September 11, 2018
Cardno 01361304.W01

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Ms. Olivia Yu
Environmental Specialist
State of New Mexico Oil Conservation Division
District 1
1625 North French Drive
Hobbs, New Mexico 88240

SUBJECT **Work Plan for Additional Soil Assessment**
Former State K Tank Battery No. 3
Vacuum Oil Field
Lea County, New Mexico
NMOCD IRP No. 09-7-2239

Ms. Yu:

At the request of ExxonMobil Environmental Services Company (EMES) on behalf of ExxonMobil US Production Company, Cardno prepared this work plan for the subject site. The purpose of the work is to further assess previously identified chloride concentrations in soil by drilling and sampling soil beneath the site property.

Please call the undersigned at 949 457 8941 if you have questions.

Sincerely,

David M. Purdy
Senior Project Manager
for Cardno
Direct Line 949 457 8941
Email: dave.purdy@cardno.com

APPROVED
By Olivia Yu at 12:27 pm, Sep 19, 2018

NMOCD approves of the proposed release characterization plan for 1RP-2239.

cc: Ms. Marla D. Madden, EMES

Work Plan for Additional Soil Assessment

Former State K Tank Battery No. 3 Vacuum Oil Field

Vacuum Oil Field
Lea County, New Mexico
OCD No. AP038

Cardno 01361304.W01

Prepared for
ExxonMobil Environmental Services Company

September 11, 2018

Cardno®

Work Plan for Additional Soil Assessment

Former State K Tank Battery No. 3
Vacuum Oil Field
Lea County, New Mexico
NMOCD IRP No. 09-7-2239

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September 11, 2018

David M. Purdy
Senior Project Manager
for Cardno
Direct Line 949 457 8941
Email: dave.purdy@cardno.com

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Plates

Tables

Appendices

1 Introduction

At the request of ExxonMobil Environmental Services Company (EMES), on behalf of Exxon Mobil Corporation, Cardno prepared this work plan for the site (Plate 1). The purpose of the work is to further assess previously identified chloride concentrations in soil by drilling and sampling soil beneath the site property.

2 Site Description

The former State K Tank Battery No. 3 is located in the Vacuum Oil Field, Lea County, New Mexico. The property is located in the northwest corner of the northeast quarter of the southeast quarter of Section 32, Township 17 South, Range 35 East of the New Mexico Meridian and Baseline (Plate 1). The property is owned by the New Mexico State Land Office (NMSLO). An ExxonMobil Oil Corporation affiliate was the former oil and gas lease holder and operator of the tank battery. Prior to the divestment of the lease, the tank battery was decommissioned and removed from the site property. Chesapeake Energy Corporation currently holds an oil and gas lease for the site. The property is currently unoccupied.

3 Geology and Hydrogeology

The site is located in northeastern Lea County, New Mexico, within the Maljamar-Vacuum field. The Maljamar-Vacuum field belongs to a larger system in the Permian basin. The field sediments are mainly Paleozoic carbonates with periodic siliciclastic and evaporate deposition dating from Ordovician through Permian age with the thickness exceeding 9 km in the Southern Delaware Basin (Roche, 1997). Soils encountered during previous investigations at the site are comprised of dense dry silt and clayey silty sand, calcareous silty sand, limestone and sandstone to the maximum depth drilled of 30 feet bgs (Kleinfelder, 2012a).

Based on well data collected from the New Mexico Office of the State Engineer Water Administration Technical Engineering Resource System database (NM State Engineer database) in the general area of the site, the depth to groundwater varies within the range of 80 and 120 feet bgs. The primary source of water is the Ogallala Aquifer. The Ogallala formation is comprised of variably cemented calcic sands, silts, caliche, gravel and some clays, and ranges in thickness from 50 to 300 feet. Groundwater is being rapidly depleted in certain areas. Due to intensive groundwater pumping, water levels have declined and the direction of groundwater flow has shifted. In Lea County, groundwater levels have declined 50 to 100 feet (McGuire, 2014) with rates of decline up to 4 feet per year and averaging 0.59 foot per year for wells in Lea County (USGS, 2013). According to the NM State Engineer database, no water wells are located within 1,000 feet of the site. Based on observations in the general vicinity of the site and review of aerial photographs, there are no surface bodies of water within 1,000 feet of the site.

4 Regulatory Framework and Site Classification

The NMOCD has regulatory jurisdiction over oil and gas production operations including closure activities in the State of New Mexico. The NMOCD requires that soil impacted by a crude oil production activities be remediated in such a manner that the potential for future impacts to groundwater or the environment be minimized. The NMOCD hydrocarbon remediation levels are determined by ranking criteria on a site-by-site basis as outlined in the New Mexico Administrative Code (NMAC) Title 19 – Natural Resources and Wildlife, Chapter 15, Oil and Gas. The

ranking criteria are based on three site characteristics: depth below bottom of pit to groundwater less than 10,000 mg/l TDS, groundwater, wellhead protection; and distance to surface water.

During June 2009, ExxonMobil's former environmental consultant Kleinfelder conducted a sensitive receptor survey of the area. The depth to groundwater varies within the range of 50 to 99 feet bgs based on well data collected prior to the submittal of this work plan from the New Mexico Office of the State Engineer Water Administration Technical Engineering Resource System database (NM State Engineer database). According to the database, there are no water wells located within 1,000 feet of the site. This data provides a ranking score of 10 for this site as follows:

RANKING CRITERIA AND SCORING
NEW MEXICO STATE K TANK BATTERY NO. 3

CHARACTERISTIC	SELECTION	SCORE
Depth to Groundwater	50-99 feet	10
Wellhead Protection Area	>1,000 feet	0
Distance to Surface Water	>1,000 feet	0

Total Score = 10

Based on a score of 10, the following soil hydrocarbon Recommended Remediation Action Levels (RRALs) apply to the site:

SOIL REMEDIATION LEVELS
NEW MEXICO STATE K TANK BATTERY NO. 3

CONSTITUENT OF CONCERN	RRALs (mg/kg)
Benzene	10
Total BTEX	50
TPH	1,000

On January 25, 2012, Kleinfelder contacted Mr. Geoffrey Leking of the NMOCD regarding chloride regulatory action levels. Mr. Leking indicated that although there is currently no established chloride RRAL, chloride limits are generally applied based on the distance between the depths of the chloride impacted soil and the depth of the groundwater, according to the following guidelines:

DISTANCE BETWEEN THE DEPTH OF THE CHLORIDE IMPACTED SOIL AND THE DEPTH OF THE GROUNDWATER	CHLORIDE LIMIT (mg/kg)
<50 feet	250
50 – 100 feet	500
>100 feet	1,000

5 Previous Work

Soil investigations have been conducted at the site since 2005. Previous work has included the drilling of soil borings, the remedial excavation of naturally occurring radioactive materials (NORM) containing soil and subsurface investigations to determine the lateral and vertical extent of chloride in soil beneath the site property (Plate 2). For detailed information regarding these investigations, refer to the documents listed in the reference section. Cumulative soil analytical results are summarized in Table 1.

5.1 Site Assessment and Remediation Activities

May through August, 2005. Conestoga-Rovers and Associates (CRA) conducted an assessment and remediation of NORM at the site. The NORM assessment consisted of conducting a NORM survey and remedial excavation and disposal of soils exceeding the NORM remediation action level as defined by the New Mexico Administrative Code 20.3.14.1403. Confirmation soil samples were collected from remedial excavation areas. The activity levels in the confirmation samples were below the remediation action levels. NORM assessment and remediation has been completed at the site (CRA, 2005).

In addition, CRA conducted a subsurface investigation that consisted of advancing 11 soil borings (SB1 through SB11) to assess petroleum hydrocarbons and chloride concentrations in soil beneath the site. One soil sample collected from soil boring SB2 at a depth of 1 to 2 feet bgs, was reported to contain a concentration of TPH greater than the RRAL of 1,000 mg/kg. No BTEX concentrations were reported in the soil samples greater than the laboratory reporting limit (CRA, 2005). Chloride concentrations above the laboratory reporting limit were reported in samples collected from each of the 11 soil borings up to a maximum concentration of 4,950 mg/kg. CRA collected a background chloride soil sample just off the site property across the south access road which was analyzed below the laboratory reporting limit of 12.6 mg/kg. In addition, it appears that CRA advanced soil boring SB-5 to a depth of 20 feet bgs, logged the boring for lithology and collected soil samples at 1, 15 and 20 feet bgs, but the location of the boring does not appear on any site plan(CRA, 2005).

March and April 2010. Kleinfelder performed additional soil investigation activities to assess the extent of chlorides in the subsurface. A geophysical survey of the site was conducted to estimate the extent of the chloride plume and to select boring locations for sampling. The results of the survey indicated that there were three potential areas of increased conductivity (which equates to elevated chloride concentrations) between the surface and 18 feet bgs. Three additional potential areas of increased conductivity between the depths of 18 to 49 feet were also identified. The potential areas of increased conductivity are presented on Plates 3 and 4 and have been separated between 1 to 2 feet bgs and from 20 to 30 feet bgs. Based on this data, six soil borings (KSB-01, KSB-02, and KSB-04 through KSB-07) were advanced to a depth of 30 feet bgs. Concentrations of BTEX and TPH were reported below the RRALs and chloride concentrations ranged from 43.2 mg/kg to 4,800 mg/kg in soil samples collected.

February 2012. Kleinfelder attended a meeting with the NMOCD to discuss the subsurface investigations previously conducted at the site and to come up with a pathway to environmental case closure for the property. During the meeting, the NMOCD and Kleinfelder determined that based on the anticipated depth to groundwater at the site, chloride concentrations in soil must be vertically and horizontally delineated to the cleanup standard of 250 mg/kg. In the event that chloride concentrations do not drop below 250 mg/kg before reaching groundwater, upgradient and downgradient groundwater monitoring wells will be installed to assess chloride in groundwater. In the event that the lateral and vertical extent of chloride beneath the site property is adequately assess to <250 mg/kg chloride, the top five feet of soil will be excavated in the areas deemed to exceed the cleanup standard and will be backfilled with a sealing material (Kleinfelder, 2012b).

6 Proposed Work

To determine the lateral and vertical extent of chloride in soil beneath the site property, Cardno proposes to advance 12 soil borings in the vicinity of previously drilled borings that yielded chloride concentrations in excess of 250 mg/kg and inside areas that were designated chloride plume zones by geophysical survey. The boring locations are shown on the Chloride Soil Concentration Map 1-2 Feet bgs (Plate 3) and the Chloride Soil Concentration Map 20-30 Feet Bgs (Plate 4).

6.1 Proposed Soil Boring Locations

The proposed boring locations are detailed in the following subsections.

6.1.1 Previous boring location KSB-05

One soil boring will be advanced to a minimum depth of 20 feet bgs adjacent to previous boring KSB-05 which yielded a chloride concentration of 5,223 at 1 foot bgs (Plate 3).

6.1.2 Chloride Plume Zone 1 (0-18 feet bgs)

One soil boring will advanced to a minimum depth of 35 feet bgs adjacent to previous boring KSB-01 which yielded a chloride concentration of 2,220 mg/kg at 30 feet bgs and soil boring SB11 which yielded a chloride concentration of 269 mg/kg at 21 feet bgs.

One soil boring will advanced to a minimum depth of 20 feet bgs adjacent to previous boring KSB-06 which yielded a chloride concentration of 1,632 mg/kg at 1 foot bgs.

One soil boring will be advanced to a minimum depth of 30 feet bgs adjacent to boring SB1 which yielded a chloride concentration of 955 mg/kg at 20 feet bgs.

Two soil borings will be advanced to a minimum depth of 20 feet bgs just north and south of the westernmost plume zone 1 for lateral delineation of chloride.

One soil boring will be advanced to a minimum depth of 35 feet bgs adjacent to previous boring KSB-02 which yielded a chloride concentration of 289 mg/kg at 30 feet bgs and one soil boring will be advanced south of the concrete form to a depth of 30 feet to delineate in the middle plume zone.

One soil boring will be advanced to a minimum depth of 30 feet bgs adjacent to previous boring SB4 which yielded a chloride concentration of 1,220 mg/kg at 21 feet bgs.

One soil boring will be advanced to a minimum depth of 35 feet bgs adjacent to previous boring KSB-04 which yielded a chloride concentration of 520 mg/kg at 30 feet bgs.

One soil boring will be advanced to a minimum depth of 20 feet bgs south of previous boring KSB-04 to further delineate the easternmost plume zone.

6.1.3 Chloride Plume Zone 2 (18-49 feet bgs)

One soil boring will be advanced to a minimum depth of 20 feet bgs approximately 60 feet north of KSB-05 to delineate chloride in soil in the vicinity of the chloride plume zone as detected by previous geotechnical survey.

One soil boring will be advanced to a minimum depth of 30 feet bgs adjacent to previous boring SB3 which yielded a chloride concentration of 1,470 mg/kg at 21 feet bgs.

6.2 Pre-Field Activities

Prior to the onset of drilling, Cardno will obtain a Right of Entry Permit (Remediation) with NMSLO and will notify Chesapeake Energy Corporation of our intent to conduct this investigation. Cardno will conduct a geophysical survey to check for subsurface obstructions and to confirm areas of increased chloride

concentrations. Cardno will then line out a 30-foot squared grid as annotated on Plates 3 and 4 and mark out the proposed boring locations. Marking out the grid will aid Cardno in determining where previous assessment has been completed and after the subsurface investigation is completed, will aid Cardno in selecting areas for excavation and removal. New Mexico One Call will be contacted and affected utility companies will mark any underground lines. Prior to the onset of drilling, a well installation permit will be obtained from the New Mexico Office of the State Engineer (NMOSE). The NMOSE and NMOCD will be notified at least 48 hours prior to the onset of field activities.

6.3 Soil Boring Sampling and Logging Activities

The proposed locations of the soil borings are depicted on Plate 2. The procedures for drilling, decontamination, and well construction are described in the field protocol contained in Appendix A. The fieldwork will be conducted under the advisement of a professional geologist and in accordance with applicable regulatory guidelines.

For soil samples collected from borings advanced in Chloride Plume Zone 2 and adjacent to previous boring KSB-06 and KSB-05, Cardno will conduct field screening by heated head space in accordance with NMED Petroleum Storage Tank Bureau's Guidelines using a PID calibrated to a 100 ppmv isobutylene standard. The soil will be placed in a 16-ounce or larger glass jar, filled halfway. The top of the jar will be sealed with clean aluminium foil. After the soil has reached approximately 60 to 80 degrees Fahrenheit for approximately 5 to 10 minutes, the sample will be vigorously shaken, the foil seal will be punctured with the PID probe and the highest measurement recorded.

The borings will be drilled using an air rotary rig. The drilling locations will be sampled at 5-foot intervals, at significant changes in lithology and at capillary fringe (if encountered) to total depth for geologic logging purposes. The borings will be drilled to their respective proposed depths or until concentrations of chloride in soil samples collected from each boring is less than 250 mg/kg based on field instruments and/or mobile lab results.

Cardno will use a conductivity probe to determine if soil samples contain chloride and if deeper soil sampling is warranted for vertical delineation. Soil boring locations will be backfilled within 5 feet of surface grade with a neat cement/bentonite mixture and completed in accordance with the field protocol. Cardno may convert the borings to groundwater monitoring wells should field conditions and/or mobile laboratory analytical results indicate the presence of chloride in groundwater.

Based upon the results of field screening or laboratory analysis, additional step out borings may be advanced where concentrations exceeding regulatory action levels are identified to continue progression of necessary delineation activities.

6.4 Groundwater Monitoring Well Construction, Development, and Sampling

If groundwater is encountered during this investigation, groundwater grab samples will be collected from each of the borings. If analytical results of field instruments and/or the on-site mobile laboratory indicate the presence of COCs in groundwater, the borings will be converted to groundwater monitoring wells.

The wells will be constructed using 4-inch diameter, Schedule 40, PVC casings. Each well will be screened from 5 feet above to 10 feet below static groundwater (Plate 3). Following construction, the groundwater monitoring wells will be developed and sampled.

6.5 Laboratory Analyses

Soil and groundwater samples will be submitted for analysis to a State-certified mobile laboratory or Eurofins Laboratories, Inc., a New Mexico State-certified analytical laboratory, under Chain-of-Custody protocol. Soil samples collected from borings advanced in Chloride Plume Zone 2 and adjacent to previous boring KSB-06 and KSB-05 will be analyzed for TPH using EPA Method 8015B and for BTEX using EPA Method 8260B. All soil samples will be analyzed for chloride using EPA Method 300 and for chloride synthetic precipitation

leaching procedure (SPLP) using EPA Method 9056. If necessary, the groundwater samples will be analyzed for chlorides using SM 4500-Cl-E, for TPH using EPA Method 8015M, and using BTEX by EPA Method 8260B. Select soil samples collected from the near surface will also be analyzed for Exchangeable Sodium Percent (ESP), Sodium Adsorption Ratio (SAR), and conductivity (EC).

6.6 Waste Management Plan

The soil and decontamination water generated during soil boring drilling activities will be temporarily stored on site in DOT-approved, 55-gallon drums. Soil cuttings will be transported under non-hazardous waste manifest or bill of lading to Contract Environmental Services, Inc. disposal facility in San Juan County, Utah, an EMES- and state-approved facility. Decontamination water will be will be transported under proper manifest and disposed of at Thermo Fluids, Inc., in Phoenix, Arizona, an EMES- and state-approved recycling facility. Copies of the manifests will be provided in the assessment report.

If the borings are converted to groundwater monitoring wells, soil cuttings and decontamination water generated during drilling and well installation activities will be temporarily stored in DOT-approved, sealed 55-gallon drums. The soil and water will then be transported by Alamo1 to Sundance Services, Inc. in Eunice, New Mexico. Copies of waste bills of lading and/or manifests will be provided in the well assessment report.

6.7 Site Safety Plan

The fieldwork will be performed in accordance with the site-specific safety plan.

6.8 Report

After completion of the proposed field activities, a report summarizing field and laboratory procedures, boring logs, and laboratory results will be submitted to EMES and the NMOCD.

7 Contact Information

The responsible party contact is Ms. Marla D. Madden, EMES, 18685 Main Street, Suite 101 PMB 601, Huntington Beach, California, 92648-1719.

The consultant contact is Mr. David M. Purdy, Cardno, 20505 Crescent Bay Drive, Lake Forest, California, 92630.

The agency contact is Ms. Oliva Yu, State of New Mexico Oil Conservation Division District 1, 1625 North French Drive, Hobbs, New Mexico, 88240.

8 Limitations

For documents cited that were not generated by Cardno, the data taken from those documents is used “as is” and is assumed to be accurate. Cardno does not guarantee the accuracy of this data and makes no warranties for the referenced work performed nor the inferences or conclusions stated in these documents.

This document and the work performed have been undertaken in good faith, with due diligence and with the expertise, experience, capability, and specialized knowledge necessary to perform the work in a good and workmanlike manner and within all accepted standards pertaining to providers of environmental services in New Mexico at the time of investigation. No soil engineering or geotechnical references are implied or should be inferred. The evaluation of the geologic conditions at the site for this investigation is made from a limited number of data points. Subsurface conditions may vary away from these data points.

9 References

Conestoga-Rovers. December 9, 2005. *New Mexico State K Tank Battery No. 3 Site Assessment, Vacuum Oil Field, Lea County, New Mexico*.

Earth Measurement Corporation. April 16, 2010. *Geophysical Subsurface Investigation Survey, New Mexico Station "K" – Chloride Delineation Tank Battery No. 3, Lea County, New Mexico*.

Kleinfelder. February 13, 2012. *Limited Site Assessment Report, Former State Site K Tank Battery No. 3, Vacuum Oil Field, Lea County, New Mexico*.

Kleinfelder. February 2012. Meeting with New Mexico Oil Conservation Division to discuss site conditions at Former State Site K Tank Battery No. 3, Vacuum Oil Field, Lea County, New Mexico.

New Mexico Oil Conservation Division. August 13, 1993. *Guidelines for Remediation of Leaks, Spills and Releases*.

New Mexico Office of the State Engineer Water Administration Technical Engineering Resource System database.

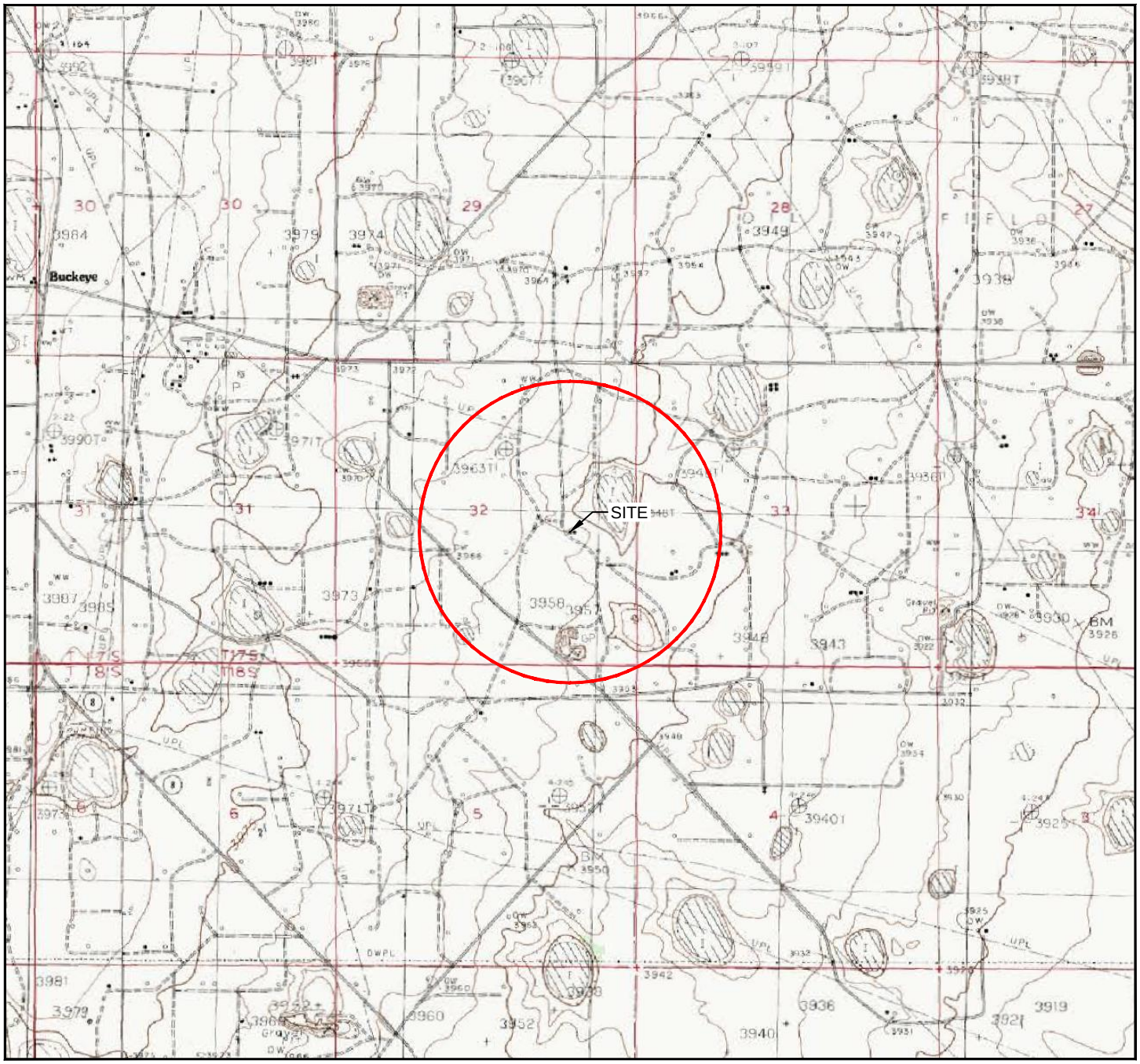
S. Roach. 1997. "Time-lapse, Multi-component, three-dimensional, seismic characterization of a San Andreas shallow shelf carbonate reservoir, Vacuum Field, Lea County, New Mexico." Ph.D. Dissertation, Colorado School of Mines.

Virgina L. McGuire. 2014. "Water-level changes and change in water in storage in High Plains Aquifer, Predevelopment to 2013 and 2011-13." USGS Scientific Investigations Report 2014-5218.

U.S. Geological Survey. 2013. "USGS High Plains water-level monitoring study water-level data by Water Year (October 1 to September 30; 2013)." http://ne.water.usgs.gov.

10 Acronym List

µg/L	Micrograms per liter
µg/m^3	Micrograms per cubic meter
µs	Microsiemens
1,2-DCA	1,2-dichloroethane
acfm	Actual cubic feet per minute
AS	Air sparge
AST	Aboveground storage tank
bgs	Below ground surface
BTEX	Benzene, toluene, ethylbenzene, and total xylenes
cfm	Cubic feet per minute
COC	Chain-of-Custody
CPT	Cone Penetration (Penetrometer) Test
DIPE	Di-isopropyl ether
DO	Dissolved oxygen
DOT	Department of Transportation
DPE	Dual-phase extraction
DTW	Depth to water
EDB	1,2-dibromoethane
EPA	Environmental Protection Agency
ESL	Environmental screening level
ETBE	Ethyl tertiary butyl ether
FID	Flame-ionization detector
fpm	Feet per minute
GAC	Granular activated carbon
gpd	Gallons per day
gpm	Gallons per minute
GWPTS	Groundwater pump and treat system
HIT	High-intensity targeted
HVOC	Halogenated volatile organic compound
J	Estimated value between MDL and PQL (RL)
LEL	Lower explosive limit
LPC	Liquid-phase carbon
LRP	Liquid-ring pump
LUFT	Leaking underground fuel tank
LUST	Leaking underground storage tank
MCL	Maximum contaminant level
MDL	Method detection limit
mg/kg	Milligrams per kilogram
mg/L	Milligrams per liter
mg/m^3	Milligrams per cubic meter
MPE	Multi-phase extraction
MRL	Method reporting limit
msl	Mean sea level
MTBE	Methyl tertiary butyl ether
MTCA	Model Toxics Control Act
NAI	Natural attenuation indicators
NAPL	Non-aqueous phase liquid
NEPA	National Environmental Policy Act
NGVD	National Geodetic Vertical Datum
NPDES	National Pollutant Discharge Elimination System
O&M	Operations and Maintenance
ORP	Oxidation-reduction potential
OSHA	Occupational Safety and Health Administration
OVA	Organic vapor analyzer
P&ID	Process and Instrumentation Diagram
PAH	Polycyclic aromatic (or polyaromatic) hydrocarbon
PCB	Polychlorinated biphenyl
PCE	Tetrachloroethene or perchloroethylene
PID	Photo-ionization detector
PLC	Programmable logic control
POTW	Publicly-owned treatment works
ppmv	Parts per million by volume
PQL	Practical quantitation limit
psi	Pounds per square inch
PVC	Polyvinyl chloride
QA/QC	Quality assurance/quality control
RBSL	Risk-based screening levels
RCRA	Resource Conservation and Recovery Act
RL	Reporting limit
scfm	Standard cubic feet per minute
SSTL	Site-specific target level
STLC	Soluble threshold limit concentration
SVE	Soil vapor extraction
SVOC	Semi-volatile organic compound
TAME	Tertiary amyl methyl ether
TBA	Tertiary butyl alcohol
TCE	Trichloroethene
TOC	Top of well casing elevation; datum is msl
TOG	Total oil and grease
TPH	Total petroleum hydrocarbons
TPHd	Total petroleum hydrocarbons as diesel
TPHg	Total petroleum hydrocarbons as gasoline
TPHmo	Total petroleum hydrocarbons as motor oil
TPHs	Total petroleum hydrocarbons as stoddard solvent
TRPH	Total recoverable petroleum hydrocarbons
UCL	Upper confidence level
USCS	Unified Soil Classification System
USGS	United States Geologic Survey
UST	Underground storage tank
VCP	Voluntary Cleanup Program
VOC	Volatile organic compound
VPC	Vapor-phase carbon



FN 01361304.W01

EXPLANATION

1/2-mile distance from site

N

APPROXIMATE SCALE

0 0.5 1 mile

SOURCE: Modified from a map provided by MapPass

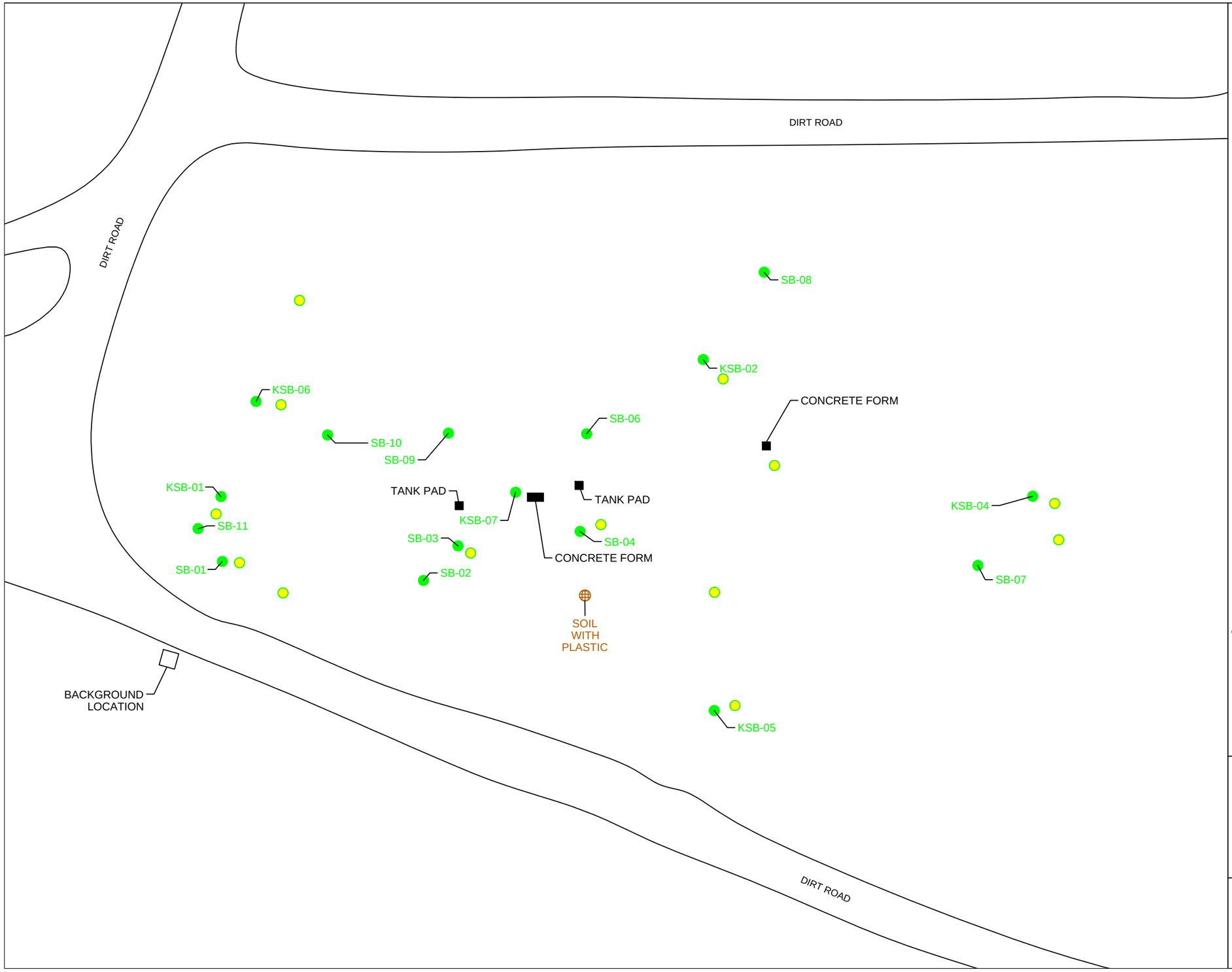
Cardno

SITE LOCATION MAP

FORMER STATE K TANK BATTERY NO. 3
Vacuum Oil Field
Lea County, New Mexico

PROJECT NO. 3613

PLATE 1



EXPLANATION

SB-11 Soil boring

Proposed soil boring

N

SOURCE:
Modified from maps provided by
CONESTOGA-ROVERS & ASSOCIATES
Google Earth Pro, KLEINFELDER and
© 2017 Digital ©CNES (2017) Distribution Airbus DS © 2017 Microsoft Corporation

APPROXIMATE SCALE

0 50 100
FEET

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GENERALIZED SITE PLAN

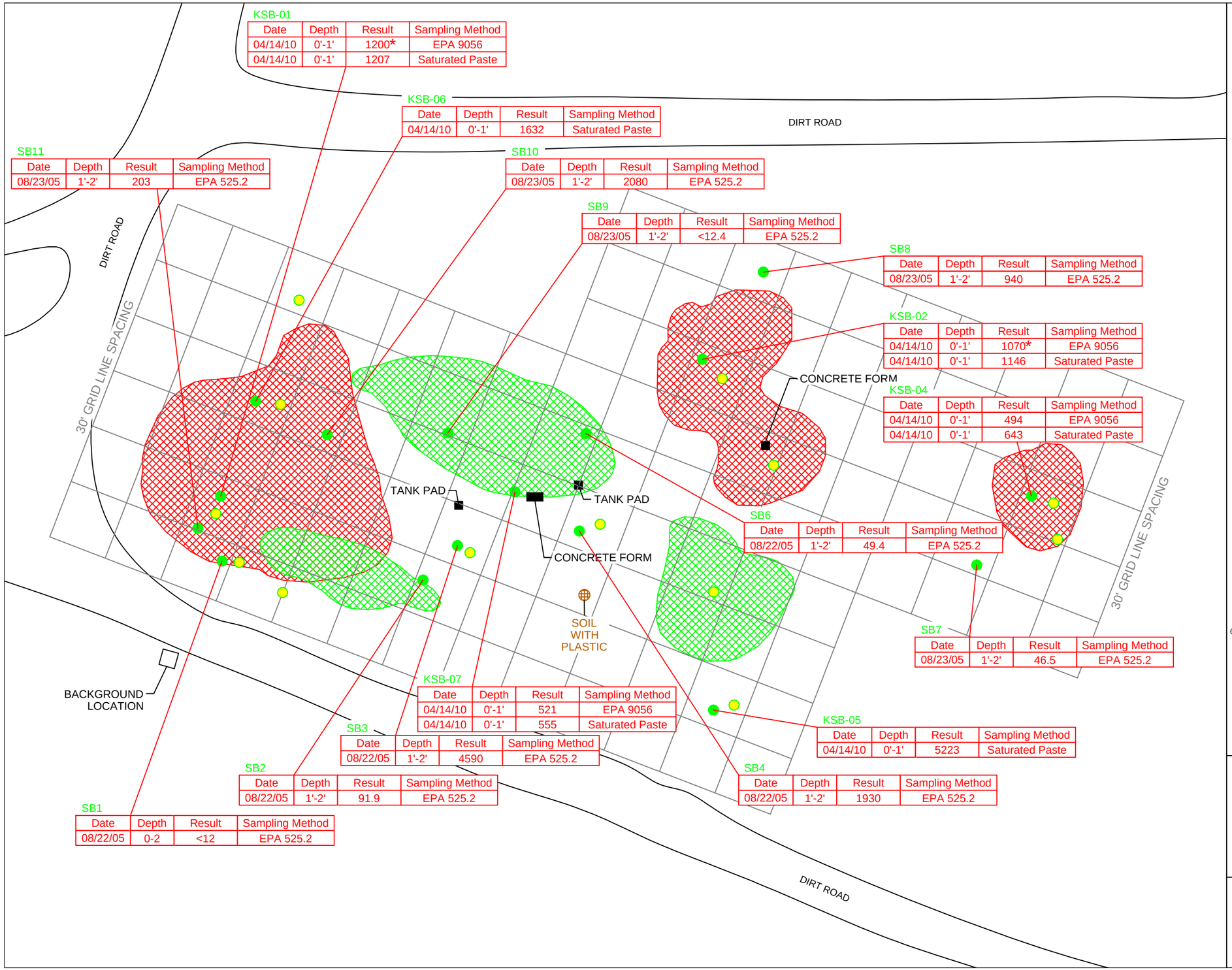
FORMER STATE K TANK BATTERY NO. 3
Vacuum Oil Field
Lea County, New Mexico

Cardno

PROJECT NO. 3613

PLATE 2

DATE: 09/11/18



EXPLANATION

- SB-11 — Soil boring
- Proposed soil boring
- Chloride plume zone 1 (0-18')
- Chloride plume zone 2 (18'-49')
- * — Analyte was detected in the associated Method Blank - analyte concentration in the sample is greater than 10 times the concentration found in the Method Blank
- < — Not detected at or above the stated laboratory reporting limit

Concentrations in milligrams per kilogram

N

SOURCE:
Modified from maps provided by
CONESTOGA-ROVERS & ASSOCIATES
Google Earth Pro, KLEINFELDER and

APPROXIMATE SCALE

0 50 100 FEET

FN 01361304.W01

CHLORIDE SOIL CONCENTRATION MAP 1 - 2 FEET BGS

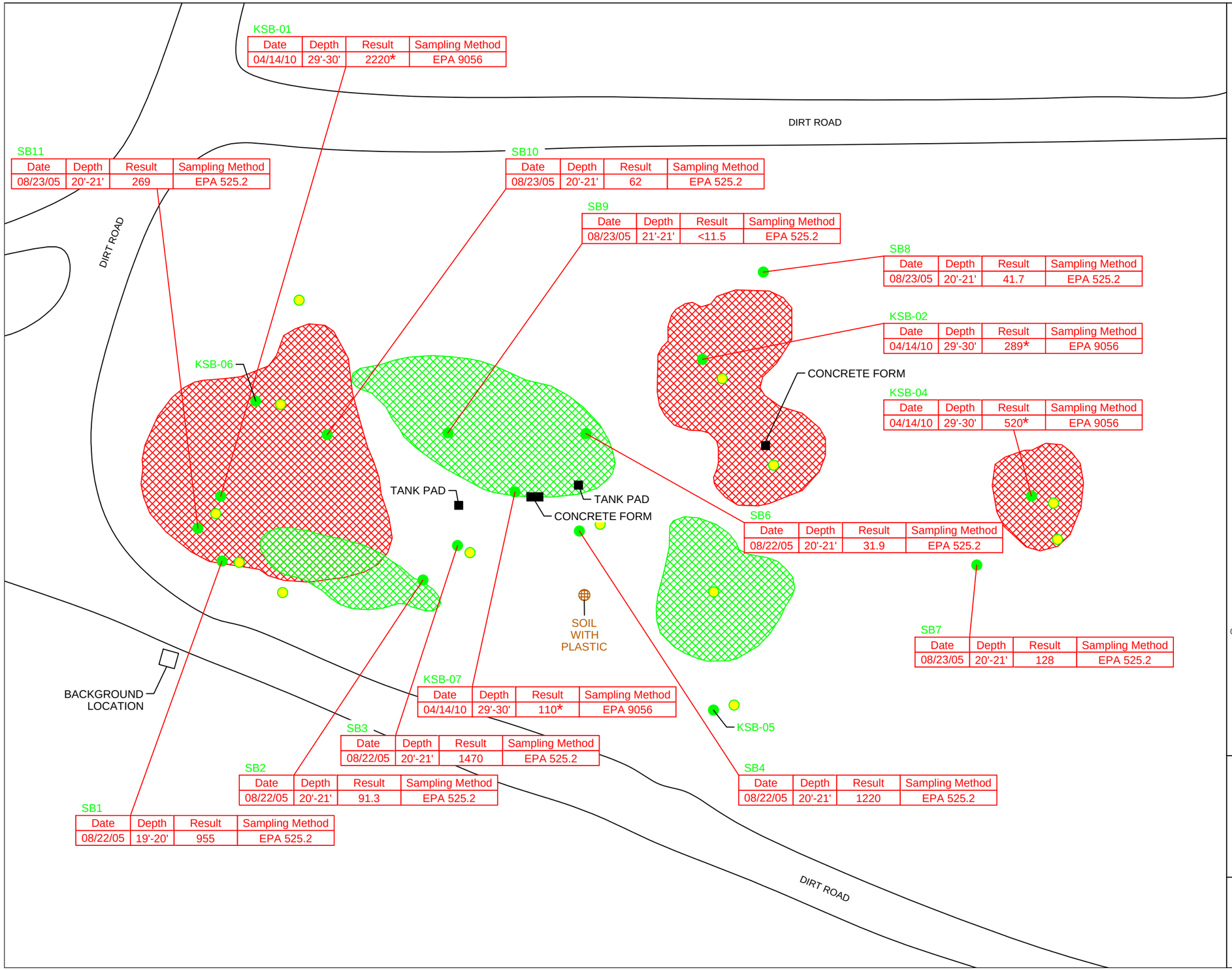
FORMER STATE K TANK BATTERY NO. 3
Vacuum Oil Field
Lea County, New Mexico

Cardno

PROJECT NO. 3613

PLATE 3

DATE: 09/11/18



EXPLANATION

- SB-11 — Soil boring
- Proposed soil boring
- Chloride plume zone 1 (0-18')
- Chloride plume zone 2 (18'-49')
- * — Analyte was detected in the associated Method Blank - analyte concentration in the sample is greater than 10 times the concentration found in the Method Blank
- < — Not detected at or above the stated laboratory reporting limit

Concentrations in milligrams per kilogram

N

SOURCE:
Modified from maps provided by
CONESTOGA-ROVERS & ASSOCIATES
Google Earth Pro, KLEINFELDER and

APPROXIMATE SCALE

0 50 100
FEET

FN 01361304.W01

CHLORIDE SOIL CONCENTRATION MAP 20 - 30 FEET BGS

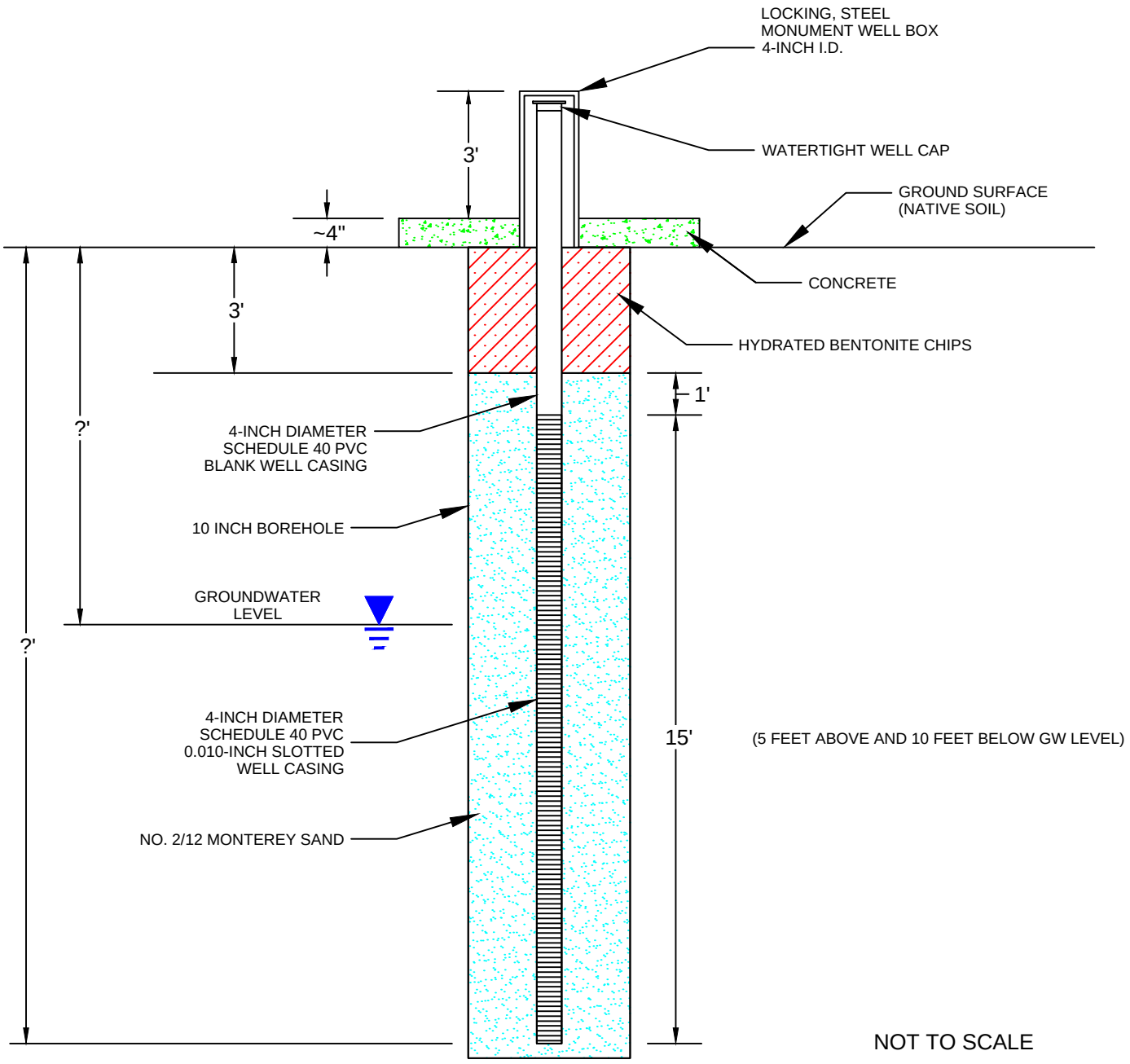
FORMER STATE K TANK BATTERY NO. 3
Vacuum Oil Field
Lea County, New Mexico

Cardno

PROJECT NO. 3613

PLATE 4

DATE: 09/11/18



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PROPOSED GROUNDWATER MONITORING WELL CONSTRUCTION DIAGRAM

FORMER STATE K TANK BATTERY NO. 3
Vacuum Oil Field
Lea County, New Mexico

PROJECT NO. 3613

PLATE 5

DATE: 09/11/18

TABLE 1
CUMULATIVE SOIL ANALYTICAL RESULTS
New Mexico State K Tank Battery No. 3
Lea County, New Mexico
Cardno 3613

Sampling Method				EPA 8021B					EPA 8015B			EPA 525.2	EPA 9056	Saturated Paste
Sample ID	Boring	Sampling Date	Depth (feet)	Benzene (mg/kg)	Toluene (mg/kg)	Ethyl-benzene (mg/kg)	Xylenes (mg/kg)	Total BTEX (mg/kg)	TPH as Diesel (mg/kg)	TPH as Gasoline (mg/kg)	Total TPH (mg/kg)	Chloride (mg/kg)	Chloride (mg/kg)	Chloride (mg/kg)
NMOCD RRAL				**10**	**---**	**---**	**---**	**50**	**---**	**---**	**1,000**	**---**	**---**	**---**
SB1-0-2'	SB1	08/22/05	0-2	<0.0012	<0.0012	<0.0012	<0.0012	BDL	<0.12	870	870	<12	---	---
SB1-14-15'	SB1	08/22/05	14-15	<0.0011	<0.0011	<0.0011	<0.0011	BDL	<0.11	<5.3	BDL	132	---	---
SB1-19-20'	SB1	08/22/05	19-20	<0.001	<0.001	<0.001	<0.001	BDL	<0.1	<5.2	BDL	955	---	---
SB2-1-2'	SB2	08/22/05	1-2	<0.001	0.0075	<0.001	0.002	0.0095	<0.1	4,200	**4,200**	91.9	---	---
SB2-15-16'	SB2	08/22/05	15-16	<0.001	<0.001	<0.001	<0.001	BDL	<0.1	32	32	25.6	---	---
SB2-20-21'	SB2	08/22/05	20-21	<0.001	<0.001	<0.001	<0.001	BDL	<0.1	19	19	91.3	---	---
SB3-1-2'	SB3	08/22/05	1-2	<0.0012	0.0073	<0.0012	<0.0012	0.0073	<0.12	160	160	4,590	---	---
SB3-14-15'	SB3	08/22/05	14-15	<0.0011	<0.0011	<0.0011	<0.0011	BDL	<0.11	<0.54	BDL	1,050	---	---
SB3-20-21'	SB3	08/22/05	20-21	<0.0011	<0.0011	<0.0011	<0.0011	BDL	<0.11	<0.53	BDL	1,470	---	---
SB4-1-2'	SB4	08/22/05	1-2	<0.0011	<0.0011	<0.0011	<0.0011	BDL	<0.11	250	250	1,930	---	---
SB4-14-15'	SB4	08/22/05	14-15	<0.001	<0.001	<0.001	<0.001	BDL	<0.1	11	11	877	---	---
SB4-20-21'	SB4	08/22/05	20-21	<0.0011	<0.0011	<0.0011	<0.0011	BDL	<0.11	14	14	1,220	---	---
SB5-1-2'	SB5	08/22/05	1-2	<0.0011	<0.0011	<0.0011	<0.0011	BDL	<0.11	<11	BDL	<10.6	---	---
SB5-15-16'	SB5	08/22/05	15-16	<0.001	<0.001	<0.001	<0.001	BDL	<0.1	<5.2	BDL	104	---	---
SB5-20-21'	SB5	08/22/05	20-21	<0.0011	<0.0011	<0.0011	<0.0011	BDL	<0.11	<5.3	BDL	138	---	---
SB6-1-2'	SB6	08/22/05	1-2	<0.0012	0.039	0.0018	0.0055	0.0463	<0.12	410	410	49.4	---	---
SB6-15-16'	SB6	08/22/05	15-16	<0.001	<0.001	<0.001	<0.001	BDL	<0.1	<5.1	BDL	35	---	---
SB6-20-21'	SB6	08/22/05	20-21	<0.001	<0.001	<0.001	<0.001	BDL	<0.1	<5.1	BDL	31.9	---	---
SB7-1-2'	SB7	08/23/05	1-2	<0.0011	<0.0011	<0.0011	<0.0011	BDL	<0.11	<5.6	BDL	46.5	---	---
SB7-15-16'	SB7	08/23/05	15-16	<0.0011	<0.0011	<0.0011	<0.0011	BDL	<0.11	<5.6	BDL	117	---	---
SB7-20-21'	SB7	08/23/05	20-21	<0.0012	<0.0012	<0.0012	<0.0012	BDL	<0.12	<5.8	BDL	128	---	---
SB8-1-2'	SB8	08/23/05	1-2	<0.0013	<0.0013	<0.0013	<0.0013	BDL	<0.13	530	530	940	---	---
SB8-15-16'	SB8	08/23/05	15-16	<0.001	<0.001	<0.001	<0.001	BDL	<0.1	17	17	84	---	---
SB8-20-21'	SB8	08/23/05	20-21	<0.001	<0.001	<0.001	<0.001	BDL	<0.1	<5.2	BDL	41.7	---	---
SB9-1-2'	SB9	08/23/05	1-2	<0.0012	<0.0012	<0.0012	<0.0012	BDL	<0.12	<6.2	BDL	<12.4	---	---
SB9-15-16'	SB9	08/23/05	15-16	<0.0011	<0.0011	<0.0011	<0.0011	BDL	<0.11	<5.3	BDL	19.5	---	---
SB9-15-16' Dup	SB9	08/23/05	15-16	<0.001	<0.001	<0.001	<0.001	BDL	<0.1	<5.2	BDL	15.9		
SB9-21-21'	SB9	08/23/05	21-21	<0.0012	<0.0012	<0.0012	<0.0012	BDL	<0.12	<6.2	BDL	<11.5	---	---

TABLE 1
CUMULATIVE SOIL ANALYTICAL RESULTS
New Mexico State K Tank Battery No. 3
Lea County, New Mexico
Cardno 3613

Sampling Method				EPA 8021B					EPA 8015B			EPA 525.2	EPA 9056	Saturated Paste
Sample ID	Boring	Sampling Date	Depth (feet)	Benzene (mg/kg)	Toluene (mg/kg)	Ethyl-benzene (mg/kg)	Xylenes (mg/kg)	Total BTEX (mg/kg)	TPH as Diesel (mg/kg)	TPH as Gasoline (mg/kg)	Total TPH (mg/kg)	Chloride (mg/kg)	Chloride (mg/kg)	Chloride (mg/kg)
NMOCD RRAL				**10**	**---**	**---**	**---**	**50**	**---**	**---**	**1,000**	**---**	**---**	**---**
SB10-1-2'	SB10	08/23/05	1-2	<0.0011	<0.0011	<0.0011	<0.0011	BDL	<0.11	50	50	2,080	---	---
SB10-15-16'	SB10	08/23/05	15-16	<0.0011	<0.0011	<0.0011	<0.0011	BDL	<0.11	<5.3	BDL	887	---	---
SB10-20-21'	SB10	08/23/05	20-21	<0.0011	<0.0011	<0.0011	<0.0011	BDL	<0.11	<5.6	BDL	62	---	---
SB11-1-2'	SB11	08/23/05	1-2	<0.0012	<0.0012	<0.0012	<0.0012	BDL	<0.12	<61	BDL	203	---	---
SB11-15-16'	SB11	08/23/05	15-16	<0.001	<0.001	<0.001	0.0014	0.0014	<0.1	<5.2	BDL	300	---	---
SB11-20-21'	SB11	08/23/05	20-21	<0.0011	<0.0011	<0.0011	0.0016	0.0016	<0.11	<0.53	BDL	269	---	---
Background	---	08/23/05	1-2	---	---	---	---	---	---	---	---	<12.6	---	---
SB1 0-1	KSB-01	04/14/10	0-1	---	---	---	---	---	---	---	---	---	1,200 B1	1,207
SB1 4-5	KSB-01	04/14/10	4-5	---	---	---	---	---	---	---	---	---	895 B1	1,793
SB1 9-10	KSB-01	04/14/10	9-10	<0.000929	<0.000929	<0.000929	<0.000929	BDL	<4.84	<0.0929	BDL	---	866 B1	---
SB1 14-15	KSB-01	04/14/10	14-15	---	---	---	---	---	---	---	---	---	962 B1	---
SB1 19-20	KSB-01	04/14/10	19-20	---	---	---	---	---	---	---	---	---	4,800 B1	---
SB1 24-5	KSB-01	04/14/10	24-5	---	---	---	---	---	---	---	---	---	4,420 B1	---
SB1 29-30	KSB-01	04/14/10	29-30	<0.000931	<0.000931	<0.000931	<0.000931	BDL	<4.84	<0.0931	BDL	---	2,220 B1	---
SB2 0-1	KSB-02	04/14/10	0-1	---	---	---	---	---	---	---	---	---	1,070 B1	1,146
SB2 4-5	KSB-02	04/14/10	4-5	---	---	---	---	---	---	---	---	---	807 B1	821
SB2 9-10	KSB-02	04/14/10	9-10	---	---	---	---	---	---	---	---	---	705 B1	---
SB2 14-15	KSB-02	04/14/10	14-15	---	---	---	---	---	---	---	---	---	283 B1	---
SB2 19-20	KSB-02	04/14/10	19-20	---	---	---	---	---	---	---	---	---	292 B1	---
SB2 24-5	KSB-02	04/14/10	24-5	<0.000947	<0.000947	<0.000947	<0.000947	BDL	<4.88	<0.0947	BDL	---	64.3 B1	---
SB2 29-30	KSB-02	04/14/10	29-30	<0.000943	<0.000943	<0.000943	<0.000943	BDL	10.9	<0.0943	10.9	---	289 B1	---
SB4 0-1	KSB-04	04/14/10	0-1	---	---	---	---	---	---	---	---	---	494	643
SB4 4-5	KSB-04	04/14/10	4-5	---	---	---	---	---	---	---	---	---	43.2 B1	880
SB4 9-10	KSB-04	04/14/10	9-10	<0.000873	<0.000873	<0.000873	<0.000873	BDL	5.69	<0.0873	5.69	---	732 B1	---
SB4 14-15	KSB-04	04/14/10	14-15	---	---	---	---	---	---	---	---	---	958 B1	---
SB4 19-20	KSB-04	04/14/10	19-20	---	---	---	---	---	---	---	---	---	163 B1	---
SB4 24-5	KSB-04	04/14/10	24-5	---	---	---	---	---	---	---	---	---	552 B1	---
SB4 29-30	KSB-04	04/14/10	29-30	<0.000926	<0.000926	<0.000926	<0.000926	BDL	12.0	<0.0926	12.0	---	520 B1	---

TABLE 1
CUMULATIVE SOIL ANALYTICAL RESULTS
New Mexico State K Tank Battery No. 3
Lea County, New Mexico
Cardno 3613

Sampling Method				EPA 8021B					EPA 8015B			EPA 525.2	EPA 9056	Saturated Paste
Sample ID	Boring	Sampling Date	Depth (feet)	Benzene (mg/kg)	Toluene (mg/kg)	Ethyl-benzene (mg/kg)	Xylenes (mg/kg)	Total BTEX (mg/kg)	TPH as Diesel (mg/kg)	TPH as Gasoline (mg/kg)	Total TPH (mg/kg)	Chloride (mg/kg)	Chloride (mg/kg)	Chloride (mg/kg)
NMOCD RRAL				**10**	**---**	**---**	**---**	**50**	**---**	**---**	**1,000**	**---**	**---**	**---**
SB5 0-1	KSB-05	04/14/10	0-1	---	---	---	---	---	---	---	---	---	---	5,223
SB6 0-1	KSB-06	04/14/10	0-1	---	---	---	---	---	---	---	---	---	---	1,632
SB7 0-1	KSB-07	04/14/10	0-1	---	---	---	---	---	---	---	---	---	521	555
SB7 4-5	KSB-07	04/14/10	4-5	---	---	---	---	---	---	---	---	---	349 B1	19
SB7 9-10	KSB-07	04/14/10	9-10	<0.000990	<0.000990	<0.000990	<0.000990	BDL	<4.86	<0.0990	BDL	---	94.6 B1	---
SB7 14-15	KSB-07	04/14/10	14-15	---	---	---	---	---	---	---	---	---	1,150 B1	---
SB7 19-20	KSB-07	04/14/10	19-20	---	---	---	---	---	---	---	---	---	1,450 B1	---
SB7 24-5	KSB-07	04/14/10	24-5	---	---	---	---	---	---	---	---	---	155 B1	---
SB7 29-30	KSB-07	04/14/10	29-30	<0.000904	<0.000904	<0.000904	<0.000904	BDL	<4.86	<0.0904	BDL	---	110 B1	---

Explanation:

NMOCD RRAL = New Mexico Oil Conservation Division Recommended Remediation Action Levels for Sites with Total Ranking Score <19.
EPA = Environmental Protection Agency.
BDL = Individual analyses below respective laboratory detection limits.
BTEX = Benzene, toluene, ethylbenzene, and total xylenes.
TPH = Total petroleum hydrocarbons.
mg/kg = Milligrams per kilogram.
< = Not detected at or above the stated laboratory reporting limit.
--- = Not analyzed/not available.
B1 = Analyte was detected in the associated Method Blank. Analyte concentration in the sample is greater than 10 times the concentration found in the Method Blank.

APPENDIX A

FIELD PROTOCOL

Soil Boring and Well Installation Field Protocol

Preliminary Activities

Prior to the onset of field activities at the site, Cardno obtains the appropriate permit(s) from the governing agency(s). Advance notification is made as required by the agency(s) prior to the start of work. Cardno marks the borehole locations and contacts the local one call utility locating service at least 48 hours prior to the start of work to mark buried utilities. Borehole locations may also be checked for buried utilities by a private geophysical surveyor. Prior to drilling, the borehole location is cleared in accordance with the client's procedures. Fieldwork is conducted under the advisement of a registered professional geologist and in accordance with an updated site-specific safety plan prepared for the project, which is available at the job site during field activities.

Drilling and Soil Sampling Procedures

Cardno contracts a licensed driller to advance the boring and collect soil samples. The specific drilling method (e.g., hollow-stem auger, direct push method, or sonic drilling), sampling method [e.g., core barrel or California-modified split spoon sampler (CMSSS)] and sampling depths are documented on the boring log and may be specified in a work plan. Soil samples are typically collected at the capillary fringe and at 5-foot intervals to the total depth of the boring. To determine the depth of the capillary fringe prior to drilling, the static groundwater level is measured with a water level indicator in the closest monitoring well to the boring location, if available.

The borehole is advanced to just above the desired sampling depth. For CMSSSs, the sampler is placed inside the auger and driven to a depth of 18 inches past the bit of the auger. The sampler is driven into the soil with a standard 140-pound hammer repeatedly dropped from a height of 30 inches onto the sampler. The number of blows required to drive the sampler each 6-inch increment is recorded on the boring log. For core samplers (e.g., direct push), the core is driven 18 inches using the rig apparatus.

Soil samples are preserved in the metal or plastic sleeve used with the CMSSS or core sampler, in glass jars or other manner required by the local regulatory agency (e.g., Environmental Protection Agency Method 5035). Sleeves are removed from the sample barrel, and the lowermost sample sleeve is immediately sealed with Teflon™ tape, capped, labeled, placed in a cooler chilled to 4º Celsius and transported to a state-certified laboratory. The samples are transferred under chain-of-custody (COC) protocol.

Field Screening Procedures

Cardno places the soil from the middle of the sampling interval into a plastic re-sealable bag. The bag is placed away from direct sunlight for a period of time which allows volatilization of chemical constituents, after which the tip of a photo-ionization detector (PID) or similar device is inserted through the plastic bag to measure organic vapor concentrations in the headspace. The PID measurement is recorded on the boring log. At a minimum, the PID or other device is calibrated on a daily basis in accordance with manufacturer's specifications using a hexane or isobutylene standard. The calibration gas and concentration are recorded on a calibration log. Instruments such as the PID are useful for evaluating relative concentrations of volatilized hydrocarbons, but they do not measure the concentration of petroleum hydrocarbons in the soil matrix with the same precision as laboratory analysis. Cardno trained personnel describe the soil in the bag according to the Unified Soil Classification System and record the description on the boring log, which is included in the final report.

Air Monitoring Procedures

Cardno performs a field evaluation for volatile hydrocarbon concentrations in the breathing zone using a calibrated photo-ionization detector or lower explosive level meter.

Groundwater Sampling

A groundwater sample, if desired, is collected from the boring by using Hydropunch™ sampling technology or installing a well in the borehole. In the case of using Hydropunch™ technology, after collecting the capillary fringe soil sample, the boring is advanced to the top of the soil/groundwater interface and a sampling probe is pushed to approximately 2 feet below the top of the static water level. The probe is opened by partially withdrawing it and thereby exposing the screen. A new or decontaminated bailer is used to collect a water sample from the probe. The water sample is then emptied into laboratory-supplied containers constructed of the correct material and with the correct volume and preservative to comply with the proposed laboratory test. The container is slowly filled with the retrieved water sample until no headspace remains and then promptly sealed with a Teflon-lined cap, checked for the presence of bubbles, labeled, entered onto a COC record and placed in chilled storage at 4° Celsius. Laboratory-supplied trip blanks accompany the water samples as a quality assurance/quality control procedure. Equipment blanks may be collected as required. The samples are kept in chilled storage and transported under COC protocol to a client-approved, state-certified laboratory for analysis.

Backfilling of Soil Boring

If a well is not installed, the boring is backfilled from total depth to approximately 5 feet below ground surface (bgs) with either neat cement or bentonite grout using a tremie pipe and either the boring is backfilled from 5 feet bgs to approximately 1 foot bgs with hydrated bentonite chips or backfill is continued to just below grade with neat cement grout. The borehole is completed to surface grade with material that best matches existing surface conditions and meets local agency requirements. Site-specific backfilling details are shown on the respective boring log.

Well Construction

A well (if constructed) is completed using materials documented on the boring log or specified in a work plan. The well is constructed with slotted casing across the desired groundwater sampling depth(s) and completed with blank casing to within 6 inches of surface grade. No further construction is conducted on temporary wells. For permanent wells, the annular space of the well is backfilled with Monterey sand from the total depth to approximately 2 feet above the top of the screened casing. A hydrated granular bentonite seal is placed on top of the sand filter pack. Grout may be placed on top of the bentonite seal to the desired depth using a tremie pipe. The well may be completed to surface grade with a 1-foot thick concrete pad. A traffic-rated well vault and locking cap for the well casing may be installed to protect against surface-water infiltration and unauthorized entry. Site-specific well construction details including type of well, well depth, casing diameter, slot size, length of screen interval and sand size are documented on the boring log or specified in the work plan.

Well Development and Sampling

If a permanent groundwater monitoring well is installed, the grout is allowed to cure a minimum of 48 hours before development. Cardno personnel or a contracted driller use a submersible pump or surge block to develop the newly installed well. Prior to development, the pump is decontaminated by allowing it to run and re-circulate while immersed in a non-phosphate solution followed by successive immersions in potable water and de-ionized water baths. The well is developed until sufficient well casing volumes are removed so that turbidity is within allowable limits and pH, conductivity and temperature levels stabilize in the purge water. The volume of groundwater extracted is recorded on a log.

Following development, groundwater within the well is allowed to recharge until at least 80% of the drawdown is recovered. A new or decontaminated bailer is slowly lowered past the air/water interface in the well, and a water sample is collected and checked for the presence of non-aqueous phase liquid, sheen or emulsions. The water sample is then emptied into laboratory-supplied containers as discussed above.

Surveying

If required, wells are surveyed by a licensed land surveyor relative to an established benchmark of known elevation above mean sea level to an accuracy of +/- 0.01 foot. The casing is notched or marked on one side to identify a consistent surveying and measuring point.

Decontamination Procedures

Cardno or the contracted driller decontaminates soil and water sampling equipment between each sampling event with a non-phosphate solution, followed by a minimum of two tap water rinses. De-ionized water may be used for the final rinse. Downhole drilling equipment is steam-cleaned prior to drilling the borehole and at completion of the borehole.

Waste Treatment and Soil Disposal

Soil cuttings generated from the drilling or sampling are stored on site in labeled, Department of Transportation-approved, 55-gallon drums or other appropriate storage container. The soil is removed from the site and transported under manifest to a client- and regulatory-approved facility for recycling or disposal. Decontamination fluids and purge water from well development and sampling activities, if conducted, are stored on site in labeled, regulatory-approved storage containers. Fluids are subsequently transported under manifest to a client- and regulatory-approved facility for disposal or treated with a permitted mobile or fixed-base carbon treatment system.