
0.01, 0.01, 0.01, 0.01, 0.01, 0.01, 0.05, 0.05,         FPET
0.05, 0.05, 0.05, 0.05, 0.06, 0.07, 0.08, 0.09,         FPET
0.08, 0.07, 0.06, 0.05, 0.05, 0.01, 0.01, 0.01,         FPET
   0.2, 1264.9, 2., 985.,                  ALBEDO, ALT, ZU, PMB
1,37.0,12.0,19.0,507.95,2.0,2.0,0.00,
2,40.0,15.0,26.0,518.24,2.0,0.0,0.00,
3,43.0,27.0,33.0,450.32,3.0,1.0,0.00,
4,38.0,22.0,30.0,387.06,3.0,5.0,0.00,
5,43.0,23.0,28.0,508.15,3.0,2.0,0.00,
6,43.0,20.0,27.0,521.74,6.0,2.0,0.00,
7,42.0,25.0,26.0,432.90,8.0,5.0,0.00,
8,49.0,13.0,21.0,579.09,4.0,0.0,0.00,
9,49.0,18.0,24.0,554.68,6.0,0.0,0.00,
10,39.0,22.0,23.0,451.29,6.0,3.0,0.00,
11,51.0,22.0,27.0,645.44,5.0,0.0,0.00,
12,52.0,21.0,27.0,671.83,5.0,0.0,0.00,
13,33.0,25.0,28.0,287.15,6.0,5.0,0.00,
14,52.0,23.0,26.0,687.21,9.0,1.0,0.00,
15,53.0,19.0,23.0,613.40,4.0,0.0,0.00,
16,62.0,30.0,30.0,683.62,6.0,0.0,0.00,
```

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17,66.0,27.0,32.0,565.20,5.0,0.0,0.00,
18,63.0,33.0,30.0,688.70,9.0,0.0,0.00,
19,60.0,26.0,28.0,423.12,9.0,0.0,0.00,
20,63.0,34.0,26.0,547.85,9.0,0.0,0.00,
21,52.0,33.0,29.0,371.89,5.0,4.0,0.00,
22,53.0,24.0,27.0,698.94,6.0,1.0,0.00,
23,55.0,25.0,20.0,654.93,7.0,0.0,0.00,
24,59.0,24.0,24.0,648.22,7.0,0.0,0.00,
25,66.0,26.0,18.0,753.16,12.0,0.0,0.00,
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27,69.0,25.0,21.0,622.69,3.0,0.0,0.00,
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31,64.0,31.0,21.0,757.00,7.0,0.0,0.00,
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33,66.0,22.0,21.0,608.81,4.0,0.0,0.00,
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35,39.0,34.0,34.0,260.73,7.0,7.0,0.05,
36,47.0,34.0,36.0,275.50,5.0,7.0,0.04,
37,55.0,35.0,34.0,595.07,7.0,4.0,0.00,
38,62.0,28.0,31.0,530.64,8.0,4.0,0.00,
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292,69.0,53.0,41.0,275.53,5.0,6.0,0.11,
293,55.0,49.0,49.0,263.65,6.0,8.0,0.78,
294,53.0,49.0,49.0,245.58,7.0,8.0,0.48,
295,57.0,50.0,49.0,251.43,4.0,8.0,0.01,
296,62.0,50.0,50.0,232.30,7.0,7.0,0.01,
297,70.0,47.0,52.0,580.03,5.0,5.0,0.00,
298,77.0,50.0,54.0,481.01,9.0,0.0,0.00,
299,79.0,58.0,56.0,541.97,12.0,5.0,0.00,
300,64.0,48.0,56.0,505.34,8.0,7.0,1.48,
301,72.0,42.0,46.0,660.99,4.0,2.0,0.48,
302,73.0,42.0,47.0,711.42,5.0,1.0,0.35,
303,78.0,56.0,57.0,446.59,5.0,7.0,1.79,
304,62.0,46.0,51.0,450.49,11.0,6.0,0.64,
305,61.0,43.0,42.0,544.46,7.0,5.0,0.52,
306,62.0,40.0,45.0,786.37,4.0,1.0,0.20,
307,62.0,43.0,44.0,613.17,7.0,3.0,0.00,
308,49.0,44.0,45.0,242.63,6.0,8.0,0.01,
309,47.0,42.0,42.0,232.27,11.0,8.0,0.02,
310,52.0,42.0,44.0,269.56,13.0,8.0,0.00,
311,64.0,41.0,43.0,560.70,9.0,5.0,0.00,
312,75.0,36.0,39.0,659.78,8.0,0.0,0.00,
313,73.0,44.0,34.0,599.31,20.0,2.0,0.00,
314,57.0,34.0,21.0,705.16,10.0,0.0,0.00,
315,68.0,27.0,31.0,722.69,6.0,0.0,0.00,
316,60.0,38.0,38.0,414.40,5.0,1.0,0.00,
317,63.0,35.0,36.0,744.12,6.0,0.0,0.00,
318,74.0,34.0,34.0,683.39,3.0,0.0,0.00,
319,74.0,39.0,36.0,724.10,5.0,0.0,0.00,
320,74.0,37.0,34.0,733.30,5.0,0.0,0.00,
321,74.0,34.0,36.0,689.41,5.0,0.0,0.00,
322,76.0,40.0,34.0,644.84,8.0,0.0,0.00,
323,70.0,42.0,33.0,680.46,6.0,0.0,0.00,
324,48.0,35.0,34.0,373.47,5.0,0.0,0.00,
325,69.0,30.0,32.0,696.50,6.0,0.0,0.00,
326,76.0,31.0,31.0,706.83,2.0,0.0,0.00,
327,72.0,34.0,29.0,693.63,4.0,0.0,0.00,
328,76.0,31.0,32.0,587.23,4.0,0.0,0.00,
329,72.0,36.0,29.0,695.81,4.0,0.0,0.00,
330,74.0,31.0,31.0,669.59,3.0,0.0,0.00,
331,73.0,35.0,35.0,633.94,3.0,0.0,0.00,

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332,77.0,38.0,40.0,467.01,4.0,0.0,0.00,
333,57.0,40.0,46.0,310.13,7.0,4.0,0.19,
334,65.0,33.0,37.0,676.99,3.0,0.0,0.00,
335,66.0,35.0,38.0,596.67,5.0,0.0,0.10,
336,56.0,43.0,47.0,278.63,5.0,6.0,0.55,
337,61.0,41.0,44.0,393.83,5.0,2.0,0.18,
338,70.0,35.0,42.0,653.47,5.0,0.0,0.00,
339,74.0,38.0,35.0,716.01,9.0,0.0,0.00,
340,54.0,35.0,28.0,630.98,13.0,1.0,0.00,
341,46.0,28.0,27.0,601.98,10.0,1.0,0.00,
342,48.0,20.0,22.0,672.66,6.0,0.0,0.00,
343,48.0,24.0,27.0,652.61,5.0,2.0,0.00,
344,41.0,32.0,31.0,234.34,15.0,8.0,0.05,
345,46.0,28.0,28.0,629.92,6.0,1.0,0.00,
346,56.0,23.0,25.0,698.19,3.0,0.0,0.00,
347,60.0,28.0,27.0,698.11,5.0,0.0,0.00,
348,60.0,22.0,27.0,559.72,1.0,0.0,0.00,
349,56.0,28.0,29.0,650.11,6.0,0.0,0.00,
350,61.0,25.0,29.0,648.62,5.0,0.0,0.00,
351,56.0,27.0,32.0,647.42,6.0,0.0,0.00,
352,71.0,35.0,34.0,599.40,9.0,3.0,0.10,
353,46.0,30.0,34.0,269.22,9.0,3.0,0.00,
354,71.0,39.0,35.0,551.26,18.0,4.0,0.00,
355,50.0,17.0,20.0,555.88,13.0,0.0,0.00,
356,27.0,11.0,3.0,610.61,8.0,0.0,0.00,
357,32.0,14.0,8.0,404.59,5.0,0.0,0.00,
358,39.0,19.0,15.0,644.81,6.0,0.0,0.00,
359,61.0,15.0,16.0,620.94,4.0,0.0,0.00,
360,64.0,20.0,20.0,564.37,5.0,0.0,0.00,
361,69.0,31.0,22.0,494.23,6.0,0.0,0.00,
362,70.0,26.0,23.0,443.37,8.0,0.0,0.00,
363,65.0,34.0,24.0,590.53,6.0,0.0,0.00,
364,63.0,27.0,30.0,638.41,4.0,0.0,0.00,
365,52.0,36.0,34.0,514.95,12.0,0.0,0.00,
55,                                          NWATER
35,1,2,1.0,
18.0,0.13,
19.0,0.00,
36,1,2,1.0,
18.0,0.10,
19.0,0.00,
46,1,2,1.0,
18.0,0.03,
19.0,0.00,
49,1,2,1.0,
18.0,0.08,
19.0,0.00,
66,1,2,1.0,
18.0,0.13,
19.0,0.00,
74,1,2,1.0,
18.0,0.53,
19.0,0.00,
75,1,2,1.0,
18.0,1.09,
19.0,0.00,
76,1,5,1.0,
8.0,0.14,
9.0,0.02,
10.0,0.00,
18.0,0.20,
19.0,0.00,
77,1,2,1.0,
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18.0,0.03,
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89,1,2,1.0,
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19.0,0.00,
107,1,2,1.0,
18.0,0.13,
19.0,0.00,
161,1,2,1.0,
18.0,0.46,
19.0,0.00,
183,1,2,1.0,
18.0,0.43,
19.0,0.00,
185,1,2,1.0,
18.0,1.57,
19.0,0.00,
186,1,7,1.0,
8.0,0.15,
9.0,0.15,
10.0,0.15,
11.0,0.06,
12.0,0.00,
18.0,0.05,
19.0,0.00,
189,1,2,1.0,
18.0,0.51,
19.0,0.00,
190,1,2,1.0,
18.0,0.03,
19.0,0.00,
196,1,2,1.0,
18.0,0.61,
19.0,0.00,
211,1,2,1.0,
18.0,1.78,
19.0,0.00,
212,1,6,1.0,
8.0,0.14,
9.0,0.14,
10.0,0.14,
11.0,0.14,
12.0,0.13,
13.0,0.00,
214,1,2,1.0,
18.0,0.53,
19.0,0.00,
217,1,2,1.0,
18.0,0.25,
19.0,0.00,
223,1,2,1.0,
18.0,0.03,
19.0,0.00,
224,1,2,1.0,
18.0,1.75,
19.0,0.00,
225,1,8,1.0,
8.0,0.15,
9.0,0.15,
10.0,0.15,
11.0,0.15,
12.0,0.09,
13.0,0.00,
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18.0,0.10,
19.0,0.00,
231,1,2,1.0,
18.0,0.30,
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238,1,2,1.0,
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240,1,2,1.0,
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19.0,0.00,
257,1,2,1.0,
18.0,0.15,
19.0,0.00,
272,1,2,1.0,
18.0,0.33,
19.0,0.00,
273,1,2,1.0,
18.0,0.13,
19.0,0.00,
274,1,3,1.0,
18.0,2.54,
19.0,1.37,
20.0,0.00,
275,1,9,1.0,
8.0,0.17,
9.0,0.17,
10.0,0.17,
11.0,0.17,
12.0,0.17,
13.0,0.17,
14.0,0.17,
15.0,0.17,
16.0,0.00,
276,1,8,1.0,
8.0,0.16,
9.0,0.16,
10.0,0.16,
11.0,0.16,
12.0,0.16,
13.0,0.16,
14.0,0.09,
15.0,0.00,
292,1,2,1.0,
18.0,0.28,
19.0,0.00,
293,1,2,1.0,
18.0,1.98,
19.0,0.00,
294,1,10,1.0,
8.0,0.16,
9.0,0.16,
10.0,0.16,
11.0,0.16,
12.0,0.16,
13.0,0.16,
14.0,0.16,
15.0,0.00,
18.0,0.10,
19.0,0.00,
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295,1,2,1.0,
18.0,0.03,
19.0,0.00,
296,1,2,1.0,
18.0,0.03,
19.0,0.00,
300,1,3,1.0,
18.0,2.54,
19.0,1.22,
20.0,0.00,
301,1,9,1.0,
8.0,0.15,
9.0,0.15,
10.0,0.15,
11.0,0.15,
12.0,0.15,
13.0,0.15,
14.0,0.15,
15.0,0.15,
16.0,0.00,
302,1,7,1.0,
8.0,0.16,
9.0,0.16,
10.0,0.16,
11.0,0.16,
12.0,0.16,
13.0,0.11,
14.0,0.00,
303,1,3,1.0,
18.0,2.54,
19.0,2.01,
20.0,0.00,
304,1,11,1.0,
8.0,0.16,
9.0,0.16,
10.0,0.16,
11.0,0.16,
12.0,0.16,
13.0,0.16,
14.0,0.16,
15.0,0.16,
16.0,0.00,
18.0,0.38,
19.0,0.00,
305,1,9,1.0,
8.0,0.16,
9.0,0.16,
10.0,0.16,
11.0,0.16,
12.0,0.16,
13.0,0.16,
14.0,0.16,
15.0,0.16,
16.0,0.00,
306,1,5,1.0,
8.0,0.17,
9.0,0.17,
10.0,0.17,
11.0,0.01,
12.0,0.00,
308,1,2,1.0,
18.0,0.03,
19.0,0.00,

309,1,2,1.0,
18.0,0.05,
19.0,0.00,
333,1,2,1.0,
18.0,0.48,
19.0,0.00,
335,1,2,1.0,
18.0,0.25,
19.0,0.00,
336,1,2,1.0,
18.0,1.40,
19.0,0.00,
337,1,4,1.0,
8.0,0.15,
9.0,0.15,
10.0,0.15,
11.0,0.00,
344,1,2,1.0,
18.0,0.13,
19.0,0.00,
352,1,2,1.0,
18.0,0.25,
19.0,0.00,

Scenario:

1986

No Stormwater Recirculation

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Triassic Park: 1986 No Stormwater Recirculation
1,1,                                IPLANT,NGRAV
365,1,365,                          IFDEND,IDTBEG,IDTEND
1,1,0,1,1,                          IYS,NYEARS,ISTEAD,IFLIST,NFLIST
0,24.0,                             NPRINT,STOPHR
0,2,1,1.E-6,                        ISMETH,INMAX,ISWDIF,DMAXBA
1.0,1.0E-10,0.0,                    DELMAX,DELMIN,OUTTIM
1.2,1.0E-06,0.0,0.0,0.0,            RFACT,RAINIF,DHTOL,DHMAX,DHFACT
4,3,0.0,                            KOPT,KEST,WTF
0,1,1,1,                            ITOPBC,IEVOPT,NFHOUR,LOWER
0.0,1.5E+04,0.0,0.40,               HIRRI,HDRY,HTOP,RHA
1,1,1,                              IETOPT,ICLOUD,ISHOPT
1,2.54,                             IRAIN,HPR
0,0,0,0,0,                          IHYS,AIRTOL,HYSTOL,HYSMXH,HYFILE
0,0,0,                              IHEAT,ICONVH,DMAXHE
0,0,0,0,                            UPPERH,TSMEAN,TSAMP,QHCTOP
0,0.0,0.0,                          LOWERH,QHLEAK,TGRAD
1,0.66,294.0,0.24,                  IVAPOR,TORT,TSOIL,VAPDIF
2,   116,                           MATN,NPT
1,0.0, 1,0.5, 1,1.0, 1,1.5,
1,2.0, 1,2.5, 1,3.0, 1,3.5,
1,4.0, 1,4.5, 1,5.0, 1,6.0,
1,7.0, 1,8.0, 1,9.0, 1,10.0,
1,10.5, 1,11.0, 1,11.5, 1,12.0,
1,12.5, 1,13.0, 1,13.5, 1,14.0,
1,14.5, 1,15.0, 2,15.5, 2,16.0,
2,16.5, 2,17.0, 2,17.5, 2,18.0,
2,18.5, 2,19.0, 2,19.5, 2,20.0,
2,21.0, 2,22.0, 2,23.0, 2,24.0,
2,25.0, 2,30.0, 2,35.0, 2,40.0,
2,45.0, 2,50.0, 2,60.0, 2,70.0,
2,80.0, 2,90.0, 2,100.0, 2,125.0,
2,150.0, 2,175.0, 2,200.0, 2,225.0,
2,250.0, 2,260.0, 2,270.0, 2,280.0,
2,290.0, 2,295.0, 2,300.0, 2,305.0,
2,310.0, 2,311.0, 2,312.0, 2,313.0,
2,314.0, 2,315.0, 2,315.5, 2,316.0,
2,316.5, 2,317.0, 2,317.5, 2,318.0,
2,318.5, 2,319.0, 2,319.5, 1,320.0,
1,320.5, 1,321.0, 1,321.5, 1,322.0,
1,322.5, 1,323.0, 1,323.5, 1,324.0,
1,324.5, 1,325.0, 1,330.0, 1,335.0,
1,340.0, 1,345.0, 1,350.0, 1,355.0,
1,360.0, 1,365.0, 1,370.0, 1,371.0,
1,372.0, 1,373.0, 1,374.0, 1,375.0,
1,375.5, 1,376.0, 1,376.5, 1,377.0,
1,377.5, 1,378.0, 1,378.5, 1,379.0,
1,379.5, 1,380.0, 1,380.5, 1,381.0,
MAT#1: Daily cover/protective soil
0.327, 0.0277, 0.0526, 1.49,            THES,THER,ALPHA,N
SOIL CONDUCTIVITY DATA
2, 3.31, 0.0526, 1.49, 0.5,           KMOD,KSAT,ALPHA,N,EPIT
MAT#2: Waste
0.3354, 0.0319, 0.018, 1.3200,            THES,THER,ALPHA,N
SOIL CONDUCTIVITY DATA
2, 0.7367, 0.018, 1.3200, 0.5,           KMOD,KSAT,ALPHA,N,EPIT
    0,    (TOSS.OUT file for day  3.65000E+02)             NDAY
   1.62600E+03, 1.62600E+03, 1.62600E+03, 1.62600E+03,   Head Values
   1.62600E+03, 1.62600E+03, 1.62600E+03, 1.62600E+03,
   1.62600E+03, 1.62600E+03, 1.62600E+03, 1.62600E+03,
   1.62600E+03, 1.62600E+03, 1.62600E+03, 1.62600E+03,
   1.62600E+03, 1.62600E+03, 1.62600E+03, 1.62600E+03,
   1.62600E+03, 1.62600E+03, 1.62600E+03, 1.62600E+03,
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   1.62600E+03, 1.62600E+03, 1.58900E+03, 1.58900E+03,
   1.58900E+03, 1.58900E+03, 1.58900E+03, 1.58900E+03,
   1.58900E+03, 1.58900E+03, 1.58900E+03, 1.58900E+03,
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   1.62600E+03, 1.62600E+03, 1.62600E+03, 1.62600E+03,
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   1.62600E+03, 1.62600E+03, 1.62600E+03, 1.62600E+03,
   1.62600E+03, 1.62600E+03, 1.62600E+03, 1.62600E+03,
   1.62600E+03, 1.62600E+03, 1.62600E+03, 1.62600E+03,
   1, 1, 1, 1, 364, 365,       LEAF,NFROOT,NUPTAK,NFPET,NSOW,NHRVST
   1.0,                       BARE
    4,                        NDLAI
    95, 0., 125, 1.5, 271, 1.5, 301, 0.,           IDLAI,VLAI
 8.705E-01, 6.108E-02, 0.0144E+0,                  AA,B1,B2
    1, 1, 1, 1, 1, 1, 1, 1, 1, 1,                  NTROOT
    1, 1, 1, 1, 1, 1, 1, 1, 1, 1,                  NTROOT
    1, 1, 1, 1, 1, 1, 1, 1, 1, 1,                  NTROOT
    1, 1, 1, 1, 1, 1, 1, 1, 1, 1,                  NTROOT
    1, 1, 1, 1, 1, 1, 1, 1, 1, 1,                  NTROOT
    1, 1, 1, 1, 1, 1, 1, 1, 1, 1,                  NTROOT
    1, 1, 1, 1, 1, 1, 1, 1, 1, 1,                  NTROOT
    1, 1, 1, 1, 1, 1, 1, 1, 1, 1,                  NTROOT
    1, 1, 1, 1, 1, 1, 1, 1, 1, 1,                  NTROOT
    1, 1, 1, 1, 1, 1, 1, 1, 1, 1,                  NTROOT
    1, 1, 1, 1, 1, 1, 1, 1, 1, 1,                  NTROOT
    1, 1, 1, 1, 1, 1,                              NTROOT
 1.500E+04, 3.000E+03, 1.000E+0,          HW,HD,HN
 1.500E+04, 3.000E+03, 1.000E+0,          HW,HD,HN
   0.0, 0.52, 0.5, 0.1, 2.7,              PETPC(1:5)
0.01, 0.01, 0.01, 0.01, 0.01, 0.01, 0.05, 0.05,         FPET
0.05, 0.05, 0.05, 0.05, 0.06, 0.07, 0.08, 0.09,         FPET
0.08, 0.07, 0.06, 0.05, 0.05, 0.01, 0.01, 0.01,         FPET
   0.2, 1264.92, 2., 985.,                  ALBEDO, ALT, ZU, PMB

year
dat
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255,85.0,54.0,51.0,782.1,8.0,1.0,0.00,
256,83.0,61.0,59.0,347.25,6.0,7.0,0.04,
257,85.0,62.0,62.0,211.79,6.0,6.0,0.00,
258,88.0,59.0,60.0,723.92,5.0,5.0,0.00,
259,85.0,63.0,60.0,404.48,10.0,4.0,0.00,
260,91.0,58.0,54.0,786.75,6.0,1.0,0.00,
261,93.0,59.0,54.0,636.66,9.0,2.0,0.00,
262,93.0,65.0,59.0,588.98,12.0,5.0,0.00,
263,91.0,63.0,59.0,752.75,10.0,1.0,0.00,
264,90.0,63.0,61.0,533.3,8.0,4.0,0.00,
265,85.0,65.0,64.0,35.71,8.0,6.0,0.12,
266,84.0,61.0,63.0,151.12,8.0,7.0,0.29,
267,79.0,53.0,45.0,629.78,11.0,3.0,0.00,
268,83.0,51.0,39.0,856.71,9.0,0.0,0.00,
269,85.0,51.0,41.0,860.67,7.0,0.0,0.00,
270,86.0,49.0,44.0,845.35,7.0,0.0,0.00,
271,85.0,56.0,53.0,340.62,8.0,4.0,0.00,
272,86.0,59.0,51.0,366.44,9.0,4.0,0.08,
273,82.0,48.0,41.0,738.21,7.0,0.0,0.00,
274,88.0,47.0,36.0,671.77,7.0,2.0,0.00,
275,76.0,59.0,61.0,65.66,7.0,8.0,0.07,
276,82.0,56.0,50.0,662.13,6.0,2.0,0.00,
277,77.0,52.0,42.0,577.71,8.0,5.0,0.00,
278,62.0,54.0,56.0,3.36,7.0,8.0,0.13,
279,61.0,51.0,52.0,53.36,8.0,8.0,0.07,
280,74.0,50.0,52.0,764.03,5.0,4.0,0.00,
281,83.0,47.0,49.0,676.85,5.0,3.0,0.00,
282,75.0,53.0,51.0,74.35,8.0,5.0,0.59,
283,70.0,54.0,58.0,55.59,9.0,7.0,3.46,
284,64.0,43.0,45.0,3.44,8.0,7.0,0.00,
285,43.0,37.0,31.0,4.3,9.0,8.0,0.00,
286,66.0,38.0,34.0,795.87,7.0,2.0,0.00,
287,72.0,36.0,35.0,793.29,4.0,0.0,0.00,
288,72.0,39.0,38.0,766.52,5.0,3.0,0.00,
289,70.0,43.0,41.0,271.86,3.0,6.0,0.00,
290,76.0,44.0,46.0,686.23,6.0,3.0,0.18,
291,80.0,46.0,49.0,511.36,7.0,3.0,0.00,
292,63.0,57.0,54.0,49.57,9.0,8.0,0.00,
293,61.0,56.0,55.0,0.69,11.0,8.0,0.11,
294,78.0,50.0,53.0,356.37,10.0,5.0,0.87,
295,70.0,43.0,42.0,704.65,6.0,5.0,0.00,
296,66.0,46.0,47.0,396.21,7.0,7.0,0.00,
297,69.0,49.0,50.0,249.31,6.0,6.0,0.00,
298,70.0,46.0,46.0,497.85,6.0,3.0,0.00,
299,72.0,44.0,42.0,608.18,6.0,1.0,0.00,
300,77.0,43.0,38.0,586.49,6.0,2.0,0.00,
301,82.0,40.0,35.0,684.85,5.0,1.0,0.00,
302,66.0,45.0,44.0,198.11,7.0,4.0,0.00,
303,75.0,42.0,44.0,512.82,6.0,1.0,0.00,
304,80.0,47.0,46.0,547.68,8.0,2.0,0.00,
305,69.0,41.0,49.0,3.61,7.0,7.0,0.00,
306,41.0,38.0,38.0,0.95,13.0,8.0,0.70,
307,47.0,39.0,42.0,0.77,8.0,8.0,0.79,
308,50.0,36.0,37.0,140.71,12.0,6.0,0.14,
309,63.0,30.0,35.0,720.83,4.0,0.0,0.00,
310,72.0,34.0,36.0,736.14,6.0,0.0,0.00,
311,62.0,38.0,32.0,461.1,13.0,1.0,0.00,
312,65.0,33.0,27.0,740.79,6.0,0.0,0.00,
313,57.0,31.0,24.0,725.73,6.0,0.0,0.00,
314,61.0,27.0,32.0,431.93,6.0,5.0,0.00,
315,50.0,25.0,26.0,697.59,8.0,5.0,0.00,

316,43.0,26.0,25.0,4.48,8.0,7.0,0.00,
317,29.0,24.0,22.0,1.46,7.0,8.0,0.13,
318,53.0,26.0,30.0,687.69,7.0,6.0,0.00,
319,60.0,35.0,39.0,36.32,4.0,7.0,0.00,
320,71.0,40.0,40.0,148.19,4.0,8.0,0.00,
321,76.0,43.0,39.0,466.95,6.0,6.0,0.00,
322,64.0,49.0,39.0,58.18,8.0,7.0,0.00,
323,74.0,42.0,41.0,598.8,9.0,2.0,0.06,
324,61.0,39.0,33.0,740.36,8.0,1.0,0.00,
325,66.0,32.0,36.0,676.16,6.0,0.0,0.00,
326,74.0,36.0,35.0,534.51,7.0,1.0,0.00,
327,48.0,30.0,31.0,64.46,14.0,7.0,0.07,
328,52.0,24.0,23.0,722.46,4.0,0.0,0.00,
329,61.0,22.0,27.0,605.94,5.0,0.0,0.00,
330,48.0,30.0,19.0,574.61,9.0,2.0,0.00,
331,61.0,24.0,26.0,710.07,4.0,0.0,0.00,
332,67.0,26.0,26.0,561.02,5.0,0.0,0.00,
333,70.0,28.0,27.0,521.69,6.0,2.0,0.00,
334,63.0,33.0,21.0,649.23,10.0,1.0,0.00,
335,58.0,25.0,22.0,658.09,5.0,0.0,0.00,
336,66.0,23.0,20.0,720.65,4.0,0.0,0.00,
337,58.0,28.0,26.0,456.45,6.0,3.0,0.00,
338,42.0,27.0,29.0,2.67,6.0,5.0,0.00,
339,53.0,40.0,37.0,175.65,5.0,8.0,0.00,
340,53.0,44.0,45.0,1.72,11.0,8.0,0.00,
341,67.0,39.0,42.0,3.7,6.0,5.0,0.00,
342,58.0,36.0,36.0,0.09,8.0,5.0,0.15,
343,38.0,32.0,33.0,0.43,8.0,7.0,0.00,
344,32.0,25.0,24.0,81.07,9.0,8.0,0.18,
345,42.0,23.0,23.0,659.04,5.0,4.0,0.00,
346,51.0,20.0,23.0,707.4,3.0,0.0,0.00,
347,54.0,22.0,28.0,707.4,4.0,2.0,0.00,
348,58.0,26.0,31.0,701.98,5.0,3.0,0.00,
349,63.0,26.0,29.0,579.6,4.0,3.0,0.00,
350,49.0,34.0,38.0,21.08,6.0,8.0,0.08,
351,45.0,33.0,38.0,0.6,7.0,8.0,0.26,
352,41.0,32.0,31.0,126.85,8.0,6.0,0.10,
353,52.0,24.0,29.0,441.39,4.0,2.0,0.00,
354,55.0,27.0,31.0,386.66,5.0,4.0,0.00,
355,43.0,37.0,37.0,155.59,7.0,8.0,0.26,
356,37.0,33.0,33.0,1.2,9.0,8.0,0.44,
357,47.0,29.0,34.0,318.07,3.0,6.0,0.00,
358,49.0,29.0,31.0,58.18,5.0,5.0,0.00,
359,48.0,30.0,31.0,266.01,5.0,5.0,0.00,
360,53.0,27.0,27.0,692.94,4.0,0.0,0.00,
361,52.0,25.0,28.0,539.41,6.0,2.0,0.00,
362,51.0,29.0,32.0,428.57,4.0,6.0,0.00,
363,55.0,26.0,25.0,705.34,6.0,0.0,0.00,
364,59.0,22.0,23.0,506.54,6.0,0.0,0.00,
365,52.0,22.0,19.0,595.7,6.0,2.0,0.00,

Scenario:

1986

Stormwater Recirculation Every Day

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Triassic Park: 1986 Recirculation Every Day
1,1,                                IPLANT,NGRAV
365,1,365,                          IFDEND,IDTBEG,IDTEND
1,1,0,0,1,                          IYS,NYEARS,ISTEAD,IFLIST,NFLIST
0,24.0,                             NPRINT,STOPHR
0,2,1,1.E-6,                        ISMETH,INMAX,ISWDIF,DMAXBA
1.0,1.0E-10,0.0,                    DELMAX,DELMIN,OUTTIM
1.2,1.0E-06,0.0,0.0,0.0,            RFACT,RAINIF,DHTOL,DHMAX,DHFACT
4,3,0.0,                            KOPT,KEST,WTF
0,1,1,1,                            ITOPBC,IEVOPT,NFHOUR,LOWER
0.0,1.5E+04,0.0,0.40,               HIRRI,HDRY,HTOP,RHA
1,1,1,                              IETOPT,ICLOUD,ISHOPT
0,0.0,                              IRAIN,HPR
0,0,0,0,0,                          IHYS,AIRTOL,HYSTOL,HYSMXH,HYFILE
0,0,0,                              IHEAT,ICONVH,DMAXHE
0,0,0,0,                            UPPERH,TSMEAN,TSAMP,QHCTOP
0,0.0,0.0,                          LOWERH,QHLEAK,TGRAD
1,0.66,294.0,0.24,                  IVAPOR,TORT,TSOIL,VAPDIF
2,   116,                           MATN,NPT
1,0.0, 1,0.5, 1,1.0, 1,1.5,
1,2.0, 1,2.5, 1,3.0, 1,3.5,
1,4.0, 1,4.5, 1,5.0, 1,6.0,
1,7.0, 1,8.0, 1,9.0, 1,10.0,
1,10.5, 1,11.0, 1,11.5, 1,12.0,
1,12.5, 1,13.0, 1,13.5, 1,14.0,
1,14.5, 1,15.0, 2,15.5, 2,16.0,
2,16.5, 2,17.0, 2,17.5, 2,18.0,
2,18.5, 2,19.0, 2,19.5, 2,20.0,
2,21.0, 2,22.0, 2,23.0, 2,24.0,
2,25.0, 2,30.0, 2,35.0, 2,40.0,
2,45.0, 2,50.0, 2,60.0, 2,70.0,
2,80.0, 2,90.0, 2,100.0, 2,125.0,
2,150.0, 2,175.0, 2,200.0, 2,225.0,
2,250.0, 2,260.0, 2,270.0, 2,280.0,
2,290.0, 2,295.0, 2,300.0, 2,305.0,
2,310.0, 2,311.0, 2,312.0, 2,313.0,
2,314.0, 2,315.0, 2,315.5, 2,316.0,
2,316.5, 2,317.0, 2,317.5, 2,318.0,
2,318.5, 2,319.0, 2,319.5, 1,320.0,
1,320.5, 1,321.0, 1,321.5, 1,322.0,
1,322.5, 1,323.0, 1,323.5, 1,324.0,
1,324.5, 1,325.0, 1,330.0, 1,335.0,
1,340.0, 1,345.0, 1,350.0, 1,355.0,
1,360.0, 1,365.0, 1,370.0, 1,371.0,
1,372.0, 1,373.0, 1,374.0, 1,375.0,
1,375.5, 1,376.0, 1,376.5, 1,377.0,
1,377.5, 1,378.0, 1,378.5, 1,379.0,
1,379.5, 1,380.0, 1,380.5, 1,381.0,
MAT#1: Daily cover/protective soil
0.327, 0.0277, 0.0526, 1.49,            THES,THER,ALPHA,N
SOIL CONDUCTIVITY DATA
2, 3.31, 0.0526, 1.49, 0.5,           KMOD,KSAT,ALPHA,N,EPIT
MAT#2: Waste
0.3354, 0.0319, 0.018, 1.3200,            THES,THER,ALPHA,N
SOIL CONDUCTIVITY DATA
2, 0.7367, 0.018, 1.3200, 0.5,          KMOD,KSAT,ALPHA,N,EPIT
    0,     (TOSS.OUT file for day  3.65000E+02)              NDAY
   1.62600E+03, 1.62600E+03, 1.62600E+03, 1.62600E+03,   Head Values
   1.62600E+03, 1.62600E+03, 1.62600E+03, 1.62600E+03,
   1.62600E+03, 1.62600E+03, 1.62600E+03, 1.62600E+03,
   1.62600E+03, 1.62600E+03, 1.62600E+03, 1.62600E+03,
   1.62600E+03, 1.62600E+03, 1.62600E+03, 1.62600E+03,
   1.62600E+03, 1.62600E+03, 1.62600E+03, 1.62600E+03,
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   1.62600E+03, 1.62600E+03, 1.58900E+03, 1.58900E+03,
   1.58900E+03, 1.58900E+03, 1.58900E+03, 1.58900E+03,
   1.58900E+03, 1.58900E+03, 1.58900E+03, 1.58900E+03,
   1.58900E+03, 1.58900E+03, 1.58900E+03, 1.58900E+03,
   1.58900E+03, 1.58900E+03, 1.58900E+03, 1.58900E+03,
   1.58900E+03, 1.58900E+03, 1.58900E+03, 1.58900E+03,
   1.58900E+03, 1.58900E+03, 1.58900E+03, 1.58900E+03,
   1.58900E+03, 1.58900E+03, 1.58900E+03, 1.58900E+03,
   1.58900E+03, 1.58900E+03, 1.58900E+03, 1.58900E+03,
   1.58900E+03, 1.58900E+03, 1.58900E+03, 1.58900E+03,
   1.58900E+03, 1.58900E+03, 1.58900E+03, 1.58900E+03,
   1.58900E+03, 1.58900E+03, 1.58900E+03, 1.58900E+03,
   1.58900E+03, 1.58900E+03, 1.58900E+03, 1.58900E+03,
   1.58900E+03, 1.58900E+03, 1.58900E+03, 1.62600E+03,
   1.62600E+03, 1.62600E+03, 1.62600E+03, 1.62600E+03,
   1.62600E+03, 1.62600E+03, 1.62600E+03, 1.62600E+03,
   1.62600E+03, 1.62600E+03, 1.62600E+03, 1.62600E+03,
   1.62600E+03, 1.62600E+03, 1.62600E+03, 1.62600E+03,
   1.62600E+03, 1.62600E+03, 1.62600E+03, 1.62600E+03,
   1.62600E+03, 1.62600E+03, 1.62600E+03, 1.62600E+03,
   1.62600E+03, 1.62600E+03, 1.62600E+03, 1.62600E+03,
   1.62600E+03, 1.62600E+03, 1.62600E+03, 1.62600E+03,
   1.62600E+03, 1.62600E+03, 1.62600E+03, 1.62600E+03,
   1, 1, 1, 1, 364, 365,       LEAF,NFROOT,NUPTAK,NFPET,NSOW,NHRVST
   1.0,                       BARE
    4,                        NDLAI
    95, 0., 125, 1.5, 271, 1.5, 301, 0.,           IDLAI,VLAI
 8.705E-01, 6.108E-02, 0.0144E+0,                  AA,B1,B2
    1, 1, 1, 1, 1, 1, 1, 1, 1, 1,                  NTROOT
    1, 1, 1, 1, 1, 1, 1, 1, 1, 1,                  NTROOT
    1, 1, 1, 1, 1, 1, 1, 1, 1, 1,                  NTROOT
    1, 1, 1, 1, 1, 1, 1, 1, 1, 1,                  NTROOT
    1, 1, 1, 1, 1, 1, 1, 1, 1, 1,                  NTROOT
    1, 1, 1, 1, 1, 1, 1, 1, 1, 1,                  NTROOT
    1, 1, 1, 1, 1, 1, 1, 1, 1, 1,                  NTROOT
    1, 1, 1, 1, 1, 1, 1, 1, 1, 1,                  NTROOT
    1, 1, 1, 1, 1, 1, 1, 1, 1, 1,                  NTROOT
    1, 1, 1, 1, 1, 1, 1, 1, 1, 1,                  NTROOT
    1, 1, 1, 1, 1, 1, 1, 1, 1, 1,                  NTROOT
    1, 1, 1, 1, 1, 1,                              NTROOT
 1.500E+04, 3.000E+03, 1.000E+0,          HW,HD,HN
 1.500E+04, 3.000E+03, 1.000E+0,          HW,HD,HN
   0.0, 0.52, 0.5, 0.1, 2.7,              PETPC(1:5)
0.01, 0.01, 0.01, 0.01, 0.01, 0.01, 0.05, 0.05,         FPET
0.05, 0.05, 0.05, 0.05, 0.06, 0.07, 0.08, 0.09,         FPET
0.08, 0.07, 0.06, 0.05, 0.05, 0.01, 0.01, 0.01,         FPET
   0.2, 1264.9, 2., 985.,                  ALBEDO, ALT, ZU, PMB
1,65.0,33.0,32.0,642.34,7.0,2.0,0.00,
2,67.0,25.0,21.0,226.16,5.0,2.0,0.00,
3,57.0,28.0,23.0,81.33,6.0,5.0,0.00,
4,51.0,27.0,18.0,465.40,8.0,1.0,0.00,
5,49.0,22.0,16.0,456.11,8.0,5.0,0.00,
6,67.0,28.0,24.0,460.93,8.0,3.0,0.20,
7,41.0,18.0,28.0,120.14,13.0,7.0,0.47,
8,33.0,13.0,20.0,622.63,7.0,0.0,0.12,
9,38.0,13.0,17.0,678.23,6.0,0.0,0.00,
10,56.0,23.0,23.0,685.63,7.0,0.0,0.00,
11,59.0,25.0,22.0,682.53,5.0,0.0,0.00,
12,58.0,31.0,24.0,646.82,9.0,0.0,0.00,
13,60.0,27.0,27.0,663.17,5.0,0.0,0.00,
14,60.0,28.0,26.0,433.65,6.0,5.0,0.00,
15,68.0,29.0,30.0,485.37,5.0,3.0,0.00,
16,67.0,37.0,28.0,694.75,8.0,0.0,0.00,
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17,71.0,30.0,28.0,306.97,5.0,1.0,0.00,
18,62.0,37.0,28.0,410.59,10.0,2.0,0.00,
19,74.0,29.0,28.0,593.80,5.0,1.0,0.00,
20,77.0,30.0,26.0,628.14,7.0,0.0,0.00,
21,72.0,36.0,25.0,427.19,8.0,5.0,0.00,
22,52.0,30.0,19.0,425.99,8.0,5.0,0.00,
23,64.0,24.0,24.0,377.71,5.0,4.0,0.00,
24,70.0,31.0,23.0,384.17,7.0,2.0,0.00,
25,53.0,25.0,19.0,748.02,8.0,0.0,0.00,
26,55.0,21.0,17.0,623.15,7.0,1.0,0.00,
27,60.0,24.0,19.0,749.23,6.0,0.0,0.00,
28,77.0,26.0,17.0,681.33,6.0,0.0,0.00,
29,61.0,39.0,20.0,582.01,8.0,0.0,0.00,
30,71.0,27.0,23.0,545.35,7.0,0.0,0.00,
31,70.0,32.0,24.0,196.73,7.0,5.0,0.00,
32,71.0,36.0,36.0,482.62,6.0,6.0,0.00,
33,65.0,43.0,41.0,133.39,7.0,7.0,0.00,
34,68.0,34.0,25.0,601.03,8.0,0.0,0.00,
35,54.0,30.0,27.0,540.53,5.0,4.0,0.04,
36,43.0,24.0,32.0,3.18,9.0,5.0,0.00,
37,49.0,18.0,25.0,28.74,5.0,6.0,0.00,
38,41.0,23.0,27.0,392.77,12.0,7.0,0.03,
39,28.0,21.0,21.0,4.04,7.0,7.0,0.04,
40,29.0,19.0,23.0,0.86,9.0,8.0,0.31,
41,25.0,14.0,17.0,445.01,7.0,5.0,0.08,
42,28.0,21.0,24.0,257.92,6.0,8.0,0.00,
43,29.0,19.0,23.0,35.97,7.0,8.0,0.00,
44,46.0,26.0,31.0,418.93,8.0,6.0,0.00,
45,68.0,37.0,35.0,262.99,6.0,5.0,0.00,
46,78.0,39.0,33.0,83.56,8.0,6.0,0.00,
47,72.0,46.0,35.0,482.70,10.0,4.0,0.00,
48,77.0,40.0,32.0,494.23,8.0,2.0,0.00,
49,82.0,42.0,34.0,300.95,7.0,5.0,0.00,
50,84.0,42.0,29.0,272.20,7.0,7.0,0.00,
51,79.0,47.0,27.0,508.00,9.0,6.0,0.00,
52,61.0,33.0,27.0,693.29,8.0,5.0,0.00,
53,69.0,34.0,16.0,725.47,8.0,1.0,0.00,
54,78.0,32.0,19.0,513.60,6.0,3.0,0.00,
55,77.0,42.0,27.0,566.44,6.0,2.0,0.00,
56,85.0,39.0,30.0,715.66,6.0,0.0,0.00,
57,85.0,45.0,24.0,741.82,8.0,1.0,0.00,
58,61.0,43.0,25.0,245.18,11.0,2.0,0.00,
59,65.0,34.0,22.0,725.56,7.0,1.0,0.00,
60,81.0,31.0,22.0,792.08,5.0,0.0,0.00,
61,77.0,44.0,23.0,458.61,8.0,5.0,0.00,
62,67.0,49.0,30.0,288.90,9.0,6.0,0.00,
63,69.0,36.0,28.0,798.97,7.0,0.0,0.00,
64,72.0,38.0,23.0,767.99,9.0,0.0,0.00,
65,78.0,34.0,25.0,861.36,8.0,0.0,0.00,
66,68.0,43.0,25.0,409.12,8.0,3.0,0.00,
67,81.0,35.0,26.0,374.18,7.0,4.0,0.00,
68,76.0,51.0,22.0,401.03,13.0,4.0,0.00,
69,72.0,39.0,21.0,102.50,9.0,5.0,0.00,
70,63.0,47.0,32.0,264.72,10.0,7.0,0.00,
71,63.0,44.0,24.0,204.99,13.0,5.0,0.00,
72,59.0,35.0,30.0,73.06,7.0,4.0,0.00,
73,52.0,35.0,37.0,72.03,8.0,7.0,0.04,
74,68.0,34.0,23.0,656.88,9.0,0.0,0.00,
75,74.0,31.0,19.0,752.58,8.0,3.0,0.00,
76,68.0,40.0,20.0,665.83,11.0,2.0,0.00,
77,57.0,32.0,28.0,105.85,8.0,5.0,0.02,
78,56.0,39.0,25.0,523.41,7.0,5.0,0.05,
79,59.0,34.0,30.0,624.78,8.0,3.0,0.01,

80,72.0,30.0,23.0,881.41,7.0,0.0,0.00,
81,80.0,35.0,18.0,826.33,8.0,0.0,0.00,
82,81.0,36.0,15.0,754.91,7.0,0.0,0.00,
83,82.0,40.0,23.0,458.09,9.0,3.0,0.00,
84,83.0,42.0,30.0,549.40,11.0,1.0,0.00,
85,77.0,45.0,33.0,902.84,9.0,0.0,0.00,
86,78.0,45.0,41.0,815.15,8.0,0.0,0.00,
87,82.0,44.0,34.0,909.64,8.0,0.0,0.00,
88,80.0,50.0,39.0,521.26,7.0,7.0,0.00,
89,85.0,48.0,35.0,623.32,7.0,2.0,0.00,
90,88.0,49.0,28.0,675.04,6.0,4.0,0.00,
91,72.0,51.0,36.0,324.70,11.0,5.0,0.00,
92,80.0,47.0,34.0,583.99,12.0,1.0,0.00,
93,68.0,46.0,21.0,301.72,11.0,3.0,0.00,
94,74.0,40.0,24.0,929.95,7.0,0.0,0.00,
95,79.0,41.0,22.0,562.13,6.0,4.0,0.00,
96,85.0,49.0,37.0,201.03,7.0,7.0,0.00,
97,92.0,57.0,35.0,257.23,8.0,6.0,0.00,
98,82.0,51.0,38.0,142.17,8.0,6.0,0.31,
99,68.0,46.0,42.0,308.35,8.0,6.0,0.00,
100,79.0,40.0,37.0,546.47,7.0,3.0,0.00,
101,81.0,51.0,24.0,560.41,10.0,4.0,0.00,
102,85.0,50.0,26.0,723.49,8.0,2.0,0.00,
103,86.0,57.0,26.0,873.92,12.0,4.0,0.00,
104,76.0,39.0,14.0,644.15,10.0,4.0,0.00,
105,79.0,47.0,25.0,794.32,7.0,3.0,0.00,
106,83.0,48.0,38.0,416.01,8.0,4.0,0.00,
107,82.0,54.0,34.0,887.87,17.0,1.0,0.00,
108,77.0,42.0,14.0,792.00,11.0,3.0,0.00,
109,62.0,41.0,30.0,150.86,14.0,3.0,0.00,
110,77.0,37.0,28.0,528.92,7.0,2.0,0.00,
111,81.0,44.0,31.0,826.51,7.0,0.0,0.00,
112,87.0,48.0,36.0,688.64,9.0,3.0,0.00,
113,87.0,50.0,31.0,649.05,10.0,5.0,0.00,
114,88.0,51.0,31.0,697.93,9.0,4.0,0.00,
115,84.0,59.0,38.0,558.43,10.0,6.0,0.00,
116,85.0,57.0,35.0,484.60,14.0,6.0,0.00,
117,76.0,49.0,13.0,935.37,15.0,1.0,0.00,
118,88.0,45.0,17.0,635.20,8.0,6.0,0.00,
119,86.0,58.0,39.0,592.69,9.0,4.0,0.00,
120,91.0,60.0,38.0,613.17,7.0,5.0,0.00,
121,85.0,54.0,49.0,666.09,8.0,2.0,0.00,
122,83.0,62.0,49.0,347.85,11.0,7.0,0.00,
123,85.0,59.0,49.0,601.81,11.0,5.0,0.00,
124,92.0,59.0,44.0,704.22,13.0,4.0,0.00,
125,90.0,51.0,24.0,998.28,9.0,0.0,0.00,
126,89.0,52.0,18.0,847.07,11.0,0.0,0.00,
127,87.0,56.0,20.0,792.00,12.0,1.0,0.00,
128,75.0,51.0,17.0,946.47,10.0,1.0,0.00,
129,82.0,43.0,14.0,665.15,7.0,1.0,0.00,
130,85.0,50.0,20.0,711.79,9.0,0.0,0.00,
131,92.0,49.0,17.0,977.37,7.0,2.0,0.00,
132,93.0,63.0,15.0,793.20,10.0,2.0,0.00,
133,88.0,52.0,27.0,746.64,9.0,3.0,0.00,
134,89.0,57.0,19.0,594.84,7.0,1.0,0.00,
135,92.0,55.0,15.0,367.99,10.0,1.0,0.00,
136,89.0,54.0,24.0,573.15,9.0,3.0,0.00,
137,57.0,43.0,40.0,4.99,18.0,6.0,0.27,
138,74.0,38.0,36.0,913.08,6.0,0.0,0.00,
139,86.0,47.0,29.0,681.76,9.0,0.0,0.00,
140,94.0,53.0,28.0,821.00,11.0,1.0,0.00,
141,97.0,56.0,31.0,673.92,10.0,4.0,0.00,
142,94.0,61.0,28.0,404.22,9.0,5.0,0.00,

143,84.0,56.0,40.0,474.35,9.0,6.0,0.00,
144,93.0,62.0,48.0,94.15,7.0,7.0,0.00,
145,79.0,59.0,57.0,133.56,8.0,8.0,0.02,
146,77.0,57.0,54.0,214.97,8.0,7.0,0.07,
147,73.0,55.0,44.0,612.74,8.0,6.0,0.01,
148,82.0,52.0,43.0,365.32,7.0,3.0,0.00,
149,80.0,55.0,53.0,1.38,7.0,6.0,0.06,
150,77.0,54.0,54.0,197.76,9.0,6.0,0.51,
151,69.0,57.0,57.0,3.18,6.0,6.0,0.34,
152,77.0,53.0,54.0,249.05,6.0,2.0,0.02,
153,79.0,60.0,57.0,173.15,7.0,6.0,0.00,
154,79.0,59.0,58.0,525.99,6.0,7.0,0.00,
155,89.0,62.0,57.0,445.35,7.0,4.0,0.01,
156,89.0,60.0,57.0,606.20,6.0,3.0,0.00,
157,97.0,63.0,51.0,927.97,7.0,2.0,0.00,
158,100.0,64.0,50.0,626.33,9.0,3.0,0.00,
159,87.0,61.0,59.0,622.20,11.0,6.0,0.36,
160,90.0,61.0,51.0,650.00,10.0,4.0,0.00,
161,90.0,58.0,37.0,741.14,7.0,1.0,0.00,
162,83.0,58.0,46.0,874.10,10.0,0.0,0.00,
163,92.0,60.0,48.0,989.16,6.0,0.0,0.00,
164,93.0,62.0,48.0,948.11,9.0,3.0,0.00,
165,96.0,65.0,49.0,665.32,9.0,2.0,0.00,
166,99.0,65.0,49.0,1003.10,10.0,1.0,0.00,
167,102.0,67.0,47.0,864.97,9.0,3.0,0.00,
168,92.0,66.0,49.0,888.38,9.0,3.0,0.00,
169,93.0,63.0,57.0,423.49,6.0,5.0,0.94,
170,89.0,65.0,62.0,416.27,9.0,7.0,0.53,
171,90.0,65.0,60.0,369.97,8.0,5.0,0.00,
172,91.0,63.0,60.0,666.78,7.0,5.0,0.00,
173,90.0,66.0,63.0,129.43,9.0,5.0,0.00,
174,68.0,63.0,62.0,16.95,7.0,8.0,1.04,
175,74.0,63.0,63.0,88.04,8.0,8.0,1.89,
176,78.0,64.0,64.0,175.39,8.0,8.0,1.54,
177,82.0,65.0,63.0,435.89,7.0,7.0,0.49,
178,87.0,65.0,64.0,734.68,4.0,5.0,0.45,
179,94.0,66.0,63.0,769.28,6.0,2.0,0.00,
180,94.0,68.0,65.0,604.82,5.0,5.0,0.00,
181,96.0,69.0,65.0,657.49,6.0,5.0,0.00,
182,92.0,66.0,64.0,142.00,11.0,6.0,0.66,
183,78.0,66.0,64.0,503.18,6.0,7.0,0.45,
184,85.0,68.0,66.0,640.96,5.0,6.0,0.02,
185,92.0,68.0,63.0,825.47,10.0,4.0,0.00,
186,93.0,68.0,63.0,716.18,6.0,2.0,0.00,
187,89.0,66.0,62.0,780.90,9.0,3.0,0.00,
188,89.0,69.0,62.0,576.68,8.0,3.0,0.00,
189,90.0,66.0,59.0,744.75,7.0,3.0,0.00,
190,90.0,66.0,59.0,556.97,7.0,4.0,0.10,
191,91.0,68.0,60.0,503.10,7.0,7.0,0.01,
192,97.0,66.0,58.0,718.16,6.0,3.0,0.00,
193,98.0,66.0,58.0,965.23,8.0,1.0,0.00,
194,93.0,67.0,60.0,676.08,11.0,3.0,0.00,
195,86.0,67.0,61.0,621.94,10.0,5.0,0.00,
196,88.0,65.0,58.0,650.86,11.0,2.0,0.00,
197,92.0,66.0,57.0,704.82,11.0,2.0,0.00,
198,91.0,64.0,57.0,614.89,7.0,3.0,0.02,
199,91.0,65.0,57.0,782.53,8.0,2.0,0.00,
200,94.0,62.0,54.0,843.55,6.0,1.0,0.00,
201,92.0,64.0,55.0,687.52,8.0,1.0,0.00,
202,86.0,67.0,58.0,540.28,7.0,5.0,0.02,
203,86.0,67.0,57.0,378.83,8.0,6.0,0.00,
204,91.0,65.0,58.0,762.39,7.0,5.0,0.06,
205,94.0,65.0,54.0,753.44,7.0,4.0,0.00,

206,98.0,65.0,54.0,945.61,5.0,1.0,0.00,
207,100.0,64.0,51.0,729.09,6.0,1.0,0.00,
208,101.0,68.0,50.0,510.07,7.0,1.0,0.00,
209,100.0,67.0,51.0,934.17,7.0,2.0,0.00,
210,99.0,65.0,47.0,805.68,7.0,0.0,0.00,
211,100.0,65.0,47.0,908.95,7.0,0.0,0.00,
212,98.0,64.0,47.0,495.09,7.0,1.0,0.00,
213,98.0,66.0,46.0,597.25,3.0,1.0,0.00,
214,98.0,67.0,51.0,559.64,9.0,3.0,0.08,
215,89.0,65.0,60.0,633.56,11.0,4.0,0.16,
216,91.0,64.0,61.0,707.92,9.0,4.0,0.12,
217,94.0,65.0,59.0,910.76,7.0,3.0,0.00,
218,95.0,67.0,57.0,398.54,6.0,4.0,0.04,
219,96.0,68.0,58.0,720.14,7.0,6.0,0.00,
220,91.0,68.0,59.0,511.27,7.0,5.0,0.00,
221,92.0,64.0,59.0,599.74,5.0,4.0,0.00,
222,90.0,67.0,58.0,557.06,7.0,4.0,0.00,
223,90.0,65.0,61.0,652.15,5.0,3.0,0.00,
224,92.0,66.0,60.0,588.73,7.0,3.0,0.00,
225,95.0,71.0,62.0,477.45,10.0,7.0,0.01,
226,92.0,70.0,61.0,233.91,6.0,6.0,0.00,
227,94.0,71.0,62.0,590.96,7.0,3.0,0.00,
228,96.0,67.0,61.0,782.79,5.0,3.0,0.00,
229,98.0,69.0,55.0,678.92,6.0,3.0,0.00,
230,97.0,67.0,52.0,825.04,5.0,3.0,0.00,
231,98.0,67.0,50.0,698.02,6.0,1.0,0.00,
232,103.0,66.0,44.0,709.21,6.0,0.0,0.00,
233,94.0,73.0,58.0,459.12,9.0,6.0,0.00,
234,92.0,66.0,63.0,414.46,9.0,6.0,0.59,
235,82.0,66.0,61.0,349.74,8.0,7.0,0.33,
236,85.0,64.0,61.0,394.66,5.0,6.0,0.00,
237,86.0,61.0,59.0,689.50,7.0,5.0,0.00,
238,89.0,65.0,62.0,354.56,9.0,5.0,0.85,
239,80.0,66.0,64.0,216.35,10.0,7.0,0.85,
240,68.0,62.0,61.0,27.11,9.0,8.0,0.27,
241,78.0,63.0,63.0,387.69,8.0,8.0,0.03,
242,85.0,65.0,64.0,612.13,11.0,5.0,0.11,
243,89.0,65.0,63.0,272.46,11.0,5.0,0.29,
244,84.0,63.0,62.0,294.15,7.0,5.0,0.74,
245,82.0,60.0,62.0,622.72,9.0,7.0,2.05,
246,80.0,63.0,62.0,449.05,8.0,5.0,0.45,
247,87.0,61.0,59.0,221.08,6.0,4.0,1.38,
248,82.0,57.0,58.0,632.53,6.0,1.0,0.45,
249,84.0,62.0,61.0,654.30,5.0,5.0,0.16,
250,79.0,62.0,59.0,67.81,9.0,5.0,0.02,
251,77.0,61.0,59.0,425.39,11.0,6.0,0.00,
252,87.0,63.0,62.0,652.84,11.0,6.0,0.00,
253,89.0,68.0,55.0,582.53,10.0,4.0,0.00,
254,81.0,56.0,44.0,880.90,8.0,0.0,0.00,
255,85.0,54.0,51.0,782.10,8.0,1.0,0.00,
256,83.0,61.0,59.0,347.25,6.0,7.0,0.04,
257,85.0,62.0,62.0,211.79,6.0,6.0,0.00,
258,88.0,59.0,60.0,723.92,5.0,5.0,0.00,
259,85.0,63.0,60.0,404.48,10.0,4.0,0.00,
260,91.0,58.0,54.0,786.75,6.0,1.0,0.00,
261,93.0,59.0,54.0,636.66,9.0,2.0,0.00,
262,93.0,65.0,59.0,588.98,12.0,5.0,0.00,
263,91.0,63.0,59.0,752.75,10.0,1.0,0.00,
264,90.0,63.0,61.0,533.30,8.0,4.0,0.00,
265,85.0,65.0,64.0,35.71,8.0,6.0,0.12,
266,84.0,61.0,63.0,151.12,8.0,7.0,0.29,
267,79.0,53.0,45.0,629.78,11.0,3.0,0.00,
268,83.0,51.0,39.0,856.71,9.0,0.0,0.00,

269,85.0,51.0,41.0,860.67,7.0,0.0,0.00,
270,86.0,49.0,44.0,845.35,7.0,0.0,0.00,
271,85.0,56.0,53.0,340.62,8.0,4.0,0.00,
272,86.0,59.0,51.0,366.44,9.0,4.0,0.08,
273,82.0,48.0,41.0,738.21,7.0,0.0,0.00,
274,88.0,47.0,36.0,671.77,7.0,2.0,0.00,
275,76.0,59.0,61.0,65.66,7.0,8.0,0.07,
276,82.0,56.0,50.0,662.13,6.0,2.0,0.00,
277,77.0,52.0,42.0,577.71,8.0,5.0,0.00,
278,62.0,54.0,56.0,3.36,7.0,8.0,0.13,
279,61.0,51.0,52.0,53.36,8.0,8.0,0.07,
280,74.0,50.0,52.0,764.03,5.0,4.0,0.00,
281,83.0,47.0,49.0,676.85,5.0,3.0,0.00,
282,75.0,53.0,51.0,74.35,8.0,5.0,0.59,
283,70.0,54.0,58.0,55.59,9.0,7.0,3.65,
284,64.0,43.0,45.0,3.44,8.0,7.0,0.45,
285,43.0,37.0,31.0,4.30,9.0,8.0,0.45,
286,66.0,38.0,34.0,795.87,7.0,2.0,0.45
287,72.0,36.0,35.0,793.29,4.0,0.0,0.45,
288,72.0,39.0,38.0,766.52,5.0,3.0,0.27,
289,70.0,43.0,41.0,271.86,3.0,6.0,0.00,
290,76.0,44.0,46.0,686.23,6.0,3.0,0.18,
291,80.0,46.0,49.0,511.36,7.0,3.0,0.00,
292,63.0,57.0,54.0,49.57,9.0,8.0,0.00,
293,61.0,56.0,55.0,0.69,11.0,8.0,0.11,
294,78.0,50.0,53.0,356.37,10.0,5.0,0.87,
295,70.0,43.0,42.0,704.65,6.0,5.0,0.45,
296,66.0,46.0,47.0,396.21,7.0,7.0,0.02,
297,69.0,49.0,50.0,249.31,6.0,6.0,0.00,
298,70.0,46.0,46.0,497.85,6.0,3.0,0.00,
299,72.0,44.0,42.0,608.18,6.0,1.0,0.00,
300,77.0,43.0,38.0,586.49,6.0,2.0,0.00,
301,82.0,40.0,35.0,684.85,5.0,1.0,0.00,
302,66.0,45.0,44.0,198.11,7.0,4.0,0.00,
303,75.0,42.0,44.0,512.82,6.0,1.0,0.00,
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305,69.0,41.0,49.0,3.61,7.0,7.0,0.00,
306,41.0,38.0,38.0,0.95,13.0,8.0,0.70,
307,47.0,39.0,42.0,0.77,8.0,8.0,1.11,
308,50.0,36.0,37.0,140.71,12.0,6.0,0.56,
309,63.0,30.0,35.0,720.83,4.0,0.0,0.00,
310,72.0,34.0,36.0,736.14,6.0,0.0,0.00,
311,62.0,38.0,32.0,461.10,13.0,1.0,0.00,
312,65.0,33.0,27.0,740.79,6.0,0.0,0.00,
313,57.0,31.0,24.0,725.73,6.0,0.0,0.00,
314,61.0,27.0,32.0,431.93,6.0,5.0,0.00,
315,50.0,25.0,26.0,697.59,8.0,5.0,0.00,
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318,53.0,26.0,30.0,687.69,7.0,6.0,0.00,
319,60.0,35.0,39.0,36.32,4.0,7.0,0.00,
320,71.0,40.0,40.0,148.19,4.0,8.0,0.00,
321,76.0,43.0,39.0,466.95,6.0,6.0,0.00,
322,64.0,49.0,39.0,58.18,8.0,7.0,0.00,
323,74.0,42.0,41.0,598.80,9.0,2.0,0.06,
324,61.0,39.0,33.0,740.36,8.0,1.0,0.00,
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326,74.0,36.0,35.0,534.51,7.0,1.0,0.00,
327,48.0,30.0,31.0,64.46,14.0,7.0,0.07,
328,52.0,24.0,23.0,722.46,4.0,0.0,0.00,
329,61.0,22.0,27.0,605.94,5.0,0.0,0.00,
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331,61.0,24.0,26.0,710.07,4.0,0.0,0.00,

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335,58.0,25.0,22.0,658.09,5.0,0.0,0.00,
336,66.0,23.0,20.0,720.65,4.0,0.0,0.00,
337,58.0,28.0,26.0,456.45,6.0,3.0,0.00,
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340,53.0,44.0,45.0,1.72,11.0,8.0,0.00,
341,67.0,39.0,42.0,3.70,6.0,5.0,0.00,
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347,54.0,22.0,28.0,707.40,4.0,2.0,0.00,
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7,1,2,1.0,
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8,1,3,1.0,
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9.0,0.1530,
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40,1,2,1.0,
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73,1,2,1.0,
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79,1,2,1.0,
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19.0,0.0000,
98,1,2,1.0,
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137,1,2,1.0,
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145,1,2,1.0,
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146,1,2,1.0,
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147,1,2,1.0,
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149,1,2,1.0,
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150,1,2,1.0,
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151,1,5,1.0,
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9.0,0.0898,
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155,1,2,1.0,
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159,1,2,1.0,
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19.0,0.0000,
169,1,2,1.0,
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19.0,0.0000,
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272,1,2,1.0,
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306,1,2,1.0,
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19.0,0.0000,
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9.0,0.1597,
10.0,0.1597,
11.0,0.1597,
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342,1,2,1.0,
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344,1,2,1.0,
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350,1,2,1.0,
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356,1,2,1.0,
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8.0,0.1776,
9.0,0.0601,
10.0,0.0000,
```

Scenario:

1986

Stormwater Recirculation Alternating Days

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TriassicPark: 1986 Recirculation Alternating Days
1,1,                            IPLANT,NGRAV
365,1,365,                      IFDEND,IDTBEG,IDTEND
1,1,0,0,1,                      IYS,NYEARS,ISTEAD,IFLIST,NFLIST
0,24.0,                         NPRINT,STOPHR
0,2,1,1.E-6,                    ISMETH,INMAX,ISWDIF,DMAXBA
1.0,1.0E-10,0.0,                DELMAX,DELMIN,OUTTIM
1.2,1.0E-06,0.0,0.0,0.0,        RFACT,RAINIF,DHTOL,DHMAX,DHFACT
4,3,0.0,                        KOPT,KEST,WTF
0,1,1,1,                        ITOPBC,IEVOPT,NFHOUR,LOWER
0.0,1.5E+04,0.0,0.40,           HIRRI,HDRY,HTOP,RHA
1,1,1,                          IETOPT,ICLOUD,ISHOPT
0,0.0,                          IRAIN,HPR
0,0,0,0,0,                      IHYS,AIRTOL,HYSTOL,HYSMXH,HYFILE
0,0,0,                          IHEAT,ICONVH,DMAXHE
0,0,0,0,                        UPPERH,TSMEAN,TSAMP,QHCTOP
0,0.0,0.0,                      LOWERH,QHLEAK,TGRAD
1,0.66,294.0,0.24,              IVAPOR,TORT,TSOIL,VAPDIF
2,   116,                       MATN,NPT
1,0.0, 1,0.5, 1,1.0, 1,1.5,
1,2.0, 1,2.5, 1,3.0, 1,3.5,
1,4.0, 1,4.5, 1,5.0, 1,6.0,
1,7.0, 1,8.0, 1,9.0, 1,10.0,
1,10.5, 1,11.0, 1,11.5, 1,12.0,
1,12.5, 1,13.0, 1,13.5, 1,14.0,
1,14.5, 1,15.0, 2,15.5, 2,16.0,
2,16.5, 2,17.0, 2,17.5, 2,18.0,
2,18.5, 2,19.0, 2,19.5, 2,20.0,
2,21.0, 2,22.0, 2,23.0, 2,24.0,
2,25.0, 2,30.0, 2,35.0, 2,40.0,
2,45.0, 2,50.0, 2,60.0, 2,70.0,
2,80.0, 2,90.0, 2,100.0, 2,125.0,
2,150.0, 2,175.0, 2,200.0, 2,225.0,
2,250.0, 2,260.0, 2,270.0, 2,280.0,
2,290.0, 2,295.0, 2,300.0, 2,305.0,
2,310.0, 2,311.0, 2,312.0, 2,313.0,
2,314.0, 2,315.0, 2,315.5, 2,316.0,
2,316.5, 2,317.0, 2,317.5, 2,318.0,
2,318.5, 2,319.0, 2,319.5, 1,320.0,
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1,340.0, 1,345.0, 1,350.0, 1,355.0,
1,360.0, 1,365.0, 1,370.0, 1,371.0,
1,372.0, 1,373.0, 1,374.0, 1,375.0,
1,375.5, 1,376.0, 1,376.5, 1,377.0,
1,377.5, 1,378.0, 1,378.5, 1,379.0,
1,379.5, 1,380.0, 1,380.5, 1,381.0,
MAT#1: Daily cover/protective soil
0.327, 0.0277, 0.0526, 1.49,            THES,THER,ALPHA,N
SOIL CONDUCTIVITY DATA
2, 3.31, 0.0526, 1.49, 0.5,           KMOD,KSAT,ALPHA,N,EPIT
MAT#2: Waste
0.3354, 0.0319, 0.018, 1.3200,            THES,THER,ALPHA,N
SOIL CONDUCTIVITY DATA
2, 0.7367, 0.018, 1.3200, 0.5,           KMOD,KSAT,ALPHA,N,EPIT
    0,     (TOSS.OUT file for day  3.65000E+02)              NDAY
   1.62600E+03, 1.62600E+03, 1.62600E+03, 1.62600E+03,   Head Values
   1.62600E+03, 1.62600E+03, 1.62600E+03, 1.62600E+03,
   1.62600E+03, 1.62600E+03, 1.62600E+03, 1.62600E+03,
   1.62600E+03, 1.62600E+03, 1.62600E+03, 1.62600E+03,
   1.62600E+03, 1.62600E+03, 1.62600E+03, 1.62600E+03,
   1.62600E+03, 1.62600E+03, 1.62600E+03, 1.62600E+03,
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   1.62600E+03, 1.62600E+03, 1.58900E+03, 1.58900E+03,
   1.58900E+03, 1.58900E+03, 1.58900E+03, 1.58900E+03,
   1.58900E+03, 1.58900E+03, 1.58900E+03, 1.58900E+03,
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   1.62600E+03, 1.62600E+03, 1.62600E+03, 1.62600E+03,
   1.62600E+03, 1.62600E+03, 1.62600E+03, 1.62600E+03,
   1, 1, 1, 1, 364, 365,       LEAF,NFROOT,NUPTAK,NFPET,NSOW,NHRVST
   1.0,                       BARE
    4,                        NDLAI
    95, 0., 125, 1.5, 271, 1.5, 301, 0.,            IDLAI,VLAI
 8.705E-01, 6.108E-02, 0.0144E+0,                   AA,B1,B2
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    1, 1, 1, 1, 1, 1, 1, 1, 1, 1,                   NTROOT
    1, 1, 1, 1, 1, 1, 1, 1, 1, 1,                   NTROOT
    1, 1, 1, 1, 1, 1, 1, 1, 1, 1,                   NTROOT
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    1, 1, 1, 1, 1, 1, 1, 1, 1, 1,                   NTROOT
    1, 1, 1, 1, 1, 1, 1, 1, 1, 1,                   NTROOT
    1, 1, 1, 1, 1, 1,                               NTROOT
 1.500E+04, 3.000E+03, 1.000E+0,          HW,HD,HN
 1.500E+04, 3.000E+03, 1.000E+0,          HW,HD,HN
   0.0, 0.52, 0.5, 0.1, 2.7,              PETPC(1:5)
0.01, 0.01, 0.01, 0.01, 0.01, 0.01, 0.05, 0.05,         FPET
0.05, 0.05, 0.05, 0.05, 0.06, 0.07, 0.08, 0.09,         FPET
0.08, 0.07, 0.06, 0.05, 0.05, 0.01, 0.01, 0.01,         FPET
   0.2, 1264.9, 2., 985.,                  ALBEDO, ALT, ZU, PMB
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3,57.0,28.0,23.0,81.33,6.0,5.0,0.00,
4,51.0,27.0,18.0,465.40,8.0,1.0,0.00,
5,49.0,22.0,16.0,456.11,8.0,5.0,0.00,
6,67.0,28.0,24.0,460.93,8.0,3.0,0.20,
7,41.0,18.0,28.0,120.14,13.0,7.0,0.47,
8,33.0,13.0,20.0,622.63,7.0,0.0,0.00,
9,38.0,13.0,17.0,678.23,6.0,0.0,0.10,
10,56.0,23.0,23.0,685.63,7.0,0.0,0.00,
11,59.0,25.0,22.0,682.53,5.0,0.0,0.00,
12,58.0,31.0,24.0,646.82,9.0,0.0,0.00,
13,60.0,27.0,27.0,663.17,5.0,0.0,0.00,
14,60.0,28.0,26.0,433.65,6.0,5.0,0.00,
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171,90.0,65.0,60.0,369.97,8.0,5.0,0.45,
172,91.0,63.0,60.0,666.78,7.0,5.0,0.00,
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177,82.0,65.0,63.0,435.89,7.0,7.0,0.55,
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Appendix C

Model Output Files

Scenario:

1998

Stormwater Recirculation Every Day

Scenario: 1998 Stormwater Recirculation Every Day

Day	Water (cm3/cm3)	Head (cm)	Water Flow (cm)	Water Flow (cm) Accum	Plant Sink (cm)	Prestor	Infil	Infil Accum	Runoff	Runoff Accum	Evapo	Evapo Accum	Trans	Trans Accum	Drain	Drain Accum	Newstor
1	0.06152	1626	5.03685E-06	5.03685E-06	0	45.9313	0	0	0	0	0.0284	0.0284	0	0	0	0	45.9029
2	0.06152	1626	5.03685E-06	1.00737E-05	0	45.903	0	0	0	0	0.0031	0.0315	0	0	0	0	45.8999
3	0.06152	1626	5.03685E-06	1.51106E-05	0	45.8999	0	0	0	0	0.0055	0.037	0	0	0	0	45.8944
4	0.06152	1626	5.03685E-06	2.01474E-05	0	45.8944	0	0	0	0	0	0.037	0	0	0	0	45.8944
5	0.06152	1626	5.03685E-06	2.51843E-05	0	45.8944	0	0	0	0	0.0139	0.0509	0	0	0	0	45.8805
6	0.06152	1626	5.03685E-06	3.02211E-05	0	45.8805	0	0	0	0	0.0075	0.0584	0	0	0	0	45.873
7	0.06152	1626	5.03685E-06	3.5258E-05	0	45.873	0	0	0	0	0.011	0.0694	0	0	0	0	45.862
8	0.06152	1626	5.03685E-06	4.02948E-05	0	45.862	0	0	0	0	0.0117	0.0811	0	0	0	0	45.8503
9	0.06152	1626	5.03685E-06	4.53317E-05	0	45.8503	0	0	0	0	0.009	0.0901	0	0	0	0	45.8413
10	0.06152	1626	5.03685E-06	5.03685E-05	0	45.8414	0	0	0	0	0.0066	0.0967	0	0	0	0	45.8348
11	0.06152	1626	5.03685E-06	5.54054E-05	0	45.8348	0	0	0	0	0.0079	0.1046	0	0	0	0	45.8269
12	0.06152	1626	5.03685E-06	6.04422E-05	0	45.8269	0	0	0	0	0.0072	0.1118	0	0	0	0	45.8197
13	0.06152	1626	5.03685E-06	6.54791E-05	0	45.8197	0	0	0	0	0	0.1118	0	0	0	0	45.8197
14	0.06152	1626	5.03685E-06	7.05159E-05	0	45.8197	0	0	0	0	0.0108	0.1226	0	0	0	0	45.8089
15	0.06152	1626	5.03685E-06	7.55528E-05	0	45.809	0	0	0	0	0.0084	0.131	0	0	0	0	45.8006
16	0.06152	1626	5.03685E-06	8.05896E-05	0	45.8006	0	0	0	0	0.0087	0.1397	0	0	0	0	45.7919
17	0.06152	1626	5.03685E-06	8.56265E-05	0	45.7919	0	0	0	0	0.0072	0.1469	0	0	0	0	45.7847
18	0.06152	1626	5.03685E-06	9.06633E-05	0	45.7847	0	0	0	0	0.0085	0.1554	0	0	0	0	45.7762
19	0.06152	1626	5.03685E-06	9.57002E-05	0	45.7762	0	0	0	0	0.0066	0.162	0	0	0	0	45.7696
20	0.06152	1626	5.03685E-06	0.000100737	0	45.7696	0	0	0	0	0.0094	0.1714	0	0	0	0	45.7602
21	0.06152	1626	5.03685E-06	0.000105774	0	45.7602	0	0	0	0	0.0048	0.1762	0	0	0	0	45.7554
22	0.06152	1626	5.03685E-06	0.000110811	0	45.7554	0	0	0	0	0.0046	0.1808	0	0	0	0	45.7508
23	0.06152	1626	5.03685E-06	0.000115848	0	45.7508	0	0	0	0	0.0086	0.1894	0	0	0	0	45.7421
24	0.06152	1626	5.03685E-06	0.000120884	0	45.7421	0	0	0	0	0.0058	0.1952	0	0	0	0	45.7363
25	0.06152	1626	5.03685E-06	0.000125921	0	45.7363	0	0	0	0	0.0091	0.2043	0	0	0	0	45.7272
26	0.06152	1626	5.03685E-06	0.000130958	0	45.7272	0	0	0	0	0.007	0.2113	0	0	0	0	45.7202
27	0.06152	1626	5.03685E-06	0.000135995	0	45.7202	0	0	0	0	0.0076	0.2189	0	0	0	0	45.7126
28	0.06152	1626	5.03685E-06	0.000141032	0	45.7126	0	0	0	0	0.007	0.2259	0	0	0	0	45.7056
29	0.06152	1626	5.03685E-06	0.000146069	0	45.7056	0	0	0	0	0.0051	0.231	0	0	0	0	45.7005
30	0.06152	1626	5.03685E-06	0.000151106	0	45.7005	0	0	0	0	0.0069	0.2379	0	0	0	0	45.6937
31	0.06152	1626	5.03685E-06	0.000156142	0	45.6937	0	0	0	0	0.0067	0.2446	0	0	0	0	45.6869
32	0.06152	1626	5.03685E-06	0.000161179	0	45.6869	0	0	0	0	0.0043	0.2489	0	0	0	0	45.6826
33	0.06152	1626	5.03685E-06	0.000166216	0	45.6826	0	0	0	0	0.0063	0.2552	0	0	0	0	45.6763
34	0.06152	1626	5.03685E-06	0.000171253	0	45.6763	0	0	0	0	0.0053	0.2605	0	0	0	0	45.671
35	0.06152	1626	5.03685E-06	0.00017629	0	45.671	0.13	0.13	0	0	0.0189	0.2794	0	0	0	0	45.7821
36	0.06152	1626	5.03685E-06	0.000181327	0	45.7818	0.1	0.23	0	0	0.0586	0.338	0	0	0	0	45.8232
37	0.06152	1626	5.03685E-06	0.000186363	0	45.8231	0	0.23	0	0	0.0633	0.4013	0	0	0	0	45.7598
38	0.06152	1626	5.03685E-06	0.0001914	0	45.7599	0	0.23	0	0	0.0285	0.4298	0	0	0	0	45.7314
39	0.06152	1626	5.03685E-06	0.000196437	0	45.7315	0	0.23	0	0	0.0274	0.4572	0	0	0	0	45.704
40	0.06152	1626	5.03685E-06	0.000201474	0	45.7041	0	0.23	0	0	0.0146	0.4718	0	0	0	0	45.6895
41	0.06152	1626	5.03685E-06	0.000206511	0	45.6896	0	0.23	0	0	0.0113	0.4831	0	0	0	0	45.6783
42	0.06152	1626	5.03685E-06	0.000211548	0	45.6783	0	0.23	0	0	0.0088	0.4919	0	0	0	0	45.6694

Scenario: 1998 Stormwater Recirculation Every Day

Day	Water (cm3/cm3)	Head (cm)	Water Flow (cm)	Water Flow (cm) Accum	Plant Sink (cm)	Prestor	Infil	Infil Accum	Runoff	Runoff Accum	Evapo	Evapo Accum	Trans	Trans Accum	Drain	Drain Accum	Newstor
43	0.06152	1626	5.03685E-06	0.000216585	0	45.6694	0	0.23	0	0	0.0026	0.4945	0	0	0	0	45.6668
44	0.06152	1626	5.03685E-06	0.000221621	0	45.6668	0	0.23	0	0	0.0069	0.5014	0	0	0	0	45.6599
45	0.06152	1626	5.03685E-06	0.000226658	0	45.6599	0	0.23	0	0	0.0063	0.5077	0	0	0	0	45.6536
46	0.06152	1626	5.03685E-06	0.000231695	0	45.6536	0.03	0.26	0	0	0.0289	0.5366	0	0	0	0	45.6548
47	0.06152	1626	5.03685E-06	0.000236732	0	45.6547	0	0.26	0	0	0.0082	0.5448	0	0	0	0	45.6466
48	0.06152	1626	5.03685E-06	0.000241769	0	45.6466	0	0.26	0	0	0.0049	0.5497	0	0	0	0	45.6417
49	0.06152	1626	5.03685E-06	0.000246806	0	45.6417	0.08	0.34	0	0	0.0521	0.6018	0	0	0	0	45.6697
50	0.06152	1626	5.03685E-06	0.000251843	0	45.6696	0	0.34	0	0	0.0289	0.6307	0	0	0	0	45.6407
51	0.06152	1626	5.03685E-06	0.000256879	0	45.6408	0	0.34	0	0	0.0036	0.6343	0	0	0	0	45.6371
52	0.06152	1626	5.03685E-06	0.000261916	0	45.6371	0	0.34	0	0	0.0052	0.6395	0	0	0	0	45.6319
53	0.06152	1626	5.03685E-06	0.000266953	0	45.6319	0	0.34	0	0	0.0066	0.6461	0	0	0	0	45.6253
54	0.06152	1626	5.03685E-06	0.00027199	0	45.6253	0	0.34	0	0	0.006	0.6521	0	0	0	0	45.6194
55	0.06152	1626	5.03685E-06	0.000277027	0	45.6194	0	0.34	0	0	0.0068	0.6589	0	0	0	0	45.6126
56	0.06152	1626	5.03685E-06	0.000282064	0	45.6126	0	0.34	0	0	0.0059	0.6648	0	0	0	0	45.6067
57	0.06152	1626	5.03685E-06	0.0002871	0	45.6067	0	0.34	0	0	0.0065	0.6713	0	0	0	0	45.6001
58	0.06152	1626	5.03685E-06	0.000292137	0	45.6001	0	0.34	0	0	0.005	0.6763	0	0	0	0	45.5951
59	0.06152	1626	5.03685E-06	0.000297174	0	45.5951	0	0.34	0	0	0.004	0.6803	0	0	0	0	45.5911
60	0.06152	1626	5.03685E-06	0.000302211	0	45.5911	0	0.34	0	0	0.0067	0.687	0	0	0	0	45.5844
61	0.06152	1626	5.03685E-06	0.000307248	0	45.5844	0	0.34	0	0	0.0044	0.6914	0	0	0	0	45.58
62	0.06152	1626	5.03685E-06	0.000312285	0	45.58	0	0.34	0	0	0.0055	0.6969	0	0	0	0	45.5745
63	0.06152	1626	5.03685E-06	0.000317322	0	45.5745	0	0.34	0	0	0.0055	0.7024	0	0	0	0	45.569
64	0.06152	1626	5.03685E-06	0.000322358	0	45.569	0	0.34	0	0	0.0035	0.7059	0	0	0	0	45.5655
65	0.06152	1626	5.03685E-06	0.000327395	0	45.5655	0	0.34	0	0	0.0019	0.7078	0	0	0	0	45.5636
66	0.06152	1626	5.03685E-06	0.000332432	0	45.5636	0.13	0.47	0	0	0.0645	0.7723	0	0	0	0	45.6291
67	0.06152	1626	5.03685E-06	0.000337469	0	45.6289	0	0.47	0	0	0.0507	0.823	0	0	0	0	45.5782
68	0.06152	1626	5.03685E-06	0.000342506	0	45.5783	0	0.47	0	0	0.0152	0.8382	0	0	0	0	45.5631
69	0.06152	1626	5.03685E-06	0.000347543	0	45.5632	0	0.47	0	0	0.0062	0.8444	0	0	0	0	45.5569
70	0.06152	1626	5.03685E-06	0.00035258	0	45.5569	0	0.47	0	0	0.0029	0.8473	0	0	0	0	45.554
71	0.06152	1626	5.03685E-06	0.000357616	0	45.554	0	0.47	0	0	0.003	0.8503	0	0	0	0	45.5511
72	0.06152	1626	5.03685E-06	0.000362653	0	45.5511	0	0.47	0	0	0.0041	0.8544	0	0	0	0	45.5469
73	0.06152	1626	5.03685E-06	0.00036769	0	45.5469	0	0.47	0	0	0.0008	0.8552	0	0	0	0	45.5462
74	0.06152	1626	5.03685E-06	0.000372727	0	45.5462	0.53	1	0	0	0.0684	0.9236	0	0	0	0	46.0078
75	0.06152	1626	5.03685E-06	0.000377764	0	46.0071	1.09	2.09	0	0	0.1141	1.0377	0	0	0	0	46.983
76	0.06152	1626	5.03685E-06	0.000382801	0	46.9823	0.36	2.45	0	0	0.2067	1.2444	0	0	0	0	47.1356
77	0.06152	1626	5.03685E-06	0.000387837	0	47.1353	0.03	2.48	0	0	0.2138	1.4582	0	0	0	0	46.9515
78	0.06152	1626	5.03685E-06	0.000392874	0	46.9515	0	2.48	0	0	0.0659	1.5241	0	0	0	0	46.8856
79	0.06152	1626	5.03685E-06	0.000397911	0	46.8856	0	2.48	0	0	0.0493	1.5734	0	0	0	0	46.8363
80	0.06152	1626	5.03685E-06	0.000402948	0	46.8363	0	2.48	0	0	0.0628	1.6362	0	0	0	0	46.7735
81	0.06152	1626	5.03685E-06	0.000407985	0	46.7735	0	2.48	0	0	0.0653	1.7015	0	0	0	0	46.7082
82	0.06152	1626	5.03685E-06	0.000413022	0	46.7083	0	2.48	0	0	0.0491	1.7506	0	0	0	0	46.6591
83	0.06152	1626	5.03685E-06	0.000418059	0	46.6592	0	2.48	0	0	0.0369	1.7875	0	0	0	0	46.6223
84	0.06152	1626	5.03685E-06	0.000423095	0	46.6224	0	2.48	0	0	0.0357	1.8232	0	0	0	0	46.5867

Scenario: 1998 Stormwater Recirculation Every Day

Day	Water (cm3/cm3)	Head (cm)	Water Flow (cm)	Water Flow (cm) Accum	Plant Sink (cm)	Prestor	Infil	Infil Accum	Runoff	Runoff Accum	Evapo	Evapo Accum	Trans	Trans Accum	Drain	Drain Accum	Newstor
85	0.06152	1626	5.03685E-06	0.000428132	0	46.5867	0	2.48	0	0	0.0224	1.8456	0	0	0	0	46.5643
86	0.06152	1626	5.03685E-06	0.000433169	0	46.5644	0	2.48	0	0	0.0246	1.8702	0	0	0	0	46.5397
87	0.06152	1626	5.03685E-06	0.000438206	0	46.5397	0	2.48	0	0	0.0233	1.8935	0	0	0	0	46.5165
88	0.06152	1626	5.03685E-06	0.000443243	0	46.5165	0	2.48	0	0	0.0218	1.9153	0	0	0	0	46.4947
89	0.06152	1626	5.03685E-06	0.00044828	0	46.4947	0.1	2.58	0	0	0.0717	1.987	0	0	0	0	46.523
90	0.06152	1626	5.03685E-06	0.000453317	0	46.5229	0	2.58	0	0	0.0461	2.0331	0	0	0	0	46.4768
91	0.06152	1626	5.03685E-06	0.000458353	0	46.477	0	2.58	0	0	0.0202	2.0533	0	0	0	0	46.4568
92	0.06152	1626	5.03685E-06	0.00046339	0	46.4568	0	2.58	0	0	0.0194	2.0727	0	0	0	0	46.4374
93	0.06152	1626	5.03685E-06	0.000468427	0	46.4375	0	2.58	0	0	0.0139	2.0866	0	0	0	0	46.4235
94	0.06152	1626	5.03685E-06	0.000473464	0	46.4236	0	2.58	0	0	0.0138	2.1004	0	0	0	0	46.4097
95	0.06152	1626	5.03685E-06	0.000478501	0	46.4097	0	2.58	0	0	0.0146	2.115	0	0	0	0	46.3951
96	0.06152	1626	5.03685E-06	0.000483538	0	46.3952	0	2.58	0	0	0.013	2.128	0	0	0	0	46.3821
97	0.06152	1626	5.03685E-06	0.000488574	0	46.3821	0	2.58	0	0	0.0129	2.1409	0	0	0	0	46.3692
98	0.06152	1626	5.03685E-06	0.000493611	0	46.3692	0	2.58	0	0	0.0125	2.1534	0	0	0	0	46.3566
99	0.06152	1626	5.03685E-06	0.000498648	0	46.3567	0	2.58	0	0	0.01	2.1634	0	0	0	0	46.3466
100	0.06152	1626	5.03685E-06	0.000503685	0	46.3466	0	2.58	0	0	0.0119	2.1753	0	0	0	0	46.3347
101	0.06152	1626	5.03685E-06	0.000508722	0	46.3347	0	2.58	0	0	0.0098	2.1851	0	0	0	0	46.3249
102	0.06152	1626	5.03685E-06	0.000513759	0	46.3249	0	2.58	0	0	0.0119	2.197	0	0	0	0	46.313
103	0.06152	1626	5.03685E-06	0.000518796	0	46.313	0	2.58	0	0	0.0108	2.2078	0	0	0	0	46.3022
104	0.06152	1626	5.03685E-06	0.000523832	0	46.3022	0	2.58	0	0	0.0116	2.2194	0	0	0	0	46.2906
105	0.06152	1626	5.03685E-06	0.000528869	0	46.2906	0	2.58	0	0	0.0099	2.2293	0	0	0	0	46.2807
106	0.06152	1626	5.03685E-06	0.000533906	0	46.2807	0	2.58	0	0	0.0071	2.2364	0	0	0	0	46.2736
107	0.06152	1626	5.03685E-06	0.000538943	0	46.2736	0.13	2.71	0	0	0.0407	2.2771	0	0	0	0	46.3629
108	0.06152	1626	5.03685E-06	0.00054398	0	46.3626	0	2.71	0	0	0.056	2.3331	0	0	0	0	46.3066
109	0.06152	1626	5.03685E-06	0.000549017	0	46.3067	0	2.71	0	0	0.0274	2.3605	0	0	0	0	46.2794
110	0.06152	1626	5.03685E-06	0.000554054	0	46.2794	0	2.71	0	0	0.0129	2.3734	0	0	0	0	46.2665
111	0.06152	1626	5.03685E-06	0.00055909	0	46.2666	0	2.71	0	0	0.0075	2.3809	0	0	0	0	46.259
112	0.06152	1626	5.03685E-06	0.000564127	0	46.259	0	2.71	0	0	0.0087	2.3896	0	0	0	0	46.2503
113	0.06152	1626	5.03685E-06	0.000569164	0	46.2503	0	2.71	0	0	0.0084	2.398	0	0	0	0	46.2419
114	0.06152	1626	5.03685E-06	0.000574201	0	46.2419	0	2.71	0	0	0.0095	2.4075	0	0	0	0	46.2324
115	0.06152	1626	5.03685E-06	0.000579238	0	46.2325	0	2.71	0	0	0.0088	2.4163	0	0	0	0	46.2236
116	0.06152	1626	5.03685E-06	0.000584275	0	46.2237	0	2.71	0	0	0.0047	2.421	0	0	0	0	46.2189
117	0.06152	1626	5.03685E-06	0.000589311	0	46.2189	0	2.71	0	0	0.0051	2.4261	0	0	0	0	46.2139
118	0.06152	1626	5.03685E-06	0.000594348	0	46.2139	0	2.71	0	0	0.0047	2.4308	0	0	0	0	46.2091
119	0.06152	1626	5.03685E-06	0.000599385	0	46.2091	0	2.71	0	0	0.0071	2.4379	0	0	0	0	46.202
120	0.06152	1626	5.03685E-06	0.000604422	0	46.202	0	2.71	0	0	0.0083	2.4462	0	0	0	0	46.1937
121	0.06152	1626	5.03685E-06	0.000609459	0	46.1937	0	2.71	0	0	0.0081	2.4543	0	0	0	0	46.1856
122	0.06152	1626	5.03685E-06	0.000614496	0	46.1856	0	2.71	0	0	0.0077	2.462	0	0	0	0	46.1779
123	0.06152	1626	5.03685E-06	0.000619533	0	46.1779	0	2.71	0	0	0.0055	2.4675	0	0	0	0	46.1725
124	0.06152	1626	5.03685E-06	0.000624569	0	46.1725	0	2.71	0	0	0.0089	2.4764	0	0	0	0	46.1636
125	0.06152	1626	5.03685E-06	0.000629606	0	46.1636	0	2.71	0	0	0.0078	2.4842	0	0	0	0	46.1557
126	0.06152	1626	5.03685E-06	0.000634643	0	46.1557	0	2.71	0	0	0.0073	2.4915	0	0	0	0	46.1485

Scenario: 1998 Stormwater Recirculation Every Day

Day	Water (cm3/cm3)	Head (cm)	Water Flow (cm)	Water Flow (cm) Accum	Plant Sink (cm)	Prestor	Infil	Infil Accum	Runoff	Runoff Accum	Evapo	Evapo Accum	Trans	Trans Accum	Drain	Drain Accum	Newstor
127	0.06152	1626	5.03685E-06	0.00063968	0	46.1485	0	2.71	0	0	0.0072	2.4987	0	0	0	0	46.1413
128	0.06152	1626	5.03685E-06	0.000644717	0	46.1413	0	2.71	0	0	0.0073	2.506	0	0	0	0	46.1339
129	0.06152	1626	5.03685E-06	0.000649754	0	46.1339	0	2.71	0	0	0.0063	2.5123	0	0	0	0	46.1276
130	0.06152	1626	5.03686E-06	0.000654791	0	46.1276	0	2.71	0	0	0.006	2.5183	0	0	0	0	46.1216
131	0.06152	1626	5.03686E-06	0.000659827	0	46.1216	0	2.71	0	0	0.0074	2.5257	0	0	0	0	46.1142
132	0.06152	1626	5.03686E-06	0.000664864	0	46.1142	0	2.71	0	0	0.0066	2.5323	0	0	0	0	46.1076
133	0.06152	1626	5.03686E-06	0.000669901	0	46.1076	0	2.71	0	0	0.0067	2.539	0	0	0	0	46.101
134	0.06152	1626	5.03686E-06	0.000674938	0	46.101	0	2.71	0	0	0.0063	2.5453	0	0	0	0	46.0946
135	0.06152	1626	5.03686E-06	0.000679975	0	46.0946	0	2.71	0	0	0.0065	2.5518	0	0	0	0	46.0881
136	0.06152	1626	5.03686E-06	0.000685012	0	46.0881	0	2.71	0	0	0.006	2.5578	0	0	0	0	46.0821
137	0.06152	1626	5.03686E-06	0.000690049	0	46.0821	0	2.71	0	0	0.0047	2.5625	0	0	0	0	46.0775
138	0.06152	1626	5.03686E-06	0.000695085	0	46.0775	0	2.71	0	0	0.0052	2.5677	0	0	0	0	46.0722
139	0.06152	1626	5.03686E-06	0.000700122	0	46.0722	0	2.71	0	0	0.0051	2.5728	0	0	0	0	46.0672
140	0.06152	1626	5.03686E-06	0.000705159	0	46.0672	0	2.71	0	0	0.0054	2.5782	0	0	0	0	46.0617
141	0.06152	1626	5.03686E-06	0.000710196	0	46.0617	0	2.71	0	0	0.0055	2.5837	0	0	0	0	46.0563
142	0.06152	1626	5.03686E-06	0.000715233	0	46.0563	0	2.71	0	0	0.0065	2.5902	0	0	0	0	46.0498
143	0.06152	1626	5.03686E-06	0.00072027	0	46.0498	0	2.71	0	0	0.0067	2.5969	0	0	0	0	46.0431
144	0.06152	1626	5.03686E-06	0.000725307	0	46.0431	0	2.71	0	0	0.0061	2.603	0	0	0	0	46.037
145	0.06152	1626	5.03686E-06	0.000730343	0	46.037	0	2.71	0	0	0.0028	2.6058	0	0	0	0	46.0342
146	0.06152	1626	5.03686E-06	0.00073538	0	46.0342	0	2.71	0	0	0.0023	2.6081	0	0	0	0	46.0319
147	0.06152	1626	5.03686E-06	0.000740417	0	46.0319	0	2.71	0	0	0.0071	2.6152	0	0	0	0	46.0249
148	0.06152	1626	5.03686E-06	0.000745454	0	46.0249	0	2.71	0	0	0.0065	2.6217	0	0	0	0	46.0183
149	0.06152	1626	5.03686E-06	0.000750491	0	46.0183	0	2.71	0	0	0.0057	2.6274	0	0	0	0	46.0127
150	0.06152	1626	5.03686E-06	0.000755528	0	46.0127	0	2.71	0	0	0.0056	2.633	0	0	0	0	46.0071
151	0.06152	1626	5.03686E-06	0.000760565	0	46.0071	0	2.71	0	0	0.0055	2.6385	0	0	0	0	46.0015
152	0.06152	1626	5.03686E-06	0.000765601	0	46.0015	0	2.71	0	0	0.0056	2.6441	0	0	0	0	45.9959
153	0.06152	1626	5.03686E-06	0.000770638	0	45.9959	0	2.71	0	0	0.0054	2.6495	0	0	0	0	45.9905
154	0.06152	1626	5.03686E-06	0.000775675	0	45.9905	0	2.71	0	0	0.005	2.6545	0	0	0	0	45.9855
155	0.06152	1626	5.03686E-06	0.000780712	0	45.9855	0	2.71	0	0	0.0055	2.66	0	0	0	0	45.98
156	0.06152	1626	5.03686E-06	0.000785749	0	45.98	0	2.71	0	0	0.0028	2.6628	0	0	0	0	45.9772
157	0.06152	1626	5.03686E-06	0.000790786	0	45.9772	0	2.71	0	0	0.0019	2.6647	0	0	0	0	45.9752
158	0.06152	1626	5.03686E-06	0.000795823	0	45.9752	0	2.71	0	0	0.0039	2.6686	0	0	0	0	45.9714
159	0.06152	1626	5.03686E-06	0.000800859	0	45.9714	0	2.71	0	0	0.0063	2.6749	0	0	0	0	45.9651
160	0.06152	1626	5.03686E-06	0.000805896	0	45.9651	0	2.71	0	0	0.0055	2.6804	0	0	0	0	45.9595
161	0.06152	1626	5.03686E-06	0.000810933	0	45.9595	0.46	3.17	0	0	0.0893	2.7697	0	0	0	0	46.3302
162	0.06152	1626	5.03686E-06	0.00081597	0	46.3296	0	3.17	0	0	0.1204	2.8901	0	0	0	0	46.2091
163	0.06152	1626	5.03686E-06	0.000821007	0	46.2092	0	3.17	0	0	0.0579	2.948	0	0	0	0	46.1512
164	0.06152	1626	5.03686E-06	0.000826044	0	46.1513	0	3.17	0	0	0.0354	2.9834	0	0	0	0	46.1159
165	0.06152	1626	5.03686E-06	0.000831081	0	46.116	0	3.17	0	0	0.0285	3.0119	0	0	0	0	46.0875
166	0.06152	1626	5.03686E-06	0.000836117	0	46.0875	0	3.17	0	0	0.0179	3.0298	0	0	0	0	46.0696
167	0.06152	1626	5.03686E-06	0.000841154	0	46.0697	0	3.17	0	0	0.0189	3.0487	0	0	0	0	46.0508
168	0.06152	1626	5.03686E-06	0.000846191	0	46.0508	0	3.17	0	0	0.0173	3.066	0	0	0	0	46.0335

Scenario: 1998 Stormwater Recirculation Every Day

Day	Water (cm3/cm3)	Head (cm)	Water Flow (cm)	Water Flow (cm) Accum	Plant Sink (cm)	Prestor	Infil	Infil Accum	Runoff	Runoff Accum	Evapo	Evapo Accum	Trans	Trans Accum	Drain	Drain Accum	Newstor
169	0.06152	1626	5.03686E-06	0.000851228	0	46.0336	0	3.17	0	0	0.0145	3.0805	0	0	0	0	46.019
170	0.06152	1626	5.03686E-06	0.000856265	0	46.0191	0	3.17	0	0	0.0131	3.0936	0	0	0	0	46.0059
171	0.06152	1626	5.03686E-06	0.000861302	0	46.0059	0	3.17	0	0	0.0123	3.1059	0	0	0	0	45.9937
172	0.06152	1626	5.03686E-06	0.000866339	0	45.9937	0	3.17	0	0	0.0106	3.1165	0	0	0	0	45.983
173	0.06152	1626	5.03686E-06	0.000871375	0	45.983	0	3.17	0	0	0.009	3.1255	0	0	0	0	45.974
174	0.06152	1626	5.03687E-06	0.000876412	0	45.974	0	3.17	0	0	0.0071	3.1326	0	0	0	0	45.967
175	0.06152	1626	5.03687E-06	0.000881449	0	45.967	0	3.17	0	0	0.0066	3.1392	0	0	0	0	45.9604
176	0.06152	1626	5.03687E-06	0.000886486	0	45.9604	0	3.17	0	0	0.0059	3.1451	0	0	0	0	45.9545
177	0.06152	1626	5.03687E-06	0.000891523	0	45.9545	0	3.17	0	0	0.0057	3.1508	0	0	0	0	45.9488
178	0.06152	1626	5.03687E-06	0.00089656	0	45.9488	0	3.17	0	0	0.006	3.1568	0	0	0	0	45.9428
179	0.06152	1626	5.03687E-06	0.000901597	0	45.9428	0	3.17	0	0	0.0046	3.1614	0	0	0	0	45.9382
180	0.06152	1626	5.03687E-06	0.000906634	0	45.9382	0	3.17	0	0	0.0035	3.1649	0	0	0	0	45.9347
181	0.06152	1626	5.03687E-06	0.00091167	0	45.9348	0	3.17	0	0	0.0025	3.1674	0	0	0	0	45.9322
182	0.06152	1626	5.03687E-06	0.000916707	0	45.9323	0	3.17	0	0	0.0029	3.1703	0	0	0	0	45.9294
183	0.06152	1626	5.03687E-06	0.000921744	0	45.9294	0.43	3.6	0	0	0.0717	3.242	0	0	0	0	46.2877
184	0.06152	1626	5.03687E-06	0.000926781	0	46.287	0	3.6	0	0	0.1091	3.3511	0	0	0	0	46.1779
185	0.06152	1626	5.03687E-06	0.000931818	0	46.1779	1.5556	5.1556	0.0144	0.0144	0.1759	3.527	0	0	0	0	47.5577
186	0.06152	1626	5.03687E-06	0.000936855	0	47.5592	0.56	5.7156	0	0.0144	0.4891	4.0161	0	0	0	0	47.6301
187	0.06152	1626	5.03687E-06	0.000941892	0	47.63	0	5.7156	0	0.0144	0.0773	4.0934	0	0	0	0	47.5526
188	0.06152	1626	5.03687E-06	0.000946929	0	47.5526	0	5.7156	0	0.0144	0.0745	4.1679	0	0	0	0	47.4781
189	0.06152	1626	5.03688E-06	0.000951965	0	47.4781	0.51	6.2256	0	0.0144	0.2523	4.4202	0	0	0	0	47.7357
190	0.06152	1626	5.03688E-06	0.000957002	0	47.7355	0.03	6.2556	0	0.0144	0.1722	4.5924	0	0	0	0	47.5933
191	0.06152	1626	5.03688E-06	0.000962039	0	47.5934	0	6.2556	0	0.0144	0.0707	4.6631	0	0	0	0	47.5226
192	0.06152	1626	5.03688E-06	0.000967076	0	47.5227	0	6.2556	0	0.0144	0.0877	4.7508	0	0	0	0	47.435
193	0.06152	1626	5.03688E-06	0.000972113	0	47.435	0	6.2556	0	0.0144	0.0491	4.7999	0	0	0	0	47.386
194	0.06152	1626	5.03688E-06	0.00097715	0	47.386	0	6.2556	0	0.0144	0.0423	4.8422	0	0	0	0	47.3437
195	0.06152	1626	5.03688E-06	0.000982187	0	47.3437	0	6.2556	0	0.0144	0.0379	4.8801	0	0	0	0	47.3059
196	0.06152	1626	5.03688E-06	0.000987224	0	47.3059	0.61	6.8656	0	0.0144	0.1892	5.0693	0	0	0	0	47.7267
197	0.06152	1626	5.03688E-06	0.00099226	0	47.7263	0	6.8656	0	0.0144	0.1294	5.1987	0	0	0	0	47.5969
198	0.06152	1626	5.03689E-06	0.000997297	0	47.5969	0	6.8656	0	0.0144	0.0689	5.2676	0	0	0	0	47.528
199	0.06152	1626	5.03689E-06	0.001002334	0	47.528	0	6.8656	0	0.0144	0.0641	5.3317	0	0	0	0	47.4639
200	0.06152	1626	5.03689E-06	0.001007371	0	47.4639	0	6.8656	0	0.0144	0.046	5.3777	0	0	0	0	47.4179
201	0.06152	1626	5.03689E-06	0.001012408	0	47.418	0	6.8656	0	0.0144	0.0363	5.414	0	0	0	0	47.3817
202	0.06152	1626	5.03689E-06	0.001017445	0	47.3817	0	6.8656	0	0.0144	0.0297	5.4437	0	0	0	0	47.352
203	0.06152	1626	5.03689E-06	0.001022482	0	47.352	0	6.8656	0	0.0144	0.0264	5.4701	0	0	0	0	47.3256
204	0.06152	1626	5.03689E-06	0.001027519	0	47.3256	0	6.8656	0	0.0144	0.0203	5.4904	0	0	0	0	47.3053
205	0.06152	1626	5.03689E-06	0.001032556	0	47.3053	0	6.8656	0	0.0144	0.0217	5.5121	0	0	0	0	47.2836
206	0.06152	1626	5.0369E-06	0.001037592	0	47.2836	0	6.8656	0	0.0144	0.0179	5.53	0	0	0	0	47.2657
207	0.06152	1626	5.0369E-06	0.001042629	0	47.2657	0	6.8656	0	0.0144	0.0145	5.5445	0	0	0	0	47.2513
208	0.06152	1626	5.0369E-06	0.001047666	0	47.2513	0	6.8656	0	0.0144	0.0133	5.5578	0	0	0	0	47.2379
209	0.06152	1626	5.0369E-06	0.001052703	0	47.2379	0	6.8656	0	0.0144	0.0168	5.5746	0	0	0	0	47.2212
210	0.06152	1626	5.0369E-06	0.00105774	0	47.2212	0	6.8656	0	0.0144	0.0173	5.5919	0	0	0	0	47.2038

Scenario: 1998 Stormwater Recirculation Every Day

Day	Water (cm3/cm3)	Head (cm)	Water Flow (cm)	Water Flow (cm) Accum	Plant Sink (cm)	Prestor	Infil	Infil Accum	Runoff	Runoff Accum	Evapo	Evapo Accum	Trans	Trans Accum	Drain	Drain Accum	Newstor
211	0.06152	1625.99	5.0369E-06	0.001062777	0	47.2038	1.737	8.6026	0.043	0.0574	0.1807	5.7726	0	0	0	0	48.7601
212	0.06152	1625.99	5.03691E-06	0.001067814	0	48.7618	0.69	9.2926	0	0.0574	0.4028	6.1754	0	0	0	0	49.049
213	0.06152	1625.99	5.03691E-06	0.001072851	0	49.049	0	9.2926	0	0.0574	0.165	6.3404	0	0	0	0	48.8839
214	0.06152	1625.99	5.03691E-06	0.001077888	0	48.884	0.53	9.8226	0	0.0574	0.1753	6.5157	0	0	0	0	49.2387
215	0.06152	1625.99	5.03691E-06	0.001082925	0	49.2385	0	9.8226	0	0.0574	0.1721	6.6878	0	0	0	0	49.0664
216	0.06152	1625.99	5.03691E-06	0.001087962	0	49.0665	0	9.8226	0	0.0574	0.0572	6.745	0	0	0	0	49.0093
217	0.06152	1625.99	5.03692E-06	0.001092998	0	49.0093	0.25	10.0726	0	0.0574	0.1048	6.8498	0	0	0	0	49.1545
218	0.06152	1625.99	5.03692E-06	0.001098035	0	49.1544	0	10.0726	0	0.0574	0.1232	6.973	0	0	0	0	49.0312
219	0.06152	1625.99	5.03692E-06	0.001103072	0	49.0313	0	10.0726	0	0.0574	0.0753	7.0483	0	0	0	0	48.956
220	0.06152	1625.99	5.03692E-06	0.001108109	0	48.956	0	10.0726	0	0.0574	0.0825	7.1308	0	0	0	0	48.8735
221	0.06152	1625.99	5.03692E-06	0.001113146	0	48.8736	0	10.0726	0	0.0574	0.0539	7.1847	0	0	0	0	48.8196
222	0.06152	1625.99	5.03693E-06	0.001118183	0	48.8197	0	10.0726	0	0.0574	0.0432	7.2279	0	0	0	0	48.7765
223	0.06152	1625.99	5.03693E-06	0.00112322	0	48.7765	0.03	10.1026	0	0.0574	0.0659	7.2938	0	0	0	0	48.7407
224	0.06152	1625.99	5.03693E-06	0.001128257	0	48.7407	1.7264	11.829	0.0236	0.081	0.1202	7.414	0	0	0	0	50.3469
225	0.06152	1625.99	5.03693E-06	0.001133294	0	50.3488	0.79	12.619	0	0.081	0.481	7.895	0	0	0	0	50.6578
226	0.06152	1625.99	5.03694E-06	0.001138331	0	50.6578	0	12.619	0	0.081	0.1892	8.0842	0	0	0	0	50.4686
227	0.06152	1625.99	5.03694E-06	0.001143368	0	50.4687	0	12.619	0	0.081	0.0781	8.1623	0	0	0	0	50.3905
228	0.06152	1625.99	5.03694E-06	0.001148405	0	50.3906	0	12.619	0	0.081	0.0766	8.2389	0	0	0	0	50.3139
229	0.06152	1625.99	5.03695E-06	0.001153442	0	50.3139	0	12.619	0	0.081	0.0684	8.3073	0	0	0	0	50.2456
230	0.06152	1625.99	5.03695E-06	0.001158479	0	50.2456	0	12.619	0	0.081	0.0592	8.3665	0	0	0	0	50.1864
231	0.06152	1625.99	5.03695E-06	0.001163516	0	50.1864	0.3	12.919	0	0.081	0.1377	8.5042	0	0	0	0	50.3487
232	0.06152	1625.99	5.03695E-06	0.001168552	0	50.3486	0.1	13.019	0	0.081	0.1638	8.668	0	0	0	0	50.2847
233	0.06152	1625.99	5.03696E-06	0.001173589	0	50.2847	0	13.019	0	0.081	0.0864	8.7544	0	0	0	0	50.1983
234	0.06152	1625.99	5.03696E-06	0.001178626	0	50.1984	0	13.019	0	0.081	0.0687	8.8231	0	0	0	0	50.1297
235	0.06152	1625.99	5.03696E-06	0.001183663	0	50.1297	0	13.019	0	0.081	0.0559	8.879	0	0	0	0	50.0738
236	0.06152	1625.99	5.03697E-06	0.0011887	0	50.0739	0	13.019	0	0.081	0.0344	8.9134	0	0	0	0	50.0394
237	0.06152	1625.99	5.03697E-06	0.001193737	0	50.0394	0	13.019	0	0.081	0.031	8.9444	0	0	0	0	50.0085
238	0.06152	1625.99	5.03697E-06	0.001198774	0	50.0085	0.3	13.319	0	0.081	0.1426	9.087	0	0	0	0	50.1659
239	0.06152	1625.99	5.03698E-06	0.001203811	0	50.1657	0	13.319	0	0.081	0.066	9.153	0	0	0	0	50.0997
240	0.06152	1625.99	5.03698E-06	0.001208848	0	50.0997	0.28	13.599	0	0.081	0.1527	9.3057	0	0	0	0	50.227
241	0.06152	1625.99	5.03698E-06	0.001213885	0	50.2268	0	13.599	0	0.081	0.1109	9.4166	0	0	0	0	50.116
242	0.06152	1625.99	5.03699E-06	0.001218922	0	50.1161	0	13.599	0	0.081	0.0703	9.4869	0	0	0	0	50.0457
243	0.06152	1625.99	5.03699E-06	0.001223959	0	50.0458	0	13.599	0	0.081	0.0437	9.5306	0	0	0	0	50.0021
244	0.06152	1625.99	0.000005037	0.001228996	0	50.0021	0	13.599	0	0.081	0.0377	9.5683	0	0	0	0	49.9644
245	0.06152	1625.99	0.000005037	0.001234033	0	49.9645	0	13.599	0	0.081	0.028	9.5963	0	0	0	0	49.9365
246	0.06152	1625.98	0.000005037	0.00123907	0	49.9365	0	13.599	0	0.081	0.0305	9.6268	0	0	0	0	49.906
247	0.06152	1625.98	5.03701E-06	0.001244107	0	49.906	0	13.599	0	0.081	0.0281	9.6549	0	0	0	0	49.8779
248	0.06152	1625.98	5.03701E-06	0.001249144	0	49.8779	0	13.599	0	0.081	0.022	9.6769	0	0	0	0	49.8559
249	0.06152	1625.98	5.03702E-06	0.001254181	0	49.856	0	13.599	0	0.081	0.0225	9.6994	0	0	0	0	49.8335
250	0.06152	1625.98	5.03702E-06	0.001259218	0	49.8335	0	13.599	0	0.081	0.0227	9.7221	0	0	0	0	49.8107
251	0.06152	1625.98	5.03703E-06	0.001264255	0	49.8108	0	13.599	0	0.081	0.0192	9.7413	0	0	0	0	49.7916
252	0.06152	1625.98	5.03703E-06	0.001269292	0	49.7916	0	13.599	0	0.081	0.0127	9.754	0	0	0	0	49.7789

Scenario: 1998 Stormwater Recirculation Every Day

Day	Water (cm3/cm3)	Head (cm)	Water Flow (cm)	Water Flow (cm) Accum	Plant Sink (cm)	Prestor	Infil	Infil Accum	Runoff	Runoff Accum	Evapo	Evapo Accum	Trans	Trans Accum	Drain	Drain Accum	Newstor
253	0.06152	1625.98	5.03704E-06	0.001274329	0	49.7789	0	13.599	0	0.081	0.0147	9.7687	0	0	0	0	49.7642
254	0.06152	1625.98	5.03704E-06	0.001279366	0	49.7642	0	13.599	0	0.081	0.017	9.7857	0	0	0	0	49.7472
255	0.06152	1625.98	5.03705E-06	0.001284403	0	49.7472	0	13.599	0	0.081	0.015	9.8007	0	0	0	0	49.7321
256	0.06152	1625.98	5.03705E-06	0.00128944	0	49.7322	0	13.599	0	0.081	0.0153	9.816	0	0	0	0	49.7168
257	0.06152	1625.98	5.03706E-06	0.001294478	0	49.7169	0.15	13.749	0	0.081	0.0829	9.8989	0	0	0	0	49.7839
258	0.06152	1625.98	5.03706E-06	0.001299515	0	49.7837	0	13.749	0	0.081	0.0506	9.9495	0	0	0	0	49.7331
259	0.06152	1625.98	5.03707E-06	0.001304552	0	49.7332	0	13.749	0	0.081	0.0225	9.972	0	0	0	0	49.7108
260	0.06152	1625.98	5.03707E-06	0.001309589	0	49.7108	0	13.749	0	0.081	0.0165	9.9885	0	0	0	0	49.6943
261	0.06152	1625.98	5.03708E-06	0.001314626	0	49.6943	0	13.749	0	0.081	0.0158	10.0043	0	0	0	0	49.6785
262	0.06152	1625.98	5.03708E-06	0.001319663	0	49.6785	0	13.749	0	0.081	0.0173	10.0216	0	0	0	0	49.6612
263	0.06152	1625.98	5.03709E-06	0.0013247	0	49.6612	0	13.749	0	0.081	0.0167	10.0383	0	0	0	0	49.6445
264	0.06152	1625.98	5.0371E-06	0.001329737	0	49.6445	0	13.749	0	0.081	0.0155	10.0538	0	0	0	0	49.6289
265	0.06152	1625.97	5.0371E-06	0.001334774	0	49.629	0	13.749	0	0.081	0.0101	10.0639	0	0	0	0	49.6189
266	0.06152	1625.97	5.03711E-06	0.001339811	0	49.6189	0	13.749	0	0.081	0.0094	10.0733	0	0	0	0	49.6095
267	0.06152	1625.97	5.03711E-06	0.001344848	0	49.6095	0	13.749	0	0.081	0.0112	10.0845	0	0	0	0	49.5984
268	0.06152	1625.97	5.03712E-06	0.001349886	0	49.5984	0	13.749	0	0.081	0.0098	10.0943	0	0	0	0	49.5886
269	0.06152	1625.97	5.03713E-06	0.001354923	0	49.5886	0	13.749	0	0.081	0.0125	10.1068	0	0	0	0	49.5761
270	0.06152	1625.97	5.03713E-06	0.00135996	0	49.5761	0	13.749	0	0.081	0.0135	10.1203	0	0	0	0	49.5626
271	0.06152	1625.97	5.03714E-06	0.001364997	0	49.5626	0	13.749	0	0.081	0.0084	10.1287	0	0	0	0	49.5542
272	0.06152	1625.97	5.03715E-06	0.001370034	0	49.5542	0.33	14.079	0	0.081	0.1064	10.2351	0	0	0	0	49.7777
273	0.06152	1625.97	5.03715E-06	0.001375071	0	49.7772	0.13	14.209	0	0.081	0.1275	10.3626	0	0	0	0	49.7797
274	0.06152	1625.97	5.03716E-06	0.001380108	0	49.7797	3.91	18.119	0	0.081	0.0784	10.441	0	0	0	0	53.6112
275	0.06152	1625.97	5.03717E-06	0.001385146	0	53.6103	1.36	19.479	0	0.081	0.4609	10.9019	0	0	0	0	54.5093
276	0.06152	1625.97	5.03718E-06	0.001390183	0	54.5093	1.05	20.529	0	0.081	0.6547	11.5566	0	0	0	0	54.9046
277	0.06152	1625.97	5.03718E-06	0.00139522	0	54.9046	0	20.529	0	0.081	0.2246	11.7812	0	0	0	0	54.68
278	0.06152	1625.97	5.03719E-06	0.001400257	0	54.6801	0	20.529	0	0.081	0.0877	11.8689	0	0	0	0	54.5924
279	0.06152	1625.97	5.0372E-06	0.001405294	0	54.5924	0	20.529	0	0.081	0.0785	11.9474	0	0	0	0	54.5139
280	0.06152	1625.96	5.03721E-06	0.001410332	0	54.5139	0	20.529	0	0.081	0.0799	12.0273	0	0	0	0	54.434
281	0.06152	1625.96	5.03721E-06	0.001415369	0	54.434	0	20.529	0	0.081	0.0835	12.1108	0	0	0	0	54.3505
282	0.06152	1625.96	5.03722E-06	0.001420406	0	54.3505	0	20.529	0	0.081	0.0833	12.1941	0	0	0	0	54.2672
283	0.06152	1625.96	5.03723E-06	0.001425443	0	54.2672	0	20.529	0	0.081	0.0844	12.2785	0	0	0	0	54.1828
284	0.06152	1625.96	5.03724E-06	0.00143048	0	54.1828	0	20.529	0	0.081	0.0897	12.3682	0	0	0	0	54.0931
285	0.06152	1625.96	5.03725E-06	0.001435518	0	54.0931	0	20.529	0	0.081	0.0398	12.408	0	0	0	0	54.0533
286	0.06152	1625.96	5.03726E-06	0.001440555	0	54.0534	0	20.529	0	0.081	0.0406	12.4486	0	0	0	0	54.0128
287	0.06152	1625.96	5.03727E-06	0.001445592	0	54.0128	0	20.529	0	0.081	0.043	12.4916	0	0	0	0	53.9697
288	0.06152	1625.96	5.03727E-06	0.001450629	0	53.9697	0	20.529	0	0.081	0.0396	12.5312	0	0	0	0	53.9301
289	0.06152	1625.96	5.03728E-06	0.001455667	0	53.9301	0	20.529	0	0.081	0.0466	12.5778	0	0	0	0	53.8835
290	0.06152	1625.96	5.03729E-06	0.001460704	0	53.8836	0	20.529	0	0.081	0.0493	12.6271	0	0	0	0	53.8342
291	0.06152	1625.95	5.0373E-06	0.001465741	0	53.8343	0	20.529	0	0.081	0.0299	12.657	0	0	0	0	53.8044
292	0.06152	1625.95	5.03731E-06	0.001470779	0	53.8044	0.28	20.809	0	0.081	0.0722	12.7292	0	0	0	0	54.0122
293	0.06152	1625.95	5.03732E-06	0.001475816	0	54.0118	1.98	22.789	0	0.081	0.0942	12.8234	0	0	0	0	55.8977
294	0.06152	1625.95	5.03733E-06	0.001480853	0	55.8972	1.22	24.009	0	0.081	0.0958	12.9192	0	0	0	0	57.0214

Scenario: 1998 Stormwater Recirculation Every Day

Day	Water (cm3/cm3)	Head (cm)	Water Flow (cm)	Water Flow (cm) Accum	Plant Sink (cm)	Prestor	Infil	Infil Accum	Runoff	Runoff Accum	Evapo	Evapo Accum	Trans	Trans Accum	Drain	Drain Accum	Newstor
295	0.06152	1625.95	5.03734E-06	0.001485891	0	57.0214	0.03	24.039	0	0.081	0.1981	13.1173	0	0	0	0	56.8533
296	0.06152	1625.95	5.03735E-06	0.001490928	0	56.8533	0.03	24.069	0	0.081	0.2297	13.347	0	0	0	0	56.6536
297	0.06152	1625.95	5.03736E-06	0.001495965	0	56.6536	0	24.069	0	0.081	0.1304	13.4774	0	0	0	0	56.5233
298	0.06152	1625.95	5.03737E-06	0.001501003	0	56.5233	0	24.069	0	0.081	0.0536	13.531	0	0	0	0	56.4698
299	0.06152	1625.95	5.03738E-06	0.00150604	0	56.4698	0	24.069	0	0.081	0.0561	13.5871	0	0	0	0	56.4136
300	0.06152	1625.95	5.03739E-06	0.001511077	0	56.4136	3.76	27.829	0	0.081	0	13.5871	0	0	0	0	60.1736
301	0.06152	1625.94	5.0374E-06	0.001516115	0	60.1736	1.2	29.029	0	0.081	0.2783	13.8654	0	0	0	0	61.0953
302	0.06152	1625.94	5.03742E-06	0.001521152	0	61.0953	0.91	29.939	0	0.081	0.4076	14.273	0	0	0	0	61.5977
303	0.06152	1625.94	5.03743E-06	0.00152619	0	61.5977	3.8291	33.7681	0.7209	0.8019	0.3894	14.6624	0	0	0	0	65.0374
304	0.06152	1625.94	5.03744E-06	0.001531227	0	65.0494	1.66	35.4281	0	0.8019	0.1641	14.8265	0	0	0	0	66.5453
305	0.06152	1625.94	5.03745E-06	0.001536265	0	66.5452	1.28	36.7081	0	0.8019	0.254	15.0805	0	0	0	0	67.5713
306	0.06152	1625.94	5.03746E-06	0.001541302	0	67.5712	0.52	37.2281	0	0.8019	0.4414	15.5219	0	0	0	0	67.6498
307	0.06152	1625.94	5.03747E-06	0.00154634	0	67.6498	0	37.2281	0	0.8019	0.3409	15.8628	0	0	0	0	67.3089
308	0.06152	1625.94	5.03748E-06	0.001551377	0	67.309	0.03	37.2581	0	0.8019	0.1445	16.0073	0	0	0	0	67.1945
309	0.06152	1625.93	5.0375E-06	0.001556415	0	67.1944	0.05	37.3081	0	0.8019	0.1688	16.1761	0	0	0	0	67.0756
310	0.06152	1625.93	5.03751E-06	0.001561452	0	67.0756	0	37.3081	0	0.8019	0.1685	16.3446	0	0	0	0	66.9071
311	0.06152	1625.93	5.03752E-06	0.00156649	0	66.9072	0	37.3081	0	0.8019	0.0553	16.3999	0	0	0	0	66.8519
312	0.06152	1625.93	5.03753E-06	0.001571527	0	66.8519	0	37.3081	0	0.8019	0.0665	16.4664	0	0	0	0	66.7854
313	0.06152	1625.93	5.03755E-06	0.001576565	0	66.7854	0	37.3081	0	0.8019	0.0779	16.5443	0	0	0	0	66.7074
314	0.06152	1625.93	5.03756E-06	0.001581602	0	66.7074	0	37.3081	0	0.8019	0.0794	16.6237	0	0	0	0	66.628
315	0.06152	1625.93	5.03757E-06	0.00158664	0	66.628	0	37.3081	0	0.8019	0.0639	16.6876	0	0	0	0	66.5641
316	0.06152	1625.93	5.03759E-06	0.001591677	0	66.5641	0	37.3081	0	0.8019	0.0504	16.738	0	0	0	0	66.5136
317	0.06152	1625.92	5.0376E-06	0.001596715	0	66.5136	0	37.3081	0	0.8019	0.0549	16.7929	0	0	0	0	66.4587
318	0.06152	1625.92	5.03761E-06	0.001601753	0	66.4587	0	37.3081	0	0.8019	0.069	16.8619	0	0	0	0	66.3898
319	0.06152	1625.92	5.03763E-06	0.00160679	0	66.3898	0	37.3081	0	0.8019	0.0695	16.9314	0	0	0	0	66.3203
320	0.06152	1625.92	5.03764E-06	0.001611828	0	66.3203	0	37.3081	0	0.8019	0.072	17.0034	0	0	0	0	66.2483
321	0.06152	1625.92	5.03766E-06	0.001616866	0	66.2483	0	37.3081	0	0.8019	0.065	17.0684	0	0	0	0	66.1833
322	0.06152	1625.92	5.03767E-06	0.001621903	0	66.1833	0	37.3081	0	0.8019	0.0586	17.127	0	0	0	0	66.1248
323	0.06152	1625.92	5.03769E-06	0.001626941	0	66.1248	0	37.3081	0	0.8019	0.0409	17.1679	0	0	0	0	66.0839
324	0.06152	1625.91	5.0377E-06	0.001631979	0	66.0839	0	37.3081	0	0.8019	0.021	17.1889	0	0	0	0	66.0629
325	0.06152	1625.91	5.03772E-06	0.001637016	0	66.0629	0	37.3081	0	0.8019	0.0362	17.2251	0	0	0	0	66.0267
326	0.06152	1625.91	5.03773E-06	0.001642054	0	66.0267	0	37.3081	0	0.8019	0.0408	17.2659	0	0	0	0	65.9859
327	0.06152	1625.91	5.03775E-06	0.001647092	0	65.9859	0	37.3081	0	0.8019	0.0422	17.3081	0	0	0	0	65.9437
328	0.06152	1625.91	5.03776E-06	0.00165213	0	65.9437	0	37.3081	0	0.8019	0.0391	17.3472	0	0	0	0	65.9046
329	0.06152	1625.91	5.03778E-06	0.001657167	0	65.9046	0	37.3081	0	0.8019	0.0428	17.39	0	0	0	0	65.8618
330	0.06152	1625.91	5.03779E-06	0.001662205	0	65.8618	0	37.3081	0	0.8019	0.039	17.429	0	0	0	0	65.8228
331	0.06152	1625.9	5.03781E-06	0.001667243	0	65.8228	0	37.3081	0	0.8019	0.0356	17.4646	0	0	0	0	65.7872
332	0.06152	1625.9	5.03783E-06	0.001672281	0	65.7872	0	37.3081	0	0.8019	0.0332	17.4978	0	0	0	0	65.754
333	0.06152	1625.9	5.03784E-06	0.001677319	0	65.754	0.48	37.7881	0	0.8019	0.0288	17.5266	0	0	0	0	66.2052
334	0.06152	1625.9	5.03786E-06	0.001682356	0	66.2048	0	37.7881	0	0.8019	0.1385	17.6651	0	0	0	0	66.0664
335	0.06152	1625.9	5.03788E-06	0.001687394	0	66.0665	0.25	38.0381	0	0.8019	0.102	17.7671	0	0	0	0	66.2144
336	0.06152	1625.9	5.03789E-06	0.001692432	0	66.2143	1.4	39.4381	0	0.8019	0.1399	17.907	0	0	0	0	67.4744

Scenario: 1998 Stormwater Recirculation Every Day

Day	Water (cm3/cm3)	Head (cm)	Water Flow (cm)	Water Flow (cm) Accum	Plant Sink (cm)	Prestor	Infil	Infil Accum	Runoff	Runoff Accum	Evapo	Evapo Accum	Trans	Trans Accum	Drain	Drain Accum	Newstor
337	0.06152	1625.89	5.03791E-06	0.00169747	0	67.4741	0.45	39.8881	0	0.8019	0.2396	18.1466	0	0	0	0	67.6845
338	0.06152	1625.89	5.03793E-06	0.001702508	0	67.6845	0	39.8881	0	0.8019	0.242	18.3886	0	0	0	0	67.4426
339	0.06152	1625.89	5.03795E-06	0.001707546	0	67.4427	0	39.8881	0	0.8019	0.0759	18.4645	0	0	0	0	67.3667
340	0.06152	1625.89	5.03796E-06	0.001712584	0	67.3667	0	39.8881	0	0.8019	0.0679	18.5324	0	0	0	0	67.2988
341	0.06152	1625.89	5.03798E-06	0.001717622	0	67.2988	0	39.8881	0	0.8019	0.0532	18.5856	0	0	0	0	67.2456
342	0.06152	1625.88	0.000005038	0.00172266	0	67.2456	0	39.8881	0	0.8019	0.0565	18.6421	0	0	0	0	67.1891
343	0.06152	1625.88	5.03802E-06	0.001727698	0	67.1891	0	39.8881	0	0.8019	0.0473	18.6894	0	0	0	0	67.1418
344	0.06152	1625.88	5.03804E-06	0.001732736	0	67.1418	0.13	40.0181	0	0.8019	0.0602	18.7496	0	0	0	0	67.2115
345	0.06152	1625.88	5.03806E-06	0.001737774	0	67.2114	0	40.0181	0	0.8019	0.0995	18.8491	0	0	0	0	67.1119
346	0.06152	1625.88	5.03808E-06	0.001742812	0	67.112	0	40.0181	0	0.8019	0.0595	18.9086	0	0	0	0	67.0525
347	0.06152	1625.87	5.0381E-06	0.00174785	0	67.0525	0	40.0181	0	0.8019	0.064	18.9726	0	0	0	0	66.9884
348	0.06152	1625.87	5.03812E-06	0.001752888	0	66.9885	0	40.0181	0	0.8019	0.0565	19.0291	0	0	0	0	66.9319
349	0.06152	1625.87	5.03814E-06	0.001757927	0	66.932	0	40.0181	0	0.8019	0.0533	19.0824	0	0	0	0	66.8787
350	0.06152	1625.87	5.03816E-06	0.001762965	0	66.8787	0	40.0181	0	0.8019	0.0564	19.1388	0	0	0	0	66.8222
351	0.06152	1625.87	5.03818E-06	0.001768003	0	66.8223	0	40.0181	0	0.8019	0.0421	19.1809	0	0	0	0	66.7802
352	0.06152	1625.86	5.0382E-06	0.001773041	0	66.7802	0.25	40.2681	0	0.8019	0.1209	19.3018	0	0	0	0	66.9093
353	0.06152	1625.86	5.03822E-06	0.001778079	0	66.9091	0	40.2681	0	0.8019	0.0723	19.3741	0	0	0	0	66.8368
354	0.06152	1625.86	5.03824E-06	0.001783118	0	66.8369	0	40.2681	0	0.8019	0.0685	19.4426	0	0	0	0	66.7684
355	0.06152	1625.86	5.03826E-06	0.001788156	0	66.7684	0	40.2681	0	0.8019	0.0569	19.4995	0	0	0	0	66.7114
356	0.06152	1625.86	5.03828E-06	0.001793194	0	66.7115	0	40.2681	0	0.8019	0.0413	19.5408	0	0	0	0	66.6701
357	0.06152	1625.85	5.0383E-06	0.001798232	0	66.6702	0	40.2681	0	0.8019	0.0336	19.5744	0	0	0	0	66.6366
358	0.06152	1625.85	5.03832E-06	0.001803271	0	66.6366	0	40.2681	0	0.8019	0.0312	19.6056	0	0	0	0	66.6054
359	0.06152	1625.85	5.03835E-06	0.001808309	0	66.6054	0	40.2681	0	0.8019	0.0415	19.6471	0	0	0	0	66.5639
360	0.06152	1625.85	5.03837E-06	0.001813347	0	66.5639	0	40.2681	0	0.8019	0.0359	19.683	0	0	0	0	66.528
361	0.06152	1625.84	5.03839E-06	0.001818386	0	66.528	0	40.2681	0	0.8019	0.0317	19.7147	0	0	0	0	66.4964
362	0.06152	1625.84	5.03841E-06	0.001823424	0	66.4964	0	40.2681	0	0.8019	0.0295	19.7442	0	0	0	0	66.4668
363	0.06152	1625.84	5.03844E-06	0.001828463	0	66.4668	0	40.2681	0	0.8019	0.0298	19.774	0	0	0	0	66.437
364	0.06152	1625.84	5.03846E-06	0.001833501	0	66.4371	0	40.2681	0	0.8019	0.0206	19.7946	0	0	0	0	66.4165
365	0.06152	1625.84	5.03848E-06	0.00183854	0	66.4165	0	40.2681	0	0.8019	0.0151	19.8097	0	0	0	0	66.4013

Scenario: 1998 Stormwater Recirculation Every Day

Day	Storage	Mass Balance	Evap Potential	Evap Actual	Trans Potential	Trans Actual	Precip
1	45.903	-0.000075365	0.1897	0.0284	0	0	0
2	45.8999	2.9371E-06	0.1766	0.0031	0	0	0
3	45.8944	-1.7833E-06	0.1814	0.0055	0	0	0
4	45.8944	0.000002529	0.144	0	0	0	0
5	45.8805	-0.000034738	0.2343	0.0139	0	0	0
6	45.873	-0.000011714	0.25	0.0075	0	0	0
7	45.862	-0.000020548	0.2868	0.011	0	0	0
8	45.8503	-0.000021635	0.2895	0.0117	0	0	0
9	45.8414	-0.000012475	0.3135	0.009	0	0	0
10	45.8348	-5.7348E-06	0.243	0.0066	0	0	0
11	45.8269	-8.1821E-06	0.3746	0.0079	0	0	0
12	45.8197	-0.000012341	0.3906	0.0072	0	0	0
13	45.8197	1.1029E-06	0.1006	0	0	0	0
14	45.809	-0.000019933	0.4959	0.0108	0	0	0
15	45.8006	-0.000016205	0.3605	0.0084	0	0	0
16	45.7919	-0.000011943	0.5511	0.0087	0	0	0
17	45.7847	-0.000009986	0.4344	0.0072	0	0	0
18	45.7762	-8.9756E-06	0.6722	0.0085	0	0	0
19	45.7696	-8.9954E-06	0.4041	0.0066	0	0	0
20	45.7602	-5.8238E-06	0.6199	0.0094	0	0	0
21	45.7554	-8.2822E-06	0.3062	0.0048	0	0	0
22	45.7508	-3.1679E-06	0.4636	0.0046	0	0	0
23	45.7421	-3.4539E-06	0.5314	0.0086	0	0	0
24	45.7363	-1.4117E-06	0.5218	0.0058	0	0	0
25	45.7272	-3.9717E-06	0.8933	0.0091	0	0	0
26	45.7202	-8.0456E-06	0.6294	0.007	0	0	0
27	45.7126	-8.6042E-06	0.483	0.0076	0	0	0
28	45.7056	-9.9204E-07	0.5863	0.007	0	0	0
29	45.7005	-2.8248E-06	0.5684	0.0051	0	0	0
30	45.6937	-1.4864E-06	0.6562	0.0069	0	0	0
31	45.6869	-4.6758E-06	0.7275	0.0067	0	0	0
32	45.6826	-4.5228E-06	0.5691	0.0043	0	0	0
33	45.6763	5.7231E-07	0.4702	0.0063	0	0	0
34	45.671	-4.9727E-07	0.6485	0.0053	0	0	0
35	45.7818	0.00028552	0.1453	0.0189	0	0	0.13
36	45.8231	0.000091938	0.1812	0.0586	0	0	0.1
37	45.7599	-0.00010832	0.491	0.0633	0	0	0
38	45.7315	-0.000058181	0.5007	0.0285	0	0	0
39	45.7041	-0.00006944	0.9658	0.0274	0	0	0
40	45.6896	-0.000025696	0.4752	0.0146	0	0	0
41	45.6783	-0.000019904	0.541	0.0113	0	0	0
42	45.6694	-0.000013525	0.4737	0.0088	0	0	0

Scenario: 1998 Stormwater Recirculation Every Day

Day	Storage	Mass Balance	Evap Potential	Evap Actual	Trans Potential	Trans Actual	Precip
43	45.6668	-2.6793E-06	0.3681	0.0026	0	0	0
44	45.6599	-0.000001327	0.5761	0.0069	0	0	0
45	45.6536	4.1209E-08	0.6463	0.0063	0	0	0
46	45.6547	0.000021659	0.3542	0.0289	0	0	0.03
47	45.6466	-5.8843E-06	0.6766	0.0082	0	0	0
48	45.6417	-3.3721E-07	0.6599	0.0049	0	0	0
49	45.6696	0.000089897	0.4375	0.0521	0	0	0.08
50	45.6408	-0.000077506	0.5809	0.0289	0	0	0
51	45.6371	4.8216E-07	0.3724	0.0036	0	0	0
52	45.6319	-5.7385E-07	0.6659	0.0052	0	0	0
53	45.6253	2.5391E-07	0.6909	0.0066	0	0	0
54	45.6194	8.1682E-07	0.8625	0.006	0	0	0
55	45.6126	-1.2331E-07	1.1992	0.0068	0	0	0
56	45.6067	-3.0145E-06	1.1834	0.0059	0	0	0
57	45.6001	-3.5131E-08	1.1448	0.0065	0	0	0
58	45.5951	-2.0011E-06	0.6096	0.005	0	0	0
59	45.5911	-3.3854E-06	0.517	0.004	0	0	0
60	45.5844	-8.3869E-07	0.8418	0.0067	0	0	0
61	45.58	-3.0685E-06	0.6621	0.0044	0	0	0
62	45.5745	-1.4843E-07	0.7909	0.0055	0	0	0
63	45.569	-1.7143E-06	0.8771	0.0055	0	0	0
64	45.5655	-3.7349E-06	0.8789	0.0035	0	0	0
65	45.5636	-3.9539E-06	0.6178	0.0019	0	0	0
66	45.6289	0.00017253	0.7082	0.0645	0	0	0.13
67	45.5783	-0.00010479	0.6027	0.0507	0	0	0
68	45.5632	-0.000042879	0.4537	0.0152	0	0	0
69	45.5569	9.2268E-07	0.6658	0.0062	0	0	0
70	45.554	-9.9077E-07	0.5044	0.0029	0	0	0
71	45.5511	-1.2956E-07	0.5094	0.003	0	0	0
72	45.5469	1.1008E-06	0.6415	0.0041	0	0	0
73	45.5462	-2.7968E-06	0.5283	0.0008	0	0	0
74	46.0071	0.0007481	0.5245	0.0684	0	0	0.53
75	46.9823	0.00065433	0.2695	0.1141	0	0	1.09
76	47.1353	0.0002909	0.2461	0.2067	0	0	0.36
77	46.9515	-0.000081478	0.615	0.2138	0	0	0.03
78	46.8856	-7.3773E-06	0.7141	0.0659	0	0	0
79	46.8363	-0.000004359	0.4271	0.0493	0	0	0
80	46.7735	-0.00001358	0.7658	0.0628	0	0	0
81	46.7083	-0.000075711	0.8031	0.0653	0	0	0
82	46.6592	-0.000040272	0.9376	0.0491	0	0	0
83	46.6224	-0.000039715	1.1288	0.0369	0	0	0
84	46.5867	-0.000053672	1.2183	0.0357	0	0	0

Scenario: 1998 Stormwater Recirculation Every Day

Day	Storage	Mass Balance	Evap Potential	Evap Actual	Trans Potential	Trans Actual	Precip
85	46.5644	-5.4314E-06	1.2359	0.0224	0	0	0
86	46.5397	-0.000018231	1.3788	0.0246	0	0	0
87	46.5165	-0.000036527	1.0891	0.0233	0	0	0
88	46.4947	-0.0000162	1.5362	0.0218	0	0	0
89	46.5229	0.00010525	0.6079	0.0717	0	0	0.1
90	46.477	-0.0001288	1.0033	0.0461	0	0	0
91	46.4568	-0.000036357	0.9965	0.0202	0	0	0
92	46.4375	-0.000020633	1.4088	0.0194	0	0	0
93	46.4236	-0.000012931	0.8243	0.0139	0	0	0
94	46.4097	-9.3231E-06	0.9557	0.0138	0	0	0
95	46.3952	-0.000025933	1.1147	0.0146	0	0	0
96	46.3821	-5.6451E-06	1.1657	0.013	0	0	0
97	46.3692	-0.000013252	1.0839	0.0129	0	0	0
98	46.3567	-0.000015873	1.2205	0.0125	0	0	0
99	46.3466	-3.7418E-06	0.8049	0.01	0	0	0
100	46.3347	-0.000011321	1.0747	0.0119	0	0	0
101	46.3249	-0.000010309	1.2112	0.0098	0	0	0
102	46.313	-4.1114E-06	1.5353	0.0119	0	0	0
103	46.3022	-0.000011464	1.1322	0.0108	0	0	0
104	46.2906	-0.000015252	1.2389	0.0116	0	0	0
105	46.2807	-9.7157E-07	1.2219	0.0099	0	0	0
106	46.2736	-2.6963E-06	1.0782	0.0071	0	0	0
107	46.3626	0.00024774	0.311	0.0407	0	0	0.13
108	46.3067	-0.00012164	0.5286	0.056	0	0	0
109	46.2794	-0.000078189	0.7616	0.0274	0	0	0
110	46.2666	-0.000019272	1.0494	0.0129	0	0	0
111	46.259	-5.3622E-06	0.7879	0.0075	0	0	0
112	46.2503	-4.7682E-07	0.9424	0.0087	0	0	0
113	46.2419	-2.1294E-06	0.9387	0.0084	0	0	0
114	46.2325	-7.1755E-06	1.5496	0.0095	0	0	0
115	46.2237	-0.000015416	1.3224	0.0088	0	0	0
116	46.2189	-3.3105E-06	0.7774	0.0047	0	0	0
117	46.2139	-6.1546E-07	0.7941	0.0051	0	0	0
118	46.2091	-7.2826E-07	0.6967	0.0047	0	0	0
119	46.202	-7.4539E-07	0.8458	0.0071	0	0	0
120	46.1937	-5.5964E-07	1.0178	0.0083	0	0	0
121	46.1856	-3.9448E-06	1.0061	0.0081	0	0	0
122	46.1779	-8.5619E-06	1.1553	0.0077	0	0	0
123	46.1725	-4.0924E-06	0.9251	0.0055	0	0	0
124	46.1636	3.4239E-07	1.2001	0.0089	0	0	0
125	46.1557	-7.0187E-07	1.5191	0.0078	0	0	0
126	46.1485	-2.5834E-06	1.1132	0.0073	0	0	0

Scenario: 1998 Stormwater Recirculation Every Day

Day	Storage	Mass Balance	Evap Potential	Evap Actual	Trans Potential	Trans Actual	Precip
127	46.1413	-3.8911E-06	1.2142	0.0072	0	0	0
128	46.1339	-7.4177E-06	1.2597	0.0073	0	0	0
129	46.1276	-3.3309E-06	1.3702	0.0063	0	0	0
130	46.1216	-3.6688E-07	1.4738	0.006	0	0	0
131	46.1142	1.4529E-06	1.5152	0.0074	0	0	0
132	46.1076	-1.2197E-06	1.3395	0.0066	0	0	0
133	46.101	-2.0609E-06	1.3045	0.0067	0	0	0
134	46.0946	-3.5558E-06	1.0186	0.0063	0	0	0
135	46.0881	-4.6588E-06	1.4875	0.0065	0	0	0
136	46.0821	-1.2463E-06	1.2473	0.006	0	0	0
137	46.0775	-1.9031E-06	0.7253	0.0047	0	0	0
138	46.0722	-1.7718E-07	1.0814	0.0052	0	0	0
139	46.0672	-5.5102E-07	1.3651	0.0051	0	0	0
140	46.0617	-2.0954E-07	1.0957	0.0054	0	0	0
141	46.0563	-8.1374E-07	1.1151	0.0055	0	0	0
142	46.0498	1.7222E-07	1.3877	0.0065	0	0	0
143	46.0431	-5.3127E-09	1.1542	0.0067	0	0	0
144	46.037	-9.5217E-07	1.3058	0.0061	0	0	0
145	46.0342	-7.2618E-06	1.1847	0.0028	0	0	0
146	46.0319	-4.0738E-06	1.0669	0.0023	0	0	0
147	46.0249	2.1688E-06	1.2297	0.0071	0	0	0
148	46.0183	0.000002303	1.386	0.0065	0	0	0
149	46.0127	-4.4892E-07	1.4668	0.0057	0	0	0
150	46.0071	-1.6586E-06	1.5477	0.0056	0	0	0
151	46.0015	-2.5596E-06	1.2995	0.0055	0	0	0
152	45.9959	-5.1804E-07	1.3713	0.0056	0	0	0
153	45.9905	-5.4416E-07	1.527	0.0054	0	0	0
154	45.9855	-1.9167E-06	1.3207	0.005	0	0	0
155	45.98	-1.3613E-06	1.8153	0.0055	0	0	0
156	45.9772	-5.2142E-06	1.3767	0.0028	0	0	0
157	45.9752	-3.6604E-06	0.9827	0.0019	0	0	0
158	45.9714	5.0683E-07	1.2313	0.0039	0	0	0
159	45.9651	1.1996E-06	1.6571	0.0063	0	0	0
160	45.9595	1.5051E-06	1.3237	0.0055	0	0	0
161	46.3296	0.00065551	0.687	0.0893	0	0	0.46
162	46.2092	-0.000033968	1.2273	0.1204	0	0	0
163	46.1513	-0.00010159	1.4871	0.0579	0	0	0
164	46.116	-0.00006388	1.7636	0.0354	0	0	0
165	46.0875	-0.000049342	1.7043	0.0285	0	0	0
166	46.0697	-0.000029367	1.5042	0.0179	0	0	0
167	46.0508	-0.000036268	1.7137	0.0189	0	0	0
168	46.0336	-0.000036101	1.7678	0.0173	0	0	0

Scenario: 1998 Stormwater Recirculation Every Day

Day	Storage	Mass Balance	Evap Potential	Evap Actual	Trans Potential	Trans Actual	Precip
169	46.0191	-0.000023964	1.3893	0.0145	0	0	0
170	46.0059	-0.000023582	1.2628	0.0131	0	0	0
171	45.9937	-0.000015535	1.4216	0.0123	0	0	0
172	45.983	-0.000014371	1.5283	0.0106	0	0	0
173	45.974	-0.000010034	1.3103	0.009	0	0	0
174	45.967	-8.1129E-06	1.5589	0.0071	0	0	0
175	45.9604	-2.9247E-06	1.597	0.0066	0	0	0
176	45.9545	-1.0575E-06	1.5238	0.0059	0	0	0
177	45.9488	2.486E-07	1.5906	0.0057	0	0	0
178	45.9428	1.2706E-06	1.2461	0.006	0	0	0
179	45.9382	-0.000001332	1.3418	0.0046	0	0	0
180	45.9348	-2.5569E-06	1.5895	0.0035	0	0	0
181	45.9323	-2.9268E-06	1.3871	0.0025	0	0	0
182	45.9294	-8.4897E-07	1.2705	0.0029	0	0	0
183	46.287	0.00063822	0.551	0.0717	0	0	0.43
184	46.1779	-0.000019333	0.9585	0.1091	0	0	0
185	47.5592	-0.0014777	1.0306	0.1759	0	0	1.57
186	47.63	0.00012275	1.3128	0.4891	0	0	0.56
187	47.5526	1.8449E-06	1.1506	0.0773	0	0	0
188	47.4781	-0.00001412	1.378	0.0745	0	0	0
189	47.7355	0.00018195	1.5115	0.2523	0	0	0.51
190	47.5934	-0.000061863	1.1785	0.1722	0	0	0.03
191	47.5227	-0.000018545	0.9858	0.0707	0	0	0
192	47.435	-0.000058658	1.1375	0.0877	0	0	0
193	47.386	-0.000037142	1.351	0.0491	0	0	0
194	47.3437	-0.000017879	1.2497	0.0423	0	0	0
195	47.3059	-0.000050596	1.3232	0.0379	0	0	0
196	47.7263	0.00044553	1.2878	0.1892	0	0	0.61
197	47.5969	-0.000091136	1.0558	0.1294	0	0	0
198	47.528	-0.000015919	0.9953	0.0689	0	0	0
199	47.4639	-0.000072716	0.9559	0.0641	0	0	0
200	47.418	-0.000026265	1.3535	0.046	0	0	0
201	47.3817	-0.000042504	1.3321	0.0363	0	0	0
202	47.352	-0.000014048	1.3539	0.0297	0	0	0
203	47.3256	-0.000036196	1.6168	0.0264	0	0	0
204	47.3053	-4.5732E-06	1.138	0.0203	0	0	0
205	47.2836	-0.000015871	1.2097	0.0217	0	0	0
206	47.2657	-0.000022622	0.7951	0.0179	0	0	0
207	47.2513	-1.9167E-06	0.6265	0.0145	0	0	0
208	47.2379	-2.1613E-06	0.6803	0.0133	0	0	0
209	47.2212	-0.000016833	1.2133	0.0168	0	0	0
210	47.2038	-0.000026116	1.2565	0.0173	0	0	0

Scenario: 1998 Stormwater Recirculation Every Day

Day	Storage	Mass Balance	Evap Potential	Evap Actual	Trans Potential	Trans Actual	Precip
211	48.7618	-0.0016906	1.3143	0.1807	0	0	1.78
212	49.049	0.000019661	0.5444	0.4028	0	0	0.69
213	48.884	-0.000096588	0.8493	0.165	0	0	0
214	49.2385	0.00019384	0.9677	0.1753	0	0	0.53
215	49.0665	-0.00010563	0.7846	0.1721	0	0	0
216	49.0093	-4.5476E-06	0.569	0.0572	0	0	0
217	49.1544	0.00013518	0.5483	0.1048	0	0	0.25
218	49.0313	-0.000085969	0.8326	0.1232	0	0	0
219	48.956	-0.0000189	1.2486	0.0753	0	0	0
220	48.8736	-0.000036517	1.5931	0.0825	0	0	0
221	48.8197	-0.000050114	1.3155	0.0539	0	0	0
222	48.7765	-0.000012377	1.0245	0.0432	0	0	0
223	48.7407	-5.6613E-06	1.0984	0.0659	0	0	0.03
224	50.3488	-0.0019184	0.7742	0.1202	0	0	1.75
225	50.6578	8.3804E-06	0.7074	0.481	0	0	0.79
226	50.4687	-0.00010376	0.9489	0.1892	0	0	0
227	50.3906	-8.5585E-06	0.9204	0.0781	0	0	0
228	50.3139	-8.8763E-06	0.9965	0.0766	0	0	0
229	50.2456	-6.5985E-06	0.9611	0.0684	0	0	0
230	50.1864	-5.4984E-06	0.9639	0.0592	0	0	0
231	50.3486	0.00016588	0.7842	0.1377	0	0	0.3
232	50.2847	-0.000014905	0.6064	0.1638	0	0	0.1
233	50.1984	-0.000069054	0.8332	0.0864	0	0	0
234	50.1297	-0.000020032	0.7542	0.0687	0	0	0
235	50.0739	-0.00005872	0.8664	0.0559	0	0	0
236	50.0394	-2.6597E-06	1.0705	0.0344	0	0	0
237	50.0085	-0.000002767	0.8969	0.031	0	0	0
238	50.1657	0.00021429	0.9378	0.1426	0	0	0.3
239	50.0997	-0.000043739	1.0228	0.066	0	0	0
240	50.2268	0.00015442	0.8514	0.1527	0	0	0.28
241	50.1161	-0.000087445	1.0117	0.1109	0	0	0
242	50.0458	-0.000077706	0.9353	0.0703	0	0	0
243	50.0021	-0.0000144	1.1828	0.0437	0	0	0
244	49.9645	-0.000044503	0.8079	0.0377	0	0	0
245	49.9365	-5.5756E-06	0.8561	0.028	0	0	0
246	49.906	-0.000018047	0.9386	0.0305	0	0	0
247	49.8779	-0.000038645	1.0448	0.0281	0	0	0
248	49.856	-3.8686E-06	1.1123	0.022	0	0	0
249	49.8335	-0.000012802	1.0443	0.0225	0	0	0
250	49.8108	-0.000035854	0.9046	0.0227	0	0	0
251	49.7916	-3.1859E-06	0.9969	0.0192	0	0	0
252	49.7789	-1.2214E-06	0.9023	0.0127	0	0	0

Scenario: 1998 Stormwater Recirculation Every Day

Day	Storage	Mass Balance	Evap Potential	Evap Actual	Trans Potential	Trans Actual	Precip
253	49.7642	-1.0659E-06	1.0797	0.0147	0	0	0
254	49.7472	-0.000011932	0.9211	0.017	0	0	0
255	49.7322	-0.000018041	0.9019	0.015	0	0	0
256	49.7169	-9.9966E-06	1.0018	0.0153	0	0	0
257	49.7837	0.00019936	1.1608	0.0829	0	0	0.15
258	49.7332	-0.000092954	0.9098	0.0506	0	0	0
259	49.7108	-0.000054497	0.7314	0.0225	0	0	0
260	49.6943	-0.000027485	0.8747	0.0165	0	0	0
261	49.6785	-0.000020357	0.9564	0.0158	0	0	0
262	49.6612	-0.00002063	1.0927	0.0173	0	0	0
263	49.6445	-0.000016851	0.9416	0.0167	0	0	0
264	49.629	-0.000014868	1.0432	0.0155	0	0	0
265	49.6189	-1.8899E-06	1.0964	0.0101	0	0	0
266	49.6095	-7.8575E-07	0.9852	0.0094	0	0	0
267	49.5984	-1.1854E-06	1.3416	0.0112	0	0	0
268	49.5886	-2.0021E-06	1.2632	0.0098	0	0	0
269	49.5761	-0.00001239	1.3206	0.0125	0	0	0
270	49.5626	-0.000012297	0.9824	0.0135	0	0	0
271	49.5542	-1.9628E-06	0.7599	0.0084	0	0	0
272	49.7772	0.00051933	0.7724	0.1064	0	0	0.33
273	49.7797	7.5994E-06	0.8615	0.1275	0	0	0.13
274	53.6103	0.00096148	0.6598	0.0784	0	0	3.91
275	54.5093	0.000039346	0.9219	0.4609	0	0	1.36
276	54.9046	-8.9327E-06	1.1097	0.6547	0	0	1.05
277	54.6801	-0.000096446	1.1964	0.2246	0	0	0
278	54.5924	6.3567E-08	0.8601	0.0877	0	0	0
279	54.5139	-2.2258E-06	0.7758	0.0785	0	0	0
280	54.434	-3.7615E-06	0.8281	0.0799	0	0	0
281	54.3505	-6.0349E-06	0.7577	0.0835	0	0	0
282	54.2672	-8.4802E-06	0.7966	0.0833	0	0	0
283	54.1828	-0.0000157	1.1453	0.0844	0	0	0
284	54.0931	-0.00005001	0.9378	0.0897	0	0	0
285	54.0534	-0.00002897	0.8991	0.0398	0	0	0
286	54.0128	-2.3932E-06	0.8365	0.0406	0	0	0
287	53.9697	-0.000002317	1.2488	0.043	0	0	0
288	53.9301	-1.6703E-06	1.1182	0.0396	0	0	0
289	53.8836	-0.000016267	1.464	0.0466	0	0	0
290	53.8343	-0.000059638	1.0168	0.0493	0	0	0
291	53.8044	-0.000001175	0.7591	0.0299	0	0	0
292	54.0118	0.00032174	0.4129	0.0722	0	0	0.28
293	55.8972	0.00044081	0.21	0.0942	0	0	1.98
294	57.0214	0.000041064	0.1808	0.0958	0	0	1.22

Scenario: 1998 Stormwater Recirculation Every Day

Day	Storage	Mass Balance	Evap Potential	Evap Actual	Trans Potential	Trans Actual	Precip
295	56.8533	-0.000017279	0.2107	0.1981	0	0	0.03
296	56.6536	-0.000021178	0.2443	0.2297	0	0	0.03
297	56.5233	-0.0000857	0.5039	0.1304	0	0	0
298	56.4698	-0.000001171	0.5121	0.0536	0	0	0
299	56.4136	-1.6148E-06	0.8019	0.0561	0	0	0
300	60.1736	0.000053579	0.3565	0	0	0	3.76
301	61.0953	0.000020866	0.5566	0.2783	0	0	1.2
302	61.5977	0.000013151	0.6083	0.4076	0	0	0.91
303	65.0494	-0.012026	0.5112	0.3894	0	0	4.55
304	66.5452	0.000060351	0.3731	0.1641	0	0	1.66
305	67.5712	0.000037428	0.5079	0.254	0	0	1.28
306	67.6498	5.8552E-06	0.5518	0.4414	0	0	0.52
307	67.309	-0.00011266	0.5212	0.3409	0	0	0
308	67.1944	0.000046604	0.1541	0.1445	0	0	0.03
309	67.0756	4.9472E-06	0.1796	0.1688	0	0	0.05
310	66.9072	-0.000080193	0.2382	0.1685	0	0	0
311	66.8519	0.000012585	0.5531	0.0553	0	0	0
312	66.7854	2.7107E-06	0.6802	0.0665	0	0	0
313	66.7074	-1.2004E-06	1.2435	0.0779	0	0	0
314	66.628	-1.3973E-06	0.7516	0.0794	0	0	0
315	66.5641	4.4401E-07	0.5977	0.0639	0	0	0
316	66.5136	1.0986E-06	0.3187	0.0504	0	0	0
317	66.4587	1.0194E-06	0.5958	0.0549	0	0	0
318	66.3898	-0.000003233	0.5609	0.069	0	0	0
319	66.3203	-4.5058E-06	0.6855	0.0695	0	0	0
320	66.2483	-0.000014397	0.6904	0.072	0	0	0
321	66.1833	-0.000012674	0.6164	0.065	0	0	0
322	66.1248	-0.00005926	0.7721	0.0586	0	0	0
323	66.0839	-6.334E-07	0.698	0.0409	0	0	0
324	66.0629	9.0066E-07	0.213	0.021	0	0	0
325	66.0267	-0.00000653	0.6057	0.0362	0	0	0
326	65.9859	-2.6225E-06	0.5516	0.0408	0	0	0
327	65.9437	-1.6845E-06	0.614	0.0422	0	0	0
328	65.9046	-1.0968E-06	0.5208	0.0391	0	0	0
329	65.8618	-4.7594E-06	0.6294	0.0428	0	0	0
330	65.8228	-2.6024E-06	0.5446	0.039	0	0	0
331	65.7872	-1.6921E-06	0.5165	0.0356	0	0	0
332	65.754	-1.3019E-06	0.4256	0.0332	0	0	0
333	66.2048	0.00035134	0.1843	0.0288	0	0	0.48
334	66.0665	-0.000094738	0.4741	0.1385	0	0	0
335	66.2143	0.00014011	0.4703	0.102	0	0	0.25
336	67.4741	0.00028861	0.176	0.1399	0	0	1.4

Scenario: 1998 Stormwater Recirculation Every Day

Day	Storage	Mass Balance	Evap Potential	Evap Actual	Trans Potential	Trans Actual	Precip
337	67.6845	-1.1416E-06	0.2818	0.2396	0	0	0.45
338	67.4427	-0.00011071	0.5108	0.242	0	0	0
339	67.3667	-3.5361E-06	0.8158	0.0759	0	0	0
340	67.2988	-2.6746E-06	0.6841	0.0679	0	0	0
341	67.2456	-1.4069E-06	0.4347	0.0532	0	0	0
342	67.1891	-1.9711E-06	0.4057	0.0565	0	0	0
343	67.1418	-1.1618E-06	0.3867	0.0473	0	0	0
344	67.2114	0.00011574	0.2475	0.0602	0	0	0.13
345	67.112	-0.000081026	0.3854	0.0995	0	0	0
346	67.0525	-4.3494E-06	0.4289	0.0595	0	0	0
347	66.9885	-7.3828E-06	0.5263	0.064	0	0	0
348	66.932	-4.3632E-06	0.3069	0.0565	0	0	0
349	66.8787	-6.1339E-06	0.4669	0.0533	0	0	0
350	66.8223	-0.000021672	0.4622	0.0564	0	0	0
351	66.7802	-0.000026728	0.4279	0.0421	0	0	0
352	66.9091	0.00019267	0.7011	0.1209	0	0	0.25
353	66.8369	-0.00006911	0.1503	0.0723	0	0	0
354	66.7684	-0.00001866	1.0044	0.0685	0	0	0
355	66.7115	-0.000028027	0.4642	0.0569	0	0	0
356	66.6702	-0.000036547	0.3078	0.0413	0	0	0
357	66.6366	-1.2589E-06	0.1995	0.0336	0	0	0
358	66.6054	-1.0482E-06	0.3638	0.0312	0	0	0
359	66.5639	-0.000016739	0.4255	0.0415	0	0	0
360	66.528	-0.000043002	0.4484	0.0359	0	0	0
361	66.4964	-3.0738E-06	0.5287	0.0317	0	0	0
362	66.4668	-1.8464E-06	0.5262	0.0295	0	0	0
363	66.4371	-4.2831E-06	0.5829	0.0298	0	0	0
364	66.4165	-1.8674E-06	0.456	0.0206	0	0	0
365	66.4013	-1.5942E-06	0.4582	0.0151	0	0	0

Scenario:

1986

No Stormwater Recirculation

Scenario: 1986 No Stormwater Recirculation

Day	Water (cm3/cm3)	Head (cm)	Water Flow (cm)	Water Flow (cm) Accum	Plant Sink (cm)	Prestor	Infil	Infil Accum	Runoff	Runoff Accum	Evapo	Evapo Accum	Trans	Trans Accum	Drain	Drain Accum	Newstor
1	0.06152	1626	5.03685E-06	5.03685E-06	0	45.9313	0	0	0	0	0.046	0.046	0	0	0	0	45.8854
2	0.06152	1626	5.03685E-06	1.00737E-05	0	45.8855	0	0	0	0	0.0257	0.0717	0	0	0	0	45.8598
3	0.06152	1626	5.03685E-06	1.51106E-05	0	45.8599	0	0	0	0	0.0159	0.0876	0	0	0	0	45.844
4	0.06152	1626	5.03685E-06	2.01474E-05	0	45.844	0	0	0	0	0.0145	0.1021	0	0	0	0	45.8295
5	0.06152	1626	5.03685E-06	2.51843E-05	0	45.8295	0	0	0	0	0.0122	0.1143	0	0	0	0	45.8173
6	0.06152	1626	5.03685E-06	3.02211E-05	0	45.8174	0.508	0.508	0	0	0.1399	0.2542	0	0	0	0	46.1854
7	0.06152	1626	5.03685E-06	3.5258E-05	0	46.1848	1.1938	1.7018	0	0	0.0513	0.3055	0	0	0	0	47.3274
8	0.06152	1626	5.03685E-06	4.02948E-05	0	47.3267	0	1.7018	0	0	0.166	0.4715	0	0	0	0	47.1606
9	0.06152	1626	5.03685E-06	4.53317E-05	0	47.1607	0	1.7018	0	0	0.0491	0.5206	0	0	0	0	47.1116
10	0.06152	1626	5.03685E-06	5.03685E-05	0	47.1117	0	1.7018	0	0	0.0641	0.5847	0	0	0	0	47.0476
11	0.06152	1626	5.03685E-06	5.54054E-05	0	47.0476	0	1.7018	0	0	0.0714	0.6561	0	0	0	0	46.9762
12	0.06152	1626	5.03685E-06	6.04422E-05	0	46.9762	0	1.7018	0	0	0.0591	0.7152	0	0	0	0	46.9171
13	0.06152	1626	5.03685E-06	6.54791E-05	0	46.9172	0	1.7018	0	0	0.0335	0.7487	0	0	0	0	46.8837
14	0.06152	1626	5.03685E-06	7.05159E-05	0	46.8837	0	1.7018	0	0	0.0354	0.7841	0	0	0	0	46.8483
15	0.06152	1626	5.03685E-06	7.55528E-05	0	46.8483	0	1.7018	0	0	0.0302	0.8143	0	0	0	0	46.8181
16	0.06152	1626	5.03685E-06	8.05896E-05	0	46.8181	0	1.7018	0	0	0.0285	0.8428	0	0	0	0	46.7896
17	0.06152	1626	5.03685E-06	8.56265E-05	0	46.7896	0	1.7018	0	0	0.0259	0.8687	0	0	0	0	46.7637
18	0.06152	1626	5.03685E-06	9.06633E-05	0	46.7637	0	1.7018	0	0	0.0202	0.8889	0	0	0	0	46.7436
19	0.06152	1626	5.03685E-06	9.57002E-05	0	46.7436	0	1.7018	0	0	0.0212	0.9101	0	0	0	0	46.7224
20	0.06152	1626	5.03685E-06	0.000100737	0	46.7224	0	1.7018	0	0	0.0208	0.9309	0	0	0	0	46.7016
21	0.06152	1626	5.03685E-06	0.000105774	0	46.7016	0	1.7018	0	0	0.0193	0.9502	0	0	0	0	46.6823
22	0.06152	1626	5.03685E-06	0.000110811	0	46.6824	0	1.7018	0	0	0.0161	0.9663	0	0	0	0	46.6663
23	0.06152	1626	5.03685E-06	0.000115848	0	46.6663	0	1.7018	0	0	0.0131	0.9794	0	0	0	0	46.6532
24	0.06152	1626	5.03685E-06	0.000120884	0	46.6532	0	1.7018	0	0	0.016	0.9954	0	0	0	0	46.6372
25	0.06152	1626	5.03685E-06	0.000125921	0	46.6372	0	1.7018	0	0	0.0127	1.0081	0	0	0	0	46.6245
26	0.06152	1626	5.03685E-06	0.000130958	0	46.6245	0	1.7018	0	0	0.0123	1.0204	0	0	0	0	46.6123
27	0.06152	1626	5.03685E-06	0.000135995	0	46.6123	0	1.7018	0	0	0.0125	1.0329	0	0	0	0	46.5998
28	0.06152	1626	5.03685E-06	0.000141032	0	46.5998	0	1.7018	0	0	0.0155	1.0484	0	0	0	0	46.5843
29	0.06152	1626	5.03685E-06	0.000146069	0	46.5843	0	1.7018	0	0	0.0126	1.061	0	0	0	0	46.5717
30	0.06152	1626	5.03685E-06	0.000151106	0	46.5717	0	1.7018	0	0	0.0112	1.0722	0	0	0	0	46.5605
31	0.06152	1626	5.03685E-06	0.000156142	0	46.5605	0	1.7018	0	0	0.0115	1.0837	0	0	0	0	46.549
32	0.06152	1626	5.03685E-06	0.000161179	0	46.549	0	1.7018	0	0	0.0071	1.0908	0	0	0	0	46.542
33	0.06152	1626	5.03685E-06	0.000166216	0	46.542	0	1.7018	0	0	0.0054	1.0962	0	0	0	0	46.5365
34	0.06152	1626	5.03685E-06	0.000171253	0	46.5365	0	1.7018	0	0	0.0116	1.1078	0	0	0	0	46.5249
35	0.06152	1626	5.03685E-06	0.00017629	0	46.5249	0.1016	1.8034	0	0	0.0753	1.1831	0	0	0	0	46.5512
36	0.06152	1626	5.03685E-06	0.000181327	0	46.5511	0	1.8034	0	0	0	1.1831	0	0	0	0	46.5511
37	0.06152	1626	5.03685E-06	0.000186363	0	46.5511	0	1.8034	0	0	0.0155	1.1986	0	0	0	0	46.5355
38	0.06152	1626	5.03685E-06	0.0001914	0	46.5356	0.0762	1.8796	0	0	0.0447	1.2433	0	0	0	0	46.567
39	0.06152	1626	5.03685E-06	0.000196437	0	46.5669	0.1016	1.9812	0	0	0.0026	1.2459	0	0	0	0	46.6659
40	0.06152	1626	5.03685E-06	0.000201474	0	46.6657	0.7874	2.7686	0	0	0	1.2459	0	0	0	0	47.4531
41	0.06152	1626	5.03685E-06	0.000206511	0	47.4525	0.2032	2.9718	0	0	0.159	1.4049	0	0	0	0	47.4967
42	0.06152	1626	5.03685E-06	0.000211548	0	47.4967	0	2.9718	0	0	0.0948	1.4997	0	0	0	0	47.402

Scenario: 1986 No Stormwater Recirculation

Day	Water (cm3/cm3)	Head (cm)	Water Flow (cm)	Water Flow (cm) Accum	Plant Sink (cm)	Prestor	Infil	Infil Accum	Runoff	Runoff Accum	Evapo	Evapo Accum	Trans	Trans Accum	Drain	Drain Accum	Newstor
43	0.06152	1626	5.03685E-06	0.000216585	0	47.402	0	2.9718	0	0	0	1.4997	0	0	0	0	47.402
44	0.06152	1626	5.03685E-06	0.000221621	0	47.402	0	2.9718	0	0	0.0609	1.5606	0	0	0	0	47.3411
45	0.06152	1626	5.03685E-06	0.000226658	0	47.3411	0	2.9718	0	0	0.0635	1.6241	0	0	0	0	47.2776
46	0.06152	1626	5.03685E-06	0.000231695	0	47.2776	0	2.9718	0	0	0.0554	1.6795	0	0	0	0	47.2222
47	0.06152	1626	5.03685E-06	0.000236732	0	47.2223	0	2.9718	0	0	0.0412	1.7207	0	0	0	0	47.1811
48	0.06152	1626	5.03685E-06	0.000241769	0	47.1811	0	2.9718	0	0	0.0313	1.752	0	0	0	0	47.1498
49	0.06152	1626	5.03685E-06	0.000246806	0	47.1498	0	2.9718	0	0	0.0305	1.7825	0	0	0	0	47.1194
50	0.06152	1626	5.03685E-06	0.000251843	0	47.1194	0	2.9718	0	0	0.0273	1.8098	0	0	0	0	47.0921
51	0.06152	1626	5.03685E-06	0.000256879	0	47.0921	0	2.9718	0	0	0.0264	1.8362	0	0	0	0	47.0657
52	0.06152	1626	5.03685E-06	0.000261916	0	47.0657	0	2.9718	0	0	0.0158	1.852	0	0	0	0	47.05
53	0.06152	1626	5.03685E-06	0.000266953	0	47.05	0	2.9718	0	0	0.0222	1.8742	0	0	0	0	47.0278
54	0.06152	1626	5.03685E-06	0.00027199	0	47.0278	0	2.9718	0	0	0.0206	1.8948	0	0	0	0	47.0072
55	0.06152	1626	5.03685E-06	0.000277027	0	47.0073	0	2.9718	0	0	0.0169	1.9117	0	0	0	0	46.9904
56	0.06152	1626	5.03685E-06	0.000282064	0	46.9904	0	2.9718	0	0	0.0166	1.9283	0	0	0	0	46.9738
57	0.06152	1626	5.03685E-06	0.0002871	0	46.9738	0	2.9718	0	0	0.0172	1.9455	0	0	0	0	46.9566
58	0.06152	1626	5.03685E-06	0.000292137	0	46.9566	0	2.9718	0	0	0.0129	1.9584	0	0	0	0	46.9438
59	0.06152	1626	5.03685E-06	0.000297174	0	46.9438	0	2.9718	0	0	0.0134	1.9718	0	0	0	0	46.9303
60	0.06152	1626	5.03685E-06	0.000302211	0	46.9304	0	2.9718	0	0	0.0138	1.9856	0	0	0	0	46.9165
61	0.06152	1626	5.03685E-06	0.000307248	0	46.9165	0	2.9718	0	0	0.0138	1.9994	0	0	0	0	46.9028
62	0.06152	1626	5.03685E-06	0.000312285	0	46.9028	0	2.9718	0	0	0.0111	2.0105	0	0	0	0	46.8916
63	0.06152	1626	5.03685E-06	0.000317322	0	46.8916	0	2.9718	0	0	0.0098	2.0203	0	0	0	0	46.8819
64	0.06152	1626	5.03685E-06	0.000322358	0	46.8819	0	2.9718	0	0	0.0118	2.0321	0	0	0	0	46.8701
65	0.06152	1626	5.03685E-06	0.000327395	0	46.8701	0	2.9718	0	0	0.011	2.0431	0	0	0	0	46.8591
66	0.06152	1626	5.03685E-06	0.000332432	0	46.8591	0	2.9718	0	0	0.0105	2.0536	0	0	0	0	46.8486
67	0.06152	1626	5.03685E-06	0.000337469	0	46.8486	0	2.9718	0	0	0.0103	2.0639	0	0	0	0	46.8384
68	0.06152	1626	5.03685E-06	0.000342506	0	46.8384	0	2.9718	0	0	0.0118	2.0757	0	0	0	0	46.8266
69	0.06152	1626	5.03685E-06	0.000347543	0	46.8266	0	2.9718	0	0	0.0103	2.086	0	0	0	0	46.8163
70	0.06152	1626	5.03685E-06	0.00035258	0	46.8163	0	2.9718	0	0	0.0068	2.0928	0	0	0	0	46.8096
71	0.06152	1626	5.03685E-06	0.000357616	0	46.8096	0	2.9718	0	0	0.0088	2.1016	0	0	0	0	46.8008
72	0.06152	1626	5.03685E-06	0.000362653	0	46.8008	0	2.9718	0	0	0.0046	2.1062	0	0	0	0	46.7962
73	0.06152	1626	5.03685E-06	0.00036769	0	46.7962	0.1016	3.0734	0	0	0.0501	2.1563	0	0	0	0	46.8477
74	0.06152	1626	5.03685E-06	0.000372727	0	46.8475	0	3.0734	0	0	0.044	2.2003	0	0	0	0	46.8035
75	0.06152	1626	5.03685E-06	0.000377764	0	46.8036	0	3.0734	0	0	0.0153	2.2156	0	0	0	0	46.7883
76	0.06152	1626	5.03685E-06	0.000382801	0	46.7883	0	3.0734	0	0	0.0099	2.2255	0	0	0	0	46.7784
77	0.06152	1626	5.03685E-06	0.000387837	0	46.7784	0.0508	3.1242	0	0	0.0495	2.275	0	0	0	0	46.7797
78	0.06152	1626	5.03685E-06	0.000392874	0	46.7797	0.127	3.2512	0	0	0.0919	2.3669	0	0	0	0	46.8148
79	0.06152	1626	5.03685E-06	0.000397911	0	46.8146	0.0254	3.2766	0	0	0.0461	2.413	0	0	0	0	46.7939
80	0.06152	1626	5.03685E-06	0.000402948	0	46.794	0	3.2766	0	0	0.0188	2.4318	0	0	0	0	46.7751
81	0.06152	1626	5.03685E-06	0.000407985	0	46.7752	0	3.2766	0	0	0.0122	2.444	0	0	0	0	46.763
82	0.06152	1626	5.03685E-06	0.000413022	0	46.763	0	3.2766	0	0	0.0103	2.4543	0	0	0	0	46.7528
83	0.06152	1626	5.03685E-06	0.000418059	0	46.7528	0	3.2766	0	0	0.0089	2.4632	0	0	0	0	46.7438
84	0.06152	1626	5.03685E-06	0.000423095	0	46.7438	0	3.2766	0	0	0.008	2.4712	0	0	0	0	46.7358

Scenario: 1986 No Stormwater Recirculation

Day	Water (cm3/cm3)	Head (cm)	Water Flow (cm)	Water Flow (cm) Accum	Plant Sink (cm)	Prestor	Infil	Infil Accum	Runoff	Runoff Accum	Evapo	Evapo Accum	Trans	Trans Accum	Drain	Drain Accum	Newstor
85	0.06152	1626	5.03685E-06	0.000428132	0	46.7358	0	3.2766	0	0	0.0071	2.4783	0	0	0	0	46.7287
86	0.06152	1626	5.03685E-06	0.000433169	0	46.7287	0	3.2766	0	0	0.0048	2.4831	0	0	0	0	46.7239
87	0.06152	1626	5.03685E-06	0.000438206	0	46.7239	0	3.2766	0	0	0.0076	2.4907	0	0	0	0	46.7163
88	0.06152	1626	5.03685E-06	0.000443243	0	46.7163	0	3.2766	0	0	0.006	2.4967	0	0	0	0	46.7103
89	0.06152	1626	5.03685E-06	0.00044828	0	46.7103	0	3.2766	0	0	0.0074	2.5041	0	0	0	0	46.7028
90	0.06152	1626	5.03685E-06	0.000453317	0	46.7028	0	3.2766	0	0	0.0085	2.5126	0	0	0	0	46.6943
91	0.06152	1626	5.03685E-06	0.000458353	0	46.6943	0	3.2766	0	0	0.0053	2.5179	0	0	0	0	46.689
92	0.06152	1626	5.03685E-06	0.00046339	0	46.6891	0	3.2766	0	0	0.0069	2.5248	0	0	0	0	46.6821
93	0.06152	1626	5.03685E-06	0.000468427	0	46.6821	0	3.2766	0	0	0.0078	2.5326	0	0	0	0	46.6743
94	0.06152	1626	5.03685E-06	0.000473464	0	46.6743	0	3.2766	0	0	0.0065	2.5391	0	0	0	0	46.6678
95	0.06152	1626	5.03685E-06	0.000478501	0	46.6678	0	3.2766	0	0	0.0072	2.5463	0	0	0	0	46.6605
96	0.06152	1626	5.03685E-06	0.000483538	0	46.6605	0	3.2766	0	0	0.0054	2.5517	0	0	0	0	46.6552
97	0.06152	1626	5.03685E-06	0.000488574	0	46.6552	0	3.2766	0	0	0.0074	2.5591	0	0	0	0	46.6478
98	0.06152	1626	5.03685E-06	0.000493611	0	46.6478	0.7822	4.0588	0.0052	0.0052	0.2057	2.7648	0	0	0	0	47.2243
99	0.06152	1626	5.03685E-06	0.000498648	0	47.2247	0	4.0588	0	0.0052	0.0568	2.8216	0	0	0	0	47.1679
100	0.06152	1626	5.03685E-06	0.000503685	0	47.1679	0	4.0588	0	0.0052	0.0649	2.8865	0	0	0	0	47.103
101	0.06152	1626	5.03685E-06	0.000508722	0	47.1031	0	4.0588	0	0.0052	0.0497	2.9362	0	0	0	0	47.0534
102	0.06152	1626	5.03685E-06	0.000513759	0	47.0535	0	4.0588	0	0.0052	0.036	2.9722	0	0	0	0	47.0175
103	0.06152	1626	5.03685E-06	0.000518796	0	47.0175	0	4.0588	0	0.0052	0.0291	3.0013	0	0	0	0	46.9884
104	0.06152	1626	5.03685E-06	0.000523832	0	46.9885	0	4.0588	0	0.0052	0.0248	3.0261	0	0	0	0	46.9636
105	0.06152	1626	5.03685E-06	0.000528869	0	46.9637	0	4.0588	0	0.0052	0.0211	3.0472	0	0	0	0	46.9425
106	0.06152	1626	5.03685E-06	0.000533906	0	46.9426	0	4.0588	0	0.0052	0.0148	3.062	0	0	0	0	46.9277
107	0.06152	1626	5.03685E-06	0.000538943	0	46.9277	0	4.0588	0	0.0052	0.0171	3.0791	0	0	0	0	46.9106
108	0.06152	1626	5.03685E-06	0.00054398	0	46.9107	0	4.0588	0	0.0052	0.0178	3.0969	0	0	0	0	46.8928
109	0.06152	1626	5.03685E-06	0.000549017	0	46.8928	0	4.0588	0	0.0052	0.0106	3.1075	0	0	0	0	46.8822
110	0.06152	1626	5.03685E-06	0.000554054	0	46.8823	0	4.0588	0	0.0052	0.013	3.1205	0	0	0	0	46.8692
111	0.06152	1626	5.03685E-06	0.00055909	0	46.8692	0	4.0588	0	0.0052	0.0125	3.133	0	0	0	0	46.8567
112	0.06152	1626	5.03685E-06	0.000564127	0	46.8567	0	4.0588	0	0.0052	0.012	3.145	0	0	0	0	46.8447
113	0.06152	1626	5.03685E-06	0.000569164	0	46.8447	0	4.0588	0	0.0052	0.0124	3.1574	0	0	0	0	46.8324
114	0.06152	1626	5.03685E-06	0.000574201	0	46.8324	0	4.0588	0	0.0052	0.0121	3.1695	0	0	0	0	46.8203
115	0.06152	1626	5.03685E-06	0.000579238	0	46.8203	0	4.0588	0	0.0052	0.0103	3.1798	0	0	0	0	46.81
116	0.06152	1626	5.03685E-06	0.000584275	0	46.81	0	4.0588	0	0.0052	0.0106	3.1904	0	0	0	0	46.7993
117	0.06152	1626	5.03685E-06	0.000589311	0	46.7993	0	4.0588	0	0.0052	0.0127	3.2031	0	0	0	0	46.7866
118	0.06152	1626	5.03685E-06	0.000594348	0	46.7866	0	4.0588	0	0.0052	0.0114	3.2145	0	0	0	0	46.7752
119	0.06152	1626	5.03685E-06	0.000599385	0	46.7753	0	4.0588	0	0.0052	0.0077	3.2222	0	0	0	0	46.7676
120	0.06152	1626	5.03685E-06	0.000604422	0	46.7676	0	4.0588	0	0.0052	0.009	3.2312	0	0	0	0	46.7586
121	0.06152	1626	5.03685E-06	0.000609459	0	46.7586	0	4.0588	0	0.0052	0.0049	3.2361	0	0	0	0	46.7536
122	0.06152	1626	5.03685E-06	0.000614496	0	46.7537	0	4.0588	0	0.0052	0.0069	3.243	0	0	0	0	46.7468
123	0.06152	1626	5.03685E-06	0.000619533	0	46.7468	0	4.0588	0	0.0052	0.0065	3.2495	0	0	0	0	46.7403
124	0.06152	1626	5.03685E-06	0.000624569	0	46.7403	0	4.0588	0	0.0052	0.0085	3.258	0	0	0	0	46.7317
125	0.06152	1626	5.03685E-06	0.000629606	0	46.7317	0	4.0588	0	0.0052	0.0102	3.2682	0	0	0	0	46.7216
126	0.06152	1626	5.03685E-06	0.000634643	0	46.7216	0	4.0588	0	0.0052	0.0093	3.2775	0	0	0	0	46.7122

Scenario: 1986 No Stormwater Recirculation

Day	Water (cm3/cm3)	Head (cm)	Water Flow (cm)	Water Flow (cm) Accum	Plant Sink (cm)	Prestor	Infil	Infil Accum	Runoff	Runoff Accum	Evapo	Evapo Accum	Trans	Trans Accum	Drain	Drain Accum	Newstor
127	0.06152	1626	5.03685E-06	0.00063968	0	46.7122	0	4.0588	0	0.0052	0.0088	3.2863	0	0	0	0	46.7034
128	0.06152	1626	5.03685E-06	0.000644717	0	46.7034	0	4.0588	0	0.0052	0.0084	3.2947	0	0	0	0	46.695
129	0.06152	1626	5.03685E-06	0.000649754	0	46.695	0	4.0588	0	0.0052	0.0088	3.3035	0	0	0	0	46.6862
130	0.06152	1626	5.03686E-06	0.000654791	0	46.6862	0	4.0588	0	0.0052	0.0084	3.3119	0	0	0	0	46.6778
131	0.06152	1626	5.03686E-06	0.000659827	0	46.6778	0	4.0588	0	0.0052	0.0084	3.3203	0	0	0	0	46.6694
132	0.06152	1626	5.03686E-06	0.000664864	0	46.6694	0	4.0588	0	0.0052	0.0085	3.3288	0	0	0	0	46.6609
133	0.06152	1626	5.03686E-06	0.000669901	0	46.6609	0	4.0588	0	0.0052	0.0066	3.3354	0	0	0	0	46.6543
134	0.06152	1626	5.03686E-06	0.000674938	0	46.6543	0	4.0588	0	0.0052	0.0082	3.3436	0	0	0	0	46.6461
135	0.06152	1626	5.03686E-06	0.000679975	0	46.6461	0	4.0588	0	0.0052	0.0082	3.3518	0	0	0	0	46.6379
136	0.06152	1626	5.03686E-06	0.000685012	0	46.6379	0	4.0588	0	0.0052	0.007	3.3588	0	0	0	0	46.6309
137	0.06152	1626	5.03686E-06	0.000690049	0	46.6309	0.6824	4.7412	0.0034	0.0086	0.1644	3.5232	0	0	0	0	47.1489
138	0.06152	1626	5.03686E-06	0.000695085	0	47.1492	0	4.7412	0	0.0086	0.0688	3.592	0	0	0	0	47.0804
139	0.06152	1626	5.03686E-06	0.000700122	0	47.0804	0	4.7412	0	0.0086	0.0673	3.6593	0	0	0	0	47.013
140	0.06152	1626	5.03686E-06	0.000705159	0	47.0131	0	4.7412	0	0.0086	0.0434	3.7027	0	0	0	0	46.9697
141	0.06152	1626	5.03686E-06	0.000710196	0	46.9698	0	4.7412	0	0.0086	0.0323	3.735	0	0	0	0	46.9375
142	0.06152	1626	5.03686E-06	0.000715233	0	46.9375	0	4.7412	0	0.0086	0.0275	3.7625	0	0	0	0	46.91
143	0.06152	1626	5.03686E-06	0.00072027	0	46.9101	0	4.7412	0	0.0086	0.0185	3.781	0	0	0	0	46.8916
144	0.06152	1626	5.03686E-06	0.000725307	0	46.8916	0	4.7412	0	0.0086	0.0161	3.7971	0	0	0	0	46.8755
145	0.06152	1626	5.03686E-06	0.000730343	0	46.8755	0.0508	4.792	0	0.0086	0.0495	3.8466	0	0	0	0	46.8768
146	0.06152	1626	5.03686E-06	0.00073538	0	46.8768	0.1778	4.9698	0	0.0086	0.0788	3.9254	0	0	0	0	46.9758
147	0.06152	1626	5.03686E-06	0.000740417	0	46.9755	0.0254	4.9952	0	0.0086	0.0611	3.9865	0	0	0	0	46.9399
148	0.06152	1626	5.03686E-06	0.000745454	0	46.9399	0	4.9952	0	0.0086	0.0289	4.0154	0	0	0	0	46.911
149	0.06152	1626	5.03686E-06	0.000750491	0	46.9111	0.1524	5.1476	0	0.0086	0.0705	4.0859	0	0	0	0	46.993
150	0.06152	1626	5.03686E-06	0.000755528	0	46.9928	1.2954	6.443	0	0.0086	0.2675	4.3534	0	0	0	0	48.0207
151	0.06152	1626	5.03686E-06	0.000760565	0	48.0201	0.635	7.078	0	0.0086	0.038	4.3914	0	0	0	0	48.617
152	0.06152	1626	5.03686E-06	0.000765601	0	48.6168	0.0508	7.1288	0	0.0086	0.1932	4.5846	0	0	0	0	48.4744
153	0.06152	1626	5.03686E-06	0.000770638	0	48.4745	0	7.1288	0	0.0086	0.0547	4.6393	0	0	0	0	48.4197
154	0.06152	1626	5.03686E-06	0.000775675	0	48.4197	0	7.1288	0	0.0086	0.0482	4.6875	0	0	0	0	48.3716
155	0.06152	1626	5.03686E-06	0.000780712	0	48.3716	0.0254	7.1542	0	0.0086	0.0936	4.7811	0	0	0	0	48.3034
156	0.06152	1626	5.03686E-06	0.000785749	0	48.3034	0	7.1542	0	0.0086	0.0596	4.8407	0	0	0	0	48.2438
157	0.06152	1626	5.03686E-06	0.000790786	0	48.2438	0	7.1542	0	0.0086	0.0601	4.9008	0	0	0	0	48.1837
158	0.06152	1626	5.03686E-06	0.000795823	0	48.1838	0	7.1542	0	0.0086	0.0463	4.9471	0	0	0	0	48.1375
159	0.06152	1626	5.03686E-06	0.000800859	0	48.1375	0.9113	8.0655	0.0031	0.0117	0.2326	5.1797	0	0	0	0	48.8162
160	0.06152	1626	5.03686E-06	0.000805896	0	48.8173	0	8.0655	0	0.0117	0.0757	5.2554	0	0	0	0	48.7415
161	0.06152	1626	5.03686E-06	0.000810933	0	48.7416	0	8.0655	0	0.0117	0.0894	5.3448	0	0	0	0	48.6521
162	0.06152	1626	5.03686E-06	0.00081597	0	48.6522	0	8.0655	0	0.0117	0.075	5.4198	0	0	0	0	48.5772
163	0.06152	1626	5.03686E-06	0.000821007	0	48.5772	0	8.0655	0	0.0117	0.0624	5.4822	0	0	0	0	48.5148
164	0.06152	1626	5.03686E-06	0.000826044	0	48.5148	0	8.0655	0	0.0117	0.0445	5.5267	0	0	0	0	48.4703
165	0.06152	1626	5.03686E-06	0.000831081	0	48.4703	0	8.0655	0	0.0117	0.0424	5.5691	0	0	0	0	48.4279
166	0.06152	1626	5.03686E-06	0.000836117	0	48.428	0	8.0655	0	0.0117	0.032	5.6011	0	0	0	0	48.3959
167	0.06152	1626	5.03686E-06	0.000841154	0	48.3959	0	8.0655	0	0.0117	0.034	5.6351	0	0	0	0	48.3619
168	0.06152	1626	5.03686E-06	0.000846191	0	48.362	0	8.0655	0	0.0117	0.0234	5.6585	0	0	0	0	48.3386

Scenario: 1986 No Stormwater Recirculation

Day	Water (cm3/cm3)	Head (cm)	Water Flow (cm)	Water Flow (cm) Accum	Plant Sink (cm)	Prestor	Infil	Infil Accum	Runoff	Runoff Accum	Evapo	Evapo Accum	Trans	Trans Accum	Drain	Drain Accum	Newstor
169	0.06152	1626	5.03686E-06	0.000851228	0	48.3386	2.3128	10.3783	0.0748	0.0865	0.3999	6.0584	0	0	0	0	50.2516
170	0.06152	1626	5.03686E-06	0.000856265	0	50.2541	0.2032	10.5815	0	0.0865	0.2157	6.2741	0	0	0	0	50.2417
171	0.06152	1626	5.03686E-06	0.000861302	0	50.2416	0	10.5815	0	0.0865	0.0665	6.3406	0	0	0	0	50.1751
172	0.06152	1626	5.03686E-06	0.000866339	0	50.1751	0	10.5815	0	0.0865	0.0621	6.4027	0	0	0	0	50.113
173	0.06152	1626	5.03686E-06	0.000871375	0	50.113	0	10.5815	0	0.0865	0.0557	6.4584	0	0	0	0	50.0573
174	0.06152	1626	5.03687E-06	0.000876412	0	50.0573	2.6416	13.2231	0	0.0865	0.045	6.5034	0	0	0	0	52.6539
175	0.06152	1626	5.03687E-06	0.000881449	0	52.6535	3.6385	16.8616	0.0191	0.1056	0.1678	6.6712	0	0	0	0	56.1241
176	0.06152	1626	5.03687E-06	0.000886486	0	56.1372	2.5761	19.4377	0.1925	0.2981	0.289	6.9602	0	0	0	0	58.4243
177	0.06152	1626	5.03687E-06	0.000891523	0	58.4426	0.1016	19.5393	0	0.2981	0.3975	7.3577	0	0	0	0	58.1467
178	0.06152	1626	5.03687E-06	0.00089656	0	58.1468	0	19.5393	0	0.2981	0.0801	7.4378	0	0	0	0	58.0667
179	0.06152	1626	5.03687E-06	0.000901597	0	58.0667	0	19.5393	0	0.2981	0.0766	7.5144	0	0	0	0	57.9901
180	0.06152	1626	5.03687E-06	0.000906634	0	57.9901	0	19.5393	0	0.2981	0.0707	7.5851	0	0	0	0	57.9194
181	0.06152	1626	5.03687E-06	0.00091167	0	57.9194	0	19.5393	0	0.2981	0.0689	7.654	0	0	0	0	57.8504
182	0.06152	1626	5.03687E-06	0.000916707	0	57.8504	1.6764	21.2157	0	0.2981	0.5193	8.1733	0	0	0	0	59.0075
183	0.06152	1626	5.03687E-06	0.000921744	0	59.0074	0.5588	21.7745	0	0.2981	0.3549	8.5282	0	0	0	0	59.2113
184	0.06152	1626	5.03687E-06	0.000926781	0	59.2113	0.0508	21.8253	0	0.2981	0.1762	8.7044	0	0	0	0	59.086
185	0.06152	1626	5.03687E-06	0.000931818	0	59.0859	0	21.8253	0	0.2981	0.0695	8.7739	0	0	0	0	59.0165
186	0.06152	1626	5.03687E-06	0.000936855	0	59.0165	0	21.8253	0	0.2981	0.0675	8.8414	0	0	0	0	58.949
187	0.06152	1626	5.03687E-06	0.000941892	0	58.949	0	21.8253	0	0.2981	0.0624	8.9038	0	0	0	0	58.8866
188	0.06152	1626	5.03687E-06	0.000946929	0	58.8866	0	21.8253	0	0.2981	0.0629	8.9667	0	0	0	0	58.8236
189	0.06152	1626	5.03688E-06	0.000951965	0	58.8236	0	21.8253	0	0.2981	0.0652	9.0319	0	0	0	0	58.7585
190	0.06152	1626	5.03688E-06	0.000957002	0	58.7585	0.254	22.0793	0	0.2981	0.1602	9.1921	0	0	0	0	58.8522
191	0.06152	1626	5.03688E-06	0.000962039	0	58.8522	0.0254	22.1047	0	0.2981	0.1151	9.3072	0	0	0	0	58.7625
192	0.06152	1626	5.03688E-06	0.000967076	0	58.7624	0	22.1047	0	0.2981	0.0713	9.3785	0	0	0	0	58.6912
193	0.06152	1626	5.03688E-06	0.000972113	0	58.6912	0	22.1047	0	0.2981	0.0716	9.4501	0	0	0	0	58.6196
194	0.06152	1626	5.03688E-06	0.00097715	0	58.6196	0	22.1047	0	0.2981	0.0641	9.5142	0	0	0	0	58.5554
195	0.06152	1626	5.03688E-06	0.000982187	0	58.5554	0	22.1047	0	0.2981	0.0543	9.5685	0	0	0	0	58.5011
196	0.06152	1626	5.03688E-06	0.000987224	0	58.5011	0	22.1047	0	0.2981	0.0615	9.63	0	0	0	0	58.4396
197	0.06152	1626	5.03688E-06	0.00099226	0	58.4396	0	22.1047	0	0.2981	0.0605	9.6905	0	0	0	0	58.3792
198	0.06152	1626	5.03689E-06	0.000997297	0	58.3792	0.0508	22.1555	0	0.2981	0.0819	9.7724	0	0	0	0	58.3482
199	0.06152	1626	5.03689E-06	0.001002334	0	58.3481	0	22.1555	0	0.2981	0.0436	9.816	0	0	0	0	58.3046
200	0.06152	1626	5.03689E-06	0.001007371	0	58.3046	0	22.1555	0	0.2981	0.0392	9.8552	0	0	0	0	58.2654
201	0.06152	1626	5.03689E-06	0.001012408	0	58.2654	0	22.1555	0	0.2981	0.038	9.8932	0	0	0	0	58.2274
202	0.06152	1626	5.03689E-06	0.001017445	0	58.2274	0.0508	22.2063	0	0.2981	0.0728	9.966	0	0	0	0	58.2054
203	0.06152	1626	5.03689E-06	0.001022482	0	58.2054	0	22.2063	0	0.2981	0.0341	10.0001	0	0	0	0	58.1713
204	0.06152	1626	5.03689E-06	0.001027519	0	58.1713	0.1524	22.3587	0	0.2981	0.1113	10.1114	0	0	0	0	58.2124
205	0.06152	1626	5.03689E-06	0.001032556	0	58.2123	0	22.3587	0	0.2981	0.0634	10.1748	0	0	0	0	58.1489
206	0.06152	1626	5.0369E-06	0.001037592	0	58.149	0	22.3587	0	0.2981	0.0422	10.217	0	0	0	0	58.1067
207	0.06152	1626	5.0369E-06	0.001042629	0	58.1067	0	22.3587	0	0.2981	0.0452	10.2622	0	0	0	0	58.0615
208	0.06152	1626	5.0369E-06	0.001047666	0	58.0616	0	22.3587	0	0.2981	0.033	10.2952	0	0	0	0	58.0285
209	0.06152	1626	5.0369E-06	0.001052703	0	58.0285	0	22.3587	0	0.2981	0.0316	10.3268	0	0	0	0	57.9969
210	0.06152	1626	5.0369E-06	0.00105774	0	57.9969	0	22.3587	0	0.2981	0.033	10.3598	0	0	0	0	57.9639

Scenario: 1986 No Stormwater Recirculation

Day	Water (cm3/cm3)	Head (cm)	Water Flow (cm)	Water Flow (cm) Accum	Plant Sink (cm)	Prestor	Infil	Infil Accum	Runoff	Runoff Accum	Evapo	Evapo Accum	Trans	Trans Accum	Drain	Drain Accum	Newstor
211	0.06152	1625.99	5.0369E-06	0.001062777	0	57.9639	0	22.3587	0	0.2981	0.033	10.3928	0	0	0	0	57.9309
212	0.06152	1625.99	5.03691E-06	0.001067814	0	57.9309	0	22.3587	0	0.2981	0.0251	10.4179	0	0	0	0	57.9058
213	0.06152	1625.99	5.03691E-06	0.001072851	0	57.9058	0	22.3587	0	0.2981	0.0256	10.4435	0	0	0	0	57.8802
214	0.06152	1625.99	5.03691E-06	0.001077888	0	57.8802	0.2032	22.5619	0	0.2981	0.1276	10.5711	0	0	0	0	57.9558
215	0.06152	1625.99	5.03691E-06	0.001082925	0	57.9556	0.4064	22.9683	0	0.2981	0.1444	10.7155	0	0	0	0	58.2176
216	0.06152	1625.99	5.03691E-06	0.001087962	0	58.2174	0.3048	23.2731	0	0.2981	0.1578	10.8733	0	0	0	0	58.3644
217	0.06152	1625.99	5.03692E-06	0.001092998	0	58.3643	0	23.2731	0	0.2981	0.0671	10.9404	0	0	0	0	58.2972
218	0.06152	1625.99	5.03692E-06	0.001098035	0	58.2972	0.1016	23.3747	0	0.2981	0.1185	11.0589	0	0	0	0	58.2803
219	0.06152	1625.99	5.03692E-06	0.001103072	0	58.2803	0	23.3747	0	0.2981	0.0716	11.1305	0	0	0	0	58.2087
220	0.06152	1625.99	5.03692E-06	0.001108109	0	58.2087	0	23.3747	0	0.2981	0.0657	11.1962	0	0	0	0	58.143
221	0.06152	1625.99	5.03692E-06	0.001113146	0	58.143	0	23.3747	0	0.2981	0.0497	11.2459	0	0	0	0	58.0933
222	0.06152	1625.99	5.03693E-06	0.001118183	0	58.0934	0	23.3747	0	0.2981	0.0352	11.2811	0	0	0	0	58.0581
223	0.06152	1625.99	5.03693E-06	0.00112322	0	58.0581	0	23.3747	0	0.2981	0.03	11.3111	0	0	0	0	58.0281
224	0.06152	1625.99	5.03693E-06	0.001128257	0	58.0281	0	23.3747	0	0.2981	0.033	11.3441	0	0	0	0	57.9951
225	0.06152	1625.99	5.03693E-06	0.001133294	0	57.9951	0.0254	23.4001	0	0.2981	0.0551	11.3992	0	0	0	0	57.9654
226	0.06152	1625.99	5.03694E-06	0.001138331	0	57.9654	0	23.4001	0	0.2981	0.0312	11.4304	0	0	0	0	57.9342
227	0.06152	1625.99	5.03694E-06	0.001143368	0	57.9343	0	23.4001	0	0.2981	0.0236	11.454	0	0	0	0	57.9106
228	0.06152	1625.99	5.03694E-06	0.001148405	0	57.9106	0	23.4001	0	0.2981	0.0236	11.4776	0	0	0	0	57.8871
229	0.06152	1625.99	5.03695E-06	0.001153442	0	57.8871	0	23.4001	0	0.2981	0.0292	11.5068	0	0	0	0	57.8578
230	0.06152	1625.99	5.03695E-06	0.001158479	0	57.8579	0	23.4001	0	0.2981	0.0287	11.5355	0	0	0	0	57.8291
231	0.06152	1625.99	5.03695E-06	0.001163516	0	57.8292	0	23.4001	0	0.2981	0.0241	11.5596	0	0	0	0	57.8051
232	0.06152	1625.99	5.03695E-06	0.001168552	0	57.8051	0	23.4001	0	0.2981	0.0269	11.5865	0	0	0	0	57.7781
233	0.06152	1625.99	5.03696E-06	0.001173589	0	57.7782	0	23.4001	0	0.2981	0.0201	11.6066	0	0	0	0	57.7581
234	0.06152	1625.99	5.03696E-06	0.001178626	0	57.7581	1.4761	24.8762	0.0225	0.3206	0.3337	11.9403	0	0	0	0	58.9005
235	0.06152	1625.99	5.03696E-06	0.001183663	0	58.9022	0.4318	25.308	0	0.3206	0.2718	12.2121	0	0	0	0	59.0622
236	0.06152	1625.99	5.03697E-06	0.0011887	0	59.0622	0	25.308	0	0.3206	0.0611	12.2732	0	0	0	0	59.0011
237	0.06152	1625.99	5.03697E-06	0.001193737	0	59.0011	0	25.308	0	0.3206	0.0586	12.3318	0	0	0	0	58.9425
238	0.06152	1625.99	5.03697E-06	0.001198774	0	58.9425	2.159	27.467	0	0.3206	0.4428	12.7746	0	0	0	0	60.6587
239	0.06152	1625.99	5.03698E-06	0.001203811	0	60.6585	1.016	28.483	0	0.3206	0.4092	13.1838	0	0	0	0	61.2654
240	0.06152	1625.99	5.03698E-06	0.001208848	0	61.2653	0.6604	29.1434	0	0.3206	0.0829	13.2667	0	0	0	0	61.8428
241	0.06152	1625.99	5.03698E-06	0.001213885	0	61.8427	0.0762	29.2196	0	0.3206	0.2716	13.5383	0	0	0	0	61.6473
242	0.06152	1625.99	5.03699E-06	0.001218922	0	61.6474	0.2794	29.499	0	0.3206	0.226	13.7643	0	0	0	0	61.7008
243	0.06152	1625.99	5.03699E-06	0.001223959	0	61.7007	0.7366	30.2356	0	0.3206	0.348	14.1123	0	0	0	0	62.0893
244	0.06152	1625.99	0.000005037	0.001228996	0	62.0892	1.8796	32.1152	0	0.3206	0.4393	14.5516	0	0	0	0	63.5296
245	0.06152	1625.99	0.000005037	0.001234033	0	63.5296	3.7898	35.905	0.5536	0.8742	0.7592	15.3108	0	0	0	0	66.5602
246	0.06152	1625.98	0.000005037	0.00123907	0	66.5812	0	35.905	0	0.8742	0.3046	15.6154	0	0	0	0	66.2766
247	0.06152	1625.98	5.03701E-06	0.001244107	0	66.2767	2.3622	38.2672	0	0.8742	0.377	15.9924	0	0	0	0	68.2619
248	0.06152	1625.98	5.03701E-06	0.001249144	0	68.262	0	38.2672	0	0.8742	0.3392	16.3316	0	0	0	0	67.9228
249	0.06152	1625.98	5.03702E-06	0.001254181	0	67.9229	0	38.2672	0	0.8742	0.0765	16.4081	0	0	0	0	67.8464
250	0.06152	1625.98	5.03702E-06	0.001259218	0	67.8463	0.0508	38.318	0	0.8742	0.2262	16.6343	0	0	0	0	67.671
251	0.06152	1625.98	5.03703E-06	0.001264255	0	67.671	0	38.318	0	0.8742	0.0583	16.6926	0	0	0	0	67.6126
252	0.06152	1625.98	5.03703E-06	0.001269292	0	67.6126	0	38.318	0	0.8742	0.0614	16.754	0	0	0	0	67.5512

Scenario: 1986 No Stormwater Recirculation

Day	Water (cm3/cm3)	Head (cm)	Water Flow (cm)	Water Flow (cm) Accum	Plant Sink (cm)	Prestor	Infil	Infil Accum	Runoff	Runoff Accum	Evapo	Evapo Accum	Trans	Trans Accum	Drain	Drain Accum	Newstor
253	0.06152	1625.98	5.03704E-06	0.001274329	0	67.5512	0	38.318	0	0.8742	0.0749	16.8289	0	0	0	0	67.4764
254	0.06152	1625.98	5.03704E-06	0.001279366	0	67.4764	0	38.318	0	0.8742	0.0766	16.9055	0	0	0	0	67.3997
255	0.06152	1625.98	5.03705E-06	0.001284403	0	67.3997	0	38.318	0	0.8742	0.0658	16.9713	0	0	0	0	67.334
256	0.06152	1625.98	5.03705E-06	0.00128944	0	67.334	0.1016	38.4196	0	0.8742	0.1194	17.0907	0	0	0	0	67.3161
257	0.06152	1625.98	5.03706E-06	0.001294478	0	67.3161	0	38.4196	0	0.8742	0.0512	17.1419	0	0	0	0	67.2649
258	0.06152	1625.98	5.03706E-06	0.001299515	0	67.2649	0	38.4196	0	0.8742	0.0541	17.196	0	0	0	0	67.2108
259	0.06152	1625.98	5.03707E-06	0.001304552	0	67.2108	0	38.4196	0	0.8742	0.0542	17.2502	0	0	0	0	67.1566
260	0.06152	1625.98	5.03707E-06	0.001309589	0	67.1566	0	38.4196	0	0.8742	0.0665	17.3167	0	0	0	0	67.0901
261	0.06152	1625.98	5.03708E-06	0.001314626	0	67.0901	0	38.4196	0	0.8742	0.0689	17.3856	0	0	0	0	67.0212
262	0.06152	1625.98	5.03708E-06	0.001319663	0	67.0212	0	38.4196	0	0.8742	0.0643	17.4499	0	0	0	0	66.9569
263	0.06152	1625.98	5.03709E-06	0.0013247	0	66.957	0	38.4196	0	0.8742	0.0603	17.5102	0	0	0	0	66.8967
264	0.06152	1625.98	5.0371E-06	0.001329737	0	66.8967	0	38.4196	0	0.8742	0.0543	17.5645	0	0	0	0	66.8423
265	0.06152	1625.97	5.0371E-06	0.001334774	0	66.8423	0.3048	38.7244	0	0.8742	0.1413	17.7058	0	0	0	0	67.0059
266	0.06152	1625.97	5.03711E-06	0.001339811	0	67.0057	0.7366	39.461	0	0.8742	0.3032	18.009	0	0	0	0	67.4391
267	0.06152	1625.97	5.03711E-06	0.001344848	0	67.4389	0	39.461	0	0.8742	0.0725	18.0815	0	0	0	0	67.3664
268	0.06152	1625.97	5.03712E-06	0.001349886	0	67.3664	0	39.461	0	0.8742	0.0809	18.1624	0	0	0	0	67.2855
269	0.06152	1625.97	5.03713E-06	0.001354923	0	67.2855	0	39.461	0	0.8742	0.0789	18.2413	0	0	0	0	67.2066
270	0.06152	1625.97	5.03713E-06	0.00135996	0	67.2066	0	39.461	0	0.8742	0.0732	18.3145	0	0	0	0	67.1334
271	0.06152	1625.97	5.03714E-06	0.001364997	0	67.1334	0	39.461	0	0.8742	0.0602	18.3747	0	0	0	0	67.0732
272	0.06152	1625.97	5.03715E-06	0.001370034	0	67.0732	0.2032	39.6642	0	0.8742	0.1259	18.5006	0	0	0	0	67.1505
273	0.06152	1625.97	5.03715E-06	0.001375071	0	67.1504	0	39.6642	0	0.8742	0.0745	18.5751	0	0	0	0	67.0758
274	0.06152	1625.97	5.03716E-06	0.001380108	0	67.0758	0	39.6642	0	0.8742	0.0871	18.6622	0	0	0	0	66.9887
275	0.06152	1625.97	5.03717E-06	0.001385146	0	66.9887	0.1778	39.842	0	0.8742	0.1014	18.7636	0	0	0	0	67.0651
276	0.06152	1625.97	5.03718E-06	0.001390183	0	67.065	0	39.842	0	0.8742	0.0638	18.8274	0	0	0	0	67.0012
277	0.06152	1625.97	5.03718E-06	0.00139522	0	67.0012	0	39.842	0	0.8742	0.0726	18.9	0	0	0	0	66.9286
278	0.06152	1625.97	5.03719E-06	0.001400257	0	66.9286	0.3302	40.1722	0	0.8742	0	18.9	0	0	0	0	67.2588
279	0.06152	1625.97	5.0372E-06	0.001405294	0	67.2586	0.1778	40.35	0	0.8742	0.0827	18.9827	0	0	0	0	67.3536
280	0.06152	1625.96	5.03721E-06	0.001410332	0	67.3536	0	40.35	0	0.8742	0.1083	19.091	0	0	0	0	67.2453
281	0.06152	1625.96	5.03721E-06	0.001415369	0	67.2454	0	40.35	0	0.8742	0.0599	19.1509	0	0	0	0	67.1855
282	0.06152	1625.96	5.03722E-06	0.001420406	0	67.1855	1.4986	41.8486	0	0.8742	0.2417	19.3926	0	0	0	0	68.4424
283	0.06152	1625.96	5.03723E-06	0.001425443	0	68.442	6.105	47.9536	2.6834	3.5576	0.0872	19.4798	0	0	0	0	74.4597
284	0.06152	1625.96	5.03724E-06	0.00143048	0	74.4621	0	47.9536	0	3.5576	0.1085	19.5883	0	0	0	0	74.3536
285	0.06152	1625.96	5.03725E-06	0.001435518	0	74.3536	0	47.9536	0	3.5576	0.1171	19.7054	0	0	0	0	74.2365
286	0.06152	1625.96	5.03726E-06	0.001440555	0	74.2365	0	47.9536	0	3.5576	0.22	19.9254	0	0	0	0	74.0165
287	0.06152	1625.96	5.03727E-06	0.001445592	0	74.0166	0	47.9536	0	3.5576	0.0777	20.0031	0	0	0	0	73.9389
288	0.06152	1625.96	5.03727E-06	0.001450629	0	73.9389	0	47.9536	0	3.5576	0.0732	20.0763	0	0	0	0	73.8657
289	0.06152	1625.96	5.03728E-06	0.001455667	0	73.8657	0	47.9536	0	3.5576	0.0679	20.1442	0	0	0	0	73.7978
290	0.06152	1625.96	5.03729E-06	0.001460704	0	73.7978	0.4572	48.4108	0	3.5576	0.2723	20.4165	0	0	0	0	73.9827
291	0.06152	1625.95	5.0373E-06	0.001465741	0	73.9826	0	48.4108	0	3.5576	0.0666	20.4831	0	0	0	0	73.916
292	0.06152	1625.95	5.03731E-06	0.001470779	0	73.916	0	48.4108	0	3.5576	0.1408	20.6239	0	0	0	0	73.7752
293	0.06152	1625.95	5.03732E-06	0.001475816	0	73.7752	0.2794	48.6902	0	3.5576	0.0549	20.6788	0	0	0	0	73.9997
294	0.06152	1625.95	5.03733E-06	0.001480853	0	73.9996	2.2098	50.9	0	3.5576	0.5073	21.1861	0	0	0	0	75.7021

Scenario: 1986 No Stormwater Recirculation

Day	Water (cm3/cm3)	Head (cm)	Water Flow (cm)	Water Flow (cm) Accum	Plant Sink (cm)	Prestor	Infil	Infil Accum	Runoff	Runoff Accum	Evapo	Evapo Accum	Trans	Trans Accum	Drain	Drain Accum	Newstor
295	0.06152	1625.95	5.03734E-06	0.001485891	0	75.7023	0	50.9	0	3.5576	0.2176	21.4037	0	0	0	0	75.4847
296	0.06152	1625.95	5.03735E-06	0.001490928	0	75.4848	0	50.9	0	3.5576	0.0667	21.4704	0	0	0	0	75.4181
297	0.06152	1625.95	5.03736E-06	0.001495965	0	75.4181	0	50.9	0	3.5576	0.0626	21.533	0	0	0	0	75.3555
298	0.06152	1625.95	5.03737E-06	0.001501003	0	75.3555	0	50.9	0	3.5576	0.0626	21.5956	0	0	0	0	75.293
299	0.06152	1625.95	5.03738E-06	0.00150604	0	75.293	0	50.9	0	3.5576	0.0665	21.6621	0	0	0	0	75.2265
300	0.06152	1625.95	5.03739E-06	0.001511077	0	75.2265	0	50.9	0	3.5576	0.0743	21.7364	0	0	0	0	75.1522
301	0.06152	1625.94	5.0374E-06	0.001516115	0	75.1522	0	50.9	0	3.5576	0.0792	21.8156	0	0	0	0	75.073
302	0.06152	1625.94	5.03742E-06	0.001521152	0	75.073	0	50.9	0	3.5576	0.0518	21.8674	0	0	0	0	75.0212
303	0.06152	1625.94	5.03743E-06	0.00152619	0	75.0212	0	50.9	0	3.5576	0.0576	21.925	0	0	0	0	74.9636
304	0.06152	1625.94	5.03744E-06	0.001531227	0	74.9636	0	50.9	0	3.5576	0.0626	21.9876	0	0	0	0	74.9009
305	0.06152	1625.94	5.03745E-06	0.001536265	0	74.9009	0	50.9	0	3.5576	0.0545	22.0421	0	0	0	0	74.8464
306	0.06152	1625.94	5.03746E-06	0.001541302	0	74.8464	1.778	52.678	0	3.5576	0	22.0421	0	0	0	0	76.6244
307	0.06152	1625.94	5.03747E-06	0.00154634	0	76.624	2.0066	54.6846	0	3.5576	0	22.0421	0	0	0	0	78.6306
308	0.06152	1625.94	5.03748E-06	0.001551377	0	78.6308	0.3556	55.0402	0	3.5576	0.173	22.2151	0	0	0	0	78.8134
309	0.06152	1625.93	5.0375E-06	0.001556415	0	78.8134	0	55.0402	0	3.5576	0.2974	22.5125	0	0	0	0	78.516
310	0.06152	1625.93	5.03751E-06	0.001561452	0	78.5161	0	55.0402	0	3.5576	0.0768	22.5893	0	0	0	0	78.4393
311	0.06152	1625.93	5.03752E-06	0.00156649	0	78.4393	0	55.0402	0	3.5576	0.0758	22.6651	0	0	0	0	78.3636
312	0.06152	1625.93	5.03753E-06	0.001571527	0	78.3636	0	55.0402	0	3.5576	0.079	22.7441	0	0	0	0	78.2846
313	0.06152	1625.93	5.03755E-06	0.001576565	0	78.2846	0	55.0402	0	3.5576	0.0751	22.8192	0	0	0	0	78.2095
314	0.06152	1625.93	5.03756E-06	0.001581602	0	78.2095	0	55.0402	0	3.5576	0.059	22.8782	0	0	0	0	78.1504
315	0.06152	1625.93	5.03757E-06	0.00158664	0	78.1504	0	55.0402	0	3.5576	0.0575	22.9357	0	0	0	0	78.093
316	0.06152	1625.93	5.03759E-06	0.001591677	0	78.093	0	55.0402	0	3.5576	0.0875	23.0232	0	0	0	0	78.0055
317	0.06152	1625.92	5.0376E-06	0.001596715	0	78.0054	0.3302	55.3704	0	3.5576	0.0208	23.044	0	0	0	0	78.3148
318	0.06152	1625.92	5.03761E-06	0.001601753	0	78.3147	0	55.3704	0	3.5576	0.143	23.187	0	0	0	0	78.1717
319	0.06152	1625.92	5.03763E-06	0.00160679	0	78.1718	0	55.3704	0	3.5576	0.0614	23.2484	0	0	0	0	78.1104
320	0.06152	1625.92	5.03764E-06	0.001611828	0	78.1104	0	55.3704	0	3.5576	0.106	23.3544	0	0	0	0	78.0044
321	0.06152	1625.92	5.03766E-06	0.001616866	0	78.0045	0	55.3704	0	3.5576	0.0691	23.4235	0	0	0	0	77.9353
322	0.06152	1625.92	5.03767E-06	0.001621903	0	77.9353	0	55.3704	0	3.5576	0.0631	23.4866	0	0	0	0	77.8722
323	0.06152	1625.92	5.03769E-06	0.001626941	0	77.8722	0.1524	55.5228	0	3.5576	0.1177	23.6043	0	0	0	0	77.907
324	0.06152	1625.91	5.0377E-06	0.001631979	0	77.9069	0	55.5228	0	3.5576	0.0637	23.668	0	0	0	0	77.8432
325	0.06152	1625.91	5.03772E-06	0.001637016	0	77.8433	0	55.5228	0	3.5576	0.0533	23.7213	0	0	0	0	77.79
326	0.06152	1625.91	5.03773E-06	0.001642054	0	77.79	0	55.5228	0	3.5576	0.0685	23.7898	0	0	0	0	77.7215
327	0.06152	1625.91	5.03775E-06	0.001647092	0	77.7215	0.1778	55.7006	0	3.5576	0.1144	23.9042	0	0	0	0	77.7849
328	0.06152	1625.91	5.03776E-06	0.00165213	0	77.7848	0	55.7006	0	3.5576	0.0603	23.9645	0	0	0	0	77.7244
329	0.06152	1625.91	5.03778E-06	0.001657167	0	77.7244	0	55.7006	0	3.5576	0.058	24.0225	0	0	0	0	77.6665
330	0.06152	1625.91	5.03779E-06	0.001662205	0	77.6665	0	55.7006	0	3.5576	0.0724	24.0949	0	0	0	0	77.5941
331	0.06152	1625.9	5.03781E-06	0.001667243	0	77.5941	0	55.7006	0	3.5576	0.052	24.1469	0	0	0	0	77.542
332	0.06152	1625.9	5.03783E-06	0.001672281	0	77.5421	0	55.7006	0	3.5576	0.039	24.1859	0	0	0	0	77.5031
333	0.06152	1625.9	5.03784E-06	0.001677319	0	77.5031	0	55.7006	0	3.5576	0.0403	24.2262	0	0	0	0	77.4629
334	0.06152	1625.9	5.03786E-06	0.001682356	0	77.4629	0	55.7006	0	3.5576	0.0455	24.2717	0	0	0	0	77.4173
335	0.06152	1625.9	5.03788E-06	0.001687394	0	77.4173	0	55.7006	0	3.5576	0.0377	24.3094	0	0	0	0	77.3797
336	0.06152	1625.9	5.03789E-06	0.001692432	0	77.3797	0	55.7006	0	3.5576	0.0435	24.3529	0	0	0	0	77.3362

Scenario: 1986 No Stormwater Recirculation

Day	Water (cm3/cm3)	Head (cm)	Water Flow (cm)	Water Flow (cm) Accum	Plant Sink (cm)	Prestor	Infil	Infil Accum	Runoff	Runoff Accum	Evapo	Evapo Accum	Trans	Trans Accum	Drain	Drain Accum	Newstor
337	0.06152	1625.89	5.03791E-06	0.00169747	0	77.3362	0	55.7006	0	3.5576	0.0277	24.3806	0	0	0	0	77.3085
338	0.06152	1625.89	5.03793E-06	0.001702508	0	77.3086	0	55.7006	0	3.5576	0.0006	24.3812	0	0	0	0	77.308
339	0.06152	1625.89	5.03795E-06	0.001707546	0	77.3079	0	55.7006	0	3.5576	0.026	24.4072	0	0	0	0	77.2819
340	0.06152	1625.89	5.03796E-06	0.001712584	0	77.2819	0	55.7006	0	3.5576	0.0116	24.4188	0	0	0	0	77.2704
341	0.06152	1625.89	5.03798E-06	0.001717622	0	77.2704	0	55.7006	0	3.5576	0.0273	24.4461	0	0	0	0	77.243
342	0.06152	1625.88	0.000005038	0.00172266	0	77.2431	0.381	56.0816	0	3.5576	0.1042	24.5503	0	0	0	0	77.5198
343	0.06152	1625.88	5.03802E-06	0.001727698	0	77.5195	0	56.0816	0	3.5576	0	24.5503	0	0	0	0	77.5195
344	0.06152	1625.88	5.03804E-06	0.001732736	0	77.5195	0.4572	56.5388	0	3.5576	0.0738	24.6241	0	0	0	0	77.903
345	0.06152	1625.88	5.03806E-06	0.001737774	0	77.9028	0	56.5388	0	3.5576	0.1367	24.7608	0	0	0	0	77.7661
346	0.06152	1625.88	5.03808E-06	0.001742812	0	77.7662	0	56.5388	0	3.5576	0.0572	24.818	0	0	0	0	77.7089
347	0.06152	1625.87	5.0381E-06	0.00174785	0	77.7089	0	56.5388	0	3.5576	0.0486	24.8666	0	0	0	0	77.6603
348	0.06152	1625.87	5.03812E-06	0.001752888	0	77.6603	0	56.5388	0	3.5576	0.0494	24.916	0	0	0	0	77.611
349	0.06152	1625.87	5.03814E-06	0.001757927	0	77.611	0	56.5388	0	3.5576	0.06	24.976	0	0	0	0	77.551
350	0.06152	1625.87	5.03816E-06	0.001762965	0	77.551	0.2032	56.742	0	3.5576	0.0215	24.9975	0	0	0	0	77.7327
351	0.06152	1625.87	5.03818E-06	0.001768003	0	77.7325	0.6604	57.4024	0	3.5576	0	24.9975	0	0	0	0	78.3929
352	0.06152	1625.86	5.0382E-06	0.001773041	0	78.3927	0.254	57.6564	0	3.5576	0.1016	25.0991	0	0	0	0	78.5452
353	0.06152	1625.86	5.03822E-06	0.001778079	0	78.5452	0	57.6564	0	3.5576	0.1734	25.2725	0	0	0	0	78.3718
354	0.06152	1625.86	5.03824E-06	0.001783118	0	78.3719	0	57.6564	0	3.5576	0.0532	25.3257	0	0	0	0	78.3187
355	0.06152	1625.86	5.03826E-06	0.001788156	0	78.3187	0.6604	58.3168	0	3.5576	0.1053	25.431	0	0	0	0	78.8738
356	0.06152	1625.86	5.03828E-06	0.001793194	0	78.8736	1.1176	59.4344	0	3.5576	0	25.431	0	0	0	0	79.9912
357	0.06152	1625.85	5.0383E-06	0.001798232	0	79.9911	0	59.4344	0	3.5576	0.1705	25.6015	0	0	0	0	79.8206
358	0.06152	1625.85	5.03832E-06	0.001803271	0	79.8206	0	59.4344	0	3.5576	0.0521	25.6536	0	0	0	0	79.7685
359	0.06152	1625.85	5.03835E-06	0.001808309	0	79.7685	0	59.4344	0	3.5576	0.1703	25.8239	0	0	0	0	79.5982
360	0.06152	1625.85	5.03837E-06	0.001813347	0	79.5983	0	59.4344	0	3.5576	0.059	25.8829	0	0	0	0	79.5393
361	0.06152	1625.84	5.03839E-06	0.001818386	0	79.5393	0	59.4344	0	3.5576	0.0527	25.9356	0	0	0	0	79.4865
362	0.06152	1625.84	5.03841E-06	0.001823424	0	79.4865	0	59.4344	0	3.5576	0.0455	25.9811	0	0	0	0	79.4411
363	0.06152	1625.84	5.03844E-06	0.001828463	0	79.4411	0	59.4344	0	3.5576	0.0622	26.0433	0	0	0	0	79.3788
364	0.06152	1625.84	5.03846E-06	0.001833501	0	79.3788	0	59.4344	0	3.5576	0.0661	26.1094	0	0	0	0	79.3127
365	0.06152	1625.84	5.03848E-06	0.00183854	0	79.3127	0	59.4344	0	3.5576	0.0677	26.1771	0	0	0	0	79.245

Scenario: 1986 No Stormwater Recirculation

Day	Storage	Mass Balance	Evap Potential	Evap Actual	Trans Potential	Trans Actual	Precip
1	45.8855	-0.00012694	0.6036	0.046	0	0	0
2	45.8599	-0.000059776	0.2755	0.0257	0	0	0
3	45.844	-0.000025966	0.1907	0.0159	0	0	0
4	45.8295	-0.00002415	0.443	0.0145	0	0	0
5	45.8174	-0.00001604	0.4345	0.0122	0	0	0
6	46.1848	0.00062078	0.556	0.1399	0	0	0.508
7	47.3267	0.00070361	0.0518	0.0513	0	0	1.1938
8	47.1607	-0.000089055	0.23	0.166	0	0	0
9	47.1117	-2.2231E-06	0.314	0.0491	0	0	0
10	47.0476	-0.000014244	0.5188	0.0641	0	0	0
11	46.9762	-0.000019899	0.5163	0.0714	0	0	0
12	46.9172	-0.000066453	0.6306	0.0591	0	0	0
13	46.8837	-0.00000511	0.4943	0.0335	0	0	0
14	46.8483	-0.000020109	0.4285	0.0354	0	0	0
15	46.8181	-0.000041091	0.4513	0.0302	0	0	0
16	46.7896	-0.000016863	0.7485	0.0285	0	0	0
17	46.7637	-0.00003617	0.3326	0.0259	0	0	0
18	46.7436	-5.9236E-06	0.5699	0.0202	0	0	0
19	46.7224	-0.000019082	0.5666	0.0212	0	0	0
20	46.7016	-0.000028454	0.7008	0.0208	0	0	0
21	46.6824	-0.000015011	0.6626	0.0193	0	0	0
22	46.6663	-0.000023303	0.4847	0.0161	0	0	0
23	46.6532	-2.3399E-06	0.3654	0.0131	0	0	0
24	46.6372	-0.000013294	0.5066	0.016	0	0	0
25	46.6245	-0.000015638	0.6058	0.0127	0	0	0
26	46.6123	-5.1852E-06	0.5074	0.0123	0	0	0
27	46.5998	-6.5242E-06	0.6066	0.0125	0	0	0
28	46.5843	-0.000023373	0.7179	0.0155	0	0	0
29	46.5717	-5.5535E-06	0.6847	0.0126	0	0	0
30	46.5605	-0.000011914	0.5831	0.0112	0	0	0
31	46.549	-0.000013675	0.4029	0.0115	0	0	0
32	46.542	-2.2316E-06	0.5467	0.0071	0	0	0
33	46.5365	-1.3227E-06	0.2606	0.0054	0	0	0
34	46.5249	-7.1557E-06	0.6813	0.0116	0	0	0
35	46.5511	0.00010999	0.4279	0.0753	0	0	0.1016
36	46.5511	0.000010237	0	0	0	0	0
37	46.5356	-0.000050981	0.0432	0.0155	0	0	0
38	46.5669	0.00012792	0.2712	0.0447	0	0	0.0762
39	46.6657	0.00022658	0.0027	0.0026	0	0	0.1016
40	47.4525	0.00056775	0	0	0	0	0.7874
41	47.4967	8.1478E-06	0.1606	0.159	0	0	0.2032
42	47.402	-0.000028242	0.0948	0.0948	0	0	0

Scenario: 1986 No Stormwater Recirculation

Day	Storage	Mass Balance	Evap Potential	Evap Actual	Trans Potential	Trans Actual	Precip
43	47.402	2.8434E-06	0	0	0	0	0
44	47.3411	-0.000065325	0.2696	0.0609	0	0	0
45	47.2776	-0.000026384	0.352	0.0635	0	0	0
46	47.2223	-0.000062327	0.3986	0.0554	0	0	0
47	47.1811	-0.00004007	0.7752	0.0412	0	0	0
48	47.1498	-0.000030232	0.6966	0.0313	0	0	0
49	47.1194	-0.000030418	0.5723	0.0305	0	0	0
50	47.0921	-0.000033925	0.6347	0.0273	0	0	0
51	47.0657	-0.000036583	0.9438	0.0264	0	0	0
52	47.05	-3.8587E-06	0.7137	0.0158	0	0	0
53	47.0278	-0.000015865	0.8565	0.0222	0	0	0
54	47.0073	-0.000029282	0.6653	0.0206	0	0	0
55	46.9904	-9.7674E-06	0.7199	0.0169	0	0	0
56	46.9738	-0.000018574	0.8445	0.0166	0	0	0
57	46.9566	-0.000018218	1.0691	0.0172	0	0	0
58	46.9438	-9.1269E-06	0.5595	0.0129	0	0	0
59	46.9304	-0.000019713	0.7445	0.0134	0	0	0
60	46.9165	-7.9656E-06	0.8081	0.0138	0	0	0
61	46.9028	-0.000012886	0.8125	0.0138	0	0	0
62	46.8916	-0.000013552	0.6347	0.0111	0	0	0
63	46.8819	-0.00000156	0.804	0.0098	0	0	0
64	46.8701	-5.6589E-06	0.9462	0.0118	0	0	0
65	46.8591	-0.000012296	0.9849	0.011	0	0	0
66	46.8486	-5.5597E-06	0.6435	0.0105	0	0	0
67	46.8384	-2.8776E-06	0.6168	0.0103	0	0	0
68	46.8266	-0.000011301	1.0792	0.0118	0	0	0
69	46.8163	-0.000010379	0.4964	0.0103	0	0	0
70	46.8096	-1.8919E-06	0.5906	0.0068	0	0	0
71	46.8008	3.8394E-07	0.6907	0.0088	0	0	0
72	46.7962	-2.8377E-06	0.1936	0.0046	0	0	0
73	46.8475	0.00018051	0.1074	0.0501	0	0	0.1016
74	46.8036	-0.00013007	0.7778	0.044	0	0	0
75	46.7883	-0.000025889	0.9057	0.0153	0	0	0
76	46.7784	-6.1885E-06	0.9797	0.0099	0	0	0
77	46.7797	0.000018582	0.2394	0.0495	0	0	0.0508
78	46.8146	0.00014758	0.5868	0.0919	0	0	0.127
79	46.794	-0.000043067	0.5985	0.0461	0	0	0.0254
80	46.7752	-0.000046187	0.8739	0.0188	0	0	0
81	46.763	-0.000011963	1.0249	0.0122	0	0	0
82	46.7528	-2.8703E-06	0.9417	0.0103	0	0	0
83	46.7438	-7.5634E-06	0.8387	0.0089	0	0	0
84	46.7358	-0.000012088	0.9651	0.008	0	0	0

Scenario: 1986 No Stormwater Recirculation

Day	Storage	Mass Balance	Evap Potential	Evap Actual	Trans Potential	Trans Actual	Precip
85	46.7287	-4.2445E-06	1.1083	0.0071	0	0	0
86	46.7239	-1.8886E-06	0.9215	0.0048	0	0	0
87	46.7163	-4.4545E-07	1.1041	0.0076	0	0	0
88	46.7103	-1.2848E-06	0.8127	0.006	0	0	0
89	46.7028	3.6021E-09	0.8813	0.0074	0	0	0
90	46.6943	-0.000001647	0.9786	0.0085	0	0	0
91	46.6891	-6.5901E-06	0.7378	0.0053	0	0	0
92	46.6821	-3.3469E-06	1.0248	0.0069	0	0	0
93	46.6743	-1.9352E-07	0.7489	0.0078	0	0	0
94	46.6678	-5.9006E-07	1.0224	0.0065	0	0	0
95	46.6605	3.9572E-07	0.7789	0.0072	0	0	0
96	46.6552	-2.7129E-06	0.5689	0.0054	0	0	0
97	46.6478	2.3423E-07	0.7861	0.0074	0	0	0
98	47.2247	-0.00041218	0.5278	0.2057	0	0	0.7874
99	47.1679	-8.6244E-08	0.457	0.0568	0	0	0
100	47.1031	-0.000074301	0.6882	0.0649	0	0	0
101	47.0535	-0.000065065	1.0875	0.0497	0	0	0
102	47.0175	-0.000050442	1.1011	0.036	0	0	0
103	46.9885	-0.000031599	1.6108	0.0291	0	0	0
104	46.9637	-0.000030389	1.0561	0.0248	0	0	0
105	46.9426	-0.000032523	1.0526	0.0211	0	0	0
106	46.9277	-9.4613E-06	0.7288	0.0148	0	0	0
107	46.9107	-0.000026757	1.6872	0.0171	0	0	0
108	46.8928	-0.000016421	1.2608	0.0178	0	0	0
109	46.8823	-0.000014838	0.53	0.0106	0	0	0
110	46.8692	-0.0000109	0.6888	0.013	0	0	0
111	46.8567	-0.000012895	0.994	0.0125	0	0	0
112	46.8447	-0.00001551	1.0712	0.012	0	0	0
113	46.8324	-8.5424E-06	1.1877	0.0124	0	0	0
114	46.8203	-0.000017526	1.1774	0.0121	0	0	0
115	46.81	-4.7243E-06	1.1202	0.0103	0	0	0
116	46.7993	-6.2838E-06	1.2981	0.0106	0	0	0
117	46.7866	-0.000015284	1.6638	0.0127	0	0	0
118	46.7753	-6.9383E-06	1.1204	0.0114	0	0	0
119	46.7676	-3.2904E-06	1.061	0.0077	0	0	0
120	46.7586	-9.6642E-07	1.0536	0.009	0	0	0
121	46.7537	-0.000003864	0.8945	0.0049	0	0	0
122	46.7468	-6.7822E-07	0.8651	0.0069	0	0	0
123	46.7403	-2.1717E-06	1.0649	0.0065	0	0	0
124	46.7317	-6.6336E-06	1.4199	0.0085	0	0	0
125	46.7216	-9.4525E-06	1.4558	0.0102	0	0	0
126	46.7122	-9.3522E-08	1.4699	0.0093	0	0	0

Scenario: 1986 No Stormwater Recirculation

Day	Storage	Mass Balance	Evap Potential	Evap Actual	Trans Potential	Trans Actual	Precip
127	46.7034	-2.3553E-06	1.5122	0.0088	0	0	0
128	46.695	-4.3691E-06	1.3664	0.0084	0	0	0
129	46.6862	-0.000009989	0.9416	0.0088	0	0	0
130	46.6778	-0.000010062	1.1476	0.0084	0	0	0
131	46.6694	2.5527E-07	1.3621	0.0084	0	0	0
132	46.6609	-3.247E-07	1.5267	0.0085	0	0	0
133	46.6543	-3.8902E-06	1.2407	0.0066	0	0	0
134	46.6461	-1.7202E-06	1.0033	0.0082	0	0	0
135	46.6379	-7.7186E-06	1.0124	0.0082	0	0	0
136	46.6309	-0.000006944	1.116	0.007	0	0	0
137	47.1492	-0.00032697	0.292	0.1644	0	0	0.6858
138	47.0804	6.8503E-06	0.8664	0.0688	0	0	0
139	47.0131	-0.000083894	1.0539	0.0673	0	0	0
140	46.9698	-0.000066985	1.4689	0.0434	0	0	0
141	46.9375	-0.000047727	1.3522	0.0323	0	0	0
142	46.9101	-0.000045019	1.0654	0.0275	0	0	0
143	46.8916	-0.000022698	0.9337	0.0185	0	0	0
144	46.8755	-0.000017299	0.5235	0.0161	0	0	0
145	46.8768	0.000026421	0.3462	0.0495	0	0	0.0508
146	46.9755	0.00028557	0.4154	0.0788	0	0	0.1778
147	46.9399	-0.000057451	0.8444	0.0611	0	0	0.0254
148	46.9111	-0.000065617	0.6003	0.0289	0	0	0
149	46.9928	0.00023499	0.1974	0.0705	0	0	0.1524
150	48.0201	0.00067769	0.3765	0.2675	0	0	1.2954
151	48.6168	0.00024129	0.0384	0.038	0	0	0.635
152	48.4745	-0.000097524	0.2896	0.1932	0	0	0.0508
153	48.4197	-4.1847E-06	0.3371	0.0547	0	0	0
154	48.3716	-3.2075E-06	0.6355	0.0482	0	0	0
155	48.3034	0.000007026	0.6932	0.0936	0	0	0.0254
156	48.2438	-0.000014196	0.7816	0.0596	0	0	0
157	48.1838	-0.000068394	1.3063	0.0601	0	0	0
158	48.1375	-0.000032332	1.1734	0.0463	0	0	0
159	48.8173	-0.0011182	0.9711	0.2326	0	0	0.9144
160	48.7416	-0.000016542	1.1101	0.0757	0	0	0
161	48.6522	-0.000012792	1.091	0.0894	0	0	0
162	48.5772	-0.000017673	1.2145	0.075	0	0	0
163	48.5148	-0.000068973	1.2325	0.0624	0	0	0
164	48.4703	-0.000015654	1.4279	0.0445	0	0	0
165	48.428	-0.000056211	1.1771	0.0424	0	0	0
166	48.3959	-0.000013634	1.6066	0.032	0	0	0
167	48.362	-0.000045853	1.5031	0.034	0	0	0
168	48.3386	-4.4756E-06	1.3909	0.0234	0	0	0

Scenario: 1986 No Stormwater Recirculation

Day	Storage	Mass Balance	Evap Potential	Evap Actual	Trans Potential	Trans Actual	Precip
169	50.2541	-0.0025673	0.6911	0.3999	0	0	2.3876
170	50.2416	0.000027944	0.7379	0.2157	0	0	0.2032
171	50.1751	-5.5451E-06	0.6709	0.0665	0	0	0
172	50.113	-4.1935E-06	0.9226	0.0621	0	0	0
173	50.0573	-3.4216E-06	0.4235	0.0557	0	0	0
174	52.6535	0.00040576	0.0459	0.045	0	0	2.6416
175	56.1372	-0.013047	0.1713	0.1678	0	0	3.6576
176	58.4426	-0.018288	0.2949	0.289	0	0	2.7686
177	58.1468	-0.000097524	0.594	0.3975	0	0	0.1016
178	58.0667	0.000018192	0.8234	0.0801	0	0	0
179	57.9901	0.000011264	0.9768	0.0766	0	0	0
180	57.9194	0.000011132	0.8047	0.0707	0	0	0
181	57.8504	0.000009986	0.9275	0.0689	0	0	0
182	59.0074	0.0000846	0.5246	0.5193	0	0	1.6764
183	59.2113	-0.000042438	0.5864	0.3549	0	0	0.5588
184	59.0859	6.5881E-06	0.755	0.1762	0	0	0.0508
185	59.0165	-0.000001293	1.2137	0.0695	0	0	0
186	58.949	-1.7058E-06	0.9321	0.0675	0	0	0
187	58.8866	-1.3402E-06	1.0648	0.0624	0	0	0
188	58.8236	-1.4017E-06	0.8583	0.0629	0	0	0
189	58.7585	-1.7801E-06	1.0089	0.0652	0	0	0
190	58.8522	0.00005979	0.8315	0.1602	0	0	0.254
191	58.7624	0.000019932	0.8411	0.1151	0	0	0.0254
192	58.6912	-4.2473E-06	1.0177	0.0713	0	0	0
193	58.6196	-5.9433E-06	1.3581	0.0716	0	0	0
194	58.5554	-4.1656E-06	1.1424	0.0641	0	0	0
195	58.5011	-2.1734E-06	0.956	0.0543	0	0	0
196	58.4396	-0.000016268	1.0392	0.0615	0	0	0
197	58.3792	-0.000062959	1.1827	0.0605	0	0	0
198	58.3481	0.000043571	0.8902	0.0819	0	0	0.0508
199	58.3046	-0.000042569	1.1016	0.0436	0	0	0
200	58.2654	-2.3428E-06	1.0896	0.0392	0	0	0
201	58.2274	-2.0937E-06	1.016	0.038	0	0	0
202	58.2054	0.000012983	0.8108	0.0728	0	0	0.0508
203	58.1713	-2.6748E-06	0.718	0.0341	0	0	0
204	58.2123	0.00012283	1.0683	0.1113	0	0	0.1524
205	58.149	-0.000070846	1.12	0.0634	0	0	0
206	58.1067	-0.000014198	1.2055	0.0422	0	0	0
207	58.0616	-0.000055688	1.063	0.0452	0	0	0
208	58.0285	-5.3216E-06	0.9388	0.033	0	0	0
209	57.9969	-2.7166E-06	1.3803	0.0316	0	0	0
210	57.9639	-0.000012694	1.215	0.033	0	0	0

Scenario: 1986 No Stormwater Recirculation

Day	Storage	Mass Balance	Evap Potential	Evap Actual	Trans Potential	Trans Actual	Precip
211	57.9309	-0.00004377	1.3319	0.033	0	0	0
212	57.9058	-7.6921E-07	0.8897	0.0251	0	0	0
213	57.8802	-9.3555E-07	0.7616	0.0256	0	0	0
214	57.9556	0.00022008	1.1035	0.1276	0	0	0.2032
215	58.2174	0.0002212	1.0244	0.1444	0	0	0.4064
216	58.3643	0.000076758	1.0212	0.1578	0	0	0.3048
217	58.2972	-0.000010862	1.2124	0.0671	0	0	0
218	58.2803	0.000030811	0.7003	0.1185	0	0	0.1016
219	58.2087	-0.000014209	1.1267	0.0716	0	0	0
220	58.143	-0.000018518	0.8303	0.0657	0	0	0
221	58.0934	-0.000050799	0.7931	0.0497	0	0	0
222	58.0581	-2.6223E-06	0.8542	0.0352	0	0	0
223	58.0281	-1.3362E-06	0.8045	0.03	0	0	0
224	57.9951	-7.5805E-06	0.8584	0.033	0	0	0
225	57.9654	2.7248E-06	0.9978	0.0551	0	0	0.0254
226	57.9343	-0.000038986	0.519	0.0312	0	0	0
227	57.9106	-1.1781E-06	0.9087	0.0236	0	0	0
228	57.8871	-1.3503E-06	1.0113	0.0236	0	0	0
229	57.8579	-0.000016275	1.0371	0.0292	0	0	0
230	57.8292	-0.000043777	1.1299	0.0287	0	0	0
231	57.8051	-2.8094E-06	1.0445	0.0241	0	0	0
232	57.7782	-0.000013007	1.0998	0.0269	0	0	0
233	57.7581	-2.9853E-06	0.987	0.0201	0	0	0
234	58.9022	-0.0016595	0.7538	0.3337	0	0	1.4986
235	59.0622	0.000057363	0.5833	0.2718	0	0	0.4318
236	59.0011	-4.9146E-06	0.5334	0.0611	0	0	0
237	58.9425	-4.0201E-06	0.8792	0.0586	0	0	0
238	60.6585	0.00018914	0.6461	0.4428	0	0	2.159
239	61.2653	0.00010063	0.4133	0.4092	0	0	1.016
240	61.8427	0.000068051	0.0838	0.0829	0	0	0.6604
241	61.6474	-0.00010308	0.5076	0.2716	0	0	0.0762
242	61.7007	0.000037299	0.8638	0.226	0	0	0.2794
243	62.0892	0.000077865	0.6087	0.348	0	0	0.7366
244	63.5296	-0.000016514	0.4437	0.4393	0	0	1.8796
245	66.5812	-0.021008	0.7747	0.7592	0	0	4.3434
246	66.2767	-0.00010979	0.5723	0.3046	0	0	0
247	68.262	-0.00011563	0.3809	0.377	0	0	2.3622
248	67.9229	-0.00012015	0.6706	0.3392	0	0	0
249	67.8463	2.2695E-06	0.7475	0.0765	0	0	0
250	67.671	3.8361E-06	0.2621	0.2262	0	0	0.0508
251	67.6126	4.2793E-07	0.6241	0.0583	0	0	0
252	67.5512	1.2221E-07	0.9658	0.0614	0	0	0

Scenario: 1986 No Stormwater Recirculation

Day	Storage	Mass Balance	Evap Potential	Evap Actual	Trans Potential	Trans Actual	Precip
253	67.4764	-1.6489E-06	1.0581	0.0749	0	0	0
254	67.3997	-2.0385E-06	1.1058	0.0766	0	0	0
255	67.334	-1.0824E-06	0.967	0.0658	0	0	0
256	67.3161	0.000035031	0.5109	0.1194	0	0	0.1016
257	67.2649	-6.2952E-07	0.3497	0.0512	0	0	0
258	67.2108	-9.2452E-07	0.8377	0.0541	0	0	0
259	67.1566	-1.1346E-06	0.6747	0.0542	0	0	0
260	67.0901	-4.3896E-06	0.9658	0.0665	0	0	0
261	67.0212	-0.00000626	0.9913	0.0689	0	0	0
262	66.957	-5.4807E-06	1.1145	0.0643	0	0	0
263	66.8967	-7.5677E-06	1.0868	0.0603	0	0	0
264	66.8423	-8.0687E-06	0.7835	0.0543	0	0	0
265	67.0057	0.00014382	0.2251	0.1413	0	0	0.3048
266	67.4389	0.00018208	0.3146	0.3032	0	0	0.7366
267	67.3664	-4.1314E-06	0.9637	0.0725	0	0	0
268	67.2855	-7.6037E-06	1.1457	0.0809	0	0	0
269	67.2066	-7.1888E-06	1.0574	0.0789	0	0	0
270	67.1334	-0.00000786	1.0073	0.0732	0	0	0
271	67.0732	-3.7902E-06	0.5797	0.0602	0	0	0
272	67.1504	0.000079104	0.7148	0.1259	0	0	0.2032
273	67.0758	-0.000016458	0.886	0.0745	0	0	0
274	66.9887	-0.000038466	0.9366	0.0871	0	0	0
275	67.065	0.00011059	0.1543	0.1014	0	0	0.1778
276	67.0012	-0.000012732	0.7917	0.0638	0	0	0
277	66.9286	-0.000023048	0.8314	0.0726	0	0	0
278	67.2586	0.00025463	0	0	0	0	0.3302
279	67.3536	0.00002679	0.0836	0.0827	0	0	0.1778
280	67.2454	-0.000080278	0.7216	0.1083	0	0	0
281	67.1855	-4.3503E-06	0.7198	0.0599	0	0	0
282	68.442	0.00038262	0.2442	0.2417	0	0	1.4986
283	74.4621	-0.0023287	0.0909	0.0872	0	0	8.7884
284	74.3536	-7.2728E-06	0.1085	0.1085	0	0	0
285	74.2365	-0.00001057	0.1171	0.1171	0	0	0
286	74.0166	-0.00010821	0.762	0.22	0	0	0
287	73.9389	-1.6008E-06	0.6758	0.0777	0	0	0
288	73.8657	-1.7572E-06	0.7235	0.0732	0	0	0
289	73.7978	-1.5823E-06	0.2908	0.0679	0	0	0
290	73.9826	0.000071473	0.6932	0.2723	0	0	0.4572
291	73.916	-1.8711E-06	0.5916	0.0666	0	0	0
292	73.7752	3.0954E-06	0.141	0.1408	0	0	0
293	73.9996	0.000082628	0.0555	0.0549	0	0	0.2794
294	75.7023	-0.0001801	0.5124	0.5073	0	0	2.2098

Scenario: 1986 No Stormwater Recirculation

Day	Storage	Mass Balance	Evap Potential	Evap Actual	Trans Potential	Trans Actual	Precip
295	75.4848	-0.00010576	0.7085	0.2176	0	0	0
296	75.4181	-1.3179E-06	0.4278	0.0667	0	0	0
297	75.3555	-1.2855E-06	0.2876	0.0626	0	0	0
298	75.293	-1.3611E-06	0.4934	0.0626	0	0	0
299	75.2265	-1.7414E-06	0.6068	0.0665	0	0	0
300	75.1522	-2.7289E-06	0.6715	0.0743	0	0	0
301	75.073	-3.7144E-06	0.741	0.0792	0	0	0
302	75.0212	-5.6501E-07	0.2589	0.0518	0	0	0
303	74.9636	-1.3182E-06	0.5145	0.0576	0	0	0
304	74.9009	-2.2361E-06	0.6919	0.0626	0	0	0
305	74.8464	0.000020472	0.0546	0.0545	0	0	0
306	76.624	0.00033056	0	0	0	0	1.778
307	78.6308	-0.00018423	0	0	0	0	2.0066
308	78.8134	0.000012079	0.1748	0.173	0	0	0.3556
309	78.5161	-0.00011743	0.5028	0.2974	0	0	0
310	78.4393	-1.4015E-06	0.6655	0.0768	0	0	0
311	78.3636	-1.9646E-06	0.6445	0.0758	0	0	0
312	78.2846	-2.4192E-06	0.6683	0.079	0	0	0
313	78.2095	-2.0283E-06	0.5922	0.0751	0	0	0
314	78.1504	-0.000001085	0.3735	0.059	0	0	0
315	78.093	-1.0911E-06	0.5232	0.0575	0	0	0
316	78.0054	0.000015641	0.0875	0.0875	0	0	0
317	78.3147	0.00010862	0.021	0.0208	0	0	0.3302
318	78.1718	-0.000093137	0.5091	0.143	0	0	0
319	78.1104	0.000034875	0.0614	0.0614	0	0	0
320	78.0045	-0.000082192	0.2433	0.106	0	0	0
321	77.9353	-3.2763E-06	0.609	0.0691	0	0	0
322	77.8722	-2.2389E-06	0.2946	0.0631	0	0	0
323	77.9069	0.000054293	0.712	0.1177	0	0	0.1524
324	77.8433	-4.3384E-06	0.704	0.0637	0	0	0
325	77.79	-1.5372E-06	0.5449	0.0533	0	0	0
326	77.7215	-0.000015077	0.5906	0.0685	0	0	0
327	77.7848	0.000083425	0.188	0.1144	0	0	0.1778
328	77.7244	-5.7155E-06	0.4545	0.0603	0	0	0
329	77.6665	-0.000004345	0.4254	0.058	0	0	0
330	77.5941	-0.000025487	0.5388	0.0724	0	0	0
331	77.5421	-0.000052581	0.494	0.052	0	0	0
332	77.5031	-1.7947E-06	0.4729	0.039	0	0	0
333	77.4629	-1.5984E-06	0.5258	0.0403	0	0	0
334	77.4173	-0.000010071	0.7754	0.0455	0	0	0
335	77.3797	-1.9911E-06	0.4926	0.0377	0	0	0
336	77.3362	-0.00002706	0.5589	0.0435	0	0	0

Scenario: 1986 No Stormwater Recirculation

Day	Storage	Mass Balance	Evap Potential	Evap Actual	Trans Potential	Trans Actual	Precip
337	77.3086	-0.000025766	0.406	0.0277	0	0	0
338	77.3079	0.000029692	0.0006	0.0006	0	0	0
339	77.2819	-0.000035144	0.199	0.026	0	0	0
340	77.2704	-8.7261E-06	0.0455	0.0116	0	0	0
341	77.2431	-0.000030744	0.0803	0.0273	0	0	0
342	77.5195	0.0003039	0.1053	0.1042	0	0	0.381
343	77.5195	8.3405E-07	0	0	0	0	0
344	77.9028	0.0001333	0.0745	0.0738	0	0	0.4572
345	77.7662	-0.000093038	0.3839	0.1367	0	0	0
346	77.7089	-3.1822E-06	0.3933	0.0572	0	0	0
347	77.6603	-1.7768E-06	0.4302	0.0486	0	0	0
348	77.611	-2.4607E-06	0.4935	0.0494	0	0	0
349	77.551	-0.000010493	0.4438	0.06	0	0	0
350	77.7325	0.00017533	0.0217	0.0215	0	0	0.2032
351	78.3927	0.00018386	0	0	0	0	0.6604
352	78.5452	0.000023976	0.1026	0.1016	0	0	0.254
353	78.3719	-0.00009904	0.2573	0.1734	0	0	0
354	78.3187	-1.6688E-06	0.2786	0.0532	0	0	0
355	78.8736	0.00025387	0.1064	0.1053	0	0	0.6604
356	79.9911	0.000059846	0	0	0	0	1.1176
357	79.8206	-0.000021799	0.1705	0.1705	0	0	0
358	79.7685	-4.6189E-06	0.0521	0.0521	0	0	0
359	79.5983	-0.000092719	0.184	0.1703	0	0	0
360	79.5393	-0.000001383	0.4406	0.059	0	0	0
361	79.4865	-1.2277E-06	0.3627	0.0527	0	0	0
362	79.4411	-9.563E-07	0.2909	0.0455	0	0	0
363	79.3788	-3.5714E-06	0.5111	0.0622	0	0	0
364	79.3127	-4.8798E-06	0.3965	0.0661	0	0	0
365	79.2451	-8.2897E-06	0.4459	0.0677	0	0	0

Scenario:

1986

Stormwater Recirculation Every Day

Scenario: 1986 Recirculation Every Day

Day	Water (cm3/cm3)	Head (cm)	Water Flow (cm)	Water Flow (cm) Accum	Plant Sink (cm)	Prestor	Infil	Infil Accum	Runoff	Runoff Accum	Evapo	Evapo Accum	Trans	Trans Accum	Drain	Drain Accum	Newstor
1	0.06152	1626	5.03685E-06	5.03685E-06	0	45.9313	0	0	0	0	0.046	0.046	0	0	0	0	45.8854
2	0.06152	1626	5.03685E-06	1.00737E-05	0	45.8855	0	0	0	0	0.0257	0.0717	0	0	0	0	45.8598
3	0.06152	1626	5.03685E-06	1.51106E-05	0	45.8599	0	0	0	0	0.0159	0.0876	0	0	0	0	45.844
4	0.06152	1626	5.03685E-06	2.01474E-05	0	45.844	0	0	0	0	0.0145	0.1021	0	0	0	0	45.8295
5	0.06152	1626	5.03685E-06	2.51843E-05	0	45.8295	0	0	0	0	0.0122	0.1143	0	0	0	0	45.8173
6	0.06152	1626	5.03685E-06	3.02211E-05	0	45.8174	0.508	0.508	0	0	0.0816	0.1959	0	0	0	0	46.2437
7	0.06152	1626	5.03685E-06	3.5258E-05	0	46.2431	1.1938	1.7018	0	0	0.0487	0.2446	0	0	0	0	47.3882
8	0.06152	1626	5.03685E-06	4.02948E-05	0	47.3876	0.3279	2.0297	0	0	0.207	0.4516	0	0	0	0	47.5085
9	0.06152	1626	5.03685E-06	4.53317E-05	0	47.5084	0	2.0297	0	0	0.1742	0.6258	0	0	0	0	47.3343
10	0.06152	1626	5.03685E-06	5.03685E-05	0	47.3344	0	2.0297	0	0	0.0657	0.6915	0	0	0	0	47.2687
11	0.06152	1626	5.03685E-06	5.54054E-05	0	47.2687	0	2.0297	0	0	0.0712	0.7627	0	0	0	0	47.1974
12	0.06152	1626	5.03685E-06	6.04422E-05	0	47.1975	0	2.0297	0	0	0.0724	0.8351	0	0	0	0	47.1251
13	0.06152	1626	5.03685E-06	6.54791E-05	0	47.1251	0	2.0297	0	0	0.0502	0.8853	0	0	0	0	47.0748
14	0.06152	1626	5.03685E-06	7.05159E-05	0	47.0749	0	2.0297	0	0	0.0356	0.9209	0	0	0	0	47.0393
15	0.06152	1626	5.03685E-06	7.55528E-05	0	47.0393	0	2.0297	0	0	0.0356	0.9565	0	0	0	0	47.0037
16	0.06152	1626	5.03685E-06	8.05896E-05	0	47.0037	0	2.0297	0	0	0.0335	0.99	0	0	0	0	46.9701
17	0.06152	1626	5.03685E-06	8.56265E-05	0	46.9702	0	2.0297	0	0	0.0273	1.0173	0	0	0	0	46.9428
18	0.06152	1626	5.03685E-06	9.06633E-05	0	46.9429	0	2.0297	0	0	0.0247	1.042	0	0	0	0	46.9182
19	0.06152	1626	5.03685E-06	9.57002E-05	0	46.9182	0	2.0297	0	0	0.0213	1.0633	0	0	0	0	46.8969
20	0.06152	1626	5.03685E-06	0.000100737	0	46.8969	0	2.0297	0	0	0.0233	1.0866	0	0	0	0	46.8736
21	0.06152	1626	5.03685E-06	0.000105774	0	46.8736	0	2.0297	0	0	0.0203	1.1069	0	0	0	0	46.8533
22	0.06152	1626	5.03685E-06	0.000110811	0	46.8533	0	2.0297	0	0	0.0166	1.1235	0	0	0	0	46.8368
23	0.06152	1626	5.03685E-06	0.000115848	0	46.8368	0	2.0297	0	0	0.0153	1.1388	0	0	0	0	46.8214
24	0.06152	1626	5.03685E-06	0.000120884	0	46.8215	0	2.0297	0	0	0.0167	1.1555	0	0	0	0	46.8048
25	0.06152	1626	5.03685E-06	0.000125921	0	46.8048	0	2.0297	0	0	0.0129	1.1684	0	0	0	0	46.7919
26	0.06152	1626	5.03685E-06	0.000130958	0	46.7919	0	2.0297	0	0	0.0137	1.1821	0	0	0	0	46.7782
27	0.06152	1626	5.03685E-06	0.000135995	0	46.7782	0	2.0297	0	0	0.0134	1.1955	0	0	0	0	46.7648
28	0.06152	1626	5.03685E-06	0.000141032	0	46.7649	0	2.0297	0	0	0.0157	1.2112	0	0	0	0	46.7491
29	0.06152	1626	5.03685E-06	0.000146069	0	46.7492	0	2.0297	0	0	0.0139	1.2251	0	0	0	0	46.7353
30	0.06152	1626	5.03685E-06	0.000151106	0	46.7353	0	2.0297	0	0	0.0115	1.2366	0	0	0	0	46.7238
31	0.06152	1626	5.03685E-06	0.000156142	0	46.7238	0	2.0297	0	0	0.0117	1.2483	0	0	0	0	46.7121
32	0.06152	1626	5.03685E-06	0.000161179	0	46.7121	0	2.0297	0	0	0.0078	1.2561	0	0	0	0	46.7043
33	0.06152	1626	5.03685E-06	0.000166216	0	46.7043	0	2.0297	0	0	0.006	1.2621	0	0	0	0	46.6983
34	0.06152	1626	5.03685E-06	0.000171253	0	46.6983	0	2.0297	0	0	0.012	1.2741	0	0	0	0	46.6864
35	0.06152	1626	5.03685E-06	0.00017629	0	46.6864	0.1016	2.1313	0	0	0.0601	1.3342	0	0	0	0	46.7279
36	0.06152	1626	5.03685E-06	0.000181327	0	46.7278	0	2.1313	0	0	0	1.3342	0	0	0	0	46.7278
37	0.06152	1626	5.03685E-06	0.000186363	0	46.7277	0	2.1313	0	0	0.0267	1.3609	0	0	0	0	46.701
38	0.06152	1626	5.03685E-06	0.0001914	0	46.7011	0.0762	2.2075	0	0	0.0431	1.404	0	0	0	0	46.7342
39	0.06152	1626	5.03685E-06	0.000196437	0	46.7341	0.1016	2.3091	0	0	0.0025	1.4065	0	0	0	0	46.8332
40	0.06152	1626	5.03685E-06	0.000201474	0	46.833	0.7874	3.0965	0	0	0	1.4065	0	0	0	0	47.6204
41	0.06152	1626	5.03685E-06	0.000206511	0	47.6199	0.212	3.3085	0	0	0.1429	1.5494	0	0	0	0	47.6889
42	0.06152	1626	5.03685E-06	0.000211548	0	47.6889	0	3.3085	0	0	0.0948	1.6442	0	0	0	0	47.5941

Scenario: 1986 Recirculation Every Day

Day	Water (cm3/cm3)	Head (cm)	Water Flow (cm)	Water Flow (cm) Accum	Plant Sink (cm)	Prestor	Infil	Infil Accum	Runoff	Runoff Accum	Evapo	Evapo Accum	Trans	Trans Accum	Drain	Drain Accum	Newstor
43	0.06152	1626	5.03685E-06	0.000216585	0	47.5941	0	3.3085	0	0	0	1.6442	0	0	0	0	47.5941
44	0.06152	1626	5.03685E-06	0.000221621	0	47.5941	0	3.3085	0	0	0.0772	1.7214	0	0	0	0	47.5169
45	0.06152	1626	5.03685E-06	0.000226658	0	47.5169	0	3.3085	0	0	0.0633	1.7847	0	0	0	0	47.4536
46	0.06152	1626	5.03685E-06	0.000231695	0	47.4536	0	3.3085	0	0	0.0695	1.8542	0	0	0	0	47.3841
47	0.06152	1626	5.03685E-06	0.000236732	0	47.3842	0	3.3085	0	0	0.0412	1.8954	0	0	0	0	47.3431
48	0.06152	1626	5.03685E-06	0.000241769	0	47.3431	0	3.3085	0	0	0.0401	1.9355	0	0	0	0	47.3029
49	0.06152	1626	5.03685E-06	0.000246806	0	47.303	0	3.3085	0	0	0.0305	1.966	0	0	0	0	47.2725
50	0.06152	1626	5.03685E-06	0.000251843	0	47.2725	0	3.3085	0	0	0.032	1.998	0	0	0	0	47.2405
51	0.06152	1626	5.03685E-06	0.000256879	0	47.2406	0	3.3085	0	0	0.0265	2.0245	0	0	0	0	47.214
52	0.06152	1626	5.03685E-06	0.000261916	0	47.2141	0	3.3085	0	0	0.0188	2.0433	0	0	0	0	47.1953
53	0.06152	1626	5.03685E-06	0.000266953	0	47.1953	0	3.3085	0	0	0.0234	2.0667	0	0	0	0	47.1719
54	0.06152	1626	5.03685E-06	0.00027199	0	47.1719	0	3.3085	0	0	0.0216	2.0883	0	0	0	0	47.1503
55	0.06152	1626	5.03685E-06	0.000277027	0	47.1503	0	3.3085	0	0	0.0181	2.1064	0	0	0	0	47.1323
56	0.06152	1626	5.03685E-06	0.000282064	0	47.1323	0	3.3085	0	0	0.0167	2.1231	0	0	0	0	47.1156
57	0.06152	1626	5.03685E-06	0.0002871	0	47.1156	0	3.3085	0	0	0.0187	2.1418	0	0	0	0	47.0969
58	0.06152	1626	5.03685E-06	0.000292137	0	47.097	0	3.3085	0	0	0.013	2.1548	0	0	0	0	47.0839
59	0.06152	1626	5.03685E-06	0.000297174	0	47.0839	0	3.3085	0	0	0.0136	2.1684	0	0	0	0	47.0704
60	0.06152	1626	5.03685E-06	0.000302211	0	47.0704	0	3.3085	0	0	0.015	2.1834	0	0	0	0	47.0554
61	0.06152	1626	5.03685E-06	0.000307248	0	47.0554	0	3.3085	0	0	0.014	2.1974	0	0	0	0	47.0414
62	0.06152	1626	5.03685E-06	0.000312285	0	47.0414	0	3.3085	0	0	0.0113	2.2087	0	0	0	0	47.03
63	0.06152	1626	5.03685E-06	0.000317322	0	47.0301	0	3.3085	0	0	0.0106	2.2193	0	0	0	0	47.0194
64	0.06152	1626	5.03685E-06	0.000322358	0	47.0195	0	3.3085	0	0	0.0121	2.2314	0	0	0	0	47.0074
65	0.06152	1626	5.03685E-06	0.000327395	0	47.0074	0	3.3085	0	0	0.0111	2.2425	0	0	0	0	46.9963
66	0.06152	1626	5.03685E-06	0.000332432	0	46.9963	0	3.3085	0	0	0.0109	2.2534	0	0	0	0	46.9853
67	0.06152	1626	5.03685E-06	0.000337469	0	46.9854	0	3.3085	0	0	0.0107	2.2641	0	0	0	0	46.9746
68	0.06152	1626	5.03685E-06	0.000342506	0	46.9746	0	3.3085	0	0	0.0118	2.2759	0	0	0	0	46.9628
69	0.06152	1626	5.03685E-06	0.000347543	0	46.9628	0	3.3085	0	0	0.0104	2.2863	0	0	0	0	46.9524
70	0.06152	1626	5.03685E-06	0.00035258	0	46.9524	0	3.3085	0	0	0.0075	2.2938	0	0	0	0	46.9449
71	0.06152	1626	5.03685E-06	0.000357616	0	46.9449	0	3.3085	0	0	0.0095	2.3033	0	0	0	0	46.9354
72	0.06152	1626	5.03685E-06	0.000362653	0	46.9354	0	3.3085	0	0	0.0047	2.308	0	0	0	0	46.9307
73	0.06152	1626	5.03685E-06	0.00036769	0	46.9307	0.1016	3.4101	0	0	0.0141	2.3221	0	0	0	0	47.0182
74	0.06152	1626	5.03685E-06	0.000372727	0	47.018	0	3.4101	0	0	0.0767	2.3988	0	0	0	0	46.9413
75	0.06152	1626	5.03685E-06	0.000377764	0	46.9415	0	3.4101	0	0	0.0197	2.4185	0	0	0	0	46.9217
76	0.06152	1626	5.03685E-06	0.000382801	0	46.9218	0	3.4101	0	0	0.0102	2.4287	0	0	0	0	46.9116
77	0.06152	1626	5.03685E-06	0.000387837	0	46.9116	0.0508	3.4609	0	0	0.0341	2.4628	0	0	0	0	46.9283
78	0.06152	1626	5.03685E-06	0.000392874	0	46.9282	0.127	3.5879	0	0	0.0858	2.5486	0	0	0	0	46.9694
79	0.06152	1626	5.03685E-06	0.000397911	0	46.9693	0.0254	3.6133	0	0	0.0719	2.6205	0	0	0	0	46.9228
80	0.06152	1626	5.03685E-06	0.000402948	0	46.9228	0	3.6133	0	0	0.0216	2.6421	0	0	0	0	46.9012
81	0.06152	1626	5.03685E-06	0.000407985	0	46.9013	0	3.6133	0	0	0.0116	2.6537	0	0	0	0	46.8897
82	0.06152	1626	5.03685E-06	0.000413022	0	46.8897	0	3.6133	0	0	0.0101	2.6638	0	0	0	0	46.8796
83	0.06152	1626	5.03685E-06	0.000418059	0	46.8796	0	3.6133	0	0	0.0089	2.6727	0	0	0	0	46.8707
84	0.06152	1626	5.03685E-06	0.000423095	0	46.8707	0	3.6133	0	0	0.008	2.6807	0	0	0	0	46.8626

Scenario: 1986 Recirculation Every Day

Day	Water (cm3/cm3)	Head (cm)	Water Flow (cm)	Water Flow (cm) Accum	Plant Sink (cm)	Prestor	Infil	Infil Accum	Runoff	Runoff Accum	Evapo	Evapo Accum	Trans	Trans Accum	Drain	Drain Accum	Newstor
85	0.06152	1626	5.03685E-06	0.000428132	0	46.8626	0	3.6133	0	0	0.007	2.6877	0	0	0	0	46.8556
86	0.06152	1626	5.03685E-06	0.000433169	0	46.8556	0	3.6133	0	0	0.0048	2.6925	0	0	0	0	46.8508
87	0.06152	1626	5.03685E-06	0.000438206	0	46.8508	0	3.6133	0	0	0.0076	2.7001	0	0	0	0	46.8432
88	0.06152	1626	5.03685E-06	0.000443243	0	46.8432	0	3.6133	0	0	0.006	2.7061	0	0	0	0	46.8372
89	0.06152	1626	5.03685E-06	0.00044828	0	46.8372	0	3.6133	0	0	0.0074	2.7135	0	0	0	0	46.8297
90	0.06152	1626	5.03685E-06	0.000453317	0	46.8297	0	3.6133	0	0	0.0085	2.722	0	0	0	0	46.8212
91	0.06152	1626	5.03685E-06	0.000458353	0	46.8212	0	3.6133	0	0	0.0053	2.7273	0	0	0	0	46.816
92	0.06152	1626	5.03685E-06	0.00046339	0	46.816	0	3.6133	0	0	0.007	2.7343	0	0	0	0	46.809
93	0.06152	1626	5.03685E-06	0.000468427	0	46.809	0	3.6133	0	0	0.008	2.7423	0	0	0	0	46.801
94	0.06152	1626	5.03685E-06	0.000473464	0	46.801	0	3.6133	0	0	0.0066	2.7489	0	0	0	0	46.7944
95	0.06152	1626	5.03685E-06	0.000478501	0	46.7944	0	3.6133	0	0	0.0073	2.7562	0	0	0	0	46.7871
96	0.06152	1626	5.03685E-06	0.000483538	0	46.7871	0	3.6133	0	0	0.0054	2.7616	0	0	0	0	46.7817
97	0.06152	1626	5.03685E-06	0.000488574	0	46.7817	0	3.6133	0	0	0.0074	2.769	0	0	0	0	46.7744
98	0.06152	1626	5.03685E-06	0.000493611	0	46.7744	0.783	4.3963	0.0044	0.0044	0.0723	2.8413	0	0	0	0	47.4851
99	0.06152	1626	5.03685E-06	0.000498648	0	47.4855	0	4.3963	0	0.0044	0.1377	2.979	0	0	0	0	47.3478
100	0.06152	1626	5.03685E-06	0.000503685	0	47.3478	0	4.3963	0	0.0044	0.0733	3.0523	0	0	0	0	47.2745
101	0.06152	1626	5.03685E-06	0.000508722	0	47.2745	0	4.3963	0	0.0044	0.0671	3.1194	0	0	0	0	47.2075
102	0.06152	1626	5.03685E-06	0.000513759	0	47.2076	0	4.3963	0	0.0044	0.0412	3.1606	0	0	0	0	47.1663
103	0.06152	1626	5.03685E-06	0.000518796	0	47.1664	0	4.3963	0	0.0044	0.0336	3.1942	0	0	0	0	47.1328
104	0.06152	1626	5.03685E-06	0.000523832	0	47.1329	0	4.3963	0	0.0044	0.0285	3.2227	0	0	0	0	47.1044
105	0.06152	1626	5.03685E-06	0.000528869	0	47.1045	0	4.3963	0	0.0044	0.0218	3.2445	0	0	0	0	47.0827
106	0.06152	1626	5.03685E-06	0.000533906	0	47.0827	0	4.3963	0	0.0044	0.0171	3.2616	0	0	0	0	47.0656
107	0.06152	1626	5.03685E-06	0.000538943	0	47.0656	0	4.3963	0	0.0044	0.0173	3.2789	0	0	0	0	47.0484
108	0.06152	1626	5.03685E-06	0.00054398	0	47.0484	0	4.3963	0	0.0044	0.0195	3.2984	0	0	0	0	47.0288
109	0.06152	1626	5.03685E-06	0.000549017	0	47.0289	0	4.3963	0	0.0044	0.0107	3.3091	0	0	0	0	47.0182
110	0.06152	1626	5.03685E-06	0.000554054	0	47.0182	0	4.3963	0	0.0044	0.014	3.3231	0	0	0	0	47.0042
111	0.06152	1626	5.03685E-06	0.00055909	0	47.0042	0	4.3963	0	0.0044	0.0132	3.3363	0	0	0	0	46.991
112	0.06152	1626	5.03685E-06	0.000564127	0	46.991	0	4.3963	0	0.0044	0.0122	3.3485	0	0	0	0	46.9787
113	0.06152	1626	5.03685E-06	0.000569164	0	46.9788	0	4.3963	0	0.0044	0.0133	3.3618	0	0	0	0	46.9654
114	0.06152	1626	5.03685E-06	0.000574201	0	46.9654	0	4.3963	0	0.0044	0.0122	3.374	0	0	0	0	46.9532
115	0.06152	1626	5.03685E-06	0.000579238	0	46.9532	0	4.3963	0	0.0044	0.0109	3.3849	0	0	0	0	46.9423
116	0.06152	1626	5.03685E-06	0.000584275	0	46.9423	0	4.3963	0	0.0044	0.011	3.3959	0	0	0	0	46.9313
117	0.06152	1626	5.03685E-06	0.000589311	0	46.9313	0	4.3963	0	0.0044	0.0128	3.4087	0	0	0	0	46.9184
118	0.06152	1626	5.03685E-06	0.000594348	0	46.9184	0	4.3963	0	0.0044	0.0122	3.4209	0	0	0	0	46.9063
119	0.06152	1626	5.03685E-06	0.000599385	0	46.9063	0	4.3963	0	0.0044	0.0083	3.4292	0	0	0	0	46.898
120	0.06152	1626	5.03685E-06	0.000604422	0	46.898	0	4.3963	0	0.0044	0.0091	3.4383	0	0	0	0	46.8889
121	0.06152	1626	5.03685E-06	0.000609459	0	46.8889	0	4.3963	0	0.0044	0.0049	3.4432	0	0	0	0	46.884
122	0.06152	1626	5.03685E-06	0.000614496	0	46.884	0	4.3963	0	0.0044	0.0069	3.4501	0	0	0	0	46.8771
123	0.06152	1626	5.03685E-06	0.000619533	0	46.8771	0	4.3963	0	0.0044	0.0065	3.4566	0	0	0	0	46.8705
124	0.06152	1626	5.03685E-06	0.000624569	0	46.8705	0	4.3963	0	0.0044	0.0086	3.4652	0	0	0	0	46.8619
125	0.06152	1626	5.03685E-06	0.000629606	0	46.8619	0	4.3963	0	0.0044	0.0105	3.4757	0	0	0	0	46.8514
126	0.06152	1626	5.03685E-06	0.000634643	0	46.8514	0	4.3963	0	0.0044	0.0101	3.4858	0	0	0	0	46.8413

Scenario: 1986 Recirculation Every Day

Day	Water (cm3/cm3)	Head (cm)	Water Flow (cm)	Water Flow (cm) Accum	Plant Sink (cm)	Prestor	Infil	Infil Accum	Runoff	Runoff Accum	Evapo	Evapo Accum	Trans	Trans Accum	Drain	Drain Accum	Newstor
127	0.06152	1626	5.03685E-06	0.00063968	0	46.8413	0	4.3963	0	0.0044	0.009	3.4948	0	0	0	0	46.8323
128	0.06152	1626	5.03685E-06	0.000644717	0	46.8324	0	4.3963	0	0.0044	0.0085	3.5033	0	0	0	0	46.8239
129	0.06152	1626	5.03685E-06	0.000649754	0	46.8239	0	4.3963	0	0.0044	0.0088	3.5121	0	0	0	0	46.8151
130	0.06152	1626	5.03686E-06	0.000654791	0	46.8151	0	4.3963	0	0.0044	0.0085	3.5206	0	0	0	0	46.8065
131	0.06152	1626	5.03686E-06	0.000659827	0	46.8066	0	4.3963	0	0.0044	0.009	3.5296	0	0	0	0	46.7976
132	0.06152	1626	5.03686E-06	0.000664864	0	46.7976	0	4.3963	0	0.0044	0.0088	3.5384	0	0	0	0	46.7888
133	0.06152	1626	5.03686E-06	0.000669901	0	46.7888	0	4.3963	0	0.0044	0.0067	3.5451	0	0	0	0	46.7821
134	0.06152	1626	5.03686E-06	0.000674938	0	46.7821	0	4.3963	0	0.0044	0.0082	3.5533	0	0	0	0	46.7739
135	0.06152	1626	5.03686E-06	0.000679975	0	46.7739	0	4.3963	0	0.0044	0.0082	3.5615	0	0	0	0	46.7657
136	0.06152	1626	5.03686E-06	0.000685012	0	46.7657	0	4.3963	0	0.0044	0.0071	3.5686	0	0	0	0	46.7586
137	0.06152	1626	5.03686E-06	0.000690049	0	46.7586	0.6854	5.0817	0.0004	0.0048	0.038	3.6066	0	0	0	0	47.4059
138	0.06152	1626	5.03686E-06	0.000695085	0	47.4063	0	5.0817	0	0.0048	0.1396	3.7462	0	0	0	0	47.2667
139	0.06152	1626	5.03686E-06	0.000700122	0	47.2667	0	5.0817	0	0.0048	0.0899	3.8361	0	0	0	0	47.1768
140	0.06152	1626	5.03686E-06	0.000705159	0	47.1769	0	5.0817	0	0.0048	0.0537	3.8898	0	0	0	0	47.1232
141	0.06152	1626	5.03686E-06	0.000710196	0	47.1233	0	5.0817	0	0.0048	0.0379	3.9277	0	0	0	0	47.0854
142	0.06152	1626	5.03686E-06	0.000715233	0	47.0854	0	5.0817	0	0.0048	0.0302	3.9579	0	0	0	0	47.0552
143	0.06152	1626	5.03686E-06	0.00072027	0	47.0552	0	5.0817	0	0.0048	0.0201	3.978	0	0	0	0	47.0351
144	0.06152	1626	5.03686E-06	0.000725307	0	47.0352	0	5.0817	0	0.0048	0.0182	3.9962	0	0	0	0	47.017
145	0.06152	1626	5.03686E-06	0.000730343	0	47.017	0.0508	5.1325	0	0.0048	0.038	4.0342	0	0	0	0	47.0298
146	0.06152	1626	5.03686E-06	0.00073538	0	47.0297	0.1778	5.3103	0	0.0048	0.0757	4.1099	0	0	0	0	47.1318
147	0.06152	1626	5.03686E-06	0.000740417	0	47.1315	0.0254	5.3357	0	0.0048	0.0939	4.2038	0	0	0	0	47.0631
148	0.06152	1626	5.03686E-06	0.000745454	0	47.0632	0	5.3357	0	0.0048	0.0316	4.2354	0	0	0	0	47.0315
149	0.06152	1626	5.03686E-06	0.000750491	0	47.0316	0.1524	5.4881	0	0.0048	0.0362	4.2716	0	0	0	0	47.1478
150	0.06152	1626	5.03686E-06	0.000755528	0	47.1475	1.2954	6.7835	0	0.0048	0.0994	4.371	0	0	0	0	48.3435
151	0.06152	1626	5.03686E-06	0.000760565	0	48.3428	0.893	7.6765	0	0.0048	0.0323	4.4033	0	0	0	0	49.2035
152	0.06152	1626	5.03686E-06	0.000765601	0	49.2034	0.0508	7.7273	0	0.0048	0.2723	4.6756	0	0	0	0	48.9819
153	0.06152	1626	5.03686E-06	0.000770638	0	48.9819	0	7.7273	0	0.0048	0.1493	4.8249	0	0	0	0	48.8326
154	0.06152	1626	5.03686E-06	0.000775675	0	48.8327	0	7.7273	0	0.0048	0.0497	4.8746	0	0	0	0	48.783
155	0.06152	1626	5.03686E-06	0.000780712	0	48.783	0.0254	7.7527	0	0.0048	0.0855	4.9601	0	0	0	0	48.7229
156	0.06152	1626	5.03686E-06	0.000785749	0	48.7229	0	7.7527	0	0.0048	0.0597	5.0198	0	0	0	0	48.6632
157	0.06152	1626	5.03686E-06	0.000790786	0	48.6632	0	7.7527	0	0.0048	0.0747	5.0945	0	0	0	0	48.5886
158	0.06152	1626	5.03686E-06	0.000795823	0	48.5886	0	7.7527	0	0.0048	0.0462	5.1407	0	0	0	0	48.5424
159	0.06152	1626	5.03686E-06	0.000800859	0	48.5425	0.9129	8.6656	0.0015	0.0063	0.147	5.2877	0	0	0	0	49.3083
160	0.06152	1626	5.03686E-06	0.000805896	0	49.3094	0	8.6656	0	0.0063	0.1775	5.4652	0	0	0	0	49.1319
161	0.06152	1626	5.03686E-06	0.000810933	0	49.132	0	8.6656	0	0.0063	0.0892	5.5544	0	0	0	0	49.0428
162	0.06152	1626	5.03686E-06	0.00081597	0	49.0429	0	8.6656	0	0.0063	0.0744	5.6288	0	0	0	0	48.9684
163	0.06152	1626	5.03686E-06	0.000821007	0	48.9684	0	8.6656	0	0.0063	0.0809	5.7097	0	0	0	0	48.8875
164	0.06152	1626	5.03686E-06	0.000826044	0	48.8876	0	8.6656	0	0.0063	0.0497	5.7594	0	0	0	0	48.8379
165	0.06152	1626	5.03686E-06	0.000831081	0	48.8379	0	8.6656	0	0.0063	0.046	5.8054	0	0	0	0	48.7919
166	0.06152	1626	5.03686E-06	0.000836117	0	48.7919	0	8.6656	0	0.0063	0.0379	5.8433	0	0	0	0	48.754
167	0.06152	1626	5.03686E-06	0.000841154	0	48.754	0	8.6656	0	0.0063	0.0341	5.8774	0	0	0	0	48.7199
168	0.06152	1626	5.03686E-06	0.000846191	0	48.7199	0	8.6656	0	0.0063	0.0291	5.9065	0	0	0	0	48.6908

Scenario: 1986 Recirculation Every Day

Day	Water (cm3/cm3)	Head (cm)	Water Flow (cm)	Water Flow (cm) Accum	Plant Sink (cm)	Prestor	Infil	Infil Accum	Runoff	Runoff Accum	Evapo	Evapo Accum	Trans	Trans Accum	Drain	Drain Accum	Newstor
169	0.06152	1626	5.03686E-06	0.000851228	0	48.6909	2.3225	10.9881	0.0651	0.0714	0.1034	6.0099	0	0	0	0	50.9099
170	0.06152	1626	5.03686E-06	0.000856265	0	50.9124	1.4584	12.4465	0	0.0714	0.3247	6.3346	0	0	0	0	52.0461
171	0.06152	1626	5.03686E-06	0.000861302	0	52.046	0.0111	12.4576	0	0.0714	0.3299	6.6645	0	0	0	0	51.7272
172	0.06152	1626	5.03686E-06	0.000866339	0	51.7273	0	12.4576	0	0.0714	0.0724	6.7369	0	0	0	0	51.6549
173	0.06152	1626	5.03686E-06	0.000871375	0	51.6549	0	12.4576	0	0.0714	0.0641	6.801	0	0	0	0	51.5908
174	0.06152	1626	5.03687E-06	0.000876412	0	51.5908	2.6416	15.0992	0	0.0714	0.0408	6.8418	0	0	0	0	54.1917
175	0.06152	1626	5.03687E-06	0.000881449	0	54.1916	4.3894	19.4886	0.6362	0.7076	0.0668	6.9086	0	0	0	0	58.5142
176	0.06152	1626	5.03687E-06	0.000886486	0	58.5259	3.3197	22.8083	0.7953	1.5029	0.115	7.0236	0	0	0	0	61.7307
177	0.06152	1626	5.03687E-06	0.000891523	0	61.7494	1.4056	24.2139	0	1.5029	0.2614	7.285	0	0	0	0	62.8936
178	0.06152	1626	5.03687E-06	0.00089656	0	62.8935	1.2904	25.5043	0	1.5029	0.4117	7.6967	0	0	0	0	63.7722
179	0.06152	1626	5.03687E-06	0.000901597	0	63.7722	0	25.5043	0	1.5029	0.4431	8.1398	0	0	0	0	63.3291
180	0.06152	1626	5.03687E-06	0.000906634	0	63.3292	0	25.5043	0	1.5029	0.0862	8.226	0	0	0	0	63.243
181	0.06152	1626	5.03687E-06	0.00091167	0	63.243	0	25.5043	0	1.5029	0.0801	8.3061	0	0	0	0	63.1629
182	0.06152	1626	5.03687E-06	0.000916707	0	63.1629	1.6764	27.1807	0	1.5029	0.1232	8.4293	0	0	0	0	64.716
183	0.06152	1626	5.03687E-06	0.000921744	0	64.7159	1.2399	28.4206	0	1.5029	0.3987	8.828	0	0	0	0	65.5571
184	0.06152	1626	5.03687E-06	0.000926781	0	65.5571	0.0508	28.4714	0	1.5029	0.5011	9.3291	0	0	0	0	65.1067
185	0.06152	1626	5.03687E-06	0.000931818	0	65.1068	0	28.4714	0	1.5029	0.1822	9.5113	0	0	0	0	64.9246
186	0.06152	1626	5.03687E-06	0.000936855	0	64.9246	0	28.4714	0	1.5029	0.0743	9.5856	0	0	0	0	64.8503
187	0.06152	1626	5.03687E-06	0.000941892	0	64.8503	0	28.4714	0	1.5029	0.0693	9.6549	0	0	0	0	64.7811
188	0.06152	1626	5.03687E-06	0.000946929	0	64.7811	0	28.4714	0	1.5029	0.0684	9.7233	0	0	0	0	64.7127
189	0.06152	1626	5.03688E-06	0.000951965	0	64.7127	0	28.4714	0	1.5029	0.0693	9.7926	0	0	0	0	64.6434
190	0.06152	1626	5.03688E-06	0.000957002	0	64.6434	0.254	28.7254	0	1.5029	0.1589	9.9515	0	0	0	0	64.7385
191	0.06152	1626	5.03688E-06	0.000962039	0	64.7383	0.0254	28.7508	0	1.5029	0.1799	10.1314	0	0	0	0	64.5838
192	0.06152	1626	5.03688E-06	0.000967076	0	64.5839	0	28.7508	0	1.5029	0.0727	10.2041	0	0	0	0	64.5112
193	0.06152	1626	5.03688E-06	0.000972113	0	64.5112	0	28.7508	0	1.5029	0.0726	10.2767	0	0	0	0	64.4386
194	0.06152	1626	5.03688E-06	0.00097715	0	64.4386	0	28.7508	0	1.5029	0.0653	10.342	0	0	0	0	64.3733
195	0.06152	1626	5.03688E-06	0.000982187	0	64.3733	0	28.7508	0	1.5029	0.0561	10.3981	0	0	0	0	64.3171
196	0.06152	1626	5.03688E-06	0.000987224	0	64.3171	0	28.7508	0	1.5029	0.062	10.4601	0	0	0	0	64.2551
197	0.06152	1626	5.03688E-06	0.00099226	0	64.2551	0	28.7508	0	1.5029	0.0683	10.5284	0	0	0	0	64.1869
198	0.06152	1626	5.03689E-06	0.000997297	0	64.1869	0.0508	28.8016	0	1.5029	0.0929	10.6213	0	0	0	0	64.1447
199	0.06152	1626	5.03689E-06	0.001002334	0	64.1447	0	28.8016	0	1.5029	0.0667	10.688	0	0	0	0	64.078
200	0.06152	1626	5.03689E-06	0.001007371	0	64.0781	0	28.8016	0	1.5029	0.0714	10.7594	0	0	0	0	64.0066
201	0.06152	1626	5.03689E-06	0.001012408	0	64.0067	0	28.8016	0	1.5029	0.0385	10.7979	0	0	0	0	63.9681
202	0.06152	1626	5.03689E-06	0.001017445	0	63.9681	0.0508	28.8524	0	1.5029	0.0644	10.8623	0	0	0	0	63.9546
203	0.06152	1626	5.03689E-06	0.001022482	0	63.9545	0	28.8524	0	1.5029	0.0632	10.9255	0	0	0	0	63.8913
204	0.06152	1626	5.03689E-06	0.001027519	0	63.8913	0.1524	29.0048	0	1.5029	0.0949	11.0204	0	0	0	0	63.9488
205	0.06152	1626	5.03689E-06	0.001032556	0	63.9487	0	29.0048	0	1.5029	0.0749	11.0953	0	0	0	0	63.8738
206	0.06152	1626	5.0369E-06	0.001037592	0	63.8738	0	29.0048	0	1.5029	0.0634	11.1587	0	0	0	0	63.8104
207	0.06152	1626	5.0369E-06	0.001042629	0	63.8104	0	29.0048	0	1.5029	0.0454	11.2041	0	0	0	0	63.7651
208	0.06152	1626	5.0369E-06	0.001047666	0	63.7651	0	29.0048	0	1.5029	0.0479	11.252	0	0	0	0	63.7172
209	0.06152	1626	5.0369E-06	0.001052703	0	63.7172	0	29.0048	0	1.5029	0.0404	11.2924	0	0	0	0	63.6768
210	0.06152	1626	5.0369E-06	0.00105774	0	63.6768	0	29.0048	0	1.5029	0.0333	11.3257	0	0	0	0	63.6435

Scenario: 1986 Recirculation Every Day

Day	Water (cm3/cm3)	Head (cm)	Water Flow (cm)	Water Flow (cm) Accum	Plant Sink (cm)	Prestor	Infil	Infil Accum	Runoff	Runoff Accum	Evapo	Evapo Accum	Trans	Trans Accum	Drain	Drain Accum	Newstor
211	0.06152	1625.99	5.0369E-06	0.001062777	0	63.6435	0	29.0048	0	1.5029	0.0334	11.3591	0	0	0	0	63.6101
212	0.06152	1625.99	5.03691E-06	0.001067814	0	63.6101	0	29.0048	0	1.5029	0.0326	11.3917	0	0	0	0	63.5775
213	0.06152	1625.99	5.03691E-06	0.001072851	0	63.5775	0	29.0048	0	1.5029	0.0336	11.4253	0	0	0	0	63.5439
214	0.06152	1625.99	5.03691E-06	0.001077888	0	63.5439	0.2032	29.208	0	1.5029	0.1009	11.5262	0	0	0	0	63.6461
215	0.06152	1625.99	5.03691E-06	0.001082925	0	63.6459	0.4064	29.6144	0	1.5029	0.1766	11.7028	0	0	0	0	63.8757
216	0.06152	1625.99	5.03691E-06	0.001087962	0	63.8755	0.3048	29.9192	0	1.5029	0.2387	11.9415	0	0	0	0	63.9416
217	0.06152	1625.99	5.03692E-06	0.001092998	0	63.9416	0	29.9192	0	1.5029	0.1331	12.0746	0	0	0	0	63.8084
218	0.06152	1625.99	5.03692E-06	0.001098035	0	63.8085	0.1016	30.0208	0	1.5029	0.1222	12.1968	0	0	0	0	63.7879
219	0.06152	1625.99	5.03692E-06	0.001103072	0	63.7879	0	30.0208	0	1.5029	0.0716	12.2684	0	0	0	0	63.7163
220	0.06152	1625.99	5.03692E-06	0.001108109	0	63.7163	0	30.0208	0	1.5029	0.0657	12.3341	0	0	0	0	63.6506
221	0.06152	1625.99	5.03692E-06	0.001113146	0	63.6506	0	30.0208	0	1.5029	0.0499	12.384	0	0	0	0	63.6007
222	0.06152	1625.99	5.03693E-06	0.001118183	0	63.6008	0	30.0208	0	1.5029	0.0353	12.4193	0	0	0	0	63.5655
223	0.06152	1625.99	5.03693E-06	0.00112322	0	63.5655	0	30.0208	0	1.5029	0.0301	12.4494	0	0	0	0	63.5354
224	0.06152	1625.99	5.03693E-06	0.001128257	0	63.5354	0	30.0208	0	1.5029	0.0331	12.4825	0	0	0	0	63.5023
225	0.06152	1625.99	5.03693E-06	0.001133294	0	63.5023	0.0254	30.0462	0	1.5029	0.058	12.5405	0	0	0	0	63.4697
226	0.06152	1625.99	5.03694E-06	0.001138331	0	63.4697	0	30.0462	0	1.5029	0.034	12.5745	0	0	0	0	63.4357
227	0.06152	1625.99	5.03694E-06	0.001143368	0	63.4357	0	30.0462	0	1.5029	0.0256	12.6001	0	0	0	0	63.4101
228	0.06152	1625.99	5.03694E-06	0.001148405	0	63.4101	0	30.0462	0	1.5029	0.0237	12.6238	0	0	0	0	63.3864
229	0.06152	1625.99	5.03695E-06	0.001153442	0	63.3864	0	30.0462	0	1.5029	0.0294	12.6532	0	0	0	0	63.357
230	0.06152	1625.99	5.03695E-06	0.001158479	0	63.357	0	30.0462	0	1.5029	0.0302	12.6834	0	0	0	0	63.3269
231	0.06152	1625.99	5.03695E-06	0.001163516	0	63.3269	0	30.0462	0	1.5029	0.0294	12.7128	0	0	0	0	63.2975
232	0.06152	1625.99	5.03695E-06	0.001168552	0	63.2975	0	30.0462	0	1.5029	0.0271	12.7399	0	0	0	0	63.2705
233	0.06152	1625.99	5.03696E-06	0.001173589	0	63.2705	0	30.0462	0	1.5029	0.0203	12.7602	0	0	0	0	63.2502
234	0.06152	1625.99	5.03696E-06	0.001178626	0	63.2502	1.4807	31.5269	0.0179	1.5208	0.1088	12.869	0	0	0	0	64.6221
235	0.06152	1625.99	5.03696E-06	0.001183663	0	64.6236	0.8864	32.4133	0	1.5208	0.4608	13.3298	0	0	0	0	65.0493
236	0.06152	1625.99	5.03697E-06	0.0011887	0	65.0492	0	32.4133	0	1.5208	0.2618	13.5916	0	0	0	0	64.7874
237	0.06152	1625.99	5.03697E-06	0.001193737	0	64.7875	0	32.4133	0	1.5208	0.0636	13.6552	0	0	0	0	64.7239
238	0.06152	1625.99	5.03697E-06	0.001198774	0	64.7239	2.159	34.5723	0	1.5208	0.1294	13.7846	0	0	0	0	66.7535
239	0.06152	1625.99	5.03698E-06	0.001203811	0	66.7533	2.2925	36.8648	0	1.5208	0.1818	13.9664	0	0	0	0	68.8639
240	0.06152	1625.99	5.03698E-06	0.001208848	0	68.8639	0.6958	37.5606	0	1.5208	0.0746	14.041	0	0	0	0	69.4851
241	0.06152	1625.99	5.03698E-06	0.001213885	0	69.4851	0.0762	37.6368	0	1.5208	0.4771	14.5181	0	0	0	0	69.0842
242	0.06152	1625.99	5.03699E-06	0.001218922	0	69.0842	0.2794	37.9162	0	1.5208	0.2945	14.8126	0	0	0	0	69.0691
243	0.06152	1625.99	5.03699E-06	0.001223959	0	69.0691	0.7366	38.6528	0	1.5208	0.2832	15.0958	0	0	0	0	69.5225
244	0.06152	1625.99	0.000005037	0.001228996	0	69.5224	1.8796	40.5324	0	1.5208	0.3475	15.4433	0	0	0	0	71.0545
245	0.06152	1625.99	0.000005037	0.001234033	0	71.0545	4.1565	44.6889	1.1668	2.6876	0.3719	15.8152	0	0	0	0	74.8392
246	0.06152	1625.98	0.000005037	0.00123907	0	74.8417	1.2912	45.9801	0	2.6876	0.2861	16.1013	0	0	0	0	75.8468
247	0.06152	1625.98	5.03701E-06	0.001244107	0	75.8467	3.1106	49.0907	0.5356	3.2232	0.1676	16.2689	0	0	0	0	78.7898
248	0.06152	1625.98	5.03701E-06	0.001249144	0	78.802	1.288	50.3787	0	3.2232	0.3353	16.6042	0	0	0	0	79.7547
249	0.06152	1625.98	5.03702E-06	0.001254181	0	79.7547	0.4496	50.8283	0	3.2232	0.6354	17.2396	0	0	0	0	79.5689
250	0.06152	1625.98	5.03702E-06	0.001259218	0	79.5689	0.0508	50.8791	0	3.2232	0.2464	17.486	0	0	0	0	79.3733
251	0.06152	1625.98	5.03703E-06	0.001264255	0	79.3733	0	50.8791	0	3.2232	0.2052	17.6912	0	0	0	0	79.1681
252	0.06152	1625.98	5.03703E-06	0.001269292	0	79.1682	0	50.8791	0	3.2232	0.0682	17.7594	0	0	0	0	79.1

Scenario: 1986 Recirculation Every Day

Day	Water (cm3/cm3)	Head (cm)	Water Flow (cm)	Water Flow (cm) Accum	Plant Sink (cm)	Prestor	Infil	Infil Accum	Runoff	Runoff Accum	Evapo	Evapo Accum	Trans	Trans Accum	Drain	Drain Accum	Newstor
253	0.06152	1625.98	5.03704E-06	0.001274329	0	79.1	0	50.8791	0	3.2232	0.0783	17.8377	0	0	0	0	79.0217
254	0.06152	1625.98	5.03704E-06	0.001279366	0	79.0217	0	50.8791	0	3.2232	0.0791	17.9168	0	0	0	0	78.9426
255	0.06152	1625.98	5.03705E-06	0.001284403	0	78.9425	0	50.8791	0	3.2232	0.069	17.9858	0	0	0	0	78.8736
256	0.06152	1625.98	5.03705E-06	0.00128944	0	78.8736	0.1016	50.9807	0	3.2232	0.11	18.0958	0	0	0	0	78.8651
257	0.06152	1625.98	5.03706E-06	0.001294478	0	78.865	0	50.9807	0	3.2232	0.1184	18.2142	0	0	0	0	78.7466
258	0.06152	1625.98	5.03706E-06	0.001299515	0	78.7467	0	50.9807	0	3.2232	0.0556	18.2698	0	0	0	0	78.6911
259	0.06152	1625.98	5.03707E-06	0.001304552	0	78.6911	0	50.9807	0	3.2232	0.0558	18.3256	0	0	0	0	78.6353
260	0.06152	1625.98	5.03707E-06	0.001309589	0	78.6353	0	50.9807	0	3.2232	0.0673	18.3929	0	0	0	0	78.568
261	0.06152	1625.98	5.03708E-06	0.001314626	0	78.568	0	50.9807	0	3.2232	0.0693	18.4622	0	0	0	0	78.4988
262	0.06152	1625.98	5.03708E-06	0.001319663	0	78.4988	0	50.9807	0	3.2232	0.0646	18.5268	0	0	0	0	78.4342
263	0.06152	1625.98	5.03709E-06	0.0013247	0	78.4342	0	50.9807	0	3.2232	0.0604	18.5872	0	0	0	0	78.3738
264	0.06152	1625.98	5.0371E-06	0.001329737	0	78.3738	0	50.9807	0	3.2232	0.0545	18.6417	0	0	0	0	78.3193
265	0.06152	1625.97	5.0371E-06	0.001334774	0	78.3193	0.3048	51.2855	0	3.2232	0.0614	18.7031	0	0	0	0	78.5627
266	0.06152	1625.97	5.03711E-06	0.001339811	0	78.5625	0.7366	52.0221	0	3.2232	0.1627	18.8658	0	0	0	0	79.1364
267	0.06152	1625.97	5.03711E-06	0.001344848	0	79.1362	0	52.0221	0	3.2232	0.2236	19.0894	0	0	0	0	78.9126
268	0.06152	1625.97	5.03712E-06	0.001349886	0	78.9128	0	52.0221	0	3.2232	0.0831	19.1725	0	0	0	0	78.8296
269	0.06152	1625.97	5.03713E-06	0.001354923	0	78.8297	0	52.0221	0	3.2232	0.08	19.2525	0	0	0	0	78.7496
270	0.06152	1625.97	5.03713E-06	0.00135996	0	78.7496	0	52.0221	0	3.2232	0.0739	19.3264	0	0	0	0	78.6757
271	0.06152	1625.97	5.03714E-06	0.001364997	0	78.6757	0	52.0221	0	3.2232	0.0614	19.3878	0	0	0	0	78.6143
272	0.06152	1625.97	5.03715E-06	0.001370034	0	78.6143	0.2032	52.2253	0	3.2232	0.1443	19.5321	0	0	0	0	78.6731
273	0.06152	1625.97	5.03715E-06	0.001375071	0	78.673	0	52.2253	0	3.2232	0.122	19.6541	0	0	0	0	78.551
274	0.06152	1625.97	5.03716E-06	0.001380108	0	78.5511	0	52.2253	0	3.2232	0.0858	19.7399	0	0	0	0	78.4653
275	0.06152	1625.97	5.03717E-06	0.001385146	0	78.4653	0.1778	52.4031	0	3.2232	0.0421	19.782	0	0	0	0	78.601
276	0.06152	1625.97	5.03718E-06	0.001390183	0	78.6008	0	52.4031	0	3.2232	0.116	19.898	0	0	0	0	78.4848
277	0.06152	1625.97	5.03718E-06	0.00139522	0	78.4849	0	52.4031	0	3.2232	0.0719	19.9699	0	0	0	0	78.413
278	0.06152	1625.97	5.03719E-06	0.001400257	0	78.413	0.3302	52.7333	0	3.2232	0	19.9699	0	0	0	0	78.7432
279	0.06152	1625.97	5.0372E-06	0.001405294	0	78.743	0.1778	52.9111	0	3.2232	0.0786	20.0485	0	0	0	0	78.8423
280	0.06152	1625.96	5.03721E-06	0.001410332	0	78.8422	0	52.9111	0	3.2232	0.1362	20.1847	0	0	0	0	78.706
281	0.06152	1625.96	5.03721E-06	0.001415369	0	78.7061	0	52.9111	0	3.2232	0.0618	20.2465	0	0	0	0	78.6443
282	0.06152	1625.96	5.03722E-06	0.001420406	0	78.6443	1.4986	54.4097	0	3.2232	0.072	20.3185	0	0	0	0	80.0709
283	0.06152	1625.96	5.03723E-06	0.001425443	0	80.0705	6.1492	60.5589	3.2086	6.4318	0.0572	20.3757	0	0	0	0	86.1625
284	0.06152	1625.96	5.03724E-06	0.00143048	0	86.1633	1.3056	61.8645	0	6.4318	0.0542	20.4299	0	0	0	0	87.4147
285	0.06152	1625.96	5.03725E-06	0.001435518	0	87.4146	1.2688	63.1333	0	6.4318	0.0585	20.4884	0	0	0	0	88.6249
286	0.06152	1625.96	5.03726E-06	0.001440555	0	88.6248	1.2328	64.3661	0	6.4318	0.381	20.8694	0	0	0	0	89.4766
287	0.06152	1625.96	5.03727E-06	0.001445592	0	89.4766	1.24	65.6061	0	6.4318	0.3379	21.2073	0	0	0	0	90.3787
288	0.06152	1625.96	5.03727E-06	0.001450629	0	90.3787	0.7525	66.3586	0	6.4318	0.5354	21.7427	0	0	0	0	90.5958
289	0.06152	1625.96	5.03728E-06	0.001455667	0	90.5958	0	66.3586	0	6.4318	0.2908	22.0335	0	0	0	0	90.305
290	0.06152	1625.96	5.03729E-06	0.001460704	0	90.305	0.4572	66.8158	0	6.4318	0.2629	22.2964	0	0	0	0	90.4993
291	0.06152	1625.95	5.0373E-06	0.001465741	0	90.4992	0	66.8158	0	6.4318	0.2765	22.5729	0	0	0	0	90.2227
292	0.06152	1625.95	5.03731E-06	0.001470779	0	90.2229	0	66.8158	0	6.4318	0.1408	22.7137	0	0	0	0	90.082
293	0.06152	1625.95	5.03732E-06	0.001475816	0	90.082	0.2794	67.0952	0	6.4318	0.0521	22.7658	0	0	0	0	90.3092
294	0.06152	1625.95	5.03733E-06	0.001480853	0	90.3092	2.2098	69.305	0	6.4318	0.2679	23.0337	0	0	0	0	92.251

Scenario: 1986 Recirculation Every Day

Day	Water (cm3/cm3)	Head (cm)	Water Flow (cm)	Water Flow (cm) Accum	Plant Sink (cm)	Prestor	Infil	Infil Accum	Runoff	Runoff Accum	Evapo	Evapo Accum	Trans	Trans Accum	Drain	Drain Accum	Newstor
295	0.06152	1625.95	5.03734E-06	0.001485891	0	92.2511	1.2552	70.5602	0	6.4318	0.3542	23.3879	0	0	0	0	93.1521
296	0.06152	1625.95	5.03735E-06	0.001490928	0	93.1521	0.0655	70.6257	0	6.4318	0.4064	23.7943	0	0	0	0	92.8112
297	0.06152	1625.95	5.03736E-06	0.001495965	0	92.8112	0	70.6257	0	6.4318	0.2876	24.0819	0	0	0	0	92.5236
298	0.06152	1625.95	5.03737E-06	0.001501003	0	92.5236	0	70.6257	0	6.4318	0.1343	24.2162	0	0	0	0	92.3894
299	0.06152	1625.95	5.03738E-06	0.00150604	0	92.3894	0	70.6257	0	6.4318	0.068	24.2842	0	0	0	0	92.3215
300	0.06152	1625.95	5.03739E-06	0.001511077	0	92.3215	0	70.6257	0	6.4318	0.0759	24.3601	0	0	0	0	92.2455
301	0.06152	1625.94	5.0374E-06	0.001516115	0	92.2455	0	70.6257	0	6.4318	0.0803	24.4404	0	0	0	0	92.1652
302	0.06152	1625.94	5.03742E-06	0.001521152	0	92.1652	0	70.6257	0	6.4318	0.0552	24.4956	0	0	0	0	92.11
303	0.06152	1625.94	5.03743E-06	0.00152619	0	92.11	0	70.6257	0	6.4318	0.0602	24.5558	0	0	0	0	92.0498
304	0.06152	1625.94	5.03744E-06	0.001531227	0	92.0498	0	70.6257	0	6.4318	0.0644	24.6202	0	0	0	0	91.9854
305	0.06152	1625.94	5.03745E-06	0.001536265	0	91.9854	0	70.6257	0	6.4318	0.0545	24.6747	0	0	0	0	91.9309
306	0.06152	1625.94	5.03746E-06	0.001541302	0	91.9308	1.778	72.4037	0	6.4318	0	24.6747	0	0	0	0	93.7088
307	0.06152	1625.94	5.03747E-06	0.00154634	0	93.7086	2.9593	75.363	0.0299	6.4617	0	24.6747	0	0	0	0	96.6679
308	0.06152	1625.94	5.03748E-06	0.001551377	0	96.6727	1.552	76.915	0	6.4617	0.0769	24.7516	0	0	0	0	98.1478
309	0.06152	1625.93	5.0375E-06	0.001556415	0	98.1478	0	76.915	0	6.4617	0.5028	25.2544	0	0	0	0	97.6449
310	0.06152	1625.93	5.03751E-06	0.001561452	0	97.645	0	76.915	0	6.4617	0.2676	25.522	0	0	0	0	97.3774
311	0.06152	1625.93	5.03752E-06	0.00156649	0	97.3775	0	76.915	0	6.4617	0.0796	25.6016	0	0	0	0	97.2979
312	0.06152	1625.93	5.03753E-06	0.001571527	0	97.2979	0	76.915	0	6.4617	0.0821	25.6837	0	0	0	0	97.2158
313	0.06152	1625.93	5.03755E-06	0.001576565	0	97.2157	0	76.915	0	6.4617	0.0779	25.7616	0	0	0	0	97.1378
314	0.06152	1625.93	5.03756E-06	0.001581602	0	97.1378	0	76.915	0	6.4617	0.0633	25.8249	0	0	0	0	97.0745
315	0.06152	1625.93	5.03757E-06	0.00158664	0	97.0745	0	76.915	0	6.4617	0.0611	25.886	0	0	0	0	97.0134
316	0.06152	1625.93	5.03759E-06	0.001591677	0	97.0133	0	76.915	0	6.4617	0.0875	25.9735	0	0	0	0	96.9258
317	0.06152	1625.92	5.0376E-06	0.001596715	0	96.9258	0.3302	77.2452	0	6.4617	0.0198	25.9933	0	0	0	0	97.2362
318	0.06152	1625.92	5.03761E-06	0.001601753	0	97.2361	0	77.2452	0	6.4617	0.1966	26.1899	0	0	0	0	97.0395
319	0.06152	1625.92	5.03763E-06	0.00160679	0	97.0396	0	77.2452	0	6.4617	0.0614	26.2513	0	0	0	0	96.9782
320	0.06152	1625.91	5.03766E-06	0.001611828	0	96.9781	0	77.2452	0	6.4617	0.122	26.3733	0	0	0	0	96.8562
321	0.06159	1618.91	5.04601E-06	0.001616874	0	96.8562	0	77.2452	0	6.4617	0.0697	26.443	0	0	0	0	96.7866
322	0.10194	323.899	0.000121676	0.00173855	0	96.7865	0	77.2452	0	6.4617	0.0636	26.5066	0	0	0.0001	0.0001	96.7228
323	0.14576	121.829	0.00792157	0.00966012	0	96.7228	0.1524	77.3976	0	6.4617	0.139	26.6456	0	0	0.0079	0.008	96.7283
324	0.16801	83.1396	0.0397235	0.04938362	0	96.7282	0	77.3976	0	6.4617	0.1015	26.7471	0	0	0.0397	0.0477	96.5869
325	0.18118	67.6041	0.0894523	0.13883592	0	96.587	0	77.3976	0	6.4617	0.0531	26.8002	0	0	0.0895	0.1372	96.4445
326	0.18915	59.9299	0.141386	0.28022192	0	96.4445	0	77.3976	0	6.4617	0.0685	26.8687	0	0	0.1414	0.2786	96.2346
327	0.19395	55.8195	0.184594	0.46481592	0	96.2346	0.1778	77.5754	0	6.4617	0.0528	26.9215	0	0	0.1846	0.4632	96.175
328	0.19676	53.5555	0.215672	0.68048792	0	96.1748	0	77.5754	0	6.4617	0.105	27.0265	0	0	0.2157	0.6789	95.8542
329	0.19835	52.3284	0.235722	0.91620992	0	95.8543	0	77.5754	0	6.4617	0.0586	27.0851	0	0	0.2357	0.9146	95.56
330	0.19915	51.7175	0.247266	1.16347592	0	95.56	0	77.5754	0	6.4617	0.0717	27.1568	0	0	0.2473	1.1619	95.241
331	0.19946	51.4886	0.252749	1.41622492	0	95.241	0	77.5754	0	6.4617	0.0634	27.2202	0	0	0.2527	1.4146	94.9249
332	0.19944	51.5045	0.254096	1.67032092	0	94.9249	0	77.5754	0	6.4617	0.0538	27.274	0	0	0.2541	1.6687	94.617
333	0.1992	51.6816	0.252691	1.92301192	0	94.617	0	77.5754	0	6.4617	0.0404	27.3144	0	0	0.2527	1.9214	94.324
334	0.19882	51.9669	0.249492	2.17250392	0	94.324	0	77.5754	0	6.4617	0.0456	27.36	0	0	0.2495	2.1709	94.0289
335	0.19835	52.3261	0.245154	2.41765792	0	94.0289	0	77.5754	0	6.4617	0.0377	27.3977	0	0	0.2452	2.4161	93.7461
336	0.19782	52.736	0.240118	2.65777592	0	93.7461	0	77.5754	0	6.4617	0.0434	27.4411	0	0	0.2401	2.6562	93.4626

Scenario: 1986 Recirculation Every Day

Day	Water (cm3/cm3)	Head (cm)	Water Flow (cm)	Water Flow (cm) Accum	Plant Sink (cm)	Prestor	Infil	Infil Accum	Runoff	Runoff Accum	Evapo	Evapo Accum	Trans	Trans Accum	Drain	Drain Accum	Newstor
337	0.19724	53.1811	0.234683	2.89245892	0	93.4626	0	77.5754	0	6.4617	0.034	27.4751	0	0	0.2347	2.8909	93.1939
338	0.19664	53.6503	0.229051	3.12150992	0	93.194	0	77.5754	0	6.4617	0.0006	27.4757	0	0	0.2291	3.12	92.9643
339	0.19603	54.136	0.223355	3.34486492	0	92.9643	0	77.5754	0	6.4617	0.0387	27.5144	0	0	0.2234	3.3434	92.7022
340	0.19541	54.6326	0.217687	3.56255192	0	92.7023	0	77.5754	0	6.4617	0.0118	27.5262	0	0	0.2177	3.5611	92.4729
341	0.19478	55.1361	0.212107	3.77465892	0	92.4729	0	77.5754	0	6.4617	0.0297	27.5559	0	0	0.2121	3.7732	92.2311
342	0.19416	55.6436	0.206653	3.98131192	0	92.2312	0.381	77.9564	0	6.4617	0.0326	27.5885	0	0	0.2067	3.9799	92.373
343	0.19354	56.1529	0.20135	4.18266192	0	92.3726	0	77.9564	0	6.4617	0	27.5885	0	0	0.2013	4.1812	92.1713
344	0.19293	56.6624	0.196212	4.37887392	0	92.1713	0.4572	78.4136	0	6.4617	0.07	27.6585	0	0	0.1962	4.3774	92.3622
345	0.19233	57.1708	0.191246	4.57011992	0	92.3621	0	78.4136	0	6.4617	0.1984	27.8569	0	0	0.1912	4.5686	91.9725
346	0.19173	57.6773	0.186456	4.75657592	0	91.9726	0	78.4136	0	6.4617	0.0592	27.9161	0	0	0.1865	4.7551	91.727
347	0.19114	58.1812	0.18184	4.93841592	0	91.727	0	78.4136	0	6.4617	0.0503	27.9664	0	0	0.1818	4.9369	91.4949
348	0.19057	58.6819	0.177397	5.11581292	0	91.4949	0	78.4136	0	6.4617	0.0505	28.0169	0	0	0.1774	5.1143	91.2671
349	0.19	59.1792	0.17312	5.28893292	0	91.2671	0	78.4136	0	6.4617	0.0603	28.0772	0	0	0.1731	5.2874	91.0336
350	0.18944	59.6726	0.169006	5.45793892	0	91.0336	0.2032	78.6168	0	6.4617	0.0203	28.0975	0	0	0.169	5.4564	91.0475
351	0.1889	60.1621	0.165048	5.62298692	0	91.0474	0.6604	79.2772	0	6.4617	0	28.0975	0	0	0.165	5.6214	91.5427
352	0.18836	60.6475	0.161241	5.78422792	0	91.5425	0.254	79.5312	0	6.4617	0.0964	28.1939	0	0	0.1612	5.7826	91.5389
353	0.18783	61.1287	0.157577	5.94180492	0	91.5388	0	79.5312	0	6.4617	0.238	28.4319	0	0	0.1576	5.9402	91.1432
354	0.18731	61.6057	0.154051	6.09585592	0	91.1433	0	79.5312	0	6.4617	0.055	28.4869	0	0	0.1541	6.0943	90.9343
355	0.1868	62.0784	0.150656	6.24651192	0	90.9343	0.6604	80.1916	0	6.4617	0.0997	28.5866	0	0	0.1507	6.245	91.3443
356	0.1863	62.5469	0.147387	6.39389892	0	91.3441	1.1176	81.3092	0	6.4617	0	28.5866	0	0	0.1474	6.3924	92.3143
357	0.18581	63.011	0.144237	6.53813592	0	92.3143	0.2377	81.5469	0	6.4617	0.1535	28.7401	0	0	0.1442	6.5366	92.2543
358	0.18533	63.471	0.141201	6.67933692	0	92.2543	0	81.5469	0	6.4617	0.0521	28.7922	0	0	0.1412	6.6778	92.0609
359	0.18486	63.9266	0.138275	6.81761192	0	92.061	0	81.5469	0	6.4617	0.184	28.9762	0	0	0.1383	6.8161	91.7386
360	0.18439	64.378	0.135453	6.95306492	0	91.7387	0	81.5469	0	6.4617	0.1224	29.0986	0	0	0.1355	6.9516	91.4808
361	0.18393	64.8251	0.13273	7.08579492	0	91.4809	0	81.5469	0	6.4617	0.0547	29.1533	0	0	0.1327	7.0843	91.2935
362	0.18349	65.268	0.130103	7.21589792	0	91.2935	0	81.5469	0	6.4617	0.048	29.2013	0	0	0.1301	7.2144	91.1154
363	0.18304	65.7066	0.127567	7.34346492	0	91.1154	0	81.5469	0	6.4617	0.0633	29.2646	0	0	0.1276	7.342	90.9246
364	0.18261	66.1408	0.125119	7.46858392	0	90.9246	0	81.5469	0	6.4617	0.0667	29.3313	0	0	0.1251	7.4671	90.7328
365	0.18219	66.5707	0.122754	7.59133792	0	90.7328	0	81.5469	0	6.4617	0.0679	29.3992	0	0	0.1228	7.5899	90.5422

Scenario: 1986 Recirculation Every Day

Day	Storage	Mass Balance	Evap Potential	Evap Actual	Trans Potential	Trans Actual	Precip
1	45.8855	-0.00012694	0.6036	0.046	0	0	0
2	45.8599	-0.000059776	0.2755	0.0257	0	0	0
3	45.844	-0.000025966	0.1907	0.0159	0	0	0
4	45.8295	-0.00002415	0.443	0.0145	0	0	0
5	45.8174	-0.00001604	0.4345	0.0122	0	0	0
6	46.2431	0.00069592	0.556	0.0816	0	0	0.508
7	47.3876	0.000534	0.0518	0.0487	0	0	1.1938
8	47.5084	0.00009367	0.23	0.207	0	0	0.3279
9	47.3344	-0.000092886	0.314	0.1742	0	0	0
10	47.2687	-5.3821E-06	0.5188	0.0657	0	0	0
11	47.1975	-0.000018359	0.5163	0.0712	0	0	0
12	47.1251	-0.000025364	0.6306	0.0724	0	0	0
13	47.0749	-0.000051057	0.4943	0.0502	0	0	0
14	47.0393	-8.7387E-06	0.4285	0.0356	0	0	0
15	47.0037	-0.000020306	0.4513	0.0356	0	0	0
16	46.9702	-0.000047238	0.7485	0.0335	0	0	0
17	46.9429	-0.000013562	0.3326	0.0273	0	0	0
18	46.9182	-0.000034231	0.5699	0.0247	0	0	0
19	46.8969	-8.9179E-06	0.5666	0.0213	0	0	0
20	46.8736	-0.000027812	0.7008	0.0233	0	0	0
21	46.8533	-0.00002086	0.6626	0.0203	0	0	0
22	46.8368	-0.000010675	0.4847	0.0166	0	0	0
23	46.8215	-0.000019411	0.3654	0.0153	0	0	0
24	46.8048	-0.000013284	0.5066	0.0167	0	0	0
25	46.7919	-5.2938E-06	0.6058	0.0129	0	0	0
26	46.7782	-0.000015423	0.5074	0.0137	0	0	0
27	46.7649	-0.000014978	0.6066	0.0134	0	0	0
28	46.7492	-0.000013977	0.7179	0.0157	0	0	0
29	46.7353	-0.000023299	0.6847	0.0139	0	0	0
30	46.7238	-3.1054E-06	0.5831	0.0115	0	0	0
31	46.7121	-0.000008541	0.4029	0.0117	0	0	0
32	46.7043	-8.3376E-06	0.5467	0.0078	0	0	0
33	46.6983	-0.000002591	0.2606	0.006	0	0	0
34	46.6864	-8.7789E-06	0.6813	0.012	0	0	0
35	46.7278	0.00014539	0.4279	0.0601	0	0	0.1016
36	46.7277	0.000014628	0	0	0	0	0
37	46.7011	-0.000080946	0.0432	0.0267	0	0	0
38	46.7341	0.00012058	0.2712	0.0431	0	0	0.0762
39	46.833	0.0001563	0.0027	0.0025	0	0	0.1016
40	47.6199	0.00054738	0	0	0	0	0.7874
41	47.6889	0.00005824	0.1606	0.1429	0	0	0.212
42	47.5941	-0.000022234	0.0948	0.0948	0	0	0

Scenario: 1986 Recirculation Every Day

Day	Storage	Mass Balance	Evap Potential	Evap Actual	Trans Potential	Trans Actual	Precip
43	47.5941	3.4708E-07	0	0	0	0	0
44	47.5169	-0.000072699	0.2696	0.0772	0	0	0
45	47.4536	-0.000012519	0.352	0.0633	0	0	0
46	47.3842	-0.00007455	0.3986	0.0695	0	0	0
47	47.3431	-0.000013079	0.7752	0.0412	0	0	0
48	47.303	-0.000055636	0.6966	0.0401	0	0	0
49	47.2725	-0.000015023	0.5723	0.0305	0	0	0
50	47.2406	-0.000048676	0.6347	0.032	0	0	0
51	47.2141	-0.000016387	0.9438	0.0265	0	0	0
52	47.1953	-0.000018074	0.7137	0.0188	0	0	0
53	47.1719	-0.00003097	0.8565	0.0234	0	0	0
54	47.1503	-0.000020171	0.6653	0.0216	0	0	0
55	47.1323	-0.000015495	0.7199	0.0181	0	0	0
56	47.1156	-0.000011412	0.8445	0.0167	0	0	0
57	47.097	-0.000033421	1.0691	0.0187	0	0	0
58	47.0839	-4.0696E-06	0.5595	0.013	0	0	0
59	47.0704	-0.000010058	0.7445	0.0136	0	0	0
60	47.0554	-0.000021796	0.8081	0.015	0	0	0
61	47.0414	-0.000007831	0.8125	0.014	0	0	0
62	47.0301	-0.000010628	0.6347	0.0113	0	0	0
63	47.0195	-0.00001051	0.804	0.0106	0	0	0
64	47.0074	-5.9587E-06	0.9462	0.0121	0	0	0
65	46.9963	-6.2444E-06	0.9849	0.0111	0	0	0
66	46.9854	-0.000011789	0.6435	0.0109	0	0	0
67	46.9746	-6.6491E-06	0.6168	0.0107	0	0	0
68	46.9628	-4.0129E-06	1.0792	0.0118	0	0	0
69	46.9524	-0.000012393	0.4964	0.0104	0	0	0
70	46.9449	-0.000015782	0.5906	0.0075	0	0	0
71	46.9354	-4.4922E-06	0.6907	0.0095	0	0	0
72	46.9307	-2.7022E-06	0.1936	0.0047	0	0	0
73	47.018	0.000235	0.1074	0.0141	0	0	0.1016
74	46.9415	-0.00018688	0.7778	0.0767	0	0	0
75	46.9218	-0.00004811	0.9057	0.0197	0	0	0
76	46.9116	-9.0606E-06	0.9797	0.0102	0	0	0
77	46.9282	0.000062557	0.2394	0.0341	0	0	0.0508
78	46.9693	0.00010709	0.5868	0.0858	0	0	0.127
79	46.9228	-0.000067872	0.5985	0.0719	0	0	0.0254
80	46.9013	-0.000062236	0.8739	0.0216	0	0	0
81	46.8897	-7.8185E-06	1.0249	0.0116	0	0	0
82	46.8796	-3.1416E-06	0.9417	0.0101	0	0	0
83	46.8707	-7.8387E-06	0.8387	0.0089	0	0	0
84	46.8626	-0.000012177	0.9651	0.008	0	0	0

Scenario: 1986 Recirculation Every Day

Day	Storage	Mass Balance	Evap Potential	Evap Actual	Trans Potential	Trans Actual	Precip
85	46.8556	-3.1658E-06	1.1083	0.007	0	0	0
86	46.8508	-0.000001929	0.9215	0.0048	0	0	0
87	46.8432	-3.9632E-07	1.1041	0.0076	0	0	0
88	46.8372	-1.1908E-06	0.8127	0.006	0	0	0
89	46.8297	2.1727E-07	0.8813	0.0074	0	0	0
90	46.8212	-9.421E-07	0.9786	0.0085	0	0	0
91	46.816	-5.7077E-06	0.7378	0.0053	0	0	0
92	46.809	-3.3361E-06	1.0248	0.007	0	0	0
93	46.801	-2.4658E-06	0.7489	0.008	0	0	0
94	46.7944	-3.7451E-07	1.0224	0.0066	0	0	0
95	46.7871	6.156E-07	0.7789	0.0073	0	0	0
96	46.7817	-0.000002516	0.5689	0.0054	0	0	0
97	46.7744	6.0335E-07	0.7861	0.0074	0	0	0
98	47.4855	-0.00042886	0.5278	0.0723	0	0	0.7874
99	47.3478	9.9499E-06	0.457	0.1377	0	0	0
100	47.2745	-0.000024771	0.6882	0.0733	0	0	0
101	47.2076	-0.00008723	1.0875	0.0671	0	0	0
102	47.1664	-0.000051301	1.1011	0.0412	0	0	0
103	47.1329	-0.00004933	1.6108	0.0336	0	0	0
104	47.1045	-0.000046381	1.0561	0.0285	0	0	0
105	47.0827	-0.000014543	1.0526	0.0218	0	0	0
106	47.0656	-0.000023175	0.7288	0.0171	0	0	0
107	47.0484	-0.000014036	1.6872	0.0173	0	0	0
108	47.0289	-0.00003298	1.2608	0.0195	0	0	0
109	47.0182	-5.3903E-06	0.53	0.0107	0	0	0
110	47.0042	-0.00001675	0.6888	0.014	0	0	0
111	46.991	-0.000016847	0.994	0.0132	0	0	0
112	46.9788	-0.000012017	1.0712	0.0122	0	0	0
113	46.9654	-0.000020994	1.1877	0.0133	0	0	0
114	46.9532	-0.000011747	1.1774	0.0122	0	0	0
115	46.9423	-0.000011538	1.1202	0.0109	0	0	0
116	46.9313	-6.3374E-06	1.2981	0.011	0	0	0
117	46.9184	-0.000011542	1.6638	0.0128	0	0	0
118	46.9063	-0.000016798	1.1204	0.0122	0	0	0
119	46.898	-2.2945E-06	1.061	0.0083	0	0	0
120	46.8889	-3.3039E-07	1.0536	0.0091	0	0	0
121	46.884	-3.4319E-06	0.8945	0.0049	0	0	0
122	46.8771	-3.0657E-08	0.8651	0.0069	0	0	0
123	46.8705	-9.3622E-07	1.0649	0.0065	0	0	0
124	46.8619	-2.4357E-06	1.4199	0.0086	0	0	0
125	46.8514	-0.000013289	1.4558	0.0105	0	0	0
126	46.8413	-0.000010387	1.4699	0.0101	0	0	0

Scenario: 1986 Recirculation Every Day

Day	Storage	Mass Balance	Evap Potential	Evap Actual	Trans Potential	Trans Actual	Precip
127	46.8324	-1.0466E-06	1.5122	0.009	0	0	0
128	46.8239	-2.4838E-06	1.3664	0.0085	0	0	0
129	46.8151	-4.0691E-06	0.9416	0.0088	0	0	0
130	46.8066	-8.9942E-06	1.1476	0.0085	0	0	0
131	46.7976	-0.000013058	1.3621	0.009	0	0	0
132	46.7888	2.5549E-07	1.5267	0.0088	0	0	0
133	46.7821	-3.0917E-06	1.2407	0.0067	0	0	0
134	46.7739	-4.8463E-08	1.0033	0.0082	0	0	0
135	46.7657	-3.0444E-06	1.0124	0.0082	0	0	0
136	46.7586	-7.1555E-06	1.116	0.0071	0	0	0
137	47.4063	-0.00033393	0.292	0.038	0	0	0.6858
138	47.2667	-3.0385E-06	0.8664	0.1396	0	0	0
139	47.1769	-0.000079381	1.0539	0.0899	0	0	0
140	47.1233	-0.000068851	1.4689	0.0537	0	0	0
141	47.0854	-0.000047957	1.3522	0.0379	0	0	0
142	47.0552	-0.000037244	1.0654	0.0302	0	0	0
143	47.0352	-0.000027577	0.9337	0.0201	0	0	0
144	47.017	-0.000021308	0.5235	0.0182	0	0	0
145	47.0297	0.000059056	0.3462	0.038	0	0	0.0508
146	47.1315	0.00026322	0.4154	0.0757	0	0	0.1778
147	47.0632	-0.00010969	0.8444	0.0939	0	0	0.0254
148	47.0316	-0.000074777	0.6003	0.0316	0	0	0
149	47.1475	0.00031365	0.1974	0.0362	0	0	0.1524
150	48.3428	0.00065895	0.3765	0.0994	0	0	1.2954
151	49.2034	0.0001455	0.0384	0.0323	0	0	0.893
152	48.9819	-8.6517E-06	0.2896	0.2723	0	0	0.0508
153	48.8327	-0.000091693	0.3371	0.1493	0	0	0
154	48.783	-2.1752E-06	0.6355	0.0497	0	0	0
155	48.7229	0.000012375	0.6932	0.0855	0	0	0.0254
156	48.6632	-0.000012382	0.7816	0.0597	0	0	0
157	48.5886	-0.000075152	1.3063	0.0747	0	0	0
158	48.5425	-0.00001608	1.1734	0.0462	0	0	0
159	49.3094	-0.0010576	0.9711	0.147	0	0	0.9144
160	49.132	-0.00010633	1.1101	0.1775	0	0	0
161	49.0429	-0.000015628	1.091	0.0892	0	0	0
162	48.9684	-0.00001406	1.2145	0.0744	0	0	0
163	48.8876	-0.000044816	1.2325	0.0809	0	0	0
164	48.8379	-0.000044127	1.4279	0.0497	0	0	0
165	48.7919	-0.000022778	1.1771	0.046	0	0	0
166	48.754	-0.000046497	1.6066	0.0379	0	0	0
167	48.7199	-0.000016782	1.5031	0.0341	0	0	0
168	48.6909	-0.000041477	1.3909	0.0291	0	0	0

Scenario: 1986 Recirculation Every Day

Day	Storage	Mass Balance	Evap Potential	Evap Actual	Trans Potential	Trans Actual	Precip
169	50.9124	-0.0024546	0.6911	0.1034	0	0	2.3876
170	52.046	0.000050903	0.7379	0.3247	0	0	1.4584
171	51.7273	-0.00011903	0.6709	0.3299	0	0	0.0111
172	51.6549	2.5228E-06	0.9226	0.0724	0	0	0
173	51.5908	-2.0347E-06	0.4235	0.0641	0	0	0
174	54.1916	0.000070676	0.0459	0.0408	0	0	2.6416
175	58.5259	-0.01169	0.1713	0.0668	0	0	5.0256
176	61.7494	-0.0187	0.2949	0.115	0	0	4.115
177	62.8935	0.000099803	0.594	0.2614	0	0	1.4056
178	63.7722	0.000052445	0.8234	0.4117	0	0	1.2904
179	63.3292	-0.00012343	0.9768	0.4431	0	0	0
180	63.243	9.9302E-06	0.8047	0.0862	0	0	0
181	63.1629	8.7479E-06	0.9275	0.0801	0	0	0
182	64.7159	0.00010198	0.5246	0.1232	0	0	1.6764
183	65.5571	0.000026186	0.5864	0.3987	0	0	1.2399
184	65.1068	-0.000047696	0.755	0.5011	0	0	0.0508
185	64.9246	-0.000089662	1.2137	0.1822	0	0	0
186	64.8503	8.6464E-07	0.9321	0.0743	0	0	0
187	64.7811	0.000001254	1.0648	0.0693	0	0	0
188	64.7127	3.0099E-06	0.8583	0.0684	0	0	0
189	64.6434	2.9618E-06	1.0089	0.0693	0	0	0
190	64.7383	0.00012782	0.8315	0.1589	0	0	0.254
191	64.5839	-0.00007058	0.8411	0.1799	0	0	0.0254
192	64.5112	-9.6284E-07	1.0177	0.0727	0	0	0
193	64.4386	-2.2607E-06	1.3581	0.0726	0	0	0
194	64.3733	-1.7128E-06	1.1424	0.0653	0	0	0
195	64.3171	-1.1079E-06	0.956	0.0561	0	0	0
196	64.2551	-2.5734E-06	1.0392	0.062	0	0	0
197	64.1869	-7.0742E-06	1.1827	0.0683	0	0	0
198	64.1447	0.00002719	0.8902	0.0929	0	0	0.0508
199	64.0781	-0.000018351	1.1016	0.0667	0	0	0
200	64.0067	-0.000071609	1.0896	0.0714	0	0	0
201	63.9681	-4.6528E-07	1.016	0.0385	0	0	0
202	63.9545	0.000059169	0.8108	0.0644	0	0	0.0508
203	63.8913	-0.000070115	0.718	0.0632	0	0	0
204	63.9487	0.00012191	1.0683	0.0949	0	0	0.1524
205	63.8738	-0.000025466	1.12	0.0749	0	0	0
206	63.8104	-0.000064758	1.2055	0.0634	0	0	0
207	63.7651	-6.9292E-06	1.063	0.0454	0	0	0
208	63.7172	-0.000020016	0.9388	0.0479	0	0	0
209	63.6768	-0.00004466	1.3803	0.0404	0	0	0
210	63.6435	-1.0603E-06	1.215	0.0333	0	0	0

Scenario: 1986 Recirculation Every Day

Day	Storage	Mass Balance	Evap Potential	Evap Actual	Trans Potential	Trans Actual	Precip
211	63.6101	-0.00000142	1.3319	0.0334	0	0	0
212	63.5775	-0.000001536	0.8897	0.0326	0	0	0
213	63.5439	-4.3614E-06	0.7616	0.0336	0	0	0
214	63.6459	0.0002108	1.1035	0.1009	0	0	0.2032
215	63.8755	0.00020857	1.0244	0.1766	0	0	0.4064
216	63.9416	0.000052219	1.0212	0.2387	0	0	0.3048
217	63.8085	-0.000085211	1.2124	0.1331	0	0	0
218	63.7879	0.00002849	0.7003	0.1222	0	0	0.1016
219	63.7163	-0.000010035	1.1267	0.0716	0	0	0
220	63.6506	-0.000018471	0.8303	0.0657	0	0	0
221	63.6008	-0.00005035	0.7931	0.0499	0	0	0
222	63.5655	-1.9805E-06	0.8542	0.0353	0	0	0
223	63.5354	-9.8703E-07	0.8045	0.0301	0	0	0
224	63.5023	-4.0349E-06	0.8584	0.0331	0	0	0
225	63.4697	8.1019E-06	0.9978	0.058	0	0	0.0254
226	63.4357	-0.000027796	0.519	0.034	0	0	0
227	63.4101	-0.000020017	0.9087	0.0256	0	0	0
228	63.3864	-6.6706E-07	1.0113	0.0237	0	0	0
229	63.357	-6.7457E-06	1.0371	0.0294	0	0	0
230	63.3269	-0.000014064	1.1299	0.0302	0	0	0
231	63.2975	-0.000040959	1.0445	0.0294	0	0	0
232	63.2705	-3.1317E-06	1.0998	0.0271	0	0	0
233	63.2502	-1.1735E-06	0.987	0.0203	0	0	0
234	64.6236	-0.0015858	0.7538	0.1088	0	0	1.4986
235	65.0492	0.000042092	0.5833	0.4608	0	0	0.8864
236	64.7875	-0.00011688	0.5334	0.2618	0	0	0
237	64.7239	-3.8174E-06	0.8792	0.0636	0	0	0
238	66.7533	0.00023612	0.6461	0.1294	0	0	2.159
239	68.8639	6.8864E-06	0.4133	0.1818	0	0	2.2925
240	69.4851	0.000013631	0.0838	0.0746	0	0	0.6958
241	69.0842	-0.000039019	0.5076	0.4771	0	0	0.0762
242	69.0691	0.000024743	0.8638	0.2945	0	0	0.2794
243	69.5224	0.000084016	0.6087	0.2832	0	0	0.7366
244	71.0545	-0.000087964	0.4437	0.3475	0	0	1.8796
245	74.8417	-0.0025311	0.7747	0.3719	0	0	5.3233
246	75.8467	0.000025351	0.5723	0.2861	0	0	1.2912
247	78.802	-0.012216	0.3809	0.1676	0	0	3.6462
248	79.7547	0.000029753	0.6706	0.3353	0	0	1.288
249	79.5689	-0.000044944	0.7475	0.6354	0	0	0.4496
250	79.3733	-5.3434E-06	0.2621	0.2464	0	0	0.0508
251	79.1682	-0.00009159	0.6241	0.2052	0	0	0
252	79.1	6.6033E-06	0.9658	0.0682	0	0	0

Scenario: 1986 Recirculation Every Day

Day	Storage	Mass Balance	Evap Potential	Evap Actual	Trans Potential	Trans Actual	Precip
253	79.0217	0.00001588	1.0581	0.0783	0	0	0
254	78.9425	0.000017101	1.1058	0.0791	0	0	0
255	78.8736	5.3152E-06	0.967	0.069	0	0	0
256	78.865	0.000101	0.5109	0.11	0	0	0.1016
257	78.7467	-0.000079908	0.3497	0.1184	0	0	0
258	78.6911	6.0152E-06	0.8377	0.0556	0	0	0
259	78.6353	5.2188E-06	0.6747	0.0558	0	0	0
260	78.568	2.7399E-06	0.9658	0.0673	0	0	0
261	78.4988	0.000002445	0.9913	0.0693	0	0	0
262	78.4342	1.2577E-06	1.1145	0.0646	0	0	0
263	78.3738	4.8416E-07	1.0868	0.0604	0	0	0
264	78.3193	1.3623E-06	0.7835	0.0545	0	0	0
265	78.5625	0.00020027	0.2251	0.0614	0	0	0.3048
266	79.1362	0.0001876	0.3146	0.1627	0	0	0.7366
267	78.9128	-0.00011479	0.9637	0.2236	0	0	0
268	78.8297	-6.0918E-06	1.1457	0.0831	0	0	0
269	78.7496	-3.7438E-06	1.0574	0.08	0	0	0
270	78.6757	-3.0594E-06	1.0073	0.0739	0	0	0
271	78.6143	-0.000001413	0.5797	0.0614	0	0	0
272	78.673	0.00011619	0.7148	0.1443	0	0	0.2032
273	78.5511	-0.000081167	0.886	0.122	0	0	0
274	78.4653	-0.000017203	0.9366	0.0858	0	0	0
275	78.6008	0.00014924	0.1543	0.0421	0	0	0.1778
276	78.4849	-0.000082	0.7917	0.116	0	0	0
277	78.413	-0.00001739	0.8314	0.0719	0	0	0
278	78.743	0.00018515	0	0	0	0	0.3302
279	78.8422	0.000030834	0.0836	0.0786	0	0	0.1778
280	78.7061	-0.000094117	0.7216	0.1362	0	0	0
281	78.6443	-4.0959E-06	0.7198	0.0618	0	0	0
282	80.0705	0.00039702	0.2442	0.072	0	0	1.4986
283	86.1633	-0.00083418	0.0909	0.0572	0	0	9.3578
284	87.4146	0.000044103	0.1085	0.0542	0	0	1.3056
285	88.6248	0.000053349	0.1171	0.0585	0	0	1.2688
286	89.4766	0.000024155	0.762	0.381	0	0	1.2328
287	90.3787	0.00003006	0.6758	0.3379	0	0	1.24
288	90.5958	-0.000012032	0.7235	0.5354	0	0	0.7525
289	90.305	-0.000028253	0.2908	0.2908	0	0	0
290	90.4992	0.000058312	0.6932	0.2629	0	0	0.4572
291	90.2229	-0.00011658	0.5916	0.2765	0	0	0
292	90.082	0.000026422	0.141	0.1408	0	0	0
293	90.3092	0.000062303	0.0555	0.0521	0	0	0.2794
294	92.2511	-0.00010227	0.5124	0.2679	0	0	2.2098

Scenario: 1986 Recirculation Every Day

Day	Storage	Mass Balance	Evap Potential	Evap Actual	Trans Potential	Trans Actual	Precip
295	93.1521	0.000018452	0.7085	0.3542	0	0	1.2552
296	92.8112	-0.000038427	0.4278	0.4064	0	0	0.0655
297	92.5236	-0.000048327	0.2876	0.2876	0	0	0
298	92.3894	-0.000080016	0.4934	0.1343	0	0	0
299	92.3215	9.7689E-06	0.6068	0.068	0	0	0
300	92.2455	0.000015353	0.6715	0.0759	0	0	0
301	92.1652	0.000012041	0.741	0.0803	0	0	0
302	92.11	0.000014601	0.2589	0.0552	0	0	0
303	92.0498	0.000010934	0.5145	0.0602	0	0	0
304	91.9854	0.000014599	0.6919	0.0644	0	0	0
305	91.9308	0.000044224	0.0546	0.0545	0	0	0
306	93.7086	0.0002549	0	0	0	0	1.778
307	96.6727	-0.0048757	0	0	0	0	2.9892
308	98.1478	0.00006792	0.1748	0.0769	0	0	1.552
309	97.645	-0.000040993	0.5028	0.5028	0	0	0
310	97.3775	-0.00010394	0.6655	0.2676	0	0	0
311	97.2979	0.000012642	0.6445	0.0796	0	0	0
312	97.2157	0.000011649	0.6683	0.0821	0	0	0
313	97.1378	0.000012036	0.5922	0.0779	0	0	0
314	97.0745	8.9298E-06	0.3735	0.0633	0	0	0
315	97.0133	0.000015892	0.5232	0.0611	0	0	0
316	96.9258	0.000038722	0.0875	0.0875	0	0	0
317	97.2361	0.000096813	0.021	0.0198	0	0	0.3302
318	97.0396	-0.0001004	0.5091	0.1966	0	0	0
319	96.9781	0.000055922	0.0614	0.0614	0	0	0
320	96.8562	-0.00007107	0.2433	0.122	0	0	0
321	96.7865	0.000026492	0.609	0.0697	0	0	0
322	96.7228	0.00001416	0.2946	0.0636	0	0	0
323	96.7282	0.000092534	0.712	0.139	0	0	0.1524
324	96.587	-0.000066668	0.704	0.1015	0	0	0
325	96.4445	1.2434E-07	0.5449	0.0531	0	0	0
326	96.2346	-0.000014098	0.5906	0.0685	0	0	0
327	96.1748	0.00014491	0.188	0.0528	0	0	0.1778
328	95.8543	-0.000085645	0.4545	0.105	0	0	0
329	95.56	-7.8558E-06	0.4254	0.0586	0	0	0
330	95.241	-0.000016628	0.5388	0.0717	0	0	0
331	94.9249	-0.000019501	0.494	0.0634	0	0	0
332	94.617	-0.000058092	0.4729	0.0538	0	0	0
333	94.324	-5.7643E-06	0.5258	0.0404	0	0	0
334	94.0289	-0.000010307	0.7754	0.0456	0	0	0
335	93.7461	-5.6629E-06	0.4926	0.0377	0	0	0
336	93.4626	-0.0000175	0.5589	0.0434	0	0	0

Scenario: 1986 Recirculation Every Day

Day	Storage	Mass Balance	Evap Potential	Evap Actual	Trans Potential	Trans Actual	Precip
337	93.194	-5.3336E-06	0.406	0.034	0	0	0
338	92.9643	0.000023583	0.0006	0.0006	0	0	0
339	92.7023	-0.000069798	0.199	0.0387	0	0	0
340	92.4729	-0.000012793	0.0455	0.0118	0	0	0
341	92.2312	-0.000042896	0.0803	0.0297	0	0	0
342	92.3726	0.00032678	0.1053	0.0326	0	0	0.381
343	92.1713	-1.6279E-06	0	0	0	0	0
344	92.3621	0.00013103	0.0745	0.07	0	0	0.4572
345	91.9726	-0.00010728	0.3839	0.1984	0	0	0
346	91.727	-7.0646E-06	0.3933	0.0592	0	0	0
347	91.4949	-5.3626E-06	0.4302	0.0503	0	0	0
348	91.2671	-5.7306E-06	0.4935	0.0505	0	0	0
349	91.0336	-0.000010672	0.4438	0.0603	0	0	0
350	91.0474	0.00012802	0.0217	0.0203	0	0	0.2032
351	91.5425	0.00017169	0	0	0	0	0.6604
352	91.5388	0.000025362	0.1026	0.0964	0	0	0.254
353	91.1433	-0.00011296	0.2573	0.238	0	0	0
354	90.9343	-5.4039E-06	0.2786	0.055	0	0	0
355	91.3441	0.00022797	0.1064	0.0997	0	0	0.6604
356	92.3143	0.000042365	0	0	0	0	1.1176
357	92.2543	-4.0214E-06	0.1705	0.1535	0	0	0.2377
358	92.061	-0.000010543	0.0521	0.0521	0	0	0
359	91.7387	-0.000028681	0.184	0.184	0	0	0
360	91.4809	-0.000086457	0.4406	0.1224	0	0	0
361	91.2935	-3.6758E-06	0.3627	0.0547	0	0	0
362	91.1154	-3.4356E-06	0.2909	0.048	0	0	0
363	90.9246	-5.2192E-06	0.5111	0.0633	0	0	0
364	90.7328	-5.9322E-06	0.3965	0.0667	0	0	0
365	90.5422	-7.1497E-06	0.4459	0.0679	0	0	0

Scenario:

1986

Stormwater Recirculation Alternating Days

Scenario: 1986 Stormwater Recirculation Alternating Days

Day	Water (cm3/cm3)	Head (cm)	Water Flow (cm)	Water Flow (cm) Accum	Plant Sink (cm)	Prestor	Infil	Infil Accum	Runoff	Runoff Accum	Evapo	Evapo Accum	Trans	Trans Accum	Drain	Drain Accum	Newstor
1	0.06152	1626	5.03685E-06	5.03685E-06	0	45.9313	0	0	0	0	0.046	0.046	0	0	0	0	45.8854
2	0.06152	1626	5.03685E-06	1.00737E-05	0	45.8855	0	0	0	0	0.0257	0.0717	0	0	0	0	45.8598
3	0.06152	1626	5.03685E-06	1.51106E-05	0	45.8599	0	0	0	0	0.0159	0.0876	0	0	0	0	45.844
4	0.06152	1626	5.03685E-06	2.01474E-05	0	45.844	0	0	0	0	0.0145	0.1021	0	0	0	0	45.8295
5	0.06152	1626	5.03685E-06	2.51843E-05	0	45.8295	0	0	0	0	0.0122	0.1143	0	0	0	0	45.8173
6	0.06152	1626	5.03685E-06	3.02211E-05	0	45.8174	0.508	0.508	0	0	0.0816	0.1959	0	0	0	0	46.2437
7	0.06152	1626	5.03685E-06	3.5258E-05	0	46.2431	1.1938	1.7018	0	0	0.0487	0.2446	0	0	0	0	47.3882
8	0.06152	1626	5.03685E-06	4.02948E-05	0	47.3876	0	1.7018	0	0	0.23	0.4746	0	0	0	0	47.1576
9	0.06152	1626	5.03685E-06	4.53317E-05	0	47.1576	0.2416	1.9434	0	0	0.2169	0.6915	0	0	0	0	47.1823
10	0.06152	1626	5.03685E-06	5.03685E-05	0	47.1823	0	1.9434	0	0	0.0662	0.7577	0	0	0	0	47.1162
11	0.06152	1626	5.03685E-06	5.54054E-05	0	47.1162	0	1.9434	0	0	0.0713	0.829	0	0	0	0	47.0449
12	0.06152	1626	5.03685E-06	6.04422E-05	0	47.0449	0	1.9434	0	0	0.0723	0.9013	0	0	0	0	46.9726
13	0.06152	1626	5.03685E-06	6.54791E-05	0	46.9726	0	1.9434	0	0	0.0518	0.9531	0	0	0	0	46.9208
14	0.06152	1626	5.03685E-06	7.05159E-05	0	46.9208	0	1.9434	0	0	0.0356	0.9887	0	0	0	0	46.8852
15	0.06152	1626	5.03685E-06	7.55528E-05	0	46.8852	0	1.9434	0	0	0.0356	1.0243	0	0	0	0	46.8496
16	0.06152	1626	5.03685E-06	8.05896E-05	0	46.8496	0	1.9434	0	0	0.0331	1.0574	0	0	0	0	46.8166
17	0.06152	1626	5.03685E-06	8.56265E-05	0	46.8166	0	1.9434	0	0	0.0273	1.0847	0	0	0	0	46.7893
18	0.06152	1626	5.03685E-06	9.06633E-05	0	46.7893	0	1.9434	0	0	0.0241	1.1088	0	0	0	0	46.7652
19	0.06152	1626	5.03685E-06	9.57002E-05	0	46.7652	0	1.9434	0	0	0.0213	1.1301	0	0	0	0	46.7439
20	0.06152	1626	5.03685E-06	0.000100737	0	46.7439	0	1.9434	0	0	0.0232	1.1533	0	0	0	0	46.7207
21	0.06152	1626	5.03685E-06	0.000105774	0	46.7208	0	1.9434	0	0	0.0198	1.1731	0	0	0	0	46.701
22	0.06152	1626	5.03685E-06	0.000110811	0	46.701	0	1.9434	0	0	0.0166	1.1897	0	0	0	0	46.6844
23	0.06152	1626	5.03685E-06	0.000115848	0	46.6844	0	1.9434	0	0	0.015	1.2047	0	0	0	0	46.6694
24	0.06152	1626	5.03685E-06	0.000120884	0	46.6694	0	1.9434	0	0	0.0162	1.2209	0	0	0	0	46.6532
25	0.06152	1626	5.03685E-06	0.000125921	0	46.6532	0	1.9434	0	0	0.0129	1.2338	0	0	0	0	46.6403
26	0.06152	1626	5.03685E-06	0.000130958	0	46.6403	0	1.9434	0	0	0.0135	1.2473	0	0	0	0	46.6268
27	0.06152	1626	5.03685E-06	0.000135995	0	46.6268	0	1.9434	0	0	0.0128	1.2601	0	0	0	0	46.614
28	0.06152	1626	5.03685E-06	0.000141032	0	46.614	0	1.9434	0	0	0.0157	1.2758	0	0	0	0	46.5983
29	0.06152	1626	5.03685E-06	0.000146069	0	46.5983	0	1.9434	0	0	0.0135	1.2893	0	0	0	0	46.5848
30	0.06152	1626	5.03685E-06	0.000151106	0	46.5849	0	1.9434	0	0	0.0113	1.3006	0	0	0	0	46.5735
31	0.06152	1626	5.03685E-06	0.000156142	0	46.5735	0	1.9434	0	0	0.0117	1.3123	0	0	0	0	46.5619
32	0.06152	1626	5.03685E-06	0.000161179	0	46.5619	0	1.9434	0	0	0.0077	1.32	0	0	0	0	46.5542
33	0.06152	1626	5.03685E-06	0.000166216	0	46.5542	0	1.9434	0	0	0.0056	1.3256	0	0	0	0	46.5486
34	0.06152	1626	5.03685E-06	0.000171253	0	46.5486	0	1.9434	0	0	0.0117	1.3373	0	0	0	0	46.5369
35	0.06152	1626	5.03685E-06	0.00017629	0	46.5369	0.1016	2.045	0	0	0.06	1.3973	0	0	0	0	46.5784
36	0.06152	1626	5.03685E-06	0.000181327	0	46.5783	0	2.045	0	0	0	1.3973	0	0	0	0	46.5783
37	0.06152	1626	5.03685E-06	0.000186363	0	46.5783	0	2.045	0	0	0.0267	1.424	0	0	0	0	46.5516
38	0.06152	1626	5.03685E-06	0.0001914	0	46.5517	0.0762	2.1212	0	0	0.0431	1.4671	0	0	0	0	46.5847
39	0.06152	1626	5.03685E-06	0.000196437	0	46.5846	0.1016	2.2228	0	0	0.0025	1.4696	0	0	0	0	46.6837
40	0.06152	1626	5.03685E-06	0.000201474	0	46.6836	0.7874	3.0102	0	0	0	1.4696	0	0	0	0	47.471
41	0.06152	1626	5.03685E-06	0.000206511	0	47.4704	0.212	3.2222	0	0	0.1429	1.6125	0	0	0	0	47.5395
42	0.06152	1626	5.03685E-06	0.000211548	0	47.5395	0	3.2222	0	0	0.0948	1.7073	0	0	0	0	47.4447

Scenario: 1986 Stormwater Recirculation Alternating Days

Day	Water (cm3/cm3)	Head (cm)	Water Flow (cm)	Water Flow (cm) Accum	Plant Sink (cm)	Prestor	Infil	Infil Accum	Runoff	Runoff Accum	Evapo	Evapo Accum	Trans	Trans Accum	Drain	Drain Accum	Newstor
43	0.06152	1626	5.03685E-06	0.000216585	0	47.4447	0	3.2222	0	0	0	1.7073	0	0	0	0	47.4447
44	0.06152	1626	5.03685E-06	0.000221621	0	47.4447	0	3.2222	0	0	0.0765	1.7838	0	0	0	0	47.3682
45	0.06152	1626	5.03685E-06	0.000226658	0	47.3683	0	3.2222	0	0	0.0633	1.8471	0	0	0	0	47.305
46	0.06152	1626	5.03685E-06	0.000231695	0	47.305	0	3.2222	0	0	0.0687	1.9158	0	0	0	0	47.2363
47	0.06152	1626	5.03685E-06	0.000236732	0	47.2364	0	3.2222	0	0	0.0412	1.957	0	0	0	0	47.1952
48	0.06152	1626	5.03685E-06	0.000241769	0	47.1953	0	3.2222	0	0	0.0395	1.9965	0	0	0	0	47.1557
49	0.06152	1626	5.03685E-06	0.000246806	0	47.1558	0	3.2222	0	0	0.0305	2.027	0	0	0	0	47.1252
50	0.06152	1626	5.03685E-06	0.000251843	0	47.1253	0	3.2222	0	0	0.0316	2.0586	0	0	0	0	47.0937
51	0.06152	1626	5.03685E-06	0.000256879	0	47.0937	0	3.2222	0	0	0.0265	2.0851	0	0	0	0	47.0672
52	0.06152	1626	5.03685E-06	0.000261916	0	47.0672	0	3.2222	0	0	0.0187	2.1038	0	0	0	0	47.0485
53	0.06152	1626	5.03685E-06	0.000266953	0	47.0485	0	3.2222	0	0	0.0229	2.1267	0	0	0	0	47.0256
54	0.06152	1626	5.03685E-06	0.00027199	0	47.0256	0	3.2222	0	0	0.0216	2.1483	0	0	0	0	47.004
55	0.06152	1626	5.03685E-06	0.000277027	0	47.0041	0	3.2222	0	0	0.0177	2.166	0	0	0	0	46.9863
56	0.06152	1626	5.03685E-06	0.000282064	0	46.9863	0	3.2222	0	0	0.0167	2.1827	0	0	0	0	46.9697
57	0.06152	1626	5.03685E-06	0.0002871	0	46.9697	0	3.2222	0	0	0.0185	2.2012	0	0	0	0	46.9512
58	0.06152	1626	5.03685E-06	0.000292137	0	46.9512	0	3.2222	0	0	0.013	2.2142	0	0	0	0	46.9382
59	0.06152	1626	5.03685E-06	0.000297174	0	46.9382	0	3.2222	0	0	0.0135	2.2277	0	0	0	0	46.9247
60	0.06152	1626	5.03685E-06	0.000302211	0	46.9247	0	3.2222	0	0	0.0148	2.2425	0	0	0	0	46.9099
61	0.06152	1626	5.03685E-06	0.000307248	0	46.9099	0	3.2222	0	0	0.0139	2.2564	0	0	0	0	46.896
62	0.06152	1626	5.03685E-06	0.000312285	0	46.896	0	3.2222	0	0	0.0113	2.2677	0	0	0	0	46.8847
63	0.06152	1626	5.03685E-06	0.000317322	0	46.8847	0	3.2222	0	0	0.0104	2.2781	0	0	0	0	46.8743
64	0.06152	1626	5.03685E-06	0.000322358	0	46.8743	0	3.2222	0	0	0.0119	2.29	0	0	0	0	46.8624
65	0.06152	1626	5.03685E-06	0.000327395	0	46.8624	0	3.2222	0	0	0.0111	2.3011	0	0	0	0	46.8514
66	0.06152	1626	5.03685E-06	0.000332432	0	46.8514	0	3.2222	0	0	0.0109	2.312	0	0	0	0	46.8405
67	0.06152	1626	5.03685E-06	0.000337469	0	46.8405	0	3.2222	0	0	0.0105	2.3225	0	0	0	0	46.83
68	0.06152	1626	5.03685E-06	0.000342506	0	46.83	0	3.2222	0	0	0.0118	2.3343	0	0	0	0	46.8182
69	0.06152	1626	5.03685E-06	0.000347543	0	46.8182	0	3.2222	0	0	0.0104	2.3447	0	0	0	0	46.8078
70	0.06152	1626	5.03685E-06	0.00035258	0	46.8079	0	3.2222	0	0	0.0073	2.352	0	0	0	0	46.8005
71	0.06152	1626	5.03685E-06	0.000357616	0	46.8005	0	3.2222	0	0	0.0091	2.3611	0	0	0	0	46.7915
72	0.06152	1626	5.03685E-06	0.000362653	0	46.7915	0	3.2222	0	0	0.0046	2.3657	0	0	0	0	46.7868
73	0.06152	1626	5.03685E-06	0.00036769	0	46.7868	0.1016	3.3238	0	0	0.0141	2.3798	0	0	0	0	46.8743
74	0.06152	1626	5.03685E-06	0.000372727	0	46.8741	0	3.3238	0	0	0.0767	2.4565	0	0	0	0	46.7974
75	0.06152	1626	5.03685E-06	0.000377764	0	46.7976	0	3.3238	0	0	0.0197	2.4762	0	0	0	0	46.7779
76	0.06152	1626	5.03685E-06	0.000382801	0	46.7779	0	3.3238	0	0	0.0101	2.4863	0	0	0	0	46.7678
77	0.06152	1626	5.03685E-06	0.000387837	0	46.7678	0.0508	3.3746	0	0	0.0341	2.5204	0	0	0	0	46.7845
78	0.06152	1626	5.03685E-06	0.000392874	0	46.7845	0.127	3.5016	0	0	0.0858	2.6062	0	0	0	0	46.8256
79	0.06152	1626	5.03685E-06	0.000397911	0	46.8255	0.0254	3.527	0	0	0.0719	2.6781	0	0	0	0	46.779
80	0.06152	1626	5.03685E-06	0.000402948	0	46.7791	0	3.527	0	0	0.0216	2.6997	0	0	0	0	46.7575
81	0.06152	1626	5.03685E-06	0.000407985	0	46.7575	0	3.527	0	0	0.0116	2.7113	0	0	0	0	46.746
82	0.06152	1626	5.03685E-06	0.000413022	0	46.746	0	3.527	0	0	0.0101	2.7214	0	0	0	0	46.7359
83	0.06152	1626	5.03685E-06	0.000418059	0	46.7359	0	3.527	0	0	0.0089	2.7303	0	0	0	0	46.727
84	0.06152	1626	5.03685E-06	0.000423095	0	46.727	0	3.527	0	0	0.0079	2.7382	0	0	0	0	46.7191

Scenario: 1986 Stormwater Recirculation Alternating Days

Day	Water (cm3/cm3)	Head (cm)	Water Flow (cm)	Water Flow (cm) Accum	Plant Sink (cm)	Prestor	Infil	Infil Accum	Runoff	Runoff Accum	Evapo	Evapo Accum	Trans	Trans Accum	Drain	Drain Accum	Newstor
85	0.06152	1626	5.03685E-06	0.000428132	0	46.7191	0	3.527	0	0	0.0067	2.7449	0	0	0	0	46.7124
86	0.06152	1626	5.03685E-06	0.000433169	0	46.7124	0	3.527	0	0	0.0046	2.7495	0	0	0	0	46.7078
87	0.06152	1626	5.03685E-06	0.000438206	0	46.7078	0	3.527	0	0	0.0076	2.7571	0	0	0	0	46.7002
88	0.06152	1626	5.03685E-06	0.000443243	0	46.7002	0	3.527	0	0	0.006	2.7631	0	0	0	0	46.6942
89	0.06152	1626	5.03685E-06	0.00044828	0	46.6942	0	3.527	0	0	0.0074	2.7705	0	0	0	0	46.6868
90	0.06152	1626	5.03685E-06	0.000453317	0	46.6868	0	3.527	0	0	0.0085	2.779	0	0	0	0	46.6783
91	0.06152	1626	5.03685E-06	0.000458353	0	46.6783	0	3.527	0	0	0.0052	2.7842	0	0	0	0	46.673
92	0.06152	1626	5.03685E-06	0.00046339	0	46.673	0	3.527	0	0	0.0068	2.791	0	0	0	0	46.6662
93	0.06152	1626	5.03685E-06	0.000468427	0	46.6662	0	3.527	0	0	0.0076	2.7986	0	0	0	0	46.6586
94	0.06152	1626	5.03685E-06	0.000473464	0	46.6586	0	3.527	0	0	0.0064	2.805	0	0	0	0	46.6522
95	0.06152	1626	5.03685E-06	0.000478501	0	46.6522	0	3.527	0	0	0.0072	2.8122	0	0	0	0	46.645
96	0.06152	1626	5.03685E-06	0.000483538	0	46.645	0	3.527	0	0	0.0054	2.8176	0	0	0	0	46.6396
97	0.06152	1626	5.03685E-06	0.000488574	0	46.6396	0	3.527	0	0	0.0073	2.8249	0	0	0	0	46.6323
98	0.06152	1626	5.03685E-06	0.000493611	0	46.6323	0.783	4.31	0.0044	0.0044	0.0723	2.8972	0	0	0	0	47.343
99	0.06152	1626	5.03685E-06	0.000498648	0	47.3434	0	4.31	0	0.0044	0.1378	3.035	0	0	0	0	47.2056
100	0.06152	1626	5.03685E-06	0.000503685	0	47.2056	0	4.31	0	0.0044	0.0733	3.1083	0	0	0	0	47.1323
101	0.06152	1626	5.03685E-06	0.000508722	0	47.1323	0	4.31	0	0.0044	0.0673	3.1756	0	0	0	0	47.065
102	0.06152	1626	5.03685E-06	0.000513759	0	47.0651	0	4.31	0	0.0044	0.0413	3.2169	0	0	0	0	47.0238
103	0.06152	1626	5.03685E-06	0.000518796	0	47.0238	0	4.31	0	0.0044	0.0335	3.2504	0	0	0	0	46.9903
104	0.06152	1626	5.03685E-06	0.000523832	0	46.9904	0	4.31	0	0.0044	0.0283	3.2787	0	0	0	0	46.9621
105	0.06152	1626	5.03685E-06	0.000528869	0	46.9621	0	4.31	0	0.0044	0.0218	3.3005	0	0	0	0	46.9403
106	0.06152	1626	5.03685E-06	0.000533906	0	46.9404	0	4.31	0	0.0044	0.0169	3.3174	0	0	0	0	46.9235
107	0.06152	1626	5.03685E-06	0.000538943	0	46.9235	0	4.31	0	0.0044	0.0172	3.3346	0	0	0	0	46.9063
108	0.06152	1626	5.03685E-06	0.00054398	0	46.9063	0	4.31	0	0.0044	0.0193	3.3539	0	0	0	0	46.887
109	0.06152	1626	5.03685E-06	0.000549017	0	46.887	0	4.31	0	0.0044	0.0107	3.3646	0	0	0	0	46.8763
110	0.06152	1626	5.03685E-06	0.000554054	0	46.8763	0	4.31	0	0.0044	0.0139	3.3785	0	0	0	0	46.8624
111	0.06152	1626	5.03685E-06	0.00055909	0	46.8624	0	4.31	0	0.0044	0.013	3.3915	0	0	0	0	46.8494
112	0.06152	1626	5.03685E-06	0.000564127	0	46.8494	0	4.31	0	0.0044	0.0122	3.4037	0	0	0	0	46.8372
113	0.06152	1626	5.03685E-06	0.000569164	0	46.8372	0	4.31	0	0.0044	0.0131	3.4168	0	0	0	0	46.8241
114	0.06152	1626	5.03685E-06	0.000574201	0	46.8241	0	4.31	0	0.0044	0.0122	3.429	0	0	0	0	46.8119
115	0.06152	1626	5.03685E-06	0.000579238	0	46.8119	0	4.31	0	0.0044	0.0108	3.4398	0	0	0	0	46.8011
116	0.06152	1626	5.03685E-06	0.000584275	0	46.8011	0	4.31	0	0.0044	0.0108	3.4506	0	0	0	0	46.7903
117	0.06152	1626	5.03685E-06	0.000589311	0	46.7903	0	4.31	0	0.0044	0.0128	3.4634	0	0	0	0	46.7775
118	0.06152	1626	5.03685E-06	0.000594348	0	46.7775	0	4.31	0	0.0044	0.012	3.4754	0	0	0	0	46.7655
119	0.06152	1626	5.03685E-06	0.000599385	0	46.7655	0	4.31	0	0.0044	0.008	3.4834	0	0	0	0	46.7575
120	0.06152	1626	5.03685E-06	0.000604422	0	46.7575	0	4.31	0	0.0044	0.0091	3.4925	0	0	0	0	46.7485
121	0.06152	1626	5.03685E-06	0.000609459	0	46.7485	0	4.31	0	0.0044	0.0049	3.4974	0	0	0	0	46.7435
122	0.06152	1626	5.03685E-06	0.000614496	0	46.7435	0	4.31	0	0.0044	0.0069	3.5043	0	0	0	0	46.7366
123	0.06152	1626	5.03685E-06	0.000619533	0	46.7366	0	4.31	0	0.0044	0.0065	3.5108	0	0	0	0	46.7301
124	0.06152	1626	5.03685E-06	0.000624569	0	46.7301	0	4.31	0	0.0044	0.0086	3.5194	0	0	0	0	46.7215
125	0.06152	1626	5.03685E-06	0.000629606	0	46.7215	0	4.31	0	0.0044	0.0104	3.5298	0	0	0	0	46.7111
126	0.06152	1626	5.03685E-06	0.000634643	0	46.7111	0	4.31	0	0.0044	0.0097	3.5395	0	0	0	0	46.7014

Scenario: 1986 Stormwater Recirculation Alternating Days

Day	Water (cm3/cm3)	Head (cm)	Water Flow (cm)	Water Flow (cm) Accum	Plant Sink (cm)	Prestor	Infil	Infil Accum	Runoff	Runoff Accum	Evapo	Evapo Accum	Trans	Trans Accum	Drain	Drain Accum	Newstor
127	0.06152	1626	5.03685E-06	0.00063968	0	46.7014	0	4.31	0	0.0044	0.0089	3.5484	0	0	0	0	46.6925
128	0.06152	1626	5.03685E-06	0.000644717	0	46.6925	0	4.31	0	0.0044	0.0084	3.5568	0	0	0	0	46.6841
129	0.06152	1626	5.03685E-06	0.000649754	0	46.6841	0	4.31	0	0.0044	0.0088	3.5656	0	0	0	0	46.6752
130	0.06152	1626	5.03686E-06	0.000654791	0	46.6752	0	4.31	0	0.0044	0.0085	3.5741	0	0	0	0	46.6668
131	0.06152	1626	5.03686E-06	0.000659827	0	46.6668	0	4.31	0	0.0044	0.0087	3.5828	0	0	0	0	46.6581
132	0.06152	1626	5.03686E-06	0.000664864	0	46.6581	0	4.31	0	0.0044	0.0086	3.5914	0	0	0	0	46.6495
133	0.06152	1626	5.03686E-06	0.000669901	0	46.6495	0	4.31	0	0.0044	0.0066	3.598	0	0	0	0	46.6428
134	0.06152	1626	5.03686E-06	0.000674938	0	46.6429	0	4.31	0	0.0044	0.0082	3.6062	0	0	0	0	46.6346
135	0.06152	1626	5.03686E-06	0.000679975	0	46.6346	0	4.31	0	0.0044	0.0082	3.6144	0	0	0	0	46.6264
136	0.06152	1626	5.03686E-06	0.000685012	0	46.6264	0	4.31	0	0.0044	0.0071	3.6215	0	0	0	0	46.6194
137	0.06152	1626	5.03686E-06	0.000690049	0	46.6194	0.6853	4.9953	0.0005	0.0049	0.038	3.6595	0	0	0	0	47.2667
138	0.06152	1626	5.03686E-06	0.000695085	0	47.267	0	4.9953	0	0.0049	0.1397	3.7992	0	0	0	0	47.1273
139	0.06152	1626	5.03686E-06	0.000700122	0	47.1273	0	4.9953	0	0.0049	0.0901	3.8893	0	0	0	0	47.0372
140	0.06152	1626	5.03686E-06	0.000705159	0	47.0372	0	4.9953	0	0.0049	0.0538	3.9431	0	0	0	0	46.9834
141	0.06152	1626	5.03686E-06	0.000710196	0	46.9835	0	4.9953	0	0.0049	0.0379	3.981	0	0	0	0	46.9456
142	0.06152	1626	5.03686E-06	0.000715233	0	46.9456	0	4.9953	0	0.0049	0.0302	4.0112	0	0	0	0	46.9154
143	0.06152	1626	5.03686E-06	0.00072027	0	46.9154	0	4.9953	0	0.0049	0.0201	4.0313	0	0	0	0	46.8953
144	0.06152	1626	5.03686E-06	0.000725307	0	46.8953	0	4.9953	0	0.0049	0.0182	4.0495	0	0	0	0	46.8772
145	0.06152	1626	5.03686E-06	0.000730343	0	46.8772	0.0508	5.0461	0	0.0049	0.0379	4.0874	0	0	0	0	46.89
146	0.06152	1626	5.03686E-06	0.00073538	0	46.89	0.1778	5.2239	0	0.0049	0.0757	4.1631	0	0	0	0	46.9921
147	0.06152	1626	5.03686E-06	0.000740417	0	46.9918	0.0254	5.2493	0	0.0049	0.0939	4.257	0	0	0	0	46.9233
148	0.06152	1626	5.03686E-06	0.000745454	0	46.9234	0	5.2493	0	0.0049	0.0316	4.2886	0	0	0	0	46.8918
149	0.06152	1626	5.03686E-06	0.000750491	0	46.8919	0.1524	5.4017	0	0.0049	0.0362	4.3248	0	0	0	0	47.0081
150	0.06152	1626	5.03686E-06	0.000755528	0	47.0078	1.2954	6.6971	0	0.0049	0.0994	4.4242	0	0	0	0	48.2038
151	0.06152	1626	5.03686E-06	0.000760565	0	48.2031	0.893	7.5901	0	0.0049	0.0323	4.4565	0	0	0	0	49.0638
152	0.06152	1626	5.03686E-06	0.000765601	0	49.0636	0.0508	7.6409	0	0.0049	0.2723	4.7288	0	0	0	0	48.8422
153	0.06152	1626	5.03686E-06	0.000770638	0	48.8422	0	7.6409	0	0.0049	0.1488	4.8776	0	0	0	0	48.6934
154	0.06152	1626	5.03686E-06	0.000775675	0	48.6935	0	7.6409	0	0.0049	0.0496	4.9272	0	0	0	0	48.6439
155	0.06152	1626	5.03686E-06	0.000780712	0	48.6439	0.0254	7.6663	0	0.0049	0.0854	5.0126	0	0	0	0	48.5839
156	0.06152	1626	5.03686E-06	0.000785749	0	48.5839	0	7.6663	0	0.0049	0.0597	5.0723	0	0	0	0	48.5242
157	0.06152	1626	5.03686E-06	0.000790786	0	48.5242	0	7.6663	0	0.0049	0.0742	5.1465	0	0	0	0	48.45
158	0.06152	1626	5.03686E-06	0.000795823	0	48.4501	0	7.6663	0	0.0049	0.0462	5.1927	0	0	0	0	48.4039
159	0.06152	1626	5.03686E-06	0.000800859	0	48.4039	0.9129	8.5792	0.0015	0.0064	0.147	5.3397	0	0	0	0	49.1698
160	0.06152	1626	5.03686E-06	0.000805896	0	49.1709	0	8.5792	0	0.0064	0.1772	5.5169	0	0	0	0	48.9936
161	0.06152	1626	5.03686E-06	0.000810933	0	48.9937	0	8.5792	0	0.0064	0.0892	5.6061	0	0	0	0	48.9045
162	0.06152	1626	5.03686E-06	0.00081597	0	48.9046	0	8.5792	0	0.0064	0.0744	5.6805	0	0	0	0	48.8301
163	0.06152	1626	5.03686E-06	0.000821007	0	48.8301	0	8.5792	0	0.0064	0.0809	5.7614	0	0	0	0	48.7492
164	0.06152	1626	5.03686E-06	0.000826044	0	48.7492	0	8.5792	0	0.0064	0.0491	5.8105	0	0	0	0	48.7001
165	0.06152	1626	5.03686E-06	0.000831081	0	48.7002	0	8.5792	0	0.0064	0.046	5.8565	0	0	0	0	48.6542
166	0.06152	1626	5.03686E-06	0.000836117	0	48.6542	0	8.5792	0	0.0064	0.0376	5.8941	0	0	0	0	48.6166
167	0.06152	1626	5.03686E-06	0.000841154	0	48.6167	0	8.5792	0	0.0064	0.0341	5.9282	0	0	0	0	48.5825
168	0.06152	1626	5.03686E-06	0.000846191	0	48.5826	0	8.5792	0	0.0064	0.0287	5.9569	0	0	0	0	48.5538

Scenario: 1986 Stormwater Recirculation Alternating Days

Day	Water (cm3/cm3)	Head (cm)	Water Flow (cm)	Water Flow (cm) Accum	Plant Sink (cm)	Prestor	Infil	Infil Accum	Runoff	Runoff Accum	Evapo	Evapo Accum	Trans	Trans Accum	Drain	Drain Accum	Newstor
169	0.06152	1626	5.03686E-06	0.000851228	0	48.5539	2.3195	10.8987	0.0681	0.0745	0.1034	6.0603	0	0	0	0	50.7699
170	0.06152	1626	5.03686E-06	0.000856265	0	50.7724	0.2032	11.1019	0	0.0745	0.409	6.4693	0	0	0	0	50.5666
171	0.06152	1626	5.03686E-06	0.000861302	0	50.5666	1.1431	12.245	0	0.0745	0.3354	6.8047	0	0	0	0	51.3742
172	0.06152	1626	5.03686E-06	0.000866339	0	51.3742	0	12.245	0	0.0745	0.2247	7.0294	0	0	0	0	51.1495
173	0.06152	1626	5.03686E-06	0.000871375	0	51.1496	0	12.245	0	0.0745	0.0659	7.0953	0	0	0	0	51.0837
174	0.06152	1626	5.03687E-06	0.000876412	0	51.0837	2.6416	14.8866	0	0.0745	0.0408	7.1361	0	0	0	0	53.6845
175	0.06152	1626	5.03687E-06	0.000881449	0	53.6844	4.411	19.2976	0.6146	0.6891	0.0668	7.2029	0	0	0	0	58.0286
176	0.06152	1626	5.03687E-06	0.000886486	0	58.0312	2.5777	21.8753	0.1909	0.88	0.2624	7.4653	0	0	0	0	60.3465
177	0.06152	1626	5.03687E-06	0.000891523	0	60.3474	1.4056	23.2809	0	0.88	0.2614	7.7267	0	0	0	0	61.4916
178	0.06152	1626	5.03687E-06	0.00089656	0	61.4915	0	23.2809	0	0.88	0.4921	8.2188	0	0	0	0	60.9994
179	0.06152	1626	5.03687E-06	0.000901597	0	60.9995	1.2368	24.5177	0	0.88	0.3627	8.5815	0	0	0	0	61.8736
180	0.06152	1626	5.03687E-06	0.000906634	0	61.8734	0	24.5177	0	0.88	0.3537	8.9352	0	0	0	0	61.5197
181	0.06152	1626	5.03687E-06	0.00091167	0	61.5198	0.3859	24.9036	0	0.88	0.2964	9.2316	0	0	0	0	61.6093
182	0.06152	1626	5.03687E-06	0.000916707	0	61.6093	1.6764	26.58	0	0.88	0.1273	9.3589	0	0	0	0	63.1584
183	0.06152	1626	5.03687E-06	0.000921744	0	63.1584	1.2399	27.8199	0	0.88	0.3987	9.7576	0	0	0	0	63.9995
184	0.06152	1626	5.03687E-06	0.000926781	0	63.9995	0.0508	27.8707	0	0.88	0.5038	10.2614	0	0	0	0	63.5464
185	0.06152	1626	5.03687E-06	0.000931818	0	63.5465	0	27.8707	0	0.88	0.1829	10.4443	0	0	0	0	63.3636
186	0.06152	1626	5.03687E-06	0.000936855	0	63.3637	0	27.8707	0	0.88	0.0744	10.5187	0	0	0	0	63.2893
187	0.06152	1626	5.03687E-06	0.000941892	0	63.2893	0	27.8707	0	0.88	0.0692	10.5879	0	0	0	0	63.2201
188	0.06152	1626	5.03687E-06	0.000946929	0	63.2201	0	27.8707	0	0.88	0.0684	10.6563	0	0	0	0	63.1517
189	0.06152	1626	5.03688E-06	0.000951965	0	63.1517	0	27.8707	0	0.88	0.0692	10.7255	0	0	0	0	63.0825
190	0.06152	1626	5.03688E-06	0.000957002	0	63.0825	0.254	28.1247	0	0.88	0.1589	10.8844	0	0	0	0	63.1776
191	0.06152	1626	5.03688E-06	0.000962039	0	63.1775	0.0254	28.1501	0	0.88	0.1794	11.0638	0	0	0	0	63.0235
192	0.06152	1626	5.03688E-06	0.000967076	0	63.0235	0	28.1501	0	0.88	0.0727	11.1365	0	0	0	0	62.9508
193	0.06152	1626	5.03688E-06	0.000972113	0	62.9508	0	28.1501	0	0.88	0.0725	11.209	0	0	0	0	62.8783
194	0.06152	1626	5.03688E-06	0.00097715	0	62.8783	0	28.1501	0	0.88	0.0653	11.2743	0	0	0	0	62.813
195	0.06152	1626	5.03688E-06	0.000982187	0	62.813	0	28.1501	0	0.88	0.056	11.3303	0	0	0	0	62.757
196	0.06152	1626	5.03688E-06	0.000987224	0	62.757	0	28.1501	0	0.88	0.0619	11.3922	0	0	0	0	62.6951
197	0.06152	1626	5.03688E-06	0.00099226	0	62.6951	0	28.1501	0	0.88	0.0683	11.4605	0	0	0	0	62.6268
198	0.06152	1626	5.03689E-06	0.000997297	0	62.6268	0.0508	28.2009	0	0.88	0.0925	11.553	0	0	0	0	62.5851
199	0.06152	1626	5.03689E-06	0.001002334	0	62.5851	0	28.2009	0	0.88	0.0667	11.6197	0	0	0	0	62.5184
200	0.06152	1626	5.03689E-06	0.001007371	0	62.5184	0	28.2009	0	0.88	0.0675	11.6872	0	0	0	0	62.4509
201	0.06152	1626	5.03689E-06	0.001012408	0	62.4509	0	28.2009	0	0.88	0.0385	11.7257	0	0	0	0	62.4124
202	0.06152	1626	5.03689E-06	0.001017445	0	62.4124	0.0508	28.2517	0	0.88	0.0643	11.79	0	0	0	0	62.3989
203	0.06152	1626	5.03689E-06	0.001022482	0	62.3988	0	28.2517	0	0.88	0.0612	11.8512	0	0	0	0	62.3376
204	0.06152	1626	5.03689E-06	0.001027519	0	62.3377	0.1524	28.4041	0	0.88	0.0947	11.9459	0	0	0	0	62.3954
205	0.06152	1626	5.03689E-06	0.001032556	0	62.3953	0	28.4041	0	0.88	0.075	12.0209	0	0	0	0	62.3203
206	0.06152	1626	5.0369E-06	0.001037592	0	62.3203	0	28.4041	0	0.88	0.0619	12.0828	0	0	0	0	62.2584
207	0.06152	1626	5.0369E-06	0.001042629	0	62.2585	0	28.4041	0	0.88	0.0453	12.1281	0	0	0	0	62.2132
208	0.06152	1626	5.0369E-06	0.001047666	0	62.2132	0	28.4041	0	0.88	0.048	12.1761	0	0	0	0	62.1652
209	0.06152	1626	5.0369E-06	0.001052703	0	62.1652	0	28.4041	0	0.88	0.0378	12.2139	0	0	0	0	62.1274
210	0.06152	1626	5.0369E-06	0.00105774	0	62.1274	0	28.4041	0	0.88	0.0333	12.2472	0	0	0	0	62.0941

Scenario: 1986 Stormwater Recirculation Alternating Days

Day	Water (cm3/cm3)	Head (cm)	Water Flow (cm)	Water Flow (cm) Accum	Plant Sink (cm)	Prestor	Infil	Infil Accum	Runoff	Runoff Accum	Evapo	Evapo Accum	Trans	Trans Accum	Drain	Drain Accum	Newstor
211	0.06152	1625.99	5.0369E-06	0.001062777	0	62.0941	0	28.4041	0	0.88	0.0334	12.2806	0	0	0	0	62.0607
212	0.06152	1625.99	5.03691E-06	0.001067814	0	62.0607	0	28.4041	0	0.88	0.0326	12.3132	0	0	0	0	62.0281
213	0.06152	1625.99	5.03691E-06	0.001072851	0	62.0281	0	28.4041	0	0.88	0.0336	12.3468	0	0	0	0	61.9945
214	0.06152	1625.99	5.03691E-06	0.001077888	0	61.9946	0.2032	28.6073	0	0.88	0.101	12.4478	0	0	0	0	62.0967
215	0.06152	1625.99	5.03691E-06	0.001082925	0	62.0965	0.4064	29.0137	0	0.88	0.1766	12.6244	0	0	0	0	62.3264
216	0.06152	1625.99	5.03691E-06	0.001087962	0	62.3262	0.3048	29.3185	0	0.88	0.2381	12.8625	0	0	0	0	62.3929
217	0.06152	1625.99	5.03692E-06	0.001092998	0	62.3928	0	29.3185	0	0.88	0.1323	12.9948	0	0	0	0	62.2606
218	0.06152	1625.99	5.03692E-06	0.001098035	0	62.2607	0.1016	29.4201	0	0.88	0.1216	13.1164	0	0	0	0	62.2406
219	0.06152	1625.99	5.03692E-06	0.001103072	0	62.2406	0	29.4201	0	0.88	0.0716	13.188	0	0	0	0	62.169
220	0.06152	1625.99	5.03692E-06	0.001108109	0	62.169	0	29.4201	0	0.88	0.0658	13.2538	0	0	0	0	62.1032
221	0.06152	1625.99	5.03692E-06	0.001113146	0	62.1032	0	29.4201	0	0.88	0.0469	13.3007	0	0	0	0	62.0563
222	0.06152	1625.99	5.03693E-06	0.001118183	0	62.0564	0	29.4201	0	0.88	0.0352	13.3359	0	0	0	0	62.0211
223	0.06152	1625.99	5.03693E-06	0.00112322	0	62.0211	0	29.4201	0	0.88	0.03	13.3659	0	0	0	0	61.9911
224	0.06152	1625.99	5.03693E-06	0.001128257	0	61.9911	0	29.4201	0	0.88	0.0331	13.399	0	0	0	0	61.958
225	0.06152	1625.99	5.03693E-06	0.001133294	0	61.958	0.0254	29.4455	0	0.88	0.0579	13.4569	0	0	0	0	61.9255
226	0.06152	1625.99	5.03694E-06	0.001138331	0	61.9255	0	29.4455	0	0.88	0.0329	13.4898	0	0	0	0	61.8926
227	0.06152	1625.99	5.03694E-06	0.001143368	0	61.8927	0	29.4455	0	0.88	0.0237	13.5135	0	0	0	0	61.8689
228	0.06152	1625.99	5.03694E-06	0.001148405	0	61.8689	0	29.4455	0	0.88	0.0237	13.5372	0	0	0	0	61.8452
229	0.06152	1625.99	5.03695E-06	0.001153442	0	61.8452	0	29.4455	0	0.88	0.0293	13.5665	0	0	0	0	61.8159
230	0.06152	1625.99	5.03695E-06	0.001158479	0	61.8159	0	29.4455	0	0.88	0.0302	13.5967	0	0	0	0	61.7857
231	0.06152	1625.99	5.03695E-06	0.001163516	0	61.7858	0	29.4455	0	0.88	0.0274	13.6241	0	0	0	0	61.7583
232	0.06152	1625.99	5.03695E-06	0.001168552	0	61.7583	0	29.4455	0	0.88	0.027	13.6511	0	0	0	0	61.7313
233	0.06152	1625.99	5.03696E-06	0.001173589	0	61.7313	0	29.4455	0	0.88	0.0202	13.6713	0	0	0	0	61.7111
234	0.06152	1625.99	5.03696E-06	0.001178626	0	61.7111	1.4806	30.9261	0.018	0.898	0.1088	13.7801	0	0	0	0	63.083
235	0.06152	1625.99	5.03696E-06	0.001183663	0	63.0845	0.8864	31.8125	0	0.898	0.4608	14.2409	0	0	0	0	63.5102
236	0.06152	1625.99	5.03697E-06	0.0011887	0	63.5101	0	31.8125	0	0.898	0.2609	14.5018	0	0	0	0	63.2492
237	0.06152	1625.99	5.03697E-06	0.001193737	0	63.2493	0	31.8125	0	0.898	0.0634	14.5652	0	0	0	0	63.1859
238	0.06152	1625.99	5.03697E-06	0.001198774	0	63.1859	2.159	33.9715	0	0.898	0.1293	14.6945	0	0	0	0	65.2156
239	0.06152	1625.99	5.03698E-06	0.001203811	0	65.2153	2.2925	36.264	0	0.898	0.1818	14.8763	0	0	0	0	67.326
240	0.06152	1625.99	5.03698E-06	0.001208848	0	67.326	0.6604	36.9244	0	0.898	0.0787	14.955	0	0	0	0	67.9076
241	0.06152	1625.99	5.03698E-06	0.001213885	0	67.9076	0.0762	37.0006	0	0.898	0.4771	15.4321	0	0	0	0	67.5067
242	0.06152	1625.99	5.03699E-06	0.001218922	0	67.5067	0.2794	37.28	0	0.898	0.2909	15.723	0	0	0	0	67.4952
243	0.06152	1625.99	5.03699E-06	0.001223959	0	67.4952	0.7366	38.0166	0	0.898	0.2807	16.0037	0	0	0	0	67.951
244	0.06152	1625.99	0.000005037	0.001228996	0	67.9509	1.8796	39.8962	0	0.898	0.3464	16.3501	0	0	0	0	69.4842
245	0.06152	1625.99	0.000005037	0.001234033	0	69.4843	4.1634	44.0596	1.1599	2.0579	0.3719	16.722	0	0	0	0	73.2758
246	0.06152	1625.98	0.000005037	0.00123907	0	73.2764	0	44.0596	0	2.0579	0.5723	17.2943	0	0	0	0	72.7041
247	0.06152	1625.98	5.03701E-06	0.001244107	0	72.7042	3.3149	47.3745	0.3313	2.3892	0.1676	17.4619	0	0	0	0	75.8515
248	0.06152	1625.98	5.03701E-06	0.001249144	0	75.8644	0	47.3745	0	2.3892	0.6706	18.1325	0	0	0	0	75.1937
249	0.06152	1625.98	5.03702E-06	0.001254181	0	75.1938	1.2944	48.6689	0	2.3892	0.3738	18.5063	0	0	0	0	76.1145
250	0.06152	1625.98	5.03702E-06	0.001259218	0	76.1144	0.0508	48.7197	0	2.3892	0.2464	18.7527	0	0	0	0	75.9188
251	0.06152	1625.98	5.03703E-06	0.001264255	0	75.9188	1.2656	49.9853	0	2.3892	0.3121	19.0648	0	0	0	0	76.8723
252	0.06152	1625.98	5.03703E-06	0.001269292	0	76.8723	0	49.9853	0	2.3892	0.3515	19.4163	0	0	0	0	76.5207

Scenario: 1986 Stormwater Recirculation Alternating Days

Day	Water (cm3/cm3)	Head (cm)	Water Flow (cm)	Water Flow (cm) Accum	Plant Sink (cm)	Prestor	Infil	Infil Accum	Runoff	Runoff Accum	Evapo	Evapo Accum	Trans	Trans Accum	Drain	Drain Accum	Newstor
253	0.06152	1625.98	5.03704E-06	0.001274329	0	76.5209	0	49.9853	0	2.3892	0.0864	19.5027	0	0	0	0	76.4344
254	0.06152	1625.98	5.03704E-06	0.001279366	0	76.4344	0	49.9853	0	2.3892	0.0844	19.5871	0	0	0	0	76.35
255	0.06152	1625.98	5.03705E-06	0.001284403	0	76.35	0	49.9853	0	2.3892	0.0744	19.6615	0	0	0	0	76.2756
256	0.06152	1625.98	5.03705E-06	0.00128944	0	76.2756	0.1016	50.0869	0	2.3892	0.1147	19.7762	0	0	0	0	76.2625
257	0.06152	1625.98	5.03706E-06	0.001294478	0	76.2624	0	50.0869	0	2.3892	0.1532	19.9294	0	0	0	0	76.1092
258	0.06152	1625.98	5.03706E-06	0.001299515	0	76.1093	0	50.0869	0	2.3892	0.058	19.9874	0	0	0	0	76.0513
259	0.06152	1625.98	5.03707E-06	0.001304552	0	76.0512	0	50.0869	0	2.3892	0.058	20.0454	0	0	0	0	75.9932
260	0.06152	1625.98	5.03707E-06	0.001309589	0	75.9932	0	50.0869	0	2.3892	0.0684	20.1138	0	0	0	0	75.9248
261	0.06152	1625.98	5.03708E-06	0.001314626	0	75.9248	0	50.0869	0	2.3892	0.07	20.1838	0	0	0	0	75.8547
262	0.06152	1625.98	5.03708E-06	0.001319663	0	75.8547	0	50.0869	0	2.3892	0.0653	20.2491	0	0	0	0	75.7894
263	0.06152	1625.98	5.03709E-06	0.0013247	0	75.7894	0	50.0869	0	2.3892	0.0612	20.3103	0	0	0	0	75.7282
264	0.06152	1625.98	5.0371E-06	0.001329737	0	75.7282	0	50.0869	0	2.3892	0.0554	20.3657	0	0	0	0	75.6728
265	0.06152	1625.97	5.0371E-06	0.001334774	0	75.6728	0.3048	50.3917	0	2.3892	0.0625	20.4282	0	0	0	0	75.9151
266	0.06152	1625.97	5.03711E-06	0.001339811	0	75.9149	0.7366	51.1283	0	2.3892	0.1752	20.6034	0	0	0	0	76.4763
267	0.06152	1625.97	5.03711E-06	0.001344848	0	76.4761	0	51.1283	0	2.3892	0.2292	20.8326	0	0	0	0	76.247
268	0.06152	1625.97	5.03712E-06	0.001349886	0	76.2471	0	51.1283	0	2.3892	0.0834	20.916	0	0	0	0	76.1637
269	0.06152	1625.97	5.03713E-06	0.001354923	0	76.1637	0	51.1283	0	2.3892	0.0802	20.9962	0	0	0	0	76.0834
270	0.06152	1625.97	5.03713E-06	0.00135996	0	76.0834	0	51.1283	0	2.3892	0.0742	21.0704	0	0	0	0	76.0093
271	0.06152	1625.97	5.03714E-06	0.001364997	0	76.0093	0	51.1283	0	2.3892	0.0618	21.1322	0	0	0	0	75.9475
272	0.06152	1625.97	5.03715E-06	0.001370034	0	75.9475	0.2032	51.3315	0	2.3892	0.1444	21.2766	0	0	0	0	76.0063
273	0.06152	1625.97	5.03715E-06	0.001375071	0	76.0061	0	51.3315	0	2.3892	0.1238	21.4004	0	0	0	0	75.8823
274	0.06152	1625.97	5.03716E-06	0.001380108	0	75.8824	0	51.3315	0	2.3892	0.0855	21.4859	0	0	0	0	75.7969
275	0.06152	1625.97	5.03717E-06	0.001385146	0	75.7969	0.1778	51.5093	0	2.3892	0.0428	21.5287	0	0	0	0	75.932
276	0.06152	1625.97	5.03718E-06	0.001390183	0	75.9318	0	51.5093	0	2.3892	0.1175	21.6462	0	0	0	0	75.8143
277	0.06152	1625.97	5.03718E-06	0.00139522	0	75.8144	0	51.5093	0	2.3892	0.0719	21.7181	0	0	0	0	75.7425
278	0.06152	1625.97	5.03719E-06	0.001400257	0	75.7425	0.3302	51.8395	0	2.3892	0	21.7181	0	0	0	0	76.0727
279	0.06152	1625.97	5.0372E-06	0.001405294	0	76.0725	0.1778	52.0173	0	2.3892	0.0786	21.7967	0	0	0	0	76.1718
280	0.06152	1625.96	5.03721E-06	0.001410332	0	76.1717	0	52.0173	0	2.3892	0.1384	21.9351	0	0	0	0	76.0333
281	0.06152	1625.96	5.03721E-06	0.001415369	0	76.0334	0	52.0173	0	2.3892	0.062	21.9971	0	0	0	0	75.9714
282	0.06152	1625.96	5.03722E-06	0.001420406	0	75.9714	1.4986	53.5159	0	2.3892	0.0722	22.0693	0	0	0	0	77.3978
283	0.06152	1625.96	5.03723E-06	0.001425443	0	77.3974	6.1318	59.6477	3.226	5.6152	0.0572	22.1265	0	0	0	0	83.4719
284	0.06152	1625.96	5.03724E-06	0.00143048	0	83.485	1.3056	60.9533	0	5.6152	0.0542	22.1807	0	0	0	0	84.7364
285	0.06152	1625.96	5.03725E-06	0.001435518	0	84.7363	1.2688	62.2221	0	5.6152	0.0585	22.2392	0	0	0	0	85.9466
286	0.06152	1625.96	5.03726E-06	0.001440555	0	85.9465	0	62.2221	0	5.6152	0.4881	22.7273	0	0	0	0	85.4584
287	0.06152	1625.96	5.03727E-06	0.001445592	0	85.4586	1.24	63.4621	0	5.6152	0.2607	22.988	0	0	0	0	86.4379
288	0.06152	1625.96	5.03727E-06	0.001450629	0	86.4377	0	63.4621	0	5.6152	0.3824	23.3704	0	0	0	0	86.0553
289	0.06152	1625.96	5.03728E-06	0.001455667	0	86.0555	1.2616	64.7237	0	5.6152	0.1454	23.5158	0	0	0	0	87.1717
290	0.06152	1625.96	5.03729E-06	0.001460704	0	87.1716	0.4572	65.1809	0	5.6152	0.4517	23.9675	0	0	0	0	87.1771
291	0.06152	1625.95	5.0373E-06	0.001465741	0	87.1771	1.2904	66.4713	0	5.6152	0.2958	24.2633	0	0	0	0	88.1717
292	0.06152	1625.95	5.03731E-06	0.001470779	0	88.1716	0	66.4713	0	5.6152	0.141	24.4043	0	0	0	0	88.0307
293	0.06152	1625.95	5.03732E-06	0.001475816	0	88.0307	0.9404	67.4117	0	5.6152	0.0494	24.4537	0	0	0	0	88.9217
294	0.06152	1625.95	5.03733E-06	0.001480853	0	88.9216	2.2098	69.6215	0	5.6152	0.4238	24.8775	0	0	0	0	90.7076

Scenario: 1986 Stormwater Recirculation Alternating Days

Day	Water (cm3/cm3)	Head (cm)	Water Flow (cm)	Water Flow (cm) Accum	Plant Sink (cm)	Prestor	Infil	Infil Accum	Runoff	Runoff Accum	Evapo	Evapo Accum	Trans	Trans Accum	Drain	Drain Accum	Newstor
295	0.06152	1625.95	5.03734E-06	0.001485891	0	90.7078	1.2552	70.8767	0	5.6152	0.3542	25.2317	0	0	0	0	91.6088
296	0.06152	1625.95	5.03735E-06	0.001490928	0	91.6087	0	70.8767	0	5.6152	0.4278	25.6595	0	0	0	0	91.1809
297	0.06152	1625.95	5.03736E-06	0.001495965	0	91.1809	0	70.8767	0	5.6152	0.2876	25.9471	0	0	0	0	90.8933
298	0.06152	1625.95	5.03737E-06	0.001501003	0	90.8934	0	70.8767	0	5.6152	0.1467	26.0938	0	0	0	0	90.7467
299	0.06152	1625.95	5.03738E-06	0.00150604	0	90.7468	0	70.8767	0	5.6152	0.069	26.1628	0	0	0	0	90.6778
300	0.06152	1625.95	5.03739E-06	0.001511077	0	90.6778	0	70.8767	0	5.6152	0.0766	26.2394	0	0	0	0	90.6011
301	0.06152	1625.94	5.0374E-06	0.001516115	0	90.6011	0	70.8767	0	5.6152	0.0807	26.3201	0	0	0	0	90.5204
302	0.06152	1625.94	5.03742E-06	0.001521152	0	90.5204	0	70.8767	0	5.6152	0.0563	26.3764	0	0	0	0	90.4641
303	0.06152	1625.94	5.03743E-06	0.00152619	0	90.4641	0	70.8767	0	5.6152	0.0609	26.4373	0	0	0	0	90.4031
304	0.06152	1625.94	5.03744E-06	0.001531227	0	90.4031	0	70.8767	0	5.6152	0.0649	26.5022	0	0	0	0	90.3382
305	0.06152	1625.94	5.03745E-06	0.001536265	0	90.3382	0	70.8767	0	5.6152	0.0546	26.5568	0	0	0	0	90.2836
306	0.06152	1625.94	5.03746E-06	0.001541302	0	90.2836	1.778	72.6547	0	5.6152	0	26.5568	0	0	0	0	92.0616
307	0.06152	1625.94	5.03747E-06	0.00154634	0	92.0613	2.9559	75.6106	0.0333	5.6485	0	26.5568	0	0	0	0	95.0172
308	0.06152	1625.94	5.03748E-06	0.001551377	0	95.0224	0.3556	75.9662	0	5.6485	0.1643	26.7211	0	0	0	0	95.2137
309	0.06152	1625.93	5.0375E-06	0.001556415	0	95.2137	1.1214	77.0876	0	5.6485	0.2967	27.0178	0	0	0	0	96.0384
310	0.06152	1625.93	5.03751E-06	0.001561452	0	96.0384	0	77.0876	0	5.6485	0.4097	27.4275	0	0	0	0	95.6287
311	0.06152	1625.93	5.03752E-06	0.00156649	0	95.6288	0	77.0876	0	5.6485	0.0857	27.5132	0	0	0	0	95.5431
312	0.06152	1625.93	5.03753E-06	0.001571527	0	95.5431	0	77.0876	0	5.6485	0.0853	27.5985	0	0	0	0	95.4578
313	0.06152	1625.93	5.03755E-06	0.001576565	0	95.4578	0	77.0876	0	5.6485	0.0803	27.6788	0	0	0	0	95.3776
314	0.06152	1625.93	5.03756E-06	0.001581602	0	95.3775	0	77.0876	0	5.6485	0.0661	27.7449	0	0	0	0	95.3114
315	0.06152	1625.93	5.03757E-06	0.00158664	0	95.3114	0	77.0876	0	5.6485	0.0633	27.8082	0	0	0	0	95.2481
316	0.06152	1625.93	5.03759E-06	0.001591677	0	95.2481	0	77.0876	0	5.6485	0.0875	27.8957	0	0	0	0	95.1606
317	0.06152	1625.92	5.0376E-06	0.001596715	0	95.1605	0.3302	77.4178	0	5.6485	0.0198	27.9155	0	0	0	0	95.4709
318	0.06152	1625.92	5.03761E-06	0.001601753	0	95.4708	0	77.4178	0	5.6485	0.2064	28.1219	0	0	0	0	95.2645
319	0.06152	1625.92	5.03763E-06	0.00160679	0	95.2646	0	77.4178	0	5.6485	0.0614	28.1833	0	0	0	0	95.2032
320	0.06152	1625.92	5.03764E-06	0.001611828	0	95.2031	0	77.4178	0	5.6485	0.1269	28.3102	0	0	0	0	95.0762
321	0.06152	1625.92	5.03766E-06	0.001616866	0	95.0763	0	77.4178	0	5.6485	0.0698	28.38	0	0	0	0	95.0065
322	0.06152	1625.92	5.03767E-06	0.001621903	0	95.0065	0	77.4178	0	5.6485	0.0638	28.4438	0	0	0	0	94.9426
323	0.06152	1625.92	5.03769E-06	0.001626941	0	94.9426	0.1524	77.5702	0	5.6485	0.1391	28.5829	0	0	0	0	94.9559
324	0.06152	1625.91	5.0377E-06	0.001631979	0	94.9558	0	77.5702	0	5.6485	0.1032	28.6861	0	0	0	0	94.8526
325	0.06152	1625.91	5.03772E-06	0.001637016	0	94.8526	0	77.5702	0	5.6485	0.0533	28.7394	0	0	0	0	94.7993
326	0.06152	1625.9	5.03776E-06	0.001642054	0	94.7993	0	77.5702	0	5.6485	0.0687	28.8081	0	0	0	0	94.7306
327	0.06238	1544.87	5.13594E-06	0.00164719	0	94.7306	0.1778	77.748	0	5.6485	0.0531	28.8612	0	0	0	0	94.8553
328	0.11643	223.534	0.000604489	0.002251679	0	94.8551	0	77.748	0	5.6485	0.1066	28.9678	0	0	0.0006	0.0006	94.7479
329	0.14892	115.022	0.0115642	0.013815879	0	94.748	0	77.748	0	5.6485	0.0587	29.0265	0	0	0.0116	0.0122	94.6777
330	0.16634	85.4181	0.0400183	0.053834179	0	94.6777	0	77.748	0	5.6485	0.0717	29.0982	0	0	0.04	0.0522	94.566
331	0.17695	72.1604	0.077092	0.130926179	0	94.5661	0	77.748	0	5.6485	0.0632	29.1614	0	0	0.0771	0.1293	94.4258
332	0.18364	65.1189	0.113352	0.244278179	0	94.4258	0	77.748	0	5.6485	0.0593	29.2207	0	0	0.1134	0.2427	94.2531
333	0.18788	61.0802	0.143555	0.387833179	0	94.2532	0	77.748	0	5.6485	0.0404	29.2611	0	0	0.1436	0.3863	94.0692
334	0.19057	58.6826	0.166264	0.554097179	0	94.0692	0	77.748	0	5.6485	0.0456	29.3067	0	0	0.1663	0.5526	93.8574
335	0.19223	57.2534	0.182097	0.736194179	0	93.8574	0	77.748	0	5.6485	0.0378	29.3445	0	0	0.1821	0.7347	93.6375
336	0.19321	56.4275	0.192375	0.928569179	0	93.6375	0	77.748	0	5.6485	0.0434	29.3879	0	0	0.1924	0.9271	93.4018

Scenario: 1986 Stormwater Recirculation Alternating Days

Day	Water (cm3/cm3)	Head (cm)	Water Flow (cm)	Water Flow (cm) Accum	Plant Sink (cm)	Prestor	Infil	Infil Accum	Runoff	Runoff Accum	Evapo	Evapo Accum	Trans	Trans Accum	Drain	Drain Accum	Newstor
337	0.19373	55.9931	0.198445	1.127014179	0	93.4018	0	77.748	0	5.6485	0.034	29.4219	0	0	0.1984	1.1255	93.1694
338	0.19394	55.821	0.201436	1.328450179	0	93.1694	0	77.748	0	5.6485	0.0006	29.4225	0	0	0.2014	1.3269	92.9674
339	0.19393	55.8291	0.202222	1.530672179	0	92.9673	0	77.748	0	5.6485	0.0417	29.4642	0	0	0.2022	1.5291	92.7234
340	0.19377	55.9637	0.201452	1.732124179	0	92.7235	0	77.748	0	5.6485	0.0138	29.478	0	0	0.2015	1.7306	92.5082
341	0.1935	56.1882	0.199596	1.931720179	0	92.5083	0	77.748	0	5.6485	0.0355	29.5135	0	0	0.1996	1.9302	92.2732
342	0.19315	56.4778	0.196995	2.128715179	0	92.2732	0.381	78.129	0	5.6485	0.0329	29.5464	0	0	0.197	2.1272	92.4244
343	0.19275	56.8146	0.193894	2.322609179	0	92.424	0	78.129	0	5.6485	0	29.5464	0	0	0.1939	2.3211	92.2302
344	0.19231	57.186	0.190467	2.513076179	0	92.2302	0.4572	78.5862	0	5.6485	0.07	29.6164	0	0	0.1905	2.5116	92.4268
345	0.19184	57.5829	0.18684	2.699916179	0	92.4267	0	78.5862	0	5.6485	0.1983	29.8147	0	0	0.1868	2.6984	92.0416
346	0.19136	57.9983	0.183104	2.883020179	0	92.0417	0	78.5862	0	5.6485	0.0592	29.8739	0	0	0.1831	2.8815	91.7994
347	0.19086	58.4272	0.179324	3.062344179	0	91.7994	0	78.5862	0	5.6485	0.0503	29.9242	0	0	0.1793	3.0608	91.5698
348	0.19036	58.8658	0.175545	3.237889179	0	91.5698	0	78.5862	0	5.6485	0.0505	29.9747	0	0	0.1755	3.2363	91.3438
349	0.18985	59.3112	0.1718	3.409689179	0	91.3438	0	78.5862	0	5.6485	0.0603	30.035	0	0	0.1718	3.4081	91.1117
350	0.18934	59.7611	0.168112	3.577801179	0	91.1117	0.2032	78.7894	0	5.6485	0.0203	30.0553	0	0	0.1681	3.5762	91.1264
351	0.18884	60.2137	0.164498	3.742299179	0	91.1263	0.6604	79.4498	0	5.6485	0	30.0553	0	0	0.1645	3.7407	91.6222
352	0.18834	60.6678	0.160967	3.903266179	0	91.622	0.254	79.7038	0	5.6485	0.0964	30.1517	0	0	0.161	3.9017	91.6186
353	0.18784	61.1223	0.157527	4.060793179	0	91.6186	0	79.7038	0	5.6485	0.2388	30.3905	0	0	0.1575	4.0592	91.2222
354	0.18734	61.5764	0.154182	4.214975179	0	91.2223	0	79.7038	0	5.6485	0.055	30.4455	0	0	0.1542	4.2134	91.0132
355	0.18686	62.0294	0.150934	4.365909179	0	91.0132	0.6604	80.3642	0	5.6485	0.0997	30.5452	0	0	0.1509	4.3643	91.4229
356	0.18637	62.4808	0.147782	4.513691179	0	91.4227	1.1176	81.4818	0	5.6485	0	30.5452	0	0	0.1478	4.5121	92.3925
357	0.1859	62.9303	0.144728	4.658419179	0	92.3925	0.2377	81.7195	0	5.6485	0.1535	30.6987	0	0	0.1447	4.6568	92.332
358	0.18543	63.3774	0.141768	4.800187179	0	92.332	0	81.7195	0	5.6485	0.0521	30.7508	0	0	0.1418	4.7986	92.1381
359	0.18496	63.8219	0.138903	4.939090179	0	92.1381	0	81.7195	0	5.6485	0.184	30.9348	0	0	0.1389	4.9375	91.8152
360	0.18451	64.2635	0.136129	5.075219179	0	91.8152	0	81.7195	0	5.6485	0.1226	31.0574	0	0	0.1361	5.0736	91.5564
361	0.18406	64.7021	0.133443	5.208662179	0	91.5565	0	81.7195	0	5.6485	0.0547	31.1121	0	0	0.1334	5.207	91.3683
362	0.18362	65.1375	0.130845	5.339507179	0	91.3683	0	81.7195	0	5.6485	0.048	31.1601	0	0	0.1308	5.3378	91.1895
363	0.18318	65.5695	0.12833	5.467837179	0	91.1895	0	81.7195	0	5.6485	0.0633	31.2234	0	0	0.1283	5.4661	90.9978
364	0.18275	65.998	0.125898	5.593735179	0	90.9979	0	81.7195	0	5.6485	0.0667	31.2901	0	0	0.1259	5.592	90.8053
365	0.18233	66.4228	0.123544	5.717279179	0	90.8053	0	81.7195	0	5.6485	0.0679	31.358	0	0	0.1235	5.7155	90.6139

Scenario: 1986 Stormwater Recirculation Alternating Days

Day	Storage	Mass Balance	Evap Potential	Evap Actual	Trans Potential	Trans Actual	Precip
1	45.8855	-0.00012694	0.6036	0.046	0	0	0
2	45.8599	-0.000059776	0.2755	0.0257	0	0	0
3	45.844	-0.000025966	0.1907	0.0159	0	0	0
4	45.8295	-0.00002415	0.443	0.0145	0	0	0
5	45.8174	-0.00001604	0.4345	0.0122	0	0	0
6	46.2431	0.00069592	0.556	0.0816	0	0	0.508
7	47.3876	0.000534	0.0518	0.0487	0	0	1.1938
8	47.1576	0.000045002	0.23	0.23	0	0	0
9	47.1823	-0.000046523	0.314	0.2169	0	0	0.2416
10	47.1162	-0.000010064	0.5188	0.0662	0	0	0
11	47.0449	-0.000018602	0.5163	0.0713	0	0	0
12	46.9726	-0.000023641	0.6306	0.0723	0	0	0
13	46.9208	-0.000055397	0.4943	0.0518	0	0	0
14	46.8852	-9.3615E-06	0.4285	0.0356	0	0	0
15	46.8496	-0.000021563	0.4513	0.0356	0	0	0
16	46.8166	-0.000046231	0.7485	0.0331	0	0	0
17	46.7893	-0.000015168	0.3326	0.0273	0	0	0
18	46.7652	-0.000032705	0.5699	0.0241	0	0	0
19	46.7439	-0.000010739	0.5666	0.0213	0	0	0
20	46.7208	-0.000033995	0.7008	0.0232	0	0	0
21	46.701	-0.000015537	0.6626	0.0198	0	0	0
22	46.6844	-0.000011946	0.4847	0.0166	0	0	0
23	46.6694	-0.000021295	0.3654	0.015	0	0	0
24	46.6532	-9.8222E-06	0.5066	0.0162	0	0	0
25	46.6403	-8.8075E-06	0.6058	0.0129	0	0	0
26	46.6268	-0.000020368	0.5074	0.0135	0	0	0
27	46.614	-5.8192E-06	0.6066	0.0128	0	0	0
28	46.5983	-0.000015137	0.7179	0.0157	0	0	0
29	46.5849	-0.000012357	0.6847	0.0135	0	0	0
30	46.5735	-4.7466E-06	0.5831	0.0113	0	0	0
31	46.5619	-0.000013032	0.4029	0.0117	0	0	0
32	46.5542	-9.7154E-06	0.5467	0.0077	0	0	0
33	46.5486	-0.000001114	0.2606	0.0056	0	0	0
34	46.5369	-5.5997E-06	0.6813	0.0117	0	0	0
35	46.5783	0.00014403	0.4279	0.06	0	0	0.1016
36	46.5783	0.00001431	0	0	0	0	0
37	46.5517	-0.000080376	0.0432	0.0267	0	0	0
38	46.5846	0.00011947	0.2712	0.0431	0	0	0.0762
39	46.6836	0.00015229	0.0027	0.0025	0	0	0.1016
40	47.4704	0.00054503	0	0	0	0	0.7874
41	47.5395	0.000058246	0.1606	0.1429	0	0	0.212
42	47.4447	-0.000021839	0.0948	0.0948	0	0	0

Scenario: 1986 Stormwater Recirculation Alternating Days

Day	Storage	Mass Balance	Evap Potential	Evap Actual	Trans Potential	Trans Actual	Precip
43	47.4447	4.3116E-07	0	0	0	0	0
44	47.3683	-0.000073185	0.2696	0.0765	0	0	0
45	47.305	-0.000012275	0.352	0.0633	0	0	0
46	47.2364	-0.000076575	0.3986	0.0687	0	0	0
47	47.1953	-0.000013487	0.7752	0.0412	0	0	0
48	47.1558	-0.000054519	0.6966	0.0395	0	0	0
49	47.1253	-0.000015137	0.5723	0.0305	0	0	0
50	47.0937	-0.000048346	0.6347	0.0316	0	0	0
51	47.0672	-0.000017015	0.9438	0.0265	0	0	0
52	47.0485	-0.000021808	0.7137	0.0187	0	0	0
53	47.0256	-0.000024053	0.8565	0.0229	0	0	0
54	47.0041	-0.000024946	0.6653	0.0216	0	0	0
55	46.9863	-0.000012819	0.7199	0.0177	0	0	0
56	46.9697	-0.000011574	0.8445	0.0167	0	0	0
57	46.9512	-0.000032053	1.0691	0.0185	0	0	0
58	46.9382	-4.6792E-06	0.5595	0.013	0	0	0
59	46.9247	-0.000012243	0.7445	0.0135	0	0	0
60	46.9099	-0.000020832	0.8081	0.0148	0	0	0
61	46.896	-8.5778E-06	0.8125	0.0139	0	0	0
62	46.8847	-0.00001327	0.6347	0.0113	0	0	0
63	46.8743	-9.5721E-06	0.804	0.0104	0	0	0
64	46.8624	-0.00000319	0.9462	0.0119	0	0	0
65	46.8514	-9.8041E-06	0.9849	0.0111	0	0	0
66	46.8405	-0.000010675	0.6435	0.0109	0	0	0
67	46.83	-2.9168E-06	0.6168	0.0105	0	0	0
68	46.8182	-6.0507E-06	1.0792	0.0118	0	0	0
69	46.8079	-0.000013315	0.4964	0.0104	0	0	0
70	46.8005	-0.000010101	0.5906	0.0073	0	0	0
71	46.7915	1.0946E-07	0.6907	0.0091	0	0	0
72	46.7868	-2.8025E-06	0.1936	0.0046	0	0	0
73	46.8741	0.00023559	0.1074	0.0141	0	0	0.1016
74	46.7976	-0.00018764	0.7778	0.0767	0	0	0
75	46.7779	-0.000048208	0.9057	0.0197	0	0	0
76	46.7678	-8.7665E-06	0.9797	0.0101	0	0	0
77	46.7845	0.000061743	0.2394	0.0341	0	0	0.0508
78	46.8255	0.00010825	0.5868	0.0858	0	0	0.127
79	46.7791	-0.0000673	0.5985	0.0719	0	0	0.0254
80	46.7575	-0.000061961	0.8739	0.0216	0	0	0
81	46.746	-7.6243E-06	1.0249	0.0116	0	0	0
82	46.7359	-4.9899E-06	0.9417	0.0101	0	0	0
83	46.727	-0.000012169	0.8387	0.0089	0	0	0
84	46.7191	-0.000010839	0.9651	0.0079	0	0	0

Scenario: 1986 Stormwater Recirculation Alternating Days

Day	Storage	Mass Balance	Evap Potential	Evap Actual	Trans Potential	Trans Actual	Precip
85	46.7124	-7.7604E-07	1.1083	0.0067	0	0	0
86	46.7078	-2.2604E-06	0.9215	0.0046	0	0	0
87	46.7002	-5.2305E-07	1.1041	0.0076	0	0	0
88	46.6942	-1.4299E-06	0.8127	0.006	0	0	0
89	46.6868	-3.5182E-07	0.8813	0.0074	0	0	0
90	46.6783	-2.9843E-06	0.9786	0.0085	0	0	0
91	46.673	-7.5018E-06	0.7378	0.0052	0	0	0
92	46.6662	-1.2424E-06	1.0248	0.0068	0	0	0
93	46.6586	1.3147E-06	0.7489	0.0076	0	0	0
94	46.6522	-8.8162E-07	1.0224	0.0064	0	0	0
95	46.645	2.3295E-07	0.7789	0.0072	0	0	0
96	46.6396	-0.00000288	0.5689	0.0054	0	0	0
97	46.6323	-1.0917E-07	0.7861	0.0073	0	0	0
98	47.3434	-0.00042645	0.5278	0.0723	0	0	0.7874
99	47.2056	6.5425E-06	0.457	0.1378	0	0	0
100	47.1323	-0.000018628	0.6882	0.0733	0	0	0
101	47.0651	-0.000089596	1.0875	0.0673	0	0	0
102	47.0238	-0.000054371	1.1011	0.0413	0	0	0
103	46.9904	-0.000049086	1.6108	0.0335	0	0	0
104	46.9621	-0.000049183	1.0561	0.0283	0	0	0
105	46.9404	-0.000015942	1.0526	0.0218	0	0	0
106	46.9235	-0.000023061	0.7288	0.0169	0	0	0
107	46.9063	-0.000014112	1.6872	0.0172	0	0	0
108	46.887	-0.0000336	1.2608	0.0193	0	0	0
109	46.8763	-6.4463E-06	0.53	0.0107	0	0	0
110	46.8624	-0.00002107	0.6888	0.0139	0	0	0
111	46.8494	-0.000011931	0.994	0.013	0	0	0
112	46.8372	-0.000012512	1.0712	0.0122	0	0	0
113	46.8241	-0.000018296	1.1877	0.0131	0	0	0
114	46.8119	-0.000013584	1.1774	0.0122	0	0	0
115	46.8011	-0.000013338	1.1202	0.0108	0	0	0
116	46.7903	-3.6179E-06	1.2981	0.0108	0	0	0
117	46.7775	-0.000011356	1.6638	0.0128	0	0	0
118	46.7655	-0.000017386	1.1204	0.012	0	0	0
119	46.7575	-0.000002294	1.061	0.008	0	0	0
120	46.7485	-5.9394E-07	1.0536	0.0091	0	0	0
121	46.7435	-3.5769E-06	0.8945	0.0049	0	0	0
122	46.7366	-2.3723E-07	0.8651	0.0069	0	0	0
123	46.7301	-1.3249E-06	1.0649	0.0065	0	0	0
124	46.7215	-4.0284E-06	1.4199	0.0086	0	0	0
125	46.7111	-0.000015719	1.4558	0.0104	0	0	0
126	46.7014	-3.3977E-06	1.4699	0.0097	0	0	0

Scenario: 1986 Stormwater Recirculation Alternating Days

Day	Storage	Mass Balance	Evap Potential	Evap Actual	Trans Potential	Trans Actual	Precip
127	46.6925	-0.000001779	1.5122	0.0089	0	0	0
128	46.6841	-3.2684E-06	1.3664	0.0084	0	0	0
129	46.6752	-6.5137E-06	0.9416	0.0088	0	0	0
130	46.6668	-0.000012494	1.1476	0.0085	0	0	0
131	46.6581	-4.4604E-06	1.3621	0.0087	0	0	0
132	46.6495	2.383E-07	1.5267	0.0086	0	0	0
133	46.6429	-3.5424E-06	1.2407	0.0066	0	0	0
134	46.6346	-8.8609E-07	1.0033	0.0082	0	0	0
135	46.6264	-5.4798E-06	1.0124	0.0082	0	0	0
136	46.6194	-9.0916E-06	1.116	0.0071	0	0	0
137	47.267	-0.00032736	0.292	0.038	0	0	0.6858
138	47.1273	-2.2878E-06	0.8664	0.1397	0	0	0
139	47.0372	-0.000078664	1.0539	0.0901	0	0	0
140	46.9835	-0.000068833	1.4689	0.0538	0	0	0
141	46.9456	-0.000048008	1.3522	0.0379	0	0	0
142	46.9154	-0.000037719	1.0654	0.0302	0	0	0
143	46.8953	-0.000027849	0.9337	0.0201	0	0	0
144	46.8772	-0.000021941	0.5235	0.0182	0	0	0
145	46.89	0.00006059	0.3462	0.0379	0	0	0.0508
146	46.9918	0.00026164	0.4154	0.0757	0	0	0.1778
147	46.9234	-0.00011184	0.8444	0.0939	0	0	0.0254
148	46.8919	-0.000074845	0.6003	0.0316	0	0	0
149	47.0078	0.00031337	0.1974	0.0362	0	0	0.1524
150	48.2031	0.00066745	0.3765	0.0994	0	0	1.2954
151	49.0636	0.00014948	0.0384	0.0323	0	0	0.893
152	48.8422	-8.0284E-06	0.2896	0.2723	0	0	0.0508
153	48.6935	-0.000090393	0.3371	0.1488	0	0	0
154	48.6439	-2.1555E-06	0.6355	0.0496	0	0	0
155	48.5839	0.000012462	0.6932	0.0854	0	0	0.0254
156	48.5242	-0.000012728	0.7816	0.0597	0	0	0
157	48.4501	-0.00007665	1.3063	0.0742	0	0	0
158	48.4039	-0.000016229	1.1734	0.0462	0	0	0
159	49.1709	-0.0010571	0.9711	0.147	0	0	0.9144
160	48.9937	-0.00010299	1.1101	0.1772	0	0	0
161	48.9046	-0.000015189	1.091	0.0892	0	0	0
162	48.8301	-0.000013854	1.2145	0.0744	0	0	0
163	48.7492	-0.000048326	1.2325	0.0809	0	0	0
164	48.7002	-0.000042136	1.4279	0.0491	0	0	0
165	48.6542	-0.000023666	1.1771	0.046	0	0	0
166	48.6167	-0.000045914	1.6066	0.0376	0	0	0
167	48.5826	-0.000017457	1.5031	0.0341	0	0	0
168	48.5539	-0.000037151	1.3909	0.0287	0	0	0

Scenario: 1986 Stormwater Recirculation Alternating Days

Day	Storage	Mass Balance	Evap Potential	Evap Actual	Trans Potential	Trans Actual	Precip
169	50.7724	-0.0024534	0.6911	0.1034	0	0	2.3876
170	50.5666	3.2125E-06	0.7379	0.409	0	0	0.2032
171	51.3742	0.000064722	0.6709	0.3354	0	0	1.1431
172	51.1496	-0.00011167	0.9226	0.2247	0	0	0
173	51.0837	-2.7585E-06	0.4235	0.0659	0	0	0
174	53.6844	0.000064942	0.0459	0.0408	0	0	2.6416
175	58.0312	-0.002604	0.1713	0.0668	0	0	5.0256
176	60.3474	-0.00086109	0.2949	0.2624	0	0	2.7686
177	61.4915	0.000093012	0.594	0.2614	0	0	1.4056
178	60.9995	-0.00010346	0.8234	0.4921	0	0	0
179	61.8734	0.00016344	0.9768	0.3627	0	0	1.2368
180	61.5198	-0.00011402	0.8047	0.3537	0	0	0
181	61.6093	0.000027786	0.9275	0.2964	0	0	0.3859
182	63.1584	0.000069285	0.5246	0.1273	0	0	1.6764
183	63.9995	0.000024726	0.5864	0.3987	0	0	1.2399
184	63.5465	-0.000047987	0.755	0.5038	0	0	0.0508
185	63.3637	-0.000085511	1.2137	0.1829	0	0	0
186	63.2893	9.0712E-06	0.9321	0.0744	0	0	0
187	63.2201	2.3804E-06	1.0648	0.0692	0	0	0
188	63.1517	2.354E-07	0.8583	0.0684	0	0	0
189	63.0825	-8.7339E-07	1.0089	0.0692	0	0	0
190	63.1775	0.00012561	0.8315	0.1589	0	0	0.254
191	63.0235	-0.000070419	0.8411	0.1794	0	0	0.0254
192	62.9508	-8.4885E-07	1.0177	0.0727	0	0	0
193	62.8783	-1.6325E-06	1.3581	0.0725	0	0	0
194	62.813	-1.1517E-06	1.1424	0.0653	0	0	0
195	62.757	-7.0553E-07	0.956	0.056	0	0	0
196	62.6951	-2.4961E-06	1.0392	0.0619	0	0	0
197	62.6268	-7.9684E-06	1.1827	0.0683	0	0	0
198	62.5851	0.000027761	0.8902	0.0925	0	0	0.0508
199	62.5184	-0.000016044	1.1016	0.0667	0	0	0
200	62.4509	-0.000070841	1.0896	0.0675	0	0	0
201	62.4124	-6.8483E-07	1.016	0.0385	0	0	0
202	62.3988	0.000058313	0.8108	0.0643	0	0	0.0508
203	62.3377	-0.000069036	0.718	0.0612	0	0	0
204	62.3953	0.00012099	1.0683	0.0947	0	0	0.1524
205	62.3203	-0.000025793	1.12	0.075	0	0	0
206	62.2585	-0.000065671	1.2055	0.0619	0	0	0
207	62.2132	-0.000008309	1.063	0.0453	0	0	0
208	62.1652	-0.00002222	0.9388	0.048	0	0	0
209	62.1274	-0.000038333	1.3803	0.0378	0	0	0
210	62.0941	-1.1708E-06	1.215	0.0333	0	0	0

Scenario: 1986 Stormwater Recirculation Alternating Days

Day	Storage	Mass Balance	Evap Potential	Evap Actual	Trans Potential	Trans Actual	Precip
211	62.0607	-1.7152E-06	1.3319	0.0334	0	0	0
212	62.0281	-2.0276E-06	0.8897	0.0326	0	0	0
213	61.9946	-7.6991E-06	0.7616	0.0336	0	0	0
214	62.0965	0.00020933	1.1035	0.101	0	0	0.2032
215	62.3262	0.0002092	1.0244	0.1766	0	0	0.4064
216	62.3928	0.000051807	1.0212	0.2381	0	0	0.3048
217	62.2607	-0.00008587	1.2124	0.1323	0	0	0
218	62.2406	0.000029394	0.7003	0.1216	0	0	0.1016
219	62.169	-9.8782E-06	1.1267	0.0716	0	0	0
220	62.1032	-0.000022238	0.8303	0.0658	0	0	0
221	62.0564	-0.00004697	0.7931	0.0469	0	0	0
222	62.0211	-2.2882E-06	0.8542	0.0352	0	0	0
223	61.9911	-1.0899E-06	0.8045	0.03	0	0	0
224	61.958	-5.1178E-06	0.8584	0.0331	0	0	0
225	61.9255	6.6993E-06	0.9978	0.0579	0	0	0.0254
226	61.8927	-0.000044848	0.519	0.0329	0	0	0
227	61.8689	-8.9906E-07	0.9087	0.0237	0	0	0
228	61.8452	-7.5349E-07	1.0113	0.0237	0	0	0
229	61.8159	-8.6233E-06	1.0371	0.0293	0	0	0
230	61.7858	-0.000019295	1.1299	0.0302	0	0	0
231	61.7583	-0.000034332	1.0445	0.0274	0	0	0
232	61.7313	-3.8315E-06	1.0998	0.027	0	0	0
233	61.7111	-1.1734E-06	0.987	0.0202	0	0	0
234	63.0845	-0.0015719	0.7538	0.1088	0	0	1.4986
235	63.5101	0.000040569	0.5833	0.4608	0	0	0.8864
236	63.2493	-0.000118	0.5334	0.2609	0	0	0
237	63.1859	-3.8909E-06	0.8792	0.0634	0	0	0
238	65.2153	0.00024623	0.6461	0.1293	0	0	2.159
239	67.326	-0.000008332	0.4133	0.1818	0	0	2.2925
240	67.9076	0.000013484	0.0838	0.0787	0	0	0.6604
241	67.5067	-0.000041182	0.5076	0.4771	0	0	0.0762
242	67.4952	0.000028235	0.8638	0.2909	0	0	0.2794
243	67.9509	0.000083575	0.6087	0.2807	0	0	0.7366
244	69.4843	-0.00010111	0.4437	0.3464	0	0	1.8796
245	73.2764	-0.00057609	0.7747	0.3719	0	0	5.3233
246	72.7042	-0.000066789	0.5723	0.5723	0	0	0
247	75.8644	-0.012854	0.3809	0.1676	0	0	3.6462
248	75.1938	-0.00007455	0.6706	0.6706	0	0	0
249	76.1144	0.000056034	0.7475	0.3738	0	0	1.2944
250	75.9188	-8.1263E-06	0.2621	0.2464	0	0	0.0508
251	76.8723	0.000049878	0.6241	0.3121	0	0	1.2656
252	76.5209	-0.00012294	0.9658	0.3515	0	0	0

Scenario: 1986 Stormwater Recirculation Alternating Days

Day	Storage	Mass Balance	Evap Potential	Evap Actual	Trans Potential	Trans Actual	Precip
253	76.4344	4.8928E-06	1.0581	0.0864	0	0	0
254	76.35	2.4778E-06	1.1058	0.0844	0	0	0
255	76.2756	5.6564E-08	0.967	0.0744	0	0	0
256	76.2624	0.00010283	0.5109	0.1147	0	0	0.1016
257	76.1093	-0.000088336	0.3497	0.1532	0	0	0
258	76.0512	4.1644E-06	0.8377	0.058	0	0	0
259	75.9932	3.5256E-06	0.6747	0.058	0	0	0
260	75.9248	1.0037E-06	0.9658	0.0684	0	0	0
261	75.8547	-6.1769E-07	0.9913	0.07	0	0	0
262	75.7894	-9.7458E-07	1.1145	0.0653	0	0	0
263	75.7282	-7.8876E-07	1.0868	0.0612	0	0	0
264	75.6728	-2.6421E-07	0.7835	0.0554	0	0	0
265	75.9149	0.00018722	0.2251	0.0625	0	0	0.3048
266	76.4761	0.00017991	0.3146	0.1752	0	0	0.7366
267	76.2471	-0.00011603	0.9637	0.2292	0	0	0
268	76.1637	-6.2471E-06	1.1457	0.0834	0	0	0
269	76.0834	-3.9004E-06	1.0574	0.0802	0	0	0
270	76.0093	-2.9729E-06	1.0073	0.0742	0	0	0
271	75.9475	-1.4175E-06	0.5797	0.0618	0	0	0
272	76.0061	0.0001174	0.7148	0.1444	0	0	0.2032
273	75.8824	-0.000077922	0.886	0.1238	0	0	0
274	75.7969	-0.000015657	0.9366	0.0855	0	0	0
275	75.9318	0.00014833	0.1543	0.0428	0	0	0.1778
276	75.8144	-0.000081814	0.7917	0.1175	0	0	0
277	75.7425	-0.00001398	0.8314	0.0719	0	0	0
278	76.0725	0.00018177	0	0	0	0	0.3302
279	76.1717	0.000029868	0.0836	0.0786	0	0	0.1778
280	76.0334	-0.000093535	0.7216	0.1384	0	0	0
281	75.9714	-3.9661E-06	0.7198	0.062	0	0	0
282	77.3974	0.00038885	0.2442	0.0722	0	0	1.4986
283	83.485	-0.013091	0.0909	0.0572	0	0	9.3578
284	84.7363	0.000039626	0.1085	0.0542	0	0	1.3056
285	85.9465	0.000052186	0.1171	0.0585	0	0	1.2688
286	85.4586	-0.00013861	0.762	0.4881	0	0	0
287	86.4377	0.00015959	0.6758	0.2607	0	0	1.24
288	86.0555	-0.00012618	0.7235	0.3824	0	0	0
289	87.1716	0.000098465	0.2908	0.1454	0	0	1.2616
290	87.1771	0.000026359	0.6932	0.4517	0	0	0.4572
291	88.1716	0.000042629	0.5916	0.2958	0	0	1.2904
292	88.0307	-0.000013776	0.141	0.141	0	0	0
293	88.9216	0.000063162	0.0555	0.0494	0	0	0.9404
294	90.7078	-0.00018097	0.5124	0.4238	0	0	2.2098

Scenario: 1986 Stormwater Recirculation Alternating Days

Day	Storage	Mass Balance	Evap Potential	Evap Actual	Trans Potential	Trans Actual	Precip
295	91.6087	0.000028783	0.7085	0.3542	0	0	1.2552
296	91.1809	-0.000039275	0.4278	0.4278	0	0	0
297	90.8934	-0.000039135	0.2876	0.2876	0	0	0
298	90.7468	-0.000089169	0.4934	0.1467	0	0	0
299	90.6778	3.8937E-06	0.6068	0.069	0	0	0
300	90.6011	5.3732E-06	0.6715	0.0766	0	0	0
301	90.5204	0.000010468	0.741	0.0807	0	0	0
302	90.4641	0.000017197	0.2589	0.0563	0	0	0
303	90.4031	0.000012283	0.5145	0.0609	0	0	0
304	90.3382	9.6929E-06	0.6919	0.0649	0	0	0
305	90.2836	0.000048955	0.0546	0.0546	0	0	0
306	92.0613	0.00024024	0	0	0	0	1.778
307	95.0224	-0.0052579	0	0	0	0	2.9892
308	95.2137	0.000018848	0.1748	0.1643	0	0	0.3556
309	96.0384	0.000030885	0.5028	0.2967	0	0	1.1214
310	95.6288	-0.00011984	0.6655	0.4097	0	0	0
311	95.5431	0.000012407	0.6445	0.0857	0	0	0
312	95.4578	0.000014111	0.6683	0.0853	0	0	0
313	95.3775	8.5349E-06	0.5922	0.0803	0	0	0
314	95.3114	0.000010824	0.3735	0.0661	0	0	0
315	95.2481	0.000010723	0.5232	0.0633	0	0	0
316	95.1605	0.000043175	0.0875	0.0875	0	0	0
317	95.4708	0.000095365	0.021	0.0198	0	0	0.3302
318	95.2646	-0.00010065	0.5091	0.2064	0	0	0
319	95.2031	0.000051833	0.0614	0.0614	0	0	0
320	95.0763	-0.000077894	0.2433	0.1269	0	0	0
321	95.0065	0.000011268	0.609	0.0698	0	0	0
322	94.9426	0.000012986	0.2946	0.0638	0	0	0
323	94.9558	0.000093791	0.712	0.1391	0	0	0.1524
324	94.8526	-0.000055663	0.704	0.1032	0	0	0
325	94.7993	0.000010955	0.5449	0.0533	0	0	0
326	94.7306	0.000027273	0.5906	0.0687	0	0	0
327	94.8551	0.00015687	0.188	0.0531	0	0	0.1778
328	94.748	-0.000066982	0.4545	0.1066	0	0	0
329	94.6777	0.000010175	0.4254	0.0587	0	0	0
330	94.5661	-0.000014891	0.5388	0.0717	0	0	0
331	94.4258	-0.000012588	0.494	0.0632	0	0	0
332	94.2532	-0.000063352	0.4729	0.0593	0	0	0
333	94.0692	-3.1737E-06	0.5258	0.0404	0	0	0
334	93.8574	-7.6819E-06	0.7754	0.0456	0	0	0
335	93.6375	-4.3761E-06	0.4926	0.0378	0	0	0
336	93.4018	-0.000013833	0.5589	0.0434	0	0	0

Scenario: 1986 Stormwater Recirculation Alternating Days

Day	Storage	Mass Balance	Evap Potential	Evap Actual	Trans Potential	Trans Actual	Precip
337	93.1694	-4.6299E-06	0.406	0.034	0	0	0
338	92.9673	0.000025148	0.0006	0.0006	0	0	0
339	92.7235	-0.000064332	0.199	0.0417	0	0	0
340	92.5083	-0.000013285	0.0455	0.0138	0	0	0
341	92.2732	-0.000037393	0.0803	0.0355	0	0	0
342	92.424	0.00031094	0.1053	0.0329	0	0	0.381
343	92.2302	-1.5298E-06	0	0	0	0	0
344	92.4267	0.0001319	0.0745	0.07	0	0	0.4572
345	92.0417	-0.0001103	0.3839	0.1983	0	0	0
346	91.7994	-6.9803E-06	0.3933	0.0592	0	0	0
347	91.5698	-5.3066E-06	0.4302	0.0503	0	0	0
348	91.3438	-5.6785E-06	0.4935	0.0505	0	0	0
349	91.1117	-0.000010545	0.4438	0.0603	0	0	0
350	91.1263	0.00012884	0.0217	0.0203	0	0	0.2032
351	91.622	0.00017121	0	0	0	0	0.6604
352	91.6186	0.000025259	0.1026	0.0964	0	0	0.254
353	91.2223	-0.00011361	0.2573	0.2388	0	0	0
354	91.0132	-5.4118E-06	0.2786	0.055	0	0	0
355	91.4227	0.00022844	0.1064	0.0997	0	0	0.6604
356	92.3925	0.000041803	0	0	0	0	1.1176
357	92.332	-3.9977E-06	0.1705	0.1535	0	0	0.2377
358	92.1381	-0.000010545	0.0521	0.0521	0	0	0
359	91.8152	-0.000028561	0.184	0.184	0	0	0
360	91.5565	-0.000087069	0.4406	0.1226	0	0	0
361	91.3683	-3.6881E-06	0.3627	0.0547	0	0	0
362	91.1895	-3.4491E-06	0.2909	0.048	0	0	0
363	90.9979	-5.2182E-06	0.5111	0.0633	0	0	0
364	90.8053	-5.9224E-06	0.3965	0.0667	0	0	0
365	90.6139	-7.1134E-06	0.4459	0.0679	0	0	0

Permit Renewal Application
October 17, 2011

Attachment M

Construction Quality Assurance Plan

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Table of Contents

Section **Page**

Table of Contents (Continued)

Section **Page**

Table of Contents (Continued)

Section **Page**

Table of Contents (Continued)

Section **Page**

Table of Contents (Continued)

Section **Page**

Table of Contents (Continued)

Table of Contents (Continued)

Section **Page**

List of Figures

Figure **Page**

List of Tables

Table **Page**

List of Tables (Continued)

Table **Page**

List of Appendices

Appendix

Section I. General

I.1 Introduction

Triassic Park Waste Disposal Facility will consist of waste receiving facilities, a RCRA-compliant hazardous waste landfill, a stormwater control system including a lined stormwater detention basin, and access roadways. ~~, evaporation pond, stabilization facility drum handling facility, liquid waste storage area, truck roll-off area and truck wash.~~ This Construction Quality Assurance (CQA) plan is intended to be used in conjunction with the design drawings and construction specifications for the Triassic Park Waste Disposal Facility.

The CQA Plan addresses the construction quality assurance of the soils, geosynthetics, and related liner system components for the facilities listed above at the Triassic Park Facility. The CQA Plan is divided into the following sections:

- Section I: General;
- Section II: Soils CQA;
- Section III: Geosynthetic Clay Liner CQA;
- Section IV: Geomembrane CQA;
- Section V: Geotextile CQA;
- Section VI: Geocomposite CQA;
- Section VII: Geonet CQA;
- Section VIII: Polyethylene Pipe and Fittings CQA;
- Section IX: ADS Slotted CPT CQA;
- Section X: Corrugated Metal Pipe CQA;
- Section XI: Carbon Steel and Stainless Steel Pipe CQA;
- Section XII: Polyethylene Tank CQA;
- ~~Section XIII: Stabilization Bins CQA;~~
- Section XIV: Concrete Formwork CQA;
- Section XV: Reinforcement Steel CQA;
- Section XVI: Joints in Concrete CQA;
- Section XVII: Miscellaneous Metalwork CQA;
- Section XVIII: Cast in Place Concrete CQA
- Section XIX: Electrical System and Pump Control CQA;
- Section XX: Pumps, Piping, Meters, and Valve CQA; and
- Section XXI: CQA Documentation.

The facility will not accept waste until NMED has approved the CQA certification report.

I.2 Definitions Relating to Construction Quality Assurance

I.2.1 Construction Quality Assurance and Construction Quality Control

The CQA Plan is a site-specific document which addresses the following: (i) CQA personnel responsibilities, authorities, and qualifications; (ii) inspection, monitoring, and testing activities necessary to document that the facility is constructed to meet or exceed design criteria, plans, and specifications; and (iii) CQA documentation requirements.

Construction Quality Assurance (CQA) - A planned and systematic pattern of the means and actions designed to provide adequate confidence that items or services meet contractual and regulatory requirements, and will perform satisfactorily in service.

Construction Quality Control (CQC) -Those actions which provide a means to measure and control the characteristics of an item or service to meet contractual and regulatory requirements.

I.2.2 Use of the Terms in This Plan

In the context of this document:

- Construction Quality Assurance (CQA) refers to means and actions employed by the CQA Engineer to assure conformity of liner system preparation, production, and installation with this CQA Plan, the General Specifications, and the Construction Drawings. CQA is provided by a party independent from the product Manufacturer and Contractor.

- Construction Quality Control (CQC) refers to those actions taken by Manufacturers, Suppliers, Contractors, or Owners, including their designated representatives, to ensure that the materials and the workmanship meet the requirements of the General Specifications, and the Construction Drawings. In the case of soils, and within this CQA Plan, CQC is typically made a part of the CQA requirements and is provided by the CQA Engineer. In the case of geosynthetic and other non soil components, CQC is provided by the Manufacturers and installers of the various geosynthetics.

I.3 Parties to Construction Quality Assurance

I.3.1 Organization Chart

A typical project organization chart for construction of the landfill~~s, surface impoundments~~ and associated facilities is provided in Figure I-1[AK1].

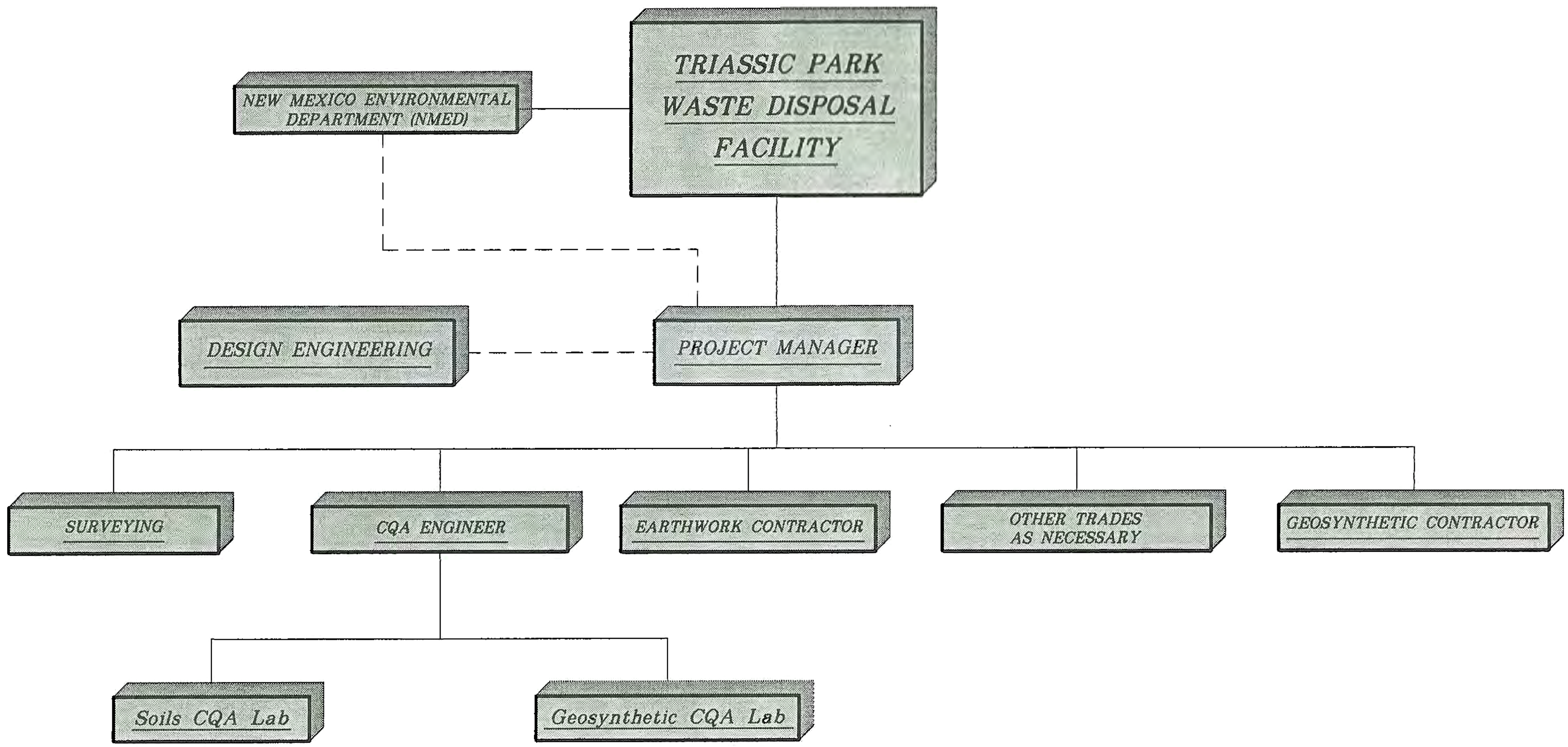
I.3.2 Description of the Parties

I.3.2.1 Design Engineer

The Design Engineer is the individual, firm or corporation having direct responsibility for the design of the landfill or surface impoundment structure. During construction, the Design Engineer must approve any significant deviation from the design requirements of the Contract Documents. The Design Engineer may be an employee of the Owner. An individual representing the Design Engineer directly responsible for the project must be registered as a Professional Engineer in the State of New Mexico.

I.3.2.2 Contractor

The individual, firm, or corporation undertaking the execution of the work under the terms of the Contract Documents. The Contractor may be responsible for constructing the entire liner system (earthwork and geosynthetics), or only selected components of the liner system. The reference to Contractor refers to the General Contractor and all subcontractors which the General Contractor may employ in meeting the requirements of the Contract Documents.



REV. No.	REVISIONS	DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	TECH LAW REVIEW COPY	4/24/00	J.Pellicer	J.Bever	J.Pellicer

TerraMatrix
MONTGOMERY WATSON
Mining Group

PROJECT No: 602-0200
AutoCAD FILE: TPORG-TECHLAW-1
SCALE: Not to Scale
FIGURE No: I-1

Triassic Park Waste Disposal Facility

TYPICAL PROJECT ORGANIZATION

I.3.2.3 Drainage Gravel Supplier

The drainage gravel supplier excavates (or manufactures) and delivers drainage gravel to the Contractor at the Triassic Park Facility.

I.3.2.4 Road Base Material Supplier

The road base supplier excavates (or manufactures) and road base material to the Contractor at the Triassic Park Facility.

I.3.2.5 Select Subbase Supplier

The select subbase supplier excavates (or manufactures) and delivers select subbase to the Contractor at the Triassic Park Facility.

I.3.2.6 Resin Supplier

The resin supplier produces and delivers resin to the manufacturer of geosynthetic materials or polymer based products such as pipe.

I.3.2.7 Manufacturer

The Manufacturer manufactures a specific component (e.g., geomembrane, geosynthetic clay liner, geotextile, geocomposite, geonet or pipe) of the proposed liner system and delivers the component to the Contractor at the site. In the General Specifications, the term Manufacturer may refer to the geomembrane Manufacturer, geotextile Manufacturer, geocomposite/geonet Manufacturer, GCL Manufacturer, or pipe Manufacturer.

I.3.2.8 Construction Quality Assurance Engineer

The CQA Engineer is an individual, firm, or corporation, independent from the Owner, Contractor, and Manufacturer, that observes, tests, and documents activities related to the CQA of the earthworks at the site, and observes, tests, and documents activities related to the CQA of the installation of the geosynthetic components of the liner system. The CQA Engineer observes, tests, and documents activities related to the CQA of pipes and other liner system components. The CQA Engineer must provide an engineer which directly manages the CQA activities who is a Professional Engineer registered in the State of New Mexico. The CQA Engineer may be the same as the Design Engineer, but must be independent from the Owner.

I.3.2.9 Soils Construction Quality Assurance Laboratory

The Soils CQA Laboratory is independent from the Owner, Gravel Supplier, Granular Material Supplier, and Contractor. The Soils CQA Laboratory conducts tests in the laboratory (which may be on-site or off-site) on samples of soil taken from the borrow pits, stockpiles, or the liner system.

I.3.2.10 Geosynthetic CQA Laboratory

The Geosynthetics CQA Laboratory is independent from the Owner, Resin Supplier, Manufacturer, and Contractor. The Geosynthetics CQA Laboratory conducts tests on samples of geosynthetics taken from the site. The Geosynthetics CQA Laboratory may also conduct tests on pipes or other liner system components. The Geosynthetics CQA Laboratory service cannot be provided by any party involved with the manufacture or installation of any of the geosynthetic components.

I.3.2.11 Owner

The Owner owns and operates the landfill or surface impoundment. In this CQA Plan, the term "Owner" refers specifically to the Triassic Park Waste Disposal Facility.

I.3.3 Qualifications of the Parties

I.3.3.1 Design Engineer

The representative of the Design Engineer, who is directly responsible for the project, will be a qualified Professional Engineer registered in the State of New Mexico. The Design Engineer will have a history which demonstrates familiarity with all liner system components, including detailed design methods and procedures.

I.3.3.2 Geomembrane Installer

The Geomembrane Installer (who may be either the Contractor or a subcontractor to the Contractor) will be trained and qualified to install geosynthetics, as well as other liner system components such as pipe, if necessary.

All personnel performing seaming operations will be qualified by experience (i.e., each seamer will have installed no less than 100,000 square feet of geomembrane using the same methods of seaming that will be used on this project). At least one seamer will have experience seaming a minimum of 1,000,000 square feet of geomembrane using the same method of seaming that will be used on this project. The most experienced seamer, the "master seamer", will provide direct supervision, as required, over less experienced seamers. Field seaming may not take place without an approved master seamer being present.

The Contractor will provide the Owner and CQA Engineer with a list of proposed seaming personnel and their professional records. Any proposed seaming personnel deemed insufficiently experienced will not be accepted by the Owner or will be required to pass a seaming test prior to working on the Project.

I.3.3.3 Construction Quality Assurance Engineer Personnel

Personnel representing the CQA Engineer shall be properly trained and qualified to test and inspect soils, including high and low permeability soils, geosynthetics, including geomembranes, geotextiles, geocomposites, GCLs, and pipe. The CQA Engineer will predominately be represented by a Resident Engineer who has direct responsibility for management of the CQA activities. The CQA Resident Engineer will be experienced in construction, CQA of soils; CQA of geosynthetics and pipe; and preparation of CQA documentation including CQA forms, reports, and plans.

As a minimum, CQA Monitors will have a high school diploma and at least two years of construction related experience and one year of experience conducting CQA monitoring for landfill construction involving both soil and geosynthetic components, or a Bachelor of Science degree from a four year college or university and one year of experience conducting CQA monitoring for landfill construction involving both soil and geosynthetic components. In addition, the lead CQAMs shall be certified in geosynthetic by the National Institute for Certification in Engineering Technologies (NICET). The number of NICET certified monitors assigned to the work shall comply with the recommendation of the U.S. Environmental Protection Agency (EPA) as indicated in Table I-1.

Qualification of CQA Personnel shall be documented by training records and professional résumés, and shall be reviewed by the Project Manager.

Table I-1. Recommended Implementation Program for Construction Quality Assurance for Geosynthetics

No. of Field Crews at Each Site [a]	End of 18 Months ~~(i.e., June 30, 1994)~~	End of 36 Months ~~(i.e., January 1, 1996)~~
1–2	1 - Level II	1 - Level III [b]
3–4	1 - Level II	1 - Level III [b]
	1 - Level I	1 - Level I
≥5	1 - Level II	1 - Level III [b]
	2 - Level I	1 - Level II
		1 - Level I

Source: ~~EPA~~U.S. EPA Technical Guidance Document: Quality Assurance and Quality Control for Waste Containment Facilities. EPA/600/R-93/182, September 1993.

Note: Certification for natural materials is under development as of this writing.

[a] Performing a critical operation; typically 4–6 people per crew.

[b] Or PE with applicable experience

I.3.3.4 Soils Construction Quality Assurance Laboratory

The Soils CQA Laboratory will have experience with the physical testing of soils, meet all applicable regulatory requirements, and be familiar with ASTM and other required test standards. The Soils CQA Laboratory will be capable of providing test results in accordance with the specifications.

I.3.3.5 Geosynthetics Construction Quality Assurance Laboratory

The Geosynthetics CQA Laboratory will have experience in testing geosynthetics and other relevant liner system components and be familiar with ASTM and other applicable test standards.

I.3.4 Duties of Construction Quality Assurance Engineer

The overall responsibility of the CQA Engineer is to perform those activities specified in the CQA Plan (e.g., inspection, sampling, testing and documentation final certification). At a minimum, the CQA Engineer will be represented by a CQA Resident Engineer and the necessary supporting CQA inspection personnel. Specific responsibilities of the CQA Resident Engineer may include:

- Reviewing design criteria, plans, and specifications for clarity and completeness so that the CQA Plan can be implemented.
- Educating CQA personnel on CQA requirements and procedures.
- Scheduling and coordinating CQA activities.
- Directing and supporting the CQA personnel in performing observations and tests by:
  - confirming that regular calibration of testing equipment is properly conducted and recorded;
  - confirming that the testing equipment, personnel, and procedures do not change adversely over time and verifying that changes do not adversely impact the inspection process;
  - confirming that the test data are accurately recorded and maintained; and
  - verifying that the raw data are properly recorded, validated, reduced, summarized, and interpreted.

- Providing to the Owner reports on the observation results including:
  - review and interpretation of data sheets and reports;
  - identification of work that the CQA Resident Engineer believes should be accepted, rejected, or uncovered for observation, or that may require special testing, observation, or approval; and
  - rejection of defective work and verification that corrective measures are implemented.

- Verifying that the Contractor's construction quality control plan, if required, is in accordance with the site specific CQA Plan
- At the Owner's request, reporting to the Contractor results of observations and tests as the work progresses and interacting with the Contractor to provide assistance in modifying the materials and work to comply with the specified design
- Providing the final report and certifications required by the CQA Plan.

For the supporting CQA personnel, specific responsibilities may include:

- Performing independent on-site observation of the work in progress to verify conformance with the facility design criteria, plans and specifications;
- Verifying that the equipment used in testing meets the test requirements and that the tests are conducted according to the standardized procedures defined by the CQA plan; and
- Reporting to the CQA Resident Engineer results of all observation including work that is not of acceptable quality or that fails to meet the specified design.

I.4 Scope of Construction Quality Assurance

The scope of this CQA Plan includes the CQA of the subgrade, preparation and soil, pipe, concrete and geosynthetic components of the liner and cover system. This CQA Plan does not address design guidelines, installation specifications, or selection of soils, geosynthetics, pipe or other liner system components, which are all described in the General Specifications.

The CQA Plan does not provide for Construction Quality Control which the Contractor may independently undertake to facilitate the Contractor's achieving his requirements under the General Specifications.

I.5 Units

In this CQA Plan, all properties and dimensions are expressed in customary U.S. units.

I.6 References

I.6.1 Applicable Organizations

Organizations whose standards are referenced in the CQA Plan and the General Specifications are as follows:

- NMDOT~~SH~~ - New Mexico Department of Transportation~~State Highway and Transportation Department of Highways~~ (Standard Specifications for Road and Bridge Construction);
- ASTM - American Society for Testing and Materials;

- GRI - Geosynthetic Research Institute;
- OSHA - Occupational Safety and Health Administration; and
- U.S. EPA - United States Environmental Protection Agency.

I.6.2 Applicable Standards

Any reference to standards of any society, institute, association, or governmental agency will pertain to the edition in effect as of the date of this CQA Plan, unless stated otherwise.

I.6.3 Specific Standards

Specific test standards which may be cited in the CQA Plan and the General Specifications are given in Table I-2. These standards may be modified due to technological advances since compilation of Table I-2. All such modifications are to be approved by the Owner.

Table I-2. Test Methods Cited in General Specifications and CQA Plan

Method Number	Title
American Society of Testing and Materials	
1. ASTM A 307	Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength
2. ASTM A 726	Standard Specification for Cold-Rolled Carbon Steel sheet, Magnetic Laminated Quality, types 1, 2, and 2S
3. ASTM C 88	Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate
4. ASTM C 131	Resistance to Degradation of Small-size coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
5. ASTM D 374C or D 1777	Method for Measuring Thickness of Geotextile Materials.
6. ASTM D 413	Standard Test Method for Rubber Property Adhesion to Flexible Substrate.
7. ASTM D 422	Standard Method for Particle-Size Analysis of Soils.
8. ASTM D 570	Standard Test Method for Water Absorption of Plastics.
9. ASTM D 638	Standard Test Method for Tensile Properties of Plastics.
10. ASTM D 698	Standard Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5.5-lb (2.49-kg) Rammer and 12-in. (305-mm) Drop.
11. ASTM D 746	Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
12. ASTM D 751	Standard Methods of Testing Coated Fabrics.
13. ASTM D 792	Standard Test Methods for Specific Gravity (Relative density) and Density of Plastics by Displacement.
14. ASTM D 882	Standard Test Methods for Tensile Properties of Thin Plastic Sheeting.
15. ASTM D 1004	Standard Test Method of Initial Tear Resistance of Plastic film and Sheeting.
16. ASTM D 1204	Standard Plastics Test Method for Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperature.
17. ASTM D 1238	Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer.
18. ASTM D 1248	Standard Specification for Polyethylene Plastic Molding and extrusion Metals.
19. ASTM D 1505	Standard Test Methods for Density of Plastics by Density-Gradient Technique.
20. ASTM D 1556	Standard Test Method for Density of Soil In Place by the Sand-Cone Method.
21. ASTM D 1593	Standard Specification for Nonrigid Vinyl Chloride Plastic Sheeting.
22. ASTM D 1603	Standard Test Method for Carbon Black in Olefin Plastics.

Table I-2. Test Methods Cited in General Specifications and CQA Plan (Continued)

Method Number	Title
American Society of Testing and Materials (cont.)	
23. ASTM D 2167	Standard Test Method for Density and Unit Weight of Soils in Place by Rubber Balloon Method.
24. ASTM D 2216 or D 4643	Standard Method for Laboratory Determination of water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures.
25. ASTM D 2434	Standard Test Method for Permeability of Granular Soils (Constant Head).
26. ASTM D 2487	Standard Test Method for Classification of Soils for Engineering Purposes.
27. ASTM D 2657	Standard Practice for Heat-Joining for Polyolefin Pipe and Fittings.
28. ASTM D 2663	Carbon-Black Dispersion in Rubber.
29. ASTM D 2837	Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials.
30. ASTM D 2922	Standard Test Method for Density of Soil and Soil-Aggregate In Place by Nuclear Methods (Shallow Depth).
31. ASTM D 3015	Recommended Practice for Microscopic Examination of Pigment Dispersion in Plastic Compounds.
32. ASTM D 3017	Standard Test Method for Moisture Content of Soil and Rock In Place by Nuclear Methods (Shallow Depth).
33. ASTM D 3083	Standard Specification for Flexible Poly (Vinyl Chloride) Plastic Sheeting for Pond, Canal, and Reservoir Lining.
34. ASTM D 3350	Standard Specifications for Polyethylene Plastic Pipe and Fittings Materials.
35. ASTM D 3776	Mass Per Unit Area (Weight) of Woven Fabric.
36. ASTM D 4253	Standard Test Method for Maximum Index Testing of Soils Using a Vibratory Table.
37. ASTM D 4254	Standard test Method for Minimum Index Density of Soils and Calculations of Relative Density.
38. ASTM D 4318	Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
39. ASTM D 4373	Standard Test Method for Calcium Carbonate Content of Soils.
40. ASTM D 4437	Standard Test Methods for Determining the Integrity of Field Seams Used in Joining Flexible Polymeric Geomembranes.
41. ASTM D 4491	Standard Test Method for Water Permeability of Geotextiles by the Permittivity Method.
42. ASTM D 4533	Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
43. ASTM D 4632	Standard Test Method for Breaking Load and Elongation of Geotextiles (Grab Elongation Method and Peel Strength).
44. ASTM D 4643	Determination of Water (Moisture) Content of Soil by the Microwave Oven Method.
45. ASTM D 4716	Standard Test Method for Constant Head Hydraulic Transmissivity (In-Plane Flow) of Geotextiles and Geotextile Related Products.
46. ASTM D 4751	Standard Test Method for Determining Apparent Opening Size of a Geotextile
47. ASTM D 4833	Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.
48. ASTM D 5084	Standard Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter.
49. ASTM D 5261	Measuring Mass Per Unit Area of Geotextile
50. ASTM D 5321	Coefficient of Soil and Geosynthetics or Geosynthetics and Geosynthetics Friction by Direct Shear.
51. ASTM D 5890	Standard Test Method for Swell Index of Clay Mineral Component of Geosynthetic Clay Liners.
52. ASTM 5891	Standard Test Method for Fluid Loss of Clay Component of Geosynthetic Clay Liners.
53. ASTM E 11	Specification for Wire-Cloth Sieves for Testing Purposes.
54. ASTM F 714	Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.
55. ASTM F 904	Standard Test Method for Comparison of Bond Strength or Ply Adhesion of Similar Laminates Made from Flexible Materials.

Table I-2. Test Methods Cited in General Specifications and CQA Plan (Continued)

Method Number		Title
Geosynthetic Research Institute		
1.	GRI-GMI	Standard Test Method for Ductile/Brittle Transition Time for Notched Polyethylene Specimen under Constant Stress.
United States Environmental Protection Agency		
1.	U.S. EPA 9090	Compatibility Test for Wastes and Membrane Liners.

Section II. Soils Construction Quality Assurance

II.1 Introduction

This section of the CQA Plan addresses the soils components of the liner and cover systems and specifies the soils CQA program to be implemented with regard to materials selection and evaluation, laboratory test requirements, field test requirements, and treatment of problems.

This section of the CQA Plan also addresses for construction of the foundation subgrade, clay liners, clay covers, granular drainage layers, sump and pipe bedding gravel, the protective soil layer, and cover soil.

II.2 Excavated Subgrade

II.2.1 Verification of Subgrade Continuity

When the excavation of the landfill or surface impoundment is completed, the CQA Engineer will:

- Inspect the subgrade on the side slopes and base of the landfill or surface impoundment and note areas of weak or excessively weathered subgrade materials; and

- Observe the proof rolling of the base of the landfill or surface impoundment and note areas that exhibit excessive rutting, heaving, or softening.

Backfill material in the excavation will be structural fill or clay liner material that will be placed and compacted. The CQA Engineer will observe any excavation and backfilling operations.

The CQA Engineer will report any problems or deviations from the above requirements to the Owner.

II.2.2 Structural Fill Placement and Compaction

The General Specifications will be followed for the placement and compaction of structural fill. The CQA Engineer will monitor the fill placement and compaction to verify and document the following:

- The soil being placed meets the General Specification requirements for fill as determined by the test methods and frequencies specified within this CQA Plan;
- The compacted lift thickness is in accordance with the requirements of the General Specifications;
- The previous lift is scarified as specified in the General Specifications before placing the next lift;
- Fill is moisture conditioned, as required in the General Specifications; and
- The compacted moisture content and dry unit weight of the fill meets specifications as determined by the test methods and frequencies described below.

II.2.3 Construction Quality Assurance Evaluation

The minimum frequency of soils testing for CQA purposes will conform to the minimum frequencies presented in Table II-1.

Table II-1. Minimum Frequency of Testing for CQA Evaluation of Structural Fill

Test	Frequency	Standard Test Method
Material Properties		
Modified Proctor	1 per 5,000 cy placed (minimum 1 per source)	ASTM D 1557
Sieve Analysis	1 per 5,000 cy placed (minimum 1 per source)	ASTM D 422
Atterberg Limits	1 per 5,000 cy placed (minimum 1 per source)	ASTM D 4318
IN PLACE		
Nuclear Density Meter (50 ft. Grid)		
In-Situ Moisture Content	1 per 2,500 ft^2 per lift	ASTM D 3017
In-Situ Dry Unit Weight	1 per 2,500 ft^2 per lift	ASTM D 2922
Calibration and Check		
Standard Count Calibration or Sandstone	1 per day of fill placement	ASTM D 1556/D2922
Oven Moisture Contents (In-Situ Moisture Content)	1 per day of fill placement	ASTM D 2216

Nuclear density meter test methods will be used for the field testing of the in-situ dry unit weight and moisture content of the in-place, compacted fill. Standard Count Calibration, Sand Cone tests and/or Rubber Balloon tests and oven moisture content tests will be conducted to calibrate the results of the nuclear density meter and in cases of uncertainty with the nuclear density meter test results. Any conflict over the test results will be resolved by the CQA Engineer and the Owner. All perforations in the fill will be backfilled in accordance with the General Specifications.

If an in-place density test result fails to meet specifications, a confirmatory test will be performed immediately adjacent to the failed test. If the confirmatory test meets or exceeds specifications then a second confirmatory test will be performed at a second location immediately next to the failed test. If the second confirmatory test also meets or exceeds specifications then the area will be declared as meeting project specifications and the confirmatory tests will be reported. In the event that either confirmatory test fails to meet specifications, then additional testing will be performed to identify the limits of the area that does not meet project specifications.

If a defective area is discovered in the fill, the CQA Engineer will determine the extent and nature of the defect. If the defect is indicated by an unsatisfactory test result, the CQA Engineer will determine the extent of the defective area by additional tests, observations, a review of records, or other means that the CQA Engineer deems appropriate. If the defect is related to adverse site conditions, such as excessively wet soils or surface desiccation, the CQA Engineer will define the limits and nature of the defect by testing or observation. After the extent and nature of a defect is determined, the CQA Engineer will notify the Owner, and verify that the deficiency is corrected by the Contractor before any additional work is performed in the area of the deficiency.

II.2.4 Surveying

A Professional Land Surveyor registered in the State of New Mexico will perform the CQA survey. The CQA Surveyor will independently survey the excavation to confirm that the grades and elevations in the field agree with those shown on the Construction Drawings. CQA Surveys will be conducted in accordance with the requirements described in Part 14 of Section II.

The results of the survey conducted by the CQA Surveyor will be compiled in a report signed by the CQA Surveyor and the CQA Engineer. The CQA Engineer and the Owner will review and approve the survey results before the next phase of the lining system is constructed.

II.3 Prepared Subgrade

II.3.1 Prepared Subgrade Placement and Compaction

The CQA Engineer will verify and document that the prepared subgrade is constructed to the elevations, grades, and thicknesses shown on the Construction Drawings, with material meeting the requirements of the General Specifications as determined by the test methods and frequencies specified within this CQA Plan.

Prior to the placement of the prepared subgrade, the CQA Engineer will verify and document that:

- All or an approved portion of the excavation are complete, and that a survey has been conducted to verify that the subgrade grades and elevations conform to the Construction Drawings;
- The subgrade meets specifications as determined by the test requirements of this CQA Plan;
- The surface of the subgrade is free of debris, wet and soft areas, ponded water, vegetation, mud, ice or frozen material; and
- If frozen subgrade material is encountered, it is removed and replaced in accordance with the General Specifications.

During placement and compaction of the prepared subgrade, the CQA Engineer will verify and document that:

- Close inspection of the placement and compaction of the prepared subgrade with earthmoving equipment is performed by the CQA Engineer;
- The prepared subgrade material meets the requirements of the General Specifications as determined by the CQA testing methods and frequency in Table II 2;
- The prepared subgrade is placed in accordance with the conditions and minimum requirements of the General Specifications;
- Each lift is compacted to the required thickness and minimum dry unit weight within the range of moisture contents established by the General Specifications as determined by the CQA testing methods and frequency in Table II 2;
- The Contractor uses the compaction equipment and the number of passes specified in the General Specifications;
- Perforations in the prepared subgrade at testing and sampling locations are backfilled in accordance with the General Specifications; and
- The CQA Engineer will document the properties of the prepared subgrade as determined by the test methods and frequency prescribed by this CQA Plan and will report any nonconformance with the General Specifications to the Owner.

Table II-2. Minimum Frequency of Testing for CQA Evaluation of Prepared Subgrade

Test	Frequency	Standard Test Method
Modified Proctor	1 per 250,000 SF	ASTM D 1557
IN PLACE		
Nuclear Density Meter (50 ft. Grid)		
In-Situ Moisture Content	1 per 2,500 ft^2 per lift	ASTM D 3017
In-Situ Dry Unit Weight	1 per 2,500 ft^2 per lift	ASTM D 2922
Calibration and Check		
Sand Cone (In-Situ Density)	1 per day of fill placement	ASTM D 1556
Oven Moisture Content (In-Situ Moisture Content)	1 per day of fill placement	ASTM D 2216
Material Properties		
Sieve Analysis	1 per 125,000 ft^2	ASTM D 422
Atterberg Limits	1 per 125,000 ft^2	ASTM D 4318

II.3.2 Construction Quality Assurance Evaluation

Construction quality assurance testing is required of the prepared subgrade, and the Contractor must take quality assurance testing into account when planning his construction schedule. Nuclear density meter test methods will be used for testing the in-situ compacted dry unit weight and moisture content of the materials. Standard Count Calibration, Sand Cone and/or Rubber Balloon tests and oven moisture content tests will be used to calibrate the reading of the nuclear density meter and in cases of uncertainty with the nuclear density meter readings. Any discrepancies between test results will be resolved by the CQA Engineer and the Owner. The CQA Engineer will conduct moisture, and density tests as specified in Table II-2.

The testing frequency during prepared subgrade construction may be increased or modified at the discretion of the CQA Engineer when visual observations of construction performance indicate potential problems.

During construction, the frequency of testing may be increased by the CQA Engineer during adverse weather conditions, if equipment breaks down, at the start and finish of grading, if the material fails to meet the requirements of the General Specifications, or the extent of the work area is reduced.

If an in-place density test result fails to meet specifications, a confirmatory test will be performed immediately adjacent to the failed test. If the confirmatory test meets or exceeds specifications then a second confirmatory test will be performed at a second location immediately next to the failed test. If the second confirmatory test also meets or exceeds specifications then the area will be declared as meeting project specifications and the confirmatory tests will be reported. In the event that either confirmatory test fails to meet specifications, then additional testing will be performed to identify the limits of the area that does not meet project specifications.

If a defective area is discovered in the prepared subgrade, the CQA Engineer will determine the extent and nature of the defect. If the defect is indicated by an unsatisfactory test result, the CQA Engineer will determine the extent of the defective area by additional tests, observations, a review of records, or other means that the CQA Engineer deems appropriate. If the defect is related to adverse site conditions, such as excessively wet soils or surface desiccation, the CQA Engineer will define the limits and nature of the defect by testing or observation. After the extent and nature of a defect is determined and has been remedied by the Contractor, the CQA Engineer will verify that the deficiency is corrected by retesting repaired areas before any additional work is performed by the Contractor in the area of the deficiency.

Based on the requirements of the General Specifications, the Contractor will be required to use all means necessary to protect all prior work, as well as all materials and completed work of other Sections. In the event of damage, the Contractor will be required to immediately make all repairs and replacements necessary. The CQA Engineer will verify and document that all damages are repaired.

II.3.3 Surveying

A Professional Land Surveyor registered in the State of New Mexico will perform the CQA surveys. The CQA Surveyor will independently survey the elevations and grades of the clay liner surfaces, and to confirm that the lines and elevations in the field agree with those shown on the Construction Drawings. CQA surveys will be conducted in accordance with the requirements described in Part 14 of Section II.

The results of the survey conducted by the CQA Surveyor will be compiled in a report signed by the CQA Surveyor and the CQA Engineer, and will be reviewed by the Owner. The owner and the CQA Engineer will approve the survey results before the next phase of the liner system (geomembrane installation) is constructed.

II.4 Clay Liners

II.4.1 Clay Liner Placement and Compaction

The CQA Engineer will verify and document that the clay liner is constructed to the elevations, grades, and thicknesses shown on the Construction Drawings, with material meeting the requirements of the General Specifications as determined by the test methods and frequencies specified within this CQA Plan.

Prior to the placement of the clay liner, the CQA Engineer will verify and document that:

- A test fill has been constructed with the proposed liner material and production scale equipment to confirm processing and placement procedures. In addition, field and laboratory testing shall be completed on the test fill to confirm clay placement specifications will achieve the specified permeability. A test fill plan is presented in Appendix A.
- All or an approved portion of the excavation are complete, and that a survey has been conducted to verify that the subgrade grades and elevations conform to the Construction Drawings;
- The subgrade meets specifications as determined by the test requirements of this CQA Plan;
- The surface of the subgrade is free of debris, wet and soft areas, ponded water, vegetation, mud, ice or frozen material; and
- If frozen subgrade material is encountered, it is removed and replaced in accordance with the General Specifications.

During placement and compaction of the clay liner, the CQA Engineer will verify and document that:

- Close observation of the placement and compaction of clay liner material with earthmoving equipment is performed by the CQA Engineer;
- The clay liner material meets the requirements of the General Specifications as determined by the CQA testing methods and frequency in Table II 3;
- The clay liner is placed in accordance with the conditions and minimum requirements of the General Specifications;

- Each lift is compacted to the required thickness and minimum dry unit weight within the range of moisture contents established by the General Specifications as determined by the CQA testing methods and frequency in Table II 3;
- The Contractor uses the compaction equipment and the number of passes specified in the General Specifications;
- Thin-walled (i.e., Shelby tube) samples of clay liner material are collected and laboratory permeability testing is performed at the frequency specified in Table II-3;
- Perforations in the clay liner at testing and sampling locations are backfilled in accordance with the General Specifications; and
- Excessive wrinkles in the geosynthetic components underlying the clay have been "worked" out.

The CQA Engineer will document the properties of the clay soil as determined by the test methods and frequency prescribed by this CQA Plan and will report any nonconformance with the General Specifications to the Owner.

Table II-3. Minimum Frequency of Testing for CQA Evaluation of Clay Liner

Test	Frequency	Standard Test Method
Material Properties		
Recompacted Permeability (moisture content and dry density inside placement window)	1 per 5,000 cy placed (minimum 1 per source)	ASTM D 5084
Sieve Analysis	1 per 1,053 cy placed (minimum 1 per source)	ASTM D 422
Atterberg Limits	1 per 1,053 cy placed (minimum 1 per source)	ASTM D 4318
Compaction	1 per 5,263 cy placed (minimum 1 per source)	ASTM D 1557
IN PLACE		
Lift Thickness Before Compaction	1 per 2,500 ft^2 per lift	Field Measurement
Nuclear Density Meter[1] (50 ft. Grid)		
In-Situ Moisture Content	5/ac/lift	ASTM D 3017
In-Situ Dry Unit Weight	5/ac/lift	ASTM D 2922
Calibration and Check		
Sand Cone or Rubber Balloon (In-Situ Density)	1 per 20 nuclear densities	ASTM D 1556/D 2167
Oven Moisture Contents (In-situ Moisture Content)	1 per 10 nuclear moisture	ASTM D 2216
Permeability		
Shelby tube Samples	1/acre/lift	ASTM D 5084

II.4.2 Construction Quality Assurance Evaluation

Extensive construction quality assurance testing is required of the clay liners, and the Contractor must take quality assurance testing into account when planning his construction schedule. Nuclear density meter test methods will be used for testing the in-situ compacted dry unit weight and moisture content of the clay materials. Standard Count Calibration, Sand Cone and/or Rubber Balloon tests and oven moisture content tests will be used to calibrate the reading of the nuclear density meter and in cases of uncertainty with the nuclear density meter readings. Any discrepancies between test results will be resolved by the CQA Engineer and the Owner. Thin-walled (i.e., Shelby) tube samples will be collected for hydraulic conductivity testing. At the request of the CQA Engineer, on-site construction equipment operated by the Contractor will be used to slowly push the sample tube through the clay layer. The CQA Engineer will conduct moisture, density, and hydraulic conductivity tests as specified in Table II-3.

The testing frequency during clay liner construction may be increased or modified at the discretion of the CQA Engineer when visual observations of construction performance indicate potential problems or when field experience with the proposed soil liner material have been obtained.

During construction, the frequency of testing may be increased by the CQA Engineer during adverse weather conditions, if equipment breaks down, at the start and finish of grading, if the material fails to meet the requirements of the General Specifications, or the extent of the work area is reduced.

All perforations in the clay liner at nuclear density test probe locations will be backfilled by the CQA Engineer with clay liner material and compacted by hand tamping. All perforations at sand cone or rubber balloon test locations, Shelby tube sample locations, and test pit locations will be backfilled by the Contractor with clay liner material and compacted in accordance with the specifications for clay liner.

If an in-place density test results fail to meet specifications, a confirmatory test will be performed immediately adjacent to the failed test. If the confirmatory test meets or exceeds specifications then a second confirmatory test will be performed at a second location immediately next to the failed test. If the second confirmatory test also meets or exceeds specifications then the area will be declared as meeting project specifications and the confirmatory tests will be reported. In the event that either confirmatory test fails to meet specifications, then additional testing will be performed to identify the limits of the area that does not meet project specifications.

If a defective area is discovered in the clay liner, the CQA Engineer will determine the extent and nature of the defect. If the defect is indicated by an unsatisfactory test result, the CQA Engineer will determine the extent of the defective area by additional tests, observations, a review of records, or other means that the CQA Engineer deems appropriate. If the defect is related to adverse site conditions, such as excessively wet soils or surface desiccation, the CQA Engineer will define the limits and nature of the defect by testing or observation. After the extent and nature of a defect is determined and has been remedied by the Contractor, the CQA Engineer will verify that the deficiency is corrected by retesting repaired areas before any additional work is performed by the Contractor in the area of the deficiency.

Based on the requirements of the General Specifications, the Contractor will be required to use all means necessary to protect all prior work, as well as all materials and completed work of other Sections. In the event of damage, the Contractor will be required to immediately make all repairs and replacements necessary. The CQA Engineer will verify and document that all damages are repaired.

II.4.3 Surveying

A Professional Land Surveyor registered in the State of New Mexico will perform the CQA surveys. The CQA Surveyor will independently survey the elevations and grades of the clay liner surfaces, and to confirm that the lines and elevations in the field agree with those shown on the Construction Drawings. CQA surveys will be conducted in accordance with the requirements described in Part 14 of Section II.

The results of the survey conducted by the CQA Surveyor will be compiled in a report signed by the CQA Surveyor and the CQA Engineer, and will be reviewed by the Owner. The Owner and the CQA Engineer will approve the survey results before the next phase of the liner system (geomembrane installation) is constructed.

II.5 Drainage Gravel

II.5.1 Supplier

The Contractor will require that the drainage gravel Supplier provide the CQA Engineer with quality control test results and a written certification signed by a responsible party of the Supplier that the tests required by the General Specifications have been performed on the material to be delivered to the site.

The CQA Engineer will examine the tests results and report any deviations to the Owner. If the drainage gravel supplier cannot provide test results required by the general specifications, then the CQA Engineer may perform or arrange to perform the tests.

II.5.2 Conformance Evaluation

The test methods and frequency for CQA conformance testing of the drainage gravel are specified in Table II-4.

If the material fails to meet the requirements of the General Specifications, the CQA Engineer will perform sufficient sampling and testing to identify the extent of the nonconforming material at the expense of the Contractor. Nonconforming material will be removed from the site.

Table II-4. Minimum Frequency of Testing for CQA Evaluation of Drainage Gravel

Test	Frequency	Standard Test Method
Material Properties		
Sieve Analysis	1 per 500 cy placed (minimum 1 per source)	ASTM D 422
Permeability	1 per source	ASTM D 2434

II.5.3 Placement and Compaction

The CQA Engineer will verify and document that the drainage gravel is constructed to the elevations, grades, and thicknesses shown on the Construction Drawings, with material meeting the requirements of the General Specifications as determined by the test methods and frequencies specified within this CQA Plan.

Prior to the placement of the drainage gravel, the CQA Engineer will verify and document that:

- The underlying geosynthetic layers are free of holes, tears, excessive wrinkles, or foreign objects; and
- All work on underlying layers is complete and accepted by the Owner.

During placement and compaction of the drainage gravel, the CQA Engineer will verify and document that:

- Drainage gravel material satisfies the requirements of the General Specifications as determined by the testing prescribed within the CQA Plan;
- Drainage gravel material is spread before 12:00 noon, unless otherwise approved by the Owner;
- The equipment wheel ground pressure versus the material thickness requirements given in the General Specifications are complied with;

- The drainage gravel is placed in a manner so that the maximum material drop height is in accordance with the General Specifications;
- Close observation of the placement and compaction of drainage gravel with earth moving equipment is performed; and
- The drainage gravel is compacted utilizing the equipment and number of passes specified in the General Specifications.

II.5.4 Construction Quality Assurance Evaluation

No density tests will be conducted on the drainage gravel. If the CQA Engineer suspects damage to pipes or underlying geosynthetic, the contractor will be required to expose the potentially damaged materials and repair any observed damage.

II.5.5 Surveying

A Professional Land Surveyor registered in the State of New Mexico will perform CQA surveys. The CQA surveyor will independently survey the elevations and grades of the top of the drainage gravel, and to confirm that the grades and elevations in the field agree with those shown on the Construction Drawings. The CQA surveys will be performed in accordance with the requirements described in Part 14 of Section II.

The results of the survey conducted by the CQA Surveyor will be compiled in a report signed by the CQA Surveyor and the CQA Engineer, and will be reviewed by the Owner. The Owner and CQA Engineer will approve the survey results before the next phase of the lining system is constructed.

II.6 Road Base

II.6.1 Supplier

The Contractor will provide the CQA Engineer with quality control test results and a written certification signed by a responsible party of the road base Supplier that the tests required by the General Specifications have been performed on material representative of that which is to be delivered to the site.

The CQA Engineer will examine the tests results and report any deviations from the General Specifications to the Owner. If the road base Supplier cannot provide test results required by the General Specifications, then the CQA Engineer may perform or arrange to perform the tests.

II.6.2 Conformance Evaluation

The test methods and frequency for CQA testing of the road base is specified in Table II 5.

If the gravel fails to meet the requirements of the General Specifications, the CQA Engineer will perform sufficient sampling and testing to identify the extent of the nonconforming material with the cost of such tests borne by the Contractor. Nonconforming material will be removed from the site.

Table II-5. Minimum Frequency of Testing for CQA Evaluation of Road Base

Test	Frequency	Standard Test Method
Material Properties		
Sieve Analysis	1 per 1000 cy placed (minimum 1 per source)	ASTM D 422
Modified Proctor	1 per 1000 cy placed (minimum 1 per source)	ASTM D 1557
IN PLACE		
In-Situ Moisture Content	1 per 300 cy	ASTM D 3017
In-Situ Dry Unit Weight	1 per 300 cy	ASTM D 2922

II.6.3 Placement

The CQA Engineer will verify and document that the road base is constructed to the elevations, grades, and thicknesses shown on the Construction Drawings, with material meeting the requirements of the General Specifications as determined by the test methods and frequencies specified within this CQA Plan.

Prior to the placement of the road base, the CQA Engineer will verify and document that:

- The underlying geotextile is free of holes, tears, excessive wrinkles, or foreign objects; and
- All work on underlying layers is complete and accepted by the Owner.

During placement of the road base, the CQA Engineer will verify and document that:

- Close observation of the placement of road base with earth moving equipment is performed;
- The road base is suitable and meets the requirements of the General Specifications as determined by the test methods and frequency prescribed within this CQA Plan; and
- The road base is placed in accordance with the General Specifications.

II.6.4 Construction Quality Assurance Evaluation

Nuclear density tests will be used for testing the in-situ dry unit weight and moisture content of the road base. If the CQA Engineer suspects damage to underlying geosynthetics, the Contractor will be required to expose the potentially damaged materials and repair any observed damage.

II.7 Cover Soil

II.7.1 Placement and Compaction

The CQA Engineer will verify and document that the cover soil is constructed to the elevations, grades, and thicknesses shown on the Construction Drawings, with material meeting the requirements of the General Specifications as determined by the test methods and frequencies specified within this CQA Plan.

Prior to the placement of the cover soil, the CQA Engineer will verify and document that:

- All or an approved portion of the waste filling plan is complete, and that a survey has been conducted to verify that the waste grades and elevations conform to the Construction Drawings; and

- The surface of the subgrade is free of debris, wet and soft areas, ponded water, vegetation, mud, ice or frozen material.

During placement and compaction of the cover soil, the CQA Engineer will verify and document that:

- Close observation of the placement and compaction of cover soil with earthmoving equipment is performed by the CQA Engineer;
- The cover soil meets the requirements of the General Specifications as determined by the CQA testing methods and frequency in Table II 6;
- The cover soil is placed in accordance with the conditions and minimum requirements of the General Specifications;
- Each lift is compacted to the required thickness and minimum dry unit weight within the range of moisture contents established by the General Specifications as determined by the CQA testing methods and frequency in Table II 6;
- The Contractor uses the compaction equipment and the number of passes specified in the General Specifications; and
- The CQA Engineer will document the properties of the cover soil as determined by the test methods and frequency prescribed by this CQA Plan and will report any nonconformance with the General Specifications to the Owner.

Table II-6. Minimum Frequency of Testing for CQA Evaluation of Soil Cover

Test	Frequency	Standard Test Method
Material Properties		
Sieve Analysis	1 per 3000 cy placed (minimum 1 per source)	ASTM D 422
Atterberg Limits	1 per 3000 cy placed (minimum 1 per source)	ASTM D 4318
IN PLACE		
In-Situ Moisture Content	1 per 300 ft^2 per lift	ASTM D 3017
In-Situ Dry Unit Weight	1 per 300 ft^2 per lift	ASTM D 2922

II.7.2 Construction Quality Assurance Evaluation

Nuclear density tests will be used for testing the in-situ unit weight and moisture content of the cover soil.

The Contractor will be required to use all means necessary to protect all prior work, as well as all material and completed work of other Sections. In the event of damage, the Contractor will be required to immediately make all repairs and replacements necessary. The CQA Engineer will verify and document that all damages are repair.

II.7.3 Surveying

A Professional Land Surveyor registered in the State of New Mexico will perform the CQA surveys. The CQA Surveyor will independently survey the elevations and grades of the cover soil to confirm that the lines and elevations in the field agree with those shown on the Construction Drawings. CQA surveys will be conducted in accordance with the requirements described in Part 14 of Section II.

The results of the survey conducted by the CQA Surveyor will be compiled in a report signed by the CQA Surveyor and the CQA Engineer, and will be reviewed by the Owner. The Owner and the CQA Engineer will approve the survey results before the next phase of construction.

II.8 Vegetative Cover

II.8.1 Placement and Compaction

The CQA Engineer will verify and document that the vegetative cover is constructed to the elevations, grades, and thicknesses shown on the Construction Drawings, with material meeting the requirements of the General Specifications as determined by the test methods and frequencies specified within this CQA Plan.

Prior to the placement of the vegetative cover, the CQA Engineer will verify and document that:

- All work on underlying layers is complete and accepted by Owner; and
- The underlying geocomposite is free of holes, team, excessive wrinkles, or foreign objects.

During placement and compaction of the vegetative cover, the CQA Engineer will verify and document that:

- Close observation of the placement and compaction of vegetative cover with earthmoving equipment is performed;
- The vegetative cover meets the requirements of the General Specifications as determined by the CQA testing methods and frequency in Table II 7;
- The vegetative cover is placed in accordance with the conditions and minimum requirements of the General Specifications;
- The Contractor uses the compaction equipment and the number of passes specified in the General Specifications; and
- The CQA Engineer will document the properties of the vegetative cover as determined by the test methods and frequency prescribed by this CQA Plan and will report any nonconformance with the General Specifications to the Owner.

Table II-7. Minimum Frequency of Testing for CQA Evaluation of Vegetative Cover

Test	Frequency	Standard Test Method
Material Properties		
Sieve Analysis	1 per 3000 cy placed (minimum 1 per source)	ASTM D 422
Atterberg Limits	1 per 3000 cy placed (minimum 1 per source)	ASTM D 4318

II.8.2 Construction Quality Assurance Evaluation

The Contractor will be required to use all means necessary to protect all prior work, as well as all material and completed work of other Sections. In the event of damage, the Contractor will be required to immediately make all repairs and replacements necessary. The CQA Engineer will verify and document that all damages are repaired.

II.8.3 Surveying

A Professional Land Surveyor registered in the State of New Mexico will perform the CQA surveys. The CQA Surveyor will independently survey the elevations and grades of the vegetative cover to confirm that the lines and elevations in the field agree with those shown on the Construction Drawings. CQA surveys will be conducted in accordance with the requirements described in Part 14 of Section II.

The results of the survey conducted by the CQA Surveyor will be compiled in a report signed by the CQA Surveyor and the CQA Engineer, and will be reviewed by the Owner. The Owner and the CQA Engineer will approve the survey results before the next phase of construction.

II.9 Pipe Bedding Sand

II.9.1 Placement and Compaction

The CQA Engineer will verify and document that the pipe bedding is constructed to the elevations, grades, and thicknesses shown on the Construction Drawings, with material meeting the requirements of the General Specifications as determined by the test methods and frequencies specified within this CQA Plan.

Prior to the placement of the pipe bedding sand, the CQA Engineer will verify and document that:

- All work on underlying layers is complete and accepted by the Owner; and
- The underlying geotextile is free of holes, tears, excessive wrinkles, or foreign objects.

During placement and compaction of the pipe bedding sand, the CQA Engineer will verify and document that:

- Close observation of the placement and compaction of pipe bedding with earthmoving equipment is performed;
- The pipe bedding sand meets the requirements of the General Specifications as determined by the CQA testing methods and frequency in Table II 8;
- The pipe bedding sand is placed in accordance with the conditions and minimum requirements of the General Specifications;
- The Contractor uses the compaction equipment and the number of passes specified in the General Specifications; and
- The CQA Engineer will document the properties of the pipe bedding sand as determined by the test methods and frequency prescribed by this CQA Plan and will report any nonconformance with the General Specifications to the Owner.

Table II-8. Minimum Frequency of Testing for CQA Evaluation of Pipe Bedding Sand

Test	Frequency	Standard Test Material
Material Properties		
Sieve Analysis	1 per 500 cy placed	ASTM D 422
Atterberg Limits	1 per 500 cy placed	ASTM D 4318

II.9.2 Construction Quality Assurance Evaluation

The Contractor will be required to use all means necessary to protect all prior work, as well as all material and completed work of other Sections. In the event of damage, the Contractor will be required to immediately make all repairs and replacements necessary. The CQA Engineer will verify and document that all damages are repair.

II.9.3 Surveying

A Professional Land Surveyor registered in the State of New Mexico will perform the CQA surveys. The CQA Surveyor will independently survey the elevations and grades of the pipe bedding sand to confirm that the lines and elevations in the field agree with those shown on the Construction Drawings. CQA surveys will be conducted in accordance with the requirements described in Part 14 of Section II.

The results of the survey conducted by the CQA Surveyor will be compiled in a report signed by the CQA Surveyor and the CQA Engineer, and will be reviewed by the Owner. The Owner and the CQA Engineer will approve the survey results before the next phase of construction.

II.10 Select Subbase

II.10.1 Placement and Compaction

Prior to the placement of the select subbase, the CQA Engineer will verify and document that:

- All work on underlying layers is complete and accepted by the Owner; and
- The underlying geocomposite is free of holes, tears, excessive wrinkles, or foreign objects.

During placement and compaction of the select subbase, the CQA Engineer will verify and document that:

- Close observation of the placement and compaction of select subbase with earthmoving equipment is performed by the CQA Engineer;
- The select subbase meets the requirements of the General Specifications as determined by the CQA testing methods and frequency in Table II 9;
- The select subbase is placed in accordance with the conditions and minimum requirements of the General Specifications;
- Each lift is compacted to the required thickness and minimum dry unit weight within the range of moisture contents established by the General Specifications as determined by the CQA testing methods and frequency in Table II 9;
- The Contractor uses the compaction equipment and the number of passes specified in the General Specifications; and
- The CQA Engineer will document the properties of the select subbase as determined by the test methods and frequency prescribed by this CQA Plan and will report any nonconformance with the General Specifications to the Owner.

Table II-9. Minimum Frequency of Testing for CQA Evaluation of Select Subbase

Test	Frequency	Standard Test Method
Material Properties		
Sieve Analysis	1 per 1,000 cy placed (minimum 1 per source)	ASTM D 422
Modified Proctor	1 per 1,000 cy placed (minimum 1 per source)	ASTM D 1557
IN PLACE		
In-Situ Moisture Content	1 per 300 cy	ASTM D 3017
In-Situ Dry Unit Weight	1 per 300 cy	ASTM D 2922

II.10.2 Construction Quality Assurance Evaluation

Nuclear density tests will be used for testing the in-situ unit weight and moisture content of the select subbase.

The Contractor will be required to use all means necessary to protect all prior work, as well as all material and completed work of other Sections. In the event of damage, the Contractor will be required to immediately make all repairs and replacements necessary. The CQA Engineer will verify and document that all damages are repair.

II.10.3 Surveying

A Professional Land Surveyor registered in the State of New Mexico will perform the CQA surveys. The CQA Surveyor will independently survey the elevations and grades of the select subbase to confirm that the lines and elevations in the field agree with those shown on the Construction Drawings. CQA surveys will be conducted in accordance with the requirements described in Part 14 of Section II.

The results of the survey conducted by the CQA Surveyor will be compiled in a report signed by the CQA Surveyor and the CQA Engineer, and will be reviewed by the Owner. The Owner and the CQA Engineer will approve the survey results before the next phase of construction.

II.11 Subbase

II.11.1 Placement and Compaction

The CQA Engineer will verify and document that the subbase is constructed to the elevations, grades, and thicknesses shown on the Construction Drawings, with material meeting the requirements of the General Specifications as determined by the test methods and frequencies specified within this CQA Plan.

Prior to the placement of subbase, the CQA Engineer will verify and document that:

- All work on underlying layers is complete and accepted by the Owner.

During placement and compaction of the subbase, the CQA Engineer will verify and document that:

- Close observation of the placement and compaction of subbase with earthmoving equipment is performed by the CQA Engineer;

- The subbase meets the requirements of the General Specifications as determined by the CQA testing methods and frequency in Table II 10;
- The subbase is placed in accordance with the conditions and minimum requirements of the General Specifications;
- Each lift is compacted to the required thickness and minimum dry unit weight within the range of moisture contents established by the General Specifications as determined by the CQA testing methods and frequency in Table II 10; and
- The Contractor uses the compaction equipment and the number of passes specified in the General Specifications;
- The CQA Engineer will document the properties of the subbase as determined by the test methods and frequency prescribed by this CQA Plan and will report any nonconformance with the General Specifications to the Owner.

Table II-10. Minimum Frequency of Testing for CQA Evaluation of Subbase

Test	Frequency	Standard Test Method
Material Properties		
Sieve Analysis	1 per 1,000 cy placed (minimum 1 per source)	ASTM D 422
Modified Proctor	1 per 1,000 cy placed (minimum 1 per source)	ASTM D 1557
IN PLACE		
In-Situ Moisture Content	1 per 300 cy	ASTM D 3017
In-Situ Dry Unit Weight	1 per 300 cy	ASTM D 2922

II.11.2 Construction Quality Assurance Evaluation

Nuclear density tests will be used for testing the in-situ unit weight and moisture content of the subbase.

The Contractor will be required to use all means necessary to protect all prior work, as well as all material and completed work of other Sections. In the event of damage, the Contractor will be required to immediately make all repairs and replacements necessary. The CQA Engineer will verify and document that all damages are repair.

II.11.3 Surveying

A Professional Land Surveyor registered in the State of New Mexico will perform the CQA surveys. The CQA Surveyor will independently survey the elevations and grades of the subbase to confirm that the lines and elevations in the field agree with those shown on the Construction Drawings. CQA surveys will be conducted in accordance with the requirements described in Part 14 of Section II.

The results of the survey conducted by the CQA Surveyor will be compiled in a report signed by the CQA Surveyor and the CQA Engineer, and will be reviewed by the Owner. The Owner and the CQA Engineer will approve the survey results before the next phase of construction.

II.12 Foundation Sand

II.12.1 Placement and Compaction

The CQA Engineer will verify and document that the foundation sand is constructed to the elevations, grades, and thicknesses shown on the Construction Drawings, with material meeting the requirements of the General Specifications as determined by the test methods and frequencies specified within this CQA Plan.

Prior to the placement of the foundation sand, the CQA Engineer will verify and document that:

- All work on underlying layers is complete and accepted by the Owner; and
- The underlying geomembrane is free of holes, tears, excessive wrinkles, or foreign objects.

During placement and compaction of the foundation sand, the CQA Engineer will verify and document that:

- Close observation of the placement and compaction of foundation sand with earthmoving equipment is performed;
- The foundation sand meets the requirements of the General Specifications as determined by the CQA testing methods and frequency in Table II 11;
- The foundation sand is placed in accordance with the conditions and minimum requirements of the General Specifications;
- Each lift is compacted to the required thickness and minimum dry unit weight within the range of moisture contents established by the General Specifications as determined by the CQA testing methods and frequency in Table II 11;
- The Contractor uses the compaction equipment and the number of passes specified in the General Specifications; and
- The CQA Engineer will document the properties of the foundation sand as determined by the test methods and frequency prescribed by this CQA Plan and will report any nonconformance with the General Specifications to the Owner.

Table II-11. Minimum Frequency of Testing for CQA Evaluation of Foundation Sand

Test	Frequency	Standard Test Method
Material Properties		
Sieve Analysis	1 per 1000 cy placed (minimum 1 per source)	ASTM D 422
Modified Proctor	1 per 1000 cy placed(minimum 1 per source)	ASTM D 1557
IN PLACE		
In-Situ Moisture Content	1 per 300 cy	ASTM D 3017
In-Situ Dry Unit Weight	1 per 300 cy	ASTM D 2922

II.12.2 Construction Quality Assurance Evaluation

Nuclear density tests will be used for testing the in-situ unit weight and moisture content of the foundation sand.

The Contractor will be required to use all means necessary to protect all prior work, as well as all material and completed work of other Sections. In the event of damage, the Contractor will be required to immediately make all repairs and replacements necessary. The CQA Engineer will verify and document that all damages are repair.

II.12.3 Surveying

A Professional Land Surveyor registered in the State of New Mexico will perform the CQA surveys. The CQA Surveyor will independently survey the elevations and grades of the foundation sand to confirm that the lines and elevations in the field agree with those shown on the Construction Drawings. CQA surveys will be conducted in accordance with the requirements described in Part 14 of Section II.

The results of the survey conducted by the CQA Surveyor will be compiled in a report signed by the CQA Surveyor and the CQA Engineer, and will be reviewed by the Owner. The Owner and the CQA Engineer will approve the survey results before the next phase of construction.

II.13 Protective Soil Layer

II.13.1 Placement and Compaction

The CQA Engineer will verify and document that the protective soil layer is constructed to the elevations, grades, and thicknesses shown on the Construction Drawings, with material meeting the requirements of the General Specifications as determined by the test methods and frequencies specified within this CQA Plan.

Prior to the placement of the protective soil layer, the CQA Engineer will verify and document that:

- The underlying geocomposite is free of holes, tears, excessive wrinkles, or foreign objects; and
- All work on underlying layers is complete and accepted by the Owner.

During placement of the protective soil layer, the CQA Engineer will verify and document that:

- The soil is suitable and satisfies the requirements of the General Specifications as determined by the test methods and frequencies prescribed in Table 11-12;
- The protective soil is placed in accordance with the General Specifications;
- The lift thicknesses and total thickness of the protective soil layer agree with the requirements of the General Specifications;
- If excessive wrinkles begin to develop in the underlying geosynthetics during material placement or spreading, the wrinkles are worked out prior to continued placement operations;
- The protective soil layer is lightly compacted as described in the General Specifications;
- The protective soil is placed on the side slopes to the limits shown on the construction drawings; and
- No protective soil layer material is placed or compacted during periods of unfavorable weather conditions.

Table II-12. Minimum Frequency of Testing for CQA Evaluation of Protective Soil

Test	Frequency	Standard Test Method
Material Properties		
Sieve Analysis	1 per 5,000 cy placed (minimum 1 per source)	ASTM D 422
Atterberg Limits	1 per 5,000 cy placed (minimum 1 per source)	ASTM D 4318

II.13.2 Conformance Evaluation

There are no CQA testing requirements for the protective soil layer, other than thickness requirements.

If damage to underlying geosynthetics is expected, the CQA Engineer will require that the overlying protective soil layer material be removed to expose the geosynthetics.

The Contractor will be required to use all means necessary to protect all prior work, as well as all materials and completed work of other Sections. In the event of damage, the Contractor will be required to immediately make all repairs and replacements necessary. The CQA Engineer will verify and document that all damages are repaired.

II.13.3 Surveying

A Professional Land Surveyor registered in the State of New Mexico will perform the CQA surveys. The CQA surveyor will independently survey the elevations and grades of the top of the protective soil layer on the base and side-slopes of the landfill, and to confirm that the grades and elevations in the field agree with those shown on the Construction Drawings. The CQA surveys will be performed in accordance with the requirements described in Part 14 of Section II. The results of the survey conducted by the CQA Surveyor will be compiled in a report signed by the CQA Surveyor and the CQA Engineer, and will be reviewed by the Owner.

II.14 Surveying

The Surveyor will be required to survey each soil layer of the liner system and cover system (except the vegetative soil cover) for the landfill or surface impoundment in accordance with the requirements of the General Specifications. If required by the Owner, a Record Drawing will be submitted by the Surveyor before the placement of the next liner system layer. The surveys will be conducted at a 100 foot grid for slopes greater than 25 percent and at 50 foot grid for slopes less than 25 percent. All pipes for leachate detection, collection and/or removal will be surveyed at start and end points and at 50 foot intervals in between. The CQA survey will include enough information to confirm that the following features of the landfill or surface impoundment are constructed in accordance with the Construction Drawings:

- Toe of slope;
- Crest of slope;
- Grade breaks;
- Anchor trench;
- Leachate collection sump;
- Leak detection sump;
- Permanent landfill sump ~~(landfills only)~~; and
- Perimeter drainage ditches.

The CQA results will be submitted to the Owner for final approval to proceed on the liner system construction.

Section III. Geosynthetic Clay Liner Construction Quality Assurance

III.1 Geosynthetic Clay Liner Manufacture and Delivery

III.1.1 Manufacture and Quality Control

Prior to the installation of the Geosynthetic Clay Liner (GCL), the Contractor will be required to provide the CQA Engineer with the following information from the GCL Manufacturer:

- The certification required by the General Specifications signed by a responsible party employed by the GCL Manufacturer based on sampling interval of 1 per 50,000 square feet; and
- The manufacturing quality control certificates for each shift's production of GCL, signed by a responsible party employed by the GCL Manufacturer (such as the production manager). The quality control certificates will include:
  - Roll numbers and identification; and
  - Sampling procedures and results of quality control tests specified by the General Specifications including descriptions of the test methods used for GCL rolls assigned to the Triassic Park project.

The CQA Engineer will verify and document that:

- The property values certified by the GCL Manufacturer meet all of the specified values listed in the General Specifications;
- The measurements of properties by the GCL Manufacturer are properly documented and the test methods used are in accordance with the General Specifications; and
- The quality control certificates have been provided at the specified frequency for GCL rolls, and each certificate identifies the rolls or batch number related to that certificate.

The CQA Engineer will report deviations from the above requirements to the Owner prior to installation of the GCL.

III.1.2 Labeling

The CQA Engineer will verify and document that the GCL Manufacturer has labeled each roll of GCL as specified in the General Specifications.

The CQA Engineer will examine GCL rolls upon delivery and deviation from the above requirements will be reported to the Owner prior to installation of the GCL.

III.1.3 Transportation and Handling

The CQA engineer will observe and document the type of GCL handling equipment used by the installer is consistent with handling equipment identified in the general specifications.

Upon delivery at the site, the CQA Engineer will conduct a visual inspection of all rolls for defects and for damage. This examination will be conducted without unrolling rolls unless visible defects or damages are found. The CQA Engineer will indicate to the Owner:

- Any rolls that should be unrolled to allow for their inspection;
- Any rolls, or portions thereof, which should be rejected and removed from the site because they have severe flaws; and
- Any rolls which include minor repairable flaws.

III.1.4 Storage

The CQA Engineer will verify and document that storage of the GCL is in accordance with the General Specifications.

III.1.5 Quality Assurance Conformance Testing

Either at the Manufacture's plant or upon delivery of the rolls of GCL, the CQA Engineer will ensure that samples are removed at the specified frequency and forwarded to the Geosynthetics CQA Laboratory for testing to verify and document conformance with the General Specifications.

Unless otherwise specified, samples will be taken at a rate of one per lot or one per 100,000 square feet, whichever is greater. These samples will be tested for:

- Bentonite Moisture Content ASTM D 4643
- GCL Grab Strength, Elongation, Per Strength ASTM D 4632
- GCL Permeability ASTM D 5084
- GCL Interface Shear Strength ASTM D 5321

Conformance samples will be taken across the entire width of the roll and will not include the first 3 feet along the length of the roll. Unless otherwise specified, samples will be 1.5 feet (minimum) long by the roll width. The CQA Engineer will mark the machine direction on the samples with an arrow.

The CQA Engineer will examine all results from laboratory conformance testing and will compare the results to the specifications presented in Table 02780-1 of the Specifications. In addition, the CQA Engineer will report any nonconformance to the Owner as soon as practical after the test results become available.

The following procedure will apply whenever a sample fails a conformance test that is conducted by the Geosynthetics CQA Laboratory:

- The Contractor will be required to replace the roll (or rolls) of GCL that is not in conformance with the specifications with a roll that meets the requirements of the General Specifications.
- The CQA Engineer will ensure that conformance samples are removed for testing by the Geosynthetics CQA Laboratory from the closest numerical roll on both sides of the roll from which the failing sample was obtained. These two samples must pass the above conformance tests. If either of these samples fails to meet the requirements, samples will be collected from the five numerically closest untested rolls on both sides of the failed samples and tested by the Geosynthetics CQA Laboratory. These ten samples must pass the above conformance tests. If any of these

samples fail, a sample from every roll of GCL on site and a sample from every roll that is subsequently delivered from the same Manufacturer must be conformance tested by the Geosynthetics CQA Laboratory. The costs of all such tests are to be borne by the Contractor.

The CQA Engineer will document actions taken in conjunction with conformance test failures and report all actions to the Owner.

III.2 Geosynthetic Clay Liner Installation

III.2.1 Earthworks

III.2.1.1 Surface Preparation

The Contractor or subcontractor responsible for GCL installation will be required to certify in writing that the surface on which the GCL will be installed is acceptable. The certificate of acceptance will be required to be given by the Contractor to the CQA Engineer, who will then verify to the Owner that the subgrade and/or clay liner installation is accepted immediately prior to commencement of GCL installation in the area under consideration.

After the surface on which the GCL is to be installed has been accepted by the Contractor responsible for GCL installation, it will be the CQA Engineer's responsibility to indicate to the Owner any change in the underlying layer that may, in accordance with the General Specifications, require repair work. If the Owner requires repair work, then it will be the responsibility of the Contractor to repair the underlying layer.

III.2.1.2 Anchor Trenches

The CQA Engineer will verify and document that the anchor trench backfill meets the requirements of the General Specifications and that the backfill is placed in accordance with the General Specifications.

III.2.2 Geosynthetic Clay Liner Deployment

III.2.2.1 Field Panel Identification

A field panel is the unit area of GCL which is to be placed in the field, i.e., a field panel is a roll or a portion of roll cut in the field.

The CQA Engineer will verify that each field panel is given an identification code (number or letter-number) consistent with the layout plan. This identification code will be agreed upon by the Owner, and the Contractor. This field panel identification code should be as simple and logical as possible. (Note: manufacturing plant roll numbers are usually cumbersome and are not related to location in the field.) It will be the responsibility of the Contractor to ensure that each field panel placed is marked with the manufacturing plant roll number. The roll number will be marked in the center of the panel in a color to allow for easy inspection.

The CQA Engineer will establish a table or chart showing correspondence between manufacturing plant roll numbers and field panel identification codes. The field panel identification code will be used for all CQA records.

III.2.2.2 Field Panel Placement

III.2.2.2.1 Installation Schedule

The CQA Engineer will evaluate significant changes in the schedule proposed by the Contractor and advise the Owner on the acceptability of that change. The CQA Engineer will verify and document that the condition of the underlying layer has not changed detrimentally during installation. Any damage to the surface of the underlying layer will be repaired by the Contractor in accordance with the General Specifications.

The CQA Engineer will record the identification code, location, and date of installation of each field panel.

III.2.2.2.2 Weather Conditions

The CQA Engineer will verify and document that GCL is not placed during inclement weather conditions as specified within the General Specifications.

Additionally, the CQA Engineer will verify and document that the underlying layer has not been damaged by weather conditions.

III.2.2.2.3 Damage

The CQA Engineer will visually observe each panel, after placement, for damage. The CQA Engineer will advise the Owner which panels, or portions of panels, should be rejected, repaired, or accepted. Damaged panels or portions of damaged panels which have been rejected by the Owner will be marked, and their removal from the work area will be documented by the CQA Engineer.

III.2.2.2.4 Seam Overlap and Bentonite Seal

The CQA engineer will observe and document that the seam overlaps and bentonite material placed between panels along the seams meet specification guidelines. The CQA engineer will verify overlap width and will observe bentonite seal placement.

III.2.3 Defects and Repairs

III.2.3.1 Identification

All seams and non-seam areas of the GCL will be inspected by the CQA Engineer for evidence of defects, holes, contamination of geotextiles, displaced panels, premature hydration, and any sign of contamination by foreign matter. The CQA Engineer will observe and document repair procedures described below.

III.2.3.2 Repair Procedures

Prior to cover material placement, damage to the GCL shall be identified and repaired by the installer.

III.2.3.2.1 Rip and Tear Repair (Flat Surfaces)

Rips or tears may be repaired by completely exposing the affected area, removing all foreign objects or soil, and by then placing a patch cut from unused GCL over the damage (damaged material may be left in place), with a minimum overlap of 12 inches on all edges.

Accessory bentonite should be placed between the patch edges and the repaired material at a rate of a quarter pound per lineal foot of edge spread in a continuous ~~six~~ 6-inch fillet.

III.2.3.2.2 Rip and Tear Repair (Slopes)

Damaged GCL material on slopes shall be repaired by the same procedures above, however, the overlapped edges of the patch should be wide enough to ensure the patch will keep its position during backfill or cover operations.

III.2.3.2.3 Displaced Panels

Displaced panels shall be adjusted to the correct position and orientation. The adjusted panel shall then be inspected for any geotextile damage or bentonite loss. Damage shall be repaired by the above procedure.

III.2.3.2.4 Premature Hydration

If the GCL is subjected to premature hydration, the GCL installer shall notify the CQA Engineer and Design Engineer for a site specific determination as to whether the material is acceptable or if alternative measures must be taken to ensure the quality of the design dependent upon the degree of damage.

Section IV. Geomembrane Construction Quality Assurance

IV.1 Geomembrane Manufacture and Delivery

IV.1.1 Resin

Prior to the installation of the HDPE geomembrane material, the Contractor will be required to provide the CQA Engineer with the following information from the geomembrane Manufacturer:

- A copy of the quality control certificates issued by the resin Supplier that includes the origin (resin Supplier's name and resin production plant), identification (brand name, number) the production date of the resin used in the manufacture of the geomembrane shipped to the site, and the results of tests conducted to verify that the quality of the resin used to manufacture the geomembrane rolls assigned to the project meets the General Specifications; and
- Certification from the geomembrane Manufacturer that no reclaimed polymer is added to the resin during the manufacture of the geomembrane to be used in this project; the use of polymer recycled during the manufacturing process is permitted if the recycled polymer does not exceed 2 percent by weight of the total polymer weight.

The CQA Engineer will review these documents and report any discrepancies with the above requirements to the Owner.

IV.1.2 Geomembrane Manufacturing Quality Control

Prior to the installation of the HDPE geomembrane, the Contractor will be required to provide the CQA Engineer with the following information from the geomembrane Manufacturer:

- The certification required by the General Specifications signed by a responsible party employed by the geomembrane Manufacturer based on sampling interval of 1 per 50,000 square feet; and
- The manufacturing quality control certificates for each shift's production of geomembrane, signed by a responsible party employed by the geomembrane Manufacturer (such as the production manager). The quality control certificates will include:
  - Roll numbers and identification; and
  - Sampling procedures and results of quality control tests specified by the General Specifications including descriptions of the test methods used for geomembrane rolls assigned to the Triassic Park project.

The CQA Engineer will verify and document that:

- The property values certified by the geomembrane Manufacturer meet all of the specified values listed in the General Specifications;
- The measurements of properties by the geomembrane Manufacturer are properly documented and the test methods used are in accordance with the General Specifications; and
- The quality control certificates have been provided at the specified frequency for geomembrane rolls, and each certificate identifies the rolls or batch number related to that certificate.

The CQA Engineer will report deviations from the above requirements to the Owner prior to installation of the geomembrane.

IV.1.3 Labeling

The CQA Engineer will verify and document that the geomembrane Manufacturer has labeled each roll of geomembrane as specified in the General Specifications.

The CQA Engineer will examine geomembrane rolls upon delivery and deviation from the above requirements will be reported to the Owner prior to installation of the geomembrane.

IV.1.4 Transportation and Handling

Upon delivery at the site, the CQA Engineer will conduct a visual inspection of all rolls for defects and for damage. This examination will be conducted without unrolling rolls unless visible defects or damages are found. The CQA Engineer will indicate to the Owner:

- Any rolls that should be unrolled to allow for their inspection;
- Any rolls, or portions thereof, which should be rejected and removed from the site because they have severe flaws; and
- Any rolls which include minor repairable flaws.

IV.1.5 Storage

The CQA Engineer will verify and document that storage of the geomembrane is in accordance with the General Specifications.

IV.1.6 Quality Assurance Conformance Testing

Either at the Manufacture's plant or upon delivery of the rolls of geomembrane, the CQA Engineer will ensure that samples are removed at the specified frequency and forwarded to the Geosynthetics CQA Laboratory for testing to verify and document conformance with the General Specifications.

Conformance samples will be taken by the CQA Engineer across the entire width of the roll and will not include the first 3 feet. Unless otherwise specified, samples will be 1.5 feet (minimum) long by the roll width. The CQA Engineer will mark the direction of the machine used to cut the samples with an arrow.

Unless otherwise specified, samples will be taken at a rate of one per lot or one per 100,000 square feet, whichever is greater. These samples will be tested for:

- Specific gravity
- Thickness
- Yield strength and yield elongation
- Tensile strength and tensile elongation at break
- Carbon black content
- Carbon black dispersion
- Puncture Resistance

Test shall be conducted in accordance with the test procedure presented in the specification.

The CQA Engineer will examine all results from laboratory conformance testing and will report any nonconformance to the Owner as soon practical after the test results become available.

The following procedure will apply whenever a sample fails a conformance test that is conducted by the CQA Engineer:

- The Contractor will be required to replace the roll (or rolls) of geomembrane that is in nonconformance with the General Specifications with a roll that meets the General Specifications.
- The CQA Engineer will ensure that conformance samples are removed for testing by the Geosynthetics CQA Laboratory from the closest numerical roll on both sides of the failed roll. These two samples must pass the above conformance tests. If either of these samples fails, samples will be collected from the five numerically closest untested rolls on both sides of the failed sample and tested by the Geosynthetics CQA Laboratory. These ten samples must pass the above conformance tests. If any of these samples fail, a sample from every roll of geomembrane on site and every roll subsequently delivered from the same Manufacturer must be conformance tested by the Geosynthetics CQA Laboratory; the cost of all such additional tests are to be borne by the Contractor.

The CQA Engineer will document actions taken in conjunction with conformance test failures and report all actions to the Owner.

IV.2 Geomembrane Installation

IV.2.1 Earthwork

IV.2.1.1 Surface Preparation

The Contractor or subcontractor responsible for geomembrane installation will be required to certify in writing that the surface on which the geomembrane will be installed is acceptable.

The certificate of acceptance will be required to be given by the Contractor to the CQA Engineer, who will then verify to the Owner that the subgrade is accepted immediately prior to commencement of geomembrane installation in the area under consideration.

After the surface on which the geomembrane is to be installed has been accepted by the Contractor responsible for geomembrane installation, it will be the CQA Engineer's responsibility to indicate to the Owner any change in the underlying layer that may, in accordance with the General Specifications, require repair work. If the Owner requires repair work, then it will be the responsibility of the Contractor to repair the underlying layer.

IV.2.1.2 Anchor Trenches

The CQA Engineer will verify and document that the anchor trench backfill meets the requirements of the General Specifications and that the backfill is placed in accordance with the General Specifications.

IV.2.2 Geomembrane Deployment

IV.2.2.1 Layout Drawing

The Contractor will be required to produce layout drawings which show the geomembrane panel configuration, dimensions, details, seam locations, etc. The layout drawings must be approved by the Owner prior to the installation of the geomembrane. The layout drawings, as modified and/or approved by the Owner will be part of the specifications, and a copy will be furnished to the CQA Engineer. The CQA Engineer will become familiar with the layout drawings.

IV.2.2.2 Field Panel Identification

A field panel is the unit area of geomembrane which is to be seamed in the field~~,~~ (i.e., ~~a field panel is~~ a roll or a portion of roll cut in the field).

The CQA Engineer will verify that each field panel is given an identification code (number or letter-number) consistent with the layout plan. This identification code will be agreed upon by the Owner, and the Contractor. This field panel identification code should be as simple and logical as possible. (Note: manufacturing plant roll numbers are usually cumbersome and are not related to location in the field.) It will be the responsibility of the Contractor to ensure that each field panel placed is marked with the manufacturing plant roll number. The roll number will be marked in the center of the panel in a color to allow for easy inspection.

The CQA Engineer will establish a table or chart showing correspondence between manufacturing plant roll numbers and field panel identification codes. The field panel identification code will be used for all CQA records.

IV.2.2.3 Field Panel Placement

IV.2.2.3.1 Location

The CQA Engineer will verify and document that field panels are installed at the locations and positions indicated in the Contractor's layout plan, as approved or modified by the Owner.

IV.2.2.3.2 Installation Schedule

The CQA Engineer will evaluate significant changes in the schedule proposed by the Contractor and advise the Owner on the acceptability of that change. The CQA Engineer will verify and document that the condition of the underlying layer has not changed detrimentally during installation. Any damage to the surface of the underlying layer will be repaired by the Contractor in accordance with the General Specifications.

The CQA Engineer will record the identification code, location, and date of installation of each field panel.

IV.2.2.3.3 Weather Conditions

The CQA Engineer will verify and document that geomembrane is not placed during inclement weather conditions as specified within the General Specifications.

Additionally, the CQA Engineer will verify and document that the underlying layer has not been damaged by weather conditions.

IV.2.2.3.4 Damage

The CQA Engineer will visually observe each panel, after placement and prior to seaming, for damage (e.g., holes, blisters, creases). The CQA Engineer will advise the Owner which panels, or portions of panels, should be rejected, repaired, or accepted. Damaged panels or portions of damaged panels which have been rejected by the Owner will be marked, and their removal from the work area will be documented by the CQA Engineer.

IV.2.3 Field Seaming

IV.2.3.1 Seam Layout

The CQA Engineer will verify and document that the seam layout shown on the Panel Layout Drawing (Part 2.2.1) is consistent with the General Specifications. No panels may be seamed in the field without the Owner's approval. In addition, seams not specifically shown on the seam layout drawing may not be made without the Owner's prior approval.

A seam numbering system compatible with the panel numbering system will be agreed upon by the Contractor, the Owner, and CQA Engineer.

IV.2.3.2 Seaming Equipment and Products

Processes approved by the General Specifications for field seaming are: (i) extrusion seaming; and (ii) fusion seaming. Proposed alternate processes will be required to be documented and submitted to the Owner for approval. Only seaming apparatus which the Owner has specifically approved by make and model will be used. The Contractor will be required to use a pyrometer to ensure that accurate temperatures of the extrudate and seamer nozzle are being achieved.

The extrusion seaming apparatus will be equipped with gauges indicating the temperatures of the extrudate and nozzle. The Contractor will be required to provide to the CQA Engineer the Manufacturer's certification that the extrudate is compatible with the General Specifications and is comprised of the same resin as the geomembrane.

The CQA Engineer will log ambient temperatures, seaming apparatus temperatures, and extrudate temperatures or fusion seaming apparatus speeds. Ambient temperatures will be measured as specified in the General Specifications.

IV.2.3.3 Seam Preparation

The CQA Engineer will verify and document that:

- Prior to seaming, the seam area is clean and free of moisture, dust, dirt, debris, and foreign material; and
- Preparation of seams is in accordance with the General Specifications.

IV.2.3.4 Weather Conditions for Seaming

The CQA Engineer will verify and document that weather conditions for seaming are within the limits specified in the General Conditions.

IV.2.3.5 Trial Seams

The Contractor will be required to make trial seams on fragment pieces of geomembrane liner to verify that seaming conditions are adequate. The Contractor will be required to make and test trial seams at the frequency and in accordance with the methods specified in the General Specifications.

The CQA Engineer will observe all trial seam procedures. The successful trial seam sample will be assigned a number and marked accordingly by the CQA Engineer, who will log the date, hour, ambient temperature, number of seaming unit, name of seamer, and pass or fail description. The sample itself will be retained only until the construction of the liner is complete and the liner has been accepted by the Owner.

IV.2.3.6 Nondestructive Seam Continuity Testing

IV.2.3.6.1 Introduction

Except as otherwise noted in the General Specifications, the Contractor will nondestructively test all field seams over their full length in accordance with the General Specifications. The purpose of nondestructive tests is to check the continuity of seams. Continuity testing will be carried out as the seaming work progresses, not at the completion of all field seaming. Nondestructive testing will not be permitted before sunrise or after sunset unless the Contractor demonstrates to the Owner that the Contractor has the capabilities to perform continuity testing under reduced light conditions.

The CQA Engineer will:

- Observe the continuity testing;
- Record location, date, test unit number, name of tester, and outcome of all testing; and
- Document and inform the Contractor of any required repairs.

The Contractor will be required to complete any required repairs in accordance with the General Specifications.

The CQA Engineer will:

- Observe the repair and re-testing of the repair;
- Mark on the geomembrane that the repair has been made; and
- Document the results.

The CQA Engineer will verify and document the procedures specified in the General Specifications where seams cannot be nondestructively tested.

The location, date of visual observation, name of tester, and outcome of the test or observation will be recorded by the CQA Engineer and reported to the Owner.

IV.2.3.7 Destructive Seam Testing

IV.2.3.7.1 Concept

Destructive seam tests will be performed at selected locations. The purpose of these tests is to evaluate seam strength and integrity. Seam strength testing will be done as the seaming work progresses, not at the completion of all field seaming.

IV.2.3.7.2 Location and Frequency

The CQA Engineer will select locations where seam samples will be cut out for laboratory testing. The test frequency and locations will be established as follows:

- Samples will be collected at a minimum frequency of one test location per 500 feet of seam length (this minimum frequency is to be determined as an average taken throughout the entire landfill or surface impoundment project); and
- Test locations will be determined during seaming at the CQA Engineer's discretion; selection of such locations may be prompted by suspicion of excess crystallinity, contamination, offset seams, or any other potential cause of imperfect seaming.

The Contractor will not be informed in advance of the locations where the seam samples will be taken.

IV.2.3.7.3 Sampling Procedure

The Contractor will be required to cut samples as directed by the CQA Engineer as the seaming progresses in order to have laboratory test results before the geomembrane is covered by another material. The CQA Engineer will:

- Observe sample cutting;
- Assign a number to each sample and mark it accordingly;
- Record the sample number and location on the panel layout drawing; and
- Record the reason for taking the sample at this location (e.g., routine testing, suspicious feature of the geomembrane, etc.).

All holes in the geomembrane resulting from destructive seam sampling will be covered by the Contractor immediately after sampling and repaired in accordance with the repair procedures described in the General Specifications. The continuity of the new seams in the repaired area will be nondestructively tested according to the General Specifications.

IV.2.3.7.4 Size of Samples

At a given sampling location, two types of samples will be required to be taken by the Contractor.

First, two specimens for field testing will be taken. Each of these specimens will be 1 inch wide by 6 to 12 inches long, with the seam centered parallel to the width. The distance between these two specimens will be approximately 42 inches. If both specimens pass the field test described in the General Specifications, a sample for laboratory testing will be taken.

The sample for laboratory testing will be required to be taken between the two specimens for field testing. The destructive sample will be 12 inches wide by 42 inches long with the seam centered lengthwise. The sample will be cut into three parts and distributed as follows:

- One portion to the Contractor, 12 inches long;
- One portion to the CQA Engineer for archive storage, 12 inches long; and
- One portion to the CQA Engineer for CQA Laboratory testing, 18 inches long.

Final determination of the sample sizes will be made at the preconstruction meeting.

IV.2.3.7.5 Field Testing

The two 1-inch wide specimens specified above will be required to be tested in the field, by the Contractor, by tensiometer for peel and should not fail in the seam. If any field test sample fails to pass, then the procedures outlined in the General Specifications will be required to be followed.

The CQA Engineer will observe field tests and mark all samples and portions with their number, date, and time.

IV.2.3.7.6 Geosynthetic Construction Quality Assurance Laboratory Testing

Laboratory destructive test samples will be packaged and shipped to the CQA Laboratory by the CQA Engineer in a manner which will not damage the test sample. The CQA Engineer will store the archive samples until the completion of the project. Laboratory destructive test samples will be tested by the Geosynthetics CQA Laboratory.

Testing will include "Shear Strength", and "Peel Strength", (ASTM D 443) with 1-inch-wide strip, tested at 2 inches per minute). The minimum acceptable values to be obtained in these tests are those indicated in Table 02775-2 of Section 02775 of the General Specifications. At least 5 specimens will be tested for each test method. Specimens will be selected alternately by test from the samples (i.e., peel, shear, peel, shear). At least 4 out of 5 of the specimens must pass.

The Geosynthetics CQA Laboratory will provide test results verbally to the CQA Engineer in a timely manner after they receive the samples. The CQA Engineer will review laboratory test results as soon as they become available, and inform the Owner of the test results.

IV.2.3.7.7 Procedures for Destructive Test Failure

The procedures specified within the General Specifications will be required whenever a sample fails a destructive test, whether that test is conducted by the Geosynthetics CQA Laboratory, the Contractor's laboratory (if required), or by field tensiometer. The CQA Engineer will verify and document that one of the options specified within the General Specifications is followed.

The CQA Engineer will document all actions taken in conjunction with destructive test failures.

IV.2.4 Defects and Repairs

IV.2.4.1 Identification

All seams and non-seam areas of the geomembrane will be inspected by the CQA Engineer for evidence of defects, holes, blisters, undispersed raw materials, and any sign of contamination by foreign matter. Because light reflected by the geomembrane helps to detect defects, the surface of the geomembrane will be required to be clean at the time of examination. The geomembrane surface will be required to be broomed or washed by the Contractor if the amount of dust or mud inhibits examination.

IV.2.4.2 Evaluation

Each suspect location both in seam and non-seam areas will be required to be either non-destructively tested using the methods described in the General Specifications, or repaired as appropriate as determined by the CQA Engineer. Each location which fails the non-destructive testing will be marked by the CQA Engineer and will be required to be repaired by the Contractor. Materials should not be placed over geomembrane locations that have been repaired until the CQA Engineer has approved the repair.

IV.2.4.3 Large Wrinkles

When seaming of the geomembrane is completed (or when seaming of a large area of the geomembrane is completed) and prior to placing overlying materials, the CQA Engineer will visually inspect the geomembrane for wrinkles. The CQA Engineer will indicate to the Contractor which wrinkles, if any, should be cut and reseamed. The seam thus produced will be tested like any other seam.

IV.2.4.4 Repair Procedures

Any portion of the geomembrane exhibiting a flaw, or failing a destructive or nondestructive test will be repaired by the Contractor in accordance with the applicable method specified within the General Specifications.

IV.2.4.5 Testing of Repairs

Each repair will be located and logged by the CQA Engineer. Each repair will be non-destructively tested using the methods described in the General Specifications as appropriate. Repairs which pass the non-destructive test will be considered as an adequate repair. Large caps may be of sufficient extent to require destructive testing, at the discretion of the CQA Engineer. Failed tests will require the repair to be redone and retested until passing test results are obtained. The CQA Engineer will observe the non-destructive testing of repairs and will document the date of the repair and test outcome.

IV.2.5 Appurtenances

The CQA Engineer will verify and document that:

- Installation of the geomembrane around, and connection of geomembrane to appurtenances have been made according to the General Specifications;

- Extreme care is taken while seaming around appurtenances since neither non-destructive nor destructive testing may be feasible in these areas; and

- The geomembrane has not been visibly damaged while being connected to appurtenances.

The CQA Engineer will inform the Owner if the above conditions are not fulfilled.

IV.3 Surveying

The CQA Engineer, in conjunction with the Surveyor, will be required to prepare an "as-built" Record Drawing for geomembrane installations. It will include the surveyed location of field panels, seams (factory and field), repairs, and test locations.

The CQA results (Record Drawing and certification of Contractor's work) will be submitted to the Owner for final review and approval prior to proceeding with construction of any subsequent liner system components.

Section V. Filter Or Cushion Geotextile Construction Quality Assurance

V.1 Geotextiles

V.1.1 Manufacturing

The Geosynthetics Contractor will be required to provide the CQA Engineer with the following information from the geotextile Manufacturer:

- Certification required by the General Specifications signed by a responsible party employed by the geotextile Manufacturer; and
- The manufacturing quality control certificates for each shift's production of geotextile rolls, which include geotextile roll numbers and identification, sampling procedures, and descriptions and results of the quality control tests specified in the General Specifications signed by a responsible party employed by the geotextile Manufacturer.

The CQA Engineer will examine all geotextile Manufacturer's certifications to verify and document that the property values listed on the certifications meet or exceed those specified within the General Specifications and that proper and complete documentation has been provided by the geotextile Manufacturer for all geotextile used at the site. The CQA Engineer will report any deviations from the above requirements to the Owner prior to installation of the geotextile.

V.1.2 Labeling

The CQA Engineer will verify and document that the geotextile Manufacturer has labeled all rolls of geotextile with the information specified in the General Specifications.

The CQA Engineer will examine rolls upon delivery and any deviation from the above requirements will be reported to the Owner prior to installation of the geotextile.

V.1.3 Shipment and Storage

The CQA Engineer will observe rolls of geotextile upon delivery at the site and any deviation from the requirements specified within the General Specifications will be reported to the Owner. Any damaged rolls will be rejected by the CQA Engineer and required to be repaired or replaced by the Contractor.

V.1.4 Conformance Testing

Either at the Manufacturer's factory or upon delivery of the geotextile rolls, the CQA Engineer will ensure that samples are removed and forwarded to the Geosynthetics CQA Laboratory for testing to verify and document conformance with the requirements of the General Specifications.

Conformance samples will be taken across the entire width of the roll and will not include the first 3 feet along the length of the roll. Unless otherwise specified, samples will be 1.5 feet (minimum) long by the roll width. The CQA Engineer will mark the machine direction on the samples with an arrow.

Samples will be taken at a rate of one per lot or one per 100,000 square feet, whichever is greater. These samples will be tested for:

- Mass per unit area
- Grab strength
- Tear strength
- Puncture strength
- Permittivity

(Note: All tests should be conducted in accordance with the test methods listed in the specification.)

If the geotextile is being used as a filter, cushion or separator, the samples will also be tested for apparent opening size.

The CQA Engineer will examine all results of laboratory conformance testing and report any nonconformance to the Owner as soon as results become available.

The following procedure will apply whenever a sample fails a conformance test that is conducted by the Geosynthetics CQA Laboratory:

- The Contractor will be required to replace the roll (or rolls) of geotextile that is not in conformance with the specifications with a roll that meets the requirements of the General Specifications.
- The CQA Engineer will ensure that conformance samples are removed for testing by the Geosynthetics CQA Laboratory from the closest numerical roll on both sides of the roll from which the failing sample was obtained. These two samples must pass the above conformance tests. If either of these samples fails to meet the requirements, samples will be collected from the five numerically closest untested rolls on both sides of the failed sample and tested by the Geosynthetics CQA Laboratory. These ten samples must pass the above conformance tests. If any of these samples fail, a sample from every roll of geotextile on site and a sample from every roll that is subsequently delivered from the same Manufacturer must be conformance tested by the Geosynthetics CQA Laboratory. The costs of all such tests are to be borne by the Contractor.

The CQA Engineer will document actions taken in conjunction with conformance test failures and report all actions taken to the Owner.

V.1.5 Handling and Placement

The Geosynthetics Contractor will be required to handle all geotextile in such a manner as to ensure the geotextile is not damaged in any way. The CQA Engineer will verify and document compliance with the following:

- Just prior to geotextile placement, the layer that underlies the geotextile, if it is a geosynthetic, is clean and free of excessive amounts of dust, dirt, stones, rocks, or other obstructions that could potentially damage the liner system.
- In the presence of excessive wind, the geotextile is weighted with sandbags (or equivalent weight approved by the CQA Engineer).
- Geotextile is kept under tension to minimize the presence of wrinkles in the geotextile. If necessary, the geotextile is positioned by hand after being unrolled to minimize wrinkles.

- Geotextiles are cut using a geotextile cutter approved by the geotextile Manufacturer and the CQA Engineer. If in place, special care is taken to protect other materials (such as underlying geosynthetics) from damage which could be caused by the cutting of the geotextiles.
- The Contractor takes any necessary precautions to prevent damage to the underlying layers during placement of the geotextile.
- During placement of geotextiles, care is taken not to entrap in the geotextile stones, excessive dust, or moisture that could damage the underlying layers, generate clogging of drains or filters, or hamper subsequent seaming.
- Geotextile is not left exposed for a period in excess of 30 days after placement unless a longer exposure period is approved by the CQA Engineer and Owner.

The CQA Engineer will document any noncompliance with the above requirements and report them to the Owner.

V.1.6 Seams and Overlaps

The CQA Engineer will verify and document that all geotextile seams are oriented, overlapped and sewn in accordance with the General Specifications.

The Contractor will be required to pay close attention at seams to ensure that no protective soil layer material could be inadvertently placed beneath the geotextile.

Sewing will be required to be performed as required in the General Specifications.

V.1.7 Repair

The CQA Engineer will verify and document that any holes or tears in the geotextile are repaired in accordance with the requirements of the General Specifications.

The CQA Engineer will document any noncompliance with the above requirements and report it to the Owner.

Section VI. Geocomposite Construction Quality Assurance

VI.1 Geocomposites

VI.1.1 Manufacturing

The Geosynthetics Contractor will be required to provide the CQA Engineer with the following information from the geocomposite Manufacturer:

- Certification required by the General Specifications signed by a responsible party employed by the geocomposite Manufacturer;
- The certification from the geocomposite Manufacturer that no reclaimed polymer was added to the resin during the manufacture of the geonet component of the geocomposite rolls assigned this project; and
- The manufacturing quality control certificates for each shift's production of geocomposite rolls which include geocomposite roll numbers and identification, sampling procedures, and descriptions and results of quality control tests for the geonet specified in the General Specifications signed by a responsible party employed by the geocomposite Manufacturer.

The CQA Engineer will examine all of the geocomposite Manufacturer certifications to verify and document that the property values listed on the certifications meet or exceed those specified within the General Specifications and that proper and complete documentation has been provided by the geocomposite Manufacturer for all geocomposite used at the site. The CQA Engineer will report any deviations from the above requirements to the Owner prior to installation of the geocomposite.

VI.1.2 Labeling

The CQA Engineer will verify and document that the geocomposite Manufacturer has labeled all rolls of geocomposite as specified within the General Specifications.

The CQA Engineer will examine rolls upon delivery and any deviation from the above requirements will be reported to the Owner prior to installation of the geocomposite.

VI.1.3 Shipment and Storage

The CQA Engineer will observe rolls of geocomposite upon delivery at the site and any deviation from the requirements of the General Specifications will be reported to the Owner. Any damaged rolls will be rejected by the CQA Engineer and required to be repaired or replaced by the Contractor.

VI.1.4 Conformance Testing

Either at the Manufacturer's plant or upon delivery of the geocomposite rolls, the CQA Engineer will ensure that samples are removed and forwarded to the Geosynthetics CQA Laboratory for testing to verify and document conformance with the requirements of the General Specifications.

Conformance samples will be taken across the entire width of the roll and will not include the first 3 feet. Unless otherwise specified, samples will be 1.5 feet long (minimum) by the roll width. The CQA Engineer will mark the machine direction on the samples with an arrow.

Samples will be taken at a rate of one per lot or one per 100,000 square feet, whichever is greater. These samples will be tested for: peel strength (ASTM F 904); and hydraulic transmissivity, in accordance with the text methods presented in the specification.

The CQA Engineer will examine all results from laboratory conformance testing and will report any nonconformance to the Owner as soon as the results are become available.

The following procedure will apply whenever a sample fails a conformance test that is conducted by the Geosynthetics CQA Laboratory:

- The Contractor will be required to replace the roll (or rolls) of geocomposite that is not in conformance with the specifications with a roll that meets the requirements of the General Specifications.
- The CQA Engineer will ensure that conformance samples are removed for testing by the Geosynthetics CQA Laboratory from the closest numerical roll on both sides of the failed roll. These two samples must pass the above conformance tests. If either of these samples fails, samples will be collected from the 5 numerically closest untested rolls on both sides of the failed sample and tested by the Geosynthetics CQA Laboratory. These ten samples must pass the above conformance tests. If any of these samples fail, a sample from every roll of geocomposite on site and a sample from every roll that is subsequently delivered from the same Manufacturer must be conformance tested by the Geosynthetics CQA Laboratory. The cost of such tests is to be borne by the Contractor.

The CQA Engineer will document actions taken in conjunction with conformance test failures and report all actions to the Owner.

VI.1.5 Handling and Placement

The Contractor will be required to handle all geocomposite in such a manner as to ensure it is not damaged. The CQA Engineer will verify and document compliance with the following:

- Just prior to geocomposite placement, the layer that will underlie the geocomposite is clean and free of excessive amounts of dust, dirt, stones, rocks, or other obstructions that could potentially damage the underlying layers or clog the drainage system.
- In the presence of excessive wind, the geocomposite is weighted with sandbags (or equivalent weight approved by the CQA Engineer).
- Geocomposite is kept under tension to minimize the presence of wrinkles in the geocomposite. If necessary, the geocomposite is positioned by hand after being unrolled to minimize wrinkles.
- Geocomposites are cut using a geocomposite cutter approved by the geocomposite Manufacturer and the CQA Engineer. If in place, special care is taken to protect other materials from damage which could be caused by the cutting of the geocomposites.
- The Geosynthetics Contractor takes all necessary precautions to prevent damage to the underlying layers during placement of the geocomposite.
- Geocomposite is not welded to geomembranes.

- During placement of clean geocomposite, care is taken not to entrap stones, excessive dust, or moisture that could damage the underlying geomembrane, generate clogging of drains or filters, or hamper subsequent seaming.
- A visual examination of the geocomposite is carried out over the entire surface, after installation, to ensure that no potentially harmful foreign objects, such as needles, are present.
- Geocomposite is not left exposed for a period in excess of 30 days after placement unless a longer exposure period is approved by the CQA Engineer and the Owner.

The CQA Engineer will document any noncompliance with the above requirements and report it to the Owner.

VI.1.6 Seams and Overlaps

The components of the geocomposite (e.g., geotextile-geonet-geotextile) are not bonded together at the ends and edges of the rolls. The CQA Engineer will document that the geocomposite is overlapped and secured or seamed in accordance with the General Specifications.

VI.1.7 Repair

The CQA Engineer will verify that any holes or tears in the geocomposite are repaired in accordance with the General Specifications.

The CQA Engineer will observe any repair, document any noncompliance with the above requirements, and report the noncompliance to the Owner.

Section VII. Geonet Construction Quality Assurance

VII.1 Geonet

VII.1.1 Manufacturing

The Geosynthetics Contractor will be required to provide the CQA Engineer with the following information from the geonet Manufacturer:

- Certifications required by the General Specifications signed by a responsible party employed by the geonet Manufacturer;
- The certification from the geonet Manufacturer that no reclaimed polymer was added to the resin during the manufacture of the geonet rolls assigned to this project; and
- The manufacturing quality control certificates for each shift's production of geonet rolls, which include geonet roll numbers and identification, sampling procedures, and descriptions and results of quality control tests for polymer specified in the General Specifications signed by a responsible party employed by the geonet Manufacturer.

The CQA Engineer will examine all geonet Manufacturer's certifications to verify and document that the property values listed on the certifications meet or exceed those specified within the General Specifications and that proper and complete documentation has been provided by the geonet Manufacturer for all geonet used at the site. The CQA Engineer will report any deviations from the above requirements to the Owner.

VII.1.2 Labeling

The CQA Engineer will verify and document that the geonet Manufacturer has labeled all rolls of geonet as specified within the General Specifications.

The CQA Engineer will examine rolls upon delivery and any deviation from the above requirements will be reported to the Owner prior to installation of the geonet.

VII.1.3 Shipment and Storage

The CQA Engineer will observe the rolls of geonet upon delivery at the site and any deviations from the requirements specified within the General Specifications will be reported to the Owner. Any damaged rolls will be rejected by the CQA Engineer and will be required to be repaired or replaced by the Contractor.

VII.1.4 Conformance Testing

Either at the Manufacturer's plant or upon delivery of the geonet rolls, the CQA Engineer will ensure that samples are removed and forwarded to the Geosynthetic CQA Laboratory for testing, to verify and document conformance with the requirements of the General Specifications.

Conformance samples will be taken across the entire width of the roll and will not include the first 3 feet. Unless otherwise specified, samples will be 1.5 feet long (minimum) by the roll width. The CQA Engineer will mark the machine direction on the samples with an arrow.

Samples will be taken at a rate of one per lot or one per 100,000 square feet, whichever is greater. These samples will be tested for:

- Polymer specific gravity
- Carbon black
- Thickness
- Transmissivity
- Polymer melt index

Tests shall be conducted in accordance with the method indicated in the specification.

The CQA Engineer will examine all results from laboratory conformance testing and will report any nonconformance to the Owner as soon as the results become available.

The following procedure will apply whenever a sample fails a conformance test that is conducted by the Geosynthetics CQA Laboratory:

- The Contractor will be required to replace the roll (or rolls) of geonet that is not in conformance with the specifications with a roll that meets the requirements of the General Specifications.
- The CQA Engineer will ensure that conformance samples are removed for testing by the Geosynthetics CQA Laboratory from the closest numerical roll on both sides of the failed roll. These two samples must pass the above conformance tests. If either of these samples fails, samples will be collected from the five numerically closest untested rolls on both sides of the failed sample and tested by the Geosynthetics CQA Laboratory. These ten samples must pass the above conformance tests. If any of these samples fail, a sample from every roll of geonet on site and a sample from every roll that is subsequently delivered from the same Manufacturer must be conformance tested by the Geosynthetics CQA Laboratory. The cost of such tests is to be borne by the Contractor.

The CQA Engineer will document actions taken in conjunction with conformance test failures and report all actions taken to the Owner.

VII.1.5 Handling and Placement

The Contractor will handle all geonet in such a manner as to ensure the geonet is not damaged. The CQA Engineer will verify and document compliance with the following:

- The geonet is free of dirt or excessive dust just before installation.
- Just prior to geonet placement, the geomembrane liner that will underlie the geonet is clean and free of excessive amounts of dust, dirt, stones, rocks, or other obstructions that could potentially damage the geomembrane or clog the drainage system.
- On side slopes, the geonet is secured at the top of the slope then rolled down the slope in such a manner as to keep the geonet sheet in tension. If necessary, the geonet is positioned by hand after being unrolled to minimize wrinkles. Geonet can be place in the horizontal direction (i.e., across the slope) in some special locations (e.g., at the toe of a slope). If an extra layer of geonet is required, this extra layer of geonet can be placed in the horizontal direction. Such locations will be identified on the Construction Drawings.
- In the presence of excessive wind, the geonet is weighted with sandbags or the equivalent.

- Unless otherwise specified, geonet is not welded to geomembrane.
- Geonet will only be cut using a cutter approved by the geonet Manufacturer and the CQA Engineer. If in place, special care is taken to protect underlying geosynthetics from damage that could be caused by cutting of the geonet.
- The Geosynthetics Contractor takes any necessary precautions to prevent damage to underlying layers during placement of the geonet.
- During placement of geonets, care is taken not to entrap in the geonet dirt or excessive dust that could cause clogging of the drainage system, and/or stones that could damage the adjacent geomembrane. If dirt or excessive dust is entrapped in the geonet, it is hosed clean prior to placement of the next material on top of it. In this regard, care should be taken with the handling or sandbags, to prevent rupture or damage of the sandbag.
- Geonet is not placed in direct contact with textured geomembrane liner unless specifically called for in the Construction Drawings.

The CQA Engineer will document any noncompliance with the above requirements and report it to the Owner.

VII.1.6 Stacking and Joining

Geonet will be stacked and joined in accordance with the Construction Drawings and the General Specifications. As a minimum, the CQA Engineer will verify and document that staking, joining and overlapping is in accordance with the General Specifications.

The CQA Engineer will document any noncompliance with the above requirements and report it to the Owner.

VII.1.7 Repair

The CQA Engineer will verify and document that any holes or tears in the geonet are repaired in accordance with the General Specifications.

The CQA Engineer will observe any repair, note any noncompliance with the above requirements and report them to the Owner.

Section VIII. Polyethylene Pipe and Fittings Construction Quality Assurance

VIII.1 Polyethylene Pipe Manufacture and Delivery

VIII.1.1 Manufacturing

Prior to incorporating the polyethylene pipe and fittings into the work the Contractor will be required to provide the CQA Engineer with the certifications required by the General Specifications signed by a responsible party employed by the pipe Manufacturer.

The CQA Engineer will verify and document that the property values certified by the pipe Manufacturer meet the requirements of the General Specifications based on a sampling interval of one sample per lot. The CQA Engineer will report any deviations from the above requirements to the Owner.

VIII.1.2 Labeling

The CQA Engineer will verify that the pipe is labeled with the information specified in the General Specification. Any deviations from the labeling requirements will be reported to the Owner prior to pipe installation.

VIII.1.3 Shipment and Storage

The CQA Engineer will verify and document that the pipe and fittings are stored in accordance with the General Specifications.

The CQA Engineer will visually inspect the pipe upon delivery at the site and any deviations from the requirements of the General Specifications will be reported to the Owner.

VIII.1.4 Conformance Testing

No conformance testing will be conducted on the materials delivered to the site.

VIII.2 Pipe Installation

VIII.2.1 Handling and Laying

The CQA Engineer will verify and document that the pipe is installed at the specified locations and grades and that placement of backfill around and over the pipe is conducted in accordance with the requirements of the General Specifications, and in a manner intended to prevent damage to the pipe.

The pipe and fittings will be carefully examined before installation by the CQA Engineer. The CQA Engineer will verify and document that cracks, damage or defects are not present in the pipe and fittings in excess of that allowed by the General Specifications.

The CQA Engineer will also note the condition of the interior of pipes and fittings. Foreign material shall be removed from the pipe interior before it is moved into final position. No pipe will be permitted to be placed until the CQA Engineer has observed the condition of the pipe. The CQA Engineer will document any deviation from the above requirements and report it to the Owner.

VIII.2.2 Joints and Connections

Lengths of pipe will be required to be assembled into suitable installation lengths by the butt fusion process. Butt fusion refers to the butt joining of the pipe by softening the aligned faces of the pipe ends in a suitable apparatus and pressing them together under controlled pressure.

The CQA Engineer will spot monitor butt fusion welding operations to ensure that the Contractor follows the General Specifications.

The CQA Engineer will document any noncompliance with the above requirements and report it to the Owner.

VIII.2.3 Surveying

A Professional Land Surveyor registered in the State of New Mexico will provide the CQA Surveys. The CQA Surveyor will independently survey the final elevation of the invert of all polyethylene leachate collection pipe (excluding laterals).

The results of the survey will be compiled in a report signed by the CQA Surveyor and the CQA Engineer and will be reviewed by the Owner. The Owner and the CQA Engineer will approve the results contained in the report before any subsequent construction that completely covers the pipe occurs.

Section IX. ADS Slotted CPT and N12 Construction Quality Assurance

IX.1 ADS Slotted CPT Manufacture and Delivery

IX.1.1 Manufacturing

Prior to incorporating the slotted CPT into the work the Contractor will be required to provide the CQA Engineer with the certifications required by the General Specifications signed by a responsible party employed by the pipe Manufacturer.

The CQA Engineer will verify and document that the property values certified by the pipe Manufacturer meet the requirements of the General Specifications based on a sampling interval of one sample per lot. The CQA Engineer will report any deviations from the above requirements to the Owner.

IX.1.2 Labeling

The CQA Engineer will verify that the pipe is labeled with the information specified in the General Specification. Any deviations from the labeling requirements will be reported to the Owner prior to pipe installation.

IX.1.3 Shipment and Storage

The CQA Engineer will verify and document that the pipe and fittings are stored in accordance with the General Specifications.

The CQA Engineer will visually inspect the pipe upon delivery at the site and any deviations from the requirements of the General Specifications will be reported to the Owner.

IX.1.4 Conformance Testing

No conformance testing will be conducted on the materials delivered to the site.

IX.2 Pipe Installation

IX.2.1 Handling and Laying

The CQA Engineer will verify and document that the pipe is installed at the specified locations and grades and that placement of backfill around and over the pipe is conducted in accordance with the requirements of the General Specifications, and in a manner intended to prevent damage to the pipe.

The pipe and fittings will be carefully examined before installation by the CQA Engineer. The CQA Engineer will verify and document that cracks, damage or defects are not present in the pipe and fittings in excess of that allowed by the General Specifications.

The CQA Engineer will also note the condition of the interior of pipes and fittings. Foreign material shall be removed from the pipe interior before it is moved into final position. No pipe will be permitted to be placed until the CQA Engineer has observed the condition of the pipe.

The CQA Engineer will document any deviation from the above requirements and report it to the Owner.

IX.2.2 Joints and Connections

Lengths of pipe will be required to be assembled into suitable installation lengths by split couplers. The CQA Engineer will spot monitor installation of the split couplers to ensure that the Contractor follows the General Specifications. The CQA Engineer will document any noncompliance with the above requirements and report it to the Owner.

IX.2.3 Surveying

A Professional Land Surveyor registered in the State of New Mexico will provide the CQA Surveys. The CQA Surveyor will independently survey the final elevation of the invert of all slotted CPT.

The results of the survey will be compiled in a report signed by the CQA Surveyor and the CQA Engineer and will be reviewed by the Owner. The Owner and the CQA Engineer will approve the results contained in the report before any subsequent construction that completely covers the pipe occurs.

Section X. Corrugated Metal Pipe Construction Quality Assurance

X.1 Corrugated Metal Pipe Manufacture and Delivery

X.1.1 Manufacturing

Prior to incorporating the corrugated metal pipe (CMP) into the work the Contractor will be required to provide the CQA Engineer with the certifications required by the General Specifications signed by a responsible party employed by the pipe Manufacturer.

The CQA Engineer will verify and document that the property values certified by the pipe Manufacturer meet the requirements of the General Specifications based on a sampling interval of one sample per lot. The CQA Engineer will report any deviations from the above requirements to the Owner.

X.1.2 Labeling

No labels required in specifications.

X.1.3 Shipment and Storage

The CQA Engineer will verify and document that the pipe and fittings are stored in accordance with the General Specifications.

The CQA Engineer will visually inspect the pipe upon delivery at the site and any deviations from the requirements of the General Specifications will be reported to the Owner.

X.1.4 Conformance Testing

No conformance testing will be conducted on the materials delivered to the site.

X.2 CMP Installation

X.2.1 Handling and Laying

The CQA Engineer will verify and document that the pipe is installed at the specified locations and grades and that placement of backfill around and over the pipe is conducted in accordance with the requirements of the General Specifications, and in a manner intended to prevent damage to the pipe.

The pipe and fittings will be carefully examined before installation by the CQA Engineer. The CQA Engineer will verify and document that cracks, damage or defects are not present in the pipe and fittings in excess of that allowed by the General Specifications.

The CQA Engineer will also note the condition of the interior of pipes and fittings. Foreign material shall be removed from the pipe interior before it is moved into final position. No pipe will be permitted to be placed until the CQA Engineer has observed the condition of the pipe.

The CQA Engineer will document any deviation from the above requirements and report it to the Owner.

X.2.2 Joints and Connections

Lengths of pipe will be required to be assembled into suitable installation lengths. The CMP will be joined using the manufacturer's recommended equipment and procedures. The CQA Engineer will spot monitor joining operations to ensure that the Contractor follows the manufacturer's specifications. The CQA Engineer will document any noncompliance with the above requirements and report it to the Owner.

X.2.3 Surveying

A Professional Land Surveyor registered in the State of New Mexico will provide the CQA Surveys. The CQA Surveyor will independently survey the final elevation of the invert of all CMP.

The results of the survey will be compiled in a report signed by the CQA Surveyor and the CQA Engineer and will be reviewed by the Owner. The Owner and the CQA Engineer will approve the results contained in the report before any subsequent construction that completely covers the pipe occurs.

Section XI. Carbon and Stainless Steel Pipe Construction Quality Assurance

XI.1 Steel Pipe Manufacture and Delivery

XI.1.1 Manufacturing

Prior to incorporating the steel pipe into the work the Contractor will be required to provide the CQA Engineer with the certifications required by the General Specifications signed by a responsible party employed by the pipe Manufacturer.

The CQA Engineer will verify and document that the property values certified by the pipe Manufacturer meet the requirements of the General Specifications based on a sampling interval of one sample per lot. The CQA Engineer will report any deviations from the above requirements to the Owner.

XI.1.2 Labeling

The CQA Engineer will verify that the pipe is labeled with the information specified in the General Specification. Any deviations from the labeling requirements will be reported to the Owner prior to pipe installation.

XI.1.3 Shipment and Storage

The CQA Engineer will verify and document that the pipe and fittings are stored in accordance with the General Specifications.

The CQA Engineer will visually inspect the pipe upon delivery at the site and any deviations from the requirements of the General Specifications will be reported to the Owner.

XI.1.4 Conformance Testing

No conformance testing will be conducted on the materials delivered to the site.

XI.2 Pipe Installation

XI.2.1 Handling and Laying

The CQA Engineer will verify and document that the pipe is installed at the specified locations and grades and that placement of backfill around the pipe is conducted in accordance with the requirements of the General Specifications, and in a manner intended to prevent damage to the pipe.

The pipe will be carefully examined before installation by the CQA Engineer. The CQA Engineer will verify and document that cracks, damage or defects are not present in the pipe fittings in excess of that allowed by the General Specifications.

The CQA Engineer will also note the condition of the interior of pipes. Foreign material shall be removed from the pipe interior before it is moved into final position. No pipe will be permitted to be placed until the CQA Engineer has observed the condition of the pipe.

The CQA Engineer will document any deviation from the above requirements and report it to the Owner.

XI.2.2 Joints and Connections

Lengths of pipe will be required to be assembled into suitable installation lengths by butt welding.

The CQA Engineer will spot monitor welding operations to ensure that the Contractor follows the General Specifications.

The CQA Engineer will document any noncompliance with the above requirements and report it to the Owner.

XI.2.3 Surveying

A Professional Land Surveyor registered in the State of New Mexico will provide the CQA Surveys. The CQA Surveyor will independently survey the final elevation of the basal location of all steel pipe.

The results of the survey will be compiled in a report signed by the CQA Surveyor and the CQA Engineer and will be reviewed by the Owner. The Owner and the CQA Engineer will approve the results contained in the report before any subsequent construction that completely covers the pipe occurs.

Section XII. Polyethylene Tank Construction Quality Assurance

XII.1 Polyethylene Tank Manufacture and Delivery

XII.1.1 Manufacturing

Prior to incorporating the polyethylene tank into the work the Contractor will be required to provide the CQA Engineer with the certifications required by the General Specifications signed by a responsible party employed by the polyethylene tank Manufacturer.

The CQA Engineer will verify and document that the property values certified by the polyethylene tank Manufacturer meet the requirements of the General Specifications based on a sampling interval of one sample per lot. The CQA Engineer will report any deviations from the above requirements to the Owner.

XII.1.2 Labeling

The CQA Engineer will verify that the polyethylene tank is labeled with the information specified in the General Specification. Any deviations from the labeling requirements will be reported to the Owner prior to pipe installation.

XII.1.3 Shipment and Storage

The CQA Engineer will verify and document that the polyethylene tanks are stored in accordance with the General Specifications.

The CQA Engineer will visually inspect the polyethylene tank upon delivery at the site and any deviations from the requirements of the General Specifications will be reported to the Owner.

XII.1.4 Conformance Testing

No conformance testing will be conducted on the materials delivered to the site.

XII.2 Polyethylene Tank Installation

XII.2.1 Handling and Laying

The CQA Engineer will verify and document that the polyethylene tank is installed at the specified locations, and in a manner intended to prevent damage to the polyethylene tank.

The polyethylene tank will be carefully examined before installation by the CQA Engineer. The CQA Engineer will verify and document that cracks, damage or defects are not present in the polyethylene tank in excess of that allowed by the General Specifications.

The CQA Engineer will document any deviation from the above requirements and report it to the Owner.

The owner will obtain and keep on file at the facility written statements by the CQA engineer certifying that the design and installation of the tank system was performed in accordance with the requirements of paragraphs (B) through (F) of 40 CFR 264192.

XII.2.2 Surveying

A Professional Land Surveyor registered in the State of New Mexico will provide the CQA Surveys. The CQA Surveyor will independently survey the final locations and elevation of the base of the polyethylene tank.

The results of the survey will be compiled in a report signed by the CQA Surveyor and the CQA Engineer and will be reviewed by the Owner. The Owner and the CQA Engineer will approve the results contained in the report before any subsequent construction hinders surveying of the polyethylene tank.

Section XIII.Stabilization Bins Construction Quality Assurance

XIII.1Stabilization Bins Manufacture and Delivery

XIII.1.1Manufacturing

Prior to incorporating the stabilization bins into the work the Contractor will be required to provide the CQA Engineer with the certifications required by the General Specifications signed by a responsible party employed by the stabilization bins tank Manufacturer.

The CQA Engineer will verify and document that the property values certified by the stabilization bins manufacturer meet the requirements of the General Specifications based on a sampling interval of one sample per lot. The CQA Engineer will report any deviations from the above requirements to the Owner.

XIII.1.2Labeling

The CQA Engineer will verify that the stabilization bins are labeled with the information specified in the General Specification. Any deviations from the labeling requirements will be reported to the Owner prior to pipe installation.

XIII.1.3Shipment And Storage

The CQA Engineer will verify and document that the stabilization bins are stored in accordance with the General Specifications.

The CQA Engineer will visually inspect the stabilization bins upon delivery at the site and any deviations from the requirements of the General Specifications will be reported to the Owner.

XIII.1.4Conformance Testing

No conformance testing will be conducted on the materials delivered to the site.

XIII.2Stabilization Bins Installation

XIII.2.1Handling and Laying

The CQA Engineer will verify and document that the stabilization bins are installed at the specified locations, and in a manner intended to prevent damage to the stabilization bins.

The stabilization bins will be carefully examined before installation by the CQA Engineer. The CQA Engineer will verify and document that cracks, damage or defects are not present in the stabilization bins in excess of that allowed by the General Specifications.

The CQA Engineer will document any deviation from the above requirements and report it to the Owner.

~~The owner will obtain and keep on file at the facility written statements by the CQA engineer certifying that the design and installation of the stabilization bins was performed in accordance with the requirements of paragraphs (B) through (F) of 40 CFR 264192.~~

~~XIII.2.2Surveying~~

~~A Professional Land Surveyor registered in the State of New Mexico will provide the CQA Surveys. The CQA Surveyor will independently survey the final locations and elevation of the base of the stabilization bins.~~

~~The results of the survey will be compiled in a report signed by the CQA Surveyor and the CQA Engineer and will be reviewed by the Owner. The Owner and the CQA Engineer will approve the results contained in the report before any subsequent construction hinders surveying of the stabilization bins.~~

Section XIV. Concrete Formwork Construction Quality Assurance

XIV.1 Concrete Formwork Manufacture

Prior to incorporating the formwork into the work the Contractor will be required to provide the CQA Engineer with the requirements of the General Specifications.

The CQA Engineer will verify and document that the material properties meet the requirements of the General Specifications. The CQA Engineer will report any deviations from the above requirements to the Owner.

XIV.2 Formwork Installation

XIV.2.1 Handling and Laying

The CQA Engineer will verify and document that the formwork is installed at the specified locations, and in the manner intended by the General Specifications.

The CQA Engineer will document any deviation from the above requirements and report it to the Owner.

XIV.2.2 Surveying

A Professional Land Surveyor registered in the State of New Mexico will provide the CQA Surveys. The CQA Surveyor will independently survey the final locations and elevation of the formwork.

The results of the survey will be compiled in a report signed by the CQA Surveyor and the CQA Engineer and will be reviewed by the Owner. The Owner and the CQA Engineer will approve the results contained in the report before any subsequent construction hinders surveying of the formwork.

Section XV. Reinforcement Steel Construction Quality Assurance

XV.1 Reinforcement Steel Manufacture and Delivery

XV.1.1 Manufacturing

Prior to incorporating the reinforcement steel into the work, the Contractor will be required to provide the CQA Engineer with the material certifications required by the General Specifications signed by a responsible party employed by the reinforcement steel Manufacturer.

The CQA Engineer will verify and document that the property values certified by the reinforcement steel Manufacturer meet the requirements of the General Specifications. The CQA Engineer will report any deviations from the above requirements to the Owner.

XV.1.2 Labeling

The CQA Engineer will verify that the reinforcement steel is labeled with the information specified in the General Specification. Any deviations from the labeling requirements will be reported to the Owner prior to pipe installation.

XV.1.3 Shipment and Storage

The CQA Engineer will verify and document that the reinforcement steel is stored in accordance with the General Specifications.

XV.1.4 Testing

If requested by the Engineer, testing outlined in the General Specifications will be conducted.

XV.2 Reinforcement Steel Installation

The CQA Engineer will verify and document that the reinforcement steel is installed at the specified locations, and in a manner intended to prevent damage to the work.

The reinforcement steel will be examined to ensure that the requirements of the General Specifications are followed.

The CQA Engineer will document any deviation from the above requirements and report it to the Owner.

Section XVI. Joints in Concrete Construction Quality Assurance

XVI.1 Joint Material Manufacture

Prior to incorporating the joint materials into the work the Contractor will be required to provide the CQA Engineer with the certifications required by the General Specifications signed by a responsible party employed by the Manufacturer.

The CQA Engineer will verify and document that the property values certified by the Manufacturer meet the requirements of the General Specifications. The CQA Engineer will report any deviations from the above requirements to the Owner.

XVI.2 Joint Installation

The CQA Engineer will verify and document that the joint materials, locations and installation procedures are in accordance with the General Specifications. The CQA Engineer will document any deviation from the above requirements and report it to the Owner.

Section XVII. Miscellaneous Metalwork Construction Quality Assurance

XVII.1 Miscellaneous Metalwork Submittals

Prior to incorporating the miscellaneous metalwork into the work, the Contractor will be required to provide the CQA Engineer with the submittals required by the General Specifications.

XVII.2 Fabrication and Installation

The CQA Engineer will verify and document that the miscellaneous metalwork is fabricated and installed at the specified locations, and in a manner intended by the General Specifications.

Section XVIII. Cast in Place Concrete Construction Quality Assurance

XVIII.1 Submittals

Prior to incorporating the cast in place concrete into the work, the Contractor will be required to provide the CQA Engineer all submittals required by the General Specifications.

XVIII.2 Conference

Prior to incorporating the cast in place concrete into the work, the Contractor will be required to hold a meeting to discuss items required in the General Specifications.

XVIII.3 Testing

The CQA Engineer will verify and document that material sampling and testing required in the General Specifications is completed.

Section XIX. Electrical System and Pump Control Construction Quality Assurance

XIX.1 Submittals

Prior to incorporating the electrical system and pump controls into the work, the Contractor will be required to provide the CQA Engineer with the submittals required by the General Specifications.

XIX.2 Installation

The CQA Engineer will systematically examine wiring and conduits before covering or backfilling to confirm proper routing, wire size, and connection methods.

XIX.3 Component Check

The CQA Engineer will perform or review component checks of resistance, grounding, and load prior to complete system check.

Checking and calibration of these systems will be performed according to manufacturer recommendations and procedures.

XIX.4 Testing

The CQA Engineer will witness and document acceptance testing of the pump control system.

Section XX. Pumps, Piping, Meters, and Valve Construction Quality Assurance

XX.1 Submittals

Prior to incorporating the pumps, piping, instruments (such as flow meter), and valves into the work, the Contractor will be required to provide the CQA Engineer with the submittals required by the General Specifications.

XX.2 Installation

The CQA Engineer will observe connections and components for proper assembly, usage and construction.

XX.3 Component Check

The CQA Engineer will perform or review component checks of equipment to confirm operation in accordance with the specifications.

Checking and calibration of these systems will be performed according to manufacturer recommendations and procedures.

XX.4 Testing

The CQA Engineer will witness and document acceptance testing of the leachate removal system.

Section XXI. Construction Quality Assurance Documentation

XXI.1 Documentation

XXI.1.1 Introduction

An effective CQA plan depends largely on recognition of all construction activities that should be monitored, and on assigning responsibilities for the monitoring of each activity. This is most effectively accomplished and verified by the documentation of construction quality assurance activities. The CQA Engineer will document that all quality assurance requirements have been addressed and satisfied.

The CQA Engineer will provide the Owner with signed descriptive remarks, data sheets, and logs to verify and document that all monitoring activities have been carried out. The Owner will maintain at the site a complete file of Construction Drawings, the CQA plan, the General Specifications, (test procedures, daily reports, testing logs, and other pertinent forms and documents. The forms to be used for CQA documentation should include, at a minimum, those presented in this CQA Plan. The forms presented in this CQA Plan may be revised as necessary by the CQA Engineer.

XXI.1.2 Daily Record Keeping

XXI.1.2.1 Overview

Daily records will be completed in the field documenting CQA project administration, soils CQA, geosynthetics CQA, and other required CQA activities. The forms to be completed that pertain to each of these categories of records are discussed below.

XXI.1.2.2 Project Administration Records

Most project administration records are completed daily by the CQA Engineer and submitted weekly to the Owner. Examples of these forms are included in Appendix B and are briefly described below.

XXI.1.2.2.1 Daily Field Report

The Daily Field Report will be prepared by the CQA Engineer and submitted weekly to the Owner. At a minimum, the Daily Field Report will include the following information:

- The date, project name, location, and other identification;
- A narrative of the events and activities, including meetings and observation which occurred during a given day;
- The weather conditions;
- Source and amount of water used to construct the clay liner, if any;
- The name of parties to any discussions;
- The relevant subject matter or issues;
- The activities planned and performed;
- The schedule; and
- The signature of the CQA Engineer.

XXI.1.2.2.2 Weekly Field Report

On a weekly basis, the CQA Engineer will summarize in a Weekly Field Report the activities recorded on the Daily Field Reports. This report will be submitted each week to the Owner along with the Daily Field Reports, and will include, at a minimum, the following information:

- The date, project name, location, and other information;
- A summary of work activities during reporting period;
- A summary of construction situations, deficiencies, and/or defects occurring during the reporting period;
- A summary of actions taken to remedy such situations, deficiencies and or defects; and
- The signature of the CQA Resident Engineer.

Since the weekly report is presented in a report format, a form is not presented in Appendix B.

XXI.1.2.3 Soils CQA Records

Records kept for soils related activities will be completed by the CQA Engineer. The information will be recorded as testing is done in the field or as results are received from the laboratory. The records will be available for review on site, and copies will be issued as part of the Final Report. Examples of the relevant forms are included in Appendix B and are briefly described below.

XXI.1.2.3.1 Field Laboratory Compaction Test Log (ASTM D 698 Method A, B, C, D and ASTM D 1557 Method A, B, C)

The results of field compaction tests will be recorded on the Field Laboratory Compaction Test Log. Separate forms are available for each test method used.

XXI.1.2.3.2 Standard Count, Field Sand Cone and Rubber Balloon Density Test Log

The results of the sand cone and or rubber balloon Density Test Log. The results will be used for comparison or calibration with nuclear density test results.

XXI.1.2.3.3 Summary of Sieve Analysis Test Data

This form will provide a summary of sieve analysis test results for soils.

XXI.1.2.3.4 Summary of Field Density Test

This form will provide a summary of field nuclear density test results and sand cone test results for soils.

XXI.1.2.3.5 Summary of Index Laboratory Test Data

This form will provide a summary of index test results performed as required for soils.

XXI.1.2.3.6 Summary of Permeability Laboratory Data

This form will provide a summary of laboratory permeability test data required for clay liners.

XXI.1.2.4 Geosynthetics CQA Records

Records for the installation of geosynthetics will be completed by the CQA Engineer. The information will be recorded as the work progresses. The records will be available for review on site and copies will be issued as part of the final CQA report. Examples of the CQA forms to be completed for geosynthetics are included in Appendix D and briefly described below.

XXI.1.2.4.1 Material Inventory

The identifying roll number and pertinent information of each roll of geosynthetic received at the site will be recorded on this form as the materials arrive at the site. This information will be used to track manufacturer's quality control information, conformance test samples, and other CQA documentation.

XXI.1.2.4.2 Nondestructive Test Log

This form will be used to record the time, date, equipment operator, and results of vacuum box or air pressure testing of production geomembrane seaming operations.

XXI.1.2.4.3 Panel Placement Monitoring Log

This form will be used to record geomembrane panel numbers as they are placed in the field and to cross-reference the assigned panel numbers with roll numbers. The weather conditions, time, and temperature at placement will be recorded on the log. Measured dimensions used to calculate the area of the geomembrane will be recorded on the log.

XXI.1.2.4.4 Repair Summary Log

Information on repairs to geomembrane panels and seams will be recorded on this form. The information recorded will include a code to describe the type of repair, the name of the operator making the repair, the location (i.e. seam or panel location) of the repair, nondestructive testing results of the repair, and initials of the CQA Engineer observing the repair.

XXI.1.2.4.5 Seam and Panel Location Log

The relative location of repairs to geomembrane panels and seams described in the Repair Summary Log will be recorded on this form. The results of destructive tests and nondestructive can be indicated in this log, as well as, location and results of thickness measurements taken for each panel.

XXI.1.2.4.6 Destructive Test Log

This form will be used to record the results from testing performed on geomembrane seams at the Geosynthetics CQA Laboratory (an independent testing laboratory). The results for both pep and shear will be recorded. The form will be completed as data becomes available.

XXI.1.2.4.7 Trail Seam and Seaming Log

This form will be used to record results of trial geomembrane seam testing and to track production seaming activities. The time, temperature, type of seaming equipment used, name of seamer, and length of seam will be recorded.

XXI.1.2.4.8 Certificate of Acceptance Subgrade Surface

The Certificate of Acceptance is required to be signed by the Contractor prior to the installation of the geomembrane. The area being accepted must be described on the certificate.

XXI.1.2.5 Survey Records

Record Drawings resulting from the surveying performed by the CQA Surveyor will be reviewed by the CQA Engineer and the Owner. The Record Drawings will be available for review onsite, and copies will be issued as part of the final CQA Report issued by the CQA Engineer. At a minimum, these Records Drawings will include as-built survey data for the following liner system components:

- Prepared subgrade;
- Structural fill

- Clay liner;
- Polyethylene pipe and fittings;
- Geomembrane liners;
- Drainage Gravel;
- Protective soil layer;
- Road Base;
- Cover Soil;
- Vegetative cover;
- Pipe bedding;
- Select Subbase;
- Subbase;
- Foundation sand;
- Geocomposite;
- Geonet;
- Geotextile;
- Polyvinyl Chloride Pipe;
- Geosynthetic Clay Liner
- Steel Pipe; and
- Polyethylene Tank.

XXI.1.3 Photographic Documentation

Photographic documentation will serve as a pictorial record of work progress, problems, and mitigation activities. The basic file will contain color prints; negatives will also be stored in a separate file in chronological order. These photographs will be available for review by the Owner, the CQA Engineer, and other interested parties. Selected photographs will be reproduces as part of the Final Report. The remaining photographs will be transmitted to the Owner and archived by the Owner as part of the operating records.

XXI.1.4 Design and/or Specification Changes

Design and/or specification changes may be required during construction. In such cases, the CQA Engineer will notify the Owner. The Owner will submit these changes to NMED for review and approval according to permit notifications requirements of 40 CFR 270.41 and 42.

Major design and/or specifications changes will be made only with the written agreement of the Design Engineer and the Owner and will take the form of an addendum to the General Specifications.

XXI.1.5 Signatures and Final Reports

At the completion of the work, the CQA Engineer will submit a final CQA report to the Owner.

At a minimum, this report will include: (a) summaries of all construction activities; (b) sources and amounts of water used to construct the clay liners; (c) results of chemical quality analyses of construction water from each source; (d) observation logs and testing data sheets including sample location plans; (e) a discussion of any changes from design and material specifications; (f) CQA Record Drawings; and (g) a summary statement sealed and signed by a Professional Engineer registered in the State of New Mexico that construction quality assurance was conducted as provided in the CQA Plan and, based on visual observations and data generated in accordance with the CQA Plan, the landfill or surface impoundment was constructed in accordance with

40 CFR 264.19, the Construction Drawings, the CQA Plan, and the General Specifications, except as properly authorized and documented in the CQA final report. The CQA Record Drawings will include the following: primary and secondary geomembrane panel layout drawings; all drawings (including cross-sections) depicting any deviations from the Construction Drawings; and all survey conformance data.

A separate Final Report will be issued for each phase of the landfill. The final CQA Report will present the results of CQC tests conducted by the installation constructors as well as the CQA tests.

Appendix A

Test Fill Plan

1.0 PURPOSE AND SCOPE

The purpose of the test fill is to establish a sequential and logical approach for the development of placement and compaction procedures to be used during construction of cohesive soil liners as an indicator that the soil liners are constructed in a way that meets design performance specifications. The test fill program will allow the Contractor, the Design Engineer, and the Construction Quality Assurance (CQA) engineer to identify appropriate placement and compaction procedures by establishing relationships between various compaction parameters, density, water content, Atterberg limits, particle size distribution, and permeability of the fill.

Once the construction procedures have been established by the test fill program, the Contractor and the CQA Engineer will monitor the cohesive soil liner construction procedures as an indicator that the design performance specifications are being achieved, Test fill construction procedures will include measuring lift thickness, counting the number of compactor coverages, and performing in-place density and moisture content tests to verify that the specified degree of compaction is achieved.

The test fill will be constructed in uniform horizontal lifts of uniform thicknesses.

This test fill program documents the requirements for constructing the test fill. The test fill program will include:

- subgrade preparation
- construction of a 3-foot-thick test fill
- inspection and testing of the test fill
- sampling of portions of the test fill

The test fill program described in this appendix may be modified based on site specific design and construction considerations.

Feasibility testing of clay sources will have been performed before the start of the test fill. These tests should provide the basic relationship of permeability with varying density and moisture content.

2.0 CONSTRUCTION EQUIPMENT

The equipment to be used for the test fill shall be proposed by the Contractor, and approved by the CQA Engineer and Project Manager.

3.0 TEST FILL MATERIAL

Test fill material shall be approved by the CQA Engineer. The material shall meet the requirements of the Specification Section 02221. The Material shall be an inorganic cohesive soil with a plasticity index (PI) ranging between 10 and 40; at least 50 percent of the soil shall pass the No. 200 sieve. As approved by the CQA Engineer, small quantities of fill with PI greater than 40 may be allowed if such materials are thoroughly mixed with other less plastic soils. Other materials may be considered based upon laboratory testing and upon approval of the Project Manager. The maximum particle size shall be 2 inches before processing. No frozen material shall be used, and in-place material that becomes frozen prior to completion of operations shall be removed.

4.0 TEST FILL CONSTRUCTION

4.1 SUBGRADE PREPARATION

The area within the limits of the test fill shall be cleared and grubbed of all trees, debris, brushes, stumps, roots, trash, and any other vegetation or objectionable material. Following clearing and grubbing, the area shall be stripped of topsoil. Topsoil shall be stockpiled in an area designated by the Project Manager.

The surface of the subgrade shall be proof-rolled so as to be free of soft zones, irregularities, loose earth, and abrupt changes in grade. The subgrade and test fill shall be sloped at a 2 percent grade. No standing water or excessive moisture shall be allowed on the surface of the subgrade. The surface shall be inspected by the CQA Engineer prior to beginning construction of the test fill.

If placement and compaction of soil materials on slope areas is to be accomplished by the downslope compaction method rather than by horizontal benching, the test fill shall have a sloped area of similar grade to the intended liner installation where the downslope compaction method can be evaluated.

4.2 CONFIGURATION

The test fill shall be a rectangle approximately 60 feet long by 20 feet wide. The test fill shall be constructed to a thickness of 3 feet in uniform horizontal lifts. Lines and grades shall be controlled by survey.

4.3 FILL PLACEMENT

The test fill shall be constructed in uniform horizontal lifts to a total thickness of 3 feet after compaction in accordance with the procedures specified below. The procedures, which vary with the lift considered, are intended to allow determination of a relationship between soil compaction criteria, which include density and moisture content, permeability, and compaction method parameters. Compaction method parameters include: (1) compactor characteristics; (2) thickness of compacted/uncompacted layers; (3) number of compactor coverages; and, soils moisture content.

4.3.1 First Lift

1. The first lift of test fill material shall be placed to a thickness resulting in 6 inches after compaction.

2. Soils moisture content shall be maintained when the placement window defined in the Specifications (Section 02221). The contractor shall adjust the moisture content as necessary to obtain the specified density criteria.

3. The test fill material shall be compacted with two one-way coverages using the Contractor's proposed compaction equipment.

4. The Contractor shall permit the CQA Engineer to perform in-place density tests and collect soil samples as specified in 5-3..

5. QA Engineer to perform in-place density tests and collect soil samples as specified in Section 5.3.

6. Holes left in the lift shall be repaired in accordance with methods outlined in the CQA plan. The repairs shall be compacted using procedures which have been shown to meet the required moisture and density criteria.

7. The test fill material shall be compacted a second time by applying two more one-way coverages with the selected compactor.

8. Steps 4 and 5 shall be repeated. Second tests shall be taken near the original tests.

9. The test fill material shall be compacted a third time by applying two more one-way coverages with the selected compactor.

10. Steps 4 and 5 shall be repeated. Third tests shall be taken near the first and second tests.

11. Steps 8 and 9, respectively, shall be repeated and continued until specified compaction criteria are obtained as identified by the CQA Engineer.

4.3.2 Second Lift

1. The loose thickness of the second lift shall be such that the thickness of the lift will be 6 inches after compaction.

2. A competent bond with the first lift shall be achieved by the Contractor and approved by the CQA Engineer.

3. Steps 2 through 10 of Section 4.3.1 shall be repeated.

4.3.3 Remaining Lifts

1. The loose thickness of the remaining lifts shall be such that the thickness of the lifts will be 6 inches after compaction.

2. The procedures for compacting and testing the remaining lifts shall be those that have been tested and proven effective during the compaction of the second lift.

4.3.4 Final Surface Preparation

The surface of the test fill shall be rolled with a smooth steel drum or pneumatic rolled so as to be free of irregularities, loose earth, and abrupt changes in grade. All stones larger than 1 inch shall be removed. Stones which are smaller than 1 inch and are judged to be detrimental to a geomembrane liner will be removed. One-half of the prepared soil surface shall be protected against drying with temporary plastic sheets. The sheets shall be placed immediately after the completion of surface preparation. Observations and documentation of desiccation cracking versus time shall be made on the uncovered section of the test fill.

5.0 INSPECTION AND TESTING

5.1 TEST FILL MATERIAL

The CQA Engineer shall perform testing on the cohesive soil material prior to its use in the test fill. Testing, using the most recent ASTM method, will include at least the following:

- soil density/moisture content relationship using the Modified and Standard Proctor Compaction Method (ASTM D 698 and ASTM D 1557)
- natural water content (ASTM D 2216)
- particle size distribution (ASTM D 422)
- Atterberg limits (ASTM D 4318)
- soil classification (ASTM D 2487)

5.2 SUBGRADE PREPARATION

The CQA Engineer shall observe the prepared subgrade for firmness, smoothness, and absence of abrupt changes in grade.

5.3 TEST FILL CONSTRUCTION

5.3.1 Lift Compaction

For the first and second lifts, the CQA Engineer shall perform the following activities:

- estimate the thickness of the loose lifts
- count the number of compactor coverages and observe compactor coverage of the test fill (Figure 1)
- at every two (2) coverages, perform a minimum of eight nuclear gauge in-place density and moisture reading (ASTM D 2292); compute degree of compaction (i.e., in-place dry density divided by the Standard Proctor or Modified maximum dry density; collect four additional soil samples for moisture content determination (ASTM D 2216)
- observe the repair of holes left in the lift as a result of density testing and soil sample collection
- continue in-place density testing and moisture content determination to enable development of a curve giving in-lace dry density versus number of compactor coverages for each lift thickness

For each of the remaining lifts, the CQA engineer shall perform the following activities:

- verify that the thickness of the loose lift does not exceed the loose thickness determined from testing of the second lift
- count the number of compactor coverages, determined from testing of the second lift, which are necessary to achieve the specified density and observe compactor coverage of the test fill
- perform a minimum of eight nuclear density tests per lift to verify the adequacy of the construction procedures previously established

The CQA Engineer shall collect a minimum of six (6) undisturbed samples from varying depths of the completed test fill. The samples shall be waxed or otherwise protected to retain natural moisture and tested in the laboratory for the following:

- hydraulic conductivity (permeability) using water as the permeant (ASTM D 5084)
- dry density
- particle size distribution (ASTM D 422)
- Atterberg limits (ASTM D 4318)
- soil classification (ASTM D 2487)
- soil moisture content (ASTM D 2216)

The CQA Engineer shall observe the test fill to verify the adequacy of the bonding between adjacent lifts. Such observation shall be exercised on the portion of the test fill which has been excavated to permit removal of undisturbed soil block samples.

5.3.2 Final Surface Preparation

The CQA Engineer shall observe the prepared surface for firmness, smoothness, and absence of abrupt changes in grade.

5.3.3 Permeability Testing

The permeability of the test fill shall be assessed by performance of a minimum of six (6) laboratory tests on 12-inch diameter undisturbed specimens obtained at a location selected by the CQA Engineer.

5.4 TEST RESULTS

The test results which will be used to verify that the specified construction procedures meet the design performance criteria shall be:

- compaction testing (i.e., degree of compaction, in-place dry density, and moisture content)
- results of laboratory permeability testing performed on undisturbed soils samples
- soil index testing to evaluate material suitability

5.5 LINES AND GRADES

The following surfaces shall be surveyed to verify that proper thicknesses have been constructed:

- prepared surface of the subgrade
- final surface of the test fill

6.0 DOCUMENTATION

The CQA Engineer shall document activities associated with the construction, monitoring, and testing of the test fill. Such documentation shall include daily reports of construction activities and oral communications with the contractor. In addition, the following shall be documented for each of the section listed below:

6.1 TEST FILL MATERIAL

The CQA Engineer shall provide a moisture-density relationship for the test fill liner material and other and other test results as specified in Section 5.1.

6.2 TEST FILL CONSTRUCTION

6.2.1 Subgrade preparation

The CQA Engineer shall document observations on subgrade preparation, as specified in Section 5.2.

6.2.2 Test Fill Construction

The CQA Engineer shall document activities of the test fill construction, monitoring, and testing in a test fill summary report, which shall include but not be limited to:

- record of the compactor type, configuration, and weight; for sheepsfoot compactors, record the drum diameter and length, empty and ballasted weight, length and face area of feet, and yoking arrangement, if any
- record thicknesses of lifts prior to and after compaction
- record density versus number of compactor coverages for each lift thickness, as specified in Section 5.3.1
- record the number of compactor coverage which will provide the specified degree of compaction and permeability
- record the procedure to bond lifts
- results of moisture, in-place density and degree of compaction, as specified in Section 5.3.1
- repair of holes left in the lift as a result of density testing and soil sample collection, as specified in Section 5.3.1
- results of laboratory permeability testing and other soil properties tests performed on undisturbed soil samples
- as-built drawing of the test fill and locations of all test samples for each lift
- cross-section of the test fill showing number of lifts and lift thickness
- description of actual construction procedures
- observations of test fill excavation for removal of undisturbed soils samples and observations of layer bonding, as specified in Section 5.3.1

Appendix B

Project Administration Records

TerraMatrix
Engineering & Environmental Services
1475 Pine Grove Road, P.O. Box 774018
Steamboat Springs, Colorado 80477

FIELD ENGINEER'S DAILY REPORT

PROJECT NAME: TRIASSIC PARK WASTE DISPOSAL FACILITY
PROJECT NUMBER: 602
PAGE ____ of ____
FIELD ENGINEER:____________________

DATE:______________ S M T W T F S
AREA:____________________
____
WEATHER:____________________

CONTRACTOR WORK PERFORMED..

TESTING OR SURVEYING PERFORMED..

DISCUSSIONS WITH CONTRACTOR OR CLIENT..

COMMENTS..

VISITORS:

Field Book Number ___ Pages ___ to ___
SIGNATURE:____________________

MONTGOMERY WATSON WEEKLY FIELD SUMMARY REPORT
TRIASSIC PARK WASTE DISPOSAL FACILITY
CONSTRUCTION QUALITY ASSURANCE
WEEK #1

Introduction

In accordance with the CQA Implementation Plan for cover construction at the Triassic Park Waste Disposal project, Montgomery Watson is providing a weekly summary of construction and CQA activities for the construction related to the earthworks geosynthetics. Copies of Daily Reports and associated field book notes have been submitted previously. The following table presents a summary of construction conditions and activities for the week.

	Date	Date	Date	Date	Date	Date	Date		Cumulative
	Su	M	T	W	Th	F	Sa	Week Total	Total to Date
1. Staff On-site:									
Name									
Name									
Name									
Name									
Name									
Name									
Name									
Name									
Total On-site Hours									
2. Weather Conditions									
Temperature									
Precipitation									
Site Closure									
3. Contractor Activity									
Earth Works									
Type D subgrade preparation									
Sand placement									
Type B placement over geonet									
Type E placement over geotextile									
Other									
Geosynthetics									
Geosynthetics deployment									
Geosynthetics detail work									

MONTGOMERY WATSON WEEKLY FIELD SUMMARY REPORT
TRIASSIC PARK WASTE DISPOSAL FACILITY
CONSTRUCTION QUALITY ASSURANCE
WEEK #1 (Continued)

	6/13 Su	6/14 M	6/15 T	6/16 W	6/17 Th	6/18 F	6/19 Sa	Week Total	
4. Geosynthetics Activity									
Material Inventory (see attached material quantities summary)									
Geomembrane									
Geonet									
Geotextile									
Material Deployment (based on total deployed lengths of panels, including overlaps and prior to trimming)									
Geomembrane (square feet)									
Geonet (square feet)									
Geotextile (square feet)									
Geomembrane Field Seaming									
Fusion welding footage									
Fusion destructive tests									
Extrusion welding footage									
Extrusion destructive tests									
5. QA Soil Testing									
Field Testing									
Laboratory Testing									

MONTGOMERY WATSON DAILY FIELD REPORT
TRIASSIC PARK WASTE DISPOSAL FACILITY

Daily Report Number
Date Work Performed

MONDAY

Staff On-site

- ☐ Name ☐ Name ☐ Name
- ☐ Name ☐ Name ☐ Name
- ☐ Name ☐ Name ☐ Name

Weather Conditions

Temperature (F)_______
Skies________________
Wind________________
Precipitation? ☐
Site Closure? ☐

Contractor Activity

Earthworks

- ☐ Type D subgrade preparation
- ☐ Sand placement
- ☐ Type B placement over geonet
- ☐ Type E placement over geotextile
- ☐ Other

Geosynthetics

- ☐ Geosynthetics deployment
- ☐ Geosynthetics detail work

Geosynthetic Activity Summary (Geosynthetic Installation Monitoring Summary attached)

Material Inventory (see Weekly Summary Report for material quantities)

- ☐ Geomembrane
- ☐ Geonet
- ☐ Geotextile

Material Deployment	today (sf)	total to date (sf)
Geomembrane		
Geonet		
Geotextile		

Issues List Updated ☐ (attached)

Area Approved for Sand Placement (see attached drawing)

Other:

QA Soil Testing

- ☐ Field Testing
- ☐ Laboratory Testing

Meeting Attendance (meeting notes attached)
Daily Construction Meeting

- ☐ Name
- ☐ Name
- ☐ Name
- ☐ Name
- ☐ Name

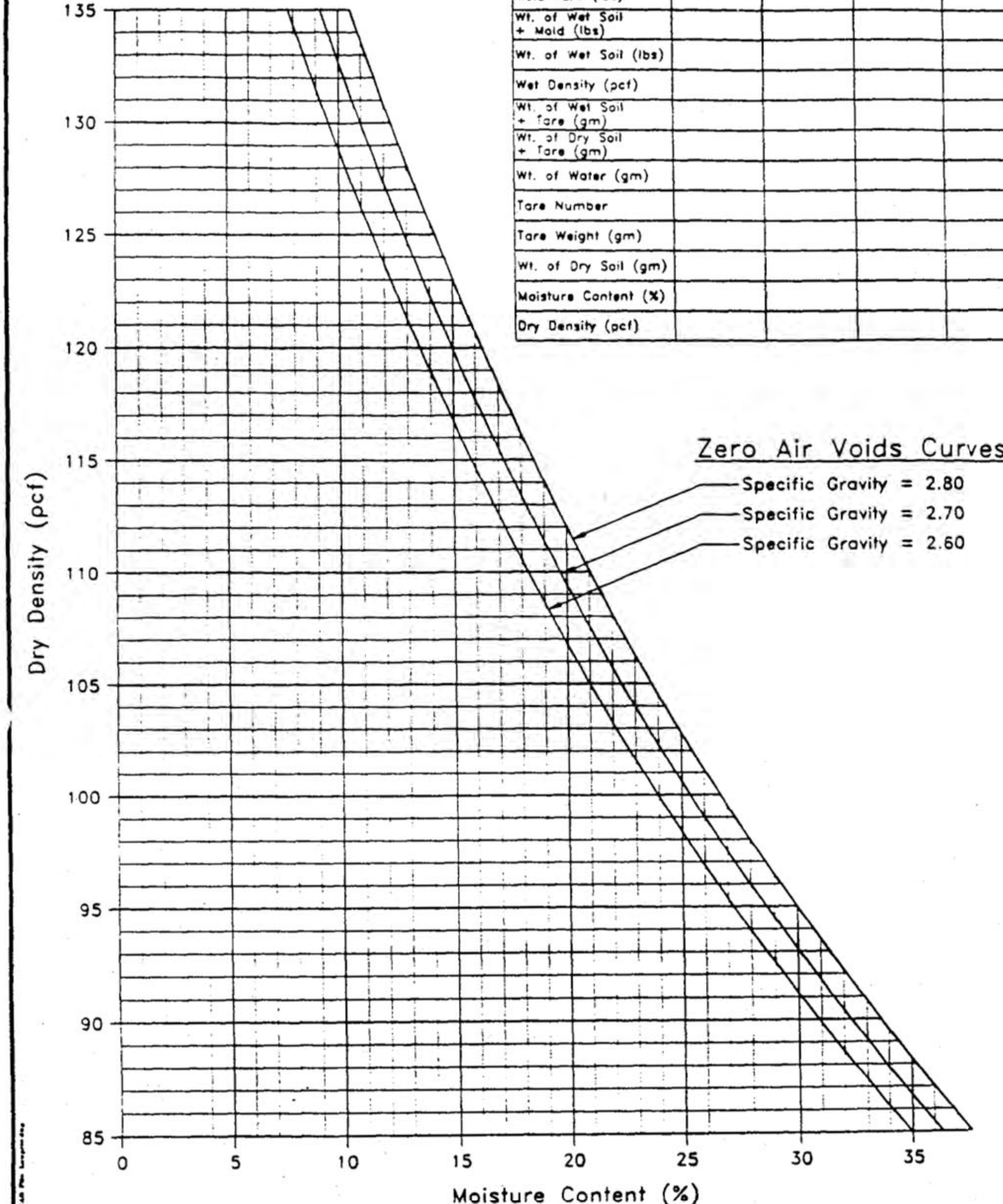
Miscellaneous

Report prepared by:

Appendix C

Soils CQA Records

Point					
Mold Number					
Mold Tare (lbs)					
Wt. of Wet Soil + Mold (lbs)					
Wt. of Wet Soil (lbs)					
Wet Density (pcf)					
Wt. of Wet Soil + Tare (gm)					
Wt. of Dry Soil + Tare (gm)					
Wt. of Water (gm)					
Tare Number					
Tare Weight (gm)					
Wt. of Dry Soil (gm)					
Moisture Content (%)					
Dry Density (pcf)					



Project Name:		TerraMatrix
Sample Location:	Sample No.:	
Sample Source:	Technician:	MOISTURE-DENSITY RELATIONSHIP OF SOIL
Sample Description:		
Max. Dry Density (pcf):	Opt. Moisture (%):	Procedure:
Liquid Limit (%):	Plasticity Index (%):	Natural Moisture (%):
% - 3/4 in.:	% - No. 4:	% - No. 200:

Project No.:

Date:

NUCLEAR GUAGE (ASTM D2922)
STANDARD COUNT LOG (ASTM D3017)

PROJECT NAME: TRIASSIC PARK WASTE DISPOSAL FACILITY **PROJECT NO. 602**

NUCLEAR GUAGE MODEL________________ **SERIAL NO.:**____________

DATE ARRIVED ON SITE:__________ **DATE DEPART SITE:**______________

DATE (day/mo)	QA ID	MOISTURE COUNT	DENSITY COUNT	PASS/ FAIL	PECENT CHANGE		DATE (day/mo)	QA ID	MOISTURE COUNT	DENSITY COUNT	PASS/ FAIL	PECENT CHANGE

IN-SITU DENSITY TESTS - RUBBE[illegible] [illegible]OON METHOD (ASTM D 2167)
TRIASSIC PARK WAS[illegible] [illegible]SPOSAL FACILITY

[illegible]WNER: GANDY MARLEY INC. PROJECT NUMBER: 602

[illegible]ATE:______ MATERIAL TESTED:______ OPTIMUM WATER CONTENT:____ MAX DRY DENSITY (pcf):___

[illegible]ESTED BY:______ REVIEWED BY:_______ WEATHER:______ PAGE___ OF ___

TEST NUMBER	RUBBER BALLOON	NUCLEAR DENSITY	RUBBER BALLOON	NUCLEAR DENSTIY	RUBBER BALLOON	NUCLEAR DENSITY
ELEVATION						
LOCATION						
FINAL READINGS (ft³)						
AVERAGE FINAL READING (ft³)						
INITIAL READING (ft³)						
CORRECTED VOLUME (ft³)						
SOIL WEIGHT + TARE (gm)						
TARE (gm)						
WEIGHT WET SOIL (gm)						
WET DENSITY (pcf)						
TIN NUMBER						
WEIGHT WET SOIL + TARE (gm)						
WEIGHT DRY SOIL + TARE (gm)						
WEIGHT OF WATER (gm)						
TARE (gm)						
WEIGHT DRY SOIL (gm)						
MOISTURE CONTENT						
DRY DENSITY (pcf)						
MAXIMUM DRY DENSITY (pcf)						
PERCENT COMPACTION						
CORRELATION TO TROXLER						

SAMPLE:______________________

Sieve	Cumulative Weight Retained	Cumulative % Retained	Cumulative % Passing	Specification % Passing
3"				
2"				
1"				
3/4"				
3/8"				
#4				
#10				
#20				
#40				
#60				
#100				
#200				
PAN				

SAMPLE AND TARE WT: ______________

TARE WT: ______________ CONTAINER NO.:__________

WEIGHT BEFORE SIEVING:________________________

UNIFORMITY COEFFICIENT, (D_{60}/D_{10}):________________
COEFFICIENT OF CURVATURE, (D_{30})/(D_{10} X D_{60}):__________

SIEVE ANALYSIS FORM (ASTM D 422)

PROJECT: TRIASSIC PARK WASTE DISPOSAL FACILITY CQA

PROJECT NO. 602 DATE:______________ TESTED BY:______________

TERRAMATRIX
1475 Pine Grove Road
Steamboat Springs, Colorado 80477

NUCLEAR FIEL[illegible]EN[illegible]/MOISTURE TEST DATA
TRIASSIC PARK WA[illegible] DISPOSAL FACILITY
(ASTM 2922, D3017)

PROJECT NUMBER: 602
OWNER: GANDY MARLEY INC.
LOCATION:

CONTRACTOR:______

SHEET NUMBER_____

TROXLER MODEL __________ SERIAL NO.:__________ STANDARD COUNT: DENSITY: ________ MOISTURE:______ REQUIRED COMPACTION (%): __

WEATHER: ______________________________ FIELD MONITOR: __________

TEST NUMBER							
GENERAL TEST LOCATION							
REFERENCE STAKE	I.D. NUMBER						
	NORTH COORDINATE						
	EAST COORDINATE						
	ELEVATION						
	BEARING (TO TEST)						
	DISTANCE						
MODE & DEPTH							
WET DENSITY (pcf)							
DRY DENSITY (pcf)		TROXLER / LAB	TROXLER / LAB	TROXLER / LAB	TROXLER / LAB	TROXLER / LAB	TROXLER / LAB
% MOISTURE							
% COMPACTION							
OPTIMUM MOISTURE (%)							
MAXIMUM DRY DENSITY (pcf)							
PASS/FAIL							

SOILS TEST REQUEST SHEET

PROJECT NAME: TRIASSIC PARK WASTE DISPOSAL FACILITY **PROJECT NO. 602** **LAB NO.________**

REQUESTED BY____________________ PROJECT MANAGER APPROVAL______________ **PAGE___ OF ___**

SAMPLE NUMBER	SAMPLE DEPTH LOCATION AND/OR STATION	VISUAL USCS SYMBOL	MOISTURE CONTENT	DRY DENSITY	ATTERBERG LIMITS	SIEVE ANALYSIS	#200 WASH	HYDROMETER ANALYSIS	COMPACTION TEST	UNDISTURBED PERMEABILITY	DIRECT SEHAR	UNCONFINED COMPRESSION	REMOLDED PERMEABILITY	DATE REQUESTED	RESULTS DUE BY	DATE COMPLETED	DATE SAMPLE STORED	DATE SAMPLE DISPOSED OF

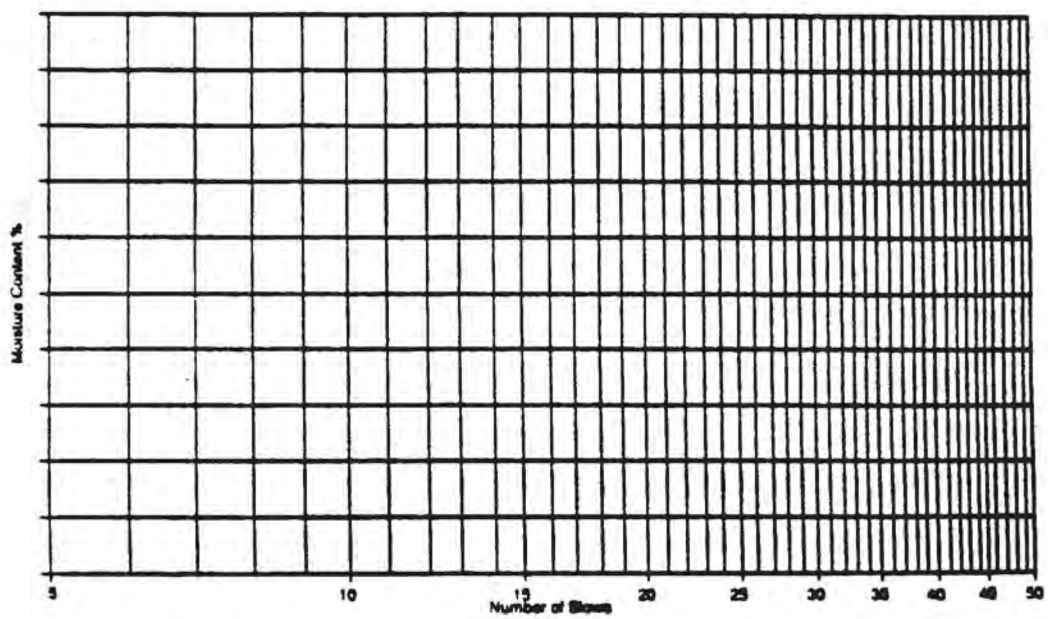
COMMENTS:

SAMPLES DELIVERED BY:__________
SAMPLES RECEIVED BY:__________

SPECIAL INSTRUCTIONS:

Type of Test	LL	LL	LL	LL	Nat. M.C.
Container #					
Tare Wt. (g)					
Number of Blows					
Wt. Sample Wet + Tare (g)					
Wt. Sample Dry + Tare (g)					
Weight of Water (g)					
Weight of Dry Soil (g)					
Moisture Content (%)					

Type of Test	PL	PL	Borehole #	
Container #			Sample #	
Tare (g)			Depth	
Wt. Sample Wet + Tare (g)			Liquid Limit	
Wt. Sample Dry + Tare (g)			Plastic Limit	
Weight of Water (g)			Plasticity Index	
Weight of Dry Soil (g)			Moisture Content	
Moisture Content (%)			Liquidity Index	



Sample Description: ______________________________

____

ATTERBERG LIMITS

Project: TRIASSIC PARK WASTE DISPOSAL FACILITY CQA
Project No.: DATE: TESTED BY: TERRAMATRIX

CONSTANT HEAD PERMEABILITY ON GRANULAR SOIL
GANDY MARLEY INC.
CHAVES COUNTY, NEW MEXICO

DATE: ______________ SHEET ___ OF ___

OWNER: ______________________________ PROJECT NUMBER: ______________

PROJECT NAME: ______________________________ LOCATION: ______________

SAMPLE NO.: ______________ TECH. ______________

DESCRIPTION: ____

HEIGHT BEFORE (H1):

(1) __________

(2) __________

(3) __________

(4) __________

HEIGHT AFTER (H2):

(1) __________

(2) __________

(3) __________

(4) __________

AVERAGE (H1) __________ AVERAGE (H2) __________

SAMPLE DIMENSIONS

HEIGHT, L=(H1-H2), cm: ______________ HEAD, h, cm: ______________

DIAMETER, cm: ______________

AREA, A, sq. cm: ______________

QUANTITY OF WATER, Q (cubic cm)	TIME, t (sec)
TRIAL 1: ______________	______________
TRIAL 2: ______________	______________
TRIAL 3: ______________	______________
AVERAGE: ______________	______________

$K = QL/Ath =$ ______________ cm/sec

1 inch = 2.45 cm
1 gal = 3785.41 cubic cm

Appendix D

Geosynthetics CQA Records

GEOSYNTHETICS INVENTORY, QUALITY NTROL AND CONFORMANCE TESTING LOG

PROJECT NUMBE
PROJECT NAME:
OWNER:
INSTALLER:

DATE OF INVENTORY:__________
DATE OF DELIVERY:__________
TRUCK TYPE:__________
BILL OF LADING NUMBER:__________

QAM:__________
UNLOADING EQUIPMENT:__________
WEATHER CONDITIONS:__________
MANUFACTURER:__________

MATERIAL TYPE: GEOMEMBRANE GCL GEONET (COMPOSITE) GEOTEXTILE(CU) OTHER:__________

	INVENTORY LOG						QUALITY CONTROL CERTIFICATES AND CONFORMANCE TESTING VERIFICATION				
	ROLL NUMBER	LOT #	MON ID	ROLL LXW (ft,ft)	AREA (ft2)	DAMAGE REMARKS	QC CERT RECD Y/N	DATE CONF. SAMPLE CUT/ SENT OUT	DATE CONF. RESULTS RECD.	CONF. RESULTS REVIEWED BY/DATE	P/F
1.											
2.											
3.											
4.											
5.											
6.											
7.											
8.											
9.											
10.											
11.											
12.											
13.											
14.											
15.											
16.											
17.											
18.											
19.											
20.											

NCR#__________

TOTAL AREA THIS PAGE

REVIEWED BY: DATE:

GEOSYNTHETICS PANEL DEPLOYMENT LOG

PROJECT NUMBER:
OWNER:
INSTALLER:

DATE : ______________
SHEET NUMBER ____ **of** ____

GEOSYNTHETIC TYPE: **PRIMARY/SECONDARY/TERTIARY/CLOSURE**
GEOMEMBRANE **GCL** **GEONET(COMPOSITE)** **GEOTEXTILE(CU)**

OTHER/COMMENTS: ____
SUBGRADE CONDITION (Surface Compaction, Protrusions, Desiccation, Excessive Moisture): ______________

PANEL NUMBER			
ROLL NUMBER			
DEPLOYED LENGTH (FT)			
*AMBIENT AIR TEMP (F)			
VISUAL OBSERVATION			
**OBSERVED OVERLAP			
MONITOR			
REMARKS			

SHEET THICKNESS (MILS)	LEAD	TRAIL	SPEC	P F	LEAD	TRAIL	SPEC	P F	LEAD	TRAIL	SPEC	P F
			54				54				54	
			54				54				54	
			54				54				54	
			54				54				54	
			54				54				54	
AVERAGE			60				60				60	

PANEL NUMBER			
ROLL NUMBER			
DEPLOYED LENGTH (FT)			
*AMBIENT AIR TEMP (F)			
VISUAL OBSERVATION			
**OBSERVED OVERLAP			
MONITOR			
REMARKS			

SHEET THICKNESS (MILS)	LEAD	TRAIL	SPEC	P F	LEAD	TRAIL	SPEC	P F	LEAD	TRAIL	SPEC	P F
			54				54				54	
			54				54				54	
			54				54				54	
			54				54				54	
			54				54				54	
AVERAGE			60				60				60	

NCR REFERENCE NUMBER (IF REQUIRED) ______________

INSTRUMENT ID#
THERMOMETER _____
MICROMETER _____
WIND GAUGE _____

REVIEWED BY _______ **DATE** _________

* Ambient air temperature must be between 40° and 100° F for HDPE deployment
** Observed overlap must conform to construction specifications for relevant material type

File: Paneldep.log
Printed: December 9, 1997 (10:01am)

GEOMEMBRANE DEFECT LOG

PROJECT NUMBER:
OWNER:
LOCATION:
INSTALLER:

SHEET NUMBER: _____

DEFECT CODE	DEFECT LOCATION		DEFECT TYPE (SEE BELOW)	LOG DATE	CQA MON	REMARKS	REPAIR DATE*	TEST DATE*
	SEAM, PANEL OR REPAIR NO	DEFECT LOCATION DESCRIPTION						
A								
B								
C								
D								
E								
F								
G								
H								
I								
J								
K								
M								
N								
P								
Q								
R								
S								
T								
W								
X								

AD ANIMAL RELATED DAMAGE
B UNDISPERSED RESIN BEAD
BO FUSION WELDER BURN
BS BOOT/SKIRT FOR FML PENETRATION
CO CHANGE OF OVERLAP
CR CREASE
D INSTALLATION DAMAGE
DF-# FUSION DESTRUCTIVE TEST NUMBER
DX-# EXTRUSION DESTRUCTIVE TEST NUMBER
EE EARTHWORKS DAMAGE
EXT EXTENSION
FM FISHMOUTH
FS FAILED SEAM LENGTH
FTS FIELD TEST STRIP
MT HEAT TRACK BURN
IO INSUFFICIENT OVERLAP (UNDER SPEC)
MO MANUFACTURER/DELIVERY DAMAGE
PT PRESSURE TEST CUT
SI SOIL IRREGULARITY
SL SLAG ON TEXTURED SHEET
T THREE PANEL INTERSECTION
VL VACUUM TEST LEAK
WR WRINKLE
WS WELDER RESTART
OTHER

NOTE: * COLUMNS TO BE USED BY THE DATA REVIEWER ONLY

REVIEWED BY: ______ DATE______________

NCR REFERENCE NUMBER (IF REQUIRED)_______________________

GEOMEMBRANE S[illegible] . PRESSURE TEST LOG

PROJECT NUMBER:
OWNER:
LOCATION:

INSTALLER:

DATE: ____________

MACHINE NUMBER: _______ **CQA MONITOR:** _________ **SHEET NUMBER:** ____of____

SEAM NUMBER*	SEAM SECTION** FROM - TO	TECH ID	START TIME	FINISH TIME	INITIAL PRESSURE	FINAL PRESSURE	PRESSURE DIFFERENCE	PASS/FAIL	OBS TEST Y/N	ENTIRE SEAM COMPLETE NO	ENTIRE SEAM COMPLETE YES	REMARKS
/	-											
/	-											
/	-											
/	-											
/	-											
/	-											
/	-											
/	-											
/	-											
/	-											
/	-											
/	-											
/	-											
/	-											
/	-											
/	-											
/	-											
/	-											
/	-											
/	-											

* Indicate seam number by two adjacent panel numbers, with the lowest panel number indicated first.
** Reference seam endpoints from an End of Seam (EOS), a defect repair number or a point location on the seam (reference point, distance from reference point).

REVIEWED BY______ DATE_____

NCR REFERENCE NUMBER (IF REQUIRED)______________________________

GEOMEMBRANE S I VACUUM TEST LOG

PROJECT NUMBER:
OWNER:
LOCATION:
INSTALLER:

CQA MONITOR: ___________
VACUUM BOX NUMBER________

SHEET ____ **OF** __

SEAMS

SEAM NUMBER*	SEAM SECTION ** FROM - TO	TEST DATE	TECH ID	DEFECTS***	SEAM COMPLETE NO / YES	OBS TEST	REMARKS
/	-				/		
/	-				/		
/	-				/		
/	-				/		
/	-				/		
/	-				/		
/	-				/		
/	-				/		
/	-				/		
/	-				/		
/	-				/		
/	-				/		
/	-				/		
/	-						
/	-				/		
/	-				/		
/	-				/		

REPAIRS

DEFECT CODE	TEST DATE	TECH ID	DEFECTS***	OBS TEST	REMARKS

* Indicate seam number by two adjacent panel numbers, with the lowest panel number indicated first and proper layer (i.e., Tertiary, Secondary Primary).
** Reference seam endpoints from an End of Seam (EOS), a repair number or a point location on the seam (i.e., Reference point, distance from reference point).
*** Record quantity of leaks detected and reference new defect code in remarks column.

NCR REFERENCE NUMBER (IF REQUIRED)______________________________

REVIEWED BY______ **DATE**______

GEOMEMBRANE EX[illegible]SION TRIAL SEAM LOG

PROJECT NUMBER:
OWNER:
LOCATION:
INSTALLER:

DATE: ___________

SHEET NUMBER: _____of_____

TRIAL SEAM NUMBER (TSX-#)	TIME WELDED	AMBIENT TEMPERATURE (F)	TECH ID	MACHINE NUMBER (MX-#)	CQA MON ID	TEMPERATURE SETTINGS		PEEL TEST RESULTS			SHEAR TEST RESULTS			PASS/FAIL	REMARKS
						PRE-HEAT SETTING	BARREL TEMP. (F)	SAMPLE	STRENGTH (lbs/in)	BREAK TYPE	SAMPLE	STRENGTH (lbs/in)	BREAK TYPE		
								A			D				
								B			E				
								C							
								A			D				
								B			E				
								C							
								A			D				
								B			E				
								C							
								A			D				
								B			E				
								C							
								A			D				
								B			E				
								C							
								A			D				
								B			E				
								C							
SPECIFICATION REQUIREMENTS : 60 mil GEOMEMBRANE								PEEL		FTB	SHEAR		FTB		

(CIRCLE MACHINE USED)

TMI TENSIOMETER CALIBRATION: SERIAL #: 124 CALIBRATION DATE: 4/1/96 RECALIBRATION DATE: 4/1/97
NSC TENSIOMETER CALIBRATION: SERIAL #'S:93021/91001 CALIBRATION DATE: 10/14/96 RECALIBRATION DATE: 10/14/97

NCR REFERENCE NUMBER (IF REQUIRED)______________________

REVIEWED BY_______ DATE_______

GEOMEMBRANE FUSION DESTRUCTIVE LOG

ROJECT NUMBER:
OWNER:
LOCATION:
INSTALLER:

DESTRUCTIVE MONITOR: ____________

DATE TESTED: ____________

DESTRUCTIVE SAMPLE NUMBER: ____________(ASSIGNED BY QAM)

DESTRUCTIVE INFORMATION:

DEFECT NO.	SEAM NO.	LOCATION	TECH ID	MACHINE NUMBER	DATE	CQA MON ID

DESTRUCTIVE TEST DATA:

PEEL TEST RESULTS					
SAMPLE (INSIDE TRACK)	STRENGTH (lbs/in)	BREAK TYPE	SAMPLE (OUT. TRACK)	STRENGTH (lbs/in)	BREAK TYPE
A1			A2		
B1			B2		
C1			C2		
D1			D2		
E1			E2		
SPECIFICATION REQUIREMENTS	90	FTB		90	FTB

SHEAR TEST RESULTS						
SAMPLE	PEAK STRENGTH (lbs/in)	BREAK TYPE	WELD TO GRIP LENGTH (a)	WELD TO GRIP FAILING SIDE AT YIELD (b)	WELD TO GRIP FAILING SIDE AT BREAK (c)	SHEAR STRAIN (%) AT YIELD((b-a)/a)/ AT BREAK ((c-a)/a)
F						
G						
H						
I						
J						
SPECIFICATION REQUIREMENTS	119	FTB				AT YIELD - 10 % MIN AT BREAK - 50 % MIN

PASS/FAIL: ____________
REMARKS: ____________
REVIEWED BY ____________ DATE ____________

(CIRCLE MACHINE USED)

TMI TENSIOMETER CALIBRATION:	SERIAL #: 124	CALIBRATION DATE: 4/1/96	RECALIBRATION DATE: 4/1/97
NSC TENSIOMETER CALIBRATION:	SERIAL #'S: 93021/91001	CALIBRATION DATE: 10/14/96	RECALIBRATION DATE: 10/14/97

NCR REFERENCE NUMBER (IF REQUIRED) ____________

GEOMEMBRANE EXT[illegible]SION SEAM/REPAIR LOG

PROJECT NUMBER:
OWNER:
LOCATION:
INSTALLER:

MACHINE NUMBER: MX______ **CARRYOVER:** ______ **CQA MONITOR:** ______ **DATE:** ______

PASSING TRIAL SEAM INFORMATION **EXTRUDER PURGED OF HEAT DEGRADED EXTRUDATE (1)**______ **SHEET NUMBER:** ____ of ____

NO	TIME	TECH ID	PRE HEAT	BARREL

SEAM NUMBER(2)	SEAM SECTION(3)		DEFECT CODE	START TIME	TECH ID	TEMPERATURE VERIFICATION		REPAIR SIZE	APPROX. LENGTH WELDED	DISTANCE FROM LAST DESTRUCTIVE	DESTRUCTIVE NUMBER	ENTIRE SEAM COMPLETE		REMARKS	NON-DEST TEST DATE
	FROM	TO				PRE-HEAT SETTING	BARREL TEMP. (F)	(ft x ft)	(ft)	(ft)		No	Yes		[illegible]
/															
/															
/															
/															
/															
/															
/															
/															
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/															
/															
/															

(1) Extruder must be purged when starting a seam and when welding stops for more than 1 minute.
(2) Indicate seam number by two adjacent panel numbers, with the lowest panel number indicated first.
(3) Reference seam endpoints from an End of Seam (EOS), a defect repair number or a point location on the seam (reference point, distance from reference point).

REVIEWED BY______ DATE______

(CIRCLE MACHINE USED)
TMI TENSIOMETER CALIBRATION: SERIAL NUMBER: 124 CALIBRATION DATE: 4/1/96 RE-CALIBRATION DATE: 4/1/97
NSC TENSIOMETER CALIBRATION: SERIAL NUMBER: 93021/91001 CALIBRATION DATE: 10/14/96 RE-CALIBRATION DATE: 10/14/97

NCR REFERENCE NUMBER (IF REQUIRED) ______________

GEOMEMBRA USION SEAM LOG

PROJECT NUMBER:
OWNER:
LOCATION:
INSTALLER:

DATE: ___________

MACHINE NUMBER: M# ________ CARRYOVER: ________ CQA MONITOR: _____ SHEET NUMBER: _____of_____

PASSING TRIAL SEAM INFORMATION

NO.	TIME	TECH ID	WEDGE TEMP.	SPEED

SEAM NUMBER[1]	SEAM SECTION[2] FROM - TO	START TIME	TECH ID	TEMPERATURE/SPEED VERIFICATION		APPROX. LENGTH WELDED (ft)	DISTANCE FROM LAST DESTRUCTIVE (ft)	DESTRUCTIVE NUMBER	ENTIRE SEAM COMPLETE		REMARKS	NON-DESTRUCT TEST DATE (reviewer only)
				WEDGE TEMP.(F)	SPEED				NO	YES		
/	-											
/	-											
/	-											
/	-											
/	-											
/	-											
/	-											
/	-											
/	-											
/	-											
/	-											
/	-											
/	-											

(1) Indicate seam number by two adjacent panel numbers, with the lowest panel number indicated first.
(2) Reference seam endpoints from an End of Seam (EOS), a defect repair number or a point location on the seam (reference point, distance from reference point).

REVIEWED BY_______ DATE______

(CIRCLE MACHINE USED)

TMI TENSIOMETER CALIBRATION: SERIAL NUMBER: 124 CALIBRATION DATE: 4/1/96 RECALIBRATION DATE: 4/1/97
NSC TENSIOMETER CALIBRATION: SERIAL NUMBER: 93021/91001 CALIBRATION DATE: 10/14/96 RECALIBRATION DATE: 10/14/97

NCR REFERENCE NUMBER (IF REQUIRED)________________________

LETTER OF ACCEPTANCE
OF SOIL SUBGRADE SURFACE

PROJECT NUMBER:
OWNER:
LOCATION:
INSTALLER:

	Check Applicable
Pond 4	_____
Repository	_____

I, the Undersigned, the duly authorized representative of __TerraMatrix Inc. (TMI)__, have visually observed the soil subgrade surface within the area described below, and found that: 1.) all stones, rocks, debris, trash, roots, branches, and foreign matter, as well as pockets of soft or loose soil, and stones and rocks larger than ½ inch, have been removed from the surface; 2.) the surface is smooth and free of irregularities, sharp objects and abrupt changes in grade; and, 3.) the surface has been smooth-drum rolled.

This is a general acceptance for the area described below. The area of deployment for any given day will be reinspected by TerraMatrix to ensure that the subgrade surface continues to meet the above described criteria. The final inspection will be recorded in the TerraMatrix daily logs.

Area that has been observed is outlined on the attached drawing and is identified by:

____

____

____

TMI REPRESENTATIVE

NAME	SIGNATURE	TITLE	DATE

LETTER RECEIVED BY

NAME	SIGNATURE	TITLE	DATE

NCR REFERENCE NUMBER (IF REQUIRED)____________________

File: P:\SHELLY\FIELDFRM\SURFACCP.FRM
Printed: December 9, 1997 (10:07am)

Permit Renewal Application
October 17, 2011

Attachment N

Operations and Maintenance Plan

Prepared for:
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The New Mexico Environment Department
March 2002

Table of Contents

Section **Page**

Attachment N. Operations and Maintenance Plan

1. Operations and Maintenance Plan

1.1 General

The Triassic Park Hazardous Waste Facility will be a full-service Resource Conservation and Recovery Act (RCRA) Subtitle C waste ~~treatment, storage, and~~ disposal operation. The Facility will offer the RCRA-regulated services for disposal of hazardous waste. ~~described in the following paragraphs: treatment, storage and disposal.~~

Support units and structures include a chemical laboratory, administration building, weigh scale area, maintenance shop, ~~truck wash unit,~~ clay processing area, clay liner material stockpiles, daily cover stockpiles, stormwater d~~r~~etention basin, stormwater diversion ditches, perimeter vadose zone monitoring wells, and access roads.

This Operations and Maintenance Plan refers to the landfill ~~treatment, storage and disposal units,~~ and the site runoff and drainage control system.

~~1.2 Treatment~~

~~Two treatment processes will be used at the Facility, including an evaporation pond for managing wastewaters that meet LDR standards and a stabilization process for treating liquids, sludges, and solids to ensure that no free liquids are present and that LDR standards are met prior to placing wastes in the landfill.~~

~~1.3 Storage~~

~~Four aboveground storage tanks will be utilized to accumulate regulated bulk liquid hazardous wastes prior to stabilization. Two container storage areas (roll-off storage area and drum handling unit) will be used to stage waste at the Facility for treatment or disposal. These container storage units will ensure that waste is stored in compliance with RCRA requirements for permitted storage. Neither of the container storage units will be used for long-term storage of waste.~~

1.4 Land Disposal

A landfill will be utilized for the disposal of waste that meets LDR standards.

2. Description of Units and Drainage System

2.1 Landfill

~~The~~ Phase 1~~I~~A of the landfill will have an area of approximately 47 acres and will have a capacity of approximately 553,200 cubic yards of waste. This unit has been designed as a double-lined landfill with a~~n~~ leachate collection and removal system (LCRS) above the primary liner and a~~n~~ leak detection and removal system (LDRS) between the primary and secondary liners. A vadose zone monitoring system (VZMS) has also been included as a detection system for leaking in the secondary LDRS system. Leachate that collects in the sumps of the LCRS, LDRS, and ~~vadose zone~~VZMS will be pumped through ~~a~~ pipes to the surface of the landfill, where it will be collected in temporary storage tanks located on a crest riser pad at the north end of the landfill. Leachate will be managed by recirculating the liquid and applying it to the landfill soil cover for enhanced evaporation, thereby containing all leachate and potential contaminants within the lined landfill cell.

A run-on/runoff system willis contemplated to control the water volume resulting from a 24-hour, 25-year storm. Run-on originating off-site will be directed around or away from the proposed landfill area using unlined ditches. Potentially impacted rRunoff in the active portion of the landfill will be collected in the bottom of the landfill in a contaminated stormwater collection basin that overlies the landfill liner systemand pumped out within 24 hours of a storm event. Runoff water collected within the contaminated water basin will be managed by pumping the water to remove the standing water in the basin and applying it using a moveable piping and sprinkler system or tank trucks to the landfill soil cover for enhanced evaporation.Contaminated water will be treated either in the stabilization process or the evaporation pond. Clean rRunoff from within the excavated area of the landfill unit, but not from the active portion of the landfill, will be directed to the stormwater collection basin located at the south end of the landfill (Dwg.Drawing 10). Clean stormwater will be pumped out to the stormwater control system for the site.

A daily cover consisting of soil will be spread on top of the waste placement area to limit wind dispersal. Dust generation will be reduced by restricting traffic to predetermined haul roads on the surface of the daily cover and by applying small amounts of water spray to moisten the soil surface. Water applied for dust control may include clean water supply, leachate, and runoff water collected within the landfill contaminated water basin.

Access to the landfill will be provided by two roads located on the east and west slopes. During interim filling stages, the landfill will be partially lined to the axis of the access roads (Dwg.Drawing 10). A ramp will be provided to access the stormwater collection basin.

2.2 Evaporation Pond

The evaporation pond will have an approximate operating capacity of 5.2 million gallons over an approximate area of 78,600 square feet. The evaporation pond has been designed as a double-lined unit with a LDRS between the primary and secondary liners. A vadose zone sump has been located beneath the liner system. Pumps will be used to transfer leachate collected in the sumps to tanker trucks. Leachate will either be returned to the evaporation pond, stabilized in the on-site treatment unit, or stored in one of the liquid waste storage tanks. The truck discharge and leachate collection stations are located on the south and east side of the pond. The pond is divided in two sections by a separator berm, providing two independent treatment areas in case repairs need to be completed in one of them.

A run-on/run-off system is contemplated to control water volume resulting from a 24-hour, 25-year storm. Run-on originating off site will be directed around the proposed evaporation pond into the site wide surface water diversion channels shown in Drawing 25.

2.3 Liquid Waste Storage Tanks

The liquid waste receiving and storage unit will house four aboveground tanks. Each tank will have a capacity of approximately 9,000 gallons. The tanks will be double-walled and constructed of high density polyethylene. The tank system will be placed on a surrounding concrete base. The concrete area will be sloped to provide drainage to a sump. This concrete area will provide secondary containment for all ancillary equipment.

Liquids in the storage tanks will be transferred to the stabilization unit with tanker trucks. Tanker trucks will be parked over a concrete pad while discharging or removing liquids from the tanks. All connections to the trucks will be with dry connect valves.

2.4 Stabilization

The stabilization unit will consist of four in-ground double lined steel stabilization bins, two dry reagent silos, two liquid reagent tanks, and a water tank. Additionally, there will be a control room from which operations will be directed and coordinated. The stabilization bins will be located inside the stabilization building.

Waste may be offloaded directly from trucks into the stabilization bins or transferred from the drum handling unit or roll-off storage area. The bins will be covered while dry reagents are being added to control particulate air emissions. The cover will be removed and a backhoe positioned adjacent to the bin will mix the waste and reagents.

The nominal dimensions of the bins will be 25 feet long by 10 feet wide by 10 feet deep. The ends of the bins will be shaped to conform to the reach profile of the backhoe selected for the mixing. The bins will be contained in a concrete vault. The bins will be double-walled tanks with the space between the walls serving as LDRS. Shock absorbing coiled wire rope isolators will maintain separation between the bins. In order to ensure no fugitive dust emissions during stabilization processing, the bins and the stabilization building will be equipped with an exhausting ventilation system which will maintain a negative pressure inside the building. Dust will be removed from the exhaust air in the bag house located on the west side of the building. Collected dust will be processed in the stabilization facility.

2.5 Drum Handling

The Facility will contain seven separate containment areas (cells). Each of the areas will have its own floor drain and containment sump, allowing incompatible wastes to be placed in separate cells. Two of the cells will be designed to accommodate only TSCA PCB wastes. The TSCA cells will be surrounded by a 6-inch concrete berm. The drums will be stored in an open-sided and roofed building to prevent run-on from precipitation.

Each cell will have a concrete floor that slopes toward a trench covered by a steel grating. Each trench will lead to a separate secondary containment sum for that where any spilled liquids will be accumulated. The trench and sump system include a double HDPE geomembrane liner and leak detection and leachate removal system.

2.6 Truck Roll-Off

Roll-off containers will be stored on an open pad. The pad will be divided into two sections. One section will hold tarped, DOT approved, lined roll-off containers with non-stabilized waste awaiting treatment at the stabilization unit. The other section of the pad is intended as a staging area for roll-off containers containing stabilized waste awaiting TCLP test results and landfill disposal approval.

Secondary containment of the roll-off storage area will be provided by a geomembrane liner. The floor will be sloped to a sump located in the corner of the storage area. The entire roll-off storage area will be surrounded by a 4 to 8 feet high berm.

Roll-off containers will be inspected for free liquids prior to acceptance at the unit. Containers which are received for disposal, but are found to contain free liquids upon inspection, will be managed in accordance with stabilization procedures described in Section 2.4 of the application text. If the waste generator will not allow the Facility to prioritize handling of the load to eliminate free liquid, the load will not be admitted to the Facility. Otherwise, free liquids will be removed with a vacuum truck characterized, and managed in accordance with stabilization procedures described in Section 2.4. The volume of free liquids in the roll-off containers is expected to be minimal. Following the removal of free liquids, the waste (in the roll-off container) will either be managed through the stabilization process or landfilled, whichever is appropriate. Section 2.2.12 of the application text describes the methods that will be used to separate incompatible wastes. The area will be equipped with fire extinguishers, a telephone, alarm systems, spill control, and first aid kits.

Waste in the roll-off containers that meet the requirements for free liquids (or lack thereof) will be placed in the landfill. Other wastes in roll-off containers that do not pass the appropriate acceptance testing (i.e. paint filler test) will be transferred to the stabilization area for treatment. Upon completion of the stabilization process, the waste will once again be tested to ensure that it meets the landfill criteria.

2.7 Runoff and Drainage Control System

Facility stormwater control is provided by a network of surface water run-on and runoff diversion channels and collection and detention basins. A diversion channel located on the east of the Facility will provide run-on control from the east watershed area. To control the runoff from the facilities area, several collection channels and culverts will be built to divert discharges from storm events to a stormwater detention basin. The location of the collection channels, culverts, and detention pond are shown on Drawing 25.

3. Operations

3.1 Waste Acceptance

Prior to initiation of a shipment of waste to the Facility, the generator of the waste will provide a full characterization of its waste and receive approval from the Facility to ship the waste. The Facility will use the waste characterization data to perform the following activities:

- ensure that the waste can be accepted in accordance with the RCRA permit;
- verify that the Facility has the capability to properly treat and/or dispose of the waste;
- identify any safety precautions that must be taken to properly manage the waste;
- use the physical characteristics and chemical composition of the waste to determine the most effective treatment and disposal methods for the waste; and
- select parameters to be tested to determine the formula for stabilization of appropriate wastes; and,
- select parameters to be tested upon arrival at the Facility to verify that the waste accepted is the waste characterized.

The following sections provide details of the waste acceptance procedures that will be implemented at the Facility.

3.1.1 Pre-Shipment Procedures

A. Prior to entering into an agreement to manage a waste stream for a generator, the Facility will require the generator to supply enough data to determine the physical and chemical characteristics of the waste stream, as well as the U.S. Environmental Protection Agency (EPA) waste codes applicable to the waste stream.

B. The Facility will work with the waste generator to assure that all waste analyses and waste characterization information are provided to meet the applicable requirements of 20.4.1 NMAC 4.1. If the data supplied are not adequate to provide a complete characterization of the waste stream, the Facility will either require additional data from the generator or will not accept the waste.

C. Before a waste stream may be accepted by the Facility for ~~treatment, storage, or~~ disposal, the generator must provide the following information:

C.1 A completed Waste Profile Form (EPA 530-R-94-024) or a comparable form approved by the Facility and signed by an authorized agent of the generator. The typical parameters that the generator should include in the waste stream profile are provided are discussed in Sections 4.3.3.

C.2 A representative sample of the waste.

C.3 A description of the process that generated the waste.

C.4 A Land Disposal Restriction Notification.

C.5 All supporting data required by 40 CFR 268.7.

C.6 If the waste is an LDR waste that the generator has treated to applicable BDAT standards, the generator must supply applicable LDR Certification specified in 40 CFR 268.7, a copy of the waste analysis plan required by 268.7, and the applicable LDR Certification and analytical data necessary to show compliance with 40 CFR 268.7.

C.7 If the waste is an LDR waste that the generator has determined meets the BDAT treatment standards without any type of secondary treatment, applicable LDR Certification and analytical data necessary to show compliance with 40 CFR 268.

C.8 Documentation that supports the information presented on the waste profile form.

D. The representative sample submitted during the pre-acceptance process will be analyzed by an independent laboratory. Each waste with reactive properties will also be tested for compatibility with the landfill and surface impoundment materials. The analytical results will be compared with the generator's waste profile form, and the discrepancies will be resolved with the generator prior to approval being granted to the generator to ship the waste. Information from the waste profile form and analytical results will be compared with the Facility's permit to ensure that the waste is acceptable for ~~storage, treatment and~~ disposal at the Facility.

E. The Facility will conduct required/supplemental analysis according to EPA or ASTM methods on all incoming hazardous waste to further characterize the waste. Supplemental analyses will be performed on all waste suitable for direct landfilling from the generator if slight discrepancies exist between the Waste Profile Form and the shipped waste. Sampling methods are described in Section 4.5.

F. The Facility may waive one or more of the analyses under the following conditions:

F.1 The waste is a portion of continuously shipped, well documented waste stream.

F.2 The waste has been approved for receipt by NMED on an emergency basis.

F.3 Facility personnel at the point of generation sampled, or oversaw the sampling of the waste and the required/supplemental analyses have been conducted.

F.4 A representative sample cannot be practically obtained.

F.5 Other factors are introduced which preclude the need for required/supplemental analyses.

F.6 The Facility will document the reason for the waiver of required/supplemental analyses.

G. Generators will conduct random sampling and analyses of waste streams. The procedures for selecting and sampling waste are described in Section 4.6.

3.1.2 First-Time Waste Acceptance Procedure

A. When a waste has been approved for ~~treatment and/or~~ disposal at the Facility, the waste may be scheduled for shipment. 24-hour notice will be required from each generator prior to waste shipment. This time will enable the Facility to prepare for receipt of the waste, including~~.~~ ~~Such preparation will include ensuring that adequate capacity exists in the storage areas or treatment units,~~ preparing for sample collection and fingerprint analyses~~,~~ and preparing all necessary documentation on the waste shipment. If adequate capacity to receive the waste is not available, the generator will be told not to ship the waste until notified by the Facility.

B. Upon arrival at the Facility, the waste will be analyzed to determine if it matches the Waste Profile Form and representative sample (Table 4.4). If discrepancies are noted, the waste will be further analyzed using supplemental analyses methods (Table 4.5). In addition, the Facility may specify any testing that is deemed necessary to ensure that the waste is properly characterized.

C. Any waste that does not meet the waste acceptance criteria will be returned to the generator.

3.1.3 Ongoing Waste Acceptance Procedure

A. Confirmatory analyses will be performed according to Section 4.4.

B. The Facility will conduct random sampling and analysis of incoming hazardous waste.

3.2 Waste Handling

This section refers to the general procedures and analyses that will be performed once a waste stream has been accepted in the Facility. Specific procedures for waste handling within each unit are addressed in specific sections for each unit.

3.2.1 Incoming Load Procedures

A. When a waste shipment arrives at the Facility, the truck will be routed to a parking area outside the Facility gate while documents are reviewed. Required documentation will include a waste manifest, an LDR certification, and a copy of the Waste Profile Form (or waste profile number if the form is already on file). The paperwork will be reviewed for completeness and checked against the waste shipment to verify that the numbers of containers and waste labels match the description on the manifest.

B. If the paperwork is in order, the truck will be routed to the truck sample station, a staging area inside the Facility gate.

C. If a discrepancy is found in the paperwork, the Facility will contact the generator for resolution prior to acceptance of the load and will reject the load if the discrepancy cannot be resolved (generally in less than 24 hours). During the time the discrepancy is being resolved, the waste shipment will remain in a secure area inside the Facility gate.

D. In those instances where a discrepancy with the manifest cannot be resolved within 15 days of receiving the waste, a letter will be submitted to NMED describing the discrepancy and the attempts to reconcile it. A copy of the manifest or shipping paper at issue also will be provided to NMED, as specified in 40 CFR

264.72(b). All discrepancy resolutions will be documented in writing and maintained in the Facility operating record.

3.2.2 Ongoing Complete Waste Analysis

A. If one or more waste shipments in a calendar year from any single generator do not match the fingerprint tests, full sample analyses of each waste stream from the generator will be performed annually.

B. If all waste shipments in any given calendar year from a single generator match the fingerprint analyses, full sample analyses of each waste stream from that generator will be performed annually.

C. On an annual basis, the Facility will randomly sample and analyze a minimum of 10% of the incoming waste streams that are to be directly landfilled. The ~~sampled~~ samples will be split into a minimum of two aliquots. One will be retained and the other analyzed for conformance to the LDR requirements. If the results of the analysis indicate that the waste does not conform with the applicable LDR requirements, the Facility will immediately contact the generator and suspend the placement of that waste stream into the landfill. Disposal of the waste stream will be discontinued until the discrepancy regarding compliance with the LDR requirements has been resolved and the generator has demonstrated that its ongoing program for compliance with LDR requirements is adequate.

3.2.3 Waste Tracking

A. A Facility specific number will be assigned to each waste stream. The designated number will identify the generator, a sequential number specific to the substance and source and the delivery date.

B. The number will be recorded on: (1) all incoming paperwork from the generator; (2) samples received from the generator; (3) samples taken on site; and (4) site-generated records.

3.2.4 Compliance with Regulations for ~~Storage, Treatment and~~ Disposal

A. Additional analyses may be required dependent on the ~~interim and~~ final disposition of the waste.

B. Containers will be inspected to ensure that the integrity of the container is suitable for storage.

~~C. Containerized wastes that are not compatible will be segregated within the storage area. Storage procedures within each storage unit are detailed in the following sections.~~

~~D.~~C. Solid wastes that exceed 500 parts per million by weight (ppmw) of volatile organics will only be stored in DOT containers approved for shipment of hazardous waste. ~~No wastes which exceed 500 ppmw of volatile organics will be stored in the liquid waste tanks~~.

~~E. A second representative sample of any waste that will require stabilization prior to placement in the landfill will be supplied by the generator. This sample will be used for bench-scale testing to determine regulated constituent leaching based on varying admixes and ratios. The stabilization process will result in a dry and structurally stable material that is suitable for compaction and landfilling.~~

~~F. Wastes that are treated on site in the solidification unit will be tested after treatment and before disposal to verify that LDR standards have been met.~~

~~G.~~D. No wastes will be placed in the landfill until those wastes meet applicable LDR standards. All information obtained to document LDR compliance will be maintained in the Facility operating record.

H.E. Wastes that carry more than one characteristic or listed waste code will be treated to the most stringent treatment requirements for each hazardous waste constituent of concern prior to disposal in the landfill. When wastes with differing treatment standards are combined solely for the purpose of treatment, the most stringent treatment specified will be met for each constituent of concern in the combined waste prior to land disposal.

I.F. Prior to disposal, hazardous wastes contained in lab packs will be treated to meet applicable treatment standards for each waste type.

J.G. Reactive hazardous waste will not be placed in the landfill until is has been rendered non-reactive by treatment.

K.H. F001 – F005 spent solvents will not be disposed of in the landfill unless applicable treatment standards, set forth in 40 CFR 368 Subpart D, are met.

L.I. "California List Wastes" will not be accepted at the Facility unless they can be treated to LDR standards.

M.J. Unacceptable PCB contaminated wastes are defined in Section 4.1.2 of the Waste Analysis Plan.

N.K. The Facility will accept contaminated debris only in the cases where that debris will remain hazardous after it has been treated in accordance with 40 CFR 268.45(b) or (c).

3.3 General Procedures for Hazardous Waste Generated at the Facility

A. The types of waste that might be expected to be generated at the site are discussed in Section 4.5.6.

B. During inspections of these facilities, if waste materials are identified, they will be removed from the system, characterized, and managed according to the waste analysis plan. Management of spill residues that do not require the implementation of the contingency plan will be managed in accordance with site procedures. Spills or releases that require implementation of the contingency plan will be managed in accordance with the requirements of the plan.

C. Leachate collected in the unit sumps will be pumped into temporary storage tanks that are part of the landfill operation. tanker trucks. It will then be tested to assure compliance with LDR requirements defined in 40 CFR Part 268 for F039 listed wastes. Based on the test results, the frequency of sampling and required parameters for leachate analysis will be determined. Leachate that meets applicable LDR requirements will be Leachate will be managed within the landfill unit by applying the leachate to the landfill soil cover for enhanced evaporation and dust suppressionplaced in the evaporation pond. Leachate that does not meet applicable LDR requirements will be stabilized before landfilling.

D. Wastes will be treated at the stabilization unit prior to disposal in the landfill and may be sampled and characterized to determine an appropriate treatment mixture prior to their acceptance.

E. After wastes have been treated at the stabilization unit, they will be retested prior to placement in the landfill to determine if they meet LDR requirements. All solidified wastes will be tested for the presence of free liquids using the paint filter test and will be analyzed for other parameters determined by the characterization of the waste before solidification. For most materials, the TCLP extraction method will be performed, followed by an analysis of the leachate for the appropriate parameters (refer to EPA test method 1311, 40 CFR Part 261, Appendix II).

3.4 Landfill Operation

3.4.1 Records

A. The Facility will maintain complete records of the wastes disposed of in the landfill. The documentation will contain results of waste analyses, waste compatibility analyses and waste handling compliance. Additional documentation will register the exact location of a waste within a three-dimensional grid system. Grid spacing will be a minimum of 50 feet.

B. Records of inspections of the landfill will be maintained in an operating record kept in the administration building.

C. ~~Preventative~~ Preventive maintenance information will be documented and kept in the operating record in the administration building.

D. Maintenance performed on the structures and equipment part of the landfill unit will be documented in the operating record kept in the administration building.

3.4.2 Procedures for Ignitable/Reactive Wastes

A. Reactive wastes will be treated or mixed prior to placement in the landfill so that the resulting waste mixture no longer meets the definition of reactive waste.

B. Ignitable waste will be treated or mixed prior to placement in the landfill so that the resulting waste mixture no longer meets the definition of ignitable waste.

C. Reactive wastes will be separated from sources of reaction.

3.4.3 Waste Placement

A. The landfill will be accessed by means of ramps indicated in Drawing 10.

B. The active areas of the landfill will be accessed by temporary roadways that will be established on top of the waste and daily cover.

C. Incompatible wastes will be spaced at least one grid distance to prevent commingling.

D. Lab packs may be placed in the landfill only if they meet the requirements in 40 CFR 264.316. Lab packs will not be accepted if incompatible wastes are placed within the same lab pack or if reactive wastes have not been treated to render them non-reactive.

E. Bulk and containerized wastes will not be placed in the landfill unless they meet the requirements in 40 CFR 264.314.

F. Containers less than 90% full will be crushed~~, shredded, or otherwise reduced in volume~~ to the maximum extent possible through compaction when~~prior to~~ placeed~~ment~~ in the landfill.

G. Wind dispersal will be controlled with a daily cover consisting of soil spread on top of the waste with a minimum thickness of 0.5 foot.

H. Dust generation will be reduced by applying small amounts of water spray to moisten the soil surfaces. Water applied for dust control may include clean water supply, leachate, and runoff water collected within the landfill contaminated water basin. The water will be applied using both a piping and sprinkler system andwith a water trucks equipped with a pump, piping and an array of nozzles that spray very small water droplets. The frequency of the water application will depend on the climate and traffic. Sufficient moisture will be applied to all soil surfaces on an as-needed basis to prevent wind erosion. However, the application of water will be limited so that ponding in the landfill does not occur.

I. Waste placement operations will be halted when wind speed exceeds 35 mph.

J. Landfill operational staff will visually observe trucks leaving the area for excessive accumulation of waste on the tires and/or truck body. If excessive accumulation is noted, physical cleaning of the trucks will be performed within the lined landfill on an area with soil cover daily waste disposal working face.the trucks will be routed to the truck wash area for cleaning. Any waste resulting from cleaning will be covered with daily soil cover. The potential for waste accumulating on trucks will be minimized by limiting the waste daily waste disposal working face to the smallest practical area. All other areas will have soil cover over the waste.

3.4.4 Operation of Leachate Collection and Detection Systems

A. Pumpable liquid in the LCRS, LDRS, and vadose VZMS sump will be removed in a timely manner to prevent the head on the respective liners from exceeding 12 inches above the floor liner system. The depression in the sump will be used to provide sufficient head to activate the pumps.

B. The leachate collected from the sumps will be temporarily stored in tanks.

C. Overfilling of the tanks will be controlled with high-level control switches which will automatically shut down the sump pumps. An alarm will be activated that will notify personnel that the system requires maintenance. Volume of leachate pumped will be monitored by means of cumulating flow meters. Total liquids pumped will be recorded daily.

D. The leachate collection tanks will be used as 90-day storage units and managed accordingly.

E. Once the leachate levels in the riser crest pad tanks exceed 50 percent of the holding capacity the liquids will be removed by tanker truck to the main liquid waste storage tanks.

F. A fluid level pressure transducer will be installed in the LCRS, LDRS, and vadose VZMS sump. The pressure transducer will be wired to a digital readout box located at the crest riser pad. The readout box will show the depth of leachate in the sump. The readout box will be checked during the routine inspections which are presented in Table 5-1. When the leachate level is 12 inches or greater then the pump will be activated to remove leachate from the sump. The pump will be turned off when the leachate inflow rate becomes too small for the pump to stay activated. Volumes of leachate will be recorded as previously stated in paragraph C of this section.

G. In the event of large rain storms both the side slope riser pipe pumps and the vertical riser pipe pumps will be used to minimize head. Liner systems facility staff will be available to address large rain storm events by utilizing vacuum trucks or portable pumps to remove excess leachate and contaminated runoff, if required. Runoff water collected within the contaminated water basin will be managed by pumping the water to remove the standing water in the basin and applying it to the landfill soil cover for enhanced evaporation. A moveable piping and sprinkler system will be used to distribute the water onto the soil cover. Vacuum trucks with spray bars may also be used to apply water to the soil cover and landfill roads.~~Vacuum trucks typically have a capacity range of 2,000 to 3,000 gallons. Portable pumps with a pumping rate in the range of 10 to 25 gallons per minute (gpm) may also be used, if needed.~~

3.4.5 Inspection and Monitoring

A. Inspections will be performed according to the schedule matrix indicated in Table 5-1.

B. The schedule matrix will be expanded, as necessary, to reflect new equipment or changes to existing equipment inspection frequencies.

C. The landfill and associated equipment will be inspected weekly and after storms.

D. The LCRS, LDRS and vadose sumps will be checked daily for the presence of liquid. Pressured transducers will be used to measure the presence of liquids in the sump. The elevation of the transducer will be determined during installation. The transducer elevation combined with the fluid pressure on the transducer will allow calculation of the fluid elevation at any time.

E. The leachate collection tank will be inspected according to the procedures indicated in Section 5.2.5.

F. Ancillary equipment will be inspected according to the manufacturer recommended programs.

G. Surveys of the active landfill surface area and the riser pipes with an organic vapor monitor (OVM) or comparable device will be performed quarterly to detect the presence of organic compounds.

H. The landfill will be inspected by properly-trained personnel for items such as spills, leaks, odors, wind-blown particulate matter, deterioration of the landfill itself, malfunction or improper operation of the run-on/runoff control systems.

I. Inspections will be documented in inspection checklists that will be kept for at least 3 years.

J. If deterioration or any other abnormalities are noted, the inspector's supervisor will be notified and will determine the appropriate course of action for correction. If the supervisor is not available, the Emergency Coordinator (EC) will be summoned to make the determination.

K. The stormwater and contaminated water basin will be inspected to ensure that liquid has not accumulated. The collection systems will be emptied as quickly as possible to ensure that the design capacity of the system is not exceeded. Stormwater collected within the landfill that has the potential to have contacted waste with be managed by enhanced evaporation through recirculation on the landfill soil cover. Vacuum trucks may~~will~~ also be used to empty the basins. Management of runoff water by recirculation for enhanced evaporation keeps all water that has a potential to contact waste within the lined landfill cell. ~~Contaminated water that meets applicable LDR requirements will be placed in the evaporation pond. Contaminated water that does not meet applicable LDR requirements will be stabilized before landfilling.~~

L. The sump pumping and instrumentation system will be checked annually to ensure that it is functioning properly. The pumping system will be turned on to check if the system works. If the system is not functioning properly the systems will be repaired in accordance with the manufacturer's recommendations or will be replaced. If there is adequate leachate in the sump, visual observation of flow into the storage tanks will be used to determine if the system is functioning properly. If there is insufficient leachate, then audible indications that the pump has engaged will be used to determine if the pump is functioning. The pressure transducers will be extracted from the sump and placed in the solution of known depth to determine if the transducer is functioning properly.

M. If either the pumping system or transducer fails to function as designed, then the failing piece of equipment will either be replaced or fixed.

N. Determination if the Action Leakage Rate (ALR) has been exceeded in the landfill will be conducted in accordance with 40 CFR 264.302(b). This is discussed in further detail in the Action Leakage Rate and Response Action Plan ~~report included in the engineering report~~(Permit Attachment J).

O. The average daily flow in the LDRS sump will be calculated as follows:

O.1 Determine volume from cumulative flows for the week

O.2 Determine landfill area based area of landfill in service (horizontal protected area)

O.3 Calculate average daily flow by calculating total gallons for the week/7/area of landfill in service.

P. The Response Action Plan will be implemented if leaks are detected.

Q. Trucks will be inspected to prevent tracking of waste out of the landfill on vehicles tires or bodies.

R. Wind speed will be monitored using a hand-held wind meter to determine if wind speed exceeds 35 mph. Waste placement operations will be halted when wind speed exceeds 35 mph.

~~3.5 Evaporation Pond Operation~~

~~3.5.1 Records~~

~~A.Results of waste analyses will be maintained in an operating record kept in the administration building.~~

~~B. The Facility will maintain complete records of the wastes disposed of in the evaporation pond.~~

~~C. Inspection records will be maintained in the inspection log for the evaporation pond. This log will be kept in the administration building.~~

~~A.Preventative maintenance information will be documented and kept in an operating record in the administration building.~~

~~B.Maintenance performed on the structures and equipment part of the evaporation pond will be documented in the operating record kept in the administration building.~~

~~C.The average daily flow rate to the sump system will be calculated and recorded weekly during the active life of the evaporation pond to ensure that ALR for the evaporation pond (1,000 gpd) is not exceeded.~~

~~3.5.2 Procedures for Ignitable/Reactive Wastes~~

~~A.Wastes that are ignitable, reactive, and/or incompatible will not be placed in the evaporation pond at the same time.~~

~~3.5.3 Waste Placement~~

~~A.Off site and on site waste will be analyzed according to the Waste Analysis Plan to ensure that the waste acceptance criteria specified in the RCRA permit are met and to identify any safety precautions that~~

~~must be taken to properly manage the waste. Hazardous waste which may be placed in the evaporation pond includes all wastes listed in Part A of the application (Volume I), provided that LDR treatment standards are met prior to placement of the wastes. Hazardous wastes that require compliance with CFR 264, Subparts BB and CC will not be placed in the evaporation pond.~~

~~B.Approved off site waste and on site leachate tanker trucks will transport the waste to the tanker discharge pad at the evaporation pond.~~

~~C.Tanker trucks will be unloaded directly into the evaporation pond through a series of hoses, valves and pipes, as shown on Drawing 31 in Volume III.~~

~~D.The pond is separated into two independent sections by a separator berm. In the event that a leak should occur in one section of the pond, liquids could be pumped into the other section until repairs are completed.~~

~~E.Two feet of freeboard will be maintained in the evaporation pond at all times.~~

~~F.Sludge will be removed by vacuum trucks and treated in the stabilization unit. Sludge will be removed on a routine basis to maintain the level of waste in the pond below the maximum operational level.~~

~~G.The vacuum trucks will park on the concrete pad during sludge removal. Sludge will be removed by means of pumps and flexible hosing.~~

~~H.Site personnel will be present during all fluid discharge and transfer operations to ensure that pond overtopping does not occur in the event of equipment malfunction or other human error.~~

~~3.5.4 Operation of Leachate Detection and Vadose Zone Monitoring Systems~~

~~A.Pumps located in the LDRS pipe and vadose zone sump will be used to remove leachate accumulating in the leachate collection systems. When leachate accumulates it will be pumped to a tanker truck and either returned to the evaporation pond, stabilized in the onsite treatment unit, or stored in one of the liquid waste storage tanks. Any time liquids are detected at a specified level, the sump pump will be activated and the liquid will be removed. The pump activation level will be related to the pump selected.~~

~~B.All pumpable liquids in the sumps will be removed in a timely manner to maintain the head on the bottom liner below 12 inches above the floor liner. The depression in the sump will be used to provide sufficient head to activate the pumps.~~

~~C.The volume of liquids removed from the sumps will be recorded in cumulating flow meters. Total liquids pumped will be recorded after each pumping event.~~

~~3.5.5 Inspection and Monitoring~~

~~A.Inspections will be performed according to the schedule matrix indicated in Table 5-1.~~

~~B.The freeboard level will be inspected daily to ensure that approved or acceptable freeboard levels are maintained and that overtopping does not occur. Liquid elevations will be checked by visual observation against the staff gauges. The staff gauges will consist of a rod made of relatively inert material which will be labeled in feet and marked every tenth of a foot. In order to prevent overtopping, the maximum liquid level allowed to maintain the minimum freeboard level will be marked on the staff gauge or noted on the inspection checklists. The bottom of the staff gauge will~~

~~be fixed to a heavy base that will sit on the pond bottom. It is not anticipated that the staff gauge will require maintenance or repair, the pond level could be lowered or a boat could be used to access the staff gauge. The data will be recorded on standard forms and filed with the operating records.~~

~~C.Elevation rods, survey monuments, staff gauges, flow meters and fluid level transducers will be used to measure and record liquid handling volumes.~~

~~D.Flow meters will be used to record volumes of liquids discharged into the pond and removed from the sumps. Transducers located in the sumps will provide a liquid level reading in the sumps. The elevation of the transducers will be determined during installation. The transducer elevation combined with the fluid pressure above the transducer will allow calculation of the fluid elevation at any time.~~

~~E.Inspections will occur on a weekly basis and after storms to detect evidence of deterioration, malfunction, improper operation of overtopping control systems (portable pump) or sudden drops in liquid levels in the pond.~~

~~E1.The overtopping control system (portable pump) will be started during the course of routine inspection. If the pump does not function as designed, the pump will be replaced or fixed. Pump operation inspection will be completed by visual inspection.~~

~~E2.Sudden drops in liquid levels will be determined using a staff gauge system discussed in paragraph B in conjunction with criteria outlined in paragraph F of this section. The liquid level will be compared to the previous liquid level reading and adjusted for estimated evaporation loss and documented liquid addition and removal to determine whether an unexplained drop in the liquid level has occurred.~~

~~F.If liquid losses exceed daily evaporation losses and no other reasonable explanation is found, then that section of the pond will be shut down and authorities at the NMED will be notified immediately.~~

~~G.Weekly visual inspections will be conducted to verify the integrity of the liners and associated systems. Visible portions of the leachate collection pipes and pump will be visually inspected for deterioration.~~

~~H.The concrete pad for tanker discharge will be visually inspected weekly for accumulation of liquids.~~

~~I.The area around the pond will be inspected weekly for any signs of deterioration, leaks or erosion. The evaporation pond berm will be inspected for any sign of abnormal deterioration, which may include excessive sloughing or the development of significant cracks.~~

~~3.6 Liquid Waste Storage Operation~~

~~3.6.1 Records~~

~~A.The results of each daily inspection will be documented in a daily operating record.~~

~~B.The quantity of waste received and the date each period of accumulation begins will be documented for each tank.~~

~~C.Inspection records will be maintained in the Facility operating record, which will be kept in the administration building.~~

D.Maintenance performed on the structures and equipment part of the storage tank unit will be documented in the operating record kept in the administration building.

3.6.2 Procedures for Ignitable/Reactive Wastes

A.Only the waste types approved for a tank system will be placed in the tanks. No new waste types will be placed into an existing tank system unless:

A.1 The compatibility of the new waste type with the prior contents of the tank is determined by testing or documentation.

A.2 The existing tank system is cleaned or flushed to the extent necessary to ensure compatibility with the new waste type.

B.Ignitable or reactive wastes will not be placed into any tank system unless the tank system is protected from sources of ignition be measures including but not limited to the following: signs prohibiting smoking, open flames or welding; an inert atmosphere blanket; enclosed vents isolated from sources of ignition.

3.6.3 Waste Placement and Storage

A.Each storage tank will be clearly marked with a description of the contents and records will be kept documenting the quantity of waste received, and the date each period of accumulation begins.

B. Only the waste types approved for a tank system will be placed in the tanks. No new waste types will be placed into an existing tank system unless:

B.1 The compatibility of the new waste type with the prior contents of the tank is determined by testing or documentation.

B.2 The existing tank system will be cleaned or flushed to the extent necessary to ensure compatibility with the new waste type.

C.The tanks will be operated at ambient pressure and temperature when storing liquids. One of the following feed mechanisms for tank systems or an equivalent transfer mechanism will be used.

C.1 Pump transfer: liquids will be pumped into or out of the tank through permanent or temporary transfer lines.

C.2 Gravity drain: liquids will be allowed to drain by gravity through permanent or temporary transfer lines.

D.Appropriate controls and practices will be used to prevent spills from and overfills of the tank or containment systems.

E.Spill prevention will be primarily maintained by hard-plumbed piping. When transfer lines are not hard plumbed or when open-ended lines are used, one or more of the following spill prevention controls or an equivalent device will be used as described in Section 2.3.3.

F.Response to releases from tank systems will be initiated immediately upon discovery, and regulations specified in 20 NMAC 4.1 Subpart V, 40 CFR 264.196(d) or 40 CFR 264.56 will be followed as appropriate (see Section 5.0), including notification to the Hazardous and Radioactive Materials

Bureau (HRMB) of the New Mexico Environment Department (NMED) and National Response Center (NRC). The secondary containment tank will be emptied by pumping fluids from the drainage port located near the base of the tank or by use of a vacuum truck.

G.Transfer of liquids from the liquid waste storage tanks to the stabilization unit will be accomplished by tanker trucks approved for liquid waste transfer. Tanker trucks will be cleaned following a transfer operation to ensure that subsequent transfers do not result in mixing of incompatible or reactive wastes.

H.The contingency plan for leaks or spills is indicated in Section 6.3.5.2.

3.6.4 Inspection and Monitoring

A.The floor and berm of the concrete area will be inspected regularly for gaps and cracks.

B.Daily visual inspection will be used to detect releases to the secondary containment.

C.Inspections will be performed according to the schedule matrix indicated in Table 5-1. Inspections will focus on: (1) overfill control; (2) equipment condition to detect signs of corrosion or releases of waste from the tanks or ancillary equipment; and (3) data gathered from monitoring and leak detection equipment. A typical inspection checklist is provided in Appendix I in Volume II.

D.Ancillary equipment, monitoring and leak detection systems will be inspected daily.

3.7 Operation of Stabilization Unit

3.7.1 Records

A.Inspection records will be maintained in the administration building. The results of each daily inspection will be documented in a daily operating record.

B.Maintenance performed on the structures and equipment part of the stabilization unit will be documented in the operating record kept in the administration building.

3.7.2 Procedures for Ignitable/Reactive Wastes

A.Prior to treating wastes, waste characteristics will be analyzed to ensure that proper measures can be taken to safely manage ignitable, reactive, and incompatible wastes.

B.If ignitable or reactive wastes are placed in the bins, they will be immediately mixed with sufficient quantities of fly ash and/or cement to render them non-ignitable or non-reactive.

3.7.3 Waste Placement and Treatment

A.Operations in the stabilization building will be directed and coordinated from the control room.

B.As indicated in Section 4.0, wastes will be tested prior to stabilization to determine the appropriate reagent formula.

C. Wastes may be offloaded directly from trucks into the stabilization bins or transferred from the drum handling unit or roll-off storage area. Waste receiving will involve positioning the loaded waste hauler at the end of the bin, dumping the waste load, and washing out any residue left in the truck bed into the bin.

D. The bins will be covered while dry reagents are being added to control particulate air emissions. Reagent addition involves placing a cover on top of the bin, connecting ventilation and dry reagent delivery ducts, and injecting reagents into the bin. Reagent delivery to the bins will be controlled by a process controller system which will automatically sequence and deliver the necessary quantities of reagent based on a predetermined waste processing recipe.

E. A backhoe positioned adjacent to the bin will mix the waste and reagents.

F. Following mixing, the waste will be sampled and a paint filter test will be conducted to ensure that no free liquids are present. If necessary, samples will be gathered for toxicity characteristic leachate procedure (TCLP) testing. If the paint filter test is passed, the backhoe will load the stabilized waste into a waste hauler (roll-off truck) and the trucks roll-off cover will be positioned over the waste. The stabilized waste will be stored temporarily at the roll-off unit while tests are completed to determine how and if the material can be disposed of in the landfill.

G. Wastes that are treated on site in the solidification unit will be tested after treatment and before disposal to verify that LDR standards have been met.

H. The backhoe bucket and stabilization bin will be thoroughly cleaned before a load of waste which is not compatible with the waste previously stabilized in that bin is mixed. After the last bin load of a specific stabilization mixture has been loaded out, Facility personnel will use a high-pressure water hose located near the bins to rinse the backhoe bucket and the bin walls. The rinsing will cause residual clods of stabilized waste to fall to the bottom of the bin along with the rinse water. Reagents will then be added to the bin at the same mixture proportions and the remaining waste and rinse water will be stabilized, tested for free liquid, and loaded out before a different waste stabilization mixture is processed in that bin.

I. Releases into the LDRS will be detected within 24 hours by liquid sensing instruments or inspection. Accumulated liquids will be removed within 24 hours of detection. The secondary containment will be emptied by pumping accumulated liquids into a temporary storage tank or into another stabilization bin by portable pumps.

J. In case a breach should occur in a bin, such bin will be removed from service and repaired.

K. Spill and overfill prevention will be accomplished by continuous direct monitoring of transfer operations.

L. The stabilization bins will be operated at ambient temperature and pressure.

M. Reagents will either be pumped from reagent tanks or manually fed.

N. Liquid hazardous wastes will be pumped from vacuum or tanker trucks. Other wastes may be manually transferred from the incoming waste hauler truck or from the container storage areas.

O. The contingency plan for leaks or spills is indicated in Section 6.3.5.2.

P. Dust will be removed from the exhaust air in the bag house. Collected dust will be processed in the stabilization bins.

3.7.4 Inspection and Monitoring

A.Inspections will be performed according to the schedule matrix indicated in Table 5-1.

B.Each stabilization bin will be visually inspected once each operating day.

C. The concrete vault area of the stabilization unit will be inspected monthly. If liquids are found they will be removed with a portable pump and transported to the liquid waste storage unit.

D. At least once per month, the daily visual inspection will be conducted on empty bins to ensure integrity of the bins and welds.

E. An annual sonic test will be conducted to ensure the thickness of the inner tank and outer shell is maintained.

F. Ancillary equipment and monitoring systems will be inspected once each operation day.

3.8 Drum Handling Operation

3.8.1 Records

A.Records of inspections of the drum handling unit will be maintained in an operating record kept in the administration building.

B.The results of all container storage analyses, trial tests, waste compatibility analyses, and ignitable and reactive waste handling documentation pertaining to compliance will be maintained in the Facility operating record.

C.Maintenance performed on the structures and equipment part of the drum handling unit will be documented in the operating record kept in the administration building.

3.8.2 Procedures for Ignitable/Reactive Wastes

A.Ignitable or reactive wastes will be protected from any sources of ignition or reaction.

B.If ignitable wastes are handled, special precautions will be instituted, including the use of special non-sparking bung wrenches or other tools for opening drums.

3.8.3 Waste Placement and Storage

A.All containers being stored will be clearly marked with hazardous waste labels which will be clearly visible while containers are being stored.

B.All containers will remain closed during storage except when they are sampled.

C.Handling procedures will be developed to ensure that containers are not opened, handled, or stored in a manner that may cause them to rupture or leak.

D.Wastes stored will be placed in individual storage cells segregated by waste type and compatibility. Labels will be added to each section of the unit to identify the type of waste to be stored.

~~E.Two of the cells will be designed to accommodate only TSCA PCB wastes.~~

~~F.Containers will be managed according to the conditions indicated in Section 2.2.10.~~

~~G.Aisle spacing will be maintained to assure inspectability and accessibility for operational and emergency equipment to containers. A minimum 30-inch aisle space will be maintained between double rows of containers. Containers will be stored in single rows only if they are against a wall or other barrier that prohibits inspection from all sides.~~

~~3.8.4 Operation of Leachate Collection and Detection Systems~~

~~A.Liquids present in the LCRS and LDRS sumps will be sampled and analyzed to determine the nature and concentration of waste constituents. An appropriate treatment and disposal method will be selected in accordance with Section 4.0.~~

~~B.Pumpable quantities of liquids will be removed with a vacuum truck.~~

~~C.Leaks and spills will be removed from the sumps in a timely manner.~~

~~3.8.5 Inspection and Monitoring~~

~~A.Inspections will be performed according to the schedule matrix indicated in Table 5-1.~~

~~B.The floor will be inspected regularly to determine if any gaps or cracks have developed or if the epoxy coating has been damaged.~~

~~C.The leachate collection and removal system (LCRS) and leak detection and removal system (LDRS) sumps will be checked regularly for the presence of liquid.~~

~~D.Drum storage areas will be visually inspected at least once a week for leaking containers and deterioration of the containers and containment area. If a container is found to be in poor condition, the inspector's supervisor will be notified, who will arrange to transfer the hazardous waste to a new container, repair the existing container as specified by the manufacturer, or place the container in an overpack drum.~~

~~E.Containers with more than 500 ppmw volatile organic compounds will be inspected at least once a month for cracks, holes or gaps in the container, cover or closure devices. Defects detected will be repaired according to 40 CFR 264.1086(c)(4)(iii) and 40 CFR 264.1086(d)(4)(iii), for container Levels 1 and 2, respectively.~~

~~F.Weekly visual inspections will be performed to identify the status of warning signs, condition of containers and labels, availability and accessibility of spill control and PPE, and the adequacy of aisle space and access/egress routes.~~

~~G.Secondary containment areas will be inspected weekly. Inspections will focus on (1) the condition of the sump pits and trenches to ensure that they are free of cracks or gaps and are sufficiently impervious to contain leaks, spills, and accumulated liquids until the collected material is detected and removed; and, (2) pump operation.~~

~~H.Ancillary equipment will be inspected according to manufacturer recommended programs.~~

3.9 Operation of Truck Roll-Off Unit

3.9.1 Records

A. Results of container waste analyses, trial tests, waste compatibility analyses, and ignitable and reactive waste handling documentation pertaining to compliance will be maintained in the Facility operating record.

B. Records of inspections of the roll-off storage unit will be maintained in an operating record kept in the administration building.

C. Maintenance performed on the structures and equipment part of the roll-off storage unit will be documented in the operating record kept in the administration building.

3.9.2 Procedures for Ignitable/Reactive Wastes

A. Ignitable or reactive wastes will be protected from any sources of ignition or reaction.

3.9.3 Waste Placement and Storage

A. Containers being stored will be clearly marked with hazardous waste labels which identify the contents of each container as well as the date of receipt (accumulation date). All labels will be clearly visible while containers are being stored.

B. All containers will remain closed during storage, except when waste is removed or added.

C. Containers will be managed according to the conditions indicated in Section 2.2.10.

D. Container storage and handling procedures will be developed to ensure that containers are not opened, handled, or stored in a manner that cause them to rupture or leak.

E. The unit is divided in two sections. One section will hold tarped, U.S. Department of Transportation (DOT) approved, lined, roll-off containers with non-stabilized waste awaiting treatment. The other section will be a staging area for roll-off containers containing stabilized waste TCLP test results and landfill disposal approval.

F. Waste will be characterized and screened as part of the waste acceptance procedures. This will confirm that no free liquids are present in the roll-off units. If liquids are found they will be pumped and removed. In addition, this procedure will prevent incompatible wastes from being stored in the same roll-off containers that are delivered to the site.

G. Materials from a single stabilization batch will not be mixed with material from a different batch.

H. Hazardous waste will be compatible with the container or liner as defined by the following conditions:

- H.1 All containers used to store hazardous waste will be made of, or lined with, material that will not react with, or otherwise be incompatible with, the waste being stored so that the ability of the container to hold waste is not impaired.

- H.2 Hazardous waste will not be placed in an unwashed container that has previously held incompatible waste or material.

I. Incompatible solid wastes stored within the container storage areas will be separated by a distance of at least 10 feet unless separated by a berm.

J. Roll-off containers will be spaced 4 feet apart side to side, 2.5 ft. end to end and 4 feet from the edge of the berm. Roll-off containers will not be placed within the storage area inundated by the 25 year, 24 hour storm. The inundation limits for the 25 year, 24 hour storm will be marked in the storage area.

K. Operational staff will visually observe trucks leaving the area for excessive accumulation of waste on the tires and/or truck body. If excessive accumulation is noted, the truck will be routed to the truck wash for cleaning.

L. Roll-off containers will be covered before exiting the stabilization unit and will remain covered while they are staged in the roll-off storage area.

M. Free liquids found upon inspection of containers received for disposal will be removed with a vacuum truck, characterized and managed in accordance with stabilization procedures.

N. Liquids collected on the surface of the sump or in the sump drainage gravel will be removed by vacuum truck.

O. Samples of sump liquids will be chemically analyzed to determine the presence and concentration of any waste constituent. After this determination, an appropriate method of treatment or disposal will be selected in accordance with the criteria prescribed in the Waste Analysis Plan (Section 4.0).

P. Leaks, spills and precipitation will be removed from the sump as soon as possible.

Q. In the case of a leak, the liquids in the roll-off container will be stabilized and the stained soil will be excavated and handled as a potential hazardous waste.

3.9.4 Inspection and Monitoring

A. Inspections will be performed according to the schedule matrix indicated in Table 5-1.

D. Container storage areas will be visually inspected at least once a week for leaking containers and deterioration of the containers and containment area. All inspection information will be recorded and any problems noted during the inspection will be resolved in a timely manner.

E. Identified leaks will be resolved as described in Section 2.2.10.

F. Containers with more than 500 ppmw volatile organic compounds will be inspected at least once a month for cracks, holes or gaps in the container, cover or closure devices. Defects detected will be repaired according to 40 CFR 264.1086(c)(4)(iii) and 40 CFR 264.1086(d)(4)(iii), for container levels 1 and 2, respectively

G. Weekly visual inspections will be performed to identify the status of warning signs, condition of containers and labels, availability and accessibility of spill control and PPE, and the adequacy of aisle space and access/egress routes.

4. Maintenance

4.1 Landfill

A. The landfill structure will be maintained through a routine ~~preventative~~ preventive maintenance program, which will be fully defined in the final operations plan.

B. ~~Preventative~~ Preventive maintenance will involve regular visual inspections of the landfill liner where feasible and review of leachate collection and analysis results.

C. Defects detected in the liner systems will be repaired according to the procedures indicated in the Construction Specifications: Sections 02710, 02775 and 02780. Soil surfaces that need to be repaired will be removed and placed according to the Construction Specifications: Sections 02226 and 02119.

D. The LCRS and LDRS equipment, such as pumps, transducers, generators, electrical lighting, and warning systems, will be subject to manufacturer's or standard ~~preventative~~ preventive maintenance procedures.

E. Preventive maintenance information will be documented and any deviation from normal conditions will be closely tracked and corrected as necessary.

F. Landfill run-on/runoff control systems will be maintained/repaired after regular inspections (as described in Table 5-1) that determine that the design criteria are not met. Once a deficiency in the run-on/runoff control system is noted, it will be repaired in a timely manner to a state such that it meets or exceeds design criteria.

~~4.2 Evaporation Pond~~

~~A. If a section of the evaporation pond must be removed from service, flow of waste to that section will be stopped by draining the pond to below the level of the leak, surface leakage will be contained, and all necessary steps will be taken to repair the liner system and prevent future failure.~~

~~B. Preventative maintenance will involve regular visual inspections of the evaporation pond liner where feasible and review of leachate collection analysis results.~~

~~C. Defects detected in the liner systems will be repaired according to the procedures indicated in the Construction Specifications. Soil surfaces that need to be repaired will be removed and placed according to the Construction Specifications:~~

~~D. The LDRS equipment, such as pumps, generators, electrical lighting, transducers and warning systems, will be subject to manufacturer's or standard preventative procedures.~~

~~E. Evaporation pond run-on/runoff control systems will be maintained/repaired after regular inspections (as described in Table 5-1) that determine that the design criteria are not met. Once a deficiency in the run-on/runoff control system is noted, it will be repaired in a timely manner to a state such that it meets or exceeds design criteria.~~

4.3 Liquid Waste Storage

A. Should gaps or cracks develop in the concrete, repairs will be scheduled immediately. The nature of the repair will depend on the extent of the cracking and could range from the application of chemically resistant epoxy fillers or coatings to the replacement of portions of the concrete floor.

B. If a release occurs from the primary tank system, the tank will be removed from service immediately. Wastes in the tank will be removed within 24 hours to the extent necessary to prevent further release and allow inspection and repair of the tank system. All released materials will be removed from the secondary containment as soon as possible and within 24 hours of detection.

C. The tank system will be repaired or replaced prior to returning it to service. An independent New Mexico registered professional engineer will certify major repairs. The certification will be submitted to the NMED within seven days after the tank system is returned to service.

D. Tanks, pumps, generators, electrical lighting and warning systems will be maintained according to manufacturers recommended programs.

4.4 Stabilization Unit

A. If a release occurs from a primary tank system, the tank will be removed from service and all materials will be removed from the tank or secondary containment within 24 hours or as soon as reasonably possible. The tank system will be repaired prior to return to service. Major repairs will be certified by an independent New Mexico registered professional engineer. The certification will be submitted to the NMED within seven days after the tank system is returned to service.

B. Equipment such as pumps, generators, electrical lighting, and warning systems, will be subject to manufacturer recommended maintenance programs.

C. The stabilization unit run-on/run-off will be maintained/repaired after regular inspections (as described in Table 5-1) that determine that the design criteria are not met. Once a deficiency in the run-on/runoff control system is noted, it will be repaired in a timely manner to a state such that it meets or exceeds design criteria.

4.5 Drum Handling Unit

A. Should cracks or gaps develop in the concrete, repairs will be scheduled immediately. The nature of the repair will depend on the extent of the cracking and could range from the application of chemically resistant epoxy fillers or coatings to the replacement of portions of the concrete floor.

B. Equipment such as pumps, generators, electrical lighting, and warning systems, will be subject to manufacturer recommended maintenance programs.

C. The drum handling unit run-on/run-off will be maintained/repaired after regular inspections (as described in Table 5-1) that determine that the design criteria are not met. Once a deficiency in the run-on/runoff control system is noted, it will be repaired in a timely manner to a state such that it meets or exceeds design criteria.

~~4.6 Roll-Off Container Storage Unit~~

~~A.Equipment such as pumps, generators, electrical lighting, and warning systems, will be subject to manufacturer recommended maintenance programs.~~

~~1.The roll-off container storage unit run-on/run-off will be maintained/repaired after regular inspections (as described in Table 5-1) that determine that the design criteria are not met. Once a deficiency in the run-on/runoff control system is noted, it will be repaired in a timely manner to a state such that it meets or exceeds design criteria.~~

4.7 Drainage Ditch

A. Drainage ditches will be inspected weekly and immediately after a major storm event.

B. Excess debris that prevents flow in accordance with the design specifications will be removed manually or with a backhoe.

C. Drainage ditches will be maintained/repaired after regular inspections (as described in Table 5-1) that determine that the design criteria are not met. Once a deficiency in the run-on/runoff control system is noted, it will be repaired in a timely manner to a state such that it meets or exceeds design criteria.

Permit Renewal Application
October 17, 2011

Attachment O

Closure Plan

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March 2002

~~Permit~~ Attachment O. Closure Plan

~~Modified from the Permit Application, Volume I, Sections 8.0, 8.1, 8.3, 8.5, and 8.6~~

8. Closure of Permitted Units

This closure plan describes specific activities required for closure of the ~~drum handling unit, roll-off storage area, stabilization unit and associated liquid waste receiving and storage unit, evaporation pond, and~~ landfill, in compliance with Resource Conservation and Recovery Act (RCRA) closure requirements. ~~It is currently planned that all of these units will be cleaned closed with the exception of the landfill.~~ The closure activities are designed to minimize the need for further maintenance and any potential impacts to human health and the environment. Closure activities are described in Section 8.1. Section 8.3 presents the closure performance standard~~;~~ and Permit Attachment O1, Compliance Schedule~~s~~ for Closure, discusses the closure schedule. Closure certification and modifications are discussed in Sections 8.5 and 8.6, respectively. Closure cost estimates and compliance with financial assurance requirements are discussed in Permit Attachments O2, Financial Assurance for Closure, and P1, Financial Assurance for Post-Closure Care.

8.1 Closure Activities

At the end of the active life of the Facility, the landfill and all ~~units and~~ structures of the Facility will be closed and dismantled in compliance with 40 CFR 264, Subpart G. Any solid hazardous waste and debris will be placed in the landfill, and non-hazardous waste will be sent off site for reuse, recycle, or disposal in compliance with 40 CFR 264, Subpart G. Liquids generated during closure (decontamination solutions~~,~~ and leachates~~, and evaporation pond liquid~~) will be treated off-site.~~onsite (stabilization unit) unless it is determined that shipment offsite for treatment is more cost effective.~~ The landfill will be capped with a final cover, and post-closure care will be initiated for the landfill. These closure activities are described in detail in the following sections. ~~The unit-specific closure descriptions are presented in the order in which the units are anticipated to be closed.~~

An off-site laboratory will be used for analysis of hazardous waste and soil samples at closure. The off-site laboratory will be a~~n~~ U.S. Environmental Protection Agency (EPA) approved laboratory with an internal quality control/quality assurance (QA/QC) program and specific procedures for each analytical method. All laboratory samples will be analyzed for the hazardous constituents specified in 40 CFR Part 261, Appendix VIII and all other constituents considered by the New Mexico Environment Department (NMED) to be a threat to human health and the environment.

Prior to the commencement of closure activities, Gandy Marley, Inc. (GMI) will notify the Secretary of the NMED in writing at least 60 days prior to the date GMI expects to begin closure~~ of the units~~. The schedule for closure is described in more detail in Permit Attachment O1, Compliance Schedule~~s~~ for Closure.
~~, Section 8.4, Closure Schedule.~~

~~8.1.1 Drum Handling Unit~~

~~The following steps will be necessary to complete closure of the drum handling unit:~~

- ~~removal of remaining waste and other material in the storage area;~~
- ~~decontamination of equipment in the area;~~
- ~~sampling of any areas or equipment suspected, based on visual observations, of being contaminated;~~
- ~~dismantling of the building structure;~~

- dismantling of the concrete floor and secondary containment; and
- sampling of soil beneath the floor to determine if contamination is present.

8.1.1.1 Removal of Inventory

Closure of the drum handling unit will commence with removal of any inventory or other materials stored in the area according to standard procedures. Remaining inventory will be removed within 90 days after receipt of the final volume of hazardous wastes at the unit. For the purposes of this plan, GMI will arrange for all waste remaining in inventory to either be disposed of directly in the landfill, treated at the onsite treatment unit prior to disposal in the landfill, or returned to the generator if either of the previous two options is not available. If required, the hazardous materials could be returned to the generator utilizing the same method of transportation that was used to deliver the material to the site (e.g., end dump trucks).

Closure cost estimates and waste volumes for disposal are based on the worst-case scenario of all wastes requiring stabilization at the onsite treatment unit prior to landfilling. In the case of the drum handling unit, it is assumed that all 1,120 drums contain sludge that must be stabilized. For these calculations, the maximum inventory of the drum handling unit at the time of closure is assumed to be the maximum permitted capacity of the unit.

8.1.1.2 Decontamination of Equipment and Dismantling of Building Structure

Equipment in the area, such as drum-moving equipment, that may have contacted hazardous waste will either be decontaminated or disposed of as hazardous waste. Large equipment, such as the fork trucks, will be decontaminated. Disposal as waste will be the preferred option only for items, such as wood pallets, that are difficult to decontaminate.

The building structure is not anticipated to be contaminated with hazardous waste; however, it will be cleaned and rinsed prior to, or during, dismantling. The dismantled building structure will either be reused elsewhere or recycled as scrap metal.

A high-pressure detergent wash and water rinse will be used to clean off all visible residues. Cleaning will continue until sampling and analysis of the wash water indicates that contaminants have been removed. The use of wash water will be limited to minimize the amount of waste generated. Wash water use will be limited by using only the necessary amount to decontaminate the facility and equipment. All decontamination solutions will be collected in containers or portable tanks. The decontamination solutions will either be treated onsite or trucked to an approved off site facility for treatment. The expected volume of decontamination solutions that will be generated during closure of the drum handling unit is included in the liquid waste amounts shown in Table 8-1.

Table 8-1. Closure Generated Waste Quantities

Facility Unit	Inventory	Waste (tons)	Waste for Disposal[a] (tons)
Drum Handling Unit	1,120 drums	309	803
Evaporation Pond Unit	78,300 ft^3	2,936	7,634
Liquid Waste Receiving and Storage Unit	36,000 gal	162	1,692
Stabilization Unit	3,600 ft^3	180	468
Roll-Off Storage Unit	142,560 ft^3	7,128	18,533
Landfill[b]	NA	NA	NA

[a] Waste for disposal includes waste and reagents quantities added together.
[b] No waste will be moved from the landfill at closure time.

Clean closure of the building will be ensured by the development and implementation of a sampling and analysis plan (SAP). The plan will be provided to the New Mexico Environment Department for approval 90 days prior to implementation. At a minimum, it will specify the following aspects of the sampling and analysis activities:

- 1.0 Sampling Program
  - 1.1 Sampling Locations
  - 1.2 Sample Matrix
  - 1.3 Sample Containers, Type and Size
  - 1.4 Sampling Tools
  - 1.5 Sample Management
  - 1.6 Field Screening Methods
- 2.0 Analytical Methods
  - 2.1 Analytes for Analysis
  - 2.2 Analysis Procedures (Specified SW-846 Methods)
- 3.0 Quality Assurance
  - 3.1 Organization
  - 3.2 Sample Management
  - 3.3 Analytical System
    - 3.3.1 Instrument Maintenance
    - 3.3.2 Instrument Calibration
    - 3.3.3 Personnel Training
    - 3.3.4 Reagents and Standards
    - 3.3.5 Corrective Actions
  - 3.4 Data Quality Objectives
  - 3.5 Performance and System Audits
- 4.0 Data Management
  - 4.1 Data Collection
  - 4.2 Data Reduction
  - 4.3 Data Reporting

The sampling and analysis plan will specify the use of equipment, methods, and techniques current at the time the plan is prepared. Applicable provisions of the then-current version of SW-846 (or other applicable standard reference then in effect) will be specified. Applicable reporting requirements will also be specified, as appropriate.

8.1.1.3 Dismantling of Concrete Floor and Secondary Containment

Secondary containment for the drum handling unit will be provided by a geomembrane lined trench and collection sump system. Drums will be stored on a coated concrete floor that drains to the trench and sump system. Because the concrete will be coated, decontamination at closure is proposed so that the concrete will be broken up and disposed of as non-hazardous debris. The liner and collection sump system will be removed at closure but will not be decontaminated. Since this material will be considered a hazardous waste, upon certification of compliance with LDR requirements, it will be disposed of in the landfill. The expected volume of solid hazardous waste that will be generated during closure is provided in Table 8-1.

8.1.1.4 Soil Sampling

After removal of the building, any contaminated soils will be removed for disposal and the area resampled until the sampling and analyses indicate that the area meets the performance standard provided in Section 8.32. Sampling will be performed in the vicinity of the loading dock and in open areas. Individual samples will be collected at a frequency equivalent to one per every 2,000 square feet (i.e. one sample to be taken at the center of each 2,000 square foot grid).

Contaminated soils will be disposed of in accordance with the regulations applicable to the contaminant of concern. If the landfill portion of the Facility is still operational and the contaminated soil meets the waste acceptance criteria for the landfill it will be landfilled at GMI. If the GMI landfill cannot accept the waste it will be manifested and shipped to an appropriately licensed disposal facility.

In addition, seven samples will be collected from specific locations that correspond to all of the floor drain sumps (see Permit Attachment L1, Engineering Drawings, Drawings 37, 38 and 39). Eight additional samples will be collected in the dock area and samples will be collected at 20-foot intervals beneath the drainage trenches. Sample results will be compared against the closure performance standard presented in Section 8.32.

Any contaminated soils will be removed for disposal and the area resampled until the sampling and analyses indicate that the area meets the performance standard provided in Section 8.32. Contaminated soils will be disposed of in accordance with the regulations applicable to the contaminant of concern. If the landfill portion of the Facility is still operational and the contaminated soil meets the waste acceptance criteria for the landfill it will be landfilled at GMI. If the GMI landfill cannot accept the waste it will be manifested and shipped to an appropriately licensed disposal facility.

8.1.2 Evaporation Pond

Clean closure of the evaporation pond will be ensured by the development of a sampling and analysis plan. The plan will be provided to the New Mexico Environment Department for approval 90 days prior to implementation. The plan will follow the outline contained in Section 8.1.1.2.

The primary steps required to complete closure of the evaporation pond are the following:

- removal of remaining liquid waste;
- removal and solidification of sludge;
- removal and disposal of liner and leachate collection system;
- sampling of soil beneath the unit to determine if contamination is present; and
- filling and revegetating the area.

8.1.2.1 Removal of Liquid Waste

The liquid in the evaporation pond will be allowed to evaporate naturally. At the beginning of closure of the evaporation pond, no further waste will be accepted into the pond. The water balance for the site indicates that there is a net loss of approximately 80 inches of water per year (90 inches of evaporation minus 10 inches of precipitation). The liquid in the evaporation pond has an approximate depth of 9 feet, and it is assumed that at closure there will be 2 feet of sludge in the bottom of the pond, leaving 7 feet of liquid (84 inches). Therefore, approximately 1 year is projected to be adequate time to evaporate all the liquid in the pond, assuming it is full to capacity at the time closure is initiated.

8.1.2.2 Removal and Solidification of Sludge

Following evaporation of the pond liquid, the sludge will be removed from the bottom with trash pumps or hand excavation equipment. Removal operations will continue until visual examination shows that all sludge has been removed. The removed sludge will be solidified in the treatment unit. The stabilized waste will be placed in roll-off containers and cured in accordance with the provisions of Permit Attachment F, Waste Analysis Plan, prior to disposal in the landfill. The expected volume of sludge that will be removed and

~~disposed in the landfill is shown in Table 8-1. This information is based on an estimated sludge depth of 2 feet at the sump.~~

~~8.1.2.3 Removal and Disposal of Liner and Leachate Collection System~~

~~The pond liner and leachate collection system will be dismantled and removed as hazardous debris. Prior to removal, the liner will be washed to remove the visible contaminants. The method of treatment is consistent with debris treatment technologies as defined in 40 CFR 268.7(d). Upon certification of compliance with the LDR debris treatment requirements, as required by 20 NMAC 4.1.800 incorporating 40 CFR 268.45, the waste will be disposed in the landfill. The expected volume of solid hazardous waste and debris that will be generated during closure is provided in Table 8-1. The vadose zone monitoring wells associated with the evaporation pond will be left functional to continue monitoring the landfill, as specified in Section 3.0Permit Attachment I.~~

~~8.1.2.4 Soil Sampling~~

~~After removal of all waste, the evaporation pond liners, and the leachate collection system, soil samples will be collected and analyzed for a facility proposed subset of the constituents defined in Section 8.1 of the permit application and approved by NMED. Individual samples will be collected at a frequency equivalent to one per 2,000 square feet over the entire Surface Impoundment area (i.e. one sample to be taken at the center of each 2,000 square foot grid). In addition, a sample will be obtained from each leachate collection sump and beneath the tanker pad fill lines at the influent location and at 10-foot intervals beneath the transfer piping. Samples also will be collected adjacent to each side of the concrete containment pad. Sample results will be compared against the closure performance standard presented in Section 8.32.~~

~~Contaminated soils will be removed for disposal and the area resampled until the sampling and analyses indicate that the area meets the performance standard provided in Section 8.32. Contaminated soils will be disposed of in accordance with the regulations applicable to the contaminant of concern. If the landfill portion of the Facility is still operational and the contaminated soil meets the waste acceptance criteria for the landfill it will be landfilled at GMI. If the GMI landfill cannot accept the waste it will be manifested and shipped to an appropriately licensed disposal facility.~~

~~8.1.2.5 Filling and Revegetating~~

~~The final step in closing the Surface Impoundment will be filling the depression with clean soil to the approximate original grade and revegetating the disturbed areas. The Surface Impoundment will be graded to ensure that the direction of surface water runoff is not towards the landfill units. A seed mixture appropriate for the area will be applied and the site will be watered as necessary to promote germination.~~

~~8.1.3 Liquid Waste Receiving and Storage Unit~~

~~Clean closure of the liquid waste receiving and storage unit will be ensured by the development of a sampling and analysis plan. The plan will be provided to the New Mexico Environment Department for approval 90 days prior to implementation. The plan will follow the outline contained in Section 8.1.1.2.~~

~~The following steps will occur during closure of the liquid waste receiving and storage unit associated with the stabilization unit:~~

- ~~removal and treatment of tank contents;~~
- ~~dismantling and removal of tanks, ancillary equipment, and concrete containment area; and~~
- ~~sampling of soil beneath the unit to determine if contamination is present.~~

8.1.3.1 Removal of Inventory

Closure of the liquid waste receiving and storage unit will commence with removal of any inventory in the tanks according to standard procedures. The major steps of inventory removal, equipment decontamination, primary and secondary containment removal, and soil sampling will be identical to these described in Section 8.1.1.1. Remaining inventory will be removed within 90 days after receipt of the final volume of hazardous wastes in the tanks. All wastes remaining in inventory can be treated at the onsite stabilization unit prior to disposal in the landfill. Closure cost estimates and waste volumes for disposal were based on the worst-case scenario of all four tanks being full to capacity at the start of closure. The maximum possible inventory for each tank at the time closure is initiated is equal to the permitted capacity of the tanks.

8.1.3.2 Dismantling of Tanks, Equipment, and Concrete Secondary Containment Area

The tanks and ancillary equipment will be dismantled and disposed in the landfill after certification of compliance with LDR debris treatment requirements under 40 CFR 268.45, as required by 20 NMAC 4.1.800 incorporating 40 CFR 268.7 d). The piping system used to transfer waste from the tanks to tankers will be considered part of the tanks and will be drained and dismantled as part of the tank closure. After removal of the tanks, the concrete containment will be washed and broken up for disposal as hazardous debris. Upon certification of compliance with the LDR debris treatment requirements, as required by 40 CFR 268.7(d), any hazardous materials will be disposed in the landfill. The expected volume of solid hazardous waste that will be generated during closure is provided in Table 8-1.

8.1.3.3 Soil Sampling

After removal of the tanks and containment, soil samples will be collected and analyzed for a facility proposed subset of the constituents defined in Section 8.1 of the permit application and approved by NMED. Due to the limited footprint area of the liquid waste storage area, sampling will not be based on a per area basis. Rather, it is proposed that one sample be obtained beneath each sump in the concrete base for the liquid waste storage units, beneath each tank after demolition, and adjacent to each side of each tank pad. In addition, samples will be obtained at locations where visual or field screening evidence of contamination is present. Sample results will be compared against the closure performance standard presented in Section 8.32.

8.1.4 Stabilization Unit

Clean closure of the stabilization unit will be ensured by the development of a sampling and analysis plan. The plan will be provided to the New Mexico Environment Department for approval 90 days prior to implementation. The plan will follow the outline contained in Section 8.1.1.2.

The primary steps required to complete closure of the stabilization unit are the following:

- removal of remaining waste inventory;
- decontamination and removal of equipment and building structure;
- dismantling of the tanks and secondary containment area; and
- sampling of soil beneath the floor to determine if contamination is present.

8.1.4.1 Removal of Inventory

Closure of the stabilization unit will commence with removal of any inventory remaining in the tanks according to standard procedures. The major steps of inventory removal equipment primary and secondary containment removal, and soil sampling will be identical to those described in Section 8.1.1.1. Remaining inventory will be stabilized and removed within 90 days after receipt of the final volume of hazardous wastes at the unit. The stabilized waste will be placed in roll-off containers and cured in accordance with the provisions of Permit Attachment F prior to disposal in the landfill. The maximum possible inventory for the tanks, at the time closure is initiated, is equal to the working capacity of the unit (approximately one-third full) because adequate space must remain for addition of reagents and for mixing.

8.1.4.2 Decontamination of Equipment and Dismantling of Building Structure

Equipment in the area, such as waste mixing equipment or other ancillary equipment that may have contacted hazardous waste, will either be decontaminated and certified as clean or disposed of as hazardous debris. The building structure (roof and walls) is not expected to be contaminated with hazardous waste; however, the building will be decontaminated prior to dismantling. The building structure will be dismantled after cleaning and will either be reused or recycled as scrap metal. Building components and associated reagent silos that did not contact hazardous waste will be dismantled and removed from the site. The equipment and building will be subject to the requirements of the closure sampling and analysis plan.

A high-pressure detergent wash and water rinse will be used to clean off all visible residue. The use of wash water will be limited to minimize the amount of waste generated. All decontamination solutions will be collected in containers or portable tanks. The decontamination solutions will be trucked to an approved off site facility for treatment. The expected volume of decontamination solutions that may be generated during closure of the stabilization unit is included in the liquid waste amounts shown in Table 8-1.

8.1.4.3 Dismantling of Tanks, Ancillary Equipment, Piping and Secondary Containment Area

The tanks, ancillary equipment, piping concrete, and secondary containment system will be dismantled and removed as hazardous debris. Upon certification of compliance with the LDR requirements, the waste will be disposed in the landfill. The expected volume of solid hazardous waste that will be generated during closure is provided in Table 8-1.

8.1.4.4 Soil Sampling

After removal of the stabilization unit structure, tanks, piping, the bag house, and the containment system, soil samples will be collected and analyzed for RCRA characteristic properties and the constituents defined in Section 8.1 paragraph 2 of this permit application. Individual samples will be collected at locations specified by NMED at closure and at a frequency of one sample per 2,000 square feet in the entire stabilization unit area (i.e. one sample to be taken at the center of each 2,000 square foot grid). Sample results will be compared against the closure performance standard presented in Section 8.32.

8.1.5 Roll-off Storage Area

Clean closure of the roll-off storage area will be ensured by the development of a sampling and analysis plan. The plan will be provided to the New Mexico Environment Department for approval 90 days prior to implementation. The plan will follow the outline contained in Section 8.1.1.2.

Closure of the roll-off storage area will be identical to closure of the drum handling unit, except that the roll-off storage area does not have a structure associated with it. The major steps of inventory removal, equipment decontamination, primary and secondary containment removal, and soil sampling will be identical to those described for the drum handling unit in Section 8.1. Details of the sampling and analysis program will be specified in a sampling and analysis plan providing information similar to that to be developed for the drum handling unit (see Sections 8.1.1.2 and 8.1.1.4). Sample results will be compared against the closure performance standard presented in Section 8.32.

Estimated waste volumes for closure of the roll-off storage area are included in Table 8-1.

8.1.6 Landfill

Appropriate closure of the landfill will be ensured by the development of a sampling and analysis plan (SAP). The plan will be provided to the ~~New Mexico Environment Department~~NMED for approval 90 days prior to implementation. ~~The plan will follow the outline contained in Section 8.1.1.2.~~ At a minimum, it will specify the following aspects of the sampling and analysis activities:

- 1.0 Sampling Program
  - 1.1 Sampling Locations
  - 1.2 Sample Matrix
  - 1.3 Sample Containers, Type and Size
  - 1.4 Sampling Tools
  - 1.5 Sample Management
  - 1.6 Field Screening Methods
- 2.0 Analytical Methods
  - 2.1 Analytes for Analysis
  - 2.2 Analysis Procedures (Specified SW-846 Methods)
- 3.0 Quality Assurance
  - 3.1 Organization
  - 3.2 Sample Management
  - 3.3 Analytical System
    - 3.3.1 Instrument Maintenance
    - 3.3.2 Instrument Calibration
    - 3.3.3 Personnel Training
    - 3.3.4 Reagents and Standards
    - 3.3.5 Corrective Actions
  - 3.4 Data Quality Objectives
  - 3.5 Performance and System Audits
- 4.0 Data Management
  - 4.1 Data Collection
  - 4.2 Data Reduction
  - 4.3 Data Reporting

The SAP will specify the use of equipment, methods, and techniques current at the time the plan is prepared. Applicable provisions of the then-current version of SW-846 (or other applicable standard reference then in effect) will be specified. Applicable reporting requirements will also be specified, as appropriate.

This Part B Permit Application only includes the Phase ~~IA~~1A portion of the landfill. Therefore, this Closure Plan only addresses Phase ~~IA~~1A. If future expansions are required, they will be addressed in future permit modifications and will include revised closure plans.

At closure of the landfill, a final cover will be constructed with a permeability that is less than or equal to the permeability of the bottom liner. The final cover will consist of a three-layer cap design consisting of a vegetative cover, a geocomposite drainage layer, and a geomembrane and geosynthetic clay liner (GCL) barrier layer over a prepared subgrade, as described in Permit Attachment L, Engineering Report, Section 3.1.6~~5~~, Final Cover. The final cover will meet the following requirements:

- The vegetative cover will have a minimum thickness of 2.5 feet and final upper slopes of between 3 and 5 percent after settlement and subsidence of the waste. Native grasses will be planted.
- The drainage layer will have a transmissivity of greater than or equal to 2.2 x 10^{-4} square meters per second (m^2/s)and consist of a high-density polyethylene (HDPE) geonet sandwiched between two

geotextile layers (generally referred to as a geocomposite) and will be designed to allow lateral flow and discharge of liquids.

- The bottom layer will consist of a 60-mil HDPE geomembrane layer and GCL with permeability of less than or equal to 5 x 10^{-9} centimeters per second (cm/s) underlain by 6 inches of prepared subgrade and 1.5 feet of protective soil.

- The cover will be designed to function with minimum maintenance, including minimal erosion. The vegetative cover will be designed with a surface drainage system capable of conducting runoff across the cap without forming rills and gullies.

In addition, remaining water ~~and sediments~~ in the contaminated water basin (as shown in Drawing 10, Filling Plan - Phase 1A) that cannot be eliminated through evaporation will be removed, tested, and disposed of appropriately. Then, the contaminated water basin will be filled with soil and the cover will be constructed across this area. This will ensure that all lined areas of the landfill will be covered.

Prior to closure of the landfill, an assessment will be made of the landfill waste gas generating potential. This will be made from the quarterly landfill gas monitoring data that will be collected over the life of the landfill. Following closure, if it is concluded that gas generation may result in gas build-up~~s~~ beneath the barrier layer of the cover or releases that exceed regulatory air quality standards, then provisions will be made to collect and monitor gas generation and release during the post-closure period. If this occurs, the best available technology ~~available~~ will be implemented into the construction of the cover system. In this case, the NMED Secretary will be informed and shall approve a monitoring plan and any changes in the construction of the cover system.

Any leachate from the landfill will be pumped from the primary and secondary collection systems and, if detected, from the vadose zone monitoring sump~~s~~ throughout the closure period and will continue throughout post-closure care. The leachate will be collected, sampled, and managed as hazardous waste, as appropriate. The leachate will be collected at a frequency appropriate to the rate at which it collects in the sump. As indicated in Permit Attachment P, Post-Closure Care~~, Table 8-2, Post-Closure Inspection Schedule~~, the collection sump will be inspected monthly until the sump remains dry for six months. Thereafter, the sump will be inspected semi-annually. Details of the leachate sampling and analysis program will be specified in a SAP.

~~After~~Before the landfill cap is completed, soil samples will be collected from outside the perimeter of the landfill cap to determine if any soil contamination is present. The sampling locations will primarily correspond to the transportation corridor used by waste hauling trucks during the active life of the landfill. In addition, samples will be collected at the landfill stormwater retention basin and within ditches directing flow to the basin.

It is proposed that individual samples be obtained along the haul roads at 100-foot intervals and at locations where visible staining is observed. Because the stormwater detention basin (Drawing 25, Surface Water Control Features) is lined with a geomembrane, individual samples will be collected from there and its associated drainage ditches at a frequency equivalent to one per 40,000 square feet over the entire area (i.e., one sample to be taken at the center of each 40,000-square-foot grid). However, if the liner in the stormwater runoff basin is observed to be damaged, additional sampling may be required. Sample results will be compared against the closure performance standards presented in Section 8.3. If any contaminated materials are identified they will be excavated and removed to the landfill prior to placement of the final cover.

No later than the submission of the certification of closure of the landfill in compliance with 40 CFR §264.115, the Facility will submit to the local zoning authority and to the NMED a survey plat indicating the location and dimensions of the landfill with respect to permanently surveyed benchmarks in compliance with 40 CFR §264.116. This plat will be prepared and certified by a professional land surveyor. The survey plat will contain a prominent note that asserts the Facility's obligation to restrict disturbance of the hazardous waste disposal unit. The Facility will also record a notation on the deed to the Facility property in compliance with 40 CFR §264.119(b)(1) to notify any potential purchasers of the property that (1) the land has been used to manage hazardous wastes; (2) use of the land is restricted to activities that will not disturb integrity of the final cover system or monitoring system during the post-closure care period; and (3) the survey plat and record of waste disposal have been submitted to the local zoning authority and to the NMED.

A record of the type, location, and quantity of hazardous wastes disposed of within the disposal unit will be submitted to the local zoning authority and to the NMED no later than 60 days after certification of closure of the landfill in compliance with 40 CFR §264.119(a).

The vadose zone monitoring wells will be sampled and analyzed in accordance with the procedures that are presented in Permit Attachment I, Vadose Zone Monitoring System Work Plan. The frequency of sampling and parameters to be tested are outlined in Permit Attachment I.

8.1.7 Closure of Non-Waste Management Units

Other areas within the facility boundary which have the potential to become Solid Waste Management Units during the operational life of the facility will be closed in accordance with the requirements of the closure sampling and analysis planSAP. Those non-waste management units having structures or liners, such as the truck wash maintenance shop and the storm-water detention basin,collection basin (Permit Attachment L1, Drawing 10) will be sampled to verify the absence of contamination prior to closure and removal. If the non-waste management unit structures or liners show contamination, they will be managed in accordance with the requirements of this closure plan. If contamination is not present they will be disposed of as solid waste.

After removal of the structures, other appurtenances, and liner, the areas will be contoured and revegetated as necessary.

8.3 Closure Performance Standard

The RCRA closure performance standard (40 CFR 264.111) specifies that hazardous waste facilities are to be closed in such a way as to minimize the need for further maintenance at the Facility and protect human health and the environment by controlling, minimizing, or eliminating potential releases of hazardous waste to the environment. The Facility will meet a clean-closure performance standard for all non-waste management units except the landfill and will not impact any environmental media in excess of agency-approved background levels or pose a threat to human health or the environment.

The Facility-specific clean-closure performance standard for the drum handling unit, roll-off storage area, tank storage area, stabilization unit, and evaporation pond is based on sampling soil from beneath the units. The landfill will not be clean-closed; therefore, the Facility-specific, clean-closure performance standard is not applicable.

Indicator parameters will be selected and approved by NMED for each unit at closure. These parameters will be representative of the wastes disposedstored and/or treated in that unit of during the Facilityits operating life. The waste information used to make these selections will be based upon the Facility operating record. For soil, analytical results that show that these concentrations of contaminants of concern are within a statistically significant range relative to clean background soil as determined by NMED will constitute demonstration of clean closure. Clean background samples will be obtained from the alluvium unit and from the Upper and Lower Dockum units from each of the vadose zone monitoring well borings, for a total of six background samples per stratigraphic unit. If the alluvium is not present at a specific vadose zone monitoring well boring location, a surface sample from the southern portion of the site shall be substituted for the sample. Each sample will be submitted to an analytical laboratory for chemical analysis of metals listed in 40 CFR 264, Appendix VIII, using EPA SW-846 analytical methods or equivalent methods approved by NMED.

8.5 Certification of Closure

Within 60 days of completion of closure ~~of each unit, and within 60 days of completion of final Facility closure~~, the Facility will submit to NMED~~,~~ a certification that the~~each~~ hazardous waste management unit has been closed in accordance with the approved closure plan in compliance with 40 CFR 264.115. The closure certification ~~for each unit~~ will be signed by the owner/operator and by an independent New Mexico registered professional engineer.

8.6 Modifications to the Closure Plan

After this closure plan is approved, it will be amended whenever it is affected by changes in operating plans or Facility design. While conducting partial or final closure activities, unexpected events may be identified that also require amendment of the approved closure plan. Requests for modification will be made within 30 days of identifying an event that justifies plan modification.

~~Permit~~ Attachment O1. Compliance Schedule~~s~~ for Closure
~~Modified from the Permit Application, Volume I, Section 8.4~~

8.4 Closure Schedule

Closure of ~~all units at~~ the Facility will be initiated when the landfill nears its final capacity. ~~b~~Because the other non-waste management units exist only to support landfill disposal activities~~. In other words~~, non-waste management units~~the drum handling unit, roll-off storage area, liquid waste receiving and storage unit, stabilization unit, and evaporation pond~~ will not continue to operate after the landfill has reached capacity and is no longer in use. Closure is expected to begin when the landfill is nearing final capacity, allowing enough capacity in the landfill to dispose of all solid wastes generated on site during closure activities. ~~Expected w~~Waste volumes generated by non-waste management units are expected to be negligible, and therefore incidental to final closure of the Facility.~~that will be generated during closure are shown in Permit Attachment O, Closure Plan, Table 8-1, Closure Generated Waste Quantities.~~

~~The schedule for closure is shown in Figure 8-1, Closure Schedule (Days).~~ At the time of final Facility closure, ~~the drum-handling unit (container storage area) will be closed first, as wastes from this area may need to be processed through the stabilization unit prior to disposal onsite. Concurrent with the closure of the drum-handling unit, the evaporation pond closure will begin because sludge from the pond must also be treated in the stabilization unit. After closure of the evaporation pond begins,~~ the leachate from the landfill will be collected in tanks and shipped off-site for proper disposal at a permitted facility. ~~Following closure of the drum-handling unit and during evaporation of the liquid in the ponds, the liquid waste receiving and storage unit (storage tanks) will be closed. After the pond sludge has been removed and treated, the stabilization unit (storage tanks) will be closed, and last the roll-off storage area will be closed.~~ The landfill cover will be constructed when all closure wastes have been placed in the landfill, and non-waste management units will cease operations.

Notification will be provided to the New Mexico Environment Department (NMED) in writing at least 60 days prior to beginning closure of a hazardous waste management unit or of the entire Facility. ~~Closure of the drum handling unit, liquid waste receiving and storage unit, stabilization unit, and roll-off storage area will proceed sequentially, and each closure will be completed within 180 days. Closure of the evaporation pond will require more than 180 days to complete, since it is projected that approximately one year will be required for evaporation of all the liquid in the pond.~~ Closure of ~~T~~the landfill ~~also~~ is expected to require more than 180 days~~ for closure,~~ due to the length of time necessary to construct the cover.

The closure regulations allow a period of 180 days from receipt of the final volume of waste ~~at each unit~~ for closure activities to begin [per 40 CFR Section 264.113(b)(1)]. The closure period can be extended with approval from NMED and if the owner or operator complies with 40 CFR 264.113(d).

~~Permit~~ Attachment O2. Financial Assurance for Closure

~~Modified from the Permit Application, Volume I, Sections 8.7.1 and 8.8.1~~

8.7.1 Closure Costs

Table O2-1 summarizes the landfill closure cost estimate. ~~s for the drum handling unit, roll-off storage area, liquid waste receiving and storage unit, truck wash unit, stabilization unit, evaporation pond, and landfill closure.~~ The original landfill closure cost estimate included in the March 2002 Triassic Park Waste Disposal Facility permit was ~~These estimates are~~ based on 2000 dollars. The landfill closure cost estimate presented in this permit modification has been updated to account for inflation using the change in the Consumer Price Index (CPI) between 2000 and 2011 (U.S. Department of Labor CPI, 2011). ~~and~~ Using the CPI, the 2011 costs are 32 percent higher than those from 2000. All 2000 costs were increased by 32 percent for purposes of this analysis. After the Facility is constructed and operations begin, the landfill closure cost estimate will be updated annually as required in 40 CFR Part 264.142(b).

~~These estimates are~~The landfill closure cost estimate is based on costs for closure when ~~each unit~~ the Facility is at maximum capacity, which is the point in the Facility's active life when the extent and manner of its operation would make closure the most expensive. As required in 40 CFR Part 264.142(a)(2), ~~cost estimates are~~the landfill closure cost estimate is based on the costs of hiring a third party to close the Facility. ~~Costs for onsite disposal are used in this cost estimate because Facility closure will be scheduled when sufficient landfill capacity remains to handle closure wastes. The maximum volume of waste that the Facility is projected to generate through closure activities is shown in Permit Attachment O, *Closure Plan*, Table 8-1, *Closure Generated Waste Quantities*.~~

Water

The Gandy-Marley, Inc. (GMI) landfill closure cost estimate ~~has been revised (increased) to~~ matches the total amount recommended by the Hearing Officer when considering approval of the original permit in 2002. ~~This~~ The estimate includes detailed unit rates for all closure activities. In addition, it includes~~d~~ costs for water usage during construction and revegetation and for maintenance of the cover during the post-closure care period~~. ($30,000 per year for 30 years total of $900,000)~~. Financial assurance for closure includes costs to acquire water rights for the water that will be needed for closure and post-closure care. The water requirements for closure were based on estimates from local revegetation specialists that estimated approximately $2,000/acre for water rights ($2,640/acre escalated to 2011). ~~We~~The landfill closure cost estimate utilizes~~d~~ almost twice that number~~ in the estimate~~. Water costs are included for~~in~~ the earthwork~~s~~ for backfilling, which is expected to be the major demand for water.

Cost Estimating Handbook

~~A check using~~ Cost-estimating handbooks (CRG and Caterpillar production program) were used for the major earthwork~~s~~ items in the closure costs. This includes the backfilling for the landfill during closure and clean soil backfilling for other facilities. Also included~~s~~ are major components of the cover placement. The handbook estimated backfill direct costs at $1.12 to 1.28/cubic yard (cy) ($1.48 to 1.69/cy escalated to 2011). This compares to the GMI estimate of $1.46/cy ($1.93/cy escalated to 2011). These numbers do not include the additional costs included in the landfill closure cost estimate of 25% for indirect costs and 10% for New Mexico Environment Department (NMED) supervision.

Conclusion

The unit rates used in the cost estimate are conservative for the major earthwork~~s~~ components.

Erosion Control and Revegetation

The type and density of vegetation was assumed in the erosion calculations (60% cover). The drainage structures are also specified in the design drawings and specifications. The top surface slopes are sufficiently flat (6%) that contour ditches are not required. The access road ditches are sufficient to handle any runoff. The calculation of erosion of topsoil was based on the vegetation density of (60% cover). The topsoil removed from the footprint of the facilities landfill will be used for the final cover. Water needs and costs are discussed above. Maintenance of the cover is included in the post-closure cost estimate. This includes approximately $30,000 per year ($39,600 per year escalated to 2011) for maintenance (reseeding and erosion repair). Over the 30-year period, this totals approximately $900,000 ($1,188,000 escalated to 2011).

Seed Mix

Upon closure, Gandy GMI will work with the local soil conservation service to develop a seed mixture which that will consist of both locale types of vegetation along with good cover types of vegetation.

Vegetation Density

According to the sediment demonstration for the final cover, a 60% herbaceous cover (which includes litter) is required to keep erosion down to 2 tons/acre/year.

Final Drainage Channels

Channels 1, 2, 3, 4, and 5 will remain as permanent channels. The locations and designs for the channels are shown on Drawings 25 and 26.

Topsoil

Upon closure, Gandy GMI will use the topsoil that was stripped and stockpiled prior to construction of the site. At that time, the topsoil will be tested and, according to the test results, appropriate soil amendments will be determined and added.

8.8.1 Financial Assurance for Closure

40 CFR 264.143 defines the standards for financial assurance for closure. The financial instrument selected to provide coverage for this requirement must be implemented and submitted to the NMED at least 60 days prior to the initial receipt of waste.

Upon receipt of the final permit for the Facility, GMI will evaluate and select one of the financial instruments defined in 40 CFR 264.143 to provide financial assurance for the closure of the Facility. Selection of one of the following six financial instruments will consider the effectiveness and economics of the particular options. The instruments defined in the regulations are:

- Financial test and corporate guarantee for closure
- Closure trust fund
- Surety bond guaranteeing payment into a closure trust fund
- Surety bond guaranteeing performance of closure
- Closure letter of credit
- Closure insurance

The appropriate instrument will be selected, implemented, and submitted a minimum of 60 days prior to the initial receipt of waste as required by 40 CFR 264, Subpart H.

Landfill Item **DRUM HANDLING UNIT**	Cost ($) **COST ($)**	
Stabilization and Disposal of Remaining Drum Waste Inventory	36,071	
Decontamination of Equipment and Buildings	7,200	
Stabilization and Disposal of Decontamination Water	14,630	
Chemical Testing of Decontamination Water	2,040	
Dismantling and Moving Structure and Equipment	23,775	
Dismantling and Disposal of Concrete Floor and Secondary Containment	122,570	
Soil Sampling and Chemical Analysis	138,720	
Excavation of Contaminated Soils	7,307	
Disposal of Contaminated Soils	15,930	
Earth Backfill for Excavated Contaminated Soils	1,827	
Revegetation	1,840	
Certification of Closure Inspection	3,000	
Certification of Closure Report	20,000	
Subtotal	$394,910	
EVAPORATION POND	**COST ($)**	
Stabilization and Disposal of Remaining Liquid Waste Inventory	342,954	
Decontamination of Equipment	240	
Stabilization and Disposal of Decontamination Water	7,315	
Chemical Testing of Decontamination Water	2,040	
Removal and Disposal of Liner and Leachate Collection System	99,880	
Soil Sampling and Chemical Analysis	128,520	
Excavation of Contaminated Soils	18,019	
Disposal of Contaminated Soil	37,790	
Earth Backfill for Excavated Contaminated Soils	6,832	
Revegetation	1,873	
Certification of Closure Inspection	3,000	
Certification of Closure Report	20,000	
Subtotal	$668,463	
LIQUID WASTE RECEIVING AND STORAGE UNIT	**COST ($)**	
Stabilization and Disposal of Remaining Waste Inventory	*105,336*	
Decontamination of Equipment and Buildings	2,400	
Chemical Testing of Decontamination Water	2,040	
Stabilization and Disposal of Decontamination Water	14,630	
Removal and Disposal of Tanks and Concrete Pad	14,605	
Soil Sampling and Chemical Analysis	61,200	

Landfill Item	Cost ($)	
Excavation of Contaminated Soils	436	
Disposal of Contaminated Soil	967	
Earth Backfill for Excavated Contaminated Soils	218	
Revegetation	731	
Certification of Closure Inspection	3,000	
Certification of Closure Report	15,000	
Subtotal	$220,563	
1.1.1.1.1 STABILIZATION UNIT	**Cost ($)**	
Stabilization and Disposal of Remaining Waste Inventory	21,024	
Decontamination of Equipment and Buildings	4,560	
Chemical Testing of Decontamination Water	2,040	
Stabilization and Disposal of Decontamination Water	14,630	
Dismantling and Salvaging Tanks, Ancillary Equipment, and Building	24,905	
Removal and Disposal of Tanks and Concrete Pad	57,980	
Soil Sampling and Chemical Analysis	40,800	
Excavation of Contaminated Soils	2,150	
Disposal of Contaminated Soil	4,766	
Earth Backfill for Excavated Contaminated Soils	1,076	
Revegetation	1,464	
Certification of Closure Inspection	3,000	
Certification of Closure Report	15,000	
Subtotal	$193,395	
ROLL-OFF STORAGE AREA UNIT	**Cost ($)**	
Stabilization and Disposal of Remaining Waste Inventory	832,550	
Decontamination of Equipment	0	
Chemical Testing of Decontamination Water	0	
Stabilization and Disposal of Decontamination Water	0	
Demolition and Disposal of Liner System	105,248	
Soil Sampling and Chemical Analysis	144,840	
Excavation of Contaminated Soils	21,353	
Disposal of Contaminated Soil	44,781	
Earth Backfill for Excavated Contaminated Soils	10,120	
Revegetation	2,733	
Certification of Closure Inspection	3,000	
Certification of Closure Report	15,000	
Subtotal	$1,179,625	
TRUCK WASH UNIT	**Cost**	

Landfill Item	Cost ($)	
	($)	
Stabilization and Disposal of Remaining Waste Inventory	5,270	
Chemical Testing of Decontamination Water	2,040	
Decontamination of Equipment	0	
Stabilization and Disposal of Decontamination Water	0	
Demolition and Disposal of Tanks, Structures, Concrete and Liner Systemt	16,769	
Soil Sampling and Chemical Analysis	20,400	
Excavation of Contaminated Soils	285	
Disposal of Contaminated Soil	598	
Earth Backfill for Excavated Contaminated Soils	178	
Revegetation	99	
Certification of Closure Inspection	3,000	
Certification of Closure Report	5,000	
Subtotal	$53,639	

Table O2-1. LandfillSite Closure Cost Estimates

Landfill Item	Cost	
	Approved Permit ($ in 2000)	Permit Renewal ($ in 2011)
Landfill Excavation Backfill	4,120,000	5,438,400
Cover Engineering Design	30,000	39,600
Landfill Cover	3,374,432	4,454,250
Demolition of Tanks, Concrete and Liner System	2,426	3,202
Leachate Treatment Facility Construction	0	0
Leachate Treatment Facility Operations	0	0
Leachate Pumping and Disposal (volume = 133,000 Gallons [551 tons])	98,021	129,388
Sump Vadose Zone Sampling and Analysis	8,000	10,560
Well Vadose Zone Monitoring System Sampling and Analysis	48,000	63,360
Soil Sampling and Analysis	104,040	137,333
Final Plat Survey	2,400	3,168
Certification of Closure Inspection	3,000	3,960
Certification of Closure Report	15,000	19,800
Subtotal	7,805,319	10,303,021
~~Total from unit closures~~	~~$2,710,595~~	
Water Rights and Application	114,000	150,480
Total Closure Cost	10,599,914	10,453,501

Permit Renewal Application
October 17, 2011

Attachment P

Post-Closure Care

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March 2002

~~Permit~~ Attachment P. Post-Closure Care

~~Modified from the Permit Application, Volume I, Section 8.2~~

8.2 Post-Closure Activities

Post-closure care involves long-term maintenance, monitoring, and reporting of activities that are carried out after closure is completed. Post-closure care is anticipated to be needed only for the landfill after closure. However, if clean closure cannot be certified for any non-waste management unit components~~ or secondary containment areas associated with the drum handling unit, liquid waste storage area, stabilization unit, evaporation pond, or roll-off storage area~~, then those closure activities that have been completed will be certified and a permit modification request will be submitted to the New Mexico Environment Department (NMED) to include post-closure activities for those portions of the units that do not meet the closure performance standard.

The post-closure care period for the landfill will begin after completion of closure activities and continue for an anticipated 30 years. Inspection, maintenance, and repair activities to be conducted during post-closure are described in the following sections. The schedule for performing inspections is shown in Table ~~8-2~~P-1.~~, Post-Closure Inspection Schedule~~

Table ~~8-2~~P-1. Post-Closure Inspection Schedule

Inspection Item – Problem or Problem Area	Inspection Time
Facility	
Fence	Monthly
Locks and gates	Monthly
Warning signs	Monthly
Landfill Cover	
Cracking, subsidence, ponding water, erosion, burrowing animals, deep-rooted vegetation	Quarterly
Perimeter Diversion Ditch	
Sediment and debris accumulation,	Quarterly
Leachate Collection System	
Sump	Quarterly until the sump remains dry for 6 months, then semiannually
Pumps	Quarterly
Riser pipes, grout seals, other visible portions of the system	Quarterly
Leak detection system	Quarterly until the sump remains dry for 6 months, then semiannually
Vadose Zone Monitoring System	
System	Semiannually

8.2.1 Security Systems

As shown in Permit Attachment L1, Engineering Drawings, Facility Drawing Number 4, the Facility perimeter fence encloses the entire 480 acres of the Facility. The fence and warning signs mounted on the fence will be inspected and maintained throughout the post-closure period. Monthly inspections will include checking the condition of fencing, locks, gates, and warning signs. Any signs of unauthorized entry will be reported to the local sheriff's office and NMED. Routine maintenance will be performed based on inspection findings to repair or replace damaged or deteriorating items.

8.2.2 Landfill Final Cover

The integrity and effectiveness of the landfill final cover will be maintained, including making necessary repairs to correct the effects of settling, erosion, water damage, animal damage, or other events. The landfill cover will be inspected quarterly. Inspections will include checking for signs of cracking, subsidence, ponding water, erosion, burrowing animals, or deep-rooted vegetation. Repairs will be scheduled in a timely manner upon noting deficiencies in order to ensure that the final cover maintains its effectiveness.

General maintenance will include the following activities:

- fertilizing the vegetation periodically;
- re-establishing damaged or sparse vegetative cover, including seeding and fertilizing;
- conducting erosion damage repair, including soil excavation, transport and placement, seeding and fertilizing;
- regrading as needed to overcome the effects of subsidence or to repair areas where ponding is occurring; and
- providing rodent control as needed, including trapping and relocating animals and repairing damage caused by burrowing.

Soil for erosion repair and regrading will be excavated from unused on-site areas ~~on-site~~ and transported to the cap area for use in maintenance activities.

8.2.3 Perimeter Diversion Ditch

The perimeter diversion ditch (as shown in Permit Attachment L1 on Drawings 22 and 25) will be inspected and maintained throughout the post-closure period to ensure its designed functions to divert precipitation and run-on from the landfill area are met. Inspections will be conducted quarterly and will include checking for accumulated sediments and debris, and signs of erosion. Repairs will be scheduled in a timely manner, upon deficiencies being noted, to ensure that the diversion ditch maintains its effectiveness.

General maintenance activities will include diversion ditch cleaning to remove accumulated sediments and debris, and regrading, as needed, to repair the effects of erosion.

8.2.4 Leachate Management System

8.2.4.1 Leachate Collection System

The leachate collection system will be operated when necessary to ensure leachate depth over the liner does not exceed 30 centimeters (cm) (1 foot) until the completion of post-closure care. Leachate pumps will be operated at least quarterly. The site log will be kept on-site or at a location approved by the NMED Secretary. The volume of leachate pumped will be recorded in a site log. After records indicate that the sump has remained dry for six months, the frequency of inspection and operation of the sump pumps will be changed to semiannually. Any leachate collected will be pumped to an aboveground storage tank.

The leachate collection system will be inspected quarterly or semiannually as described in the preceding paragraph. Pumps will be inspected for proper operation. The riser pipes, grout seals, and other visible aboveground portions of the system will be inspected for integrity. The level of liquid in the sumps will be measured prior to pumping out accumulated leachate.

Routine maintenance will be conducted to ensure that the leachate collection system remains operable. Locking caps and standpipe grouting will be repaired or replaced as necessary. Accumulated sediments or sand in the standpipes will be removed as necessary to enable the system to function properly. Based on the amount of leachate collected over time, a determination will be made about the integrity of the collection system. If a system is suspected of being clogged, an assessment by a New Mexico registered professional engineer will be made. All repairs will be made according to the New Mexico registered professional engineer's assessment and upon approval by NMED.

8.2.4.2 Management of Leachate

During the post-closure care period, leachate pumped from the collection system will be temporarily stored in an aboveground tank. The leachate will be sampled and managed at an off-site facility as hazardous waste, as appropriate. Details of the leachate sampling and analysis program will be specified in a sampling and analysis plan.

8.2.4.3 Leak Detection System

During the post-closure care period, the leak detection system beneath the landfill primary liner will initially be monitored and inspected quarterly to ensure that it is operating correctly and that any leachate that has migrated through the primary liner is collected and removed. As with the primary leachate system, the volume of leachate pumped from the secondary leak detection system will be recorded in a site log. After records indicate that the sump has remained dry for six months, the frequency of inspection and operation of the leak detection system will be changed to semi-annually.

Inspections and maintenance will be equivalent to those described for the leachate collection system (see Section 8.2.4.1).

8.2.5 Vadose Zone Monitoring System

The vadose zone monitoring system will be maintained and monitored throughout the post-closure care period. The following sections outline the post-closure monitoring plan for this system. The vadose zone monitoring system is described in Permit Attachment I, Vadose Zone Monitoring System Work Plan, and consists of a vadose zone sump in the landfill and vadose zone monitoring well network.

8.2.5.1 Sampling and Analysis

Vadose zone monitoring will be conducted semiannually to test for the presence of contaminants in the unsaturated sediments hosting the landfill. Sampling procedures and analytical parameters will be defined according to the Vadose Zone Monitoring System Work Plan (Permit Attachment I) ~~(Volume II, Appendix N)~~ and will follow the same guidelines used during the active life of the Facility.

8.2.5.2 Inspection and Maintenance

The visible aboveground portions of the vadose zone monitoring system will be inspected semiannually for integrity. Routine maintenance will be conducted to ensure that the vadose zone monitoring system remains in operable condition. System equipment will be repaired or replaced as necessary.

8.2.6 Recordkeeping

A post-closure Facility record will be maintained. This record will include the dates and times of inspections, inspection findings, name of inspector, volumes of leachate pumped, disposition of leachate, sampling results of leachate and vadose zone samples, and dates and nature of any corrective actions taken.

8.2.7 Certification of Post-Closure

Within 60 days after completion of the established post-closure care period for the Facility, the permittee will submit to NMED a certification that the post-closure operations were performed in accordance with the approved post-closure plan in compliance with 40 CFR 264.120. The certification will be signed by the permittee and an independent New Mexico registered professional engineer.

8.2.8 Amendment of Plan

The permittee will submit a permit modification request for changes to the post-closure plan if changes in operating plans or Facility design, or events that occur during the active life of the Facility, affect the approved post-closure plan. The owner or operator may also request a modification to the post-closure plan at any time during the active life of the Facility or during the post-closure care period. Permit modification requests will be submitted at least 60 days prior to a proposed change in Facility design, or no later than 60 days after an unexpected event which affects the post-closure plan.

If clean closure cannot be certified for any non-waste management unit components or secondary containment areas associated with the drum handling unit, tank storage area, stabilization unit, evaporation pond, or roll-off storage area, then the post-closure care permit will be amended to include those portions of the units that do not meet the closure performance standard. The post-closure care plan amendments will be submitted to NMED no later than 90 days after the owner or operator determines that the hazardousnon-waste management unit must be closed as a regulated unitlandfill.

8.2.9 Facility Post-Closure Contact

During the post-closure care period, the Facility contact organization will be the following:

Gandy Marley, Inc.
P.O. Box 1658
Roswell, New Mexico 88202
(575) 347-0434
1109 East Broadway
Tatum, New Mexico 88267
(505) 398-4960

Permit Attachment P1. Financial Assurance for Post-Closure Care

Modified from the Permit Application, Volume I, Sections 8.7.2 and 8.8.2

8.7.2 Post-Closure Costs

Table P1-1, *Landfill Post-Closure Cost Estimate*, summarizes the post-closure cost estimate for the landfill. The costs include 30 years of monitoring and maintenance activities, as described in Permit Attachment P, Post-Closure Care, Section 8.2, *Post-Closure Activities*. These original post-closure cost estimate included in the March 2002 Triassic Park Waste Disposal Facility permit estimates are was based on 2000 dollars. The post-closure cost estimate presented in this permit renewal application has been updated to account for inflation using the change in the Consumer Price Index (CPI) between 2000 and 2011 (U.S. Department of Labor CPI, 2011). Using the CPI, the 2011 costs are 32 percent higher than those from 2000. All 2000 costs were increased by 32 percent for purposes of this analysis. After the Facility is constructed and operations begin, the post-closure cost estimate willand must be updated annually as required in 40 CFR Part 264.144(b).

Table P1-1. Landfill Post-Closure Cost Estimate

Item	Cost	
	Approved Permit ($ in 2000)	Permit Renewal ($ in 2011)
Facility Inspection	201,600	266,112
Routine Landfill Cover Maintenance and Repair	600,000	792,000
Severe Landfill Cover Erosion Damage Repair	300,000	396,000
Perimeter Diversion Ditch Maintenance and Repair	300,000	396,000
Leachate Pumping and Treatment	239,476	316,108
Leachate Collection System Maintenance	67,200	88,704
Well and Sump Vadose Zone Maintenance	67,200	88,704
Sump Vadose Zone Sampling and Analysis	240,000	316,800
Vadose Zone Monitoring Wells Sampling and Analysis	1,440,000	1,900,800
Notation of Property Deed	2,500	3,300
Certification of Post-Closure Inspection	3,000	3,960
Certification of Post-Closure Report	150,000	198,000
SubtotalTotal Post-Closure Costs	3,610,976	4,766,488
Total Closure Cost + Post-Closure Costs	12,899,323	15,219,989

8.8.2 Financial Assurance for Post-Closure Care

Similar to the financial assurance requirements for closure activities, the Facility is required to provide assurances for the post-closure care of the Facility. Upon receipt of the final permit, and 60 days prior to the initial receipt of waste, the owner/operators will provide the appropriate financial instrument to fulfill this requirement. Selection of the instrument to be used will be based upon economic and performance considerations. The financial instruments allowed by this subpart of the regulations are listed in Permit Attachment O2, ~~*Cost Estimates for Closure*, Section 8.8.1,~~ Financial Assurance for Closure.

Permit Renewal Application
October 17, 2011

Attachment Q

Statistics for Release Determination

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Attachment Q. Statistics for Release Determination

1. Overview

Statistical analysis procedures approved in the original 2002 permit for the Triassic Park Waste Disposal Facility will be used to determine whether monitoring results show that a release has occurred from the facility. In accordance with Permit Condition 7.5.1.a., these procedures will~~shall~~ be used to perform release determinations for metals and radionuclides in water (i.e., fluid) samples obtained in the vadose zone monitoring system (VZMS) wells. These procedures shall be applicable to the following analytes obtained under Permit Conditions 7.3.1 and 7.3.3: dissolved and total metals (Sb, As, Ba, Be, Cd, Cr, Cu, Pb, Hg, Ni, Se, Ag, Ti, Zn) and radionuclides (gross alpha, gross beta, gamma emitters, total uranium, radium 226/228, radon).

As indicated~~identified~~ in Permit Condition 7.5.1.a, ~~note that the following~~ statistical release determination procedures do not apply to general water chemistry parameters (bicarbonate, chloride, dissolved major cations) or to organic parameters. ~~As identified in Permit Condition 7.5.1.a, r~~Release determinations for general water chemistry parameters will~~shall~~ be made through a trilinear diagram comparison between ~~vadose zone monitoring system (~~VZMS~~)~~ well fluid samples and baseline non-leachate fluid samples (i.e., fluid obtained by extracting non-leachate source water through representative soil samples obtained from the installation of the VZMS wells). The release determinations for organics shall be made by the detection of any anthropogenic organic in a VZMS well sample.

The overall statistical procedure for making release determinations for metals and radionuclides in VZMS well samples is as follows:

- An upper tolerance limit shall be constructed for non-leachate analytes in water samples extracted under the Synthetic Precipitation Leaching Procedure (SPLP; U.S. EPA method 1312) ~~Meteoric Water Mobility Procedure (MWMP)~~ (see Permit Attachment I, Vadose Zone Monitoring System Work Plan, Appendix A, Synthetic Precipitation Leaching Procedure~~Meteoric Water Mobility Procedure~~) for baseline soil boring samples (or baseline soil cutting samples) obtained under Permit Condition 7.3.1. This non-leachate ~~MWMP~~SPLP-extract~~ant~~ analyte tolerance limit will~~shall~~ be constructed for each individual metal analyte and for each individual radionuclide analyte in the non-leachate ~~MWMP~~SPLP-extracted samples. These non-leachate ~~MWMP~~SPLP-extract~~ant~~ analyte tolerance limits will~~shall~~ be reported as required by~~at~~ Permit Condition 7.3.1.b.

- Analyte concentrations of dissolved/total metals and radionuclides from VZMS well samples, as obtained under Permit Condition 7.3.3, will~~shall~~ be compared to~~against~~ each individual non-leachate ~~MWMP~~SPLP-extract~~ant~~ analyte tolerance limit. The results of this comparison will~~shall~~ be reported according to VZMS well sample reporting requirements established under Permit Conditions 7.4.2 and 7.5.2.

The construction of the non-leachate ~~MWMP~~SPLP-extract~~ant~~ analyte tolerance limits shall adhere to the following guidelines:

- A minimum of 20 non-leachate ~~MWMP~~SPLP-extract~~ant~~ analyte concentrations (e.g., total lead) from baseline ~~MWMP~~SPLP-extract~~ant~~ samples are required to construct an adequate upper tolerance limit for each non-leachate analyte in the ~~MWMP~~SPLP-extract~~ant~~ data sets.

- Each set of non-leachate ~~MWMP~~SPLP-extract~~ant~~ analyte concentrations will~~shall~~ be evaluated for the occurrence of values reported below the achievable detection limits (i.e., non-detects). The procedure for performing this evaluation, and the methods to manage non-detects, is provided below.

- Each set of non-leachate ~~MWMP~~SPLP-extract~~ant~~ analyte concentrations will~~shall~~ be evaluated for normality using the procedure described below. If a~~each~~ data set of non-leachate ~~MWMP~~SPLP-extract~~ant~~ analyte concentrations ~~from the MWMP-extractant samples~~ exhibits a normal distribution, the non-leachate ~~MWMP~~SPLP-extract~~ant~~ analyte tolerance limits will~~shall~~ be constructed on the original (i.e., raw) data set using the parametric tolerance limit procedure described below. If a~~each~~ data set of non-leachate ~~MWMP~~SPLP-extract~~ant~~ analyte concentrations ~~from the MWMP-extractant samples~~ exhibits a log-normal distribution instead, the non-leachate ~~MWMP~~SPLP-extract~~ant~~ analyte tolerance limit will~~shall~~ be constructed on the log-transformed baseline data set using the parametric tolerance limit procedure, with the respective log-transformed~~normal~~ VZMS well sample concentration for that analyte being used in the comparison of the VZMS well sample to the log-transformed~~normal~~ non-leachate ~~MWMP~~SPLP-extract~~ant~~ analyte tolerance limit.

These procedures are based upon the following guidance developed by the U.S. Environmental Protection Agency (EPA): *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Interim Final Guidance*, (U.S. EPA~~ Interim Final Guidance~~, ~~April~~ 1989); ~~and~~ *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Draft Addendum to Interim Final Guidance*, (U.S. EPA, ~~July~~ 1992); and *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* (U.S. EPA, ~~March~~ 2009). Requirements set forth in *Use of Tolerance Intervals for Determining Inorganic Background Concentrations* (~~New Mexico Environment Department [~~(NMED~~]), Hazardous Materials Bureau, March 2~~, 2000) shall also be adhered to, including the following:

- Each parametric and non-parametric analyte tolerance limit will~~shall~~ be constructed with a minimum of 20 ~~MWMP~~SPLP-extract~~ant~~ samples.

- Each parametric analyte tolerance limit shall be constructed with a minimum coverage of 95% and a minimum tolerance coefficient of 95%.

2. Managing Non-Detects in Non-Leachate ~~MWMP~~SPLP-Extract~~ant~~ Data Sets

If concentrations of any non-leachate ~~MWMP~~SPLP-extract~~ant~~ analyte are reported below the achievable detection limits in ~~each non-leachate MWMP-extractant analyte~~ a data set (i.e., minimum of 20 samples), the following procedure must be followed before the tolerance limit is calculated for the data set.

If the non-leachate ~~MWMP~~SPLP-extract~~ant~~ analyte data set has no more than 15% non-detects, use one-half of the detection limit for that particular measurement. Subsequently, proceed to the normality test procedures described in Section 3~~below~~.

If the non-leachate ~~MWMP~~SPLP-extract~~ant~~ analyte data set has more than 15% non-detects, but less than or equal to 50% non-detects, use Cohen's approximation to approximate the mean and standard deviation of the ~~analyte non-leachate MWMP-extractant analyte~~ data set. However, before calculating Cohen's approximation, it must be decided whether the analyte data are~~is~~ more closely approximate to a normal or a log-normal distribution. To make this determination, censored probability plots, as described in EPA's ~~Draft Addendum to Interim Final G~~guidance (U.S. EPA, 1992), should be constructed on both the raw measurements and the log-transformed measurements.

~~Compare the two~~The censored probability plots will be compared to determine whether~~. If~~ the plot based on the raw measurements is more linear than the plot based on the log-transformed values.~~, compute~~ Cohen's approximation will be computed using the raw measurements and then proceed with the normality test procedures described below. If the plot based on the log-transformed measurements is more linear, ~~compute~~ Cohen's approximation will be computed using the log-transformed measurements and then proceed with the normality test procedures described in Section 3~~below~~.

If the non-leachate ~~MWMP~~SPLP-extract~~ant~~ analyte data set contains more than 50% non-detects, then~~ use~~ the procedure to calculate the non-parametric tolerance limit for the data set will be used, as described in Section 5~~below~~.

3. Normality Test of Non-Leachate ~~MWMP~~SPLP-Extract~~ant~~ Data Sets

Following the management of non-detects for each non-leachate ~~MWMP~~SPLP-extract~~ant~~ analyte data set, the normality or log-normality of each ~~non-leachate MWMP-extractant analyte~~ data set must be confirmed before constructing the analyte tolerance limit~~ for each data set~~. If the non-leachate ~~MWMP~~SPLP-extract~~ant~~ analyte data set contains more than 50% non-detects, the data set is~~do~~ not tested for normality, and ~~and proceed directly to~~ the method for calculating the non-parametric tolerance limit for the data set is used, as described in Section 5~~below~~.

The normality or log-normality of each non-leachate ~~MWMP~~SPLP-extract~~ant~~ analyte data set will~~shall~~ be tested by first constructing a probability plot on the compliance data, as described in EPA's ~~Addendum to Interim Final G~~guidance (U.S. EPA, 1992). In addition, ~~since~~ because the probability plot is not a formal test of distribution, each compliance data set will~~shall~~ be assessed using the Shapiro-Wilk test of normality at the 0.01 level of significance. Note that to test normality of each non-leachate ~~MWMP~~SPLP-extract~~ant~~ analyte data set, the raw measurements should be used in the construction of the probability plot and the calculation of the Shapiro-Wilk test. If normality of the data is confirmed, the non-leachate ~~MWMP~~SPLP-extract~~ant~~ analyte data set tolerance limit can be calculated on the raw measurements, as described in Section 4~~below~~ in the discussion of parametric tolerance limit procedures.

If the probability plot and the results of the Shapiro-Wilk test indicate~~s~~ the non-leachate ~~MWMP~~SPLP-extract~~ant~~ analyte data set is not normally distributed, the data set should be log-transformed. Subsequently, the normality tests (i.e., probability plot and Shapiro-Wilk test) should be applied to the log-transformed data set to determine if the non-leachate ~~MWMP~~SPLP-extract~~ant~~ analyte data set is log-normally distributed. If log-normality of the data is confirmed, the parametric tolerance limit can be calculated on the log-transformed data set, as described ~~below~~in Section 4 in the discussion of parametric tolerance limit procedures.

If both normality and log-normality of the non-leachate ~~MWMP~~SPLP-extract~~ant~~ analyte data set are rejected using the probability test and the Shapiro-Wilk test at the 0.01 level of significance, then ~~construct~~ the non-parametric tolerance limit will be constructed as described in Section 5~~below~~.

4. Parametric Tolerance Limit for Non-Leachate ~~MWMP~~SPLP-Extract~~ant~~ Analyte Data Set

For log-normally distributed or log-transformed data sets of SPLP-extract analyte data, the following procedure will be followed to establish the parametric tolerance limit.

1. ~~Calculate t~~The mean ~~,~~ (X)~~,~~ and standard deviation ~~,~~ (S)~~,~~ for the non-leachate ~~MWMP~~SPLP-extract~~ant~~ analyte data set will be calculated.

2. ~~Construct t~~The one-sided, upper tolerance limit for the non-leachate ~~MWMP~~SPLP-extract~~ant~~ analyte data set will be constructed as:

$$\text{Tolerance Limit} = X + K\,S$$

where K = the one-sided normal tolerance factor found in U.S. EPA (2009, Appendix D Table 17-3)~~Interim Final Guidance (Appendix B, Table 5)~~

3. ~~Compare e~~Each dissolved/total metal analyte and radionuclide analyte obtained for each VZMS well sample, as obtained under Permit Condition 7.3.3, will be compared to each respective non-leachate ~~MWMP~~SPLP-extract~~ant~~ analyte data set parametric tolerance limit constructed for the analyte under Step 2. If the non-leachate ~~MWMP~~SPLP-extract~~ant~~ analyte data set tolerance limit was constructed on the logarithm of the original data, the logarithm of the VZMS well sample analyte should be compared to the non-leachate ~~MWMP~~SPLP-extract~~ant~~ analyte data set tolerance limit for each analyte under Step 2.

4. If the VZMS well sample analyte concentration exceeds the respective parametric non-leachate ~~MWMP~~SPLP-extract~~ant~~ analyte data set tolerance limit for that analyte, then there is statistically significant evidence that the VZMS well sample is composed of leachate from the landfill.~~ or the Surface Impoundment~~.

5. Non-Parametric Tolerance Limit for Non-Leachate ~~MWMP~~SPLP-Extract~~ant~~ Analyte Data Set

For data sets of SPLP-extract analyte data found to not be normally or log-normally distributed, the following procedure will be followed to establish the non-parametric tolerance limit.

1. ~~Examine t~~The non-leachate ~~MWMP~~SPLP-extract~~ant~~ analyte data set should be examined to observe and obtain the maximum value for the data set.

2. ~~Set t~~The non-parametric upper tolerance limit for the non-leachate ~~MWMP~~SPLP-extract~~ant~~ analyte data set will be established as ~~to~~ th~~is~~e maximum value obtained in Step 1.

3. ~~Compare e~~Each dissolved/total metal analyte and radionuclide analyte obtained for each VZMS well sample, as obtained under Permit Condition 7.3.3, will be compared to the non-parametric non-leachate ~~MWMP~~SPLP-extract~~ant~~ analyte data set tolerance limit constructed for each analyte under Step 2.

   If the VZMS well sample analyte concentration exceeds the respective non-parametric non-leachate ~~MWMP~~SPLP-extract~~ant~~ analyte data set tolerance limit for that analyte, then there is statistically significant evidence that the VZMS well sample is composed of leachate from the l~~L~~andfill~~ or the Surface Impoundment~~.

References

U.S. Environmental Protection Agency (EPA). 1989. *Statistical analysis of groundwater monitoring data at RCRA facilities, Interim final guidance.* U.S. EPA Office of Solid Waste. April 1989.

U.S. EPA. 1992. *Statistical analysis of ground-water monitoring data at RCRA facilities, Addendum to interim final guidance.* U.S. EPA Office of Solid Waste. July 1992.

U.S. EPA. 2009. *Statistical analysis of groundwater monitoring data at RCRA facilities, Unified guidance.* EPA 530-R-09-007. March 2009.

Attachment R

Action Levels for Corrective Action

Attachment R. Action Levels for Corrective Action

(Placeholder for future determination)

R1. Background Concentrations for Soil

R2. Vadose Zone Baseline Concentrations for Non-Leachates

R3. Background Concentrations for Vadose Zone Water

Attachment R of the permit application provides a placeholder for the future determination of action levels for corrective action. The Vadose Zone Monitoring System (VZMS) Work Plan in Attachment I establishes plans for determining background/baseline concentrations for soil, non-leachate fluids, and vadose zone water. Samples will be collected and analyzed during installation of the VZMS and monitoring during facility operations. Analytical results will be evaluated according to the statistical analysis methods described in Attachment Q. This testing will be used to determine the background/baseline concentrations needed to establish action levels for corrective action.

Attachment S

Vadose Zone Monitoring Indicator Parameters

Attachment S. Vadose Zone Monitoring Indicator Parameters

(Placeholder for future determination)

Attachment S of the permit application provides a placeholder for the future determination of vadose zone monitoring indicator parameters. The Vadose Zone Monitoring System (VZMS) Work Plan in Attachment I establishes plans to select indicator parameters for vadose zone monitoring. The indicator parameters will be established during operations by testing the chemical characteristics of leachate and non-leachate fluids. Leachate testing will be performed following the Waste Analysis Plan in Section 4 of the Part B permit application. Using the baseline water quality characterizations and the leachate fluid analyses, chemical profiles of the water types as well as a suite of appropriate analytical indicator parameters will be selected to be incorporated into the vadose zone monitoring program for leak detection during facility operation.