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June 30, 2017

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WQCC

Via Hand Delivery
Pam Castaneda
Administrator to Boards and Commissions
Environmental Improvement Board
Water Quality Control Commission
Harold Runnels Building
1190 St. Frances Dr., Ste. N4050
Santa Fe, NM 87505

Re: ***WQCC 16-05, UNC Statement of Intent and Exhibits***

Dear Ms. Castaneda:

Enclosed are an original and thirteen copies of UNC's Statement of Intent to Present Technical Testimony and Exhibits for the July 11, 2017 WQCC Hearing on Petition for Alternative Abatement Standards in the above-referenced case. The copies consist of three sets of hard copies in binders and ten sets on CD.

If you have any questions or require any additional sets, please let us know.

Sincerely,

Jodi Haines
Paralegal to Jon J. Indall

Enclosures

Cc: John Grubesic
Annie Maxfield
Richard W. Hughes

K:\UNC - ST ANTHONY MINE, 157-33\Letters\P Castaneda w-UNC SOI & Exhibits docx

STATE OF NEW MEXICO
BEFORE THE WATER QUALITY CONTROL COMMISSION

IN THE MATTER OF:
THE PETITION FOR ALTERNATE ABATEMENT STANDARDS FOR THE FORMER ST. ANTHONY MINE, CIBOLA COUNTY IN THE STATE OF NEW MEXICO

No. WQCC 16-05

STATEMENT OF INTENT TO PRESENT TECHNICAL TESTIMONY

United Nuclear Corporation ("UNC") is submitting its Notice of Intent to Present Technical Testimony in support of its Petition for Alternative Abatement Standards in the above-captioned matter.

The following witnesses will present technical testimony in support of UNC's Petition for Alternate Abatement Standards:

1. Roy Blickwedel: Mr. Blickwedel will provide a description for the St. Anthony Site and activities for which the alternate abatement standards are sought, current conditions at the Site, and how the Petitioner would propose to reclaim the Site. Mr. Blickwedel's direct testimony should take approximately 30 to 45 minutes. Mr. Blickwedel's declaration and exhibits are attached to UNC's Statement of Intent.

2. Cynthia Ardito: Ms. Ardito will provide testimony regarding UNC's Stage 1 and Stage 2 Abatement Plans, site characterization and field investigations, the process by which stakeholders arrived at the preferred reclamation alternative, how UNC complies with the criterion required for approval of alternate abatement standards and other matters related to Applicant's Petition. Ms. Ardito's direct testimony should take approximately 1.5 to 2 hours. Ms. Ardito's declaration and exhibits are attached to UNC's Statement of Intent.

3. John Sigda: Mr. Sigda will provide testimony regarding site characteristics; water quantity and water quality at the Site; the development and results of conceptual and numerical models of the groundwater at the Site including, but not limited to, future migration and groundwater exposure pathways; potential water development in the area; and other matters related to Applicant's Petition. Mr. Sigda's direct testimony should take approximately 1 to 1.5 hours. Mr. Sigda's declaration and exhibits are attached to UNC's Statement of Intent.

4. William Konstedt: Mr. Konstedt will provide testimony regard geochemical modeling and results for the Site, site characteristics, determination of constituents and proposed alternate abatement standards, potential geochemical stabilization actions, and other matters related to Applicant's Petition. Mr. Konstedt's direct testimony should take approximately 1 to 1.5 hours. Mr. Konstedt's declaration and exhibits are attached to UNC's Statement of Intent.

Also attached are UNC's Exhibit List and copies of the exhibits UNC plans to present in support of its witnesses' testimony.

Respectfully submitted,

COMEAU, MALDEGEN, TEMPLEMAN & INDALL, LLP

By ______________________
Jon J. Indall
P. O. Box 669
Santa Fe, NM 87594-0669
505-982-4611
Attorneys for Petitioner
United Nuclear Corporation

CERTIFICATE OF SERVICE

I hereby certify that on June 30, 2017, I served a copy of the foregoing STATEMENT OF INTENT TO PRESENT TECHNICAL TESTIMONY, by first-class mail (hand delivery) to all parties listed below:

John Grubesic
Office of the Attorney General
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Santa Fe, NM 87504-1508
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Annie Maxfield
New Mexico Environment Department
121 Tijeras Avenue, NE #1000
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Fax: 505 982-0307
Counsel for the Pueblo of Laguna

Jon J. Indall

St. Anthony AAS Petition Hearing
July 11, 2017

Exhibits

Exhibit 1 **St. Anthony AAS Petition: Volume I, Petition and Figure Exhibits**

Exhibit 2 **Affidavit of Notice of Public Hearing**

Exhibit 3 **Roy Blickwedel Resume**

Exhibit 4 **Declaration of Roy Blickwedel**

- 4a Mineral Lease Between UNC and Cebolleta Land Grant
- 4b St. Anthony Mine Site Locations Map
- 4c St. Anthony Mine Site Features

Exhibit 5 **Cynthia Ardito Resume**

Exhibit 6 **Declaration of Cynthia Ardito**

- 6a St. Anthony Mine in the Grants Uranium Mineral Belt
- 6b St. Anthony Ore Body Projections
- 6c Ore Deposit Features on Jackpile Outcrop
- 6d NMED Approval Letter, St. Anthony Mine Stage 1 Abatement Investigation
- 6e Site Plan Monitoring Wells and Arroyo Sampling Locations
- 6f Soil Sample Location Map for Overburden Pile Characterization
- 6g Groundwater Heads in the Jackpile Sandstone, St. Anthony Mine 2013
- 6h Water Supply Wells in the Vicinity of the St. Anthony Mine
- 6i Post-Reclamation Particle Track Analysis St. Anthony Mine AAS Petition
- 6j COPC Distribution in Groundwater at the St. Anthony Mine
- 6k NMED Approval Letters, St. Anthony Mine Stage 2 Abatement

Exhibit 7 **William Kostedt Resume**

Exhibit 8 **Declaration of William Kostedt**

- 8a Photomicrograph of Sandstone from MW-8
- 8b Diagram of AAS Determination Through Geochemical Modeling
- 8c Determination of Radium Concentrations in Groundwater
- 8d Summary of Proposed AASs

Exhibit 9 **John Sigda Resume**

Exhibit 10 **Declaration of John Sigda**

- 10a Surficial Geology for St. Anthony Hydrogeologic Conceptual Model
- 10b St. Anthony Subsurface Geology
- 10c Conceptual Cross-Section for St. Anthony Site
- 10d Jackpile Sandstone Groundwater Heads Across SCM Area
- 10e Conceptual Water Balance on Large Pit
- 10f Hydraulic Conductivity Estimates for Jackpile Sandstone in SCM Area
- 10g Observed and Predicted Groundwater Heads for Current Conditions
- 10h Predicted Groundwater Heads and Particle Tracks for Post-Closure Conditions
- 10i Estimated Travel Times from Large Pit After Closure
- 10j Area of Affected Groundwater for All Predictive Simulations

Exhibit 11 **Proposed Area for the AAS Petition, St. Anthony Mine**

Exhibit 12 **Presentation Slides**

- 12a Powerpoint Slide: Stage 1 Requirements
- 12b Powerpoint Slide: Summary of Stage 1 Investigation Activities
- 12c Powerpoint Slide: Stratigraphic Sequence of the St. Anthony Mine
- 12d Powerpoint Slide: Summary of Stage 2 Requirements
- 12e Powerpoint Slide: Multiple Accounts Analysis (MAA)
- 12f Powerpoint Slide: MAA Results
- 12g Powerpoint Slide: Second Phase of Site Characterization
- 12h Powerpoint Slide: Three Criteria Required for AAS Approval

Exhibit 1

St. Anthony AAS Petition: Volume I, Petition and Figure Exhibits

STATE OF NEW MEXICO
BEFORE THE WATER QUALITY CONTROL COMMISSION

IN THE MATTER OF:
THE PETITION FOR ALTERNATE ABATEMENT STANDARDS FOR THE FORMER ST. ANTHONY MINE, CIBOLA COUNTY IN THE STATE OF NEW MEXICO

No. WQCC 16-05

PETITION FOR ALTERNATE ABATEMENT STANDARDS
AND REQUEST FOR HEARING

United Nuclear Corporation hereby petitions the Water Quality Control Commission ("WQCC") to grant alternate abatement standards for the former St. Anthony Mine Site ("Site") in Cibola County, New Mexico. The Site has been in abatement under 20.6.2 NMAC since 2004. Concentrations of uranium, radium (^{226} Ra and ^{228} Ra), fluoride, sulfate, total dissolved solids, boron and chloride exceed WQCC standards.

Future reclamation plans for the Site require a determination as to whether alternate abatement standards as defined in 20.6.2.4103F NMAC are to be applied to groundwater at the Site. Implementation of the proposed abatement option for the Site will require alternate abatement standards to be granted by the WQCC for the groundwater in a limited area defined in the Petition attached hereto as Exhibit A.

Exhibit A specifies the information required by 20.6.2.4103F(2) NMAC and 20.6.1210 NMAC.

Petitioner requests that a hearing be scheduled on this matter during the WQCC's regularly scheduled January 2017 meeting. Petitioner anticipates that a hearing on this matter will take approximately six hours.

Respectfully submitted,

UNITED NUCLEAR CORPORATION

By ________________________

Jon J. Indall
Comeau, Maldegen, Templeman
& Indall, LLP
P. O. Box 669
Santa Fe, NM 87594-0669
505-982-4611
Attorneys for Petitioner
United Nuclear Corporation

EXHIBIT A

PETITION FOR ALTERNATIVE ABATEMENT STANDARDS

Former St. Anthony Mine,

Cibola County, New Mexico

Prepared for:

UNITED NUCLEAR CORPORATION

McKinley County, New Mexico

Prepared by:

INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

6000 Uptown Boulevard NE, Suite 220
Albuquerque, New Mexico 87110

December 16, 2016

INTERA

PETITION FOR ALTERNATIVE ABATEMENT STANDARDS

Former St. Anthony Mine,

Cibola County, New Mexico

Prepared for:

UNITED NUCLEAR CORPORATION

McKinley County, New Mexico

Prepared by:

INTERA Incorporated

6000 Uptown Boulevard NE, Suite 220
Albuquerque, New Mexico 87110

December 16, 2016

Roy Blickwedel

Roy Blickwedel, GE/United Nuclear Corporation — 12/ 16 /2016 Date

Cynthia Ardito, INTERA Incorporated — 12/ 16 /2016 Date

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LIST OF EXHIBITS

ACRONYMS AND ABBREVIATIONS

°F	Degrees Fahrenheit
^{226}Ra	radium-226
^{228}Ra	radium-228
U_3O_8	uranium oxide
AASs	alternative abatement standards
COPC	contaminants of potential concern
ft	foot or feet
ft/day	feet per day
gpm	gallons per minute
INTERA	INTERA Incorporated
Large Pit	large open pit at the Site at 35.16213° north and 107.30531° west
MAA	Multiple Accounts Analysis
MMD	New Mexico Energy, Minerals and Natural Resource Department's Mining and Minerals Division
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
NMOSE	New Mexico Office of the State Engineer
WQCC	New Mexico Water Quality Control Commission
Petition	This alternative abatement standard petition for the former St. Anthony Mine Site
SCM	site conceptual model
Site	GE/UNC's former St. Anthony Mine, Cibola, New Mexico
STPP	sodium tripolyphosphate
TDS	total dissolved solids
UNC	United Nuclear Corporation

1.0 INTRODUCTION

This document ("Petition") has been prepared on behalf of United Nuclear Corporation (UNC) to petition for Alternative Abatement Standards (AASs) for the former St. Anthony Mine Site ("Site") in Cibola County, New Mexico. The Site has been in abatement under Title 20, Chapter 6, Part 2 of New Mexico Administrative Code (20.6.2 NMAC) since 2004. Concentrations of uranium,
radium (^{226}Ra + ^{228}Ra), fluoride, sulfate, total dissolved solids (TDS), boron, and chloride exceed New Mexico Water Quality Control Commission (WQCC) standards.

Future reclamation plans for the Site require a determination as to whether the AASs as defined in 20.6.2.4103F NMAC are to be applied to the groundwater within the Jackpile sandstone. Implementation of the proposed abatement option will result in a need for AASs in the Jackpile sandstone groundwater in a limited area defined within this Petition.

The St. Anthony Mine, operated by UNC under a former lease from the Cebolleta Land Grant, is located in northwestern New Mexico within the Grants Uranium Mineral Belt (**Exhibit 1**). In its current state, the large open pit at the Site ("Large Pit") of the St. Anthony Mine captures groundwater via a cone of depression that has developed in response to evaporation of pit water; however, preferred abatement options that include backfilling of the Large Pit would eliminate the evaporation and ultimately result in the loss of groundwater containment. Based on extensive conferences between the New Mexico Environment Department (NMED), the New Mexico Energy, Minerals and Natural Resource Department's Mining and Minerals Division (MMD), and numerous other stakeholders, using the Multiple Accounts Analysis (MAA) process[1], the preferred abatement option would include backfilling of the Large Pit. Pit backfilling is also the presumptive reclamation option defined by 19.10.5.507B NMAC. Backfilling of the St. Anthony Mine open pits will result in the loss of the evaporative containment of groundwater, and as is explained further in this Petition and in the Stage 2 Report (**Exhibit 3**; INTERA, 2015), necessitates the inclusion of AASs into the preferred abatement option.

The Jackpile sandstone, a member of the Jurassic Morrison Formation, contains uranium ore and extensive uranium mineralized zones. Groundwater constituents naturally exceed WQCC Standards for some regulated constituents in uranium ore deposits. Groundwater monitoring and modeling results do not support a finding that the process of mining resulted in increased levels of contaminants in groundwater. However, the water contained by evaporation in the Large Pit has increased concentrations of mineral constituents, as a direct result of evapo-concentration and

[1] The MAA is a systematic process to select among multiple remediation approaches to reclaim the Site. Stakeholder collaboration is at the core of the MAA process, with all viewpoints being represented and validated

would accompany backfilling the Large Pit would allow the water in the Large Pit to migrate away from the pit.

For the pit backfill reclamation alternative to be implemented at the Site, AASs are necessary; compliance with WQCC Standards cannot be met, due to the existence of natural mineralization, the presence of the pit water that would no longer be contained by evapotranspiration, and the release of regulated constituents above standards from future dissolution of secondary mineralization after the pit vicinity re-saturates. An AAS Petition (20.6.2.4103 NMAC), therefore, is a necessary precursor to implementing the preferred abatement option. Specifically, AASs are sought for chloride, boron, sulfate, TDS, fluoride, uranium, and radium (^{226}Ra + ^{228}Ra).

1.1 Site Location

The St. Anthony Mine is located in Cibola County in west-central New Mexico, approximately 3 miles east-southeast of Moquino and approximately 13 miles north of Laguna Pueblo (**Exhibit 2**). The St. Anthony Mine is located within Township 11 North, Range 4 and 5 West, at the base of the northern and eastern slopes of the Gavilan Mesa. The latitude and longitude of the approximate center of the Large Pit at the Site is 35.16213° north and 107.30531 ° west. The property containing the St. Anthony Mine is owned by Cebolleta Land Grant and was leased to UNC for mining purposes. The neighboring property owners include Cebolleta Land Grant, Laguna Pueblo, and a private owner.

1.2 Site History

The Site is located in the Grants Uranium Belt (**Exhibit 1**). The Site was operated by UNC from 1975 to 1981. During this time, mining by UNC was conducted in two open pits and in one underground mine. The St. Anthony Mine produced approximately 280 tons of triuranium octoxide (U_3O_8) in 1979, and approximately 288 tons to 1980. The ore trends at the Site were confirmed using surface drilling before production. The ore body projections were mapped using statistical methods. UNC's exploration drilling established that the zones of mineralization in the Jackpile sandstone extended beyond those areas that were considered economical to mine. In addition, the known extent of the ore deposit was never fully mined.

When UNC surrendered its lease to the Cebolleta Land Grant, it left the pits and underground mine in their existing state per the terms of the lease, as there were ore reserves remaining at these sources. With the enactment of the 1993 New Mexico Mining Act, UNC became responsible for the reclamation of the Site. UNC is also responsible for complying with the rules of the WQCC as administered by NMED. As described in detail in this Petition, NMED's requirements described in 20.6.4103 NMAC (the "Abatement Regulations"), must be completed before the preferred abatement option can be implemented, and final reclamation of the Site under MMD's regulations can be accomplished.

UNC has completed the Stage 1 and Stage 2 phases of the Abatement Regulations. The *St. Anthony Mine Stage 2 Abatement Plan* ("Stage 2 Abatement Plan") (INTERA, 2015) is attached as **Exhibit 3** to this Petition. Figures and tables from the Stage 2 Abatement Plan that are used in this Petition are designated by reference where applicable. The preferred abatement option selected through the Stage 2 Abatement process, and ultimately the mine closeout, is dependent on selection of the proposed AASs described herein.

The Site has an areal extent of approximately one square mile. It consists of two open pits, overburden piles, and former underground mines. The current surface features at the Site are shown on **Exhibit 4** (INTERA, 2015, Figure 1.2). The underground mine workings have been sealed at the surface. The two open pits have been identified as Pit #1 and Pit #2 in other documents (including the *St. Anthony Mine Site Stage 1 Abatement Plan* ["Stage 1 Abatement Plan"] [MWH, 2002]); however, herein they are referred to as the Large Pit and the Small Pit, respectively. The Large Pit, which is located on the west side of the Site and penetrates most of the Jackpile sandstone thickness, perennially contains standing water in direct communication with the saturated portion of the Jackpile Sandstone. The Small Pit, which is located southeast of the Large Pit and exposes the top of the Jackpile sandstone, intermittently contains ponded water that is not in direct communication. with the saturated portion of the Jackpile Sandstone, but which provides a source of some recharge to the Jackpile. There are several large overburden piles on the eastern portion of the Site, located next to Meyer Draw. Meyer Draw is an ephemeral drainage (arroyo) that runs only during and shortly after storms large enough to produce runoff. From the north boundary of the Site, the arroyo passes between the open pits and several large overburden piles in a southeasterly direction and is joined by Arroyo de Pedro Padilla from the northeast before leaving the Site and entering the Laguna Pueblo, which is directly south of the Site.

The Site remains in the same condition as it was at the time of the lease termination as part of the terms of the Site lease from the Cebolleta Land Grant. There are no remaining building structures on the Site. Besides the pits and overburden piles, some of the mine infrastructure equipment and components still exist, including roads, utility lines across the Site, utility connection locations, a surface completion of an old well, and the slab of a former structure.

2.0 AAS PETITION REQUIREMENTS

This petition for AASs at the former St. Anthony Mine must address the requirements of 20.6.2 NMAC Section 1210, "Variance Petitions," and Section 4103.F, "Alternative Abatement Standards." The responses to these requirements are discussed below.

2.1 Variance Petition Requirements

Section 1210A requires that "Any person seeking a variance pursuant to Section 74-6-4 (G) NMSA 1978, shall do so by filing a written petition with the commission."

Petitions shall:

1. *State the petitioner's name and address;*
   United Nuclear Corporation
   P.O. Box
   Gallup, New Mexico

2. *State the date of the petition;*
   December 16, 2016

3. *Describe the facility or activity for which the variance is sought;*
   The facility is a former open pit and underground uranium mine. Pursuant to the 1993 Mining Act and the 1978 Water Quality Act, UNC is working with the landowner, MMD, and NMED to reclaim the Site. The current surface features at the Site are shown on **Exhibit 4** (INTERA, 2015, Figure 1.2).

4. *State the address or description of the property upon which the facility is located;*
   The St. Anthony Mine is located on the Cebolleta Land Grant within Township 11 North, Range 4 and 5 West, at the base of the northern and eastern slopes of the Gavilan Mesa, Cibola County, New Mexico.

5. *Describe the water body or watercourse affected by the discharge;*
   The Jackpile sandstone is the only water-bearing formation that could become potentially affected as a result of proposed reclamation actions (i.e. pit backfilling). The Large Pit on the west side of the Site penetrates most of the Jackpile sandstone thickness and perennially contains standing water from groundwater discharge into the pit (**Exhibit 4**; INTERA, 2015, Figure 1.2). The Small Pit, located southeast of the Large Pit, exposes the top section of the Jackpile sandstone and intermittently contains small amounts of ponded water from surface water runoff. The Small Pit does not penetrate groundwater in the Jackpile sandstone.

The Jackpile sandstone is the first water-bearing unit beneath the ground surface at this Site and consists of relatively well-lithified, medium- to coarse-grained, arkosic sandstone. The Jackpile sandstone has a relatively low hydraulic conductivity (0.005 to 0.9 feet per day [ft/day]) and, where saturated, generally has low yields of groundwater.

The characterization activities described in the Stage 1 Investigation Report (**Exhibit 6**; INTERA, 2006) and Stage 2 Abatement Plan (**Exhibit 3**; INTERA, 2015) provide the data and analysis to support the following conclusions concerning groundwater flow in the Jackpile sandstone:

- Groundwater flows out from the Jackpile sandstone into the alluvial sediments of Meyer Draw (**Exhibit 4**; INTERA, 2015, Figure 1.2), where it is lost through transpiration by tamarisk trees and evaporation at the outcrop;
- Groundwater in the Jackpile sandstone will not migrate off-site in the event that the Large Pit is backfilled and regional groundwater gradients (to the south/southeast) are re-established (**Exhibit 5**);
- Groundwater within the mineralized zones in the Jackpile sandstone is not drinking water quality due to the presence of uranium and other associated minerals throughout this area; and,
- Water quantity and water quality in the Jackpile sandstone will not support water supply development for any sustainable use.

6. *Identify the regulation of the commission from which the variance is sought;*
   Section A and B of 20.6.2.3103 NMAC as provided in Subsection 5 of 20.6.2.4103 NMAC.

7. *State in detail the extent to which the petition wishes to vary from the regulation;*
   The Alternate Abatement Standards sought under this petition are listed below in **Table 1**.

Table 1. Proposed Alternative Abatement Standards

COPC	Proposed AAS
Uranium	12.4 mg/L
$^{226}Ra + ^{228}Ra$	2913 pCi/L
Fluoride	10.7 mg/L
Sulfate	77,000 mg/L
Total Dissolved Solids	113,000 mg/L
Boron	5.05 mg/L
Chloride	908 mg/L

Notes:
mg/L = milligrams per liter
pCi/L = picoCuries per liter

8. *State why the petitioner believes that compliance with the regulation will impose an unreasonable burden upon his activity;*

   In its current state, the Large Pit at the St. Anthony Mine captures groundwater via a cone of depression that has developed in response to evaporation of pit water; however, the preferred abatement alternative of backfilling the Large Pit would eliminate evaporation and ultimately result in the loss of groundwater containment. Based upon the results of the MAA process, the stakeholder group selected the preferred abatement option that includes backfilling of the Large Pit.

   In addition, the MMD regulations require mine pits to be backfilled and reclaimed unless the requirements identified in the pit waiver rule (19.10.5.507B NMAC) process can be met. Based upon several criteria, a pit waiver would be unlikely to be granted given the conditions at St. Anthony.

   For a backfill alternative to be selected, AASs are necessary for groundwater that exceeds WQCC Standards due to mineralization associated with the Jackpile sandstone ore body, secondary mineralization within the pit, and mobilization of evapo-concentrated pit water resulting from changes in hydraulic gradient to pre-mining condtions. An AAS Petition (20.6.2.4103 NMAC) is, therefore, a necessary precursor to implementing the preferred abatement alternative.

9. *State the period of time for which the variance is desired.*

   The AASs are requested in perpetuity to facilitate Site closure and a post-mining property use that includes grazing and wildlife habitat.

2.2 Alternative Abatement Standards Requirements

The demonstration requirements codified in Subpart F of 20.6.2.4103 NMAC include the following:

1. *Compliance with the abatement standard(s) is/are not feasible, by the maximum use of technology within the economic capability of the responsible person; OR there is no reasonable relationship between the economic and social costs and benefits (including attainment of the standard(s) set forth in Section 20.6.2.4103 NMAC) to be obtained;(Criterion 1)*

   Criterion 1 is met because the Jackpile sandstone is an ore-bearing formation in the vicinity of the Site, and the only way to attain WQCC Standards would be to remove the mineralization that adversely impacts the quality of water by virtue of its association and contact with groundwater. It is not feasible or desirable to remove the entire mineral deposit. In essence, the only means to attain the WQCC Standards would be to physically remove the host rock that contains the groundwater, recognizing that the groundwater would also be removed. This approach would result in a highly negative net environmental impact (high resource consumption and no beneficial impact).

2. *The proposed alternative abatement standard(s) is/are technically achievable and cost benefit justifiable (Criterion 2); and*

   Criterion 2 is met because the AASs are technically feasible and justified by cost-benefit analysis. Backfilling of open mine pits is the presumptive regulatory approach as put forth in 19.10.5.507B NMAC and the preferred abatement option for the St Anthony Mine. However, to accomplish backfilling there would be an accompanying loss of the evaporative containment of nearby groundwater. As groundwater gradients return to pre-mining conditions, groundwater migrating away from the Site will come into contact with secondary mineralization in the pit walls, evapo-concentrated water in the area of the former Large Pit, and the mineralized ore body. All of these Site features will act to increase levels of constituents of potential concern (COPCs) downgradient of the Site. The proposed AASs are the geochemically-modeled maximum concentrations that could be observed downgradient of the Site and are, therefore, achievable.

3. *Compliance with the proposed alternative abatement standard(s) will not create a present or future hazard to public health or undue damage to property (Criterion 3).*

   Criterion 3 is met because there is no complete pathway for migration of COPCs in groundwater to a receptor. Post-reclamation groundwater within the mine permit area will travel no more than approximately 9,100 feet (ft) (1.72 miles) before being consumed by evapotranspiration, and will not migrate onto adjoining properties. The present and foreseeable future use on the surface above the proposed AAS area (approximately 1,080 acres) is grazing and wildlife habitat. There is no current use of groundwater for consumption in the affected area, and the water quality is naturally such that it is unsuitable for consumption. In addition, there are no foreseeable plans for future use of groundwater in the affected area by the owners of the property, Cebolleta Land Grant.

   The incomplete groundwater pathway has been thoroughly analyzed during development of the Stage 2 Abatement Plan (**Exhibit 3**; INTERA, 2015). The hydrogeologic site conceptual model and the accompanying modeling of the groundwater flow system in the Site vicinity are described in detail in Section 5 of the Stage 2 Abatement Plan (**Exhibit 3**; INTERA, 2015). The groundwater flow model determines the future migration of groundwater and solutes away from the Site. The results of the model demonstrate that the very small rate of groundwater discharge to the Meyer Draw is consumed through tamarisk transpiration and evaporation at the seepage face. As detailed in the Stage 2 Abatement Plan (**Exhibit 3**; INTERA, 2015), the process of evaporation at the seepage face alone effectively eliminates the potential for seepage into Meyer Draw. Flow modeling also has shown that it would potentially take hundreds of years after pit backfilling of the Large Pit for any groundwater to reach Meyer Draw (**Exhibit 5**).

Finally, as per 19.27.5.13 NMAC, the New Mexico Office of the State Engineer (NMOSE) may reject an application for a 72-12-1 domestic well permit when the proposed 72-12-1 domestic well is to be located in an area of water quality concern where a prohibition on or recommendation against the drilling of new wells has been established by a government entity. The WQCC approval of the AAS Petition would be that recommendation. Therefore, the proposed AASs will not create a present or future hazard to public health or undue property damage.

3.0 SITE GEOLOGY AND HYDROLOGY

Numerous site-specific data have been collected through UNC's site characterization and bench-scale remedial technology evaluation programs conducted between 2004 and 2014. A detailed description of this work is found in the Stage 1 Investigation Report (**Exhibit 6**; INTERA, 2006) and the Stage 2 Abatement Plan (**Exhibit 3**; INTERA, 2015). Additional data has been collected from nearby mines to further the understanding of the Site and its characteristics. UNC's consultants have developed a conceptual model of the Site's hydrology and a numerical model of groundwater flow under current and post-closure conditions.

3.1 Physiography and Climate

The St. Anthony Mine is located in the southeastern part of the San Juan Basin, a large structural basin that encompasses roughly 21,000 square miles within New Mexico, Colorado, Arizona, and Utah. Lying within the Colorado Plateau Physiographic Province, the basin is bounded by structural uplifts on all sides, whereas the central part of the basin consists of relatively flat-lying sedimentary rocks. Topographic relief spans more than 7,000 ft between the high-elevation mountains and uplifts and the low-elevation sags and basin center.

The regional surface topography is a combination of steep-sided mesas separated by broad, gently sloping valleys. These valleys are infilled with alluvial and colluvial deposits, with primary stream channels incised through previously deposited sediments. Regional drainage is to the south; first into Rio Moquino, then Rio Paguate, then Rio San Jose, then Rio Puerco further south and east, and eventually into the Rio Grande in central New Mexico. To the north and northwest of the Site, surface topography is dominated by the Mount Taylor volcanic field, which consists of broad, gently sloping basaltic flows with steep sides at flow edges. Numerous volcanic plugs occur in the area, similar to Cerro Negro immediately north of the Site. To the south and east, topography consists of alternating mesas and valleys. As evaluated from data collected at Laguna, New Mexico meteorological station, the mine area received an average of 9.86 inches of precipitation annually between 1914 and 2005. Approximately 51 % of the precipitation occurs in the monsoonal months of July, August, and September. Mean monthly temperatures at the Laguna meteorological station range from 35.2 degrees Fahrenheit (°F) in the winter months to 72.6°F in the summer months.

3.2 Geologic Setting

The St. Anthony Mine is located in within the San Juan Basin. Up to 14,400 ft of sedimentary rocks fill the basin, ranging in age from Devonian to Tertiary. These rocks dip into the basin relatively gently along the southern and eastern margins compared to the western and northern margins. The older rocks crop out along the basin perimeter and are overlain by successively younger rocks toward the center of the basin. Organized by age from oldest to youngest, the major geologic units in the San Juan Basin are set forth in **Exhibit 7** (INTERA, 2015, Figure 1.4).

The San Juan Basin stratigraphic units exposed at the Site and its surroundings include, from oldest to youngest, the Brushy Basin Member, the Jackpile sandstone, the Dakota Sandstone (Cretaceous), the Mancos Shale (Late Cretaceous), and Quaternary alluvium and colluvium. All Mesozoic units are visible in the St. Anthony Mine pits and along the Meyer Draw drainage channel. The stratigraphic units dip slightly to the north-northeast. Uranium production at the Site was from the Jackpile sandstone. The Large Pit penetrated this unit to approximately 75 ft bgs. Penetration of the Jackpile sandstone in the Small Pit ranges from approximately 30-50 feet depending on the location within the pit. The Jackpile sandstone varies in thickness in the area from approximately 80 to 120 ft and is representative of deposition in a braided stream environment. The Jackpile consists of a lens of relatively well-lithified, medium- to coarse-grained, arkosic sandstone.

Ore trends at St. Anthony extend north-northwest through the property as a discontinuous assemblage of ore bodies. The ore bodies follow dispositional trends of braided stream channels and clay seams. Through the mining zones, concentrations of ore grade material are set against a widespread, but highly variable background of mineralization.

3.3 Hydrogeology and Water Supply

The hydrostratigraphic unit of interest to thisAAS Petition is the Jackpile sandstone. The investigation drilling activities conducted in 2004, 2008, and 2012 showed that the Jackpile sandstone unit is the first water-bearing unit beneath the ground surface at this Site, and it is underlain by an aquitard consisting of a thick sequence of Brushy Basin shale. The Jackpile sandstone has a relatively low hydraulic conductivity (0.005 to 0.9 ft/day) and, where saturated, generally has low yields of groundwater.

Other studies in the St. Anthony area indicate that there are discontinuous water-bearing zones in the Mancos Shale and Dakota Sandstone units (**Exhibit 6**; INTERA, 2006). Groundwater, however, was not observed in these units at the Site during drilling or as seepage from the walls of the open pits.

The groundwater system of the San Juan Basin, including the Jackpile sandstone, is recharged primarily in the topographically high areas, such as the Zuni, Chuska, and Cebolleta Mountains (Stone et al., 1983). Locally, recharge likely occurs to the northwest of the Site in the San Mateo Mountains, which comprise Mt. Taylor and the Mesa Chivato volcanic field. Regional groundwater flow in the Jackpile sandstone, is to the south/southeast.

Regional groundwater flow patterns in the vicinity of the Site are influenced by the occurrence of recharge areas, discharge areas, and hydrogeologic characteristics of the aquifer. In general, the potentiometric surface map for deep groundwater indicates that groundwater enters the area from the north and northwest in the San Mateo Mountains and flows south and southeast, discharging to the numerous arroyos (including Meyer Draw) that ultimately feed the Rio Puerco (**Exhibit 8**; INTERA, 2015, Figure 1.6). Groundwater in the Jackpile Sandstone near the Site follows the same general pattern at the regional deep groundwater, but the Large Pit and evaporation act together to locally draw down groundwater levels (**Exhibit 9**).

The NMOSE's Waters Database of water supply wells within a 5-mile radius of the Site revealed six records with location and well construction information. Of these six records, two water supply wells are found within a 2-mile radius of the Site, and four others are located between 3 and 5 miles from the Site. (See **Exhibit 10**; INTERA, 2015, Figure 1.7). All wells in the Waters Database within 5 miles of the Site are located upgradient of the Site and in an area where the Dakota Sandstone is saturated. The Dakota Sandstone is the shallowest aquifer used as a drinking water supply in the area; however, in the vicinity of the Site, it is not water bearing.

The Dakota Sandstone, at a depth of about 300 to 350 ft, was used by the Village of Moquino, approximately 3.7 miles west-northwest and upgradient of the Site; however, due to low yields, the Moquino well was supplemented in approximately 1990 by a deeper well into the Westwater Canyon Member of the Morrison Formation. The JJ No. I well field, to the northeast of the Moquino well, is also completed in the Westwater Canyon Member at depths exceeding 1,000 ft, and produces good quality water (**Exhibit 6;** INTERA, 2006). This well is also upgradient of the Site.

There are no drinking water supply wells in the vicinity of the St. Anthony Mine. There are six wells within five miles of the site, all of which are used for stock watering or irrigation, and all of which are upgradient of the Site. Two stock watering wells, RG 93922 and RG 74154, are about one mile from the Site and can extract water from the Jackpile sandstone. Well RG 93922 (**Exhibit 10**; INTERA, 2015, Figure 1.7) has a 745-foot-long perforated interval and accesses more permeable units deeper than the Jackpile Sandstone, whereas well RG 74154 has a 20-foot-long well screen. The four RG 27627 irrigation wells were drilled 300 to 400 ft below the bottom of the Jackpile sandstone and constructed with two or three screened intervals below the Jackpile, in order to intercept enough groundwater. The well owners most likely incurred the considerable expense to drill hundreds of feet below the Jackpile because the Jackpile sandstone has a low permeability and is unable to provide sufficient inflow to meet the intended use. This is consistent with the hydraulic data obtained for the Jackpile sandstone during the Stage 1 and Stage 2 abatement investigations, which show that a low pumping rate of 5 gallons per minute (gpm) results in complete dewatering of Jackpile Sandstone near the well within one to two days. In addition, it is known that the water supply for the St. Anthony Mine operation had to be supplemented by a deeper well believed to be constructed in the Westwater Canyon sandstone, hundreds of feet below the Jackpile sandstone.

3.4 Distribution of Contaminants

3.4.1 Background Groundwater Quality in Uranium Ore Deposits

Naturally-occurring uranium is an expected constituent in the Jackpile sandstone and groundwater at the Site since its presence was what motivated mining. The Jackpile sandstone water bearing zone has spatially varying geochemistry over short distances due to stationary pockets of black organic humate (a material that looks like coal and is indicative of the uranium ore mined at the site) and flowing groundwater with dissolved oxygen (**Exhibit 11**). This black organic humate material concentrated uranium by converting dissolved uranium (uranium (VI)) from groundwater with dissolved oxygen to a less soluble form (uranium (IV)) and continuously incorporating it into its structure over millions of years. The uranium contained in the black organic humate is not bound irreversibly, and can be released if the natural geochemical conditions change. Depending on the composition of groundwater, direction of flow, and minerals contained within the black organic humate, the concentration of uranium in groundwater samples will vary (**Exhibit 11**).

Characterization of Site materials demonstrated that mineral uranophane would determine uranium groundwater concentrations in those places where it is elevated to its upper bounding concentration above the WQCC Standards. Intensive study of uranium ore bodies indicates that uranophane is the most common U(VI) mineral observed in uranium deposits where lead and phosphate are not significant (Frondel 1958, Smith 1984, and Pearcy, et al. 1994). In addition, uranophane was observed in the Grants Uranium district (Adams and Saucier 1981) including the Jackpile Mine (Moench and Schlee 1967), which is located southwest of the St. Anthony Mine. Uranophane would be observed in the portion of the ore body exposed to oxidizing groundwater and containing sufficient uranium, calcium and silicon. Other minerals including uranium (VI) sulfates were observed in Large Pit wall samples and can release higher concentrations of uranium than that found in the mineralized zones found throughout the Jackpile Sandstone.

3.4.2 Contaminant Sources

Groundwater quality at the Site exceeds certain WQCC Standards, due to the presence of the ore deposits and other mineralized zones in the Jackpile sandstone. Concentrations of regulated constituents in water samples from the Large Pit resulting from mining activity have significantly increased over time, due to the effects of evapo-concentration. The Large Pit is acting as a groundwater sink driven by the process of evaporation; thus, mineral-concentrated water in the

Large Pit is contained within the pit as long as the pit is not backfilled. After backfilling, the Large Pit water would be a potential source of groundwater impacts as the evapo-concentrated water will migrate away from the Large Pit once pre-mining hydraulic gradients are re-established. Additionally, secondary minerals formed over time in the Large Pit side walls would come into contact with groundwater migrating through the former Large Pit area after backfilling; these minerals could dissolve into groundwater, providing another source of water quality impacts. Finally, as discussed in numerous places in this Petition, the mineralized zones within the Jackpile sandstone are themselves natural sources for groundwater quality impacts.

3.4.3 Nature and Extent of Current and Potential Groundwater Impacts

As noted earlier, the constituents for which AASs are being sought exceed WQCC standards due to the presence of ore deposits and mineralization in the water-bearing Jackpile formation as well as evapo-concentration of mineralized pit water left after mining activities ceased. Migration of this concentrated pit waste (and dissolved secondary mineralization) in pit walls will occur once the preferred abatement option (i.e. backfilling the pit) is completed. Water sampling undertaken at the Site over the period of 2004 to 2014 gave the following range of analytical values in the groundwater and in the Large Pit water for multiple constituents.

The ranges of water quality observed in this time period are displayed as **Table 2**:

Table 2. Groundwater and Pit Lake Water Quality Ranges

COPC	Range of Analytical Values in Groundwater at St. Anthony	Range of Analytical Values in Pit Water at St. Anthony	WQCC Standard (20.6.2.3103)
Uranium	0.0059 - 0.85 mg/L	0.85 - 17 mg/L	0.03mg/L
^{226}Ra + ^{228}Ra	ND - 325 pCi/L	0 - 45 pCi/L	30 pCi/L
Fluoride	ND - 2.1 mg/L	0.66 - 1.1 mg/L	1.6 mg/L
Sulfate	190 - 2700 mg/L	3210 - 62,000 mg/L	600 mg/L
TDS	680 - 4100 mg/L	5134 - 90900 mg/L	1,000 mg/L
Boron	0.1 - 0.6 mg/L	0.6 - 4.1 mg/L	0.75 mg/L
Chloride	14 - 44 mg/L	23.6 - 710 mg/L	250 mg/L

Notes:
mg/L = milligrams per liter
pCi/L = picoCuries per liter
ND = Non-Detect

Exhibit 12 illustrates the most recent sampling results for COPCs in groundwater.

4.0 ABATEMENT ACTIVITIES COMPLETED

4.1 Feasibility Study and Remedial Alternative Selection

UNC commenced Site remediation activities by characterizing the Site and then filing and obtaining approval for Stage 1 and Stage 2 Abatement Plans.The approved Stage 2 Abatement Proposal described the process for identifying and selecting a preferred abatement option for managing the water in the St. Anthony Large Pit.

UNC analyzed the various remediation alternatives available for the Site using the Multiple Accounts Analysis (MAA) technique. MAA is a systematic process to select among multiple remediation approaches to reclaiming the St. Anthony Mine. The MAA process provided a means to objectively balance multiple and often competing goals amongst the stakeholders; the ultimate aim being the attainment of a consensus or near-consensus approach. The stakeholders involved in this process included NMED, MMD, New Mexico Department of Game and Fish, Cebolleta Land Grant (landowner), Laguna Pueblo and Everest Holdings (neighboring landowners), Neutron Energy (lessee of the mineral estate), and UNC.

Stakeholder collaboration is at the core of the MAA process, with all viewpoints being represented and validated. Through weighting and scoring the alternatives together, each stakeholder is able to identify other views and the sensitivity of the remedial alternatives to those attributes. The process allowed for the inclusion of less tangible impacts (e.g., aesthetics) as well as more intangible impacts (e.g., costs, reliability, safety) in the alternatives evaluation. After numerous meetings and discussions concerning the various indicators for the alternatives, the stakeholders narrowed the list of 22 remediation alternatives and sub-alternatives down to six and the final abatement option, pit backfilling and in situ stabilization of pit water, was selected after a second phase of site characterization and modeling was completed.

UNC filed its modified St. Anthony Mine Stage 2 Abatement Plan on February 9, 2015. As required by 20.6.2.4106.E (3) NMAC, the Stage 2 Plan must describe and justify a single alternative. Based on the additional field investigations and bench scale studies conducted as a result of the MAA process, Alternative E3 - Partial Pit Backfill with Geochemical Stabilization of Sediments and AASs, is the preferred abatement option for closure of the St. Anthony Site. The key factors influencing this alternative abatement selection are summarized as follows:

- Backfilling of the Large Pit is preferred by all parties.
- Groundwater in the Jackpile Sandstone will not migrate beyond the proposed AAS boundary after the Large Pit is backfilled and regional groundwater gradients are re-established.

- In general, water quality in the Jackpile Sandstone is not drinking water quality due to the presence of mineralized zones throughout this area.
- Water quantity and water quality in the Jackpile Sandstone do not support water supply development for any sustainable future use.
- As described further below, geochemical stabilization will prevent migration of the uranium and radium beyond the immediate vicinity of the Large Pit. However, mobilization of secondary mineralization in pit wall fissures and fractures does have the potential to cause increased concentrations of COPCs downgradient of the Large Pit to concentrations that could be similar to those of the Large Pit water. (**Table 2**).

4.2 Geochemical Modeling to Determine AASs

As described in detail in Section 4.0 of the Stage 2 Abatement Plan (**Exhibit 3**; INTERA, 2015), COPCs for which proposed AASs are required to move forward with implementing the Stage 2 Abatement Plan were identified using a comprehensive screening and analysis procedure that is consistent with the requirements and guidelines set forth in 20.6.2.4106 NMAC. All water samples contained in the St. Anthony Mine database, including groundwater, pit sediment pore water, pit water, surface water, and leachate were queried to identify COPCs. Application of this process resulted in identification of the following list of COPCs:

- Boron
- Chloride
- Fluoride
- $^{226}Ra + ^{228}Ra$
- Sulfate
- TDS
- Uranium

Each proposed AAS is a conservative upper bound for concentrations expected in Jackpile sandstone groundwater downgradient of the Large Pit following backfill. Some AAS determinations involved equilibrium modeling using software that calculates concentrations of water constituents for water in contact with minerals after a long time in order to simulate conditions determined to be reasonable by analyzing materials from the Site. For constituents influenced by evapoconcentration in the Large Pit, future concentrations were predicted assuming a linear increase in concentrations over time since this process will continue until the Large Pit is backfilled. Laboratory testing results for sodium tripolyphosphate (STPP) immobilization indicated that it was effective for reducing uranium and radium concentrations, but did not affect sulfate, chloride, or TDS.

The geochemical modeling and analysis of site-specific data resulted in a predicted future concentration for uranium of 12.4 mg/L which represents the expected maximum concentration for the Jackpile sandstone throughout the Site. This is higher than current observations for water in the open pit as it is the predicted maximum concentration based on geochemical modeling; therefore, this AAS concentration for uranium is achievable. It takes into consideration that current observations are an incomplete representation of the water quality that could be realized at other locations within and near the discontinuous ore deposits and non-ore-grade mineralization. After backfill is complete, groundwater flow direction will change due to loss of the evaporative sink provided by the Large Pit and may cause concentrations of uranium, radium and other constituents observed in monitoring wells to increase, depending on their location within the ore-bearing unit and the new direction of flow.

Radium, listed as the sum of ^{226}Ra + ^{228}Ra in groundwater in the WQCC Standard, is often found associated with uranium-bearing deposits. Natural uranium primarily consists of the long half-life radioactive ^{238}U isotope, which includes ^{226}Ra as one of its decay byproducts. ^{228}Ra is a decay byproduct from ^{232}Th, which is a naturally occurring isotope that is broadly distributed, but not a driver for groundwater concentrations at the Site due to its low concentrations compared to ^{226}Ra. Radium concentrations in groundwater are impacted by different geochemical processes than uranium and tend to be controlled by formation of solid solution minerals (mixtures of one or more minor components with a mineral that typically contains only two components). In this case, the solid solution used for modeling contains barium, radium, and sulfate ($(Ba,Ra)SO_4$ or barite solid solution). $(Ba,Ra)SO_4$ has a considerably lower solubility than $RaSO_4$, and this lower solubility provides a natural bond to radium concentrations in natural water. Barium sulfate solid solution was observed in samples from the Site, which indicates that this is the most probable controlling mineral phase and was used for geochemical modeling.

The ^{226}Ra concentration in groundwater at the St. Anthony Site varies widely among monitoring wells, with the highest concentrations observed near uranium ore bodies. Groundwater ^{226}Ra concentrations range from 0.31 to 325 picoCuries per liter (pCi/L) with an upper range that is above the WQCC combined limit of 30 pCi/L for ^{226}Ra + ^{228}Ra. In contrast, ^{228}Ra concentrations were lower, with a range of 0.02 to 7.90 pCi/L and a median value of 1.60 pCi/L and was not considered in determining AASs since ^{226}Ra concentrations were higher. Geochemical calculations used to estimate the maximum ^{226}Ra concentration in Site groundwater were based on barite solid solution yields values of 940 to 2,914 pCi/L. The upper value in this range is proposed as the AAS value for radium (^{226}Ra + ^{228}Ra).

Evapoconcentration has increased the concentration of dissolved constituents of Large Pit water over its history and is expected to continue to do so until backfilled. Since the rate of future evapoconcentration is dependent on atmospheric precipitation and evaporation, past trends were used to predict future concentrations. Using this relationship, a simple linear model (straight line through the points) was used to estimate the concentration far enough into the future to account for the time between the present time and the time when the Large Pit is backfilled. Future concentrations were estimated based on both the lower long-term evaporation rate (2000-2012) and the higher, more recent rate (2008-2012). A time period of 10 years after completion of the Stage 2 Abatement Plan (2014-2024) was chosen to be conservative and allow sufficient time for the regulatory process including approval of the Plan, approval of proposed AASs, and portions of the reclamation that must occur prior to backfill. The concentration ranges determined were: boron (4.74–5.05 mg/L), chloride (837–908 mg/L), sulfate (72,200–77,000 mg/L), and TDS (105,000–113,000 mg/L). The upper bounds in these ranges are proposed as AASs for the respective solutes and TDS.

Fluoride has periodically exceeded its WQCC Standard in samples from Site groundwater monitoring wells. A simple thermodynamic equilibrium chemistry model for CaF_2 (fluorite), a common mineral expected to control geochemistry at the Site was used to determine that fluoride concentrations on the site could be conservatively expected to reach their maximum value at locations where the calcium concentration is at its lowest level observed at the Site. For groundwater in the Jackpile sandstone, the highest expected flouride concentration would correspond with the lowest measured calcium concentration (3.4 mg/L). The maximum concentration, is 10.7 mg/L, which is the proposed as the AAS value.

4.3 Hydrologic Modeling for Groundwater Pathway Analysis

INTERA developed a hydrogeologic site conceptual model (SCM) for the Site to describe the key features of the groundwater flow system in the Site vicinity. The SCM was used to develop a groundwater flow model to determine the future migration of groundwater and solutes across the Site if the Large Pit was backfilled. A detailed water balance was performed to understand how much water enters the subsurface and moves through as groundwater before exiting the system as either streamflow or evapotranspiration. The resulting groundwater flow model was used to predict groundwater flow patterns and rates across the Site under future, post-reclamation conditions.

Development of the groundwater flow model revealed the following hydrogeologic findings: (1) the Jackpile sandstone is the only water-bearing formation potentially influenced by mining activities at the Site and is predominantly a confined system; (2) precipitation is far exceeded by transpiration during the growing season and evaporation throughout the year, with negligible opportunity for areal recharge of the Jackpile sandstone; (3) groundwater flows into the Large Pit at a rate of approximately 7 gpm and is then removed by evapotranspiration processes; and (4) groundwater flows out from the Jackpile sandstone into the alluvial sediments of Meyer Draw, where it is lost to transpiration by tamarisk trees (at an estimated rate of approximately 14 gpm) and evaporation at the outcrop as demonstrated by the lack of observable seeps or the presence of groundwater in a well pair downgradient from the Site.

The findings from the predictive groundwater modeling demonstrate that local groundwater discharge to Meyer Draw via evapotranspiration in the Jackpile outcrop band is more than sufficient to capture groundwater migrating through the St. Anthony Mine area in the event that a backfill reclamation alternative was implemented for the mine. The modeling results are very reliable because major changes in boundary conditions or hydraulic conductivity did not change the model result that predicted capture of all groundwater in the mine permit area by Meyer Draw. For example, modeling sensitivity analyses revealed that evaporation from the seepage face alone was enough to capture all the groundwater and that the addition of tamarisk transpiration was not needed.

The groundwater flow model was used to determine the three-dimensional area for the proposed AASs which is illustrated in **Exhibit 13** (INTERA, 2015, Figure 6.1). The model was also used to predict how long it would potentially take for groundwater to reach Meyer Draw after backfilling of the Large Pit (illustrated in **Exhibit 5**).

5.0 GROUNDWATER PATHWAY AND EXPOSURE EVALUATION

5.1 Potential for Future Use of Water

INTERA conducted a groundwater sampling program in accordance with the procedures and methods established by the Stage 1 Abatement Plan for the Site. The sampling program included the installation of monitoring wells to fully characterize the Site. Key observations from the sampling program established that TDS, uranium, sulfate, and radium (sum of ^{226}Ra and ^{228}Ra) consistently exceeded WQCC standards for a domestic water supply due to natural mineralization.

The Jackpile sandstone has low hydraulic conductivity (0.005 to 0.9 ft/day) and, where saturated, has low yields. At a pumping rate of 5 gpm the Jackpile sandstone in and around a supply well is completely dewatered within 1 to 2 days, which means the Jackpile is not a sustainable water supply. As a result of the sampling program and the Stage 2 Site Characterization, it is clear that the Jackpile sandstone water naturally exceeds WQCC standards in proximity to uranium mineralization and is not appropriate for consumption by humans or animals.

As part of the MAA process, the owner of the Site has indicated that there are no foreseeable plans for any future use of groundwater from the Jackpile sandstone for consumption at the Site.

5.2 Completion of Water Supply Wells in Contaminated Groundwater Prohibition

INTERA's investigation confirmed that the Jackpile sandstone is not used as a drinking water supply in the vicinity of the Site and the Cebolleta Land Grant has no plans to put water supply wells in the AAS Petition arear. The nearest well to the Site is five miles away.

Additionally, as per 19.27.5.13 NMAC, the NMOSE may reject an application for a 72-12-1 domestic well permit when the proposed 72-12-1 domestic well is to be located in an area of water quality concern where a prohibition on or recommendation against the drilling of new wells has been established by a government entity. The WQCC approval of the AAS Petition would be that recommendation.

5.3 Water Quality in Uranium Ore Bearing Formations

The Jackpile sandstone is a mineralized uranium -bearing formation in the vicinity of the Site, and the only way to attain WQCC Standards at the Site is to remove the minerals that adversely impact water quality by contact with groundwater. It is not feasible or desirable to remove the entire mineral deposit. The only means to attain the WQCC Standards would be to physically remove the host rock that contains the groundwater, recognizing that the groundwater would also be removed. This approach would result in a highly negative net environmental impact (high resource consumption and no beneficial impact). Geochemical and hydrologic modeling has demonstrated the proposed AASs are achievable, and that there will be no risk to human health or the environment after implementation of the proposed abatement alternative.

6.0 PROPOSED ALTERNATIVE ABATEMENT STANDARDS

AASs are necessary for Site closure for three main reasons: 1) the Jackpile sandstone is a uranium ore-bearing unit with groundwater quality conditions that naturally exceed WQCC Standards; 2) under the preferred abatement option, regional groundwater flow returns to its pre-mining direction and groundwater in the mine vicinity is no longer captured in the Large Pit via evapotranspiration; and, 3) evapo-concentrated water in the Large Pit, as well as secondary mineralization in the Large Pit walls, will be mobilized downgradient from the Site under post-reclamation conditions. For these reasons, groundwater quality exceeds WQCC Standards now, and, under the preferred abatement approach, will continue to exceed WQCC Standards at higher levels for certain COPCs down gradient of the Site. It is therefore not feasible to achieve the WQCC Standards.

Table 3 provides a summary of the COPCs, the range of concentrations that have been observed in groundwater over the groundwater monitoring period, the range of concentrations observed in water samples from the Large Pit, the range of modeled concentrations in groundwater, and the proposed AAS for each COPC. **Exhibit 13** illustrates the area within which these proposed AASs are to apply. The surface area in **Exhibit 13,** illustrated by the dashed blue and white line, extends vertically throughout the saturated thickness of the Jackpile sandstone.

The proposed AASs are higher than the maximum observed groundwater concentrations. This is because concentrations of this magnitude are possible in groundwater associated with the mineralized zone in the Jackpile sandstone as demonstrated by geochemical modeling results presented in the Stage 2 Abatement Plan. The largest differences between observed groundwater concentrations and proposed AASs occur for sulfate, chloride, and TDS. The AASs for these constituents are the theoretical maximum concentrations that could result from migration of dissolved secondary minerals and evapoconcentrated solutes (e.g., chloride) away from the Large Pit area after the pit is backfilled. After backfilling, regional groundwater levels will rise to pre-mining levels, and the cone of depression will no longer exist to prevent transport of solutes away from the pit. It is technically infeasible to remove all of the secondary mineralization associated with the Large Pit; therefore, there is potential to see a rise in constituent concentrations in some locations after the regional gradient returns. However, groundwater flow modeling demonstrates that the water will not leave the site.

Most importantly, as demonstrated through conservative groundwater flow modeling, there is no complete groundwater exposure pathway for any of the COPCs listed in **Table 3.** Post-reclamation groundwater within the mine permit area will travel no more than approximately 9,100 ft (1.72 miles) before being consumed by evapotranspiration, and will not migrate onto adjoining properties. The proposed AAS area (approximately 1,080 acres) will be used for grazing and wildlife habitat. Groundwater at the proposed AAS area is currently not used for consumption and is unsuitable for consumption. In addition, there are no foreseeable plans for future use of groundwater in the proposed AAS area. Therefore, the proposed AASs will not create a present or future hazard to public health or undue property damage.

Table 3. Proposed Alternative Abatement Standards Compared to Existing and Modeled Groundwater Quality Concentration Ranges

COPC	Range of Analytical Values in Groundwater at St. Anthony	Range of Analytical Values in Pit Water at St. Anthony	Methodology for Determining AAS	Range of Values from Geochemical Analysis	Proposed AAS
Uranium	0.0059 - 0.85 mg/L	0.85 - 17 mg/L	Equilibrium model, EQ3/6	0.69 - 12.4 mg/L	12.4 mg/L
$^{226}Ra + ^{228}Ra$	ND - 325 pCi/L	0 - 45 pCi/L	Equilibrium model, EQ3/6	940 - 2913 pCi/L	2913 pCi/L
Fluoride	ND - 2.1 mg/L	0.66 - 1.1 mg/L	Simple Equilibrium model	10.7 mg/L	10.7 mg/L
Sulfate	190 - 2700 mg/L	3210 - 62,000 mg/L	Extrapolation, Pit Evaporation	72,200 - 77,000 mg/L	77,000 mg/L
TDS	680 - 4100 mg/L	5134 - 90900 mg/L	Extrapolation, Pit Evaporation	105,000 - 113,000 mg/L	113,000 mg/L
Boron	0.1 - 0.6 mg/L	0.6 - 4.1 mg/L	Extrapolation, Pit Evaporation	4.74 - 5.05 mg/L	5.05 mg/L
Chloride	14 - 44 mg/L	23.6 - 710 mg/L	Extrapolation, Pit Evaporation	837 - 908 mg/L	908 mg/L

Notes:
mg/L = milligrams per liter
pCi/L = picoCuries per liter
ND = Non-Detect

7.0 CRITERIA FOR ALTERNATE ABATEMENT STANDARDS

The Stage 2 Abatement Plan (**Exhibit 3**; INTERA, 2015) demonstrates that the three criteria for AASs to be approved (20.6.2.4103F NMAC) are met.

7.1 Criterion 1

Criterion 1 is met because the Jackpile sandstone is an ore-bearing formation in the vicinity of the Site, and the only way to attain WQCC Standards would be to remove the mineralization that adversely impacts the quality of water by virtue of its association and contact with groundwater. It is not feasible or desirable to remove the entire mineral deposit. In essence, the only means to attain the WQCC Standards would be to physically remove the host rock that contains the groundwater, recognizing that the groundwater would also be removed. This approach would result in a highly negative net environmental impact (high resource consumption and no beneficial impact).

7.2 Criterion 2

Criterion 2 is met because the AASs are technically feasible and justified by cost-benefit analysis. Backfilling of open mine pits is the presumptive regulatory approach as put forth in 19.10.5.507B NMAC and the preferred abatement option for the St Anthony Mine. However, to accomplish backfilling there would be an accompanying loss of the evaporative containment of nearby groundwater. The AASs are the maximum concentrations that are expected to be observed in groundwater after backfilling, as a result of groundwater in contact with the mineralized ore body, secondary mineralization in the pit walls, and mobilization of pit lake water.

7.3 Criterion 3

UNC has demonstrated that the granting of the requested AASs will meet the third criterion, that compliance with the AASs will not create a present or future hazard to public health or damage to property. The predictive groundwater modeling and Site investigation has established that there are no complete groundwater exposure pathways, nor will there be migration of the COPCs from the Site.

The hydrologic system for the Jackpile sandstone groundwater is highly constrained by several key factors: (1) low permeability and low rates of groundwater flow, (2) low recharge, (3) high evapotranspiration rates (relative to recharge and groundwater flow rates), and (4) physical controls (i.e., the dissection of the unit by Meyer Draw incision or transpiration-driven groundwater extraction). The findings from the groundwater modeling demonstrate that local groundwater discharge to Meyer Draw via evapotranspiration in the Jackpile outcrop band is more than sufficient to capture groundwater migrating through the St. Anthony Mine area in the event that a backfill reclamation alternative is implemented for the mine. The modeling results are conservative because major changes in boundary conditions (e.g., removal of tamarisk and changes in recharge) or hydraulic conductivity did not change the capture of all groundwater in the mine permit area by Meyer Draw.

Even when groundwater flow conditions are no longer under the influence of the Large Pit evaporative sink, Jackpile sandstone groundwater will not migrate from the Site where it could impact any potential receptors. There are currently no receptors in the area and the Jackpile sandstone does not support water development in the mine area.

Finally, there are no foreseeable plans for future use of groundwater in the affected area by the owners of the property, the Cebolleta Land Grant. As per 19.27.5.13 NMAC, the OSE may reject an application for a 72-12-1 domestic well permit when the proposed 72-12-1 domestic well is to be located in an area of water quality concern where a prohibition on or recommendation against the drilling of new wells has been established by a government entity. The WQCC approval of the AAS Petition would be that recommendation. Therefore, the proposed AASs will not create a present or future hazard to public health or undue property damage

8.0 SUMMARY AND CONCLUSIONS

The St. Anthony Mine ceased operation in 1982. Groundwater at the Site is contained in the Jackpile sandstone formation. The Jackpile sandstone contains uranium ore, ubiquitous uranium mineralization, and certain groundwater constituents naturally exceed the New Mexico WQCC standards. In its current state, the Large Pit captures groundwater via a cone of depression that has developed in response to evaporation of pit water. The preferred abatement option of backfilling the Large Pit would result in the loss of evaporative containment of nearby groundwater.

Based upon the results of Site investigations and predictive groundwater modeling, INTERA determined that there is no complete groundwater exposure pathway for migration of COPCs from the Site to a receptor as groundwater is lost to evaporation and/or transpiration at Meyer Draw (**Exhibit 5**). The results of geochemical modeling and bench scale studies determined that geochemical stabilization prevents migration of uranium and radium beyond the immediate vicinity of the Large Pit; however, secondary mineralization and other more mobile COPCs have the potential to migrate downgradient of the Site once pre-mining gradients return.

Under all considered remedial alternatives, groundwater quality in the Jackpile sandstone will exceed WQCC Standards. After extensive discussions among the stakeholders of the various abatement alternatives considered for the Site, a basis for the selection of the preferred alternative was achieved. The preferred mine reclamation and groundwater remediation alternative is a pit backfill with geochemical stabilization of pit water and sediment. This remedial alternative recognizes the MMD's regulatory presumption of backfilling open pit mines. However, the backfill of the Large Pit will result in the loss of the current evaporative containment of evapo-concentrated minerals and water in the Large Pit and nearby groundwater in the ore body. As such, the preferred alternative incorporates the adoption of AASs into the abatement alternative. The AASs address groundwater that cannot attain WQCC Standards due to the natural mineralization within the Jackpile ore body, the evapo-concentrated minerals in the Large Pit water, and secondary mineralization in the pit walls which will be mobilized after implementation of the preferred abatement alternative.

The granting of the AASs sought in this Petition will allow Site closure to be undertaken under the preferred abatement alternative to backfill the Large Pit, stabilize uranium and radium in the immediate vicinity of the pit, and return to the Site to self-sustaining ecosystem. The backfill of the Large and Small Pits will provide additional grazing land and wildlife habitat sought by the Cebolleta Land Grant and achieve the preferred alternative derived from the Multiple Accounts Analysis conducted by the interested and impacted stakeholders.

The proposed AASs pose no hazard to public health and do not create any undue damage to property. The AASs are technically achievable and cost-justified for the reasons stated.

9.0 REFERENCES

Adams, S.S., and A.E. Saucier. 1981. "Geology and Recognition Criteria for Uraniferous Humate Deposits, Grants Uranium Region, New Mexico: Final Report," National Uranium Resource Evaluation Program. NTIS., PC A14/MF A01.

Frondel, C. 1958. "Systematic Mineralogy of Uranium and Thorium." Vol. 1064, U.S. Geological Survey Bulletin. Washington D.C.: U.S. Government Printing Office.

INTERA Incorporated (INTERA). 2006. "Stage 1 Abatement Plan Investigation Report, St. Anthony Mine Site, Cebolleta, New Mexico." Prepared for New Mexico Environment Department, on behalf of United Nuclear Corporation. October 26.

_____. 2015. "St. Anthony Mine Stage 2 Abatement Plan, Cibola County, New Mexico." Submitted to the New Mexico Environment Department on behalf of United Nuclear Corporation. February 9.

Moench, R.H, and J.S. Schlee. 1967. "Geology and Uranium Deposits of the Laguna District of New Mexico." U.S. Geological Survey Professional Paper no. 519. 117 pp.

Montgomery Watson Harza (MWH). 2002. "St. Anthony Mine Site Stage 1 Abatement Plan, August, 2002." Prepared by Montgomery Watson Harza, Albuquerque, New Mexico.

_____. 2006. "St. Anthony Mine Site Closeout Plan." Prepared for United Nuclear Corporation. January.

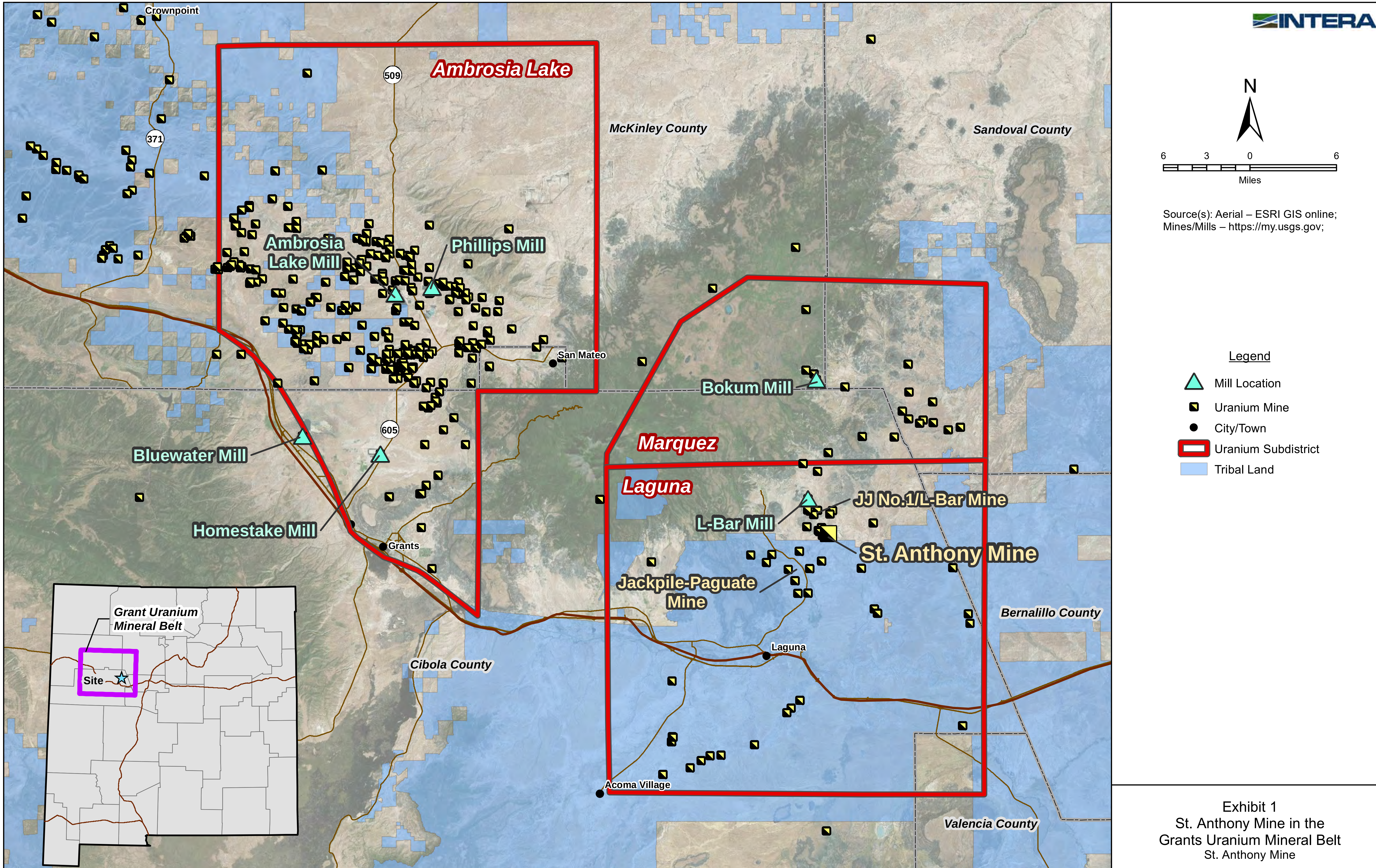
Pearcy, E.C., J.D. Prikryl, W.M. Murphy, and B.W. Leslie. 1994. "Alteration of uraninite from the Nopal I deposit, Pena Blanca district, Chihuahua, Mexico, compared to degradation of spent nuclear fuel in the proposed high-level nuclear waste repository at Yucca Mountain, Nevada." Applied Geochemistry no. 9:713-732.

Smith, D. K. 1984. "Uranium Mineralogy." In *Uranium Geochemistry, Mineralogy, Geology, Exploration, and Resources*, edited by F. Ippolito, B. DeVero and G. Capaldi, 43-88. London: Institute of Mining and Metallurgy.

Standard Oil Company of Ohio (SOHIO). 1980. "Environmental Report: L-Bar Uranium Project Valencia County, New Mexico." Prepared in Support of Radioactive Material License Renewal Application NM-SOH-ML.

Stone, W. J., F. P. Lyford, P. F. Frenzel, N. H. Mizell, and E. T. Padgett, 1983. "Hydrogeology and Water Resources of the San Juan Basin, New Mexico." New Mexico Bureau of Mines and Mineral Resources Hydrologic Report 6, New Mexico Bureau of Mines and Mineral Resources, Socorro, New Mexico, 70 pp.

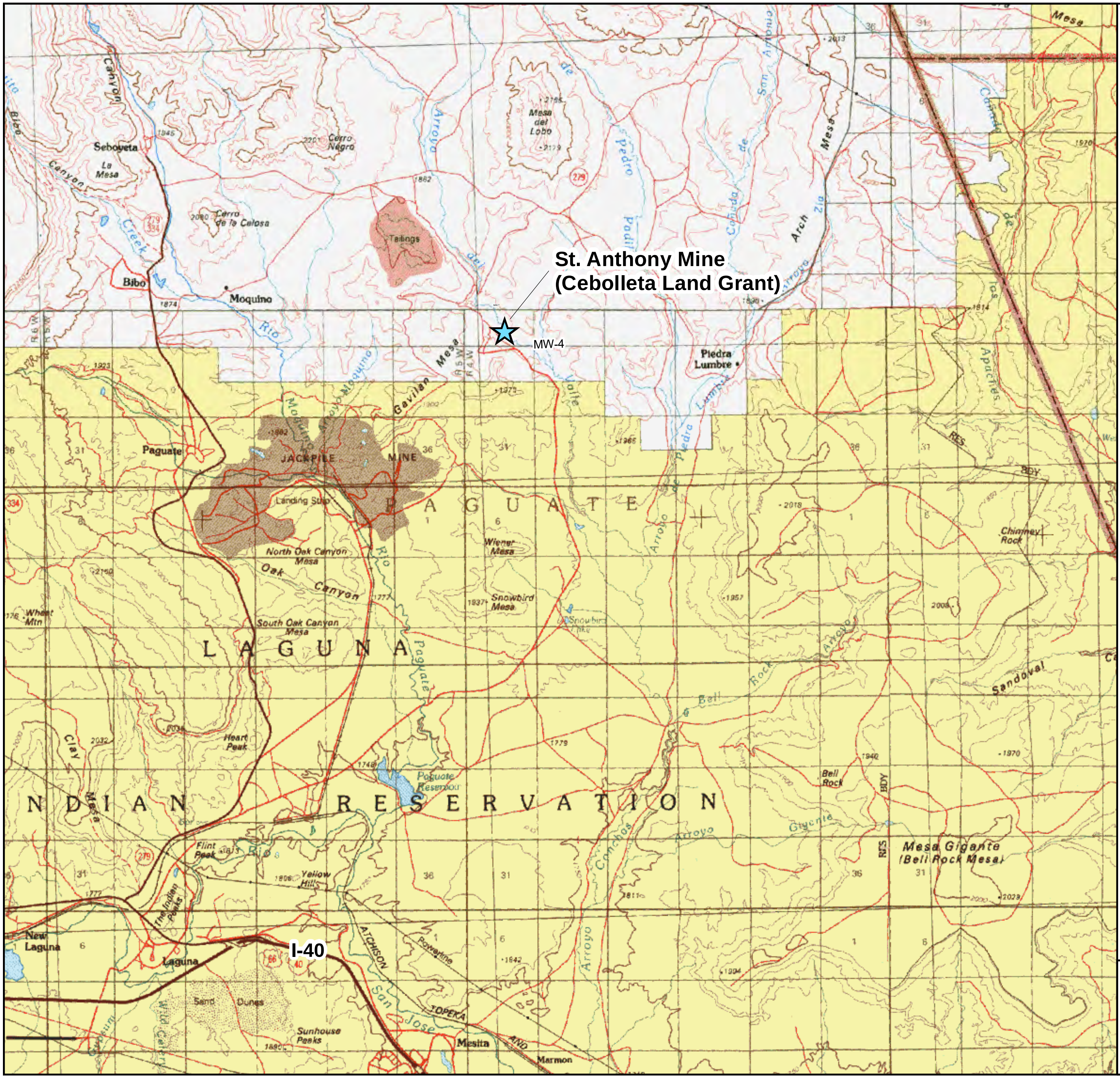
EXHIBITS



INTERA

Exhibit 1
St. Anthony Mine in the
Grants Uranium Mineral Belt
St. Anthony Mine

FILE: S:\ABQ\GE1-UNC_St_Anthony\Graphics-Drafting\GIS\MapDocuments\AAS_Petition\Exhibit01_AreaMap.mxd 9/1/2016



![INTERA]

N

2 1 0
Miles

Source(s):
Topo – MapTech, 2006.

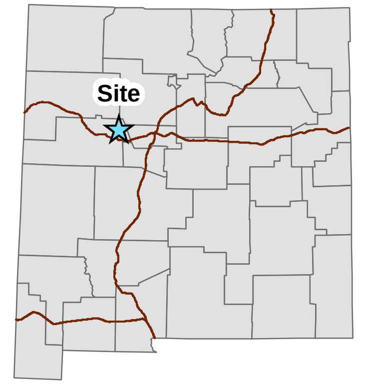


Exhibit 2
Site Location Map
St. Anthony Mine

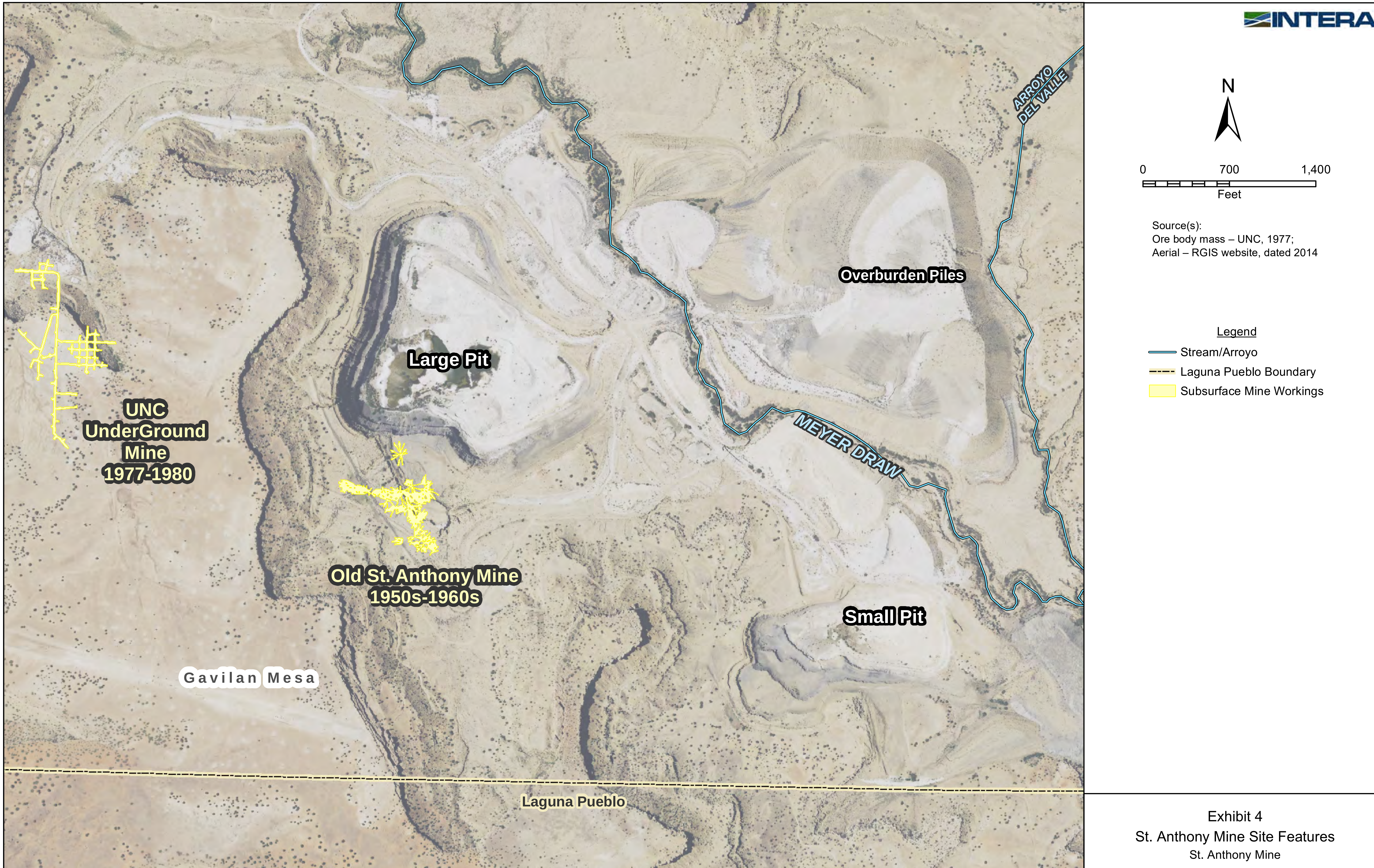


Exhibit 4
St. Anthony Mine Site Features
St. Anthony Mine

S:\ABQ\GE1-UNC_St_Anthony\Graphics-Drafting\GIS\MapDocuments\AAS_Petition\Exhibit04_SiteFeatures.mxd 9/1/2016

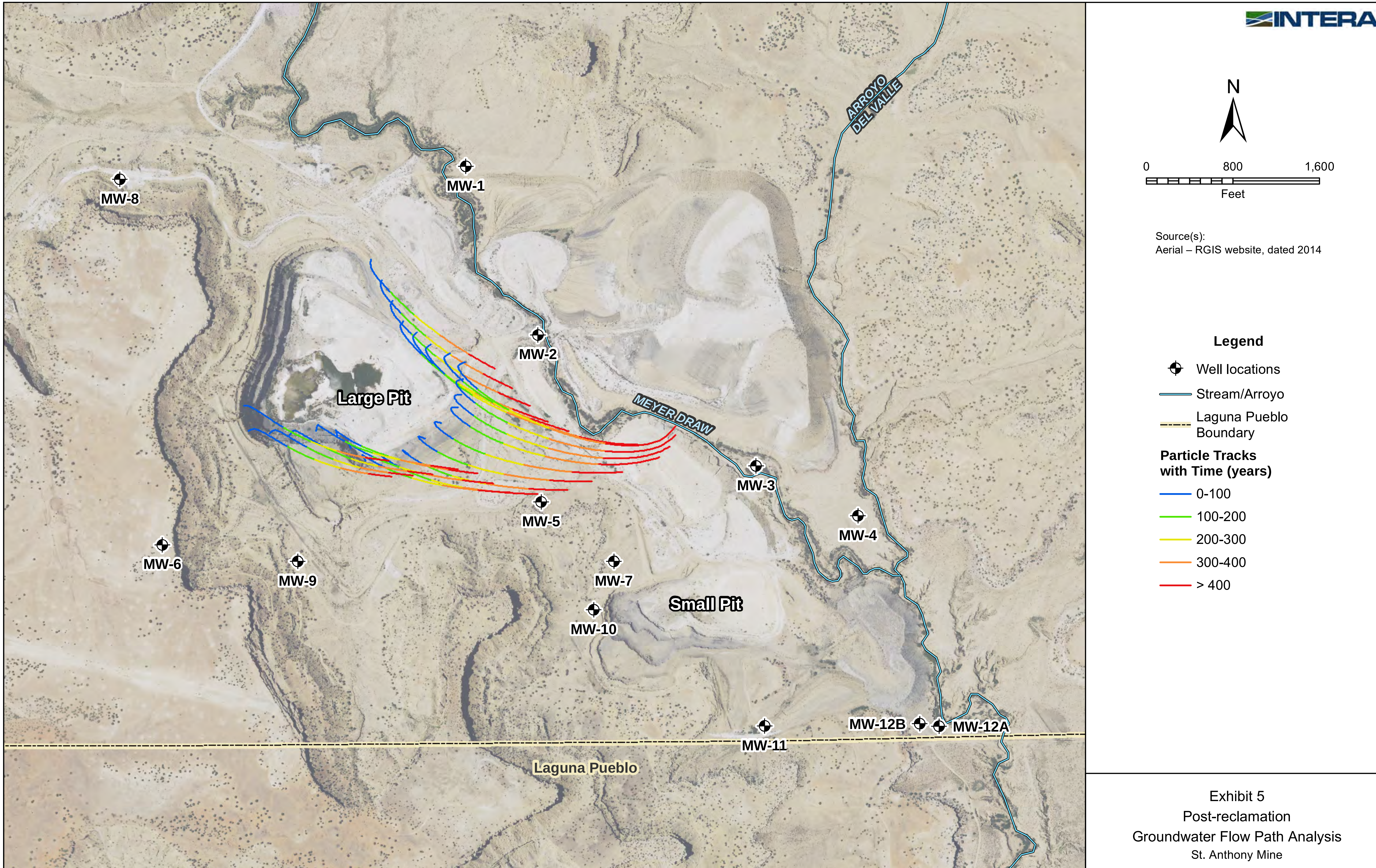


Exhibit 5
Post-reclamation
Groundwater Flow Path Analysis
St. Antony Mine

FILE: S:\ABQ\GE1-UNC_St_Anthony\Graphics-Drafting\GIS\MapDocuments\AAS_Petition\Exhibit05_BaseCase_SA_particletrack_03242016.mxd 9/1/2016

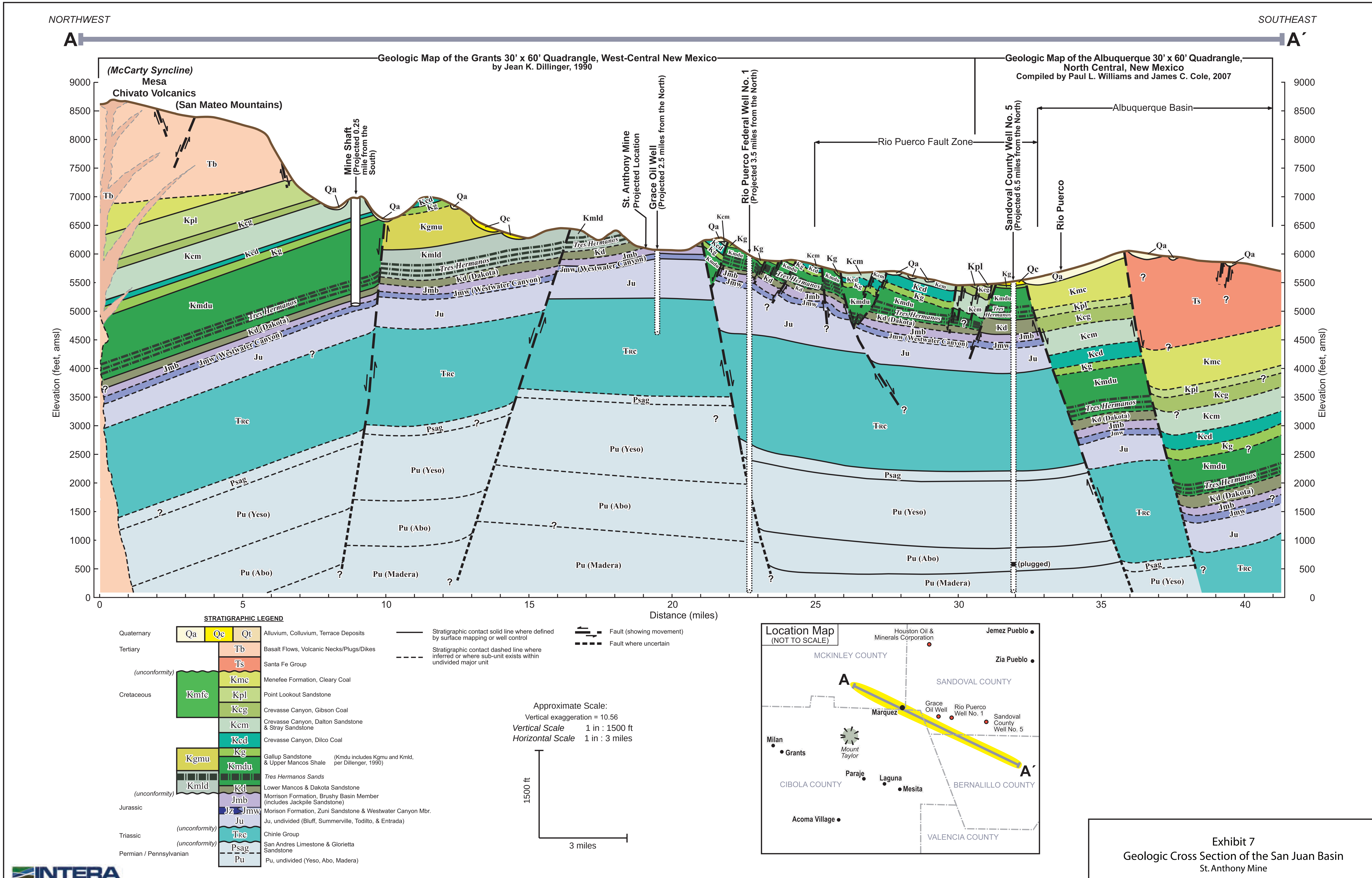
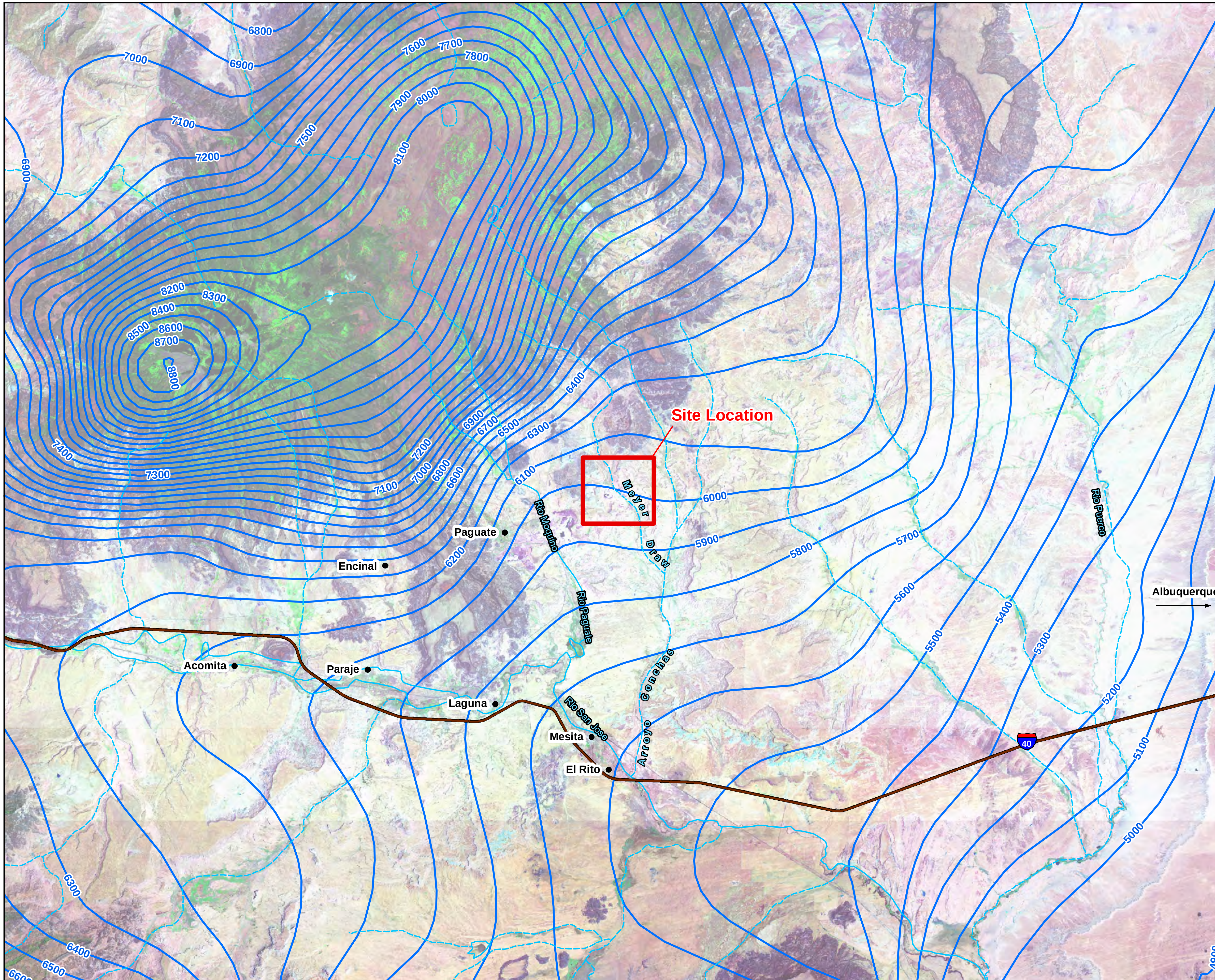


Exhibit 7
Geologic Cross Section of the San Juan Basin
St. Anthony Mine

S:\ABQ\GE1-UNC_St_Anthony\Graphics-Drafting\GIS\MapDocuments\AAS_Petition\Exhibit07_GeologicCrossSecAA.pdf



INTERA

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4 0 4
Miles

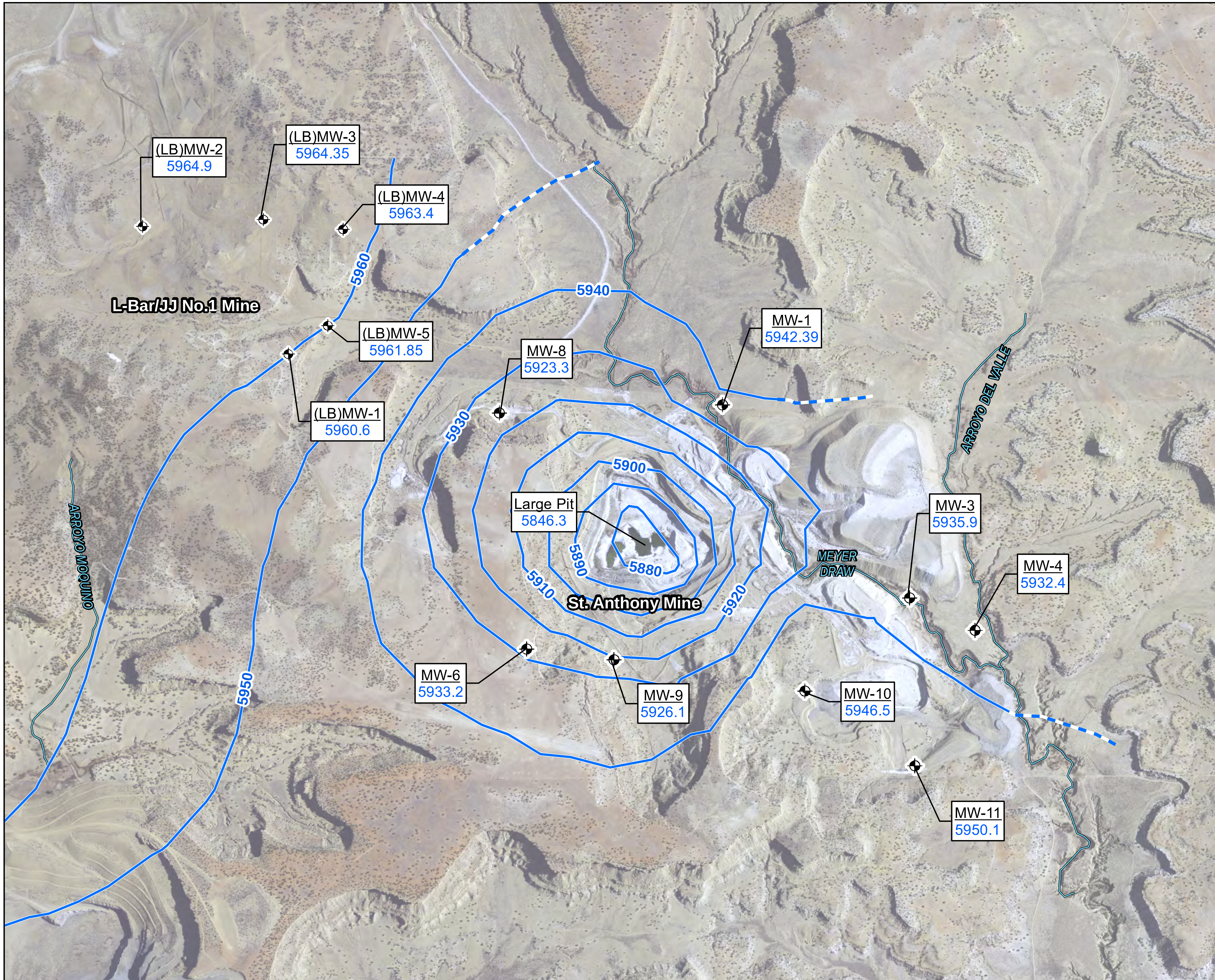
Source(s):
Landast image – University of Maryland;
Pre-development water table surface – Plate 3, *Framework for Public Input to a State Water Plan,*
New Mexico Interstate Stream Commission/
New Mexico Office of the State Engineer, 2002;
Shaded topography – USGS DEM;
Roads, cities, hydrography – NM RGIS.

Legend

- Surface Water, Perennial
- Surface Water, Intermittant
- Ground Water Elevation, ft msl

Exhibit 8
Regional Groundwater Contours
St. Anthony Mine

S:\ABQ\GE1-UNC_St_Anthony\Graphics-Drafting\GIS\MapDocuments\AAS_Petition\Exhibit08_RegionalGWcontours.mxd 9/1/2016



INTERA

N

1,400 0 1,400

Feet

Sources:
Aerial – RGIS website, dated 2011

Legend

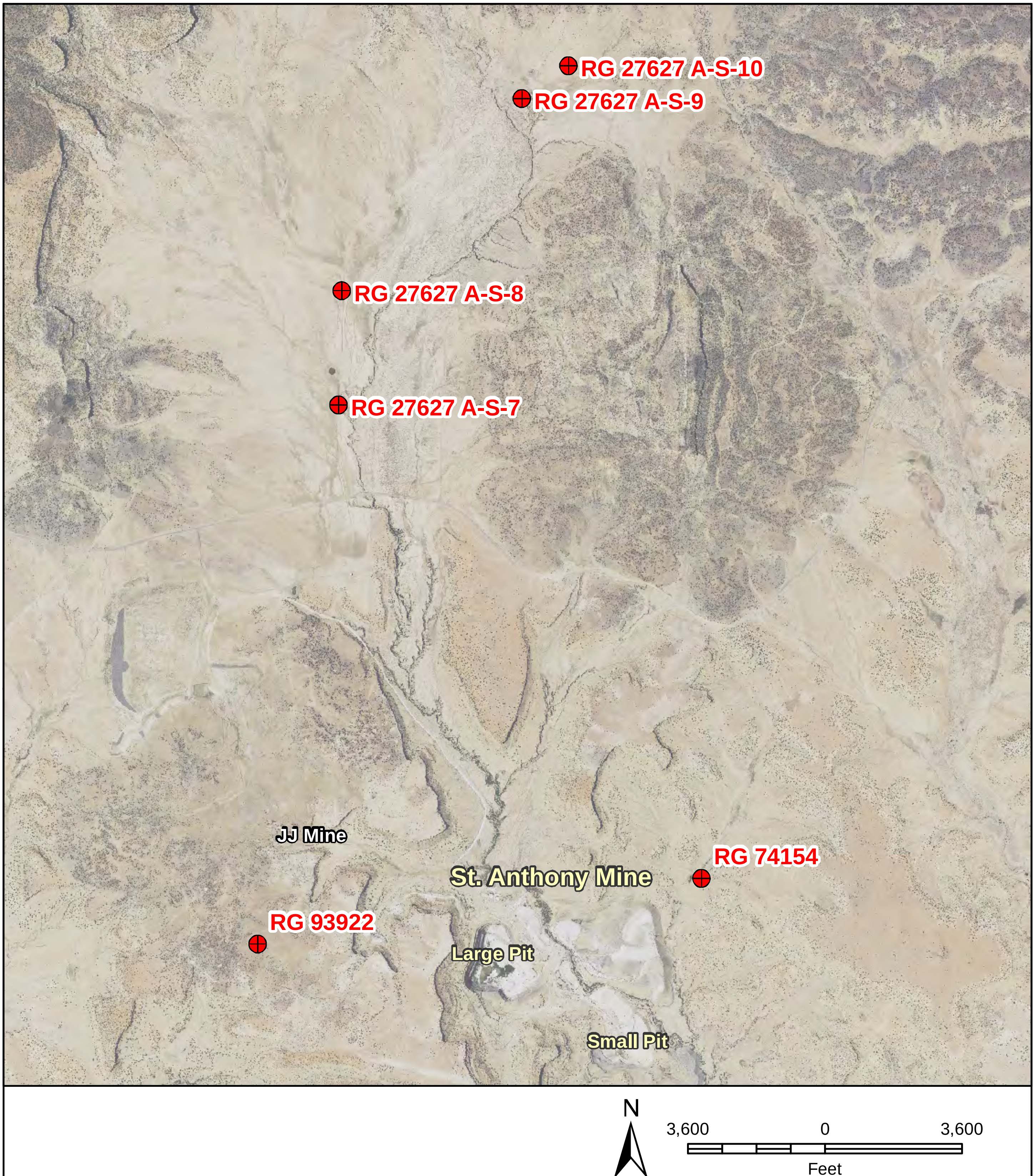
Monitoring Well Location

Groundwater Elevation Contour (2013)

(dashed where inferred)

Note:
(LB)MW-# = L-Bar/JJ No. 1 Mine Monitoring Well

Exhibit 9
Groundwater Heads at the
St. Anthony Mine
St. Anthony Mine



Legend

Water Supply Well

Source(s): Aerial - RGIS website, dated 2014

Exhibit 10
Water Supply Wells in the Vicinity of the St. Anthony Mine
St. Anthony Mine

FILE: S:\ABQ\GE1-UNC_St_Anthony\Graphics-Drafting\GIS\MapDocuments\AAS_Petition\Exhibit10_WaterSupplyWells.mxd Date: 11/13/2016

Exhibit 11
Close-up View of
SALP-12-01 Type Material in Place
St. Anthony Mine

INTERA

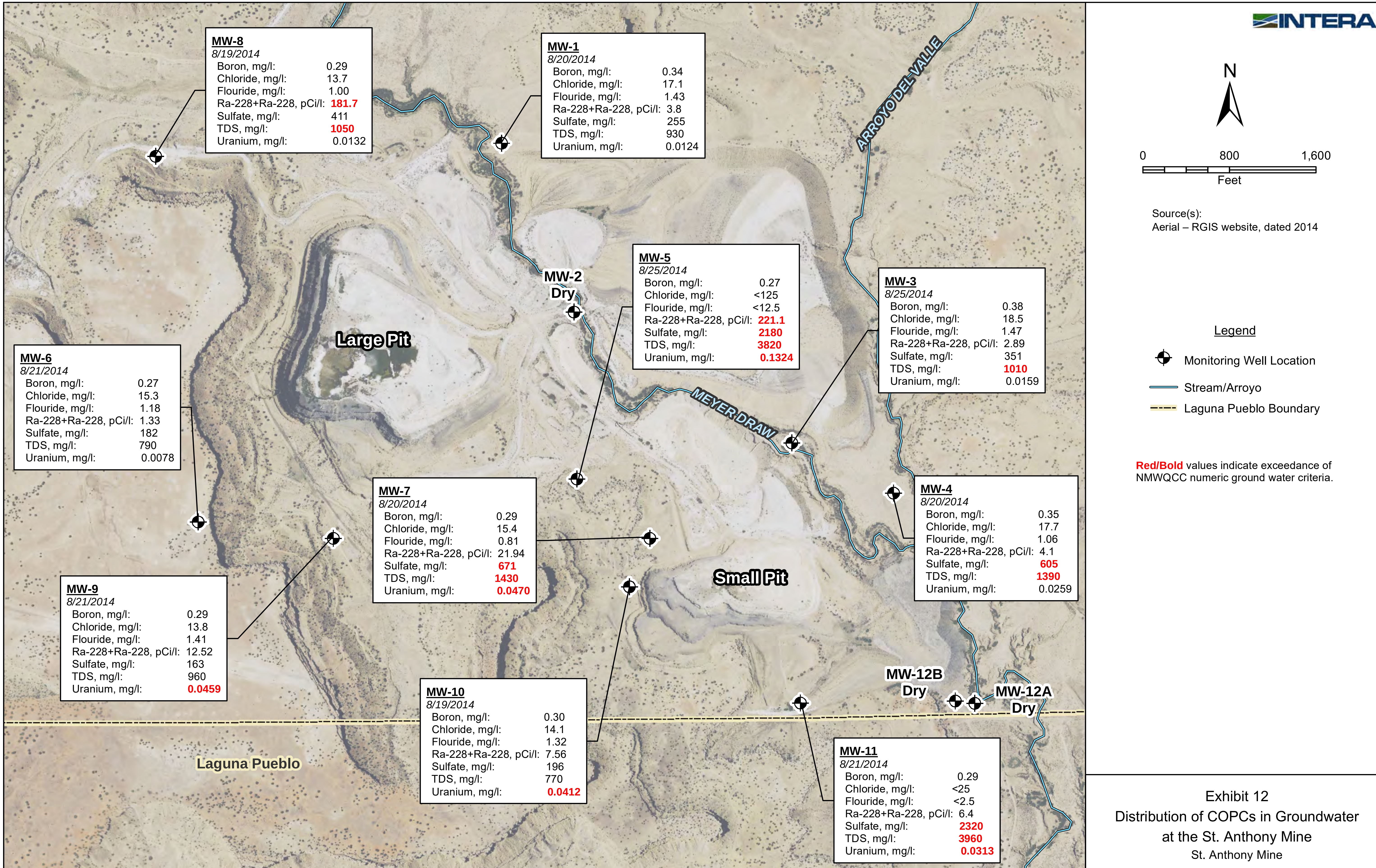


Exhibit 12
Distribution of COPCs in Groundwater at the St. Anthony Mine
St. Anthony Mine

FILE: S:\ABQ\GE1-UNC_St_Anthony\Graphics-Drafting\GIS\MapDocuments\AAS_Petition\Exhibit12_GWresults.mxd 11/15/2016

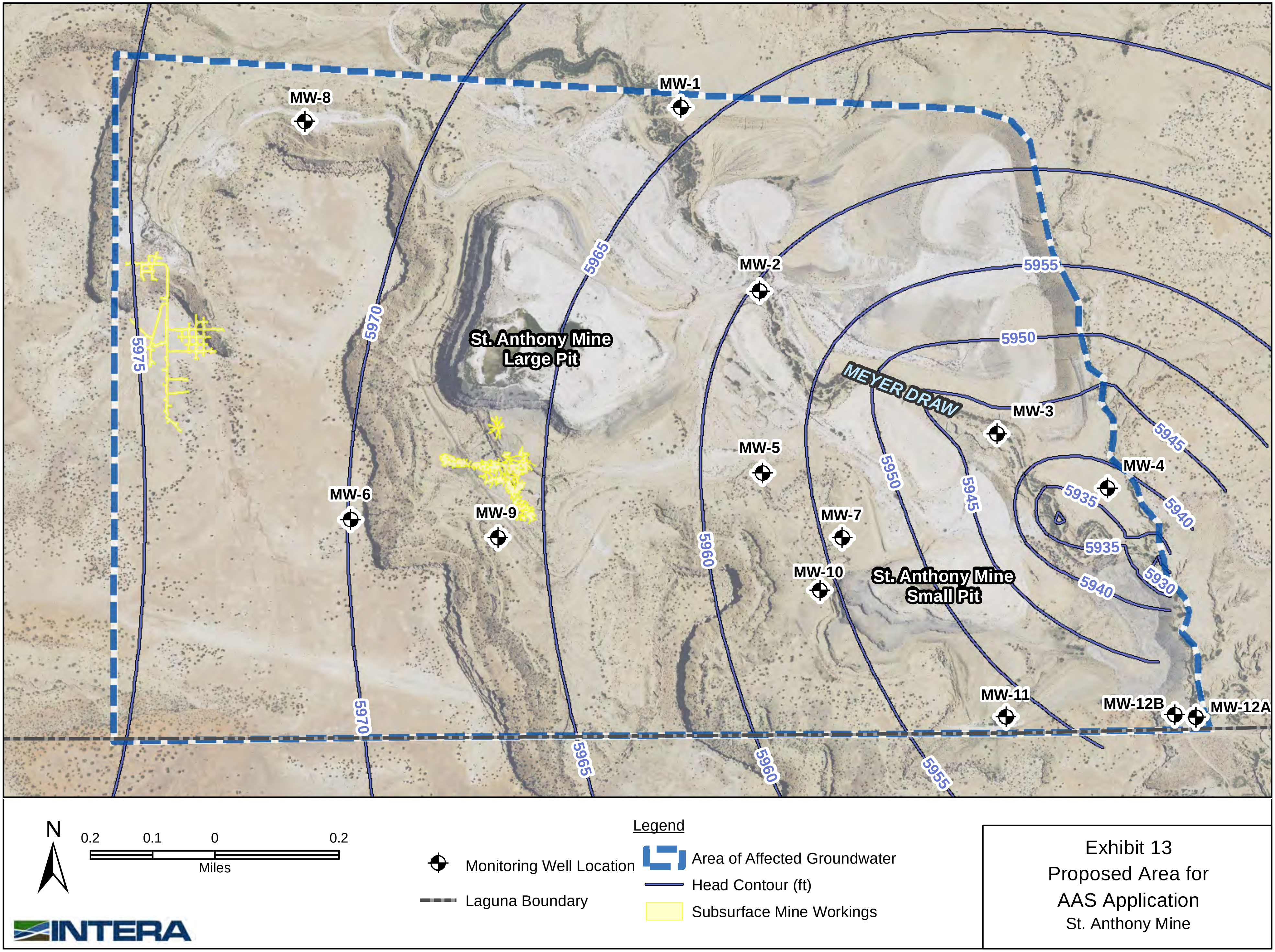


Exhibit 13
Proposed Area for
AAS Application
St. Anthony Mine

S:\ABQ\GE1-UNC_St_Anthony\Graphics-Drafting\GIS\MapDocuments\AAS_Petition\Exhibit13_AAS-application.mxd 11/15/2016

Exhibit 2
Affidavit of Notice of Public Hearing

RECEIVED
JUN 12 2017
WQCC

STATE OF NEW MEXICO
WATER QUALITY CONTROL COMMISSION

IN THE MATTER OF THE PETITION FOR ALTERNATIVE ABATEMENT STANDARDS FOR THE FORMER ST. ANTHONY MINE, CIBOLA COUNTY, NEW MEXICO

WQCC 16-05 (A)

UNITED NUCLEAR CORPORATION,

Petitioner.

AFFIDAVIT OF CERTIFICATION FOR NOTICE OF PUBLIC HEARING AND AFFIDAVITS OF PUBLICATION

Pursuant to 20.1.3.17 NMAC of the Water Quality Control Commission Adjudicatory Procedures, the Commission Administrator hereby certifies that the Notice of Public Hearing was published in Spanish and English in the Albuquerque Journal and The Cibola Beacon on June 9, 2017. On June 12, 2017, the Commission Administrator distributed a copy of the Notice of Public Hearing via hand delivery, email and U.S. mail to each interested participant who has filed an entry of appearance, and to each person who participated in the Department's permitting proceeding, or who has expressed, in writing to the Department or the Water Quality Control Commission, interest in the matter pursuant to 20.1.3.17(3) NMAC.

Pam Castañeda

Pam Castañeda, Commission Administrator
Water Quality Control Commission
P.O. Box 5469
Santa Fe, NM 87502
Phone: (505) 827-2425
Fax: (505) 827-2836

PUBLIC LEGAL NOTICES

LEGAL NOTICE

STATE OF NEW MEXICO
CIBOLA, COUNTY OF
THIRTEENTH JUDICIAL
DISTRICT COURT

No. D-1333-CV-2016-00147

THE BANK OF NEW YORK MELLON F/K/A THE BANK OF NEW YORK AS SUCCESSOR TO JPMORGAN CHASE BANK, N.A., AS TRUSTEE FOR THE BENEFIT OF THE CERTIFICATEHOLDERS OF POPULAR ABS, INC. MORTGAGE PASS-THROUGH CERTIFICATES SERIES 2006-D,
Plaintiff,

vs.

THE UNKNOWN HEIRS DEVISEES OR LEGATEES OF EMILY VALLEJOS, UNKNOWN TENANT (REAL NAME UNKNOWN), JESSE VALLEJOS, JESSICA VALLEJOS, AND BENEFICIAL NEW MEXICO. INC. D/B/A BENEFICIAL MORTGAGE CO.,
Defendants.

AMENDED NOTICE OF SUIT

TO: The Unknown Heirs, Devisees or Legatees of Emily Vallejos, and Jessica Vallejos

YOU ARE HEREBY NOTIFIED that a civil action has been filed against you in the District Court of Cibola County, New Mexico, by Plaintiff, The Bank of New York Mellon f/k/a The Bank of New York as successor to JPMorgan Chase Bank, N.A., as trustee for the benefit of the Certificateholders of Popular ABS, Inc. Mortgage Pass-Through Certificates Series 2006-D, in which Plaintiff prays for the foreclosure of its Note and Mortgage encumbering the real estate and improvements located at HC 77 Box 25, Seboyeta, New Mexico 87014 in Cibola County, New Mexico, and more particularly described as follows:

A Tract of Land in Cibola County, New Mexico; Tract #334-061; Map# B-17-17, (Property Tax Code No. 2-028-083-334-061) as the same is shown and designated on said property Map for Private Lands within the Cebolleta Grant, for the New Mexico Engineer, and filed in Cause No. 17608, entitled "In the Matter of the Establishment of Private Claims within the Cebolleta Grant."

[illegible] N.M. State Place Coordinates (West Zone) Tract No. 334-0[illegible] Point No. 1 Ground Dist: [illegible] Point No. 2 Ground Dist: [illegible] Point No. 3 Ground Dist: 227.1', Grid Bearings: N23 deg. 38'W, X: 832,153.7, Y: 1,519,615.9 Point: No. 4 Ground Dist: 808.1', Grid Bearings: N34 deg. 46'E, X: 831,935.9, Y: 1,519,679.0 Point: No. 5 Ground Dist: 226.5', Grid Bearings: S 63 deg. 42'W, X: 832,382.8, Y 1,520,336.9 Point: No. 6. X: 837,595.1, Y: 1,520,238.2,

including any improvements, fixtures, and attachments, such as, but not limited to, mobile homes. If there is a conflict between the legal description and the street address, the legal description shall control.

You are further notified that Plaintiff prays that the aforementioned real property be sold according to the law and practice of this Court to pay the mortgage lien held by Plaintiff, and that the interests of each Defendant, and all persons claiming under or through them, and all other persons bound by these proceedings, be barred and foreclosed of all rights, interests, and claims to the aforementioned real property, and for such other and further relief as the Court may deem just and proper.

You are further notified that unless you enter or cause to be entered your appearance or file responsive pleadings or motions

LEGAL NOTICE

STATE OF NEW MEXICO
CIBOLA, COUNTY OF
THIRTEENTH JUDICIAL
DISTRICT COURT

CASE NO. D-1333-CV-2016-00173

21ST MORTGAGE CORPORATION,
Plaintiff,

vs.

ANDREA C. MILAN and JASON P. TURNER,
Defendant.

NOTICE OF SALE

NOTICE IS HEREBY GIVEN that on July 11, 2017, at 11:00 a.m., the undersigned Special Master will sell to the highest bidder near the entrance of the Thirteenth Judicial District Courthouse for Cibola County, located at 515 West High St. Grants, NM 87020 all Defendants interest in the real property located at 1205 Piron St., Milan, NM 87021 in Cibola County, New Mexico, and more particularly described as:

Lot numbered Twenty-A (20A), an Amended & Corrected Replat No. 1 of Lots 20 & 21, Block One-B (1-B), of the replat of a portion of Block 1), of VALCO SUBDIVISION, Village of Milan, Cibola County, New Mexico.

"Which" was originally recorded as:

Lots numbered Twenty (20) and Twenty-one (21), in Block numbered One-B (1-B), (replat of a portion of Block 1), of VALCO SUBDIVISION, a subdivision located in the Village of Milan, Cibola County, New Mexico, as the same is shown and designated on the replat thereof, filed in the office of the County Clerk of Valencia County, New Mexico on April 30, 1976.

The sale will satisfy all or a portion of a Default Judgment and Decree of Foreclosure entered on June 2, 2017 against Defendant Andrea Milan and a Default Judgment and Decree of Foreclosure entered on March 2, 2017 against Defendant Jason Turner as follows:

Judgment in the amount of $70,825.53, with interest accruing at 9.74% per year from September 1, 2016, forward; and

The Default Judgments and Decrees of Foreclosure may be obtained from either the court clerk or the undersigned Special Master prior to the sale date. 21st Mortgage Corporation has the right to bid at the sale and to apply its judgment or a portion thereof to the purchase price in lieu of cash. For all other bidders, the sale terms are cash or its equivalent, by the close of business on the day of sale. The sale may be postponed and rescheduled at the Special Master's discretion.

PROSPECTIVE PURCHASERS AT SALE ARE ADVISED TO MAKE THEIR OWN EXAMINATION OF THE TITLE AND THE CONDITION OF THE PROPERTY AND TO CONSULT THEIR OWN ATTORNEY BEFORE BIDDING.

/s/ Edward S. Little 06/06/17
Edward S. Little, Special Master
1509 37th Street SE
Rio Rancho, NM 87124
505/328-6289

Published in the Cibola Beacon June 13, 20, 27, and July 4, 2017. Invoice #1336

LEGAL NOTICE

STATE OF NEW MEXICO
CIBOLA, COUNTY OF
13TH JUDICIAL
DISTRICT COURT

Case No. D1333 CV-2017-00177

IN THE MATTER OF A PETITION FOR NAME CHANGE FOR,
The Petitioner,

NOTICE OF CHANGE OF NAME

TAKE NOTICE that in accordance with provision of NMSA 1978 Sections 40-8-1 through 40-8-3 the above captioned Petitioner(s) will apply to the Honorable Pedro G. Rael, District

Kashero, an enrolled member of the Pueblo of Laguna (Enrollment #03-1143), be changed to Adulas Mary Konico, an enrolled member of the Pueblo of Laguna (Enrollment #03-1143). Please send all inquiries to: Laguna Tribal Court, Pueblo of Laguna, P.O. Box 194, Laguna, NM 87026.

Dated this June day of 6th, 2017
Lucille Kashero
Petitioner
P.O. Box #66
New Laguna, NM 87038

Published in the Cibola Beacon June 9 and 16, 2017 Invoice #1350

LEGAL NOTICE

STATE OF NEW MEXICO
CIBOLA, COUNTY OF
13TH JUDICIAL
DISTRICT COURT

Case No. D1333 CV-2017-00141

IN THE MATTER OF A PETITION FOR NAME CHANGE FOR:
RAYMOND FABIAN ADAME

NOTICE OF PETITION

NOTICE IS HEREBY GIVEN that STORMIE RAINS has petitioned the Thirteenth Judicial District Court of New Mexico to change her child's name from RAYMOND FABIAN ADAME to RAYMOND FABIAN RAINS ADAME; that said Petition is not filed for the purpose of defrauding but only to request a change of name in as much as the Petitioner and child prefer the requested name change.

Any person having objections hereto may file same before said District Court of Cibola, New Mexico on or before Monday June 26, 2017 at 9 a.m.. the date of said hearing.

TOINETTE GARCIA
District Court Clerk
Submitted by:
Monica D. Baca
Attorney for Petitioner
1412 6th St. NW
Albuquerque, NM 87102

Published in the Cibola Beacon June 9 and 16, 2017 Invoice #1356

LEGAL NOTICE

STATE OF NEW MEXICO
CIBOLA, COUNTY OF
ORDER EXTENDED CERTAIN DEADLINES PROPERTY TAX DIVISION STATE ASSESSED PROPERTIES BUREAU, STATE OF NEW MEXICO

NOTICE IS HEREBY GIVEN pursuant to my authority under Section 7-38-85, NMSA 1978, I hereby extend the following deadline found in Section 7-38-20 of the Property Tax Code with respect to the 2017 tax year only:

1) The deadline to allocate and certify valuations to county assessors is extended from June 1, 2017 to June 7, 2017.

Date this 31st day of May 2017.
Michael O'Melia, Deputy Director
Property Tax Division

Published in the Cibola Beacon June 9, 13, and 20 2017. Invoice #1338

LEGAL NOTICE

STATE OF NEW MEXICO
CIBOLA, COUNTY OF
ORDER EXTENDING DEADLINES
CIBOLA COUNTY, NEW MEXICO

NOTICE IS HEREBY GIVEN pursuant to my authority under Section 7-38-85 NMSA 1978, I hereby extend the following deadline found in Section 7-38-20 of the Property Tax Code with respect to the 2017 tax year only:

1) The deadline for the Cibola County Assessor to mail out Amended Notices of Value from May 31, 2017 to no later than June 16, 2017.

Date this 31st day of May 2017.
Michael O'Melia, Deputy Director
Property Tax Division

Published in the Cibola Beacon June 9, 16, and 23, 2017. Invoice #1339

PUBLIC NOTICE

GRANTS, CITY OF

The Recreation Board is scheduled to meet at 6:00 P.M., Thursday, June 15, 2017, at the City Hall Council Chambers. Agendas are available Monday,

NEW MEXICO WATER QUALITY CONTROL COMMISSION

NOTICE OF PUBLIC HEARING TO CONSIDER PETITION FOR ALTERNATIVE ABATEMENT STANDARDS FOR THE FORMER ST. ANTHONY MINE IN CIBOLA COUNTY, NM, WQCC 16-05(A)

The New Mexico Water Quality Control Commission (WQCC) will hold a public hearing on July 11, 2017 at the New Mexico State Capitol building in Santa Fe to consider a Petition filed by United Nuclear Corporation for alternative abatement standards under Subsection 20.6.2.4103(F) for the former St. Anthony Mine located on the Cebolleta Land Grant, Cibola County, New Mexico. The affected property area is approximately 1,072 acres located approximately three miles east-southeast of Moquino and approximately 13 miles north of Laguna Pueblo. The St. Anthony Mine is located within Township 11 North, Range 4 and 5 West. The latitude and longitude of the four corners of the affected property area are: the northwest corn 35.17 degrees north and -107.32 degrees west; the northeast corner 35.17 degrees north and -107.29 degrees west; the southeast corner, 35.15 degrees north and -107.29 degrees west; and the southwest corner, 35.15 degrees north and -107.32 degrees west.

The Petition proposes alternative abatement standards for sulfate, fluoride, boron, uranium, radium, chloride, and total dissolved solids in the affected water-bearing zone of the Jackpile sandstone groundwater. The Petition includes proposed administrative controls to ensure that the affected area of Jackpile sandstone groundwater is not used as a potable water supply going forward. As one of the proposed administrative controls, the Petition contemplates that the New Mexico Environment Department will petition the New Mexico State Engineer to issue an Order under Subsection 19.27.5.13(A), prohibiting construction of wells in the affected prop erty area in the water-bearing zone of the Jackpile sandstone groundwater. The New Mexico Environment Department has recommended that the Commission approve the Petition.

The public hearing will begin immediately following the Commission's regular business mee ing, which starts at 9 a.m.

The Petition and the Department's recommendation may be obtained electronically or reviewed in person by contacting:
Pam Castaneda, Administrator
1190 S. St. Francis Drive
P.O.Box 5469
Santa Fe, NM 87502
Tel (505) 827-2425, Fax (505) 827-2836, E-mail pam.castaneda@state.nm.us

The hearing will be conducted in accordance with Section 74-6-4 of the Water Quality Act, t WQCC Adjudicatory Procedures at 20.1.3 NMAC, the Water Quality Regulations at 20.6.2 NMAC, and any Procedural Order or Scheduling Order issued by the WQCC or Hearing Office These documents, including a map of the affected property area, are available at https://www.env.nm.gov/water-quality-control-commission/wqcc/, or by contacting the WQCC Administrator.

Technical Testimony: In order to present technical testimony at the hearing, a person must fi a notice of intent to present technical testimony in WQCC No. 16-05(A) with the WQCC Admin istrator no later than June 30, 2017 at 5:00 p.m. The notice shall comply with the requirements of 20.1.3.18 NMAC.

Participation by the General Public: Any member of the general public may present non-tecl nical testimony at the hearing. No prior notification is required. A member of the general public may submit a written non-technical statement to the WQCC Administrator at any time prior to the close of the hearing.

Assistance: If any person requires assistance, an interpreter or auxiliary aid to participate in this process, please contact Pam Castaneda, WQCC Administrator at least 14 days prior to th hearing date at P.O. Box 5469, 1190 St. Francis Drive, Santa Fe, New Mexico, 87502, telephone (505) 827-2425 or email pam.castaneda@state.nm.us. (TDD or TTY) users please access the number via the New Mexico Relay Network, 1-800-659-1779 (voice); TTY users: 1-800-659-8331).

Published in the Cibola Beacon June 9, 2017. Invoice #1354

COMISIÓN DEL CONTROL DE CALIDAD DEL AGUA DE NUEVO MÉXICO

AVISO DE AUDIENCIA PÚBLICA PARA CONSIDERAR PETICIÓN PARA ESTÁNDARES ALTERNATIVOS DE REDUCCIÓN PARA LA MINA ANTERIOR DE ST. ANTHONY EN EL CONDADO DE CÍBOLA, NM, WQCC 16-05 (A)

La Comisión del control de calidad del agua de Nuevo México (WQCC) llevará a cabo una audiencia pública el 11 de julio de 2017 en el edificio del Capitolio Estatal del estado de Nuev México para considerar una petición presentada por la Corporación Unida Nuclear para los es tándares alternativos de reducción bajo subsección 20.6.2.4103(F) para la mina anterior de S Anthony situada en la Cibolleta concesión de tierras, condado de Cíbola, Nuevo México. El área de propiedad afectada es aproximadamente 1,072 acres ubicado aproximadamente tres millas de este-sureste de Moquino y aproximadamente 13 millas de norte del pueblo de Laguna. La mina de St. Anthony se encuentra en el Municipio 11 Norte, rango 4 y 5 oeste. La lat tud y longitud de las cuatro esquinas del área de propiedad afectada son: la esquina del noroeste, 35.17 grados norte y -107.32 grados Oeste; la esquina noreste 35.17 grados norte y 107.29 grados Oeste; la esquina sureste, 35.15 grados norte y -107.29 grados Oeste; y la esquina del sudoeste, 35.15 grados norte y -107.32 grados Oeste.

La petición propone estándares alternativos de reducción de sulfato, fluoruro, boro, uranio, radium, cloruro y sólidos totales disueltos en la zona afectada de acuíferos de agua subterránea de piedra arenisca de Jackpile. La petición incluye controles administrativos propuestos para asegurar que el área afectada de agua subterránea de piedra arenisca Jackpile no es ut lizado como un suministro de agua potable en el futuro. Como uno de los controles administra tivos propuestos, la petición contempla que el Departamento de medio ambiente de Nuevo México solicitará al ingeniero del estado de Nuevo México para emitir una orden bajo la subsección 19.27.5.13(A), prohibiendo la construcción de pozos en el área de propiedad afectad en la zona de acuíferos de agua subterránea de piedra arenisca de Jackpile. El Departament de medio ambiente de Nuevo México ha recomendado que la Comisión apruebe la petición.

La audiencia pública comenzará inmediatamente después de la reunión de negocio regular de la Comisión, que comienza a las 9:00a.m.

La petición y recomendación del Departamento se puede obtener electrónicamente o revisa dos en persona por ponerse en contacto con:
Pam Castañeda, administrador
1190 S. St. Francis Drive
PO Box 5469
Santa Fe, NM 87502
Tel (505) 827-2425, Fax (505) 827-2836, correo electrónico. pam.castaneda@state.nm.us

La audiencia se llevará a cabo conforme a la sección 74-6-4 de la Ley de Calidad de Agua, los Procedimientos Decisorios de la WQCC en 20.1.3 NMAC, las Normas de Calidad de Agua en 20.6.2 NMAC y cualquier Orden de Procedimiento o auto de programación emitida por el WQCC o el oficial de audiencia. Estos documentos, incluyendo un mapa de la zona de la propiedad afectada, están disponibles en https://www.env.nm.gov/water-quality-control-comm

Public Legal Notices

LEGAL NOTICE
STATE OF NEW MEXICO
CIBOLA COUNTY OF
THIRTEENTH JUDICIAL
DISTRICT COURT
No. D-1333-CV-2016-00147
THE BANK OF NEW YORK MELLON F/K/A THE BANK OF NEW YORK AS SUCCESSOR TO JPMORGAN CHASE BANK, N.A., AS TRUSTEE FOR THE BENEFIT OF THE CERTIFI-[illegible]

N.M. State Plane Coordi-[illegible] (West Zone), Tract [illegible]
[illegible]
227.1', Grid Bearings: N23 deg. 38'W, X: 632,153.7, Y: 1,519,815.8
Point: No. 4, Ground Dist: [illegible], Grid Bearings: N34 deg. 46'E, X: 631,935.9, Y: 1,519,979.8
Point: No. 5, Ground Dist: 226.5', Grid Bearings: S 63 deg. 45'W, X: 632,392.8, Y: 1,520,339.9
Point: No. 6, X: 637,385.1, Y: 1,520,236.8,
including any improvements, fixtures, and attachments, such as, but not limited to, mobile homes. If there is a conflict between the legal description and the street address, the legal description shall control.

You are further notified that Plaintiff prays that the aforementioned real property be sold according to the law and practice of this Court to pay the mortgage lien held by Plaintiff, and that the interests of each Defendant, and all persons claiming under or through them, and all other persons bound by these proceedings, be barred and foreclosed of all rights, interests, and claims to the aforementioned real property, and for such other and further relief as the Court may deem just and proper.

You are further notified that unless you enter or cause to be entered your appearance or file responsive pleadings or motions in said cause within thirty (30) days of the third consecutive publication of this Notice of Suit, judgment will be rendered against each Defendant by default, and the relief prayed for by Plaintiff will be granted.

The name of the counsel for Plaintiff, The Bank of New York Mellon f/k/a The Bank of New York as successor to JPMorgan Chase Bank, N.A., as trustee for the benefit of the Certificate holders of Popular ABS, Inc. Mortgage Pass-Through Certificates Series 2006-D, is Rose L. Brand & Associates, P.C., 7430 Washington Street, NE, Albuquerque, New Mexico 87109, Telephone: (505) 833-3036.

BY ORDER OF The Honorable Pedro G. Rael, District Judge of the Thirteenth Judicial District Court of the State of New Mexico, and the Seal of the District Court of Cibola County, entered on this 5th day of June, 2017
PABLITA COHOE
Clerk of the District Court
06/05/2017
Published in the Cibola Beacon June 9, 16, and 23, 2017. Invoice #1335

LEGAL NOTICE
STATE OF NEW MEXICO
CIBOLA COUNTY OF
THIRTEENTH JUDICIAL
DISTRICT COURT
CASE NO: D-1333-CV-2016-00173
21ST MORTGAGE CORPORATION,
Plaintiff,
vs.
ANDREA S. MILAN and [illegible]

[illegible] The Default Judgments and [illegible] be [illegible] either [illegible] court [illegible] the sale date. 21st Mortgage Corporation has the right to bid at the sale and to apply its judgment or a portion thereof to the purchase price in lieu of cash. All other bidders, the [illegible] or its equivalent [illegible] of business on the day of sale. The sale may be postponed and rescheduled at the Special Master's discretion.

PROSPECTIVE PURCHASERS AT SALE ARE ADVISED TO MAKE THEIR OWN EXAMINATION OF THE TITLE AND THE CONDITION OF THE PROPERTY AND TO CONSULT THEIR OWN ATTORNEY BEFORE BIDDING.
/s/ Edward S. Little 06/08/17
Edward S. Little, Special Master
1509 37th Street SE
Rio Rancho, NM 87124
505/328-6269
Published in the Cibola Beacon June 13, 20, 27, and July 4, 2017. Invoice #1336

LEGAL NOTICE
STATE OF NEW MEXICO
CIBOLA, COUNTY OF
13TH JUDICIAL
DISTRICT COURT
Case No. D1333 CV-2017-00177
IN THE MATTER OF A PETITION FOR NAME CHANGE FOR:
[illegible]
NOTICE OF CHANGE OF NAME
TAKE NOTICE that in accordance with provision of NMSA 1978 Sections 40-8-1 through 40-8-3 the above captioned Petitioner(s) will apply to the Honorable Pedro G. Rael, District Judge of the 13th Judicial District, Cibola County, New Mexico, at 9:30 a.m. on the 20th day of June, 2017 for an ORDER FOR CHANGE OF NAME from: Cherylene Luther to Cheryl Lee Luther.

TOINETTE GARCIA
District Court Clerk
Submitted by:
Joseph Artie
Attorney for Petitioner
P.O. Box 7251
Grants, New Mexico
(505) 858-6613
Artielaw@Gmail.com
Published in the Cibola Beacon June 9 and 16, 2017. Invoice #1358

LEGAL NOTICE
STATE OF NEW MEXICO
CIBOLA, COUNTY OF
LAGUNA TRIBAL COURT
Case No. CN17-00007
IN THE MATTER OF LUCILLE KASHERO
FOR A NAME CHANGE FOR: ADULAS MARY KONICO
PETITION FOR CHANGE OF NAME
NOTICE IS HEREBY GIVEN that a petition has been filed in the Pueblo of Laguna Tribal Court requesting that the name of: Lucille Kashero, an enrolled member of the Pueblo of Laguna (Enrollment #03-1143), be charged to Adulas Mary Konico, an enrolled member of the Pueblo of Laguna (Enrollment #03-1143). Please send all inquiries to: Laguna Tribal Court, Pueblo of Laguna, P.O. Box 194, Laguna, NM 87026.
Dated this June day of 6th, 2017
Lucille Kashero
Petitioner

Section 7-38-85 NMSA 1978, I hereby extend the following deadline found in Section 7-38-20 of the Property Tax Code with respect to the 2017 tax year only:
1) The deadline to allocate and certify valuations to county assessors is extended from June [illegible] to June 7, 2017.
Date this 31st day of May 2017.
Michael O'Melia, Deputy Director
Property Tax Division
Published in the Cibola Beacon June 9, 13, and 20, 2017. Invoice #1338

LEGAL NOTICE
STATE OF NEW MEXICO
CIBOLA, COUNTY OF
ORDER EXTENDING DEADLINES
CIBOLA COUNTY NEW MEXICO
NOTICE IS HEREBY GIVEN pursuant to my authority under Section 7-38-85 NMSA 1978, I hereby extend the following deadline found in Section 7-38-20 of the Property Tax Code with respect to the 2017 tax year only:
1) The deadline for the Cibola County Assessor to mail out Amended Notices of Value from May 31, 2017 to no later than June 16, 2017.
Date this 31st day of May 2017.
Michael O'Melia, Deputy Director
Property Tax Division
Published in the Cibola Beacon June 9, 16, and 23, 2017. Invoice #1339

PUBLIC NOTICE
GRANTS, CITY OF
The Recreation Board is scheduled to meet at 6:00 P.M., Thursday, June 15, 2017, at the City Hall Council Chambers. Agendas are available Monday, June 12, 2017 at City Hall. The public is invited to attend.
If you are an individual with a handicap/disability and require a type of auxiliary aid or service to participate in city meetings, please contact the city clerk at 287-7927 at least one week in advance of the scheduled meeting or as soon as possible, to make necessary arrangements.
Cynthia Arroesa, City Clerk
Published in the Cibola Beacon June 9, 2017. Invoice #1337a

PUBLIC NOTICE
GRANTS, CITY OF
The Animal Services Board is scheduled to meet at 12 P.M., Thursday, June 15, 2017, at the City Hall Council Chambers, 600 W. Santa Fe Ave., Grants, NM. The public is invited to attend.
If you are an individual with a handicap/disability and require a type of auxiliary aid or service to participate in city meetings, please contact the city clerk at 287-7927 at least one week in advance of the scheduled meeting or as soon as possible, to make necessary arrangements.
Cynthia Arroesa, City Clerk
Published in the Cibola Beacon June 9, 2017. Invoice #1337b

NEW MEXICO WATER QUALITY CONTROL COMMISSION

NOTICE OF PUBLIC HEARING TO CONSIDER PETITION FOR ALTERNATIVE ABATEMENT STANDARDS FOR THE FORMER ST. ANTHONY MINE IN CIBOLA COUNTY, NM, WQCC 16-05(A)

The New Mexico Water Quality Control Commission (WQCC) will hold a public hearing on July 11, 2017 at the New Mexico State Capitol building in Santa Fe to consider a Petition filed by United Nuclear Corporation for alternative abatement standards under Subsection 20.6.2.4103(F) for the former St. Anthony Mine located on the Cebolleta Land Grant, Cibola County, New Mexico. The affected property area is approximately 1,072 acres located approxi-

COMISIÓN DEL CONTROL DE CALIDAD DEL AGUA DE NUEVO MÉXICO

AVISO DE AUDIENCIA PÚBLICA PARA CONSIDERAR PETICIÓN PARA ESTÁNDARES ALTERNATIVOS DE REDUCCIÓN PARA LA MINA ANTERIOR DE ST. ANTHONY EN EL CONDADO DE CÍBOLA, NM, WQCC 16-05 (A)

La Comisión del control de calidad del agua de Nuevo México (WQCC) llevará a cabo una audiencia pública el 11 de julio del 2017 en el edificio del Capitolio Estatal del estado de Nuevo México para considerar una petición presentada por la Corporación Unida Nuclear para los estándares alternativos de reducción bajo subsección 20.6.2.4103(F) para la mina anterior de St. Anthony situada en Cebolleta concesión de tierras, condado de Cibola, Nuevo México. El área de propiedad afectada es aproximadamente 1,072 acres ubicado aproximadamente tres millas de este-sureste de Moquino y aproximadamente 13 millas de norte del pueblo de Laguna. La mina de St. Anthony se encuentra en el Municipio 11 Norte, rango 4 y 5 oeste. La latitud y longitud de las cuatro esquinas del área de propiedad afectada son: la esquina del noroeste, 35.17 grados norte y -107.32 grados Oeste; la esquina noreste 35.17 grados norte y -107.29 grados Oeste; la esquina sureste, 35.15 grados norte y -107.29 grados Oeste; y la esquina del sudoeste, 35.15 grados norte y -107.32 grados Oeste.

La petición propone estándares alternativos de reducción de sulfato, fluoruro, boro, uranio, radium, cloruro y sólidos totales disueltos en la zona afectada de acuíferos de agua subterránea de piedra arenisca de Jackpile. La petición incluye controles administrativos propuestos para asegurar que el área afectada de agua subterránea de piedra arenisca Jackpile no es utilizado como un suministro de agua potable en el futuro. Como uno de los controles administrativos propuestos, la petición contempla que el Departamento de medio ambiente de Nuevo México solicitara el ingeniero del estado de Nuevo México para emitir una orden bajo la subsección 19.27.5.13(A), prohibiendo la construcción de pozos en el área de propiedad afectada en la zona de acuíferos de agua subterránea de piedra arenisca de Jackpile. El Departamento de medio ambiente de Nuevo México ha recomendado que la Comisión apruebe la petición.

La audiencia pública comenzará inmediatamente después de la reunión de negocio regular de la Comisión, que comienza a las 9:00a.m.

La petición y recomendación del Departamento se puede obtener electrónicamente o revisados en persona por ponerse en contacto con:
Pam Castañeda, administrador
1190 S. St. Francis Drive
PO Box 5469
Santa Fe, NM 87502
Tel (505) 827-2425, Fax (505) 827-2836, correo electrónico: pam.castaneda@state.nm.us

La audiencia se llevará a cabo conforme a la sección 74-6-4 de la Ley de Calidad de Agua, los Procedimientos Decisorios de la WQCC en 20.1.3 NMAC, las Normas de Calidad de Agua en 20.6.2 NMAC y cualquier Orden de Procedimiento o auto de programación emitida por el WQCC o el oficial de audiencia. Estos documentos, incluyendo un mapa de la zona de la propiedad afectada, están disponibles en https://www.env.nm.gov/water-quality-control-commission/wqcc/, o poniéndose en contacto con el administrador de WQCC.

Testimonio técnico: Con el fin de presentar testimonio técnico en la audiencia, una persona debe presentar un aviso de intención a presentar testimonio técnico en WQCC no. 16-05(A) con el WQCC administrador no más tarde del 30 de junio de 2017 en 5:00p.m. La notificación deberá cumplir con los requisitos de 20.1.3.18 NMAC.

Participación del Público General: Cualquier miembro del público general puede presentar testimonio no técnico en la audiencia. Previa notificación no es necesaria. Un miembro del público general podrá presentar una declaración escrita no técnico al administrador de WQCC en cualquier momento antes del cierre de la audiencia.

Asistencia: Si cualquier persona requiere asistencia, un intérprete o ayuda auxiliar a participar en este proceso, póngase en contacto con Pam Castañeda, administrador de WQCC por lo menos 14 días antes de la fecha de la audiencia en P.O. Box 5469, 1190 St Francis Drive, Santa Fe, Nuevo México, 87502, teléfono (505) 827-2425 o por correo electrónico: pam.castaneda@state.nm.us. Los usuarios (TDD o TTY) por favor acceder el número a través de la red de retransmisión de Nuevo México, 1-800-659-1779 (voz), Usuarios de TTY: 1-800-659-8331).

Published in the Cibola Beacon June 9, 2017. Invoice #1354

County: Bernalillo
Printed In: Albuquerque Journal
Printed On: 2017/06/09

NEW MEXICO WATER QUALITY CONTROL COMMISSION NOTICE OF PUBLIC HEARING TO CONSIDER PETITION FOR ALTERNATIVE ABATEMENT STANDARDS FOR THE FORMER ST. ANTHONY MINE IN CIBOLA COUNTY, NM, WQCC 16-05(A) The New Mexico Water Quality Control Commission (WQCC) will hold a public hearing on July 11, 2017 at the New Mexico State Capitol building in Santa Fe to consider a Petition filed by United Nuclear Corporation for alternative abatement standards under Subsection 20.6.2.4103(F) for the former St. Anthony Mine located on the Cebolleta Land Grant, Cibola County, New Mexico. The affected property area is approximately 1,072 acres located approximately three miles east-southeast of Moquino and approximately 13 miles north of Laguna Pueblo. The St. Anthony Mine is located within Township 11 North, Range 4 and 5 West. The latitude and longitude of the four corners of the affected property area are: the northwest corner, 35.17 degrees north and -107.32 degrees west; the northeast corner 35.17 degrees north and -107.29 degrees west; the southeast corner, 35.15 degrees north and -107.29 degrees west; and the southwest corner, 35.15 degrees north and -107.32 degrees west. The Petition proposes alternative abatement standards for sulfate, fluoride, boron, uranium, radium, chloride, and total dissolved solids in the affected water-bearing zone of the Jackpile sandstone groundwater. The Petition includes proposed administrative controls to ensure that the affected area of Jackpile sandstone groundwater is not used as a potable water supply going forward. As one of the proposed administrative controls, the Petition contemplates that the New Mexico Environment Department will petition the New Mexico State Engineer to issue an Order under Subsection 19.27.5.13(A), prohibiting construction of wells in the affected property area in the water-bearing zone of the Jackpile sandstone groundwater. The New Mexico Environment Department has recommended that the Commission approve the Petition. The public hearing will begin immediately following the Commission's regular business meeting, which starts at 9 a.m. The Petition and the Department's recommendation may be obtained electronically or reviewed in person by contacting: Pam Castaneda, Administrator 1190 S. St. Francis Drive PO Box 5469 Santa Fe, NM 87502 Tel (505) 827-2425, Fax (505) 827-2836, E-mail: pam.castaneda@state.nm.us The hearing will be conducted in accordance with Section 74-6-4 of the Water Quality Act, the WQCC Adjudicatory Procedures at 20.1.3 NMAC, the Water Quality Regulations at 20.6.2 NMAC, and any Procedural Order or Scheduling Order issued by the WQCC or Hearing Officer. These documents, including a map of the affected property area, are available at https://www.env.nm.gov/ water-quality-control-commission/wqcc/, or by contacting the WQCC Administrator. Technical Testimony: In order to present technical testimony at the hearing, a person must file a notice of intent to present technical testimony in WQCC No. 16-05(A) with the WQCC Administrator no later than June 30, 2017 at 5:00 p.m. The notice shall comply with the requirements of 20.1.3.18 NMAC. Participation by the General Public: Any member of the general public may present non-technical testimony at the hearing. No prior notification is required. A member of the general public may submit a written non-technical statement to the WQCC Administrator at any time prior to the close of the hearing. Assistance: If any person requires assistance, an interpreter or auxiliary aid to participate in this process, please contact Pam Castaneda, WQCC Administrator at least 14 days prior to the hearing date at P.O. Box 5469, 1190 St. Francis Drive, Santa Fe, New Mexico, 87502, telephone (505) 827-2425 or email pam.castaneda@state.nm.us. (TDD or TTY) users please access the number via the New Mexico Relay Network, 1-800-659-1779 (voice); TTY users: 1-800-659-8331). Journal: June 9, 2017

Public Notice ID:

AlbuquerqueJournal

Published in the Albuquerque Journal on Friday June 09, 2017

COMISIN DEL CONTROL DE CALIDAD DEL AGUA DE NUEVO MXICO AVISO DE AUDIENCIA PBLICA PARA CONSIDERAR PETICIN PARA ESTNDARES ALTERNATIVOS DE REDUCCIN PARA LA MINA ANTERIOR DE ST. ANTHONY EN EL CONDADO DE CBOLA, NM, WQCC 16-05 (A) La Comisin del control de calidad del agua de Nuevo Mxico (WQCC) llevar a cabo una audiencia pblica el 11 de julio de 2017 en el edificio del Capitolio Estatal del estado de Nuevo Mxico para considerar una peticin presentada por la Corporacin Unida Nuclear para los estndares alternativos de reduccin bajo subseccin 20.6.2.4103(F) para la mina anterior de St. Anthony situada en la Cibolleta concesin de tierras, condado de Cbola, Nuevo Mxico. El rea de propiedad afectada es aproximadamente 1,072 acres ubicado aproximadamente tres millas de este-sureste de Moquino y aproximadamente 13 millas de norte del pueblo de Laguna. La mina de St. Anthony se encuentra en el Municipio 11 Norte, rango 4 y 5 oeste. La latitud y longitud de las cuatro esquinas del rea de propiedad afectada son: la esquina del noroeste, 35.17 grados norte y -107.32 grados Oeste; la esquina noreste 35.17 grados norte y -107.29 grados Oeste; la esquina sureste, 35.15 grados norte y -107.29 grados Oeste; y la esquina del sudoeste, 35.15 grados norte y -107.32 grados Oeste. La peticin propone estndares alternativos de reduccin de sulfato, fluoruro, boro, uranio, radium, cloruro y slidos totales disueltos en la zona afectada de acuferos de agua subterrnea de piedra arenisca de Jackpile. La peticin incluye controles administrativos propuestos para asegurar que el rea afectada de agua subterrnea de piedra arenisca Jackpile no es utilizado como un suministro de agua potable en el futuro. Como uno de los controles administrativos propuestos, la peticin contempla que el Departamento de medio ambiente de Nuevo Mxico solicitara el ingeniero del estado de Nuevo Mxico para emitir una orden bajo la subseccin 19.27.5.13(A), prohibiendo la construccin de pozos en el rea de propiedad afectada en la zona de acuferos de agua subterrnea de piedra arenisca de Jackpile. El Departamento de medio ambiente de Nuevo Mxico ha recomendado que la Comisin aprueba la peticin. La audiencia pblica comenzar inmediatamente despus de la reunin de negocio regular de la Comisin, que comienza a las 9:00a.m. La peticin y recomendacin del Departamento se puede obtener electrnicamente o revisados en persona por ponerse en contacto con: Pam Castaeda, administrador 1190 S. St. Francis Drive PO Box 5469 Santa Fe, NM 87502 Tel (505) 827-2425, Fax (505) 827-2836, correo electrnico: pam.castaneda@state.nm.us La audiencia se llevar a cabo conforme a la seccin 74-6-4 de la Ley de Calidad de Agua, los Procedimientos Decisorios de la WQCC en 20.1.3 NMAC, las Normas de Calidad de Agua en 20.6.2 NMAC y cualquier Orden de Procedimiento o auto de programacin emitida por el WQCC o el oficial de audiencia. Estos documentos, incluyendo un mapa de la zona de la propiedad afectada, estn disponibles en https://www.env.nm.gov/water-quality-control-commission/wqcc/, o ponindose en contacto con el administrador de WQCC. Testimonio tcnico: Con el fin de presentar testimonio tcnico en la audiencia, una persona debe presentar un aviso de intencin a presentar testimonio tcnico en WQCC no. 16-05(A) con el WQCC administrador no ms tarde del 30 de junio de 2017 en 5:00p.m. La notificacin deber cumplir con los requisitos de

20.1.3.18 NMAC. Participacin del Pblico General: Cualquier miembro del pblico general puede presentar testimonio no tcnico en la audiencia. Previa notificacin no es necesaria. Un miembro del pblico general podr presentar una declaracin escrita no tcnico al administrador de WQCC en cualquier momento antes del cierre de la audiencia. Asistencia: Si cualquier persona requiere asistencia, un intrprete o ayuda auxiliar a participar en este proceso, pngase en contacto con Pam Castaeda, administrador de WQCC por lo menos 14 das antes de la fecha de la audiencia en P.O. Box 5469, 1190 St Francis Drive, Santa Fe, Nuevo Mxico, 87502, telfono (505) 827-2425 o por correo electrnico: pam.castaneda@state.nm.us. Los usuarios (TDD o TTY) por favor acceder el nmero a travs de la red de retransmisin de Nuevo Mxico, 1-800-659-1779 (voz); Usuarios de TTY: 1-800-659-8331). Journal: June 9, 2017

Exhibit 3
Roy S. Blickwedel Resume

ROY S. BLICKWEDEL, P.G.

503 Springbrook Lane ♦ Wayne, Pennsylvania 19087 ♦ (610) 529-6323 ♦ r.blickwedel@verizon.net

PROFESSIONAL SUMMARY

An expert in leading cross-functional teams to achieve environmental restoration. A proven leader that translates scientific and risk-based strategies into consensus-based solutions that achieve the best interests of stakeholders, government, and executive level management. An articulate communicator able to convey complex technical and regulatory issues up and down the organizational structure. Dedicated to maintaining a reputation built on quality, service, and uncompromising ethics.

PROFESSIONAL HISTORY and ACCOMPLISHMENTS

General Electric Company, 1998-present, Remedial Project Manager, Corporate Environmental Programs. Resolves environmental liabilities on Superfund, RCRA, and voluntary cleanup sites. Advocacy, Six Sigma.

- Manages $50MM+ in FASB reserves on about a dozen active projects at any one time. Annual budgets typically range between $5-10MM.
- Reclamation of United Nuclear Corporation (a GE subsidiary) mines and mills in AZ, NM, OR. Closed tailings impoundments and received No Further Action notice for Cornucopia Gold Mine. Negotiated favorable settlement at Pine Mountain Mine. Manages a portfolio of legacy UNC uranium mine and mill closures including: NRC-licensed facilities, CERCLA actions, and State-lead mine reclamation.
- Grand Street Mercury Site lead. One of the top four GE Superfund sites. Directly responsible for the demolition and site restoration of a former factory in high-profile, urban setting. Over 32,000 man-hours worked; zero OSHA-reportable injuries, administrative deficiencies or adverse community relations incidents over the 3-year project.
- Six Sigma. Acting Black Belt for Corporate Remedial Group. Conducted Green Belt project supervision and instructed training classes for 9 Green Belt candidates from 2002-2004. Facilitated and/or leader for Lean Sigma workouts for compliance, business contingency planning and special projects.
- RCRA Corrective Action Advocacy Lead. Chaired the Institutional Control Committee for RCAP's 2006 Long-term Stewardship Work Shop in Charlottesville, VA. Communicates regulatory developments across GE business units.
- Manager Development Course (MDC), Munich, Germany, 2006 – Graduate of GE's 3 week course that is the core of GE's Executive education program.

Advanced GeoServices Corp., 1994-1998, Associate Project Consultant. Project management, technical peer review, regulatory strategy and negotiations.

- Geochemical development of passive acid mine drainage treatment technology for mine water discharges at Asarco's West Fork, MO, and Cyprus-Amax's Pecos, NM mines.
- Attained an Explanation of Significant Difference (ESD) at the Marathon Battery Plant, Cold Spring, New York. The ESD allowed subsurface cadmium to remain in-place at concentrations exceeding the site cleanup level, saving a minimum of $615,000 in excavation and treatment costs.
- Achieved an institutional control remedy through the application of geostatistics at the Anaconda Smelter NPL site in Montana.

Independent Consultant, 1990-1994. Subcontractor to Advanced GeoServices Corp., NTH, Ltd., Harding-Lawson Associates, Environmental and Energy Consultants, Inc., and others.

- Conducted thermodynamic modeling and experimental simulations of lead mobility at the Marjol Battery Site, in Throop, PA that averted a corrective action for groundwater.
- Received The Nature Conservancy's 1992 Science Award for efforts to identify and protect critical land management areas that surround cave systems harboring endangered wildlife.
- Performed aquifer test evaluations and prepared water supply permit applications to the Delaware River Basin Commission.

E.I. duPont de Nemours & Co., 1990, Engineering Consultant. Internal consulting and subcontractor oversight at DuPont facilities.

- Managed projects at the Chambers Works and Pompton Lakes facilities related to on-going RCRA studies, remedial design and permits.

BCM Engineers, 1988-1989, Technical Consultant. Supervision and management of environmental projects.

- Successfully led effort to delist RCA's, Barceloneta, Puerto Rico waste impoundments from the NPL.

Environmental and Energy Consultants, Inc., 1986-1988, Vice President. Co-founder of the firm. Corporate administration. Managed the hydrogeology group which grew to eight professionals. Directed and approved investigations, technical reports and remedial programs.

- Conducted briefings for Directors and senior management at 3M and Rohm and Haas on the progress and direction of the high-exposure, Woodlands and Lipari Landfill NPL sites.

U.S. Geological Survey, 1983-1985, Project Chief. Research and publishing in hydrogeology and geochemistry.

- Reported on the effects of land use and geology on the distribution of trace metal and organic compounds in the groundwater of southeastern Pennsylvania.
- Performed a pilot-study with the City of Philadelphia on the use of composted sewage sludge for land reclamation.

Woodward-Clyde Consultants, 1980-1982, Staff Geologist. Geotechnical and environmental project work.

- Geotechnical investigations on the Merrill Creek, NJ reservoir project.
- Environmental Impact Statements for the Bald Mountain, ME copper prospect and a Bartow, FL gypsum stack-cooling pond complex.

Exploration Logging, Inc., 1978, Wellsite Geologist. Operated offshore laboratories in the Gulf of Mexico and Baltimore Canyon oil exploration areas.

EDUCATION

B.A. Geology, Franklin and Marshall College, Lancaster, PA (1978)
M.A. Geology, Indiana University, Bloomington, IN (1983)

TEACHING EXPERIENCE

Pennsylvania State University, 1993-1998, Guest Lecturer. Geochemical modeling for chemical fate and transport and water treatment applications.
Indiana University, 1978-1980, Associate Instructor. Petrology, Optical and X-ray mineralogy.
University of Maryland, 1977, Teaching Assistant. Field Geology.

PROFESSIONAL REGISTRATION and AFFILIATIONS

Professional Geologist, Commonwealth of Pennsylvania (inactive) and State of Arizona
Member American Geophysical Union
Instrument-rated Commercial Pilot
President, Lowry House Condominium Association (4 consecutive 1-year terms from 2008-2012)
Member, Board of Directors of New Gulph Children’s Center (1994-1999)

PUBLICATIONS and PRESENTATIONS

Blickwedel, R.S., (1997) Cadmium Chemistry and Transport in Groundwater at the Marathon Battery Plant, Cold Spring, New York: Presented at the 1997 University of Massachusetts Conference on Contaminated Soils.

Blickwedel, R.S (1994) Hydrogeochemistry of Lead from Battery Waste in the Northern Anthracite Coal Region of Pennsylvania: Presented at the SEGH Conference, Salt Lake City.

Blickwedel, R.S. and C.R. Wood (1989) Chemical quality of ground water as related to land use in the Philadelphia, Pennsylvania - Camden, New Jersey area: U.S. Geological Survey Water-Resources Investigation Report 88-4211.

Blickwedel, R.S. and J. Linn (1986) Hydrogeology and ground water quality at a land reclamation site, Neshaminy State Park, Pennsylvania: U.S. Geological Survey Water-Resources Investigation Report 86-4164.

Exhibit 4
Declaration of Roy S. Blickwedel

DECLARATION OF ROY BLICKWEDEL

My name is Roy Blickwedel and I reside at 503 Springbrook Lane, Wayne, PA. I am providing this declaration in support of United Nuclear Corporation's ("UNC") Petition for Alternate Abatement Standards ("AAS Petition"). UNC is petitioning for a variance from Water Quality Control Commission ("WQCC") Standards with AASs for the Constituents of Possible Concern ("COPCs") listed in Table ES.1[FN1]. The AAS Petition is supported by conceptual and numerical hydrologic models, geochemical calculations, and bench scale studies of groundwater/bedrock reaction equilibria. The work has led to a thorough understanding of the St. Anthony Mine site ("Site"), and a preferred reclamation plan for the mine.

I hold Bachelor's and Master's degrees in Geology from Franklin & Marshall College (1978), and Indiana University (1983), respectively. I am a registered Professional Geologist in Pennsylvania (PA-000026-G, currently inactive), and Arizona (No. 31648). I have been employed for more than 35 years as an academic, consultant, and environmental project manager in both governmental and private positions. I currently hold the position of Remedial Project Manager at the General Electric Company (GE), where among other duties, I have been responsible for directing the remediation and reclamation of UNC's mining and milling operations since their acquisition by GE in 1998. At the St. Anthony Mine, I have led the planning and execution of groundwater investigations, feasibility studies, closeout plans, financial assurance mechanisms, and stakeholder relations.

UNC leased the Site from the Cebolleta Land Grant and operated an open pit mine at the Site from 1976 to 1982 (Exhibit 4a). The Site is located approximately three miles east-southeast of Moquino and approximately thirteen miles north of Laguna (See Exhibit 4b).

The Site has an areal extent of approximately one square mile. It consists of two open pits, overburden and overburden piles and former underground mines. The current surface features are shown on Exhibit 4c. The underground mine workings have been sealed at the surface. The two open pits are referred to as the Large Pit and the Small Pit. The Large Pit, which is located on the west side of the Site and penetrates all but about 20 feet of the Jackpile Sandstone, perennially contains standing water, and the Small Pit, which is located southeast of the Large Pit and exposes the top of the Jackpile Sandstone, intermittently contains pooled water. The Large Pit collects and stores surface runoff and functions as an evaporative sink for groundwater flow within the Jackpile Sandstone. There are several large overburden piles on the eastern portion of the Site, located next to Meyer Draw. Meyer Draw is an ephemeral drainage that runs only during and shortly after storms large enough to produce run off. From the north boundary of the Site, the arroyo passes between the open pits and several large overburden piles in a southeasterly direction and is joined by Arroyo de Pedro Padilla from the northeast before leaving the Site and entering the Laguna Pueblo, which is directly south of the Site.

The Site remains in the same condition as it was at the time of the lease termination. The lease provided that UNC leave the Pits open so that the Land Grant could have the ability to re-lease the Site for mining of the ore reserves remaining at the Site. There are no remaining building structures on the Site. Besides the pits and overburden piles, some of the mine infrastructure equipment and components still exist, including roads, utility lines across the Site, utility connection locations, a surface completion of an old well, and the slab of a former structure.

Groundwater at the Site is contained in the Jackpile Sandstone. The Jackpile Sandstone contains uranium ore and numerous uranium mineralized zones, and groundwater constituents naturally exceed New Mexico Water Quality Control Commission standards for some regulated constituents.

In its current state, the Large Pit of the St. Anthony Mine captures groundwater via a cone of depression that has developed in response to evaporation of pit water; however, reclamation alternatives that include backfilling the Large Pit would eliminate the evaporation and ultimately result in the loss of groundwater containment. Based on extensive discussions with the New Mexico Environment Department and the New Mexico Energy, Minerals and Natural Resource Department's Mining and Minerals Division ("MMD"), as well as other stakeholders, there is a clear preference for implementing a reclamation alternative that would include backfilling of the Large Pit. The regulatory preference of MMD for backfilling of open mine pits would result in the accompanying loss of the evaporative containment of nearby groundwater.

In order for such a remediation alternative to be selected, Alternative Abatement Standards would need to be developed to address groundwater that would not be contained because compliance with WQCC Standards could not be met due to natural mineralization and the loss of hydraulic containment after the partial backfill of the Large Pit. An AAS Petition (20.6.4103 NMAC) is therefore a necessary precursor to finalizing the St. Anthony Mine Closure Plan to select the appropriate reclamation alternative for the mine.

UNC commenced Site remediation by characterizing the Site and then filing and obtaining approval for Stage 1 and Stage 2 Abatement Plans. The approved Stage 2 Abatement Proposal described the process for identifying and selecting a preferred abatement option for managing the water in the St. Anthony Large Pit. The development of abatement alternatives focused on the following key remediation goals:

1. Preventing exposure to water in the Large Pit;

2. Reducing the risk of future groundwater impact; and

3. Stabilizing groundwater conditions for the long-term.

UNC analyzed the various remediation alternatives available for the Site using the Multiple Accounts Analysis ("MAA") technique. MAA is a systematic process to select among multiple remediation approaches to reclaiming the St. Anthony Mine. The MAA process provided a means to objectively balance multiple and often competing goals amongst the stakeholders; the ultimate aim being the attainment of a consensus or near-consensus approach. The stakeholders involved in this process included New Mexico Environment Department (GWQB and SWQB), New Mexico Mining and Minerals Division of the EMNRD, New Mexico Department of Game and Fish, Cebolleta Land Grant (landowner), Laguna Pueblo and Everest Holdings (neighboring landowners), Neutron Energy (lessee of the mineral estate), and UNC.

Stakeholder collaboration is at the core of the MAA process, with all viewpoints being represented and validated. Through weighting and scoring the alternatives together, each stakeholder is able to identify other views and the sensitivity of the remedial alternatives to those attributes. The process allowed for the inclusion of less tangible impacts (e.g., aesthetics) as well as more intangible impacts (e.g., costs, reliability, safety) in the alternatives evaluation. After numerous meetings and discussions concerning the various indicators for the alternatives, the stakeholders narrowed the list of 22 remediation alternatives and sub-alternatives down to six. Table 2.1 of Exhibit 3 of the St. Anthony AAS Petition shows the final weighted scores from the MAA process. The six sub-alternatives were carried forward in the Stage 2 Abatement Analysis.

The need for additional hydrologic analysis was presented to the stakeholder group to further refine the analysis

Additional Site characterization was conducted with hydrologic and geochemical analysis to support the most highly favored remedial alternatives determined by the MAA process.

UNC filed its modified St. Anthony Mine Stage 2 Abatement Plan on February 9, 2015. As required by 20.6.2.4106.E (3) NMAC, the Stage 2 Plan must describe and justify a single alternative. Based on the additional field investigations and bench scale studies conducted as a result of the MAA process, Alternative E3 - Partial Pit Backfill with Geochemical Stabilization of Sediments and AASs is the single preferred alternative for closure of the St. Anthony Site. The key factors influencing this remedy selection are summarized as follows:

- Partial backfilling of the Large Pit is preferred by all parties if the groundwater pathway is not complete.
- Groundwater in the Jackpile Sandstone does not migrate offsite even after the Large Pit is backfilled and regional groundwater gradients are re-established.
- Water quality in the Jackpile Sandstone is not drinking water quality due to the presence of mineralized zones throughout this area.
- Water quantity and water quality in the Jackpile Sandstone do not support water supply development for any sustainable future use.
- As described further below, geochemical stabilization prevents migration of the most hazardous COPCs (uranium and radium) beyond the immediate vicinity of the Large Pit.

Water quality in the Large Pit has been impacted by its history. After active mining ceased and the pit was no longer dewatered, it filled with groundwater and solids eroded from the pit walls. This water has evapoconcentrated, which involves water evaporating and leaving behind higher TDS-containing water. Recent sampling indicates that sediment with sufficient decaying plant matter to induce precipitation has concentrated uranium at the sediment-water interface. If the pit were backfilled with no action taken to immobilize uranium, the uranium may be transported in groundwater away from the pit after regional gradient conditions return. To mitigate this potential migration of uranium, several options were evaluated in bench-scale microcosms including bioreduction, zero-valent iron (ZVI), sodium tripolyphosphate (STPP), iron oxide, and surfactant modified zeolite. The microcosms indicated that STPP immobilized uranium effectively and was resistant to remobilization upon exposure to oxygen-containing groundwater. Larger bench-scale studies replicated this result and also indicated effective radium immobilization.

The resulting preferred alternative will meet the requirements of the MMD with respect to its preference of backfilling the Large and Small Pits. It also will meet the preference of the Cebolleta Land Grant as the reclaimed surface area can be used to graze livestock. In order for this alternative to be accomplished, AASs would need to be developed to address groundwater that would not be contained because compliance with WQCC Standards could not be met due to natural mineralization. The Site's reclamation falls within the purview of the New Mexico Mining Act which was enacted in 1993. An AAS Petition (20.6.2.4103 NMAC) is therefore a necessary precursor to finalizing the St. Anthony Mine Closure Plan as per the Mining Act.

A successful AAS Petition must demonstrate the following:

- Compliance with abatement standards is technically or economically infeasible by the maximum use of technology within the economic capability of the responsible person; OR there is no reasonable relationship between the economic and social costs and benefits (including attainment of the standard(s) set forth in 20.6.2.4103 NMAC) to be obtained (Criterion 1).
- The proposed AASs are technically feasible and can be justified by cost-benefit analysis (Criterion 2).
- Compliance with the AASs will not create a present or future hazard to public health or undue damage to property (Criterion 3).

As set forth in the Stage 2 Abatement Plan, all three conditions of approval are met for groundwater quality conditions at the St. Anthony Mine.

UNC meets Criterion 1 (compliance with the abatement standard(s) is/are not feasible ... there is no reasonable relationship between the economic and social costs and benefits ....) due to the nature of the mineralization and ore deposits in the Jackpile Sandstone at and around the Site.

Groundwater quality is influenced by the presence of a mineralized zone as well as by activities such as mining that change the redox conditions surrounding that mineralized zone. While mining has moved materials around and removed mineralized rock for shipment to a mill, it has not caused the introduction of regulated constituents that did not originate at the Site. The only way to ensure attainment of WQCC Standards at a uranium mine site is to remove the entire mineral deposit, clearly a technically impracticable endeavor which is the basis for meeting the first of the three criteria that are needed to grant AASs at this Site.

Criterion 2 requires that the AASs are technically feasible and justified by cost-benefit analysis. Backfilling of open mine pits is the regulatory preference of the MMD as set forth in 19.10.5.507B NMAC, and the preferred approach by the stakeholders for the St Anthony Mine. The MMD's strong preference for closing the pit can only be circumvented by the operator demonstrating that closing the pit is not technically or economically feasible or is environmentally unsound. In this case, UNC can close the pit and there are significant benefits to the regulatory-preferred backfilling alternative, including restoration of the pit to a post-mining land use that supports grazing and wildlife habitat. However, to accomplish this preference, there would be an accompanying loss of the evaporative containment of nearby groundwater. Because the Site is located in a mineralized zone, AASs are necessary to accomplish the preferred remediation alternative. The AASs are the calculated maximum concentrations that could be observed in groundwater that is in contact with the mineralized area following backfilling. The AASs are technically feasible. The costs of attempting to achieve NMWQCC Standards in order to implement other alternatives are disproportionate to any benefit that might be achieved, if achievable at all.

Finally, Criterion 3 "compliance with the proposed alternative abatement standard(s) will not create a present or future hazard to public health or undue damage to property is met. There are no complete groundwater exposure pathways for migration of COPCs from the St. Anthony Mine. Even when groundwater flow conditions are no longer under the influence of the Large Pit evaporative sink, Jackpile Sandstone groundwater does not migrate from the Site where it could impact any potential receptors. There are currently no receptors in the area and the Jackpile Sandstone does not support water development without the benefit of recharge from the Dakota Formation which is unsaturated in the mine area. A complete exposure pathway does not exist. Therefore, compliance with all of the proposed AASs ensures the third criterion is met and that the Site will not pose a future hazard to public health or undue damage to property.

Mine reclamation activities will not result in groundwater quality standards being met at all locations; therefore, AASs must be approved as a part of the preferred remedial action alternative, and moreover, they would have to be approved as a part of any remedial alternative that calls for the pit to be backfilled because, regional groundwater is no longer captured via evapotranspiration from the pit, and groundwater migration away from the pit could occur.

The proposed AASs are higher than the maximum observed groundwater concentrations because they represent values that are theoretically predicted from geochemical modeling of the backfilled pit. Concentrations of this magnitude are possible in groundwater associated with the mineralized zone in the Jackpile Sandstone. The petition is careful to not underestimate what could happen, even though it may not happen. The largest discrepancies between observed groundwater concentrations and proposed AASs occur for sulfate, chloride, and TDS. The AASs for these constituents are the theoretical maximum concentrations that could result from migration of dissolved secondary minerals away from the Large Pit area after the pit is backfilled. After backfilling, regional groundwater levels will rise to pre-mining levels, and the cone of depression will no longer prevent transport of solutes away from the pit. It is technically infeasible to remove all of the secondary mineralization associated with the Large Pit; therefore, there is potential to see a rise in constituent concentrations away in some locations after the regional gradient returns.

In conclusion, the AASs serve to acknowledge that natural groundwater quality between the pit and the updip terminus of the Jackpile Sandstone will not meet WQCC standards due to the presence of natural uranium mineralization. The AASs also are set to account for the dissolution of secondary evaporate and uraniferous minerals that will become exposed to rising groundwater elevations following the pit backfilling. The AASs can be technically achieved based on the analysis done by UNC because they are the predicted maximum concentrations that could be observed in groundwater that is in equilibrium with the mineralization and former pit materials. Selection of the preferred abatement alternative for the St. Anthony Mine pit closure is dependent on approval of the AAS Petition. If the AASs are approved, then implementation of Alternative E3 can be implemented for Site closure. If AASs are not approved, then the backfill alternative would no longer be the preferred alternative for groundwater at the Site.

The technical testimony that I have prepared is true and correct to the best of my personal knowledge and belief.

Respectfully submitted,

Roy Blickwedel

Roy Blickwedel

Commonwealth of Pennsylvania
County of Montgomery

Signed the 26th day of April, 2017

Subscribed and sworn to before me this 26th day of April, 2017

Mary T. Sullivan

Notary Public

My Commission Expires April 3, 2021

Seal

COMMONWEALTH OF PENNSYLVANIA
NOTARIAL SEAL
Mary T. Sullivan, Notary Public
Upper Merion Twp., Montgomery County
My Commission Expires April 3, 2021
MEMBER, PENNSYLVANIA ASSOCIATION OF NOTARIES

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14478

MINERAL LEASE

THIS INDENTURE, Made and entered into this 6th day of August, 1955, by and between THE BOARD OF TRUSTEES OF THE CEBOLLETA (Seboyeta) LAND GRANT, whose address is Seboyeta, Valencia County, New Mexico (hereinafter called "Lessor") and ST. ANTHONY URANIUM CORP., a Nevada corporation duly qualified to do business in the State of New Mexico (hereinafter called "Lessee") W I T N E S S E T H;

WHEREAS, Lessor is the owner of certain lands, property, minerals and mineral rights hereinafter more particularly described and identified, and

WHEREAS, Lessee desires to obtain the exclusive right and privilege to enter into and upon said lands and property for the purpose of prospecting, exploring and testing the same for uranium, thorium and all other minerals, whether similar or dissimilar, excepting, however, oil, gas and coal, and to develop, mine, extract, mill, sell and dispose of the same, and

WHEREAS, Lessor is willing to give to Lessee, and to its successors and assigns, such rights and privileges, upon the terms and conditions hereinafter set forth,

NOW, THEREFORE, IN CONSIDERATION of the sum of Ten Dollars ($10.00) in hand paid by Lessee to Lessor, receipt whereof is hereby acknowledged by Lessor, and in consideration of the covenants and agreements of Lessee hereinafter set forth, and by said Lessee to be kept and performed, said Lessor has demised, leased and granted, exclusively, and by these presents does demise, lease and grant, exclusively, unto said Lessee all

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of that certain land, property, mining ground and minerals, excepting only coal, oil and gas, situate in Valencia County, State of New Mexico, for the purpose of exploring for and mining uranium, thorium and all other minerals, whether similar or dissimilar, with the right to use as much of the surface as is necessary for mining purposes, described as follows, to-wit:

TRACT NO. 1 (One):

A certain tract of land in Valencia County, New Mexico, within the Laguna Indian Purchase No. 1 to which the Indian title has been extinguished according to the decree of the U. S. District Court for the District of New Mexico in the case The United States of America as Guardian of the Indians of the Pueblo of Laguna in the State of New Mexico vs. Pedro Armijo et al (No. 2080 in Equita) in pursuance of the provisions of the Act of Congress dated June 7, 1924 (43 Stat. 636). Complaint number, noted hereon, refers to the Court Decree. The survey of this tract was executed by Oscar B. Walsh, U. S. Surveyor, July 12 to August 22, 1933, under special instruction for Group 306, New Mexico, dated June 7, 1933, and approved by the Commissioner of the General Land Office June 19, 1933.

The tract comprises the south $\frac{1}{2}$ of Section 19, 20, 21, 22 and the SW$\frac{1}{4}$ of Section 23 that is south of the south boundary line of the Cebolleta Grant and which sections are within Township 11 North and Range 4 West of the N. M. P. M.; also the North $\frac{1}{2}$ of Section 29 and 30, all of sections 27 and 28, the NW$\frac{1}{4}$ of Section 26, the NW$\frac{1}{4}$ of Section 34, the NE$\frac{1}{4}$ of Section 33, All in Township 11 North and Range 4 West of the N. M. P. M.; also the south $\frac{1}{2}$ of Section 19, 20, 21, 22, 23 and 24 that are south of the south boundary line of the Cebolleta Grant and the north $\frac{1}{2}$ of section 25, 26, 27 and the NE$\frac{1}{4}$ of Section 28, all sections are within Township 11 North, and Range 5 West of the N. M. P. M.; also the south $\frac{1}{2}$ of Sections 23 and 24 that is south of the south boundary line of the Cebolleta Grant, that portion of Section 22 that is south of the Cebolleta Grant and East of the BACA TRACT, that portion of the north $\frac{1}{2}$ of Section 27 that is east of the BACA TRACT, the north $\frac{1}{2}$ of Section 26, all these sections are within Township 11 North and Range 6 West of the N. M. P. M.

The tract being more particularly described as follows:

BEGINNING at the northwest corner of the tract, which point is on the South Boundary line of the Cebolleta Grant and whence the 6 Mile Corner on the south boundary line of the Cebolleta Grant bears N 89° 34' W, a distance of 15.25 chains and running from said beginning point, along the south boundary line of the Cebolleta Grant as follows:

Thence S 89° 34' E, 63.57 chains to the 7 mile corner;
Thence S 89° 34' E, 76.03 chains to the 8 mile corner;
Thence N 89° 59' E, 75.62 chains to the 9 mile corner;
Thence S 89° 56' E, 75.20 chains to the 10 mile corner;
Thence S 89° 54' E, 79.60 chains to the 11 mile corner;
Thence S 89° 37' E, 79.34 chains to the 12 mile corner;
Thence S 89° 56' E, 79.68 chains to the 13 mile corner;
Thence S 89° 56' E, 79.67 chains to the 14 mile corner;
Thence S 89° 57' E, 79.48 chains to the 15 mile corner;
Thence S 89° 47' E, 79.95 chains to the 16 mile corner;
Thence S 89° 25' E, 78.72 chains to the 17 mile corner;
Thence S 89° 27' E, 80.94 chains to the 18 mile corner;
Thence S 89° 25' E, 78.13 chains to the 19 mile corner;
Thence S 89° 30' E, 18.90 chains to the southeast corner of the Cebolleta Grant;
Thence N 89° 25' E, 25.54 chains to the northeast corner of this tract;
Thence S 0° 10' W, 38.48 chains to the south ¼ corn of Sec. 23, T 11 N, R 4 W;
Thence S 0° 01' E, 40.00 chains to C ¼ corner of Sec. 26, T 11 N, R 4 W;
Thence S 89° 54' W, 40.07 chains to west ¼ corn. of Sec. 26, T 11 N, R 4 W;
Thence S 0° 01' E, 40.00 chains to SW corn. of Sec. 26, T 11 N, R 4 W;
Thence S 89° 55' W, 40.00 chains to north ¼ cor. of Sec. 34, T 11 N, R 4 W;
Thence S 0° 01' E, 40.00 chains to C ¼ cor. of Sec. 34, T 11 N, R 4 W;
Thence S 89° 56' W, 40.00 chains to west ¼ cor. of Sec. 34, T 11 N, R 4 W;
Thence S 89° 58' W, 40.00 chains to C ¼ Cor. of Sec. 33, T 11 N, R 4 W;
Thence N 0° 20' W, 40.02 chains to north ¼ Cor. Sec. 33, T 11 N, R 4 W;
Thence S 89° 58' W, 40.04 chains to SW Cor. of Sec. 28, T. 11 N, R 4 W;
Thence N 0° 03' W, 40.00 chains to west ¼ cor. Sec. 28, T 11 N, R 4 W;
Thence S 89° 59' W, 79.92 chains to west ¼ cor. Sec. 29, T 11 N, R 4 W;

Thence N 89° 53' W, 80.06 chains to west ¼ cor. Sec. 30, T 11 N, R 4 W,
Thence N 89° 49' W, 80.02 chains to west ¼ cor. Sec. 25, T 11 N, R 5 W,
Thence N 89° 46' W, 79.97 chains to west ¼ cor. Sec. 26, T 11 N, R 5 W,
Thence N 89° 52' W, 79.97 chains to west ¼ cor. Sec. 27, T 11 N, R 5 W,
Thence N 89° 49' W, 39.99 chains to C ¼ cor. Sec. 28, T 11 N, R 5 W,
Thence N 0° 07' E, 40.01 chains to south ¼ cor. Sec. 21, T 11 N, R 5 W,
Thence N 89° 55' W, 40.00 chains to SW cor. Sec. 21, T 11 N, R 5 W,
Thence N 89° 37' W, 79.74 chains to SW Cor. Sec. 20, T 11 N, R 5 W,
Thence N 89° 51' W, 77.74 chains to SW cor. Sec. 19, T 11 N, R 5 W,
Thence N 89° 48' W, 79.96 chains to SW cor. Sec. 24, T 11 N, R 6 W,
Thence S 0° 01' E, 40.00 chains to west ¼ cor. Sec. 25, T 11 N, R 6 W,
Thence N 89° 51' W, 79.97 chains to west ¼ cor. Sec. 26, T 11 N, R 6 W,
Thence N 89° 35' W, 65.72 chains to southwest corner of the tract;
Thence N 48° 23' W, 14.92 chains to a point;
Thence N 27° 10' E, 52.08 chains to a point;
Thence N 0° 10' E, 20.00 chains to a point;
Thence north, 6.20 chains to the northwest corner and the point of beginning, containing a total area of 8,511.68 acres from which is deducted 768.76 acres for Private Claims, leaving a net area owned by the Board of Trustees of the Cebolleta Grant of 7,742.92 acres.

TRACT NO. 3:

A certain tract of land in Valencia County, New Mexico being within Section 20, and a small portion within Section 19, Township 11 North, Range 6 West and being more particularly described as follows:

Beginning at the northeast corner, a point on the south line of the Cebolleta Grant, whence the 4½ mile corner of the south line of the Cebolleta Grant bears S 89° 44' E, a distance of 6.29 chains and running thence N 89° 44' W, 32.305 chains to the 4 mile corner on the south line of the Cebolleta Grant; thence N 89° 39' W, 29.73 chains to the Northwest corner; thence S 58° 58' E, 39.54 chains to a point; thence S 85° 07' E, 25.64 chains to the southeast corner; thence North 20.43 chains to the Northeast Corner and the point of beginning, containing 94.048 acres.

TRACT NO. 7-A

A certain tract of land in Valencia County, New Mexico, being within the Cebolleta Grant and known as Tract No. 7-A as shown on Map of the Cebolleta Grant and Subdivisions as surveyed by Geo. Pradt, H. R. Whiting and J. M. Moore in Jan. 18, 1905, and comprising portion of Sections 25, 26, 35 and all of Sections 36 in Township 12 North, Range 6 West of the New Mexico Principal Meridian; and portions of Sections 2, 11, 14, 23, 24 and all of Sections 1, 12, 13 in Township 11 North, Range 6 West of the New Mexico Principal Meridian; and portions of Sections 26, 27, 28, 29, 30, 35 and all of Sections 31, 32, 33, 34 in Township 12 North, Range 5 West of the New Mexico Principal Meridian; and portions of Sections 2, 11, 14, 19, 20, 21, 22, 23 and all of Sections 3, 4, 5, 6, 7, 8, 9, 10, 15, 16, 17, 18 in Township 11 North Range 5 West of the New Mexico Principal Meridian; the tract being more particularly described as follows;

BEGINNING at the southwest corner of the Tract, which point is also the 7½ Mile Corner on the south boundary line of the Cebolleta Grant and running from said beginning corner as follows; Thence North a distance of 374.00 chains to the northwest corner; Thence East a distance of 446.30 chains to the northeast corner; thence South a distance of 374.00 chains to the southeast corner; thence West a distance of 446.30 chains to the southwest corner and the point of beginning, containing a total area of 16,693 acres from which is deducted 3,426 acres for Private Claims leaving a net area of 13,267 acres owned by the Board of Trustees of the Cebolleta Grant,

including any and all right, title and interest of said Lessor in and to any and all lodes, veins or mineral deposits contained in said demised property, or any part thereof, except as specifically herein excluded.

TO HAVE AND TO HOLD unto said Lessee, and to its successors and assigns, for the primary term of one year, beginning on the date that the resolution of the Board of Trustees of the Cebolleta (Seboyeta) Land Grant authorizing the execution of this lease is ratified and approved by the District Court of Valencia County, State of New Mexico, and from year to year thereafter as long as the Lessee complies with the terms and conditions of this lease.

THE TERMS AND CONDITIONS OF THIS LEASE ARE AS FOLLOWS:

1. On the date on which the District Court of Valencia County, New Mexico, approves and ratifies the resolution of the Board of Trustees of the Cebolleta (Seboyeta) Land Grant authorizing the execution of this Lease, Lessee shall pay to Lessor the sum of FORTY-TWO THOUSAND TWO HUNDRED EIGHT AND NO/100 ($42,208.00) DOLLARS, which said sum shall constitute payment of rental for the period of one year from the effective date of this Lease, said sum of FORTY-TWO THOUSAND TWO HUNDRED EIGHT AND NO/100 ($42,208.00) DOLLARS being calculated on the basis of the demised premises covering approximately 21,104 acres.

Lessee is hereby given the right and option to continue and extend this lease thereafter for successive year-to-year terms by the payment by Lessee to Lessor of an annual rental of TWENTY-ONE THOUSAND ONE HUNDRED FOUR AND NO/100 ($21,104.00) DOLLARS, which amount shall be payable each year on or before the anniversary date of this lease, said annual rental payment of TWENTY-ONE THOUSAND ONE HUNDRED FOUR AND NO/100 ($21,104.00) DOLLARS being calculated on the basis of the demised premises covering approximately 21,104 acres.

2. The acreage payments provided for in this Lease have been computed on the basis of 21,104 acres, but the exact number of acreage owned by the Grant and covered by this lease has not been accurately ascertained because certain of the private claims situate in Tract No. 7-A have not been surveyed. If and when the exact amount of acreage is ascertained by survey, it is agreed that all previous and subsequent rental payments shall be adjusted to conform to the exact amount of acreage so ascertained, provided, however, that if the exact amount of acreage is not so ascertained prior to the termination of this lease, then all rental payments made during the term of the Lease, computed on the basis of 21,104 acres, shall be final

conclusive and binding upon both Lessor and Lessee.

Lessee agrees, within five (5) years from the effective date of this lease to be in actual production and from the time of beginning production to continuously engage in production, or in exploration or development work in accordance with accepted, diligent mining practices. If Lessee defaults in the performance of this covenant, the Lessor shall have the right to terminate this lease by giving Lessee written notice, in which said written notice Lessor shall specify the grounds of such claimed default. Said notice shall be sent to Lessee by registered mail, return receipt requested, and Lessee shall have thirty (30) days after receipt of such notice of default within which to cure such default and avoid forfeiture.

3. As further consideration for this lease, Lessee agrees to pay to Lessor, on any ores mined and sold by Lessee from the demised premises a percentage royalty of 10% of the mine value per dry ton.

"MINE VALUE PER DRY TON", wherever used herein, is hereby defined as the dollar value per dry ton of crude ores at the mine to be computed in accordance with the appropriate and prevailing established price schedules for such ores of the Atomic Energy Commission or other government authorized agencies. However, if the Government at any time hereafter does not establish or pay for said ores on a fixed or scheduled dollar value per dry ton of crude ores at the mine, then "mine value per dry ton" shall be deemed to be the fair market dollar value per dry ton of said crude ore at the mine. Whether or not the government has established or pays for said ores on a fixed or scheduled dollar value per dry ton of crude ores at the mine, "mine value per dry ton" shall include any mine production bonuses, but shall exclude any transportation and development allowances or bonuses.

Payments or credits shall be made on or before the twentieth (20) day of the month next following receipt by Lessee of payment for said ores, and a statement of the mine value of said ores and the amount of royalty due on each lot shipped and sold shall accompany said payment or credit.

4. All amounts and sums provided in this lease to be paid by Lessee to Lessor shall be paid by Lessee to ALBUQUERQUE NATIONAL BANK, ALBUQUERQUE, NEW MEXICO, to Lessor's credit, and said Bank shall be and hereby is constituted the agent of Lessor to receive and accept such payments. Lessee shall have no responsibility for the disposition of any sums or amounts so deposited in said Bank to Lessor's credit.

Lessor may substitute any other bank in the State of New Mexico in the place of Albuquerque National Bank, but Lessee shall not be obligated to make payments to such substituted bank until Lessee has received, by registered mail, a certified copy of the Resolution of the Board of Trustees of the Grant making such substitution, such notice to be addressed to Lessee at P. O. Box 1901, Grand Junction, Colorado, or to such other address as Lessee may hereafter furnish to Lessor in writing by registered mail, addressed to Lessor at Seboyeta, New Mexico.

5. If ore is mined and sold from the demised property during the first year, the rental payment of FORTY-TWO THOUSAND TWO HUNDRED EIGHT AND NO/100 ($42,208.00) DOLLARS shall be credited against any royalties actually earned during the first year of this lease, and no royalty payments shall be due from Lessee to Lessor in respect of the first year unless and until the royalties payable under the terms of this lease shall exceed the rental payment of FORTY-TWO THOUSAND TWO HUNDRED EIGHT AND NO/100 ($42,208.00) DOLLARS made by Lessee to Lessor.

If ore is mined and sold from the demised property in any year subsequent to the first year of this lease, each annual rental payment of TWENTY-ONE THOUSAND ONE HUNDRED FOUR AND NO/100 ($21,104.00) DOLLARS shall be credited against royalties actually earned during the yearly period covered by such annual rental payment, and no royalty payment shall be due to

Lessor in respect to such year unless and until the royalties payable under the terms of this lease shall exceed such rental payment of TWENTY-ONE THOUSAND ONE HUNDRED FOUR AND NO/100 ($21,104.00) DOLLARS made by Lessee to Lessor.

6. Lessee shall have the free and unobstructed use of so much of the surface of land herein described as may be requisite and necessary to carry on economical operations for mining therefrom, including the erection and use of milling and tailing facilities, and shall, likewise, have right-of-way in, over and upon any part or portion of any land situate on the entire 21,103.988 acres of land comprising the Grant, excepting privately owned land, for the purpose of railroads, roads, trails, tramlines, power lines or other facilities or other means of transportation or communication for the purpose of mining and transporting the same to market, it being understood, however, that no houses or buildings shall be damaged by any construction work.

7. During the term of this lease, the Lessee shall pay taxes upon personal property used by it in its business of mining, milling and transporting from said Grant lands, including sales tax upon all minerals sold, and will assess in its name and pay all taxes upon machinery installed either above or below the surface of the ground for the purpose of mining, milling, transporting and marketing all minerals taken from said lands.

8. The Lessor shall pay all taxes now due on the common lands of the Grant and shall pay all taxes which may be later assessed against the common lands of said Cebolleta Grant during the life of this lease so the Lessee may have full protection and enjoyment of its lease. In the event Lessor fails to pay any such taxes, Lessee shall have the right to pay said taxes and any such payments made by Lessee shall be deducted by Lessee from any sums due to Lessor.

9. The Lessee agrees to employ labor from among the people of the Cebolleta Community whenever possible to do so, provided such labor is competent and is willing to work at the usual and customary wage paid for similar work. Lessee agrees to notify the Board of Trustees of the Cebolleta Land Grant of Lessee's labor requirements, and said Board of Trustees shall furnish a list of all available persons in the Grant who are willing and able to be employed, provided, however, that the Lessee shall not be required to hire any persons on said list or who are members of the Grant if in Lessee's sole discretion said persons are not qualified for the available employment.

10. The Lessee shall have the right to take and use such water as may be necessary for the purpose of carrying on mining and milling operations, including the flowing water thereon, and for such purpose the Lessee shall have the right to build dams in the streams thereon for the purpose of impounding the water in said creeks, such dams not to be in excess of twenty-five feet in height and not to interfere with domestic water rights of the people entitled to the ordinary use of the water from said creeks. Water developed by Lessee from wells may be utilized exclusively by Lessee.

11. The Lessor shall have the right, during the term of this lease, to use and occupy the surface of the lands herein described for grazing or agricultural purposes, provided that such use shall not interfere with efficient mining operations of Lessee.

12. Upon termination of this lease all improvements of a permanent nature, such as roads, mine openings, timbers in mines shall become the property of the Lessor, provided, however, that equipment, machinery, milling facilities and milling structures, buildings, boilers and tools shall remain the property of the Lessee, and the Lessee shall have the right to move the same from the land within one year from the termination of this lease.

13. The Lessee agrees that it will keep, at all times, the drifts, shafts, tunnels and other passages and workings of said demised premises thoroughly drained and clear of loose rock and rubbish of all kinds, unless prevented by extraordinary mining casualty, provided that as to abandoned workings, Lessee shall only be obligated to leave the same in a safe condition.

14. All severance taxes and other taxes levied against the mining operations of Lessee shall be paid by Lessee promptly and before the same become delinquent.

15. It is specifically provided that the Lessee may assign its rights hereunder without consent of the Lessor and without notice to the Lessor, but shall furnish to Lessor an executed copy of said assignment. Upon written approval of said assignment by Lessor, Lessee shall be relieved of further obligations and liability under this lease.

16. Lessee shall and hereby agrees to indemnify, protect and save harmless Lessor from and against the following specific claims, demands and damages, and none other, arising out of Lessee's negligence or actionable faults in connection with Lessee's work and operations hereunder, to-wit:

(a) To property of third persons,

(b) To third persons for injury or death,

(c) To livestock of Lessor and to the permanent buildings and structures, fences and all water improvements of Lessor situate on the premises, but to no other property or property interest of Lessor whatsoever, and

(d) Liens or lien claims on account of labor performed upon or material furnished to the said premises at the instance of Lessee.

Lessee agrees to carry such insurance covering all persons working in or on said premises for Lessee as will fully comply with the provisions of the Statutes of the State of New Mexico, covering workmen's compensation and occupational disease, as are now in force or as they may hereafter be changed or amended. Further, Lessee agrees to comply with all of the terms and provisions of all applicable laws of the State of New Mexico and of the United States of America as now existing or hereafter amended, pertaining to social security, unemployment compensation, wages, hours and conditions of labor, and to indemnify and hold Lessor harmless from payment of any damages occasioned by Lessee's failure to comply with said laws.

17. Lessor shall and hereby agrees to indemnify, protect and save harmless Lessee from and against the following specific claims, demands and damages, and none other, arising out of Lessor's negligence or actionable faults in connection with Lessor's operations hereunder, to-wit:

(a) To property of third persons,

(b) To third persons for injury or death,

(c) To buildings, property and equipment of Lessee situate on the premises, but to no other property or property interest of Lessee whatsoever.

18. In event any productive water well drilled by Lessee is abandoned or the premises on which it is located is surrendered, said water well shall become the property of Lessor and all casing in the well necessary to continue it as a producing well shall be left therein and become the property of the owner of the land.

19. If Lessor at any time believes that Lessee is in default under the terms and provisions of this lease it shall notify Lessee, in writing, of the particular default claimed, and if such default shall not be cured within thirty (30) days after the giving of such notice, Lessor may terminate this lease by written notice to Lessee. In the event Lessee shall fail to make any payment of rentals or royalties or other fixed amounts when due, Lessor may terminate this lease upon ten days' written notice to

Lessee, and Lessee's failure to pay the full amount due within that time.

20. Any notice or other instrument in writing herein authorized to be given or delivered to Lessor, or served upon Lessor, may be served upon Lessor, or sent to Lessor by registered mail, postage prepaid, addressed to Lessor at Seboyeta, New Mexico, or to such other address as Lessor may from time to time designate in writing, and any notice or other instrument herein authorized to be given or delivered to Lessee, or served upon Lessee, may be served upon Lessee or sent to Lessee by registered mail, postage prepaid, addressed to Lessee at P. O. Box 1901, Grand Junction, Colorado, or at such other address as Lessee may designate from time to time in writing.

21. Lessee agrees to keep books and accounts covering Lessee's operations and the sale of ores hereunder, and shall permit Lessor at all reasonable hours to examine said books and accounts bearing upon percentage royalties due Lessor. The Lessee shall also furnish to the Lessor a representative pulp of each settlement lot, and Lessor shall have the right to umpire said lots upon making timely request therefor in the customary manner of umpiring.

22. All of the covenants and agreements of this lease shall extend to and be binding upon and every benefit hereof shall inure to the heirs, executors, administrators, successors or assigns of the respective parties hereto.

23. When the resolution of the Board of Trustees of the Cebolleta Land Grant authorizing this Lease, and this Lease are approved by the District Court of Valencia County, New Mexico, this lease will supersede and render null and void that certain Mineral Lease dated February 10, 1953, between the Board of Trustees of the Cebolleta (Seboyeta) Land Grant, as Lessor, and Lee Hanosh, also known as Elias Hanosh, as Lessee, and shall also supersede and render null and void that certain document acknowledged on

March 25, 1954, said document being designated as "Agreement Terminating and Cancelling Paragraph No. 2 of that Certain Mineral Lease by and between Lee Hanosh and the Board of Trustees of the Cebolleta (Seboyeta) Land Grant," and subject to the approval by the District Court of Valencia County, New Mexico, of this lease and of the resolution of the Board of Trustees of the Cebolleta Land Grant approving this lease each of the parties hereto does hereby fully release and discharge the other from any and all claims of any kind and nature whatsoever that one party may have against the other under the terms, conditions and provisions of said Mineral Lease of February 10, 1953, and that certain document acknowledged on March 25, 1954, designated "Agreement Terminating and Cancelling Paragraph No. 2 of that Certain Mineral Lease by and between Lee Hanosh and the Board of Trustees of the Cebolleta (Seboyeta) Land Grant."

IN WITNESS WHEREOF, the parties hereto have caused this instrument to be executed on the day and year first above written.

BOARD OF TRUSTEES OF CEBOLLETA (SEBOYETA) LAND GRANT

BY ______________________

ITS PRESIDENT

ATTEST:

____

ITS SECRETARY

ST. ANTHONY URANIUM CORP.

BY ______________________

ITS Vice President

ATTEST: Thomas E. Congdon

ITS SECRETARY

STATE OF NEW MEXICO
COUNTY OF Valencia ......ss

The foregoing instrument was acknowledged before me this 6th day of August, 1955, by ANASTACIO MARQUEZ, President, and ROSS MARQUEZ, Secretary of CEBOLLETA (SEBOYETA) LAND GRANT, on behalf of said corporation.

____
NOTARY PUBLIC

MY COMMISSION EXPIRES:

STATE OF Colorado
COUNTY OF Denver ::::::SS

The foregoing instrument was acknowledged before me this 6th day of August, 1955, by [illegible] and [illegible], who are [illegible] and [illegible] respectively of ST. ANTHONY URANIUM CORP., a Nevada corporation qualified to do business in New Mexico, on behalf of said corporation.

[illegible]
NOTARY PUBLIC

MY COMMISSION EXPIRES:
My Commission expires April 25, 1959

SUBJECT TO THE APPROVAL by the District Court of Valencia County, New Mexico, of the above and foregoing Mineral Lease and the Resolution of the Board of Trustees of the Cebolleta (Seboyeta) Land Grant authorizing its execution, the undersigned, LEE HANOSH AND RENE M. HANOSH, his wife, do hereby consent and agree to the cancellation of that certain Mineral Lease of February 10, 1953, between the Board of Trustees of the Cebolleta (Seboyeta) Land Grant, as Lessor, and Lee Hanosh, also known as Elias Hanosh, as Lessee, which said Mineral Lease covers the same lands as are described in the above and foregoing lease between the Board of Trustees of the Cebolleta (Seboyeta) Land Grant and St. Anthony Uranium Corp., and do hereby consent and agree to the cancellation of that certain document designated "Agreement Terminating and Cancelling Paragraph No. 2 of that Certain Mineral Lease by and between Lee Hanosh and the Board of Trustees of the Cebolleta (Seboyeta) Land Grant" acknowledged on March 25, 1954.

FURTHER, THE UNDERSIGNED, in consideration of the Lessor and Lessee entering into and executing the above and foregoing lease, do hereby relinquish any and all claims which the undersigned may have in and to the Minerals in, upon or under the lands described in the above and foregoing lease which the undersigned may have by virtue of said lease of February 10, 1953, and the document designated "Agreement Terminating and Cancelling Paragraph No. 2 of that Certain Mineral Lease by and between Lee Hanosh and the Board of Trustees of the Cebolleta (Seboyeta) Land Grant" acknowledged on March 25, 1954.

DATED this 6th day of August, 1955.

x [illegible signature]

[illegible signature]

STATE OF NEW MEXICO
COUNTY OF Bernalillo ....ss

The foregoing instrument was acknowledged before me this 11th day of August, 1955, by LEE HANOSH, also known as Elias HANOSH, and Rene M. Hanosh, his wife.

[illegible signature]

NOTARY PUBLIC

MY COMMISSION EXPIRES:

12-6-58

The above and foregoing Mineral Lease is approved and ordered delivered to St. Anthony Uranium Corp., this 12th day of August, 1955.

[illegible signature]

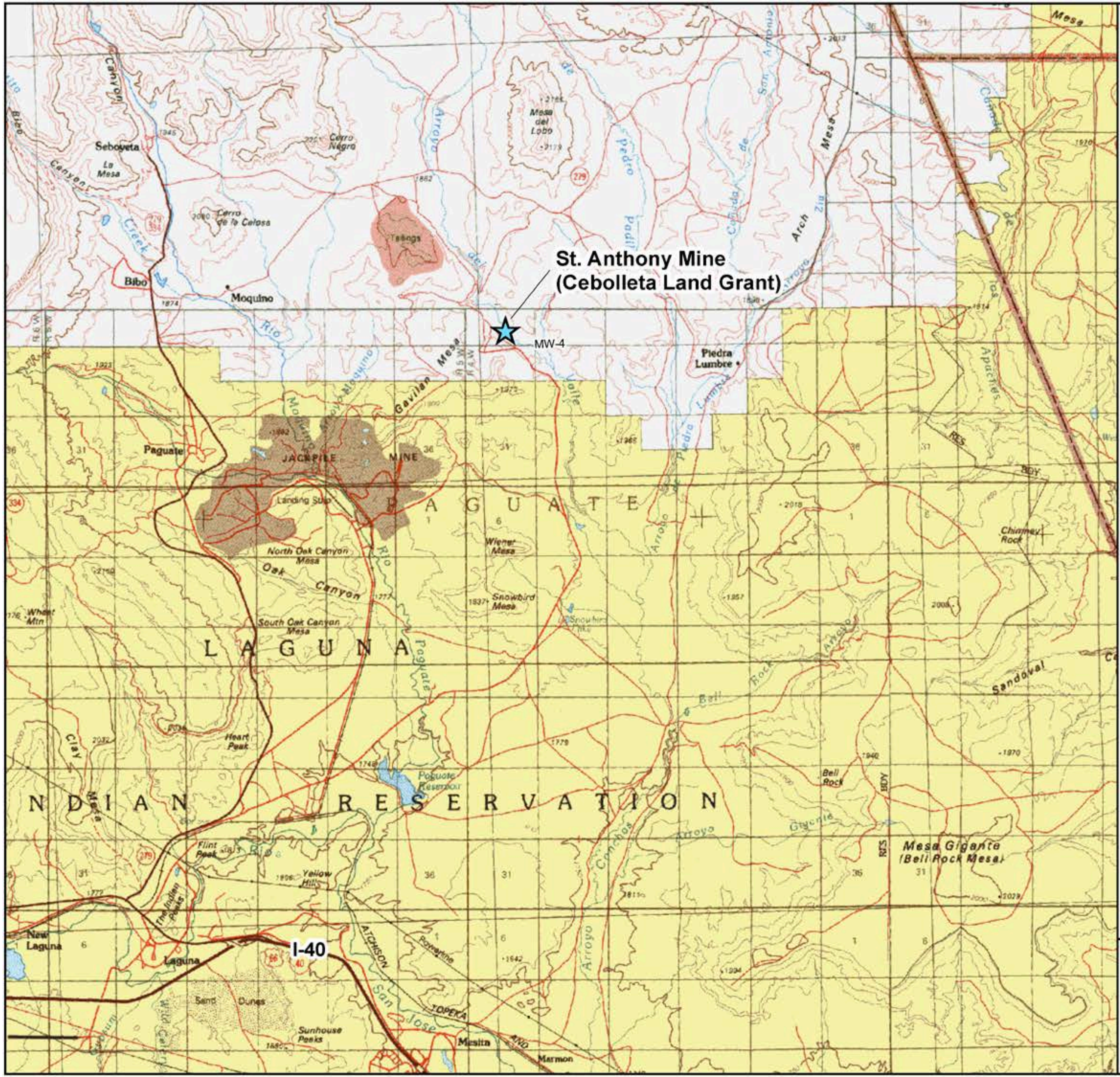
DISTRICT JUDGE

STATE OF NEW MEXICO
COUNTY OF VALENCIA } ss
This Instrument was filed for Record on

AUG 12 1955

at 2:55 o'clock P. M.
Recorded in Vol. ... of Records of ...
... Page ...
... County Clerk
By ... Deputy Rec.

INTERA



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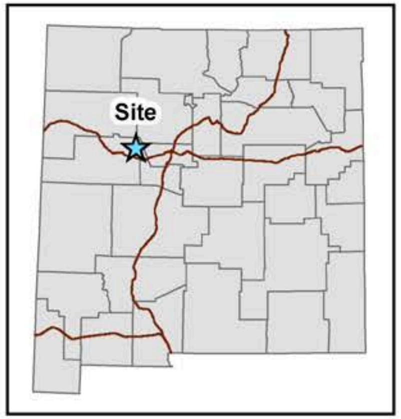
Source(s):
Topo – MapTech, 2006.



UNC Exhibit 4b

Site Location Map

St. Anthony Mine,

AAS Petition Hearing

N

0 700 1,400
Feet

Source(s):
Ore body mass – UNC, 1977;
Aerial – RGIS website, dated 2014

Legend
Stream/Arroyo
Laguna Pueblo Boundary
Subsurface Mine Workings

UNC Exhibit 4c
St. Anthony Mine Site Features
St. Anthony Mine,
AAS Petition Hearing

Exhibit 5

Cynthia Ardito Resume

Cynthia P. Ardito, PH, CGWP

Senior Hydrogeologist/Executive Vice President

Cynthia Ardito has 32 years of professional experience conducting environmental assessments, water resource evaluations, environmental permitting, site characterization, and remedial actions for private, federal, state, and municipal clients. She has specialized expertise in mine permitting and closure, site characterization design, hydrogeologic conceptual model development, application of groundwater flow models to evaluate groundwater impacts and water availability, and evaluation of impacts from chlorinated solvents and petroleum hydrocarbons. She has designed and implemented field programs for aquifer testing, surface water and groundwater characterization, and contaminant plume evaluation. Ms. Ardito's experience includes developing regulatory compliance strategies and conducting environmental assessments for mine sites, landfills, Brownfields and hazardous waste sites, underground storage tank (UST) sites and Superfund sites. She has provided technical and managerial oversight for mine reclamation, landfill reclamation, design and implementation of remediation systems (including vapor extraction/air sparging systems, pump and treat systems, surfactant-enhanced aquifer remediation systems, and bioremediation systems), and groundwater plume characterization and remediation. Her current experience includes specialized expertise in the closure and permitting of uranium mine sites. Ms. Ardito provides litigation support services and expert opinions for natural resource damage claims, water resources impact studies, and groundwater contamination evaluations. She has managed hundreds of environmental and water resource projects ranging in size from several thousand to several million dollars for private, federal, state, and municipal clients. Ms. Ardito is an Executive Vice President and member of INTERA's Board of Directors. She manages the Principal Hydrologists, Geologists and Engineers in INTERA's southwestern divisions.

Project Experience – Mining

Mine Water Management Evaluation, LKAB Lead Mine, Kiruna, Sweden. 2012 – present. *Principal-in-Charge.* Provided managerial oversight of surface water and groundwater modeling for a subsurface lead mine operation in northern Sweden. Iron ore has been produced from the Kiruna iron deposit for over 100 years. Permitting for a planned increase in production volume triggered an operation-wide updating of the mine's permit by Sweden's Environmental Court. INTERA, in concert with a local Swedish company, was tasked with development of surface water, groundwater, and mine water-management models. The team has developed a two-dimensional MODFLOW-SURFACT groundwater model to evaluate potential impacts from mine deformation and expansion on adjacent surface water and groundwater. The groundwater and surface water models were developed in tandem to provide an integrated model of the site. Model results indicated potential impacts on a nearby lake contaminated with PCBs and mercury, future mine discharges, and drawdown impacts beneath Kiruna. The modeling report was submitted as part of the mine's permit application to Sweden's Environmental Court to fulfill the requirement for assessment of mine dewatering impacts.

Natural Resource Damage Assessment, Confidential Client. 2016 – Present. *Technical Lead.* Led the regional evaluation supporting calculation of downstream soils, groundwater and surface water resources impacts caused

Years of Experience: 32

Education:

- MS, 1987, Geology (emphasis in hydrology and hydrogeochemistry), New Mexico Institute of Mining and Technology
- BS, 1983, Geology, University of California

Professional Registrations/ Affiliations:

- Professional Hydrologist, American Institute of Hydrology, 2011, No. 11-HGW-3007
- Certified Groundwater Professional, National Groundwater Association, 2008, No. 113485
- Certified Scientist, New Mexico, 1995, No. 72
- Member, New Mexico Hazardous Waste Management Society
- Member, Albuquerque Geologic Society
- Member, New Mexico Geologic Society
- Member, New Mexico Mining Association
- Member, American Institute of Hydrology
- Member, American Water Resources Association

Professional History:

1991 – Present	Vice President, Division Manager, Senior Hydrogeologist – INTERA Inc. (1992 – 1995, Duke Engineering & Services), Albuquerque, NM
1989 – 1991	Water Resources Specialist/Hydrogeologist – City of Albuquerque, Albuquerque, NM
1989 – 1986	Water Resources Specialist/Hydrogeologist – New Mexico Environment Department, Groundwater Bureau, Santa Fe, NM
1984 – 1986	Research Hydrogeologist – New Mexico Institute of Mining and Technology, Socorro, NM
1985	Hydrogeologist – Rift Engineering, Santa Fe, NM
1983 – 1984	Geologist – U.S. Geological Survey, Menlo Park, CA
1982	Geologist – Tongass National Forest, AK

Specialized Training & Software:

- Uranium mine and mill site evaluations and closure
- Organic contaminant impacts to groundwater

by mining. Review of extensive historical documentation, design of analytical methods and modeling to allocate historical impacts caused by mining activities.

Site Characterization and Closure, Lisbon Mill Tailings, Rio Algom Mining Company Limited [RAML (a subsidiary of BHP Billiton)], Grants, NM. 2014 – Present. *Technical Lead for Site Characterization, Regulatory Compliance and Closure Strategy Implementation.* Technical Lead in development of closure strategies and implementation of supplemental site characterization. INTERA was hired to assist RAML in addressing numerous site characterization deficiencies identified by the Utah Division of Radiation Control (DRC). Due to INTERA's strength in geochemical and hydrologic modeling as well as our extensive experience in uranium mine and mill site evaluations and closures, RAML hired INTERA to lead the final site characterization and closure of its Lisbon Mill Site in Utah. Tasks include: development of improved Site Conceptual Model, characterization of groundwater impacts, geochemical and hydrologic modeling, evaluation of plume migration, evaluation of tailings impacts, and development of Alternative Concentration Limits for ultimate closure of the Site.

Modeling and Performance Assessment for Pit Closure, ERA Ranger Uranium Mine, Northern Territory, Australia. 2011 – Present. *Principle-in-Charge.* Providing managerial oversight of flow and transport modeling for a uranium mine closure. Located inside Kakadu National Park, Energy Resources America's (a division of Rio Tinto) Ranger Uranium Mine has provided the world 10% of its nuclear fuel. A key to mine closure is developing a calibrated three-dimensional groundwater flow model that will be used to assess solute loading to the nearby creek that flows into world heritage wetlands. Effectively demonstrating a closure strategy that is protective of the national park resources is also key to plans for additional uranium mining at the site. Responsible for providing adequate resources for timely completion of deliverables according to client's aggressive schedule.

Regional Groundwater Flow Model Development and Water Resource Evaluations for Mine Permitting, Strathmore Resources, Roca Honda, NM. 2009 – Present. *Project Manager.* Technical oversight for the development of a regional groundwater flow model to be used in various evaluations of mine dewatering effects on local water resources. Tasks include development of a hydrogeologic conceptual model, development of a groundwater flow model, implementation of various mine dewatering scenarios, analysis of effects on water resources, and evaluation of alternatives for water disposal and development

Site Characterization and Closure, Ambrosia Lake Mine and Mill Tailings, Rio Algom Mining Company Limited (a subsidiary of BHP Billiton), Grants, NM. 2006 – Present. *Technical Lead for Regulatory and Closure Strategy Implementation.* Technical Lead in development of regulatory strategies for permit closure and site reclamation. Tasks include review of environmental assessment data for soil, surface water, and groundwater, development of site characterization approaches, presentations to regulatory agencies, development of site characterization strategies, groundwater modeling, site reclamation, and regulatory compliance strategies. Regulatory compliance lead for development of an approach for obtaining alternative abatement standards for permit closure.

Section 27 Mine Site Closure, General Electric/United Nuclear Corporation (UNC), Grants, NM. 2005 – Present. *Senior Hydrogeologist.* Lead for environmental assessment of groundwater impacts associated with former uranium mine. Under the direction of General Electric, United Nuclear Corporation is in the process of closing several inactive uranium mine sites. The Section 27 Mine is one of these sites and includes several mine shafts and vents that are currently under reclamation. Groundwater conditions at the site remain unresolved due to the presence of numerous interconnected mines in the area. The INTERA team has developed an approach for maintaining access to groundwater through ports in the closed vents in order to collect groundwater quality data through time. This task includes implementation of a unique geochemical profiling strategy to demonstrate the chemical complexity associated with groundwater chemistry of the ore-bearing aquifer in this area. INTERA's implementation of this five-year groundwater monitoring program assisted UNC in avoiding costly litigation and is a strategy for obtaining a relatively low-cost approach for closure. The monitoring data will assist the state in developing an approach for evaluation of regional groundwater conditions and a long-term monitoring program.

St. Anthony Uranium Mine Site Closure, General Electric/United Nuclear Corporation (UNC), Bibo, NM. 2004 – Present. *Program Manager and Lead Hydrogeologist.* Lead hydrogeologist for development of technical and regulatory strategies for site characterization and closure of an inactive uranium mine site. The St. Anthony site and includes a pit lake, a dry pit area, non-economic ore piles, and overburden piles associated with past mining activities. The site is currently undergoing closure under the NMED's abatement regulations. Tasks include surface water and groundwater impact investigation and modeling; aquifer testing; recharge analysis; pit lake characterization; overburden characterization approach; remedial alternative feasibility analysis; and development of technical reports documenting characterization results, remedial alternative analysis, and pilot testing. The overburden characterization approach was patterned after a unique compositing methodology developed by the U.S. Geological Survey which focuses on the potential for erosion processes to cause impacts to surface water and groundwater. The INTERA team effectively demonstrated the effects of a distributed ore zone on the variability in groundwater quality at the site and how natural attenuation is preventing the spread of contamination. INTERA has employed the multiple accounts analysis process to evaluate remedial alternatives for tracking numerous inputs from multiple stakeholders and developed a GIS-based tool to allow for multiple users at multiple locations to perform alternatives analysis. INTERA has led the stakeholder involvement process which has resulted in agreement and acceptance by multiple stakeholders of the final remedial action strategies. INTERA has developed an innovative approach for development of an alternative abatement standard (AAS) petition that relies on integration of detailed vadose zone, groundwater, and geochemical sampling, instrumentation and modeling to demonstrate no migration. The AAS Petition has been submitted and is pending regulatory approval anticipated for 2015.

Uranium Resources Inc. Mine Permitting, Uranium Resources Inc., Grants, NM. 2008 – 2014. *Technical Lead.* Lead for development of permitting and closure strategies for opening of an insitu recovery uranium mine in New Mexico. This work included development of a detailed list of pertinent regulatory agencies and key contacts as well as critical path analysis for mine permitting. Currently providing permitting support of exploration activities on a new mine site in New Mexico.

Hydrogeologic Characterization for Uranium Mines and Mill Permitting, Neutron Energy (now part of Uranium Resources Inc.), Albuquerque, NM. 2007 – 2014. *Program Manager and Senior Hydrogeologist.* Lead for development of site characterization and permitting strategies for several mines and a mill permitting site. The company had begun the process of collecting background data for the baseline studies phase of mine permitting. Currently, the projects are on hold awaiting improvements in the market. Tasks included: developing baseline site characterization strategies for soils, surface water and groundwater, work plans for surface water and groundwater sampling for state and federal agencies, and development of a three-dimensional conceptual hydrogeologic model.

Mine Permit Application, Southwest Resources Inc., Ambrosia Lake, NM. 2012 – 2014. *Principal-in-Charge.* On behalf of the owner, responsible for preparation of a Part 3 mining permit for a small (less than 10-acre disturbance) underground uranium mining operation near Ambrosia Lake, NM. Duties include oversight of permit application development and interaction with regulators to ensure appropriate regulatory requirements were imposed and addressed.

Baseline Characterization and Mine Permitting, New Mexico Copper Corporation, NM. 2009 – 2011. *Program Manager and Senior Hydrogeologist.* Providing technical and managerial oversight for baseline characterization, mine permitting, and abatement activities. New Mexico Copper Corporation desires to obtain a state mining permit for the Copper Flat Mine project, a porphyry copper-molybdenum-gold-silver deposit located in the Las Animas mining district of South Central New Mexico. Tasks include development of a sampling and analysis plan (SAP), completion of environmental baseline studies, and design and implementation of surface water and groundwater characterization to evaluate existing site impacts. The sampling program includes measurements and samples from over 40 locations in the Lower Rio Grande and Las Animas Creek Basins on a quarterly basis. This work includes gauging water levels in monitoring wells, measuring volumetric flow from springs, seeps, and streams, installing and maintaining five automated water quality and flow samplers on intermittent streams, and profiling thermal and chemical gradients in the water column of a lake. Other parts of the baseline study included cultural resources, natural resources, soils, climate, and air quality monitoring. Combining data from the study with historic field measurements collected from 1978–1998 by previous operators at the mine, INTERA developed a relational database linked to ArcGIS to aid decision making for monitoring well placement, groundwater remediation, and negotiations with regulators for groundwater and surface-water quality. Additional permitting tasks include submission of a discharge permit application and Stage I Abatement Plan to the New Mexico Environment Department (NMED) Ground Water Quality Bureau.

Abandoned Uranium Mine Assessments, Uranium Producers Group of New Mexico, NM. 2008 – 2009. *Technical Lead.* Provided technical support, recommendations, and oversight to the Uranium Producers Group on statewide environmental assessment of abandoned mine sites. The objective of this study was to evaluate abandoned uranium mine sites to determine impacts and risks and to prioritize required actions.

Fact Witness Support for Insurance Settlement for a Uranium Mine Closure, Comeau Law Firm, Bibo, NM. 2007 – 2008. *Fact Witness.* Fact witness in an insurance settlement to establish potential liabilities associated with soil and groundwater impacts at a uranium mine undergoing closure. Depositions focused on specific state requirements for characterization and closure and how the activities at the site were completed to meet these requirements in the most efficient and cost-effective manner.

Water Quality Evaluation for a Coal-Bearing Aquifer in the Moreno Hill Formation, Southern New Mexico, New Mexico Institute of Mining and Technology Master's Thesis, NM. 1984 – 1986. *Research Geologist.* Research geologist for design, development, and implementation of an integrated laboratory and field program for analysis of sedimentary petrography and groundwater chemistry. Developed a hydrogeochemical model for groundwater chemistry evolution in a coal-bearing aquifer. Through analysis of sediment diagenesis and resulting groundwater chemistry evolution, determined that feldspar weathering provided a buffering capacity for the system, preventing acidification of groundwater moving through the area.

Investigation, Characterization, and Compliance for Multiple Mines Facilities, Chino and Tyrone Mines, Hurley, NM. 1986 – 1989. *Water Resources Specialist for NMED.* Responsible for the hydrogeologic, geochemical, groundwater modeling, and engineering design aspects of mine tailings impoundments and heap leach extraction facilities. Completed compliance site investigations to address soil, surface water, and groundwater conditions at heap leach facilities and tailings impoundments. Worked with facilities to characterize sites and implement groundwater monitoring programs to evaluate compliance with discharge permits. Developed a water quality management plan for areas impacted by copper- and gold-mining operations. Manager for review and approval of design and implementation of a large pumping and treatment system designed to prevent further migration of groundwater impacted by seepage from large mine tailings facilities.

Project Experience – Environmental

Evaluation of PCE Impacts at Missile Sites in Wyoming, Wyoming Department of Environmental Quality, WY. 2014 – Present. *Principal-In-Charge*. Managing a team of experts to evaluate effectiveness of site characterization and remedial actions at former missile sites in Wyoming. The team has been hired by the Wyoming Department of Environmental Quality (WDEQ) to assist in the regulatory oversight and potential enforcement of missile site closure. At one site a ten-mile long plume threatens municipal wells.

Expert Witness for Chlorinated Solvent Impacts to Groundwater Contamination, Confidential Client, 2014 – present. *Expert Witness.* Expert witness in an insurance case settlement involving timing of impacts to groundwater associated with PCE contamination at a Superfund Site. A large-scale vapor plume and associated groundwater plume was originally detected in the 1990's and several municipal wells were taken out of service at that time. The PCE contamination is a result of numerous sources dating back to the 1950s. Tasks include evaluation of numerous reports describing site-specific hydrologic, geologic, and plume characteristics, environmental assessments to determine the potential for additional sources, modeling of timing of impacts to groundwater and development of an expert opinion.

Expert Witness for Leaking Underground Storage Tank Groundwater Contamination, Confidential Client, 2006 – 2012. *Expert Witness*. Expert witness in a litigation case to evaluate potential impacts to a third party in an area with multiple leaking underground storage tanks. A release from the client's facility is alleged to have impacted a neighbor resulting in impacts to property and business revenue. INTERA's work was focused on evaluation of multiple sources, migration pathways, and timing of releases. Tasks included evaluation of site-specific hydrologic, geologic, and plume characteristics, evaluation of regulatory files, critique of opposing expert opinions, and development of expert opinions. INTERA's work was key to final settlement of the case.

Voluntary Remediation of the Caldwell Motors Sites, Wells Fargo Bank, NM. 2002 – Present. *Senior Hydrogeologist.* Technical and managerial oversight in support of Wells Fargo Bank's management of Caldwell Trust and attempts to sell property. Tasks include site characterization and NMED's Voluntary Remediation Program (VRP) closure at this leaking underground storage tank and vehicle maintenance disposal site. Site soils contaminated with hydraulic fluids and other organic contaminants associated with vehicle maintenance were closed under the VRP. Groundwater monitoring for natural attenuation is ongoing.

NMED's Voluntary Remediation Program, New Mexico Environment Department (NMED), NM. 1999 – 2014. *Principle-In-Charge and Senior Hydrogeologist.* Provided technical and managerial oversight for the execution of INTERA's NMED Voluntary Remediation Program (VRP) contract which has been successfully awarded to INTERA three times for a total of 12 years. Environmental assessments have been conducted at more than 30 sites located throughout the state of New Mexico. Many of these sites involve municipalities considering applying for closure under NMED's VRP. Worked closely with the NMED project managers to evaluate site conditions and determine what was necessary for a particular site to come to closure through the VRP. The range of activities performed at these sites include: development of site-specific sampling and analysis plans, health and safety plans, and quality assurance project plans; sampling soil and groundwater; geophysical surveys; landfill gas sampling and analysis; groundwater modeling; aquifer testing; feasibility studies; risk assessment; community relations; and regulatory analysis. Brief descriptions of specific New Mexico sites follow:

- **Nine-Mile Hill Landfill, Bernalillo County, NM.** In conjunction with NMED VRP and the County of Bernalillo, developed a strategy for evaluating potential for groundwater impacts from this 48-acre landfill about 10 miles west of downtown Albuquerque. Designed a passive soil gas survey by installing Gore Sorber modules on a grid with approximately 100-foot spacing. The modules were installed in a small hole advanced to approximately 2–3 feet. Overall, the concentrations of contaminants from this passive soil gas survey were found to be relatively low, and determined not to be indicative of groundwater contamination.
- **Old Silver City Landfill, Silver City, NM**. Evaluated the potential for chlorinated solvent sources in the vicinity of the landfill to contaminate groundwater in the area. In addition, INTERA evaluated the viability of harnessing the methane gas from the landfill for energy purposes. Methane gas concentration estimates across the landfill indicated that there was not enough landfill gas available to provide a viable energy source.
- **San Antonio Landfill, City of Albuquerque, NM.** Worked with the NMED VRP and the City to develop a strategy for characterizing this 43-acre landfill. NMED VRP decided to complete only the first task of the Phase II investigation, which was a geophysical survey to evaluate the thickness of the cap and the depth of the buried waste material.
- **Santa Fe Railyard Property, NM.** This site is the subject of a Brownfields Redevelopment Pilot Project Grant from the EPA, and INTERA developed all work plans in conjunction with NMED VRP, EPA, and the City of Santa Fe. Completed Phase I in accordance with ASTM standards (E-1527-97) of this very complex 33-acre railyard. Designed a Phase II investigation based on the Phase I, which involved the following activities: preliminary evaluation of groundwater impacts, development of soil sampling strategy and quality assurance project plan, and review and compilation of hydrogeologic data from previous reports and published information. The hydrologic review indicated a complex groundwater flow system influenced by perching, faulting, and heterogeneity. INTERA completed an aquifer test followed by development of a simple flow model to better evaluate this complicated system, and determined that shallow groundwater contamination at the site is not likely to impact the local water supply.
- **Angel Fire and Eagle New Wastewater Treatment Plants, NM.** Performed feasibility evaluations for the two villages to determine the best options for removal and disposal of sewage lagoon sludge.
- **Peru Hill Mill, Deming, NM.** In conjunction with NMED VRP and the City of Deming, developed a work plan for a Phase II investigation which included the following: surface and subsurface soil sampling, soil boring installation, monitoring well construction, groundwater sampling, hazardous waste characterization and disposal, development of a preliminary cap design for tailings cover, and assessment for asbestos-containing building materials. Additionally, in conjunction with INTERA's risk assessment subcontractor Neptune, developed site-specific remediation goals for arsenic.
- **Wisconsin Mill and San Vicente Creek, Silver City, NM.** Performed Phase I Environmental Site Assessments for a combined 33-acre tract in Silver City, NM, in accordance with ASTM standards (designation E-1527-00). The sites are the subject of potential Brownfields Redevelopment Project Grants from the EPA. Accordingly, all work performed by INTERA was subject to review and approval by the NMED, EPA, and the Town of Silver City. The sites are located in an area of commercial and light industrial property, with a complex development history dating back more than 120 years.

Statewide Evaluation of Leaking Undergrounds Storage Tank and Hazardous Materials Sites, New Mexico State Department of Transportation (NMDOT), NM. 1991 – 2014. *Program Manager and Senior Hydrogeologist*. Led the characterization and remediation of leaking underground storage sites and hazardous materials sites throughout New Mexico. The NMDOT has utilized INTERA's expertise for evaluating potential site impacts for over 20 years. Tasks have includes Phase I and II environmental assessments in roadway corridors slated for improvements and at patrol yards that have leaking underground storage tanks requiring remediation. The NMDOT has relied on INTERA's thoroughness and expertise to enable sound decision-making for right-of-way purchases and remedial actions. Ultimately responsible for providing sufficient site characterization data for compliance with pertinent regulations, determination of contaminant sources, and determination of site risks, and for design of remedial action systems including: large-scale soil vapor extraction and air sparging systems, groundwater pumping and treatment systems, soil excavation, and on-site remediation of soil through bioaugmentation at NMDOT sites. INTERA's team has ongoing responsibilities for several of the NMDOT's leaking tank sites where long term monitoring and some remediation activities continue.

Environmental Assessment and Site Reclamation, CHRISTUS St. Vincent Regional Medical Center, Santa Fe, NM. 2009 – 2010. *Project Manager.* Manager for environmental impact assessment and remediation of historical discharge practices at the hospital.

Removed and disposed of unpermitted discharge system and demonstrated that issues associated with anomalous radiation readings were not the result of hospital practices.

Remedial Investigation of the Mountain View Subdivision, New Mexico Environment Department, NM. 2009 – 2010. *Senior Hydrogeologist.* Provided senior technical review for site characterization strategy development and evaluation of potential for further groundwater quality degradation by nitrate at the Mountain View subdivision in Albuquerque, New Mexico. Over-fertilization at a produce farm in this area caused groundwater impacts that polluted numerous private wells. Provided technical support in designing a strategy for evaluation of ongoing groundwater impacts and development of a conceptual model for contaminant migration and natural attenuation in support of ongoing remedial alternatives analysis.

Statewide Remedial Investigations, Feasibility Studies, and Remedial Design for State-led Superfund Program, New Mexico Environment Department (NMED), Santa Fe, NM. 1999 – 2008. *Program Manager and Senior Hydrogeologist*. Program manager for eight-year contract with the NMED's Superfund Program. Provided technical and managerial oversight for remedial investigations and feasibility studies (RI/FS), and remedial designs at sites in New Mexico. Worked closely with the EPA Region VI project manager and NMED program manager to evaluate site conditions, perform contaminant transport modeling, and conduct risk assessments. The range of activities performed at these sites included development and implementation of sampling strategies for soil, surface water and groundwater sampling, deep-well drilling, aquifer testing and analysis, geophysical surveys, soil gas surveys, contaminant transport modeling, risk assessment, and development of remedial investigation final reports. Representative project summaries follow:

- **Remedial Investigation, Feasibility Study, and Remedial Design, North Railroad Avenue Plume, Espanola, NM.** The site consists of an approximately 58-acre, 260-foot-deep plume of groundwater contaminated with perchloroethene (PCE) and trichloroethene (TCE). The contaminated groundwater plume is in a sole-source drinking water aquifer for the City of Española, the Santa Clara Pueblo, and nearby populations. INTERA designed and implemented the RI/ FS and the remedial design. The major components of the remedy used innovative technologies including in-situ flooding of the source area with a surfactant/cosolvent mixture and in-situ enhanced biodegradation of chlorinated ethenes in the downgradient plume. INTERA provided engineering oversight for the remedial action which included enhanced in-situ bioremediation for both the source area and the dissolved phase.
- **Remedial Investigation and Feasibility Study, Fruit Avenue Plume, Albuquerque, NM.** The site consists of wide-spread dissolved-phase TCE plume in a sole-source drinking water aquifer in downtown Albuquerque. INTERA determined that the groundwater contamination at this site extended for more than 2,750 feet downgradient and to a depth of 500 feet below ground surface. It was also determined that multiple sources were involved but the release events were too old to absolutely determine the specific source area. Deep-well drilling, aquifer testing, risk assessment, and contaminant transport modeling were the major activities accomplished, as well as completion of a feasibility study final report.

Evaluation of Groundwater Impacts in Natural Resource Damage Lawsuit, Modrall Law Firm, NM. 2000 – 2003. *Project Manager and Technical Support.* Managed a team of hydrologists, geologists, and engineers in a natural resource damage lawsuit filed by the Attorney General of New Mexico against the responsible parties of the South Valley Superfund site. Tasks included evaluation of the potential extent of groundwater impacts by one of the responsible parties through data analysis and modeling, and the valuation of the groundwater resource damaged. Assisted in strategy development and research to determine extent of client's responsibility and potential for water reuse in the area.

Site Characterization, Remediation and Closure of Environmental Restoration of Hazardous Waste Sites, Sandia National Laboratory (SNL), Albuquerque, NM. 1991 – 2004. *Program Manager.* Led a team of geologists, hydrologists, and engineers in the site characterization, remediation, and closure of numerous sites in SNL's Environmental Restoration Program. Tasks included development of field programs for contaminant plume delineation, geophysical studies, aquifer testing, soil vapor extraction pilot testing, and groundwater sampling. Additional tasks included development of regulatory compliance strategies, corrective measure studies, closure plans, and post-closure monitoring documents and development of a strategy for baseline characterization of site geology and hydrology. Recipient of SNL President's Award for Outstanding Service. Representative assignments included:

- **Development of Site Characterization, Remedial Action and Closure Strategy for SNL's Chemical Waste Landfill (CWL).** The CWL was one of SNL's highest priority sites because groundwater impacts by chlorinated solvents had occurred 500 feet below ground service from a large vapor plume. Served as technical lead for this site and designed an approach for Resource Conservation and Recovery Act (RCRA) closure that incorporated voluntary corrective actions and the employment of innovative tracer technologies for delineating dense non-aqueous phase liquids (DNAPLs) to decrease uncertainty and accelerate closure. Other tasks included development of a regulatory compliance strategy consisting of quarterly closure reporting, groundwater monitoring evaluation, and closure plan modifications. Developed numerous closure plan modification requests for changes to the groundwater monitoring and corrective action programs, which resulted in significant cost savings. Supervised a project team for soil gas characterization, data analysis, and modeling, including soil gas surveys, surface and borehole geophysical surveys, and soil and groundwater sampling programs. Designed multilevel monitoring wells to assess gradients and vertical extent of contamination. Implemented an innovative monitoring well gas sampling technique for collecting samples of a gas plume in contact with groundwater through use of inflatable packers to collect gas samples at the air/water interface. INTERA's work resulted in regulatory reconsideration of an extensive groundwater monitoring program and the potential for savings to the program of one-half million dollars. Work at this site has been published in American Society for Testing and Materials (ASTM)'s STP 1261.

- **Technical Team Member for Development of the RCRA Corrective Action Management Unit (CAMU) for SNL.** Specific responsibilities included evaluation of suitability of the CAMU role to SNL/New Mexico's Environmental Restoration Project. The CAMU was implemented and allowed SNL to manage and remediate waste from more than 100 sites at the facility. This approach resulted in significant savings in time and money for SNL. The INTERA team developed disposal cell cap design, vadose monitoring systems, and groundwater monitoring waiver application, as well as a closure plan for the CAMU.
- **Technical Coordinator for the SNL Remedial Action Technology Evaluation at the Mixed Waste Landfill Integration Demonstration Project.** Coordinator for innovative remedial action technology evaluation demonstration. Responsible for defining technical needs of the Environmental Restoration Project, evaluating proposals for suitable technologies, and assisting project teams in design of the demonstration programs.
- **Project Manager for Development of SNL's Site Wide Characterization Program**. Managed a team of hydrologists and geologists tasked with development of SNL's baseline characterization program. The final published report provided the baseline hydrogeologic conditions for evaluation of hazardous waste site characterization, remediation and closure strategies.

Environmental Assessment and Remediation, Bernalillo County Tank Sites, Albuquerque Environmental Health Department, Albuquerque, NM. 1989 – 1991. *Water Resources Specialist for Albuquerque Environmental Health Department*. Responsible for the assessment and remediation of more than 50 leaking USTs throughout the Bernalillo County area. Evaluated adequacy of site assessments, remedial designs, monitoring programs, and remedial action implementation. Responsible for site inspections, design and implementation of soil gas and groundwater monitoring programs to independently evaluate contractor performance and site conditions. Independent analysis resulted in the discovery of additional leaks and requirements for more extensive corrective action. Provided technical oversight for application of the first soil venting/air sparging remedial action in New Mexico. Evaluated the adequacy of the pumping and treatment method to remediate petroleum contamination at this site. Developed approach for application of the subsurface volatilization and ventilation system (SVVS) technology. Developed a contingency plan and monitoring strategy to assess plume migration potential.

Environmental Assessments, Multiple Facilities, NMED Groundwater Bureau, Santa Fe, NM. 1986 – 1989. *Water Resources Specialist for the New Mexico Environment Department.* Responsible for assessing the potential for impacts to groundwater resulting from discharge activities under the jurisdiction of the New Mexico Water Quality Control Commission. Reviewed more than 50 discharge plans from all types of facilities, including industrial waste lagoons and septic tanks, surface impoundments, dairies, landfills, and mines. Assessed the potential for groundwater impacts, worked with the applicants to obtain necessary information to complete a groundwater protection assessment, and made recommendations to approve or deny the discharge permits.

Natural Resource Evaluation, Piute Range, Mojave Desert, CA. 1983 – 1984. *Field Geologist.* Responsible for performing geologic reconnaissance mapping in the Piute Range Wilderness Study Area, Mojave Desert, CA. Field mapping, aerial photograph mapping, and petrographic analysis were used to determine the likelihood of available mineral resources.

Natural Resource Development, Tongass National Forest, Sitka, AK. 1982. *Field Geologist*. Geologist in charge of field team for locating potential rock quarry sites for timber access roads in remote areas. Aerial photograph analysis and field mapping were used to locate rock sources suitable for road building in an area dominated by metamorphic rocks that could not be used.

Project Experience – Water Resources

Water Availability Analysis for Ft. Sill Apache Commercial Development, Deming, NM. 2012 – Present. *Project Manager and Principal Hydrogeologist.* Led the development of an environmental assessment document to evaluate potential impacts associated with development of a gaming facility on the Ft. Sill Apache homeland just east of Deming, NM. The EA considers the environmental impacts associated with expansion to a 30,000-square-foot gaming facility. Technical lead for development of groundwater impact assessment using Office of the State Engineer regional model for the area.

Water Availability and Environmental Permitting for Ft. Sill Apache Tribe, Deming, NM. 2011 – Present. *Project Manager and Lead Hydrogeologist.* Technical lead for evaluating water supply options and environmental permitting requirements for development projects on the newly reinstated Ft. Sill Apache Tribe reservation.

Water Availability Analysis for Potash Mine Permitting, Intercontinental Potash, Carlsbad, NM. 2010 – 2013. *Principle-in-Charge.* Technical lead for feasibility study to evaluate water supply options for mining and mineral processing. This project is a critical-path water resource evaluation for the permitting of a polyhalite mine in New Mexico. As water is scarce, the INTERA team critically evaluated the cost and benefits of multiple alternatives for water development. Tasks for the project included: meetings with key state personnel, background hydrogeologic research, background regulatory research, site characterization, and water supply impact modeling.

Water Availability Analysis for Public Regulatory Commission Hearing, Modrall Law Firm, San Antonito, NM. 2010 – 2014. *Expert Witness.* Expert witness for New Mexico Water Service Company's petition to address water rights and water availability issues in its case before the New Mexico Public Regulation Commission (PRC). Development of water resources by multiple water utilities resulted in an impairment hearing before the PRC. INTERA was hired to evaluate the water availability in the area. Tasks included review of background material in the case, development of a hydrogeologic conceptual model, and development of an expert opinion with regard to the amount of water available for development in the aquifers in question. The expert opinion supported a successful outcome to the hearing for the New Mexico Water Company. More recent activities included supporting ongoing water rights litigation activities involving evaluation of defendant's water modeling and evaluation of potential impacts on New Mexico Water Company's water supply wells caused by implementation of a planned new development. INTERA's work resulted in the successful settlement of the case.

Water Treatment Feasibility Study for Brackish Water Development, Universal Assets Management (UAM), Sandoval County, NM. 2009 – 2010. *Project Manager and Technical Lead.* Led regulatory compliance analysis for water treatment feasibility study. The INTERA team provided regulatory compliance analysis support to UAM's team of engineers focused on evaluating the cost of treating brackish water from a deep aquifer in Sandoval County. Sandoval County is currently investigating alternative water resources to address development pressures in one of New Mexico's most rapidly expanding counties. Tasks included evaluating all permitting requirements for pilot testing and development of the brackish water resource and developing a critical path document for permitting success. The INTERA team provided critical local experience to ensure regulatory requirements were realistic and would adequately inform the cost-benefit analysis and ultimately the feasibility of moving forward on this project.

Brackish Water Development, Sandoval County, Sandoval County, NM. 2007 – 2010. *Program Manager.* Led development of permitting and technical requirements associated with exploration, aquifer testing, and water availability analysis of a brackish water resource. Sandoval County is currently investigating alternative water resources to address development pressures in one of New Mexico's most rapidly expanding counties. Tasks included discharge permitting; deep-well drilling oversight; aquifer test design, implementation, and analysis; water availability analysis; and development of a 40-year plan. The INTERA team successfully negotiated time-critical discharge-permitting requirements, successfully completed a 30-day aquifer test in a very unconventional aquifer (high pressure, temperature, and salinity), and provided Sandoval County with a water resource evaluation report that enabled the County to obtain necessary funds for the second step of the project, a feasibility study for brackish water treatment.

Water Availability Modeling and Impact Analysis for Santa Fe County, Santa Fe County, NM. 2004 – 2007. *Program Manager and Lead Hydrogeologist.* Led evaluation and development of a hydrogeologic conceptual model, groundwater flow model, and water resource management tool for Santa Fe County. In an effort to understand how to efficiently develop groundwater resources in the County and to evaluate potential impacts to current water uses, the INTERA team was hired by the County to develop a three-dimensional groundwater flow model and decision support tool. Tasks included background research to evaluate all available hydrologic and geologic data for the pertinent area of the Espanola Basin, development of a geologic model, incorporation of the geologic model into a groundwater flow model, and development of a decision support tool for analysis of optimal sites for new water supply wells. The main objective of this tool was to find locations which would minimize impacts to springs, streams, and existing wells and maximize water supply through evaluation of numerous decision criteria. The INTERA team completed a three-dimensional flow model, the most comprehensive model of its kind for the area. The model and decision support tool were used by the County to evaluate options for future water development and to assess impacts of continued water development on existing and future facilities as well as surface water depletions.

Water Quality Evaluation in Support of Third Party Litigation, Rodey Law Firm, NM. 2005 – 2006. *Senior Hydrogeologist*. Provided technical support to evaluate the potential for water quality impacts from discharges by a pharmaceutical company to a wastewater treatment plant. The litigation involved claims by a third party that existing family health impacts were caused by chemicals discharged by the pharmaceutical company to the wastewater treatment plant with ultimate impacts to the shallow alluvial aquifer. Tasks included evaluation of the potential for local groundwater and surface water contamination to impact plaintiff's drinking water.

Technical Assistance for Water Rights Case, Modrall Law Firm, NM. 2005 – 2006. *Technical Assistant.* Assisted in water rights case involving point-of-use transfer and assessment of potential impairment to neighboring water users. Provided direction on exhibit preparation and technical approach for modeling impacts.

Water Availability Analysis for Northern New Mexico Pueblo, Ohkay Owingeh, San Juan, NM. 2004 – 2005. *Project Manager and Lead Hydrogeologist.* Led evaluation of surface water and groundwater quantity, evaluation of water rights, and the availability of groundwater for further development. The Ohkay Owingeh hired INTERA to perform an analysis of the current water availability for future water development. All available hydrologic, geologic, and water rights information was reviewed and synthesized. A final report included an analysis of available water resources with recommendations for optimal drilling locations to fill important data gaps as well as a feasibility analysis for incorporating existing surface water resources into a conjunctive use water resources management strategy. A drought management report based on current U.S. Environmental Protection Agency (EPA) guidance was also developed for the Pueblo.

Water Resource Impact Evaluation for Coal Mine Development, Salt River Project, Phoenix, AZ. 2000 – 2004. *Lead Hydrogeologist and Expert Witness.* Lead hydrogeologist for water resource evaluation to determine possible impacts to neighboring wells and surface water features caused by mine dewatering and water resource development for a coal mine in southern New Mexico. Salt River Project desired to develop mineral rights in southern New Mexico but was challenged by local and tribal interests due to concerns over water resource impacts resulting from mine development. Tasks included background research to develop geologic and hydrologic properties of the area, development of a hydrogeologic conceptual model, aquifer testing, groundwater modeling to assess the local aquifer's potential to supply water over a 40-year period, and expert opinion development in a natural resource damage claim by the Zuni Pueblo. The INTERA team successfully designed and implemented a long-term aquifer test involving monitoring at 20 sites and incorporated the results into a three-dimensional groundwater flow model for the mine area. Through application of the modeling results, INTERA successfully demonstrated that the relatively low rates of water use by the mine and isolation of the developed aquifer would result in no impact to local water users or sacred water features.

Water Quality Evaluation, New Mexico Border Health Office, Southern New Mexico Counties, NM. 2001 – 2002. *Program Manager and Lead Hydrogeologist.* Provided management and technical support for regional water quality evaluation of domestic wells. With its understanding of the many potential impacts to water supplies in the area, the Border Health Office desired to complete a water quality study to determine potential threats to public health in the border counties of New Mexico. Tasks included evaluation of local hydrogeologic conditions, selection of 100 water supply wells based on a priority scheme developed by INTERA, sampling of wells for a full suite of chemical parameters, data analysis, development of geographic information system (GIS) maps, evaluation of water supply operations for potential non-compliance activities, assessment of risks to current water supplies, and preparation of a final report with recommendations for additional monitoring and evaluation. INTERA also developed public outreach brochures summarizing the findings and conducted public meetings to disseminate information. The INTERA team received numerous compliments on the quality of the work and presentations from our client and the public.

Water Resource Development, Taos Ski Valley, Taos, NM. 1984 – 1985. *Hydrogeologist.* In charge of conducting field investigations in fractured metamorphic terrain to locate an optimal water well site for the ski valley. Performed field mapping and fracture trace analysis utilizing aerial photographs to assist well siting. On-site geologist during drilling and installation of the water supply well, which produced an adequate supply of water for the up-mountain restaurant.

Publications, Presentations, and Reports

Ardito, C., J.M. Sigda, and R. Blickwedel. 2015. Evapotranspiration Control on Groundwater Migration at a Uranium Mine Site in the High Desert. 10th International Conference on Mine Closure. Vancouver, Canada.

Gillespie, K., K.Z. Klaber, and C. Ardito. 2014. Oil and Water: Making a Marriage of Necessity Work for All Stakeholders. Proceedings of the 60th Rocky Mountain Mineral Law Institute, Vail, Colorado.

Cheng, Cheng, PhD, J. Sigda, PhD, C. Ardito, 2013. San Juan Basin Groundwater Flow Model. Presented at the Nevada Water Resources Association, Mine Water Management Symposium, Reno, Nevada.

Linderfelt, W., C. Park, D. Jordan, C. Ardito, and P. Castiglia, 2012. Measuring Water levels in Wells Using an Acoustic Sounding Device. Presented at the ASCE 2012 EWRI World Environmental and Water Resources Congress, May 21 – 24, Albuquerque, NM.

Jordan, D., W. Linderfelt, R. Sengebush, C. Ardito, and P. Castiglia, 2012. Brackish Water for Mining in Southeastern New Mexico. In Crossing Boundaries: World Environmental & Water Resources Congress Conference, Albuquerque, NM.

Ardito, C., and M. O'Brien, 2011. Hydrologic First Principles: The Interface Between Technical and Legal in Water Resource Regulation. Proceedings of the 57th Annual Rocky Mountain Mineral Law Institute, Santa Fe, NM.

Ardito, C., 2010. Uranium Mine Dewatering, Legacy Impacts on Soils and Shallow Alluvial Aquifers in the Grants Uranium Mineral Belt. Proceedings of the National Ground Water Association's Ground Water Summit, April, Denver, CO.

Ardito, C., 2009. The Next Uranium Boom in New Mexico: Opportunities and Challenges. Presented at Energy Production in New Mexico: Developments, Liability, and Damages. Winter CLE Program, New Mexico State Bar Foundation. Dec. 18, Albuquerque, NM.

Jordan, D., and C. Ardito, 2009. A GIS-Based Water Resources Supply Decision Support System For Santa Fe County, New Mexico. Presented at the American Water Resources Association Adaptive Management Conference, June 29, Snowbird, UT.

Jordan, D., and C. Ardito, 2008. A GIS-Based Decision Support System to Determine Groundwater Availability for Santa Fe County, New Mexico. Presented at the Groundwater Resources Association of California, Sept. 25–26, Costa Mesa, CA.

Ardito, C., R. Sengebush, and G. Bralley, 2008. Deep Saline Aquifer Exploration. National Groundwater Association Conference, Groundwater Expo and Annual Meeting, Las Vegas, NV.

Jordan, D., C. Ardito, and V. Kelley, 2008. Water Resources Supply: Decision System Development. The Water Report, 48.

Erskine, D.W., and C.P. Ardito, 2008. Finding Benchmarks at Uranium Mine Sites. Southwest Hydrology, 7:6, 24–26.

Kelley, V., J. Ewing, K. Gordan, C. Ardito, and D. Jordan, 2007. Models as Tools for Hydrogeologic Reconnaissance – A Case Study in the Espanola Basin. Presented at the National Groundwater Association Conference, May 2, Albuquerque, NM.

Jordan, D., C. Ardito, V. Kelley, and S. Wust, 2007. Water Resources Supply Decision Support System for Santa Fe County, New Mexico. Presented at the American Water Resources Association Annual Water Resources Conference, Nov. 12–15, Albuquerque, NM.

Ardito, C., D. Jordan, V. Kelley, and S. Wust, 2006. Santa Fe County Groundwater Availability Model: A Water Resources Management Strategy. American Water Works Association, 2006 Water Sources Conference, Albuquerque, NM.

Ardito, C., D. Jordan, V. Kelley, and S. Wust, 2006. Development and Application of a Regional Groundwater Flow Model in Conjunction with a Decision Support System to Guide Santa Fe County's Conjunctive Resource Management Strategy. Presented at the American Water Resources Association Adaptive Management in Water Resources Conference, June 26–28, Missoula, MT.

Gordon, K., C. Ardito, J. Ewing, D. Jordan, V. Kelley, S. Wust, and G. McCurry, 2006. Application of a Geologic Model to Guide Parameterization of a Regional Groundwater Flow Model for Santa Fe County. Presented at the Espanola Basin Technical Advisory Group 5th Annual Meeting, March 7–8, Santa Fe, NM.

Jordan, D., C. Ardito, S. Wust, and V. Kelley, 2006. Water Resource Supply Decision Support System for Santa Fe County. UCOWR/NIWR Annual Conference: Increasing Fresh Water Supplies, July, Santa Fe, NM.

Jordan, D.L., C. Ardito, G. McCurry, S. Wust, and C. Borchert, 2005. Collaborative Process Used to Build Espanola Basin Model. Southwest Hydrology, 4:5, 10–11.

Ardito, C.P., D. Jordan, M. Lavenue, and G. Ruskauff, 2004. Requirements for Defensible Groundwater Modeling. Proceedings of the National Groundwater Association Environmental Law Conference, Chicago, IL.

Jordan, D.L., C. Ardito, and G. Ruskauff, 2004. Use of GIS and Remote Sensing to Build a Complex Regional Groundwater Flow Model in New Mexico. Presented at the 2004 American Water Resources Association Spring Specialty Conference Geographic Information Systems (GIS) and Water Resources III, May 17–19, Nashville, TN.

Johnson, J.C., C.P. Ardito, and M.A. Singletary, 2003. Sequential Application of Surfactant Flooding and Anaerobic Reductive Dechlorination to Remediate a DNAPL Source Zone. National Groundwater Association Environmental Conference, Phoenix, AZ.

Singletary, M.A., L.W. Todd, C.P. Ardito, and J.P. Joseph, 2001. Evidence for the Incomplete Reductive Dechlorination of PCE at a Dry Cleaning Site. Poster presentation at In Situ and On-Site Bioremediation: The Sixth International Symposium, June 4–7, San Diego, CA.

Studer, J.E., L. Brouillard, and C.P. Ardito, 1999. Vapor Extraction Voluntary Corrective Measure, at the Chemical Waste Landfill, Sandia National Laboratories/New Mexico. In Proceedings of Waste Management '99, U.S. Department of Energy's Technology and Programs for Radioactive Waste Management and Environmental Restoration, Tucson, AZ.

Brouillard, L., J.E. Studer, C.P. Ardito, and R. Fate, 1998. A Vapor Extraction Monitoring System for Performance Assessment. Presented at First International Conference — Remediation of Chlorinated and Recalcitrant Compounds, May 18–21, Monterey, CA.

Ardito, C.P., M. Fort, and J.E. Studer, 1997. Groundwater Impacts Caused by In-Well Vapor Transport. Presented at Technical Information Exchange Workshop, U.S. Department of Energy, Idaho Falls, ID.

Ardito, C.P., D.M. Peterson, T. Martorana, R.G. Knowlton,and R.E. Fate, 1995. Decision Support Tools for Site Characterization. Presented at Hazardous Waste Management Society, Annual Conference, Albuquerque, NM.

Ardito, C.P., T.A. Duval, and D.W. Reaber, 1994. Characterizing a DNAPL Site Through Real-time Analysis of Vapors. STP 1261. Proceeding of the International Symposium on Volatile Organic Compounds in the Environment. ASTM

Committee E–47 on Biological Effects and Environmental Fate.

Peterson, D.M., R. Cox, C.D. Updegraff, T.A. Duval, and C. Ardito, 1993. A Stochastic Decision Support System for Locating Gas-Sampling Boreholes in the Vadose Zone. Presented at the Rocky Mountain Groundwater Conference, Albuquerque, NM.

Duval, T.A., C. Ardito, and D. Reaber, 1993. Characterizing a DNAPL Source in the Unsaturated Zone via Real-Time Analysis of Soil Vapor. Presented at Fourth National Technology Information Exchange (TIE) Workshop, Knoxville, TN.

Peterson, D.M., R. Cox, C.D. Updegraff, T.A. Duval, C.P. Ardito, D. Reichman, and R.G. Knowlton, 1993. A Stochastic Decision Support System for Optimally Characterizing Vadose Zone Gas Plumes. In Proceedings of the American Geophysical Union Hydrology Days, Spring.

Duval, T.A., C.P. Ardito, and D.W. Reaber, 1993. Characterizing a DNAPL Source in the Unsaturated Zone via Real-time Analysis of Soil Vapor. In Proceedings of the Fourth National Technology Information Exchange Workshop, U.S. Department of Energy, Spring, Knoxville, TN.

Ardito, C.P., A.M. Parsons, E.D. Mattson, E.R. Lindgren, and J.M. Phelan, 1992. Sandia National Laboratories Chemical Waste Landfill: Innovative Strategies Towards Characterization and Remediation. In Proceedings of Waste Management '92, U.S. Department of Energy's Technology and Programs for Radioactive Waste Management and Environmental Restoration, Tucson, AZ.

Phelan, J.M., C.P. Ardito, and W.F. Booher, 1992. Thermal-Enhanced Vapor Extraction System — Cooperative ER/OTD Technology Development. In Proceedings of International Topical Meeting on Nuclear and Hazardous Waste Management — Spectrum '92, U.S. Department of Energy, American Nuclear Society, Aug. 23–27, Boise, ID.

Mattson, E.D., E.R. Lingren, W.F. Booher, and C.P. Ardito, 1992. Conceptual Model Selection of VOC Migration Using Soil Gas Collected from Existing Groundwater Monitoring Wells. In Proceedings of the International Symposium on Environmental Contamination in Central and Eastern Europe, Oct. 12–16, Budapest, Hungary.

Wild, H.S., J. Billings, W.J. Brown, and C.P. Ardito, 1991. Remediation of Petroleum Hydrocarbon Contamination of Groundwater and Soil Using In-situ Air Sparging and Active Soil Vapor Extraction at L.U.S.T Sites in New Mexico. In Abstracts with Programs 1:5, Geological Society of America Annual Meeting, San Diego, CA.

Ardito, C.P., and J.F. Billings, 1990. Alternative Remediation Strategies: The Subsurface Volatilization and Ventilation System. In Proceedings of the National Water Well Association/API Conference on Petroleum Hydrocarbons and Organic Contaminants in Groundwater, Houston, TX.

Ardito, C.P., 1988. The Relationship Between Mineralogy, Groundwater Chemistry, and Groundwater Flow in the Moreno Hill Formation. Master’s Thesis, New Mexico Institute of Mining and Technology, Socorro, NM.

Ardito, C.P., J.R. MacMillan, and F.M. Phillips, 1986. The Relationship Between Mineralogy and Observed Groundwater Chemistry in the Moreno Hill Formation. Abstract in GSA Abstracts with Programs.

Sampson, D.E., and C.P. Ardito, 1983. The Geochemistry of Quaternary Lavas from the Inyo-Mono Chains: Evidence for Several Magma Types. In Transactions, American Geophysical Union 64:45.

Exhibit 6

Declaration of Cynthia Ardito

DECLARATION OF CYNTHIA ARDITO

1.0 Introduction

My name is Cynthia Ardito and I live and work in New Mexico. I have been in charge of regulatory compliance, site characterization and feasibility studies at the St. Anthony Mine (Site) in Cibola County, New Mexico since 2004. My declaration is based on my experience at this Site and numerous uranium mine sites in New Mexico, extensive interactions with Stakeholders including United Nuclear Corporation (UNC), the Cebolleta Land Grant, the New Mexico Environment Department (NMED), Energy, Minerals, and Natural Resources Department Mining and Minerals Division (EMNRD MMD), Uranium Resources Inc. (URI) and Laguna Pueblo, as well as review of site characterization data, modeling results and background information. I am offering this declaration in support of UNC's petition for Alternate Abatement Standards (AASs).

I am currently employed as a Senior Vice President and Principal Hydrogeologist at INTERA Incorporated. I hold a Bachelor of Science in Geology from University of California (1983) and a Master of Science in Geology from New Mexico Institute of Mining and Technology (1987), where I concentrated in hydrology and hydrogeochemistry. I am a registered Professional Hydrologist with the American Institute of Hydrology and a Certified Ground Water Professional with the National Ground Water Association. My work in New Mexico on groundwater quality and groundwater quantity issues began in 1986 at NMED's (then the New Mexico Environmental Improvement Division) Ground Water Quality Bureau and led ultimately to my employment with INTERA, where I have worked for 26 years. During my tenure with INTERA, particularly over the last ten to 15 years, I have focused on water quality issues at uranium mine sites, particularly in the Grants Uranium Mineral Belt. I have extensive experience with the unique regulatory challenges inherent to these water-bearing ore deposits.

The purpose of my declaration is to provide the regulatory basis for granting Alternative Abatement Standards (AASs) for the Constituents of Potential Concern (COPCs) that could exceed New Mexico Water Quality Control Commission (WQCC) Standards after closure. This AAS Petition has been prepared to meet the requirements of Subsection F of 20.6.2.4103. As such, my declaration will provide direct evidence to demonstrate that:

(a) Compliance with abatement standards is technically or economically infeasible by the maximum use of technology within the economic capability of the responsible person; OR there is no reasonable relationship between the economic and social costs and benefits (including the attainment of standard(s) set forth in Section 20.6.2.4103 NMAC to be obtained;

(b) The proposed alternative abatement standard(s) is/are technically achievable and cost-benefit justifiable; and

(c) Compliance with the proposed alternative abatement standard(s) will not create a present or future hazard to public health or undue damage to property.

Additionally, my declaration will provide documentation that all the regulatory requirements outlined in Section 20.6.2.4106 NMAC and Section 20.6.2.4108 NMAC have been fully met at the time of the filing of this petition.

The St. Anthony Mine (Site) is in west-central New Mexico, approximately 3 miles east-southeast of Moquino and approximately 13 miles north of Laguna (Exhibit 4b), at the base of the northern and eastern slopes of the Gavilan Mesa, and has an areal extent of approximately 1 square mile. The Site is located within Township 11 North, Range 4 and 5 West. The latitude and longitude of the four corners of the affected property area are (1) the northwest corner, 35.17 degrees north and -107.32 degrees west; (2) the northeast corner 35.17 degrees north and -107.29

degrees west; (3) the southeast corner, 35.15 degrees north and -107.29 degrees west; and (4) the southwest corner, 35.15 degrees north and -107.32 degrees west. The St. Anthony Mine is part of a northwest-southeast trend of uranium ore deposits referred to as the Grants Uranium Mineral Belt (Exhibit 6a). The approximate distribution of ore at the St. Anthony Mine is illustrated in Exhibit 6b, and specific ore deposit features are illustrated in Exhibit 6c. The entire area is extensively mineralized, and groundwater quality conditions in these ore-bearing formations are known to exceed drinking water standards prior to influence by mining-related impacts.

The Site property is owned by the Cebolleta Land Grant and was leased to UNC for mining purposes. The neighboring property owners include Cebolleta Land Grant, Laguna Pueblo and a private owner. The Site features are provided in Exhibit 4c. The Site has an areal extent of less than 1 square mile and consists of two open pits, overburden, and overburden piles. The underground mine workings have been sealed at the surface. Meyer Draw is an ephemeral drainage that runs only during and shortly after storms large enough to produce runoff.

The Site remains in the condition it was left at the time of lease termination as part of the terms of the Site lease from the Cebolleta Land Grant (CLG). There are no remaining building structures on the Site. Besides the pits and overburden piles, some of the mine infrastructure equipment and

components still exist, including roads, utility lines across the Site, utility connection locations, a surface completion of an old well, and the slab of a former structure

2.0 Regulatory Compliance

The mining of uranium at the Site was conducted in accordance with the then-current regulations and industry standards. Regulations adopted by the WQCC in 1995, however, prompted the NMED to require an abatement process be completed in accordance with WQCC regulations 20.6.2.4106 NMAC through 20.6.2.4108 NMAC. As summarized in this section, UNC has completed all the requirements of WQCC's abatement regulations.

1.1 Stage 1 Abatement Plan (20.6.2.4106 NMAC)

The abatement process officially began in November 2002, with NMED's conditional approval of UNC's Stage 1 Abatement Plan Proposal, which was submitted to NMED on May 10, 2002. A Stage 1 Abatement Report that met the requirements of this Stage 1 Plan was completed and submitted to the NMED on October 26, 2006 (INTERA, 2006). The Stage 1 Investigation Report was approved by NMED in July 2008 after an extensive field investigation and several rounds of comment responses (Exhibit 6d). The full Stage 1 Report is provided as Exhibit 6 of the St. Anthony AAS Petition.

1.1.1 Stage 1 Abatement Plan Investigation Report Summary

The purpose of a Stage 1 investigation is to design and conduct a site investigation that will adequately define site conditions, and provide the necessary data to select and design an effective abatement option. In meeting this requirement, UNC and INTERA completed the following activities:

- Installation of the first phase of monitoring wells, consisting of two alluvial wells and eight bedrock wells (Exhibit 6e),
- Aquifer tests of four bedrock wells,
- Site survey of all monitoring wells and elevations of groundwater in the pits for development of a potentiometric surface,
- Quarterly groundwater monitoring from the Site well,
- Quarterly sampling of water from the Large Pit,
- Opportunistic surface water samples from Meyer Draw,
- Characterization of overburden pile (Exhibit 6f,; and

- Core samples from the Large Pit walls.

The results of these field investigations and related data analysis resulted in the following conclusions:

- There are no perennial streams near the Site; therefore, surface water impacts were evaluated from the perspective of erosion or runoff of material from the mine site to Meyer Draw and no impacts were identified;
- There is no evidence of impacts to alluvial groundwater from overburden runoff to Meyer Draw; groundwater quality in the downgradient shallow alluvial well (MW-3) does not show evidence of impacts caused by mining activities;
- The chemical characteristics of water samples from the Small Pit indicate that this water is predominately of meteoric origin; therefore, the water periodically observed to be present in the Small Pit is the result of direct precipitation, runoff, and low infiltration rates;
- Concentrations of regulated constituents in water samples from the Large Pit have significantly increased over time because of evapo-concentration and secondary mineralization due to weathering of ore material in the Large Pit walls;
- The Large Pit is acting as a sink driven by the process of evaporation and therefore, concentrated water in the Large Pit is contained on-site (Exhibit 6g);
- Surface water quality of the Large Pit is poor; however, groundwater flow near the Large Pit, where water quality impacts resulting from evapoconcentration are significant, is towards the Large Pit, not off-site, mitigating any potential impact to receptors (Exhibit 6g); and
- There are currently no water supply receptors with the potential to be impacted in the vicinity of the Site (Exhibit 6h).

2.1.2 Stage 2 Abatement Plan

As WQCC Standards are exceeded in groundwater at the Site, UNC was required to develop a Stage 2 Abatement Plan to address groundwater issues before full Site closure could be implemented. On behalf of UNC, INTERA submitted the Stage 2 Abatement Plan Proposal to the NMED on November 3, 2008. This Plan was conditionally approved by NMED on March 13, 2009. The Stage 2 Abatement Proposal described the process for identifying and selecting a preferred abatement option for managing groundwater in the St. Anthony Large Pit and identified a preliminary list of possible remedial alternatives based on an understanding of Site conditions and potential remediation strategies.

The potential list of remedial alternatives was screened using the Multiple Accounts Analysis (MAA) technique, a systematic process for managing the inherent conflict between many stakeholders having numerous differing judgments (both positive and negative). An in-depth discussion of the MAA process can be found in the Stage 2 Abatement Plan Report which was provided as Exhibit 3 of the St. Anthony AAS Petition. The MAA process provided a means to objectively balance multiple and often competing goals and objectives defined during the analysis process, and allowed for the inclusion of less tangible impacts (e.g., aesthetics) as well as more tangible impacts (e.g., costs, reliability, safety) in the alternatives evaluation.

The evaluation of remedial alternatives focused on three key remediation goals: (1) preventing exposure to water in the Large Pit, (2) reducing the risk of future groundwater impact, and (3) stabilizing groundwater conditions for the long term. Nine categories of remedial alternatives (plus numerous subcategories) were evaluated, including three pit waiver alternatives (one of which was the "no-action" alternative) and six different partial backfill alternatives. These alternatives were compared against an extensive list of concerns that were developed specifically for the St. Anthony Site, and which fell into one of four categories: technical issues, environmental issues, socio-economic issues, and project economics (i.e., costs). Each specific concern was then weighted by each stakeholder individually, thereby considering the specific needs and desires of every stakeholder.

On May 5, 2009, the first of 14 meetings held over a two-year period initiated the process of evaluating alternatives for addressing closure of the Large Pit. The MAA was deployed to work through issues with methodology and to clarify any needed features of the reclamation alternatives. Additionally, time was spent to ensure that all aspects of the Site were defined in such a way as to have the same meaning for all participants. The stakeholders and agencies represented in this process included:

- NMED GWQB
- NMED Surface Water Quality Bureau
- EMNRD MMD
- New Mexico Department of Game and Fish
- Pueblo of Laguna
- Cebolleta Land Grant
- Everest Holdings
- Neutron Energy Incorporated (currently Uranium Resources Inc.)
- UNC

In addition to the 14 meetings, the full group of stakeholders met and participated in a Site visit (April 22, 2010). During the Site visit on April 22, 2010, all participants were taken on tours of both the neighboring Jackpile Open Pit Uranium Mine (owned by the Laguna Pueblo) and the St. Anthony Mine. The Site visit allowed everyone to put into perspective the Site conditions being evaluated using the MAA process.

The highest-ranking alternatives chosen by the stakeholder group fell in to two basic categories, "Backfill Alternatives" and "No Backfill Alternatives." For the "No Backfill Alternatives," the Large Pit maintains the evaporative sink, and off-site migration of concentrated secondary mineralization is not a concern. Alternatively, for the "Backfill Alternatives," the evaporative sink is removed and off-site migration of concentrated secondary mineralization is possible.

The "No Backfill Alternatives" ranked high for stakeholders who valued groundwater containment very highly, due to the potential after backfilling for off-site migration of impacted groundwater with subsequent impacts to human health and the environment. Conversely, the "Backfill Alternatives" ranked highly for stakeholders who valued returning the land to is former use (i.e., grazing) and reducing the risk of exposure by humans and wildlife to mineralized water. Additionally, numerous other health and safety risks associated with leaving the Large Pit open were discussed and evaluated during the MAA process. In addition, the EMNRD MMD regulations require mine pits to be backfilled and reclaimed unless the requirements identified in the Pit Waiver Rule (19.10.5.507B NMAC) can be met. Based upon several criteria, a pit waiver would not likely be granted given the conditions at the St. Anthony Mine.

At the completion of the MAA Process, the stakeholder group agreed that additional hydrologic and geochemical modeling and analysis was necessary before a decision between the highest ranking "No Backfill Alternatives" and the highest ranking "Backfill Alternatives" could be made and a single alternative selected for the Stage 2 Report. INTERA developed a Work Plan for the Stage 2 Site Characterization, which was approved by NMED on April 19, 2012. This second phase of site characterization and analysis was designed to complete the following:

- Extend the understanding of the Jackpile groundwater flow directions, discharge points, and discharge rates to provide the basis for predictive groundwater modeling;
- Complete predictive groundwater modeling to more definitely evaluate groundwater pathways before and after backfilling;
- Complete additional characterization of the current water quality conditions for both the water in the Large Pit, the groundwater, and to further characterize primary and secondary mineralization in the ore deposit to provide the basis for geochemical modeling; and
- Perform geochemical modeling to determine achievable COPCs associated with naturally-mineralized zones and secondary mineralization in the Large Pit to

establish achievable AASs that meet the requirements of 6.20.2.4103 Subsection F NMAC.

As required by 20.6.2.4106.E (3) NMAC, the Stage 2 Plan must describe and justify a single alternative for implementation at the Site. Based on the additional field investigations, geochemical bench scale studies, hydrologic modeling, and geochemical modeling, Alternative E3 – Partial Pit Backfill with Geochemical Stabilization of Sediments was determined to be the single preferred alternative for closure of Large Pit at the St. Anthony Site. In order to implement this remedy, AASs must be approved by the WQCC. The key factors influencing this remedy selection are summarized as follows:

- Backfilling of the Large Pit is preferred by all stakeholders assuming there are no impacts to human health or the environment.
- Groundwater in the Jackpile sandstone is contained by the cone of depression in the Large Pit (Exhibit 6g) and does not migrate off-site even after the Large Pit is backfilled and regional groundwater gradients are re-established. Exhibit 6i are simulated particle tracks from the predictive groundwater model developed for the Site. As illustrated in Exhibit 6i, it will take hundreds of years for groundwater to reach Meyer Draw, at which point water is lost to evapotranspiration at the seepage face of Meyer Draw.
- There is no complete groundwater pathway for migration of groundwater in the Jackpile sandstone to reach a receptor. The New Mexico Office of the State Engineer (NMOSE) WATERS Database of water supply wells within a 5-mile radius of the Site revealed six records with location and well construction information. Of these six records, two water supply wells are found within a 2-mile radius of the Site, and four others are located between 3 and 5 miles from the Site. (See Exhibit 6h). All wells in the WATERS Database within 5 miles of the Site are located upgradient of the Site and in an area where the Dakota Sandstone is saturated. The Dakota Sandstone is the shallowest aquifer used as a drinking water supply in the area; however, in the vicinity of the Site, it is not water bearing.
- Water quality in the Jackpile sandstone is not drinking-water quality, due to the presence of mineralized zones throughout this area (Exhibit 6c and Exhibit 6j).
- Water quantity and water quality in the Jackpile sandstone do not support water supply development for any sustainable future use.
- Geochemical stabilization prevents migration of the most hazardous COPCs (uranium and radium) beyond the immediate vicinity of the Large Pit.

The final Stage 2 Abatement Plan Report was submitted to NMED on February 9, 2015, and was conditionally approved by NMED on May 7, 2015. INTERA submitted a response letter to NMED on July 7, 2015, and the final conditional approval was received by UNC on August 25, 2015 (Exhibit 6k). Since this time, UNC, INTERA and NMED have been in the process of the development the St. Anthony AAS Petition which includes the St. Anthony Stage 2 Abatement Plan as Exhibit 3.

UNC has completed the Stage 1 and Stage 2 Abatement Plan Process, and seeks to complete final closure of the Site, including final closure of the Large Pit. Because the Site is host to uranium ore bodies, it is technically infeasible to comply with WQCC Standards after the Large Pit is filled. UNC has demonstrated through extensive hydrogeologic and geochemical studies that the impacted area will remain completely contained within Site boundaries, will be restricted from withdrawal by the CLG, and poses no hazard to public health or threat of undue damage to property.

With these conditions in mind, the AASs are being pursued to bring the site into regulatory compliance with requirements of the 20.6.2 NMAC. The landowner (CLG) has been an active participant in this process, and agrees that this area should not be used as a source of drinking or livestock water.

3.0 Proposed Alternative Abatement Standards

Table 3 and Exhibit 13 of the St. Anthony AAS Petition provide the proposed AASs and the three-dimensional area within which these AASs would apply. Table 3 includes a list of the COPCs, the range of concentrations that have been observed in groundwater over the groundwater monitoring period, the range of concentrations observed over time in samples from the Large Pit surface water, the geochemical methodology for determining each AAS, the range of values determined from the geochemical analysis (described in detail in the Stage 2 Plan), and the proposed AAS for each COPC.

Table 3 of AAS Petition: Proposed Alternative Abatement Standards Compared to Existing and Modeled Groundwater Quality Concentration Ranges

COPC	Range of Analytical Values in Groundwater at St. Anthony	Range of Analytical Values in Pit Water at St. Anthony	Methodology for Determining AAS	Range of Values from Geochemical Analysis	Proposed AAS
Uranium	0.0059 - 0.85 mg/L	0.85 - 17 mg/L	Equilibrium model, EQ3/6	0.69 - 12.4 mg/L	12.4 mg/L
^{226}Ra + ^{228}Ra	ND - 325 pCi/L	0 - 45 pCi/L	Equilibrium model, EQ3/6	940 - 2913 pCi/L	2913 pCi/L
Fluoride	ND - 2.1 mg/L	0.66 - 1.1 mg/L	Simple Equilibrium model	10.7 mg/L	10.7 mg/L
Sulfate	190 - 2700 mg/L	3210 - 62,000 mg/L	Extrapolation, Pit Evaporation	72,200 - 77,000 mg/L	77,000 mg/L
TDS	680 - 4100 mg/L	5134 - 90900 mg/L	Extrapolation, Pit Evaporation	105,000 - 113,000 mg/L	113,000 mg/L
Boron	0.1 - 0.6 mg/L	0.6 - 4.1 mg/L	Extrapolation, Pit Evaporation	4.74 - 5.05 mg/L	5.05 mg/L
Chloride	14 - 44 mg/L	23.6 - 710 mg/L	Extrapolation, Pit Evaporation	837 - 908 mg/L	908 mg/L

Notes:
mg/L = milligrams per liter
pCi/L = picoCuries per liter
ND = Non-Detect
TDS = total dissolved solids

Although the proposed AASs provided in Table 3 are higher than the maximum observed groundwater concentrations, in almost all cases they are very close or within the range of values observed for the Large Pit water samples. Based on the geochemical modeling results presented in the Stage 2 Plan for each COPC, concentrations of this magnitude are possible in groundwater migrating from the Site after backfilling. These higher concentrations are associated with secondary mineralization caused by weathering in the Large Pit and evapo-concentration of the Large Pit water in combination with migration through the mineralized zone in the Jackpile sandstone. The largest discrepancies between observed groundwater concentrations and proposed AASs occur for sulfate, chloride, total dissolved solids (TDS), and radium. The AASs for these constituents are the theoretical maximum concentrations that could result from migration of dissolved minerals away from the Large Pit area after the pit is backfilled. After backfilling, regional groundwater levels will rise to pre-mining levels, and the cone of depression will no longer prevent transport of solutes away from the pit. It is technically infeasible to remove all the secondary mineralization associated with the Large Pit; therefore, there is potential to see a rise in constituent concentrations downgradient from the Large Pit after the regional gradient returns.

4.0 Conclusions

The information provided in the St. Anthony Mine abatement reports (Exhibits 3 and 6 of the Petition), the St. Anthony Mine AAS Petition, and the declarations provided by the experts for this hearing, provide the basis for meeting the requirements for Subsection F of 20.6.2.4103 NMAC including:

(a) Compliance with abatement standards is technically or economically infeasible by the maximum use of technology within the economic capability of the responsible person, or there is no reasonable relationship between the economic and social costs and benefits (including the attainment of standard(s) set forth in Section 20.6.2.4103 NMAC to be obtained **(Criterion 1);**

(b) The proposed alternative abatement standard(s) is/are technically achievable and cost-benefit justifiable **(Criterion 2);** and

(c) Compliance with the proposed alternative abatement standard(s) will not create a present or future hazard to public health or undue damage to property **(Criterion 3)**.

The key factors associated with this conclusion are summarized below:

Criterion 1 is met because the Jackpile sandstone is an ore-bearing formation at the Site, and WQCC Standards were exceeded even before mining influences. The only way WQCC Standards could be met at this Site is through removing the minerals that adversely impact the quality of water by their association and contact with groundwater. It is not feasible or desirable to remove the entire mineral deposit and the associated groundwater that would also have to be removed. This approach would result in a highly negative net environmental impact (i.e., high resource consumption and no beneficial impact).

Criterion 2 is met because the AASs are based on the probable highest concentration that could occur after backfilling of the Large Pit; and, when combined with backfilling, is technologically achievable and cost-benefit justifiable. Not backfilling the open pits would require a Pit Waiver from the EMNRD MMD as put forth in 19.10.5.507B NMAC, which is highly unlikely based on the requirements of this regulation. In this instance, UNC is able to close the pit and there are significant benefits to the preferred backfilling alternative, including restoration of the pit to a post-mining use that supports grazing and wildlife habitat. Backfilling of the Large Pit would be an accompanied by a loss of the evaporative containment of nearby groundwater. Therefore, the preferred remedial alternative for the St. Anthony Mine that is achievable is backfilling of the pits and approval of the AASs. Granting of AASs is necessary under the circumstances.

Criterion 3 is met because there is no complete pathway for migration of COPCs in groundwater to a receptor. Post-reclamation groundwater within the mine permit area will travel no more than approximately 9,100 feet (1.72 miles) before being consumed by evapotranspiration, and will not migrate onto adjoining properties. The present and foreseeable future use of the proposed AAS area (approximately 1,080 acres) is grazing and wildlife habitat. Therefore, the proposed AASs will not create a present or future hazard to public health or undue property damage.

The technical testimony that I have prepared is true and correct to the best of my personal knowledge and belief.

Respectfully submitted,

C. Ardito

Cynthia Ardito

Signed the 27th day of June, 2017

Subscribed and sworn to before me this 27th day of June, 2017

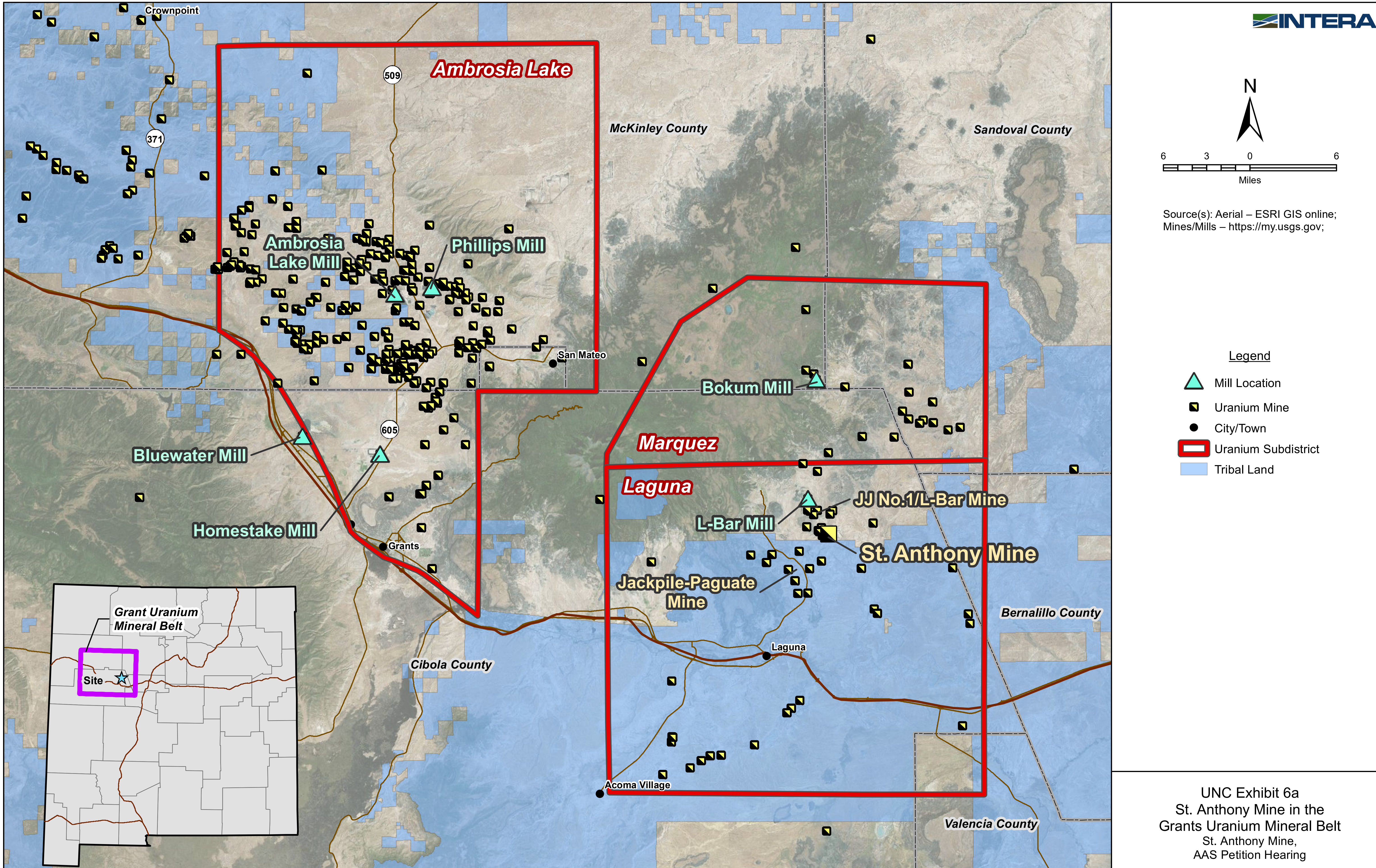
Gloria Hernandez

Notary Public

OFFICIAL SEAL
GLORIA HERNANDEZ
Notary Public
State of New Mexico
My Comm. Expires 8-5-18

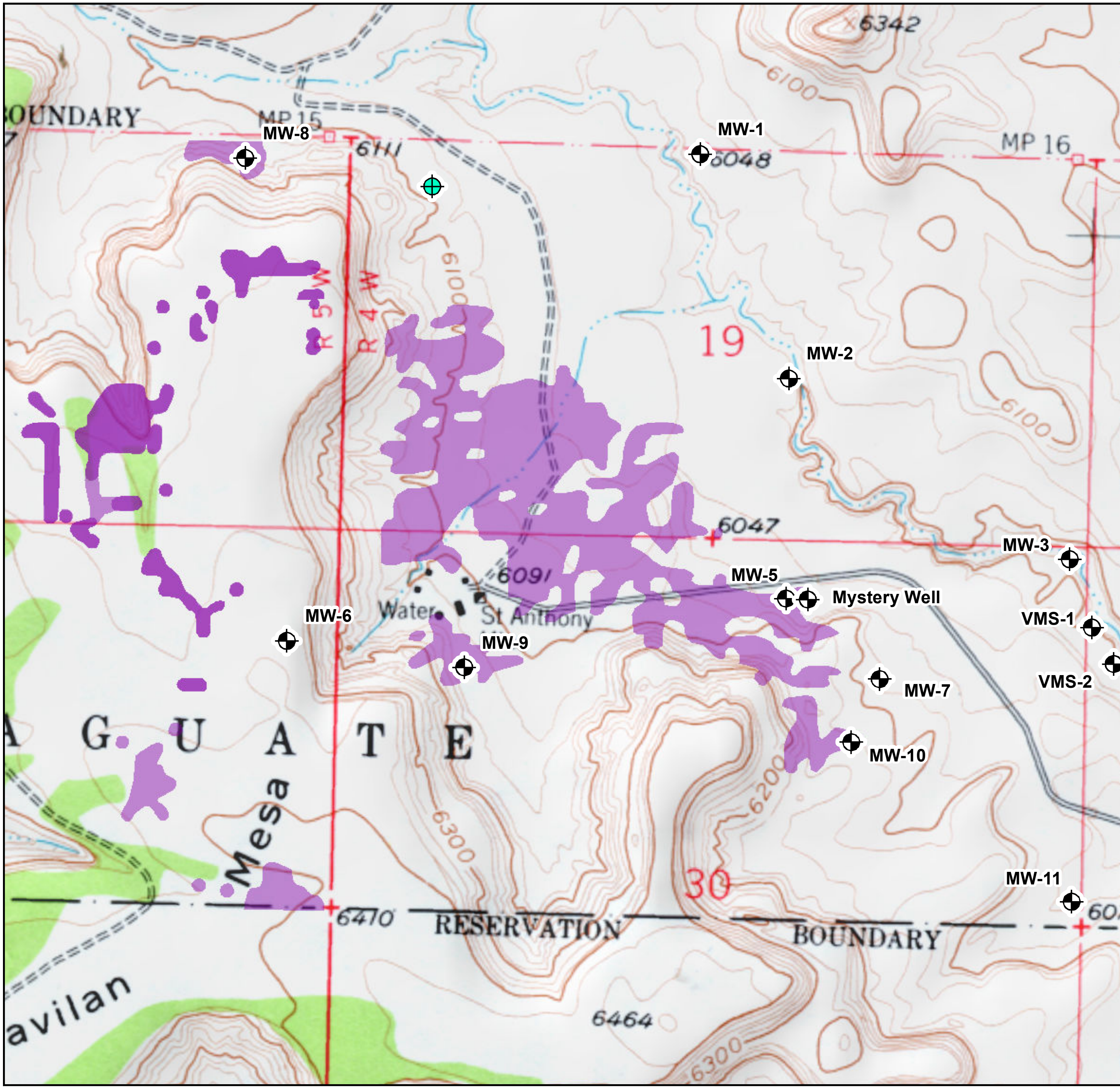
My Commission Expires 8-5-18

Seal



UNC Exhibit 6a
St. Anthony Mine in the
Grants Uranium Mineral Belt
St. Anthony Mine,
AAS Petition Hearing

FILE: S:\ABQ\GE1-UNC_St_Anthony\Graphics-Drafting\GIS\MapDocuments\AAS_Petition\WQCC_Hearing_2017\Exhibit_06_Cindy\06a_AreaMap.mxd 4/24/2017



INTERA

N

0 1,000

Feet

Source(s):
Ore body boundaries – UNC
(undated maps)

Legend

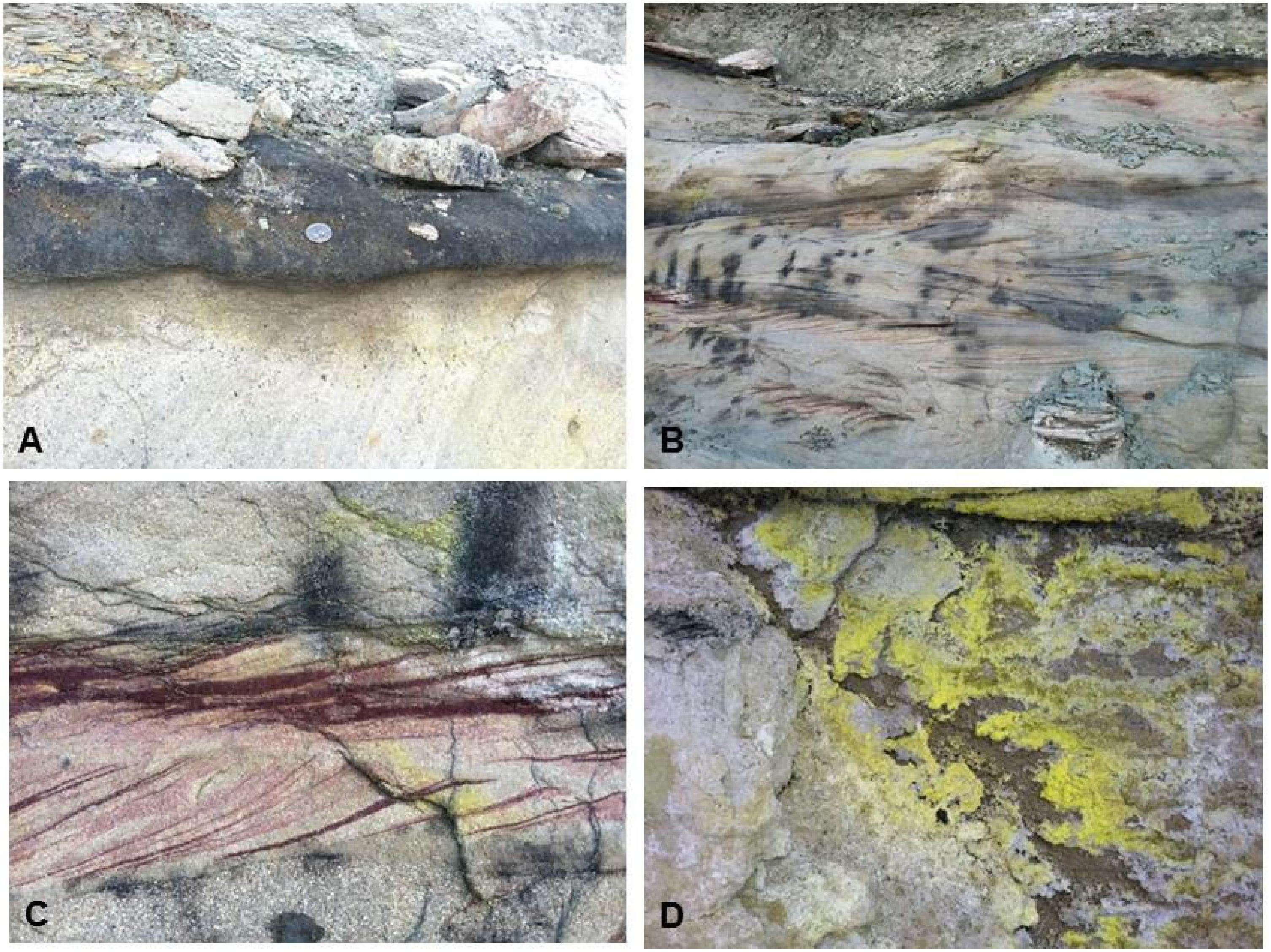
Monitoring Well Location

Water Well Location

Ore Body

UNC Exhibit 6b
Distribution of Ore at
the St. Anothony Mine
St. Anthony Mine,
AAS Petition Hearing

File: S:\ABQ\GE1-UNC_St_Anthony\Graphics-Drafting\GIS\MapDocuments\AAS_Petition\WQCC_Hearing_2017\Exhibit_06_Cindy\06b_OreBodyProjection.mxd 4/24/2017



UNC Exhibit 6c
Ore Deposit Features
on Jackpile Outcrop
St. Anthony Mine,
AAS Petition Hearing

UNC ST. ANTHONY COAG

NEW MEXICO
ENVIRONMENT DEPARTMENT

Ground Water Quality Bureau

RECEIVED JUL -7 PM 1:

GENERAL ELECTRIC CO.
CEP/RECO

BILL RICHARDSON
Governor
DIANE DENISH
Lieutenant

Harold Runnels Building
1190 St. Francis Drive, P.O. Box 26110
Santa Fe, New Mexico 87502-6110
Phone (505) 827-2918 Fax (505) 827-2965
www.nmenv.state.nm.us

RON CURRY
Secretary
JON GOLDSTEIN
Deputy Secretary

July 3, 2008

Mr. Larry Bush
United Nuclear Corporation
P. O. Box 3077
Gallup, New Mexico 87305-3077

RE: Review of United Nuclear Corporation's Response to Comments, Stage 1 Abatement and Materials Characterization Reports for the St. Anthony Site, Cebolleta, NM

Dear Mr. Bush:

The Ground Water Quality Bureau of the New Mexico Environment Department (NMED) has completed review of United Nuclear Corporation's (UNC) response to NMED comments to the Stage 1 Abatement and Materials Characterization Reports for the St. Anthony Mine Site located near Seboyeta, New Mexico. The work outlined in these documents is intended to satisfy the requirements under the New Mexico Water Quality Control Commission Regulations, Section 20.6.2.4000 – 4115 NMAC.

UNC's responses to comments related to the Stage 1 Abatement Report are acceptable. However, NMED does not agree with all responses to comments related to the Materials Characterization Report. Specifically, UNC's response related to SPLP analysis and the fact that contaminant uptake from plants and radiation protection was not considered. Nevertheless, these issues can be addressed in the Stage 2 Abatement Plan. Therefore, NMED accepts the Stage 1 Abatement Report and directs UNC to submit the Stage 2 Abatement Plan within 60 days of this letter or September 3, 2008.

If you have any questions, please contact me at (505) 827-0652.

Sincerely,

Jerry Schoeppner
Mining Environmental Compliance Section
Ground Water Quality Bureau

Cc: Mary Ann Menetrey, Manager, MECS
Karen Garcia, Chief, Mine Reclamation Bureau
Joe Vinson, MMD
Neal Schaeffer, SWQB
Roy Blickwedel, General Electric Corporation
Cindy Ardito, Intera, Inc.
Toby Leeson, MWH Americas, Inc.

INTERA

N

0 700 1,400
Feet

Legend

Monitoring Well Location

Water Well Location

Automated Arroyo Sampler

Laguna Pueblo Boundary

Source(s):
Monitoring well locations – survey by Terrametric;
Image – DOQQs, USGS, 2004.

Note(s):
The water well is an unused water well believed to be completed in the Westwater Canyon Member of the Morrison Formation. No other information is available regarding this well.

UNC Exhibit 6e
Site Plan - Monitoring Well and Arroyo Sampling Locations
St. Anthony Mine,
AAS Petition Hearing

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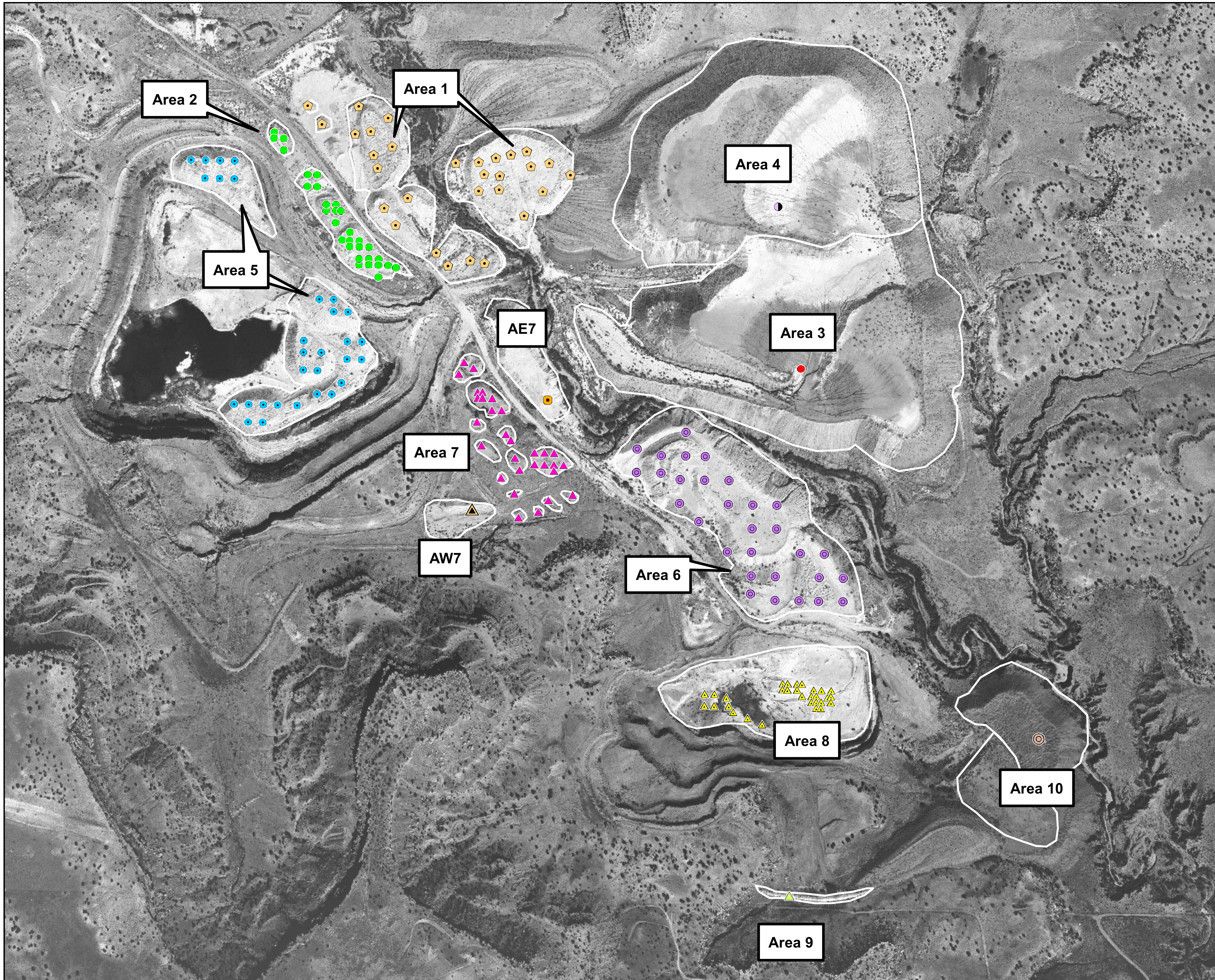

INTERA

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0 600 1,200
Feet

Sources:
Aerial – Montgomery Watson Harza, 2006

Legend

Area Boundary
- Area-1
- Area 2
- Area 3
- Area 4
- Area 5
- Area 6
- Area 7
- Area West of Area 7
- Area East of Area 7
- Area 8
- Area 9
- Area 10

UNC Exhibit 6f
Soil Sample Location Map for
Overburden Pile Characterization
St. Anthony Mine,
AAS Petition Hearing

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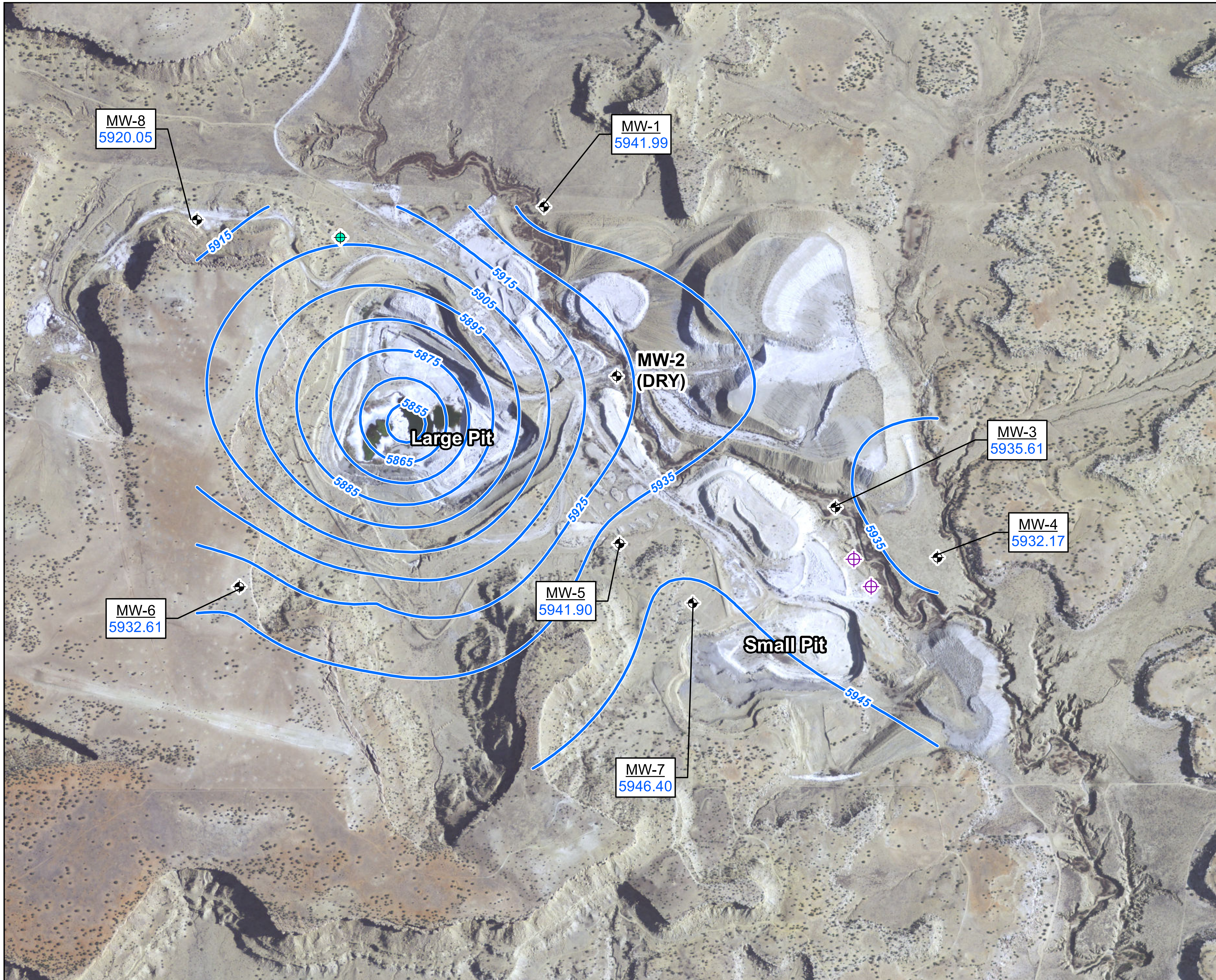

INTERA

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0 900 1,800

Feet

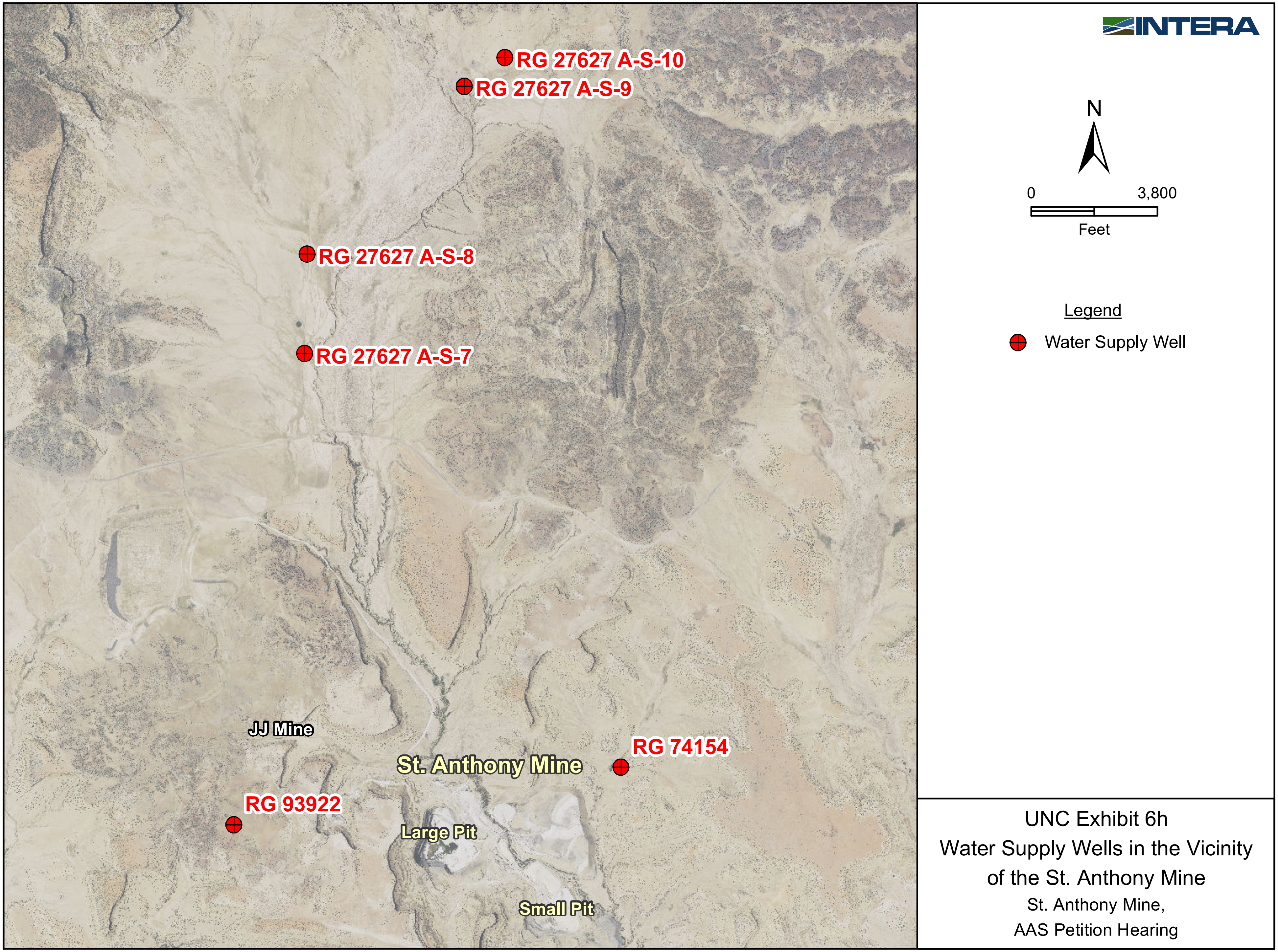
Sources:
Aerial – RGIS website, dated 2011

Legend

- Monitoring Well Location
- Vadose Zone Monitoring Station Location
- Water Well Location
- Groundwater Elevation Contour, ft amsl

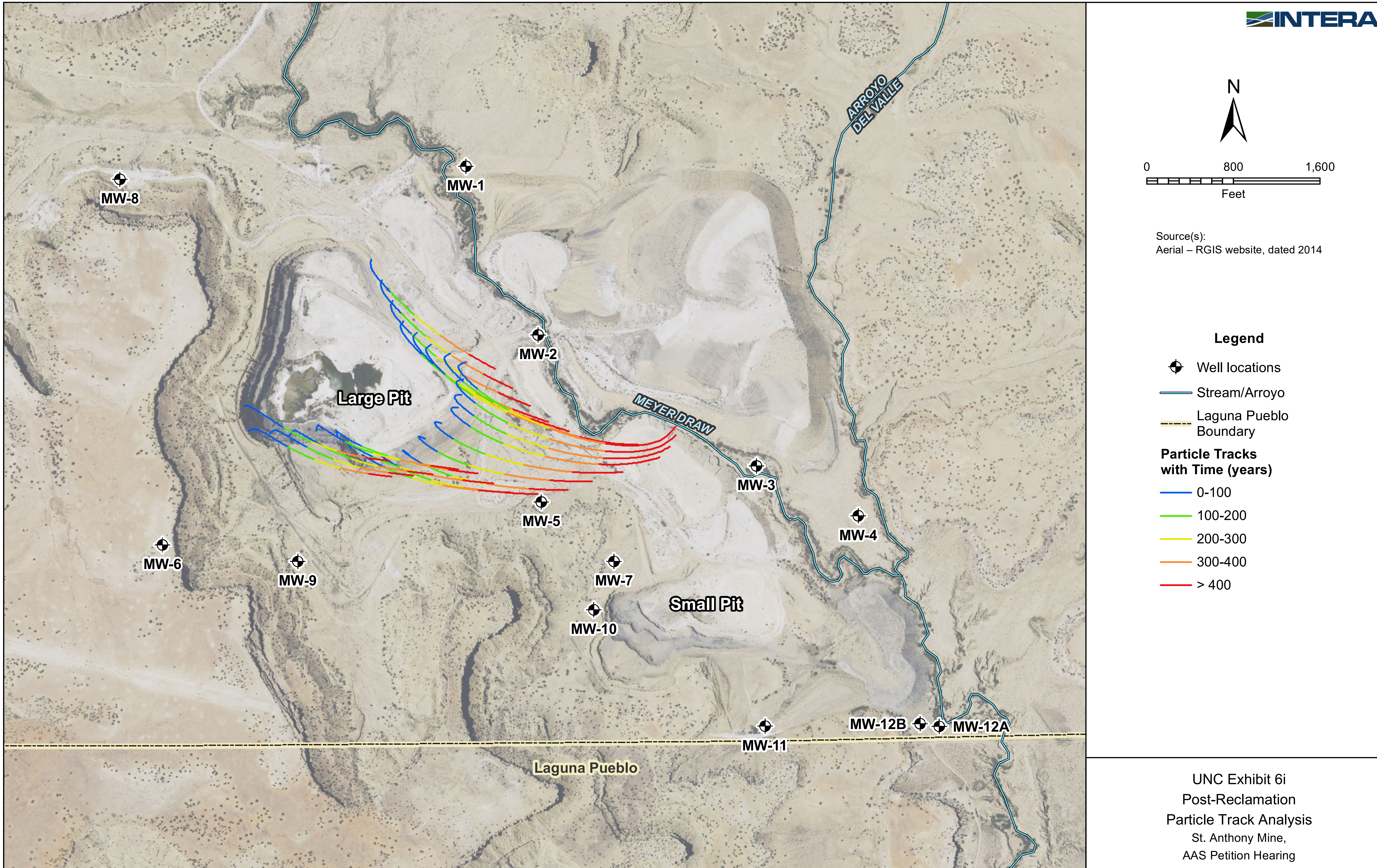
Well ID
Groundwater Elevation, ft amsl
(Aug 2013)

UNC Exhibit 6g
Groundwater Heads in Jackpile Sandstone,
St. Anthony Mine 2013
St. Anthony Mine,
AAS Petition Hearing



UNC Exhibit 6h
Water Supply Wells in the Vicinity of the St. Anthony Mine
St. Anthony Mine,
AAS Petition Hearing

FILE: S:\ABQ\GE1-UNC_St_Anthony\Graphics-Drafting\GIS\MapDocuments\AAS_Petition\WQCC_Hearing_2017\Exhibit_06_Cindy\06h_WaterSupplyWells.mxd Date: 4/28/2017



INTERA

UNC Exhibit 6i
Post-Reclamation
Particle Track Analysis
St. Anthony Mine,
AAS Petition Hearing

FILE: S:\ABQ\GE1-UNC_St_Anthony\Graphics-Drafting\GIS\MapDocuments\AAS_Petition\WQCC_Hearing_2017\Exhibit_06_Cindy\06i_BaseCase_SA_particletrack.mxd 4/24/2017

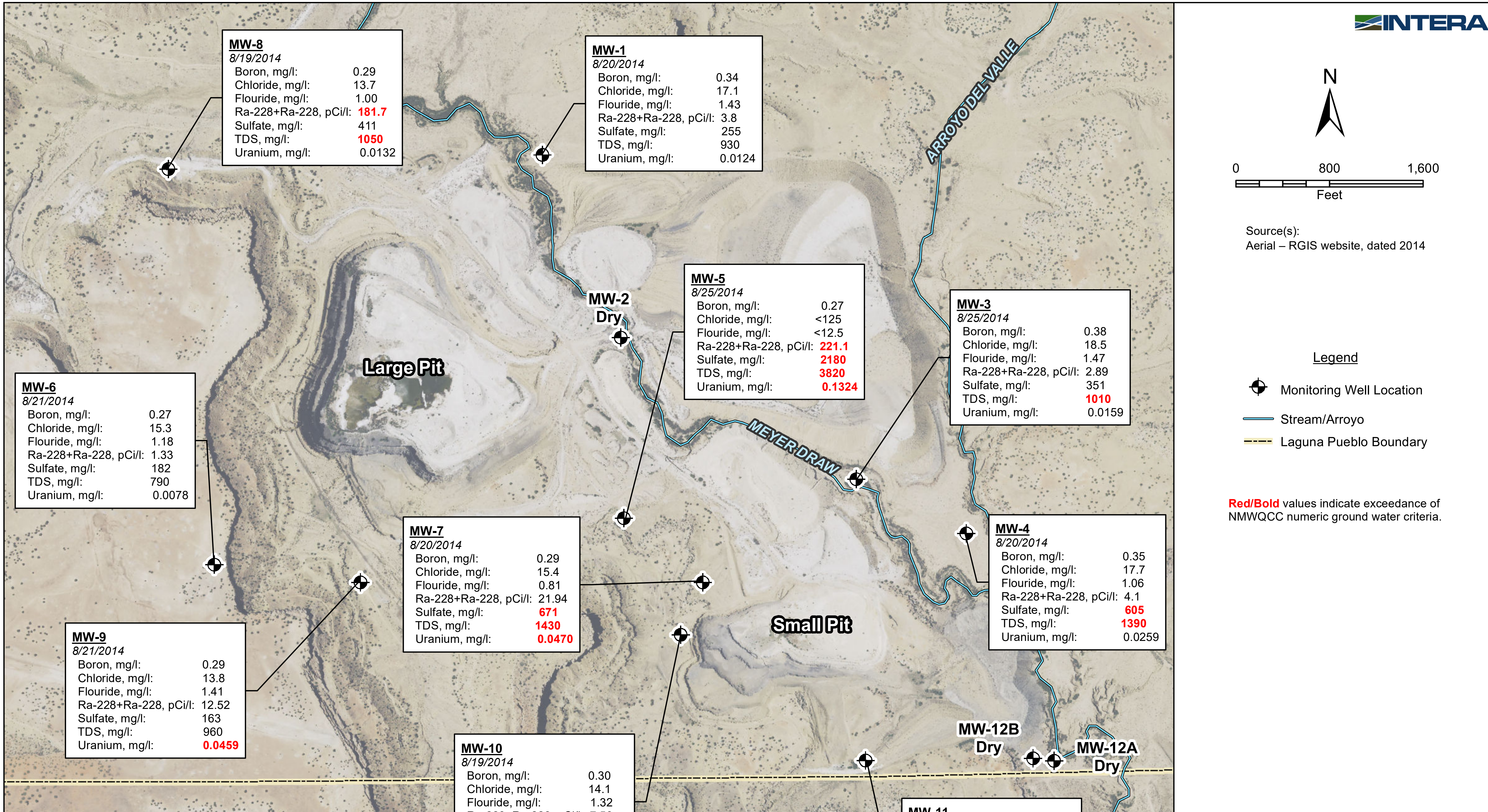


Exhibit 6j
Distribution of COPCs in Groundwater at the St. Anthony Mine
St. Anthony Mine,
AAS Petition Hearing

FILE: S:\ABQ\GE1-UNC_St_Anthony\Graphics-Drafting\GIS\MapDocuments\AAS_Petition\WQCC_Hearing_2017\Exhibit_06_Cindy\06j_COPCdistribution.mxd 4/28/2017

INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

INTERA Incorporated
6000 Uptown Boulevard NE, Suite 220
Albuquerque, New Mexico 87110 USA
505.246.1600

July 7, 2015

Phyllis Bustamante, Acting Chief
Ground Water Quality Bureau
New Mexico Environment Department
1190 St. Francis Drive
P.O. Box 5469
Santa Fe, New Mexico 87502-5469

RE: St. Anthony mine—New Mexico Environment Department conditional approval for "St. Anthony mine Stage 2 abatement plan, Cibola County, New Mexico" – United Nuclear Corporation Responses

Dear Ms. Bustamante:

United Nuclear Corporation (UNC) is in receipt of the Ground Water Quality Bureau of the New Mexico Environment Department's (NMED's) conditional approval for the "St. Anthony Mine Stage 2 Abatement Plan, Cibola County, New Mexico" dated May 7, 2015, prepared by INTERA Incorporated (INTERA). UNC and INTERA provide the following responses to the NMED conditions set forth in the May 7th letter.

1. NMED notes that the lack of saturation in MW-2 was not considered in the mapping of ground water elevations in the Jackpile Sandstone shown in Figure 3.3. Please provide explanations

a. why this well is dry within the context of the conceptual model, and

As described in the Stage 1 Investigation Report dated May 19, 2008, MW-2 was installed for the purpose of sampling groundwater in the alluvium, or in other words to investigate the alluvial aquifer. As described in detail in the Stage 2 Abatement Plan, and as further evidenced by the lack of water in MW-2, the alluvium in the vicinity of the Site is dry. MW-2 did not have any water in it at the time of installation in 2007 and ongoing monitoring at the Site through 2014 confirms the absence of water in the alluvium.

b. why water level data from this well were not included in the interpretation of potentiometric surface within the referenced figure.

Please see response to 1(a).

2. ***On page 107, Intera states that "[F]following completion of the abatement process, a subset of the existing monitoring well network to include a minimum of four wells...will be sampled on an annual basis. This subset of wells will be determined in conjunction with the NMED." UNC shall submit a proposal for "...post abatement-completion sampling stations and sampling frequencies to be used to demonstrate compliance with the standards and requirements set forth in Section 20.6.2.4103 NMAC" in accordance with 20.6.2.4106.E (3) NMAC.***

Following completion of the abatement process, UNC will sample five monitoring wells semi-annually until completing the post-closure requirements. The proposed well network currently includes: MW-5, MW-7, MW-8, MW-11, MW-12A, and MW-12B (one well upgradient and four downgradient locations from the Large Pit). The duration of post-abatement monitoring will be a minimum of two years.

3. ***UNC shall begin the implementation of its preferred alternative within one year of the date of this letter. At that time, UNC shall submit to NMED for approval a detailed schedule of construction activities.***

UNC cannot implement its preferred remedy until AASs (which are part of the preferred remedy) are approved. Therefore, UNC commits to implementation of the preferred remedy within one year of receiving approval from the New Mexico Water Quality Control Commission (WQCC) of the proposed AASs.

4. ***UNC shall ensure that backfill materials that are obtained from the site and which contain concentrations of radionuclides above background concentrations, as identified in MWH, October 2007 ("Materials characterization report, Saint Anthony Mine site"), are emplaced above the elevation of the predicted final potentiometric surface in the backfilled pit. Additionally UNC shall ensure that the backfilled pit has a minimum of 3 feet of unimpacted material at the surface, and is contoured to promote positive drainage away from the backfilled pit.***

As stated in the Stage 2 Abatement Plan, "Based on characterization work completed for the Stage 1 Abatement process and development of the draft Closeout Plan, there is likely enough non-mineralized material to fill the Large Pit above the projected groundwater level after regional groundwater conditions are re-established. UNC's objective for pit closure will be to not include mineralized overburden within the range of regional groundwater level elevations." UNC plans to achieve this objective. UNC also intends that the Large Pit reclamation area is backfilled with unimpacted cover material, contoured to promote positive drainage away from the reclaimed area, as required to prevent infiltration. The thickness of the material for the cover will be 3 feet or the equivalent best available technology. Most importantly, the focus of the design will be to prevent infiltration.

5. ***UNC shall characterize the mineralogy of uranyl phosphate and other uranium mineral phases that were formed in its bench-scale evaluation of uranium immobilization by sodium tripolyphosphate. UNC shall submit the results to NMED for approval.***

Characterization of the bench-scale precipitate in treated sediment and pit water (Stage 2 Abatement Plan, Appendix K) was focused on its propensity to release soluble uranium under the influence of oxidizing upgradient groundwater since this was the most relevant performance indicator for the technology selection process. Identification of coherent uranium-phosphate minerals after treatment with sodium tripolyphosphate (STPP) was not pursued given the small fraction of uranium-containing minerals expected to be formed after amendment application compared to the total mass of solid material in the system. For the drum study, if all dissolved uranium were precipitated as autunite, the concentration in the sediment would be about 30 µg/g, which is much lower than the concentrations found in other academic work where U(VI)-phosphate phases were formed for the purpose of fundamental research (Giammar, 2001). For these reasons, and as discussed with NMED, UNC proposes to not characterize uranyl phosphate and other mineral phases as there would be no added value.

NMED agrees that Stage 2 Abatement Plan responses by UNC are adequate to proceed	→	WQCC approves UNC proposed Alternate Abatement Standards (AAS)	→	Phase I: UNC treats 10% of the sediment/water in the large pit to determine the optimal amendment delivery method	→	Phase II: UNC treats the remaining sediment/water in the large pit prior to backfilling

Figure 1: Phased implementation plan for large pit sediment uranium immobilization

6. ***UNC shall perform and submit to NMED for approval geochemical modeling of the interaction of upgradient oxidizing ground water, as represented by samples from MW-8, with the filled-in pit lake materials containing sodium tripolyphosphate to quantify chemical changes (e.g., aqueous speciation, redox, mass transfer, and mixing) in order to evaluate a. the long-term stability of uranium minerals formed by interaction with sodium tripolyphosphate, and b. the duration of sodium tripolyphosphate effectiveness in uranium sequestration.***

Data included in the Stage 2 Abatement Plan provide information relating to the stability of minerals in Site materials treated with STPP and subsequently exposed to oxidizing MW-8 groundwater (Stage 2 Abatement Plan, Appendix K). The data collected by UNC and Pacific Northwest National Laboratory (Wellman, et al.) indicate that low solubility minerals are formed. For the UNC drum study, the concentration of uranium leaving the column extraction study was 80-120 µg/L, which is well below the proposed AAS concentration expected to be seen in the mineralized zones elsewhere on site based on geochemical modeling. Several mechanisms provide long-term immobilization potential and are better assessed with experiments on treated site samples than by modeling. Since U(VI) is the dominant aqueous species available for incorporation into calcium phosphate minerals, it is anticipated that the low solubility minerals formed will be predominantly U(VI). Oxidizing groundwater is not anticipated to oxidatively dissolve these U(VI)minerals since they are already at the highest stable oxidation state in a natural system. Dissolved U(IV) is expected to be a low enough concentration that U(IV)-phosphate minerals will not be significant. Non-uranium bearing calcium phosphate mineral particles and surface coatings formed after treatment will provide a long-term sink for U (VI) through surface complexation and subsequent incorporation into mineral structure. Also, rock phosphate will provide an additional slow-release phosphate source. Another column extraction study would provide more relevant information about mineral stability than a geochemical model. UNC will repeat the column extraction test with sediment treated in Phase I of remedy implementation. The sequence of events in this process are illustrated in Figure 1.

Another challenge with performing geochemical modeling is the lack of valid thermodynamic data. One source of information for the autunite group of minerals was identified in a textbook by Langmuir in Table A13.1. Langmuir used a unique method involving an exchange reaction and data for H-autunite from Grenthe, et al. (1992) and exchange data from Muto, et al. (1965). A critical review of the data and method used by Langmuir are provided in an OECD review (Guillaumont, 2003). The critical review does not select the thermodynamic parameters calculated by Langmuir due to the speculative nature of his method. Given the speculative and suspect nature of the thermodynamic data, any modeling results would also be speculative and suspect. Since site-specific empirical data on stability of treated materials (Stage 2 Abatement Plan, Appendix K) are available, further geochemical modeling of uranium mineral stability was not pursued.

7. ***UNC shall evaluate the potential for mobilization and subsequent sequestration of arsenic that may be released from the proposed sodium tripolyphosphate additive to demonstrate that the remedy will result in compliance with applicable ground water standards. UNC shall submit the results to NMED for review.***

UNC will analyze the STPP for arsenic prior to use and will monitor arsenic in Phase I of remedy implementation (see Figure 1).

Since even food-grade STPP contains trace arsenic, the concentration of arsenic observed after treatment will be influenced. At the dosages used for the bench-scale and drum studies (~2.5 g STPP/L overlying water), the concentration remained below the WQCC groundwater standard for arsenic of 100 µg/L. The concentration of arsenic observed was consistent with that expected given the concentration in the as-received STPP for the drum study. Hence, no mobilization based on the mechanism of displacement of physisorbed arsenic by phosphate was supported by the data. For material from area 2, the arsenic concentration started to increase after day 60, which may have been due to reduction of arsenic-bearing Fe(III)-oxide phases to Fe(II)-sulfide. The increase was not sufficient to cause an exceedance of the groundwater standard and is anticipated to be temporary since the subsequently precipitated Fe(II)-sulfide phases have a high capacity for arsenic. In the situation where Fe (II)-sulfide phases are oxidized to Fe (III)-oxide, which may occur under the influence of oxidizing groundwater, the temporary and localized increase in arsenic concentration may also be observed, but the freshly precipitated Fe (III)-oxide would act as a sink for arsenic and, given the available data, is not expected to exceed the WQCC groundwater standard. The batch system tested in the drum study represents the worst case for phosphate displacement of arsenic since the phosphate concentration will decrease over time and away from the treated materials in the pit. Lastly, after the drum study was completed, additional sources of bulk STPP with lower arsenic concentrations in the raw material were identified and these will also be evaluated for use during Phase I of remedy implementation.

8. ***As a precautionary measure to protect ground water quality, UNC shall plug and abandon the so-called "Mystery Well" of unknown completion in conjunction with Stage 2 abatement activities.***

UNC commits to proper abandonment of the "Mystery Well" as part of the Stage 2 abatement activities.

Sources

Giammar, D. E. 2001. Geochemistries of Uranium at Mineral-Water Interfaces: Rates of Sorption-Desorption and Dissolution-Precipitation Reactions. Dissertation. California Institute of Technology.

Grenthe, I., et al., eds. 1992. *Chemical Thermodynamics of Uranium.* Chem. Thermo. Ser. Amsterdam: Elsevier Science Publ.

Guillaumont, R. 2003. *Update on Chemical Thermodynamics of Uranium, Plutonium, Americium and Technetium.* OECD Nuclear Energy Agency.

Langmuir, D. 1997. *Aqueous Environmental Geochemistry.*

Muto, T. S., Hirono, S., and Kurata, H. 1965. Some Aspects of Fixation of Uranium from Natural Waters. Japan Atomic Energy Research Inst. Report NSJ Transl. No 91. *Mining Geol (Japan)* 15: 287-98.

Wellman, D. M., Pierce, E. M., and Valenta, M. M., 2007. Efficacy of Soluble Sodium Tripolyphosphate Amendments for the In-Situ Immobilisation of Uranium. *Environ. Chem.* 4: 293-300.

If you have any further questions or require further information, please contact Ms. Cynthia Ardito at 505-246-1600.

Sincerely,

INTERA Incorporated

C Ardito

Cynthia Ardito, Sr. Vice President
INTERA Incorporated

cc: Mr. David Mayerson, NMED
Mr. Roy S. Blickwedel, General Electric
Mr. Larry Bush, United Nuclear Corporation

SUSANA MARTINEZ
Governor

JOHN A. SANCHEZ
Lieutenant Governor

**NEW MEXICO
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RYAN FLYNN
Secretary

BUTCH TONGATE
Deputy Secretary

CERTIFIED MAIL—RETURN RECEIPT REQUESTED

May 7, 2015

Larry Bush, President
United Nuclear Corporation
P.O.B 3077
Gallup, NM 87305

RE: St. Anthony mine—New Mexico Environment Department conditional approval for "*St. Anthony mine Stage 2 abatement plan, Cibola County, New Mexico*" (modified February 9, 2015)

Dear Mr. Bush:

The Ground Water Quality Bureau of the New Mexico Environment Department (NMED) has reviewed the above-referenced document, which was prepared by Intera, Incorporated on behalf of United Nuclear Corporation (UNC). NMED hereby approves this Stage 2 Abatement Plan proposal, subject to the conditions that follow.

Within 60 days of the UNC's receipt of this letter, UNC shall provide responses to the following:

1. NMED notes that the lack of saturation in MW-2 was not considered in the mapping of ground water elevations in the Jackpile Sandstone shown in Figure 3.3. Please provide explanations
   a. why this well is dry within the context of the conceptual model, and
   b. why water level data from this well were not included in the interpretation of potentiometric surface within the referenced figure.

2. On page 107, Intera states that "[F]ollowing completion of the abatement process, a subset of the existing monitoring well network to include a minimum of four wells...will be sampled on an annual basis. This subset of wells will be determined in conjunction with the NMED." UNC shall submit a proposal for "...post abatement-completion sampling stations and sampling frequencies to be used to demonstrate compliance with the standards and requirements set forth in Section 20.6.2.4103 NMAC" in accordance with 20.6.2.4106.E (3) NMAC.

3. UNC shall begin the implementation of its preferred alternative within one year of the date of this letter. At that time, UNC shall submit to NMED for approval a detailed schedule of construction activities.

4. UNC shall ensure that backfill materials that are obtained from the site and which contain concentrations of radionuclides above background concentrations, as identified in MWH, October 2007 ("*Materials characterization report, Saint Anthony Mine site*"), are emplaced above the elevation of the predicted final potentiometric surface in the backfilled pit. Additionally UNC shall ensure that the backfilled pit has a minimum of 3 feet of unimpacted material at the surface, and is contoured to promote positive drainage away from the backfilled pit.

5. UNC shall characterize the mineralogy of uranyl phosphate and other uranium mineral phases that were formed in its bench-scale evaluation of uranium immobilization by sodium tripolyphosphate. UNC shall submit the results to NMED for approval.

6. UNC shall perform and submit to NMED for approval geochemical modeling of the interaction of upgradient oxidizing ground water, as represented by samples from MW-8, with the filled-in pit lake materials containing sodium tripolyphosphate to quantify chemical changes (*e.g.*, aqueous speciation, redox, mass transfer, and mixing) in order to evaluate
   a. the long-term stability of uranium minerals formed by interaction with sodium tripolyphosphate, and
   b. the duration of sodium tripolyphosphate effectiveness in uranium sequestration.

7. UNC shall evaluate the potential for mobilization and subsequent sequestration of arsenic that may be released from the proposed sodium tripolyphosphate additive to demonstrate that the remedy will result in compliance with applicable ground water standards. UNC shall submit the results to NMED for review.

8. As a precautionary measure to protect ground water quality, UNC shall plug and abandon the so-called "Mystery Well" of unknown completion in conjunction with Stage 2 abatement activities.

Please contact David L. Mayerson at (505) 476-3777 or by email at david.mayerson@state.nm.us if you should have any questions on this letter.

Sincerely,

Phyllis Bustamante

Phyllis Bustamante, Acting Chief
Ground Water Quality Bureau
New Mexico Environment Department

Emailed copies:
Cindy Ardito, Intera Incorporated (cardito@intera.com)
Roy Blickwedel (roy.blickwedel@ge.com)
David L. Mayerson, NMED
Kurt Vollbrecht, NMED

PB/dlm

INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

INTERA Incorporated
6000 Uptown Boulevard NE, Suite 220
Albuquerque, New Mexico 87110 USA
505.246.1600

August 3, 2016

Ms. Michele Hunter
New Mexico Environment Department
Ground Water Quality Bureau
P.O. Box 5469
1190 St. Francis Drive
Santa Fe, NM 87502

Re: Request for Extension to Respond to the "St. Anthony Mine Stage 2 Abatement Plan responses to INTERA, July 7, 2015 (St. Anthony Mine – New Mexico Environment Department conditional approval for the St. Anthon Mine Stage 2 Abatement Plan, Cibola County, New Mexico" – United Nuclear Corporation Responses – NMED letter dated August 25, 2015

Dear Ms. Hunter:

On behalf of United Nuclear Corporation (UNC), INTERA Incorporated (INTERA) requests an extension of the deadline to begin abatement remedy implementation identified in the New Mexico Environment Department Ground Water Quality Bureau (NMED) referenced letter of August 25, 2015. As stated in this letter, implementation should begin within one year from May 7, 2015, the date of the conditional approval of the St. Anthony Mine Stage 2 Abatement Plan. As also stated in the NMED letter, "NMED would consider a request from UNC for an extension to this schedule if information were provided indicating that the AAS process was projected to take longer than one (1) year."

UNC and INTERA have made good progress toward filing an AAS Petition with the New Mexico Water Quality Control Commission (WQCC). We have a draft petition under internal review, we have hired and are working with local counsel who will represent UNC at the WQCC hearing, we have been holding regular meetings with Kurt Volbrecht and his team to update him on our progress, and we have been working with key stakeholders.

We anticipate filing the completed Petition this Fall at which point we will request a hearing date from the WQCC. In consideration of the holidays and the legislative session, it is unlikely that we will obtain a hearing date until early Spring 2017. Therefore, we respectfully request a one-year extension to May 7, 2017, for initiating implementation of the preferred remedy.

Thank you for considering this request. Please don't hesitate to call me at 505-246-1600 if you have any questions or require additional information.

Sincerely,
INTERA Incorporated

Cynthia Ardito, PH, CGWP
Senior Vice President, Senior Hydrogeologist

cc: Roy Blickwedel, GE
Kurt Volbrecht, NMED

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Governor

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Lieutenant Governor

RYAN FLYNN
Cabinet Secretary

BUTCH TONGATE
Deputy Secretary

August 12, 2016

Ms. Cynthia Ardito, Senior Vice President
Intera Geoscience & Engineering Solutions
6000 Uptown Boulevard NE, Ste. 220
Albuquerque, New Mexico 87110

Re: Request for One Year Extension to Respond to the Stage 2 Abatement Plan, United Nuclear Corporation, St. Anthony Mine, Cibola County, New Mexico

Dear Ms. Ardito:

The Mining Environmental Compliance Section has reviewed your letter dated August 3, 2016 requesting an extension on behalf of United Nuclear Corporation (UNC). In a letter from New Mexico Environment Department (NMED) dated August 25, 2015, to UNC St. Anthony Mine, it was indicated that NMED would consider a request for an extension of one year if the Alternative Abatement Standard (AAS) process was projected to take longer than one year. NMED has participated in meetings with you and acknowledges the AAS process is moving forward. Your request for an extension of one year to May 7, 2017 to implement the preferred remedy of an AAS Petition through the Water Quality Control Commission is approved.

Should you have any questions or require additional information, please contact Mr. Kurt Vollbrecht of my staff at (505) 827-0195.

Sincerely,

Trais Kliphuis, Director
Water Protection Division

cc: Mr. Roy Blickwedel, General Electric
Mr. Kurt Vollbrecht, Program Manager, Mining Environmental Compliance Section

SUSANA MARTINEZ
Governor

JOHN A. SANCHEZ
Lieutenant Governor

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RYAN FLYNN
Cabinet Secretary

BUTCH TONGATE
Deputy Secretary

CERTIFIED MAIL—RETURN RECEIPT REQUESTED

August 25, 2015

Larry Bush, President
United Nuclear Corporation
P. O. Box 3077
Gallup, NM 87305

RE: St. Anthony Mine Stage 2 abatement plan—responses to Intera, July 7, 2015 ("*St. Anthony mine—New Mexico Environment Department conditional approval for 'St. Anthony mine stage 2 abatement plan, Cibola County, New Mexico'—United Nuclear Corporation Responses"*)

Dear Mr. Bush:

The New Mexico Environment Department (NMED) has reviewed the above-referenced letter from Intera, Inc. (Intera) submitted on behalf of United Nuclear Corporation (UNC), and accepts the responses to all numbered items except for #3 as discussed below.

As NMED has explained to UNC and Intera during several prior conversations, the Water Quality Control Commission (WQCC) abatement regulations (20.6.2.4106 - 4109 NMAC) do not provide for a mechanism for NMED to stay its approval or disapproval of an abatement plan while an owner or operator petitions the WQCC for alternative abatement standards (AASs). In its May 7, 2015 conditional approval of UNC's abatement proposal, NMED provided UNC one (1) year from the date of the correspondence to begin remedy implementation, allowing for sufficient time for UNC's submittal, and the WQCC's consideration, of an AAS petition. NMED would consider a request from UNC for an extension to this schedule if information were provided indicating that the AAS process was projected to take longer than one (1) year. However, to date NMED is not aware that UNC has either prepared or submitted an AAS petition. Based upon these considerations, NMED still requires UNC to implement the preferred alternative within one year of the conditional approval letter dated May 7, 2015. Alternatively, UNC may request NMED's approval of a different abatement remedy if it has chosen to not pursue AAS approval.

Please contact me at (505) 476-3777 or by email at david.mayerson@state.nm.us if you should have any questions on this letter.

Sincerely,

David L. Mayerson
Mining Environmental Compliance Section
Ground Water Quality Bureau
New Mexico Environment Department

Emailed copies:

David Ennis, MMD (david.ennis@state.nm.us)
Kurt Vollbrecht, NMED (kurt.vollbrecht@state.nm.us)

Exhibit 7
William L. (Beau) Kostedt Resume

William L. (Beau) Kostedt IV, PhD, P.E., BCEE

beau@unfettered.com · 8 W Wind Way, Clifton Park, NY 12065 · Phone 314-239-6794

EDUCATION

UNIVERSITY OF FLORIDA, Gainesville, FL
Doctor of Philosophy in Environmental Engineering . . . . May 2008
- Concentration in physical-chemical unit operation design and advanced materials for environmental applications
- Performance enhancement of a magnetically agitated photocatalytic reactor (MAPR) for water recovery during long-term space missions
- 3.97/4.00 GPA, Alumni Fellow

TRINITY UNIVERSITY, San Antonio, TX
Bachelor of Science in Engineering . . . . May 2002
- Concentration in Chemical Engineering, Minor in Mathematics

EXPERIENCE

WLK ENGINEERING, PLLC, Clifton Park, NY . . . . October 2015 – Present
Principal and Owner
- Provide environmental engineering services including strategy, remediation technology selection, system design, and participating in regulatory negotiations primarily for soil, sediment, and groundwater issues
- Professional engineering licensure in NY and NM

KNOLLS ATOMIC POWER LABORATORY, Niskayuna, NY . . . . April 2015 – Present
Principal Chemical Engineer – Coolant Technology Development
- Sponsor testing to evaluate existing and develop new technologies for coolant in nuclear propulsion systems on US Navy vessels
- Document work and advocate for modified operation or technology implementation using results from testing and modeling

GE GLOBAL RESEARCH, Niskayuna, NY . . . . .May 2008 – April 2015
Lead Chemical Engineer – Environmental Technology Laboratory
- Used process monitoring data and water treatment systems knowledge to improve performance and reduce operating cost
- Led multidisciplinary teams to develop and implement new technologies for water treatment and hazardous material contaminated with radionuclides, PCBs, chlorinated solvents, and petroleum
- Leveraged research laboratory facilities to tailor science-based technology solutions for complex geochemical problems
- Selected to serve on the Hazardous Waste Management Committee of the American Academy of Environmental Engineers
- Documented proprietary work in 25 internal publications and 5 patent applications

UNIVERSITY OF FLORIDA, Gainesville, FL . . . . June 2004 – May 2008
Graduate Research Assistant
- Performed research involving development of semiconductor photocatalyst material and ceramic support
- Developed strong ability to apply material science fundamentals to environmental problems
- Improved performance of the magnetically agitated photocatalytic reactor by 400 percent

PUBLICATIONS

Moore, B. C.; Matis, H.; **Kostedt, W. L. IV.**; Polizzotti, D. M.; Petersen, M. A.; Schworm, J. L.; Ku, A. K.-Y. US Patent Application. US 2014/802961, Produced Water Treatment to Remove Organic Compounds.

Silva, J.M.; Gettings, R. M..; **Kostedt, W. L. IV;** Watkins, V.; Hardy, A.; Shapiro, A. NORM Mitigation and Clean Water Recovery from Marcellus Produced Water. RPSEA Final Report. 10122-07. 4 April 2014.

Silva, J.M.; Gettings, R. M.; **Kostedt, W. L. IV;** Watkins, V. H.; Acharya, Produced Water from Hydrofracturing: Challenges and Opportunities for Reuse and Recovery. National Academy of Engineering: The Bridge 2014, 44 (2), 34-40.

Kostedt, W. L. IV Silva, J.M.; Matis, H.; Watkins, V. H.; Acharya, H. R. US Patent Application US 2013/307656, Water treatment processes for NORM removal**.**

Silva, J.M.; Matis, H.; **Kostedt, W. L. IV.** US Patent Application US 2012/0097614, NORM Removal from Frac Water.

Silva, J.M.; Matis, H.; **Kostedt, W. L. IV;** and Watkins, V.; Produced Water Pretreatment for Water Recovery and Salt Production. RPSEA Final Report. 08122 – 36. 26 January 2012.

Kostedt, W. L., IV; Byrne, H. E.; Mazyck D. W. A High Surface Area Magnetic Photocatalyst With Controlled Pore Size Distribution. Environmental Progress 2010, 29(1), 10–16.

Byrne, H. E.; **Kostedt, W. L., IV**; Stokke, J. M.; Mazyck D. W. Characterization of HF-catalyzed silica gels doped with Degussa P25 titanium dioxide. Journal of Non-Crystalline Solids 2009, 355(9), 525- 530.

Kostedt, W. L., IV; Ismail, I. I.; Mazyck D. W. Synthesis and characterization of ZnO-TiO2 nanoparticles via sol-gel technique for wastewater treatment Industrial & Engineering Chemistry Research 2008, 47(5), 1483–1487.

Kostedt, W. L., IV; Mazyck, D. W. Evaluation of a Photocatalytic Water Treatment Process. Florida Water Resources Journal 2006, 58(11), 44-48.

Kostedt, W. L., IV; Drwiega, J; Mazyck, D. W.; Lee, S.-W.; Sigmund, W.; Wu, C.-Y.; Chadik, P. Magnetically agitated photocatalytic reactor for photocatalytic oxidation of aqueous phase organic pollutants. Environmental Science & Technology 2005, 39(20), 8052-8056.

CONFERENCE PROCEEDINGS & PRESENTATIONS

Kostedt, W. L. IV*; Silva, J.M.; Gettings, R.; Watkins, V.; Matis, H.; Assessment of Marcellus Shale Produced Water Chemistry and its Implications on Tenable Water Handling. 30th Annual International Conference on Soils, Sediments, Water, and Energy, Amherst MA, October 21-24, 2013.

Kostedt, W. L., IV*; Mazyck, D. W. High Surface Area Magnetic Photocatalyst. AIChE Annual Meeting, Salt Lake City UT, November 4-9, 2007.

Kostedt, W. L., IV*; Mazyck, D. W. Oscillating Magnetic Field Gradient Induced Motion of a Magnetic Photocatalyst. AIChE Annual Meeting, San Francisco CA, November 12-17, 2006.

Kostedt, W. L., IV*; Mazyck, D. W. Performance of a Magnetically Agitated Photocatalytic Reactor for Oxidation of Ersatz Water. In Proceedings of the 36th International Conference on Environmental Systems, Society of Automotive Engineers (SAE): Norfolk, Virginia, July 17-20, 2006. 2006-01-2084.

Kostedt, W. L., IV*; Mazyck, D. W.; Powell, T.; Butters, B. Effect of Photocatalyst Type on Oxidation of Ersatz Water Using a Photocatalytic Reactor with Slurry Separation. In Proceedings of the 36th International Conference on Environmental Systems, Society of Automotive Engineers (SAE): Norfolk, Virginia, July 17-20, 2006. 2006-01-2085.

Kostedt, W. L., IV*; Mazyck, D. W.; Powell, T.; Butters, B. A Photocatalytic Water Recovery Solution Using Nanoparticles: Utilization of a Magnetic Field for Agitation and Confinement. 36th International Conference on Environmental Systems, Society of Automotive Engineers (SAE): Norfolk, Virginia, July 17-20, 2006. 2006ICESPS-4. (Poster)

Kostedt, W. L., IV*; Mazyck, D. W. Evaluation of a Photocatalytic Water Treatment Process. In Proceedings of the Florida Section American Water Works Association, Orlando FL, November 27-December 1, 2005.

Kostedt, W. L., IV*; Mazyck, D. W. Composite magnetic photocatalyst with nano-sized TiO_2 for oxidation of aqueous organic contaminants. ACS National Meeting, Washington D.C., August 28-September 1, 2005; American Chemical Society: Washington, DC, 2005; ENVR-59.

Kostedt, W. L., IV; Witwer, M. A.; Mazyck, D. W.*; Powell, T.; Butters, B. A slurry-based photocatalytic reactor with slurry separation for water recovery. In Proceedings of the 35th International Conference on Environmental Systems, Society of Automotive Engineers (SAE): Rome, Italy, July 11-14, 2005. 2005-01-2994.

Kostedt, W. L., IV*; Mazyck, D. W.; Wu, C.-Y.; Chadik, P. Optimization of a magnetically agitated photocatalytic reactor for water recovery. In Proceedings of the 35th International Conference on Environmental Systems, Society of Automotive Engineers (SAE): Rome, Italy, July 11-14, 2005. 2005-01-2995.

* indicates presenter

AWARDS & HONORS

Tau Beta Pi Engineering Honor Society, Order of the Engineer, Trinity University Presidential Scholarship, University of Florida Alumni Fellow, American Water Works Association Roy Likins Scholarship, Priede-Excellence Scholarship, Golden Key International Honor Society, Life Member of Alpha Phi Omega National Service Fraternity, Life Member of National Eagle Scout Association

Exhibit 8

Declaration of William L. (Beau) Kostedt

DECLARATION OF WILLIAM L. KOSTEDT IV, REGISTERED PROFESSIONAL ENGINEER

1.0 Introduction

My name is William L. Kostedt IV and I reside at 8 W Wind Way, Clifton Park, New York. I have conducted work related to understanding, explaining, and controlling groundwater geochemistry at St. Anthony Mine Site since 2008. I am making a declaration in support of United Nuclear Corporation's Petition for Alternate Abatement Standards. My declaration presented below is based on my experience with the Site and examination of site-related geologic, geochemical and geochemical modeling information.

I am a registered professional engineer in New York and New Mexico. Currently, I am employed as a Principal at WLK Engineering, PLLC and as an engineer at the Naval Nuclear Laboratory. I hold a Bachelor of Science degree in Engineering with a concentration in Chemical Engineering from Trinity University (2002), a Master of Engineering degree in Environmental Engineering (2006), and a Doctor of Philosophy degree in Environmental Engineering (2008). Prior to April of 2015, I was employed at the GE Global Research Center (GE-GRC) where I worked on remediation sites throughout the world, leveraging research laboratory facilities to tailor science-based technology solutions for complex geochemical problems. My work was supported by consulting firms including INTERA, Inc., Solid Solutions, CB&I (formerly Shaw Environmental, Inc.), and MWH Global who collected samples, performed studies, and constructed geochemical models. A primary focus of my work was to support mine reclamation for former United Nuclear Corporation (UNC) sites in the southwestern US. I am a Board Certified Environmental Engineer (BCEE) by the American Academy of Environmental Engineers and Scientists (AAEES) where I was selected and continue to serve on the Hazardous

Waste Management and Site Remediation Committee. I have published work in and acted as a peer reviewer for several publications including Environmental Science & Technology, Industrial & Engineering Chemistry Research, and Environmental Progress and Sustainable Energy.

The purpose of this declaration is to explain how proposed Alternate Abatement Standards (AASs) were determined using information from treatability studies, site material characterization and geochemical modeling. Proposed AAS determination involved evaluation of treatment technology options for Large Pit water and sediment. The evaluation considered those treatment options for the Large Pit water and sediment that were technically achievable and justified on a cost-benefit basis to assess whether New Mexico Standards for Groundwater from NMAC 20.6.2.3103 (WQCC Standards) were achievable for various constituents. For those constituents expected to both exceed WQCC Standards and without technology options (removal of or treatment of groundwater in contact with uranium-rich mineralized zones located away from the Large Pit is not considered), geochemical modeling was used to determine proposed AASs (NMAC 20.6.2.4103 Subsection F). This includes regions of the Jackpile sandstone away from the Large Pit where naturally-elevated concentrations of constituents are found.

At the GE-GRC, I designed and executed a multi-phase treatability study to evaluate technologies for their effectiveness to immobilize contaminants of potential concern (COPCs) at St. Anthony Mine. This involved collecting, characterizing and treating sediment and water from the St. Anthony mine (Large Pit) in bench-scale and drum-scale studies. Large Pit treatment technologies were identified in a manner similar to a feasibility study, but with more extensive direct stakeholder feedback.

Materials from both the Large Pit and from uranium-rich mineralized zones intercepted by monitoring wells were characterized and this information was used to explain current Jackpile groundwater conditions and understand their impact on future Jackpile groundwater conditions. Uranium-rich mineralized zones were mapped for past mining activities and are found throughout the Site and region (Exhibit 6b). Characterization of solid geologic materials and water collected from the Site in addition to geologic information from similar sites were used to construct geochemical models for the uranium rich-mineralized zones and for the Large Pit to determine COPCs. These geochemical models were used to determine proposed AASs for the Site.

2.0 Remedial Technology Influence on Geochemistry

In-situ immobilization of uranium and radium in Large Pit materials with sodium tripolyphosphate (STPP) was determined to be the most favorable option through treatability studies. These laboratory treatability studies established that by treating with STPP, concentrations of uranium and radium in water could be reduced to below the WQCC Standards in batch studies. Further, uranium was not appreciably remobilized under the influence of Site groundwater in a column extraction study.

Sulfate, chloride, boron and total dissolved solids (TDS) concentrations were not appreciably affected by the STPP. For proposed AASs, these constituent concentrations were estimated by understanding that water in the Large Pit has evapoconcentrated (water was evaporated leaving behind salts) and that this pit water and solid material in contact with the water are located within the inaccessible areas of the surrounding rock formation. This scenario was evaluated by using a trend analysis incorporating historical site data for evapoconcentration and is described further in the Geochemical Modeling section.

Since application of STPP technology was not viable for the region of the Jackpile sandstone outside of the Large Pit, determination of proposed AASs was necessary for areas of the sandstone outside of the Large Pit. This determination of AASs involved material characterization and geochemical modeling. The application of technology is important because the most recent analysis indicates that the uranium concentration in Large Pit water exceeds the proposed AAS, but is intended to be treated with STPP to reduce its concentration.

3.0 Material Characterization

Materials from the Large Pit and drill core samples were collected and characterized to determine their potential impact on Jackpile groundwater chemistry. Techniques used for characterization included synthetic precipitation leaching procedure (SPLP), x-ray diffraction (XRD), scanning electron microscopy (SEM), petrographic, and whole rock chemical analysis. The information gathered formed the basis for geochemical models.

SPLP was used to select COPCs by mixing solid materials collected from the Large Pit with slightly acidic water (pH 5.00). Those constituents with SPLP concentrations exceeding their respective WQCC Standard were retained for further consideration. Constituents currently exceeding their respective WQCC standards in either groundwater or Large Pit water were also evaluated as COPCs. These two screening procedures identified boron, chloride, fluoride, $^{226}Ra + {}^{228}Ra$, sulfate, TDS, and uranium as COPCs.

The composition of drill core samples and Large Pit wall samples were analyzed so that their interactions with groundwater could be evaluated with geochemical models. Multiple techniques were used to provide broader information about composition including total elemental composition, bulk phase identification, and microstructure. Several materials identified including uranium sulfates were found and are only expected to occur on the outer surface of the

Large Pit wall. Since the focus of further characterization was to identify the uranium solid phase that will determine future equilibrium groundwater concentrations throughout the uranium-rich mineralized zones outside of the Large Pit, uranium ore was examined. Drill core material and primary ore material (black, organic carbon-rich material, see Figure 1) from the Large Pit were sectioned and polished into thin sections that were examined with a petrographic microscope and an electron microprobe.

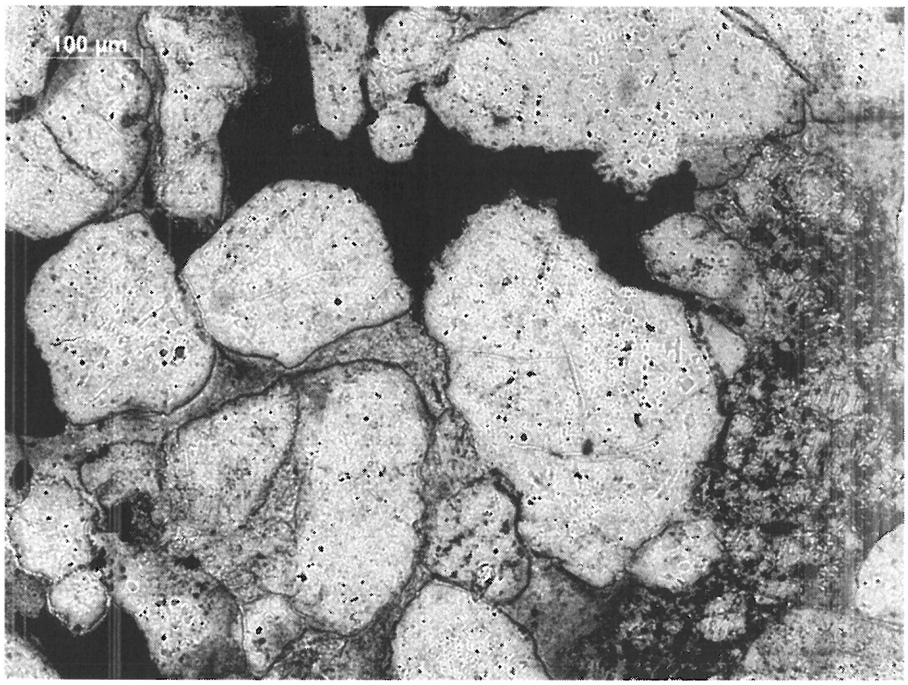


Exhibit 8a. Photomicrograph in plane polarized light of Sandstone with kaolinite matrix partially replaced by humate (black, organic carbon-rich material) from MW-8A.

4.0 Geochemical Modeling

For each COPC, an evaluation was performed to predict the maximum groundwater concentrations that result from either allowing the pit to be backfilled or contact with uranium-rich mineralized zones. Two general approaches were used: equilibrium thermodynamic chemistry modeling for the uranium-rich mineralized zones and trend analysis to predict the evolution of Large Pit COPC concentrations (see Figure 2). For equilibrium thermodynamic chemistry modeling, EQ3/6 software developed at Lawrence Livermore National Laboratory was used. These maximum concentrations are only expected to occur near localized sources: uranium-rich mineralized zones and the Large Pit. Water in the uranium-rich mineralized zones is difficult to extract and is not highly mobile due to the black, organic carbon-rich material that fills the pores. While these small, localized pockets of pore water are not expected to be easily observed or widespread, they represent the maximum concentrations of uranium, radium and fluoride expected to exist.

1.1 Uranium

Naturally-occurring uranium is an expected constituent in Jackpile Sandstone geologic materials and groundwater at the Site since its high concentration was what motivated mining. The Jackpile Sandstone water bearing zone has spatially varying geochemistry over short distances due to stationary pockets of black organic humate (a material that looks like coal and is indicative of the uranium ore mined at the site) and flowing groundwater with dissolved oxygen. This black organic humate material concentrated uranium by converting dissolved uranium (uranium (VI)) from flowing groundwater with dissolved oxygen to a less soluble form (uranium (IV)) and continuously incorporating it into its structure over millions of years. The uranium contained in the black organic humate is not bound irreversibly, and can be released if the natural geochemical conditions change. Depending on the composition of groundwater, direction of flow, and minerals contained within the black organic humate, the concentration of uranium in groundwater samples will vary. Hence, elevated concentrations of uranium in groundwater at the site result from elevated concentrations in the solid geologic materials.

Conservative estimates of the maximum expected concentration of uranium in groundwater were determined by evaluating a geochemical model comprising uranophane

($Ca[(UO_2)_2(SiO_3OH_2)](H_2O)_5$), a commonly-occurring uranium silicate mineral, and site groundwater. Characterization of Site materials demonstrated that conditions were sufficient for formation of uranophane and that this mineral would determine groundwater concentrations in those places where it is elevated to its maximum concentration that could reasonably occur due to natural conditions. Intensive study of uranium ore bodies indicates that uranophane is the most common U(VI) mineral observed in uranium deposits where lead and phosphate are not significant [1], [2], and [3] like at St. Anthony. In addition, uranophane was observed in the Grants Uranium district [4] including the Jackpile Mine [5], which is located nearby to the southwest of the St. Anthony Mine. Uranophane is observed in the portion of the ore body exposed to oxidizing groundwater and containing sufficient uranium, calcium and silicon. Other minerals including uranium (VI) sulfates were observed in Large Pit wall samples and can release higher concentrations of uranium temporarily, but these will be attenuated naturally and represent a smaller total mass of uranium than that found in the uranium-rich mineralized zones found throughout the Jackpile Sandstone. Since Large Pit materials are intended to be treated with STPP and are expected to have uranium concentrations lower than the proposed AAS, they were not included as a scenario for geochemical modeling of uranium.

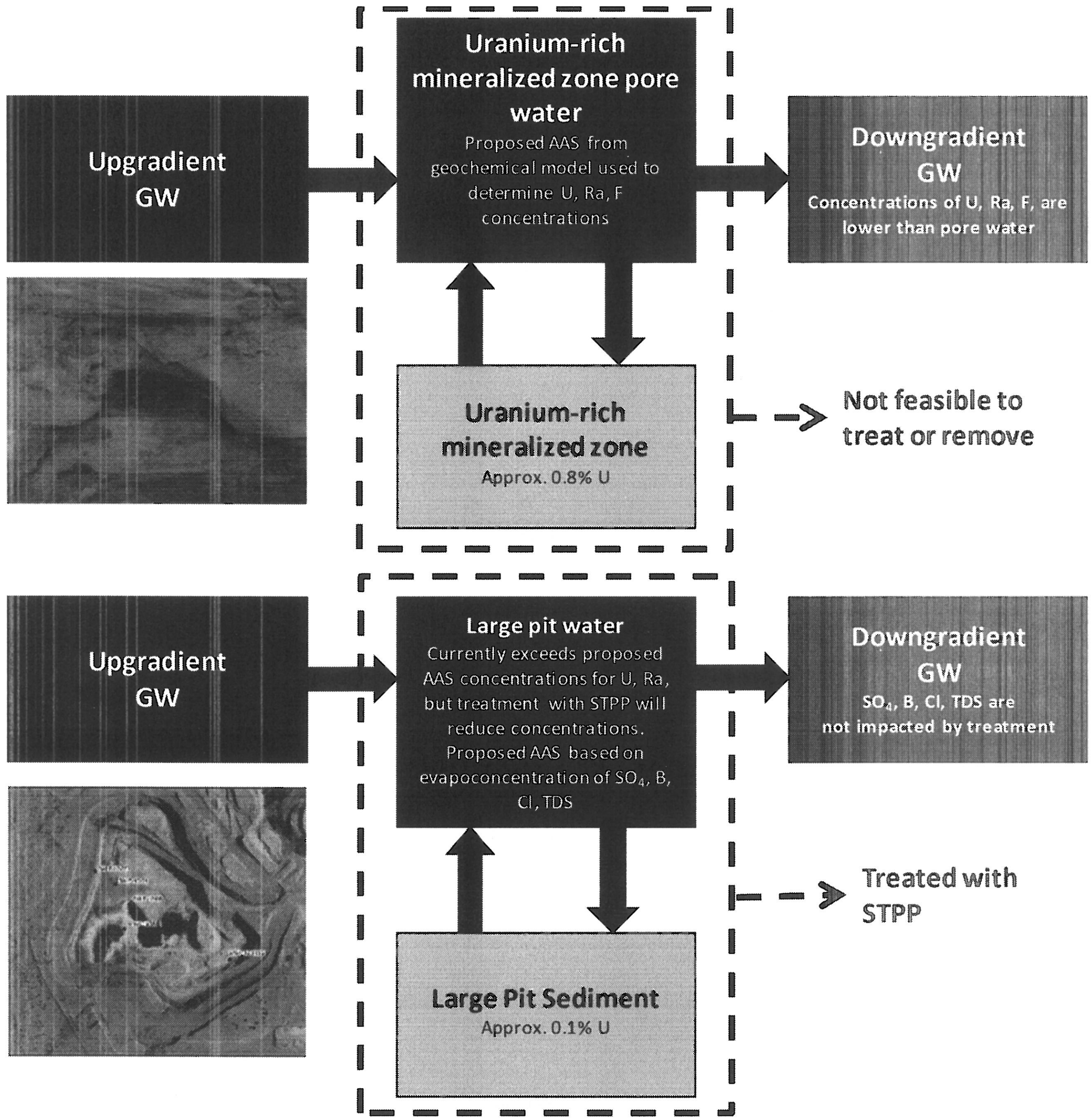


Exhibit 8b. Diagram explaining how proposed AAS were determined by geochemical modeling

1.2 Radium

Radium, listed as the sum of ^{226}Ra and ^{228}Ra in groundwater in the WQCC Standard is associated with uranium-bearing deposits. Natural uranium primarily consists of the long half-life radioactive ^{238}U isotope, which includes ^{226}Ra as one of its decay byproducts. ^{228}Ra is a decay byproduct from ^{232}Th, which is a naturally-occurring isotope that is broadly distributed at the Site, typically at lower concentrations than ^{226}Ra. Given the presence of elevated uranium in the Jackpile Sandstone and relatively low concentrations of thorium, ^{226}Ra is the dominant radium isotope observed at the Site. A natural constraint on radium concentrations is the formation of low solubility radium-containing minerals (see Figure 3). These minerals have been observed in samples from the site and were used to model the maximum observable concentrations. This modeling approach was applicable to groundwater away from the Large Pit. Sediment and water within the pit are expected to be treated with STPP. A technology evaluation at GE-GRC demonstrated that STPP is capable of immobilizing radium in addition to uranium with concentrations below those determined by geochemical modeling, so evapoconcentration in the Large Pit was not used for determining the proposed AAS concentration for radium.

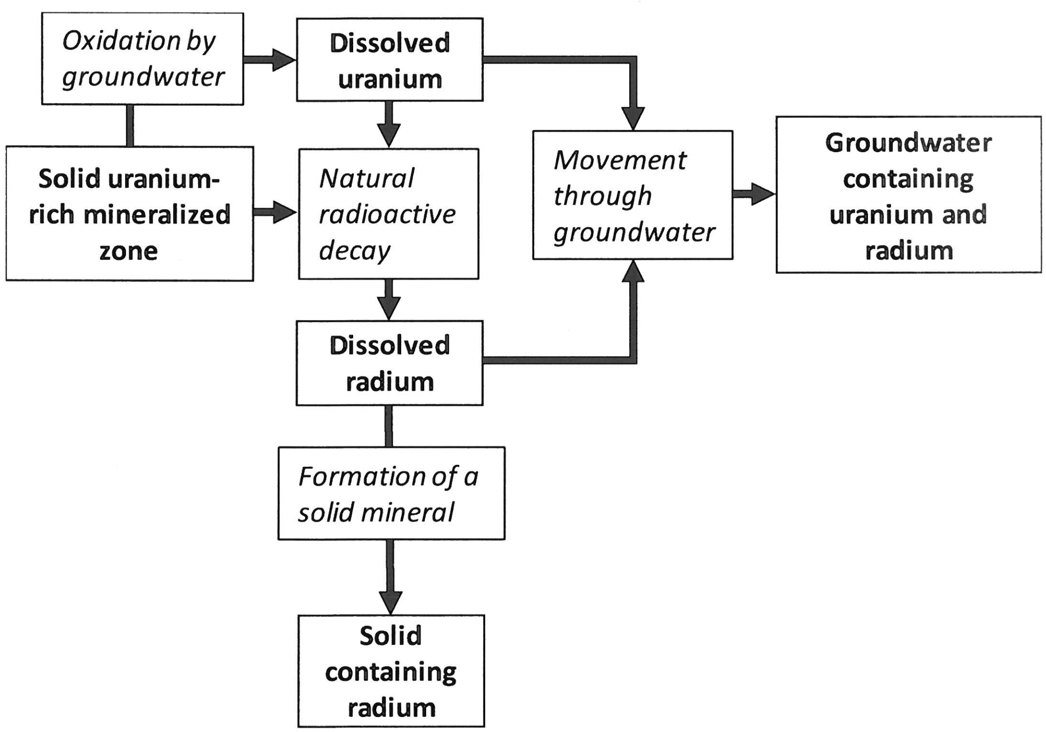


Exhibit 8c. Diagram explaining how radium (specifically ^{226}Ra) concentrations result from dissolved and solid uranium and are naturally controlled by solid mineral formation

1.3 Sulfate, Chloride, TDS, Boron

Evapoconcentration has increased the concentration of dissolved constituents of Large Pit water over its history and is expected to continue to do so until the pit is partially backfilled. Past trends were used to predict future concentrations. A simple linear trend analysis (straight lines through the points) was used to estimate the concentration far enough into the future to account for the time between determination of proposed AAS and the partial backfill of the Large Pit when water will no longer evaporate at a rate sufficient to concentrate constituents. Future concentrations were estimated based on both the lower long-term evaporation rate (2000-2012) and the higher, more recent rate (2008-2012). A time period of 10 years after completion of the Stage 2 Abatement Plan (2014-2024) was chosen to be conservative and allow sufficient time for the regulatory process including approval of the Plan, approval of proposed AASs, and portions of the reclamation that must occur prior to partial backfill. If the process takes longer or the rate of evapoconcentration increases, actual concentrations in localized areas could temporarily be higher than the proposed AASs. Uranium and radium were predicted to exceed WQCC Standards in the Large Pit water using this technique, but the concentrations predicted were not used for proposed AASs since these constituents are intended to be treated with STPP prior to partially backfilling the Large Pit.

1.4 Fluoride

Fluoride has periodically exceeded its WQCC Standard in samples from Site groundwater monitoring wells. A simple thermodynamic equilibrium chemistry model for CaF_2 (fluorite), a common mineral expected to control geochemistry at the Site was used to determine that fluoride concentrations on the site could be conservatively expected to reach their maximum value at locations where the calcium concentration is at its lowest level observed at the Site.

5.0 Summary of Proposed Alternate Abatement Standards

Using the methods described in the geochemical modeling section, the values for proposed AASs listed in Table 1 were determined. Also in the Table, the range of values observed in groundwater and Large Pit water are listed. Constituents with proposed AAS concentrations that are controlled by Large Pit evapoconcentrated residuals including sulfate, TDS, boron, and chloride, are higher than those observed in groundwater and are reflective of the >30 years of evapoconcentration. Naturally-occurring uranium-rich mineralized zones that have and will continue to influence groundwater chemistry occur throughout the area and are the impetus for the calculation for other proposed AASs including radium, and fluoride. While the concentrations of uranium and radium proposed for AAS are high compared to the WQCC standards, they are only 15x and 9x their respective maximum observed concentrations in groundwater at the Site. The mineral composition of the uranium-rich mineralized zones varies considerably over short distances, so this magnitude of variation is reasonable to expect for the Site. Reinstallation of groundwater monitoring wells, or changes in groundwater flow due to partial backfill of the Large Pit may result in observation of the concentrations derived from modeling.

Exhibit 8d. Summary of Proposed AASs

Constituent	Range of Analytical Values in Groundwater at St. Anthony	Range of Analytical Values in Large Pit Water at St. Anthony	Range of Values from Analysis	Proposed AAS
Uranium	0.0059 - 0.85 mg/L	0.85 – 17 mg/L	0.69 – 12.9 mg/L	12.9 mg/L
$^{226}Ra + ^{228}Ra$	ND - 325 pCi/L	9.48 – 42 pCi/L	940 - 2913 pCi/L	2913 pCi/L
Fluoride	ND - 2.1 mg/L	ND – 0.96 mg/L	10.7 mg/L	10.7 mg/L
Sulfate	190 - 2700 mg/L	3210 – 62,000 mg/L	72,200 - 77,000 mg/L	77,000 mg/L
Total Dissolved Solids	680 - 4100 mg/L	5134 – 90900 mg/L	105,000 - 113,000 mg/L	113,000 mg/L
Boron	0.1 - 0.6 mg/L	0.6 – 4.1 mg/L	4.74 - 5.05 mg/L	5.05 mg/L
Chloride	14 - 44 mg/L	23.6 – 720 mg/L	837 - 908 mg/L	908 mg/L

Note:
ND = non-detect

Sources:

[1] Frondel, C. 1958. Systematic mineralogy of uranium and thorium. Vol. 1064, U.S. Geological Survey Bulletin. Washington D.C.: U.S. Government Printing Office.

[2] Smith, D. K. 1984. “Uranium Mineralogy.” In Uranium Geochemistry, Mineralogy, Geology, Exploration, and Resources, edited by F. Ippolito, B. DeVero and G. Capaldi, 43-88. London: Institute of Mining and Metallurgy.

[3] Pearcy, E.C., J.D. Prikryl, W.M. Murphy, and B.W. Leslie. 1994. “Alteration of uraninite from the Nopal I deposit, Pena Blanca district, Chihuahua, Mexico, compared to degradation of spent nuclear fuel in the proposed high-level nuclear waste repository at Yucca Mountain, Nevada.” Applied Geochemistry no. 9:713-732.

[4] Adams, S.S., and A.E. Saucier. 1981. Geology and Recognition Criteria for Uraniferous Humate Deposits, Grants Uranium Region, New Mexico: Final Report, National Uranium Resource Evaluation Program. NTIS., PC A14/MF A01.

[5] Moench, R.H, and J.S. Schlee. 1967. “Geology and Uranium Deposits of the Laguna District of New Mexico.” U.S. Geological Survey Professional Paper no. 519. 117 pp.

The technical testimony that I have prepared is true and correct to the best of my personal knowledge and belief.

Respectfully submitted,

William L. Kostedt IV

Signed the 10th day of June, 2017

Subscribed and sworn to before me this 10th day of June, 2017

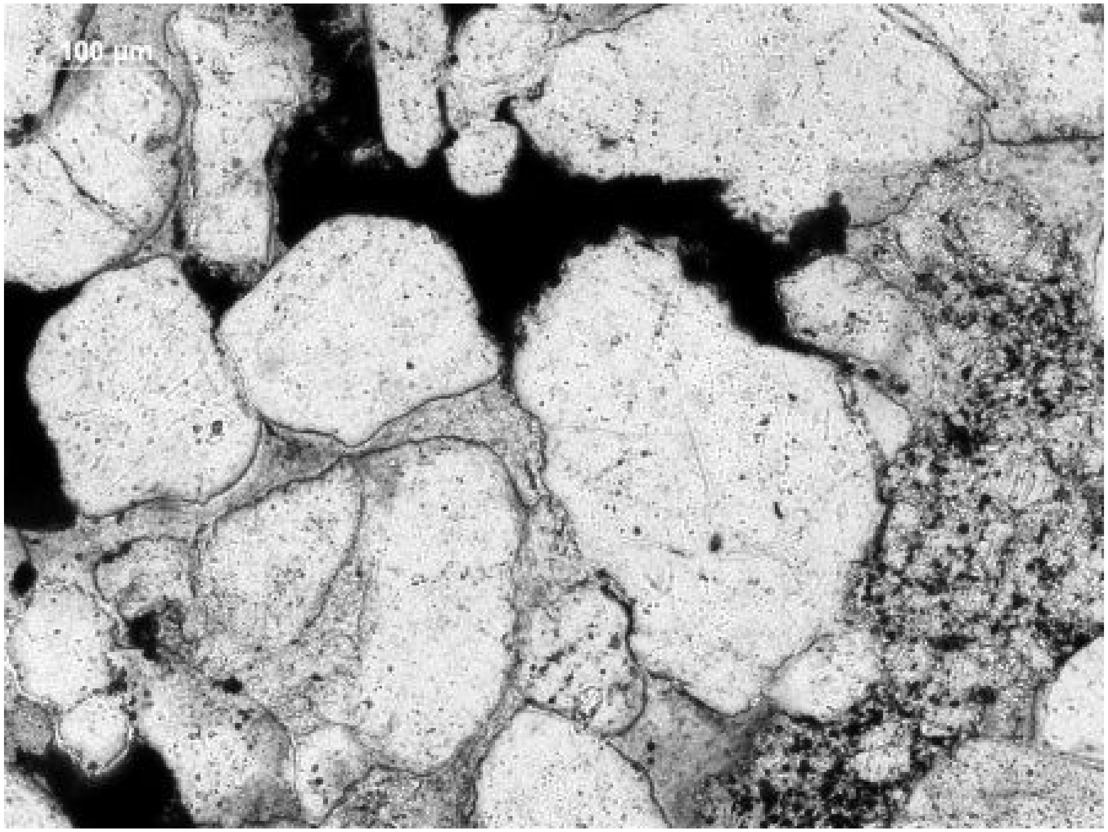
Dennis J Mitchell

Notary Public

My Commission Expires 5-19-2020

Seal

DENNIS J MITCHELL
Notary Public, State of New York
Lic. #01MI6187308
Qualified in Saratoga County
Commission Expires May 19, 2020



UNC Exhibit 8a
Photomicrograph of
Sandstone from MW-8
St. Anthony Mine,
AAS Petition Hearing

Upgradient GW

Uranium-rich mineralized zone pore water
Proposed AAS from geochemical model used to determine U, Ra, F concentrations

Uranium-rich mineralized zone
Approx. 0.8% U

Downgradient GW
Concentrations of U, Ra, F, are lower than pore water

Not feasible to treat or remove

Upgradient GW

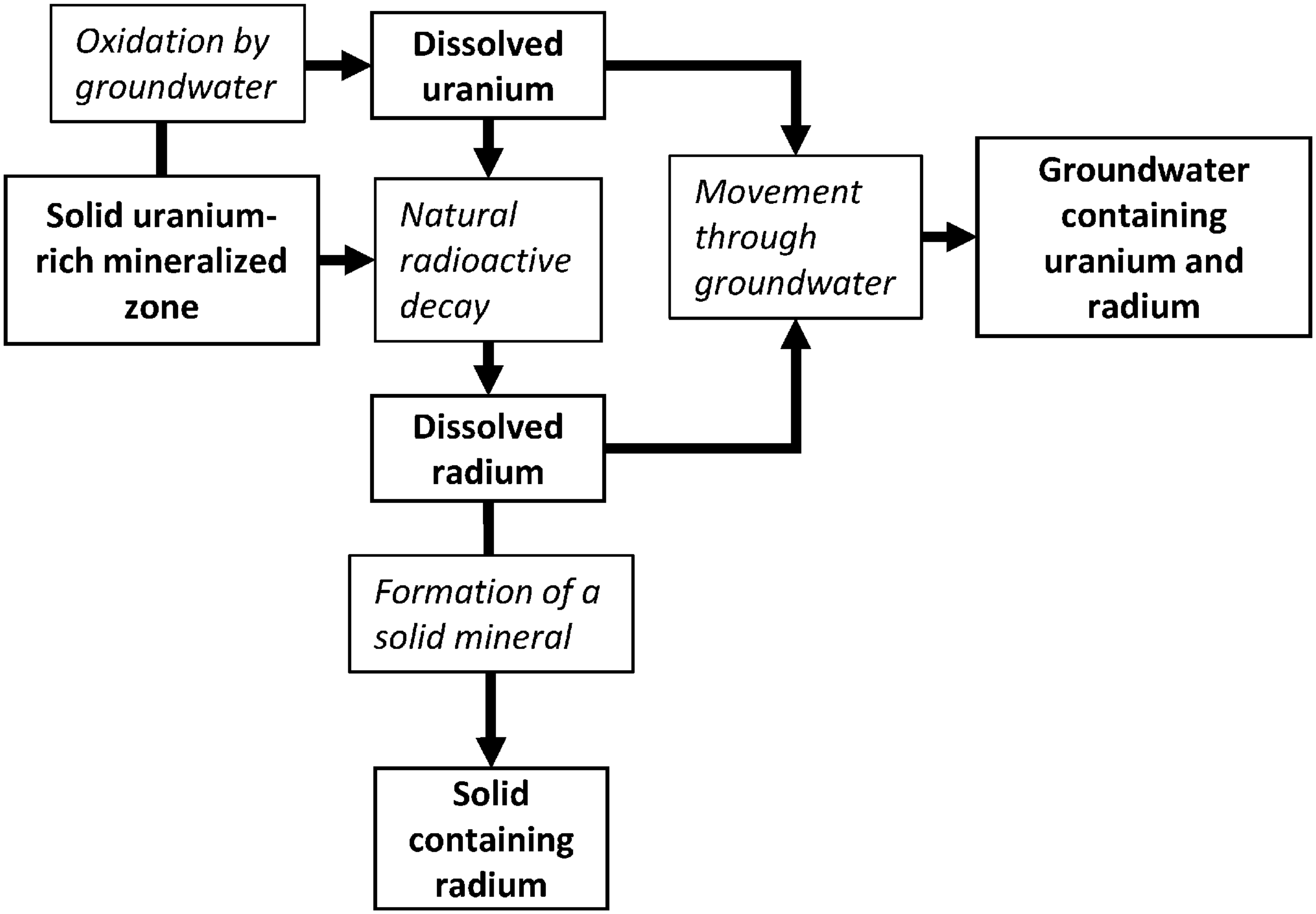
Large pit water
Currently exceeds proposed AAS concentrations for U, Ra, but treatment with STPP will reduce concentrations. Proposed AAS based on evapoconcentration of SO_4, B, Cl, TDS

Large Pit Sediment
Approx. 0.1% U

Downgradient GW
SO_4, B, Cl, TDS are not impacted by treatment

Treated with STPP

UNC Exhibit 8b
Diagram of AAS Determination Through Geochemical Modeling
St. Anthony Mine,
AAS Petition Hearing



UNC Exhibit 8c
Evolution of Radium
Concentrations in Groundwater
St. Anthony Mine,
AAS Petition Hearing

File: S:\ABQ\GE1-UNC_St_Anthony\Graphics-Drafting\GIS\MapDocuments\AAS_Petition\WQCC_Hearing_2017\Exhibit_08_Beau\08c_U_radiumTransport.mxd 4/24/2017

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Uranium	0.0059 - 0.85 mg/L	0.85 – 17 mg/L	0.69 – 12.9 mg/L	12.9 mg/L
$^{226}Ra + ^{228}Ra$	ND - 325 pCi/L	9.48 – 42 pCi/L	940 - 2913 pCi/L	2913 pCi/L
Fluoride	ND - 2.1 mg/L	ND – 0.96 mg/L	10.7 mg/L	10.7 mg/L
Sulfate	190 - 2700 mg/L	3210 – 62,000 mg/L	72,200 - 77,000 mg/L	77,000 mg/L
Total Dissolved Solids	680 - 4100 mg/L	5134 – 90900 mg/L	105,000 - 113,000 mg/L	113,000 mg/L
Boron	0.1 - 0.6 mg/L	0.6 – 4.1 mg/L	4.74 - 5.05 mg/L	5.05 mg/L
Chloride	14 - 44 mg/L	23.6 – 720 mg/L	837 - 908 mg/L	908 mg/L

UNC Exhibit 8d
Summary of Proposed AASs
St. Anthony Mine,
AAS Petition Hearing

Exhibit 9

John Sigda Resume

John M. Sigda, Ph.D.

Principal Hydrogeologist

ENVIRONMENTAL

WATER RESOURCES

INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

John Sigda has 32 years of experience in quantitative hydrology, working to solve problems in the saturated and vadose zones, mine hydrology and permitting, flow and transport modeling, groundwater remediation, seawater intrusion, field and lab measurement of hydraulic properties and water supply and sanitation in developing countries. He has built modeling tools with the MODFLOW, MODFLOW SURFACT, HYDRUS, MT3DMS, FEFLOW, TimML, and STOMP codes to assess closure impacts from mines – whether from wastes or pit lakes or underground workings, estimate dewatering inflows, design plume capture systems, investigate contamination risk to a Sole Source Hawaiian aquifer, secure operating licenses and permits for radioactive waste disposal facilities, assess and improve the performance of groundwater protection systems, secure regulatory approval for new mine works and expansions, and develop remediation goals and guide remediation efforts at sites with sediments, soil, and groundwater contaminated by fuels, heavy metals, radionuclides, nitrates, and chlorinated solvents. Dr. Sigda has provided technical expertise to water supply agencies, mining companies, state agencies, law firms, federal agencies, counties, cities, and private companies on projects located in California, Texas, Nevada, New Mexico, Minnesota, Indiana, Massachusetts, Rhode Island, New Jersey, Washington, Indiana, Hawaii, and Australia. He also worked to improve water supplies, sanitation, and child survival and development in Kenya and Tanzania.

Project Experience – Environmental

Assess Seepage Rates and Solute Loadings from the Ranger Tailings Storage Facility, Energy Resources of Australia, Australia. 2016 to Present. *Principal Hydrogeologist.* Served as technical lead on a team of INTERA hydrogeologists and modelers that determined the rates of seepage and solute loading to groundwater from a decades-old tailings storage facility during historical, closure, and post-closure periods.

Conceptual Model Development for Closure of Ranger Uranium Mine, Energy Resources of Australia, Australia. 2015 – September, 2016. *Principal Hydrogeologist.* Served on a team of hydrogeologists and hydrologists in developing a set of interrelated conceptual models for understanding migration of constituents of potential concern (COPCs) through soils, groundwater, and surface water under current and post-closure conditions for the Ranger uranium mine at regional, site-wide, and source area scales. The conceptual models are a descriptive distillation of the groundwater and surface water systems at and in the vicinity of the uranium mine and of solute migration resulting from mine-related activities and can also be used as a guide for developing future numerical models and as input to support decision making for decommissioning activities. The conceptual models were created following best practices for development of conceptual models, including those found in the Australian groundwater modelling guidelines using existing information, data, and studies on mine-area groundwater hydrology, solute transport, geochemistry, topography, and surface water hydrology from the last 30 years. Individual conceptual models were developed for the most important COPC sources, including the two mine pits, tailings storage facility, waste rock in the reclaimed landform, and the ore processing area. Presented the findings during a two-day meeting with representatives of Ranger

Years of Experience: 32

Education:

- PhD, 2004, Earth and Environmental Science (Hydrology), New Mexico Institute of Mining and Technology
- MS, 1997, Hydrology, New Mexico Institute of Mining and Technology
- BA, 1981, Engineering, Harvard College

Professional History:

2015 – Present	Principal Hydrogeologist – INTERA Inc.
2009 – 2014	Senior Hydrogeologist – INTERA Inc., Albuquerque, NM
2005 – 2009	Senior Hydrogeologist – Geomega, Albuquerque, NM
2003 – 2005	Geohydrologist – New Mexico Bureau of Geology and Mineral Resources, Albuquerque, NM
1998 – 2003	Research Assistant – New Mexico Institute of Mining and Technology, Socorro, NM
1996 – 2003	Consulting Hydrogeologist – J.M. Sigda Consulting Hydrogeologist, Albuquerque, NM
1993 – 1994	Student Intern – Sandia National Laboratories, Albuquerque, NM
1993	Rural Water Consultant – U.S. Peace Corps, Washington, D.C.
1990 – 1992	Hydrologist – ENSR Consulting & Engineering, Inc., Acton, MA
1989 – 1990	Environmental Engineer – Horsley Witten Hegemann, Inc., Cambridge, MA
1989 – 1990	Water Supply and Sanitation Development – World Bank/UNDP, Washington, D.C.
1987 – 1989	Project Officer, Water and Sanitation – UNICEF, Dar es Salaam, Tanzania
1986	Water Supply Consultant – UNICEF, Dar es Salaam, Tanzania
1985 – 1986	Consultant/Project Coordinator – UNICEF, Nairobi, Kenya

Specialized Training & Software:

- STOMP, HYDRUS-1D and 2D, MODFLOW SURFACT, MODFLOW, MT3DMS, SEAWAT, FEFLOW, TimML, Leapfrog, and FORTRAN
- Metals and Non-Metals Mining Safety Training, (MSHA) 2003
- New Miners' Training, 2003

stakeholders and scientists and staff from the regulators and their contractors, among others, in August, 2016. An updated final report was delivered in September 2016.

Groundwater Flow Modeling to Estimate Inflow Rates for an Underground Mine, Confidential Client, NM. 2016 – Present. *Principal Hydrogeologist.* Serving as technical lead, estimated mine dewatering inflow rates for a new mine plan and schedule by updating and applying a regional MODFLOW SURFACT groundwater flow model of the San Juan Basin.

Groundwater Flow Modeling to Assess Potential Impacts from a Proposed Underground Mine, Confidential Client, NM. 2016 – Present. *Principal Hydrogeologist.* Serving as technical lead for a modeling team working to update a three-dimensional groundwater flow model and assess potential impacts to springs, wells, and surface water resources from a new mine plan and schedule. We updated a calibrated regional MODFLOW SURFACT groundwater flow model of the San Juan Basin.

Development of Alternative Standards for Closure of the St. Anthony Uranium Mine, United Nuclear Corporation (UNC), Seboyeta, NM. 2009 – Present. *Senior Hydrogeologist.* Providing technical support for reclamation and closure of UNC's St. Anthony uranium mine. Operated in the 1970s, the St. Anthony mine includes two open pits and underground workings. Since its construction, the large pit has created a hydraulic sink that captures local groundwater flow but also increases uranium and sulfate levels in pit water and sediments through evapoconcentration. INTERA helped UNC reach a consensus closure plan despite conflicting demands from regulators and stakeholders, some wanting to backfill the pit and others wanting the hydraulic sink to continue. If a backfill alternative is selected, the regional groundwater gradient will eventually re-establish flow past the pit, and state standards could be exceeded downgradient from the site. Presently working with INTERA scientists and engineers to develop the scientific foundation to support an Alternative Abatement Standard (AAS) petition to the state for pit closure. Tasks include water balance calculations for the main pit, installation and use of vadose zone monitoring instruments to demonstrate negligible recharge rates, and determination of groundwater flow after pit backfilling through numerical flow modeling. Presented results to NM Environment Department and other stakeholders, including Laguna Pueblo. Prepared a declaration to present to the NM Water Quality Control Commission in support of the AAS petition that is scheduled for July 2017.

San Juan Basin Groundwater Flow Model to Assess Impacts from Mine Dewatering, Energy Fuels Resources, San Mateo, NM. 2010 – 2016. *Senior Hydrogeologist.* Strathmore Minerals is developing the new Roca Honda underground uranium mine in north central New Mexico. Served as lead modeler for all modeling required to secure the necessary mine permits. Used analytical and numerical methods to estimate dewatering inflows to the underground mine workings. INTERA's results showed that dewatering costs would not have a significant impact on ore costs, so we were asked to assess potential impacts from dewatering over the 13-year mine plan to the scarce water resources of the San Juan Basin as input to a U.S. Forest Service Environmental Impact Statement (EIS) and a mine dewatering permit application to the New Mexico State Engineer. Led INTERA's expert modeling, geology, and geographical information system (GIS) team in developing, calibrating, and applying a regional MODFLOW SURFACT groundwater flow model of the San Juan Basin to evaluate potential effects of dewatering at a proposed uranium mine. Our team constructed a digital model of the complex hydrogeologic framework using Leapfrog Hydro, USGS and New Mexico Bureau of Geology & Mineral Resources maps, and mine exploration and borehole data. The new groundwater flow model, which encompasses approximately 21,000 square miles in New Mexico, Colorado, Arizona, and Utah, is the first model calibrated to include the long history of New Mexico uranium mining and dewatering to the present. Model results were used to estimate potential impacts from mine dewatering scenarios on wells, springs, rivers, and water rights holders. The final groundwater flow model was accepted by the EIS hydrology technical group for use in the EIS. INTERA's final modeling report for federal and state regulators formed the basis for the groundwater section of the draft federal environmental impact statement, published in February 2013. The dewatering and impact assessment models helped our client secure the first mine dewatering permit (December 2012) issued by the New Mexico State Engineer since passage of the New Mexico Mine Dewatering Act in 1980.

Reclamation and Closure of the JJ No. 1/L-Bar Uranium Mine Site, Rio Tinto Legacy Management (Formerly Rio Tinto Energy America and Kennecott Energy Corporation), Seboyeta, NM. 2016 to present. *Principal Hydrogeologist.* The JJ No. 1 Mine and L-Bar Mill operated in the late 1970s and early 1980s. The JJ mine's underground workings have been reclaimed and the mine is undergoing the state closure process. Serving as technical lead, worked with the team to evaluate site-specific data and create conceptual and numerical models of groundwater flow in the uraniferous Jackpile Sandstone at the mine and vicinity. The objective of the modeling was to determine how groundwater and solutes migrate from the JJ mine under current and future conditions. Helped draft the conceptual and numerical model sections for the Stage 1 Abatement Plan and meet with officials in state regulatory agencies.

Dewatering and Permitting Support for Ranger 3 Deeps Underground Mine, Energy Resources of Australia, Australia. 2013 – 2015. *Senior Hydrogeologist.* Estimated peak and long-term dewatering flows for a proposed underground mine by constructing and applying analytical and numerical modeling tools to estimate mine dewatering inflows for different mine plans. Served as lead modeler for a team of geologists, hydrogeologists, and GIS experts that completed the initial dewatering estimation and impact assessment in less than three months. Authored the impact assessment report that served as the basis for the groundwater section in the draft Australian Environmental Impact Statement (EIS). Working with client and government agencies to resolve EIS comments.

Hydrologic and Geochemical Modeling to Support Closure of Ranger Uranium Mine, Energy Resources of Australia, Australia. 2011 – 2014. *Senior Hydrogeologist.* Provided modeling and technical support for closure of existing mine workings within the lands of traditional owners and a national Park. Efforts focused on determining cost-effective final disposition of mine wastes that secures approval from stakeholders. As lead modeler, developed conceptual and numerical modeling tools to assess solute loading from pits to the nearby creeks that flow into world heritage wetlands. Directed a team to create a new conceptual model in collaboration with Australia's Commonwealth Scientific and Industrial Research Organization and constructed and calibrated a new three-dimensional MODFLOW SURFACT flow model. Created a digital model of the key hydrolithologic units using Leapfrog Hydro, bore logs, and GIS and Vulcan data products. Created and applied three-dimensional flow and solute transport models with MODFLOW SURFACT to assess the potential impacts on the creek from different closure designs for one pit and a single design for another pit. Completed assessments of dense brine emplacement using FEFLOW and MODFLOW-SURFACT that were used by client engineers to choose an appropriate brine disposal method. Presented results in 2012, 2013, and 2014 to Australia's Office of the Supervising Scientist. Collaborated with INTERA and client geochemists to reduce uncertainty in solute leaching from waste rock.

Technical Review and Support for the U.S. Navy Red Hill Bulk Fuel Storage Facility (RHBFSF) Spill, Board of Water Supply (BWS), Honolulu, HI. 2015 – Present. *Principal Hydrogeologist.* Serving as technical lead for supporting the BWS in managing the threat to its drinking water supplies from fuel releases at the Navy's RHBFSF. The RHBFSF comprises 20 large field-constructed underground storage tanks built in the early 1940s into the Koolau Basalt, 18 of which are currently in use. Each of the steel-lined concrete tanks contains about 12.5 million gallons of fuel that lie 100 feet above the aquifer. Historic and recent fuel leaks from the facility threaten the underlying US EPA-designated Sole Source Southern Oahu Basal Aquifer and BWS water supply wells and production shaft. The INTERA team is developing an evidence-based Conceptual Site Model (CSM) that describes the processes and features controlling the migration of fuel contamination; identifying, designing, installing, and sampling a monitoring well/sentinel network to serve as an early warning system; conducting independent expert review of all technical documents and data from Navy, its contractors, and the regulatory agencies; carrying out fate and transport analyses to help BWS plan for future releases; and supporting BWS interactions with the Navy and regulatory agencies under the new Administrative Order on Consent (AOC). Helped author dozens of letters on AOC work plan inadequacies and inaccuracies. Participated in technical meetings with Navy and regulatory agencies.

Technical Review and Remediation Support for the Kirtland Air Force Base Bulk Fuel Facility Spill, Albuquerque Bernalillo County Water Utility Authority (ABCWUA), Albuquerque, NM. 2011 – Present. *Senior Hydrogeologist.* Serving as technical lead and project manager for third-party technical review of activities carried out by Kirtland Air Force Base (KAFB) and its contractors to characterize and remediate a fuel spill that threatens ABCWUA's most productive well field. KAFB's Bulk Fuels Facility (BFF) spill released between 2 and 24 million gallons of aviation gasoline and jet fuel that have contaminated the 500-foot-thick vadose zone and underlying aquifer in the highly permeable sediments of the ancestral Rio Grande River. Contamination includes light non-aqueous phase liquids (LNAPLs) in the vadose zone and aquifer and extensive dissolved-phase plumes, the longest of which contains the known carcinogen ethylene dibromide (EDB). Reviewed all work plan and design documents, including those for characterization of the vadose zone, the LNAPL lens near the water table, and the dissolved phase plumes; interim containment designs using soil vapor extraction and dissolved phase capture; aquifer testing plans; well design; contingency plan for the Ridgecrest well field; RCRA Facility Investigation Reports; and sampling protocols and strategies. Provided detailed comments and recommendations to ABCWUA, with the focus on improving the scientific defensibility, cost-efficiency, and effectiveness of the proposed activities and designs. The INTERA team supervised and logged the drilling and installation of a sentinel monitoring well nest between the Ridgecrest well field and the known EDB plume. Cost-effectively and quickly evaluated feasibility and robustness of various plume capture well field designs using the open-source TimML three-dimensional analytic element code. Conducted an independent data evaluation of the chemical and fluid level data available for the Site and developed a Conceptual Site Model (CSM) that describes the processes and features controlling the migration of fuel contamination. Currently providing support to the ABCWUA with review of new work plans and design documents and participation in meetings as a scientific advisor.

Remediation of Nitrate Groundwater Contamination at the Mountain View Site, New Mexico Environment Department (NMED) and Office of the Natural Resources Trustee (ONRT), Albuquerque, NM. 2009 – 2016. *Senior Hydrogeologist.* Collaborated in developing a conceptual model of nitrate transport through the Site's thick vadose zone as part of a remedial investigation (RI) for NMED. Directed the sample collection for water content and unsaturated hydraulic property characterization. Constructed a one-dimensional variably saturated flow model (HYDRUS-1D) to simulate the fate of nitrate during the 39 years since the cessation of farming activities. Provided technical oversight and guidance in applying the vadose zone flow model. Collaborated in writing the remedial investigation (RI) report, which demonstrated the nitrate plume extent and mass of nitrate in both the aquifer and the vadose zone and thereby provided the basis for a remediation grant. Currently assisting in conducting site characterization and modeling for construction of an innovative in-situ enhanced bioremediation system at the site for the ONRT that will remove several million pounds of nitrate contamination from groundwater.

Dewatering and Permitting Support for Ranger 3 Deeps Underground Mine, Energy Resources of Australia, Australia. 2013 – 2015. *Senior Hydrogeologist.* Estimated peak and long-term dewatering flows for a proposed underground mine by constructing and applying analytical and numerical modeling tools to estimate mine dewatering inflows for different mine plans. Served as lead modeler for a team of geologists, hydrogeologists, and GIS experts that completed the initial dewatering estimation and impact assessment in less than three months. Authored the impact assessment report that served as the basis for the groundwater section in the draft Australian Environmental Impact Statement (EIS). Working with client and government agencies to resolve EIS comments.

Hydrologic and Geochemical Modeling to Support Closure of Ranger Uranium Mine, Energy Resources of Australia, Australia. 2011 – 2014. *Senior Hydrogeologist.* Provided modeling and technical support for closure of existing mine workings within the lands of traditional owners and a national Park. Efforts focused on determining cost-effective final disposition of mine wastes that secures approval from stakeholders. As lead modeler, developed conceptual and numerical modeling tools to assess solute loading from pits to the nearby creeks that flow into world heritage wetlands. Directed a team to create a new conceptual model in collaboration with Australia's Commonwealth Scientific and Industrial Research Organization and constructed and calibrated a new three-dimensional MODFLOW SURFACT flow model. Created a digital model of the key hydrolithologic units using Leapfrog Hydro, bore logs, and GIS and Vulcan data products. Created and applied three-dimensional flow and solute transport models with MODFLOW SURFACT to assess the potential impacts on the creek from different closure designs for one pit and a single design for another pit. Completed assessments of dense brine emplacement using FEFLOW and MODFLOW-SURFACT that were used by client engineers to choose an appropriate brine disposal method. Presented results in 2012, 2013, and 2014 to Australia's Office of the Supervising Scientist. Collaborated with INTERA and client geochemists to reduce uncertainty in solute leaching from waste rock.

Flow Model Review for Proposed Phosphate Mine, Confidential Client, Southeast ID. 2014. *Senior Hydrogeologist.* Served as lead modeler for an independent review of a groundwater flow model constructed to estimate mine dewatering inflow rates for a prospective phosphate mine in southeastern Idaho. Evaluated the conceptual and numerical models and MODFLOW SURFACT input files and provided client with analysis of critical issues.

Geologic Modeling for Former Uranium Mines, Confidential Client, NM. 2012. *Senior Hydrogeologist.* Constructed a digital model of the Jurassic and Cretaceous units along the eastern flank of Mt. Taylor using Leapfrog Hydro, geologic and topographic maps, GIS data products, and borehole data from several former uranium mines. The geologic model is used by the clients to focus closure efforts and post-closure monitoring.

Modeled Variably Saturated Flow and Transport of Uranium from a Soil Pile, El Paso Gas Company, Fords, NJ. 2010. *Senior Hydrogeologist.* Simulated leaching of uranium from a soil pile under variably saturated conditions over the last 10 years and then predicted future uranium concentrations over the next 160 years in an underlying sand unit with HYDRUS-1D. Applied an analytical solution to the advection dispersion equation with a horizontal plane source (HPS) to predict concentrations of uranium in the saturated sand unit down gradient of the soil pile. Results indicated that uranium is relatively immobile at the site, allowing regulators to release the site under less restrictive conditions.

Technical Review of Vadose Zone Modeling for Litigation, Confidential Client, CO. 2010. *Senior Hydrogeologist.* Provided third-party technical review of modeling approach, results, and documentation for a litigation case involving infiltration-induced damage to a subdivision in Colorado. Reviewed draft modeling reports and submitted assessments of the defensibility of the variably saturated flow simulations produced with MODFLOW SURFACT.

Dewatering Model for Santa Fe County Judicial Complex, Santa Fe County, NM. 2009 – 2010. *Senior Hydrogeologist.* Large amounts of light non-aqueous phase liquid (LNAPL) and dissolved-phase contamination had extended into the area to be excavated for construction of a below-ground-level garage at the new Complex. Constructed, calibrated, and applied a MODFLOW SURFACT model of the Judicial Complex site and vicinity to estimate peak and total dewatering fluxes and to evaluate remobilization of LNAPL lenses near the site. Presented results to county and state officials and collaborated in writing final dewatering and remediation plans. Also applied model to investigate impacts from re-infiltration of produced water. Model results were used to guide the actual dewatering and remediation efforts prior to constructing the new judicial complex, which officially opened in 2013.

Genesis Waste Rock Impact Assessment and Draft Environmental Impact Statement, Newmont Mining, Carlin, NV. 2008 – 2009. *Senior Hydrologist.* Simulated variably saturated flow with reactive solute transport (HYDRUS and PHREEQC) through and beneath potentially acid-generating (PAG) and non-PAG waste rock for EIS assessment of proposed expansion at a large gold mine in the Carlin Trend. Presented EIS assessment methods and results to the Bureau of Land Management and state regulators. Wrote waste rock impact report for the draft federal environmental impact statement.

Evaluating Soil Vapor Extent from Heavily Contaminated Industrial Site, Shoreham Yard, Ashland Inc., Minneapolis, MN. 2008 – 2009. *Senior Hydrologist.* Conducted soil vapor intrusion analysis and long-term LNAPL remediation and monitoring for an industrial chlorinated solvent site in Minneapolis, MN. Investigated potential impacts of vapor intrusion to homeowners and businesses located across the street and downgradient from a site with heavily contaminated groundwater and soils from decades of industrial activities. Assessed laboratory results, computed intrusion screening values for the volatile organic compounds and chlorinated solvents of concern for the various building types, and wrote and submitted a report demonstrating that the measured soil vapor concentrations did not pose a threat of increased risk to the building occupants.

Groundwater Flow Modeling for Shoreham Yard, Ashland Inc., Minneapolis, MN. 2005 – 2009. *Senior Hydrologist.* Modeled groundwater flow through glacial drift with MODFLOW-SURFACT to design a groundwater remediation system in conjunction with a competing consulting company and then extended the model to design and later construct a bioremediation pilot project. Modeled flow through a karstified limestone aquifer underlying an industrial site to support monitored natural attenuation of a two-mile-long chlorinated solvent plume. Presented results to Minnesota regulators.

Large Scale Pump Test, Midway Gold, Tonopah, NV. 2007 – 2008. *Senior Hydrologist.* Conducted a large-scale aquifer test at a Nevada mine site with a complex faulted geology. Determined dewatering needs and assessed impacts using analytical models. Developed the aquifer test plan and specifications for bidding construction of the borehole and the new dewatering well.

Cortez Hills Waste Rock Impact Assessment and Draft Environmental Impact Statement (DEIS), Barrick Gold, NV. 2005 – 2008. *Senior Hydrologist.* Simulated variably saturated flow with reactive solute transport (HYDRUS and PHREEQC) through and beneath mine waste rock for EIS assessment of proposed mine expansion in eastern Nevada. Led a team of engineers, geochemists, and GIS specialists in preparing analysis and report. Presented EIS assessment methods and results to the BLM and Nevada regulators. Wrote waste rock impact report for federal environmental impact statement that was later approved by the BLM.

Litigation Support for WLCS, San Bernardino, CA. 2007. *Senior Hydrologist.* Used analytical modeling of variably saturated flow to predict perchlorate travel time through a thick vadose zone for a litigation case.

Rain Heap Leach Cover Assessment, Newmont Mining, NV. 2006 – 2007. *Senior Hydrologist.* Assessed the performance of cover design on variably saturated flow through a reclaimed heap leach pad for a Nevada gold mine in a semiarid climate.

Impact Assessment Modeling for Getchell-Turquoise Ridge JV Mine, Barrick Gold, Winnemucca, NV. 2005 – 2007. *Senior Hydrologist.* Assessed long-term impacts to water resources and pit lake hydrology from mine dewatering at two large adjacent gold mines using MODFLOW SURFACT. The original model, which focused only on the Getchell surface workings, was expanded to include underground workings at the adjacent Turquoise Ridge Gold Mine near Winnemucca, NV. The updated model's simulation period included the pre-mining flow regime, multi-decadal expansion of three small pits into the current Getchell Main Pit, dewatering of the extensive Turquoise Ridge workings, and several hundred years of water level rebound in the pit and underground workings after mining ended. Flow simulation results were incorporated into a geochemistry model to predict pit lake water quality. Produced and submitted an update report to the Nevada state regulators.

Waste Rock Stability and Weathering, Molycorp Questa, Questa, NM. 2003 – 2005. *Geohydrologist.* Conducted applied hydrologic research in service to New Mexico's governments, industry, and citizens investigating how hydrology affects the long-term stability of mine rock piles at the Molycorp Mine. Wrote the hydrologic section of the original proposal ($430,000 out of $2.2 million). Developed standard operating procedures for field and laboratory procedures. Utilized stable isotopes as environmental tracers for infiltration and vapor-phase loss. Installed and monitored nests of advanced tensiometers to quantify infiltration. Measured unsaturated properties of rock pile materials in the field and laboratory. Prospected for pyrite oxidation "hot spots" with a thermal camera. Scoped and conducted water and heat transport modeling studies. Collaborated with a large, multi-disciplinary, multi-institution team of scientists and engineers.

Tucson Superfund Site Permeability Characterization, D.B. Stephens and Associates, Phoenix, AZ. 1998. *Consulting Hydrogeologist.* Mapped in-situ permeability across a large excavation using an air mini-permeameter at an Arizona subsurface remediation site.

Industrial Remediation, ENSR Consulting & Engineering, Inc., Acton, MA. 1990 – 1992. *Hydrologist.* Provided flow and transport modeling and analytical support to all ENSR's offices. Clients were industrial companies and large public sector institutions. Conducted groundwater flow modeling in support of hazardous waste remediation efforts for several major industrial sites, including a chemical manufacturing Superfund site, and used SUTRA, FLOWPATH, and FEMWATER flow codes. Simulated river flow for a proposed power plant on the Charles River using U.S. Geological Survey flow data. Proposed and coordinated internal research and development projects to develop ENSR's workstation-based environmental data visualization system and to integrate our flow and transport modeling codes with the new visualization system. Managed water resources division's computer resources.

Project Experience – Water Resources

Groundwater Flow Modeling for Well Field Design, City of Valparaiso, IN. 2014. *Senior Hydrogeologist.* Evaluated and improved an existing groundwater flow model to represent better the groundwater flow system in order to investigate different well field designs and pumping configurations. Extended the existing model, checked calibration, and simulated drawdown impacts from new pumping on migration of a nearby contaminant plume and currently operating well fields.

Technical Review of Groundwater Flow Model for Litigation, Confidential Client, NM. 2012. *Senior Hydrogeologist.* Provided third-party technical review of modeling approach, results, and documentation for a litigation case involving groundwater pumping from the Permian San Andres Limestone – Glorieta Sandstone to supply water to a proposed sub-division east of the Sandia Mountains, NM. Reviewed MODFLOW model input and output files and report and drafted exhibits for case involving potential damages to an existing water supply system.

Aquifer Test Analysis for Interbasin Transfer, Confidential Client, NM. 2010 – 2011. *Senior Hydrogeologist.* Supervised a long-term aquifer test to provide a hydrogeologic foundation on the viability of an interbasin transfer of water rights for a private client. Devised the work plan, carried out the analysis, and drafted the final report documenting the yield of the aquifer.

Numerical Flow and Transport Model of Los Alamitos Injection Barrier, Orange County Water District, Los Angeles County Department of Public Works, and Los Angeles Water Replenishment District, Los Angeles Metropolitan Area, CA. 2009 – 2010. *Senior Hydrogeologist.* Constructed and visualized a geologic model of the Central Basin's complex geology. Collaborated in compiling and analyzing geologic, hydrologic, and chemistry data for a conceptual model report. Collaborated in developing and calibrating both steady state and transient MODFLOW and MT3D models of flow and solute transport in and around the 43 injection wells of the Los Alamitos Seawater Intrusion Barrier. The models were used to evaluate present and future barrier performance, including changes to the barrier well configuration. Presented findings and helped hand over the models to the three client agencies. Applied the variable density SEAWAT model to investigate the impact of variable-density-driven flow on barrier performance.

Hydrogeologic Characterization of Aquifer Analogs, New Mexico Bureau of Geology & Mineral Resources, Española Basin, NM. 2005. *Geohydrologist.* Characterized aquifer analogs in the Tesuque Formation in the Española Basin for the New Mexico Office of the State Engineer (OSE). Compared the surficial aquifer analogs near the Buckman well field and those along the Santa Fe River through a combination of geologic mapping, particle size analysis, and in-situ measurement of air permeability using a portable air minipermeameter specifically designed for the poorly lithified sediments found in the Rio Grande Rift. Produced and submitted a written report to the OSE.

Drought Emergency Project Evaluation, U.S. Peace Corps, Washington, D.C. 1993. *Water Supply Consultant.* Evaluated the U.S. Peace Corps Lesotho's Drought Emergency Project for Peace Corps Washington's Office of Training and Program Support. Assessed the feasibility and cost-effectiveness of different rainwater tank and gutter designs as well as project logistics. Conducted a hands-on workshop in rainwater harvesting techniques for Peace Corps volunteers and their host country counterparts.

Water Supply Studies, Horsley Witten Hegemann, Inc., Cambridge, MA. 1989 – 1990. *Environmental Engineer.* Conducted hydrogeologic investigations, review of water supply and waste water treatment designs, and drainage studies for private and public sector clients, including the U.S. Environmental Protection Agency, the Town of Marshfield, MA; Kickamuit River Council, Warren, RI; Carroll County, MD; and the Massachusetts Department of Environmental Management.

Water Supply and Sanitation Development, World Bank/United Nations Development Programme, Washington, D.C. 1989. *Consultant.* Reviewed donor-assisted water and sanitation programs in Tanzania for a series of case studies.

Child Survival and Development, Water & Sanitation, United Nations Children's Fund (UNICEF), Dar es Salaam, Tanzania. 1987 – 1989. *Project Officer.* Responsible for all technical analysis, design, materials procurement, implementation, and evaluation of large- and small-scale water supply and sanitation projects in seven regions. Projects ranged in scope from shallow well development to construction/rehabilitation of pumped/gravity schemes serving 200,000 villagers. Proposed and secured bilateral funding for the rehabilitation of the Makonde Water Supply, which serves more than 100 villages in Newala District; shallow well development in distant Ngara district; and a willingness-to-pay study for water in rural villages. The study demonstrated to officials at local to ministerial levels that villagers were spending significant portions of their limited income on purchasing water for household use. Organized and participated in a national conference on the role of water and sanitation in child survival and development for local, regional, and ministerial water engineers. Coordinated UNICEF support to government Child Survival and Development programs in two regions: water supply, sanitation, primary health care, maternal and child health, agriculture, nutrition, and community development. Planned and implemented Child Survival campaigns in 70 villages in Mtwara Region and 12 villages in Hai District in conjunction with district and regional government officials.

Water Supply Development, UNICEF, Dar es Salaam, Tanzania. 1986. *Water Supply Consultant.* Evaluated feasibility and cost efficiency of rainwater harvesting for rural drinking water supplies in two regions. Evaluated the feasibility of tank catchments and sub-surface and sand dams in Shinyanga Region and tank and rock catchments in Mtwara region. Trained local artisans and Ministry of Water technicians in ferro-cement tank construction.

Ukambani Drought Rehabilitation, UNICEF, Nairobi, Kenya. 1985 – 1986. *Consultant/Project Coordinator.* Following the drought and famine of 1983 to 1984, managed a UNICEF-funded drought rehabilitation project that focused on rainwater harvesting, improved sanitation, and promotion of drought-tolerant agriculture in Kitui and Machakos districts. Provided supplies and trainers to more than 70 primary school parents' groups to build ferro-cement rain tanks and ventilated pit latrines. Managed a community mobilizer, two drivers, and a team of ferro-cement construction trainers. Procured drought-tolerant varieties of maize, sorghum, millet, bean, pigeon pea, and green gram seeds and supervised distribution via seed care/planting workshops at each school.

Mutomo Rainwater Harvesting Self-Help Group, U.S. Peace Corps/Kenya, Nairobi, Kenya. 1983 – 1985. *Water Development Volunteer.* Provided all technical and managerial inputs to a self-help group of Kenyan artisans building rainwater harvesting water supply systems. Responsibilities included training and supervising more than 50 artisans, tank design and costing, sales, and training of trainers. Conducted training workshops in locations across Kenya. Funding agencies included the Danish Volunteer Service, Danish International Development Agency, Action Aid/Kenya, U.S. Ambassador to Kenya, schools, and churches.

Assessing Economic Impacts of Pollution Control, Metasystems, Inc., Cambridge, MA. 1981 – 1983. *Analyst/Programmer.* Assessed the economic impacts of proposed pollution control regulations on major U.S. industries. Calculated and applied end-of-pipe treatment costs to a linear programming model of the entire U.S. chemical industry to estimate the total cost of the proposed new regulations. Carried out statistical analyses using SAS and SPSS and wrote FORTRAN code employing the IMSL libraries.

Subtidal Marine Ecology of the Gulf of Maine, Biological Laboratories, Harvard University, Cambridge, MA. 1978 – 1981. *Research Assistant.* Assisted investigations of subtidal invertebrate communities in the Gulf of Maine through year-round site monitoring using SCUBA, statistical analysis using SPSS and his own software tools written in BASIC and FORTRAN, and taxonomic identification down to the species level of field specimens from nearly all marine invertebrate phyla. Year-round monitoring of one deep-water and two near-shore sites included population counts and size measurement of mobile fauna along transects on vertical rock walls, population counts of urchins along horizontal transects, underwater photography and construction, and surveying of local flounder and lobster populations.

Project Experience – Radioactive Waste Isolation

Permitting of Texas Low-level Radioactive Waste & Resource Conservation and Recovery Act (RCRA) Hazardous Waste Landfill Facility, Waste Control Specialists, Andrews County, TX. 2009 – 2012. *Senior Hydrogeologist.* In collaboration with a University of Mississippi scientist, developed and implemented an annual monitoring program for detection of seepage from a low-level radioactive waste landfill. Developed and applied a methodology for analyzing geophysical logs to detect water content changes in the arid vadose zone beneath the landfill that was accepted by the Texas Commission on Environmental Quality. In 2009, co-developed simulations of groundwater levels in the thin sandy aquifer under various climate scenarios using MODFLOW SURFACT to determine whether the saturated zone would intersect the landfill as part of permit applications for Resource Conservation and Recovery Act (RCRA) hazardous waste landfill permit renewal. The facility began receiving waste in 2011.

Development of Preliminary Remediation Goals Protective of Groundwater across the Central Plateau at the U.S. Department of Energy's Hanford Site, CH2M Hill Plateau Remediation Company, Richland, WA. 2010 – 2011. *Senior Hydrogeologist.* Helped develop, document, and extend the evidentiary basis for preliminary remediation goals (PRGs) to evaluate quickly the need for additional remediation of roughly 1,200 vadose zone waste sites in Hanford's 200 Area. PRGs were calculated using the STOMP variably saturated flow and transport model under conservative assumptions, so that soil concentrations at eligible waste sites could be compared against the appropriate PRGs to quickly ascertain whether each site would require additional remediation. Led a team of hydrologists, GIS experts, and database programmers in designing, implementing, and documenting a unique database tool that integrated all key STOMP model inputs and results from several hundred flow and solute transport model simulations previously carried out for roughly three dozen waste sites in the 200 Area. Collaborated with other CH2M Hill Plateau Remediation Company staff in creating a four-part document series that defined the graded approach to site evaluation and developed the case for calculating and applying PRGs. Served as project manager for INTERA.

Developing Soil Concentrations Protective of Groundwater for the 100 Area at the U.S. Department of Energy's Hanford Site, CH2M Hill Plateau Remediation Company, Richland, WA. 2010 – 2011. *Senior Hydrogeologist.* Worked as technical lead, project manager, and modeler, applied fate and transport modeling to assess the need for remediation of the hundreds of waste sites around Hanford's nine nuclear reactors located along the bank of the Columbia River (Hanford's 100 Area). Subsurface wastes included radioactive (e.g., technetium, uranium) and non-radioactive contaminants (e.g., chromium, lead, nitrate). Calculated contaminant masses that could be left at waste sites without exceeding water quality standards for groundwater and the Columbia River. All simulations of flow and solute transport under variably saturated conditions were made with the STOMP (Subsurface Transport Over Multiple Phases) code run in parallel on up to 40 computing nodes. Supervised a team of modelers and helped draft the remedial investigation/feasibility study (RI/FS) documents in collaboration with site managers. Deliverables were used to assess hundreds of waste sites during 2011.

Evaluating Waste Site Impacts to Groundwater for the Outer 200 Area Baseline Risk Assessment at the U.S. Department of Energy's Hanford Site, CH2M Hill Plateau Remediation Company, Richland, WA. 2010 – 2011. *Senior Hydrogeologist.* As technical lead, project manager, and modeler, worked to ascertain the threat to groundwater quality posed by 32 vadose-zone waste sites as part of the baseline risk assessment for the Outer 200 Area. Led a review of the PRGs developed for the Inner 200 Area to evaluate their applicability to the 32 waste sites in question.

Performance Assessment for the Waste Isolation Pilot Project (WIPP), Sandia National Laboratories, Carlsbad, NM. 1996 – 1997. *Consulting Hydrogeologist.* Applied Bayesian statistics and indicator geostatistics to estimate the probability of brine pockets in the Castile Formation beneath the WIPP site. Carried out exploratory data analyses, variogram fitting, and probability kriging. Assisted in the development of cross-correlation models between brine occurrence in the Castile Formation and a structural proxy for amount of deformation accommodated by the Castile's evaporites. Produced a report summarizing the findings that indicated there was no increase in risk of drilling and hitting a pressurized brine pocket beneath the WIPP site compared to the overall average risk across the entire Delaware Basin.

Hydrogeologic Decision Analysis Framework for Assessing Uranium Concentrations at the Fernald, OH, Plant for Sandia National Laboratories, Albuquerque, NM. 1993 – 1994. *Student Intern.* Helped build a hydrogeologic decision-analysis framework to remediate soil contamination cost-effectively at the U.S. Department of Energy's Fernald, OH, plant using geostatistical simulation techniques. Carried out conditional simulations based on geostatistical descriptions of uranium soil concentrations and devised and calculated the performance metric to compare the efficacy of five different methods/scales for measuring uranium in soils. Deliverable was a software tool to evaluate comparative risk of the measurement methods.

Publications, Presentations, and Reports

Sigda, J., T. Jones, R. Beauheim, D. Fryar, and J. Pickens, 2016. Final Report: Conceptual Model for Ranger Mine. Prepared for Energy Resources of Australia. 30 September 2016.

Ardito, C. J.M. Sigda, and R. Blickwedel. 2015. Evapotranspiration control on groundwater migration at a uranium mine in the high desert. Paper from the Proceedings of Mine Closure 2015 conference held in Vancouver, Canada, June 1-3, 2015.

Sigda, J. and J. Pickens, 2014. Final Report: Solute Egress Modelling for Ranger 3 Deeps Mine Closure. Prepared for Energy Resources of Australia. 15 March 2014. Included as Appendix 9 of the Ranger 3 Deeps Draft Environmental Impact Statement which was submitted to Australian Department of the Environment in 2014 (https://ntepa.nt.gov.au/environmental-assessments/register/ranger-3-deeps-underground-mine/draft-environmental-impact-statement-eis).

Sigda, J. and J. Pickens, 2014. Groundwater Impacts from Ranger 3 Deeps. Prepared for Energy Resources of Australia. 15 March 2014. Included as Appendix 10 of the Ranger 3 Deeps Draft Environmental Impact Statement which was submitted to Australian Department of the Environment in 2014 (https://ntepa.nt.gov.au/environmental-assessments/register/ranger-3-deeps-underground-mine/draft-environmental-impact-statement-eis).

Sigda, J., E. Marcillo, and P. Domenici, Jr, 2014. Groundwater Pollution Investigation and Cleanup Around Albuquerque. New Mexico Water Law Conference, September 11-12, 2014. Santa Fe, New Mexico.

Sigda, J., C. Cheng, and C. Ardito, 2014. Assessing Potential Impacts from Underground Mine Dewatering in the Gallup, Dakota, and Westwater Canyon Aquifers with a Basin-Wide Groundwater Flow Model. 2014 National Conference on Mining-Influenced Waters: Approaches for Characterization, Source Control and Treatment from August 12-14 in Albuquerque, N.M.

Cheng, C., J. Sigda, and C. Ardito, 2013. San Juan Basin Groundwater Flow Model. Nevada Mine Water Management Symposium, January 28-29, 2013, Reno, Nevada. http://www.nvwra.org/storage/2013/2013MineWater_Program.pdf

Sigda, J., 2012. Managing the Freshwater-Seawater Interface. Moderator. 2012 National Groundwater Association Summit, 6-10 May 2012, Garden Grove, CA USA. https://ngwa.confex.com/ngwa/2012gws/webprogramsummit/meeting.html

Sigda, J., N. Deeds, D. Jordan, and R. Sengebush, 2012. Assessing Current and Future Performance of the Alamitos Gap Seawater Intrusion Barrier with a New Flow and Transport Model, Los Angeles and Orange Counties, CA. 2012 National Groundwater Association Summit, May 6-10, 2012, Garden Grove, CA USA. https://ngwa.confex.com/ngwa/2012gws/webprogramsummit/Paper8419.html

J. Blainey, J.F. Pickens, R.M. Holt, J.M. Sigda, S. Cook, and E. Hughes, 2011. Groundwater Modeling of Playa-Focused Recharge at the Southwestern Edge of the High Plains Aquifer in West Texas. Poster, Eos Trans., American Geophysical Union, Fall Meeting Supplement, Abstract # H53I-1531.

Sigda, J., N. Deeds, D. Jordan, and R. Sengebush, 2010. Assessing Performance of the Alamitos Gap Seawater Intrusion Barrier with a New Flow and Transport Model, Los Angeles and Orange Counties, CA. Poster, Eos Trans., American Geophysical Union, Fall Meeting Supplement, Abstract #H43A-1209.

Sigda, J., R. Sengebush, D. Jordan, T. Sovich, and L. Li, 2010. Marrying Disparate Data Sources in Developing a Groundwater Flow and Transport Model of the Alamitos Gap Seawater Intrusion Barrier, Los Angeles and Orange Counties, CA. Oral presentation at New Mexico Water Research Symposium, August, Socorro, NM.

Sigda, J.M., R.M. Holt, and J.L. Wilson, 2007. Solving Steady Evaporation-driven Flow from a Shallow Aquifer with Piecewise-continuous Forms of Analytically Non-tractable Hydraulic Relationships. Poster, Eos Trans., American Geophysical Union, Fall Meeting Supplement. Abstract H21D-0746.

Shannon, H., J. Sigda, R. van Dam, J. Hendrickx, and V. McLemore, 2005. Thermal Camera Imaging of Rock Piles at the Questa Molybdenum Mine, Questa, New Mexico. Presented at the 22nd National Meeting of the American Society of Mining and Reclamation, June 19-24, Breckenridge, CO.

Sigda, J., 2005. Co-leader of field trip for Espanola Basin Technical Advisory Group Workshop, March 2.

Sigda, J.M., P. Paul, and D. Koning, 2004. Comparison of Permeability and Grain Size Differences in Tesuque Formation Deposits at the Santa Fe River and Buckman Well Field Areas, Española Basin, New Mexico. Poster, Espanola Basin Technical Advisory Group Workshop, March 2-3, Santa Fe, NM.

Sigda, J., 2003. Hydraulic Properties of Tesuque Formation Sediments, Buckman Area, Española Basin, NM: Preliminary Data. U.S. Geological Survey Open File Report 03-369 (M. Hudson, ed.). Poster, Espanola Basin Technical Advisory Group Workshop, March 4-5, Santa Fe, NM.

Johnson, P.S., J.M. Sigda, and J.P. Frost, 2003. Hydrogeologic Studies in the Espanola Basin. U.S. Geological Survey Open File Report 03-369 (M. Hudson, ed.). New Mexico Bureau of Geology and Mineral Resources, Espanola Basin Technical Advisory Group Workshop, March 4-5, Santa Fe, NM.

Sigda, J.M., and J.L. Wilson, 2003. Are Faults Preferential Flow Paths Through Semi-arid and Arid Vadose Zones? doi:10.1029/2002WR001406. Water Resources Research, 39, 1225.

Holt, R.M., R.J. Glass, J.M. Sigda, and E.D. Mattson, 2003. Influence of Centrifugal Forces on Phase Structure in Partially Saturated Media. doi:10.1029/2003GL017340. Geophysical Research Letters, 30:13, 1692.

Sigda, J.M., and J.L. Wilson, 2003. Centrifuge Runtime and Inversion Errors Affect Estimation of Moisture Retention Relations. Poster, Eos Trans., American Geophysical Union, Fall Meeting Supplement, Abstract H22A-0910.

Holt, R.M., R.J. Glass, J.M. Sigda, and E.D. Mattson, 2003. Phase Structure in a Centrifugal Field: Impact of Capillary Heterogeneity and Angular Velocity. Poster, Eos Trans., American Geophysical Union, Fall Meeting Supplement, Abstract H22A-0909.

Sigda, J.M, J.M. Herrin, J.L. Wilson, and L.B. Goodwin, 2003. An Outcrop Analog Study of Vadose-zone fluid Flow and Transport in Faulted Sediments. Geological Society of America Program with Abstracts, Nov. 1-5, Seattle, WA.

Sigda, J.M., 2003. Presenter for field trip to Bandelier Tuff near Los Alamos, NM, September 8, IGPP Workshop on Fluid Flow and Transport Through Faulted Ignimbrites and Other Porous Media, Sept. 8-10, Ghost Ranch, Santa Fe, NM.

Sigda, J.M., 2003. A Vadose-Zone Perspective on Fault-Related Diagenesis, IGPP Workshop on Fluid Flow and Transport Through Faulted Ignimbrites and Other Porous Media. Sept. 10, Ghost Ranch, Santa Fe, NM.

Sigda, J.M., and J.L. Wilson, 2003. Infiltration Enhancement by Fault Catchment and Conduit Behavior in Arid and Semi-arid Vadose-zone Sands. New Mexico Symposium on Hydrologic Modeling, Aug. 12, Socorro, NM.

Sigda, J., and P. Paul, 2003. Permeability and Grain Size Characterization of Santa Fe River (Tesuque Fm) Sediments. Report by the New Mexico Bureau of Geology and Mineral Resources to the New Mexico State Engineer's Office, Aug. 1.

Sigda, J., 2003. Faults in Poorly Lithified Sediments. Albuquerque Geological Society, July 2.

Sigda, J., 2003. Co-leader, field trip to Santa Fe River, June 25, Rocking Around New Mexico Teachers Training Program.

Sigda, J., 2003. Leader for field trip to Canyon Trail and Elmendorf fault zones. April 10, Association of Professional Geologists, NM Section.

Sigda, J., 2003. Co-leader of field trip to Buckman well field for Española Basin Technical Advisory Group Workshop, March 5.

Sigda, J.M, J.L. Wilson, L.B. Goodwin, and J.L. Conca, 2002. Conduits to Catchments: Deformation Band Faults in Arid and Semi-Arid Vadose Zone Sands. Eos Trans., American Geophysical Union, Fall Meeting Supplement, Abstract T12G-11.

Sigda, J., L. Goodwin, P. Mozley, and J. Wilson, 1999. Permeability Alteration in Small-displacement Faults in Poorly Lithified Sediments: Rio Grande Rift, Central New Mexico. In Faults and Subsurface Fluid Flow in the Shallow Crust (W. Haneberg, P. Mozley, J. Moore, and L.Goodwin, eds.). Geophysical Monograph Volume 113. American Geophysical Union, Washington, D.C., 51-68.

Sigda, J., P. Mozley, L. Goodwin, and W. Haneberg, 1996. Small-displacement Fault Controls on Single Phase Permeability of Poorly Consolidated Sands, Santa Fe Group, New Mexico. Abstract. Geological Society of America Abstracts, 28:7, 256. Presented at the 28th Annual Meeting of the Geological Society of America, Oct. 28-31, Denver, CO.

Sigda, J., 1995. Examining the Impacts of Faults on Aquifer Flow Systems: Implications for Regional Ground Water Flow Modeling. Presented at the 39th annual New Mexico Water Conference: The Water Future of Albuquerque and Middle Rio Grande Basin (T. Bahr, B. Creel, C. Ortega-Klett, C. Rex, G. Easterday, and T. Hennessy, eds.), Nov. 3-4, Albuquerque, NM. New Mexico Water Resources Research Institute, Las Cruces, NM, 237-244.

Sigda, J., 1995. Fault-related Controls on the Permeability of Poorly Consolidated Santa Fe Group Units. Abstract, New Mexico Geology, 17:2, 22. Presented at the New Mexico Geological Society Spring Meeting, April 7, Socorro, NM.

Rautman, C.A., M.A. McGraw, P.G. Kaplan, J.D. Istok, and J.M. Sigda, 1994. Probability Mapping of Contaminants. NTIS no. DE94008950NEG . Presented at Cost-efficient Acquisition and Utilization of Data in the Management of Hazardous Waste Sites. Sponsored by the U.S. Department of Energy, March 23-25, Herndon, VA, 10 p.

Rautman, C.A., M.A. McGraw, J.D. Istok, J.M. Sigda, and P.G. Kaplan, 1994. Probabilistic Comparison of Alternative Characterization Technologies at the Fernald Uranium-In-Soils Integrated Demonstration Project. NTIS no. DE94006587NEG. Air and Waste Management Assoc. Proceedings of Conference, Feb. 27-March 3, Tucson, AZ, 11 p.

Rautman, C.A., M.A. McGraw, J.D. Istok, J.M. Sigda, and P.G. Kaplan, 1994. Probabilistic Comparison of Alternative Characterization Technologies at the Fernald Uranium-In-Soils Integrated Demonstration Project. Sandia National Laboratories report SAND93-4075C. Sandia National Laboratories, Albuquerque, NM.

Gerath, M., T. Silva, J. Bowen, and J. Sigda, 1993. Prediction of Water Availability in River Headwaters and Control of Facility Water Demand in Response to River Flows. In Proceedings of the ASCE Engineering Hydrology Symposium, July, San Francisco, CA.

Sigda, J., and J. Herberich, 1992. Data Visualization and Modeling: Efficient New Methodologies for Ground Water Modeling. Presented at the 5th International Conference: Solving Ground Water Problems with Models, Feb. 11-13, Dallas, TX. Ground Water Management, 9, 667–669.

Engel, P. and J. Sigda, 1984. An Interview with Stanislaw Lem. Missouri Review, Volume 7, Number 2, 1984, pp. 218-237 10.1353/mis.1984.0002.

Engel, P. (and J. Sigda*), 1983. An Interview with Stanislaw Lem. New York Times Book Review, March 23. *Not listed as co-author because of NY Times Book Review's policy of single author bylines.

Kirchman, D., J. Sigda, R. Kapuscinki, and R. Mitchell, 1982. Statistical Analysis of the Direct Count Method for Enumerating Bacteria. Applied and Environmental Microbiology, 44, 376–382.

Exhibit 10

Declaration of John Sigda

DECLARATION OF JOHN M. SIGDA, Ph.D.

1.0 Introduction

My name is John M. Sigda and I recently moved to live and work in Austin, Texas after nearly 25 years living and working in Albuquerque, New Mexico. I have conducted work related to understanding, explaining, and predicting groundwater flow at the St. Anthony Mine (Site) in Cibola County, New Mexico since 2009. My declaration is based on my experience with the Site, examination of information, and calculations and analyses. I am providing this declaration in support of UNC's petition for Alternate Abatement Standards (AASs).

I am currently employed as a Principal Hydrogeologist at INTERA, Incorporated. I hold a Bachelor of Arts degree in Engineering from Harvard College (1981) and two advanced degrees from the New Mexico Institute of Mining and Technology in Socorro, NM: a Master of Science degree in Hydrology (1997), and a Doctor of Philosophy degree in Earth and Environmental Science - Hydrology (2004). My work on New Mexico hydrogeology began in 1992 and has combined field investigations and modeling of flow in the saturated and vadose zones. I have developed models to solve mining problems, including closure, for sites in New Mexico, Nevada, and Australia as well as models to help solve groundwater contamination problems in New Mexico, Texas, Washington, California, Minnesota, New Jersey, and Indiana.

Using the data collected from the St. Anthony Mine (Site) and nearby mines, I led the development of a conceptual model of the Site's hydrogeology and a numerical model of groundwater flow under current and post-closure conditions. I assisted in the planning and implementation of field work to support development of the conceptual model.

I also served as the lead modeler for a groundwater flow model of the San Juan Basin, a physiographic province spanning over 21,000 square miles that encompass the Site. After review by the environmental impact statement (EIS) hydrology technical group, which include the New Mexico Office of the State Engineer, this model was accepted by the group for use in an EIS for a new mine in central New Mexico. The final modeling report for federal and state regulators formed the basis for the groundwater section of the draft federal EIS, published in February 2013.

The St. Anthony Mine is located on the southeastern margin of the San Juan Basin where Cretaceous and Jurassic sedimentary units are exposed and near two other former uranium mines, the Jackpile-Paguate and JJ Mines. Pits at the Site and the Jackpile-Paguate Mine and the underground workings at all three mines were created to mine ore from the Jurassic uraniferous Jackpile Sandstone. The Jackpile is directly overlain by the Cretaceous Dakota Sandstone and underlain by Jurassic Brushy Basin Mudstone Member of the Morrison Formation. The thick Mancos Shale overlies the Dakota Sandstone and extends to ground surface over most of the area encompassing the three mines. Within the Site, groundwater is present in the Jackpile Sandstone and underlying units; however, only groundwater in the Jackpile Sandstone is of concern because groundwater flow is negligible within the thick Brushy Basin Mudstone, including flow between it and the underlying Westwater Sandstone Member of the Morrison Formation.

Since active mining ended in 1980, the Site has two open pit surface features: the Large Pit and Small Pit. The Large Pit penetrates all but about 20 feet of the Jackpile Sandstone, collects and stores surface run-off, and has continued to function as an evaporative sink for groundwater flow at the Site scale. An evaporative sink for a groundwater system captures local groundwater flow and discharges it to the atmosphere through evaporation. The Small Pit was excavated into the top of the Jackpile and has been observed to collect and hold surface run-off for relatively short periods of time compared to the Large Pit, but does not collect any groundwater discharge from the Jackpile Sandstone. The preferred abatement alternative for the Site includes partial backfilling of the two pits such that the Large Pit will cease to capture local groundwater flow and the Small Pit will no longer intermittently recharge the Jackpile Sandstone. Thus, site closure will remove the mining-induced controls on local groundwater flow, which will then become controlled by other natural conditions.

The purpose of this testimony is to explain how the three-dimensional extent for the proposed Alternate Abatement Standards (AASs) was determined using hydrogeologic information specific to the Site and its vicinity and modeling of groundwater flow under current and post-closure conditions. AASs for the Site were determined to be a necessary component of reclamation because of the natural mineralization and the loss of hydraulic containment after the partial backfill of the Large Pit.

2.0 Hydrogeologic Site Conceptual Model (SCM) for the St. Anthony Mine

The hydrogeologic SCM for the St. Anthony Mine is a description of the groundwater flow system in the Site vicinity. The Site groundwater flow system can be described in great detail; however, the SCM comprises only the features, processes, and events that are judged to be most important for determining the future migration of groundwater and solutes away from the Site. The SCM focuses on the Site's geologic structure and composition, the values of hydraulic properties, and how water enters the subsurface and moves through it as groundwater, and leaves it as stream flow, evaporation, or transpiration. The features and processes in the SCM were the foundation for the numerical groundwater flow model that was used to predict groundwater flow across the Site under current and future conditions and to calculate the three-dimensional extent for the proposed AASs.

I developed the SCM using Site-specific data collected by my colleagues at INTERA and other companies, and data for the area surrounding the Site and the JJ and Jackpile-Paguate Mines. Site-specific data and analyses are described in INTERA (2006) and INTERA (2015). The SCM also incorporates information from Schlee and Moench (1963), Moench (1963), Hydro-Search (1981a and b), Stone et al. (1983), Owen et al. (1984), Risser et al. (1984), Dames and Moore (1985), Zehner (1985), DOI (1986), and Weston (2011).

Section 5 of the INTERA (2015) Stage 2 report (**Exhibit 6 of the St. Anthony Mine AAS Petition** – shortened to **AAS Petition Exhibit 6** hereafter) provides a detailed description of the St. Anthony SCM. The following summarizes its key findings and cites its figures, tables, and appendices and the exhibits where needed.

1) The extent of the SCM was chosen to represent the important features and processes that govern groundwater flow into and out from the Site under current and future conditions. It encompasses the Site and the areas upgradient and downgradient from the Site, such as the upgradient JJ Mine and the Jackpile-Paguate Mine to the west, because conditions there could potentially affect groundwater migration from the Site. The area is roughly 8 miles wide and 4 miles long, with an area of approximately 32 square miles (**Exhibit 10a**).
2) The SCM climate is arid to semi-arid with variable precipitation that is consistently exceeded by evaporation and transpiration demands (Zehner, 1985; INTERA, 2006). Long-term data from three climate stations surrounding the JJ Mine (**Figure 5.1** in **AAS Petition Exhibit 6**) show that average annual precipitation, which ranges between 9.6 and 10.8 inches per year (in/yr), is far exceeded by measures of evaporation, with mean

pan evaporation at the Laguna station (**Figure 5.1** in **AAS Petition Exhibit 6**) equal to 63 in/yr, and potential evapotranspiration falling between 51 to 53 in/yr.

3) Shrubs, grasses, trees, and other plants remove water from the shallow subsurface through transpiration across much of the SCM area. Plant life is minimal on the waste rock and overburden stock piles at St. Anthony and Jackpile-Paguate, so transpiration is negligible in those areas. Trees and other plants are commonly found in the SCM drainages, including the salt cedar, *Tamarix ramosissima*, also known as tamarisk. INTERA estimated that the Jackpile sandstone is in direct contact with alluvial sediments (see **Appendix M** in **AAS Petition Exhibit 6**) along a section of Meyer Draw (**Figure 5.2** in **AAS Petition Exhibit 6**) and that the tamarisk stand along this reach comprises an area of approximately 400,000 ft^2. Given this area of tamarisk and other vegetation with an annualized transpiration rate of 6.9×10^{-3} feet per day (ft/day) per unit area, which is on the low end of the reported rates, transpiration can remove roughly 14 gpm from the Jackpile Sandstone along this reach of Meyer Draw.

4) Perennial surface water bodies in the SCM area are limited to the St. Anthony Large Pit and reaches of the Rio Paguate near the Jackpile-Paguate Mine. Ephemeral surface water bodies include ponded water in the St. Anthony Small Pit, cattle tanks (ponds), and the Meyer Draw, Rio Moquino, and Bohart Creek drainages (**Figures 5.3** and **5.4** in **AAS Petition Exhibit 6**). The perennial and ephemeral surface water bodies drain to the south toward the Rio San Jose.

5) The important hydrostratigraphic units controlling groundwater flow within the area of interest are the saturated sandstone units, the mudstone units that bound or confine the sandstones, and surficial materials that allow localized recharge. The Jackpile and Dakota

Sandstones are the shallowest sources of groundwater in the SCM area, but the Dakota is saturated in the vicinity of the JJ Mine and unsaturated in the vicinity of the St. Anthony and Jackpile-Paguate Mines. The sandstone units are only exposed at the surface within parts of the St. Anthony and Jackpile-Paguate Mines. The mudstone units act as aquitards: the Mancos shale limits vertical movement of water across the top of the underlying Dakota Sandstone, whereas the Brushy Basin mudstone limits groundwater flow across the bottom of the Jackpile Sandstone or across the bottom of incised alluvium to very small rates. Alluvium is present in the rivers and draws, which were incised into the Jurassic and Cretaceous sedimentary units (**Exhibits 10a** and **10b** and **Figure 1.5** in **AAS Petition Exhibit 6**).

6) The Jackpile Sandstone is a thick lens of arkosic uraniferous sandstone that dips to the north-northwest about 1 to 2 degrees and is incised by drainages, including the Rio Paguate, Rio Moquino, Meyer Draw, and Bohart Creek Its maximum thickness is about 120 ft near the St. Anthony Mine, 70 ft near the JJ Mine, and about 200 ft near the Jackpile-Paguate Mine. Cements are predominantly calcite in the deepest interval and kaolinite in the upper interval (Schlee and Moench, 1961; Kittel, 1963).

7) The surficial deposits in the SCM area include alluvium in the drainage systems and colluvium. Quaternary alluvium includes the sediments deposited by ephemeral flows within the erosional drainages, Meyer Draw and Bohart Creek, and the sediments deposited by flow in the Rios Paguate and Moquino. Alluvial deposits in the drainage systems consist of material that originates from the Mancos Shale and Dakota Sandstone and range from fine-grained gravels to silts and clays. Sediments range in thickness from

roughly 15 ft in Rios Paguate and Moquino to 25 ft in Meyer Draw. Colluvium typically has a thickness of 1 to 5 ft.

8) Groundwater flow is restricted to the Jackpile sandstone and alluvial sediments in the SCM area. The low-permeability Brushy Basin mudstone acts as a bottom-confining unit for the Jackpile Sandstone and the thick low-permeability Mancos Shale acts as a top-confining unit for the Dakota Sandstone (**Exhibit 10b**). Alluvial sediments within the incised drainages are in direct contact with the Jackpile Sandstone along its southern extent at the St. Anthony and Jackpile-Paguate Mines (**Exhibit 10c**).

9) Groundwater flows slowly through the Jackpile Sandstone in a roughly northwest to southeast direction within the area encompassing the three mines (**Exhibit 10d** and **Figure 5-11** in **AAS Petition Exhibit 6**).

10) Groundwater inflow to the Jackpile Sandstone comprises lateral inflow from the Jackpile Sandstone and Dakota Sandstone to the west and north and localized recharge along saturated reaches of the Rio Paguate alluvium, cattle tanks, a pond near the Jackpile pit, and St. Anthony's Small Pit. Areal recharge is negligible in the area of interest because precipitation is far exceeded by the combination of transpiration during the growing season and evaporation throughout the year. Long-term monitoring of vadose zone conditions in the Meyer Draw demonstrated there is no recharge along that part of the draw where alluvial sediments overlie the Jackpile Sandstone.

11) Groundwater outflow includes discharge to the Rio Paguate and Rio Moquino, evaporation from the water in the St. Anthony Large Pit, and evapotranspiration along the drainages where the Jackpile either outcrops or is overlain by alluvium. Groundwater outflow also includes those drainage areas where erosion has incised into the Jackpile and

deposited alluvial sediments such that the elevation of Jackpile – alluvium contact is less than local groundwater heads (**Exhibit 10c**). Historical outflows include dewatering at the JJ, St. Anthony, and Jackpile-Paguate mines.

12) Groundwater levels rebounded as much as 60 ft after mining operations ceased in the Jackpile-Paguate Mine area between 1980 and 2011. Weston (2011) attributes the groundwater rebound to the cessation of dewatering and backfilling of the pits. This explanation is reasonable for the large rebounds observed at M-7, which is located near the historical high heads west of the mine (**Figures 5.7** to **5.9** and **5.12** in **AAS Petition Exhibit 6**), and the wells near the Rio Paguate. However, the groundwater head rebounded over 50 ft at well M-14, which is far from the Rio Moquino and north of the backfilled Jackpile pit. Examination of aerial images over time revealed that a tributary to the Rio Moquino is truncated by the mine backfill near well M-14 and the presence of a pond and cattle tanks (**Figure 5.6** in **AAS Petition Exhibit 6**). Recharge to the Jackpile from these features is the most likely cause of the groundwater rebound in well M-14 (**Figure 5.12** in **AAS Petition Exhibit 6**).

13) Since its construction, the St. Anthony Large Pit controls present-day groundwater flow through the Jackpile Sandstone in the St. Anthony Mine area. The Large Pit acts as a groundwater discharge point because evaporation removes the groundwater that seeps into the pit (**Figures 5.10** and **5.14** in **AAS Petition Exhibit 6**). By acting as an evaporative sink, the Large Pit has created a large cone of depression. The cone of depression appears to be at or near steady-state conditions; **Figure 5.14** in **AAS Petition Exhibit 6** illustrates that during the period 2004 to 2013, pit water level elevations fluctuated over almost 10 ft, whereas groundwater levels fluctuated over a much smaller

range. Groundwater levels have trended lower throughout this period (**Figure 5.14** in **AAS Petition Exhibit 6**). The evaporative sink drives groundwater flow toward the Large Pit within about 2,200 ft of the pit shell.

14) Water balance calculations (**Tables 5.2** and **5.3** in **AAS Petition Exhibit 6**) revealed that groundwater inflow from the Jackpile sandstone to the Large Pit is approximately 7 gpm (**Exhibit 10e** and **Table 5.2** in **AAS Petition Exhibit 6**), which indicates that the Jackpile Sandstone is a low-flow, low-permeability unit, and the Small Pit has recharged the Jackpile Sandstone at a rate of about 1 gpm over the last several years (**Table 5.3** in **AAS Petition Exhibit 6**). Groundwater has not been observed to discharge from the Jackpile at its outcrop exposures; however, the present-day head contours show that not all Jackpile groundwater is captured by the Rios Paguate and Moquino and the St. Anthony Large Pit. Examination of the groundwater head contours near Meyer Draw indicate that Jackpile groundwater flows into the sediments of Meyer Creek Draw where it is captured by evaporation and vegetation transpiration along the stretch of the Draw where Jackpile sandstone is in contact with the alluvium **(Figures 5.2** and **5.11** in **AAS Petition Exhibit 6)** as evidenced by the lack of saturated conditions in MW-12 A & B.

15) Numerous measurements made at the three mines over several decades reveal that the Jackpile sandstone has a very low hydraulic conductivity, approximately 0.09 ft/day (**Exhibit 10f** and **Figure 5.17** in **AAS Petition Exhibit 6**). Well designs for five of the six water supply wells within 5 miles of the Site include either very long perforated intervals or two or three screened intervals below the estimated bottom of the Jackpile sandstone, corroborating that the Jackpile is a low-flow unit. The alluvial sediments in

the Rio Paguate riverbed have a hydraulic conductivity that is approximately two orders of magnitude larger than the Jackpile hydraulic conductivity.

3.0 Numerical Model of Groundwater Flow for St. Anthony Area

The overall objective of the groundwater flow modeling was to determine groundwater flow patterns in the Jackpile Sandstone in the vicinity of the Site both currently and after backfill of the two St. Anthony pits. A two-dimensional numerical flow model was constructed and calibrated to represent present-day groundwater flow in the Jackpile Sandstone. A predictive two-dimensional flow modeling tool was then constructed from the calibrated flow model to simulate migration of groundwater from the Site under St. Anthony post-backfill conditions.

INTERA developed a conservative modeling approach to simulate post-backfill groundwater flow using standard modeling practices (Anderson and Woessner, 1992; ASTM, 1994). In the context of environmental modelling under uncertainty, a conservative approach is one that intentionally increases the likelihood that impacts will occur when selecting from ranges of uncertain model inputs. That is, given a range of values for a model input, under a conservative modelling approach, the input value will be selected from the part of the range that is more likely to result in impacts being predicted than if other values were selected. The numerical models represent all the driving forces and hydrogeologic features that were identified above as the most important controls on current and future groundwater flow within the area of interest.

The numerical modeling tools used in this assessment are mathematical representations of the sub-surface geology, climate, surface water, and groundwater flow appropriate for the hydrogeologic conceptual model area. A numerical model was constructed using the information presented above and calibrated to represent the current groundwater flow system in the Jackpile Sandstone.

The numerical flow model for the present-day Jackpile Sandstone flow system was constructed and run to predict groundwater heads at locations with observed heads (water levels within wells) under steady flow conditions. The calibration process compared observed and simulated heads at these so-called “target” locations. If the match between observed and simulated heads was not adequate, model parameters for recharge and evapotranspiration rates were varied in a systematic manner to improve the match, and the model was run again. Calibration targets were identified from groundwater head data at the 25 wells available for the current time period (**Exhibit 10d** and **Figure 5-11** in **AAS Petition Exhibit 6**). The recharge and evapotranspiration rates were varied using a manual trial and error approach to carry out the calibration. The model parameters determined from the calibration process were used to construct the predictive flow model for post-closure conditions at the St. Anthony Mine.

INTERA created a numerical geologic model of the Jackpile sandstone within the area of interest using available geologic information and the Leapfrog Hydro software package (ARANZ Geo Limited, 2013). Data inputs included contact elevations from boreholes and the surficial geologic maps for the Moquino quadrangle (Schlee and Moench, 1963) and Seboyeta quadrangle (Moench, 1963). The top elevation of the Jackpile sandstone and its thickness are shown in **Figures 5.15** and **5.16** in **AAS Petition Exhibit 6**, respectively**.** Comparison of the top elevation contours with the groundwater head contours for the present day demonstrates that the Jackpile is a confined system across nearly all of the area of interest (**Figure 5.15** in **AAS Petition Exhibit 6**). Groundwater heads are lower than the estimated top of the Jackpile in the mine pits and drainages along the southern margin, indicating groundwater flows under unconfined conditions in these areas.

The numerical flow model was constructed using the Groundwater Vistas version 6 (Rumbaugh and Rumbaugh, 2007) graphical user interface and the MODFLOW-SURFACT (HydroGeoLogic, 1996a and b) version 4 finite difference flow and solute transport code. The groundwater continuity equation was solved with MODFLOW-SURFACT's PCG5 solver and a head tolerance of 0.01 ft.

The model domain encompasses the area of interest, including the St. Anthony, JJ, and Jackpile-Paguate mines (**Figure 5.18** in **AAS Petition Exhibit 6**). The domain extends approximately 30,000 ft from west to east and almost 27,000 ft from north to south. A single model layer divided into a total of 300 rows and 469 columns with a uniform grid cell size of 100 ft by 100 ft was used to represent the Jackpile Sandstone. Total number of active cells was 66,610.

Top and bottom elevations of the grid cells were set to match the top and bottom elevations of the numerical geologic model for the Jackpile Sandstone (see above). The top elevation of the model layer followed the dipping Jackpile from ground surface in the south, with a maximum elevation of 6,130 ft amsl in the southwest, to several hundred feet below ground surface, with a minimum elevation of 5,740 ft amsl in the southwest, along the north domain edge.

INTERA used steady-state conditions to represent the current groundwater flow system because they are appropriate for the low-permeability, low flow Jackpile Sandstone. Steady flow conditions are appropriate because the Jackpile Sandstone, geometric mean *K* equals 0.09 ft/day, is not a permeable formation, so groundwater heads change very slowly over time.

Consequently, changes in boundary condition behavior over time, such as river stage or recharge, will propagate very slowly across the domain. The model domain edges were defined as a combination no-flow and specified head boundary conditions. A specified head boundary condition with head equal to 5,890 ft was set along the entire northern boundary (**Figure 5.18** in **AAS Petition Exhibit 6**). The high head to the west was represented as a specified head boundary condition along 1,000 ft of the western domain edge with a head of 6,025 ft (**Figure 5.18** in **AAS Petition Exhibit 6**). These boundary head values were determined through trial and error during the initial calibration process. The remainder of the domain boundaries was set to be a no-flow boundary condition. Preliminary simulations showed that nearly all of the cells along Bohart Creek, and many along the southern margin, had head values below the bottom elevation of the grid cell, i.e., they were simulated as being unsaturated. The simulated heads showing unsaturated conditions in some model cells agreed with observed (e.g., St. Anthony MW-12 well nest) and expected heads at the downgradient margin of the Jackpile sandstone. This margin of unsaturated Jackpile sandstone is located downgradient of all three mines, so the cells showing these unsaturated conditions were set to as inactive to reduce simulation time.

The MODFLOW river package was used to represent Rio Paguate and Rio Moquino. INTERA intersected the grid cells containing the two rivers with the highest resolution digital elevation models (National Elevation Dataset, 10-meter) available to determine river bed elevations in each model grid cell. These river bed top elevations were used to set the stage height in each river boundary condition cell. River bed thickness was set to 15 ft with a hydraulic conductivity of 1 ft/day chosen to represent the bottommost sediments.

Transpiration along Meyer Draw and its tributary was simulated using the standard MODFLOW EVT package, which requires a maximum evapotranspiration rate, evapotranspiration elevation, and extinction elevation for each cell. The evapotranspiration elevation is the elevation where the evapotranspiration rate is at a maximum, typically ground surface, and the extinction elevation is the elevation where the rate reaches zero, typically just below the maximum rooting depth. MODFLOW calculates the flux to be extracted by determining where the groundwater level is located relative to the evapotranspiration elevation and extinction elevation. If groundwater head is above the evapotranspiration elevation, the maximum flux rate is applied; if groundwater head is below the extinction elevation, the rate is set to zero; otherwise, the applied rate is proportional to the distance that the groundwater level is above the extinction elevation. Thus, evapotranspiration extracts water from the subsurface at the maximum specified rate if the groundwater head is located between ground surface and the evapotranspiration elevation, but decreases linearly toward zero as groundwater level approaches the extinction elevation. The boundary condition was only applied to model cells where the roots were expected to be able to extract groundwater from the alluvial sediments overlying the Jackpile Sandstone (**Figure 5.18** in **AAS Petition Exhibit 6**). The length of the reach with transpiration is approximately 3,700 ft to the point where bottom of the Jackpile Sandstone extends above ground surface (**Figure 5.18** in **AAS Petition Exhibit 6**); however, transpiration continues within the draw far downstream of this reach.

Evaporation from St. Anthony's Large Pit was simulated using the head-dependent boundary condition called the general head boundary (GHB) condition as defined by the standard MODFLOW GHB package (**Figures 5.18** and **5.19** in **AAS Petition Exhibit 6**). The stage elevation was set to elevation 5,850 ft, which is 4 ft above the minimum observed Large Pit water level (**Figure 5.14** in **AAS Petition Exhibit 6**). The hydraulic conductivity of the conductance term was set to 0.009 ft/day to represent the low-permeability sediments at the bottom of the Large Pit. Using the GHB package instead of the EVT package allowed the model to determine the evaporative loss rate. This rate was compared to the rate estimated by the Large Pit water balance to compare our physical understanding with the simulated understanding.

4.0 Model Calibration

Initial calibration simulations were run without any recharge. However, those simulations revealed that the observed groundwater mound at well M-14 north of the Jackpile pit, and the groundwater heads that exceed 5,940 ft between the Large and Small St Anthony pits could not be replicated by adjusting the river and evapotranspiration boundary conditions or the hydraulic properties. Consequently, aerial photographs were used to determine the areal extent of the ponded areas north of the Jackpile pit and within the Small Pit. These areas were used to create small, local recharge areas (**Figures 5.19** and **5.20** in **AAS Petition Exhibit 6**). The total recharge area north of the Jackpile Pit was 490,000 ft^2 whereas the recharge area within the Small Pit was 80,000 ft^2. The recharge rates were treated as calibration parameters.

The model calibration process relied on observed head data. Groundwater heads from 2013 for the 5 wells at the JJ Mine and the 10 wells at the St. Anthony Mine were used as calibration targets (**Figure 5.21** in **AAS Petition Exhibit 6**). The most recently available head values at 10 wells around the Jackpile-Paguate Mine, from 2010 and 2011, were also used as calibration targets. Borelogs were checked to ensure that the selected targets were screened within the Jackpile sandstone.

Exhibit 10g (Figure 5.22 in **AAS Petition Exhibit 6)** shows the resulting simulated head contours for the calibrated flow model. Barring the target at MW-8 (which was a consistent outlier), simulated and observed heads have relatively small differences (residuals) at the JJ and St. Anthony mines with a good balance of overestimated and underestimated heads (**Figure 5.22**

in **AAS Petition Exhibit 6**). The simulated head contours provide a reasonably good match to the contours interpolated from the observed heads (**Exhibit 10g** and **Figure 5.22** in **AAS Petition Exhibit 6**).

Residual statistics confirm that the calibration is good. The mean head residual is -2.22 ft, the mean absolute head residual is 7.13 ft, and the minimum and maximum residuals are -22.62 and 14.13 ft, respectively. The normalized root mean square of errors is 0.07, which indicates a good- to-acceptable calibration based on the commonly used guideline of values less than 0.10 (Spitz and Moreno, 1996). **Figure 5.23** in **AAS Petition Exhibit 6** shows a plot of observed and simulated heads. Note that most of the heads near the JJ and St. Anthony mines fall fairly close to the 1 to 1 line, whereas there is a wider disparity for the heads in and near to the reclaimed workings at the Jackpile-Paguate Mine. Given the available data, the simulated heads and head contours provide a very good match to the observed heads and the contours of interpolated observed heads (**Exhibit 10g** and **Figure 5.22** in **AAS Petition Exhibit 6**).

The outflow rate for the Large Pit GHB cells is 5 gpm, which closely matches the 7 gpm rate estimated by the Large Pit water balance calculation (**Exhibit 10e** and **Table 5.2** in **AAS Petition Exhibit 6**). The final calibrated recharge rate for the Small Pit was 3.5×10^{-3} ft/day, which, when multiplied by the recharge area of 80,000 ft^2, yields 1.5 gpm. This calibrated recharge rate equals the recharge rate estimated from the Small Pit water balance (**Table 5.3** in **AAS Petition Exhibit 6**). The calibrated recharge rate for the pond and tanks north of the Jackpile pit is 6 gpm. Total outflow from the evapotranspiration boundary condition cells in Meyer Draw is 0.9 gpm, which is much less than the 14 gpm calculated from the field transect and the annualized transpiration rate, indicating that the Large Pit intercepts some of the groundwater that would flow toward Meyer Draw.

5.0 Predictive Model of Groundwater Flow Under Post-Closure Conditions

The calibrated model was used to construct a predictive flow model that simulates the change in the groundwater flow system after backfilling of the two pits at the St. Anthony Mine. Given the focus on long-term impacts, the predictive flow model was constructed using steady flow conditions. Particle tracking was used to visualize migration of groundwater from the St. Anthony Mine. The sensitivity (or robustness) of the predicted flow pattern from the St. Anthony Mine under post-closure conditions was tested by changing model inputs representing the driving forces and hydrogeologic features and by using particle tracking to visualize the resulting groundwater flow patterns. Robustness of the model simulations is defined as the sensitivity of the model prediction to the inputs that represent the driving forces (called boundary conditions) and hydrogeologic features (hydraulic properties). Our modeling approach is conservative because it directly addresses the uncertainty in model inputs by showing whether groundwater flow from the St. Anthony Mine changes when the boundary conditions and hydraulic properties change.

The predictive flow model was identical to the calibration flow model except for three important changes:

1) The GHB cells used to simulate the evaporative sink within the Large Pit were removed under the assumption that the Large Pit is now backfilled.
2) The recharge cells in the Small Pit were removed under the assumption that the Small Pit is now backfilled.
3) The initial heads were the calibrated heads from the calibration model represented by the contours of simulated groundwater heads shown in **Exhibit 10g** and **Figure 5.22** in **AAS Petition Exhibit 6**.

After solving for the final steady-state groundwater flow conditions, particle tracking was carried out to demonstrate the groundwater flow pattern in and around the backfilled Large Pit. Particles were placed along the western boundary of the mine area and around the perimeter of the Small Pit towards monitoring well MW-11 in order to encompass all mine workings and mapped ore bodies. Particle tracking was implemented using the U.S. Geological Survey MODPATH code (Pollock, 2012).

Results for the predictive simulation showed that the groundwater head at the Large Pit will eventually rebound to 5,966 ft, whereas heads at the JJ Mine will reach 5,977 ft (**Exhibit 10h** and **Figure 5.24** in **AAS Petition Exhibit 6**). Particle tracks demonstrate that groundwater from the area around the Large and Small Pits will be captured by tamarisk transpiration within Meyer Draw (**Exhibit 10h** and **Figure 5.24** in **AAS Petition Exhibit 6**). Outflow from transpiration is 1.8 gpm, which is double the outflow rate simulated for current conditions and thereby indicates that the Large Pit was intercepting some of the groundwater flowing toward Meyer Draw when the pit was acting as a hydraulic sink. This also indicates that a very small rate of groundwater discharge to Meyer Draw through tamarisk transpiration is sufficient to capture all groundwater from the area surrounding the Large and Small pits. Groundwater head contours around Meyer Draw show that it is drawing flow from the east, west, and north (**Exhibit 10h** and **Figure 5.24** in **AAS Petition Exhibit 6**).

6.0 Sensitivity Analysis of the Predictive Model of Groundwater Flow Under Post-Closure Conditions

Boundary conditions and hydraulic conductivity were changed to determine whether Meyer Draw would continue to capture groundwater from the Large Pit. The changes were conservatively chosen to investigate the full range of uncertainty in the predictive model inputs.

For the sensitivity analysis, four different scenarios were selected to test the robustness of the predicted future groundwater flow pattern. Each sensitivity scenario was carried out by revising selected model inputs, running the flow simulation and particle tracking, and comparing the particle tracks to the particle tracks from the predictive scenario. Scenario 1 tested the effect of using the maximum observed K value of 0.43 ft/day. Scenario 2 was run with the minimum observed K value of 0.005 ft/day. The recharge rate for recharge areas north of the Jackpile Pit was scaled proportionately to match the change in Jackpile K. This scaling prevented the sensitivity simulations from giving unrealistic groundwater heads because the recharge rates were calibrated to the reference K value. Scenario 3 doubled the area in Meyer Draw with tamarisk transpiration. Scenario 4 simulated the removal of all tamarisk and the effects of groundwater discharge into the alluvial sediments in contact with the eroded Jackpile sandstone (**Appendix M** in **AAS Petition Exhibit 6**). Drain boundary condition cells were used to represent the eroded contact between the alluvium and Jackpile with stage values set to the contact elevations calculated in **Appendix M** in **AAS Petition Exhibit 6.** The drain stages were consistently higher in elevation than the heads simulated at those locations in the calibrated flow model, and thus were expected to cause a smaller discharge flux.

Figures 5.25 to **5.28** in **AAS Petition Exhibit 6** show that in all cases, groundwater from the Large Pit was captured through discharge to Meyer Draw. Using the maximum observed Jackpile K value of 0.43 ft/day and proportionally scaling the calibrated recharge rate of 0.0025 ft/day to 0.012 ft/day increased the spacing between the long-term groundwater head contours so that the minimum contour value at Meyer Draw was 5,940 ft (compared to 5,930 ft for the reference case), but the particles were all captured by Meyer Draw (compare **Exhibit 10h** and **Figure 5.25** in **AAS Petition Exhibit 6**). Using the minimum observed Jackpile K value of

0.005 ft/day and proportionally scaling the calibrated recharge rate of 0.0025 ft/day to 0.00014 ft/day decreased the spacing between the long-term groundwater head contours so that the minimum contour value at Meyer Draw was 5,925 ft (compared to 5,930 ft for the reference case), but the particles were all captured by Meyer Draw (compare **Exhibit 10h** and **Figure 5.25** in **AAS Petition Exhibit 6**). Scenario 2 also examines the effect of greatly reducing recharge north of the Jackpile Pit on the particle tracks because it uses a very small recharge rate. Removing the evapotranspiration boundary condition and replacing it with drain boundary condition cells, which were based on the structural analysis (**Appendix M** in **AAS Petition Exhibit 6**) and represent discharge of Jackpile groundwater into the draw sediments, maintained capture of the Large Pit groundwater (**Figure 5.28** in **AAS Petition Exhibit 6**). The outflow rate from the drains simulated in scenario 5 is 1.3 gpm, a value that is much less than the 14 gpm estimated for tamarisk transpiration along a roughly 3,700-ft reach of Meyer Draw. In the absence of any tamarisk transpiration along that reach, Jackpile groundwater would seep into the overlying vadose zone sediments of Meyer Draw. Seepage flow will be driven downstream along the contact between the sediments and the low-permeability Brushy Basin mudstone by topography. Tamarisk are also transpiring water from Meyer Draw sediments downstream of the roughly 3,700-ft reach, so that any seepage into the vadose zone sediments will likely be captured by the downstream tamarisk trees or other plants living with the draw.

7.0 Transient Predictive Flow Model

A transient version of the predictive flow model with particle tracking was used to estimate residence and travel times for solutes to migrate from the Large Pit to the discharge zone. A sensitivity study of the transient model was performed to evaluate how these times vary with changes in hydraulic properties, such as porosity and hydraulic conductivity, of the Jackpile

Sandstone and pit backfill material. Results from the transient predictive flow simulations show that groundwater begins to flow away from the Large Pit between about 7 and 10 years after backfilling, which removes the evaporative sink, using the calibrated model parameters. Under these same hydraulic conditions, the first solutes from the Large Pit are estimated to reach the discharge zone at Meyer Draw between 450 and 500 years after backfilling (**Exhibit 10i**).

8.0 Extent of the Affected Area

Following the framework called for in 20.6.2.4103 F (2), the three-dimensional body of water pollution for which approval is sought in the Jackpile Sandstone throughout the region is the maximum area potentially affected by transport of solutes from the vicinity of the Large and Small Pits. This area was estimated by combining the particle tracks for all of the predictive simulations (**Exhibit 10j** and **Figure 6.1** in **AAS Petition Exhibit 6**). As shown in **Exhibit 10j** and **Figure 5.29** in **AAS Petition Exhibit 6,** the maximum area potentially affected by transport of solutes from the Large Pit vicinity encompasses the Large and Small Pits and the area between them.

In conclusion, the findings from the predictive modeling demonstrate that local groundwater discharge to Meyer Draw via tamarisk transpiration or seepage into alluvium in contact with the Jackpile Sandstone is more than sufficient to capture groundwater from the St. Anthony pits. The modeling results are very robust because major changes in boundary conditions or hydraulic conductivity did not change the capture of pit groundwater by Meyer Draw.

9.0 Sources

Baird et al., 1980. Baird, Charles W., Kevin W. Martin, and Robert M. Lowry, 1980, "Comparison of Braided-Stream Depositional Environment and Uranium Deposits at

Saint Anthony Underground Mine." In *Geology and Mineral Technology of the Grants Uranium Region 1979,* Christopher A. Rautman, compiler, New Mexico Bureau of Mines and Mineral Resources, Socorro, New Mexico, 401 pp.

Dames and Moore, 1985. Water Quality and Salt Balance Estimates Proposed Reservoir in North Paguate Pit Jackpile-Paguate Uranium Mine for Anaconda Minerals Company. Job No. 04010-090-06. September 26.

HydroGeoLogic, Inc., 1996a. MODHMS/Modflow-Surfact Software Documentation, Volume I: Groundwater Flow Modules. Reston, VA.

———. 1996b. MODHMS/Modflow-Surfact Software Documentation, Volume II: Transport Modules. Reston, VA.

HydroResolutions, 2012. Analysis of Pneumatic Slug Test in MW-2, MW-3, MW-4, and MW-5. Prepared by HydroResolutions, LLC. for INTERA Incorporated, August 2012.

Hydro-Search, 1981a. Ground-Water Hydrology of the Jackpile-Paguate Mine New Mexico. Prepared by Hydro-Search, Inc. for Anaconda Copper Company, February 26, 1981.

Hydro-Search, 1981b. Hydrology of the Jackpile-Paguate Mine Area, New Mexico. Prepared by Hydro-Search, Inc. for Anaconda Copper Company, October 9, 1981.

INTERA Incorporated (INTERA) 2006. Stage 1 Abatement Plan, Revision 1, JJ No. 1/L-Bar Mine, Cibola County, New Mexico, INTERA, Albuquerque, New Mexico. September.

Kittel, D. F., 1963. "Geology of the Jackpile Mine Area." In Kelley, V. C. (comp.), Geology and Technology of the Grants Uranium Region. Memoir 15. New Mexico Bureau of Mines and Mineral Resources, Socorro, New Mexico, pp. 167-176.

Kittel, Dale F., Vincent C. Kelley, and Paul E. Melancon. 1968. "Uranium Deposits of the Grants Region." In Ore Deposits of the United States, 1933-1967 (Graton-Sales Volume), edited by J. D. Ridge. New York: A.I.M.E.

Moench, R.H, and J.S. Schlee. 1967. "Geology and Uranium Deposits of the Laguna District of New Mexico." U.S. Geological Survey Professional Paper no. 519. 117 pp.

Pollock, D.W., 2012, User guide for MODPATH version 6—A particle-tracking model for MODFLOW: U.S. Geological Survey Techniques and Methods, book 6, chap. A41, 58 p.

Risser, D.W., P. A. Davis, J. A. Baldwin, and D. P. McAda, 1984. Aquifer Tests at the Jackpile-Paguate Uranium Mine, Pueblo of Laguna, West-Central New Mexico. United States Geological Survey Water-Resources Investigations Report 84-4255, 1984.

Risser, D. W., and F. P. Lyford, 1983. "Water Resources of the Pueblo of Laguna, West-Central New Mexico." U. S. Geological Survey Water–Resources Investigation Report 83-4083, 308 pp.

Rumbaugh, J. and Rumbaugh, D., 2007. Groundwater Vistas, Version 6.26, Build 24.

Schlee, J. S. and Moench, R. H., 1961. Properties and Genesis of "Jackpile" Sandstone, Laguna, New Mexico, in Geometry of Sandstone Bodies, Special Publication 22, American Association of Petroleum Geologists, 134-150.

Schlee, John S. and Moench, Robert H., 1963. Geologic Map of the Moquino Quadrangle, New Mexico, U.S. Geological Survey, Map GQ-209.

Spitz, K. and Moreno, J., 1996. A Practical Guide to Groundwater and Solute Transport Modeling. New York: John Wiley and Sons, Inc., 461 p.

Standard Oil Company of Ohio (SOHIO), 1980. "Environmental Report: L-Bar Uranium Project Valencia County, New Mexico." Prepared in Support of Radioactive Material License Renewal Application NM-SOH-ML.

Stone, W. J., F. P. Lyford, P. F. Frenzel, N. H. Mizell, and E. T. Padgett, 1983. "Hydrogeology and Water Resources of the San Juan Basin, New Mexico." New Mexico Bureau of Mines and Mineral Resources Hydrologic Report 6, New Mexico Bureau of Mines and Mineral Resources, Socorro, New Mexico, 70 pp.

Weston, 2011. Jackpile-Paguate Uranium Mine Site, Expanded Site Investigation, Revised Conceptual Site Model, Draft Version 2. Prepared by Weston Solutions, Inc. for U.S. Environmental Protection Agency, July 2011.

Zehner, H.H. 1985. Hydrology and Water-Quality Monitoring Considerations, Jackpile Uranium Mine, Northwestern New Mexico. By Harold H Zehner, United States Geological Survey Water-Resources Investigations Report 85-4226, 1985.

The technical testimony that I have prepared is true and correct to the best of my personal knowledge and belief.

Respectfully submitted,

John M. Sigda

Signed the ___9th___ day of June, 2017

Subscribed and sworn to before me this __9th____ day of June, 2017

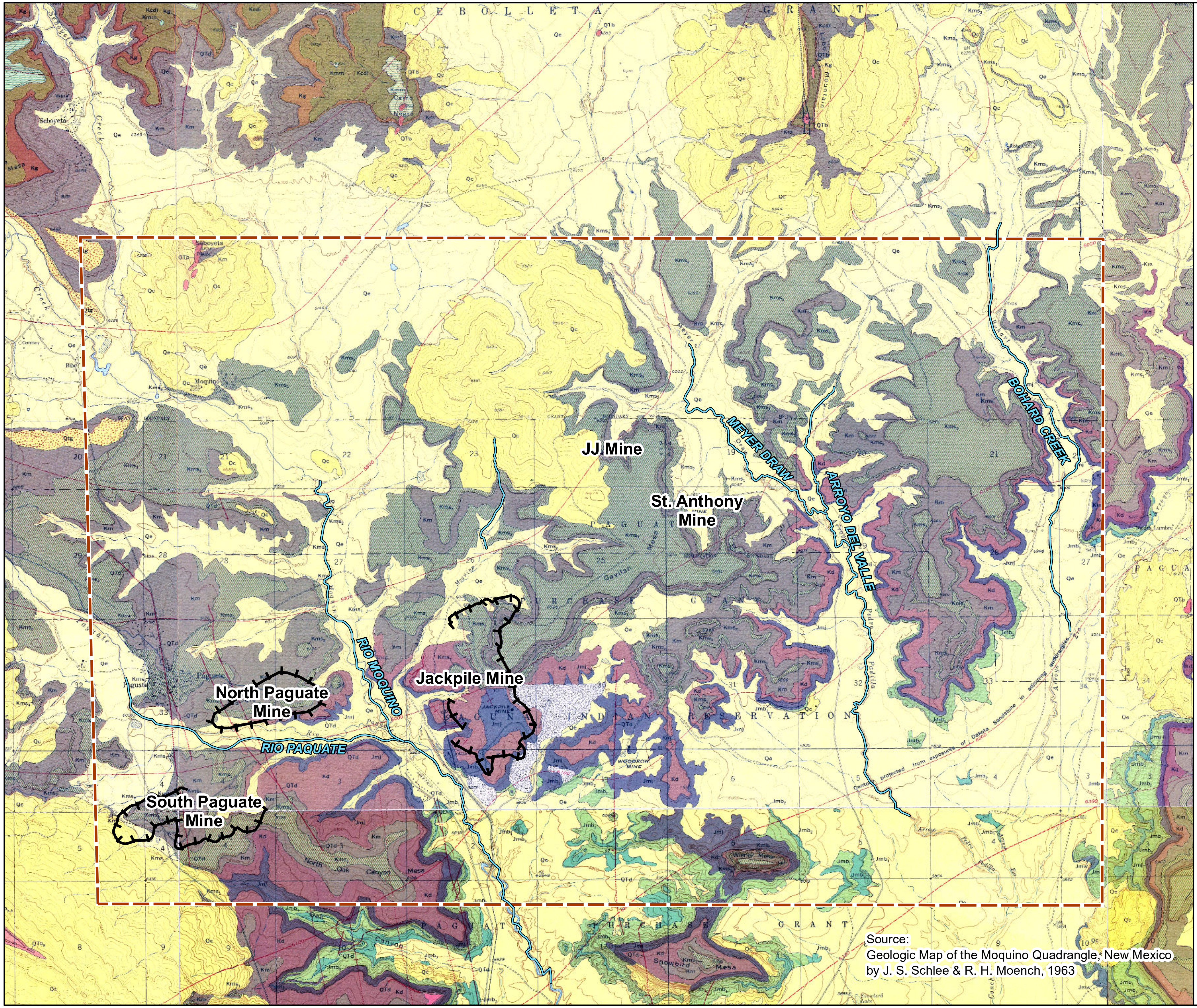
Gloria Hernandez

Notary Public

My Commission Expires 8-5-18

Seal

OFFICIAL SEAL
GLORIA HERNANDEZ
Notary Public
State of New Mexico
My Comm. Expires 8-5-18



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INTERA

0 4,000 8,000 Feet

Limit of Excavation (Zehner, 1985)

SCM Area

EXPLANATION

QUATERNARY — Pleistocene or Recent

Qe — Eolian and alluvial deposits
Unconsolidated sand and silt

Qc — Colluvial deposits
Talus, landslide blocks, and sheets of debris

CRETACEOUS — Lower Cretaceous

Km, Kms3, Kms2, Kms1 — Mancos Shale

Km, *gray, friable shale with sparse beds of yellowish-gray, friable sandstone. Main body about 750 feet thick. Lower units about 90, 50, and 20 feet thick in descending order.*

Kms_3, *grayish-orange to yellowish-gray, fine- to medium-grained, well-cemented sandstone; grades downward to siltstone and shale. About 60 feet thick.*

Kms_2, *grayish-orange to pale yellowish-brown, fine- to medium-grained, well-cemented sandstone; divided in middle by zone of siltstone and calcarenite; contains abundant brown-weathering pods of calcareous sandstone as much as 5 feet thick; lower part grades downward to siltstone and shale. About 25 to 30 feet thick.*

Kms_1, *yellowish-gray to pale yellowish-brown, fine- to medium-grained, well-cemented sandstone. About 20 feet thick*

Kd — Dakota Sandstone
Tan, orange, and white, fine- to medium-grained, very well cemented sandstone interbedded with subordinate black shale; quartz pebble conglomerate common at base. About 50 feet thick

UNCONFORMITY

JURASSIC — Upper Jurassic

Jmj, Jmb1, Jmb2 — Morrison Formation

Jmj, *Jackpile sandstone (economic use); yellowish-gray to white, fine- to coarse-grained, friable sandstone and sparse thin beds of grayish-green mudstone. 0 to 200 feet thick in subsurface.*

Jmb_1, *mudstone unit of Brushy Basin Member; grayish-green to light greenish-gray, friable, sandy, bentonitic; sparse thin beds of massive, clay-rich sandstone and light-gray, dense, massive limestone. Incompletely exposed; about 295 feet thick, including* Jmb_2, *in subsurface at Jackpile mine.*

Jmb_2, *sandstone unit of Brushy Basin Member; grayish-yellow to very pale orange, fine- to coarse-grained, friable to well-cemented sandstone. Forms lenses generally less than 20 feet thick*

UNC Exhibit 10a
Surficial Geology for St. Anthony Hydrogeologic Conceptual Model
St. Anthony Mine,
AAS Petition Hearing

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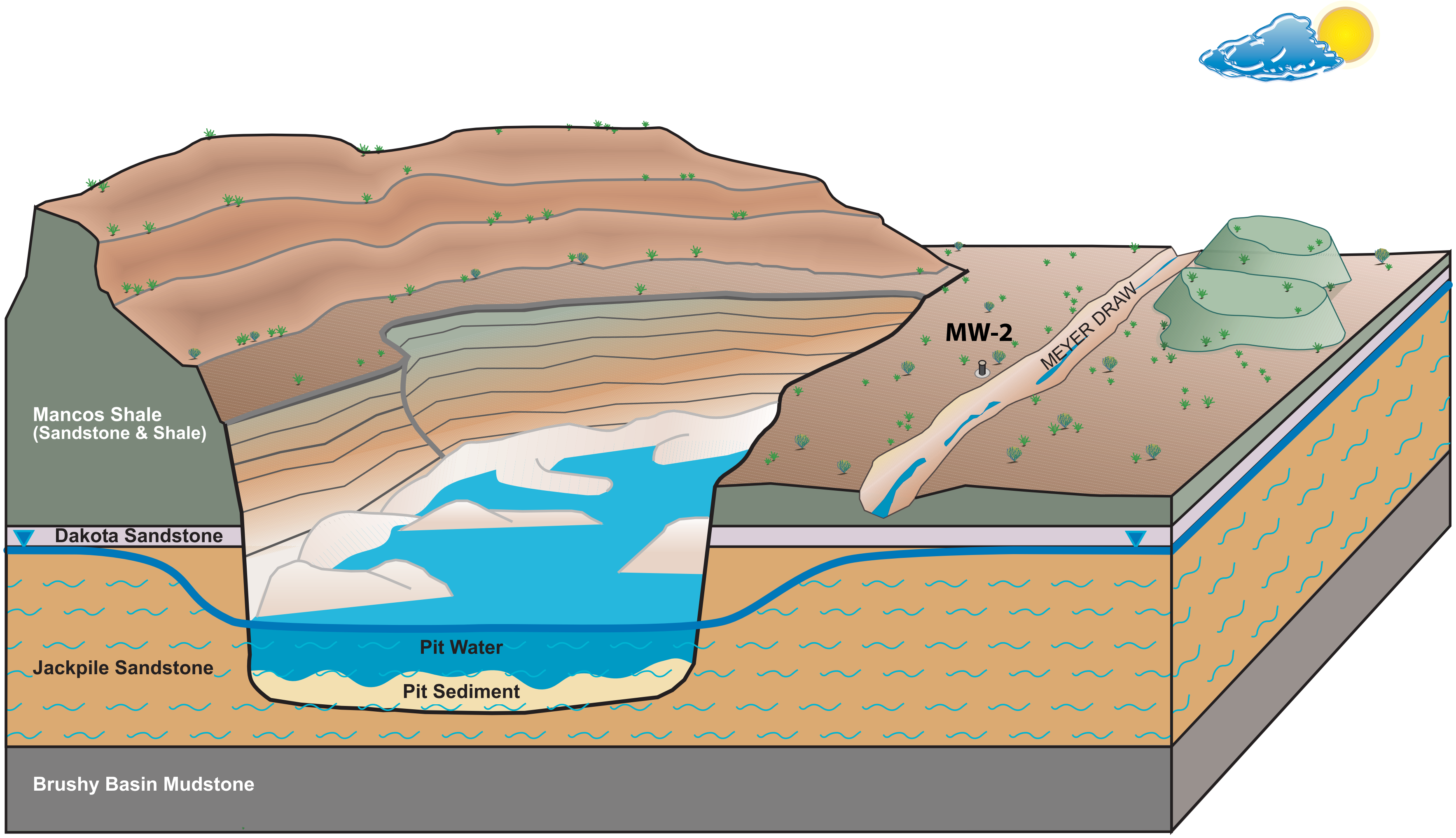

UNC Exhibit 10b
St. Anthony Subsurface Geology
St. Anthony Mine,
AAS Petition Hearing

INTERA

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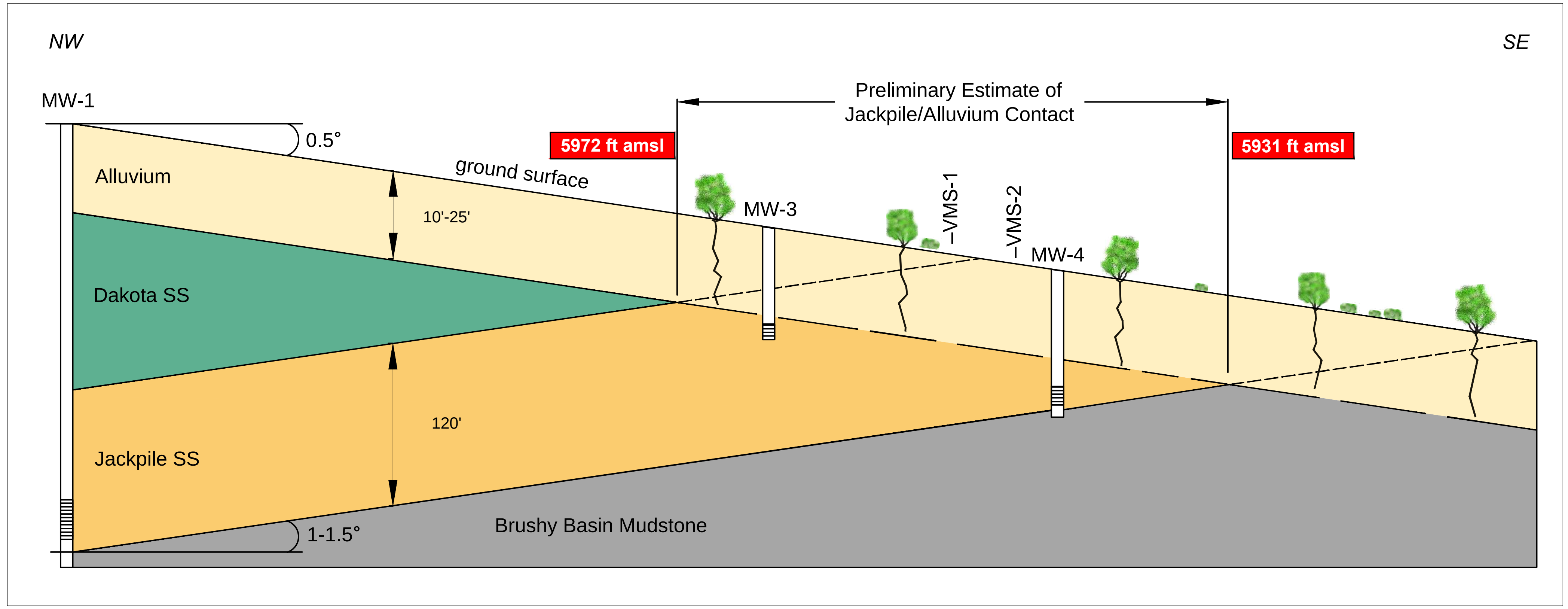
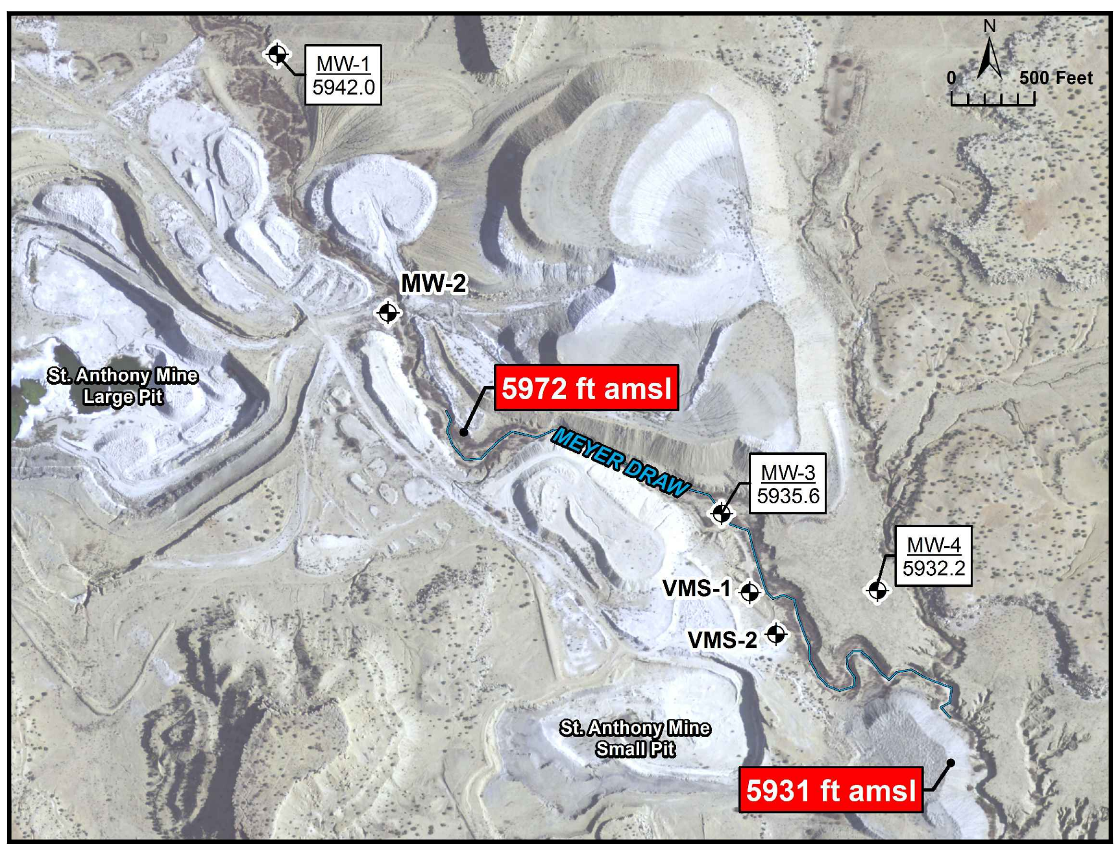


ft amsl = feet above mean sea level



Plan View

INTERA

UNC Exhibit 10c
Conceptual Cross-Section for
St. Anthony Site

St. Anthony Mine,
AAS Petition Hearing

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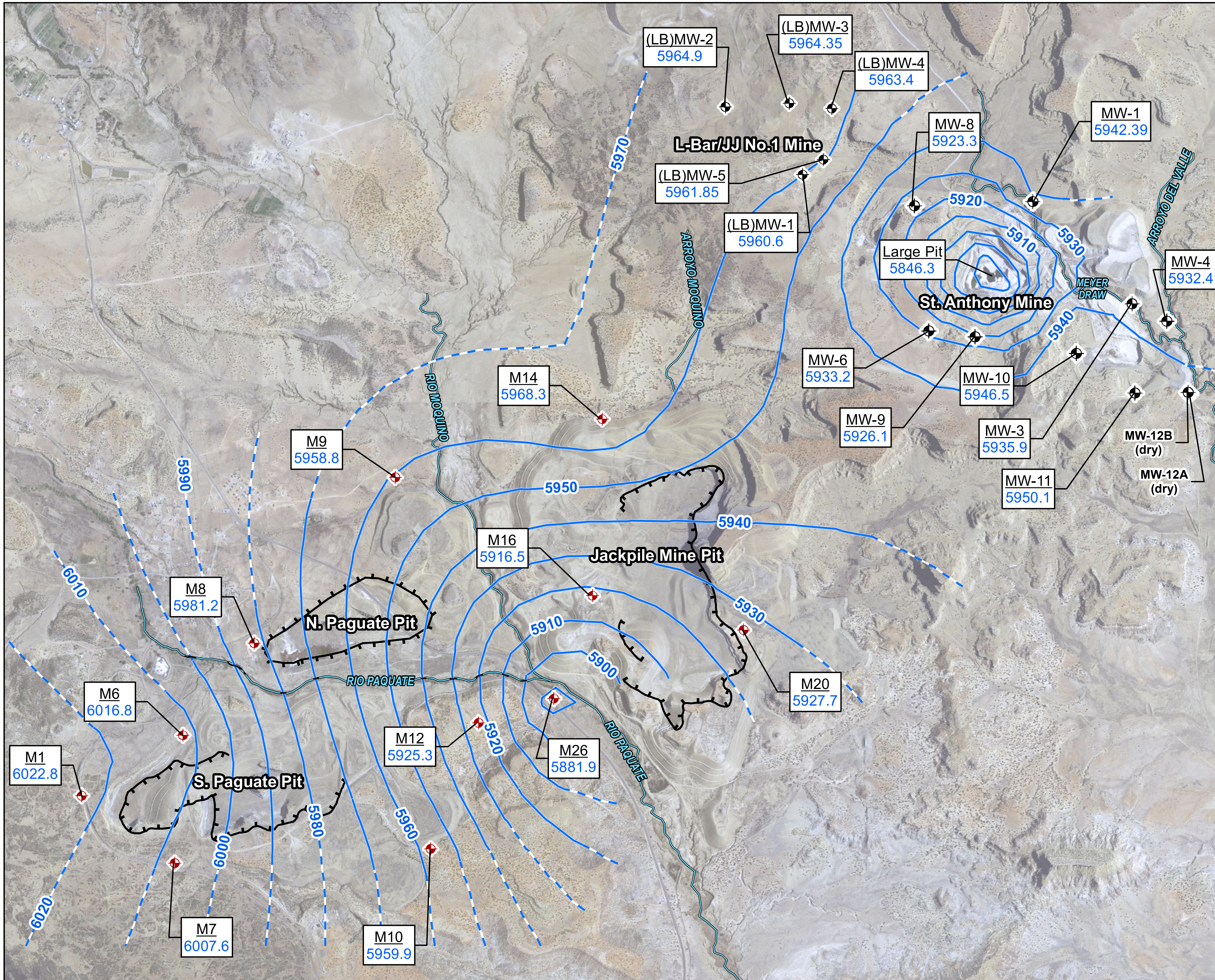

N

0 0.5 1
Miles

Sources:
Aerial – RGIS website, dated 2011

Legend

- Monitoring Well Location (Zehner, 1985/ Weston Solutions Inc, 2011)
- Monitoring Well Location (St. Anthony Mine)
- Groundwater Elevation Contour (Jackpile Mine 2011, St. Anthony Mine 2013)
- (dashed where inferred)
- Limit of Excavation (Zehner, 1985)

Note:
(LB)MW-# = L-Bar/JJ No. 1 Mine Monitoring Well

UNC Exhibit 10d
Jackpile Sandstone Groundwater
Heads Across SCM Area
St. Anthony Mine,
AAS Petition Hearing

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Parameter	Value	Units	Value	Units
Precip on Large Pit water	8.58E+04	ft^3/yr	1.2	gpm
Run-on from pit walls	7.81E+04		1.1	
Run-on from catchment area	6.86E+05		9.9	
Evaporation	5.97E+05		8.6	
Annual storage change	7.57E+05		10.8	
Groundwater inflow	5.04E+05		7.3	

Precipitation + Pit Run-on + Catchment Run-on + GW Inflow – Evaporation = Change in Storage

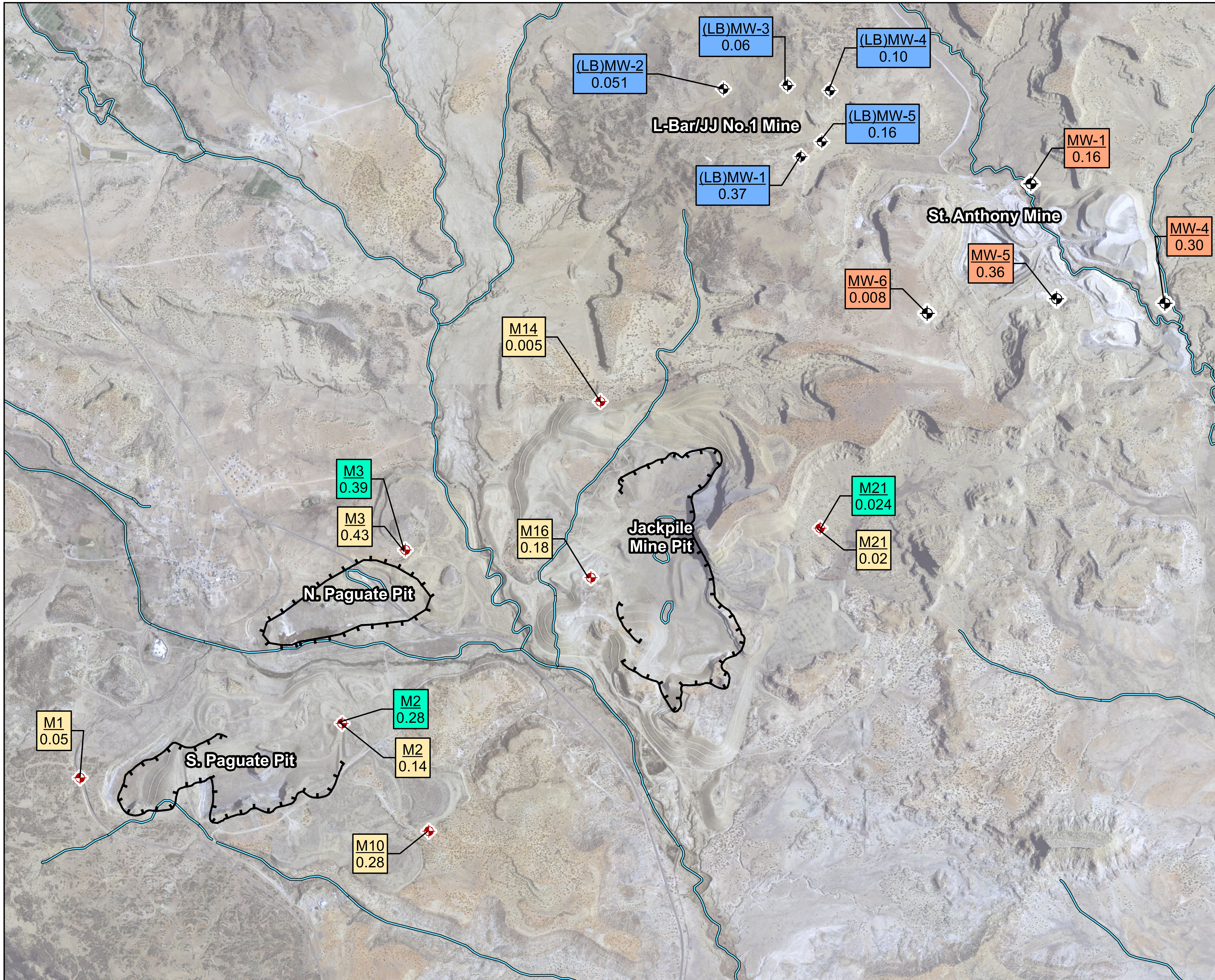
(1.2 gpm) + (1.1 gpm) + (9.9 gpm) + GW Inflow - (8.6 gpm) = (10.8 gpm)

GW Inflow = 7.3 gpm

Source: These entries are from Table 5.2 in Exhibit 6 of the St. Anthony Mine AAS Petition

INTERA

UNC Exhibit 10e
Conceptual Water Balance
on Large Pit
St. Anthony Mine,
AAS Petition Hearing



INTERA

N

0 0.5 1

Miles

Sources:
Aerial – RGIS website, dated 2011

Legend

Monitoring Well Location (Zehner, 1985/Weston Solutions Inc., 2011)

Monitoring Well Location (St. Anthony Mine)

Limit of Excavation (Zehner, 1985)

Stream/Arroyo

Note:
(LB)MW-# = L-Bar/JJ No. 1 Mine Monitoring Well

Label	Test
Well ID / K Estimate	Slug Test (Hydro Resolutions, 2006)
Well ID / K Estimate	Pump Test (Zehner, 1985)
Well ID / K Estimate	Pump Test (Hydro-Search, 1981)
Well ID / K Estimate	Slug Test (INTERA, 2004)

K values in feet per day

UNC Exhibit 10f
Hydraulic Conductivity Estimates for Jackpile Sandstone in SCM Area
St. Anthony Mine,
AAS Petition Hearing

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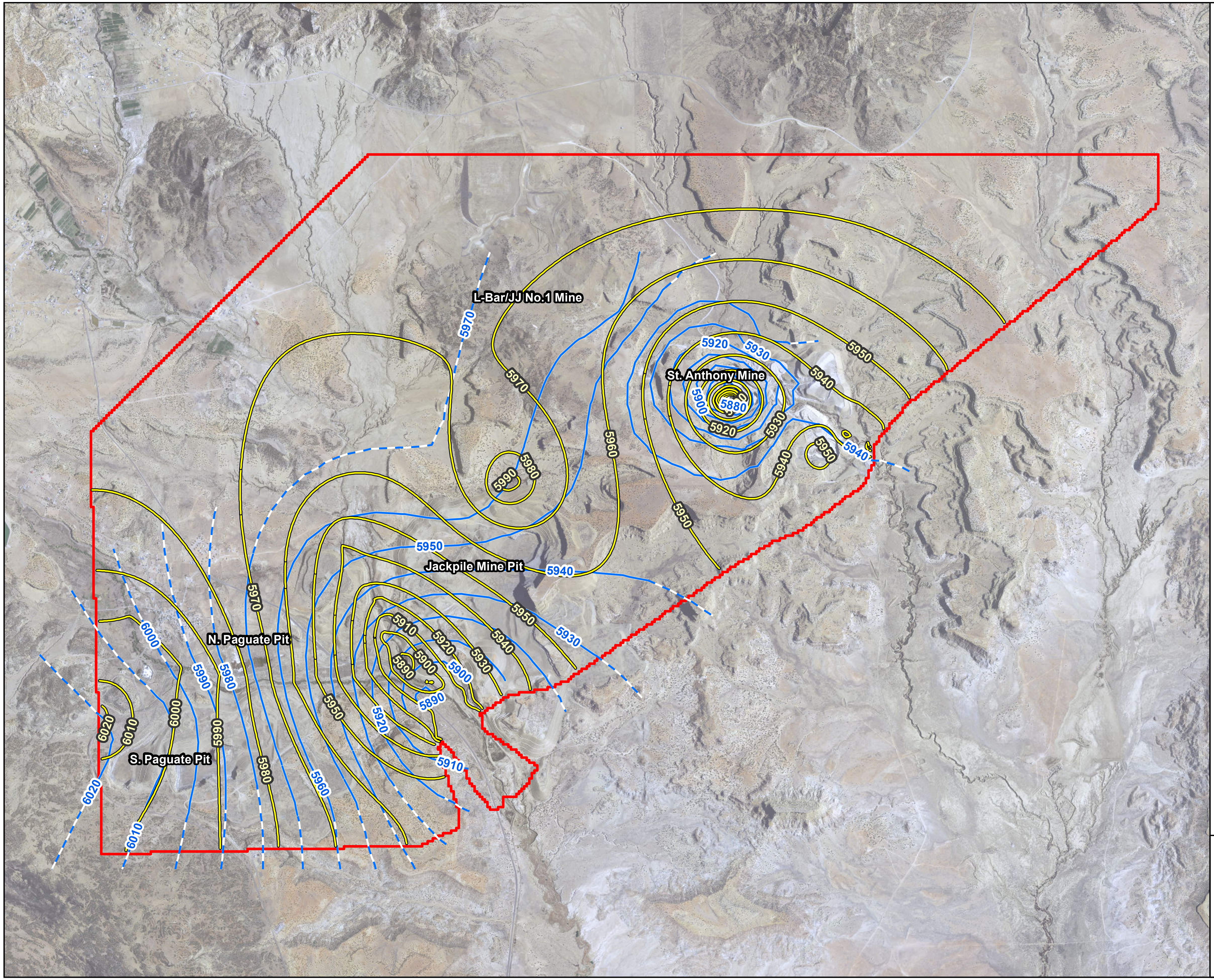

INTERA

N

0 0.7 1.4

Miles

Sources:
Aerial – RGIS website, dated 2011

Legend

Simulated Head Contour (ft)

Interpolated Groundwater Elevation Contour (Jackpile Mine 2011, St. Anthony Mine 2013)

(dashed where inferred)

Model Domain

Note:
(LB)MW-# = L-Bar/JJ No. 1 Mine Monitoring Well

UNC Exhibit 10g
Observed and Predicted Groundwater Heads for Current Conditions
Jackpile Groundwater Flow Model
St. Anthony Mine,
AAS Petition Hearing

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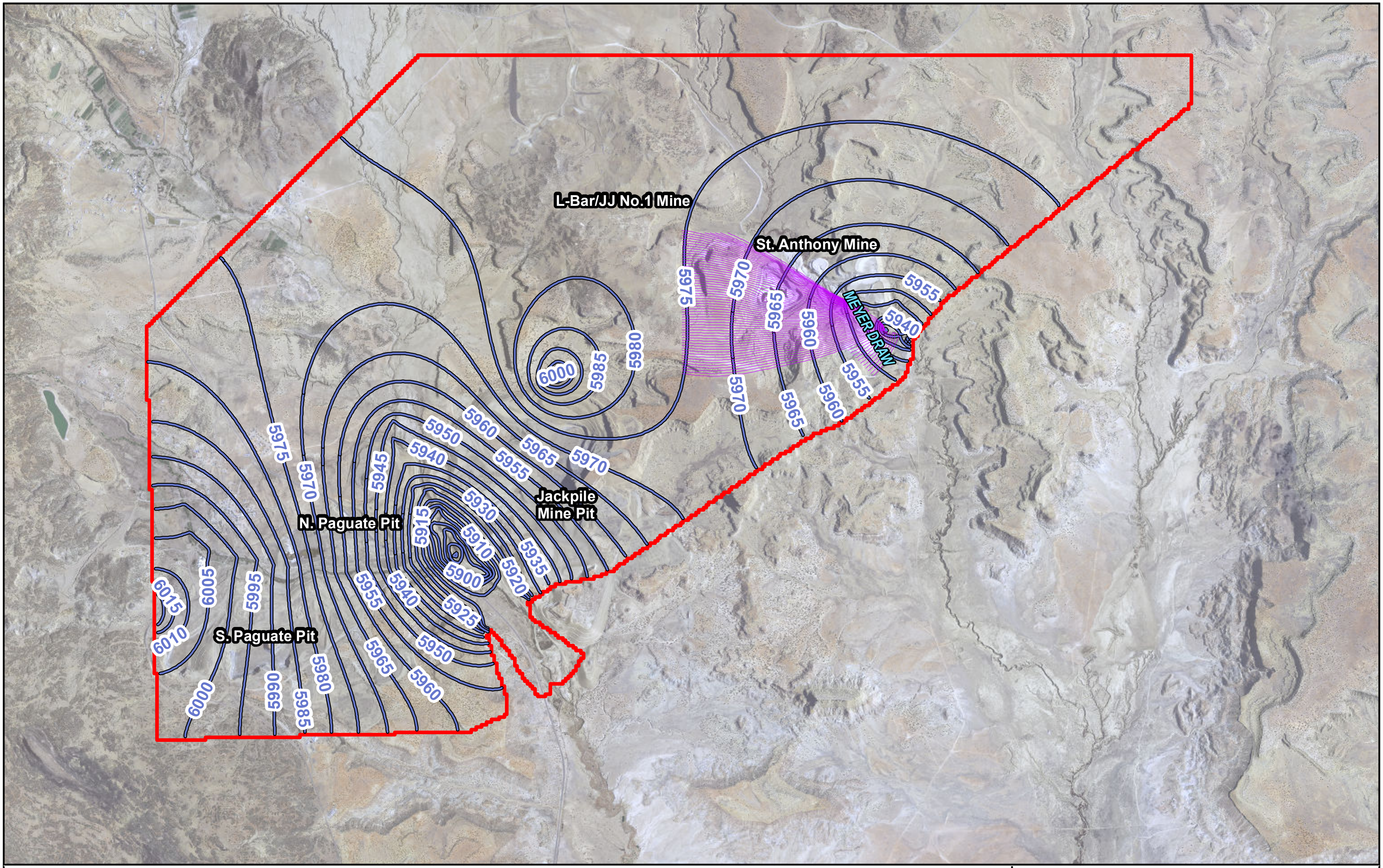

N

1 0.5 0 1

Miles

Legend

Head Contour (ft)

Model Domain

Particle Tracks

INTERA

UNC Exhibit 10h
Predicted Groundwater Heads
and Particle Tracks for
Post-Closure Conditions
St. Anthony Mine,
AAS Petition Hearing

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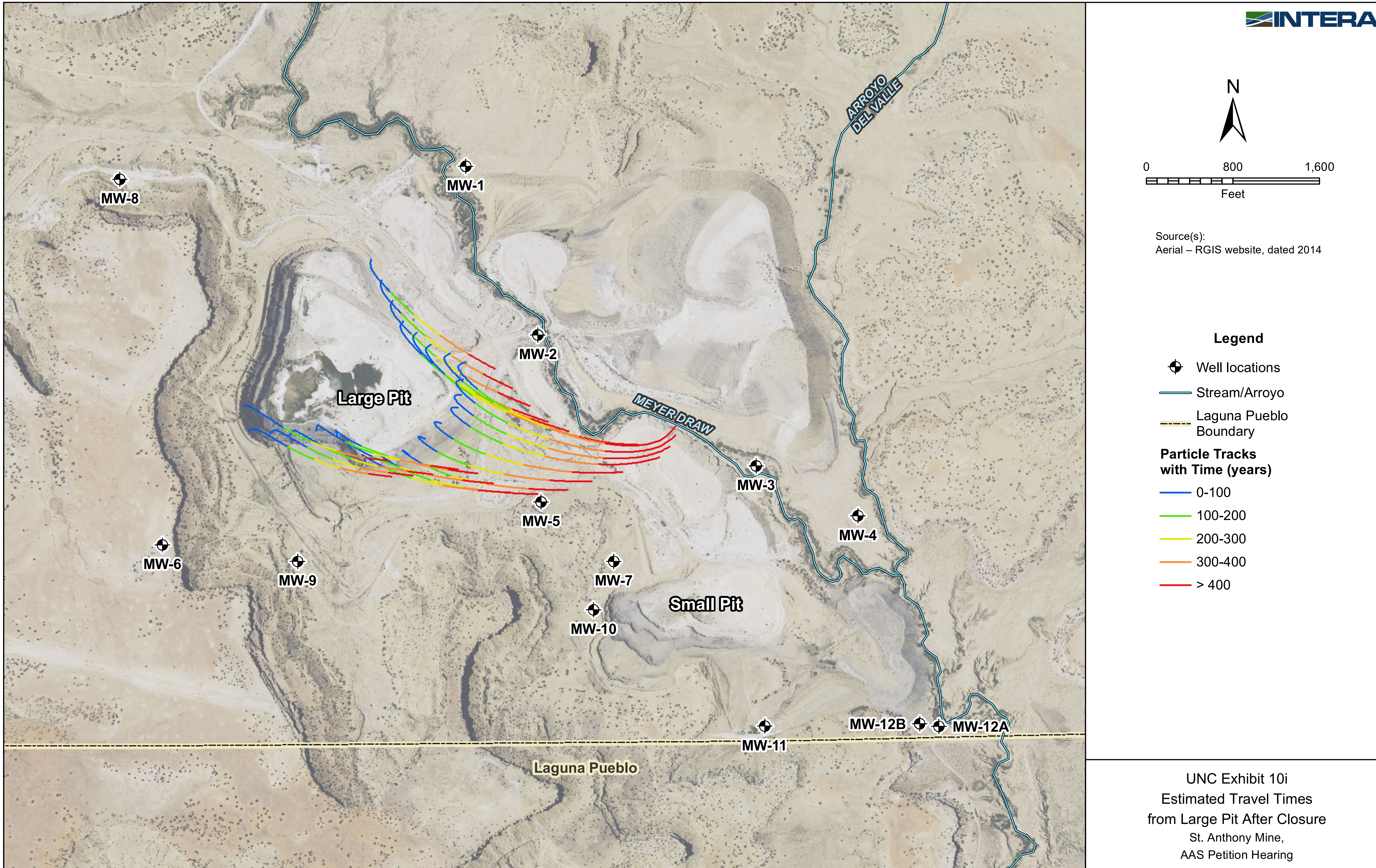

UNC Exhibit 10i
Estimated Travel Times
from Large Pit After Closure
St. Anthony Mine,
AAS Petition Hearing

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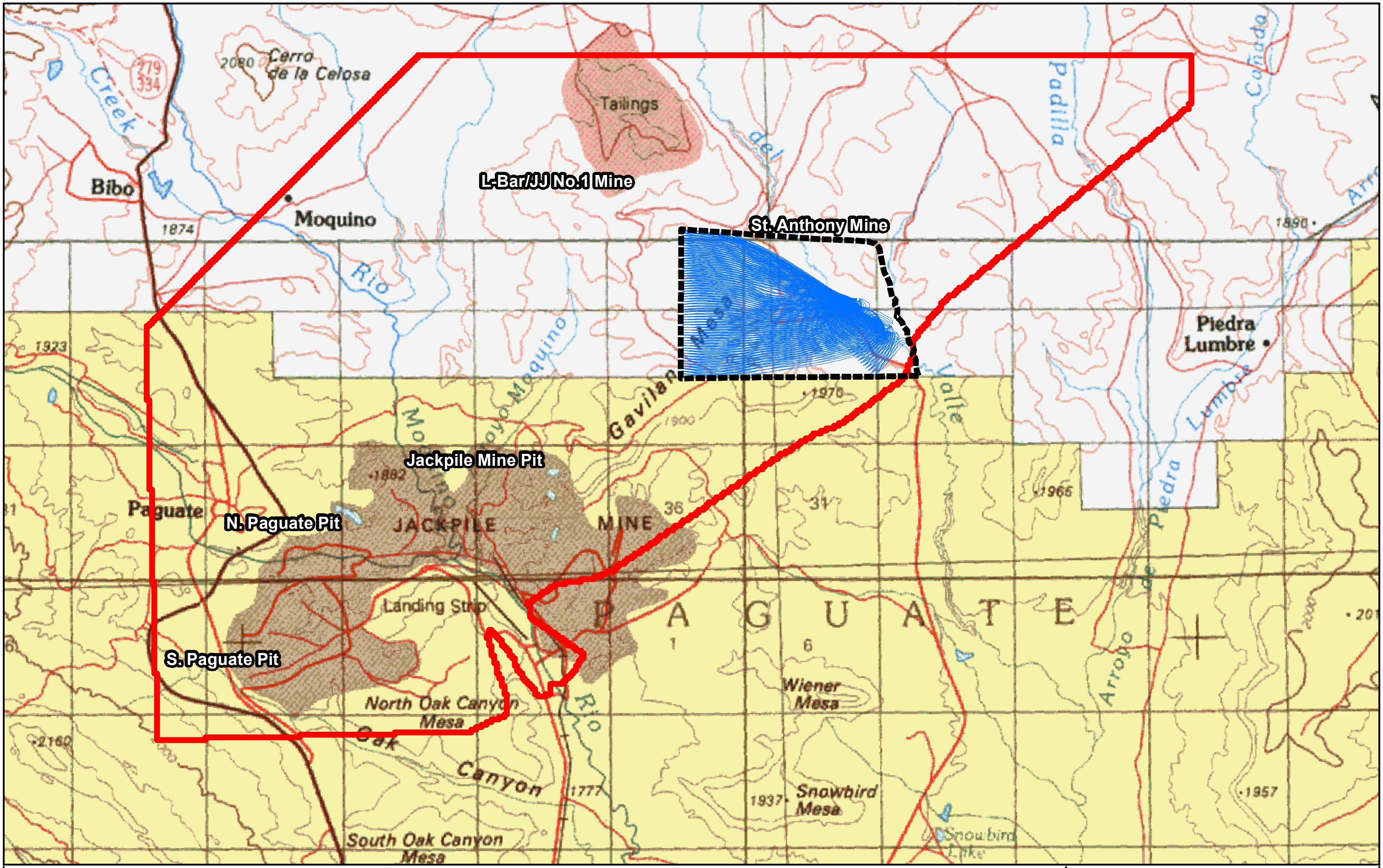

N

1 0.5 0 1

Miles

INTERA

Legend

Particle Tracks

Area of Affected Groundwater

Model Domain

UNC Exhibit 10j
Area of Affected Groundwater
for All Predictive Simulations
St. Anthony Mine,
AAS Petition Hearing

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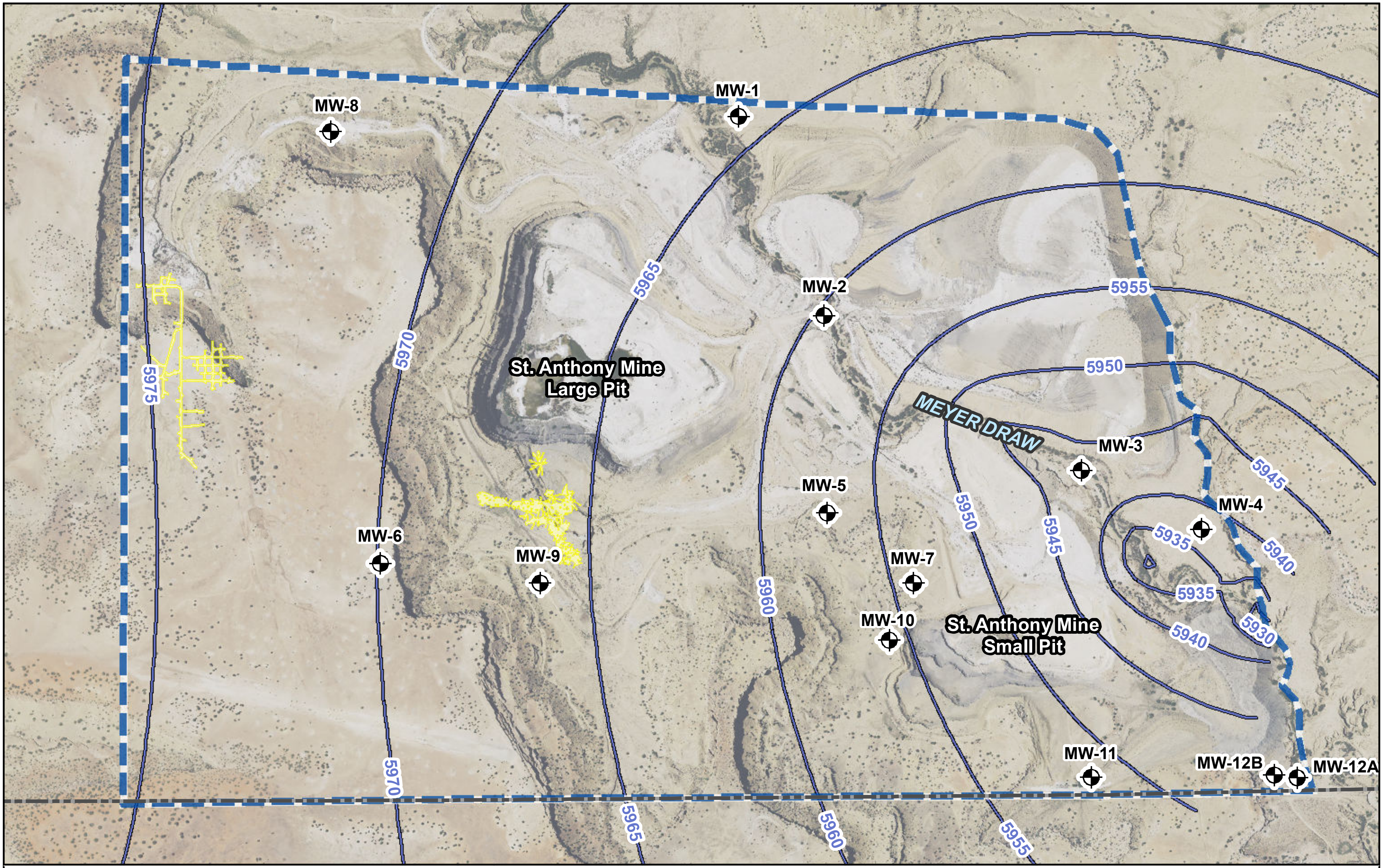
Exhibit 11

Proposed Area for the AAS Petition, St. Anthony Mine



N

0.2 0.1 0 0.2

Miles

Legend

Monitoring Well Location

Laguna Boundary

Area of Affected Groundwater

Head Contour (ft)

Subsurface Mine Workings

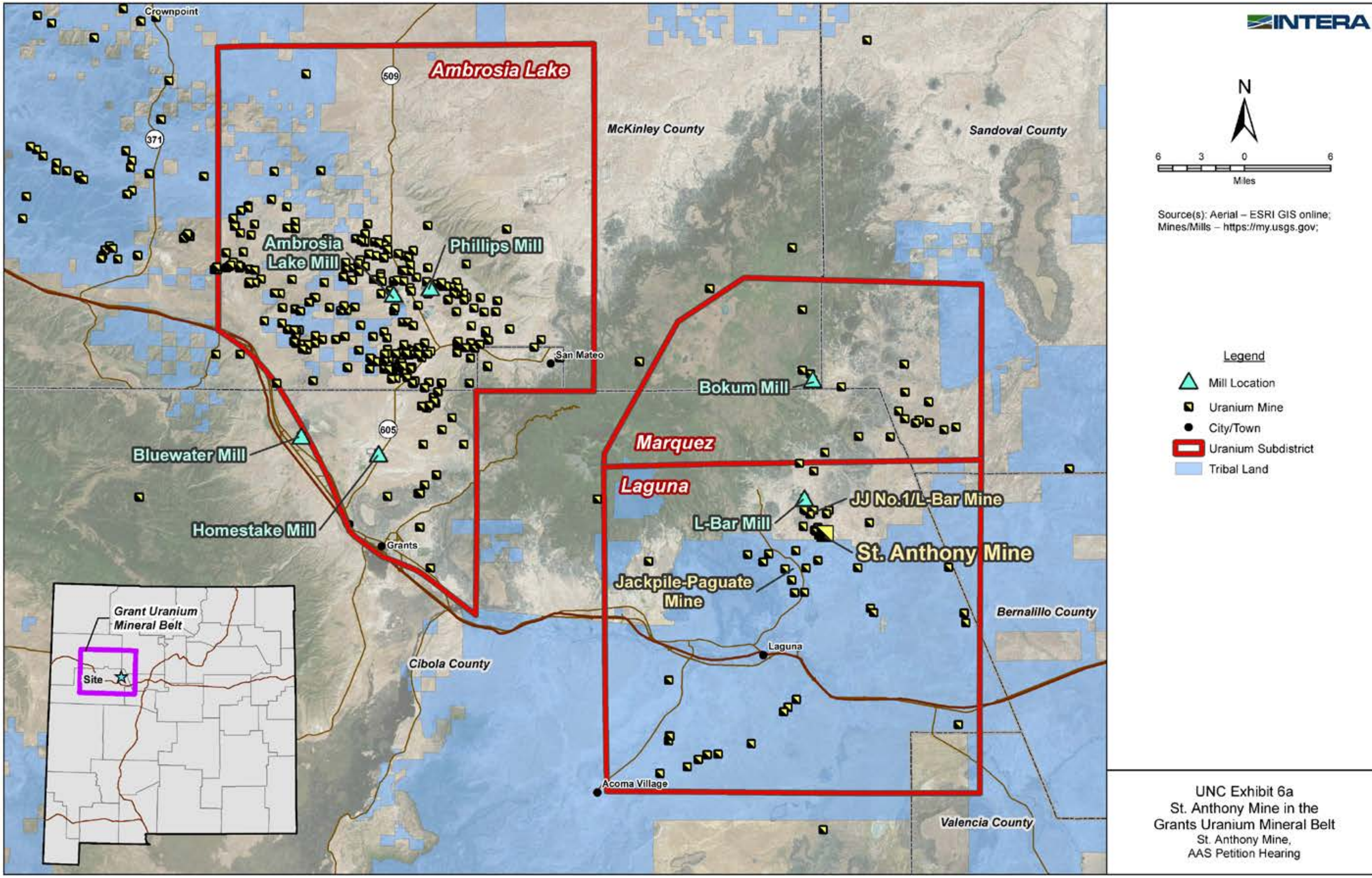
INTERA

UNC Exhibit 11
Proposed Area for
AAS Application
St. Anthony Mine,
AAS Petition Hearing

Exhibit 12

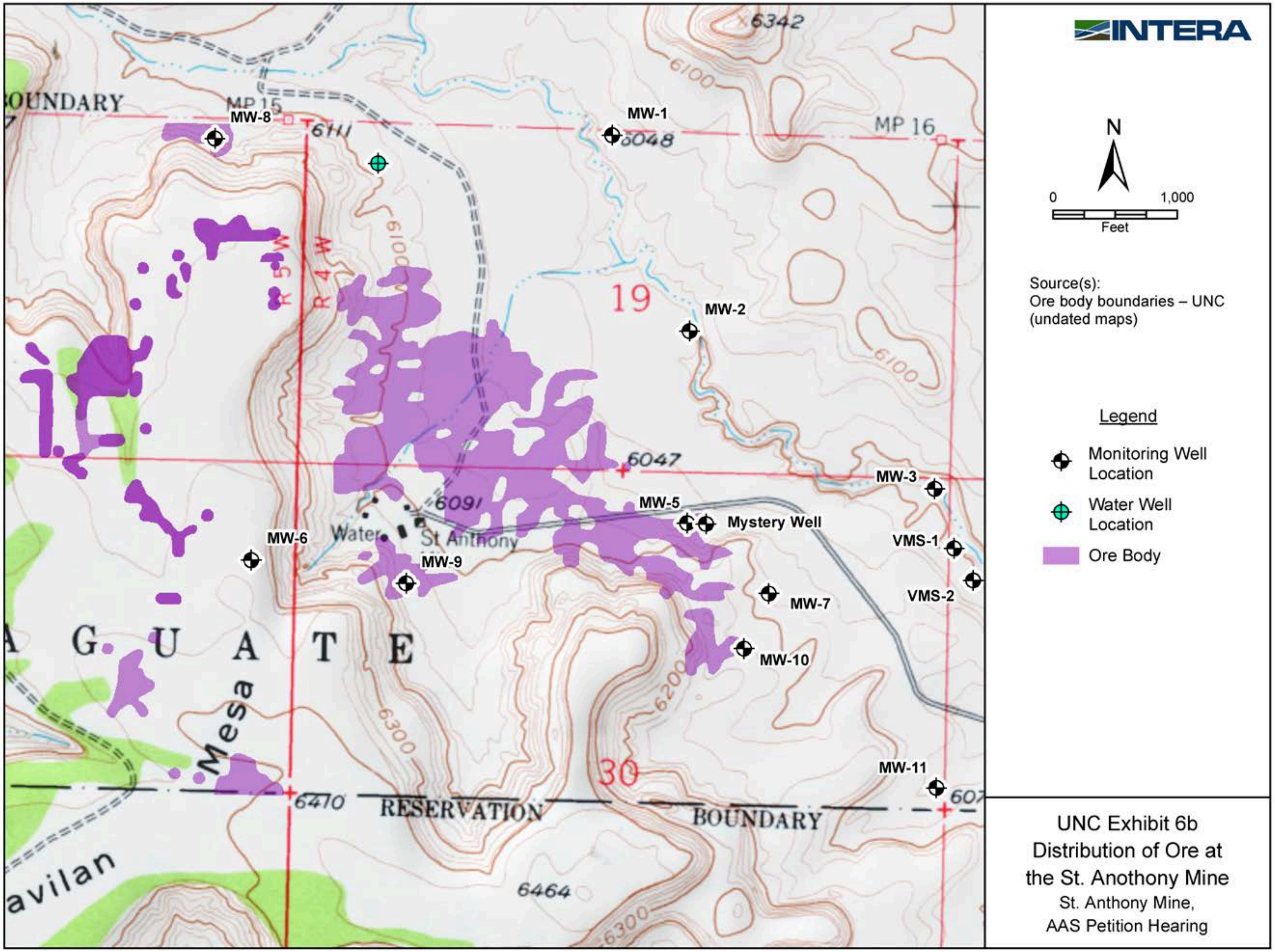
Presentation Slides

St. Anthony Mine in the Grants Uranium Mineral Belt



INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

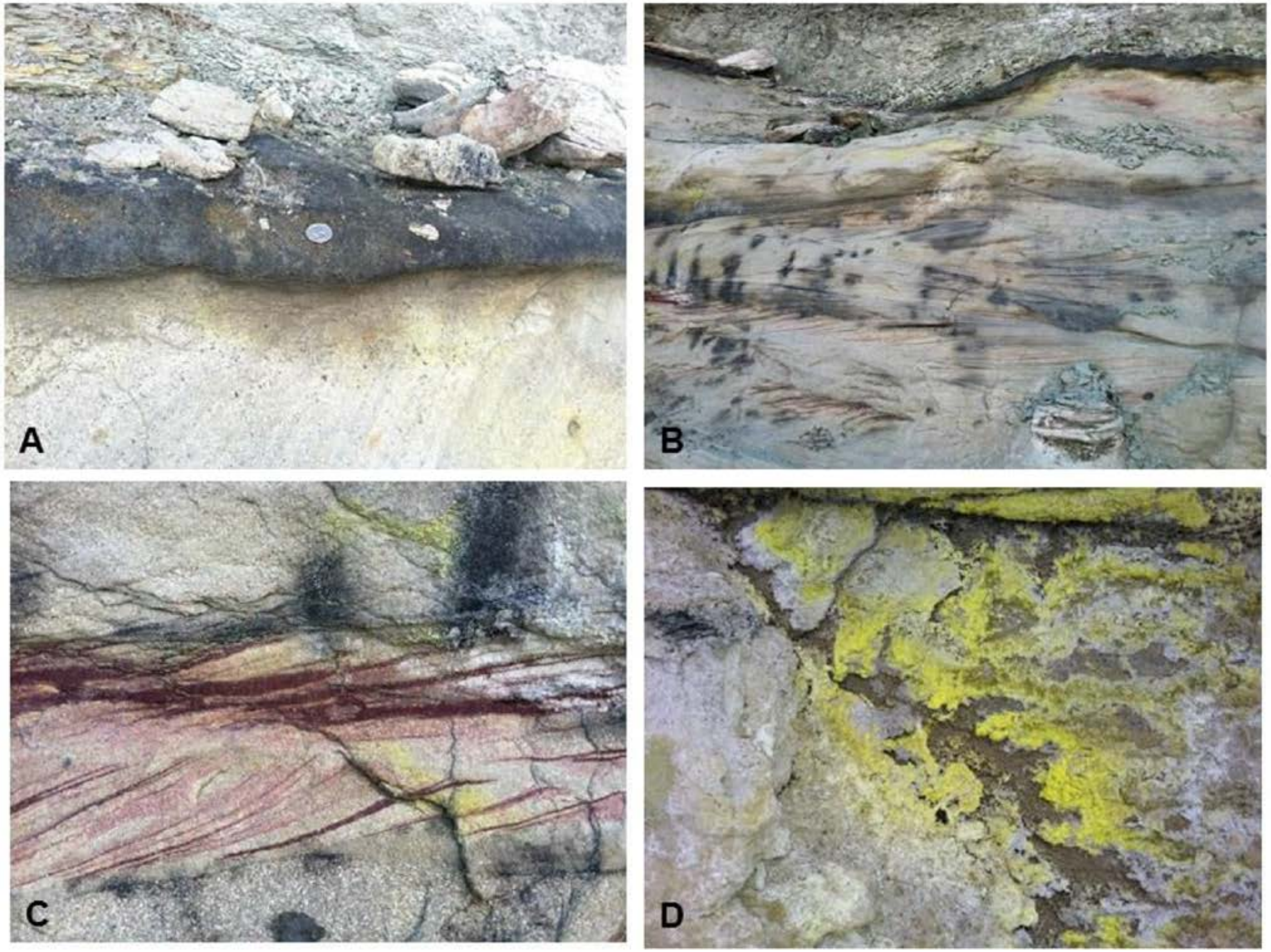
Distribution of Ore at the St. Anthony Mine



UNC Exhibit 6b
Distribution of Ore at the St. Anothony Mine
St. Anthony Mine, AAS Petition Hearing

Ore Deposit Features on Jackpile Outcrop

INTERA



UNC Exhibit 6c
Ore Deposit Features
on Jackpile Outcrop
St. Anthony Mine,
AAS Petition Hearing

Stage 1 Requirements

- Design and conduct a site investigation to define site conditions

- Provide data necessary to select and design an effective abatement option

Exhibit 12a

Summary of Stage 1 Investigation Activities

1. **Installed Monitoring Wells**
2. **Conducted aquifer tests of bedrock wells**
3. **Surveyed all monitoring wells and elevations of groundwater in the Large Pit for development of a potentiometric surface**
4. **Quarterly sampling of all wells and Large Pit groundwater**
5. **Surface water samples from Meyers Draw**
6. **Core Samples from Large Pit walls**
7. **Characterization of Overburden Piles**
8. **Evaluation of Site Receptors**

Stratigraphic Sequence of the St. Anthony Mine

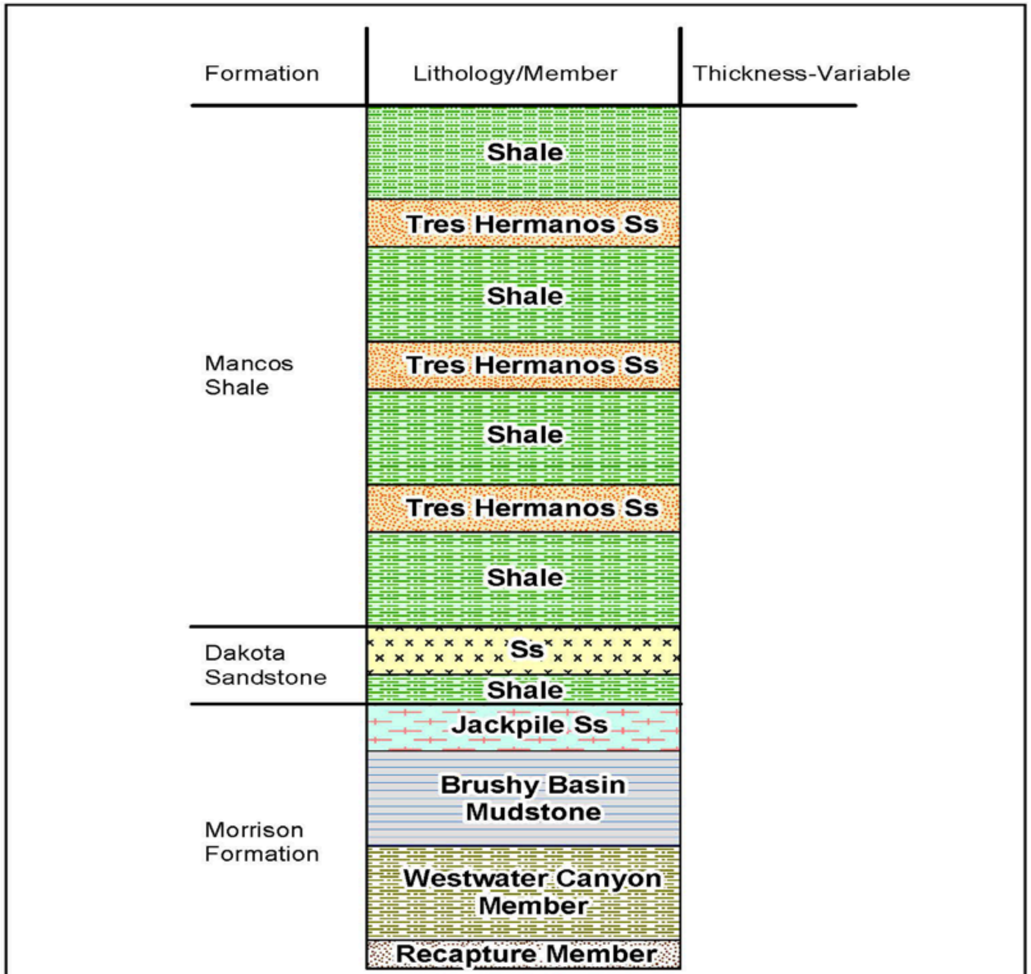


Figure 1.5
Stratigraphic Column for St. Anthony Hydrogeologic Conceptual Model
St. Anthony Mine,
Stage 2 Plan

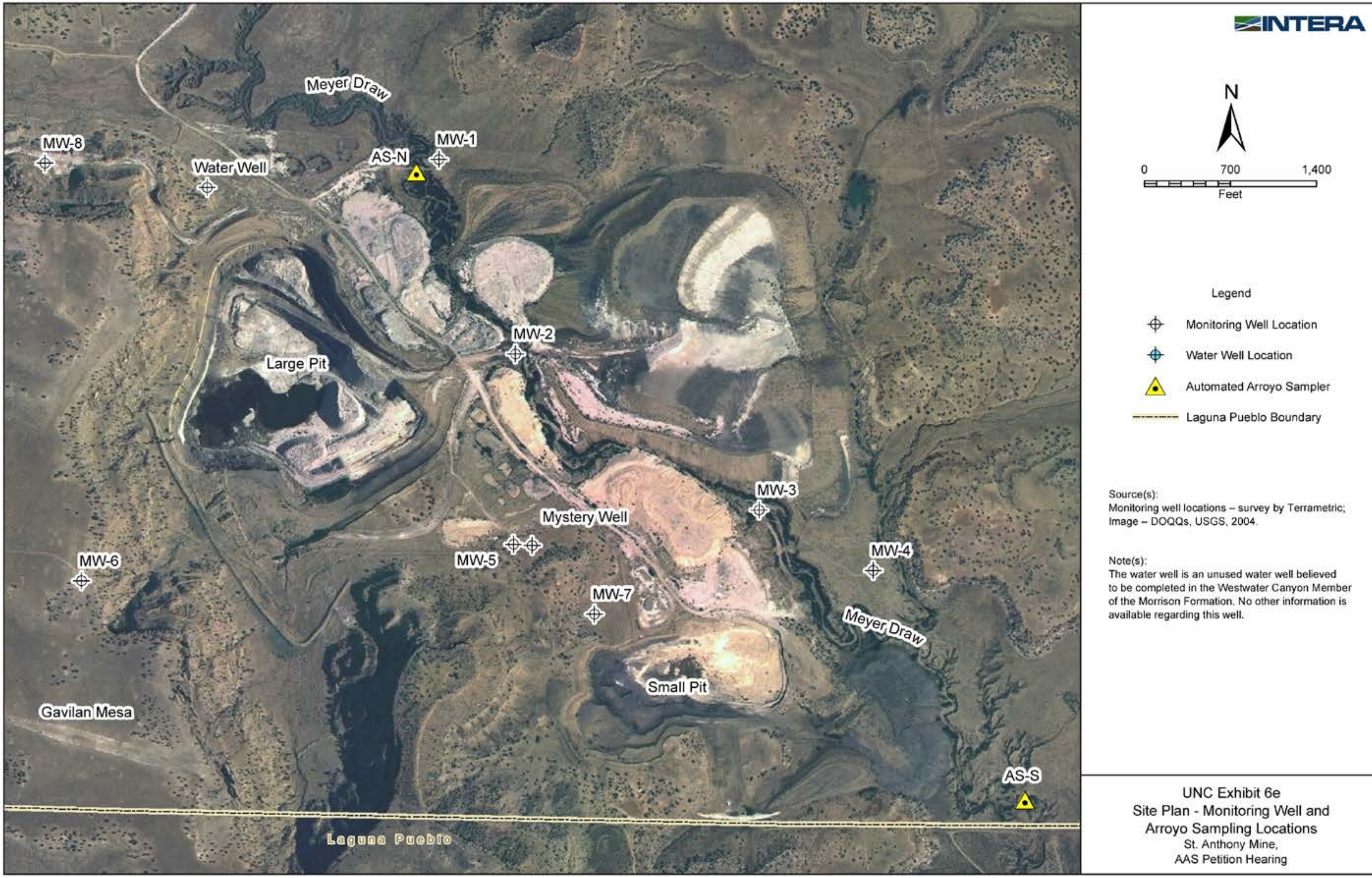
INTERA

FILE: S:\Projects\GE1-UNC_St_Anthony\Stage 2 Abatement Plan\GIS\MapDocuments\Stage2_Reporting\Section_1\01-5_StratColumnSAmodel.mxd Date: 4/11/2014

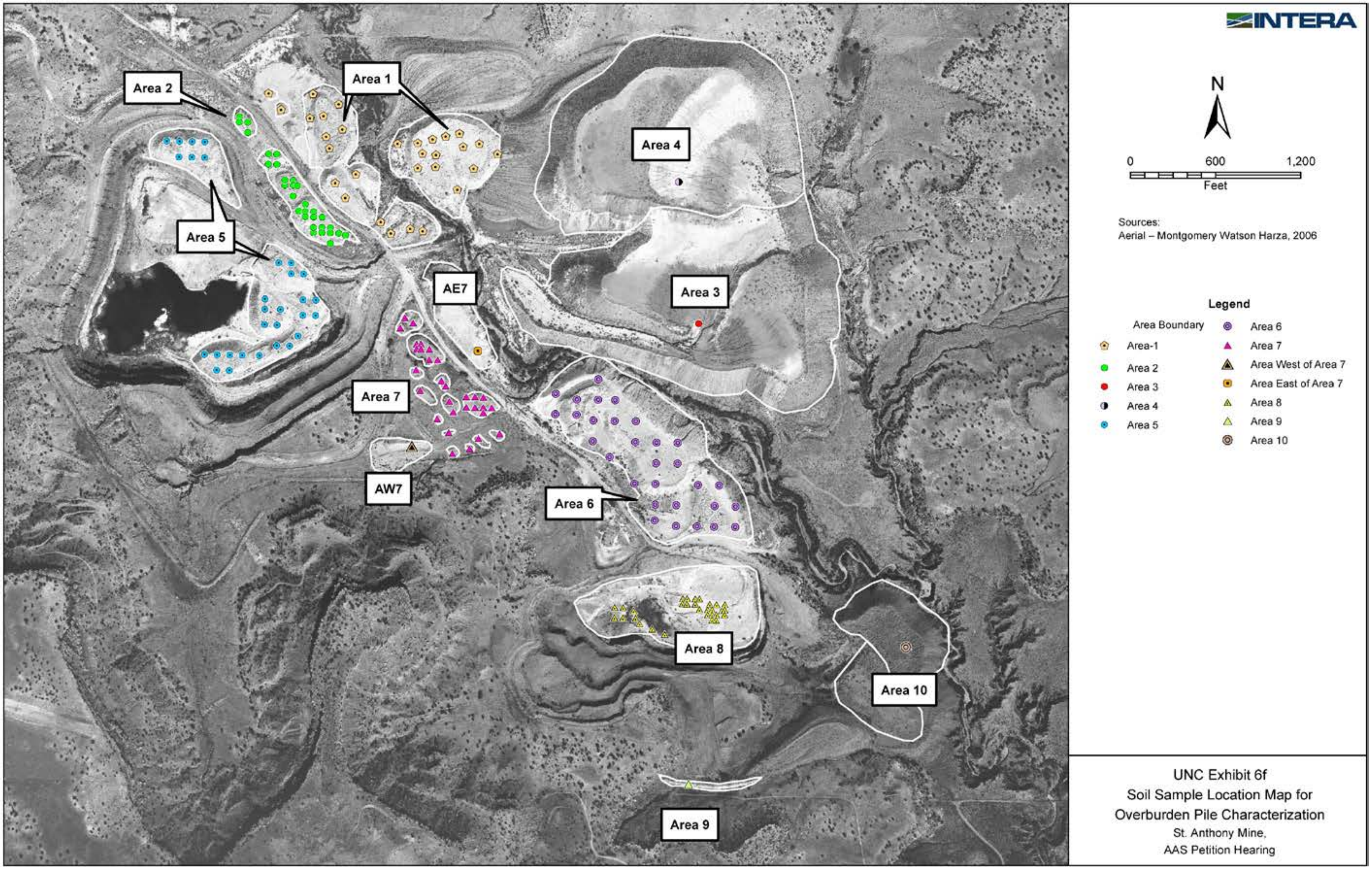
Exhibit 12c

GEOSCIENCE & ENGINEERING SOLUTIONS

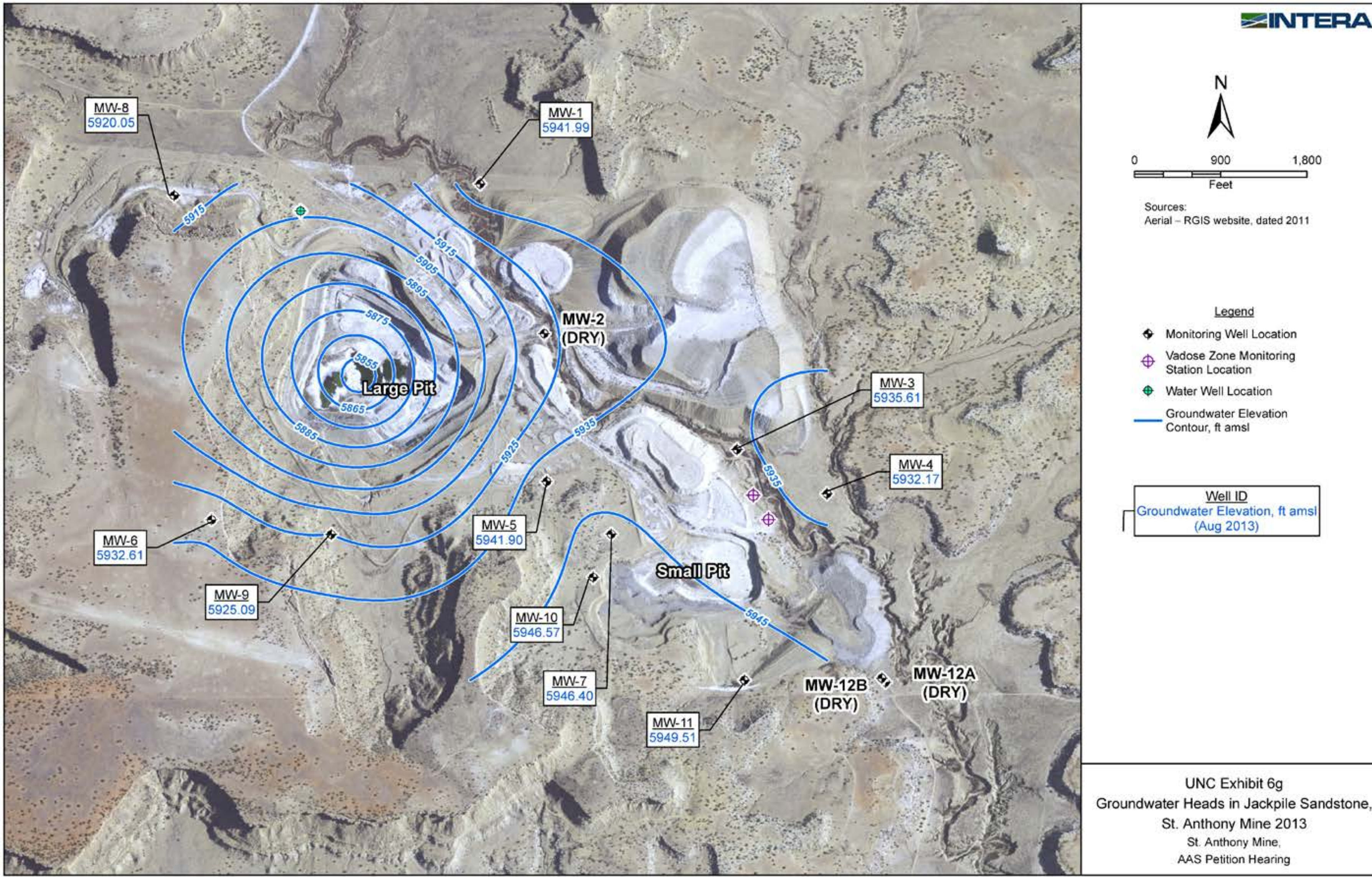
Site Plan – Monitoring Well and Arroyo Sampling Locations



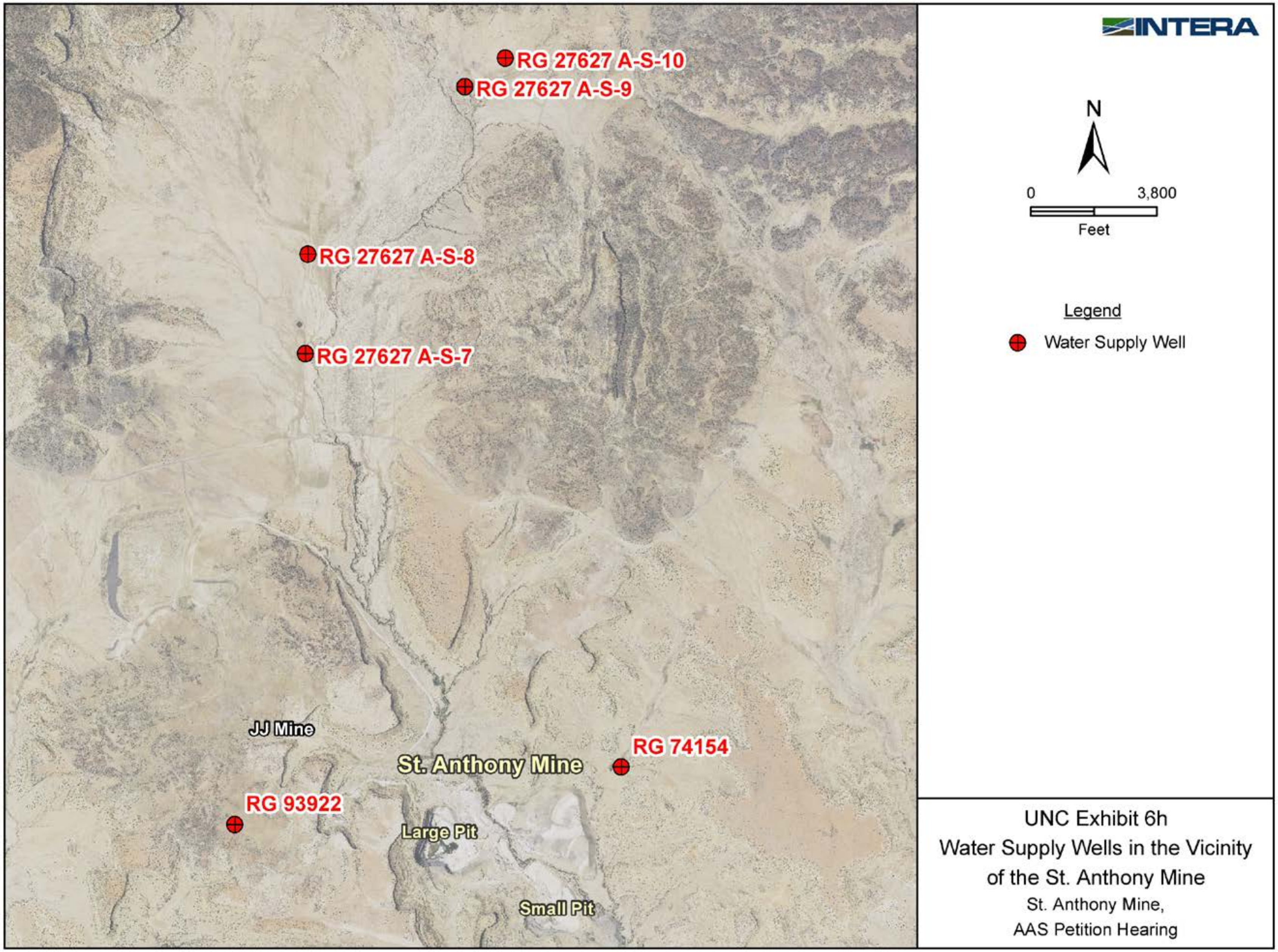
Soil Sample Location Map for Overburden Pile Characterization



Groundwater Elevations in Jackpile Sandstone, St. Anthony Mine 2013



Water Supply Wells in the Vicinity of the St. Anthony Mine



UNC Exhibit 6h
Water Supply Wells in the Vicinity of the St. Anthony Mine
St. Anthony Mine,
AAS Petition Hearing

Summary of Stage 2 Requirements

- Select and design an abatement option that, when implemented, will result in attainment of the abatement standards and requirements set forth in 20.6.2.4103 F. Alternative Abatement Standards (AASs)

- Water Quality Control Commission may Approve the AASs if:
  - **Criterion 1 -** compliance with the abatement standard(s) is not feasible by the maximum use of technology, or no reasonable relationship between the economic and social costs and benefits
  - **Criterion 2 -** proposed AASs are technically achievable and cost-benefit justifiable
  - **Criterion 3 -** compliance with the proposed AASs will not create a present or future hazard to public health or undue damage to property

Exhibit 12d

Multiple Accounts Analysis (MAA)

- Systematic Process for incorporating stakeholder input ((both positive and negative tangible (costs, reliability) and non-tangible (aesthetics)
- Objectively balance multiple often competing goals and objectives
- Three key remediation goals:
  - **Reducing risk of future groundwater impacts**
  - **Stabilizing groundwater conditions for the long term**
  - **Preventing exposure to water in the Large Pit**
- Nine categories of remedial alternatives were evaluated with many subcategories (approximately 22 total alternatives were evaluated)
- Ranked based on four categories of issues:
  - **Environmental**
  - **Socio-economic**
  - **Project economics**
  - **Technical Feasibility**

Exhibit 12e

MAA Results

- 14 meetings with nine stakeholders over a two-year period
- Highest ranking alternatives fell into two basic categories:
  - **Backfill alternatives –** returning land to sustainable ecosystem
  - **No backfill alternatives –** groundwater containment
- Backfilling the Large Pit is best - no complete groundwater pathway
- Second phase of Site Characterization was designed

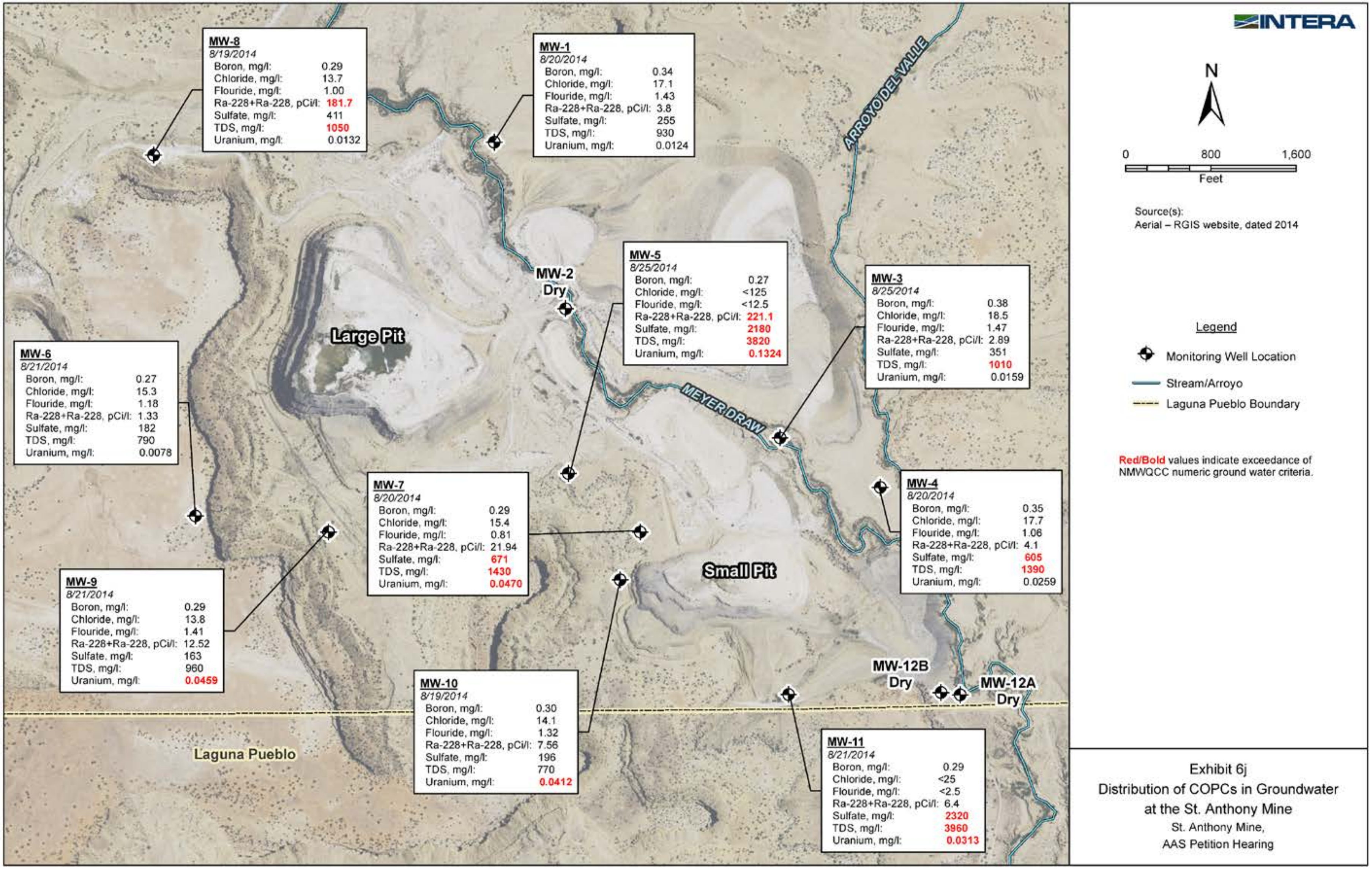
Exhibit 12f

Second Phase of Site Characterization

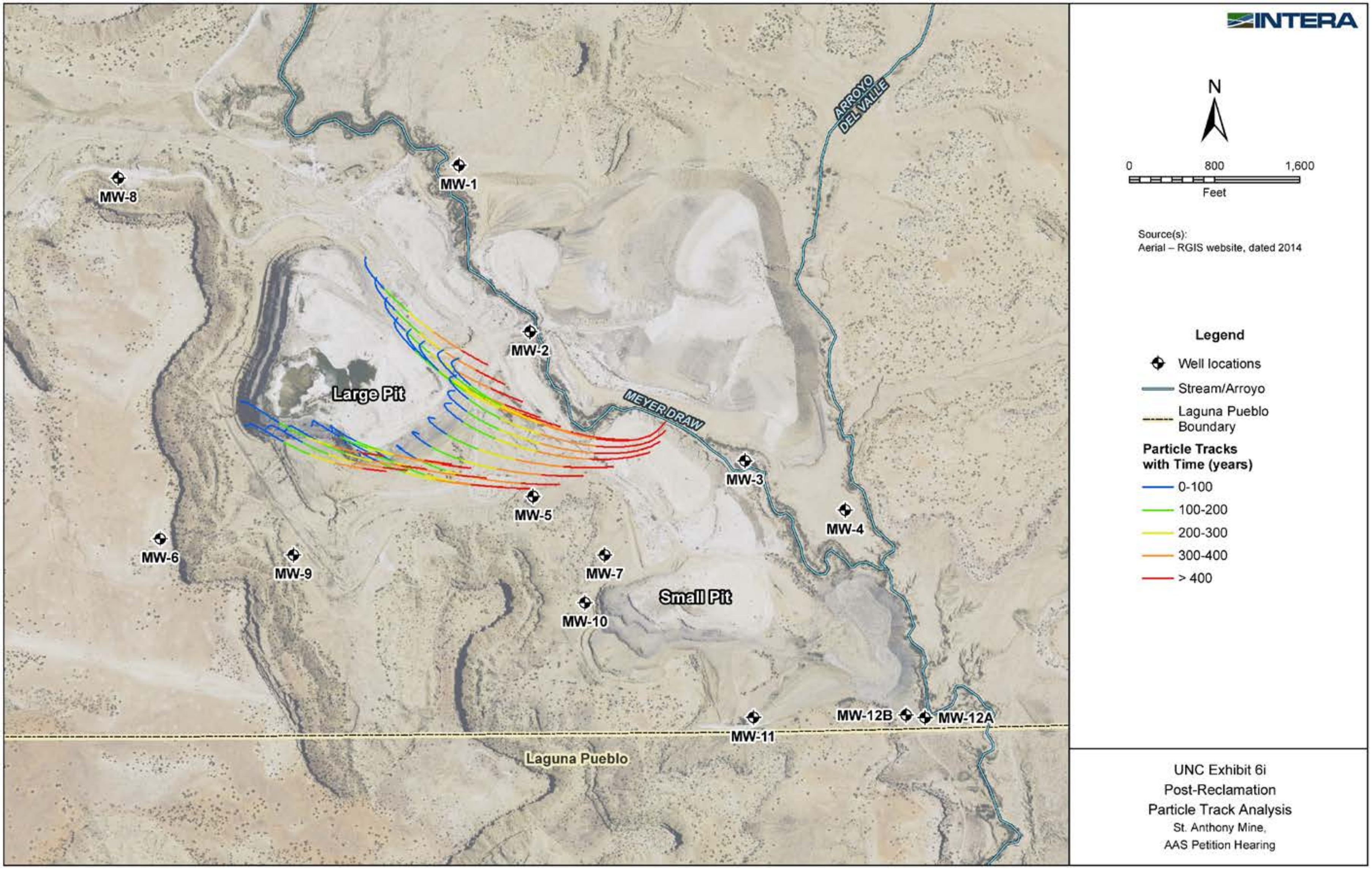
- Extend understanding of Jackpile groundwater flow directions, discharge points
- Complete predictive groundwater modeling to more definitely evaluate groundwater flow pathways
- Complete additional characterization of the water quality and geochemistry of the ore deposit
- Primary and Secondary mineralization for basis of geochemical modeling for achievable COPCs that meet the requirements of 6.20.2.4.4103 Subsection F NMAC

Exhibit 12g

Distribution of COPCs in Groundwater at the St. Anthony Mine



Post-Reclamation Particle Track Analysis



UNC Exhibit 6i
Post-Reclamation
Particle Track Analysis
St. Anthony Mine,
AAS Petition Hearing

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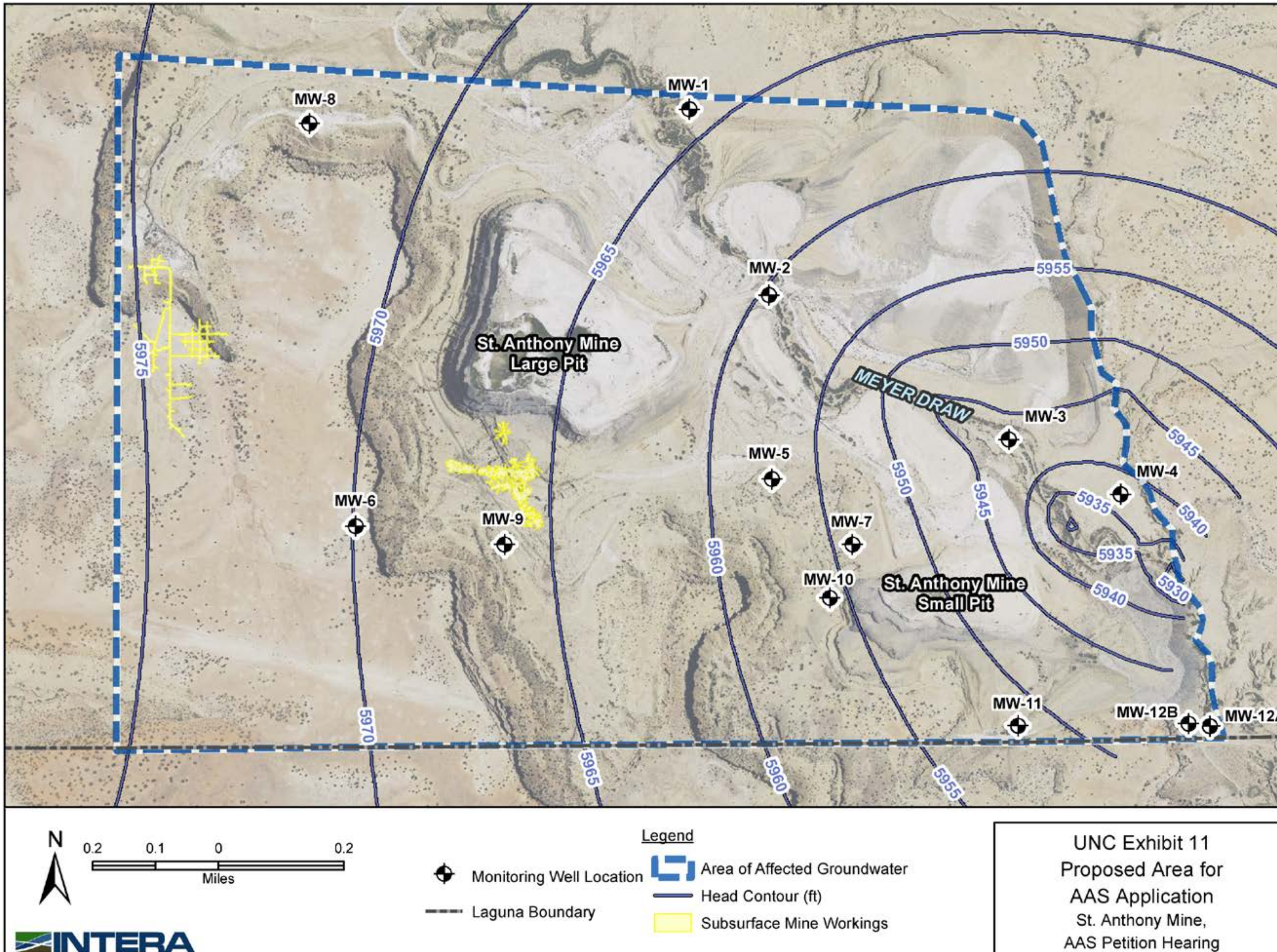
GEOSCIENCE & ENGINEERING SOLUTIONS

Three Criteria Required for AAS Approval

- **Criterion 1** - Compliance with the abatement standard(s) not feasible by the maximum use of technology or no reasonable relationship between the economic and social costs and benefits
  - Standards exceeded before mining began
  - Removal of all minerals and groundwater from Jackpile mineralized zone infeasible
- **Criterion 2** - Proposed AASs are technically achievable and cost-benefit justifiable
  - Geochemical modeling verification
  - Geochemical stabilization
- **Criterion 3** - Compliance with the proposed AASs will not create a present or future hazard to public health or undue damage to property
  - No complete groundwater pathway
  - Water quality and quantity in Jackpile SS is not sufficient for water supply

Exhibit 12h

Proposed Area for AAS Application



UNC Exhibit 11
Proposed Area for AAS Application
St. Anthony Mine, AAS Petition Hearing