EA Engineering, Science, and Technology, Inc., PBC
320 Gold Avenue SW, Suite 1300
Albuquerque, New Mexico 87102

June 7, 2022

Mr. Jaben Richards
Ground Water Quality Bureau
New Mexico Environment Department
PO Box 5469
Santa Fe, NM 87502

Dear Mr. Richards:

On behalf of Doña Ana Dairies, Inc., EA Engineering, Science, and Technology, Inc., PBC is submitting this Annual Groundwater Monitoring Report for Doña Ana Dairies located in Mesquite, Vado, and Anthony, New Mexico. The report discusses the annual groundwater sampling event conducted to fulfill requirements of the Stage 2 Abatement Plan for Doña Ana Dairies.

Please let me know if you have any questions regarding the information provided in this report.

Sincerely,

Gina Mullen
Project Manager

Jay Snyder
Senior Hydrogeologist

Enclosure

Cc: Linda Armstrong, Doña Ana Dairies
File

# ANNUAL GROUNDWATER MONITORING REPORT DOÑA ANA DAIRIES MESQUITE, NEW MEXICO

Prepared for:

Doña Ana Dairies
Mesquite, New Mexico

Prepared by:

EA Engineering, Science,
and Technology, Inc., PBC
320 Gold Avenue SW, Suite 1300
Albuquerque, New Mexico 87102

June 2022

EA Project No. 1464108.05

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Gina Mullen — 06/07/2022
Gina Mullen — Date
Project Manager

06/07/2022
Jay Snyder — Date
Senior Hydrogeologist

June 2022

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# 1.0 INTRODUCTION

On behalf of Doña Ana Dairies (Dairies), EA Engineering, Science, and Technology, Inc., PBC (EA) has prepared this Quarterly Monitoring Report for Doña Ana Dairies located south of Las Cruces, New Mexico (Figure 1). The report was completed in accordance with the *Stage 2 Abatement Plan* and the *Sampling and Analysis Plan, Doña Ana Dairies, Doña Ana County, New Mexico* dated November 7, 2013 and August 11, 2008, respectively, and the Conceptual Work Plan (CWP) dated February 1, 2008. All were prepared to satisfy requirements stated in the New Mexico Administrative Code (NMAC), Title 20, Chapter 6, Part 2, Sections 4106 through 4110 (20.6.2.4106 – 20.6.2.4110 NMAC). The Sampling and Analysis Plan was approved by the New Mexico Environment Department (NMED) Ground Water Quality Bureau (GWQB) on September 25, 2008. On March 25, 2015, the stipulated agreement to additional requirements to the Dona Ana Dairies Stage 2 Abatement Plan was agreed upon by NMED, Dona Ana Dairies, and the Rio Valle Concerned Citizens. On April 10, 2015, the Stage 2 Abatement Plan was approved by NMED by Final Order. Document references are provided in Section 10.0.

## 1.1 Objective

The objective of this monitoring program is to satisfy the requirements set forth in the Stage 2 Abatement Plan and the Stipulated Agreement and to satisfy the requirements set forth in 20.6.2.4110 NMAC.

The following work was performed to meet the objective of the monitoring program:

- Representatives from D&H Petroleum and Environmental Services, Inc. (D&H) gauged discharge plan (DP) monitoring wells, abatement plan (AP) monitoring wells, and Anthony Waste Water Treatment Plant (WWTP) wells from February 7 through February 10, 2022. Glorieta Geoscience, Inc. (Glorieta) gauged Organ Dairy wells on February 24, 2022.

- From February 14 through March 25, 2022, D&H representatives collected groundwater samples from all AP, DP, and irrigation/supply wells or sampling locations that contained sufficient water. Glorieta sampled Organ Dairy wells on February 24, 2022. Samples were analyzed for nitrate, chloride, total dissolved solids (TDS), and total Kjeldhal nitrogen (TKN). Field parameters including specific conductance, pH, temperature, oxidation reduction potential (ORP), and dissolved oxygen were monitored and recorded on field forms during sampling.

- Analyte trend analyses were updated.

- First order decay rates for nitrate at wells with decreasing nitrate concentrations were calculated.

- Geostatistical analysis of analytes was performed.

## 1.2 Background

In correspondence dated April 7, 2006, NMED required a Stage 1 Abatement Plan for 13 dairies (Organ Dairy [Former Daybreak and Del Norte Dairy], Mountain View Dairy, Buena Vista I Dairy, Bright Star Dairy, Dominguez 2 (Former D&J Dairy], Dominguez Dairy, Gonzales Dairy, Buena Vista Dairy II, River Valley Dairy, Big Sky Dairy, Sunset Dairy, Desert Land Dairy, and Del Oro Dairy) in Doña Ana County, based on analytical results from DP monitoring of on-site compliance monitoring wells that showed concentrations of nitrate, chloride and TDS exceeding ground water standards promulgated in New Mexico Water Quality Control Commission (NMWQCC) Regulations (20.6.2.3103 NMAC). On October 30, 2006, the Dairies notified NMED that they had reached an agreement to work as a group and submit a joint response to NMED's request (Doña Ana Dairies 2006). Currently the Dona Ana Dairies consortium consists of 9 dairies with the departure from the group by Buena Vista I Dairy in 2011, River Valley Dairy in April 2019, and Gonzalez Dairy in October 2020.

The Dairies are organized into the northern area, central area and southern area. The northern area of the dairies currently consists of Organ Dairy, Mountain View Dairy, Bright Star Dairy, Dominguez 2 Dairy, and Dominguez Dairy. The northern land application is also included in the northern portion of DAD. Buena Vista Dairy and Gonzalez Dairy, though no longer members of the consortium, are located within the northern area. The central area consists of Buena Vista Dairy II, Big Sky Dairy, and Sunset/Desert Land Dairy. Though no longer a member of the consortium, River Valley Dairy is also located in the central area. The southern area includes only Del Oro Dairy.

On December 11, 2006, on behalf of the Doña Ana Dairies, Golder Associates (Golder) submitted a Stage 1 and 2 Abatement Plan Proposal to address impacts to groundwater in the area of the Dairies (Golder 2006). The first major deliverable in the Abatement Plan Proposal was an Existing Data Report (EDR) to bring together in one document historical data and practices of the constituent dairies.

The EDR, submitted on February 1, 2008 (Golder 2008a), was intended to satisfy the Dairies' commitment for compilation and submission of existing data identified in the Doña Ana Dairies response (2006) to the NMED requirement for Stage I Abatement Plans. Section 9 of the EDR outlined data gaps identified during the preparation of the report, as well as the actions recommended. To facilitate the discussion of the path forward after the submittal of the EDR and concurrent with the EDR submission, a conceptual work plan (CWP) was prepared. (Golder 2008b).

On July 15, 2008, the Dairies, Golder and NMED met (Golder 2008c). During that meeting, plume maps presented in the EDR (Golder 2008a), new monitoring data, and knowledge of well locations and groundwater chemistry results at adjacent DP-regulated facilities were used to identify data gaps with respect to ground water flow direction and plume delineation. The agreed upon data gaps yielded well locations (including contingency locations) recorded in the meeting minutes (Golder 2008c) and depicted in the Sampling and Analysis Plan (SAP) dated August 8, 2008 (Golder 2008d). The SAP outlined the details of the field operations to be implemented for completion of data gaps, such that a Site Investigation Report (§4106.C.6) and

Stage 2 Abatement Plan (§4106.D) could be prepared.

Groundwater gauging was conducted concurrent to discussions with NMED at the Dairies for four quarters, February 2008, June 2008, September 2008, and December 2008, to determine the current and historical site groundwater gradient.

In May 2009, field work was conducted as outlined in the SAP and ten (10) AP monitoring wells (DAD-01 through DAD-10) were installed. In July 2009, the Site Investigation Report was submitted to the NMED.

On February 9, 2012, the Final Site Investigation Report was submitted to NMED. The report summarized field activities that occurred from October 10 through October 14, 2011, and November 10 through 18, 2011, during which eleven soil borings were advanced at the site and converted into monitoring wells DAD-12 through DAD-14, DAD-16 through DAD-22, and DP well 177-03A.

On August 16, 2012, soil boring/monitoring well DAD-15 was installed and on August 20, 2012, well DAD-15 was sampled. An addendum to the Final Site Investigation Report was submitted to NMED on September 7, 2012, which summarized DAD-15 field activities.

A Stage 2 Abatement Plan was submitted to NMED on March 13, 2013. Based on an NMED response in August 2013, a Revision to the Stage 2 Abatement Plan was submitted on November 7, 2013.

On March 25, 2015, the stipulated agreement to additional requirements to the Dona Ana Dairies Stage 2 Abatement Plan was agreed to by NMED, Dona Ana Dairies, and the Rio Valle Concerned Citizens. On April 10, 2015 the Stage 2 Abatement Plan with the stipulated agreement was approved by NMED by Final Order.

EA began implementation of the Stage 2 Abatement Plan and stipulated agreement as directed by the Final Order in December 2015. In order to meet objectives, four monitoring wells were installed (DAD-23 through DAD-26) and Del Oro Dairy discharge plan (DP) well 692-01 was plugged and abandoned. Details on implementation of these tasks are included *Stage 2 Implementation and Quarterly Groundwater Monitoring Report,* July 2016.

In accordance with the approved Stage 2 Abatement Plan and stipulated agreement, a baseline compound specific isotope analysis (CSIA) for nitrogen 14 and nitrogen 15 ($^{15}N/^{14}N$ [$\delta^{15}N$]) and total organic carbon (TOC) was completed for 16 wells in spring of 2016. Additionally, existing conditions concentrations were recalculated for the contaminants of concern. Results of these analyses are presented in the *Stage 2 Implementation and Quarterly Groundwater Monitoring Report,* July 2016. A five-year review containing results of repeated CSIA sampling and recalculated existing conditions concentrations was submitted to NMED in December 2020 (EA 2020).

Contaminant concentration trend analysis as well as geospatial analysis to evaluate changes in plume behavior are required on an annual basis and are provided in this report. Also presented in

this report are the results of the annual sampling of irrigation and supply wells and concentration trends of analytes in AP and DP wells.

A Stage 2 Abatement Plan Modification proposal was submitted to NMED on August 10, 2018 to address plume instability in the perched aquifer nitrate plume at Del Oro Dairy. Following discussions with NMED, a revised Stage 2 Abatement Plan Modification proposal was submitted on May 1, 2019. A public meeting to discuss the plan was held in Anthony, New Mexico on May 17, 2019. The Stage 2 Abatement Plan Modification proposal was revised based on additional input from NMED and the public and submitted on July 26, 2019. Public notice for the proposal was initiated on October 23, 2019 and closed on December 31, 2019. An addendum to the Stage 2 Abatement Plan Modification proposal was submitted on July 13, 2020. A revised addendum to the Stage 2 Abatement Plan Modification proposal was submitted on July 13, 2021 based on additional comments from the public. An additional virtual townhall meeting was held on December 15, 2021 that presented the current proposal. The performance plan was submitted to NMED on February 15, 2022. NMED approved the Stage 2 Abatement Plan Modification for Dona Ana Dairies (EA 2019), the accompanying Stage 2 Abatement Plan Addendum for Reuse of Pumped Groundwater at Del Oro Dairy (EA 2021b), and the Stage 2 Abatement Plan Modification Performance Plan (EA 2022) on April 26, 2022. Implementation is currently underway.

# 2.0 GROUNDWATER MONITORING ACTIVITIES

Groundwater monitoring activities included gauging DP and AP monitoring wells and Anthony Waste Water Treatment Plant monitoring wells. Groundwater samples were collected from DP and AP monitoring wells and irrigation/supply wells. Groundwater gauging and sampling was conducted for Organ Dairy by Glorieta; gauging and sampling for all other wells was conducted by D&H. Groundwater samples were analyzed for nitrate, chloride, TDS, and TKN. The resulting data from this groundwater monitoring event are compiled and presented herein.

## 2.1 Well Gauging

From February 7 through February 10, 2022, representatives from D&H gauged DP monitoring wells, AP monitoring wells, and Anthony WWTP wells with an electronic water level indicator. Organ Dairy wells were gauged by Glorieta on February 24, 2022. Table 1 provides a summary of the groundwater gauging data collected from the monitoring network. Data obtained during gauging are shown on potentiometric surface maps included as Figures 2, 3, 4, and 5. Well gauging field forms are available in Appendix A.

## 2.2 AP and DP Well Groundwater Sampling

D&H sampled all AP monitoring wells with sufficient water from March 3 through March 23, 2022. AP well DAD-06 was dry and, thus, was not sampled; well DAD-06 has been dry since September 2013. The Stage 2 Abatement Plan proposal discusses plans for a drilling company to attempt to remove silt at the bottom of the well through redevelopment. Redevelopment is being planned now that the plan has been approved. Groundwater sampling from AP wells was

accomplished with new, disposable bailers. Three well casing volumes were purged unless the well contained insufficient water.

D&H sampled DP wells from February 14 through March 10, 2022. Glorieta sampled Organ Dairy DP wells on February 24, 2022. Due to a lower water table, several DP wells were dry or contained insufficient water for sampling. Prior to sampling, the DP wells were purged of three well casing volumes, if practicable, by either (1) hand-bailing with new, disposable bailers and twine, (2) pumping with a submersible pump and new polyethylene tubing, or (3) pumping with a dedicated pump and new polyethylene tubing.

The wells were sampled from historically clean to dirty to the extent possible to minimize cross-contamination potential. All non-dedicated or disposable equipment was decontaminated between wells with an Alconox™ solution to further ensure sample quality. All meters were calibrated and/or checked with standards in accordance with the manufacturer's specifications prior to daily use. Purge water was ground discharged.

When sufficient water was available, field parameters including specific conductance, temperature, pH, and ORP were monitored using a Myron L Ultrameter II and recorded on field forms. Dissolved oxygen was measured using a YSI 556 MPS. Dissolved oxygen and ORP were only measured in the first set of readings. Field parameters from August 2015 to present are presented in Table 2. The sampling field forms are presented in Appendix A.

All groundwater samples were collected immediately after purging. Sampling was accomplished by carefully pouring groundwater from the bailer into the sample containers or by pumping groundwater through new polyethylene tubing into the sample container. Sample containers were provided by Hall Environmental Analysis Laboratory, Inc. (Hall). Container size, type, sample preservatives, analytical methods, and holding times are specified in Table 3. All samples were preserved in accordance with method requirements, labeled, then immediately cooled to <6°C with ice and delivered under chain-of-custody to Hall in Albuquerque, New Mexico. All analytical laboratory reports are provided in Appendix B.

## 2.3 Irrigation/Supply Well Groundwater Sampling

Ten irrigation/supply locations were sampled February 24 through March 25, 2022. Samples were analyzed for nitrate, chloride, TDS, and TKN. Irrigation/supply wells were sampled by collecting a grab aliquot from a faucet or tank located nearest to the pump outlet. Tap samples were collected while the pumps were running; as a result no purging was completed.

Nine of the collected samples are from dairy supply wells located near their respective milking parlors. The supply wells at Mountain View Dairy, Bright Star Dairy, Dominguez Dairy, Buena Vista Dairy II, Big Sky, Sunset Dairy, and Del Oro Dairy were sampled from their holding tanks using new disposable bailers, from taps located on the tank, or from valves located on lines going into the tank. At Del Oro Dairy three supply wells pumped water into the holding tank; therefore, the groundwater sample collected was a composite sample. Dominguez 2 well LRG-956 is not operating and as a result, the tank could not be sampled.

One irrigation well, Mountain View Land Application Area well LRG-457, was sampled. Irrigation wells LRG-314495-POD1 and Dominguez Dairy well LRG-00590-S-6 were not in use and as a result were not sampled. Dominguez Dairy well LRG-00590-S-6 will be sampled next quarter.

# 3.0 GROUNDWATER MONITORING RESULTS

## 3.1 Hydraulic Gradient and Direction of Groundwater Flow

This quarter, groundwater was present beneath the site at depths ranging from 13.71 feet below top-of-casing (ft btoc) in AP well DAD-03 to 133.50 ft btoc in Dominguez 2 DP well 42-12. Groundwater was encountered at shallower depths near the Mesquite Drain and at greater depths near I-10 where the topographic elevation increases.

AP monitoring well DAD-25 may have been completed in a perched aquifer, as groundwater elevations have consistently measured several feet higher than groundwater elevations in surrounding wells. As a result, this groundwater elevation has not been used in contouring for the central area potentiometric surface map.

Potentiometric surface maps were completed using the monitoring well gauging data for the northern, central, and southern portions (perched and regional aquifers) of the Dairies. Groundwater elevation data are provided in Table 1 and potentiometric surface maps are provided as Figures 2, 3, 4, and 5. Hydrographs were completed for select monitoring wells in each area and are provided in Appendix C. In comparison to November 2021, groundwater levels increased by an average of 0.1 foot in the northern area, though groundwater levels dropped on the west side and increased on the east side. Groundwater levels increased by an average of 0.6 foot in the central area. In the southern area, average groundwater levels increased by approximately 1.0 foot in the regional aquifer while average groundwater levels in the perched aquifer increased by an average of 0.4 foot.

At the time the Stage 2 Abatement Plan was written in 2013, groundwater flow direction in the northern portion was to the east-southeast. Over time, the groundwater flow direction has shifted. During the most recent gauging event, groundwater flow direction at the south end of the northern area was still to the southeast, but groundwater in the northern and central portions of the northern area was flowing to the east. The groundwater flow direction in the central and southern areas remains unchanged from 2013. In the central area, groundwater flow direction was generally to the southeast. Flow in the southern area regional aquifer was to the southeast and flow in the southern perched aquifer was to the south-southwest.

The hydraulic gradient across the Dairies in the regional aquifer was approximately 0.001 ft/ft and the hydraulic gradient in the perched aquifer in the southern area was approximately 0.004 ft/ft.

## 3.2 Groundwater Field Parameters

Field parameters from the most recent monitoring event including specific conductance, pH,

temperature, ORP, and dissolved oxygen were recorded on the sampling field forms (Appendix A) and are summarized in Table 2. Specific conductance, dissolved oxygen, and ORP trends for select wells are presented in Appendix D. Though dissolved oxygen and ORP measurements from wells containing a dedicated pump were recorded, these measurements are not considered representative of aquifer conditions.

## 3.3 Groundwater Nitrate, Chloride, and TDS Analytical Results

### *3.3.1 Abatement Plan Well Results*

Groundwater nitrate concentrations were below the 10 milligram per liter (mg/L) NMWQCC standard in 11 of the 25 AP monitoring wells sampled. The remaining 14 AP wells had nitrate concentrations at or above the standard: DAD-01, DAD-07, DAD-08, DAD-09, DAD-11 (vertical delineation), DAD-12 (vertical delineation), DAD-14, DAD-15, DAD-19 (vertical delineation), DAD-20, DAD-21, DAD-22, DAD-23, and DAD-26.

Nitrate concentrations decreased or remained the same in AP wells DAD-02, DAD-03, DAD-05, DAD-07, DAD-08, DAD-09, DAD-10, DAD-11 (vertical delineation), DAD-12 (vertical delineation), DAD-14, DAD-16, DAD-18 (vertical delineation), DAD-19 (vertical delineation), DAD-20, DAD-21, and DAD-23 compared to the previous sampling event. During this sampling event, nitrate concentrations in the AP wells ranged from 44 mg/L in well DAD-08 to <1.0 mg/L (the laboratory reporting limit [RL]) in wells DAD-03, DAD-05, and DAD-16.

Chloride concentrations exceeded the NMWQCC standard of 250 mg/L in all AP wells sampled except for wells DAD-17 and DAD-25, which had chloride concentrations of 170 mg/L and 120 mg/L, respectively. TDS concentrations exceeded the NMWQCC standard of 1,000 mg/L in all AP wells sampled except for wells DAD-17 and DAD-25, which had TDS concentrations of 985 mg/L and 840 mg/L, respectively. The highest chloride and TDS concentrations in the AP wells were detected at well DAD-08 located in the central area, where respective concentrations were 1,600 mg/L and 4,520 mg/L.

Table 4 and Figures 6 through 9 present the analytical results for AP monitoring wells. Analytical laboratory reports are provided in Appendix B. Nitrate, chloride, and TDS concentration trends for select AP wells are presented by area in Appendix E.

### *3.3.2 Abatement Plan and Discharge Permit Well Results by Area*

DP groundwater analytical results are presented in Table 5. Nitrate, chloride, and TDS concentration trends for the DP wells by area are presented in Appendix F. Analytical data for all sampled DP wells are also presented in Figures 6 through 9. Analytical laboratory reports are included in Appendix B. Discussions of upgradient/downgradient conditions reflect current groundwater flow directions discussed in section 3.1. The following discussions summarize the results by area at the Dairies.

*Northern Portion*

Upgradient well 86/340-01 (located north of the abatement area) has been below the nitrate NMWQCC standard of 10 mg/L since February 2018; historically, concentrations in this well were above the nitrate standard. Northern Land Application Area well 70/86/340-01 is located at the northern-most boundary of the abatement area and was above the nitrate standard in February 2022 with a concentration of 20 mg/L. Dominguez Dairy well 624-09 delineates the western edge of the plume. The nitrate plume is defined to the east by Dominguez Dairy wells 42-10, 42-11, 42-12, and AP well DAD-13. Delineation is provided by AP well DAD-02 to the south. Nitrate contamination is undefined to the east in the vicinity of DAD-01 and to the west in the vicinity of Dominguez Dairy well 624-02. The highest nitrate concentration in the northern portion was observed in Dominguez Dairy 2 well 42-06 with a concentration of 170 mg/L.

The chloride concentrations in DP wells were generally at or above the 250 mg/L standard in wells sampled within the northern portion of the Dairies. Chloride was detected below the standard at Organ Dairy well 126-09 at 150 mg/L and Northern Land Application Area well 86/340-01 at 230 mg/L. TDS concentrations were above the 1,000 mg/L standard in all wells sampled within the northern portion of the Dairies except for Organ Dairy well 126-09 with a TDS concentration of 150 mg/L and Northern Land Application Area well 86/340-01 with a TDS concentration of 230 mg/L. The highest concentrations of chloride and TDS were observed in Northern Land Application area well 70/86/340-01 at concentrations of 1,700 mg/L and 5,440 mg/L, respectively.

*Central Portion*

The northern extent of the central portion nitrate plume is defined by Buena Vista Dairy II well 74-03 where nitrate was not detected above the laboratory RL. The southern extent is defined by Las Cruces Community Farms (formerly McAnally Enterprises) well MW-4 and AP well DAD-17 with nitrate concentrations of 1.3 mg/L and 2.7 mg/L, respectively. Historically, the eastern cross-gradient extent of the plume was defined by wells DAD-07 and DAD-15. Nitrate in these wells exceeded the standard at concentrations of 18 mg/L and 22 mg/L, respectively. The western extent is defined by Buena Vista Dairy II well 74-02 and AP well DAD-16; nitrate concentrations remain below the standard in these wells. The highest nitrate concentration in the central portion was 120 mg/L, observed in Big Sky Dairy well 833-09.

Chloride and TDS concentrations were generally at or above standards in wells within the central portion of the Dairies. Chloride was below the standard in downgradient AP wells DAD-17 and DAD-25 at concentrations of 170 mg/L and 120 mg/L, respectively. TDS was below the standard in downgradient AP wells DAD-17 and DAD-25 at concentrations of 985 mg/L and 840 mg/L, respectively. The highest chloride concentration of 1,600 mg/L was observed at AP well DAD-08 and Big Sky Dairy well 833-08. The highest TDS concentration was observed at AP well DAD-08 at 4,520 mg/L. Well DAD-08 is located east of Sunset Dairy, adjacent to an irrigation well that is no longer in use. Trend analysis indicates that concentrations of chloride and TDS have been decreasing in this well.

*Southern Portion – Regional and Perched Aquifers*

Wells completed in the regional aquifer in the southern portion of the dairies include AP well

DAD-10 and Del Oro Dairy wells 692-05 through 692-09 (Figure 8). All sampled wells in the regional aquifer were below the NMWQCC standard for nitrate except for Del Oro well 692-05, which had a concentration of 16 mg/L. Chloride concentrations were above the NMWQCC standard and ranged from 360 mg/L in Del Oro well 692-09 to 510 mg/L in Del Oro Dairy well 692-07. TDS concentrations were above the NMWQCC standard and ranged from 1,370 mg/L in Del Oro Dairy well 692-08 to 1,660 mg/L in AP well DAD-10.

Wells completed in the perched aquifer in the southern portion that are sampled on a quarterly basis by DAD include wells 692-02, 629-04, DAD-09, DAD-20, DAD-21, DAD-22, and DAD-26 (Figure 9). A water line located at the intersection of East O'Hara Road and Anthony Drive was suspected to have been compromised and to have impacted analyte concentrations in the perched aquifer. Based on groundwater elevation and groundwater concentration data, it is likely the water line leak began before May 2019. Decreasing groundwater gradient and changes in analyte concentrations suggest that the water line leak may have been repaired during the winter of 2020/2021.

Nitrate was above the standard in all monitoring wells in the perched aquifer except Del Oro well 692-02, which is located near the suspected water line leak. Nitrate concentrations have increased at Del Oro well 692-02 over the past two quarters. The highest nitrate concentration of 41 mg/L was observed in AP well DAD-21; this quarter's results show a continuation of the downward trend in nitrate concentration first detected in September 2021. The concentration of nitrate at downgradient AP wells DAD-20, DAD-22, and DAD-26 are 21 mg/L, 16 mg/L, and 22 mg/L, respectively. A modified Abatement Plan proposal to address nitrate in the perched aquifer has been approved by NMED. Implementation of the plan is underway.

Chloride concentrations were above the NMWQCC standard and ranged from 300 mg/L in Del Oro Dairy well 692-02 to 900 mg/L in AP well DAD-21. TDS concentrations in the perched aquifer were above standard and ranged from 1,060 mg/L in Del Oro Dairy well 692-02 to 2,840 mg/L in AP well DAD-21.

### *3.3.3 Irrigation/Supply Well Results*

Groundwater analytical results for the sampled irrigation/supply wells are presented in Table 6. Analytical results are included in Figures 6, 7, and 8. Analytical laboratory reports are provided in Appendix B.

Nitrate concentrations were above the NMWQCC standard for nitrate in 3 of the 11 irrigation/supply well sample locations. Irrigation/supply wells LRG-00953 (Bright Star Dairy), LRG-00591-S (Dominguez Dairy), and LRG-00591-S-2 (Dominguez Dairy) had nitrate concentrations above the standard with concentrations of 15 mg/L, 30 mg/L, and 19 mg/L, respectively. All three wells are located in the northern area. The nitrate concentration in LRG-00591-S-2 is an order of magnitude higher than historical results and is the first detection over the standard from this well. This well will be resampled next quarter.

Chloride and TDS concentrations were generally above the NMWQCC standards in irrigation/supply wells. Organ Dairy well LRG-458 S had chloride and TDS concentrations

below standards at 53 mg/L and 472 mg/L, respectively. The highest chloride and TDS concentrations were detected at Dominguez Dairy well LRG-00591-S at 1,200 mg/L and 3,370 mg/L, respectively. Chloride and TDS concentration ranges in the irrigation/supply wells are generally similar to the concentrations observed in discharge plan and abatement plan monitoring wells, further indicating that chloride and TDS concentrations observed are above standards regionally.

# 4.0 TREND ANALYSIS

Trend analysis can indicate whether concentrations of constituents such as nitrate, chloride and TDS are stable, increasing, or decreasing at a particular well (Gilbert 1987). Analytical data collected from all AP and DP wells sampled in 2022 were included in a statistical trend analysis using the Mann-Kendall test. The trend analysis is based on analytical data collected from November/December 2015 through the current quarter. Concentration trend graphs for nitrate, chloride, and TDS are found in Appendices E and F. The statistical trend analysis is provided in Appendix G. Table 7 provides a summary of the trend analysis for the AP and DP wells.

## 4.1 Northern Portion

Trend analysis was conducted on 34 wells within the northern portion. Seven DP wells were not analyzed for trend because they were dry or plugged and abandoned. Of the 34 wells analyzed, two wells had increasing trends for nitrate, chloride, and TDS: Organ Dairy well 126-04 and Dominguez 2 Dairy well 42-06. Stable or decreasing trends were present for all three constituents in 20 of the 34 wells.

Nitrate decreasing and increasing concentration trends are as follows:

- Decreasing Nitrate Trend: Northern Land Application Area well 86/340-01, Organ Dairy wells 126-05, 126-12, and 126-13, Mountain View Dairy well 70-04, Bright Star Dairy well 340-02, Dominguez 2 Dairy wells 42-02, 42-03 and 42-13, Dominguez Dairy wells 624-01 and 624-02, and AP wells DAD-02, DAD-11, DAD-12, and DAD-14.

- Increasing Nitrate Trend: Organ Dairy well 126-04, Bright Star Dairy well 340-01, Dominguez 2 Dairy wells 42-06, 42-10, and 42-12, Dominguez Dairy well 624-10, and AP wells DAD-01 and DAD-23.

Chloride decreasing and increasing concentration trends are as follows:

- Decreasing Chloride Trend: Northern Land Application Area wells 70-03 and 86/340-01, Dominguez 2 Dairy wells 42-10 and 42-12, Dominguez Dairy wells 624-01 and 624-02, and AP wells DAD-01, DAD-02, DAD-11 and DAD-14.

- Increasing Chloride Trend: Organ Dairy wells 126-04 and 126-07, Mountain View Dairy well 70-01, and Dominguez 2 Dairy wells 42-06, 42-08, and 42-11.

TDS decreasing and increasing concentration trends are as follows:

- Decreasing TDS Trend: Northern Land Application Area wells 70-03 and 70/86/340-01, Organ Dairy well 126-12, Mountain View Dairy well 70-02, Dominguez 2 Dairy wells 42-03 and 42-12, Dominguez Dairy wells 624-01, 624-02, and 624-10, and AP wells DAD-01, DAD-02, DAD-11, and DAD-14.

- Increasing TDS Trend: Organ Dairy wells 126-04, 126-07, and 126-13, Mountain View Dairy wells 70-01 and 70-04, and Dominguez 2 Dairy wells 42-06, 42-08, 42-10, and 42-11.

Upgradient Land Application Area well 70/86/340-01 had stable nitrate and chloride concentrations and decreasing concentrations of TDS. Upgradient well 86/340-01 had decreasing concentrations of nitrate and chloride and stable concentrations of TDS. Nitrate, chloride, and TDS in these wells are expected to stabilize as land application has been phased out.

The Dominguez 2 eastern boundary wells 42-10, 42-11, and 42-12 had mixed concentration trends; however, nitrate concentrations are below the standard. Wells 42-10 and 42-12 had increasing nitrate and decreasing chloride concentrations, while TDS trends were increasing in well 42-10 and decreasing in 42-12. Nitrate was stable in well 42-11, but chloride and TDS trends were increasing. AP eastern boundary well DAD-01 showed an increasing nitrate trend and decreasing chloride and TDS trends. The other AP eastern boundary well, DAD-13, showed stable trends for nitrate, chloride, and TDS concentrations.

The western boundary wells Dominguez Dairy 2 well 42-02 and Dominguez Dairy well 624-09 had nitrate concentrations below the standard, and show a decreasing and stable nitrate trend, respectively. Chloride and TDS trends are stable in both well 42-02 and well 624-09. Organ Dairy well 126-12 had decreasing concentrations of nitrate and TDS and stable concentrations of chloride.

The southern boundary wells for the northern area are AP wells DAD-14, DAD-23, and DAD-02. Both DAD-14 and DAD-02 wells show decreasing concentrations of nitrate, chloride, and TDS. DAD-23 had increasing trends for nitrate, but stable trends for chloride, and TDS concentrations.

## 4.2 Central Portion

A trend analysis was conducted on all 29 wells with adequate water for sampling within the central portion. Decreasing or stable trends for all three constituents were present in 16 of the 29 wells analyzed. Increasing trends for all three contaminants (nitrate, chloride, and TDS) were only present in Buena Vista Dairy II well 74-02 and AP well DAD-15.

A decreasing to stable nitrate trend was present in wells downgradient of seven of the nine lagoons in the central area. It is expected that similar trends will occur downgradient of all synthetically lined lagoons in the future.

Nitrate decreasing and increasing concentration trends are as follows:

- Decreasing Nitrate Trend: Buena Vista Dairy II well 74-04, Big Sky Dairy wells 833-07, 833-08, 833-09, and 833-10, Sunset Dairy well 257-01, and AP wells DAD-05, DAD-18, and DAD-25.

- Increasing Nitrate Trend: Buena Vista Dairy II well 74-02, Big Sky Dairy well 833-05, and AP wells DAD-04, DAD-07, and DAD-15.

Chloride decreasing and increasing concentration trends are as follows:

- Decreasing Chloride Trend: Buena Vista Dairy II well 74-03, Big Sky Dairy well 833-07, and AP wells DAD-03, DAD-05, DAD-08, and DAD-18.

- Increasing Chloride Trend: Buena Vista Dairy II wells 74-01, 74-02, 74-04, and 74-05, Big Sky Dairy wells 833-06 and 833-10, Sunset Dairy wells 257-01 and 257-03, and AP wells DAD-15 and DAD-24.

TDS decreasing and increasing concentration trends are as follows:

- Decreasing TDS Trend: Buena Vista Dairy II well 74-03, Big Sky Dairy wells 833-02, 833-07, and 833-09, Sunset Dairy well 257-01, and AP wells DAD-03, DAD-05, DAD-08, DAD-18, and DAD-25.

- Increasing TDS Trend: Buena Vista Dairy II wells 74-02, 74-04, and 74-05, Big Sky wells 833-06, and 833-10, Sunset Dairy well 257-03, and AP wells DAD-04, DAD-07, DAD-15, and DAD-24.

Upgradient wells Buena Vista Dairy well 74-03 and AP well DAD-03 had stable nitrate trends and decreasing trends for chloride and TDS. Eastern cross-gradient AP wells DAD-07 and DAD-15 had increasing trends for all constituents except for chloride in DAD-07, which was stable. Western cross-gradient wells 833-10 (Big Sky), DAD-04 (AP), and DAD-16 (AP) showed variable trends. Big Sky well 833-10 had decreasing nitrate concentrations and increasing trends for chloride and TDS. AP well DAD-04 had increasing nitrate and TDS concentrations and stable trends for chloride. AP well DAD-16 had stable trends for nitrate, chloride, and TDS.

Downgradient wells 257-02 (Sunset Dairy) and MW-4 (Former McAnally Enterprise) had stable concentrations for nitrate, chloride, and TDS. AP well DAD-25 had decreasing trends for nitrate and TDS, but stable concentrations of chloride.

## 4.3 Southern Portion

The southern portion statistical trend analysis was completed on all wells within the regional and perched aquifers. Of the 13 wells analyzed in the southern portion of the Dairies, six had decreasing or stable concentrations of nitrate, chloride, and TDS.

Within the regional aquifer, an increasing nitrate trend was observed in Del Oro Dairy wells

692-05, 692-06, and 692-09. Nitrate was above the standard in 692-05 and below the standard in wells 692-06 and 692-09. Chloride trends were decreasing or stable in all regional wells. TDS trends were increasing in Del Oro Dairy wells 692-05, 692-07, 692-08, and 692-09.

In the perched aquifer, statistical trend analysis indicated five of the seven wells had stable or decreasing trends for all analytes. Increasing trends were observed in AP well DAD-20 for TDS and in AP well DAD-21 for nitrate and TDS. Other analytes in these wells had stable concentration trends. Nitrate was above the standard and chloride and TDS were above existing conditions in both AP wells DAD-20 and DAD-21.

## 5.0 FIRST ORDER DECAY RATE

First order nitrate decay rates were calculated for wells where nitrate was detected above the standard and nitrate concentrations were exhibiting decreasing trends according to the Mann-Kendall trend analysis. The 1$^{st}$ order decay rates for monitored natural attenuation were calculated using an excel spreadsheet developed by the Utah Leaking Underground Storage Tank program, and is based on EPA's Ground Water Issue paper EPA/540/S-02/500, "Calculation and Use of First-Order Rate Constants for Monitored Natural Attenuation Studies," by Newell, Rifai, Wilson, Connor, Aziz and Suarez, November 2002. Decay rate spreadsheets are presented in Appendix H.

Decay rates were calculated for a total of 17 monitoring wells. Ten wells from the northern area and five wells from the central area, and two wells from the southern area perched aquifer were analyzed. A summary of the results of the decay rate analysis is presented in Table 8.

- Northern Area: Nitrate decay rates ranged from 0.0048 years$^{-1}$ to 0.1865 years$^{-1}$. These rates correspond to an average half-life of approximately 20 years. In these northern locations where groundwater attenuation is occurring, cleanup times averaging 21 years are expected.

- Central Area: Nitrate decay rates ranged from 0.0457 years$^{-1}$ to 0.0998 years$^{-1}$. The predicted average half-life was calculated as approximately 10 years and the average predicted cleanup time was calculated as approximately 21 years.

- Southern Area (Perched Aquifer): The nitrate decay rates for AP wells DAD-22 and DAD-26 were calculated as 0.1190 years$^{-1}$ and 0.3545 years$^{-1}$, respectively. The predicted average half-life was calculated as approximately 4 years and the average predicted cleanup time was calculated as approximately 5 years. Note that these wells were likely impacted by a nearby municipal water line release and that calculated decay rates may not be predictive of future trends.

## 6.0 GEOSTATISTICS

A geostatistical analysis was completed to estimate analyte distribution and calculate

contaminant plume area. Nitrate plumes were defined as areas where concentrations exceed the NMWQCC nitrate standard of 10 mg/L. Consistent with the Five-Year Review (EA 2020) and 2021 Annual Report (EA 2021a), chloride and TDS plumes were defined as areas exceeding the 2016 calculated background concentration. This historical background concentration was used to provide a consistent baseline from initiation of abatement for comparison of year over year changes.

Interpolation by kriging was applied to nitrate, chloride, and TDS concentrations from the February/March 2022 sampling event. Sunset Dairy well 257-03 could not be sampled due to a well obstruction during the most recent sampling event; as a result, September 2021 data were used. Additionally, vertical delineation wells and AP well DAD-25, which was likely completed in a perched aquifer, were excluded from the data set. In locations where plume edges were not defined by the model, isopleth lines were manually drawn using professional judgment. Central area chloride and TDS and southern area TDS in the regional aquifer were not modeled because concentrations were below 2016 regional background levels.

Table 9 provides the calculated areas of plumes in the north, central, and south portions for 2016 through 2022. Distributions of contaminants modeled from 2022 data are displayed in Figures 10 through 18. Note that the contaminant plume geometries were statistically modeled, and as a result, concentration intervals may be offset from measured concentrations at individual monitoring locations.

The following is a discussion of the trend analysis for each portion of the Dairy:

- Northern portion - The total size of the nitrate, chloride, and TDS plumes decreased by over 35% between 2016 and 2022. Though the overall size of the nitrate plume decreased substantially, the highest concentration portion of the plume expanded in the vicinity of Dominguez Dairy 2 well 42-06.

- Central portion - The chloride and TDS plumes decreased in size relative to the 2016 baseline. The size of the 2022 nitrate plume increased by less than 10%, and as a result is considered stable relative to 2016.

- Southern portion (regional aquifer) – The nitrate plume size has increased between 2016 and 2022. The chloride plume size has decreased. TDS has been stable and has not been detected above existing conditions.

- Southern portion (perched aquifer) – Nitrate and chloride plumes increased in total size between 2016 and 2022; the TDS plume size has decreased since 2016. Because of the distribution of contamination and monitoring wells, the modeled plume geometries in the perched aquifer required manual interpretation for large areas and are therefore limited in their ability to offer accurate comparisons from year to year. Additionally, plume configuration and size may be impacted by a nearby municipal water line leak that appears to have been repaired in the last year.

# 7.0 CONCLUSIONS AND RECOMMENDATIONS

The groundwater monitoring event included the gauging of all accessible DP and AP wells and sampling of 25 AP wells and the DP wells that were accessible and contained sufficient water to sample. Based on the data collected, the following conclusions and recommendations are presented:

- The depth to groundwater at the site ranged from 13.71 to 133.50 ft btoc.
- On average, groundwater levels increased relative to last quarter in the northern, central and southern portions of the regional aquifer. Groundwater elevations also increased in the southern perched aquifer.
- Groundwater flow direction in the northern area varied from east to southeast during the most recent gauging event.
- Flow in the central and southern area regional aquifer was to the southeast and flow in the southern perched aquifer was to the south-southwest.
- Hydraulic gradient in the regional aquifer was 0.001 ft/ft.
- The perched aquifer at Del Oro Dairy has a groundwater flow direction toward the south-southwest. The hydraulic gradient in the perched aquifer was approximately 0.004 ft/ft.
- Nitrate was below the NMWQCC standard of 10 mg/L in 11 of the 25 groundwater samples collected from the AP wells.
- Chloride was above the NMWQCC standard of 250 mg/L in all AP monitoring wells sampled, except for wells DAD-17 and DAD-25, which had chloride concentrations of 170 mg/L and 120 mg/L, respectively.
- TDS was above the NMWQCC standard of 1,000 mg/L in all monitoring wells sampled, except for wells DAD-17 and DAD-25, which had TDS concentrations of 985 mg/L and 840 mg/L, respectively.
- Chloride and TDS remain near or above NMWQCC standards in wells upgradient of the northern, central, and southern portions of the plume at the Dairies. Chloride and TDS are regionally elevated above standards and not necessarily attributed to the Dairies.
- Trend analysis indicates that 20 of the 34 wells analyzed in the northern portion had decreasing or stable trends for nitrate, chloride, and TDS.
- Trend analysis indicates that 16 of the 29 wells analyzed in the central portion had decreasing or stable trends for nitrate, chloride, and TDS.

- Trend analysis indicates that 6 of the 13 wells analyzed in the southern portion had decreasing or stable trends for nitrate, chloride, and TDS.

- Nitrate decay rates in the northern area ranged from 0.0048 $years^{-1}$ to 0.1865 $years^{-1}$. These rates correspond to an average half-life of approximately 20 years. In these northern locations where groundwater attenuation is occurring, cleanup times averaging 21 years are expected.

- In the central area, nitrate decay rates ranged from 0.0457 $years^{-1}$ to 0.0998 $years^{-1}$. The predicted average half-life was calculated at approximately 10 years and the predicted cleanup time was calculated as approximately 21 years.

- In the southern perched aquifer, nitrate decay rates for AP wells DAD-22 and DAD-26 were calculated as 0.1190 $years^{-1}$ and 0.3545 $years^{-1}$, respectively. The predicted average half-life was calculated as approximately 4 years and the average predicted cleanup time was calculated as approximately 5 years. Note that this well was likely impacted by a nearby municipal water line release and that calculated decay rates may not be predictive of future trends.

- The total size of the northern area nitrate, chloride, and TDS plumes decreased by over 35% between 2016 and 2022.

- The central area chloride and TDS plumes decreased in size relative to the 2016 baseline. The size of the 2022 nitrate plume increased by less than 10%, and as a result is considered stable relative to 2016.

- In the southern portion of the regional aquifer, the nitrate plume size has increased between 2016 and 2022. The chloride plume size has decreased. TDS has been stable and has not been detected above existing conditions.

- In the southern perched aquifer, nitrate and chloride plumes increased in total size between 2016 and 2022; the TDS plume size has decreased since 2016.

- The nitrate plume in the perched aquifer at Del Oro Dairy is not currently defined. A modified Abatement Plan proposal to address this has been approved by NMED and is being implemented.

- Implementation of the modified abatement plan proposal includes the removal of silt from AP well DAD-06 through redevelopment so that groundwater can be gauged and sampled.

## 8.0 REFERENCES

Doña Ana Dairies. 2006. Letter Regarding Agreement for Joint Stage 1 and Stage 2 Abatement Plan and Storm Water and Wastewater Pond Upgrades. Letter from Mr. Michael

Weatherly, Chairman, Doña Ana Dairies, to Mr. William Olson, Chief, Ground Water Quality Bureau. 30 October.

EA Engineering, Science, and Technology, Inc., PBC. (EA). 2009. Site Investigation Report, Dona Ana Dairies, Mesquite, New Mexico. 16 July.

EA. 2012a. Final Site Investigation Report, Dona Ana Dairies, Mesquite, New Mexico. 9 February.

EA. 2012b. Final Site Investigation Report Addendum, Dona Ana Dairies, Mesquite, New Mexico. 9 September.

EA. 2013a. Stage 2 Abatement Plan, Dona Ana Dairies, Mesquite, New Mexico. 13 March.

EA. 2013b. Stage 2 Abatement Plan, Revision 01, Dona Ana Dairies, Mesquite, New Mexico. 7 November.

EA. 2016. Stage 2 Implementation and Quarterly Groundwater Monitoring Report, Dona Ana Dairies, Mesquite, New Mexico. 26 July.

EA. 2019. Stage 2 Abatement Plan Modification Proposal and DAD-06 Monitoring Well Rehabilitation for Dona Ana Dairies, Dona Ana County, New Mexico, Revision 02. 26 July.

EA. 2020. Five-Year Evaluation and Quarterly Groundwater Monitoring Report, Dona Ana Dairies, Mesquite, New Mexico. 23 December.

EA. 2021a. Annual Groundwater Monitoring Report, Dona Ana Dairies, Mesquite, New Mexico. 29 May.

EA. 2021b. Stage 2 Abatement Plan Addendum for Reuse of Pumped Groundwater, Revision 02, Del Oro Dairy, Anthony, New Mexico. 13 July.

EA. 2022. Stage 2 Abatement Plan Modification Performance Plan for Dona Ana Dairies. 25 January.

Gilbert, R.O. 1987. Statistical Methods for Environmental Pollution Monitoring, New York: Van Nostrand Reinhold.

Golder Associates, Inc. (Golder). 2006. Stage 1 and 2 Abatement Plan Proposal, prepared for New Mexico Environment Department, Remediation Oversight Section, on behalf of Doña Ana Dairies. 11 December.

Golder. 2008a. Existing Data Report and Conceptual Work Plan, Doña Ana Dairies, Mesquite, New Mexico. 1 February.

Golder. 2008b. Conceptual Work Plan. Doña Ana Dairies, Mesquite, New Mexico. February 1.

Golder. 2008c. Notes for the Meeting Regarding New Monitoring Well Installation. Meeting Participants: Doña Ana Dairy representative, DAD technical representatives, and NMED staff. 28 July.

Golder. 2008d. Sampling and Analysis Plan. Doña Ana Dairies, Mesquite, New Mexico. 11 August.

New Mexico Environment Department (NMED). 2018. Stage 2 Abatement Plan Modification Required and DAD-06 Monitoring Well Replacement Required for Doña Ana Dairies, Doña Ana County, New Mexico. 12 June.

NMED. 2015. Approval of Stage 2 Abatement Plan Proposal for Doña Ana Dairies. Final Order from Mr. Ryan Flynn, Secretary, Ground Water Quality Bureau. 10 April.

NMED. 2008. Approval of Sampling and Analysis Plan for the Doña Ana Dairies, Stage 1 Abatement Plan, Doña Ana County, New Mexico. 25 September.

NMED, Doña Ana Dairies, and Rio Valle Concerned Citizens. 2015. Stipulated Agreement, Dona Ana Dairies Stage 2 Abatement Plan. 25 March.

Newell, C. J., H. S. Rifai, J. Wilson, J. A. Connor, J. A. Aziz, AND M. P. Suarez. 2002. Ground Water Issue - Calculation and Use of First-Order Rate Constants for Monitored Natural Attenuation Studies. U.S. Environmental Protection Agency, Washington, DC, EPA/540/S-02/500. November.