| Fransmittal Letter Transmittal Letter To: Dr. Tom McLaughlin Division of Water Ma Environmental Prote Office of Federal an Environmental Mana United States Nucle Washington, DC 202 | ADDIS vironment, facilities n, Decommissioning Brand anagement and ection d State Materials and agement Programs ar Regulatory Commissio 555-0001 | ^{Copies:} ch Mahesh Vidyasagar, EMES Rebecca Bilodeau, Tetra Tech File | ARCADIS 1687 Cole Blvd. Suite 200 Lakewood Colorado 80401 Tel 303.231.9115 Fax 303.231.9571 |
|---|---|--|---|
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Exxon Mobil Environmental Services Corporation

FINAL

Boner Property Wells Summary

Highland Reclamation Project Converse County, Wyoming

May 2008

Returnden

Rebecca D. Lindeman, P.E. Principal Civil Engineer

FINAL Boner Property Well Summary

Highland Reclamation Project

Prepared for: Exxon Mobil Environmental Services Corporation

Prepared by: ARCADIS 1687 Cole Center Suite 200 Lakewood Colorado 80401 Tel 303.231.9115 Fax 303.231.9571

Our Ref.: B0085721.0002.00003

Date: May 2008

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Highland Reclamation Project

1. Introduction

This monitoring well summary report has been prepared at the request of the Nuclear Regulatory Commission (NRC) to document offsite groundwater conditions east of the Highland Reclamation Project located near Douglas, Wyoming. This report summarizes the installation of three MFG wells and four BBL wells on the adjacent Boner property located to the east of the Pit Lake and Tailings Basin. This report also summarizes the analytical results for all the sampling events that have occurred since each well's inception. A summary of the geology and hydrogeology of the Site is provided below as reference for the newly-installed monitoring wells.

At the request of Exxon Mobil Environmental Services Corporation (EMES), Tetra Tech, formerly MFG, Inc., and ARCADIS, formerly BBL, installed monitoring wells on the adjacent Boner property to the east of the EMES Highland Reclamation Project. Seven groundwater monitoring wells were installed between 2005 and 2006. The purpose of the MFG and BBL well installation was to enable sampling of groundwater downgradient of the tailing basin into three different sandstone formations at the Site for the MFG wells (MFG-1, MFG-2, and MFG-3),two different subsurface units, alluvial material and the first water bearing bedrock formation, for the BBL wells (BBL-1, BBL-2, BBL-3, and BBL-4). The locations of the new monitoring wells are shown on Figure 1. A cross-section of the site, including these seven new wells, is presented in Figures 2 and 3.

1.1 Geology

The Site geology, also summarized in the *Final Long Term Pit Lake and Groundwater Hydrology at the Highland Mine Site* (MFG, 2007), is provided as reference for installation of the offsite wells. The geology of the Site consists of the sedimentary deposits within the Powder River Basin of northeastern Wyoming. The units of significance to this Site lay within the upper Fort Union Formation (Paleocene), and, to a lesser extent, the lower Wasatch Formation (Eocene). A stratigraphic column of these units is presented on Figure 4. Regionally, the strata dip towards the west (Hunter, 1999), but at the Site, dip is approximately 0.5 degrees to the northwest.

The Highland Sandstone Unit (HSU) of the Fort Union Formation is the host rock of most of the uranium ore in the area. The unit is 120 to 150 feet thick and consists of sand channel and floodplain facies (Hunter, 1999). The unit is divisible into three sandstone members that are separated by intervals of claystone and siltstone. Informal nomenclature refers to the sandstones from stratigraphically highest to lowest as 50-

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Sand, 40-Sand, and 30-Sand, and the fine-grained intervals as 45-Shale and 35-Shale (Hunter, 1999). The sandstones have also been referred to as the upper, middle, and lower sandstone members (Exxon Research Production Company [EPRC], 1983). All three members are laterally extensive throughout the Site and are generally composed of fine- to medium-grained, poorly lithofied, arkosic sandstone that typically ranges from 20 to 50 feet in thickness. The fine-grained intervals are approximately 9 feet and 35 feet thick in the area of the Pit Lake, respectively, but, in some locations, are altogether absent, and the sandstones are in vertical contact (Hunter, 1999).

Overlying the HSU in the study area is the Tailings Dam Shale (TDSH), a laterally pervasive interval of siltstone and claystone that ranges from 20 feet to 50 feet in thickness. The TDSH is overlain by the Tailings Dam Sandstone (TDSS). The TDSS is composed of sand channel and floodplain facies similar to the sandstone members of the HSU and is typically 30 feet to 50 feet in thickness. Unlike the underlying deposits, the TDSS is not laterally extensive across the study area. This unit has a well-defined northwest-trending western edge approximately 1 mile west of the Pit Lake (Hunter, 1999). Along this line, the TDSS is a thick sequence of interbedded sandstone, siltstone, and claystone of the upper Fort Union Formation and the lower Wasatch Formation.

The undifferentiated Fort Union and Wasatch deposits are exposed at the surface over the majority of the area. Because the strata dip to the northwest, and topography slopes to the southeast, depth to the TDSS, TDSH, and HSU decreases from northwest to southeast until these units eventually crop out in the eastern portion of the Site (east of the Tailings Dam) between the MFG well locations and the BBL well locations.

1.2 Hydrogeology

This section discusses the overall site hydrology. This is also summarized in the *Final Long Term Pit Lake and Groundwater Hydrology at the Highland Mine Site* (MFG, 2007).

The Site is located in a regional groundwater discharge area. Prior to mining activity at the Site, regional groundwater flowed through the upper Fort Union Formation strata from the west, north, and south, and was discharged at outcrops of these strata along North Fork Box Creek and its tributaries (Dames & Moore, 1980).

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Beginning in 1972, Exxon Minerals Company/Exxon Coal and Minerals Company commenced mining operations at the Site that created a major disruption to the natural groundwater flow field. Surface or open-pit mine Pits 1 through 4 were sequentially excavated from 1972 to 1984 (Figure 1). During this time, total groundwater withdrawal from pit sumps and dewatering wells typically exceeded 1,000 gallons per minute (gpm). Following excavation, Pits 1 and 2 were backfilled with overburden materials, while Pits 3 and 4 remained open. In March 1984, dewatering of Pits 3 and 4 ceased, the Pit Lake began to fill, and the large cone of depression in the potentiometric surface began to recover.

The hydrogeology at the Site was also impacted by the placement of mill tailings in the unnamed tributary of North Fork Box Creek east of the surface mine operations (Figure 1). Tailings were deposited in this drainage beginning in 1972 and continued until the end of milling operations in June 1984. The deposition of tailings slurry over time created a groundwater mound beneath the impoundment. Waste, Water, and Land (WWL, 1984) estimated that flux from the tailings reached a maximum of approximately 180 gpm (34,500 cubic feet per day [ft³/day]) in 1984 and decreased to 3.5 gpm (670 ft³/day) by 1992.

A dam was constructed to the east of the Tailings Basin at the beginning of mining operations to prevent tailings from entering the valley located directly to the east. As discussed above, the deposition of tailings slurry over time created a groundwater mound beneath the tailings basin. Seepage of groundwater from beneath the tailings basin through the dam has been visually observed at the Site in the past in conjunction with the observation of unusually green grass. Seepage from the Tailings Dam has not been visually observed in many years.

Boner Property Wells Summary

Highland Reclamation Project

2. Monitoring Well Installation, Pump Installation, and Sampling Procedures for MFG Wells

The monitoring well installation activities for the three MFG wells commenced on October 4, 2004 and were completed by October 7, 2004. The three wells were sampled on November 17, 2004. A summary of these activities were previously submitted internally on November 16, 2004 from Joe Reed to Clint Strachan, both of Tetra Tech (MFG, 2004). A copy of this memorandum was submitted to EMES on September 12, 2006 by ARCADIS. Information from this memorandum (MFG, 2004) is summarized below. Survey data is summarized in Table 1 and well completion information is summarized in Table 2. Appendix A contains monitoring well completion diagrams. Borehole logs are presented in Appendix B.

2.1 Monitoring Well Installation Procedures

Drilling Engineers Inc., of Fort Collins, Colorado installed three boreholes using a CME 75 drill rig utilizing hollow stem augers and air rotary drilling. Hollow stem augers (8.25inch inside diameter and 12.25-inch outside diameter) were advanced to 15 feet below ground surface (bgs) and were then utilized as temporary surface casing. Air rotary drilling (using a 7 7/8-inch diameter roller bit) was then used to advance the boreholes to total depth. The boreholes were sampled during drilling by observation of drill cuttings.

The 4-inch diameter monitoring wells were constructed from Boart Longyear's Tilock Schedule 40 polyvinyl chloride (PVC). Slotted well screen (0.020-inch) and cap was installed at the depths specified in Table 2. A centralizer was installed in the middle of the screen interval of MFG-2 and MFG-3 and two centralizers were installed at the top and bottom of the screen interval of well MFG-1. Oglebay Norton Corporation's 10-20 filter pack was installed to 3-6 feet above the screen. A Cetco coated pelleted bentonite seal was installed above the filter pack. Chip bentonite was installed above the pelleted bentonite seal to near ground surface. The 4-inch diameter PVC was capped with a 4inch diameter slip cap. The surface completion for each well consisted of a lockable protective steel casing with a sloping cement pad.

2.2 Monitoring Well Pump Installation and Development

Wells were first developed by surging and bailing throughout the screened interval. Grundfos 5SQ3A, ½ horsepower, 20 volt electric submersible pumps were installed in each of the monitoring wells by Pronghorn, Pump, and Repair (PPR) of Glenrock,

Highland Reclamation Project

Wyoming. The pump was installed at 51 feet below ground surface (bgs) in MFG-1, at 90 feet bgs in MFG-2 and at 139 feet bgs in MFG-3.

PPR then further developed the wells by pumping. MFG-1 was pumped dry more than 30 times, 1,100 gallons was purged from MFG-2 and 1,800 gallons was purged from MFG-3. MFG-1 easily pumps dry but quickly recovers; MFG-2 and MFG-3 can be pumped continuously at 5 gallons per minute.

Development water and drill cutting were spread on the ground at the well site. All downhole drilling and development equipment was decontaminated by power washing with tap water and Liquinox prior to drilling the first borehole.

The monitoring wells are registered with the State of Wyoming and have been assigned the following permit numbers:

- MFG-1 Permit No. U.W. 162572
- MFG-2 Permit No. U.W. 162573
- MFG-3 Permit No. U.W. 162571
- 2.3 Initial Water Quality Analyses

Initial water quality samples were collected from the new wells on November 17, 2004. Quarterly groundwater sampling was implemented thereafter and is still ongoing. In November 2004 the three MFG wells were sampled for the Nuclear Regulatory Commission (NRC) Short List. The three wells have been sampled for the NRC Long List during the first and third quarters and for the NRC Short List during the second and fourth quarters since each well's inception.

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3. Monitoring Well Installation, Pump Installation, and Sampling Procedures for BBL Wells

The monitoring well installation activities for the four BBL wells commenced on June 26, 2006 and were completed on July 8, 2006. Development of the new monitoring wells and pump installation occurred between July 13, 2006 and July 18, 2006. Quarterly groundwater sampling included analysis of Nuclear Regulatory Commission parameters as listed in the Procedures Manual (ARCADIS, 2008). These procedures and results were previously summarized in a memorandum entitled, "Monitoring Well Installation, ExxonMobil Highland Site," to EMES dated September 12, 2006 (BBL, 2006). Survey data is summarized in Table 1 and well completion information is summarized in Table 2. Appendix A contains monitoring well completion diagrams. Borehole logs are presented in Appendix B.

3.1 Monitoring Well Installation Procedures

Drilling Engineers Inc., of Fort Collins, Colorado installed boreholes using a CME 75 drill rig utilizing hollow stem augers and air rotary drilling. The crew decontaminated downhole drilling equipment by power washing with tap water prior to and following drilling activities.

The field geologist observed downhole soil conditions via drill cuttings and split spoons recovered during drilling activities. At the completion of the borehole, drill cuttings were spread on the ground surface at the well site. Borehole logs are presented in Appendix A.

BBI-1 was initially drilled with hollow stem augers to 30 feet below ground surface (bgs) and air rotary to 56.5 feet bgs. This borehole was subsequently abandoned due to caving sands. The abandoned BBL-1 borehole encountered an alluvial channel with a high conductivity alluvial sand deposit not encountered at other boreholes. This sand deposit was not encountered at the next BBL-1 location, which supports the conclusion that it is an alluvial sand and not a bedrock sand deposit. Abandoned BBL-1 (BBL-1 P&A) was sealed by filling with chip bentonite. BBL-1 was relocated 63 feet to the northwest.

BBL-1, which is the deepest well, was drilled using hollow stem augers/air rotary drilling. BBL-1 was completed in the first water bearing bedrock formation. A hollow stem auger (8 ¼-inch inside diameter and 12 ¼-inch outside diameter) was advanced to 67 ½-feet (bgs) at BBL-1 and was then utilized as temporary surface casing. Air

Boner Property Wells Summary

Highland Reclamation Project

rotary drilling (using a 7 7/8-inch diameter Ken Claw Bullet Bit) was then used to advance the borehole to total well completion depth.

Three shallow monitoring wells were drilled using hollow stem augers: BBL-2, BBL-3, and BBL-4. The shallow monitoring wells were completed in the alluvial material overlying the bedrock. Hollow stem augers (6 ¼-inch inside diameter and 10 ¼-inch outside diameter) were advanced to total depth.

The 4-inch diameter monitoring wells were constructed from Schedule 40 PVC. Slotted well screens (0.020-inch) were installed at the depths specified in Table 2. Centralizers were installed at the top and bottom of the screen interval of monitoring well BBL-1. A bottom bentonite pellet seal was installed to 41.8 feet bgs in BBL-3 to minimize bedrock ground water entering the alluvial well. Filter pack sand (10-20) was installed to 4 to 9 feet above the screen of the four monitoring wells. A pelleted bentonite seal was installed above the filter pack in each monitoring well. Chip bentonite was installed above the pelleted bentonite seal to near ground surface. The top of each PVC opening was covered with a slip cap. The surface completion for each well consisted of a key-locked protective steel casing with a 3-foot square sloping cement pad.

The monitoring wells were installed with guidance from Wyoming Permit-By-Rule (Wyoming Department of Environmental Quality, 2000). Wyoming Department of Environmental Quality allows Permit-By-Rule installations for monitoring wells 4-inches or less in diameter.

3.2 Monitoring Well Pump Installation and Development

Grundfos 3-inch, 230 volt electric submersible pumps with single-phase motors were installed in each of the monitoring wells by Pronghorn Pump and Repair of Glenrock, Wyoming. Monitoring wells BBL-1 and BBL-4 contain ½ horsepower (hp), 5 gallons per minute (gpm) pumps. Monitoring wells BBL-2 and BBL-3 contain 1/3-hp, 5 gpm pumps. The pump was installed at 133 feet bgs in BBL-1, at 35 feet bgs in BBL-2, at 40 feet bgs in BBL-3, and at 40 feet bgs in BBL-4.

Pronghorn Pump and Repair developed the monitoring wells by pumping between 40 and 80 casing volumes per well until purge water was reasonably clear. BBL-1 was pumped for a total of 7 ³/₄ hours over three days at a rate of 5 gpm and 6.5 gpm. Due to their low flow rates, BBL-2, BBL-3, and BBL-4 were pumped dry and then allowed to recover before repeating the process at least twice. The process was complete in well BBL-2 after 5 days, in BBL-3 after 4 days, and in BBL-4 after 3 days.

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Downhole development equipment consisted of dedicated electric submersible pumps and disposable bailers. Development water was released on the ground surface in the vicinity of the well site.

Following development activities, flow restrictors were installed at monitoring wells BBL-2, BBL-3, and BBL-4. BBL-2 received a 1-gpm dole valve, while BBL-3 and BBL-4 each received a 2 gpm dole valve.

These monitoring wells were permitted under Permit-by-Rule for the State of Wyoming.

3.3 Initial Water Quality Analyses

Initial water quality samples were collected from the new wells in July 2006. Quarterly groundwater sampling was implemented thereafter and is still ongoing. In July 2006 the four BBL wells were sampled for the NRC Long List of parameters in accordance with the Procedures Manual (ARCADIS, 2008). In November 2006, the four wells were sampled for the NRC Short List. In March 2007, the four wells were again sampled for the NRC Long List. Since August 2007, all four wells have been sampled quarterly for both the NRC Long List and the Wyoming Department of Environmental Quality (WDEQ) list in accordance with the Procedures Manual (ARCADIS, 2008).

Boner Property Wells Summary

Highland Reclamation Project

4. Discussion

While there appears to be elevated levels of some constituents in the new wells, this groundwater is not used by the public. An evaluation of the data is currently being conducted to determine long-term concentrations and potential impacts. The evaluation will include a determination of whether the current groundwater monitoring data are consistent with the site groundwater model used in the Alternative Concentration Limit (ACL) application. For instance, the Point-of-Compliance well along the east site of the Tailings Basin (Monitoring Well 125) has an ACL for U-nat of 0.089 milligrams per liter (mg/l). The BBL wells, which are downgradient from Monitoring Well 125, have U-nat values which appear to be elevated but are less than the ACL and are generally declining with distance from the Tailings Basin. This behavior is consistent with geochemical modeling which predicts decreasing concentrations with distance from the Tailings Basin as natural attenuation occurs. Of course, other constituents will need to be included in the evaluation. In addition, it is possible that the proposed NRC boundary will need to be expanded to include the area to the south-east to encompass the new wells. It is anticipated that the review will be completed in the next few months.

Highland Reclamation Project

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Tables

Table 1 Survey Data

Boner Property Wells Summary Report EMES - Highlance Reclamation Project, Converse County, Wyoming

| - 1 | | | | | Elevation |
|------------------------|-----------|------------|------------------|-------------------|--------------|
| Well ID | Northing | Easting | Latitude | Longitude | (Top of PVC) |
| MFG-1 ¹ | 874029.53 | 414525.549 | 43°03' 53.51532" | 105°29' 13.69021" | 5117.827 |
| MFG-2 ¹ | 874038.33 | 414543.504 | 43°03' 53.60295" | 105°29' 13.44878" | 5116.744 |
| MFG-3 ¹ | 874047.28 | 414561.693 | 43°03' 53.69204" | 105°29' 13.20420" | 5115.079 |
| BBL-1 P&A ² | 873682.75 | 415431.73 | NA | NA | NA |
| BBL-1 ² | 873723.37 | 415383.07 | NA | NA | 5094.40 |
| BBL-2 ² | 873510.60 | 415471.18 | NA | NA | 5093.03 |
| BBL-3 ² | 873158.74 | 415961.36 | NA | NA | 5087.56 |
| BBL-4 ² | 871969.39 | 417072.44 | NA | NA | 5068.64 |

Notes:

¹Datum:WGS 84 ²Datum: NAD83 NA - Not applicable. P&A - Plugged and abandoned. PVC - Polyvinyl chloride.

Table 2Well Completion Summary

Boner Property Wells Summary Report EMES - Highlance Reclamation Project, Converse County, Wyoming

| | Total | | Bottom of | Top of | Top of Filter | | Top of Bottom | | |
|---------|-----------|-----------|-----------|----------|---------------|------------------|----------------|-------------|---------------------|
| | Depth (ft | Open Hole | PVC | Screen | Pack (ft | Top of Bentonite | Bentonite Seal | PVC Stickup | Static Water |
| Well ID | bgs) | (ft bgs) | (ft bgs) | (ft bgs) | bgs) | Pellets (ft bgs) | (ft bgs) | (ft ags) | Level* (ft bgs) |
| MFG-1 | 51.5 | NA | 50.9 | 20.5 | 14.5 | 10.5 | NA | 2.0 | 41.60 |
| MFG-2 | 96.0 | NA | 92.0 | 76.6 | 72.7 | 68.0 | 93.0 | 2.0 | 46.65 |
| MFG-3 | 151.5 | NA | 140.6 | 130.2 | 127.0 | 121.5 | NA | 2.0 | 45.40 |
| | | | | | | | | | (<24 hours after |
| BBL-1 | 136.5 | 125.9 | 126.2 | 85.8 | 79.5 | 75.0 | NA | 2.0 | construction) |
| BBL-2 | 36.5 | 36.5 | 36.1 | 20.7 | 16.0 | 14.7 | NA | 2.0 | 27.40 |
| BBL-3 | 44.5 | 42.0 | 40.2 | 24.8 | 15.5 | 14.8 | 41.8 | 2.0 | 23.40 |
| BBL-4 | 39.6 | 39.6 | 39.6 | 14.2 | 10.3 | 8.6 | NA | 2.0 | 14.80 |

Notes:

* Static water level for MFG wells measure in November 2004 and for BBL wells on 7/8/06.

ft ags - Feet above ground surface.

ft bgs - Feet below ground surface.

Table 3Groundwater Elevations

Boner Property Wells Summary Report EMES - Highlands Reclamation Project, Converse County, Wyoming

| | | | Well ID and S | Surface Eleva | tion (ft amsl) | | |
|----------|---------------------|---------|---------------|---------------|----------------|---------|---------|
| | MFG-1 | MFG-2 | MFG-3 | BBL-1 | BBL-2 | BBL-3 | BBL-4 |
| Date | 5115.83 | 5114.74 | 5113.08 | 5092.40 | 5091.03 | 5085.56 | 5066.64 |
| Measured | | | Depth to | Groundwate | r (ft amsl) | | |
| Nov-04 | 5073.94 | 5067.91 | 5069.48 | NA | NA | NA | NA |
| Feb-05 | 5073.83 | 5067.71 | 5067.88 | NA | NA | NA | NA |
| May-05 | 5073.71 | 5067.76 | 5067.76 | NA | NA | NA | NA |
| Oct-05 | 5073.56 | 5067.71 | 5067.68 | NA | NA | NA | NA |
| Dec-05 | 5073.44 | 5067.51 | 5067.53 | NA | NA | NA | NA |
| Mar-06 | 5073.37 | 5067.36 | 5068.08 | NA | NA | NA | NA |
| Jun-06 | 5073.2 9 | 5067.21 | 5067.31 | NA | NA | NA | NA |
| Jul-06 | NA | NA | NA | 5064.07 | 5065.38 | 5063.87 | 5053.52 |
| Aug-06 | 5073.19 | 5066.24 | 5067.52 | NA | NA | NA | NA |
| Nov-06 | 5073.13 | 5067.04 | 5067.28 | 5063.97 | 5065.33 | 5063.81 | 5053.24 |
| Mar-07 | 5073.02 | 5067.03 | 5067.51 | 5063.70 | 5065.28 | 5063.69 | 5053.34 |
| May-07 | 5072.93 | 5066.94 | 5067.48 | 5064.20 | 5065.20 | 5062.66 | 5054.04 |
| Aug-07 | 5072.95 | 5067.04 | 5067.28 | 5064.17 | 5065.13 | 5063.66 | 5053.21 |
| Nov-07 | 5072.88 | 5066.82 | 5067.28 | 5064.06 | 5065.13 | 5063.76 | 5052.98 |
| Average | 5073.32 | 5067.26 | 5067.70 | 5064.03 | 5065.24 | 5063.58 | 5053.39 |

Notes:

ft amsl = feet above mean sea level

NA = Not measured. Wells not installed yet.

Table 4 Water Quality Data

Boner Property Wells Summary Report EMES - Highlands Reclamation Project Converse County, Wyoming

| | I | | | | | | | | r | | | | | | 1 | | r | | | | | |
|--------------------|---------------|---------------|-----------|-------|------------|------|-----------|-----------|------|------|-------|-----------|---------|-----------|------|-----------|-----------|-----------|----------|----------|-------|----------|
| | | | | | | | | | 1 | | | | | | | | 1 | | | | | |
| | Alkalinity to | Alkalinity to | | | | | | Gross | | | | | | | | | | | | | | 1 |
| Analyte | pH 8.3 | pH 4.5 | As | Ca | Cd | CI | Cr | Alpha | ĸ | Mg | Na | Ni | NO2+NO3 | Pb | рH | Ra226 | Ra228 | Se | S04 | TDS | Th230 | U-Nat |
| Units | | | mg/L | mg/L | mg/L | mg/L | mg/L | pCi/L | | | mg/L | mg/L | mg/L | mg/L | stnd | pCi/L | pCi/L | mg/L | mg/L | mg/L | pCi/L | mg/L |
| Reporting | | | | | | | | | | | | | | | | | | | | | | |
| Reference | | | | | | | | | | | | | | | | | | | | | | |
| Concentration | - | - | 0.05 | | 0.01 | - | 0.1 | 15 | - | - | - | 0.1 | - | 0.05 | - | - | - | 0.05 | - | - | 0.55 | 0.030 |
| | | | | | | | | | | | | _ | | | | | | | | | | |
| BBL - 1 | | | | | | | | | | | | | | | | | | | | | | |
| 7/25/2006 | <0.46 | 179 | <0.002 | NS | <0.00025 | 3.4 | 0.00040 J | <1.0 | NS | NS | 68.0 | 0.0023 | <0.10 | <0.001 | 7.9 | <0.2 | <1.0 | 0.00051 J | 92.6 | 328 | <0.2 | <0.0003 |
| 11/22/2006 | NS | NS | NS | NS | NS | 3.4 | NS | NS | NS | NS | 68.1 | NS | <0.040 | NS | 7.9 | NŞ | NS | NS | 85.2 | 338 | NS | NS |
| 3/14/2007 | NS | NS | 0.00067 | NS | 0.000099 | 3.2 | 0.00029 J | <1.0 | NS | NS | 68.2 | 0.00098 J | <0.040 | 0.000047 | 7.9 | <0.2 | <1.0 | 0.0005 | 97.4 | 322 | <0.2 | <0.0003 |
| 6/4/2007 | NS | NS | NS | NS | NS | 3.4 | NS | <1.0 | NS | NS | 59.6 | NS | <0.040 | NS | 7.9 | <0.2 | <1.0 | NS | 84.9 | 329 | <0.2 | <0.0003 |
| 8/16/2007 | <0.46 | 175 | <0.00070 | 34.3 | < 0.000099 | 3.3 | <0.00042 | <1.0 | 4.76 | 7.6 | 68.9 | 0.0021 | <0.040 | 0.00016J | 7.9 | <0.2 | <1.0 | <0.00053 | 88.1 | 340 | <0.2 | <0.0003 |
| 11/9/2007 | <0.46 | 177 | <0.00070 | 36.6 | < 0.000099 | 3.1 | < 0.00042 | <1.0 | 5.11 | 7.87 | 65.1 | 0.0018J | <0.040 | 0.000053J | 7.9 | <0.2 | <1.0 | 0.00056J | 85.7 | 328 | <0.2 | <0.0003 |
| 3/15/2008 | <0.46 | 173 | <0.00070 | 35.2 | < 0.000099 | 3.4 | <0.00060 | <1.0 | 4.58 | 7.76 | 66.1 | 0.003 | <0.040 | 0.000063J | 7.8 | 0.4+/-0.2 | <1.0 | 0.00070J | 95.2 | 324 | <0.2 | <0.0003 |
| BBL - 2 | | | | | | | | | | | | | | | | | | | | | | |
| 7/25/2006 | <0.46 | 342 | <0.0100 | NS | < 0.0013 | 145 | 0.0023 J | <1.0 | NS | NS | 135 | 0.0213 | 1.2 | <0.001 | 7.3 | <0.2 | <1.0 | 0.0106 | 1,740 | 2,760 | <0.2 | 0.0624 |
| 11/22/2006 | NS | NS | NS | NS | NS | 133 | NS | NS | NS | NS | 131 | NS | 0.040 | NS | 7.1 | NS | NS | NS | 1,560 | 2,680 | NS | NS |
| 3/14/2007 | NS | NS | 0.0019 J | NS | 0.00028 | 104 | 0.00046 J | <1.0 | NS | NS | 131 | 0.0322 | 2.6 | 0.0013 | 7.6 | <0.2 | <1.0 | 0.0387 | 1,460 | 2,320 | <0.2 | 0.0554 |
| 6/4/2007 | NS | NS | NS | NS | NS | 109 | NS | 2.1+/-0.9 | NS | NS | 114 | NS | 2.6 | NS | 7.2 | 0.7+/-0.3 | <1.0 | NS | 1400 | 2530 | <0.2 | 0.0594 |
| 8/16/2007 | <0.46 | 321 | 0.0017J | 458 | < 0.000099 | 118 | 0.00043J | 1.3+/-0.7 | 5.92 | 113 | 133 | 0.0173 | 2.8 | 0.0014 | 7.3 | <0.2 | <1.0 | 0.0357 | 1330 | 2620 | <0.2 | 0.0595 |
| 11/9/2007 | <0.46 | 318 | 0.0043 | 483 | 0.00016J | 104 | < 0.00042 | <1.0 | 5.46 | 116 | 125 | 0.0188 | 3.3 | 0.002 | 7.3 | <0.2 | <1.0 | 0.0489 | 1380 | 2650 | <0.2 | 0.0629 |
| 3/15/2008 | <0.46 | 322 | 0.0015J | 450 | 0.00015J | 97.7 | < 0.00060 | 1.0+/-0.4 | 5.59 | 111 | 125 | 0.0739 | 3.1 | 0.00030J | 7.2 | <0.2 | <1.0 | 0.0501 | 1420 | 2420 | <0.2 | 0.0567 |
| BBL - 3 | | | | | | | | | | | | | | - | | | | | | | | |
| 7/26/2006 | <0.46 | 482 | <0.0100 | NS | < 0.0013 | 196 | 0.0025 J | 2.2+/-0.8 | NS | NS | 147 | 0.0093 J | <0.10 | <0.001 | 7.1 | 0.9+/-0.5 | 1.9+/-0.8 | <0.0100 | 1,800 | 3,190 | <0.2 | 0.0513 |
| 11/22/2006 | NS | NS | NS | NS | NS | 210 | NS | NS | NS | NS | 146 | NS | <0.040 | NS | 7.0 | NS | NS | NS | 1670 | 3380 | NS | NS |
| 3/14/2007 | NS | NS | 0.002 | NS | 0.000099 | 206 | 0.00045 J | 1.6+/-0.7 | NS | NS | 154 | 0.0205 | <0.040 | 0.000047 | 7.1 | 0.7+/-0.3 | 2.4+/-1.0 | 0.0017 J | 1890 | 3020 | <0.2 | 0.0510 |
| 6/4/2007 | NS | NS | NS | NS | NS | 227 | NS | 2.9+/-0.9 | NS | NS | 140 | NS | <0.040 | NS | 7.0 | 1+/-0.4 | 3.2+/-1.0 | NS | 1660 | 3250 | <0.2 | 0.0508 |
| 8/16/2007 | <0.46 | 472 | 0.0020J | 573 | < 0.000099 | 222 | <0.00042 | 3.1+/-0.9 | 9.63 | 156 | 150 | 0.0068 | <0.040 | 0.00046J | 7.0 | 0.7+/-0.3 | 3.2+/-0.9 | 0.0025 | 1650 | 3220 | <0.2 | 0.0482 |
| 11/9/2007 | <0.46 | 463 | 0.0026 | 578 | < 0.000099 | 224 | < 0.00042 | 1.8+/-0.6 | 9.27 | 166 | 138 | 0.0078 | <0.040 | 0.00016J | 7.0 | 0.6+/-0.3 | 8.3+/-1.2 | 0.0035 | 1860 | 3190 | <0.2 | 0.0525 |
| 3/15/2008 | <0.46 | 470 | 0.0025 | 599 | <0.000099 | 240 | <0.00060 | 2.3+/-0.5 | 9.52 | 164 | 142 | 0.0533 | <0.040 | 0.00012J | 7.0 | 0.8+/-0.2 | 3.3+-0.6 | 0.0031 | 1890 | 3020 | <0.2 | 0.0476 |
| BBL - 4 | | | | | | | | | | | | | | | | | | | | | | |
| 7/26/2006 | <0.46 | 268 | <0.0100 | NS | <0.0013 | 175 | 0.0029 J | <1.0 | NS | NS | 125 | 0.0083 J | <0.10 | 0.00040 J | 7.3 | <0.2 | <1.0 | 0.0148 | 1,500 | 2,790 | <0.2 | 0.0662 |
| 11/22/2006 | NS | NS | NS | NS | NS | 167 | NS | NS | NS | NS | 124 | NS | <0.040 | NS | 7.2 | NS | NS | NS | 1,460.00 | 2,880.00 | NS | NS |
| 3/14/2007 | NS | NS | 0.00067 | NS | 0.000099 | 151 | 0.00058 J | <1.0 | NS | NS | 120 | 0.0198 | <0.040 | 0.000047 | 7.4 | <0.2 | <1.0 | 0.0046 | 1,490.00 | 2,320.00 | <0.2 | 0.0494 |
| 6/4/2007 | NS | NS | NS | NS | NS | 160 | NS | <1.0 | NS | NS | 98.1 | NS | <0.040 | NS | 7.3 | <0.2 | <1.0 | NS | 1180 | 2260 | <0.2 | 0.0411 |
| 8/16/2007 | <0.46 | 213 | <0.00070 | 393 | < 0.000099 | 156 | < 0.00042 | <1.0 | 9.42 | 96.3 | 112 | 0.0106 | <0.040 | 0.00072J | 7.2 | <0.2 | <1.0 | 0.0025 | 1160 | 2260 | <0.2 | 0.0396 |
| 11/9/2007 | <0.46 | 215 | <0.00070 | 423 | < 0.000099 | 152 | < 0.00042 | <1.0 | 9.05 | 103 | 106 | 0.0125 | <0.040 | 0.00020J | 7.3 | <0.2 | <1.0 | 0.0032 | 1360 | 2190 | <0.2 | 0.0451 |
| 3/26/2008 | <0.46 | 210 | <0.00070 | 418 | < 0.000099 | 175 | < 0.00060 | 1.3+/-0.4 | 9.11 | 100 | 111 | 0.0095 | <0.040 | 0.00011J | 7.1 | 0.2+/-0.1 | <1.0 | 0.0014J | 1340 | 2180 | <0.2 | 0.0365 |
| Blind Duplicate (t | o BBL-1) | | | | | | | | | | | | | | | | | | | | | |
| 7/25/2006 | <0.46 | 176 | <0.002 | NS | < 0.00025 | 3.4 | 0.00037 J | <1.0 | NS | NS | 68.7 | 0.0024 | <0.10 | < 0.0010 | 7.9 | <0.2 | <1.0 | <0.002 | 87.7 | 385 | <0.2 | < 0.0003 |
| 11/22/2006 | NS | NS | NS | NS | NS | 3.4 | NS | NS | NS | NS | 65.4 | NS | <0.10 | NS | 8 | NS | NS | NS | 93.1 | 349 | NS | NS |
| 3/14/2007 | NS | NS | <.002 | NS | < 0.00025 | 3.1 | 0.00033J | <1.0 | NS | NS | 65.4 | 0.0012J | <0.10 | <0.0010 | 7.9 | <0.2 | <1.0 | <0.002 | 87.9 | 330 | <0.2 | <0.0003 |
| 6/4/2007 | NS | NS | NS | NS | NS | 3.4 | NS | <1.0 | NS | NS | 63.9 | NS | <0.1 | NS | 7.8 | <0.2 | <1.0 | NS | 86.1 | 331 | <0.2 | <0.0003 |
| 11/9/2007 | <0.46 | 175.00 | < 0.00070 | 38.50 | < 0.000099 | 3.00 | < 0.00042 | <1.0 | 5.10 | 8.19 | 63.70 | 0.00 | <0.040 | 0.00010J | 8.00 | <0.2 | 2.00 | <0.00053J | 85.90 | 336 | <0.2 | < 0.0003 |

Table 4 Water Quality Data

Boner Property Wells Summary Report EMES - Highlands Reclamation Project Converse County, Wyoming

| | Alkolinity to | Alkaliaitu ta | | | | | | Gross | | | | | | | | | | | | | | |
|---------------|---------------|---------------|-------------|----------|-------------|------------|--------------|--------------------|----------|-------|------|----------------|---------------------------------------|----------------|------|------------|-----------|--------------|------|------|------------------------------------|--------------|
| Anatuta | nH 8 3 | oH 4 5 | Ac | ~ | 64 | | C 7 | Alpha ¹ | к | Ma | No | Ni | NO2+NO3 | Ph | ън | Ba226 | 8-228 | 50 | SO4 | TOS | Th230 | 11-Nat |
| Linite | p// 0.0 | p11 4.5 | | ma/l | ma/l | mal | mo/l | nCi/l | <u>N</u> | - mg | mo/i | mo// | mo/i | mol | etnd | nCi/l | nGi/l | | ma/l | mo/l | DCi/l | mol |
| Benorting | | | | | | 1 <u></u> | | | | | | | | | 0 | | | | | | P | |
| Reference | | | | | | | | | | | | | | | | | | | | | | |
| Concentration | - | - | 0.05 | | 0.01 | l - | 0.1 | 15 | - | - | | 0.1 | | 0.05 | - | - | - | 0.05 | - | - | 0.55 | 0.030 |
| MFG - 1 | | 1 | | | | 1 | | | | | | | · · · · · · · · · · · · · · · · · · · | , | | | | | | | | |
| 11/17/2004 | NS | NS | NS | NS | NS | 360 | NS | NS | NS | NS | 261 | NS | 0.883 | NS | 6.4 | NS | NS | NS | 2410 | 4450 | NS | NS |
| 2/24/2005 | NS | NS | 0.00531 | NS | < 0.0005 | 300 | 0.00109 | <1 | NS | NS | 258 | 0.0139 | <0.5 | <0.001 | 6.6 | 0.5+/-0.4 | <1 | <0.001 | 2020 | 4460 | <0.2 | 0.362 |
| 5/27/2005 | NS | NS | NS | NS | NS | 300 | NS | NS | NS | NS | 234 | NS | 0.556 | NS | 6.6 | NS | NS | NS | 2090 | 4260 | NS | NS |
| 10/3/2005 | NS | NS | <0.002 | NS | < 0.001 | 300 | <0.002 | 1.9+/-0.9 | NS | NS | 206 | 0.0132 | 0.517 | <0.002 | 6.6 | 0.9+/-0.4 | <1 | <0.002 | 2560 | 2190 | <0.2 | 0.372 |
| 12/19/2005 | NS | NS | NS | NS | NS | 280 | NS | NS | NS | NS | 251 | NS | 0.372 | NS | 6.6 | NS | NS | NS | 2300 | 4250 | NS | NS |
| 3/14/2006 | NS | NS | 0.00148 | NS | < 0.0005 | 300 | < 0.001 | NS | NS | NS | 245 | 0.0118 | 0.456 | < 0.001 | 6.5 | NS | NS | <0.001 | 2370 | 4380 | NS | NS |
| 6/24/2006 | NS | NS | NS | NS | NS | 326 | NS | NS | NS | NS | 217 | NS | 0.47 | NS | 6.8 | NS | NS | NS | 2320 | 4030 | NS | NS |
| 8/18/2006 | NS | NS | 0.00067 | NS | 0.00 | 3.1 | 0.00089J | <1.0 | NS | NS | 221 | 0.0344 | 0.41 | 0.00061J | 6.7 | 0.6+/-0.3 | 2.7+/-0.9 | 0.0017J | 2240 | 3980 | <0.2 | 0.146 |
| 11/22/2006 | NS | NS | NS | NS | NS | 313 | NS | NS | NS | NS | 242 | NS | 0.43 | NS | 6.8 | NS | NS | NS | 2020 | 4380 | NS | NS |
| 3/22/2007 | NS | NS | 0.00070J | NS | 0.00 | 363 | 0.00052J | 1.6+/-0.7 | NS | NS | 270 | 0.0286 | 0.31 | 0.00079J | 6.7 | <0.2 | 2.3+/-1.0 | 0.0022 | 2370 | 4520 | <0.2 | 0.298 |
| 5/30/2007 | NS | | NS | NS | NS | 337 | NS | NS | NS | NS | 209 | NS | 0.57 | NS | 6.5 | NS | NS | NS | 1940 | 4530 | NS | NS |
| 8/18/2007 | NS | NS | <0.00070 | NS | 0.00 | 341 | 0.00051J | 1.9+/-0.8 | NS | NS | 203 | 0.0256 | 0.67 | 0.0025 | 6.6 | <0.2 | 2.7+/-0.9 | 0.0039 | 2040 | 4500 | <0.2 | 0.133 |
| 11/8/2007 | NS | NS | NS | NS | NS | 341 | NS | NS | NS | NS | 269 | NS | 0.76 | NS | 6.6 | NS | NS | NS | 2110 | 3900 | NS | NS |
| 3/20/2008 | NS | NS | <0.00070 | NS | 0.00023J | 364 | <0.0006 | 2.0+/-0.5 | NS | NS | 242 | 0.0234 | 1.0 | 0.00034J | 6.7 | 0.3+/-0.1 | 1.7+/-0.5 | 0.0018J | 2270 | 4220 | <0.2 | 0.355 |
| MFG - 2 | | | | - 10 | | 1 100 | | | | | 101 | | | | 0.0 | | | | 0100 | 0770 | | |
| 11/17/2004 | NS | NS | NS | NS | NS | 160 | NS | NS | NS | NS | 164 | NS | <0.5 | NS | 6.6 | NS | NS | NS 0.001 | 2190 | 3770 | NS | NS |
| 2/24/2005 | NS | | 0.00359 | NS | <0.0005 | 140 | 0.00101 | 2.8+/-1.3 | NS | NS | 162 | 0.00585 | <0.5 | <0.001 | 6.7 | 2.4+/-0.6 | <1 | <0.001 | 1840 | 3640 | <0.2 | 0.0141 |
| 5/27/2005 | NS | NS NO | NS | NS | NS 0.001 | 150 | NS | NS | NS | NS | 149 | NS 0.00504 | <0.1 | NS | 6.8 | NS NS | NS | NS | 1910 | 3750 | NS -0.0 | NS 0.0100 |
| 10/3/2005 | NS | NS NC | <0.002 | NO | <0.001 | 150 | <0.002 | 0.5+/-1.4 | NO | NS | 148 | 0.00584 | <0.1 | <0.002 | 0.7 | 3.2+/-U.D | 3.4+/-1.4 | <0.002 | 2340 | 3/00 | <u.2< th=""><th>0.0103</th></u.2<> | 0.0103 |
| 2/19/2005 | NO NC | NO NO | 10.001 | NO | 100005 | 180 | -0.001 | NO | NB | NO | 160 | 0.00460 | <0.1 | -0.001 | 6.6 | NO | NO | NO 001 | 2030 | 2720 | NG | NO |
| 6/2//2006 | NS | NS | | NG | <0.0005 | 160 | <0.001 NG | NG | NG | NG | 134 | 0.00459 NIC | <0.1 | NS | 6.0 | | NG | <0.001 NS | 1900 | 3/80 | NS | NS |
| 8/18/2006 | NS | NS | < 0.00067 | NS | | 16 | 0 000891 | 2 7+/-1 2 | NS | NS | 154 | 0.0218 | <0.040 | | 6.9 | 234/-05 | 4 6+/-1 0 | 0.0011. | 1990 | 3670 | <0.2 | 0.0100 |
| 11/22/2006 | NS | NS | NS | NS | NS | 159 | NS | NS | NS | NS | 140 | NS | <0.040 | NS | 6.9 | NS | NS | NS | 1990 | 3460 | NS | NS |
| 3/22/2007 | NS | NS | <0.00067 | NS | 0.00041J | 181 | 0.00041J | 3.1+/-0.8 | NS | NS | 164 | 0.0179 | <0.040 | <0.000047 | 6.8 | 1.9+/-0.5 | 3.1+/-1.0 | 0.0016J | 1920 | 3490 | <0.2 | 0.0092 |
| 5/30/2007 | NS | NS | NS | NS | NS | 166 | NS | NS | NS | NS | 135 | NS | <0.040 | NS | 6.6 | NS | NS | NS | 1960 | 3570 | NS | NS |
| 8/18/2007 | NS | NS | < 0.00070 | NS | 0.00016J | 172 | < 0.00042 | 2.9+/-0.9 | NS | NS | 154 | 0.0048 | < 0.040 | 0.00022J | 7.8 | 1.5+/-0.4 | 5.1+/-0.9 | 0.0023 | 1930 | 3500 | <0.2 | 0.0085 |
| 11/8/2007 | NS | NS | NS | NS | NS | 164 | NS | NS | NS | NS | 174 | NS | <0.1 | NS | 6.7 | NS | NS | NS | 1860 | 3660 | NS | NS |
| 3/20/2008 | NS | NS | <0.00070 | NS | < 0.000099 | 189 | <0.0006 | 3.7+/-0.6 | NS | NS | 150 | 0.0182 | <0.04 | <0.00005 | 6.6 | 1.7+/-0.3 | 3.3+/-0.6 | 0.0011J | 1990 | 3520 | <0.2 | 0.0084 |
| MFG-3 | | | | | | | | | | | | | | | | | | | | | | |
| 11/17/2004 | NS | NS | NS | NS | NS | 43 | NS | NS | NS | NS | 115 | NS | <0.5 | NS | 7.1 | NS | NS | NS | 461 | 1110 | NS | NS |
| 2/23/2005 | NS | NS | <0.001 | NS | <0.0005 | 40 | <0.001 | 2.2+/-1.2 | NS | NS | 116 | <0.005 | <0.5 | <0.001 | 7.4 | 1.7+/-0.8 | <1 | <0.001 | 435 | 1050 | <0.2 | <0.0098 |
| 5/27/2005 | NS | NS | NS | NS | NS | 43 | NS | NS | NS | NS | 101 | NS | <0.1 | NS | 7.2 | NS | NS | NS | 452 | 1070 | NS | NS |
| 10/3/2005 | NS | NS | <0.002 | NS | <0.001 | 34 | <0.002 | 2.4+/-0.9 | NS | NS | 98.4 | <0.002 | <0.1 | <0.002 | 7.4 | 1.1+/-0.4 | <1 | <0.002 | 496 | 994 | <0.2 | 0.008 |
| 12/19/2005 | NS | NS | NS | NS | NS | 39 | NS | NS | NS | NS_ | 121 | NS | <0.1 | NS | 7.4 | NS | NS | NS | 485 | 1140 | NS | NS |
| 3/14/2006 | NS | NS | NS | NS | <0.0005 | 46 | <0.001 | NS | NS | NS | 120 | 0.00162 | <0.1 | <0.001 | 7.2 | NS | NS | <0.001 | 572 | 1090 | NS | 0.00115 |
| 6/24/2006 | NS | NS | NS | NS | NS | 50.4 | NS | NS | NS | NS | 101 | NS 0.0000 | <0.040 | NS 0.000047 | 7.6 | NS | NS | NS | 536 | 1140 | NS NS | NS |
| 8/18/2006 | NS | NS NO | <0.00067 | NS | <0.000099 | 0.5 | 0.00091J | 1.6+/-1.0 | NS | NS NO | 115 | 0.0065 | <0.040 | <0.000047 | 7.6 | 1.3+/-0.4 | 2.6+/-0.9 | <0.00050 | 543 | 1110 | <0.2 | 0.0068 |
| 11/22/2006 | NS | NS | NS | NS | NS | 55 | NS 000001 | NS 0.0.10 | NS | NS | 113 | NS 0.0050 | <0.040 | NS | 7.6 | NS ON COL | NS | NS | 509 | 1210 | | NS 0.0065 |
| 3/22/2007 | NS | NS | <0.00067 | NS | <0.00099 | 01 | 0.00038J | 2.2+/-0.7 | NS | NS | 120 | 0.0056 | <0.040 | <0.00047 | 7.5 | 0.9+/-0.4 | 2.3+/-1.0 | U.UUU03J | 503 | 1070 | <0.2 | 0.0000 |
| 5/30/2007 | NO | NS | NS 20 00070 | NO | NS | 60.2 | NS | 10./00 | NO | NO | 121 | 0.0050 | <0.040 | 0.000121 | 1.4 | | 20,000 | 0.000561 | 621 | 1220 | 113 | 0.0066 |
| 0/10/2007 | | NO | <0.00070 | ON NO | <0.00099 | 02 50 A | <0.0042 | 1.9+/-0.8 | NO | NO | 141 | 0.0052 | <0.040 | | 74 | <0.2 NO | 2.9+/-U.9 | 0.000000 | 649 | 1230 | ×0.2 | 0.0000 |
| 11/0/2007 | NO NC | NO | 110 | NO | 10000000 | 00.4 | 0.0000 | 00.00 | NO | NO | 141 | 0.0076 | <0.040 | 0.000101 | 7.4 | 00.000 | 15./05 | 00000 | 706 | 1320 | 10.2 | 0.0062 |
| 3/20/2008 | NS NS | NS NS | <0.00070 | INS | <0.000033 | 05.6 | <0.0006 | 2.2+/-0.5 | NS | INS | 129 | 0.0076 | <0.04 | 0.000130 | 1.3 | 0.8+/-0.2 | 1.5+/-0.5 | <0.00099 | 120 | 1340 | <0.2 | 0.0062 |

Notes: ¹ Gross Alpha measurement minus Radon and Uranium

J = The "J" qualifier is used to indicate a value the falls between the MDL (method detection limit) and LOQ (limit of quantitation). It denotes a detection of the analyte above zero however this value is considered an estimate.

Ν.

NS = Not sampled for this analyte.

Bold = Concentrations exceeding the reporting reference concentration are bolded.

Shaded = The results for the shaded concentrations are thought to be in ug/L instead of mg/L but cannot be verified by the laboratory.

Figures



CITY: SYRACUSE DIV/GROUP: 141/ENV DB: RCB RCA PIC: PM: H. OTTERSTETTER TM: LYR: ON=*:OFF=*REF*





BY: SARTORI, KATHERINE PLOTSTYLETABLE: PLTFULL.CTB PLOTTED: 5/28/2008 7:35 AM PAGESETUP: AP-PDF LYR:(Opt)ON#*OFF#*REF* AM ACADVER: 17.0S (LMS TECH) PIC:(Opt) PMtH.OTTERSTETTER TM:(Opt) DWG LAYOUT: 4 SAVED: 5/28/2008 7:35 A DN/GROUP:141 DB1.JP KLS LD1.J; T8008572110002100003EMES85721G01.J

XREFS: IMAGES: PROJECTNAME: 85721X02.TF

CITY:SYR G:ICADVACT SOURCE: THIS DRAWING IS FROM THE FINAL DRAFT LONG-TERM PIT LAKE AND GROUNDWATER HYDROLOGY AT THE HIGHLAND MINE SITE, CONVERSE COUNTY, WYOMING BY MFG, INC., DATED FEBRUARY, 2008.

SYSTEM

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AB

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(From EPRCO, 1983)

| SERIES | FORMATION | LITHOLOGY | DESCRIPTION |
|-------------|------------|-----------|--|
| | a Kene | | Soil and Weathered Zone |
| | - | | Discontinuous Sandstones and Shales |
| E-O C.E.N.E | WASATCI | | Sandstone: grain size varies from medium-grained sand to gravel, most commonly medium to very coarse-grained sand; beds vary from loose friable sand to well-cemented (carbonate) sandstones. (Does not contain uranium mineralization.) |
| | | | Siltstone and Claystone (shale): color varies from olive orange to gray green but generally gray green: may contain thin interbedded sandstones |
| | | | and lignite beds. |
| | | | |
| | | | TAILINGS DAM SANDSTONE: same as above (Does not contain uranium mineralization in Highland area) |
| E.N.E | NOF | | TAILINGS DAM SHALE: generally gray green with thin beds of sandstone |
| LEOC | N.U. T. S. | | UPPER ORE BODY SANDSTONE: same as above. (Ore bearing unit in Highland area.) |
| d, | | | Siltstone and Claystone (shale): generally gray green. |
| | | | MIDDLE ORE BODY SANDSTONE: same as above. (Major ore bearing unit in Highland area.) |
| | | | Siltstone and Claystone (shale): generally gray green; may contain thinbedded sandstone units. |
| | | | LOWER ORE BODY SANDSTONE: same as above. (Major ore bearing unit in Highland area.) |
| | Í | | Siltstone and Claystone (shale): generally gray green. |
| | | | Sandstone: same as above. (Does not contain economic amounts of uranium in Highland area.) |
| | ' | | Siltstone and Claystone (shale): same as above. |

EMES HIGHLAND RECLAMATION PROJECT CONVERSE COUNTY, WYOMING BONER PROPERTY WELL SUMMARY REPORT GENERALIZED STRATIGRAPHIC COLUMN, HIGHLAND AREA FIGURE 4

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Appendix A

Monitoring Well Construction Diagrams









G:\PROJECTS\ExxonMobil\85598 Highland\Groundwater\MW Installation 2006\data\BBL-1 Well Completion Detail.xls



G:\PROJECTS\ExxonMobil\85598 Highland\Groundwater\MW Installation 2006\data\BBL-2 Well Completion Detail.xls





G:\PROJECTS\ExxonMobil\85598 Highland\Groundwater\MW Installation 2006\data\BBL-4 Well Completion Detail.xls

Appendix B

Monitoring Well Boring Logs

| <u></u> | <u> </u> | BORING LOG | in the second |
|-----------------------------|---------------------------|---|---|
| MFG, onsulting scientist | Inc. is and engineers | PROJECT: EXXONMOBIL HIGHLANDS PROJECT NO.: 180548 974020 528 5105510 51055 5105510 5105510 51055 5105510 51055 51055 51055 51055 51055 51055 51055 5105 5105 5105 5105 5105 510 510 | PAGE: <u>1 of 1</u> DATE: <u>10/6/04</u> |
| BORING MFG | G NO. 3-1 | DRILLING COMPANY: DRILLING ENGINEERS DRILLER: ANDY LOZANO | DRILLING METHOD: HSA/AIR ROTARY |
| DEPTH (FT) | | DESCRIPTION/NOTE | :S |
| - 0 | 0 - 3.5' | TOPSOIL. | |
| | 3.5' - 13.0' | Mixture of highly weathered shale, brown (10YR 5/3), a grained, 10% silt, brown (10YR 5/3). At 10 ft. some silt slightly moist, fine sand. | and (~10%) weathered sandstone, fine ty clayey sand, brown (10YR 5/3), very |
| - 10 - | | | |
| | 13.0 - 15.0 | Silty sandy, clay, brown (10YR 5/3), very slightly moist above. | , occasional fine gravel, less sand than |
| - 20 | 15.0 - 25.0 | Silly sand, brownish yellow (10YH 6/6), tine sand, <10 | % silt, occasional medium sand, dry. |
| - 30 | 25.0' - 36.0' | Fine sand, brown (10YR 5/3), <10% silt, dry. | |
| | 36.0' - 38.0' | Sand, brown (10YR 5/3), 50% fine sand, 30% medium rounded, slightly moist, occasional shale. | sand, 20% coarse sand, angular to sub |
| - 40 | 38.0' - 47.0' | Fine sand, gray (10YR 5/1), <5% silt, wet. | |
| | 47.0' - 51.0' | Sand, brown (10YR 5/3), 40% line sand, 40% medium | n sand, 20% coarse sand, wet. |
| - 50 | 5 1.0' - 51.5' | Shale, gray (10YR 5/1), at 65 ft. some coal, wet. | |
| | | | FIGURE |

v



| | AEG Inc | PROJECT: EXXONMOBIL HIGHLANDS | PAGE: 1 of 1 |
|-------------------|-------------------------|---|--|
| N consulting s | cientists and engineers | PROJECT NO.: 180548 | DATE: 10/7/04 |
| | | NORTHING: 874047.281 EASTING: 414561.693 | GROUND ELEVATION: 5113.079 |
| BC | DRING NO. | DRILLING COMPANY: DRILLING ENGINEERS DRILLING | IG METHOD: HSA/AIR ROTARY |
| | MFG-3 | | LOGGED BY: JOE REED |
| DEPTH (FT) | ГІТНОГОĞY | DESCRIPTION/NOTES | |
| - 0 - | ×× 0-2.5' | | |
| | 2.5' - 13.0' | Mixture of highly weathered shale, brown (10YR 5/3), and (~10 grained, 10% silt, brown (10YR 5/3). At 10 ft. some silty clayey slightly moist, fine sand. | %) weathered sandstone, fine sand, brown (10YR 5/3), very |
| | 13.0' - 15.0' | Silty sandy, clay, brown (10YR 5/3), very slightly moist, occasio above. | onal fine gravel, less sand than |
| ·<. | 15.0' - 25.0' | Silty sand, brownish yellow (10YR 6/6), line sand, <10% silt, or | ccasional medium sand, dry. |
| - 30 | 25.0' - 27.5' | Hard cemented sandstone. | |
| Į. | 27.5' - 36.0' | Fine sand, brown (10YR 5/3), <10% silt, dry. | |
| | 36.0' - 38.0' | Sand, brown (10YR 5/3), 50% fine sand, 30% medium sand, 20 rounded, slightly moist, occasional shale. | 0% coarse sand, angular to sub |
| E | 38.0' - 47.0' | Fine sand, gray (10YR 5/1), <5% silt, wet. | |
| E | 47.0' - 49.0' | Sand, brown (10YR 5/3), 40% fine sand, 40% medium sand, 20 | 0% coarse sand, wet. |
| - 60 | 49.0' - 75.0' | Shale, gray (10YR 5/1), at 65 ft. some coal, wet. | |
| | 75.0' - 92.0' | Sands, gray (10YR 5/1), 30% fine sand, 40% medium sand, 30 | 0% coarse sand. |
| - 90 | 92.0' - 129.0' | Shale, gray (10YR 5/1). | |
| | | | |
| | 129.0' - 143.0' | Sands, gray (10YR 5/1), 30% fine sand, 40% medium sand, 30 interbedded sands and shales - mostly sand. | 0% coarse sand, at 130 ft. |
| | 143.0' - 151.5' | Shale, gray (10YR 5/1). | |
| | | | |
| | | | |



| | 212 | | | | | BORING LC | G | |
|--|---|---|---|--|---|--|---|---|
| | | | Driller: Drill | ling Engineers, | Inc. | Date Drilled: | 06-29-06 | Logged By: |
| b ox! at | | IS company | Boring Dia: | 6.25 Incl | nes | Boring Number: | BBL-1 P&A | Reed Lyday |
| Sample | Blow Counts | Completion | Depth Feet | Lithology | | | Description | |
| Sar | Counts | | $\begin{array}{c ccccccccccccccccccccccccccccccccccc$ | | Co fra gra sa Ce sh (m (m | arse-medium SAND gments of cemented ay, brown, red, white, ndstone fragments, a mented fine SANDS allow sands), believer inor material: fine bla inor material: black s | (minor material: b sandstone, and q loose, mixture of lluvial gravel, sub: TONE and black s d to be bedrock, ta ck-gray cemented hale) | lack shale, uartz) multi-color: large shale and angular-subrounded thale (mixed with an to black t sandstone) |
| Comp BBL-1 w feet bgs borehold not enco BBL-1 lo sand de | letion Notes vas initially drille a. This borehole e encountered a pountered at othe posit. Abandor d 63 feet porth | : ed with hollow ster e was adandoned an alluvial channel storeholes. This supports conclusio red BBL-1 was se west of BBL-1 stars | n auger to 30 fee due to caving sa I with a high cons s sand deposit w n that it is an all aled by filling wit | et bgs and air rotar nds. The abandor ductivity alluvial sa as not encountered uvial sand and not h chip bentonite. | ry to 56. ned BBL nd depo d at the a bedro BBL-1 w | Site: Highland sit next ck Converse | d Mine ∋ County, WY | |
| reiocate | | | . | | | Project No | .: 85598 | Page 2 |

| PP | | | | | BOI | RING LOG |) | |
|---|---|---|--|--|--|--|--|--|
| | | Driller: Drilling Engineers, Inc. D | | | | e Drilled: | 7-6-06 | Logged By: |
| | Company | Boring Dia | : 8.25 Inc | hes | Bor | ing Number: | BBL-1 | Joe Reed, MFG Inc |
| Blow End Blow Counts | Completion | Depth Feet | Lithology | | | De | escription | |
| Counts | | Feet | | SA yel SA an me SII mo me | NDY (llow-br NDY (d clay) edium (-TY Cl adium (| CLAYEY SILT (mir own (10YR 5/4), s CLAYEY SILT (mir), brown (10 YR 5/3 dense or soft to mi LAY (minor materia icce white nodules (stiff | nor material: ve lightly cohesive nor material: 10 3), slightly cohe edium stiff, ven al: silt), trace ve (calcite), brown | ery fine sandy clay), a, loose, dry 0 % very fine sand esive, loose to y slightly moist ery fine sand, a (10 YR 5/3), ery fine sand, dark st |
| | | | | NO RETURN | | | | |
| Completion Notes: Schedule 40, 0.020" s 40, solid, PVC casing sand from 79.5 to 125 feet bgs, and hydrated concrete pad with 8" l at 31.1 feet bgs. | : slotted PVC casin from 0 to 85.8 fe 5.9 feet bgs, hydr d bentonite chips ocking well vault | ng from 85.8 to set bgs; backfi ated 3/8" beni s from 0 to 75 i installed at th | 0 126.2 feet bgs; led with filter pac onite pellets from eet bgs . 3' X 3' e surface. Static | scheduk k (10-20 i 75 to 7 X 8" water le | e)) 9.5 wel | Site: Highland M Converse C | /line ounty, WY | |
| | | <u></u> | | | | Project No.: | 85598 | Page 1 |

| | | | BORING LOG | | | | | | | |
|----------------------------------|--|--|---|--|---|--|--|-----------------|--|--|
| | | | Driller: Drilling Engineers, Inc. | | | Dat | te Drilled: | 7-6-06 | Logged By: | |
| Buni | an AKCAD | Company | Boring Dia: 8.25 Inc | | ches | Во | ring Number: | BBL-1 | Joe Reed, MFG Inc | |
| Sample | Blow Counts | Completion | Depth Feet | Lithology | Description | | | | | |
| Com Schec 40, so sand f | pletion Notes dule 40, 0.020" 3 bild, PVC casing from 79.5 to 125 | : slotted PVC casi from 0 to 85.8 f 5.9 feet bgs, hyd | 45 | 126.2 feet bgs; led with filter pa ponite pellets from | Ha SI (m slii Tr SF SF (G SF (G SF br (G SF (G SF (G SF)(G SF) (G | eathern ND/S. Ty fine stiff, si ALE (ley 4/1 | ling. Believe to be LAYEY SAND/SAN haterial: very fine sa larder drilling, soft- edium sand ed SHALE/Weather ANDY SHALE (min sand), dark greer lightly moist, visual minor material: tra asily with thumbna Site: Highland I | top of bedrock. | SILT, gray (5Y 5/1), moist 10% coarse sand, 4/1), medium stiff tark greenish gray (10YR 2/1), hard - | |
| feet by concre at 31. | gs, and hydrate ete pad with 8" I 1 feet bgs. | d bentonite chips locking well vaul | s from 0 to 75 fi t installed at the | eet bgs . 3' X 3' e surface. Statio | ' X 8" c water le | evel | Converse C | ounty, WY | r | |
| | | | | | | | Project No.: | 85598 | Page 2 | |

| | | • | | | l | BO | RING LOG | | | |
|--|--|-------------------------|---------------|------------------|--|---|--|---|--|--|
| | | | Driller: Dri | lling Engineers, | Inc. | Da | te Drilled: | 7-6-06 | Logged By | <i>r</i> : |
| Erral | an AKCAL | | Boring Dia | : 8.25 Inc | hes | Bo | ring Number: | BBL-1 | Joe Reed, | MFG Inc |
| Sample | Blow Counts | Completion | Depth Feet | Lithology | | Description | | | | |
| | | | | | SH 4) I NC SH 4), Tra SH 4/E Pyu SH sar 3/1 SH sha 3/1 | ALE (harde RET ALE (wet, i ace cc ALE (Black), rite ar ALE (ale int), 2 g | minor material: trai r drilling, dry URN - Believed we minor material: traintermittent returns al minor material: traintermittent returns d Coal | ce very fine sa at ce very fine sa ce very fine sa ce very fine sa ce very fine sa cater <2 gpm ce coal, trace of dy shale, very of | nd), dark gray nd), dark gray nd), dark gray nd), dark gray ands, mostly sh ery dark gray (very fine sand) dark gray, (2.5 | (Gley (Gley (Gley (Gley 2.5Y |
| Com | pletion Notes | <u> ※ = ※ </u> :: | | | | | Site: | | | |
| Scheo 40, so sand f feet b concre at 31 | Completion Notes: Schedule 40, 0.020" slotted PVC casing from 85.8 to 126.2 feet bgs; schedule 40, solid, PVC casing from 0 to 85.8 feet bgs; backfilled with filter pack (10-20) sand from 79.5 to 125.9 feet bgs, hydrated 3/8" bentonite pellets from 75 to 79 feet bgs, and hydrated bentonite chips from 0 to 75 feet bgs. 3' X 3' X 8" concrete pad with 8" locking well vault installed at the surface. Static water lev | | | | | | Highland Mine Converse County, WY | | | |
| | | | | | | | Project No.: | 85598 | Page | 3 |

| | 20 | | | | B | ORING LOG | j | | |
|--|---|--|---|--|--|--|-------------------|------------------|---------|
| | | | Driller: Dril | ling Engineers | , Inc. [| Date Drilled: | 7-6-06 | Logged By: | |
| Drans | | ∕I⊃ company | Boring Dia | : 8.25 Inc | ches I | Boring Number: | BBL-1 | Joe Reed, M | MFG Inc |
| Sample | Blow Counts | Completion | Depth Feet | Lithology | | De | escription | | |
| Com Scheo sand feet b concru at 31. | pletion Notes dule 40, 0.020" solid, PVC casing from 79.5 to 125 gs, and hydrate ete pad with 8" 1 1 feet bgs. | slotted PVC casi from 0 to 85.8 fo 5.9 feet bgs, hyd d bentonite chipt locking well vaul | - - - - - - - - - - - - - - - - - - - - - - - - - 135 - - - - - 135 - - < | o 126.2 feet bgs; led with filter pa onite pellets fro eet bgs . 3' X 3' e surface. Statio | SHAL gpm ck (10-20) n 75 to 79.5 X 8" c water level | E, no sandy shale lay Site: Highland M Converse C | Pers, very dark s | gray (2.5Y 3/1), | 2 |
| | | | | | | Project No.: | 85598 | Page | 4 |



| | 21 | • TS | BORING LOG | | | | | | |
|---|--|--|--|---|---|---|--------------------|---------------|--|
| | | | Driller: Drilling Engineers, Inc. | | | ate Drilled: | 06-28-06 | Logged By: | |
| | | | Boring Dia | : 6.25 Incl | hes B | oring Number: | BBL-3 | Reed Lyday | |
| Sample | Blow Counts | | Depth Feet | Lithology | Lithology | | Description | | |
| | | | | | SILT (r slightly Ca slightly SILT a SILT a SILT a SILT a SILT a SILT a SILT a SILT a | minor material: fine moist nodules, brown clay, moist nd CLAY (minor m irm nd CLAY (minor m CLAY (minor mate nts), soft, moist, w CLAY (minor mate nts), soft, moist, w | e sand), tan-brow | n, loose, dry | |
| Comp Schedu | letion Notes ule 40, 0.020" | s: slotted PVC casi | ng from 24.8 to | 0 40.2 feet bgs; so | chedule 40, | Site: | | | |
| olid, P ellets gs, hy enton rell va | VC casing fro from 41.8 to 4 ydrated 3/8" be ite chips from ult installed at | m 0 to 24.8 feet t 2.0 feet bgs, filte entonite pellets fr 0 to 14.8 feet bgs the surface. | ogs; backfilled r pack (10-20) om 14.8 to 15. s. 3' X 3' X 6" d | with hydrated 3/8 sand from 15.5 to 5 feet bgs, and hy concrete pad with | " bentonite o 41.8 feet ydrated 8" locking | Converse | Mine County, WY | | |
| | | | | | | Project No.: | 85598 | Page 1 | |

| | 212 | | | | I | BORING LO | G | | | |
|---|---|---|--|---|--|--|--|--------------------------|------------|--|
| <u> </u> | | | Driller: [| Drilling Engineers | s, Inc. | Date Drilled: | 06-28-06 | Logged By | <i>r</i> : | |
| Pots ar | | Company | Boring D |)ia: 6.25 In | ches | Boring Number: | oring Number: BBL-3 Reed Ly | | | |
| Sample | Blow Counts | Completion | Depth Feet | Lithology | | I | Description | | | |
| | | | _ | | SH | ALE, black, hard, beli | eved to be bedro | ck | | |
| | | | 45 | | SA witt | ND (minor material: s n large, black shale fr | hale), visible sam agments (thumb v | nple was gray s wide) | and | |
| | | | | - | | | | | | |
| | | | 55 55 | | | | | | | |
| | | | | - | | | | | | |
| | | | — — — 65 — | | | | | | | |
| | | | 70 | | | | | | | |
| | | | - | | | | | | | |
| | | | — 75 — — | | | | | | | |
| | | | | - | | · | | | | |
| Compl | letion Notes | | | | | Site: | | | | |
| solid, P solid, P solid, P sollets f sogs, hy sontonil | VC casing from from 41.8 to 42 vdrated 3/8" be te chips from (| n 0 to 24.8 feet b 2.0 feet bgs, filter entonite pellets fr 0 to 14.8 feet bgs | ng from 24.8 ogs; backfille r pack (10-2 om 14.8 to s. 3' X 3' X 0 | ed with hydrated 3 ed with hydrated 3 0) sand from 15.5 15.5 feet bgs, and 6" concrete pad wi | schedule /8" benton to 41.8 fe hydrated ith 8" locki | ng Converse | l Mine County, WY | | | |
| wen vau | ni installed at 1 | ule suliace. | | | | | | - <u>T</u> | | |



| | 20 | | | | E | | G | | | |
|--|---|---|--|---|--|-------------------------|---------------------------|---------------------|---|--|
| | | | Driller: Dril | ling Engineers | , Inc. | Date Drilled: | 07-01-06 | Logged By: | | |
| Print : | an AKCAD | S company | Boring Dia: | ing Dia: 6.25 Inches | | Boring Number: | BBL-4 | Reed Lyday | | |
| Sample | Blow Counts | Completion | Depth Feet | Lithology | | [| Description | | | |
| | 14/24 | | | | SIL | F (minor material: slig | htly sand), gray, | dense, dry; visible | | |
| Com | pletion Notes | | | | sam | <u>site:</u> | | | | |
| Scheo solid, from 1 bgs, a pad w | lule 40, 0.020" s PVC casing fror 0.3 to 39.6 feet Ind hydrated ber ith 8" locking we | slotted PVC casi n 0 to 14.2 feet bgs, hydrated 3 htonite chips fro ell vault installed | ng from 14.2 to bgs; backfilled /8" bentonite pe n 0 to 8.6 feet l at the surface. | 939.6 feet bgs; s with filter pack (ellets from 8.6 to bgs. 3' X 3' X 6 | schedule 4 10-20) sar o 10.3 feet "concrete | Highland Converse | Mine County, WY | | | |
| | | | | | | Project No.: | 85598 | Page 2 | 2 | |