Luke Welch
Project Manager

Upstream Business Unit
Environmental Management Company
1400 Smith Street
Room 07069B
Houston, Texas 77002
Tel 713-372-0292
Luke.Welch@chevron.com

RECEIVED
By OCD District 1 at 9:27 am, Jun 08, 2015

December 19, 2014

Dr. Tomas Oberding
Environmental Specialist
New Mexico Oil Conservation Division
1625 N. French Dr.
Hobbs, New Mexico 88240

Re : Chevron Special Projects – VGSAU 15 (RP# 3255)

Dear Dr. Oberding,

Please find enclosed for your records, a copy of the final report documenting the assessment activities at the Vacuum Grayburg San Andres Unit No. 15 (RP #3255).

The report was prepared by Arcadis US, Inc. (Arcadis) on behalf of Chevron Environmental Management Company (CEMC) to document remedial activities performed for CEMC at the above referenced site. Please note in the report, Arcadis states the depth to groundwater is less than 100 feet, however this information was obtained from NMOSE records dating back over twenty years ago. Chevron has several environmental projects in the immediate vicinity and has measured groundwater depths in the last year ranging from 120 – 140 feet below grade surface..

The assessment activities identified several locations with soil impacts at levels of regulatory concern. To address these issues, CEMC proposes to conduct further remedial activities where practical, given the limitations of buried and overhead lines. Should you have any questions regarding the content of the report, please do not hesitate to contact me by phone at 713-372-0292 or via e-mail at luke.welch@chevron.com.

Sincerely,

Luke Welch
Environmental Project Manager

District I
1625 N. French Dr., Hobbs, NM 88240
District II
811 S. First St., Artesia, NM 88210
District III
1000 Rio Brazos Road, Aztec, NM 87410
District IV
1220 S. St. Francis Dr., Santa Fe, NM 87505

State of New Mexico
Energy Minerals and Natural Resources

Oil Conservation Division
1220 South St. Francis Dr.
Santa Fe, NM 87505

Form C-141
Revised August 8, 2011

Submit 1 Copy to appropriate District Office in accordance with 19.15.29 NMAC.

Release Notification and Corrective Action

OPERATOR

☐ Initial Report ☒ Final Report

Name of Company: CHEVRON U.S.A. Inc.	Contact: Luke Welch
Address: 56 Texas Camp Road, Lovington NM 88260	Telephone No.: Office: (713) 372-0292 Mobile: (832) 627-9171
Facility Name: Vacuum Grayburg San Andreas Well #15	Facility Type: Injection Well

Surface Owner: State of New Mexico	Mineral Owner:	API No. 3002524328

LOCATION OF RELEASE

Unit Letter	Section	Township	Range	Feet from the	North/South Line	Feet from the	East/West Line	County
J	2	18S	34E					Lea

Latitude 32.77344976° **Longitude** -103.5306191°

NATURE OF RELEASE

Type of Release: Spill to Land	Volume of Release: 207.64 bbls of produced water	Volume Recovered: 65 bbls
Source of Release: Failed well head nipple	Date and Hour of Occurrence: 8/14/11 08:30 AM	Date and Hour of Discovery: 8/15/11 8:15 AM
Was Immediate Notice Given? ☐ Yes ☐ No ☐ Not Required	If YES, To Whom? Geoffrey Leking	
By Whom? Josie DeLeon	Date and Hour: 8/17/11 3:30 PM	
Was a Watercourse Reached? ☐ Yes ☒ No	If YES, Volume Impacting the Watercourse.	

If a Watercourse was Impacted, Describe Fully.*
N/A

Describe Cause of Problem and Remedial Action Taken.*

2 ½" well head nipple failed due to corrosion resulting in 207.65 produced water spill.

Describe Area Affected and Cleanup Action Taken.*

A vacuum truck was called to recover the standing fluid and field team excavated up to 2' the visibly contaminated soil.

Three discrete soil confirmation samples were collected from the base of the excavation before the excavated area was reportedly backfilled with imported soils. These samples indicated the presence of chlorides at levels of regulatory concern.

In response to the sampling results, an additional site assessment was conducted to confirm the extent of soil impacts.

Results of the additional assessment activities are provided in the attached report.

I hereby certify that the information given above is true and complete to the best of my knowledge and understand that pursuant to NMOCD rules and regulations all operators are required to report and/or file certain release notifications and perform corrective actions for releases which may endanger public health or the environment. The acceptance of a C-141 report by the NMOCD marked as "Final Report" does not relieve the operator of liability should their operations have failed to adequately investigate and remediate contamination that pose a threat to ground water, surface water, human health or the environment. In addition, NMOCD acceptance of a C-141 report does not relieve the operator of responsibility for compliance with any other federal, state, or local laws and/or regulations.

Signature: Luke Welch	OIL CONSERVATION DIVISION	
Printed Name: Luke Welch	Approved by Environmental Specialist:	
Title: Project Manager	Approval Date:	Expiration Date:
E-mail Address: LWelch@chevron.com	Conditions of Approval:	Attached ☐
Date: 11-19-14 Phone: (713) 372-0292		

* Attach Additional Sheets If Necessary

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www.arcadis-us.com

ENVIRONMENT

Mr. Luke Welch
Project Manager
Chevron Environmental Management Company
1400 Smith Street, Room 07069B
Houston, Texas 77002

Subject:
Site Assessment Report
Vacuum Grayburg San Andres Unit Well #15
Lea County, New Mexico

Date:
December 2, 2014

Contact:
Jonathan Olsen

Phone:
713.953.4874

Email:
Jonathan.Olsen@arcadis-us.com

Our ref:
B0048602.0000

Dear Mr. Welch:

On behalf of Chevron Environmental Management Company (CEMC), ARCADIS U.S., Inc. (ARCADIS) prepared this Site Assessment Report (report) to document cleanup actions and soil sampling activities performed at the Vacuum Grayburg San Andres Unit Well #15 (VGSAU #15) located in Lea County, New Mexico (site; Figure 1). These activities were conducted in response to a release of approximately 207.64 barrels (bbls) of produced water that occurred on August 14, 2011.

To evaluate the potential for this release to impact groundwater, ARCADIS developed a Site Conceptual Model (SCM; Attachment 1). Based on the SCM, potential impacts to groundwater are not considered possible due to the following:

- Response activities included removal of liquids and impacted surface soil.
- Local conditions include low rainfall and high evapotranspiration, which minimize potential infiltration.
- The presence of a caliche layer impedes the vertical migration of liquids.
- Groundwater is encountered at significant depth (97 feet below ground surface [bgs]).
- Geochemical modeling using the United States Environmental Protection Agency (USEPA) Multimedia Exposure Assessment Model (MULTIMED) Version 2.0 (USEPA 1996) indicates that a significantly larger release would be necessary to cause an exceedance of regulatory criteria in groundwater.

This report describes spill response activities for the August 14, 2011 release and follow-up soil assessment activities conducted on May 17, 2013.

Background Information

This section summarizes the site location and description, as well as the regional setting including geology, hydrogeology, nearby drinking water wells, surface water, and climate.

Site Location and Description

The site is located within the Chevron-operated Vacuum Unit, approximately 14 miles southwest of Lovington, New Mexico. New Mexico Highway 238 is located approximately 2 miles east of the site.

The site is located in the western edge of the Permian Basin, a 75,000-square-mile area in west Texas and New Mexico that is populated by numerous oil and gas production wells. In New Mexico, the Permian Basin extends to Roosevelt County to the north and Chaves County to the west. Lovington (the closest town) is located approximately 14 miles northeast of the site and the closest agricultural area is 9 miles east of the site.

The site is located northeast of the VGSAU #15 wellhead. The release described in the following sections occurred in the field next to the well pad. A photo log of the site is included as Attachment 2.

Nearby Water Wells and Surface Water

Based on satellite imagery, no surface-water bodies were identified within 2 miles of the site (GoogleEarth 2014). In May 2013, ARCADIS field verified that there are no surface-water bodies are located within 1,000 feet of the site.

In September 2014, ARCADIS reviewed information obtained from the New Mexico Office of the State Engineer (NMOSE) online database (NMOSE 2011), which indicates that no water-supply wells are located within 1,000 feet of the site. The NMOSE online database identified 289 water-supply wells within a 5-mile radius of the site (NMOSE 2011). A petroleum-industry-related water-supply well, located approximately 2,060 feet southeast (i.e., hydraulically downgradient) of the site, was identified as the closest designated-use well to the site.

Climate

Monthly average temperatures near the site vary from a minimum of 27.9 degrees Fahrenheit (°F) in January to a maximum of 93.9°F in July (Western Regional Climate Center [WRCC] Hobbs, New Mexico [294026] weather station). Total average precipitation recorded for the area of the site from the available WRCC period of record between 1912 and 2013 was approximately 15.75 inches per year (WRCC 2014a).

Due to the arid climate, the site experiences low precipitation and high evapotranspiration rates. The total average evapotranspiration from the available WRCC period of record between 1914 and 2005 was approximately 87.68 inches per year (WRCC 2014b).

Regional Geology and Hydrogeology

The site elevation is approximately 4,010 feet above mean sea level. The site is located in the Querecho Plains immediately west of the Mescalero Ridge, which demarcates the western boundary of the (Miocene to Pliocene) High Plains Ogallala Formation (Reeves 1972). A rapid drop in elevation of 200 to 250 feet occurs west of the northwest-trending Mescalero Ridge. East of the ridge, the Ogallala Formation is predominantly composed of unconsolidated alluvial fan deposits of sand and gravel near the base, overlain by interbedded sand and clay in the upper portion (Seni 1980). Repeated depositional events on the High Plains surface beginning approximately 7 million years ago, followed by aerial exposure, generated a thick sequence of caliche horizons that are competent enough to act as a cliff for the expression of Mescalero Ridge. These hard caliche deposits form the upper portion of the stratigraphic sequence. In the site area, the Ogallala Formation is underlain by red beds of the Upper Triassic-age Dockum Group. The nearest area where the Ogallala is underlain by the Cretaceous-age Trinity Group is approximately 55 miles to the northwest (Fallin 1988).

The Querecho Plain is 80 percent covered by a moderately stable dune field (Reeves 1972) that is deposited on top of Triassic Dockum red beds. The red bed surface, which is 400,000 to 500,000 years old, is relatively flat with minor erosional incisions and a 3- to 13-foot-thick near-surface caliche layer (Bachman 1980). Deposition of sand and the formation of the dune field began 60,000 years ago, with additional development beginning 9,000 years ago (Hall 2002). The surface and interior of these dunes do not contain caliche; however, a 1-foot layer of caliche is common at the bottom of the dunes at the contact with the red bed surface. Groundwater in the area is in the Dockum Group at a depth of approximately 100 feet bgs (Summers

1972). Compared to the Ogallala Formation to the west of the site, the Dockum Group groundwater is not a major resource in the area, with poor potential water production rates and elevated natural dissolved solids.

Water-supply wells located on the southern High Plains east of Mescalero Ridge in central Lea County and near the site, as discussed in the Nearby Water Wells and Surface Water section of this report, are completed in the High Plains Aquifer (HPA). The HPA consists primarily of the Ogallala Formation, and in localized areas, alluvial sediment of Quaternary age. Near the site, the HPA is present directly above the Triassic-age Dockum Group, which occurs at a depth of approximately 140 feet bgs (Ash 1963, Fahlquist 2003, Nativ 1988, Nicholson and Clebsch 1961, Tillery 2008). The regional groundwater flow direction is to the east-southeast (Tillery 2008).

Groundwater near the site is encountered at a depth of approximately 97 feet bgs (NMOSE 2014; Attachment 3).

Initial Release Response Activities

A release of approximately 207.64 bbls of produced water occurred at the site on August 14, 2011 due to the failure of a corroded well head nipple. Chevron personnel from the Mid-Continent Business Unit (MCBU) stopped the release and recovered approximately 65 bbls of fluids using a vacuum truck. Chevron MCBU personnel excavated visually impacted soil in the area to a depth of approximately 2 feet bgs and collected three discrete confirmation soil samples from the base of the excavation on October 13, 2011. Information regarding the disposal of the excavated soil was not available to ARCADIS. After collecting the soil samples, the excavated area was reportedly backfilled with imported soil.

Pursuant to New Mexico Oil Conservation Division (NMOCD) requirements (NMOCD 1993), Josie DeLeon (Chevron MCBU) submitted a Notification of Release and Correction (Form C-141) detailing the location, volume of release, and initial and planned cleanup efforts taken for the site. The original and updated C-141 forms are included as Attachment 4.

Confirmation Soil Sampling

Three discrete confirmation soil samples were collected from the base of the excavation on October 13, 2011. As reported in the laboratory analytical report (Attachment 5), soil sample containers were transported on ice, under chain of custody procedures to Cardinal Laboratories Environmental Analytical Services for the following analyses:

- Benzene, toluene, ethylbenzene, and total xylenes (BTEX) by USEPA Method 8021B

- Total petroleum hydrocarbons as gasoline range organics (TPH-GRO) and total petroleum hydrocarbons as diesel range organics (TPH-DRO) by USEPA Method 8015M

- Chloride by USEPA Method SM4500Cl-B.

Confirmation soil sample results are presented in Table 1. The complete laboratory analytical results with chain of custody documentation are included in Attachment 5.

Data Evaluation Approach

Chevron MCBU personnel compared data from the three October 2011 confirmation soil samples to regulatory criteria to provide context for the concentrations of analytes detected and to evaluate if additional sampling was necessary. The regulatory criteria selected are based on potential receptors near the site and consist of the following:

- NMOCD risk-based soil remediation action levels (SRALs) for benzene, total BTEX, and total petroleum hydrocarbons (TPH) for leaks, spills, and releases (NMOCD 1993). SRALs were calculated using the NMOCD criteria presented in the tables below.

Criteria	Site-Specific Result	Ranking Score
Depth to groundwater	50 to 99 feet	10
Wellhead protection area	No	0
Distance to surface-water body	>1,000 feet	0
Total Ranking Score		**10**

SRALs	Benzene (mg/kg)	Total BTEX (mg/kg)	TPH (mg/kg)
	10	50	1,000

Note:
mg/kg = milligrams per kilogram

- New Mexico Administrative Code (NMAC) closure criteria for soil beneath belowgrade tanks, drying pads associated with closed-loop systems, and pits where contents have been removed (NMAC 2009).

Criteria	Site-Specific Result	Chloride (mg/kg)
Depth below bottom of pit to groundwater	50 to 100 feet	500

Confirmation Soil Sample Results

The analytical results for BTEX, TPH-GRO, TPH-DRO, and chloride for the three discrete confirmation soil samples collected in October 2011 are provided in Table 1 and summarized below:

- Benzene and BTEX were not detected above the laboratory reporting limits (LRLs) or above the SRALs of 10 and 50 mg/kg, respectively.
- TPH-GRO and TPH-DRO were not detected above LRLs.
- TPH (TPH-DRO and TPH-GRO) was not detected above the LRLs or above the SRAL of 1,000 mg/kg in the three discrete confirmation samples.
- Chloride was detected in all three confirmation samples, at concentrations ranging from 160 mg/kg (VGSAU #15 SS#3) to 19,800 mg/kg (VGSAU #15 SS#2). Chloride was detected above the NMAC closure criterion of 500 mg/kg in two of the three soil samples (VGSAU #15 SS#1 and VGSAU #15 SS#2).

The complete laboratory analytical results with chain of custody documentation are included in Attachment 5. Chloride concentrations in confirmation soil samples VGSAU #15 SS#1 and VGSAU #15 SS#2 were above the regulatory criteria, which prompted additional site assessment activities.

Site Assessment Activities

In May 2013, ARCADIS conducted site assessment activities to characterize the lateral and vertical extents of potential soil impacts at the site. Soil boring locations were selected based on the results of confirmation soil sampling completed at the site in October 2011, locations of pipelines and other equipment at the site, and the extent of the release as documented by Chevron MCBU personnel during the initial response activities. The site assessment activities and results are discussed below.

Pre-Field Activities

Prior to initiating field activities, ARCADIS updated the site-specific Health and Safety Plan in accordance with state and federal requirements. Prior to initiating drilling activities, underground utilities and other potential subsurface obstructions near the proposed boring locations were located and marked. A New Mexico One Call ticket was issued for the site, and a private third-party utility locator cleared all proposed boring locations for potential on- and off-site utilities that were not otherwise identified. Finally, ARCADIS staff conducted a visual inspection of the site to identify potential utility lines. Boring locations were flagged during the utility locate and coordinates were recorded using a Trimble® global positioning unit with differential capability.

Soil Sampling

To evaluate the potential extent of impacts to soil at the site, ARCADIS advanced seven soil borings (VGSAU 15-01, VGSAU 15-02, VGSAU 15-03, VGSAU 15-04, VGSAU 15-05, VGSAU 15-06, and VGSAU 15-07) on May 17, 2013. Soil sample locations are shown on Figure 2.

Prior to conducting drilling activities, each boring location was cleared for subsurface utilities with an air knife. The air knife could not be advanced more than 2 to 3 inches bgs due to the presence of a thick caliche layer. Each soil boring was then advanced to a total depth of approximately 30 feet bgs using air rotary drilling equipment.

Soil was continuously logged for stratigraphic characteristics. The soil samples were field screened for the presence of volatile organic compounds using a photo ionization detector (PID) in combination with visual and olfactory screening methods for evidence of petroleum hydrocarbons. The PID used during this investigation was calibrated daily with fresh air and isobutylene gas. Field personnel recorded PID readings, soil types, and other pertinent geologic data on the boring logs (Attachment 6). No staining or elevated PID readings were observed.

Lithologic data indicate that the subsurface material primarily consists of caliche (soil carbonate) profiles including “caprock,” nodular, and sandy caliche layers from approximately 0 to 30 feet bgs (Attachment 6).

Soil Assessment Sampling

Seven soil samples were collected from each boring location (for a total of 49 soil samples) beginning at a depth of 2 feet bgs (the approximate depth of the soil

excavation in the initial release response activities) and continuing at 5-foot intervals from 5 to 30 feet bgs.

The assessment soil samples were retained in clean, laboratory-supplied glass jars, labeled, placed in an ice-chilled cooler, and submitted under appropriate chain of custody protocols to TestAmerica Laboratories.

Soil samples collected from boring location VGSAU 15-07 were placed on hold pending analytical results from the other sample locations. Based on the analytical results, only three soil samples collected from boring location VGSAU 15-07 at depths of 2, 5, and 10 feet bgs were analyzed. A total of 45 out of the 49 soil assessment samples collected were analyzed.

Soil Assessment Sample Analysis

Soil samples collected from each boring were analyzed for chloride by USEPA Method 9056.

Boring Abandonment

Following sampling, the boreholes were filled with soil cuttings from the total depth to ground surface. The ground surface was restored to match the surrounding conditions.

Soil Assessment Comparison Criteria

To support site closure, ARCADIS developed a site-specific soil screening level (SSL) for chloride, by simulating unsaturated zone flow, transport, and saturated zone mixing of chloride using the MULTIMED model Version 2.0 (USEPA 1996). The NMAC chloride standard for domestic water supply of 250 milligrams per liter (NMAC 2001) was used to estimate a maximum allowable concentration of chloride in soil that would not leach to groundwater above the standard. The NMAC chloride standard is consistent with the National Secondary Drinking Water Standard for chloride, addressing taste and odor concerns (USEPA 2010).

Conservative site-specific input parameters were used in the MULTIMED (USEPA 1996) simulations compared to actual site and release conditions. Specifically:

- Modeled source lengths and areas modeled are generally significantly larger than the actual chloride-impacted soil areas.

- Chloride-impacted soil was modeled as having a uniform chloride concentration for the entire volume (i.e., area x depth) of specified soil.

- A reduction in chloride concentrations in subsurface soil due to soil chemical transformation or adsorption mechanisms was not included in the model calculations.

Based on the depth to groundwater and the aerial and vertical extents of each of the MULTIMED (USEPA 1996) simulations, with these conservative site-specific input parameters, modeled peak chloride concentrations will reach groundwater in approximately 540 to 860 years.

The Chloride MULTIMED Simulated Soil Screening Levels for the Protection of Groundwater memo is included as Attachment 7. The site-specific SSL was calculated using the input parameters presented in the table below.

Site-Specific Input Parameters	
Source length (m)	20
Source area (m^2)	400
Source depth (m)	0 to 1
Depth to groundwater (m)	20
Chloride SSL (mg/kg)	**100,000[1]**

Notes:
[1] A chloride SSL of 108,000 mg/kg was calculated using MUTLTIMED (USEPA 1996); however, a maximum allowable soil concentration of 100,000 mg/kg is recommended in accordance with the New Mexico Environment Department (NMED) risk assessment guidance (NMED 2012).
m = meter
m^2 = square meter

Soil Assessment Sample Results

The analytical results for chloride for the 45 soil assessment samples are provided in Table 1 and summarized below. Laboratory analytical results with chain of custody documentation are provided in Attachment 5.

Chloride was detected in 44 of the 45 soil samples, at concentrations ranging from 48 mg/kg (VGSAU 15-04 at 30 feet bgs) to 1,950 mg/kg (VGSAU 15-02 at 2 feet bgs). Chloride concentrations were not detected above the site-specific SSL of 100,000 mg/kg.

Summary and Conclusions

A release of approximately 207.64 bbls of produced water occurred at the site on August 14, 2011 due to a failure of a corroded well head nipple. Visually impacted soil was excavated to a depth of approximately 2 feet bgs and three discrete confirmation soil samples were collected from the base of the excavation in October 2011. Two confirmation soil samples had chloride concentrations above regulatory criteria, which prompted an additional investigation.

In May 2013, additional soil samples were collected to assess soil impacts within the observed aerial extent of the release. Soil samples collected during the May 2013 assessment had chloride concentrations below the site-specific SSL, which was calculated using the MULTIMED model (USEPA 1996).

All 45 soil assessment samples collected in May 2013, had chloride concentrations below the site-specific SSL and only four of the 45 soil assessment samples had chloride concentrations above 1,000 mg/kg (Table 1). Due to the location of this release along the pipeline corridor, remedial activities to address the minor exceedances above 1,000 mg/kg are not recommended due to health and safety concerns. Not all chloride concentrations were delineated to 250 mg/kg, however chloride impacts in shallow soil potentially associated with the release were delineated.

Potential migration of the remaining chloride to groundwater is not expected due to the small size of the release, low precipitation (WRCC 2014a), high evapotranspiration rates (WRCC 2014b), and fine-grained nature of caliche layers present beneath the site. MULTIMED model results demonstrate that the remaining soil concentrations associated with the release do not pose a significant risk to groundwater resources or other receptors.

Soil data presented in this report support a conclusion that impacted soil associated with the August 14, 2011 release at the site poses no significant threat to groundwater resources or other receptors. ARCADIS recommends that CEMC submit a request to the NMOCD that no further investigations or additional cleanup actions need to be performed at the site and that the NMOCD grant No Further Action status to the site.

If you have any questions or comments regarding the information presented in this report, please contact Jonathan Olsen at 713.953.4874 or at Jonathan.Olsen@arcadis-us.com, or Kathleen Abbott at 925.296.7827 or at Kathleen.Abbott@arcadis-us.com.

Sincerely,

ARCADIS U.S., Inc.

Jonathan Olsen
Certified Project Manager

Kathleen M. Abbott, PG
Program Manager

Enclosures:

Table 1	Soil Sampling Analytical Results
Figure 1	Site Location Map – VGSAU #15
Figure 2	Release and Soil Boring Locations – VGSAU #15

Attachments:

Attachment 1	Site Conceptual Model
Attachment 2	Photo Log
Attachment 3	New Mexico Office of the State Engineer – Depth to Water
Attachment 4	Release Notification and Corrective Action (C-141 Form)
Attachment 5	Laboratory Analytical Reports
Attachment 6	Boring Logs (May 2013)
Attachment 7	Chloride Multimedia Exposure Assessment Model Simulated Soil Screening Levels for the Protection of Groundwater Memo

References:

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ARCADIS

Table

Table 1
Soil Sampling Analytical Results

Site Assessment Report
Vacuum Grayburg San Andres Unit #15
Lea County, New Mexico

Boring Location ID	Sample Date	Sample Depth (feet bgs)	Benzene (mg/kg)	Toluene (mg/kg)	Ethylbenzene (mg/kg)	Total Xylenes (mg/kg)	Total BTEX (mg/kg)	TPH-GRO (mg/kg)	TPH-DRO (mg/kg)	Chloride (mg/kg)
		SRALs [a]	**10**	---	---	---	**50**	**1,000**		---
		NMAC Closure Criteria [b]	---	---	---	---	---	---	---	**500**
		MULTIMED Site-Specific SSL [c]	---	---	---	---	---	---	---	**100,000**
VGSAU #15 SS#1	10/13/2011	0	<0.050	<0.050	<0.050	<0.15	--	<10.0	<10.0	1,570
VGSAU #15 SS#2	10/13/2011	0	<0.050	<0.050	<0.050	<0.15	--	<10.0	<10.0	19,800
VGSAU #15 SS#3	10/13/2011	0	<0.050	<0.050	<0.050	<0.15	--	<10.0	<10.0	160
VGSAU 15 - 01	5/17/2013	2	--	--	--	--	--	--	--	512
	5/17/2013	5	--	--	--	--	--	--	--	480
	5/17/2013	10	--	--	--	--	--	--	--	768
	5/17/2013	15	--	--	--	--	--	--	--	1,010
	5/17/2013	20	--	--	--	--	--	--	--	688
	5/17/2013	25	--	--	--	--	--	--	--	640
	5/17/2013	30	--	--	--	--	--	--	--	560
VGSAU 15 - 02	5/17/2013	2	--	--	--	--	--	--	--	1,950
	5/17/2013	5	--	--	--	--	--	--	--	1,470
	5/17/2013	10	--	--	--	--	--	--	--	288
	5/17/2013	15	--	--	--	--	--	--	--	464
	5/17/2013	20	--	--	--	--	--	--	--	1,090
	5/17/2013	25	--	--	--	--	--	--	--	960
	5/17/2013	30	--	--	--	--	--	--	--	752
VGSAU 15 - 03	5/17/2013	2	--	--	--	--	--	--	--	352
	5/17/2013	5	--	--	--	--	--	--	--	688
	5/17/2013	10	--	--	--	--	--	--	--	464
	5/17/2013	15	--	--	--	--	--	--	--	640
	5/17/2013	20	--	--	--	--	--	--	--	800
	5/17/2013	25	--	--	--	--	--	--	--	960
	5/17/2013	30	--	--	--	--	--	--	--	848
VGSAU 15 - 04	5/17/2013	2	--	--	--	--	--	--	--	816
	5/17/2013	5	--	--	--	--	--	--	--	688
	5/17/2013	10	--	--	--	--	--	--	--	288
	5/17/2013	15	--	--	--	--	--	--	--	560
	5/17/2013	20	--	--	--	--	--	--	--	640
	5/17/2013	25	--	--	--	--	--	--	--	272
	5/17/2013	30	--	--	--	--	--	--	--	48
VGSAU 15 - 05	5/17/2013	2	--	--	--	--	--	--	--	592
	5/17/2013	5	--	--	--	--	--	--	--	864
	5/17/2013	10	--	--	--	--	--	--	--	128
	5/17/2013	15	--	--	--	--	--	--	--	416
	5/17/2013	20	--	--	--	--	--	--	--	64
	5/17/2013	25	--	--	--	--	--	--	--	64
	5/17/2013	30	--	--	--	--	--	--	--	64
VGSAU 15 - 06	5/17/2013	2	--	--	--	--	--	--	--	528
	5/17/2013	5	--	--	--	--	--	--	--	144
	5/17/2013	10	--	--	--	--	--	--	--	208
	5/17/2013	15	--	--	--	--	--	--	--	208
	5/17/2013	20	--	--	--	--	--	--	--	208
	5/17/2013	25	--	--	--	--	--	--	--	288
	5/17/2013	30	--	--	--	--	--	--	--	160
VGSAU 15 - 07	5/17/2013	2	--	--	--	--	--	--	--	512
	5/17/2013	5	--	--	--	--	--	--	--	528
	5/17/2013	10	--	--	--	--	--	--	--	<16

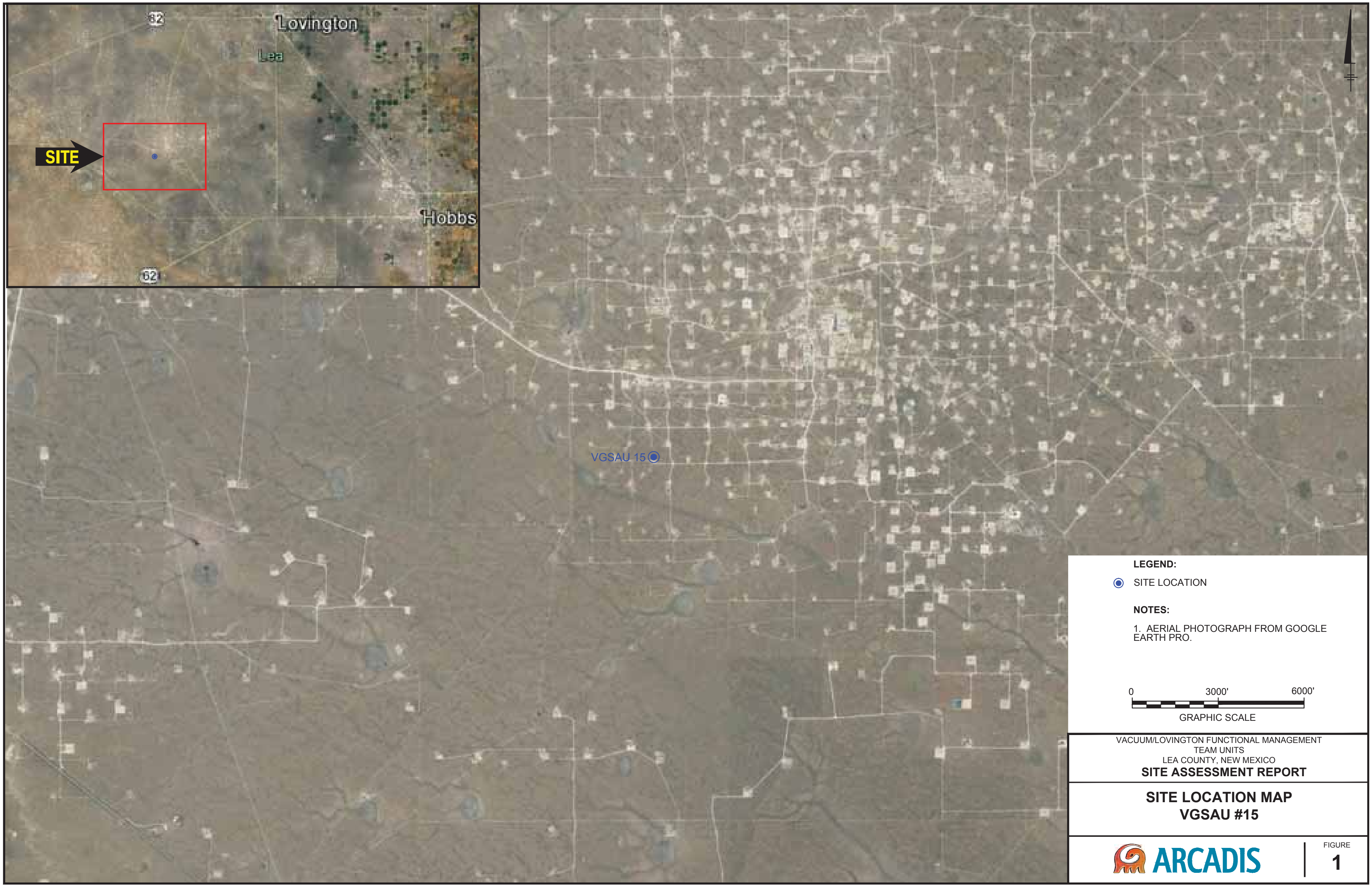
Notes:

%	Percent
mg/kg	Miligram(s) per kilogram
<	Analyte was not detected above the specified method reporting limit
--*	Information regarding the depth of these samples is not available.
--	Not Analyzed/Not Listed
bgs	Below ground surface
BTEX	Benzene, toluene, ethylbenzene, and total xylenes
MULTIMED	Multimedia Exposure Assessment Model
NMAC	New Mexico Administrative Code
TPH-GRO	Total Petroleum Hydrocarbons as Gasoline Range Organics
TPH-DRO	Total Petroleum Hydrocarbons as Diesel Range Organics
SRAL	Soil remediation action level
SSL	Soil screening level

(a) SRALs, for leaks, spills, and releases, New Mexico Oil Conservation Division, August 1993
(b) Title 19, Chapter 15 of the NMAC concerning pits, closed-loop systems, below grade tanks and sumps, and other alternative methods, 19.15.17 NMAC, Ju
(c) MULTIMED exposure assessment, 2.0 Beta, United States Environmental Protection Agency, October 1996

ARCADIS

Figures



LEGEND:

SITE LOCATION

NOTES:

1. AERIAL PHOTOGRAPH FROM GOOGLE EARTH PRO.

0 3000' 6000'

GRAPHIC SCALE

VACUUM/LOVINGTON FUNCTIONAL MANAGEMENT TEAM UNITS
LEA COUNTY, NEW MEXICO

SITE ASSESSMENT REPORT

SITE LOCATION MAP
VGSAU #15

ARCADIS

FIGURE 1

CITY: MANCHESTER DIV/GROUP: ENVCAD DB: B.SMALL PM: TM
G:\ENVCAD\Emeryville\RETURN-TO\Manchester-CT\B0048601\Final\B00486010000-B02.dwg LAYOUT: 2 SAVED: 11/15/2013 4:26 PM ACADVER: 18.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ---- PLOTTED: 11/15/2013 4:27 PM BY: REYES, ALEC

LEGEND:

- MAY 2013 ASSESSMENT SOIL SAMPLING LOCATION
- 1 OCTOBER 2011 CONFIRMATION SOIL SAMPLING LOCATION
- POTENTIAL UNDERGROUND UTILITY LINE NOT DETECTED BY THIRD PARTY SURVEYOR
- UNDERGROUND UTILITY LINE
- APPROXIMATE EXTENT OF SPILL

NOTES:

1. AERIAL PHOTOGRAPH FROM GOOGLE EARTH PRO.
2. COORDINATES FOR ALL MAY 2013 SAMPLE LOCATIONS WERE COLLECTED USING A SUB-METER TRIMBLE GPS UNIT.
3. UTILITIES WERE IDENTIFIED USING GROUND PENETRATING RADAR, RADIO FREQUENCY SURVEY OR VISUAL MEANS.

0 30' 60'

GRAPHIC SCALE

VACUUM/LOVINGTON FUNCTIONAL MANAGEMENT TEAM UNITS
LEA COUNTY, NEW MEXICO

SITE ASSESSMENT REPORT

RELEASE AND SOIL BORING LOCATIONS VGSAU #15

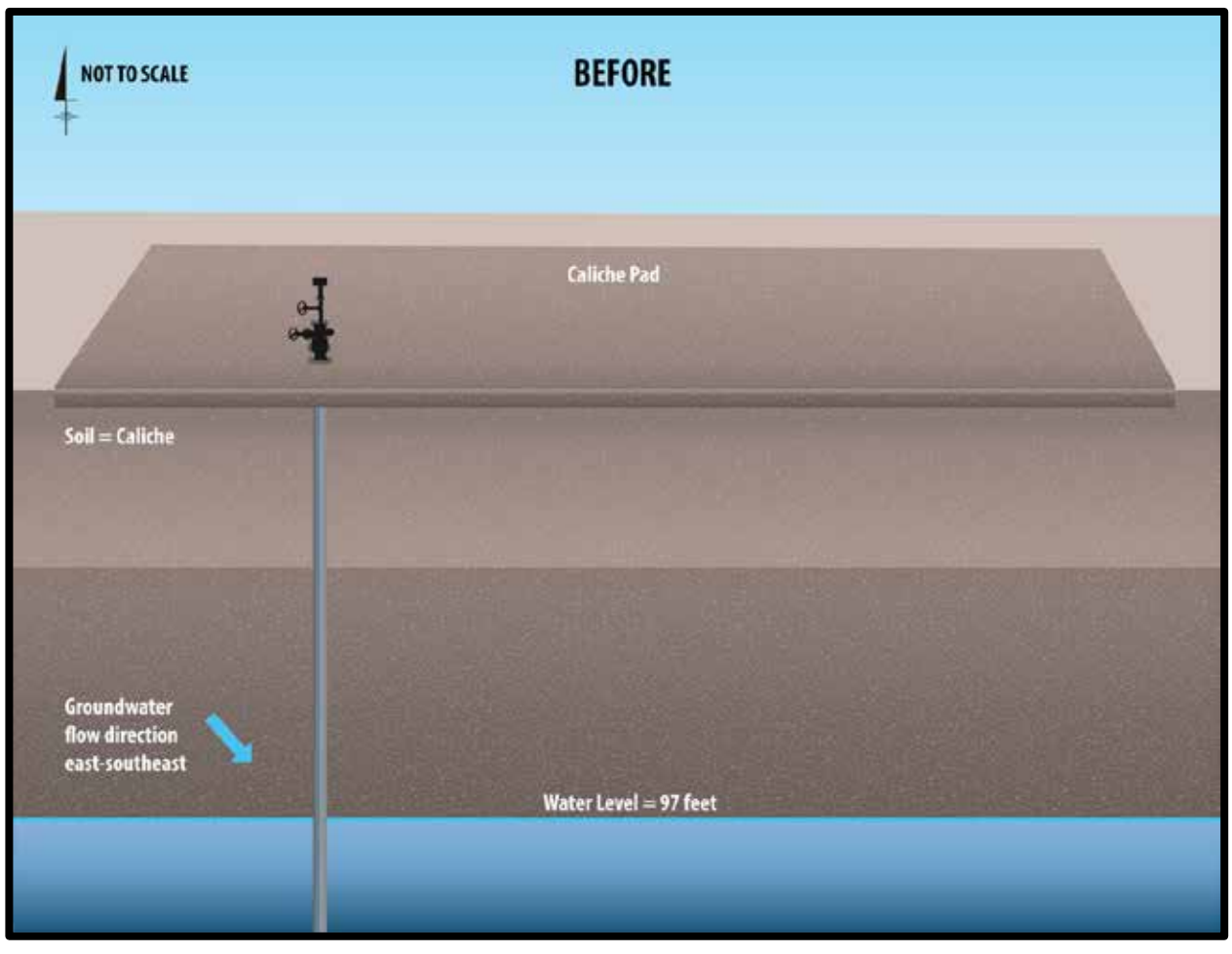
ARCADIS

FIGURE
2

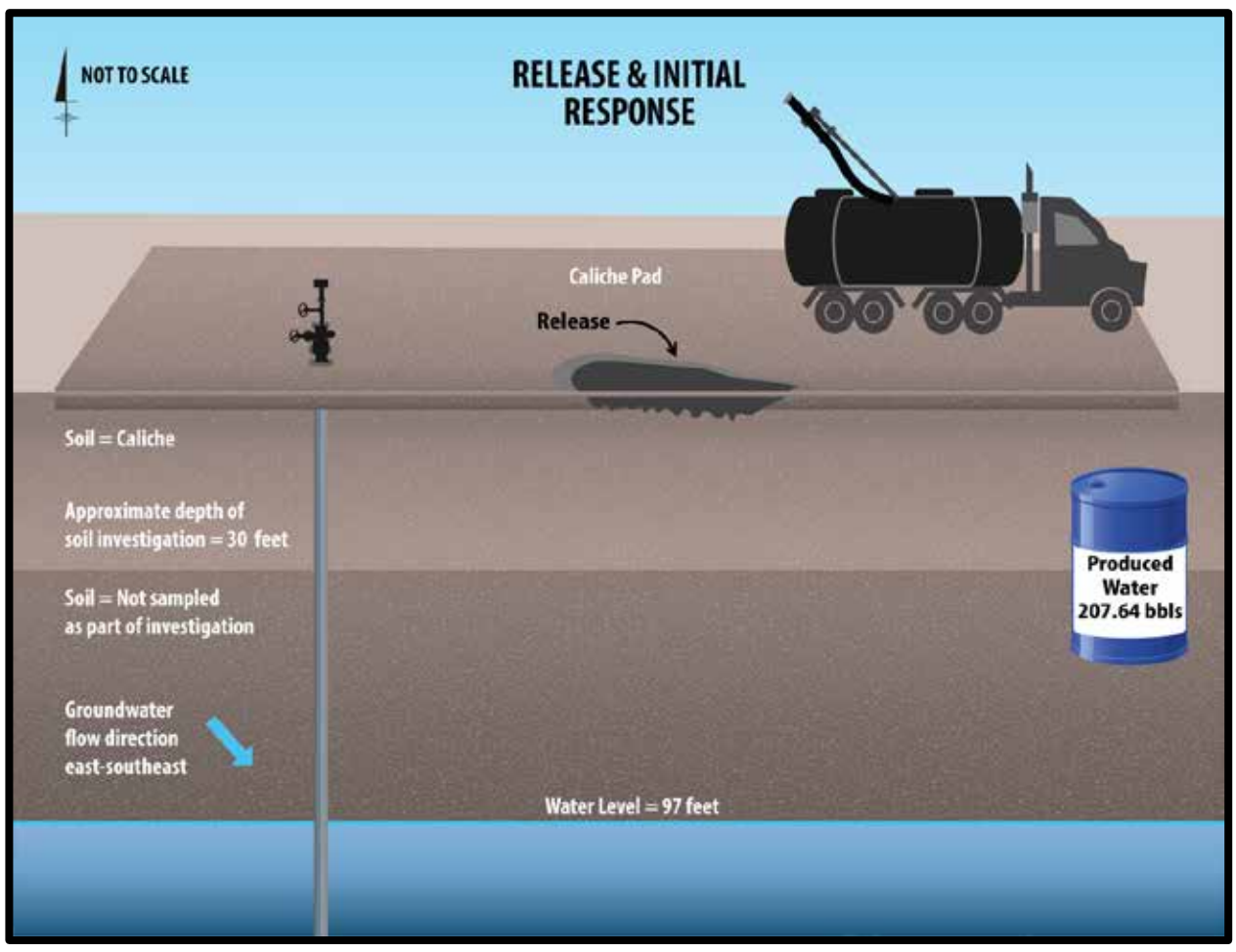
ARCADIS

Attachment 1

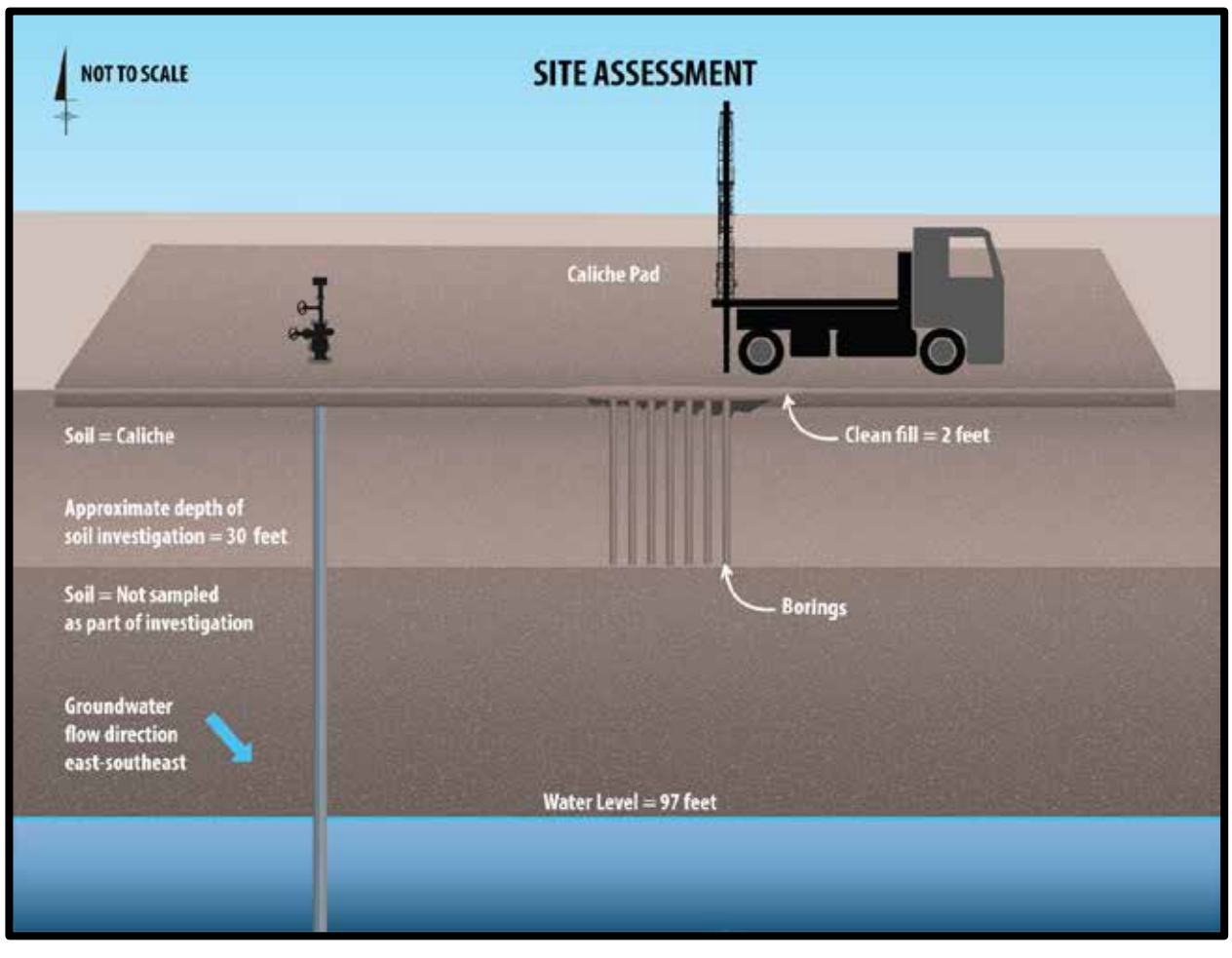
Site Conceptual Model



The site is located in the western edge of the Permian Basin with Lovington (the closest town) located approximately 14 miles northeast of the site. Due to the arid climate, the site experiences low precipitation and high evapotranspiration rates. According to information obtained from the NMOSE online database, groundwater near the site is encountered at a depth of approximately 97 feet bgs.



A release of approximately 207.64 bbls of produced water occurred at the site on August 14, 2011 due to the failure of a corroded weal head nipple. Chevron personnel from the Mid-Continent Business Unit (MCBU) stopped the release and recovered approximately 65 bbls of fluids using a vacuum truck. Chevron MCBU personnel excavated visually impacted soil in the area to a depth of approximately 2 feet bgs and collected three discrete confirmation soil samples from the base of the excavation on October 13, 2011. After collecting the soil samples, the excavated area was reportedly backfilled with imported soil. Analyte concentrations in one or more confirmation soil samples were above regulatory criteria, which prompted additional site assessment activities.



In May 2013, ARCADIS conducted site assessment activities to characterize the lateral and vertical extents of soil impacts at the site. Soil boring locations were selected based on the results of confirmation soil sampling completed at the site in October 2011, locations of pipelines and other equipment at the site, and the extent of the release as documented by Chevron MCBU personnel during the initial response activities. Analyte concentrations in samples collected during the 2013 assessment were reported below site-specific criteria. Site assessment activities demonstrate that remaining soil concentrations associated with the release do not pose significant risk to groundwater resources or other receptors.

VACUUM/LOVINGTON FUNCTIONAL MANAGEMENT TEAM UNITS
LEA COUNTY, NEW MEXICO
SITE ASSESSMENT REPORT

Site Conceptual Model
VGSAU #15

ARCADIS

FIGURE
1

ARCADIS

Attachment 2

Photolog

Photograph 1 – Vacuum Grayburg San Andres Unit Well #15; Facing Northeast

ARCADIS

Attachment 3

New Mexico Office of the State Engineer – Depth to Water

New Mexico Office of the State Engineer
Water Column/Average Depth to Water

(A CLW##### in the POD suffix indicates the POD has been replaced & no longer serves a water right file.)

(R=POD has been replaced, O=orphaned, C=the file is closed)

(quarters are 1=NW 2=NE 3=SW 4=SE)
(quarters are smallest to largest) (NAD83 UTM in meters) (In feet)

POD Number	POD Sub-basin	County	Q 64	Q 16	Q 4	Sec	Tws	Rng	X	Y	Distance	Depth Well	Depth Water	Water Column
L 02722 S3	L	LE		4	3	02	18S	34E	637374	3626892*	364			
L 05788 POD10	L	LE	4	4	1	02	18S	34E	637459	3627596*	502	240	100	140
L 05788 POD17	L	LE	4	4	1	02	18S	34E	637459	3627596*	502	240	97	143
L 05788 POD20	L	LE	1	3	2	02	18S	34E	637662	3627802*	670	240	96	144
L 05788 POD7	L	LE	1	3	2	02	18S	34E	637662	3627802*	670	240		
L 05788 POD19	L	LE	2	4	1	02	18S	34E	637459	3627796*	691	240	98	142
L 05885	L	LE		2	1	11	18S	34E	637380	3626489*	696	230	110	120
L 05788 POD11	L	LE	2	3	2	02	18S	34E	637862	3627802*	703	240	95	145
L 05788 POD16	L	LE	2	3	2	02	18S	34E	637862	3627802*	703	240	96	144
L 05788 POD6	L	LE	2	3	2	02	18S	34E	637862	3627802*	703	240	94	146
L 05788 POD9	L	LE	2	3	2	02	18S	34E	637862	3627802*	703	250	95	155

Average Depth to Water: **97 feet**

Minimum Depth: **94 feet**

Maximum Depth: **110 feet**

Record Count: 11

UTMNAD83 Radius Search (in meters):

Easting (X): 637649 **Northing (Y):** 3627131.22 **Radius:** 750

***UTM location was derived from PLSS - see Help**

ARCADIS

Attachment 4

Release Notification and Corrective Action (C-141 Form)

District I
1625 N. French Dr., Hobbs, NM 88240
District II
811 S. First St., Artesia, NM 88210
District III
1000 Rio Brazos Road, Aztec, NM 87410
District IV
1220 S. St. Francis Dr., Santa Fe, NM 87505

State of New Mexico
Energy Minerals and Natural Resources

Oil Conservation Division
1220 South St. Francis Dr.
Santa Fe, NM 87505

Form C-141
Revised August 8, 2011

Submit 1 Copy to appropriate District Office in accordance with 19.15.29 NMAC.

Release Notification and Corrective Action

OPERATOR

☐ Initial Report ☒ Final Report

Name of Company Chevron USA Inc.	Contact David Pagano
Address 56 Texas Camp Rd., Lovington NM 88260	Telephone No. 505-787-9816
Facility Name Vacuum Greyburg San Andreas Well #15	Facility Type Injection Well

Surface Owner State of New Mexico	Mineral Owner	API No. 3002524328

LOCATION OF RELEASE

Unit Letter	Section	Township	Range	Feet from the	North/South Line	Feet from the	East/West Line	County
J	2	18S	34E					Lea

Latitude 32.77344976 **Longitude** -103.5306191

NATURE OF RELEASE

Type of Release Spill to Land	Volume of Release 207.64 bbls of produced water	Volume Recovered 65 bbls
Source of Release Failed well head nipple	Date and Hour of Occurrence 8/14/2011 08:30 AM	Date and Hour of Discovery 8/15/2011 8:15 AM
Was Immediate Notice Given? ☐ Yes ☐ No ☐ Not Required	If YES, To Whom? Geoffrey Leking	
By Whom? Josie DeLeon	Date and Hour 8/17/2011 3:30:00 PM	
Was a Watercourse Reached? ☐ Yes ☒ No	If YES, Volume Impacting the Watercourse.	

If a Watercourse was Impacted, Describe Fully.*

Describe Cause of Problem and Remedial Action Taken.*
2 1/2" well head nipple failed due to corrosion resulting in 207.65 produced water spill.

Describe Area Affected and Cleanup Action Taken.*
Vacuum truck pick up standing fluid and excavated up to 2' the visibly contaminated soil. 3 Spot Samples were collected on 10/14/12 all resulting in > then the reporting limits for Chlorides with the highest amount = 19,800. Remediation turned over to the Chevron Environmental Management Company.

I hereby certify that the information given above is true and complete to the best of my knowledge and understand that pursuant to NMOCD rules and regulations all operators are required to report and/or file certain release notifications and perform corrective actions for releases which may endanger public health or the environment. The acceptance of a C-141 report by the NMOCD marked as "Final Report" does not relieve the operator of liability should their operations have failed to adequately investigate and remediate contamination that pose a threat to ground water, surface water, human health or the environment. In addition, NMOCD acceptance of a C-141 report does not relieve the operator of responsibility for compliance with any other federal, state, or local laws and/or regulations.

Signature: David Pagano	OIL CONSERVATION DIVISION
Printed Name: David A. Pagano	Approved by Environmental Specialist:
Title: Health & Environmental Specialist	Approval Date: / Expiration Date:
E-mail Address: dpgn@chevron.com	Conditions of Approval: / Attached ☐
Date: 3/12/12 Phone: 505-787-9816	

* Attach Additional Sheets If Necessary

District I
1625 N. French Dr., Hobbs, NM 88240
District II
811 S. First St., Artesia, NM 88210
District III
1000 Rio Brazos Road, Aztec, NM 87410
District IV
1220 S. St. Francis Dr., Santa Fe, NM 87505

State of New Mexico
Energy Minerals and Natural Resources

Oil Conservation Division
1220 South St. Francis Dr.
Santa Fe, NM 87505

Form C-141
Revised August 8, 2011

Submit 1 Copy to appropriate District Office in accordance with 19.15.29 NMAC.

Release Notification and Corrective Action

OPERATOR

☐ Initial Report ☒ Final Report

Name of Company: CHEVRON U.S.A. Inc.	Contact: Luke Welch
Address: 56 Texas Camp Road, Lovington NM 88260	Telephone No.: Office: (713) 372-0292 Mobile: (832) 627-9171
Facility Name: Vacuum Grayburg San Andreas Well #15	Facility Type: Injection Well

Surface Owner: State of New Mexico	Mineral Owner:	API No. 3002524328

LOCATION OF RELEASE

Unit Letter	Section	Township	Range	Feet from the	North/South Line	Feet from the	East/West Line	County
J	2	18S	34E					Lea

Latitude 32.77344976° **Longitude** -103.5306191°

NATURE OF RELEASE

Type of Release: Spill to Land	Volume of Release: 207.64 bbls of produced water	Volume Recovered: 65 bbls
Source of Release: Failed well head nipple	Date and Hour of Occurrence: 8/14/11 08:30 AM	Date and Hour of Discovery: 8/15/11 8:15 AM
Was Immediate Notice Given? ☐ Yes ☐ No ☐ Not Required	If YES, To Whom? Geoffrey Leking	
By Whom? Josie DeLeon	Date and Hour: 8/17/11 3:30 PM	
Was a Watercourse Reached? ☐ Yes ☒ No	If YES, Volume Impacting the Watercourse.	

If a Watercourse was Impacted, Describe Fully.*
N/A

Describe Cause of Problem and Remedial Action Taken.*

2 ½" well head nipple failed due to corrosion resulting in 207.65 produced water spill.

Describe Area Affected and Cleanup Action Taken.*

A vacuum truck was called to recover the standing fluid and field team excavated up to 2' the visibly contaminated soil.

Three discrete soil confirmation samples were collected from the base of the excavation before the excavated area was reportedly backfilled with imported soils. These samples indicated the presence of chlorides at levels of regulatory concern.

In response to the sampling results, an additional site assessment was conducted to confirm the extent of soil impacts.

Results of the additional assessment activities are provided in the attached report.

I hereby certify that the information given above is true and complete to the best of my knowledge and understand that pursuant to NMOCD rules and regulations all operators are required to report and/or file certain release notifications and perform corrective actions for releases which may endanger public health or the environment. The acceptance of a C-141 report by the NMOCD marked as "Final Report" does not relieve the operator of liability should their operations have failed to adequately investigate and remediate contamination that pose a threat to ground water, surface water, human health or the environment. In addition, NMOCD acceptance of a C-141 report does not relieve the operator of responsibility for compliance with any other federal, state, or local laws and/or regulations.

Signature: Luke Welch	OIL CONSERVATION DIVISION	
Printed Name: Luke Welch	Approved by Environmental Specialist:	
Title: Project Manager	Approval Date:	Expiration Date:
E-mail Address: LWelch@chevron.com	Conditions of Approval:	Attached ☐
Date: 11-19-14 Phone: (713) 372-0292		

* Attach Additional Sheets If Necessary

ARCADIS

Attachment 5

Laboratory Analytical Reports

CARDINAL Laboratories

PHONE (575) 393-2326 ° 101 E. MARLAND ° HOBBS, NM 88240

October 20, 2011

DAVID PAGANO

Chevron - Lovington

HCR 60 Box 423

Lovington, NM 88260

RE: SOIL SAMPLES

Enclosed are the results of analyses for samples received by the laboratory on 10/14/11 15:17.

Cardinal Laboratories is accredited through Texas NELAP for:

Method SW-846 8021	Benzene, Toluene, Ethyl Benzene, and Total Xylenes
Method SW-846 8260	Benzene, Toluene, Ethyl Benzene, and Total Xylenes
Method TX 1005	Total Petroleum Hydorcarbons

Certificate number T104704398-08-TX. Accreditation applies to solid and chemical materials and non-potable water matrices.

Cardinal Laboratories is accreditated through the State of Colorado Department of Public Health and Environment for:

Method EPA 552.2	Haloacetic Acids (HAA-5)
Method EPA 524.2	Total Trihalomethanes (TTHM)
Method EPA 524.4	Regulated VOCs (V2, V3)

Accreditation applies to public drinking water matrices.

This report meets NELAP requirements and is made up of a cover page, analytical results, and a copy of the original chain-of-custody. If you have any questions concerning this report, please feel free to contact me.

Sincerely,

Celey D. Keene

Celey D. Keene

Lab Director/Quality Manager

CARDINAL Laboratories

PHONE (575) 393-2326 ° 101 E. MARLAND ° HOBBS, NM 88240

Analytical Results For:

Chevron - Lovington
DAVID PAGANO
HCR 60 Box 423
Lovington NM, 88260
Fax To: None

Received:	10/14/2011	Sampling Date:	10/13/2011
Reported:	10/20/2011	Sampling Type:	Soil
Project Name:	SOIL SAMPLES	Sampling Condition:	** (See Notes)
Project Number:	VGSAU #15	Sample Received By:	Celey D. Keene
Project Location:	NOT GIVEN		

Sample ID: VGSAU #15 SS #1 (H102228-01)

BTEX 8021B mg/kg Analyzed By: cms

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Benzene*	<0.050	0.050	10/19/2011	ND	2.06	103	2.00	2.26	
Toluene*	<0.050	0.050	10/19/2011	ND	2.03	101	2.00	3.33	
Ethylbenzene*	<0.050	0.050	10/19/2011	ND	2.02	101	2.00	4.01	
Total Xylenes*	<0.150	0.150	10/19/2011	ND	6.03	101	6.00	4.41	

Surrogate: 4-Bromofluorobenzene (PIL *109 %* *64.4-134*

Chloride, SM4500Cl-B mg/kg Analyzed By: HM

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**1570**	16.0	10/18/2011	ND	448	112	400	3.64	

TPH 8015M mg/kg Analyzed By: AB

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
GRO C6-C10	<10.0	10.0	10/18/2011	ND	172	85.9	200	4.35	
DRO >C10-C28	<10.0	10.0	10/18/2011	ND	157	78.6	200	6.92	

Surrogate: 1-Chlorooctane *83.2 %* *55.5-154*

Surrogate: 1-Chlorooctadecane *90.3 %* *57.6-158*

Cardinal Laboratories *=Accredited Analyte

Celey D. Keene

Celey D. Keene, Lab Director/Quality Manager

CARDINAL Laboratories

PHONE (575) 393-2326 ° 101 E. MARLAND ° HOBBS, NM 88240

Analytical Results For:

Chevron - Lovington
DAVID PAGANO
HCR 60 Box 423
Lovington NM, 88260
Fax To: None

Received:	10/14/2011	Sampling Date:	10/13/2011
Reported:	10/20/2011	Sampling Type:	Soil
Project Name:	SOIL SAMPLES	Sampling Condition:	** (See Notes)
Project Number:	VGSAU #15	Sample Received By:	Celey D. Keene
Project Location:	NOT GIVEN		

Sample ID: VGSAU #15 SS #2 (H102228-02)

BTEX 8021B mg/kg **Analyzed By: cms**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Benzene*	<0.050	0.050	10/19/2011	ND	2.06	103	2.00	2.26	
Toluene*	<0.050	0.050	10/19/2011	ND	2.03	101	2.00	3.33	
Ethylbenzene*	<0.050	0.050	10/19/2011	ND	2.02	101	2.00	4.01	
Total Xylenes*	<0.150	0.150	10/19/2011	ND	6.03	101	6.00	4.41	

Surrogate: 4-Bromofluorobenzene (PIL *103 %* *64.4-134*

Chloride, SM4500Cl-B mg/kg **Analyzed By: HM**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**19800**	16.0	10/18/2011	ND	448	112	400	3.64	

TPH 8015M mg/kg **Analyzed By: AB**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
GRO C6-C10	<10.0	10.0	10/18/2011	ND	172	85.9	200	4.35	
DRO >C10-C28	<10.0	10.0	10/18/2011	ND	157	78.6	200	6.92	

Surrogate: 1-Chlorooctane *68.4 %* *55.5-154*

Surrogate: 1-Chlorooctadecane *70.1 %* *57.6-158*

Cardinal Laboratories *=Accredited Analyte

Celey D. Keene

Celey D. Keene, Lab Director/Quality Manager

CARDINAL Laboratories

PHONE (575) 393-2326 ° 101 E. MARLAND ° HOBBS, NM 88240

Analytical Results For:

Chevron - Lovington
DAVID PAGANO
HCR 60 Box 423
Lovington NM, 88260
Fax To: None

Received:	10/14/2011	Sampling Date:	10/13/2011
Reported:	10/20/2011	Sampling Type:	Soil
Project Name:	SOIL SAMPLES	Sampling Condition:	** (See Notes)
Project Number:	VGSAU #15	Sample Received By:	Celey D. Keene
Project Location:	NOT GIVEN		

Sample ID: VGSAU #15 SS #3 (H102228-03)

BTEX 8021B mg/kg Analyzed By: cms

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Benzene*	<0.050	0.050	10/19/2011	ND	2.06	103	2.00	2.26	
Toluene*	<0.050	0.050	10/19/2011	ND	2.03	101	2.00	3.33	
Ethylbenzene*	<0.050	0.050	10/19/2011	ND	2.02	101	2.00	4.01	
Total Xylenes*	<0.150	0.150	10/19/2011	ND	6.03	101	6.00	4.41	

Surrogate: 4-Bromofluorobenzene (PIL *103 %* *64.4-134*

Chloride, SM4500Cl-B mg/kg Analyzed By: HM

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**160**	16.0	10/18/2011	ND	448	112	400	3.64	

TPH 8015M mg/kg Analyzed By: AB

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
GRO C6-C10	<10.0	10.0	10/18/2011	ND	172	85.9	200	4.35	
DRO >C10-C28	<10.0	10.0	10/18/2011	ND	157	78.6	200	6.92	

Surrogate: 1-Chlorooctane *83.2 %* *55.5-154*

Surrogate: 1-Chlorooctadecane *78.8 %* *57.6-158*

Cardinal Laboratories *=Accredited Analyte

Celey D. Keene

Celey D. Keene, Lab Director/Quality Manager

CARDINAL Laboratories

PHONE (575) 393-2326 ° 101 E. MARLAND ° HOBBS, NM 88240

Notes and Definitions

ND	Analyte NOT DETECTED at or above the reporting limit
RPD	Relative Percent Difference
**	Samples not received at proper temperature of 6°C or below.
***	Insufficient time to reach temperature.
-	Chloride by SM4500Cl-B does not require samples be received at or below 6°C
	Samples reported on an as received basis (wet) unless otherwise noted on report

Cardinal Laboratories

*=Accredited Analyte

Celey D. Keene

Celey D. Keene, Lab Director/Quality Manager

CARDINAL Laboratories

CHAIN-OF-CUSTODY AND ANALYSIS REQUEST

101 East Marland, Hobbs, NM 88240
(575) 393-2326 FAX (575) 393-2476

Company Name: Chevron	**BILL TO**
Project Manager: David Pagano	P.O. #:
Address: 56 Texas Camp Rd.	Company: Chevron
City: Lovington State: NM Zip: 88260	Attn: Nick Moschetti
Phone #: 505-787-9816 Fax #:	Address: 56 Texas Camp Rd.
Project #: Project Owner:	City: Lovington
Project Name:	State: NM Zip: 88260
Project Location:	Phone #: 575-396-4414 x201
Sampler Name:	Fax #:

FOR LAB USE ONLY Lab I.D.	Sample I.D.	(G)RAB OR (C)OMP.	# CONTAINERS	MATRIX: GROUNDWATER	WASTEWATER	SOIL	OIL	SLUDGE	OTHER:	PRESERV.: ACID/BASE:	ICE / COOL	OTHER:	SAMPLING: DATE	TIME	ANALYSIS REQUEST: TPH	BTEX	Chlorides
H10228 01	VGSAU #15 SS#1	✓	1			✓							10-13-11	10:30	✓	✓	✓
02	VGSAU #15 SS#2	✓	1			✓					None		1	10:35	✓	✓	✓
03	VGSAU #15 SS#3	✓	1			✓								10:40	✓	✓	✓

Relinquished By:	Date:	Received By:	Phone Result: ☐ Yes ☐ No	Add'l Phone #:
	Time:		Fax Result: ☐ Yes ☐ No	Add'l Fax #:
Relinquished By: David Pagano	Date: 10/14/11 Time: 3:17p	Received By: Chris Green	REMARKS:	
Delivered By: (Circle One) Sampler - UPS - Bus - Other:	7°C	Sample Condition Cool: ☐ Yes ☑ No Intact: ☑ Yes ☐ No	CHECKED BY: (Initials) cok	

† Cardinal cannot accept verbal changes. Please fax written changes to 505-393-2476

#26

CARDINAL Laboratories

PHONE (575) 393-2326 ° 101 E. MARLAND ° HOBBS, NM 88240

June 18, 2013

JONATHAN OLSEN

ARCADIS U.S., INC. - HOUSTON

630 PLAZA DRIVE, SUITE 600

HIGHLANDS RANCH, CO 80129

RE: CHEVRON BUCKEYE

Enclosed are the results of analyses for samples received by the laboratory on 05/17/13 16:00.

Cardinal Laboratories is accredited through Texas NELAP under certificate number T104704398-11-3. Accreditation applies to drinking water, non-potable water and solid and chemical materials. All accredited analytes are denoted by an asterisk (*). For a complete list of accredited analytes and matrices visit the TCEQ website at www.tceq.texas.gov/field/qa/lab_accred_certif.html.

Cardinal Laboratories is accreditated through the State of Colorado Department of Public Health and Environment for:

Method EPA 552.2	Haloacetic Acids (HAA-5)
Method EPA 524.2	Total Trihalomethanes (TTHM)
Method EPA 524.4	Regulated VOCs (V1, V2, V3)

Accreditation applies to public drinking water matrices.

This report meets NELAP requirements and is made up of a cover page, analytical results, and a copy of the original chain-of-custody. If you have any questions concerning this report, please feel free to contact me.

Sincerely,

Celey D. Keene

Celey D. Keene

Lab Director/Quality Manager

CARDINAL Laboratories

PHONE (575) 393-2326 ° 101 E. MARLAND ° HOBBS, NM 88240

Analytical Results For:

ARCADIS U.S., INC. - HOUSTON
JONATHAN OLSEN
630 PLAZA DRIVE, SUITE 600
HIGHLANDS RANCH CO, 80129
Fax To: (713) 977-4620

Received:	05/17/2013	Sampling Date:	05/17/2013
Reported:	06/18/2013	Sampling Type:	Soil
Project Name:	CHEVRON BUCKEYE	Sampling Condition:	Cool & Intact
Project Number:	B004860.0000	Sample Received By:	Jodi Henson
Project Location:	BUCKEYE OILFIELD		

Sample ID: VGSAU 15 - 01 (2') (H301196-01)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: DW**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**512**	16.0	05/20/2013	ND	416	104	400	0.00	

Sample ID: VGSAU 15 - 01 (5') (H301196-02)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: DW**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**480**	16.0	05/20/2013	ND	416	104	400	0.00	

Sample ID: VGSAU 15 - 01 (10') (H301196-03)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: DW**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**768**	16.0	05/20/2013	ND	416	104	400	0.00	

Sample ID: VGSAU 15 - 01 (15') (H301196-04)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: DW**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**1010**	16.0	05/20/2013	ND	416	104	400	0.00	

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Celey D. Keene

Celey D. Keene, Lab Director/Quality Manager

CARDINAL Laboratories

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Analytical Results For:

ARCADIS U.S., INC. - HOUSTON
JONATHAN OLSEN
630 PLAZA DRIVE, SUITE 600
HIGHLANDS RANCH CO, 80129
Fax To: (713) 977-4620

Received:	05/17/2013	Sampling Date:	05/17/2013
Reported:	06/18/2013	Sampling Type:	Soil
Project Name:	CHEVRON BUCKEYE	Sampling Condition:	Cool & Intact
Project Number:	B004860.0000	Sample Received By:	Jodi Henson
Project Location:	BUCKEYE OILFIELD		

Sample ID: VGSAU 15 - 01 (20') (H301196-05)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: DW**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**688**	16.0	05/20/2013	ND	416	104	400	0.00	

Sample ID: VGSAU 15 - 01 (25') (H301196-06)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: DW**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**640**	16.0	05/20/2013	ND	416	104	400	0.00	

Sample ID: VGSAU 15 - 01 (30') (H301196-07)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: DW**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**560**	16.0	05/20/2013	ND	432	108	400	0.00	

Sample ID: VGSAU 15 - 03 (2') (H301196-08)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: DW**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**352**	16.0	05/20/2013	ND	432	108	400	0.00	

Sample ID: VGSAU 15 - 03 (5') (H301196-09)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: DW**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**688**	16.0	05/20/2013	ND	432	108	400	0.00	

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Celey D. Keene, Lab Director/Quality Manager

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Analytical Results For:

ARCADIS U.S., INC. - HOUSTON
JONATHAN OLSEN
630 PLAZA DRIVE, SUITE 600
HIGHLANDS RANCH CO, 80129
Fax To: (713) 977-4620

Received:	05/17/2013	Sampling Date:	05/17/2013
Reported:	06/18/2013	Sampling Type:	Soil
Project Name:	CHEVRON BUCKEYE	Sampling Condition:	Cool & Intact
Project Number:	B004860.0000	Sample Received By:	Jodi Henson
Project Location:	BUCKEYE OILFIELD		

Sample ID: VGSAU 15 - 03 (10') (H301196-10)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: DW**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**464**	16.0	05/20/2013	ND	432	108	400	0.00	

Sample ID: VGSAU 15 - 03 (15') (H301196-11)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: DW**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**640**	16.0	05/20/2013	ND	432	108	400	0.00	

Sample ID: VGSAU 15 - 03 (20') (H301196-12)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: DW**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**800**	16.0	05/20/2013	ND	432	108	400	0.00	

Sample ID: VGSAU 15 - 03 (25') (H301196-13)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: DW**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**960**	16.0	05/20/2013	ND	432	108	400	0.00	

Sample ID: VGSAU 15 - 03 (30') (H301196-14)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: DW**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**848**	16.0	05/20/2013	ND	432	108	400	0.00	

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Analytical Results For:

ARCADIS U.S., INC. - HOUSTON
JONATHAN OLSEN
630 PLAZA DRIVE, SUITE 600
HIGHLANDS RANCH CO, 80129
Fax To: (713) 977-4620

Received:	05/17/2013	Sampling Date:	05/17/2013
Reported:	06/18/2013	Sampling Type:	Soil
Project Name:	CHEVRON BUCKEYE	Sampling Condition:	Cool & Intact
Project Number:	B004860.0000	Sample Received By:	Jodi Henson
Project Location:	BUCKEYE OILFIELD		

Sample ID: VGSAU 15 - 02 (2') (H301196-15)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: DW**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**1950**	16.0	05/20/2013	ND	432	108	400	0.00	

Sample ID: VGSAU 15 - 02 (5') (H301196-16)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: DW**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**1470**	16.0	05/20/2013	ND	432	108	400	0.00	

Sample ID: VGSAU 15 - 02 (10') (H301196-17)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: DW**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**288**	16.0	05/20/2013	ND	432	108	400	0.00	

Sample ID: VGSAU 15 - 02 (15') (H301196-18)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: DW**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**464**	16.0	05/20/2013	ND	432	108	400	0.00	

Sample ID: VGSAU 15 - 02 (20') (H301196-19)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: DW**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**1090**	16.0	05/20/2013	ND	432	108	400	0.00	

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Analytical Results For:

ARCADIS U.S., INC. - HOUSTON
JONATHAN OLSEN
630 PLAZA DRIVE, SUITE 600
HIGHLANDS RANCH CO, 80129
Fax To: (713) 977-4620

Received:	05/17/2013	Sampling Date:	05/17/2013
Reported:	06/18/2013	Sampling Type:	Soil
Project Name:	CHEVRON BUCKEYE	Sampling Condition:	Cool & Intact
Project Number:	B004860.0000	Sample Received By:	Jodi Henson
Project Location:	BUCKEYE OILFIELD		

Sample ID: VGSAU 15 - 02 (25') (H301196-20)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: DW**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**960**	16.0	05/20/2013	ND	432	108	400	0.00	

Sample ID: VGSAU 15 - 02 (30') (H301196-21)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: DW**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**752**	16.0	05/20/2013	ND	432	108	400	0.00	

Sample ID: VGSAU 15 - 06 (2') (H301196-22)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: DW**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**528**	16.0	06/14/2013	ND	432	108	400	3.77	

Sample ID: VGSAU 15 - 06 (5') (H301196-23)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: DW**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**144**	16.0	06/14/2013	ND	432	108	400	3.77	

Sample ID: VGSAU 15 - 06 (10') (H301196-24)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: DW**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**208**	16.0	06/14/2013	ND	432	108	400	3.77	

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Analytical Results For:

ARCADIS U.S., INC. - HOUSTON
JONATHAN OLSEN
630 PLAZA DRIVE, SUITE 600
HIGHLANDS RANCH CO, 80129
Fax To: (713) 977-4620

Received:	05/17/2013	Sampling Date:	05/17/2013
Reported:	06/18/2013	Sampling Type:	Soil
Project Name:	CHEVRON BUCKEYE	Sampling Condition:	Cool & Intact
Project Number:	B004860.0000	Sample Received By:	Jodi Henson
Project Location:	BUCKEYE OILFIELD		

Sample ID: VGSAU 15 - 06 (15') (H301196-25)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: DW**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**208**	16.0	06/14/2013	ND	432	108	400	3.77	

Sample ID: VGSAU 15 - 06 (20') (H301196-26)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: DW**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**208**	16.0	06/14/2013	ND	432	108	400	3.77	

Sample ID: VGSAU 15 - 06 (25') (H301196-27)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: DW**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**288**	16.0	06/14/2013	ND	432	108	400	3.77	

Sample ID: VGSAU 15 - 06 (30') (H301196-28)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: DW**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**160**	16.0	06/14/2013	ND	432	108	400	3.77	

Sample ID: VGSAU 15 - 04 (2') (H301196-29)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: DW**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**816**	16.0	05/20/2013	ND	432	108	400	0.00	

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CARDINAL Laboratories

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Analytical Results For:

ARCADIS U.S., INC. - HOUSTON
JONATHAN OLSEN
630 PLAZA DRIVE, SUITE 600
HIGHLANDS RANCH CO, 80129
Fax To: (713) 977-4620

Received:	05/17/2013	Sampling Date:	05/17/2013
Reported:	06/18/2013	Sampling Type:	Soil
Project Name:	CHEVRON BUCKEYE	Sampling Condition:	Cool & Intact
Project Number:	B004860.0000	Sample Received By:	Jodi Henson
Project Location:	BUCKEYE OILFIELD		

Sample ID: VGSAU 15 - 04 (5') (H301196-30)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: DW**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**688**	16.0	05/20/2013	ND	432	108	400	0.00	

Sample ID: VGSAU 15 - 04 (10') (H301196-31)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: DW**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**288**	16.0	05/20/2013	ND	432	108	400	0.00	

Sample ID: VGSAU 15 - 04 (15') (H301196-32)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: DW**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**560**	16.0	05/20/2013	ND	432	108	400	0.00	

Sample ID: VGSAU 15 - 04 (20') (H301196-33)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: DW**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**640**	16.0	05/20/2013	ND	432	108	400	0.00	

Sample ID: VGSAU 15 - 04 (25') (H301196-34)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: DW**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**272**	16.0	05/20/2013	ND	432	108	400	0.00	

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CARDINAL Laboratories

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Analytical Results For:

ARCADIS U.S., INC. - HOUSTON
JONATHAN OLSEN
630 PLAZA DRIVE, SUITE 600
HIGHLANDS RANCH CO, 80129
Fax To: (713) 977-4620

Received:	05/17/2013	Sampling Date:	05/17/2013
Reported:	06/18/2013	Sampling Type:	Soil
Project Name:	CHEVRON BUCKEYE	Sampling Condition:	Cool & Intact
Project Number:	B004860.0000	Sample Received By:	Jodi Henson
Project Location:	BUCKEYE OILFIELD		

Sample ID: VGSAU 15 - 04 (30') (H301196-35)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: DW**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**48.0**	16.0	05/20/2013	ND	432	108	400	0.00	

Sample ID: VGSAU 15 - 05 (2') (H301196-36)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: DW**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**592**	16.0	05/20/2013	ND	432	108	400	0.00	

Sample ID: VGSAU 15 - 05 (5') (H301196-37)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: DW**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**864**	16.0	05/20/2013	ND	432	108	400	0.00	

Sample ID: VGSAU 15 - 05 (10') (H301196-38)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: DW**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**128**	16.0	05/20/2013	ND	432	108	400	0.00	

Sample ID: VGSAU 15 - 05 (15') (H301196-39)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: DW**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**416**	16.0	05/20/2013	ND	432	108	400	0.00	

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Celey D. Keene, Lab Director/Quality Manager

CARDINAL Laboratories

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Analytical Results For:

ARCADIS U.S., INC. - HOUSTON
JONATHAN OLSEN
630 PLAZA DRIVE, SUITE 600
HIGHLANDS RANCH CO, 80129
Fax To: (713) 977-4620

Received:	05/17/2013	Sampling Date:	05/17/2013
Reported:	06/18/2013	Sampling Type:	Soil
Project Name:	CHEVRON BUCKEYE	Sampling Condition:	Cool & Intact
Project Number:	B004860.0000	Sample Received By:	Jodi Henson
Project Location:	BUCKEYE OILFIELD		

Sample ID: VGSAU 15 - 05 (20') (H301196-40)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: DW**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**64.0**	16.0	05/20/2013	ND	432	108	400	0.00	

Sample ID: VGSAU 15 - 05 (25') (H301196-41)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: DW**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**64.0**	16.0	05/20/2013	ND	432	108	400	0.00	

Sample ID: VGSAU 15 - 05 (30') (H301196-42)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: DW**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**64.0**	16.0	05/22/2013	ND	432	108	400	0.00	

Sample ID: VGSAU 15 - 07 (2') (H301196-43)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: DW**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**512**	16.0	06/05/2013	ND	432	108	400	0.00	

Sample ID: VGSAU 15 - 07 (5') (H301196-44)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: DW**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**528**	16.0	06/05/2013	ND	432	108	400	0.00	

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ARCADIS U.S., INC. - HOUSTON
JONATHAN OLSEN
630 PLAZA DRIVE, SUITE 600
HIGHLANDS RANCH CO, 80129
Fax To: (713) 977-4620

Received:	05/17/2013	Sampling Date:	05/17/2013
Reported:	06/18/2013	Sampling Type:	Soil
Project Name:	CHEVRON BUCKEYE	Sampling Condition:	Cool & Intact
Project Number:	B004860.0000	Sample Received By:	Jodi Henson
Project Location:	BUCKEYE OILFIELD		

Sample ID: VGSAU 15 - 07 (10') (H301196-45)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: DW**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	<16.0	16.0	06/14/2013	ND	432	108	400	3.77	

Cardinal Laboratories *=Accredited Analyte

Celey D. Keene, Lab Director/Quality Manager

CARDINAL Laboratories

PHONE (575) 393-2326 ° 101 E. MARLAND ° HOBBS, NM 88240

Notes and Definitions

QM-07	The spike recovery was outside acceptance limits for the MS and/or MSD. The batch was accepted based on acceptable LCS recovery.
ND	Analyte NOT DETECTED at or above the reporting limit
RPD	Relative Percent Difference
**	Samples not received at proper temperature of 6°C or below.
***	Insufficient time to reach temperature.
-	Chloride by SM4500Cl-B does not require samples be received at or below 6°C
	Samples reported on an as received basis (wet) unless otherwise noted on report

Celey D. Keene

Celey D. Keene, Lab Director/Quality Manager

CARDINAL Laboratories

CHAIN-OF-CUSTODY AND ANALYSIS REQUEST

101 East Marland, Hobbs, NM 88240
(575) 393-2326 FAX (575) 393-2476

Company Name:	ARCADIS-US
Project Manager:	Jonathan Okyere
Address:	2929 Briarpark Dr., Suite 300
City:	Houston State: TX Zip: 77402
Phone #:	713.953.4874 Fax #: 713.977.4620
Project #:	B004860.0000 Project Owner: Chevron
Project Name:	Chevron Buckeye
Project Location:	Buckeye oilfield
Sampler Name:	Ryan Nunez

BILL TO

P.O. #:	
Company:	
Attn:	
Address:	
City:	
State:	Zip:
Phone #:	
Fax #:	

ANALYSIS REQUEST

Chlorides 300.1

FOR LAB USE ONLY Lab I.D.	Sample I.D.	(G)RAB OR (C)OMP.	# CONTAINERS	MATRIX: GROUNDWATER	WASTEWATER	SOIL	OIL	SLUDGE	OTHER:	PRESERV.: ACID/BASE:	ICE / COOL	OTHER: None	SAMPLING: DATE	TIME	
H301196															
1	VGSAU15-01 (2')	G	1			X						X	5-17-13	0937	1
2	VGSAU15-01 (5')	G	1			X						X	5-17-13	0942	1
3	VGSAU15-01 (10')	G	1			X						X	5-17-13	0945	1
4	VGSAU15-01 (15')	G	1			X						X	5-17-13	0948	1
5	VGSAU15-01 (20')	G	1			X						X	5-17-13	0950	1
6	VGSAU15-01 (25')	G	1			X						X	5-17-13	0953	1
7	VGSAU15-01 (30')	G	1			X						X	5-17-13	0955	1
8	VGSAU15-03 (2')	G	1			X						X	5-17-13	1014	1
9	VGSAU15-03 (5')	G	1			X						X	5-17-13	1018	1
10	VGSAU15-03 (10')	G	1			X						X	5-17-13	1026	1

Relinquished By:	Date: 5-17-13 Time: 1600	Received By: Jodi Henson	Phone Result: ☐ Yes ☐ No Add'l Phone #:
Relinquished By:	Date: Time:	Received By:	Fax Result: ☐ Yes ☐ No Add'l Fax #:
Delivered By: (Circle One) Sampler - UPS - Bus - Other: 4°C	Sample Condition: Cool ☐ Yes ☐ No, Intact ☐ Yes ☐ No	CHECKED BY: (Initials)	REMARKS:

† Cardinal cannot accept verbal changes. Please fax written changes to (575) 393-2326

#54

CARDINAL Laboratories

CHAIN-OF-CUSTODY AND ANALYSIS REQUEST

101 East Marland, Hobbs, NM 88240
(575) 393-2326 FAX (575) 393-2476

Company Name:	ARCADIS-US
Project Manager:	Jonathan Olgren
Address:	2929 Briarpark Dr, Suite 300
City:	Houston State: TX Zip: 77402
Phone #:	713.953.4874 Fax #: 713.977.4620
Project #:	B004860.0000 Project Owner: Chevron
Project Name:	Chevron Buckeye
Project Location:	Buckeye oilfield
Sampler Name:	Ryan Mann

BILL TO

P.O. #:	
Company:	
Attn:	
Address:	
City:	
State:	Zip:
Phone #:	
Fax #:	

ANALYSIS REQUEST

Chlorides 300.1

FOR LAB USE ONLY Lab I.D.	Sample I.D.	(G)RAB OR (C)OMP.	# CONTAINERS	MATRIX: GROUNDWATER	WASTEWATER	SOIL	OIL	SLUDGE	OTHER:	PRESERV.: ACID/BASE:	ICE / COOL	OTHER: None	SAMPLING DATE	SAMPLING TIME	Chlorides 300.1
H301196															
11	VGSAU15-03(15')	G	1			X						X	5-17-13	1035	1
12	VGSAU15-03(20')	G	1			X						X	5-17-13	1037	1
13	VGSAU15-03(25')	G	1			X						X	5-17-13	1038	1
14	VGSAU15-03(30')	G	1			X						X	5-17-13	1040	1
15	VGSAU15-02(2')	G	1			X						X	5-17-13	1052	1
16	VGSAU15-02(5')	G	1			X						X	5-17-13	1056	1
17	VGSAU15-02(10')	G	1			X						X	5-17-13	1058	1
18	VGSAU15-02(15')	G	1			X						X	5-17-13	1110	1
19	VGSAU15-02(20')	G	1			X						X	5-17-13	1115	1
20	VGSAU15-02(25')	G	1			X						X	5-17-13	1118	1

Relinquished By:	Date: 5-17-13	Received By: Jodi Henson	Phone Result: ☐ Yes ☐ No Add'l Phone #:
Relinquished By:	Time: 1600	Received By:	Fax Result: ☐ Yes ☐ No Add'l Fax #:
	Date:		REMARKS:
Delivered By: (Circle One)	Time:		
Sampler - UPS - Bus - Other:	4°C	Sample Condition Cool: ☑ Yes ☐ No Intact: ☑ Yes ☐ No	CHECKED BY: (Initials)

† Cardinal cannot accept verbal changes. Please fax written changes to (575) 393-2326

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CARDINAL Laboratories

CHAIN-OF-CUSTODY AND ANALYSIS REQUEST

101 East Marland, Hobbs, NM 88240
(575) 393-2326 FAX (575) 393-2476

Company Name: ARCADIS-US
Project Manager: Jonathan Olsen
Address: 2929 Briarpark Dr, Suite 300
City: Houston **State:** TX **Zip:** 77402
Phone #: 713.953.4874 **Fax #:** 713.977.4620
Project #: B0004860.0000 **Project Owner:** Chevron
Project Name: Chevron Buckeye
Project Location: Buckeye oilfield
Sampler Name: Ryan Manning

BILL TO
P.O. #:
Company:
Attn:
Address:
City:
State: Zip:
Phone #:
Fax #:

FOR LAB USE ONLY

Lab I.D.	Sample I.D.	(G)RAB OR (C)OMP.	# CONTAINERS	GROUNDWATER	WASTEWATER	SOIL	OIL	SLUDGE	OTHER :	ACID/BASE:	ICE / COOL	OTHER : None	DATE	TIME	Chlorides 300.1	Hold		Cl⁻ & % Moisture added 6/14
H301196																		
21	VGSAU15-02 (30')	G	1			X						X	5-17-13	1120	1			
22	VGSAU 15 - 06 (2')	G	1			X						X	5-17-13	1137	1	X		X
23	VGSAU 15-06 (5')	G	1			X						X	5-17-13	1140	1	X		X
24	VGSAU 15-06 (10')	G	1			X						X	5-17-13	1145	1	X		X
25	VGSAU 15-06 (15')	G	1			X						X	5-17-13	1150	1	X		X
26	VGSAU 15-06 (20')	G	1			X						X	5-17-13	1155	1	X		X
27	VGSAU 15-06 (25')	G	1			X						X	5-17-13	1158	1	X		X
28	VGSAU 15-06 (30')	G	1			X						X	5-17-13	1203	1	X		X
29	VGSAU 15-04 (2')	G	1			X						X	5-17-13	1232	1			
30	VGSAU 15-04 (5')	G	1			X						X	5-17-13	1238	1			

Relinquished By: [signature] **Date:** 5-17-13 **Time:** 1600 **Received By:** Jodi Henson
Relinquished By: **Date:** **Time:** **Received By:**

Delivered By: (Circle One)
Sampler - UPS - Bus - Other:

4°c

Sample Condition
Cool: ☑ Yes ☐ No
Intact: ☑ Yes ☐ No

CHECKED BY: (Initials) [initials]

Phone Result: ☐ Yes ☐ No Add'l Phone #:
Fax Result: ☐ Yes ☐ No Add'l Fax #:
REMARKS:
Hold VGSAU 15-06 Samples.

† Cardinal cannot accept verbal changes. Please fax written changes to (575) 393-2326

#54

CARDINAL Laboratories

CHAIN-OF-CUSTODY AND ANALYSIS REQUEST

101 East Marland, Hobbs, NM 88240
(575) 393-2326 FAX (575) 393-2476

Company Name:	ARCADIS-US
Project Manager:	Jonathan Olgren
Address:	2929 Briarpark Dr, Suite 300
City:	Houston State: TX Zip: 77402
Phone #:	713.953.4874 Fax #: 713.977.4620
Project #:	B004860.0000 Project Owner: Chevron
Project Name:	Chevron Buckeye
Project Location:	Buckeye oilfield
Sampler Name:	Ryan Mann

BILL TO

P.O. #:	
Company:	
Attn:	
Address:	
City:	
State:	Zip:
Phone #:	
Fax #:	

ANALYSIS REQUEST

Chlorides per EPA 300.1

FOR LAB USE ONLY Lab I.D.	Sample I.D.	(G)RAB OR (C)OMP.	# CONTAINERS	MATRIX: GROUNDWATER	WASTEWATER	SOIL	OIL	SLUDGE	OTHER :	PRESERV.: ACID/BASE:	ICE / COOL	OTHER : None	SAMPLING: DATE	TIME	Chlorides per EPA 300.1
H301196-31	VGSAU15-04(10')	G	1			X						X	5-17-13	1247	1
32	VGSAU15-04(15')	G	1			X						X	5-17-13	1253	1
33	VGSAU15-04(20')	G	1			X						X	5-17-13	1256	1
34	VGSAU15-04(25')	G	1			X						X	5-17-13	1258	1
35	VGSAU15-04(30')	G	1			X						X	5-17-13	1300	1
36	VGSAU15-05(2')	G	1			X						X	5-17-13	1332	1
37	VGSAU15-05(5')	G	1			X						X	5-17-13	1336	1
38	VGSAU15-05(10')	G	1			X						X	5-17-13	1345	1
39	VGSAU15-05(15')	G	1			X						X	5-17-13	1350	1
40	VGSAU15-05(20')	G	1			X						X	5-17-13	1356	1

Relinquished By:	Date: 5-17-13	Received By: Jodi Henson	Phone Result: ☐ Yes ☐ No Add'l Phone #:
Relinquished By:	Time: 1600	Received By:	Fax Result: ☐ Yes ☐ No Add'l Fax #:
	Date:		REMARKS:
	Time:		

Delivered By: (Circle One)
Sampler - UPS - Bus - Other:

Sample Condition: Cool ☑ Yes ☐ No / Intact ☑ Yes ☐ No
CHECKED BY: (Initials)

4°

† Cardinal cannot accept verbal changes. Please fax written changes to (575) 393-2326

#54

CARDINAL Laboratories

CHAIN-OF-CUSTODY AND ANALYSIS REQUEST

101 East Marland, Hobbs, NM 88240
(575) 393-2326 FAX (575) 393-2476

Company Name:	ARCADIS-US
Project Manager:	Jonathan Olguin
Address:	2929 Briarpark Dr., Suite 300
City:	Houston State: TX Zip: 77402
Phone #:	713.953.4874 Fax #: 713.977.4620
Project #:	B004860.0000 Project Owner: Chevron
Project Name:	Chevron Bridgeye
Project Location:	Bridgeye oilfield
Sampler Name:	Ryan Nunez

BILL TO

P.O. #:	
Company:	
Attn:	
Address:	
City:	
State:	Zip:
Phone #:	
Fax #:	

ANALYSIS REQUEST

FOR LAB USE ONLY Lab I.D.	Sample I.D.	(G)RAB OR (C)OMP	# CONTAINERS	MATRIX: GROUNDWATER	WASTEWATER	SOIL	OIL	SLUDGE	OTHER :	PRESERV.: ACID/BASE:	ICE / COOL	OTHER :	SAMPLING: DATE	TIME	Chlorides 300.1	Hold										
H301196																	Cl- added 5/31/13	Cl + 2% Moisture added 6/1/13								
41	VGSAU15-05(25')	6	1			X						X	5-17-13	1358	1											
42	VGSAU15-05(30')	6	1			X						X	5-17-13	1400	1											
43	VGSAU15-07(2')	6	1			X						X	5-17-13	1407	1	X		XX								
44	VGSAU15-07(5')	6	1			X						X	5-17-13	1410	1	X			X							
45	VGSAU15-07(10')	6	1			X						X	5-17-13	1413	1	X										
46	VGSAU15-07(15')	6	1			X						X	5-17-13	1415	1	X										
47	VGSAU15-07(20')	6	1			X						X	5-17-13	1417	1	X										
48	VGSAU15-07(25')	6	1			X						X	5-17-13	1418	1	X										
49	VGSAU15-07(30') EXS-17-13	6	1			X						X	5-17-13	1420	1	X										

Relinquished By:	Date: 5-17-13	Received By: Jodi Henson	
Relinquished By:	Time: 1600	Received By:	
	Date:		
	Time:		

Delivered By: (Circle One)
Sampler - UPS - Bus - Other:

4°C

Sample Condition		CHECKED BY: (Initials)
Cool	Intact	
☒ Yes ☐ No	☒ Yes ☐ No	

Phone Result:	☐ Yes	☐ No	Add'l Phone #:
Fax Result:	☐ Yes	☐ No	Add'l Fax #:

REMARKS: Hold. VGSAU15-07 Samples.

† Cardinal cannot accept verbal changes. Please fax written changes to (575) 393-2326

#54

ARCADIS

Attachment 6

Boring Logs (May 2013)

Date Start/Finish: 5/17/2013
Drilling Company: White Drilling/R Dallas

Drilling Method: Air Rotary
Sampling Method: Shovel

Borehole Depth: 30' bgs
Descriptions By: R Nanny

Well/Boring ID: VGSAU15 - 01

Client: Chevron EMC
Location: Vacuum Grayburg San Andres Unit Well 15

DEPTH	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	PID Headspace (ppm)	Analytical Sample	Geologic Column	Stratigraphic Description
0	0	1	AR	2	5.5	☒		CALICHE PAD, Very Pale Brown (10YR7/3), indurated, brecciated, trace sand, very fine to medium grain, subangular, poorly sorted, dry.
			AR	3				SANDY CLAY, Dark Brown (7.5YR3/2), mostly clay, some sand, very firm, blotchy, very fine to fine grained, subangular, poorly sorted, dry, trace caliche, Very Pale Brown (10YR8/2), concretion, nodular, indurated throughout formation.
5	-5				11.4	☒		CAPROCK CALICHE, Very Pale Brown (10YR8/3) to Pale Brown (10YR6/3), indurated, silica cemented, laminated, some sand, very fine to fine grain, subrounded, poorly sorted.
		2	AR	5				CLAYEY CALICHE, Very Pale Brown (10YR8/3), soft, arenaceous, trace sand, very fine to fine grain, subrounded, poorly sorted, dry.
10	-10				5.2	☒		SANDSTONE, Light Brown (7.5YR6/3), fine grained, subrounded, poorly sorted, indurated, silica cementation.
		3	AR	5				SANDY CALICHE, Very Pale Brown (10YR8/3), slightly firm, arenaceous, mostly caliche, some sand, fine grained, subrounded, poorly sorted, dry.
15	-15				3.2	☒		
		4	AR	5				CALCAREOUS SAND, Very Pale Brown (10YR8/2), very fine to fine grained, subrounded, poorly sorted, loose, dry.
20	-20				5.7	☒		
		5	AR	5				
25	-25				8.5	☒		Formation became slightly less calcareous, fine grained, subrounded, moderately sorted.
		6	AR	5				
30	-30				7.9	☒		Pink (7.5YR7/3), silica cementation.

Remarks: ags = above ground surface; AK = air knife; amsl = above mean sea level; AR = air rotary; bgs = below ground surface; ppm = parts per million; cm = centimeter

Date Start/Finish: 5/17/2013
Drilling Company: White Drilling/R Dallas

Drilling Method: Air Rotary
Sampling Method: Shovel

Borehole Depth: 30' bgs
Descriptions By: R Nanny

Well/Boring ID: VGSAU15 - 02

Client: Chevron EMC
Location: Vacuum Grayburg San Andres Unit Well 15

DEPTH	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	PID Headspace (ppm)	Analytical Sample	Geologic Column	Stratigraphic Description
0	0		AR	2	8.9	☒		SANDY CLAY, Dark Brown (7.5YR3/2), mostly clay, some sand, very firm, blocky, very fine grained, subangular, poorly sorted, dry, trace caliche, Very Pale Brown (10YR8/2), concretion, nodular, indurated throughout formation.
5	-5	1	AR	3	5.2	☒		CAPROCK CALICHE, Pale Brown (10YR6/3) to Very Pale Brown (10YR8/3), some sand, indurated, silica cemented, laminated, very fine to fine grain, subrounded, poorly sorted.
		2	AR	5				CLAYEY CALICHE, Very Pale Brown (10YR8/3), soft, arenaceous, dry, trace sand, very fine to fine grain, subrounded, poorly sorted.
10	-10	3	AR	5	4.2	☒		SANDSTONE, Light Brown (7.5YR6/3), fine grained, subrounded, poorly sorted, indurated, silica cementation.
15	-15				4.1	☒		SANDY CALICHE, Very Pale Brown (10YR8/3), mostly caliche, some sand, slightly firm, dry, arenaceous, fine grained, subrounded, poorly sorted.
20	-20	4	AR	5	2.3	☒		CALCAREOUS SAND, Very Pale Brown (10YR8/3), dry, very fine to fine grained, subangular to subrounded, poorly sorted.
25	-25	5	AR	5	3.5	☒		Formation sand became subrounded and fine grained
30	-30	6	AR	5	2.8	☒		Pink (7.5YR7/3), formation contained trace concretionary silty chert nodules, 0.5 cm to 1 cm.

Remarks: ags = above ground surface; AK = air knife; amsl = above mean sea level; AR = air rotary; bgs = below ground surface; ppm = parts per million; cm = centimeter

Date Start/Finish: 5/17/2013
Drilling Company: White Drilling/R Dallas

Drilling Method: Air Rotary
Sampling Method: Shovel

Borehole Depth: 30' bgs
Descriptions By: R Nanny

Well/Boring ID: VGSAU15 - 03

Client: Chevron EMC
Location: Vacuum Grayburg San Andres Unit Well 15

DEPTH	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	PID Headspace (ppm)	Analytical Sample	Geologic Column	Stratigraphic Description
0	0		AR	2	8.4	☒		SANDY CLAY, Dark Brown (7.5YR3/2), mostly clay, some sand, very firm, blocky, dry, very fine to fine grained, subangular, poorly sorted, trace caliche, Very Pale Drown (10YR8/2), concretion, nodular, indurated throughout formation.
		1	AR	3		☒		CAPROCK CALICHE, Pale Brown (10YR6/3) to Very Pale Brown (10YR8/2), some sand, indurated, silica cementation, laminated, very fine to fine grained, subangular, poorly sorted.
5	-5	2	AR	5	12	☒		CLAYEY CALICHE, Very Pale Brown (10YR8/3), soft, arenaceous, dry, trace sand, indurated, silica cementation, laminated, very fine to fine grained, subangular, poorly sorted.
10	-10				12.1	☒		SANDSTONE, Light Brown (7.5YR6/3), fine grained, subrounded, poorly sorted, indurated, silica cementation.
		3	AR	5				SANDY CALICHE, Very Pale Brown (10YR8/3), slightly firm, dry, arenaceous, mostly caliche, some sand, fine grained, subrounded, poorly sorted.
15	-15				15.3	☒		
20	-20	4	AR	5	11.8	☒		CALCAREOUS SAND, Very Pale Brown (10YR8/2), dry, very fine to fine grained, subrounded, poorly sorted.
		5	AR	5				
25	-25				9.7	☒		Formation became slightly less calcareous, Very Pale Brown (10YR8/3), fine grained, moderately sorted.
		6	AR	5				Pink (7.5YR7/3) formation contained traces concretionary silty chert nodules, 0.5 cm to 2.5 cm.
30	-30				12.8	☒		

Remarks: ags = above ground surface; AK = air knife; amsl = above mean sea level; AR = air rotary; bgs = below ground surface; ppm = parts per million; cm = centimeter

Date Start/Finish: 5/17/2013
Drilling Company: White Drilling/R Dallas

Drilling Method: Air Rotary
Sampling Method: Shovel

Borehole Depth: 30' bgs
Descriptions By: R Nanny

Well/Boring ID: **VGSAU15 - 04**

Client: Chevron EMC
Location: Vacuum Grayburg San Andres Unit Well 15

DEPTH	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	PID Headspace (ppm)	Analytical Sample	Geologic Column	Stratigraphic Description
0	0	1	AR	2	9.4	☒		SANDY CLAY, topsoil, Brown (10YR7/3), some sand, very firm, blocky, dry, very fine grained, subangular, poorly sorted, trace caliche, Very Pale Brown (10YR8/2), concretions, nodular, indurated (roots in sample).
			AR	3				CAPROCK CALICHE, Pale Brown (10YR6/3), indurated, siliceous, trace sand, dry, very fine to fine grained, subangular, poorly sorted, fractured.
5	-5				9.1	☒		CLAYEY CALICHE, Pink (7.5YR8/3), soft, arenaceous, trace sand, silt to very fine grained, subrounded to subangular, poorly sorted.
		2	AR	5				Formation became very powdery, strongly calcareous.
10	-10				13.2	☒		SANDSTONE, Light Brown (7.5YR6/3), dry. fine grained, subrounded, poorly sorted, indurated, silica cementation.
		3	AR	5				SANDY CALICHE, Very Pale Brown (10YR8/3), slightly firm to soft, dry, arenaceous, mostly caliche, some sand, fine grained, subrounded, poorly sorted.
15	-15				9.6	☒		
		4	AR	5				CALCAREOUS SAND, Very Pale Brown (10YR8/2), dry, very fine to fine grained, subangular to subrounded, poorly sorted, loose.
20	-20				10.9	☒		
		5	AR	5				
25	-25				14.4	☒		Very Pale Brown (10YR8/3), formation becomes slightly less calcareous, sand changed to fine grained, subrounded, moderately to well sorted.
		6	AR	5				
30	-30				9.9	☒		Pink (7.5YR7/3), trace concretionary, siliceous nodules, 0.3 cm to 0.7 cm.

Remarks: ags = above ground surface; AK = air knife; amsl = above mean sea level; AR = air rotary; bgs = below ground surface; ppm = parts per million; cm = centimeter

Date Start/Finish: 5/17/2013
Drilling Company: White Drilling/R Dallas

Drilling Method: Air Rotary
Sampling Method: Shovel

Borehole Depth: 30' bgs
Descriptions By: R Nanny

Well/Boring ID: VGSAU15 - 06

Client: Chevron EMC
Location: Vacuum Grayburg San Andres Unit Well 15

DEPTH	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	PID Headspace (ppm)	Analytical Sample	Geologic Column	Stratigraphic Description
0	0		AR	2	2.9	☒		SANDY CLAY, Dark Brown (7.5YR3/2), mostly clay, some sand, very firm, blocky, dry, very fine grained, subangular, poorly sorted, trace caliche, Very Pale Brown (10YR8/2), concretion, nodular, indurated throughout formation.
		1	AR	3		☒		CAPROCK CALICHE, Pale Brown (10YR6/3), indurated, siliceous, trace sand, very fine to fine grained, subangular, poorly sorted.
5	-5	2	AR	5	1.7	☒		CLAYEY CALICHE, Pink (7.5YR8/3), soft, arenaceous, trace sand, silt to very fine grained, subangular, poorly sorted. Formation becomes powdery.
10	-10	3	AR	5	2.0	☒		SANDSTONE, Light Brown (7.5YR6/3), fine grained, subrounded, poorly sorted, indurated, silica cemented.
15	-15				5.0	☒		SANDY CALICHE, Very Pale Brown (10YR8/3), mostly caliche, some sand, slightly firm to loose, dry, arenaceous, fine grained, subrounded, poorly sorted.
20	-20	4	AR	5	7.4	☒		CALCAREOUS SAND, Very Pale Brown (10YR8/2), dry, very fine to fine grained, subangular to subrounded, poorly sorted, loose.
25	-25	5	AR	5	8.0	☒		Formation becomes slightly less calcareous, color change to Very Pale Brown (10YR8/3), sand becomes fine grained, subrounded, moderately to well sorted.
		6	AR	5				Formation turns back to Very Pale Brown (10YR8/2), contains trace concretions, silty chert, Pink (7.5YR7/3), nodules, 0.5 cm to 1 cm.
30	-30				9.1	☒		

Remarks: ags = above ground surface; AK = air knife; amsl = above mean sea level; AR = air rotary; bgs = below ground surface; ppm = parts per million; cm = centimeter

ARCADIS
Infrastructure · Water · Environment · Buildings

Date Start/Finish: 5/17/2013
Drilling Company: White Drilling/R Dallas

Drilling Method: Air Rotary
Sampling Method: Shovel

Borehole Depth: 30' bgs
Descriptions By: R Nanny

Well/Boring ID: **VGSAU15 - 05**

Client: Chevron EMC
Location: Vacuum Grayburg San Andres Unit Well 15

DEPTH	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	PID Headspace (ppm)	Analytical Sample	Geologic Column	Stratigraphic Description
0	0	1	AR	2	11.8	☒		SANDY CLAY, Topsoil, Brown (10YR4/3), some sand, very firm, blocky, dry, very fine grained, subangular, poorly sorted, trace caliche, Very Pale Brown (10YR8/2), concretions, nodular, indurated (roots in sample).
			AR	3				
5	-5	2	AR	5	14.3	☒		CLAYEY SAND, Brown (7.5YR4/4), mostly sand, some intergranular clay, dry, very fine to fine grained, subrounded, poorly sorted, firm, dry, arenaceous, trace caliche, concretions. Formation becomes very firm, blocky, less sand than above.
10	-10				3.9	☒		SANDSTONE, Light Brown (7.5YR6/3), fine grained, subrounded, poorly sorted, dry, indurated, silica cementation, very powdery, when crushed by button bit.
15	-15	3	AR	5	4.4	☒		SANDY CALICHE, Very Pale Brown (10YR8/3), mostly caliche, some sand, soft, dry, arenaceous, fine grained, subrounded, poorly sorted.
20	-20	4	AR	5	7.8	☒		CALCAREOUS SANDSTONE, Very Pale Brown (10YR8/2), very fine to fine grained, subangular to subrounded, poorly sorted, weakly cemented, friable.
		5	AR	5				
25	-25	6	AR	5	7.3	☒		CALCAREOUS SAND, Very Pale Brown (10YR8/3), fine grained, subrounded, poorly sorted, loose.
30	-30				11.6	☒		Formation sand turned very firm to fine grain. Formation contained trace concretionary siliceous, silty/sandy nodules, Grayish Brown (2.5YR5/2), 0.5 cm to 3 cm, less concretions.

Remarks: ags = above ground surface; AK = air knife; amsl = above mean sea level; AR = air rotary; bgs = below ground surface; ppm = parts per million; cm = centimeter

Date Start/Finish: 5/17/2013
Drilling Company: White Drilling/R Dallas

Drilling Method: Air Rotary
Sampling Method: Shovel

Borehole Depth: 30' bgs
Descriptions By: R Nanny

Well/Boring ID: VGSAU15 - 07

Client: Chevron EMC
Location: Vacuum Grayburg San Andres Unit Well 15

Chevron

DEPTH	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	PID Headspace (ppm)	Analytical Sample	Geologic Column	Stratigraphic Description
0	0	1	AR	2	10.1	☒		SANDY CLAY, Brown (7.5YR4/4), some sand, very firm, blocky, dry, very fine grained, subangular, poorly sorted, trace caliche, Very Pale Brown (10YR8/2), concretions, nodular, indurated (roots in sample).
			AR	3				
5	-5				9.1	☒		CLAYEY CALICHE, Pink (7.5YR8/3), firm to slightly soft, dry, arenaceous, formation contains some concretionary caliche, nodular, Pink (7.5YR7/3), indurated throughout formation, trace sand, silt to very fine grained, subangular, poorly sorted.
		2	AR	5				SANDSTONE, Light Brown (7.5YR6/3), fine grained, subrounded, poorly sorted, dry, indurated, silica cementation, very powdery when crushed by button bite.
10	-10				7.2	☒		
		3	AR	5				
15	-15				8.3	☒		SANDY CALICHE, Very Pale Brown (10YR8/3), soft, dry, arenaceous, mostly caliche, some sand, fine grained, subrounded, poorly sorted.
		4	AR	5				CALCAREOUS SAND, Very Pale Brown (10YR8/2), very fine to fine grained, subangular, poorly sorted, may have very weak cementation.
20	-20				8.9	☒		
		5	AR	5				
25	-25				9.6	☒		Formation becomes slightly less calcareous, Very Pae Brown (10YR8/3), fine grained, subrounded, poorly sorted, loose.
		6	AR	5				
30	-30				10.7	☒		Formation contains trace concretionary siliceous, silty/sandy nodules, Grayish Brown (2.5YR5/2), 0.5 cm to 1.5 cm, nodules were throughout formation, concretions become less.

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Remarks: ags = above ground surface; AK = air knife; amsl = above mean sea level; AR = air rotary; bgs = below ground surface; ppm = parts per million; cm = centimeter

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Attachment 7

Chloride Multimedia Exposure Assessment Model Simulated Soil Screening Levels for the Protection of Groundwater Memo

ARCADIS U.S., Inc.
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MEMO

To:
Kegan Boyer, Chevron Environmental Management Company

Copies:
Chris Shepherd, ARCADIS
Kathleen Abbott, ARCADIS
David Evans, ARCADIS

From:
Jonathan Olsen

Date:
May 8, 2014

ARCADIS Project No.:
B0048615.0000

Subject:
Chloride Multimedia Exposure Assessment Model Simulated Soil Screening Levels for the Protection of Groundwater
HES Transfer Sites, Lea County, New Mexico

On behalf of Chevron Environmental Management Company, ARCADIS U.S., Inc. (ARCADIS) evaluated chloride remediation action levels for use at the Health Environmental Safety (HES) Transfer Sites near Hobbs, New Mexico. The New Mexico Oil Conservation District (NMOCD) has established soil screening levels (SSLs) for fluid management pits (also known as the "NMOCD PIT RULE" [NMAC 19.15.17]); however, no formal SSLs have been established by the NMOCD or the New Mexico Environmental Department (NMED) for surface releases of production water. The Risk Assessment Guidance for Investigation and Remediation (NMED 2012) states that SSLs should be based on risk to human health and the potential migration to groundwater with respect to the NMED-specific tap water SSL. Chloride is not considered hazardous and the NMED and the United States Environmental Protection Agency (USEPA) have not established tap water screening levels for chloride. However, the NMED has established a chloride standard for groundwater (NMAC 20.6.2.1101) of 250 milligrams per liter (mg/L). Therefore, the SSL for chloride should be based on the soil leaching to groundwater pathway.

To evaluate a chloride SSL for use at the HES Transfer Sites, ARCADIS performed simulations of unsaturated zone flow, transport, and saturated zone mixing of chloride using the Multimedia Exposure Assessment Model Version 2.0 (MULTIMED; USEPA 1996) to evaluate the potential migration of chloride in shallow soil through the unsaturated zone to the underlying groundwater. The initial simulations were intended to estimate a maximum allowable chloride soil concentration (site SSL) to evaluate HES Transfer

Sites in Lea County and eastern Eddy County, New Mexico, and to develop a baseline approach for using the model for potential future evaluations of solute migration at other HES Transfer Sites in New Mexico.

MULTIMED Overview

MULTIMED was originally designed to simulate the movement of solutes leaching from a landfill to various exposure pathways. Due to its general acceptance by the NMOCD and the USEPA and its ability to simulate unsaturated and saturated zone flow and transport, MULTIMED was selected for this evaluation. The model, as designed, simulates one-dimensional vertical transport in the unsaturated zone to the saturated zone based on user-provided input parameters considering vadose zone, saturated zone, and chemical-specific characteristic parameters.

The simulations were performed using both the unsaturated and saturated zone modules available in MULTIMED. The unsaturated zone module performs solutions of the downward flow of infiltrating water to the water table by Darcy's Law:

$$Q = -K_v \cdot K_{rw} \left(\frac{\delta\psi}{\delta z}\right)$$

Where:

ψ is the pressure head (meters [m])

z is the depth (m)

Kv is the saturated hydraulic conductivity (meters per year [m/year])

Krw is the relative hydraulic conductivity

The boundary condition at the water table is:

$$\psi \cdot L = 0$$

Where:

L is the thickness of the unsaturated zone (m)

In the unsaturated zone, it is necessary to specify the relationship between relative hydraulic conductivity, pressure head, and water saturation. This relationship is given by van Genuchten (1976):

$$S_e = \theta r + \frac{\theta s - \theta r}{[1 + (\alpha\psi^{\beta})^{\gamma}]}$$

Where:

θr and θs are the residual water saturation and total water saturation (dimensionless), respectively

β, γ, α are empirical soil-specific parameters (dimensionless)

ψ is the air pressure entry head (m)

S_e is the effective saturation (fraction)

Source area concentrations are input as leachate concentrations, therefore, the soil/water partition equation was used to convert between total soil concentration in milligrams per kilogram (mg/kg) and the leachate concentration in mg/L:

$$C_t = \frac{C_l \cdot R \cdot \theta_w}{\rho_b}$$

Where:

C_t is the concentration of the chemical of interest in soil (mg/kg)

C_l is the concentration of the chemical of interest in leachate (mg/L)

R is the retardation coefficient (dimensionless, assumed 1 for chloride)

ρ_b is the bulk density of the soil (mg/L or grams per cubic centimeter)

The mass of the chemical of interest that reaches the groundwater is expressed by the simplified steady-state equation (Salhotra et al. 1995) that couples the vadose zone to the groundwater:

$$M_L = A_w \cdot Q_f \cdot C_l$$

Where:

M_L is the chemical of interest mass that leaches from site soil (grams per year [g/year])

A_w is the width of the source area (m^2)

Q_f is the percolation rate from the facility/site (m/year)

The mixed groundwater concentration is controlled by the quasi-three-dimensional advection dispersion equations that are evaluated based on the following chemical concentration relationship within the mixing zone (Salhotra et al. 1995):

$$C(x,y,z,t) = \frac{H}{B} C_f(x,y,t) + \Delta C_p(x,y,z,t)$$

Where:

C is the dissolved concentration (mg/L, g/m^3)

x,y,z are the spatial coordinates (m)

t is elapsed time (year)

H is the source zone penetration (m), with a maximum equal to B

B is the thickness of the saturated zone (m)

MULTIMED's output concentration is a centerline concentration based on a calculated dilution attenuation factor. Thus, the output concentration is the maximum concentration of the chemical of interest in groundwater at a reasonable distance downgradient from the source area.

Model Design, Inputs, and Assumptions

The required input parameters for the MULTIMED simulations are summarized in Table 1. Input parameters include model structure, unsaturated and saturated zones, and chemical characteristics. Minimal site-specific data regarding the HES sites are available; therefore, numerous input parameters are based on published reports, default NMED values (2012), default values provided in the modeling code, and ARCADIS's experience, as indicated in Table 1. The model values are considered representative of the Lea County, New Mexico area. Due to the intended use of the SSL at multiple sites, more conservative values were generally selected for the given ranges of input parameters.

The general assumptions used in the MULTIMED model design include:

- The unsaturated and saturated zones are a single, homogeneous material.
- The applied recharge and infiltration are constant throughout the simulation.
- Initial chloride concentrations in soil below the source area and in groundwater are equal to 0.
- The model assumes no chemical transformation or adsorption of chloride to soil materials.

The simulations were performed using the transient model capabilities of MULTIMED. Steady-state simulations were not chosen because MUTLIMED requires the assumption that the source is continuous and constant throughout the simulation, which is not appropriate for these evaluations. Also, the transient model was selected to provide output that simulates the aquifer concentrations versus time and models a finite source.

Model Simulations and Results

Using the input parameters provided, soil concentrations for chloride were iteratively varied to arrive at an appropriate maximum allowable soil concentration that would be protective of groundwater for each of the scenarios. To calculate the maximum concentration that would be observed given the input concentrations and parameters, the simulation period selected was 1,980 years with 20-year time steps.

To ascertain the maximum allowable chloride concentration for more typical chloride concentration distribution and depth to groundwater scenarios, eight MULTIMED simulations were completed. The scenarios are summarized in Table 2. The input values for the simulations were the same, except for the thickness and width of the chloride-affected soil within the soil column. The first four simulations evaluated homogeneous chloride-affected soil 20 meters wide (400 square meters [m^2]) and varied the chloride-affected soil thickness between 1 meter and 3 meters and the depth to groundwater between 20 and 30.5 meters. The remaining four simulations evaluated homogeneous chloride-affected soil 45 meters wide (2,000 m^2) and varied the chloride affected soil thickness between 1 meter and 3 meters and the depth to groundwater between 20 and 30.5 meters

The predicted groundwater concentrations versus time are illustrated on Figures 1 through 8. The peak arrival times varied between 540 and 860 years. The simulations indicate the site SSLs for the protection of groundwater ranged from 8,525 to 266,100 mg/kg (Table 2) depending on the scenario and are protective of the New Mexico chloride groundwater standard of 250 mg/L.

The MULTIMED model, like any model, requires the use of simplifying assumptions regarding subsurface conditions and flow processes that result in inherent limitations and uncertainty compared to an actual flow system. In this case, uncertainty may be related to:

- The model assumes homogeneous unsaturated and saturated zones; the actual conditions at the sites likely contain numerous heterogeneities.

- The applied recharge and infiltration rates are constant. The aquifer hydraulic gradient is also assumed to be constant. These rates likely vary with time, and these variations may influence the solute migration and mixing, resulting in short-term changes in aquifer concentrations

- The model is a theoretical simulation of transport processes and is not verified or calibrated against site-specific data.

Conclusions and Recommendations

The model simulations reasonably represent conditions encountered at most of the Lea County and eastern Eddy County HES Transfer Sites. HES Transfer Sites with chloride-affected soil can be screened

against SSLs in Table 2, assuming they meet the specified conditions (source length, source depth, depth to groundwater, and soil concentration). For calculated SSLs greater than 100,000 mg/kg, a maximum allowable soil concentration of 100,000 mg/kg is recommended in accordance with the NMED risk assessment guidance (NMED 2012). For sites that meet all of these conditions, no further action is recommended. For the sites that do not meet these conditions, site-specific evaluations should be conducted.

Enclosures:

Tables

Table 1 MULTIMED V2.0 Model Inputs

Table 2 Soil Screening Level Matrix

Figures

Figure 1 MULTIMED Simulated Chloride Concentration vs. Time (Source = 20m, Chloride 0-1m, & Depth to Groundwater = 20m)

Figure 2 MULTIMED Simulated Chloride Concentration vs. Time (Source = 20m, Chloride 0-1m, & Depth to Groundwater = 30.5m)

Figure 3 MULTIMED Simulated Chloride Concentration vs. Time (Source = 20m, Chloride 0-3m, & Depth to Groundwater = 20m)

Figure 4 MULTIMED Simulated Chloride Concentration vs. Time (Source = 20m, Chloride 0-3m, & Depth to Groundwater = 30.5m)

Figure 5 MULTIMED Simulated Chloride Concentration vs. Time (Source = 45m, Chloride 0-1m, & Depth to Groundwater = 20m)

Figure 6 MULTIMED Simulated Chloride Concentration vs. Time (Source = 45m, Chloride 0-1m, & Depth to Groundwater = 30.5m)

Figure 7 MULTIMED Simulated Chloride Concentration vs. Time (Source = 45m, Chloride 0-3m, & Depth to Groundwater = 20m)

Figure 8 MULTIMED Simulated Chloride Concentration vs. Time (Source = 45m, Chloride 0-3m, & Depth to Groundwater = 30.5m)

References

New Mexico Environment Department. 2012. Risk Assessment Guidance for Investigations and Remediation, Volume I. February 2012 (updated June 2012).

Salhotra, A.M., P. Mineart, S. Sharp-Hansen, T. Allison, R. Johns, and W.B. Mills. 1995. Multimedia Exposure Assessment Model (MULTIMED 2.0) for Evaluating the Land Disposal of Wastes--Model Theory. United States Environmental Protection Agency, Athens, GA. Unpublished Report.

United States Environmental Protection Agency. 1996. A Subtitle D Landfill Application Manual for the Multimedia Exposure Assessment Model (MULTIMED 2.0). Final Report.

Van Genuchten, M, Th., and P.J. Wierenga. 1976. Mass Transfer Studies in Sorbing Porous Media I. Analytical Solutions. Soil Science Society of America Proceedings. v 40, 473-480.

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Tables

Table 1
MULTIMED V2.0 Model Inputs
Chevron HES Transfer Sites
Lea County, New Mexico

Parameters		Value(s)	Units	*Notes*
Unsaturated Zone Flow Parameters:				
Depth of Unsaturated Zone		20.0	m	Local water levels (20m & 30.5m)
Hydraulic Conductivity		0.06	cm/hr	Texas (2011)
Unsaturated Zone Porosity		0.44	fraction	NMED (2012) Default
Residual Water Content		0.260	fraction	NMED (2012) Default
Unsaturated Zone Transport Parameters:				
Thickness of Layer		20 & 30.5	m	Regional water levels
Percent of Organic Matter		1.5%		NMED (2012) Default (not used)
Bulk Density		1.5	g/cm^3	NMED (2012) Default
Biological Decay Coefficient		0	1/yr	(not used)
Aquifer Parameters:				
Aquifer Porosity		0.43	fraction	NMED (2012) Default
Bulk Density		1.5	g/cm^3	NMED (2012) Default
Aquifer Thickness		12.0	m	NMED (2012) Default
Hydraulic Conductivity		542	m/yr	Texas (2011), Velocity ~ 1/2 NMED Default
Hydraulic Gradient		0.010	m/m	NMED (2012) Default
Organic Carbon Content		0.020	fraction	NMED (2012) Default (not used)
Temperature of Aquifer		15.0	°C	NMED (2012) Default (not used)
pH		6.2		(not used)
x-distance Radial Distance from Site to Receptor		12	m	equal to aquifer thickness
Source Parameters:				
Infiltration Rate		0.013	m/yr	~0.5 in/yr, Texas (2011)
Area of Waste		400 & 2000	m^2	NMED (2012) Default (~45m x45m)
Recharge Rate		0.013	m/yr	Texas (2011)
Duration of Pulse		540 to 840	yr	Varied, set equal to peak arrival time
Discharge Concentrations		0	mg/L	
Initial Soil Concentrations:				
	Depth (m)			
Chloride leachate concentration	*0*	varied	mg/L	Calculated for each scenario[1]
Chloride leachate concentration	*1 & 3*	0	mg/L	
Chloride leachate concentration	*20 & 30.5*	0	mg/L	
Additional Parameters:				
Method		Gaussian		
New Mexico Environment Department. 2012. Risk		Chloride		
Chemical Parameters:				
Normalized Distribution Coefficient		0.00	mL/g	Model Derived
Van Genuchten Parameters:				
Alpha Van Genuchten coefficient		0.38	unitless	NCSS Soil Characterization Data[2]
Beta Van Genuchten coefficient		1.2	unitless	NCSS Soil Characterization Data[2]

Notes:

°C - degrees celcius
cm - centimeters
cm^3 - cubic centimeters
g - grams
hr - hour
L - liters
m - meters
m^2 - meter squared
mg - milligrams
mL - milliliters
yr - year

1 - calculated using the soil-water partitioning equation
2 - van Genutchen transport parameters are typical values for caliche-like material

References:

NMED - New Mexico Environmental Department Risk Assessment Guidance for Site Investigations and Remediation. February 2012.
NCSS - National Cooperative Soil Survey, National Cooperative Soil Characterization Database
Texas - Texas Water Development Board 2011. Update of the Groundwater Availability Model for the Edwards-Trinity (Plateau) and Pecos Valley Aquifers of Texas. January 21, 2011

Table 2
Soil Screening Level Matrix
Chevron HES Transfer Sites
Lea County, New Mexico

Scenario	Source Length (m)	Source Area (m)	Source Depth (m)	Depth to Groundwater (m)	SSL_{gw} (mg/Kg)	Notes
1	20	400	0-1	20.0	108,000	1
2	20	400	0-1	30.5	266,100	1
3	20	400	0-3	20.0	23,750	
4	20	400	0-3	30.5	45,000	
5	45	2,000	0-1	20.0	38,800	
6	45	2,000	0-1	30.5	95,500	
7	45	2,000	0-3	20.0	8,525	
8	45	2,000	0-3	30.5	16,100	

NMED SSL Ceiling = 100,000 mg/Kg

Notes:

m - meters

mg/Kg - milligrams per Kilogram

NMED - New Mexico Environmental Department

SSL_{gw} - Site soil screening levels for the migration to groundwater pathway

SSL Ceiling - Soil Screening Level Ceiling (NMED 2012)

1 - the NMED SSL ceiling should be used

References:

New Mexico Environment Department. 2012. Risk Assessment Guidance for Investigations and Remediation, Volume I. February 2012 (updated June 2012).

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Figures

Figure 1
MULTIMED Simulated Chloride Concentration Vs Time in Groundwater
(Source = 20m, Chloride 0-1m, & Depth to Groundwater = 20m)

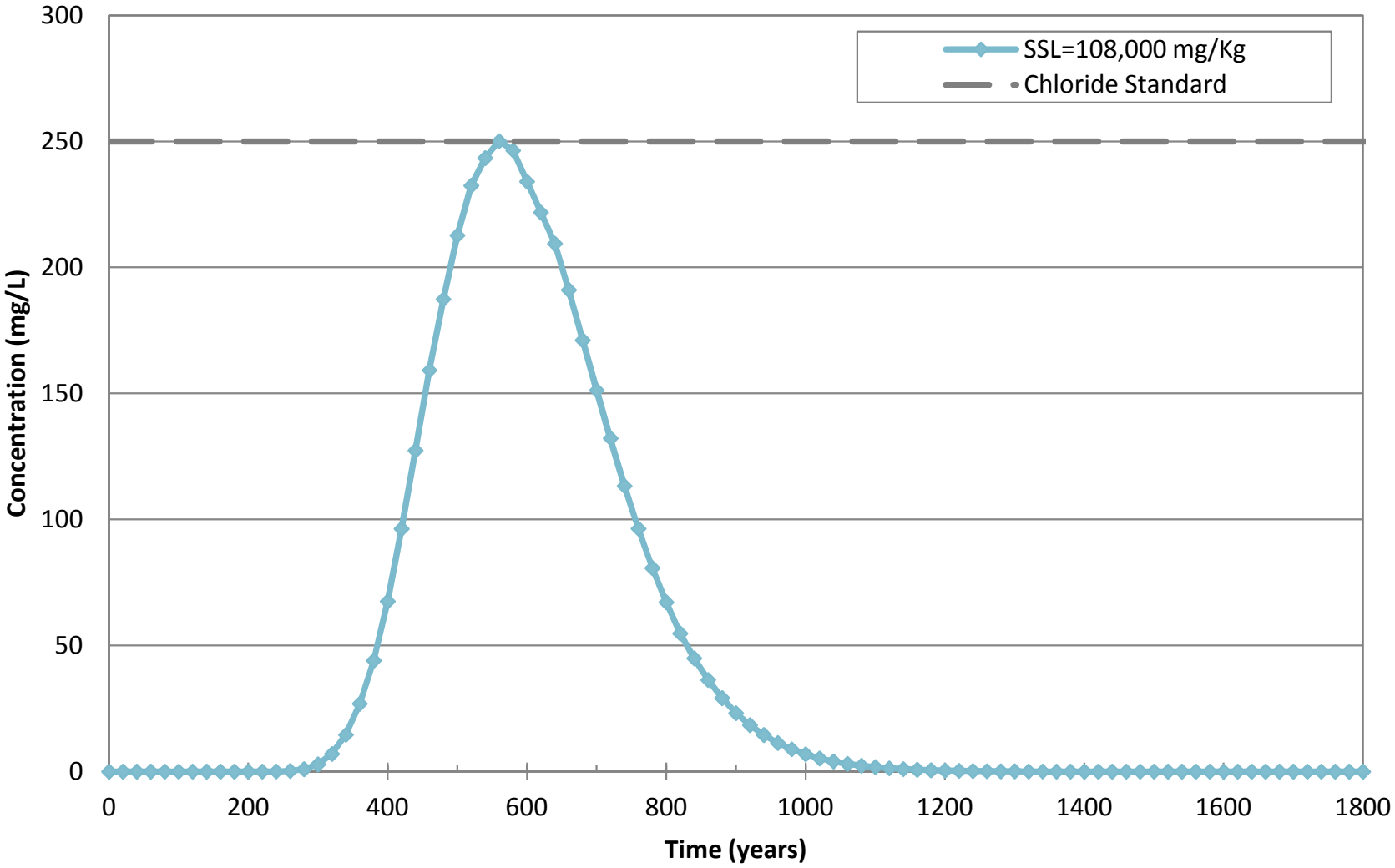

Figure 2
MULTIMED Simulated Chloride Concentration Vs Time in Groundwater
(Source = 20m, Chloride 0-1m, & Depth to Groundwater = 30.5m)

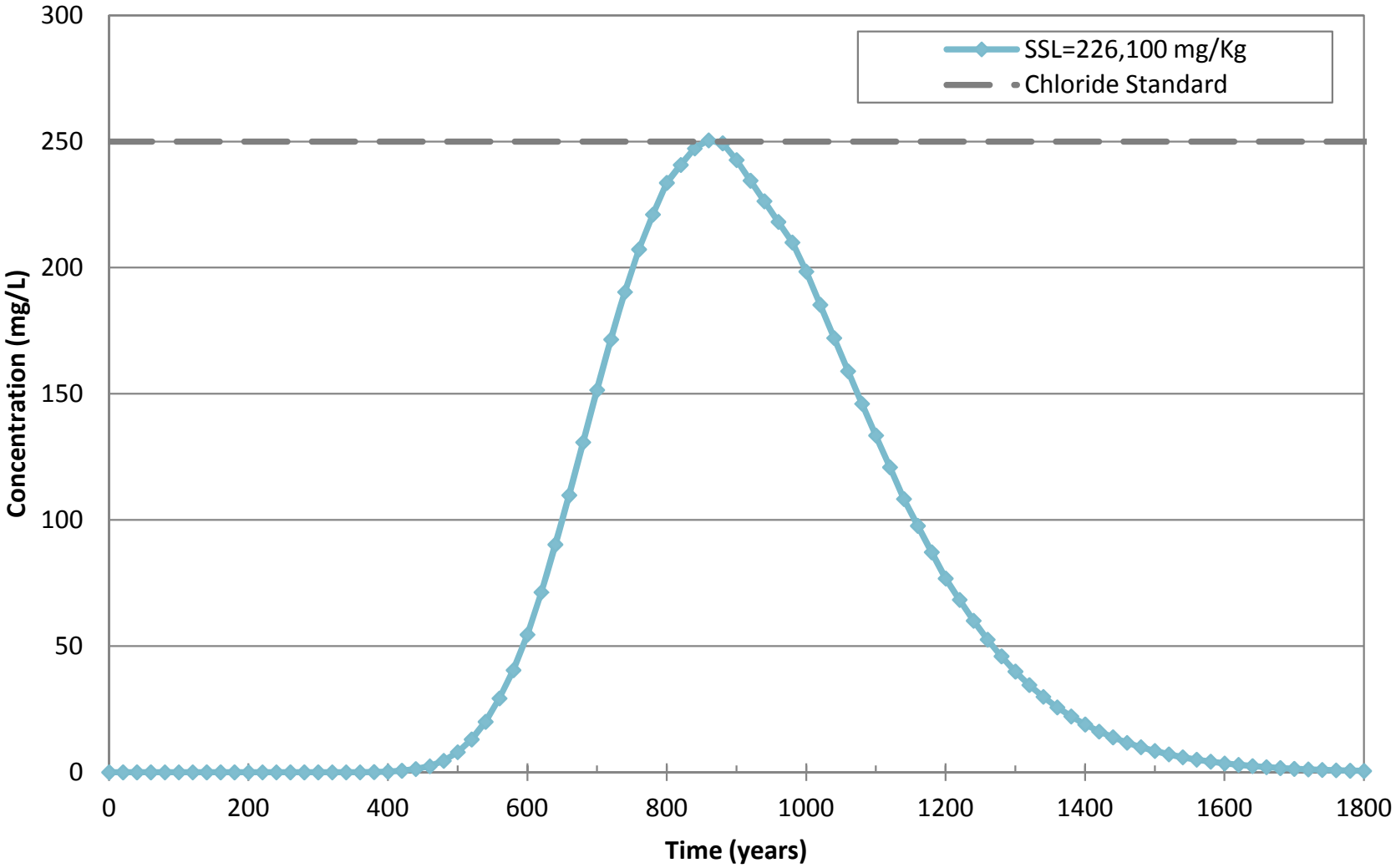

Figure 3
MULTIMED Simulated Chloride Concentration Vs Time in Groundwater
(Source = 20m, Chloride 0-3m, & Depth to Groundwater = 20m)

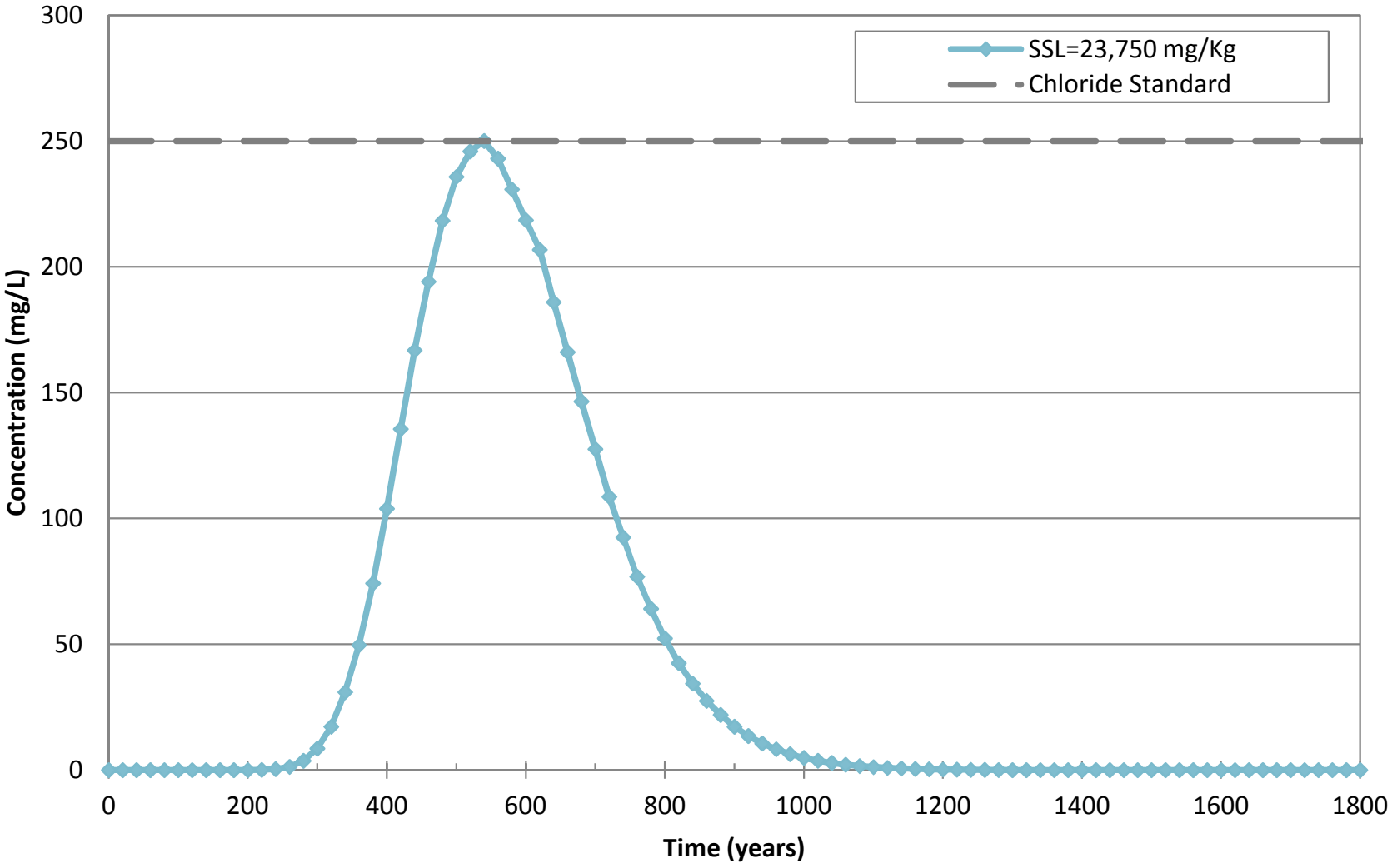

Figure 4
MULTIMED Simulated Chloride Concentration Vs Time in Groundwater
(Source = 20m, Chloride 0-3m, & Depth to Groundwater = 30.5m)

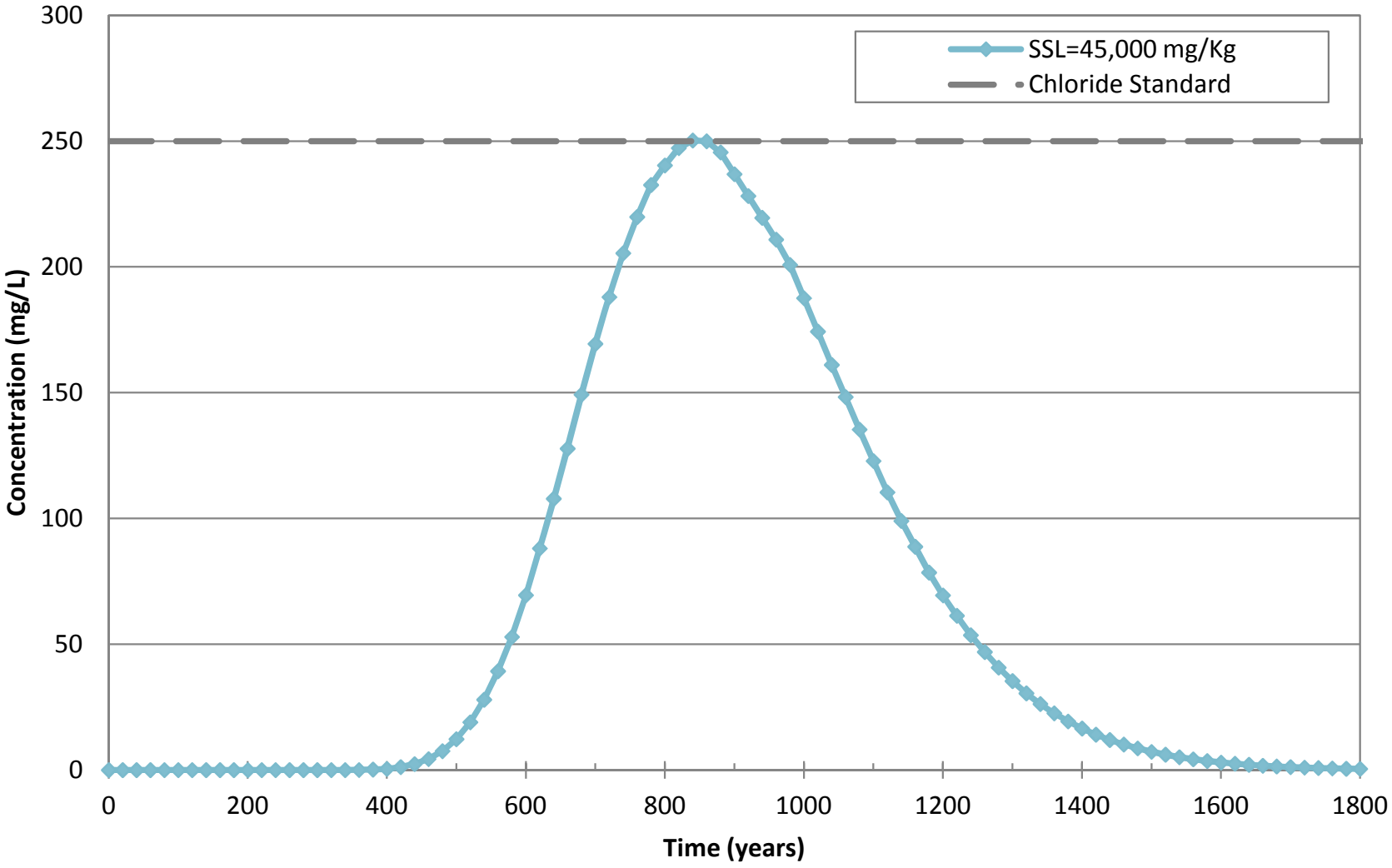

Figure 5
MULTIMED Simulated Chloride Concentration Vs Time in Groundwater
(Source = 45m, Chloride 0-1m, & Depth to Groundwater = 20m)

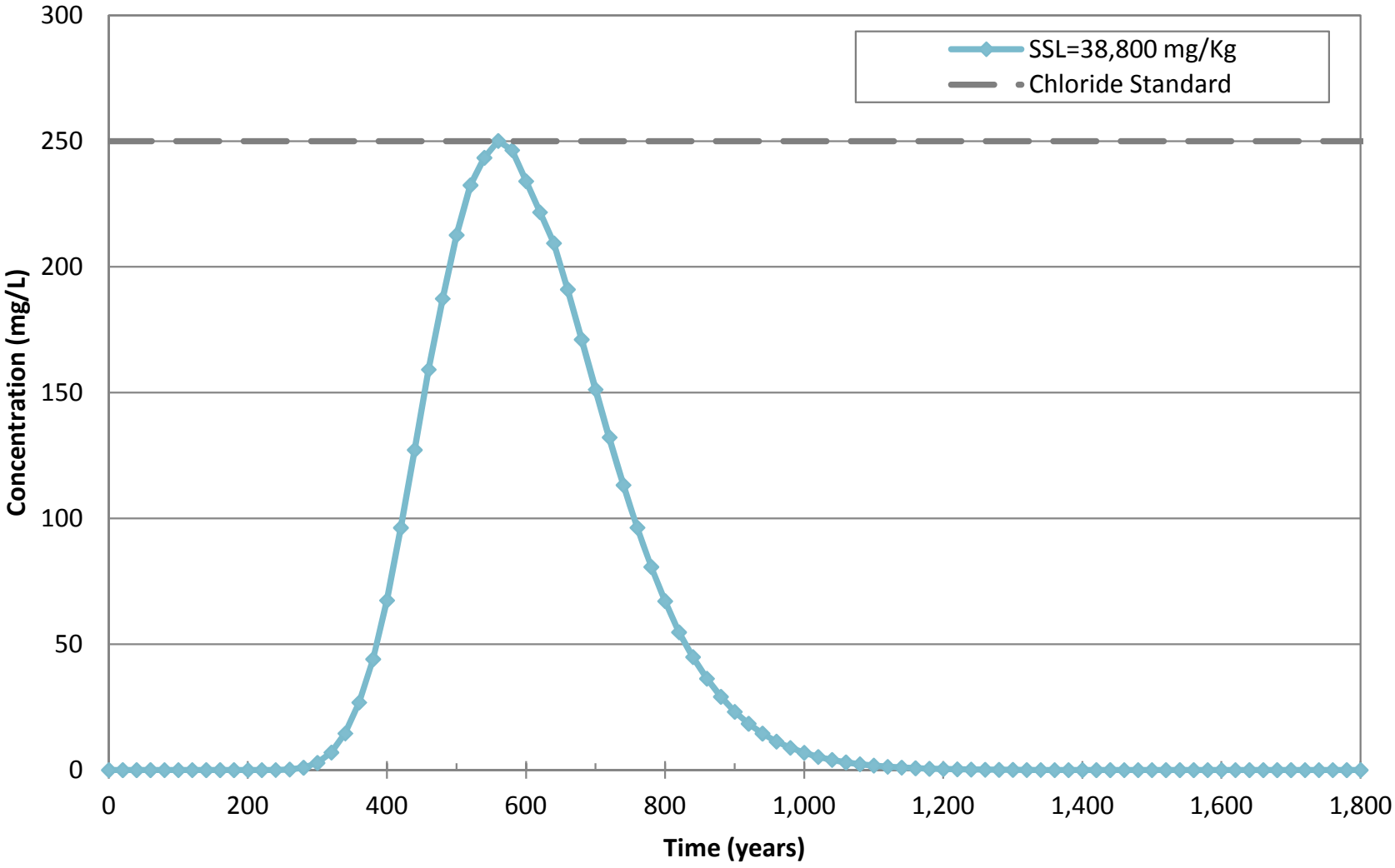

Figure 6
MULTIMED Simulated Chloride Concentration Vs Time in Groundwater
(Source = 45m, Chloride 0-1m, & Depth to Groundwater = 30.5m)

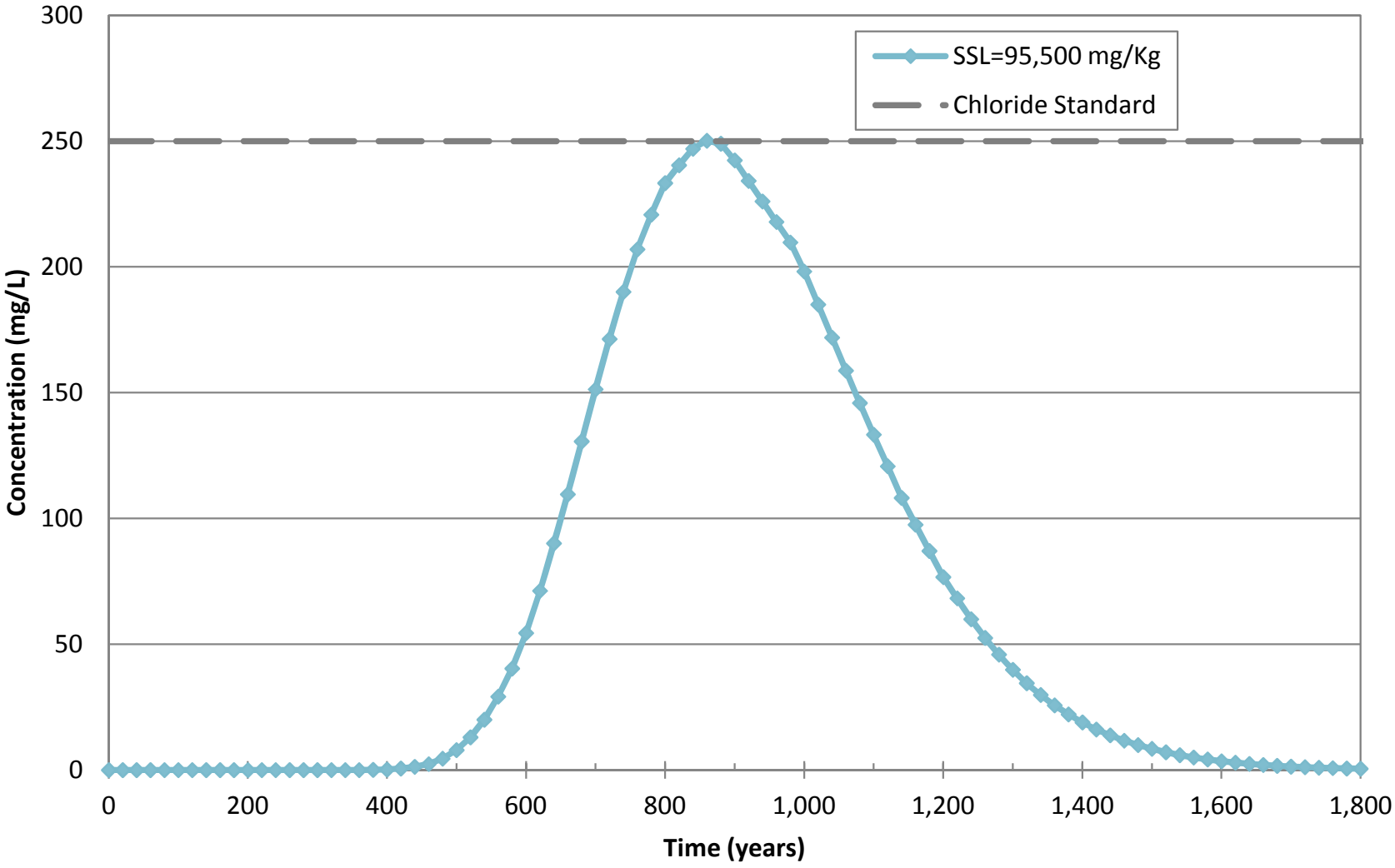

Figure 7
MULTIMED Simulated Chloride Concentration Vs Time in Groundwater
(Source = 45m, Chloride 0-3m, & Depth to Groundwater = 20m)

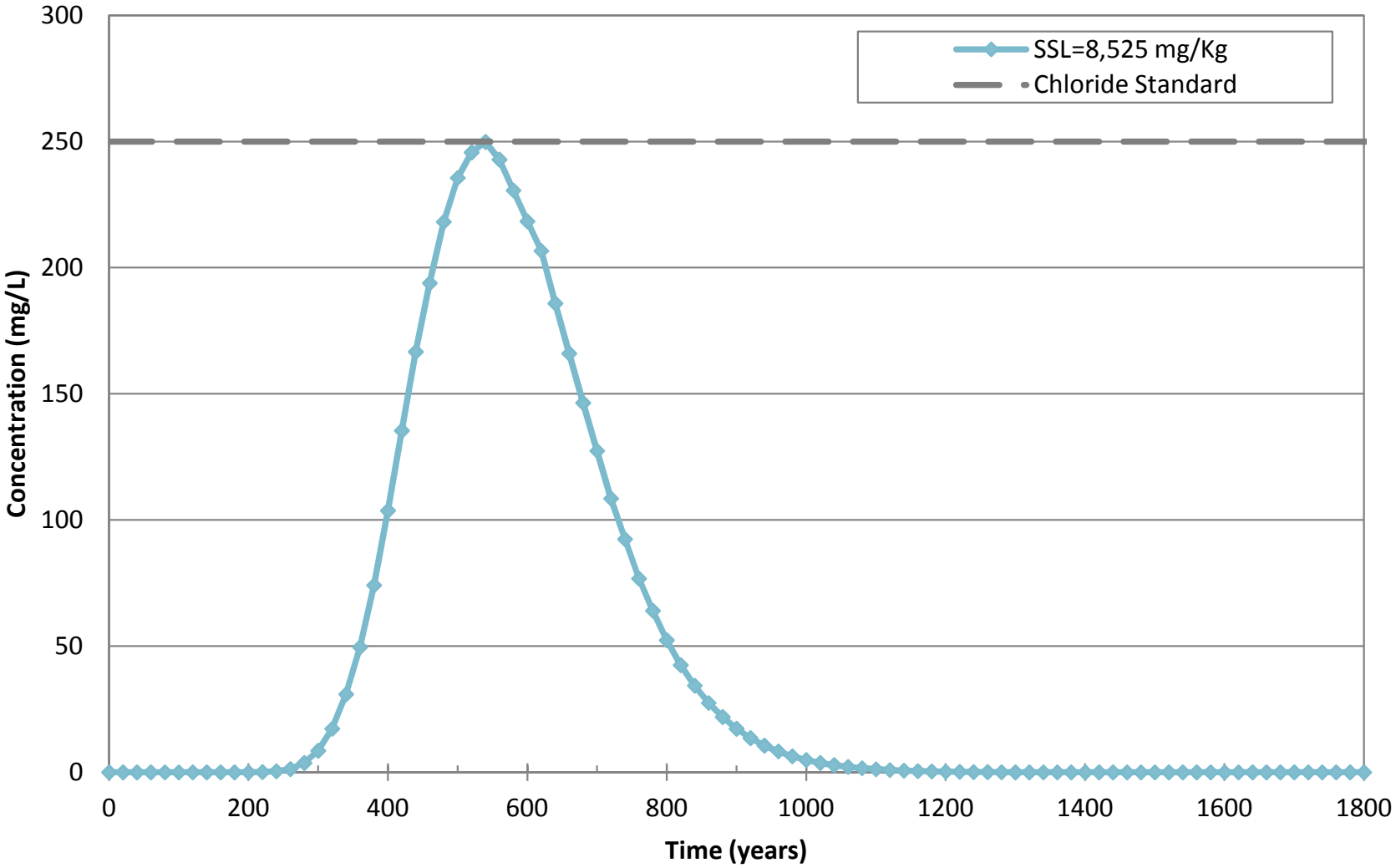

Figure 8
MULTIMED Simulated Chloride Concentration Vs Time in Groundwater
(Source = 45m, Chloride 0-3m, & Depth to Groundwater = 30.5m)