NM2 - ____24____

BORING PLAN

Feb. 2012

Jones, Brad A., EMNRD

From: Jones, Brad A., EMNRD
Sent: Thursday, February 02, 2012 3:53 PM
To: 'Shawn Higley'; Powell, Brandon, EMNRD
Cc: Hurlbut, Brett; Manus, Daniel; Vrooman, Alan; Matt Selvig
Subject: RE: East Blanco Hydrogeologic Investigation Work Plan
Attachments: East Blanco Hydrogeologic Investigation Work Plan (Reduced).pdf; 2012 0202 Boring Plan Approval.pdf

Shawn,

Please see the attached… it is the boring plan and approval. A hardcopy of the approval have been placed in the mail. Also, please keep myself and Brandon Powell (of the OCD Aztec District Office) updated on the drilling dates and times and of any changes. Brandon's office number is 505-334-6178 ext. 116 and his cell is 505-320-0200. Based upon our last conversation, the drilling is scheduled to begin sometime on Monday, February 13, 2012.

Brad

Brad A. Jones
Environmental Engineer
Environmental Bureau
NM Oil Conservation Division
1220 S. St. Francis Drive
Santa Fe, New Mexico 87505
E-mail: brad.a.jones@state.nm.us
Office: (505) 476-3487
Fax: (505) 476-3462

From: Shawn Higley [mailto:shigley@wwcengineering.com]
Sent: Thursday, February 02, 2012 10:47 AM
To: Jones, Brad A., EMNRD
Cc: Hurlbut, Brett; Manus, Daniel; Vrooman, Alan; Matt Selvig
Subject: Fwd: East Blanco Hydrogeologic Investigation Work Plan

Brad,

Attached is the latest report with revisions per our discussion. Please let me know if this works,

Shawn

-------- Original Message --------
Subject: East Blanco Hydrogeologic Investigation Work Plan
Date: Thu, 02 Feb 2012 10:06:47 -0700
From: Robert Neihart <rneihart@wwcengineering.com>
To: Shawn Higley <shigley@wwcengineering.com>

New Mexico Energy, Minerals and Natural Resources Department

Susana Martinez
Governor

John H. Bemis
Cabinet Secretary-Designate

Brett F. Woods, Ph.D.
Deputy Cabinet Secretary

Jami Bailey
Division Director
Oil Conservation Division

February 2, 2012

Shawn Higley
WWC Engineering
1275 Maple Street, Suite F
Helena, Montana 59601

RE: Boring Plan – Proposed Work Plan
Centralized Surface Waste Management Facility
Black Hills Exploration and Production – East Blanco Produced Water Reuse Facility
Facility Location: Section 13, Township 30 North, Range 4 West NMPM
Rio Arriba County, New Mexico

Dear Mr. Higley:

The Oil Conservation Division (OCD) has received WWC Engineering's boring plan proposal, dated February 2, 2012 and submitted on the behalf of Black Hills Exploration and Production, to investigate and characterize the uppermost aquifer and subsurface geology for a proposed centralized surface waste management facility permit (East Blanco Produced Water Reuse Facility) located in Section 13, Township 30 North, Range 4 West NMPM, Rio Arriba County, New Mexico. The OCD has reviewed the proposal and determined that the proposal is adequate to proceed with the site investigation.

The OCD agrees that the proposed the three (3) boring/monitoring well locations appear adequate. However, if the hydrogeologic conditions cannot be determined, additional borings or monitoring wells may be needed. It should be understood that if a monitoring well is constructed, it shall be bailed until fully developed.

The OCD appreciates your cooperation in providing a boring plan for review, in order to determine if the submitted application and the proposed site are suitable for approval. If there are any questions regarding this matter, please do not hesitate to contact me at (505) 476-3487 or brad.a.jones@state.nm.us.

Sincerely,

Brad A. Jones
Environmental Engineer

BAJ/baj
Cc: OCD District III Office, Aztec

Jones, Brad A., EMNRD

From: Shawn Higley [shigley@wwcengineering.com]
Sent: Thursday, February 02, 2012 10:47 AM
To: Jones, Brad A., EMNRD
Cc: Hurlbut, Brett; Manus, Daniel; Vrooman, Alan; Matt Selvig
Subject: Fwd: East Blanco Hydrogeologic Investigation Work Plan
Attachments: East Blanco Hydrogeologic Investigation Work Plan (Reduced).pdf

Brad,

Attached is the latest report with revisions per our discussion. Please let me know if this works,

Shawn

-------- Original Message --------
Subject: East Blanco Hydrogeologic Investigation Work Plan
Date: Thu, 02 Feb 2012 10:06:47 -0700
From: Robert Neihart <rneihart@wwcengineering.com>
To: Shawn Higley <shigley@wwcengineering.com>

Shawn,

Attached you will find the East Blanco Hydrogeologic Investigation Work Plan.

Robbie

--

WWC ENGINEERING
Robert Neihart, P.E.
Project Manager
1275 Maple Street, Suite F
Helena, Montana 59601
406-443-3962
406-449-0056 (fax)

Hydrogeologic Investigation Work Plan East Blanco Produced Water Reuse Facility

Prepared for:

Black Hills Exploration and Production
1515 Wynkoop Street, Suite 500
Denver, CO 80202

Submitted to:

New Mexico Energy, Minerals, &
Natural Resources Department
Oil Conservation Division
1220 S. St. Francis Drive
Santa Fe, NM 87505

Prepared by:

WWC ENGINEERING

1275 Maple Street, Suite F
Helena, MT 59601
(406) 443-3962

February 2, 2012

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

Hydrogeologic Investigation Work Plan
East Blanco
Produced Water Reuse Facility

INTRODUCTION

The East Blanco Produced Water Reuse Facility is designed for the collection of produced water from surrounding oil and gas operations so that it may be reused in hydraulic fracturing operations in lieu of fresh water. This document presents a work plan for a subsurface hydrogeologic investigation to be conducted in support of a Form C-137 Application for Surface Waste Management Facility. The ponds within the proposed facility will be constructed using a dual layer HDPE geomembrane liner system to prevent exfiltration, and a geonet transmission layer is included in the liner system to provide a means for leak detection. The proposed containment pits are located approximately 11.6 miles southwest of Dulce, New Mexico in Section 13, T30N, R4W. The proposed facility is located approximately 450 feet west of an existing water disposal tank battery facility owned by Black Hills Exploration and Production. The site will be accessed via a proposed access road 450 feet in length connecting to the tank battery facility. The proposed facility location is shown in Figure 1. The proposed facility layout is provided in Figure 2.

The eastern edge of the proposed facility is located a minimum of 210 feet west of a small ephemeral channel that is a tributary to an ephemeral stream running through Cabresto Canyon. Both waterways are ephemeral and flow only in response to precipitation and snowmelt. The nearest continuously flowing watercourse (Navajo River) is located more than 11 miles west of the proposed facility. The primary objectives of this Hydrogeologic Investigation Work Plan (Work Plan) are to characterize subsurface conditions in order to determine the potential environmental risks associated with the construction of the proposed reuse facility.

Problem Statement

The problem statement identified for this Work Plan is that limited groundwater and subsurface soil conditions exist. These conditions must be determined before final design and construction of the proposed facility can begin. The following sections provide further detail and descriptions of how the subsurface investigation will be performed.

It is important to realize that only a portion of the project area will be utilized for the storage of produced water in pits below ground. The existing facility pad located in the northeast corner of the project area east of the drainage contains only above-ground facilities. Therefore, the drilling activities proposed within this plan will focus on the identification of potential groundwater conditions beneath the proposed new ponds located west of the drainage as shown on Figure 2. The maximum depth of the lowest point in the proposed ponds occurs at an elevation of 6962.0. Therefore, the new boreholes will be drilled to a minimum elevation of 6907.0 to account for a depth of 50 feet below the lowest elevation in the pond system plus an additional five feet for conservative measures. Contours of the site are shown on Figure 3.

Objectives

The objective of this Work Plan is to collect information regarding subsurface water quality and soil parameters to determine the environmental risks associated with the construction of the proposed reuse facility in accordance with New Mexico OCD permit requirements. Procedures that must be performed to accomplish this objective are as follows:

1. If encountered, groundwater samples will be collected and analyzed for major cations and anions; benzene, toluene, ethyl benzene and xylenes (BTEX); RCRA metals; and total dissolved solids (TDS). Drilling will proceed to the first water-bearing zone or an elevation of 6907.0, whichever occurs first;

2. If above an elevation of 6907.0, determine the depth to, formation name, type and thickness of the shallowest fresh water aquifer;

3. Determine the soil types beneath the proposed facility, including a lithologic description of soil and rock members from ground surface to an elevation of 6907.0, or to the first water bearing interval;

4. Provide geologic cross-sections;

5. If groundwater is encountered, potentiometric maps for the shallowest fresh water aquifer will be prepared; and

6. Determine the porosity, permeability, conductivity, compaction ratios and swelling characteristics for the sediments on which the contaminated soils will be placed.

Scope of Work

To accomplish the objective of this Work Plan, the following scope of work is proposed:

1. Utility locates for borehole locations;

2. Research of local geologic conditions;

3. Drill boreholes;

4. Soil sampling and testing;

5. Installation and development of groundwater monitoring wells (if necessary); and

6. Sample groundwater from monitoring wells (if necessary).

Schedule

Drilling activities for three (3) boreholes will occur over approximately four to five days depending on weather conditions. The duration of the laboratory sampling analysis and report preparation will be approximately two to three weeks. The total project duration is expected to be up to one month after the initiation of drilling activities.

DESCRIPTION OF RESPONSIBLITIES

A drilling contractor yet to be identified contracted by Black Hills Exploration and Production will be responsible for the drilling activities and soil sample collection at the proposed location. A commercial laboratory facility yet to be identified will be responsible for groundwater sample collection and groundwater and soil sample testing. WWC Engineering personnel will be responsible for the interpretation of testing results and report preparation.

NOTIFICATION OF AFFECTED PARTIES

The drilling contractor will notify Black Hills Exploration and Production and New Mexico Oil Conservation Division representatives prior to commencement of drilling activities. The following individuals shall be notified a minimum of 1 week prior to commencement of drilling activities:

- Daniel Manus – Black Hills Exploration and Production,
- Brad Jones – New Mexico Oil Conservation Division, and
- Shawn Higley – WWC Engineering.

SAFETY CONSIDERATIONS

Possible safety hazards that may occur as a result of this Work Plan involve heavy lifting, hazardous weather, and working on uneven terrain. Care shall be taken to mitigate the risks posed by each of these hazards should they arise. Required personal protective equipment (PPE) will include work gloves, Nitrile sampling gloves, hardhats, long-sleeved shirts, safety glasses, hearing protection, and steel-toed boots. The work will be conducted in accordance with Black Hills Exploration and Production safety practices. All contractors will be responsible for adhering to these practices.

DESCRIPTION OF WORK

As previously listed in the scope of work, the following items will be completed as part of this Work Plan:

1. Utility locates for borehole locations;
2. Research of local geologic conditions;

3. Drill boreholes;

4. Soil sampling and testing;

5. Installation and development of groundwater monitoring wells (if necessary); and

6. Sample groundwater from monitoring wells (if necessary).

Details for each item in the list are given in the attached sections and figures.

Utility Locates for Borehole Locations

Utility locates will involve calling a locator service to determine whether underground utilities are located at or near the three borehole locations prior to the commencement of drilling activities. Utility locations will be clearly marked.

Research of Local Geologic Conditions

Based on a subsurface investigation performed by GEOMAT Inc. on December 22, 2011, the anticipated local geologic conditions consist of a 10-15 foot layer of clayey sand underlain by sandstone and shale layers. The two previous boreholes were drilled to depths of 76.0 feet and 68.2 feet, respectively. Although direct evidence of groundwater was not encountered in either borehole, damp zones were identified in the drilling that were not fully investigated. The borehole logs from this subsurface investigation are provided in Appendix A.

Drill Boreholes

Three (3) boreholes will be installed at the locations shown on attached Figure 2. The depth of each borehole will be determined in the field based on lithologic conditions and will be dependent on the depth at which groundwater is encountered. The maximum depth of the lowest point in the proposed ponds occurs at an elevation of 6962.0. Therefore, the new boreholes will be drilled to a minimum elevation of 6907.0 to account for a depth of 50 feet below the lowest elevation in the pond system plus an additional five feet for conservative measures. When damp soil or groundwater is indicated, drilling activities may be suspended up to 12 hours to see if free water accumulates in the borehole sufficient to verify that the water table has been identified.

The drilling of each borehole will involve the general procedures below:

1. The target depth of each borehole will be either the depth at which groundwater is initially encountered or an elevation of 6907.0, whichever occurs first;

2. The boreholes will be drilled using a fixed-piston sampler, rotary core-barrel sampler, or similar method to obtain continuous cores at 5 or 10 foot intervals from the ground surface to the final depth of the borehole;

3. The cores resulting from advancing the borehole will be photographed and monitored to determine depths at which changes in texture, color and moisture content occur to allow accurate logging of the subsurface soil stratigraphy; and

4. When damp soil or groundwater is indicated, drilling activities may be suspended up to 12 hours to see if free water accumulates in the borehole sufficient to verify that the water table has been identified.

Soil Sampling and Testing

The continuous cores obtained during the drilling of each borehole will undergo a series of laboratory tests. Testing of the engineering properties of the materials for porosity, permeability, conductivity, and other characteristics will be conducted. Additionally, lithologic sampling will occur during drilling activities that will include recording changes in texture, color, and moisture content to allow accurate logging of the lithology and hydrogeologic characteristics within each borehole.

Installation and Development of Groundwater Monitoring Wells

Groundwater monitoring wells will be installed at borehole locations where groundwater is encountered. Monitoring wells will not be installed if groundwater is not encountered within the boreholes. The drilling contractor will follow ASTM D5092 Standard Practice for Design and Installation of Groundwater Monitoring Wells. Each groundwater monitoring well will be installed using the general procedures given below:

1. A 2 inch diameter, schedule 40 PVC casing with flush thread connections will be installed in the borehole. The anticipated drilling method for installation will require a 4-1/2" I.D. (~8" O.D.) hollow stem auger pipe;

2. A 5-20 foot section of 0.010 inch slotted PVC casing will be placed at the saturated zone where groundwater is encountered. In the event of unconfined aquifer conditions, the screen will be placed 5-feet above the current water level to accommodate seasonal fluctuations such that these seasonal fluctuations in water will remain within the screened interval of the monitoring well. In the event of confined aquifer conditions, the screen will be placed directly across the confined aquifer;

3. A protective casing will be placed around the 2 inch diameter PVC casing at the top of the borehole to prevent surface damage to the monitoring well from livestock, wildlife, or facility personnel;

4. The space between the borehole wall and the screened PVC casing will be filled with a 10-20 silica sand pack to allow adequate fluid flow into the screened casing;

5. For unconfined aquifer conditions, the silica sand pack will extend 3-5 feet above the screened interval. For confined aquifer conditions, the silica sand pack will extend 0.5-1.0 feet immediately above the top of the screened interval; and

6. For unconfined aquifer conditions, the aquifer seal will consist of hydrated bentonite chips that will be placed immediately above the filter pack with a thickness of 2-3 feet. For confined aquifer conditions, a 2-3 feet thick aquifer seal will be placed within the confining formation and will consist of timed-release bentonite chips placed with a trimming pipe that will be placed immediately above the filter pack. For both unconfined and confined aquifer conditions, the remainder of the borehole above the aquifer seal to the ground surface will be filled with bentonite chips that will be hydrated in 5-foot lifts.

Each groundwater monitoring well will be developed using guidelines listed in ASTM D5521 which provides a Standard Guide for Development of Groundwater Monitoring Wells. Each groundwater monitoring well will be developed using the general procedures given below:

1. The monitoring wells will be developed by evacuating standing water in the bottom of the well using a bailer. Approximately 2-3 well casing volumes will be evacuated or until relatively sediment free water is produced in order to facilitate proper water quality sampling;

2. Well development may occur several times or for an extended period of time until the majority of the sediment from the well is removed; and

3. During sampling operations, the wells may be developed until field measurements of temperature, pH, and physical appearance have stabilized.

In the event that groundwater is not encountered during drilling, the boreholes will be backfilled with a combination of excess cuttings and bentonite chips from total depth to the ground surface.

Sample Groundwater from Monitoring Wells

In the event that groundwater is encountered and monitoring wells are installed, groundwater shall be sampled to establish the background groundwater quality at the proposed location. After the background groundwater quality has been determined, sampling will occur on a quarterly basis. The sampling procedure may be modified after an initial evaluation of the data is performed. A laboratory analysis of the groundwater samples shall be performed to determine the presence and quantities of the constituents listed in Table 1 and described in the following sections.

Field Parameters

During groundwater sampling, the pH, temperature, and static water level will be measured at each well. Static water level will be measured from the top of each well casing and the distance from the top of the casing to the existing ground shall be measured and reported with each measurement.

Laboratory Parameters

After samples have been collected and transported to an approved laboratory, the samples will be tested for major cations and anions, benzene, toluene, ethyl benzene and xylenes (BTEX), RCRA metals, and total dissolved solids (TDS). Table 1 provides a parameter list.

Sample Schedule

The sampling schedule will include two phases. The first phase of sampling will occur immediately after the groundwater monitoring wells have been installed and developed to establish the background groundwater quality at the proposed site. The second phase of sampling will involve collecting and testing samples on a quarterly basis after background groundwater quality has been established.

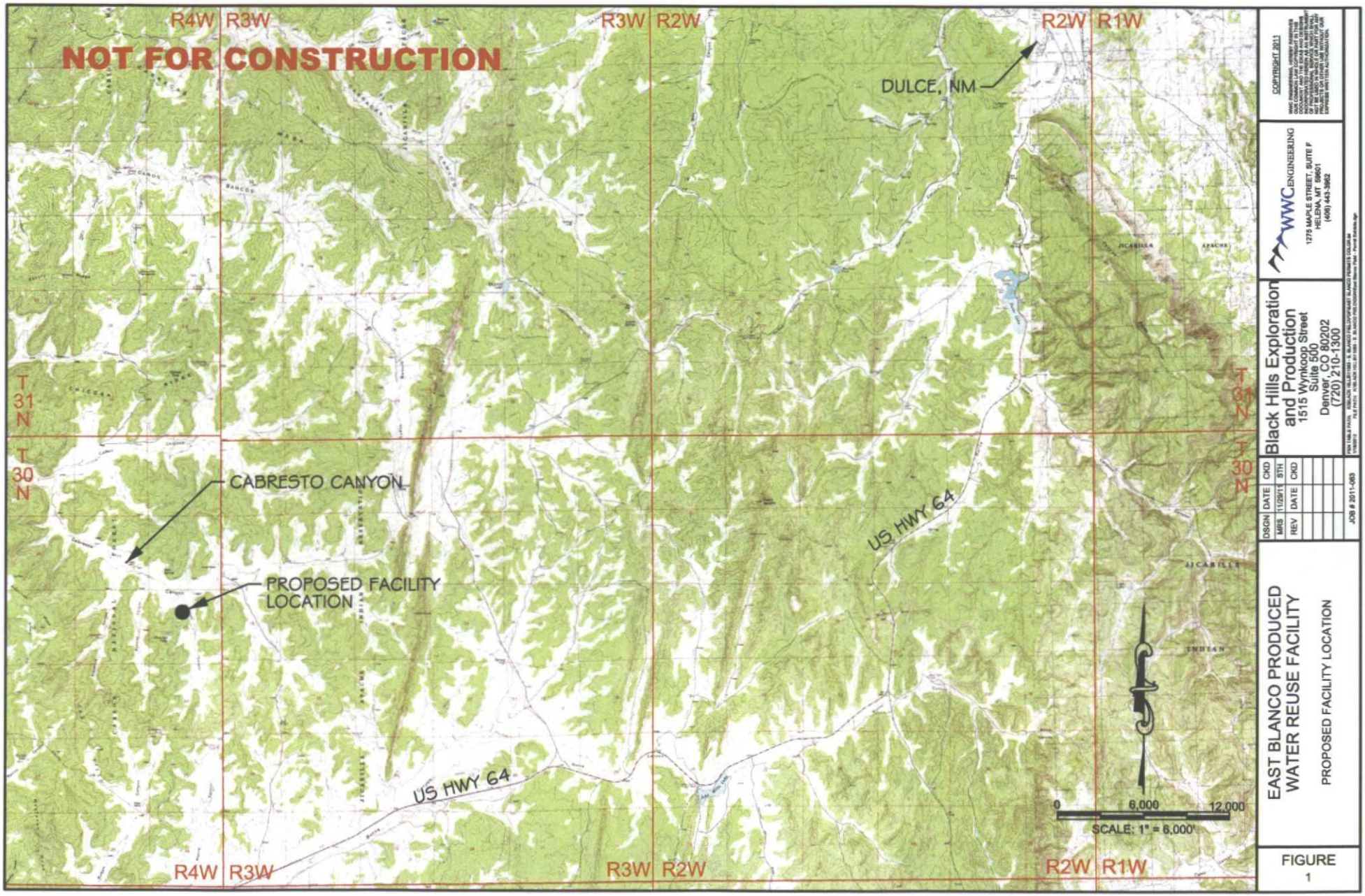
REPORTING

The laboratory results from soil and groundwater testing will be kept electronically and made available to the New Mexico Oil Conservation Division as required. A hydrogeologic assessment report will be compiled by WWC personnel within two weeks after final and accurate results have been received from soil sampling and testing along with the establishment of the background groundwater quality. The report will include the sampling results, a description of soil types beneath the proposed facility, a lithologic description of the soil and rock members from the ground surface down to the top of the shallowest fresh water aquifer, and geologic cross-sections. If groundwater is encountered in each of the three locations, background groundwater quality and potentiometric maps for the shallowest aquifer will be attached. The report and attachments will be submitted to the New Mexico Oil Conservation Division as part of the Form C-137 Application for Surface Waste Management Facility.

Table 1. Constituents List.

FIELD PARAMETERS	
pH	Temperature
Specific Conductance	Static Water Levels
LABORATORY PARAMETERS	
Analyses	**Units**
PHYSICAL PROPERTIES	
Resistivity @ 68 F	ohm-meters
Conductivity @ 25 C	umhos/cm
pH	s.u.
Solids, Total Dissolved TDS @ 180 C	mg/L
MAJOR IONS	
Carbonate as CO3	mg/L
Bicarbonate as HCO3	mg/L
Calcium	mg/L
Chloride	mg/L
Magnesium	mg/L
Potassium	mg/L
Sodium	mg/L
Sulfate	mg/L
RCRA METALS	
Arsenic	mg/L
Barium	mg/L
Cadmium	mg/L
Chromium	mg/L
Lead	mg/L
Mercury	mg/L
Selenium	mg/L
Silver	mg/L
VOLATILE ORGANIC COMPOUNDS	
Benzene	ug/L
Ethlybenzene	ug/L
m+p-Xylenes	ug/L
o-Xylenes	ug/L
Toluene	ug/L
Xylenes, Total	ug/L
Surr: 1,2 Dichlorobenzene	%REC
Surr: Dibromofluoromethane	%REC
Surr: p-Bromofluorobenzene	%REC
Surr: Toluene-d8	%REC
ORGANIC CHARACTERISTICS	
Diesel Range Organics (DRO)	mg/L
Surr: o-Terphenyl	%REC
Gasoline Range Organics (GRO)	mg/L
Surr: Trifluorotoluene	%REC

FIGURES



WWC ENGINEERING
1275 MAPLE STREET, SUITE F
HELENA, MT 59601
(406) 443-3962

Black Hills Exploration and Production
1515 Wynkoop Street
Suite 500
Denver, CO 80202
(720) 210-1300

DSGN	DATE	CKD
MRS	11/29/11	STH
REV	DATE	CKD

JOB # 2011-083

EAST BLANCO PRODUCED WATER REUSE FACILITY

PROPOSED FACILITY LOCATION

FIGURE 1

EAST BLANCO PRODUCED WATER REUSE FACILITY

PROPOSED FACILITY LAYOUT & BOREHOLE LOCATIONS

FIGURE 2

DSGN	DATE	CKD
MRS	1/17/12	STH
REV	DATE	CKD

JOB # 2011-083

Black Hills Exploration and Production
1515 Wynkoop Street
Suite 500
Denver, CO 80202
(720) 210-1300

WWC ENGINEERING
1275 MAPLE STREET, SUITE F
HELENA, MT 59601
(406) 443-3962

WWC ENGINEERING
1279 MAPLE STREET, SUITE F
HELENA, MT 59601
(406) 443-3962

Black Hills Exploration and Production
1515 Wynkoop Street
Suite 500
Denver, CO 80202
(720) 210-1300

DSGN	DATE	CKD
MRS	1/17/12	BTH

REV	DATE	CKD

JOB # 2011-083

EAST BLANCO PRODUCED WATER REUSE FACILITY

PROPOSED FACILITY LAYOUT & BOREHOLE LOCATIONS WITH TOPOGRAPHY

FIGURE 3

Appendix A

GEOMAT Inc. Subsurface Investigation Results

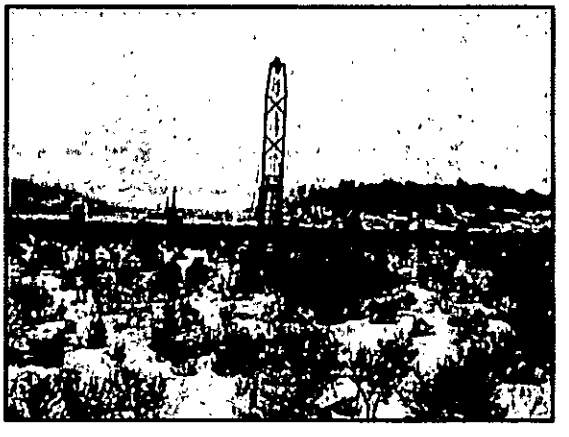
GEOMAT INC
915 Malta Avenue ◆ Farmington, NM 87401 ◆ Tel (505) 327-7928 ◆ Fax (505) 326-5721

January 3, 2012

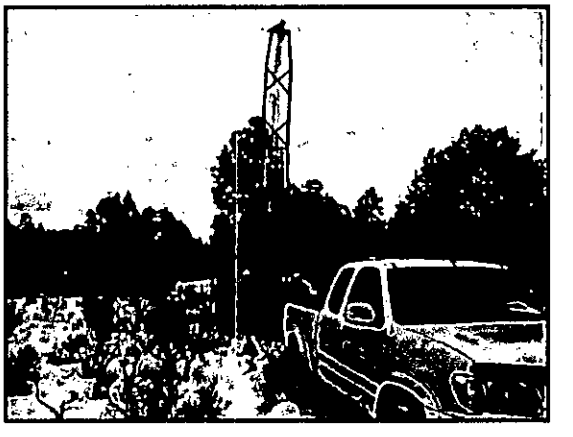
Daniel Manus
Black Hills Gas Resources
3200 North 1st Street
P.O. Box 249
Bloomfield, NM 87413

RE: East Blanco Field
Proposed Evaporation Pond Locations
Well-bore #4 Locations
GEOMAT Project No. 112-1366

As requested, GEOMAT has completed the sub-surface exploration and soil classification services for the above referenced project at the two locations identified by Black Hills Gas Resources. Present at the site during the exploration was our sub-contracted drill crew from Enviro-Drill Inc., George Madrid P.E. of GEOMAT, and yourself. The sites were drilled on December 22, 2011. The purpose of the exploratory work was to determine the soil profile and depth to groundwater at the drilled locations. The following photographs depict the site at the time of our exploration.



View of WB4 #1 Looking East



View of WB4 #2 Looking South

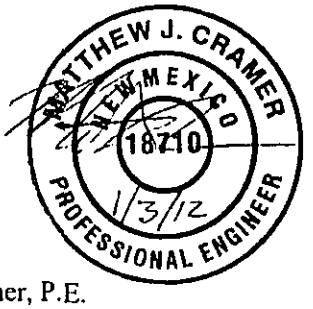
For your use, we have attached the site plans and boring logs. Groundwater was not encountered during the sub-surface exploration. The table below is a summary of our findings.

Location	Boring Number	Depth to Groundwater During Drilling (feet)	Total Boring Depth (feet)
Wellbore #4	#1	None Encountered	76.0
	#2	None Encountered	68.2

It should be noted that groundwater elevations can fluctuate over time depending upon precipitation, irrigation, runoff and infiltration of surface water. We do not have any information regarding the historical fluctuation of the groundwater level in this vicinity.

Thank you for the opportunity to work with you on this project. If you have any questions or need additional information, please let us know.

Sincerely yours,
GEOMAT Inc.



Matthew J. Cramer, P.E.
Civil/Structural Engineer

Attachments

Copies to: Addressee (1)

Approximate Not to Scale	OVERALL SITE PLAN Boring Locations (approximate) GEOMAT Project No. 112-1366 Date of Exploration: 12-22-11	PROJECT Black Hills East Blanco Field Rio Arriba County, New Mexico

GEOMAT INC

Approximate

Not to Scale

ENLARGED SITE PLAN

Boring Locations (approximate)

GEOMAT Project No. 112-1366
Date of Exploration: 12-22-11

PROJECT

Black Hills East Blanco Field
Rio Arriba County, New Mexico

GEOMAT INC

GEOMAT INC.
915 Malta Avenue
Farmington, NM 87401
Tel (505) 327-7928
Fax (505) 326-5721

Boring WB4 #1

Project Name: East Blanco Field
Project Number: 112-1366
Client: Black Hills Gas Resources
Site Location: Rio Arriba County, New Mexico
Rig Type: CME - 75
Drilling Method: 7" O.D. Hollow Stem Auger
Sampling Method: Hand and Split spoon samples
Hammer Weight: 140 lbs
Hammer Fall: 30 inches

Date Drilled: 12/22/2011
Latitude: 36° 48' 56.24" N
Longitude: 107° 12' 25.98" W
Elevation: Not Determined
Boring Location: See Site Plan
Groundwater Depth: None Encountered
Logged By: GM
Remarks: 8" - 12" of snow on ground

Laboratory Results				Blows per 6"	Sample Type & Length (in)	Recovery	USCS	Soil Symbol	Depth (ft)	Soil Description
Dry Density (pcf)	% Passing #200 Sieve	Plasticity Index	Moisture Content (%)							
							SC		1–13	CLAYEY SAND, dark brown, fine-grained, loose, damp
							RK		14–25	SANDSTONE, light brown, fine- to medium-grained, damp, highly weathered dark brown coarse-grained
							RK		26–40	SHALE, dark gray, damp

A = Auger Cuttings GRAB = Hand Sample MC = Modified California (Ring Sample) SS = Split Spoon MD = Nuclear Moisture-Density Gauge

GEOMAT 112-1366.GPJ GEOMAT.GDT 12/27/11

GEOMAT INC.
915 Malta Avenue
Farmington, NM 87401
Tel (505) 327-7928
Fax (505) 326-5721

Boring WB4 #1

Project Name: East Blanco Field
Project Number: 112-1366
Client: Black Hills Gas Resources
Site Location: Rio Arriba County, New Mexico
Rig Type: CME - 75
Drilling Method: 7" O.D. Hollow Stem Auger
Sampling Method: Hand and Split spoon samples
Hammer Weight: 140 lbs
Hammer Fall: 30 inches

Date Drilled: 12/22/2011
Latitude: 36° 48' 56.24" N
Longitude: 107° 12' 25.98" W
Elevation: Not Determined
Boring Location: See Site Plan
Groundwater Depth: None Encountered
Logged By: GM
Remarks: 8" - 12" of snow on ground

Laboratory Results: Dry Density (pcf)	Laboratory Results: % Passing #200 Sieve	Laboratory Results: Plasticity Index	Laboratory Results: Moisture Content (%)	Blows per 6"	Sample Type & Length (in)	Recovery	USCS	Soil Symbol	Depth (ft)	Soil Description
									41	SHALE, dark gray, damp
									42	
									43	
									44	
									45	interbedded with dark brown, fine- to medium-grained
									46	sandstone 44' - 46'
									47	hard drilling
									48	light gray
									49	
									50	
									51	
									52	
									53	interbedded with brown to gray, coarse-grained sandstone 52'
									54	- 55'
									55	
									56	
									57	
							RK		58	hard drilling 57' - 58'
									59	
									60	
									61	gray
									62	
									63	
									64	
									65	
									66	
									67	
									68	
									69	
									70	
									71	dark brown
									72	
									73	
									74	
					SS 12				75	
									76	
									77	Total Depth 76 feet
									78	
									79	
									80	

A = Auger Cuttings GRAB = Hand Sample MC = Modified California (Ring Sample) SS = Split Spoon MD = Nuclear Moisture-Density Gauge

GEOMAT INC.
915 Malta Avenue
Farmington, NM 87401
Tel (505) 327-7928
Fax (505) 326-5721

Boring WB4 #2

Project Name: East Blanco Field
Project Number: 112-1366
Client: Black Hills Gas Resources
Site Location: Rio Arriba County, New Mexico
Rig Type: CME - 75
Drilling Method: 7" O.D. Hollow Stem Auger
Sampling Method: Hand and Split spoon samples
Hammer Weight: 140 lbs
Hammer Fall: 30 inches

Date Drilled: 12/22/2011
Latitude: 36° 48' 49.26" N
Longitude: 107° 12' 21.75" W
Elevation: Not Determined
Boring Location: See Site Plan
Groundwater Depth: None Encountered
Logged By: GM
Remarks: 8" - 12" of snow on ground

Laboratory Results										
Dry Density (pcf)	% Passing #200 Sieve	Plasticity Index	Moisture Content (%)	Blows per 6"	Sample Type & Length (in)	Recovery	USCS	Soil Symbol	Depth (ft)	Soil Description
	39				GRAB		SC		1-11	CLAYEY SAND, dark brown, fine-grained, loose, damp
							RK		12-37	SANDSTONE, light brown, fine- to medium-grained, damp, highly weathered hard drilling 11' - 13' dark brown easier drilling light brown coarse-grained
							RK		38-40	SHALE, gray, damp

A = Auger Cuttings, GRAB = Hand Sample MC = Modified California (Ring Sample) SS = Split Spoon MD = Nuclear Moisture-Density Gauge

GEOMAT, INC
915 Malta Avenue
Farmington, NM 87401
Tel (505) 327-7928
Fax (505) 326-5721

Boring WB4 #2

Project Name: East Blanco Field
Project Number: 112-1366
Client: Black Hills Gas Resources
Site Location: Rio Arriba County, New Mexico
Rig Type: CME - 75
Drilling Method: 7" O.D. Hollow Stem Auger
Sampling Method: Hand and Split spoon samples
Hammer Weight: 140 lbs
Hammer Fall: 30 inches

Date Drilled: 12/22/2011
Latitude: 36° 48' 49.26" N
Longitude: 107° 12' 21.75" W
Elevation: Not Determined
Boring Location: See Site Plan
Groundwater Depth: None Encountered
Logged By: GM
Remarks: 8" - 12" of snow on ground

Laboratory Results: Dry Density (pcf)	Laboratory Results: % Passing #200 Sieve	Laboratory Results: Plasticity Index	Laboratory Results: Moisture Content (%)	Blows per 6"	Sample Type & Length (in)	Recovery	USCS	Soil Symbol	Depth (ft)	Soil Description
									41	SHALE, gray, damp
									42	hard drilling 40' - 41.5'
									43	
									44	interbedded with light brown, medium-grained sandstone
									45	
									46	hard drilling 45' - 46'
									47	
									48	
							RK		49	
									50	
									51	
									52	
									53	
									54	
									55	
									56	
									57	
									58	SANDSTONE, light brown, medium- to coarse-grained, damp
									59	
									60	hard drilling
									61	
									62	
							RK		63	interbedded with shale
									64	
									65	
									66	gray, fine-grained
									67	hard drilling
									68	
					SS 2				69	Auger refusal on sandstone at 68.2 feet
									70	Total Depth 68.2 feet
									71	
									72	
									73	
									74	
									75	
									76	
									77	
									78	
									79	
									80	

A = Auger Cuttings GRAB = Hand Sample MC = Modified California (Ring Sample) SS = Split Spoon MD = Nuclear Moisture-Density Gauge