SECTION 18

WATER RESOURCES

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LIST OF REVISIONS DURING PERMIT TERM

REV. NUMBER	REVISION DESCRIPTION	DATE APPROVED

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The water resources baseline information and assessment provide a description of the pre-mine conditions of surface and groundwater flow and water quality within the permit area and adjacent areas. This baseline assessment was developed previously for another mine project and now used for the No Name Mine permit application package (PAP) as it covers much of the same area. This permit area will be within portions of Area 4 South and Area 5 resource areas of the Navajo Transitional Energy Company's (NTEC) mining lease, located on the western flank of the San Juan Structural Basin south of the Navajo Mine. The coal seams to be mined are associated with the Cretaceous Age Fruitland Formation Section 17, Geologic Information. The baseline resource assessment for this PAP establishes the foundation for the determination of probable hydrologic consequences for the proposed surface mine operation Section 41, Probable Hydrologic Consequences and for the design of water resources reclamation plans Section 35, Hydrologic Reclamation Plan that may be needed to protect surface and groundwater resources.

This baseline evaluation includes a review of reports and data concerning water resources of the region obtained from state and federal agencies, as well as the information developed for NTEC's Navajo Mine and by CONSOL Energy's (formerly Consolidated Coal) Burnham Mine. NTEC implemented a baseline hydrologic monitoring program to obtain additional site-specific information from four ephemeral stream monitoring sites, three surface water impoundment sites, 12 groundwater monitoring wells and piezometers, and 14 vibrating wire piezometers located within the NTEC mining lease to supplement existing information. The baseline monitoring program and assessment were developed initially for a previous project. Upon initiation of the No Name permit, monitoring resumed and continues to take place as supplemental information to the original baseline collected.

18.1 Surface Water Resources

The No Name Mine permit area is generally bounded by the Pinabete Mine permit area (Permit No. NM-0042B) on the north, the Chaco River on the west, and is dissected by Pinabete and No Name Arroyos (Exhibit 18-1). The No Name mining area extends across approximately 18.0 square miles (sq mi; 11,526 acres). Information pertaining to additional regional surface water information is included below in this section.

Pinabete Arroyo, No Name Arroyo, and Brimhall Wash are the primary surface water features within the permit area and flow into the Chaco River above the confluence with the San Juan River. Pinabete Arroyo has a watershed of 60.3 sq mi, No Name Arroyo has a watershed of 11.5 sq mi, and Brimhall has a watershed of 85.2 sq mi (Table 18-1). The Chaco River flows north into the San Juan River and drains an area of approximately 3,640 sq mi.

Annual precipitation within the immediate area is low, averaging 6.0 inches across the mine and rainfall amounts vary considerably from year to year (Section 12, Climate). The average monthly precipitation from Met 3 station is 6.22 inches. Most precipitation occurs in July and August of each year during the monsoon season. The average annual evaporation rate for this area is approximately 55 inches per year. Due to the great differential between evaporation rate over precipitation surface water flow in streams within the permit area occurs only in response to major storm events and base flow is nonexistent.

18.1.1 Perennial and Intermittent Streams

Although flow in the No Name Arroyo, Pinabete Arroyo, Brimhall Wash, and Chaco River is ephemeral these water bodies are defined by OSMRE regulation 30 CFR 701.5 as intermittent because the drainage basin area is greater than 1 sq mi. NTEC plans to temporarily route water from 43.9 sq mi of the Pinabete Arroyo watershed through a diversion to No Name Arroyo. Details on the Pinabete Diversion and other drainage control measures can be found in Section 26, which details the drainage control plan.

No Name Arroyo drainage area upstream of the permit boundary is approximately 1.8 sq mi and 7.0 sq mi are with the permit area, for a total drainage area of approximately 8.8 sq mi upstream of the permit area exit boundary (Table 18-1 and Exhibit 18-2). Pinabete Arroyo has a drainage area upstream of the permit boundary is approximately 43.9 sq mi and 11.6 sq mi are with the permit area, for a total drainage area of approximately 55.5 sq mi upstream of the permit area exit boundary (Table 18-1 and Exhibit 18-2). Brimhall wash drainage area begins within the permit boundary with approximately 2.81 sq mi upstream of the permit area exit boundary (Table 18-1 and Exhibit 18-2).

18.1.1.1 Stream Channel Characteristics

The main channel segments of the No Name and Pinabete Arroyos within the NTEC mining lease were inventoried in 1998 and 2007 to establish baseline characteristics. This included Resource Area 4 South within the southern part of the Pinabete permit and the northern part of the No Name permit and Area 5 within the No Name permit. The results of the baseline channel inventory for the No Name and Pinabete Arroyos are included in Appendix 18-A. The purpose of this inventory was to document the channel conditions prior to mining including bedrock outcrops and indicators of channel instability such as knickpoints, channel cut-banks, and channel scour or deposition. The channel bed and bank materials, cross sections, and vegetation characteristics were also noted. These properties provide an indication of the capacity of the stream channels to adjust and recover from potential changes due to changes in flows that may occur as a result of the mining and reclamation plan.

No Name Arroyo exhibits a variable slope with several knickpoints and convex segments, typical of an unstable channel. The knickpoint present in the channel profile near inventory location NNA-2 is associated with a 15-foot head cut and a deeply incised channel downstream of this location. Smaller head

cuts were also found upstream of this point at locations both upstream and downstream of the No Name Impoundment. Sediment deposition occurs at the impoundment where Burnham Road (BIA Road No. 3005 and Navajo Road N-5082) crosses the No Name Arroyo. This deposition reduces sediment load in water that is released in outflows from the No Name Impoundment. The low sediment concentration in impoundment outflows has accelerated erosion in the channel bed immediately downstream of the impoundment (Williams and Wolman 1984) and contributes to the head cutting and channel incision observed in the reach further downstream of the impoundment. More detailed information on the channel morphology is in the 1998 and 2007 channel morphology reports in Appendix 18-A.

Pinabete Arroyo is braided in many locations, reflecting the highly variable discharge rates, high bed load, limited vegetation, and high width to depth ratio. Channel depths range from four to ten feet (ft) with widths varying from 20 to 80 ft. The main Pinabete Arroyo channel profile is mildly concave with slopes of 0.55% or higher at the upstream segment near the eastern permit boundary and decrease to about 0.33% downstream at the western permit boundary (Appendix 18-A). Sinuosity is relatively high downstream from Station P-1 for 1,500 ft, upstream and downstream of P-3 for 1,500 ft, and between P-5 and P-6 for 2,500 ft. No knickpoints, or convex segments, are present in the channel profile in the vicinity of the permit area. The channel maintains a slightly concave graded profile even though there may be continual reworking of sandy channel bed and bank materials. Minor changes in channel geometry and local slope may occur as a result of variation in the properties of channel materials and channel vegetation or in response to changing patterns of floods. Contributing tributaries are incised for as much as 300 ft upstream and show head cuts ranging in height from two to five ft. Suspended sediment concentrations in storm runoff events are very high with total suspended solids (TSS) concentrations ranging from 10,200 to 521,000 milligrams per liter (mg/L) in 28 baseline samples collected from Pinabete Arroyo (Table 18-12). For additional information refer to the 1998 and 2007 channel morphology reports in Appendix 18-A.

18.1.1.2 Surface Water Flows

Baseline surface water monitoring stations were established on No Name and Pinabete Arroyos upstream and downstream of NTEC's mining lease in 1998 as shown on Exhibit 18-1. The monitoring stations were installed on relatively uniform straight channel segments and consist of two or more single-stage samplers (Figure 18-1) and crest-stage gages (Figure 18-2).

An upstream and downstream station was also established on No Name Arroyo (Upper No Name and Lower No Name) within the mine permit area, location shown in Exhibit 18-1. This location was the only suitable monitoring location on No Name Arroyo near the eastern permit boundary due to the channel in this area being less than six ft wide and less than one ft deep.

Peak flow estimates (Q) reported in cubic feet per second (cfs) at each of the monitoring station locations (Table 18-2) were developed using Manning's equation as specified below:

$$\text{Q(cfs)} = 1.49 \times \frac{1}{n} \times A \times r^{\frac{2}{3}} \times S^{\frac{1}{2}}$$

The slope of the water surface (S) at each monitoring station location was determined from the measurements at the upstream and downstream crest stage gages. The cross-sectional area (A) and the hydraulic radius (r) corresponding to each measured crest stage gage were digitized from the channel cross section at the monitoring station location. If one of the crest gage readings was missing or erroneous, the slope of the channel was used for S and the single value for A or r was used. The site-specific Manning roughness coefficient (n) was determined for each location during the stream channel inventory using the procedure for small channels as described in Gray (1970). Peak flows determined from crest stage measurements during the 1997 to 1998 and 2007 to 2008 baseline monitoring period at the upstream and downstream sites on the No Name and Pinabete Arroyos are provided in Table 18-2.

Flows in the arroyos draining NTEC's mining lease are flashy and occur in response to short duration, high intensity precipitation events usually during the seasonal thunderstorm months of July through November. The thunderstorms are usually localized and the intense rainfall may not extend throughout the drainage area of the arroyo. Consequently, there may not be much consistency among flows measured upstream and downstream or in adjacent drainages as indicated in Table 18-2.

Zero flow was recorded between November 1997 and June 1998 at both the No Name Arroyo and Pinabete Arroyo monitoring stations. Summer monsoonal rains in 1998 resulted in peak storm flows of 22.5 cfs at the upper Pinabete Arroyo site (Upper Pinabete), and 1,717 cfs at the downstream Pinabete Arroyo site (Lower Pinabete). The adjacent, but significantly smaller No Name Arroyo watershed exhibited a peak flow of 1.5 cfs at the upstream site (Upper No Name) in July, while no flow was reported at the No Name Arroyo downstream site (Lower No Name). The maximum peak flow during the 1997 and 1998 monitoring period of 2,307 cfs was observed at Lower Pinabete in August 1998.The maximum peak flow observed in the No Name Arroyo was 39 cfs at Lower No Name in October 1998.

Peak flow measured during 2007 and 2008 ranged from 0.2 to 7.5 cfs at the Upper Pinabete site and from 0.4 to 46.6 cfs at the Lower Pinabete site (Table 18-2). These peak flows are lower than the peak flows observed along the Pinabete Arroyo in 1998. Peak flow measurements ranged from 0.7 to 19.1 cfs at the Upper No Name site and from 0.0 to 111.1 cfs at the Lower No Name site (Table 18-2). These peak flows at the Lower No Name location were higher than measured previously at this location during 1998. The 1998 water year appears to be an average water year, based on the examination of regional flows at two

United States Geological Survey (USGS) gages along the San Juan River in Farmington and Shiprock (Table 18-3, USGS 2009).

SEDCAD™4 (SEDCAD) modeling was performed on No Name and Pinabete Arroyos, as well as Brimhall Wash, and Chaco River to better characterize the flow and sediment regimes. Information used to develop the SEDCAD projections and modeling results are provided in Appendix 18-B. Table 18-4 provides a summary of the SEDCAD model results for peak flows and sediment yield of selected storm frequency events for the surface water monitoring stations on the No Name Arroyo, Pinabete Arroyo, Brimhall tributaries and confluence, and the Chaco River confluence.

The SEDCAD peak flow predictions for the No Name Arroyo, Pinabete Arroyo, and Brimhall Wash are less than the predictions using the USGS method for ungaged streams in northwestern New Mexico (Table 18-5). The USGS method was developed in cooperation with the Bureau of Indian Affairs to estimate the magnitude and frequency of peak discharges for ungaged streams within the Navajo Nation in Arizona, Utah, Colorado, and New Mexico (Waltemeyer 2006). Peak discharge estimates in Table 18-5 were calculated for No Name Arroyo, Pinabete Arroyo, and Brimhall Wash using the regional equations developed in Waltemeyer (2006). The SEDCAD predictions are thought to be more reliable, since the modeling incorporates detailed site-specific information on soils (e.g., K-factor and erodible particle size distributions) and cover values that were incorporated into subwatershed characterizations. In addition, the model accounts for the attenuation in flood flows associated with the No Name Impoundment on the No Name Arroyo.

Supplemental information is available from USGS regional sites located on Burnham Wash, southwest of Area 5 and a tributary to Brimhall Wash (Site 09367936), the Teec-Ni-Di-Tso Wash located within the region but further south from Burnham Wash (Site 09367934), and the Chaco River gage (Site 09367938; USGS 2009), however these sites no longer exist per USGS.

Site 09367936 and Site 09367934 have watersheds of 8.6 and 7.2 sq mi respectively (Table 18-3), very similar in size to the 8.2 sq mi No Name Arroyo watershed within the mining lease boundary. During the period of record the monthly average flow at Site 09367934 ranged from 0.0 to 2.2 cfs for all months and all years of data, with the highest average maximum daily flow of 10.0 cfs in August for the 5-year period between 1978 and 1982 (Table 18-6). This 5-year period had two years in the 25-50% quartile, two years in the 50-75% quartile, and one year, 1979, in the top quartile for daily flow (Table 18-3). Average zero daily flow days/month for the period of record ranged from 10 to 27 days, with the most days of flow in January and the fewest days of flow in June (Table 18-6).

The results for Site 09367936 were similar (Table 18-7) to those reported for Site 09367934 (Table 18-6). The monthly average flow for all months during the period ranged from 0.0 to 5.5 cfs, with the highest average maximum daily flow of 14.0 cfs in May for the 5-year period between 1978 and 1982. Average zero daily flow days/month for the period ranged from seven to 26 days, with the most days of flow in January and February and the least days of flow in June and July.

Stream flow in the Chaco River is ephemeral upstream of the existing Four Corners Power Plant (FCPP) discharge as indicated by the five years of monitoring at the USGS Station 09367938 near Burnham, New Mexico. Measurable flows at this station occurred only in response to rainfall or snow melt events. Annual peak storm flows for the 5-year monitoring period ranged from 950 to 6,740 cfs. The substantially larger Chaco River watershed (USGS gage 09367938) at 3,640 sq mi exhibited larger flows, but similar numbers of days without flow. Between 1978 and 1982, monthly average discharges ranged from 6.5 to 65 cfs, and the average maximum daily flow was 782 cfs (Table 18-8). The average number of zero daily flow days/month for the period ranged from 0 to 23 days, with the most days of flow in March, April and August, and the fewest days of flow in June.

Additional perspectives on flow in Pinabete Arroyo can be derived from monitoring performed at the CONSOL Energy's Burnham Mine on Brimhall Wash, south of Area 5. Part of the Brimhall Wash drainage lies immediately south and adjacent to Pinabete Arroyo. Both streams drain areas with similar landforms, soils, vegetation, and elevations. Brimhall Wash drainage is slightly larger at 85.2 sq mi as compared to Pinabete with a 60.3 sq mi watershed. Brimhall Wash was monitored daily over a three-year period, between October 1977 and May 1980, at two locations: Site M (downstream) and Site N (upstream; Exhibit 18-1). Both sites experienced from zero to four flow days/month for most months during the monitoring period, with a maximum of ten flow days during August 1978 at Site N and six flow days in November 1979 at Site M (Table 18-9). These results show that runoff from summer thunderstorms is localized and that channel conveyance losses can be considerable, as zero flow days were observed during August 1978 at Site M (downstream). For example, while ten flow days were observed August 1978 at Site N zero flow days were observed during the same period at Site M (Table 18-9). Runoff patterns on Pinabete Arroyo are expected to be similar to those observed at Brimhall Wash.

The No Name Impoundment is filled periodically by runoff from storm events. Water was first observed in the No Name Impoundment in November 1997 and remained in the impoundment until June 1998. A staff gage was installed in the impoundment during the spring of 1998. Staff gage levels were recorded on a monthly basis during 1998 and as soon as possible after major precipitation events. These results are provided in Table 18-10. It appeared that water was lost from this impoundment by both seepage and evaporation. The impoundment was dry from late June to July 26, 1998, when it refilled to the spillway elevation during a storm runoff event. Water remained in the impoundment beyond December 1998. The

invert of the spillway on the No Name Impoundment was surveyed in 2008 and was found to be six ft above the low point within the impoundment. The survey also showed the storage capacity of the impoundment at the spillway invert elevation is 19.7 acre-feet (ac-ft) and would cover an area of eight ac. Spillway and elevation-area capacity details for the structure can be reviewed in the baseline SEDCAD runs on "No Name Watershed w/Impoundment", Structure 8, in Appendix 18-B.

18.1.1.3 Surface Water Quality

The Navajo Nation has adopted the Navajo Nation Surface Water Quality Standards (Navajo Nation Environmental Protection Agency [NNEPA] 2015) which established various surface water use quality standards. These standards apply to all waters of the Navajo Nation including, but not limited to, ephemeral, intermittent, and perennial streams; springs, wetlands, and any natural or man-made depressions or basins that impound water within the border of the Navajo Nation. The standards associate specific uses with specific stream reaches including the Brimhall Wash and the Chaco River. Specific uses have not been identified for No Name and Pinabete Arroyos. However, both are non-perennial tributaries of the Chaco River, which is itself a tributary of the San Juan River and standards have been set for non-perennial tributaries of the San Juan River. Designated uses for Brimhall Wash and the Chaco River include livestock watering, aquatic and wildlife habitat, fish consumption, and secondary human contact standards (NNEPA 2015). The applicable standards for the designated uses have been identified on Table 18-11 to help assess the suitability of surface water for livestock use. The Navajo Nation surface water quality standard for suspended sediment applies only to surface water that is at or near base flow and does not apply to surface water during or soon after a precipitation event and is therefore not applicable to ephemeral flows (NNEPA 2015).

The USGS monitoring records indicate that sizeable peak flows periodically occur due to high intensity thunderstorm events. The duration of flow resulting from these events is extremely short and typical of ephemeral runoff events. Sampling of such short-duration stream flows with passive single-stage samplers ensures the collection of samples from episodic events. In addition, samplers can be located at several stages within the stream, thereby enabling collection of samples at different flow depths. Three single-stage sediment samplers were installed at locations along the channel cross section of Pinabete and No Name Arroyos. Analytical results of water samples collected at these monitoring stations are summarized in Tables 18-12 and 18-13 and are discussed below. Flows associated with the water quality samples from the single-stage samplers were inferred from the estimated peak flow for the crest stage measurements obtained at the same time that samples were collected.

Surface water data were collected and analyzed for different parameters during the three years of water monitoring conducted between 1998 and 2008 at stations on the Pinabete Arroyo. Table 18-12 provides a summary of the median concentrations for water quality analysis results from samples collected at each of

these Pinabete monitoring stations. The surface water in Pinabete Arroyo is a sodium sulfate type (Figures 18-3 and Figure 18-4) with hardness and conductivity within the range of approved standards. Dissolved aluminum ranged from 0.12 to 2.30 mg/L in detectable samples which is above the aquatic and wildlife habitat limit of 0.087 mg/L (Table 18-11) The reported method detection limit (MDL) of 0.100 mg/L is above the chronic aquatic and wildlife habitat limit of 0.087 mg/L for samples which were reported with less than detection limits. This is often related to the high concentrations of some analytes that can interfere with detection of low concentration analytes resulting in high MDLs for the affected low concentration analytes. Most of the cadmium results were less than the detection limit of 0.00005 mg/L but three samples detected cadmium at concentrations above the hardness dependent chronic aquatic and wildlife criterion of 0.00025 mg/L. Copper concentrations ranged from 0.006 to 0.026 mg/L, with a median value of 0.009 mg/L and approximately half the samples were above the hardness dependent chronic aquatic and wildlife criterion of 0.00934 mg/L. Mercury was detected in six of fifteen samples. All these detected concentrations exceeded the chronic aquatic and wildlife habitat standard of 0.000001 mg/L and one of the samples exceeded the acute aquatic and wildlife habitat criterion of 0.0024 mg/L. However, the MDL for mercury, 0.0002 mg/L, is higher than the chronic aquatic and wildlife habitat criterion but less than the acute aquatic and wildlife habitat criterion. Dissolved selenium was detected in twelve of 26 samples and seven of these detections exceeded the chronic aquatic and wildlife habitat standard of 0.002 mg/L. The MDL for selenium is higher than the chronic aquatic and wildlife habitat criterion in thirteen of the fourteen less than MDL reports. The reported selenium results range from <0.001 to 0.007 mg/L with a median value of <0.005 mg/L based on all samples including less than MDL results.

Samples were acquired from two sites in No Name Arroyo, Upper No Name and Lower No Name, during the three years of water monitoring conducted between 1998 and 2008. Table 18-13 provides a summary of the median concentrations for water quality analysis results from samples collected at each of these No Name monitoring stations. The water at the upstream site (Upper No Name 3) is a sodium-bicarbonate type, while the downstream site (Lower No Name 1) is a sodium sulfate type (Figure 18-4 and Figure 18-5). Dissolved aluminum values ranged from 0.15 to 1.65 mg/L in detectable samples which is above the aquatic and wildlife habitat limit of 0.087 mg/L (Table 18-11). Dissolved selenium was detected at <0.005 in four of the 17 samples. The MDL is above the chronic aquatic and wildlife habitat limit of 0.002 mg/L but none of the samples surpassed the acute aquatic and wildlife habitat of 0.033 mg/L (Table 18-11).

Analysis results of samples from two sites in Brimhall Wash were provided in the Burnham Mine PAP, on file in the OSMRE Library in Denver, Colorado. Seventeen samples collected at the upstream site (Site N) and 19 samples collected at the downstream site (Site M) between March 1990 and January 1995 (Table 18-14, Exhibit 18-1). Both sites exhibit sodium sulfate-type waters (Figure 18-6) Total dissolved solids (TDS) vary substantially and ranged from 360 to 24,600 mg/L at the two sites. Site N had a median TDS of 960 mg/L higher than the median at Site M. Three of 36 samples exhibited TDS levels above the relevant

livestock use criterion of 3,000 mg/L (Lardy et.al. 2008). Total selenium was analyzed three times and was always less than the MDL at <0.005 mg/L. One sample at Site M was analyzed for dissolved selenium with a reported concentration of 0.03 mg/L. The dissolved selenium in the one sample and the MDL for total selenium in the other samples exceeded the aquatic and wildlife habitat standard of 0.002 mg/L (Table 18-11). Total selenium, which had a detection limit of 0.005 mg/L, while the chronic aquatic and wildlife habitat criterion is 0.002 mg/L. Total mercury was detected in only one of four samples at a concentration of 0.0006 mg/L and was less than the MDL of 0.0005 mg/L in the other three samples. Both the detected value and the detection limit for total mercury exceed the chronic aquatic and wildlife habitat limit of 0.001 mg/L (Table 18-11). Sulfate concentrations varied substantially, with results ranging from 29 to 18,100 mg/L and a median value of 376 mg/L at Site N and 356 mg/L at Site M. Six of 35 values for sulfate exceeded the criterion for livestock use of 1,000 mg/L (Table 18-11).

From a general water quality characterization perspective, the samples from the Pinabete Arroyo, No Name Arroyo, and Brimhall Wash monitoring locations (Tables 18-12, 18-13, and 18-14, respectively) appeared to exhibit higher concentrations of major ions and TDS in the first major runoff event of the season as compared to subsequent events. The results from the Upper No Name monitoring station show lower levels of TSS, settleable solids, TDS, and major ion concentrations than were observed at the Lower No Name station or at either of the Pinabete Arroyo monitoring stations. The sodium adsorption ratios (SAR) were also lower in the samples taken from the No Name Arroyo stations as compared to the Pinabete Arroyo stations. Changes in TDS and TSS concentrations at upstream (Table 18-16) and downstream (Table 18-15) locations on Brimhall Wash were evaluated in the Burnham Mine PAP. These results show similar results for the upstream and downstream locations with a median TDS concentration of 845 mg/L at Site N and 843 mg/L at Site M. Median TSS concentrations were 20,810 mg/L at Site N and >20,000 mg/L at Site M.

The USGS monitored stream flow continuously over the period from November 1975 through September 1994 at Station 09367950 on the Chaco River near its mouth as shown on Exhibit 18-1. Suspended sediment concentrations were also monitored at this station over the period from October 1976 through September 1982. The stream-flow data show base flows ranging from 0 to 30 cfs during non-storm periods and annual peak storm flows ranging from 1,170 to 6,410 cfs. Discharges from Morgan Lake near the FCPP generate a perennial flow in this lower reach of the Chaco River. Suspended sediment concentrations vary with discharge and typically range from 300 to 5,000 mg/L, except during storm runoff events when concentrations typically range from 50,000 to 150,000 mg/L (USGS 2009).

18.1.2 Lakes, Reservoirs, Other Water Bodies

There are no lakes or reservoirs within the No Name Mine permit area. However, there are a few stock watering ponds that have been constructed to catch surface flows from some tributary drainages (Exhibit

18-2). The stock water ponds, owned by the Navajo Nation, are often dry and are not used for irrigation, consumption by humans, or purposes other than livestock watering.

The largest is the No Name Impoundment which holds varying amounts of water depending upon the occurrence of storm runoff. When full of water, the impoundment stores approximately 12.8 ac-ft and has a high-water line area of about 5.8 ac, based on a 2008 survey performed by NTEC. Water containment is seasonal and storage in the impoundment is dependent on surface water inflow from storm events. Enhanced vegetation growth immediately downstream of the No Name Impoundment strongly suggests that localized groundwater is present due to seepage from the impoundment.

Grab samples were obtained monthly in 1998 from the No Name Impoundment when it contained water and was free of ice cover. The analytical results for the water quality samples from the impoundment are summarized in Table 18-17. Comparison of the monthly sample results shows higher concentrations of major ions, TDS, and SAR in April and May as the impoundment was drying up than in July and August after the impoundment was filled by major storm runoff events in July and August, 1998. Based on these results, the water in the No Name Impoundment appears to be acceptable for livestock watering use even when concentrated by evaporation during storage. Data collected in 2007 and 2008 show polychlorinated biphenyl (PCB) values were below detection limits (Appendix 18-C). There were elevated concentrations of dissolved aluminum above chronic aquatic and wildlife habitat standard. Cadmium chronic aquatic habitat standards are hardness dependent, and the No Name Impoundment had a median hardness of 46 mg/L $CaCO_3$ from the pond samples that have hardness results as reported in Table 18-17. The concentration of dissolved cadmium in one of the three samples from the No Name Impoundment exceeded the estimated hardness dependent chronic aquatic and wildlife limit for cadmium of 0.00014 mg/L. The concentration of dissolved copper in all three of the samples from the No Name Impoundment exceeded the estimated hardness dependent chronic aquatic and wildlife limit for copper of 0.00461 mg/L. The concentration of dissolved lead in one of the three samples from the No Name Impoundment exceeded the estimated hardness dependent chronic aquatic and wildlife limit for lead of 0.00107 mg/L. Mercury was not detected in the analysis of these three samples but the detection limits for mercury exceeded the chronic aquatic and wildlife criterion for mercury.

The only Pinabete Arroyo impoundment within the permit boundary (P#1) extends across less than two ac (Exhibit 18-2), Two other impoundments, Stevenson's Well Pond and another small stock impoundment, are also present on a tributary to Pinabete Arroyo, north of the permit area within NTEC's Pinabete Mine. Water quality data were collected at Stevenson's Well Pond and Area 4N/4S Pond (both north of the permit area; Table 18-17). The concentration of dissolved aluminum in five of six samples from the Area 4N/4S Pond exceeded the chronic aquatic and wildlife limit of 0.087 mg/L (Table 18-11). Also, the sixth sample from Area 4N/4S Pond reported selenium less than detection with a detection limit of 0.100 mg/L, which

also exceeds the chronic aquatic and wildlife limit of 0.087 mg/L. The cadmium hardness dependent chronic aquatic limit is 0.00021 mg/L (using the median hardness of 77 mg/L for those samples in which it was available). It was exceeded by the concentrations observed in two of the five samples from the Area 4N/4S Pond and by two of the three samples from the Stevenson's Well Pond. The concentration of dissolved copper in two of the four samples from the Area 4N/4S Pond exceeded the estimated hardness dependent chronic aquatic and wildlife criterion for copper of 0.00716 mg/L (Table 18-11). The concentration of dissolved lead in one of the five samples from the Area 4N/4S Pond exceeded the estimated hardness dependent chronic aquatic and wildlife criterion for lead of 0.00189 mg/L. None of the samples from the Area 4N/4S Pond exceeded the chronic aquatic and wildlife criterion for selenium of 0.002 mg/L but the detection limit of 0.010 mg/L reported for dissolved selenium in two of the four samples exceeded the criterion. Likewise, the detection limit of 0.01 mg/L reported for dissolved selenium in one of the three samples from the Stevenson's Well Pond exceeded the chronic aquatic and wildlife criterion for selenium. Finally, the detected values for mercury and the detection limits for mercury in samples from both impoundments exceeded the chronic aquatic and wildlife criterion for mercury. Samples collected in 2007 and 2008 from these impoundments were also analyzed for pesticides and PCBs. These results show that pesticides and PCB values were below detection limits (Appendix 18-C).

There are seven other smaller impoundments located within Area 5 (Exhibit 18-2). The aerial footprints of these impoundments range in size from approximately 0.4 to 3.7 ac based on an aerial photo acquired after a 2007 storm event. Three impoundments discharge west into small tributaries of the Chaco River, two others discharge into a tributary of No Name Arroyo, and the last two are isolated impoundments within the No Name Arroyo watershed. There is also a 5.0-ac impoundment immediately southeast of Area 5, which collects runoff from areas within the permit boundary and drains into Brimhall Wash north of the town of Burnham, New Mexico.

18.1.3 Discharges into Surface Water Bodies

There are no springs, seeps, or man-made discharges into surface water bodies within or adjacent to the permit area.

18.1.4 Surface Water Resources Information Collection and Analysis

NTEC implemented a baseline hydrologic monitoring program in 2007 to supplement monthly data collected in 1998 at four sites for Area 4 South and Area 5 and obtained information from four stream monitoring sites located near the permit boundary on Pinabete and No Name Arroyos and three impoundments.

Data collected from the single-stage sediment samplers and crest-stage gages installed near the upstream and downstream permit boundaries on Pinabete and No Name Arroyo (Exhibit 18-1, Figure 18-1, and

Figure 18-2) included field measurements of pH, temperature, and specific conductance. Water quality parameters, consisting of TSS, settleable solids and TDS, dissolved and total iron and manganese, major cations and anions, 12 trace metals, three minor anions, and two radium isotopes. The sampling suite and associated data for Pinabete Arroyo and No Name Arroyo samples are summarized in Table 18-12 and Table 18-13, respectively. Quality assurance and quality control information for the 2007 through 2008 surface water data is provided in Appendix 18-D.

Channel profiles and cross sections at the crest gage locations were surveyed in 2007 and compared to the survey performed in 1998. This comparison provided limited evidence of midterm morphological changes for the permit area and provided insights into channel stability (Appendix 18-A).

NTEC has continued sampling the Pinabete Arroyo surface water sites since 2011. This information can be found in Table 18-41. No Name Arroyo surface water site sampling has been resumed and will be provided as supplemental information prior to permit approval, or as directed by OSMRE.

18.2 Groundwater Resources

The groundwater baseline assessment provides a description of the pre-mine conditions for each water-bearing stratum, including the coal seams and any potentially impacted strata below the lowest coal seam to be mined. The baseline assessment also establishes the foundation for the determination of probable hydrologic consequences for the surface coal mine operation (Section 41, Probable Hydrologic Consequences) and for the design of water monitoring and mitigation plans that may be needed to ensure that there is no material damage to groundwater resources.

18.2.1 Springs, Seeps, and Other Groundwater Discharges

Direct recharge of overburden is quite low due to the arid climate with average annual precipitation of less than six inches and annual evaporation rate of about 55 inches (Section 12, Climate). Recharge rates measured by chloride mass balance methods on undisturbed areas at the nearby Navajo Mine ranged from 0.002 to 0.090 inches/year (in/yr; Stone 1987). Due to the very low rates of recharge, groundwater discharge rates are also quite low and insufficient to sustain base flow at any streams in the vicinity of the No Name Mine, including the Chaco River.

Site reconnaissance and review of springs identified, by the New Mexico Office of the State Engineer (NMOSE) (2010) Navajo Settlement Agreement, no springs within or adjacent to the No Name permit area. Two springs were identified outside the adjacent area as shown on Exhibit 18-3. BIA designations 13R-103 and 13R-104, were identified on upper Cottonwood Arroyo about 7 mi northeast of the No Name permit area.

One location for potential groundwater discharge was identified during the site reconnaissance by enhanced vegetation growth and salt deposits along the channel bed and banks on Pinabete Arroyo approximately 1,400 ft upstream of the Burnham Road crossing and another immediately below the surface impoundment on No Name Arroyo. These features suggest the presence of a groundwater discharge that is insufficient to sustain flow (Brown 1976). The groundwater source may be from the No. 8 coal seam, which outcrops in the vicinity of this location or it could also be from the alluvium, which is known to be partially saturated upstream near the northern permit boundary at alluvial well PA-1. It is unlikely that these salt deposits are due to evaporation of residual runoff because they occur along the channel bed and bank, not in depressions, and do not extend upstream or downstream of this isolated location.

Groundwater flow directions in the Pinabete Arroyo alluvium follow the surface water down gradient towards the Chaco River. However, there are no indications of groundwater discharge along the Chaco River in the vicinity of Pinabete Arroyo. The only springs and seeps noted along the Chaco River are further north near the FCPP (Stone et al. 1983). This surface water flow is discussed in Section 18.1.1.

Based on the potentiometric surfaces presented in Section 18.2.4, flow directions in the Fruitland coals are toward the north-northeast. Potentiometric gradients in the Pictured Cliffs Sandstone (PCS) are toward the north. The northerly gradients in these potentiometric surfaces are influenced by the topographic low along the San Juan River valley. There may also be some local influence of topographic lows along the Chaco River tributaries on potentiometric gradients in these units. Potential rates of discharge from these bedrock units are extremely low due to the low recharge rates and low hydraulic conductivity of these units.

18.2.2 Wells

An inventory of water supply wells located within and adjacent to the permit area was prepared from well information from several sources including the water supply wells identified by the NMOSE (2010) Navajo Settlement Agreement, the inventory of wells conducted by BIA in 1987 for the Navajo Mine, wells identified in the "Groundwater Operations Manual and Well Survey for Navajo Mine and Vicinity" that was completed by Metric Corporation (1991), and wells found in review of permits on file at the Navajo Nation Water Resource Management Office in Fort Defiance, Arizona.

The study area for the well inventory presented in this section extends from the Chaco River and its alluvium on the west to about four miles east of NTEC's mining leases shown in Exhibit 18-3. Relevant information on the wells identified in the inventory is provided in Table 18-18. Wells that were installed for the sole purpose of monitoring are shown on Exhibit 18-4. These monitoring wells, including the monitoring wells that have been abandoned, are depicted on Exhibit 18-4. Although the completion zone for some of the wells is not specified in the information sources, it is believed that almost all of the water wells located within the study area are completed within the alluvium of the Chaco River, Pinabete Arroyo,

and Brimhall Wash due to their locations on Exhibit 18-3. Only four of the wells in Table 18-18 are believed to be completed in bedrock formations. Well 13-AW (13T-513) is a flowing artesian oil and gas well that was converted to stock water use that is sourced from bedrock below the PCS, most likely from the Menefee Formation. This well was included in the well survey by Metric Corporation (1991) and the coordinates and condition of the well were field verified. At the time of the survey the well was operational and flowing. The well depth from top of casing was measured at 530 ft. The completion zone for well W-606 (13-15-1), located in Area 5 of the NTEC mining lease, is not specified. This well was capped and welded shut during the site reconnaissance and the well depth could not be measured. However, based on the depth reported by Metric Corporation (1991), this well may be completely within the PCS. Likewise, Tribal Well 13-7-2, located approximately 300 ft south of the Burnham Chapter House, is a PCS well that was originally installed for water supply to Burnham. It was abandoned due to poor yield and poor water quality. Finally, Well #90, located along the Chaco River north of Brimhall Wash, was identified in the BIA survey for Navajo Mine as a PCS well with a depth of 131 ft.

The following three water wells were indicated to be within the permit area from one or more sources of available information used for the well inventory:

- Well 13R-37 is a dug alluvial well located on Pinabete Arroyo upstream of well 13R-48. This well includes a windmill and tank and is used for livestock watering.
- Well 13-5-2 is an alluvial well located on a tributary to Pinabete Arroyo adjacent to the Burnham Road. This well is recharged by an adjacent man-made pond and is equipped with a hand pump. This well is also referred to as the Stevenson Well or 13-5-1.
- Well 13-15-1 is located adjacent to the Burnham Road within Area 5. The completion zone for this well is not known and the well was capped and welded shut so that depth could not be measured. Based on the depth reported by Metric Corporation (1991), this well could be within the PCS.

18.2.3 Aquifers and Other Groundwater Resources

The hydrogeologic units within and adjacent to the permit area that could potentially be affected by the proposed mining and reclamation include:

- The alluvium of the Pinabete and No Name Arroyos.
- The coal seams of the Fruitland Formation.
- The PCS located below the Fruitland Formation No. 2 coal seam.

Alluvial fill deposits occur in the valley bottoms of the Pinabete Arroyo and No Name Arroyo, within the permit area, and along the Chaco River and Brimhall Wash, to the west and south of the permit area. However, these deposits are not considered Alluvial Valley Floors (AVF). Refer to Section 19 (Alluvial Valley Floors) for information on the negative determination for AVF within and adjacent to the permit

area. The alluvium of the Chaco River also contains groundwater as indicated by the dug wells located adjacent to the Chaco River. As stated in Section 18.2.1, the groundwater is not sufficient for sustained base flow in any of these drainages.

The alluvium of No Name Arroyo was found to be dry based on alluvial monitoring well GM-23, installed in 1976 in association with a proposed coal gasification project and screened only in the alluvium of No Name Arroyo. This well was plugged and abandoned in 1994 at the request of OSMRE. Two new alluvial monitoring wells, NNA-1 and NNA-2, were installed in 1998 at locations upstream and downstream of the No Name Impoundment as shown in Exhibit 18-4. Water level monitoring data from these wells further support the dry character of the alluvium along No Name Arroyo. However, saturated conditions may occasionally occur within the alluvium of No Name Arroyo for a relatively short distance downstream of the No Name Impoundment due to seepage from the impoundment. The No Name Impoundment is discussed in Section 18.1.2.

Groundwater is also found in the coal units of the Fruitland Formation and in the PCS, which underlies the Fruitland Formation at the No Name Mine site. The geologic strata within the permit and adjacent area dip gently to the east toward the center of the San Juan Basin at an angle of one to two degrees. A more thorough description of the regional and localized geology of the No Name permit area is provided in Section 17 (Geologic Information). Based on both regional and site-specific information, the Fruitland Formation and associated coal units, and the PCS are unsaturated or partially saturated near the outcrop of these units on the western side of the permit area but become saturated to the east and down dip of the outcrop.

Based on information obtained from water level elevations measured in the coal seam wells and piezometers the flow directions in the Fruitland Formation within Area 3, Area 4 North, Area 4 South, and Area 5 of the NTEC mining lease are vertically downward through the interbedded shale and coal units of the Fruitland Formation and into the PCS and laterally within individual coal seams are toward the north-northeast with some localized flow toward the topographic lows along the Cottonwood Arroyo and Pinabete Arroyo. Although the vertical hydraulic conductivities of the interbedded shales in the Fruitland Formation are quite low, recharge rates are lower still. Direct recharge rates measured by chloride mass balance methods on undisturbed areas at the Navajo Mine ranged from 0.002 to 0.090 in/yr (Stone 1987). The highest recharge rate of 0.090 in/yr was for valley terraces while the lowest recharge rate of 0.002 in/yr was for badland areas. Recharge from upland flats averaged 0.030 in/yr. Based on the research by Kearns and Hendrickx (1998) areal recharge is thought to occur during very large precipitation events and during extended wet periods with increasing soil moisture. Recharge is expected to be higher from saturated alluvium and surface impoundments. Although Stone's research (1986 and 1987) did not include recharge

estimates for surface impoundments, it does provide an estimate of an average recharge rate of 0.160 in/yr from depressions within reclaimed mine areas at the Navajo Mine.

The coals, overburden, and interburden in the Fruitland Formation are not expected to yield much water during mining. The saturated sands that occur in the Fruitland Formation are of limited extent and only yield significant water when recharged by water from the Navajo Indian Irrigation Project (NIIP). NIIP influences do not extend into the drainages associated with the No Name Mine. The pre-mine groundwater in the Fruitland Formation throughout most of the NTEC mining lease will not support beneficial use because of the very low well yields and poor water quality. As indicated in Section 18.2.2, there are no known water supply wells completed in the Fruitland Formation within or adjacent to the permit area.

The PCS is a well-cemented, low-permeability, marine sand and is the first water-bearing unit below the lowest coal seam to be mined (No. 2 coal seam). Based on the information in Section 17 (Geologic Information) the PCS is approximately 110 to 120 ft thick and follows the structure of the Fruitland Formation, dipping to the east at approximately two degrees, although the structure varies locally. The PCS conformably overlies the Lewis Shale, with the contact marked by a zone of interbedded sandstones and mudstones in the lower part of the PCS (Stone et al. 1983). It outcrops just west of the mine area and east of the Chaco River. Within and adjacent to the permit area, the general groundwater flow in the PCS is toward the north. The PCS is also a natural gas reservoir in the San Juan Basin. Stone et al. (1983) state that the PCS cannot be considered a major aquifer and it is important only because it is the water-bearing horizon immediately underlying the coals in the Fruitland Formation.

Water yields from monitoring wells completed in the PCS within NTEC's mining lease are quite low. Two of the PCS wells, KPC-2007-2 and KPC-2007-3, were quickly pumped or bailed dry during conventional sampling. The yield from PCS monitoring well KPC-98-01, located northwest of the permit area, was sufficient to sustain a rate of about 0.40 gallons per minute (gpm) during a constant rate pumping test. The fourth PCS monitoring well, KPC-2007-01, was installed within the NTEC Pinabete Mine north of the permit area and was pumped dry after about 140 minutes during a constant-rate pumping test at a rate of about 0.95 gpm with most of the pumped water derived from well bore storage.

One PCS water supply well, 13-7-2, is located south of the No Name permit area near the Burnham Chapter House. This well was originally completed as water supply for the Burnham Chapter House. The yield and water quality from this well was poor so it was replaced by Tribal Well 13T-514, located approximately four mi southeast of the chapter house. There are no known water supply wells completed in the PCS within the No Name Mine permit area. The completion interval for well 13-15-1 located in Area 5 is not known and could be screened in the PCS as discussed in Section 18.2.2.

18.2.3.1 Groundwater Quantity

Monitoring wells and vibrating wire piezometers (VWP) were installed in the Fruitland coal seams, in the alluvium of Pinabete and No Name Arroyos, and in the PCS in 1998 and in 2007 for baseline hydrogeology characterization of Area 4 South and Area 5 of NTEC's mining lease. The No. 3 coal seam was the target for much or the characterization of the Fruitland Coal because the No 3 coal seam is continuous over most of Area 4 South and Area 5 of the NTEC mining lease. The No. 2 and No 3 coal seams are hydrologically connected and sometimes merge within the mining lease area. The upper coal seams (Nos. 6, 7, and 8) do not exist over the entire lease area but outcrop toward the western limits of the mine lease and are washed out within portions of the drainages, particularly along Pinabete Arroyo.

Well KF-2007-01 was installed at a location near the eastern boundary of the permit area to monitor water levels and to characterize baseline water quality in the No 8 coal seam. The PCS well KPC-2007-03 was installed to measure water levels within the PCS at the western boundary of the No Name permit area. The 2007 drilling program work plan called for installation of a No. 2 coal monitoring well at this location along the western boundary of the mining lease. However, the No. 2 coal was observed to be dry during drilling at this location so the well was completed in the upper part of the PCS to monitor water levels. The PCS well KPC-2007-02 was installed to measure water levels and to characterize baseline water quality within the PCS upgradient of Area 4 South. Sampling of this well indicated high pH and elevated calcium, which is an indication of potential well-grout influence. Consequently, this well was used only for water level monitoring in the baseline program. The PCS well KPC-2007-01 was installed to measure water levels and to characterize baseline water quality in the PCS downgradient of Area 4 South. The VWPs were installed to measure potentiometric levels within the PCS and various coal units within the No Name permit area. Completion diagrams for the monitoring wells installed in years 1998 and 2007 as well as VWPs installed in 2007 are provided in Appendix 18-E.

The groundwater monitoring and hydrogeologic characterization program for Area 4 South and Area 5 of NTEC's mining lease also included the installation of one VWP in the No. 6 coal seam, one VWP in the No. 7 coal seam, and one monitoring well and one VWP in the No. 8 coal seam. The upper coal seams (Nos. 6, 7, and 8) do not exist over the entire lease area but outcrop toward the western limits of the mine lease and are washed out within portions of the drainages, particularly along Pinabete Arroyo. The No. 8 coal seam is typically the thickest coal seam and is believed to exhibit the highest hydraulic conductivity of the coals. All coal seams include splits and partings, although these are most extensive in the No. 8 coal seam as indicated in Section 17 (Geologic Information).

Historic water level data collected during the mid-1970s are also available for six wells that were completed in the PCS within or adjacent to the NTEC mining lease for a previously proposed project. The locations for these PCS monitoring wells are shown on Exhibit 18-4. Historic baseline water quality data

were obtained at five of these PCS wells. These PCS monitoring wells and piezometers were plugged and abandoned in 1994. Historic water level monitoring data and pumping test data are also available for the PCS well O-1, located at the Burnham Mine situated southeast of NTEC mining lease as shown on Exhibit 18-4. These data, together with data from the adjacent Navajo Mine and other regional sources, supplement the recent baseline groundwater information obtained at the No Name permit area.

18.2.3.1.1 Alluvial Aquifer Information

Two alluvial monitoring wells, PA-1 and PA-2, were installed in 1998 within the alluvium of Pinabete Arroyo near dug water wells at the locations shown on Exhibit 18-4. Two alluvial monitoring wells, NNA-1 and NNA-2, were installed in the alluvium of No Name Arroyo at locations upstream and downstream of the No Name Impoundment as shown on Exhibit 18-4. The purpose of the monitoring wells in the alluvium of No Name Arroyo was to determine the possible occurrence of alluvial groundwater flows into or out of the No Name Impoundment.

Water levels were measured monthly at each of the alluvial monitoring wells. Table 18-19 summarizes the water level readings in each of the Pinabete alluvial monitoring wells during the baseline monitoring program. The data for the Pinabete alluvial wells show a decline in water levels during the spring and early summer of 1998 followed by a rise in water levels due to thunderstorm runoff events in late summer and fall of 1998. In 2007, water levels declined slightly from August through December. The No Name alluvial well NNA-1, located down gradient from the No Name Impoundment, has been dry except during the latter half of 1998 when seepage associated high water levels in the impoundment provided a source of water for the alluvium at this well. The No Name alluvial well NNA-2 has been dry during the entire baseline monitoring program.

Well completion and aquifer test results for the alluvial monitoring wells are summarized in Table 18-20. Well completion diagrams for the Pinabete and No Name alluvial wells are provided in Appendix 18-E. Aquifer test data and interpretation results for the monitoring wells installed in 1998 are provided in Appendix 18-F. The calculated or measured hydraulic conductivities for the Pinabete Arroyo alluvium of 51.3 feet per day (ft/day) (1.8×10^{-2} cm per second (cm/sec)) and 11.1 ft/day (4.1×10^{-3} cm/sec) are within the range expected for clean sand and are considerably higher than the bedrock values in the area. Well yields from the alluvium, however, are limited by a very low saturated thickness of about five ft or less. Saturated thickness in the No Name alluvial wells was insufficient to permit a pumping test or slug test. Saturated thickness in the No Name alluvial wells was insufficient to permit a pumping test or displacement (slug) test. The hydraulic conductivity of the No Name alluvium is expected to be considerably lower than the Pinabete Arroyo alluvium due to the high percentage of fine-grained alluvial silts and clays, as evidenced by the drill logs.

18.2.3.1.2 Fruitland Formation Information

Groundwater production from the Fruitland coal seams is quite limited. The majority of exploration drill holes through the Fruitland Formation within the permit area did not yield measurable groundwater during drilling. Measurable water was encountered at a few locations, specifically, three boreholes located within the northeast portion of Area 4 South produced water at rates estimated at greater than 10 gpm. This groundwater is believed to be associated with the No. 6 and the No. 8 coal seams. Measurable water was also encountered in the No. 8 coal seam during completion of the No. 3 coal seam well KF-98-03. At this location, groundwater was first encountered in the unconsolidated sand and gravel above the No. 8 coal seam at a depth of about 22 ft. The No. 8 coal seam was encountered in the depth interval from 24 to 38 ft. Water was produced at a rate of about two to three gpm from the coal and the overlying sand and gravel.

In 2007, well KF-2007-01 was completed in the No. 8 coal seam to characterize the groundwater near the permit boundary to the east of the No. 3 coal well KF-98-03. Well KF-2007-01 is the only well within Area 4 South and Area 5 with sufficient yield to permit the application of a constant rate pumping test to determine hydraulic characteristics of the coal. The water yields from wells KF-98-02, KF-98-03 completed in the No. 3 coal seam, are all very low and are quickly pumped or bailed dry during conventional sampling. The locations for the additional coal monitoring wells are shown on Exhibit 18-4. Completion diagrams and lithologic logs for these coal wells are provided in Appendix 18-E.

Depth to water level and potentiometric elevations measured at the monitoring wells completed in the No. 3 and the No. 8 coal seams are provided in Table 18-21. Wide fluctuations in water levels in the No. 3 coal seam wells occurred during the 1998 monitoring period. These fluctuations were the result of well development, aquifer testing, and sampling. A considerable amount of time is required for water levels in these wells to approach equilibrium due to the low hydraulic conductivity of the coal. Quarterly sampling using micro-purge sampling techniques was performed for the sampling program starting in 2007 so that the magnitude of fluctuation resulting from sampling was limited.

Well KF-98-04 was designated to be screened in the first saturated bedrock unit adjacent to the alluvium of Pinabete Arroyo near alluvial well PA-1 just north of the No Name permit boundary. The purpose of this well was to help evaluate the relationship between water levels in alluvium and water levels in the bedrock underlying the alluvium. The first saturated bedrock below the alluvium was at a depth of about 63 to 64 ft in the No. 3 coal seam, demonstrating that the saturated alluvium within the Pinabete Arroyo at this location is perched above the underlying unsaturated bedrock. Monitoring well KF-98-04 has remained dry throughout most of the 2007 to 2008 monitoring period, with only 0.1 ft of saturation recorded on October 4, 2007. Water levels have been monitored since 2011 and are included on Table 18-41. KF-98-04 continues to provide very little water.

Static water level readings could not be obtained monthly at well KF-98-03 after October 4, 2007 because this well was being periodically purged and bailed as part of a program to remove influence from grout that may have penetrated portions of the sand pack surrounding the screened interval in this well. This well and two of the new PCS wells (KPC-2007-02 and KPC-2007-03) exhibited low yield and pH levels ≥ 12, indicating that the annular space cement grout may have penetrated the bentonite seal on top of the sand pack surrounding the screened interval in these wells during well completion. The grout penetration is believed to be the result of the low hydraulic heads in the coal combined with the high-pressure head of the grout seal placed in the annular space. The monitoring wells with the largest annular cement interval are also the wells with unusually high pH values that are indicative of grout intrusion. The low yield of the No. 3 coal seam at well KF-98-03 has also limited the prospect of grout removal by well purging. Consequently, in the fall of 2007, acid treatment was used to remediate cement contamination of the monitoring well sand pack materials. Due to the very low yield at these wells, bailing and purging of wells KF-98-03 and KPC-2007-02 have continued, reducing the times when static water level measurements could be taken at these wells.

In 1998, a slug test was performed at well KF-98-02 and bailed recovery tests were conducted at wells KF-98-03 and KF-98-04 to determine transmissivity and hydraulic conductivity in the No. 3 coal seam. Test results found very low transmissivity values ranging from 0.01 to 0.001 sq ft per day (ft^2/day) and hydraulic conductivity values ranging from 0.002 to 0.00013 ft/day (3.5×10^{-7} to 4.6×10^{-8} cm/sec) as summarized in Table 18-22. These values are consistent with the hydraulic conductivity values of 0.001, 0.002, 0.0014, and 0.003 ft/day estimated for the No. 2, No. 3, No. 4-6, and No. 7 coal seam wells, respectively, at the KF-84-22 well series located at the Navajo Mine just north of the No Name Mine site (Table 18-22). Well KF-84-22A was not tested at this location but hydraulic conductivity values ranging from 0.004 to 0.06 ft/day (1.4×10^{-5} to 1.4×10^{-6} cm/sec) with a geometric mean of 0.033 ft/day (1.16×10^{-5} cm/sec) were estimated from tests at three No. 8 seam coal wells (SJKF-84-#3, SJKF-84-#4, and SJKF-84-#5) located adjacent to the Navajo Mine. These results are comparable to the hydraulic conductivity value of 0.056 ft/day (2×10^{-5} cm/sec) estimated for the No. 8 coal seam well KF-2007-01 as described in Appendix 18-F and summarized in Table 18-22.

In a separate set of tests, the transmissivity and hydraulic conductivity values calculated from the observation well response during a pumping test of the No. 8 coal seam well, G-20, located at the San Juan Mine approximately 20 miles north of the NTEC mining lease area were 0.017 ft^2/day and 0.001 ft/day (3.5×10^{-7} cm/sec), respectively (San Juan Coal Company 2004). These results for the hydraulic conductivity of No. 8 coal at the San Juan Mine are lower than the values from well tests at NTEC's mining lease. However, the observation well response from the pumping test for this well at the San Juan Mine is useful because it provides a reliable estimate for the storage coefficient of 4.2×10^{-4} for the No. 8 coal seam.

Potentiometric elevations in the saturated coal units and the underlying PCS were also measured using VWPs installed at five locations throughout the permit area as shown on Exhibit 18-4. VWP construction details are provided in Appendix 18-E. Potentiometric elevations measured at the VWPs completed in the coals are summarized in Table 18-23. The December 2007 measurements of potentiometric elevations in the coal wells and VWPs were used to estimate the potentiometric surface for the No. 2 and No. 3 coal seams at the No Name Mine site as presented in Exhibit 18-5 and Exhibit 18-6, respectively. The potentiometric levels measured on July 6, 1989 at the No. 2 and No. 3 coal seams at the KF-84-22 well series located north of the permit area were also used in developing the potentiometric surfaces in these exhibits. The potentiometric gradients in both the No. 2 and No. 3 coal units indicate groundwater flow components toward the north-northeast in the vicinity of these monitoring wells and piezometers.

Potentiometric gradients in the upper coal seams at the No Name Mine site are expected to be generally toward the northeast, similar to the gradients observed in the No. 2 and No. 3 coals, although local gradients may be influenced by the lower elevations along Pinabete Arroyo and No Name Arroyo. The No. 6, No. 7, and No. 8 coal seams outcrop along the valleys of Pinabete, No Name, and Cottonwood Arroyos within the mining lease area. Field observations of salt deposits and enhanced vegetation production suggest that local discharge may occur from the No. 8 coal at the coal subcrop beneath the Pinabete Arroyo as discussed previously in Section 18.2.1.

Potentiometric elevations in the monitored coal units and in the underlying PCS were plotted for four of the nested VWP locations, to depict vertical gradients and possible seasonal patterns. Plots were not prepared for the one VWP installed at this location, VWP-2007-4, because the overlying Fruitland coal units appeared to be dry during piezometer installation. Figure 18-7 shows consistent potentiometric elevations over time for the No. 2 coal seam and the PCS at location VWP-2007-05. The slightly higher potentiometric elevation in the PCS indicates a slight upward gradient from the PCS to the Fruitland Formation at this location, however the overall trend for both since 2007 is down.

A plot of the potentiometric levels in the No. 2 and No. 3 coal seams and the PCS at well VWP-2007-03 is provided in Figure 18-8. The results show consistent downward gradients from the No. 3 coal seam to the PCS. The wide fluctuation in potentiometric levels in well KPC-2007-02 is due to the bailing and purging of this well. Figure 18-9 shows the potentiometric levels in the PCS and in the upper and lower coal units at the VWP-2007-02 location. The results show high downward gradients from the No. 8 coal seam to the No. 3 coal seam and slight upward gradients from the PCS to the No. 3 coal seam.

A plot of potentiometric elevations in the PCS and in No. 6, No. 3, and No. 2 coal seams at well VWP-2007-01, just north of the permit boundary, is provided in Figure 18-10. The results show consistent downward gradients from the No. 6 coal to the PCS, with the highest vertical gradients between the No. 6

and the No. 3 coal seams. The plot also includes water levels measured in the PCS well KPC-2007-01 at the VWP-2007-01 location. Measured water elevations in well KPC-2007-01 are consistently about six ft lower than the potentiometric elevation measured in the PCS at VWP-2007-01. The VWP in the PCS at this location is installed at the top of the PCS, while the well screen and filter pack extend through approximately 75 ft of the PCS. The difference between the two measurements suggests that hydrostatic heads are higher at the top of the PCS at this location and decline with depth. Thus, downward gradients are believed to continue through the PCS at this location.

18.2.3.1.3 Pictured Cliffs Sandstone Information

The PCS underlies the Fruitland Formation and follows the structure of the Fruitland coal seams. The PCS is a marginal water resource due to the low permeabilities, poor water quality, gas production, and low yields (Stone et al. 1983). The PCS conformably overlies and intertongues with the Lewis Shale. As discussed previously, the PCS appears to be on the order of 110 to 120 ft thick through the permit area.

Well KPC-98-01 was installed in 1998 northwest of the permit area near the PCS outcrop at the location shown in Exhibit 18-4. In 2007, wells KPC-2007-01, KPC-2007-02, and KPC-2007-3 were completed in the PCS at the locations shown in Exhibit 18-4. These wells are maintained as monitoring wells during mining. Completion diagrams and lithologic logs for these PCS wells are provided in Appendix 18-E.

VWPs were installed in the PCS at four of the five VWP locations as shown on Exhibit 18-4. A VWP was not installed in the PCS at the VWP-2007-03 location because monitoring well KPC-2007-02 was installed in the PCS at this location. Construction diagrams and lithologic logs for these VWP installations are provided in Appendix 18-E. Potentiometric elevations measured at the PCS wells and the VWPs installed in the PCS are summarized in Table 18-24. Table 18-41 also summarizes groundwater quality data and elevations.

Historical water level data collected during the mid-1970s are also available in a report by Science Application, Inc. (1979) for six wells that were completed in the PCS within or adjacent to the No Name Mine site (Table 18-25). These abandoned PCS monitoring wells are designated as the ground monitoring (GM) wells with water elevations shown on Exhibit 18-7. These PCS monitoring wells and piezometers were plugged and abandoned in 1994. Historic water level monitoring data are also available for the PCS monitoring wells O-1 located at the Burnham Mine southeast of NTEC's mining lease as shown in Exhibit 18-4.

The December 2007 measurements of potentiometric elevations in the PCS wells and VWPs installed in the PCS were used to estimate the potentiometric surface presented in Exhibit 18-7. The potentiometric elevations measured during the 1970s at the abandoned PCS monitoring wells were also used to develop

this potentiometric surface for the PCS. The potentiometric gradients in PCS indicate an overall northerly gradient. There is a slight easterly component in the gradients at the southern end of the site due to a structural high in the PCS along the southeast perimeter of the permit area. There are also local gradients toward the topographic lows along No Name, Pinabete, and Cottonwood Arroyos.

A potentiometric surface for the PCS was prepared using the potentiometric elevations measured at above mentioned wells and piezometers and the historic water elevations at the abandoned PCS well before the VWPs were installed in the PCS at VWP-2007-4 and VWP-2007-5 within Area 5. The potentiometric surface in the PCS within Area 5 was based on measurements obtained at the PCS (GM) monitoring wells during the 1970s. When the new data for the PCS at VWP-2007-4 and VWP-2007-5 were added to update the potentiometric surface, no change was required. These results indicate that the current potentiometric measurements in the PCS are consistent with the measurements obtained at the GM wells during the 1970s.

An aquifer test was conducted in 1975 at well T4-1 installed in the PCS near the western side of the permit boundary as shown in Exhibit 18-4. The drawdown and recovery measurements were recorded at the pumped well and at observation well GM-30A, located 55.8 ft from the pumping well, and at observation well T4-2 located 12.5 ft from the pumping well. The top of the PCS is approximately 146 ft below ground surface at the test location while the static water level was at a depth of 134 ft, demonstrating confined conditions at the test location (Science Application Inc. 1979). The results of this aquifer test are summarized in Table 18-26, along with the results of tests performed at the PCS monitoring wells installed as part of this baseline monitoring program for the No Name Mine. The testing results and interpretations of the PCS baseline monitoring are provided in Appendix 18-F.

The hydraulic conductivity from the recovery response at well GM-30A from the pumping test at the PCS well T4-1 was 0.0016 ft/day (5.6×10^{-7} cm/sec). The storage coefficient determined from the observation well response at GM-30A was 3.4×10^{-5}. The highest hydraulic conductivity estimate for the PCS near the permit area was 0.02 ft/day (7.0×10^{-6} cm/sec) obtained from the test at monitoring well KPC-98-01, located northwest of the permit boundary as shown on Exhibit 18-4. The PCS is unconfined at this location. The results for this well are consistent with the aquifer test results of 0.032 ft/day (1.1×10^{-5} cm/sec) from a slug test at Well O-1 completed in the PCS at the Burnham Mine but higher than the range from 0.01 to 0.0001 ft/day (3.5×10^{-6} to $3.5\ 10^{-8}$ cm/sec) obtained from the slug tests at the three other PCS monitoring wells as summarized in Table 18-26.

Pumping test results for the PCS monitoring well O-1 in the PAP for the Burnham Mine are on file in the library of the OSMRE. In this well test, pumping at a relatively high rate of 18.3 gpm could be sustained for only 8.7 minutes when most of the well-bore storage water was removed and the test had to be terminated. Although the results were interpreted in the Burnham Mine PAP as a pumping test, this

approach is not correct due to the predominant influence of well-bore storage. Consequently, the well test results have been reinterpreted as a slug test in this report. Slug test results indicate a hydraulic conductivity of 0.032 ft/day (1.1×10^{-5} cm/sec).

18.2.3.2 Groundwater Quality

The water quality characteristics of the Pinabete and No Name alluvium, the Fruitland coal seams, and the underlying PCS have been determined from the baseline groundwater monitoring. The results are presented in the subsequent subsections and show that the groundwater within and adjacent to the permit area is poor and suitable only for marginal livestock use based on the relevant groundwater use criteria listed Table 18-27. The use criteria in Table 18-27 are not enforceable standards with respect to groundwater and are included only as a reference for the suitability of the groundwater quality for domestic water supply and for livestock use. These use criteria are mostly derived from the Navajo Nation surface water quality criteria (NNEPA 2015) for domestic water supply and for livestock watering use. Lardy et al. (2008) provide relevant livestock watering criteria for TDS, sulfate, and fluoride but do not provide a livestock use criterion for chloride. Selenium concentrations in these waters often exceed the aquatic and wildlife habitat criteria and TDS, sulfate, and fluoride concentrations often exceed the corresponding aquatic and wildlife habitat as well as livestock use water quality criteria.

18.2.3.2.1 Alluvial Groundwater Quality

Quarterly samples were obtained in 1998, 2007, and 2008 from the two alluvial monitoring wells installed in Pinabete Arroyo. No samples were obtained from No Name well NNA-2 because the well was dry throughout the baseline monitoring program. Saturated conditions occurred during the latter half of 1998 at the No Name alluvial monitoring well NNA-1, located below the No Name Impoundment. Two quarterly samples were obtained from this well during this period. At other times during the baseline monitoring period this well was dry and no samples were obtained. The analytical results for the water quality samples from these wells are summarized below.

Water quality analytical results from quarterly monitoring at Pinabete Arroyo alluvial wells, PA-1 and PA-2, are provided in Table 18-28 and Table 18-29, respectively. These results show the water quality of the alluvium of Pinabete Arroyo to be a sodium-sulfate type with TDS concentrations ranging from 1,500 to 4,310 mg/L. The baseline and upstream data exhibit pH values between 7.2 and 7.9, with a median value of 7.5, suitable for stock use. The median total iron concentration was 3.54 mg/L, and the median total manganese level was 0.55 mg/L. Water within the alluvium is unsuitable for drinking water use due to TDS, sulfate, fluoride, iron, and manganese concentrations above secondary drinking water standards. The water is suitable for its current use for stock watering, although the TDS, sulfate, and fluoride concentrations usually exceed the Navajo Nation water quality criteria for livestock use and aquatic and

wildlife habitat use and selenium concentrations exceed the Navajo Nation water quality criteria for aquatic and wildlife habitat use.

Water quality analytical results in Table 18-30, from sampling of the No Name Arroyo alluvial well NNA-1, show the water to be a sodium-sulfate type similar to Pinabete Arroyo but with much higher sulfate, sodium, and TDS concentrations. Water quality within the alluvium downstream of the No Name Impoundment is unsuitable for either drinking water or livestock water use. With TDS levels far above the livestock criteria of 2,211 mg/L and sulfate far above livestock criteria of 1,000 mg/L, the water is not suitable for livestock use. The pH of the two samples collected at the site was 7.6, total iron ranged from 0.17 to 1.56 mg/L and total manganese concentrations ranged from 0.13 to 0.66 mg/L. The water from the No Name Arroyo alluvial well exceeds EPA secondary drinking water standards for total iron and manganese. No Name alluvial well sampling has resumed in 2025 although no the wells have been dry. Sampling will continue and data provided as supplementary prior to permit approval, or as requested by OSMRE.

The Navajo Mine has also completed several monitoring wells in the alluvium of Cottonwood Arroyo north of the No Name Mine permit area. The water quality monitoring results from these wells indicate poor water quality similar to the Pinabete alluvium. TDS concentrations at monitoring well QACW-2B, located near the mouth of Cottonwood Arroyo, ranged from 2,590 to 3,615 mg/L. This monitoring well is a stock water well that was converted to a monitoring well. The TDS and sulfate concentrations in the alluvial groundwater exceed the Navajo Nation water quality criteria for livestock and aquatic and wildlife habitat use, although the alluvial groundwater is still used for stock watering. Fluoride concentrations fluctuate in the alluvial groundwater and are often above the Navajo Nation water quality criteria for livestock, aquatic and wildlife habitat, and drinking water use. Selenium concentrations fluctuate in the alluvial groundwater and most often exceed the Navajo Nation water quality criteria for aquatic and wildlife habitat use.

18.2.3.2.2 Fruitland Formation Groundwater Quality

The No. 3 coal seam well KF-98-04, just north of the permit boundary, has been essentially dry throughout the baseline monitoring period, with the exception of about three ft of initial saturation following well completion. Although a sample was obtained from this well in March 1998 following well completion, it cannot be considered representative of baseline conditions because the well could not be purged. Through 2025, this well continues to produce very little water.

Water quality analytical results from the baseline sampling of the No. 3 coal seam well KF-98-02 are provided in Table 18-31 and 18-41. Results indicate some initial influence from drilling fluids or the annular grout seal in the first two samples from this well. The reduction in both the pH and calcium concentrations with subsequent sampling suggests the reduction of any influence from drilling fluids or

from the annular grout seal in subsequent samples from this well. The pH levels in this well have declined with time and the November 2007 results were within the range of 7 to 9 that is generally expected for the Fruitland coals within the San Juan Basin.

Based on the samples from the No. 3 coal seam well KF-98-02, the groundwater in the No. 3 coal seam at this location is a sodium-bicarbonate-chloride type, with TDS averaging 3,321 mg/L (Table 18-31). The ion composition results are consistent with the baseline coal water quality monitoring data at the Navajo Mine, although TDS concentrations are higher at the Navajo Mine wells as indicated in Table 18-32. Well KF-98-02 exhibited a range of pH between 7.5 and 8.1 between November 5, 2007 and November 20, 2008, in five samples. Previous pH results exceeded the livestock upper end criteria of 9.0, due to completion issues, as mentioned above. Total iron concentrations ranged from 0.1 to 1.0 mg/L and total manganese values ranged from 0.007 mg/L and 0.039 mg/L. Most of the samples exceed the EPA secondary drinking water standard for total iron of 0.3 mg/L. The TDS concentrations in water at this monitoring location also exceed the relevant criterion for livestock use of 3000 mg/L. Concentrations of TDS and chloride exceed the Navajo Nation water quality criteria for drinking water use with median values of 3,160 mg/L and 925 mg/L, respectively. Boron concentrations ranged from 0.09 mg/L to 1.47 mg/L, with a median value of 0.40 mg/L, exceeding the Navajo Nation water quality criteria for drinking water use of 0.63 mg/L. This well sampling has continued through 2025 and well data from 2011 – 2025 can be found in Table 18-41.

Table 18-32 provides median concentrations from baseline monitoring of coal wells at the Navajo Mine, with the exception of KF-84-20B. This well is completed in the No. 4 coal seam and is represented by a single data point. Samples collected in 1984 at monitoring wells SJKF-84-#2, SJKF-84-#3 and SJKF-84-#4 are considered to be baseline samples because these No. 8 coal wells are a sufficient distance down gradient of Navajo Mine to not be impacted by mining (Chapter 11, Navajo Mine PAP NM-0003I). The TDS concentrations in these downgradient wells ranged from 7,370 to 50,810 mg/L. Water quality monitoring data from the coal wells located within or adjacent to the Navajo Mine permit area also showed very high concentrations of TDS in the coal seam groundwater, with median concentrations at individual wells ranging from 2,770 mg/L to 13,400 mg/L. The concentrations of TDS, chloride, and sodium are lower in the No. 3 coal seam monitoring well KF-98-02 compared to the No. 3 coal seam monitoring well KF-84-21A (Table 18-32). Lower concentrations of these constituents would be expected at well KF-98-02 because it is located up gradient from well KF-84-21A and closer to the likely recharge source. The coal seam water quality results in Table 18-32 show that TDS concentrations increased with distance from the potential recharge areas, as TDS concentrations increased with depth at the nested well locations and increased from south to north toward the regional discharge location at the subcrop of the Fruitland Formation along the San Juan River Valley. Sulfate concentrations show spatial trends that are opposite of TDS with a general decrease in concentration with depth at the nested well locations and a decrease in concentration from south to north toward the regional discharge location along the San Juan River Valley.

Bicarbonate concentrations in the up gradient coal wells ranged from 800 to over 1,800 mg/L with pH ranging from 7.0 to 8.7. Freeze and Cherry (1979) note that for groundwater in this pH range to evolve such high bicarbonate concentrations, production of hydrogen ions is necessary. Production of hydrogen ions is believed to occur as a result of oxidation of sulfide minerals, which occur in the unoxidized coals and interburden of the Fruitland Formation. Oxidation of sulfide minerals also account for the gypsum precipitates in the weathered bedrock and higher sulfate concentrations in the shallow groundwater.

The coal seam water quality results in Table 18-32 show that TDS concentrations increase with depth and distance from the outcrop. Furthermore, TDS concentrations as high as 50,000 mg/L have been observed in the Fruitland coal units east of and down dip of the Navajo Mine permit area (NTEC 2009). The TDS concentrations ranged from 43,035 to 50,810 mg/L at monitoring wells SJKF-84-#2 and SJKF-84-#3 installed in the No. 8 coal down dip of the Navajo Mine as shown in Table 6-2 in Navajo Mine PAP submittal to OSMRE (NTEC 2021). The lower concentrations of TDS occur within close proximity to the coal outcrop, although concentrations of sulfate are higher near the outcrop and sulfate is generally absent down dip due to sulfate reduction.

Water quality analytical results from the baseline sampling of the No. 8 coal seam monitoring well KF-2007-01 are provided in Table 18-33. There was considerable fluctuation in the pH and in the concentrations of TDS and major ions observed in samples from this well. These fluctuations are not uncommon after completion of wells with very low rates of water production because it is not possible to fully develop the well. Stabilization of water quality parameters is expected to occur over time, similar to what has occurred at well KF-98-02. The pH has ranged from 8.1 to 9.6. Total iron concentrations have ranged from <0.1 to 1.2 mg/L and total manganese has ranged from <0.005 to 0.013 mg/L. Water quality within the No. 8 coal at this monitoring location within the No Name Mine area is unsuitable for drinking water due to concentrations of pH, TDS, chloride, fluoride, sulfate, and total iron that are above USEPA secondary drinking water quality criteria. The sulfate and TDS concentrations in coal water at this monitoring location often exceed the Navajo Nation Water Quality Criteria for livestock use.

Baseline monitoring of coal wells located within and adjacent to the permit area indicated that well yields at most locations would not be sufficient for use in livestock water supply. In limited locations where the coal wells may yield sufficiently to occasionally fill a stock tank, the water could provide marginal livestock use, although the recommended livestock criteria for TDS and sulfate are usually exceeded and well yields at most locations would not be sufficient to sustain pumping. The water quality would result in restrictions for use as a supply for young calves or as a long-term supply for cattle. The water in the coal units would not be suitable for drinking water due to elevated TDS, chloride, boron, and sulfate concentrations. Based on the trends observed from sampling at both the No Name Mine and the adjacent

Navajo Mine TDS, bicarbonate, and chloride appear to increase with depth and distance from the outcrop but sulfate concentrations appear to decrease.

There is an apparent trend of increasing TDS, chloride, and bicarbonate concentrations and decreasing sulfate concentrations toward the north-northeast in the direction of the potentiometric gradient. This trend appears in concentrations observed at the No. 8 coal seam well KF-84-22A in comparison with the concentrations observed at the No. 8 coal seam well KF-84-18B located north-northeast of well KF-84-22A. A similar trend is also observed in the comparison of results for the No. 3 coal seam well KF-98-02 with the downgradient No. 3 coal seam well KF-84-21A.

Groundwater chemistry changes or evolves along its flow path from the recharge area to the discharge area. Precipitation is low in TDS, is naturally weakly acidic, and contains bicarbonate due to the solution of carbon dioxide in the air. In this portion of the San Juan Basin, the precipitation reaching the ground is immediately neutralized and acquires sodium, sulfate, and other ions. Water that has only a short residence time in the ground is still typically high in TDS concentrations, with sodium, sulfate, and bicarbonate the dominant ions as indicated by both the surface water and alluvial groundwater samples. Calcium is also present due to dissolution of calcium carbonate, but at concentrations that are considerably lower than sodium. Chloride concentrations are typically lower near the recharge areas, although both chloride and TDS can vary with the spatial variation in recharge rates and frequency of leaching of salts from the unsaturated zone.

As groundwater migrates through the saturated zones it is no longer in contact with atmospheric carbon dioxide and its capacity to dissolve carbonates diminishes. The chemistry of the groundwater continues to evolve as other soluble minerals dissolve and cation exchange processes reduce the proportion of calcium and increase the proportion of sodium in solution. Sulfate reduction also occurs when groundwater transitions from oxidizing to reducing conditions, particularly within the coals.

18.2.3.2.3 Pictured Cliffs Sandstone Groundwater Quality

Groundwater quality data from monitoring wells located within and adjacent to the permit area indicate the groundwater in the PCS has high TDS concentrations, ranging from 5,000 mg/L to over 9,000 mg/L. Sulfate is the dominant anion, although the concentrations of chloride and bicarbonate are also relatively high. Sodium is the dominant cation. Magnesium and calcium concentrations are quite low and are typically less than the potassium concentrations, although potassium was not included in the samples from the GM wells that were collected during the 1970s. Generally, water quality changes were observed in the first few samples obtained from monitoring wells, apparently due to the difficulty in developing these low-yield wells. Thus, samples obtained after the initial two samples are believed to provide a better

representation of baseline conditions. The high concentrations of TDS, sulfate, chloride, and boron in the water from the PCS within the permit area preclude its use for domestic purposes. The PCS is also a poor source for livestock watering due to the very high TDS and sulfate concentrations, and low permeability and low yield, as stated in Section 18.2.3.1.3. The TDS and sulfate concentrations are lower in the water in the alluvium of Pinabete Arroyo, making it a better source for livestock use, although the TDS and sulfate concentrations are still often above the relevant criteria for livestock use. Details of the results from all monitored wells follow.

Water quality analytical results from the baseline sampling of PCS well KPC-98-01 are provided in Table 18-34 and 18-41. When the initial sample was collected from PCS monitoring well KPC-98-01 in 1998, it showed some influence of drilling fluids based on the low TDS, sulfate, and chloride, and higher pH and nitrate observed (Table 18-34). It is suspected that the well was not fully developed due to low permeability and limited saturation. Sampling results starting in 2007 are more consistent and representative of baseline conditions within the PCS at this location. Based on the samples, the groundwater in the PCS at this location is a sodium-sulfate-bicarbonate type with TDS above 6,000 mg/L. Data acquired between 2007 and 2008 exhibited a pH range of 7.7 to 7.9, suitable for all uses. Data from the same period exhibited total iron levels ranging from 0.2 to 29.5 mg/L and total manganese levels ranging from 0.044 to 0.183 mg/L. More than half of the samples exhibited secondary drinking water use limitations associated with total iron and total manganese.

The ion composition results in water samples from well KPC-98-01 are consistent with the results from well KPC-2007-01 (Table 18-35). TDS concentrations are quite similar at the two PCS wells with concentrations at well KPC-2007-01 slightly below 6,000 mg/L and concentrations at well KPC-98-01 slightly above 6,000 mg/L. The groundwater in the PCS at these two locations is unsuitable for either domestic or livestock use due to the high TDS and sulfate concentrations.

Water quality monitoring data for the PCS were also available from samples collected during the mid-1970s from five wells that were completed in the PCS within or adjacent to the mining lease. The locations for these PCS monitoring wells are shown on Exhibit 18-4.

Water quality analytical results of the baseline samples from PCS monitoring well GM-21, located within Area 5, are provided in Table 18-36. The water quality results are consistent with the results from wells KPC-98-01 and KPC-2007-01. The groundwater is a sodium-sulfate-bicarbonate type with TDS above 6,000 mg/L. TDS and sulfate concentrations would pose limitations to livestock use. The pH ranged from 7.0 to 7.9, values which are not limiting for any uses. Total iron and total manganese were each collected once and measured 0.4 mg/L and 0.11 mg/L, respectively. Assuming the manganese value was representative, the water from this well exceeds secondary drinking water standards.

Historic baseline water quality results from PCS monitoring well GM-20 are summarized in Table 18-37. This well was located within the center of Area 4 South. These results indicate TDS concentrations between 5,033 and 5,880 mg/L, which are comparable with results from the other PCS monitoring wells. The groundwater in the PCS at this location is a sodium-sulfate-chloride-bicarbonate type, with higher chloride concentrations than other nearby PCS monitoring wells. The earlier samples from this well also show an elevated groundwater pH. It is possible this well also encountered some influence of grout intrusion that was not removed during well development or grout curing, as the pH influence does not appear in the later samples from this well. A single sample in September 1979 was analyzed for total iron and total manganese; levels were 0.01 mg/L and 0.29 mg/L, respectively. The total manganese concentration exceeded the secondary drinking water standard of 0.05 mg/L.

Baseline water quality data for PCS monitoring well GM-19 are summarized in Table 18-38. This well was located north of the No Name Mine site, within Area 4 North. The resulting water type is similar to the water type from PCS monitoring well GM-20, although TDS concentrations are higher, ranging between 7,810 and 9,270 mg/L, with corresponding higher concentrations of sulfate, chloride, sodium, and bicarbonate. Sulfate concentrations ranged between 3,685 and 4,535 mg/L. The Pictured Cliffs Sandstone represented by this location would pose limitations for stock use due to the elevated TDS and sulfate concentrations. The pH ranged from 7.5 to 8.1, posing no limitations for use. A single sample in September 1979 was analyzed for total iron and total manganese with levels of 0.01 mg/L and 0.11 mg/L, respectively. Total manganese, chloride, sulfate, and TDS exceed secondary drinking water use criteria.

Baseline water quality data for PCS monitoring well GM-30A are provided in Table 18-39. This well was located on the west side of the No Name Mine area, within Area 5. The results indicate a sodium-sulfate-chloride type with TDS concentrations between 6,573 and 7,070 mg/L, and are comparable with the results from PCS monitoring wells within the No Name Mine area. The pH ranged from 7.5 to 7.6 in three samples. The ion balance in the first sample from this well was poor but improved in the second sample. Anion-cation balances greater than ± 0.10 are often an indicator of poor quantitative results. Sometimes, a lack of ion balance can be explained by the presence of high metals in acidic waters or soluble silica in alkaline waters that may not have been considered in calculating the ion balance. However, in this case, it appears that the lack of balance is the low sulfate concentration reported in the first sample which appears, is erroneous. All the other major ions were consistent between the two samples. Total iron, 0.02 mg/L, and total manganese, 0.05 mg/L, are reported from a September 1979 sample both meeting the secondary drinking water standards.

The water sample results from well GM-28 are not included in this report because the ion balance was poor with 37% and 48% difference in the two samples. This well was located north of the permit area, as shown

in Exhibit 18-4. Despite the poor ion balance, results for TDS are meaningful. The TDS concentrations in the samples from this well ranged from 4,334 to 6,580 mg/L. These results are consistent with the TDS concentrations observed at other PCS monitoring wells within the No Name Mine and slightly lower than the TDS concentration observed at well GM-19, north of the permit area.

18.2.4 Groundwater Resources Information Collection and Analysis

The baseline groundwater evaluation included a review of reports and data concerning groundwater resources of the region from New Mexico and federal agencies as well as the information provided in the PAP and the groundwater monitoring reports for the NTEC's Navajo Mine and CONSOL Energy's Burnham Mine. NTEC has also conducted extensive drilling within the permit area which, together with data from the adjacent Navajo Mine and the nearby Burnham Mine, provide information about the geology and groundwater hydrology of the permit area and surrounding areas. NTEC also completed a groundwater monitoring program in 1998 and in 2007 and 2008 to obtain site-specific information on groundwater levels, aquifer characteristics, and groundwater quality for the No Name project at eight well locations within and adjacent to the No Name Mine permit area. The focus of this baseline monitoring program encompassed areas within and adjacent to the permit area.

An inventory of permitted wells and springs was conducted based on information from several sources, including the NMOSE (2010) Navajo Settlement Agreement, the inventory of wells and springs conducted by BIA in 1987 for the Navajo Mine, wells identified in the "Groundwater Operations Manual and Well Survey for Navajo Mine and Vicinity" that was completed by Metric Corporation (1991), wells found in review of permits on file at the Navajo Nation Water Resource Management office in Fort Defiance, Arizona, and a site reconnaissance for springs, seeps, and wells located within the permit area and adjacent area. Some of the data used in the discussion of baseline were collected by other companies or organizations for other projects. As a result, the particular analytes considered and the associated detection limits may be slightly different from those included in NTEC's baseline monitoring in 2007 and 2008. Efforts have been made to address these differences within the discussion of the data or in the tables used to report the results. Quality assurance and quality control information for the 2007 to 2008 groundwater data is provided in Appendix 18-G. In 2025, NTEC conducted an additional inventory of springs and wells withing, and adjacent to, the permit area and the inventory has been updated based on the recent survey. NTEC utilizes Energy Laboratories Inc. for water quality laboratory results. The Energy Laboratories Inc. Corporate Quality Assurance Manual is in Appendix 18-H.

18.3 Hydrologic Model

Groundwater models are useful to support the interpretation of baseline hydrogeologic information. Furthermore, groundwater models are required for the predictive evaluations needed to prepare a probable hydrologic consequence (PHC) assessment of proposed mining and reclamation activities. Groundwater

models used for a PHC assessment can range from simple empirical equations to complex numerical computer simulations of groundwater flow and chemistry.

Site-specific data or data representative of the site conditions are needed to apply groundwater models. Extrapolation of data from adjacent or nearby areas or using typical values for parameters from similar hydrogeologic environments is acceptable when the similarity of the areas is established. Numerical groundwater flow models can help to develop a better understanding of the hydrogeologic system, including the groundwater flow relationships between hydrogeologic units and between surface water and groundwater. Model calibration can also serve to revise the conceptual model of the groundwater system and provide a better assessment of the properties of hydrogeologic units on a regional scale that cannot be obtained solely from local pumping testing results.

The first step in developing a groundwater model is to establish the objectives of the study. Specific objectives of the groundwater model are as follows:

- Provide a better understanding of the baseline groundwater flow systems within and adjacent to the permit area.
- Predict the steady state groundwater flow system that is expected to occur long after mining and reclamation activities have been completed in the area.
- Predict the transient groundwater changes that are expected during and after mining.

18.3.1 Groundwater Model Development

A multilayer, numerical, groundwater flow model has been developed to model the groundwater flow systems within and adjacent to the permit area. A detailed presentation of the numerical groundwater flow model is included in Section 41 (Probable Hydrologic Consequences). This report includes a description of the conceptual model of the groundwater flow system. A conceptual groundwater model is a complex hypothesis of the characteristics and functions of a hydrogeologic system, including recharge and discharge relationships, groundwater flow within and between hydrogeologic units, and the expected properties of these hydrogeologic units. An essential part of both the conceptual and numerical models is a graphical representation of the horizontal and vertical boundaries of the hydrogeologic system (the model domain) and the delineation of the hydrogeologic units within the model domain that are believed to have the primary controlling influence on groundwater flows. Another element of the conceptual model is to define, to the extent possible, the properties of these hydrogeologic units including the thickness, hydraulic conductivities, and storage characteristics across the model domain. The conceptual model also includes the hydrogeologist's understanding of spatial relationships between and approximate rates of recharge and discharge, including the groundwater inflows and outflows from the model domain.

One conceptualization of the hydrogeology of the permit area is to consider the Fruitland Formation as a single hydrogeologic unit. The single hydrogeologic unit approach was previously proposed by Billings and Associates (1987) for modeling groundwater at the Navajo Mine because of the complexity of the individual coal seams, which often split or pinch out. However, the interbedded strata and coal beds have a significant influence on the hydrogeology of the Fruitland Formation. Although the hydraulic conductivities of the coals are relatively low, they are still considerably higher than those of the interbedded shales, resulting in large vertical potentiometric gradients among the coals within the No Name Mine area. One of the primary hydrogeologic changes to occur as a result of mining is the removal of the coal and the interbedded shales and sandstone strata, resulting in more homogeneous and isotropic conditions within the mine backfill. Furthermore, water chemistry has been found to vary among the individual coal units within the Fruitland Formation. Typically, TDS concentrations increase with depth, while sulfate concentrations decrease with depth.

Although the coal geology is complex with multiple coal bed splits and pinch outs, there is good correlation and spatial continuity for particular coal zones, or seams, at the No Name permit area and adjacent Navajo and Pinabete areas. These coal seams may feature one coal bed, or they may include splits with multiple coal beds. For these reasons, the conceptual hydrogeologic model and the numerical groundwater model for the No Name permit area and adjacent area handle the individual coal zones, or seams, as separate and distinct hydrogeologic units. The PCS, the first hydrogeologic unit below the Fruitland Formation, has been included in the groundwater flow model. The top of the Lewis Shale, below the PCS, has been included as the base of the model domain. The delineation of these hydrogeologic units within the No Name permit area was created from the extensive geologic and groundwater information developed for the project. Information was also obtained from a variety of sources to help delineate the hydrogeologic units and define groundwater conditions for the portions of the model domain that are beyond the limits of the No Name permit area.

18.3.2 Baseline Groundwater Model Results

The multilayer groundwater model was calibrated to obtain a good match with potentiometric surfaces and water levels established from the baseline groundwater studies while maintaining consistency with the site-specific recharge estimates from Stone (1986) and the range of hydraulic conductivities associated with each hydrogeologic unit. During model calibration, hydraulic conductivities were applied only for the entire hydrogeologic unit and not spatially within a unit. Without a consistent geologic basis, spatial adjustments in hydrologic conductivities would lead to over-parameterization of the model to match modeled potentiometric levels with observed values. Although some of the differences between the modeled and observed potentiometric levels may be associated with spatial variation in hydrogeologic properties within a hydrogeologic unit, the chosen method for model calibration allows for the overall

groundwater flow within each hydrogeologic unit and between units to be represented by the calibrated groundwater model.

Generally, a shale zone such as the Lewis Shale would be considered as an impermeable boundary. However, given the low recharge rates of the permit area, the overall low permeability of the Fruitland Formation shales and coals, and the relatively low permeability of the PCS, the flow conditions at the boundary between the PCS and Lewis Shale were found to be significant for calibrating the groundwater flow model. Providing for downward flow from the PCS into the Lewis Shale was required in order to reach an adequate calibration with recharge rates consistent with the measurements from Stone (1987). Downward flow and downward gradients are also indicated by hydrogeologic studies and tests of the Lewis Shale and the PCS immediately west of the permit area (Science Application, Inc. 1979).

Table 18-40 shows the relationship between the modeled recharge rates and the measurements by Stone (1987). Outside of the alluvial valleys, recharge rates were adjusted by slope within the range of estimates from Stone (1987) for badland areas and for upland flats. The modeled potentiometric surface for the PCS, the No. 3 coal seam, and the No. 8 coal seam are provided in Figure 18-11, Figure 18-12, and Figure 18-13, respectively. These results are consistent with the potentiometric surfaces developed from baseline monitoring in Section 18.2.4. However, the modeled potentiometric surfaces extend beyond the limits that could be depicted from well measurements. These potentiometric surfaces and flow patterns are consistent with the conceptual model and all the geologic and hydrogeologic information and the specified boundary conditions.

The results in Figure 18-11 show a component of groundwater flow from the PCS to the topographic lows along the west side of the model domain in the valleys of Brimhall Wash, No Name Arroyo, Pinabete Arroyo, and Cottonwood Arroyo. Although portions of the PCS along the western outcrop remain unsaturated, as indicated in Figure 18-11, the model estimates potentiometric elevations for these unsaturated zones.

The results for the No. 3 coal seam in Figure 18-12 also show a component of groundwater flow to the topographic lows along the west side of the model domain in the valleys of No Name Arroyo, Pinabete Arroyo, and Cottonwood Arroyo. The No. 3 coal seam is not present over a portion of the Brimhall Wash drainage or along the western portion of the model domain. Also, the No 3 coal seam is unsaturated in areas along the western outcrop and remains unsaturated in the modeled potentiometric surface as indicated in Figure 18-12. A similar pattern is observed in Figure 18-13 for the No. 8 coal seam, although this coal is not present over a large portion of the Brimhall drainage or within a large portion of the No Name and Pinabete Arroyo valleys within the permit area. In addition to the flow toward the topographic lows, there is a component of flow down dip to the northeast. Portions of the No. 8 coal seam near the western outcrop

are unsaturated, as shown in Figure 18-13. Not shown in these figures for individual hydrogeologic units are the overall downward gradients and downward flow between units. In fact, the model predicts perched groundwater conditions in the shallower coals along the western portion of the permit areas as depicted by the north-south section in Figure 18-14.

The calibrated numerical model helps confirm the conceptual model. The numerical model is well constrained and consistent with the recharge rates measured by Stone (1987) and with the hydraulic conductivities and heads measured within the various hydrogeologic units in the model domain.

In 2025, NTEC incorporated new data into the model, which was built by Barr Engineering. The new model is covered extensively in Section 41 of this PAP.

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Table 18-1 Watershed Areas for NTEC Stations and USGS Gages Near NMEP

Name of watershed / description of location	Watershed (sq miles)			USGS gage
	Upstream of permit boundary	Upstream of exit from permit boundary	Entire watershed	
Drainages intersecting permit area upstream and downstream				
No Name Arroyo	1.8	8.8	11.5	NA
Pinabete Arroyo	43.9	55.5	60.3	NA
Drainages receiving flows from permit area	Area within permit boundary			
Brimhall Wash	2.81		85.2	NA
Cottonwood Arroyo	0.57		79.8	NA
Unnamed tributary to Chaco River 1	1.01		3.4	NA
Unnamed tributary to Chaco River 2	0.86		2.8	NA
Unnamed tributary to Chaco River 3	0.86		2.2	NA
Regional gages				
Teec-Ni-Di-Tso Wash	-	-	7.2	9367934
Burnham Wash	-	-	8.6	9367936
Chaco River	218.75		3,640	9367938
San Juan River at Farmington, NM	-	-	7,240	9365000
San Juan River at Shiprock, NM	218.75		12,900	9368000

Table 18-2: Baseline Peak Flow Measurements on Pinabete Arroyo and No Name Arroyo in 1997, 1998, 2007, and 2008

Monitoring period	Peak Flow Measurement - Q (cfs)			
	Pinabete Arroyo upstream (upper Pinabete)	Pinabete Arroyo downstream (lower Pinabete)	No Name Arroyo upstream (upper No Name)	No Name Arroyo downstream (lower No Name)
Nov. 1997	0	0	0	0
Dec. 1997	0	0	0	0
Jan. 1998	0	0	0	0
Feb. 1998	0	0	0	0
Mar. 1998	0	0	0	0
Apr. 1998	0	0	0	0
May 1998	0	0	0	0
June 1998	0	0	0	0
July 1998	22.5	1717	1.5	0
Aug. 1998	1079	2307	*	*
Sept. 1998	0	4.9	9.5	74
Oct. 1998	1073**	119**	17.7**	38.8**
Nov. 1998	308	145	3.9	9.9
Dec. 1998	0	0	0	0
Aug. 2007	0.68	-	-	111.06
Oct. 2007	2.04	16.41	0.73	5.66
Dec. 2007	2.04	36.32	0.73	2.62
Feb. 2008	4.46	24.05	19.14	10.19
July 2008	7.53	46.62	NA	11.64
Aug. 2008	0.22	0.44	NA	0.00

Q - runoff rate
cfs - cubic feet per second
* Site could not be accessed on 8/26/98. Measurement taken in September is likely due to the storm on 8/21/98.
** October flows determined from measurements taken on 11/7/98.

Table 18-3: Comparison of Average Annual Flows at Five Regional USGS Gages for Selected Years Between 1978 and 2007

	Teec-Ni-Di-Tso Wash	Burnham Wash	Chaco River	San Juan at Farmington	San Juan at Shiprock	Flow distribution quartile
Area (sq miles)	7.2	8.6	3640	7,240	12,900	
USGS ID	9367934	9367936	9367938	9365000	9368000	
Selected years						
1978	0.072	0.657	15.2	1303	1186	25%-50%
1979	0.207	0.333	77.7	3574	3706	75%-100%
1980	0.121	0.132	10.7	2475	2588	50%-75%
1981	0.029	0.058	7.35	1276	1309	25%-50%
1982	0.337	0.396	19.1	1967	1940	50%-75%
1998	ND	ND	ND	2036	1760	50%-75%
2007	ND	ND	ND	1782	1838	25%-50%

Lowest Quartile	1990
25%-50%	1978, 1981, 1991, 2007
50-75%	1980, 1982, 1992, 1994, **1998 (close to average)**
Top Quartile	**1979 (very high)**, 1993, 1995

ND - No data collected; gages not operated after 1983 water year

Source: USGS 2009

Table 18-4: SEDCAD™ 4 Estimated Peak Discharge and Sediment Yield at Surface Water Monitoring Stations

Watershed location	SEDCAD designation	2yr-6hr event (0.85 inches)		10yr-6hr event (1.28 inches)		10yr-24hr event (1.7 inches)		25yr-6hr event (1.56 inches)		50yr-6hr event (1.79 inches)		100yr-6hr event (2.04 inches)	
		Peak discharge (cfs)	Sediment yield (tons)	Peak dscharge (cfs)	Sediment yield (tons)	Peak discharge (cfs)	Sediment yield (tons)	Peak discharge (cfs)	Sediment yield (tons)	Peak discharge (cfs)	Sediment yield (tons)	Peak discharge (cfs)	Sediment yield (tons)
Pinabete upstream	Structure 6	406.0	2,250.6	1,124.3	8,093.3	1,694.1	15,104.2	1,714.7	13,702.7	2,252.5	19,063.8	2,879.3	25,543.8
Pinabete downstream	Structure 8	395.7	2,146.9	1,099.2	7,808.1	1,701.5	14,698.1	1,677.5	13,103.4	2,203.7	18,151.3	2,816.9	24,239.3
No Name upstream	Structure 2	54.18	68.8	231.18	302.1	280.33	494.6	297.02	461	400.79	644.6	522.95	868.3
No Name downstream	Structure 5	113.85	290	563.64	1543.5	624.8	1875.5	660.92	1781.2	870.11	2427.5	1021.67	3091.3
Brimhall tributaries downgradient of Area 5	Structure 7	113.92	122.6	293.41	367.8	416.52	618.9	434.97	578.9	560.86	775.8	705.27	1009.6
Brimhall tributaries draining NMEP	Structure 9	132.12	237.7	350.41	751.6	501.77	1283.5	525	1199.1	681.42	1619.1	862.62	2120
Brimhall at the Confluence	Structure 12	424.62	4305	1197.76	14286.1	1866.78	24877.7	1824.37	23161.2	2390.53	31496.6	3047.08	41272.4
Chaco trib 1, pre-mine	Structure 3	74.91	289.6	216.06	988.4	315	1723.8	330.44	1609.3	433.26	2195.4	553.7	2902.5
Chaco trib 2, pre-mine	Structure 3	131.44	425.7	355.9	1271.9	509.61	2063.4	537.85	1999	701.94	2660.8	891.87	3364.8
Chaco trib 3, pre-mine	Structure 3	71.05	132.5	247.39	554.1	376.22	1023.6	396.85	949.1	535.69	1334.9	698.88	1803.4

cfs - cubic feet per second

Table 18-5: Peak Discharge Estimates for Watersheds Based on Drainage Area Using Regional Equations

	Discharge area (mi^2) A	Average basin elevation (ft msl) E	Average basin slope (%) S	Peak discharge (cfs)						
				Q2	Q5	Q10	Q25	Q50	Q100	Q500
No Name Arroyo	11.5	5503.77	1.54	293.9	1,943.5	3,361.2	6,455.9	9,481.8	13,763.8	27,067.9
Pinabete Arroyo	59.1	5880	1.82	568.0	3,328.8	5,478.7	9,972.0	14,133.5	19,820.6	36,596.3
Brimhall Wash	84.9	5802.06	1.78	682.5	3,879.8	6,324.1	11,378.2	15,991.3	22,245.5	40,451.9

Source: Waltemeyer 2006

mi^2 - square mile
ft msl - feet above mean sea level
cfs - cubic feet per second
Q - runoff rate

Table 18-6: Average Monthly Flow, Maximum Daily Flow, and Number of Zero Flow Days at USGS 09367934, Teec-Ni-Di-Tso Wash near Burnham, New Mexico

Year	Monthly mean discharge (cfs) (calculation period: October 1977 to September 1982)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1977	-	-	-	-	-	-	-	-	-	0.046	0.088	0
1978	0	0	0	0.04	0.349	0	0	0.035	0.297	0.084	0.271	0.604
1979	1.41	0	0.008	0.004	0.019	0.024	0	0.023	0.003	0.071	0.173	0
1980	0.721	0.236	0	0	0.048	0	0	0.194	0.001	0	0	0
1981	0	0	0.115	0.077	0	0.007	0.12	0.006	0.026	0.081	0.064	0
1982	0	1.44	0.077	0.033	0.189	0	0.047	2.18	0.002	-	-	-
Mean of monthly discharge (cfs)	0.43	0.34	0.04	0.03	0.12	0.01	0.03	0.49	0.07	0.06	0.12	0.12
Avg. max daily flow (cfs)	3.6	2.2	0.58	0.24	1.2	0.13	0.36	10	0.66	0.48	0.76	1.3
Zero flow days	10	15	25	24	21	27	23	21	20	23	16	25

cfs - cubic feet per second

Source:

USGS

Table 18-7: Average Monthly Flow, Maximum Daily Flow, and Number of Zero Flow Days at USGS 09367936, Burnham Wash near Burnham, New Mexico

Year	Monthly mean discharge (cfs) (calculation period: October 1977 to September 1982)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1977	-	-	-	-	-	-	-	-	-	0.292	0.325	0
1978	0.173	0.068	0.1	0.181	5.48	0	0	0.053	1.13	0.409	1.53	0.366
1979	1.54	0	0.012	0.005	0.029	0.036	0	0.035	0.005	0.071	0.225	0.039
1980	0.418	0.394	0.007	0.006	0.068	0	0.005	0.278	0.087	0.01	0	0
1981	0	0	0.248	0.067	0.009	0.053	0.16	0.004	0.141	0.232	0.059	0
1982	0	2.81	0.117	0.061	0.194	0	0	1.46	0.001	-	-	-
Mean of monthly discharge	0.43	0.65	0.1	0.06	1.2	0.02	0.03	0.37	0.27	0.2	0.43	0.08
Avg. max daily flow	4.8	1.9	0.91	0.8	14	0.2	0.4	5.1	3.6	2.3	2.8	1.4
Zero flow days	7	7	14	20	17	26	26	22	18	17	17	25

cfs - cubic feet per second

Source:

USGS

Table 18-8: Average Monthly Flow, Maximum Daily Flow, and Number of Days of Zero Flow at USGS 09367938, Chaco River near Burnham, New Mexico

Year	Monthly mean discharge (cfs) (calculation period: October 1977 to September 1982)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1977	-	-	-	-	-	-	-	-	-	0	4.84	0
1978	0.081	7.45	14.1	0	50.4	0	0.077	3.28	102.8	18	109.8	39.9
1979	309	275.6	81.6	30.9	20.2	9.06	0.791	51.2	0	8.24	4.85	0
1980	14.9	40.4	0	18	27.7	0	0.055	0	15.4	0.365	0	0
1981	0	0	5.05	0.138	0	34.2	31.1	0	17.3	56.6	0.083	0
1982	0	0	21.3	8.82	0.952	0	0.33	129.1	8.03	-	-	-
Mean of monthly discharge	65	65	24	12	20	8.7	6.5	37	29	17	24	8
Avg. max daily flow	782	424	198	61	211	191	63	292	320	280	140	120
Zero flow days	8	1	0	0	3	23	7	0	3	18	5	20

cfs - cubic feet per second

Source:

USGS

Table 18-9: Days with Flow and Average Monthly Zero Flow Days at Site N (Upstream) and Site M (Downstream) on Burnham Wash between 1 October 1977 and 31 May 1980

Site N

Month/Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1977	-	-	-	-	-	-	-	-	-	0	3	0
1978	0	0	4	3	8	0	2	10	9	8	5	3
1979	4	0	0	0	2	2	1	1	0	1	0	0
1980	2	1	0	0	0	-	-	-	-	-	-	-
Average zero flow days	28	28	27	28	28	28	28	21	21	26	23	28

Site M

Month / Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1977	-	-	-	-	-	-	-	-	-	0	0	0
1978	0	0	0	0	4	0	0	0	3	3	3	0
1979	3	0	0	0	2	0	3	0	0	2	6	0
1980	0	5	0	0	0	-	-	-	-	-	-	-
Average zero flow days	28	24	29	30	20	30	28	28	22	23	20	31

Source:
Brimhall Watershed Flows from Hydrologic_Monitoring_Program_1978.pdf from CONSOL Energy's Burnham Mine SMCRA Permit (OSM permit number NM-005)

Table 18-10: No Name Impoundment Staff Gage Readings from 1998

Date	Staff gage reading (ft)
11/17/1997	Thin ice
5/12/1998	2
6/11/1998	1.04
7/21/1998	dry
7/29/1998	> 5.0
8/20/1998	> 5.0
8/26/1998	> 5.0
9/30/1998	5
10/15/1998	4.2
11/7/1998	3.8
12/17/1998	3.7

Table 18-11: Baseline Water Quality Analytes with Applicable Water Quality Standards, Methodologies, and Method Detection Levels

Analyte	Water quality standard	Methodology	MDL
Alkalinity as CaCO3 (mg/L)		2320B	10
Aluminum, D (mg/L)	0.087(D) (AqHbt)	200.7	0.10
Aluminum, T (mg/L)	0.5 (T) (L&W)	200.7	0.10
Arsenic, D (mg/L)	0.15 (AqHbt)	200.8	0.0005
Arsenic, T (mg/L)	0.42 (ScHC); 0.02 (L&W)	200.8	0.0005
Barium, D (mg/L)		200.8	0.0005
Barium, T (mg/L)	98 (ScHC); 10 (L&W)	200.8	0.0005
Bicarbonate as CaCO3 (mg/L)		2320B	10
Boron, D (mg/L)	126 (ScHC); 5 (L&W)	200.7	0.1
Cation anion balance (CAB) (%)		Calc.	
Cadmium, D (mg/L)	(AqHbt)a, 0.05(L&W)	200.8	0.00005
Calcium, D (mg/L)		200.7	0.5
Carbonate as CaCO3 (mg/L)		2320B	10
Chloride (mg/L)	600 (L&W)	4500Cl	10
Chromium, D (mg/L)	(AqHbt)b, 1(L&W)	200.8	0.001
Cobalt, D (mg/L)	1 (L&W)	200.8	0.00005
Electrical conductivity (EC) (µs/cm)		2510B	1.0
Copper, D (mg/L)	(AqHbt)c, 0.5(L&W)	200.8	0.0001
Fluoride (mg/L)	2 (L&W)	4500F C	0.2
Hardness (calc)		Calc.	
Hydroxide as CaCO3 (mg/L)		2320B	10
Iron, D (mg/L)		200.7	0.05
Iron, T (mg/L)		200.7	0.05
Lead, D (mg/L)	(AqHbt)d, 0.1(L&W)	200.8	0.0001
Magnesium, D (mg/L)		200.7	0.5
Manganese, D (mg/L)		200.7	0.005
Manganese, Tal (mg/L)		200.7	0.005
Mercury, D (mg/L)		245.1000	0.0002
Mercury, T (mg/L)	0.42 (ScHC); 0.01 (L); 0.000012 (AqHbt,W)	245.1	0.0002
Nitrate/Nitrite as N (mg/L)	100 (L&W)	353.3	0.02
pH (su)	6.5 -9 (ScHC, AqHbt)	150.1	0.1
Phosphorous, T (mg/L)		365.3	0.05
Potassium, D (mg/L)		200.7	0.5
Radium 226 (pCi/L)		7500-Ra B	1.0
Radium 228 (pCi/L)	30 (Ra-226 + Ra-228) (L&W)	7500-Ra D	1.0
Selenium, D (mg/L)	0.05 (L)	200.8	0.001
Selenium, T (mg/L)	7 (ScHC); 0.002 (AqHbt); 0.002 (W)	200.8	0.001
Settleable Solids (mL/L)		160.5	0.5
Silver, D (mg/L)	(AqHbt)f	200.8	0.00005
Sodium adsorption ratio (SAR)		Calc.	
Sodium, D (mg/L)		200.7	0.5
Sulfate (mg/L)	1000 (L&W)	4500SO4	10
Total dissolved solids (TDS) (mg/L)	2212 (L&W)	2540 C	10
Total suspended solids (TSS) (mg/L)		160.2	2
Vanadium, D (mg/L)	0.1 (L&W)	200.8	
Zinc, D (mg/L)	(AqHbt)g, 25(L&W)	200.8	0.001

L&W - Livestock & wildlife

Table 18-11: Baseline Water Quality Analytes with Applicable Water Quality Standards, Methodologies, and Method Detection Levels

Analyte	Water quality standard	Methodology	MDL

AqHbt - Aquatic habitat
ScHC - Secondary human contact
D - Dissolved
T - Total
cfs - cubic feet per second
mg/L - milligrams per liter
µs/cm - microsiemens per centimeter
su - standard units
pCi/L - picocuries per liter

Suspended sediments: The following water quality standard for suspended sediment concentration, expressed as a geometric mean (four-sample minimum) shall not be exceeded. The standard applies only to a surface water that is at or near base flow and does not apply to a surface water during or soon after a precipitation event:

AqHbt 80 mg/L

Turbidity: Turbidity attributable to other than natural causes shall not reduce light transmission to the point that the normal growth, function, or reproduction of aquatic life is impaired or that will cause substantial visible contrast with the natural apperance of the Navajo Nation Surface Water Quality Standards Navajo Nation EPA Water Quality Program water. Turbidity shall not exceed 10 Nephelometric Turbidity Units (NTU) over background turbidity when the background turbidity is 50 NTU or less, or increase more than 20 percent when the background turbidity is more than 50 NTU. Background turbidity shall be measured at a point immediately upstream of the turbidity-causing activity.

Aquatic hardness equations
a - Cadmium (dissolved)
  acute: [e (1.0166 [ln (hardness)] - 3.924)][1.136672-[ln (hardness)](0.041838)]
  chronic: [e (0.7409 [ln (hardness)] - 4.719)][1.101672-[ln (hardness)](0.041838)]
b - Chromium III (dissolved)
  acute: [e (0.8190 [ln (hardness)] + 3.7256)] 0.316
  chronic: [e (0.8190 [ln (hardness)] + 0.6848)]0.860
c - Copper (dissolved)
  acute: [e (0.9422 [ln (hardness)] - 1.700)]0.960
  chronic: [e (0.8545 [ln (hardness)] - 1.702)]0.960
d - Lead (dissolved)
  acute: [e (1.273 [ln (hardness)] - 1.460)][1.46203-[ln (hardness)](0.145712)]
  chronic: [e (1.273 [ln (hardness)] - 4.705)][1.46203-[ln (hardness)](0.145712)]
e - Nickel (dissolved)
  acute: [e (0.8460 [ln (hardness)] + 2.255)]0.998
  chronic: [e (0.8460 [ln (hardness)] + 0.0584)]0.997
f - Silver (dissolved)
g - Zinc (dissolved)
  acute: [e (0.8473 [ln (hardness)] + 0.884)]0.978
  chronic: [e (0.8473 [ln (hardness)] + 0.884)]0.986

Sample ID	Sample date	Flow (cfs)	Alkalinity as CaCO3 (mg/L)	Q	Aluminum, D (mg/L)	Q	Arsenic, D (mg/L)	Barium, D (mg/L)	Bicarbonate as CaCO3 (mg/L)	Q	Boron, D (mg/L)	Cation anion balance (CAB) (%)	Q	Cadmium, D (mg/L)	Calcium, D (mg/L)	Q	Carbonate as CaCO3 (mg/L)	Q	Chloride (mg/L)	Q	Chromium, D (mg/L)	Electrical conductivity (EC) (µS/cm)
Upper Pinabete [1]	7/29/1998	22.50	-		-		-	-	207		0.06	-		-	39	<	1		9		-	930
Upper Pinabete [1]	8/26/1998	1079	-		-		-	-	178		0.09	-		-	73	<	1		32		-	1640
Upper Pinabete [1]	9/30/1998	-	-		-		-	-	269		0.09	-		-	65	<	1		24		-	1460
Upper Pinabete [1]	11/7/1998	308	-		-		-	-	156		0.07	-		-	24	<	1		10		-	880
Upper Pinabete #3	10/8/2007	2.04	116		0.28		0.0084	0.0313	114		0.30	0.19	<	0.00005	15	<	10		10	<	0.001	584
Upper Pinabete #3	12/3/2007	2.07	119	<	0.10		0.015	0.0388	117	<	0.10	3.22	<	0.00005	22.1	<	10		10	<	0.001	962
Upper Pinabete grab [2]	2/13/2008	4.46	53		0.42		0.0204	0.0433	53		0.9	4.43	<	0.00005	23.6	<	10		11		0.002	1520
Upper Pinabete #2	8/12/2008	0.44	123	<	0.10		0.0009	0.0685	123		0.1	5.93		0.00014	94.2	<	10	<	10	<	0.001	1460
Upper Pinabete #3	8/12/2008	0.44	228	<	0.10		0.0022	0.1120	228		0.1	5.35	<	0.00005	101	<	10		10	<	0.001	1810
Lower Pinabete [1]	7/29/1998	1717	-		-		-	-	464		0.17	-		-	141	<	1		27		-	1940
Lower Pinabete [1]	8/26/1998	2307	-		-		-	-	307		0.11	-		-	71	<	1		34		-	1530
Lower Pinabete [1]	9/30/1998	4.90	-		-		-	-	132	<	0.05	-		-	50	<	1		6		-	410
Lower Pinabete [1]	11/7/1998	145	-		-		-	-	125		0.14	-		-	19	<	1		8		-	600
Lower Pinabete #1	11/18/1998	145	-		-		-	-	107		0.07	-		-	20		3		7		-	480
Lower Pinabete #2	11/18/1998	145	-		-		-	-	120		0.09	-		-	20		3		8		-	570
Lower Pinabete grab [2]	9/18/2007	-	102	<	0.10		0.0013	0.0366	102	<	0.10	0.07	<	0.00005	27.3	<	10	<	10	<	0.001	396
Lower Pinabete #1	9/24/2007	-	134		0.21		0.0133	0.2193	134		0.2	1.05	<	0.00005	48.9	<	10		13	<	0.001	866
Lower Pinabete #2	9/24/2007	-	139		0.12		0.0062	0.1359	139		0.1	6.57	<	0.00005	39.4	<	10		11	<	0.001	776
Lower Pinabete #1	10/8/2007	16.41	147		0.21		0.0015	0.0528	147		0.30	2.11	<	0.00005	32.7	<	10		13		0.001	1020
Lower Pinabete #2	10/8/2007	16.41	158		0.26		0.0100	0.0621	156		0.30	6.01	<	0.00005	34.4	<	10		15		0.001	1040
Lower Pinabete #1 [4]	12/3/2007	36.32	-		-		-	-	-		-	-		-	-		-		-		-	708
Lower Pinabete #2	12/3/2007	36.32	138	<	0.1		0.0101	0.0247	138	<	0.10	4.03	<	0.00005	18.1	<	10	<	10	<	0.001	654
Lower Pinabete #3 [4]	12/3/2007	36.30	-		-		-	-	-		-	-		-	-		-		-		-	655
Lower Pinabete #1	2/13/2008	24.05	145		2.30		0.0094	0.0344	125		0.9	5.05		0.00005	9.5		20	<	10		0.003	502
Lower Pinabete #2	2/13/2008	24.05	124	<	0.10		0.0025	0.0421	124		0.5	4.50	<	0.00005	72.4	<	10		13		0.002	666
Lower Pinabete #1	7/21/2008	46.62	212	<	0.10	<	0.005	0.076	212		0.1	2.86		0.0681	48.2	<	10	<	10	<	0.01	723
Lower Pinabete #2	7/21/2008	46.62	200	<	0.10	<	0.005	0.071	200	<	0.1	3.39		0.0037	42.8	<	10		10	<	0.01	641
Lower Pinabete #3	7/21/2008	46.62	170	<	0.10	<	0.005	0.050	170	<	0.1	4.25	<	0.0005	36.5	<	10	<	10	<	0.01	584

[1] Sampler designation was only provided if more than one sampler contained water

[2] If water was flowing when the samplers where visited, a grab sample was taken

[3] Very limited sample volume

[4] If water is present in all three samplers, full analysis was completed on one with abbreviated analyses on the other two

Q - Qualifier
D - Dissolved
T - Total
cfs - cubic feet per second
mg/L - milligrams per liter
µS/cm - microsiemens per centimeter
su - standard units
pCi/L - picocuries per liter

Sample ID	Copper, D (mg/L)	Q	Fluoride (mg/L)	Hardness (calc)	Q	Hydroxide as CaCO3 (mg/L)	Q	Iron, D (mg/L)	Iron, T (mg/L)	Q	Lead, D (mg/L)	Magnesium, D (mg/L)	Q	Manganese, D (mg/L)	Manganese, T (mg/L)	Q	Mercury (mg/L)	Q	Nitrate/ Nitrite as N (mg/L)	pH (su)	Q	Phosphorous, T (mg/L)	Potassium, D (mg/L)
Upper Pinabete [1]	-		0.78	110		-		7.00	118		-	2.9		0.357	12.80		-		-	8.10		-	5.5
Upper Pinabete [1]	-		1.09	209		-		0.15	286		-	6.8		0.007	12.90		-		-	7.80		-	5.7
Upper Pinabete [1]	-		1.19	186		-		1.17	1140		-	5.7		0.453	24.40		-		-	7.60		-	5.3
Upper Pinabete [1]	-		0.90	87		-		0.05	6		-	6.8	<	0.01	2.20		-		-	8.20		-	8.6
Upper Pinabete #3	0.0080	<	0.2	41	<	10	<	0.05	1150		0.0002	0.9	<	0.005	22.80	<	0.0002		0.74	8.24		3.09	3.5
Upper Pinabete #3	0.0096	<	0.2	62	<	10	<	0.05	1220	<	0.0001	1.7	<	0.005	24.1	<	0.0002		2.48	8.11		0.26	3.7
Upper Pinabete grab [2]	0.0261	<	0.2	68	<	10		0.26	571		0.0005	2.2		0.005	8.09		0.0016		1.65	7.99		0.89	5.5
Upper Pinabete #2	0.0115	<	0.2	262	<	10	<	0.05	[3]		0.0001	6.4	<	0.005	[3]		[3]		[3]	7.51		[3]	7.8
Upper Pinabete #3	0.0090	<	0.2	281	<	10	<	0.05	59.0	<	0.0001	7.0	<	0.005	16.1	<	0.0002		0.06	7.48		0.09	8.0
Lower Pinabete [1]	-		0.40	413		-	<	0.02	155		-	14.7		3.76	28.40		-		-	7.00		-	10.7
Lower Pinabete [1]	-		0.70	201		-		1.35	305		-	6.0		0.21	21.40		-		-	7.60		-	6.6
Lower Pinabete [1]	-		0.45	147		-		1.66	216		-	5.3		0.125	4.07		-		-	8.10		-	9.1
Lower Pinabete [1]	-		0.75	62		-		20.30	1490		-	3.4		2.11	52.00		-		-	8.20		-	5.4
Lower Pinabete #1	-		0.60	59		-		0.03	472		-	2.1	<	0.01	7.80		-		-	8.40		-	4.6
Lower Pinabete #2	-		0.75	61		-		3.50	844		-	2.6		0.11	13.40		-		-	8.30		-	3.8
Lower Pinabete grab [2]	0.0072		0.2	77	<	10		0.05	125		0.0002	2.1	<	0.005	5.86	<	0.0002		1.73	8.02		0.12	5.0
Lower Pinabete #1	0.0109	<	0.2	137	<	10		0.07	[3]		0.0003	3.6	<	0.005	[3]	<	0.0002		1.93	7.64		0.26	4.8
Lower Pinabete #2	0.0104	<	0.2	111	<	10		0.13	391	<	0.0002	3.1		0.006	20.2	<	0.0002		0.85	7.39		0.52	5.1
Lower Pinabete #1	0.0076	<	0.20	90	<	10		0.12	1550		0.0004	2.1		0.017	38.4	<	0.0002		0.31	8.07		2.06	5.0
Lower Pinabete #2	0.0095	<	0.20	95	<	10		0.13	1940		0.0002	2.2		0.009	55.90	<	0.0002		0.31	8.01		0.64	5.1
Lower Pinabete #1 [4]	-		-	-		-		-	-		-	-		-	-		-		-	8.19		-	-
Lower Pinabete #2	0.0117	<	0.20	51	<	10	<	0.05	775	<	0.0001	1.3	<	0.005	16.7	<	0.0002		3.40	8.16		0.17	4.10
Lower Pinabete #3 [4]	-		-	-		-		-	-		-	-		-	-		-		-	8.21		-	-
Lower Pinabete #1	0.0171	<	0.2	29	<	10		1.04	1120		0.0011	1.2		0.012	22.5		0.0024		0.98	8.56		0.69	3.0
Lower Pinabete #2	0.0070	<	0.2	248	<	10	<	0.05	1260	<	0.0001	16.4	<	0.005	25.5		0.0032		1.79	8.35		0.36	4.4
Lower Pinabete #1	0.009	<	0.2	139	<	10		0.30	1100	<	0.001	4.6		0.899	35.5		0.0015		0.04	7.49		0.89	6.2
Lower Pinabete #2	0.006	<	0.2	125	<	10		0.06	574	<	0.001	4.3		0.645	19.6		0.0011		0.54	7.61		0.83	6.8
Lower Pinabete #3	0.007	<	0.2	106	<	10		0.12	566		0.003	3.6		0.506	19.0		0.0010		0.46	7.66		0.58	6.2

[1] Sampler designation was only prc

[2] If water was flowing when the sa

[3] Very limited sample volume

[4] If water is present in all three sam

Q - Qualifier
D - Dissolved
T - Total
cfs - cubic feet per second
mg/L - milligrams per liter
µS/cm - microsiemens per centime
su - standard units
pCi/L - picocuries per liter

Sample ID	Radium 226 (pCi/L)	Radium 228 (pCi/L)	Sodium adsorption ratio (SAR)	Q	Selenium, D (mg/L)	Q	Settleable solids (mL/L)	Q	Silver, D (mg/L)	Sodium, D (mg/L)	Q	Sulfate (mg/L)	Total dissolved solids (TDS) (mg/L)	Total suspended solids (TSS) (mg/L)	Q	Zinc, D (mg/L)
Upper Pinabete [1]	-	-	6.3	<	0.005		705		-	151.0		319	610	109,000		-
Upper Pinabete [1]	-	-	8.0	<	0.005		714		-	265.0		581	1,200			-
Upper Pinabete [1]	-	-	7.7	<	0.005		800		-	242.0		360	1,060	178,000		-
Upper Pinabete [1]	-	-	8.0	<	0.005		14.4		-	166.0		313	620	305,000		-
Upper Pinabete #3	-	-	-		0.003		27.1	<	0.00005	115.0		180	660	64,200		0.001
Upper Pinabete #3	-	-	-		0.002		3.9	<	0.00005	194.0		390	835	89,900		0.002
Upper Pinabete grab [2]	-	-	-		0.005		9.6		0.00010	309		740	5,300	26,600		0.004
Upper Pinabete #2	-	-	-		0.002		904	<	0.00005	278.0		840	1,270	521,000		0.002
Upper Pinabete #3	-	-	-		0.001		658	<	0.00005	284.0		780	1,270	140,000		0.001
Lower Pinabete [1]	-	-	5.1	<	0.005		850		-	238.0		684	1,410	279,000		-
Lower Pinabete [1]	-	-	7.5	<	0.005		890		-	243.0		591	1,220	-		-
Lower Pinabete [1]	-	-	1.9	<	0.005		4.5		-	52.8		130	350	24,200		-
Lower Pinabete [1]	-	-	6.0	<	0.005		1.0		-	108.0		164	390	34,700		-
Lower Pinabete #1	-	-	4.8	<	0.005		9.9		-	85.1		123	370	28,400		-
Lower Pinabete #2	-	-	5.8	<	0.005		9.5		-	103.0		169	400	49,200		-
Lower Pinabete grab [2]	1.7 ± 0.6	3.0 ± 0.7	-		0.002		31.4		0.00008	54.2		100	295	17,900		0.003
Lower Pinabete #1	-	-	-		0.002		400	<	0.00005	138.0		295	570	89,600		0.016
Lower Pinabete #2	-	-	-	<	0.001		184	<	0.00005	96.2		235	460	97,600		0.015
Lower Pinabete #1	-	-	-		0.007		727	<	0.00005	180.0		360	600	132,000		0.002
Lower Pinabete #2	-	-	-		0.007		766	<	0.00005	179.0		390	620	156,000		0.002
Lower Pinabete #1 [4]	-	-	-		-		25.6		-	-		-	1,130	88,000		-
Lower Pinabete #2	-	-	-		0.003		16.7		0.00006	137.0		190	935	51,800		0.006
Lower Pinabete #3 [4]	-	-	-		-		17.9		-	-		-	1,270	68,000		-
Lower Pinabete #1	-	-	-		0.003		111.0		0.00006	140		165	28,400	10,200		0.006
Lower Pinabete #2	-	-	-		0.003		174.0	<	0.00005	30.2		170	13,600	70,400		0.004
Lower Pinabete #1	-	-	-	<	0.01		290	<	0.0005	112.0		180	500	102,000		0.16
Lower Pinabete #2	-	-	-	<	0.01		190	<	0.0005	98.5		140	430	50,300		0.01
Lower Pinabete #3	-	-	-	<	0.01		190	<	0.0005	93.6		138	400	48,900	<	0.01

[1] Sampler designation was only prc

[2] If water was flowing when the sa

[3] Very limited sample volume

[4] If water is present in all three sam

Q - Qualifier
D - Dissolved
T - Total
cfs - cubic feet per second
mg/L - milligrams per liter
µS/cm - microsiemens per centime
su - standard units
pCi/L - picocuries per liter

Sample ID	Sample date	Flow (cfs)	Alkalinity as CaCO3 (mg/L)	Q	Aluminum, D (mg/L)	Q	Arsenic, D (mg/L)	Barium, D (mg/L)	Bicarbonate as CaCO3 (mg/L)	Q	Boron, D (mg/L)	Cation anion balance (CAB) (%)	Q	Cadmium, D (mg/L)	Calcium, D (mg/L)	Q	Carbonate as CaCO3 (mg/L)	Q	Chloride (mg/L)	Q	Chromium, D (mg/L)
Upper No Name[1]	7/29/1998	2	-		-		-	-	132		<0.05	-		-	35	<	1		8		-
Upper No Name[1]	9/30/1998	10	-		-		-	-	180		<0.05	-		-	42		3		7		-
Upper No Name #2	2/13/2008	19	106		0.52		0.0027	0.0287	106		0.5	4.62	<	0.00005	11.5	<	10		19		0.002
Upper No Name #3	2/13/2008	19	122		1.65		0.0046	0.0468	122		0.4	12.4	<	0.00005	16.3	<	10	<	10		0.003
Upper No Name grab[2]	2/13/2008	19.14	132		0.56		0.0038	0.0361	132		0.3	2.28	<	0.00005	17.9	<	10	<	10		0.003
Upper No Name #2	7/21/2008	-	128	<	0.10	<	0.005	0.050	128	<	0.1	3.08		0.0099	17.0	<	10	<	10	<	0.01
Upper No Name #3	7/21/2008	-	133	<	0.10	<	0.005	0.053	133	<	0.1	4.53		0.0011	18.5	<	10	<	10	<	0.01
Upper No Name #1	8/12/2008	-	119	<	0.10		0.0032	0.0658	119	<	0.1	6.90		0.00025	23.8	<	10	<	10	<	0.001
Upper No Name #2	8/12/2008	-	121	<	0.10		0.0023	0.0606	121	<	0.1	3.63	<	0.00005	22.8	<	10	<	10	<	0.001
Upper No Name #3	8/12/2008	-	110		0.15		0.0019	0.0583	110	<	0.1	4.07		0.00062	20.3	<	10	<	10	<	0.001
Lower No Name #1	8/13/1998	-	-		-		-	-	417		0.2	-		-	92	<	1		11		-
Lower No Name #2	8/14/1998	-	-		-		-	-	232		0.2	-		-	121	<	1		17		-
Lower No Name[1]	9/30/1998	74.00	-		-		-	-	264		0.1	-		-	77	<	1		9		-
Lower No Name #1	8/28/2007	-	129	<	0.10		0.0011	0.0474	129	<	0.1	9.65	<	0.00005	45.6	<	10	<	10	<	0.001
Lower No Name #2	8/28/2007	-	158	<	0.10		0.0011	0.0500	158	<	0.1	14.2	<	0.00005	39.5	<	10	<	10	<	0.001
Lower No Name #1	8/12/2008	-	302	<	0.10		0.0051	0.122	302	<	0.1	3.80	<	0.00005	147	<	10	<	10	<	0.001
Lower No Name #2	8/12/2008	-	270	<	0.10		0.0045	0.111	270		0.2	1.19		0.00095	120	<	10	<	10	<	0.001
Lower No Name #3	8/12/2008	-	320	<	0.10		0.0058	0.138	320		0.2	9.71	<	0.00005	186	<	10	<	10	<	0.001

[1] Sampler designation was only provided if more than one sampler contained water

[2] If water was flowing when the samplers where visited, a grab sample was taken

Q - Qualifier

D - Dissolved

T - Total
cfs - cubic feet per second
mg/L - milligrams per liter

µs/cm - microsiemens per centimeter

su - standard units

Sample ID	Electrical conductivity (EC) (µs/cm)	Copper, D (mg/L)	Q	Fluoride (mg/L)	Q	Hydroxide as CaCO3 (mg/L)	Q	Iron, D (mg/L)	Iron, T (mg/L)	Q	Lead, D (mg/L)	Magnesium, D (mg/L)	Q	Manganese, D (mg/L)	Manganese, T (mg/L)	Q	Mercury (mg/L)	Q	Nitrate/Nitrite as N (mg/L)	pH (su)	Q
Upper No Name[1]	150	-		0.19		-		0.58	6020		-	2.1		0.24	1.28		-		-	8.10	
Upper No Name[1]	290	-		0.26		-		0.46	5		-	2.3		0.043	0.13		-		-	8.40	
Upper No Name #2	197	0.0067		0.20	<	10		0.28	66		0.0002	0.9	<	0.005	1.27	<	0.0002		0.26	8.16	
Upper No Name #3	217	0.0124		0.30	<	10		0.80	88		0.0006	1.4		0.008	1.96	<	0.0002		0.33	8.16	
Upper No Name grab[2]	337	0.0099		0.30	<	10		0.41	35		0.0003	1.2	<	0.005	0.40	<	0.0002		0.40	8.12	
Upper No Name #2	205	0.007		0.3	<	10		0.10	108	<	0.001	1.1		0.090	2.55		0.0003		0.04	8.07	
Upper No Name #3	215	0.008		0.3	<	10		0.08	123	<	0.001	1.2		0.115	2.67		0.0003	<	0.02	8.02	
Upper No Name #1	270	0.0044	<	0.2	<	10	<	0.05	7.07	<	0.0001	1.5		0.040	4.36	<	0.0002		0.06	7.83	<
Upper No Name #2	286	0.0044	<	0.2	<	10	<	0.05	3.24	<	0.0001	1.4	<	0.005	1.56	<	0.0002		0.06	7.88	
Upper No Name #3	241	0.0042	<	0.2	<	10		0.10	3.43		0.0002	1.2	<	0.005	2.17	<	0.0002		0.03	7.92	
Lower No Name #1	1020	-		0.64		-		0.45	5		-	10.7		0.034	0.13		-		-	7.60	
Lower No Name #2	1050	-		0.68		-		0.05	1		-	14.0	<	0.005	0.02		-		-	8.00	
Lower No Name[1]	730	-		0.89		-		3.31	290		-	8.8		0.8	6.38		-		-	7.70	
Lower No Name #1	612	0.0072		0.4	<	10	<	0.05	258	<	0.0001	4.5		0.007	5.79	<	0.0002		2.94	7.91	
Lower No Name #2	498	0.0056		0.3	<	10	<	0.05	419	<	0.0001	3.9		0.010	10.3	<	0.0002		2.94	7.90	<
Lower No Name #1	1170	0.0057	<	0.2	<	10		1.59	8.1		0.0092	17.7		0.233	13.1	<	0.0002		0.41	7.29	
Lower No Name #2	1000	0.0063	<	0.2	<	10		0.08	16.4		0.0002	14.7		0.568	13.6	<	0.0002		0.06	7.33	
Lower No Name #3	1330	0.0063	<	0.2	<	10		0.08	17.0		0.0002	22.6		0.206	25.5	<	0.0002		0.09	7.17	<

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[2] If water was flowing when the sa

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su - standard units

Sample ID	Phosphorous, T (mg/L)	Potassium, D (mg/L)	Sodium adsorption ration (SAR)	Q	Selenium, D (mg/L)	Q	Settleable solids (mL/L)	Q	Silver, D (mg/L)	Sodium, D (mg/L)	Q	Sulfate (mg/L)	Total dissolved solids (TDS) (mg/L)	Total suspended solids (TSS) (mg/L)	Q	Zinc, D (mg/L)
Upper No Name[1]	-	6.0	0.8	<	0.005		3		-	18.6		16	100	7,400		-
Upper No Name[1]	-	8.2	0.7	<	0.005		0.1		-	17.3		7	190	1,520		-
Upper No Name #2	0.26	3.7	-	<	0.001		1.6	<	0.00005	27.4	<	10	320	2,550		0.004
Upper No Name #3	0.19	4.8	-	<	0.001		3.7		0.00024	35.3	<	10	160	5,520		0.005
Upper No Name grab[2]	0.29	3.9	-	<	0.001	<	0.5		0.00007	44.9		30	490	367		0.007
Upper No Name #2	0.12	3.3	0.7	<	0.01		8.4	<	0.0005	24.5	<	10	180	8,100		0.03
Upper No Name #3	0.09	3.5	0.7	<	0.01		8.4	<	0.0005	25.2	<	10	135	6,780		0.03
Upper No Name #1	0.05	4.5	-	<	0.001		27.9	<	0.00005	25.9	<	10	220	19,400		0.002
Upper No Name #2	0.13	4.2	-	<	0.001		18.1	<	0.00005	28.8		16	195	15,900		0.001
Upper No Name #3	0.79	4.0	-		-		12.3	<	0.00005	23.5	<	10	160	8,170		0.001
Lower No Name #1	-	13.6	2.0	<	0.005		162		-	82.9		131	530	26,100		-
Lower No Name #2	-	29.5	2.0	<	0.005		194		-	95.0		383	840	78,400		-
Lower No Name[1]	-	9.6	1.7	<	0.0		251.0		-	60.6		142	520	36,800		-
Lower No Name #1	0.12	7.7	-		0.001		121	<	0.00005	64.9		220	445	16,700		0.010
Lower No Name #2	0.05	10.0	-		0.001		77.7	<	0.00005	44.7		152	385	31,500		0.002
Lower No Name #1	0.13	11.3	-		0.001		571	<	0.00005	67.1		380	810	394,000		0.001
Lower No Name #2	35.0	10.8	-		0.001		450	<	0.00005	55.1		265	670	246,000		0.004
Lower No Name #3	0.05	11.0	-		0.001		670		0.00135	75.4		600	1030	395,000		0.004

[1] Sampler designation was only prc

[2] If water was flowing when the sa

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su - standard units

Sample date	Alkalinity as CaCO3 (mg/L)	Bicarb as CaCO3 (mg/L)	Q	Boron, T (mg/L)	Q	Cation anion balance (CAB) %	Q	Cadmium, T (mg/L)	Calcium, D (mg/L)	Q	Chloride (mg/L)	Electrical conductivity (EC) (µs/cm)	Q	Fluoride (mg/L)	Hardness as CaCO3 (calc)	Q	Iron, D (mg/L)	Iron, T (mg/L)	Q	Lead, T (mg/L)	Q
											600 (L&W)			2 (L&W)						0.015 (ScHC)	
Site M																					
3/14/1990		156	<	5					188		39.4	718		1.2	774		173	234			
5/14/1990		133	<	5					411		4.04	1280		0.295	1040		0.11	0.65			
7/23/1990		461	<	5					400		10.4	27800		0.656	1390		1.15	10.1			
8/24/1990		190	<	5					316		20.3	2550		0.398	823		0.21	0.58			
9/29/1990		89	<	5					480		4.47	222		0.23	1203		2.39	3.69			
10/22/1990		88.9	<	5			<	0.005	18		4.6	359		0.33	53		1.76	1.8	<	0.05	
11/19/1990		135	<	5			<	0.005	16.7		13.4	489		0.65	53		20.9	23	<	0.05	
1/20/1991		530	<	5					550		82.2	7360		0.93	1000		0.72	0.72			
6/21/1991		1170	<	2.5					28.3		47.1	1540		0.3	2650		3.66	9.71			
1/1/1992		330	<	2.5					633		21.1	912	<	0.1	1700		580	582			
7/14/1992	494	494			<	0.84			35		10	571		0.6	100		0.53	420			
8/31/1992	146	146				4.52			13		10	798		1.5	37		0.94	1520			
1/1/1993A	266	262			<	0.47			42		13	2180		2	126	<	0.02	5.36			
1/1/1993B	116	116			<	3.15			60		13	418		0.9	146		0.16	716			<
3/11/1993	140	140				3.85			9		11	732		0.9	31		12	171			
9/6/1993	216	216			<	2.14			28		8	1040		0.9	78		0.14	1210			
7/10/1994	135	135			<	1.59			22		7			1.5	51		0.06	163			<
10/2/1994	210	210							53		21			0.4	153		2.74	4.49			
1/8/1995	172	172							3.5		4			0.6	10		0.25	520			
Site N																					
5/14/1990		277	<	5					26		13.2	1210		1.1	80		0.18	0.8			
6/19/1990		299	<	5					38.7		15.3	1440		0.848	115		0.28	1.72			
8/24/1990		518	<	5					238		4.96	1332		0.942	599		2.1	2.6			
10/22/1990		221	<	5			<	0.005	22.2		7.2	1120		0.89	68		0.49	1.11	<	0.05	
1/20/1991		588	<	5					354		360	1256	<	0.2	2200		25.7	398			
6/21/1991		268	<	2.5					22.2		7.94	676		1.1	84		1.13	2.31			
8/20/1991		407	<	2.5					43.7		4.2				2200		7.26	410			
9/26/1991		363	<	2.5					38	<	0.5	1420		0.77	120		0.17	0.27			
1/1/1992		290	<	2.5					123		32.3	996		0.2	150		97.8	388			
7/14/1992	192	192				1.59			26		24	1510		2	73	<	0.02	2860			
8/31/1992	250	250			<	5.24			49		46	1460		1.7	143		0.43	2080			
1/1/1993	88	88				1.26			38		14	1050		1.2	111		0.22	255			
3/11/1993	165	165			<	0.42			20		16	985		1.1	58		0.15	276			
9/29/1993									1246		15	142	<	0.1	4370		730	4510			
7/10/1994	260	260			<	4.49			27		17			1.4	63		0.33	3060			<
10/2/1994	950	950							29		8			1.3	85		0.11	7480			
1/8/1995	182	182							3.5		10			1	14		0.05	1000			

Q - Qualifier
BDL - Below Detection Limit
L&W -Livestock & Wildlife
AqHbt - Aquatic Habitat
ScHC - Secondary Human Contact
D - Dissolved
T - Total
mg/L - milligrams per liter
µs/cm - microsiemens per centimeter
su - standard units

Sample date	Magnesium D (mg/L)	Q	Manganese D (mg/L)	Manganese, T (mg/L)	Q	Mercury, D (mg/L)	Q	Mercury, T (mg/L)	Q	Nitrate nitrogen	Nitrate/Nitrite as N (mg/L)	Q	Nitrite as N (mg/L)	Q	Nitrogen, total Kjeldahl	pH (su)	Potassium, D (mg/L)	Sodium adsorption ratio (SAR)	Sodium adsorption ratio (SAR) Calc.	Selenium, D (mg/L)	Q
								0.42 (ScHC); 0.01 (L); 0.000012			100 (L&W)					6.5 -9 (ScHC, AqHbt)				0.05(L)	
Site M																					
3/14/1990	74			4.45						3.08						7.89	154		18.30		
5/14/1990	3.28			0.37						0.383						7.49	5.08		2.71		
7/23/1990	95			13.8						0.484						7.99	19.1		84.04		
8/24/1990	8.2			1.59						0.373						8.58	5.22		6.61		
9/29/1990	1.1			0.05						0.355						7.87	3.8		0.93		
10/22/1990	1.9			0.02			<	0.0005		0.6						7.96	3.29		5.05		<
11/19/1990	2.76			0.16				0.0006		0.66						8.18	15.9		8.30		<
1/20/1991	73.9			0.04						0.06						7.16	8.7		16.15		
6/21/1991	4.25			0.07						0.31						7.29	11.3		14.04		
1/1/1992	83.5			5.94						1.63						8.13	164		2.84		
7/14/1992	3		0.38							0.05	0.13		0.08			7.7	4		8.41		
8/31/1992	1		0.02							0.7	0.7	<	0.01			8.1	4		11.87		
1/1/1993A	5	<	0.01		<	0.0001				1.36	1.36	<	0.01			8.4	1		12.63	0.003	
1/1/1993B	1	<	0.01							3.54	3.59		0.05			7.8	1		5.26		
3/11/1993	2		7							1.22	1.24		0.02			8.3	3	12.63	12.49		
9/6/1993	2		0.01							1.92	1.98		0.06		9.4	8	4		10.39		
7/10/1994	1	<	0.01							0.67	1.3		0.63		2.4	7.6	4	13.57			
10/2/1994	5		1.04							0.04	0.04	<	0.01	<	0.1	7.5	6				
1/8/1995	0.3									7.7	7.8		0.11		3.7	8.3	1.7				
Site N																					
5/14/1990	3.67			0.17						0.651						7.43	5.61		9.78		
6/19/1990	4.57			1.4						0.289						7.21	4.94		15.07		
8/24/1990	1.1			0.11						0.61						7.87	5.29		5.34		
10/22/1990	3.03			0.1			<	0.0005		0.23						7.51	3.88		11.72		<
1/20/1991	172			5.05						1.83						7.57	17.6		1.89		
6/21/1991	3.19			0.39					<	0.05						7.51	3.38		43.51		
8/20/1991	6.7			7.21						0.39						7.98	0.81		21.40		
9/26/1991	6.91			0.83					<	0.05						6.95	5		13.95		
1/1/1992	44.5			2.97						0.11						7.98	4.72		3.54		
7/14/1992	2	<	0.01							1.2	1.2	<	0.01			8.2	3		14.81		
8/31/1992	5		0.08							0.25	0.31		0.06			8.1	5		9.94		
1/1/1993	4	<	0.01							2.11	2.14		0.03			8.1	3		11.75		
3/11/1993	2	<	0.01							1.81	1.81	<	0.01			8	3	12.23	12.10		
9/29/1993	306		39							13498.4	13500		1.6			0.6	90		2.96		
7/10/1994	1	<	0.01							0.58	0.86		0.28		2.5	7.8	4	15.91			
10/2/1994	3		0.42							0.02	0.02	<	0.01	<	0.1	8	3				
1/8/1995	1.2									3.2	3.2				5.7	8.2	1.7				

Q - Qualifier
BDL - Below Dete
L&W -Livestock
AqHbt - Aquatic H
ScHC - Secondary
D - Dissolved
T - Total
mg/L - milligrams
µs/cm - microsiem
su - standard units

Sample date	Selenium, T (mg/L)	Q	Silica	Sodium, D (mg/L)	Sulfate (mg/L)	Q	Total dissolved solids (TDS) (mg/L)	Total suspended solids (TSS) (mg/L)	Q	Vanadium, D (mg/L)	Q	Vanadium, T (mg/L)
	7 (ScHC), 0.002 (AqHbt), 0.002 (W)				1000 (L&W)					0.1 (L&W)		
Site M												
3/14/1990			71	1170	204		1980				<	0.5
5/14/1990		<	1	201	558		2500				<	0.05
7/23/1990			10.1	7200	18100		24600				<	0.5
8/24/1990			10.4	436	1091		1640				<	0.5
9/29/1990			26.2	74.2	108		360				<	0.5
10/22/1990	0.005	<	1	84.3	85		392				<	0.5
11/19/1990	0.005		3	139	166		404				<	0.5
1/20/1991			4.6	1520	3690		5760				<	0.1
6/21/1991			162	303	800		1350				<	0.5
1/1/1992			5050	286	757		2110					0.4
7/14/1992			13.5	193	29		480	61880	<	0.01		
8/31/1992			19.8	165	200		540	57660	<	0.01		
1/1/1993A			10.9	325	539		1062		<	0.01		
1/1/1993B			9.5	150	356		652	14400	<	0.01		
3/11/1993			141	159	191		456	45880		0.14		
9/6/1993			19.3	211	328		726	46200	<	0.01		
7/10/1994			16.2		393		744		<	0.01		
10/2/1994			19		490		924		<	0.01		
1/8/1995			8.4		140		370					
Site N												
5/14/1990			9.6	201	167		555				<	0.05
6/19/1990			13.3	372	135	<	720				<	0.05
8/24/1990			9.23	300	272		1000				<	0.5
10/22/1990	0.005		1.3	222	298		956				<	0.5
1/20/1991			5.3	173	3010		4381					0.38
6/21/1991			10.6	828	147		640				<	0.5
8/20/1991			38.2	575	1460		1010					1.87
9/26/1991			12.6	356	422		968				<	0.5
1/1/1992			16	180	1380		2150					0.26
7/14/1992			22.8	291	447		820	115800	<	0.01		
8/31/1992			18.7	273	494		1020	128420	<	0.01		
1/1/1993			14	285	587		960	11800	<	0.01		
3/11/1993			17.9	212	329		648	110120	<	0.01		
9/29/1993			311	450			2107		<	0.01		
7/10/1994			23.3		461		1050		<	0.01		
10/2/1994			16.1		140		520		<	0.01		
1/8/1995			13		220		440					

Q - Qualifier
BDL - Below Dete
L&W -Livestock
AqHbt - Aquatic H
ScHC - Secondary
D - Dissolved
T - Total
mg/L - milligrams
µs/cm - microsiem
su - standard units

Suspended sediments: The following water quality standard for suspended sediment concentration, expressed as a geometric mean (four-sample minimum) shall not be exceeded. The standard applies only to a surface water that is at or near base flow and does not apply to a surface water during or soon after a precipitation event:
AqHbt 80 mg/L

Turbidity: Turbidity attributable to other than natural causes shall not reduce light transmission to the point that the normal growth, function, or reproduction of aquatic life is impaired or that will cause substantial visible contrast with the natural apperance of the Navajo Nation Surface Water Quality Standards Navajo Nation EPA Water Quality Program water. Turbidity shall not exceed 10 Nephelometric Turbidity Units (NTU) over background turbidity when the background turbidity is 50 NTU or less, or increase more than 20 percent when the background turbidity is more than 50 NTU. Background turbidity shall be measured at a point immediately upstream of the turbidity-causing activity.

Aquatic hardenss equations
a - Cadmium (dissolved)
acute: [e (1.0166 [ln (hardness)] - 3.924)][1.136672-[ln (hardness)](0.041838)]
chronic: [e (0.7409 [ln (hardness)] - 4.719)][1.101672-[ln (hardness)](0.041838)]
b - Chromium III (dissolved)
acute: [e (0.8190 [ln (hardness)] + 3.7256)] 0.316
chronic: [e (0.8190 [ln (hardness)] + 0.6848)]0.860
c - Copper (dissolved)
acute: [e (0.9422 [ln (hardness)] - 1.700)]0.960
chronic: [e (0.8545 [ln (hardness)] - 1.702)]0.960
d - Lead (dissolved)
acute: [e (1.273 [ln (hardness)] - 1.460)][1.46203-[ln (hardness)](0.145712)]
chronic: [e (1.273 [ln (hardness)] - 4.705)][1.46203-[ln (hardness)](0.145712)]
e - Nickel (dissolved)
acute: [e (0.8460 [ln (hardness)] + 2.255)]0.998
chronic: [e (0.8460 [ln (hardness)] + 0.0584)]0.997
f - Silver (dissolved)
acute: [e (1.72 [ln (hardness)] - 6.59)]0.85 chronic: NCNS
g - Zinc (dissolved)
acute: [e (0.8473 [ln (hardness)] + 0.884)]0.978
chronic: [e (0.8473 [ln (hardness)] + 0.884)]0.986

Table 18-15: Comparison of Total Dissolved Solids and Total Suspended Solids at Site M (Downstream) on Brimhall Wash Between February 1979 and September 1982

Date	Grab sample	Single-stage sampler	No reference	Total solids (mg/L)	Total dissolved solids (mg/L)	Total suspended solids (mg/L)
07/01/79			X	78,820	11,520	67,300
02/01/79			X	39,327	37,489	1,838
04/16/81	X			78100	3400	74700
06/04/81	X			4,220	2,070	2,150
07/01/81	X			93,010	11,500	81,510
07/08/81	X			68,750	2,450	66,300
08/13/81	X			14,480	510	13,970
08/31/81	X			92,890	8,580	84,310
09/09/81		X		146,230	1,470	144,760
09/24/81		X		135,054	1,962	133,092
10/05/81		X		624	520	104
10/05/81		X		47,140	860	46,280
11/30/81		X		22,700	420	22,280
02/16/82	X			10,354	254	10,100
02/25/82	X			21,461	451	21,010
03/03/82	X			18,107	537	17,570
03/17/82	X			68,133	693	67,440
03/29/82	X			4,192	720	3,472
05/03/82	X			5,548	579	4,969
05/05/82	X			4,320	210	4,110
07/19/82	X			6,038	877	5,161
07/26/82	X			20,370	370	> 20,000
07/28/82		X		20,620	620	> 20,000
07/28/82	X			21,000	1,100	> 20,000
08/03/82	X			20,749	749	> 20,000
08/12/82			X	20,848	843	> 20,000
08/17/82			X	5,910	1,000	4,910
08/23/82	X			19183	863	18,320
08/25/82	X			20841	841	> 20,000
09/10/82			X	20873	873	> 20,000
09/13/82			X	20,570	570	> 20,000
Average				37,112	3,061	> 34,053
Median				20,841	843	> 20,000

mg/L - milligrams per liter

Table 18-16: Comparison of Total Dissolved Solids and Total Suspended Solids on at Site N (Upstream) on Brimhall Wash between February 1979 and September 1982

Date	Grab sample	Single-stage sampler	No reference	Total solids (mg/L)	Total dissolved solids (mg/L)	Total suspended solids (mg/L)
07/01/79			X	64,497	24,373	40,124
04/16/81	X			71,790	90	71,700
06/04/81		X		QNS		
07/01/81	X			55,730	10,280	45,450
07/08/81	X			69,550	4,220	65,330
07/10/81		X		126,720	1,844	124,876
08/12/81		X		149,080	2,110	146,970
08/31/81	X			35,470	9,050	26,420
09/09/81	X			172,938	1,910	171,028
09/24/81	X			24,568	2,404	22,164
10/05/81	X				QNS	77,780
11/30/81	X			89,850	690	89,160
02/16/82	X			7,430	220	7,210
02/25/82	X			31,310	380	30,930
03/03/82	X			21,210	400	20,810
03/17/82	X			20,341	391	19,950
03/29/82	X			4,046	600	3,446
05/03/82	X			4,729	389	4,340
05/05/82	X			4,413	420	3,993
07/28/82		X		21,062	1,062	> 20,000
08/03/82	X			20,890	890	> 20,000
08/12/82		X		20,820	820	> 20,000
08/17/82	X	X		5,169	449	4,720
08/23/82	X			19,900	900	19,000
09/10/82		X		20,800	800	> 20,000
09/13/82		X		20,870	870	> 20,000
Average				45,133	2,732	> 49,770
Median				21,136	845	20,810

mg/L - milligrams per liter
QNS - Quantity not sufficient

Sample ID	Sample date	Alkalinity as CaCO3 (mg/L)	Aluminum, D (mg/L)	Aluminum, T (mg/L)	Arsenic, D (mg/L)	Arsenic, T (mg/L)	Barium, D (mg/L)	Barium, T (mg/L)	Bicarbonate as CaCO3 (mg/L)	Boron, D (mg/L)	Cation anion balance (CAB) (%)	Cadmium, D (mg/L)	Calcium, D (mg/L)	Carbonate as CaCO3 (mg/L)	Chloride (mg/L)	Chromium, D (mg/L)
Ponds within Pinabete watershed																
4N/4S Pond (aka Mid Pinabete Pond or Pond East of Lower Pinabete)	4/10/08	-		19.9	-	0.0008	-	0.175	-	0.2	-	< 0.00005	-	-	-	0.006
4N/4S Pond (aka Mid Pinabete Pond or Pond East of Lower Pinabete)	5/12/08	-	-	181	-	0.0051	-	0.905	-	0.4	-	< 0.00005	-	-	-	0.008
4N/4S Pond (aka Mid Pinabete Pond or Pond East of Lower Pinabete)	7/21/08	248	0.38	-	< 0.005	-	0.124	-	248	0.2	3.92	0.0054	54.2	< 10	11	< 0.01
4N/4S Pond (aka Mid Pinabete Pond or Pond East of Lower Pinabete)	8/12/08	-	-	3.64	-	0.0020	-	0.2250	-	0.2	-	0.00107	-	-	-	< 0.001
Stevenson's Well Site Pond (aka Well Site Pond)	7/21/08	312	< 0.10	-	< 0.005	-	0.208	-	312	0.2	2.29	0.0083	44.6	< 10	19	< 0.01
Stevenson's Well Site Pond (aka Well Site Pond)	8/12/08	-	-	1.83	-	< 0.0025	-	0.1550	-	< 0.1	-	0.01397	-	-	-	< 0.001
Ponds within No Name watershed																
No Name Impoundment (aka Mid No Name or Pond Along No Name)	4/30/98	-	-	-	-	-	-	-	129	0.10	-	-	17	1	17	-
No Name Impoundment (aka Mid No Name or Pond Along No Name)	5/15/98	-	-	-	-	-	-	-	162	0.12	-	-	15	< 1	19	-
No Name Impoundment (aka Mid No Name or Pond Along No Name)	7/29/98	-	-	-	-	-	-	-	109	< 0.05	-	-	24	< 1	4	-
No Name Impoundment (aka Mid No Name or Pond Along No Name)	8/20/98	-	-	-	-	-	-	-	170	0.06	-	-	42	< 1	7	-
No Name Impoundment (aka Mid No Name or Pond Along No Name)	8/26/98	-	-	-	-	-	-	-	135	< 0.05	-	-	41	< 1	6	-
No Name Impoundment (aka Mid No Name or Pond Along No Name)	9/30/98	-	-	-	-	-	-	-	195	0.07	-	-	46	< 1	6	-
No Name Impoundment (aka Mid No Name or Pond Along No Name)	11/7/98	-	-	-	-	-	-	-	204	0.08	-	-	43	< 1	6	-
No Name Impoundment (aka Mid No Name or Pond Along No Name)	12/1/98	-	-	-	-	-	-	-	165	0.08	-	-	45	< 1	67	-
No Name Impoundment (aka Mid No Name or Pond Along No Name)	4/10/08	-	-	32.4	-	0.0013	-	0.356	-	0.3	-	0.00025	-	-	-	0.004
No Name Impoundment (aka Mid No Name or Pond Along No Name)	8/12/08	-	-	1.67	-	< 0.0025	-	0.1130	-	< 0.10	-	0.00010	-	-	-	< 0.001
No Name Impoundment (aka Mid No Name or Pond Along No Name)	4/1/09	189	0.13	16.60	0.002	0.0028	0.124	0.2520	185	0.20	0.07	< 0.00005	26	< 10	18	0.006

D - Dissolved
T - Total
mg/L - milligrams per liter
µs/cm - microsiemens per centimeter
su - standard units

Sample ID	Cobalt, D (mg/L)	Electrical conductivity (EC) (µs/cm)	Copper, D (mg/L)	Fluoride (mg/L)	Hardness (calc)	Hydroxide as CaCO3 (mg/L)	Iron, D (mg/L)	Iron, T (mg/L)	Lead, D (mg/L)	Magnesium, D (mg/L)	Manganese, D (mg/L)	Manganese, T (mg/L)	Mercury, T (mg/L)	Nitrate/Nitrite as N (mg/L)	pH (su)	Phosphorous, T (mg/L)
Ponds within Pinabete watershed																
4N/4S Pond (aka Mid Pinabete Pond or Pond East of Lower Pinabete)	0.00029	-	0.0064	-	-	-	-	-	< 0.0001	-	-	-	< 0.0002	-	-	-
4N/4S Pond (aka Mid Pinabete Pond or Pond East of Lower Pinabete)	0.00257	-	0.0356	-	-	-	-	-	0.0002	-	-	-	0.0008	-	-	-
4N/4S Pond (aka Mid Pinabete Pond or Pond East of Lower Pinabete)	-	673	0.016	0.9	162	< 10	0.39	19	0.007	6.4	0.377	0.910	0.0002	< 0.02	7.62	0.18
4N/4S Pond (aka Mid Pinabete Pond or Pond East of Lower Pinabete)	0.00080	-	0.0068	-	-	-	-	-	0.0016	-	-	-	< 0.0002	-	-	-
Stevenson's Well Site Pond (aka Well Site Pond)	-	608	0.014	1.2	-	< 10	0.05	383	< 0.001	< 0.5	0.357	9.26	0.0008	0.03	7.80	< 0.05
Stevenson's Well Site Pond (aka Well Site Pond)	0.00030	-	0.0068	-	-	-	-	-	0.0016	-	-	-	< 0.0002	-	-	-
Ponds within No Name watershed																
No Name Impoundment (aka Mid No Name or Pond Along No Name)	-	430	-	0.70	55	-	1.07	-	-	3.9	0.315	-	-	-	8.60	-
No Name Impoundment (aka Mid No Name or Pond Along No Name)	-	470	-	0.85	46	-	0.39	-	-	3.6	0.026	-	-	-	8.90	-
No Name Impoundment (aka Mid No Name or Pond Along No Name)	-	250	-	0.51	40	-	0.15	-	-	2.3	0.056	-	-	-	7.70	-
No Name Impoundment (aka Mid No Name or Pond Along No Name)	-	370	-	0.44	43	-	<0.02	-	-	3.5	0.152	-	-	-	7.80	-
No Name Impoundment (aka Mid No Name or Pond Along No Name)	-	320	-	0.44	42	-	0.59	-	-	3.1	0.062	-	-	-	7.50	-
No Name Impoundment (aka Mid No Name or Pond Along No Name)	-	410	-	0.57	49	-	0.98	-	-	4.3	0.112	-	-	-	8.10	-
No Name Impoundment (aka Mid No Name or Pond Along No Name)	-	440	-	0.47	54	-	0.27	-	-	5.1	0.020	-	-	-	8.20	-
No Name Impoundment (aka Mid No Name or Pond Along No Name)	-	370	-	0.40	37	-	0.37	-	-	4.2	0.020	-	-	-	8.10	-
No Name Impoundment (aka Mid No Name or Pond Along No Name)	0.00151	-	0.0285	-	-	-	-	-	0.0055	-	-	-	< 0.0002	-	-	-
No Name Impoundment (aka Mid No Name or Pond Along No Name)	0.00018	-	0.0088	-	-	-	-	-	0.0006	-	-	-	< 0.0002	-	-	-
No Name Impoundment (aka Mid No Name or Pond Along No Name)	0.00052	788	0.0151	1.2	83	< 10	0.08	11.6	< 0.0001	4.8	0.040	0.232	< 0.0002	< 0.020	8.23	0.07

D - Dissolved
T - Total
mg/L - milligrams per liter
µs/cm - microsiemens per centimeter
su - standard units

Sample ID	Potassium, D (mg/L)	Sodium adsorption ratio (SAR)	Selenium, D (mg/L)	Selenium, T (mg/L)	Settleable solids (mL/L)	Silver, D (mg/L)	Sodium, D (mg/L)	Sulfate (mg/L)	Total dissolved solids (mg/L)	Total suspended solids (mg/L)	Vanadium, D (mg/L)	Zinc, D (mg/L)
Ponds within Pinabete watershed												
4N/4S Pond (aka Mid Pinabete Pond or Pond East of Lower Pinabete)	-	-	-	< 0.001	-	-	-	-	-	-	0.0032	< 0.001
4N/4S Pond (aka Mid Pinabete Pond or Pond East of Lower Pinabete)	-	-	-	0.001	-	-	-	-	-	-	0.0077	0.008
4N/4S Pond (aka Mid Pinabete Pond or Pond East of Lower Pinabete)	12.1	-	< 0.01	-	5.2	< 0.0005	90.0	122	415	727	-	0.02
4N/4S Pond (aka Mid Pinabete Pond or Pond East of Lower Pinabete)	-	-	-	< 0.001	-	-	-	-	-	-	0.0038	0.010
Stevenson's Well Site Pond (aka Well Site Pond)	7.5	0.7	< 0.01	-	37.9	< 0.0005	86.4	39	380	9200	-	0.02
Stevenson's Well Site Pond (aka Well Site Pond)	-	-	-	0.002	-	-	-	-	-	-	0.0064	0.006
Ponds within No Name watershed												
No Name Impoundment (aka Mid No Name or Pond Along No Name)	11.1	3.4	-	< 0.005	< 0.1	-	59.3	52	340	140	-	-
No Name Impoundment (aka Mid No Name or Pond Along No Name)	8.9	4.4	-	< 0.005	0.1	-	72.4	52	310	123	0.0048	0.037
No Name Impoundment (aka Mid No Name or Pond Along No Name)	8.3	1.3	-	< 0.005	< 0.1	-	25.8	25	140	51	0.007	< 0.003
No Name Impoundment (aka Mid No Name or Pond Along No Name)	8.2	1.2	-	< 0.005	< 0.1	-	30.2	33	270	183	-	-
No Name Impoundment (aka Mid No Name or Pond Along No Name)	8.2	1.1	-	< 0.005	< 0.1	-	26.2	30	260	-	-	-
No Name Impoundment (aka Mid No Name or Pond Along No Name)	9.3	1.0	-	< 0.005	< 0.1	-	27.7	29	290	32	-	-
No Name Impoundment (aka Mid No Name or Pond Along No Name)	9.9	2.0	-	< 0.005	< 0.1	-	39.1	40	270	22	-	-
No Name Impoundment (aka Mid No Name or Pond Along No Name)	6.5	1.3	-	< 0.005	< 0.2	-	33.6	< 5	220	19	-	-
No Name Impoundment (aka Mid No Name or Pond Along No Name)	-	-	-	< 0.001	-	-	-	-	-	-	0.0048	0.037
No Name Impoundment (aka Mid No Name or Pond Along No Name)	-	-	-	< 0.001	-	-	-	-	-	-	0.0070	0.003
No Name Impoundment (aka Mid No Name or Pond Along No Name)	7.5	6.4	< 0.001	< 0.001	< 0.5	< 0.00005	133	190	710	162	0.0024	0.002

D - Dissolved
T - Total
mg/L - milligrams per liter
µs/cm - microsiemens per centimeter
su - standard units

Table 18-18: Inventory of Water Wells and Groundwater Use

Well designation (Exhibit 18.2-1)	BIA number	Approximate location	Description	Date permitted	Use	Well depth (ft)	Aquifer	Yield (gpm)	Depth to Water (ft)	Notes
13R-28	13R-28	18 mi southwest of Fruitland near mouth of Cottonwood	Dug well, plank cribbed	NS	Livestock	12.5	Alluvium	NS	11.4	Destroyed. No Longer Exists
GM-18	None	Near well 13R-28 at mouth of Cottonwood	Dug well; also desingated QACW-2	NS	Monitoring/livestock	15.15	Alluvium		14-dry	
13-R-28A	13-R-28A	18 mi south-southwest of Fruitland on Cottonwood	Dug well; also desingated QACW-2B	NS	Livestock	6.5	Alluvium	NS	4.9	
13-5-1	13-5-1	On Pinabete tributary below pond, 9 mi north of Burnham Trading Post	Dug well, hand-pump operated; also referred to as Stevenson Well and 13-15-2	1-Mar-1965	Livestock	NS	Alluvium	NS	NS	Induced recharge from man-made pond
13R-37	13R-37	Near Pinabete on lease, 5 mi north of Burnham Trading Post	Dug well with windmill and tank; also referred to as 13-8-4	NS	Livestock	7.5	Alluvium	NS	6.2	
13R-38	13R-38	Near Pinabete off lease, 6 mi north-northeast of Burnham Trading Post	Dug well with windmill and tank; also referred to as GM-22	1-Nov-1931	Monitoring/livestock	11ft indicated, 14 ft measured	Alluvium	NS	10.7	
GM-23	None	Monitoring well mear mouth of No Name Arroyo	4" PVC casing installed March 1975	NS	Monitoring	19.35	Alluvium		Dry	Destroyed/ Abandoned
	13R-39	6 mi north-northeast of Burnham Trading Post	Dug well, could not locate; could be well 13-8-1 but depths don't match	1-Sep-1931	Livestock	8.5	Alluvium	NS		No Longer Exists
13-8-1	possibly 13R-39	Near Pinabete off lease, 0.8 mi east of well 13R-37	Dug well, open surface, not operational	Unknown	Livestock	12.8	Alluvium	NS	8.8	No Longer Exists
13R-48	13R-48	Near Pinabete, west of Burnham Road 9 mi north of Burnham Trading Post	Dug, with hand pump; also referred to as 13-15-3	1-Mar-1932	Livestock	9.55	Alluvium	0.5	7.2	water level on 7/26/89, No Longer Exists
13-15-1	None	1 mi south of No Name Impoundment, adjacent to ponds	cased well, welded shut, not perational, coarse sand unit (PCS?)	Not permitted	Livestock	NS	Unknown	NS	NS	
13-15-8	None	On Chaco River 1 mi upstream of No Name	Dug well	Not permitted	Livestock	NS	Alluvium	NS	NS	No Longer Exists
13-15-4	None	On Chaco River 0.6 mi downstream of Pinabete	Dug well	Not permitted	Livestock	NS	Alluvium	NS	NS	No Longer Exists
13AW	13T-513	Artesian well east of Chaco River, 0.6 mi south of No Name confluence	Oil and gas well completed for livestock	1-Mar-1967	Livestock	530	Artesian	NS	NS	

Table 18-18: Inventory of Water Wells and Groundwater Use

Well designation (Exhibit 18.2-1)	BIA number	Approximate location	Description	Date permitted	Use	Well depth (ft)	Aquifer	Yield (gpm)	Depth to Water (ft)	Notes
Unknown 2	None	West of Chaco River, 200 yds south of GM-32	Steel casing with large concrete pad for former windmill and storage tank	NS	Livestock	25	Alluvium	NS	18.3	
Unknown 3	None	West of Chaco River, 150 ft south of GM-32	Dug well, partially silted, open casing, not operational	NS	Livestock	7	Alluvium	NS	dry	
GM-32	None	West of Chaco River at mouth of Pena Blanca Wash	Dug well, hand-pump operated	NS	Monitoring/livestock	9.3	Alluvium	NS	8.3-dry	
13-15-5	None	North of GM-32 on west bank of Chaco River	Hand dug 1916, drilled 1966, dry	NS	Livestock	7.5	Alluvium	NS	Dry	
13-15-6	13-15-6	North of 13-15-5	Dug well, sides are eroding	NS	Livestock	13.6	Alluvium		Dry	
GM-34	None	East bank of Chaco River, south of Brimhall Wash	Dug well, not operational	NS	Monitoring/livestock	10.3	Alluvium	NS	9.33 to 9.45	
GM-35	None	Adj to Brimhall Wash west of Burnham Trading Post	Dug well, hand-pump operated	NS	Monitoring/livestock	8.7	Alluvium	NS	5.7 to 6.3	No Longer Exists
GM-36	None	East of Burnham Trading Post, 100 yds south of well 13-7-4	Dug well, bucket operated	NS	Monitoring/livestock	10.4	Alluvium	NS	9	
13-7-4	None	East of Burnham Trading Post	dug well, hand pump operated	NS	Livestock	NS	Alluvium	NS	NS	Not accessible
13-7-2	None	100 yds south of Burnham Chapter House	Windmill, orignially water supply for Burnham, replaced by 13T-514.	NS	Domestic	198.8	Pictured Cliffs Sandstone	NS	39	water level on 7/25/89 No Longer Exists
13T-514	13T-514	Southeast of Burnham Trading Post	Dug well, hand-pump operated	NS	Domestic	NS	Several sands, Menefee Fm	NS	NS	

gpm - gallon per minute
NS - not specified
PCS - Pictured Cliffs Sandstone
Fm - formation

Table 18-19: Water Depths and Elevations in Alluvial Monitoring Wells

Well Name	PA-1		PA-2			NNA-1		NNA-2	
Measuring point elevation (ft msl)	5352.9		5431.43			5431.63		5455.97	
Date	Water level (ft)	Elevation (ft msl)	Date	Water level (ft)	Elevation (ft msl)	Water level (ft)	Elevation (ft msl)	Water level (ft)	Elevation (ft msl)
3/26/1998	-	-		7.61	5423.82	-	-	-	-
3/29/1998	11.35	5341.55		7.69	5423.74	Dry	-	Dry	-
4/30/1998	11.42	5341.48		7.72	5423.71	Dry	-	Dry	-
5/12/1998	11.46	5341.44		7.94	5423.49	Dry	-	Dry	-
6/11/1998	11.63	5341.27		8.16	5423.27	13.7	5417.93	Dry	-
7/21/1998	12.04	5340.86		8.38	5423.05	13.11	5418.52	Dry	-
8/20/1998	11.87	5341.03		8.24	5423.19	13.23	5418.4	Dry	-
9/30/1998	11.7	5341.20		8.09	5423.34	13.34	5418.29	Dry	-
11/8/1998	11.4	5341.50		7.88	5423.55	13.23	5418.4	Dry	-
12/17/1998	11.18	5341.72		7.63	5423.8	12.87	5418.76	Dry	-
8/22/2007	11.85	5341.05		8.78	5422.65	Dry	-	Dry	-
9/4/2007	11.95	5340.95		8.76	5422.67	Dry	-	Dry	-
10/4/2007	12.1	5340.80		NA	-	Dry	-	Dry	-
11/5/2007	12.14	5340.76		-	-	Dry	-	Dry	-
11/15/2007	-	-		8.76	5422.67	-	-	-	-
12/3/2007	12.09	5340.81		-	-	-	-	-	-
12/5/2007	-	-		8.7	5422.73	Dry	-	Dry	-
1/17/2008	12.0	5340.90		8.6	5422.83	Dry	-	Dry	-
2/19/2008	-	-		8.6	5422.83	-	-	-	-
2/21/2008	11.7	5341.20		-	-	Dry	-	Dry	-
3/20/2008	11.6	5341.30		8.3	5423.18	Dry	-	Dry	-
4/24/2008	11.5	5341.40		5.5	5425.93	Dry	-	Dry	-
5/27/2008	11.0	5341.90		5.0	5426.43	Dry	-	Dry	-
6/24/2008	12.0	5340.90		8.2	5423.23	Dry	-	Dry	-
7/24/2008	12.2	5340.70		9.0	5422.43	Dry	-	Dry	-
8/19/2008	-	-		9.2	5422.23	Dry	-	Dry	-
8/20/2008	11.2	5341.70		-	-	Dry	-	Dry	-
9/30/2008	11.0	5341.90		9.0	5422.4	Dry	-	Dry	-
12/27/2011	13.25	5339.65	2/23/2012	9.31	5422.1				
2/21/2012	13.40	5339.50	6/14/2012	9.45	5422.0				
6/14/2012	13.85	5339.05	9/12/2012	9.19	5422.2				

Table 18-20: Alluvial Monitoring Well Summary and Aquifer Test Results

Well	Location (ft)		ID (in)	Elevation (ft)	Well depth (ft)	Test type	Transmissivity (ft^2/day)	Hydraulic conductivity		Saturated thickness
	Northing	Easting						(ft/day)	(cm/sec)	
PA-1	1990260.3	300409.2	2.1	5351.2	15.2	2.0 gpm pumping test	230.7	51.3	1.8E-02	4.5
PA-2	1980956.9	306702.8	2.1	5429.6	9.6	0.75 gpm pumping test	53.6	10.7	3.8E-03	5
NNA-1	1976857.2	296773.3	2.1	5430.5	24.8	NA	NA	NA	NA	0 to 11.5
NNA-2	1975404.9	299547.6	2.1	5454.7	22.1	NA	NA	NA	NA	0

ft^2/day - square feet per day
cm/sec - centimeter per second
NA - information not available
ID - inner diameter

Table 18-21: Water Depths and Elevations in Coal Monitoring Wells

Well name	KF-98-02 (No. 3 coal)		KF-98-03 (No. 3 coal)			KF-98-04 (No. 3 coal)			KF2007-01 (No. 8 coal)		
Measuring point elevation (ft msl)	5507.04			5425.53			5353.38			5459.96	
Date	Water level (ft)	Elevation (ft msl)	Date	Water level (ft)	Elevation (ft msl)	Date	Water level (ft)	Elevation (ft msl)	Date	Water level (ft)	Elevation (ft msl)
3/29/1998	206.84*	5300.2		131.5*	5294.03		63.11*	5290.27		-	-
4/30/1998	181.29	5325.75		130.76	5294.77		63.76	5289.62		-	-
5/12/1998	176.04	5331.00		130.58	5294.95		63.79	5289.59		-	-
6/11/1998	166.21	5340.83		132.66	5292.87		64.35	5289.03		-	-
7/21/1998	157.48	5349.56		131.79	5293.74		64.31	5289.07		-	-
11/8/1998	145.19	5361.85		131.75	5293.78		64.55	5288.83		-	-
12/17/1998	191.40	5315.64		132.78	5292.75		64.53	5288.85		-	-
8/22/2007	-	-		133.32	5292.21		Dry	-		67.63	5392.33
8/23/2007	147.34	5359.70		-	-		-	-		-	-
9/4/2007	154.92	5352.12		133.16	5292.37		Dry	-		67.36	5392.60
10/4/2007	152.57	5354.47		-	-		64.90	5288.48		-	-
10/9/2007	-	-		-	-		-	-		67.15	5392.81
11/5/2007	150.88	5356.16		-	-		Dry	-		-	-
11/15/2007	-	-		-	-		-	-		67.10	5392.86
12/5/2007	183.60	5323.44		133.59	5291.94		Dry	-		67.95	5392.01
1/17/2008	177.90	5329.14		132.80	5292.73		Dry	-		66.90	5393.06
2/19/2008	174.10	5332.94		133.80	5291.73		Dry	-		66.60	5393.36
3/20/2008	179.00	5328.04		133.40	5292.13		Dry	-		67.00	5392.96
4/24/2008	175.70	5331.34		132.70	5292.83		Dry	-		66.70	5393.26
5/27/2008	-	-		Dry	-		Dry	-		66.90	5393.06
5/28/2008	174.50	5332.54		-	-		-	-		-	-
6/24/2008	208.00	5299.04		133.80	5291.73		Dry	-		66.90	5393.06
7/24/2008	203.20	5303.84		132.10	5293.43		Dry	-		94.00	5365.96
8/19/2008	201.20	5305.84		-	-		-	-		67.00	5392.96
8/20/2008	-	-		132.50	5293.03		Dry	-		-	-
9/30/2008	206.80	5300.24		132.80	5292.73		Dry	-		67.20	5392.76
12/29/2011	145.4	5361.64	12/28/2011	129.30	5296.23	12/27/2011	dry	-	12/29/2011	67.50	5392.46
2/23/2012	147.0	5360.04	2/21/2012	134.10	5291.43	2/21/2012	65.00	5288.38	2/21/2012	67.90	5392.06
6/13/2012	168.3	5338.74	6/12/2012	132.90	5292.63	6/12/2012	dry	-	6/12/2012	67.55	5392.41
9/11/2012	179.8	5327.24	9/11/2012	132.12	5293.41	9/11/2012	dry	-	9/11/2012	67.69	5392.27

Table 18-22: Coal Monitoring Well Summary and Aquifer Test Results

Well	Location (ft)[1] Northing	Easting	Coal seam	Elevation (ft)	Well depth (ft)	Test type	Transmissivity (ft^2/day)	Hydraulic conductivity (ft/day)	(cm/sec)	Saturated thickness
Kf-98-02	1974601.45	2526796.60	#3	5505.89	216.5	Displacement Test	0.0010	0.0001	4.6E-08	7.5
Kf-98-03	1984332.35	2527508.40	#3	5423.45	133.9	Bailed Recovery Test	0.010	0.002	7.1E-07	5
Kf-98-04	1990225.42	2523277.83	#3	5351.80	64.8	Bailed Recovery Test	0.010	0.001	3.5E-07	10
Kf84-22D	2009478.18	2530679.02	#3	5124.20	220	MCWhorter Recovery	0.01	0.002	7.1E-07	5.0
Kpc2007-01	1995163.61	2525504.37	#8	5352.97	118	Papadopulos-Cooper Pumping Test	1.398	0.056	2.0E-05	25
SJKF84#3	2088296.86	2558656.03	#8	4990.18	120	MCWhorter Recovery	0.71	0.04	1.4E-05	18.0
SJKF84#4	2085218.97	2557197.37	#8	5046.67	71	MCWhorter Recovery	1.03	0.06	2.1E-05	18.0
SJKF84#5	2084335.75	2554186.41	#8	5092.00	180	MCWhorter Recovery	0.07	0.004	1.4E-06	18.0
KF84-20(d)	2017120.64	304307.65	#7	5213.92	190	MCWhorter Recovery	0.01	0.002	7.1E-07	5.0
Kf84-21C	2009797.60	2526457.46	#7	5219.66	75	MCWhorter Recovery	0.04	0.008	2.8E-06	5.0
Kf84-22B	2009478.18	2530679.02	#7	5204.10	140	MCWhorter Recovery	0.02	0.003	1.1E-06	5.0
Kf84-22C	2009478.18	2530679.02	#4-6	5142.50	202	MCWhorter Recovery	0.01	0.0014	4.9E-07	7.0
Kf84-20A	2017903.13	2526824.67	#2	5163.78	240	MCWhorter Recovery	0.009	0.001	3.5E-07	10.0
Kf84-22E	2009478.18	2530679.02	#2	5107.80	237	MCWhorter Recovery	0.01	0.001	3.5E-07	10.0

ft^2/day - square feet per day
cm/sec - centimeter per second
[1] Coordinate system - State Plane New Mexico West, NAD 1983

Table 18-23: Potentiometric Elevations in the Fruitland Coal Vibrating Wire Piezometers

VWP Name	VWP 2007-01 (yellow)	VWP 2007-01 (green)	VWP 2007-01 S6 (white)	VWP 2007-02 (#2)	VWP 2007-02 (#3)	VWP 2007-02 S7 (#4)	VWP 2007-02 S8 (#5)	VWP 2007-03 (#3)	VWP 2007-03 (#2)	VWP 2007-05 S2 (blue)
Coal Unit	S2a/S2b	S3	S6	S2	S3	S7	S8	S3	S2	S2
Date	Potentiometric elev (ft msl)	Potentiometric elev (ft msl)	Potentiometric elev (ft msl)	Potentiometric elev (ft msl)	Potentiometric elev (ft msl)	Potentiometric elev (ft msl)	Potentiometric elev (ft msl)	Potentiometric elev (ft msl)	Potentiometric elev (ft msl)	Potentiometric elev (ft msl)
8/22/2007	5275.44	5278.48	5331.54	5292.06	5288.98	5372.05	5394.32	5366.22	5360.25	-
8/23/2007	-	-	-	-	-	-	-	-	-	-
9/4/2007	5273.72	5278.78	5331.85	5291.73	5288.58	5371.69	5394.47	5367.05	5357.72	-
10/4/2007	-	-	-	-	-	-	-	-	-	-
10/9/2007	5273.44	5278.79	5330.39	5291.30	5287.63	5371.25	5393.71	5367.63	5357.26	-
11/5/2007	-	-	-	-	-	-	-	5367.88	5357.23	5410.91
11/15/2007	5273.37	5278.69	5329.97	5290.94	5288.21	5370.93	5393.77	-	-	-
12/3/2007	-	-	-	-	-	-	-	5367.74	5357.60	-
12/5/2007	-	5278.56	5329.88	5291.09	5287.85	5370.81	5393.67	-	-	5410.61
1/31/2008	5273.42	5278.79	5329.84	5291.91	5288.15	5370.74	5393.81	5368.04	5357.83	5410.71
2/19/2008	5273.05	5278.62	5330.05	5289.57	5287.20	5370.63	5393.56	5368.70	5357.74	-
3/20/2008	5273.15	5278.39	5330.09	5289.18	5286.96	5370.63	5393.71	5366.44	5385.30	-
3/27/2008	-	-	-	-	-	-	-	-	-	5410.24
4/24/2008	5273.23	5278.30	5330.11	5289.12	5286.86	5370.60	5393.67	5366.52	5385.50	5410.22
5/28/2008	5273.42	5286.86	5330.11	5289.70	5286.86	5370.54	5390.11	5365.97	5385.40	5410.27
6/24/2008	5273.47	5278.62	5330.15	5287.02	5287.02	5370.59	5390.11	5365.97	5385.40	5410.33
7/24/2008	5273.30	5278.76	5330.17	5289.63	5286.89	5370.51	5390.05	5366.05	5385.50	5410.33
8/19/2008	5273.42	5278.56	5330.17	5286.99	5287.51	5370.45	5393.48	5366.19	5358.26	5410.33
9/30/2008	5273.45	5278.53	5330.42	5287.63	5287.42	5370.51	5393.36	5366.14	5358.11	5410.39
12/28/2011	5274.38	5277.53	5331.84	5286.58	5286.87	5369.41	5393.35	5366.21	5357.45	5409.40
3/6/2012	5274.19	5277.44	5331.44	5286.48	5286.84	5368.97	5392.82	5366.07	5357.05	5409.30
6/12/2012	5274.65	5277.57	5331.39	5286.52	5286.84	5369.16	5393.08	5366.01	5357.19	5409.24
9/11/2012	5274.57	5277.51	5331.50	5286.42	5286.81	5369.09	5393.04	5365.85	5356.99	5409.30
12/4/2012	5274.72	5277.59	5331.82	5286.52	5286.87	5369.31	5393.96	5365.40	5357.08	5409.13
3/13/2013	5274.79	5277.59	5331.72	5286.48	5286.84	5369.23	5392.84	5365.32	5356.91	5408.79
6/11/2013	5274.68	5277.48	5331.33	5286.39	5286.72	5368.96	5392.90	5364.02	5356.45	5408.65
12/3/2014	5274.33	5277.23	5331.72	5286.30	5286.57	5369.05	5392.61	5365.15	5356.42	5407.39
6/3/2015	5274.31	5277.04	5331.72	5286.24	5286.60	5368.76	5389.98	5364.54	5356.19	5406.78
12/7/2015										
2/16/2016	5273.47	5276.74	5332.13	5286.21	5286.57	5369.08	5387.06	5364.43	5355.94	
8/16/2016	5273.29	5276.60	5331.78	5286.21	5286.57	5368.84	5390.51	5364.04	5355.82	5406.70
12/1/2016	5273.66	5276.17	5331.95	5286.21	5286.54	5368.94	5388.65	5363.68	5355.79	
2/24/2017	5273.31	5276.56	5331.95	5286.21	5286.54	5368.61	5388.40	5363.68	5355.65	5405.15
5/18/2017	5273.25	5276.49	5331.97	5286.21	5286.54	5369.02	5380.24	5363.52	5355.56	5404.58
11/30/2017	5273.18	5276.54	5332.21	5286.33	5286.69	5369.19	5380.80	5363.52	5355.79	5404.45
2/19/2018	5272.51	5276.22	5331.99	5286.24	5286.50	5368.87	5381.35	5363.07	5355.59	5404.53
5/21/2018	5272.95	5276.37	5331.91	5286.24	5286.50	5368.64	5382.63	5362.91	5355.45	5404.13
9/5/2018	5273.31	5276.42	5332.11	5286.30	5286.47	5368.99	5383.15	5362.74	5355.68	5403.49
11/21/2018	5272.92	5276.37	5332.34	5286.33	5286.54	5368.97	5386.27	5362.82	5355.68	5403.65

Table 18-24: Water Depths and Potentiometric Elevations in the Pictured Cliffs Sandstone Monitoring Wells and Piezometers

Well Name	KPC-98-01		KPC2007-01		KPC2007-02		KPC2007-03		VWP 2007-01 Kpc (blue)	VWP 2007-02 Kpc (#1)	VWP 2007-04 Kpc	VWP 2007-05 Kpc (red)
Measuring point elevation (ft msl)	5366.46		5355.71		5515.06		5470.23					
Date	Water depth (ft)	Elevation (ft msl)	Water depth (ft)	Elevation (ft msl)	Water depth (ft)	Elevation (ft msl)	Water depth (ft)	Elevation (ft msl)	Potentiometric elev (ft msl)	Potentiometric elev (ft- msl)	Potentiometric Elev. (ft- msl)	Potentiometric Elev. (ft- msl)
3/29/1998	91.31*	5275.15	-	-	-	-	-	-	-	-	-	-
4/30/1998	86.62	5279.84	-	-	-	-	-	-	-	-	-	-
5/12/1998	84.84	5281.62	-	-	-	-	-	-	-	-	-	-
6/11/1998	106.37	5260.09	-	-	-	-	-	-	-	-	-	-
7/21/1998	97.27	5269.19	-	-	-	-	-	-	-	-	-	-
11/8/1998	80.30	5286.16	-	-	-	-	-	-	-	-	-	-
12/17/1998	89.81	5276.65	-	-	-	-	-	-	-	-	-	-
8/22/2007	-	-	93.61	5262.10	217.55	5297.51	-	-	5270.44	-	-	-
8/23/2007	75.09	5291.37	-	-	-	-	128.66	5341.57	-	5298.44	-	-
9/4/2007	79.35	5287.11	93.68	5262.03	169.11	5345.95	128.03	5342.20	5268.35	5297.90	-	-
10/4/2007	77.56	5288.90	93.65	5262.06	-	-	-	-	-	5297.37	-	-
10/9/2007	-	-	-	-	-	-	-	-	5267.89	-	-	-
11/5/2007	76.51	5289.95	93.78	5261.93	183.30	5331.76	130.67	5339.56	-	-	5393.83	5411.60
11/15/2007	-	-	-	-	-	-	-	-	5268.14	-		
12/5/2007	78.15	5288.31	93.71	5262.00	163.16	5351.90	133.71	5336.52	5268.26	5296.81	5397.48	5411.26
1/31/2008	-	-	-	-	-	-	-	-	5268.09	5297.32	5393.68	5411.54
2/19/2008	-	-	-	-	-	-	-	-	5268.91	-	-	-
2/21/2008	-	-	-	-	-	-	-	-	-	5296.42	-	-
3/20/2008	89.80	5276.66	96.80	5258.91	158.80	5356.26	128.30	5341.93	5268.95	5296.48	5401.50	5410.79
4/24/2008	85.00	5281.46	94.10	5261.61	156.40	5358.66	123.50	5346.73	5268.78	5296.42	5401.82	5410.76
5/27/2008	81.50	5284.96	98.50	5257.21	155.90	5359.16	126.50	5343.73	-	-	-	-
5/28/2008	-	-	-	-	-	-	-	-	5269.01	5296.28	5402.20	5410.82
6/24/2008	79.90	5286.56	94.10	5261.61	157.10	5357.96	127.10	5343.13	5269.04	5296.48	5402.40	5410.88
7/24/2008	79.20	5287.26	94.00	5261.71	156.30	5358.76	126.70	5343.53	5268.76	5296.39	5402.86	5410.85
8/19/2008	-	-	-	-	157.80	5357.26	-	-	5268.83	5296.14	5402.95	5410.85
8/20/2008	78.40	5288.06	94.10	5261.61	-	-	126.70	5343.53	-	-	-	-
9/30/2008	77.70	5288.76	94.40	5261.31	155.20	5359.86	126.80	5343.43	5268.66	5296.25	5403.30	5410.94
12/28/2011									5265.80	5295.68	5452.94	5410.05
3/6/2012									5265.55	5295.29	5452.97	5409.96
6/12/2012									5265.84	5295.57	5448.29	5409.90
9/11/2012									5265.84	5295.57	5446.30	5409.96

Table 18-25: Water Depths in the Pictured Cliffs Sandstone Monitoring Wells from 1970s and 1980s

Well name	GM-19		GM-20		GM-21		GM-28		GM-29		GM-30A	
	Water depth (ft)	Elevation (ft msl)	Water depth (ft)	Elevation (ft msl)	Water depth (ft)	Elevation (ft msl)	Water depth (ft)	Elevation (ft msl)	Water depth (ft)	Elevation (ft msl)	Water depth (ft)	Elevation (ft msl)
Measuring point elevation	NA	5385.0	NA	5470.0	NA	5610.0	NA	5320.0	NA	5380.0	NA	5520.0
11/16/1974	-	-	-	-	-	-	-	-	-	-	132.6	5387.4
3/27/1975	-	-	-	-	-	-	-	-	-	-	132.7	5387.3
11/19/1975	-	-	-	-	-	-	-	-	-	-	132.7	5387.3
12/9/1975	-	-	-	-	-	-	-	-	-	-	133.2	5386.8
9/26/1983	-	-	-	-	-	-	52.7	5267.4	-	-	-	-
9/27/1983	119.6	5265.5	137.5	5332.6	1892.0	5428.1	-	-	-	-	135.0	5385.0
4/17/1984	-	-	-	-	-	-	81.0	5239.0	-	-	-	-
7/7/1989	119.7	5265.3	-	-	-	-	54.6	5265.4	74.4	5305.6	-	-
7/26/1989	-	-	137.1	5332.9	181.7	5428.4	-	-	-	-	133.2	5386.8

ft msl - feet above mean sea level
NA - information not available
(-) no measurement taken

Table 18-26: Pictured Cliffs Sandstone Monitoring Well Summary and Aquifer Test Results

Well	Location (ft)[1]		Elevation (ft)	Well Depth (ft)	Test type	Transmissivity (ft^2/day)	Hydraulic conductivity		Saturated thickness (ft)	Storage coefficient
	Northing	Easting					(ft/day)	(cm/sec)		
KPC-98-01	1993802	290787	5366.46	125.7	0.4 gpm pumping test	0.79	0.020	7.1E-06	39	NA
KPC2007-01	1995103	302596	5355.71	208.84	NA	0.576	0.0074	2.6E-06	78	NA
KPC2007-02	1975119	303891	5515.06	320.98	NA	NA	0.0001	3.5E-08	NA	NA
KPC2007-03	1982885	295091	5470.23	138.4	NA	NA	0.0040	1.4E-06	NA	NA
Pumping test well T4-1	1976250	289850	5520	228	0.15 gpm pumping	0.1203	0.0014	4.9E-07	84	0.00032
Recovery test well GM-30A	1975811	290347	NA	191.6	NA	0.1337	0.0016	5.6E-07	84	0.00034
O-1 (18.3 gpm for 8.7 min)	1958366	320663	5520	414	Cooper slug test	2.7300	0.0321	1.1E-05	85	NA
					Horslev slug test	3.7500	0.0441	1.6E-05	85	NA

[1] Coordinates State Plane New Mexico West NAD 1983

ft^2/day - square feet per day
cm/sec - centimeter per second
gpm - gallon per minute
NA - information not available or not determined

Table 18-27: Baseline Surface Water Quality Analytes with Applicable Water Quality Standards

Parameter (units)	Primary and secondary drinking water standards	Livestock and wildlife watering criteria
Total alkalinity (mg/L)	NA	NA
Arsenic (mg/L)	0.05	0.2
Barium (mg/L)	1	NA
Bicarbonate (mg/L)	NA	NA
Boron (mg/L)	0.63	5
Ion balance (%)	NA	NA
Cadmium (mg/L)	0.005	0.05
Calcium (mg/L)	NA	NA
Carbonate (mg/L)	NA	NA
Chloride (mg/L)	250*	NA
Chromium (mg/L)	0.1	1
Electrical conductivity (EC) (uS/cm)	NA	NA
Copper (mg/L)	1.3	0.5
Fluoride (mg/L)	2*	2
Hydroxide (mg/L)	NA	NA
Iron (mg/L)	NA	NA
Total iron (mg/L)	0.3*	-
Lead (mg/L)	0.015	0.1
Magnesium (mg/L)	NA	NA
Manganese (mg/L)	NA	NA
Total manganese (mg/L)	0.05*	-
Mercury (mg/L)[1]	0.002	0.01
Nitrate (mg/L-N)	10	NA
pH (su)	6.5 - 9.0	NA
Potassium (mg/L)	NA	NA
Radium-226 (pCi/L)	5	5
Radium-228 (pCi/L)	5	5
Selenium (mg/L)[2]	0.05	0.05
Silver (mg/L)	0.035	NA
Sodium (mg/L)	NA	NA
Sulfate (mg/L)	250*	1000
Total dissolved solids (TDS) (mg/L)	500*	2212
Uranium (mg/L)	NA	NA
Zinc (mg/L)	5*	25

[1] Wildlife standard for mercury is 0.000012 mg/L, which is below detection limits of the analytical procedure
[2] Wildlife standard for total selenium is 0.002 mg/L
*secondary standard
** Ra-226 + Ra-228
NA - no standard for the parameter
(-) s no analysis performed
mg/L - milligram per liter
µS/cm - microsiemens per centimeter
su - standard units
pCi/L - picocuries per liter

Table 18-28: Water Quality at Pinabete Arroyo Alluvial Well PA-1

Parameter (units)	3/29/1998	5/15/1998	8/20/1998	11/8/1998	11/5/2007	2/21/2008	5/27/2008	8/20/2008	11/21/2008
Alkalinity (mg/L)	300	297	282	301	304	314	310	224	344
Arsenic (mg/L)	<0.005	<0.005	<0.005	<0.005	0.0008	<0.0005	0.0007	<0.0005	0.0008
Barium (mg/L)	0.05	0.03	0.9	0.03	0.0161	0.0144	0.0262	0.0164	0.0174
Bicarbonate (mg/L)	365	362	344	367	371	314	310	216	344
Boron (mg/L)	0.17	0.2	0.2	0.22	0.787	0.2	0.2	0.2	0.2
Ion balance (%)	6.77	0.89	3.88	2.38	5.99	1.06	1.78	0.85	1.64
Cadmium (mg/L)	<0.001	<0.001	<0.001	<0.001	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Calcium (mg/L)	85.4	68.5	103	90.6	110	116	137	139	101
Carbonate (mg/L)	<1	<1	<1	<1	<10	<10	<10	<10	<10
Chloride (mg/L)	25	22	29	16	14	17	36	25	18
Chromium (mg/L)	0.03* (total)	<0.01	<0.01	<0.01	0.005	0.004	0.004	<0.001	<0.001
Electrical conductivity (EC) (uS/cm)	2540	2410	2310	2150	2380	2380	2680	3050	2520
Copper (mg/L)	<0.01	<0.01	<0.01	<0.01	0.0106	0.0151	0.0101	0.0094	0.0079
Fluoride (mg/L)	2.49	2.36	2.39	2.53	2.2	2.2	2.1	2.2	3
Hydroxide (mg/L)	<1	<1	<1	<1	<10	<10	<10	<10	<10
Iron (mg/L)	0.99	0.06	<0.02	<0.02	<0.05	<0.05	<0.05	<0.05	<0.05
Total iron (mg/L)	41.9	3.07	4.43	0.25	16.7	17.5	53.2	1.39	3.88
Lead (mg/L)	<0.005	<0.005	<0.005	<0.005	<0.0001	<0.0001	0.0002	0.0002	0.0003
Magnesium (mg/L)	15.4	13.4	16.5	13.8	16.3	17.9	22.3	22.3	16.4
Manganese, D (mg/L)	0.138	0.005	0.017	<0.01	0.118	0.057	0.488	0.218	0.087
Manganese, T (mg/L)	1.31	0.843	0.37	0.03	0.487	0.302	3.56	0.350	0.142
Mercury (mg/L)[1]	<0.001	<0.001	<0.001	<0.001	<0.0002	<0.0002	0.0002	<0.0002	<0.0002

Table 18-28: Water Quality at Pinabete Arroyo Alluvial Well PA-1

Parameter (units)	3/29/1998	5/15/1998	8/20/1998	11/8/1998	11/5/2007	2/21/2008	5/27/2008	8/20/2008	11/21/2008
Nitrate (mg/L-N)	0.66	0.72	<0.05	NM	0.05	0.03	0.04	0.10	0.05
pH (su)	7.6	7.5	7.5	7.7	7.61	7.54	7.53	7.48	7.78
Potassium (mg/L)	9.8	1.8	1.7	2.9	1.4	1.3	2.7	1.7	1.7
Radium-226 (pCi/L)	<1.69	5.78	NM	0.91	2.9 ± 0.9	0.42 ± 0.34	1.3 ± 0.4	0.6 ± 0.42	0.10 ± 0.22
Radium-228 (pCi/L)	<1.9	5.77	NM	11.74	1.5 ± 0.7	0.60 ± 0.40	1.1 ± 0.6	0.53 ± 0.49	0.48 ± 0.38
Selenium (mg/L)[2]	0.005	0.005	<0.005	<0.005	0.006	0.004	0.006	0.003	0.006
Silver (mg/L)	<0.01	<0.01	<0.01	<0.01	<0.00005	<0.00005	0.00006	<0.00005	<0.00005
Sodium (mg/L)	375	458	374	377	418	457	511	503	445
Sulfate (mg/L)	893	833	875	805	1040	1060	1140	1280	980
Total dissolved solids (TDS) (mg/L)	1610	1640	1730	1500	1680	4310	1950	2030	1750
Uranium (mg/L)	-	-	-	-	0.01010	0.01080	0.01350	0.01620	0.01230
Zinc (mg/L)	0.053	0.037	<0.025	0.043	0.007	0.002	0.002	0.002	0.007

[1] Wildlife standard for mercury is 0.000012 mg/L, which is below detection limits of the analytical procedure
[2] Wildlife standard for total selenium is 0.002 mg/L
*secondary standard
** Ra-226 + Ra-228
(-) s no analysis performed
mg/L - milligram per liter
µS/cm - microsiemens per centimeter
su - standard units
pCi/L - picocuries per liter

Table 18-29: Water Quality at Pinabete Arroyo Alluvial Well PA-2

Parameter (units)	3/30/1998	5/15/1998	8/20/1998	11/11/1998	11/15/2007	2/21/2008	5/27/2008	8/19/2008	11/20/2008
Total alkalinity (mg/L)	293	281	315	327	410	308	328	405	430
Arsenic (mg/L)	<0.005	<0.005	<0.005	<0.005	0.0012	0.0007	0.0018	0.0008	0.0027
Barium (mg/L)	0.04	0.02	<0.2	0.02	0.0107	0.0129	0.0195	0.0143	0.0119
Bicarbonate (mg/L)	357	342	384	398	451	308	328	405	430
Boron (mg/L)	0.19	0.2	0.22	0.31	0.2	2.1	0.2	0.3	0.2
Ion balance (%)	4.27	2.64	1.65	3.2	16	6.5	5.57	0.61	8.18
Cadmium (mg/L)	<0.001	<0.001	<0.001	<0.001	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Calcium (mg/L)	56.8	61	101	95	95	96.0	96.8	90.8	92.3
Carbonate (mg/L)	<1	<1	<1	<1	24	<10	<10	<10	<10
Chloride (mg/L)	22	65	51	35	38	30	32	42	45
Chromium (mg/L)	0.03* (total)	<0.01	<0.01	<0.01	0.006	0.004	0.003	<0.001	0.009
Electrical conductivity (EC) (uS/cm)	4390	4510	4530	4520	4600	4410	4110	5010	4860
Copper (mg/L)	<0.01	<0.01	<0.01	<0.01	0.0508	0.0116	0.0225	0.0226	0.0220
Fluoride (mg/L)	2.47	2.81	3.06	2.91	2.8	2.4	2.5	3.1	3.3
Hydroxide (mg/L)	<1	<1	<1	<1	<10	<10	<10	<10	<10
Iron (mg/L)	0.11	<0.02	<0.02	0.04	<0.05	<0.05	<0.05	<0.05	<0.05
Total iron (mg/L)	63.9	2.88	6.55	0.13	1.86	5.61	3.03	1.86	3.19
Lead (mg/L)	<0.005	<0.005	<0.005	<0.005	<0.0001	<0.0001	0.0001	0.0002	0.0001
Magnesium (mg/L)	12	11	16	15	0.0277	15.5	16.7	15.5	16.7
Manganese (mg/L)	1.33	0.456	0.22	0.11	0.0277	0.090	0.141	0.128	0.135
Total manganese (mg/L)	3.71	0.525	0.88	0.24	0.552	1.27	0.599	0.551	0.748
Mercury (mg/L)[1]	<0.001	<0.001	<0.001	<0.001	<0.0002	<0.0002	0.0002	<0.0002	<0.0002

Table 18-29: Water Quality at Pinabete Arroyo Alluvial Well PA-2

Parameter (units)	3/30/1998	5/15/1998	8/20/1998	11/11/1998	11/15/2007	2/21/2008	5/27/2008	8/19/2008	11/20/2008
Nitrate (mg/L-N)	0.27	0.32	<0.05	NM	0.06	0.08	0.08	0.11	0.05
pH (su)	7.9	7.4	7.3	7.5	7.19	7.41	7.5	7.21	7.31
Potassium (mg/L)	5	2	3	5.4	2.1	2.0	2.4	3.3	3.2
Radium-226 (pCi/L)	<1.69	27.9	-	0.48	0.67 ± 0.43	0.40 ± 0.39	0.45 ± 0.34	0.60 ± 0.40	2.5 ± 0.7
Radium-228 (pCi/L)	<1.9	1.74	-	9.02	0.62 ± 0.48	1.4 ± 0.6	0.19 ± 0.56	1.2 ± 0.5	0.55 ± 0.37
Selenium (mg/L)[2]	0.0007	0.006	<0.005	<0.005	0.012	0.009	0.014	0.010	0.018
Silver (mg/L)	<0.01	<0.01	<0.01	<0.01	<0.00005	<0.00005	0.00009	<0.00005	<0.00005
Sodium (mg/L)	781	981	872	891	809	850	907	966	1000
Sulfate (mg/L)	1670	1760	1690	1940	2200	2100	2150	1950	2400
Total Dissolved Solids (TDS) (mg/L)	2990	3150	3600	3420	3500	3070	3030	3540	3580
Uranium (mg/L)	-	-	-	-	0.01230	0.01120	0.01350	0.01160	0.01170
Zinc (mg/L)	0.051	0.025	<0.025	0.18	0.003	0.008	0.009	0.004	0.008

[1] Wildlife standard for mercury is 0.000012 mg/L, which is below detection limits of the analytical procedure
[2] Wildlife standard for total selenium is 0.002 mg/L
*secondary standard
** Ra-226 + Ra-228
(-) no analysis performed
mg/L - milligram per liter
µS/cm - microsiemens per centimeter
su - standard units
pCi/L - picocuries per liter

Table 18-30: Water Quality at No Name Arroyo Alluvial Well NNA-1[1]

Parameter (units)	8/20/1998	11/11/1998
Arsenic (mg/L)	<0.005	<0.005
Barium (mg/L)	0.9	0.02
Boron (mg/L)	2.4	0.84
Cadmium (mg/L)	<0.001	<0.001
Chromium (mg/L)	<0.01	<0.01
Copper (mg/L)	<0.01	<0.01
Iron (mg/L)	<0.02	0.04
Lead (mg/L)	<0.005	<0.005
Manganese (mg/L)	0.084	0.45
Mercury (mg/L)[2]	<0.001	<0.001
Selenium (mg/L)[3]	0.008	0.043
Silver (mg/L)	<0.01	<0.01
Zinc (mg/L)	<0.025	0.21
Total Iron (mg/L)	1.56	0.17
Total manganese (mg/L)	0.13	0.66
pH (su)	7.6	7.6
Electrical conductivity (EC) (uS/cm)	13100	20700
Total dissolved solids (TDS) (mg/L)	12600	13400
Fluoride (mg/L)	1.93	0.97
Bicarbonate (mg/L)	639	719
Carbonate (mg/L)	<1	<1
Chloride (mg/L)	180	127
Sulfate (mg/L)	7150	10100

Table 18-30: Water Quality at No Name Arroyo Alluvial Well NNA-1[1]

Parameter (units)	8/20/1998	11/11/1998
Calcium (mg/L)	333	293
Magnesium (mg/L)	249	205
Potassium (mg/L)	15	28.3
Sodium (mg/L)	2640	3220
Hydroxide (mg/L)	<1	NA
Total Alkalinity (mg/L)	524	589
Nitrate (mg/L-N)	5.26	NA
Ion balance (%)	3.9	13.45
Radium-226 (pCi/L)	NA	1.37
Radium-228 (pCi/L)	NA	2.81

[1] Site visited on dates shown in Table 18.2-2. Dry during most sampling events

[2] Wildlife standard for mercury is 0.000012 mg/L, which is below detection limits of the analyt

[3] Wildlife standard for total selenium is 0.002 mg/L

*secondary standard

** Ra-226 + Ra-228

Table 18-31: Water Quality at No. 3 Coal Seam Well KF-98-02

Parameter (units)	3/29/1998	11/8/1998	8/23/2007	11/5/2007	2/19/2008	5/28/2008	8/19/2008	11/20/2008
Total alkalinity (mg/L)	2030	1830	1530	1040	1320	1390	1620	1580
Arsenic (mg/L)	<0.005	0.007	0.0055	0.0057	0.0058	0.0045	0.0028	0.0051
Barium (mg/L)	0.25	0.07	0.1399	0.0925	0.1230	0.175	0.3380	0.1420
Bicarbonate (mg/L)	<1	<1	1037	1269	1200	1390	1580	1560
Boron (mg/L)	0.09	0.44	0.3	1.47	0.4	0.3	0.4	0.5
Ion balance (%)	4.87	2.7	3.04	8.77	0.51	1.21	4.89	2.63
Cadmium (mg/L)	<0.001	<0.001	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Calcium (mg/L)	48.5	5.5	1.6	16.2	5.5	9.1	6.7	4.6
Carbonate (mg/L)	105	317	408	<10	120	<10	40	20
Chloride (mg/L)	170	404	930	650	920	950	1210	1280
Chromium (mg/L)	0.09* (total)	<0.01	0.029	0.02	0.033	0.017	0.002	0.069
Electrical conductivity (EC) (uS/cm)	12600	8540	5510	3790	4910	5440	7050	7090
Copper (mg/L)	0.04	0.03	0.0192	0.0124	0.0222	0.053	0.0305	0.0263
Fluoride (mg/L)	2.31	1.29	1.8	1.4	1.7	0.2	1.8	1.6
Hydroxide (mg/L)	-	-	<10	<10	<10	<10	<10	<10
Iron (mg/L)	0.12	0.34	<0.05	<0.05	<0.05	0.05	0.08	0.07
Total iron (mg/L)	0.4	0.45	0.14	0.891	0.53	0.52	0.42	1.01
Lead (mg/L)	<0.005	<0.005	0.0003	0.0003	0.0003	0.0002	0.0005	0.0001
Magnesium (mg/L)	<2	<0.2	0.6	<0.5	0.8	1.0	2.7	2.4
Total manganese (mg/L)	0.013	<0.01	0.007	0.016	0.020	0.019	0.039	0.017
Manganese (mg/L)	<0.005	<0.01	<0.005	<0.005	0.025	0.011	0.044	0.045

Table 18-31: Water Quality at No. 3 Coal Seam Well KF-98-02

Parameter (units)	3/29/1998	11/8/1998	8/23/2007	11/5/2007	2/19/2008	5/28/2008	8/19/2008	11/20/2008
Mercury (mg/L)[1]	<0.001	<0.001	<0.0002	<0.0002	<0.0002	0.0003	<0.0002	<0.0002
Nitrate (mg/L-N)	3.56	-	<0.02	0.06	<0.02	0.03	0.03	0.02
pH (su)	12.6	12	9.55	7.53	8.11	7.89	7.79	8.01
Potassium (mg/L)	111	50.5	12.1	8.5	11.5	12.1	13.3	13.0
Radium-226 (pCi/L)	<1.69	3.35	0.13 ± 0.28	0.31 ± 0.32	0.77 ± 0.58	0.82 ± 0.72	0.50 ± 0.36	0.18 ± 0.28
Radium-228 (pCi/L)	2.61	7.82	-0.02 ± 0.46	0.34 ± 0.50	0.64 ± 0.70	0.74 ± 0.75	0.83 ± 0.49	0.51 ± 0.43
Selenium (mg/L)[2]	0.0333	0.007	0.008	0.008	0.008	0.006	0.005	0.009
Silver (mg/L)	<0.01	<0.01	<0.00005	<0.00005	<0.00005	0.00033	<0.00005	0.00016
Sodium (mg/L)	1170	1120	1250	786	1170	1170	1310	1510
Sulfate (mg/L)	796	251	64	136	118	96	120	36
Total dissolved solids (TDS) (mg/L)	3760	3140	3180	2220	3050	3080	4040	4100
Uranium (mg/L)	-	-	-	0.00424	0.00595	0.00546	0.00532	0.00540
Zinc (mg/L)	<0.025	0.081	<0.001	0.006	0.001	<0.001	0.008	0.010

[1] Wildlife standard for mercury is 0.000012 mg/L, which is below detection limits of the analytical procedure

[2] Wildlife standard for total selenium is 0.002 mg/L

*secondary standard

** Ra-226 + Ra-228

(-) no analysis performed

mg/L - milligram per liter

µS/cm - microsiemens per centimeter

su - standard units

pCi/L - picocuries per liter

Table 18-32: Water Quality at Navajo Mine Coal Monitoring Wells

Parameter (units)	KF84-20A (No. 2 & 3) median	KF84-21A (No. 3) median	KF84-20B (No. 4) 2/6/1986	KF84-18A (No. 6) median	KF84-20C (No. 7) median	KF84-22B (No. 7) median	KF83-1 (No. 8) median	KF84 (No. 8) median	KF84-16 (No. 8) median	KF84-18B (No. 8) median	KF84-22A (No. 8) median
Well depth (ft)	236	119.3	216	180.2	190	141.65	145	141.5	293.6	134.7	125.5
Boron (mg/L)	0.56	0.61	0.13	0.72	0.41	0.38	1.01	1.30	1.27	0.74	0.26
Total iron (mg/L)	2.67	0.08	-	3.80	0.64	1.22	0.13	1.68	0.34	11.55	0.21
Manganese, D (mg/L)	0.06	-	-	1.33	0.04	0.27	-	0.13	0.03	0.37	-
Iron, D (mg/L)	0.12	-	0.04	0.10	0.13	0.22	0.04	0.10	0.10	0.49	-
Manganese, T (mg/L)	0.18	0.01	-	1.33	0.06	0.28	-	0.20	0.04	0.38	0.02
Field pH (su)	7.7	7.8	-	7.3	7.7	7.35	7.6	7.7	7.4	6.94	7.9
Total dissolved solids -180° (mg/L)	7260	8375	6660	13400	2770	6100	7140	7760	9955	9270	4680
Fluoride (mg/L)	1.39	1.62	0.80	0.67	1.74	0.88	1.05	2.70	0.69	0.44	2.19
Bicarbonate as HCO_3 (mg/L)	1090	1193	-	451	1560	852	2940	1445	2855	1030	1140
Carbonate as CO_3 (mg/L)	-	-	-	-	-	-	-	-	-	-	-
Chloride (mg/L)	3715	4435	79	7900	715	3230	2380	326.5	4551	4890	290
Sulfate (mg/L)	2.06	64	172	-	-	0.5	330	3955	15.5	3.06	2230
Calcium (mg/L)	18.4	13.4	16.5	159.0	9.6	44.5	19.6	48.0	38.7	113.0	15.5
Magnesium (mg/L)	11.0	14.9	0.0	51.2	2.8	13.1	7.0	26.0	15.0	24.2	3.5
Potassium (mg/L)	11.9	13.4	337.0	22.5	5.9	11.8	9.6	9.4	16.3	14.6	6.7
Sodium (mg/L)	2690	3095	904	4660	1040	2210	2650	2565	3815	3365	1600
Nitrate as N (mg/L)	0.115	0.1	-	0.1	0.18	0.08	6.24	0.08	0.08	0.1	0.875

T - total
D - disolved
(-) no analysis performed
mg/L - milligram per liter
su - standard units

Table 18-33: Water Quality at No. 8 Coal Seam Well KF2007-01

Parameter (units)	8/16/2007	11/15/2007	5/27/2008	8/19/2008	11/20/2008
Total alkalinity (mg/L)	1800	1670	1670	1750	1750
Arsenic (mg/L)	0.0014	0.003	0.002	0.0017	0.0028
Barium (mg/L)	0.0297	0.0351	0.0344	0.0280	0.0293
Bicarbonate (mg/L)	2098	1074	1190	1490	1550
Boron (mg/L)	0.2	0.329	0.3	0.4	0.4
Ion balance (%)	7.1	4.6	8.19	6.21	1.92
Cadmium (mg/L)	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Calcium (mg/L)	4.2	2.2	2.7	3.9	3.2
Carbonate (mg/L)	48	474	480	260	200
Chloride (mg/L)	278	364	362	338	320
Chromium (mg/L)	0.012	0.032	0.024	0.003	0.067
Electrical conductivity (EC) (uS/cm)	8240	7380	6330	5560	5170
Copper (mg/L)	0.0362	0.1180	0.0737	0.0349	0.0232
Fluoride (mg/L)	3.1	2.6	2.6	2.7	3.3
Hydroxide (mg/L)	<10.	<10	<10	<10	<10
Iron (mg/L)	<0.05	<0.05	<0.05	<0.05	<0.05
Total iron (mg/L)	<0.05	0.0847	0.33	1.20	0.29
Lead (mg/L)	<0.0001	0.0003	<0.0001	0.0004	0.0322
Magnesium (mg/L)	1.6	1.4	1.6	1.8	1.5
Manganese (mg/L)	0.008	<0.005	0.007	0.013	0.008
Total manganese (mg/L)	0.011	0.0168	0.023	0.052	0.017

Table 18-33: Water Quality at No. 8 Coal Seam Well KF2007-01

Parameter (units)	8/16/2007	11/15/2007	5/27/2008	8/19/2008	11/20/2008
Mercury (mg/L)[1]	<0.0002	<0.0002	0.0004	<0.0002	<0.0002
Nitrate (mg/L-N)	<0.02	<0.02	0.29	0.43	0.25
pH (su)	8.12	9.56	9.09	8.64	8.75
Potassium (mg/L)	9	46.9	28.9	17.9	16.4
Radium-226 (pCi/L)	0.11 ± 0.27	0.51 ± 0.35	0.33 ± 0.42	0.50 ± 0.39	0.30 ± 0.30
Radium-228 (pCi/L)	0.32 ± 0.48	0.89 ± 0.46	0.58 ± 0.50	0.76 ± 0.53	0.55 ± 0.35
Selenium (mg/L)[2]	0.006	0.004	0.005	0.004	0.005
Silver (mg/L)	<0.00005	<0.00005	0.00006	0.00007	<0.00005
Sodium (mg/L)	995	1780	1430	1160	1180
Sulfate (mg/L)	315	2050	1380	740	620
Total dissolved solids (TDS) (mg/L)	2750	5160	4130	3460	3250
Uranium (mg/L)	0.00060	0.00059	0.00044	0.00058	0.00037
Zinc (mg/L)	0.002	0.003	0.002	0.014	0.010

[1] Wildlife standard for mercury is 0.000012 mg/L, which is below detection limits of the analytical procedure

[2] Wildlife standard for total selenium is 0.002 mg/L

*secondary standard

** Ra-226 + Ra-228

mg/L - milligram per liter

µS/cm - microsiemens per centimeter

su - standard units

pCi/L - picocuries per liter

Table 18-34: Water Quality at Pictured Cliffs Sandstone Monitoring Well KPC-98-01

Parameter (units)	3/29/1998	11/8/1998	8/23/2007	11/5/2007	2/21/2008	5/27/2008	8/20/2008	11/21/2008
Total alkalinity (mg/L)	131	581	750	930	900	870	740	850
Arsenic (mg/L)	<0.005	<0.005	0.0042	0.00193	0.0019	0.002	0.0017	0.0035
Barium (mg/L)	0.02	0.02	0.0138	0.0101	0.0123	0.0236	0.0132	0.0126
Bicarbonate (mg/L)	132	709	891	1135	900	870	740	850
Boron (mg/L)	0.12	0.61	0.6	1.11	0.7	0.7	0.6	0.7
Ion balance (%)	2.13	3.71	4.6	8.3	2.17	0.49	6.89	1.61
Cadmium (mg/L)	<0.001	<0.001	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Calcium (mg/L)	26.5	33.1	28	25.2	26.8	30.8	28.4	28.6
Carbonate (mg/L)	14	<1	12	<10	<10	<10	<10	<10
Chloride (mg/L)	39	177	310	212	234	244	220	236
Chromium (mg/L)	<0.01* (total)	<0.01	0.018	0.124	0.012	0.004	0.001	0.021
Electrical conductivity (EC) (uS/cm)	1380	6550	5510	8250	8250	8250	8730	8700
Copper (mg/L)	<0.01	<0.01	0.0396	0.026	0.0571	0.43	0.0468	0.0807
Fluoride (mg/L)	2.29	1.13	1.3	1.4	1.4	1.3	1.5	1.5
Hydroxide (mg/L)	NM	NM	<10	<10	<10	<10	<10	<10
Iron (mg/L)	0.46	1.51	0.68	<0.05	<0.05	<0.05	<0.05	<0.05
Total iron (mg/L)	2.51	1.74	0.68	29.5	7.60	2.71	0.16	0.51
Lead (mg/L)	<0.005	0.005	0.0001	<0.0001	0.0003	0.0003	0.0002	0.0001
Magnesium (mg/L)	2.7	5.7	8.2	6.8	7.7	8	7.4	7.7
Manganese (mg/L)	0.013	0.08	0.063	0.0673	0.058	0.051	0.037	0.039

Table 18-34: Water Quality at Pictured Cliffs Sandstone Monitoring Well KPC-98-01

Parameter (units)	3/29/1998	11/8/1998	8/23/2007	11/5/2007	2/21/2008	5/27/2008	8/20/2008	11/21/2008
Total manganese (mg/L)	0.038	0.1	0.073	0.111	0.183	0.082	0.044	0.045
Mercury (mg/L)[1]	<0.001	<0.001	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Nitrate (mg/L-N)	1.54	NM	<0.02	2.29	1.94	4.46	2.68	1.92
pH (su)	9.1	8	7.78	7.76	7.70	7.79	7.73	7.87
Potassium (mg/L)	8.2	17.3	9.2	7.1	8.6	10	8.5	8.1
Radium-226 (pCi/L)	<1.69	3.92	0.92 ± 0.49	1.0 ± 0.5	1.2 ± 0.5	1.5 ± 0.5	0.76 ± 0.44	0.61 ± 0.36
Radium-228 (pCi/L)	<1.9	5.42	1.2 ± 0.5	1.6 ± 0.6	1.1 ± 0.4	1.2 ± 0.5	1.2 ± 0.5	1.3 ± 0.4
Selenium (mg/L)[2]	<0.005	<0.005	0.005	0.00346	0.006	0.005	0.005	0.011
Silver (mg/L)	<0.01	<0.01	<0.00005	0.00006	<0.00005	0.00007	<0.00005	<0.00005
Sodium (mg/L)	202	1490	2150	1790	1930	2270	1690	1980
Sulfate (mg/L)	350	2680	3900	3350	3300	3800	3300	3400
Total disolved soids (TDS) (mg/L)	800	4830	6640	6060	6050	5900	5820	6360
Uranium (mg/L)	-	-	0.01901	0.01230	0.01220	0.00952	0.01000	0.01010
Zinc (mg/L)	0.093	0.365	0.002	0.201	0.018	0.022	0.019	0.027

[1] Wildlife standard for mercury is 0.000012 mg/L, which is below detection limits of the analytical procedure

[2] Wildlife standard for total selenium is 0.002 mg/L

*secondary standard

Table 18-35: Water Quality at Pictured Cliffs Sandstone Monitoring Well KPC2007-01

Parameter (units)	8/16/2007	11/15/2007	2/19/2008	5/28/2008	8/20/2008	11/20/2008
Total alkalinity (mg/L)	1480	1870	1900	1280	1600	1440
Arsenic (mg/L)	0.006	0.0058	0.0052	0.0234	0.0025	0.0051
Barium (mg/L)	0.0342	0.0096	0.0214	0.0341	0.0191	0.0173
Bicarbonate (mg/L)	1420	710	340	1220	620	1060
Boron (mg/L)	0.3	0.429	0.5	0.6	0.4	0.5
Ion balance (%)	9	10.4	11.1	6.13	17.9	7.82
Cadmium (mg/L)	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Calcium (mg/L)	13.4	3.6	2.4	18.6	3	11.6
Carbonate (mg/L)	60	1160	1560	60	980	380
Chloride (mg/L)	320	304	292	374	365	580
Chromium (mg/L)	0.005	0.025	0.040	0.008	0.002	0.063
Electrical conductivity (EC) (uS/cm)	8240	8260	8070	7950	8560	9250
Copper (mg/L)	0.0934	0.104	0.0785	0.2470	0.0369	0.0412
Fluoride (mg/L)	1.7	1.5	1.5	1.8	1.6	1.6
Hydroxide (mg/L)	<10	<10	<10	<10	<10	<10
Iron (mg/L)	<0.05	<0.05	<0.05	0.13	<0.05	<0.05
Total iron (mg/L)	1.11	0.0892	0.93	533	0.17	1.57
Lead (mg/L)	<0.0001	<0.0001	<0.0001	0.0004	0.0002	0.0002
Magnesium(mg/L)	7.3	0.0056	4.2	9.4	4.4	7.1

Table 18-35: Water Quality at Pictured Cliffs Sandstone Monitoring Well KPC2007-01

Parameter (units)	8/16/2007	11/15/2007	2/19/2008	5/28/2008	8/20/2008	11/20/2008
Manganese (mg/L)	0.034	0.0244	<0.005	0.022	<0.005	0.0785
Total manganese (mg/L)	0.055	0.024	0.022	9.73	0.006	0.137
Mercury (mg/L)[1]	<0.0002	<0.0002	<0.0002	0.001	<0.0002	<0.0002
Nitrate (mg/L-N)	<0.02	<0.02	0.03	0.05	0.65	0.07
pH (su)	8.19	9.82	10.3	8.35	9.85	9.14
Potassium (mg/L)	18.1	76.9	73.3	14.3	35.2	16.2
Radium-226 (pCi/L)	0.18 ± 0.28	0.61 ± 0.39	0.01 ± 0.28	2.0 ± 0.7	0.33 ± 0.32	0.10 ± 0.22
Radium-228 (pCi/L)	0.86 ± 0.57	0.19 ± 0.44	0.37 ± 0.57	0.42 ± 0.45	0.50 ± 0.47	0.37 ± 0.43
Selenium (mg/L)[2]	0.008	0.003	0.004	0.006	0.004	0.008
Silver (mg/L)	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	0.0001
Sodium (mg/L)	1720	2020	1920	1840	1600	2020
Sulfate (mg/L)	2750	2500	2000	2900	2350	2800
Total disolved solids (TDS) (mg/L)	5820	5820	5650	6790	5640	6280
Uranium (mg/L)	0.00187	0.00149	0.00065	0.00472	0.00080	0.00089
Zinc (mg/L)	0.006	0.004	0.001	0.012	0.003	0.008

[1] Wildlife standard for mercury is 0.000012 mg/L, which is below detection limits of the analytical procedure

[2] Wildlife standard for total selenium is 0.002 mg/L

*secondary standard

Table 18-36: Water Quality at Pictured Cliffs Sandstone Monitoring Well GM-21

Parameter (units)	11/16/1974	8/4/1976	8/22/1977	9/10/1979
Arsenic (mg/L)	<0.5	<0.01	<0.01	<.0001
Barium (mg/L)	-	<0.1	<0.5	0.05
Boron (mg/L)	0.88	0.7	1.0	1.10
Cadmium (mg/L)	0.081	<0.001	<0.01	<.01
Chromium (mg/L)	-	0.005	<0.01	0.03
Copper (mg/L)	0.025	<0.001	0.01	<0.01
Iron (mg/L)	0.2	0.198	<0.05	0.04
Lead (mg/L)	<0.05	0.001	<0.05	0.26
Manganese (mg/L)	0.05	<0.039	0.07	0.03
Mercury (mg/L)[1]	<0.0005	<0.0004	<0.001	-
Selenium (mg/L)[2]	<0.05	<0.01	<0.01	0.001
Silver (mg/L)	-	<0.001	<0.05	<0.1
Zinc (mg/L)	0.447	0.045	0.06	0.62
Total iron (mg/L)	-	-	-	0.41
Total manganese (mg/L)	-	-	-	0.11
pH (su)	7.9	7.2	7.3	7
Electrical conductivity (EC) (uS/cm)	-	-	-	-
Total disolved solids (TDS) (mg/L)	6923	6624	6370	6140
Fluoride (mg/L)	-	-	-	-

Table 18-36: Water Quality at Pictured Cliffs Sandstone Monitoring Well GM-21

Parameter (units)	11/16/1974	8/4/1976	8/22/1977	9/10/1979
Bicarbonate (mg/L)	585	-	-	-
Carbonate (mg/L)	-	-	-	-
Chloride (mg/L)	780	646	150	118
Sulfate (mg/L)	3600	2502	2625	3740
Calcium (mg/L)	423	155	414	-
Magnesium (mg/L)	65	148	62	-
Potassium (mg/L)	-	-	-	-
Sodium (mg/L)	1470	920	1440	-
Hydroxide (mg/L)	-	-	-	-
Total alkalinity (mg/L)	-	-	-	-
Nitrate (mg/L-N)	-	-	0.4	-
Ion balance (%)	8.2	-	-	-
Radium-226 (pCi/L)	-	-	-	0.11
Radium-228 (pCi/L)	-	-	-	-

[1] Wildlife standard for mercury is 0.000012 mg/L, which is below detection limits of the analytical proced

[2] Wildlife standard for total selenium is 0.002 mg/L

*secondary standard

** Ra-226 + Ra-228

Table 18-37: Water Quality at Pictured Cliffs Sandstone Monitoring Well GM-20

Parameter (units)	11/16/1974	5/18/1976	10/6/1976	8/22/1977	12/20/1977	9/10/1979
Arsenic (mg/L)	<0.5	0.01	0.03	<0.01	<0.01	<0.001
Barium (mg/L)	-	0.24	<0.1	<0.5	<0.1	0.1
Boron (mg/L)	0.68	0.88	0.2	0.9	1.2	2.24
Cadmium (mg/L)	<0.010	0.001	<0.001	<0.01	0.001	<0.1
Chromium (mg/L)	-	0.013	0.019	<0.01	0.012	0.01
Copper (mg/L)	0.025	0.016	0.006	0.01	0.008	0.03
Iron (mg/L)	0.15	0.64	0.066	<0.05	0.35	0.01
Lead (mg/L)	<0.05	0.035	0.034	<0.05	<0.001	0.10
Manganese (mg/L)	0.035	0.026	0.008	<0.001	0.16	0.29
Mercury (mg/L)[1]	<0.0005	<0.0004	<0.0004	<0.001	<0.0004	-
Selenium (mg/L)[2]	<0.05	<0.01	<0.01	<0.01	<0.01	0.001
Silver (mg/L)	-	<0.001	<0.001	<0.05	<0.01	<.01
Zinc (mg/L)	0.08	0.08	<0.001	<0.05	0.04	1.06
Total iron (mg/L)	-	-	-	-	-	0.03
Total manganese (mg/L)	-	-	-	-	-	0.29
pH (su)	11.8	9.3	8.6	8.7	7.3	7
Electrical conductivity (EC) (uS/cm)	-	-	-	-	-	-
Total disoved solids (TDS) (mg/L)	5033	5711	5822	5880	5050	5260

Table 18-37: Water Quality at Pictured Cliffs Sandstone Monitoring Well GM-20

Parameter (units)	11/16/1974	5/18/1976	10/6/1976	8/22/1977	12/20/1977	9/10/1979
Fluoride (mg/L)	-	-	-	-	-	-
Bicarbonate (mg/L)	192	475	-	462	269	-
Carbonate (mg/L)	471	105	-	-	-	-
Chloride (mg/L)	1030	2118	1280	1430	757	803
Sulfate (mg/L)	1880	1725	1830	2050	2380	2250
Calcium (mg/L)	11	10.6	8.5	11	9.3	-
Magnesium (mg/L)	0.7	4.32	4.56	7	19	-
Potassium (mg/L)	-	-	-	-	-	-
Sodium (mg/L)	1640	2000	1690	2020	1600	-
Hydroxide (mg/L)	-	-	-	-	-	-
Total alkalinity (mg/L)	-	-	-	-	-	-
Nitrate (mg/L-N)	-	-	0.08	0.6	0.2	-
Ion balance (%)	9.5	9.8	-	0.9	2.5	-

[1] Wildlife standard for mercury is 0.000012 mg/L, which is below detection limits of the analytical procedure

[2] Wildlife standard for total selenium is 0.002 mg/L

*secondary standard

Table 18-38: Water Quality at Pictured Cliffs Sandstone Monitoring Well GM-19

Parameter (units)	11/16/1974	8/5/1976	8/8/1977	9/10/1979
Arsenic (mg/L)	<0.5	<0.001	<0.05	0.33
Barium (mg/L)	-	<0.1	<0.5	0.08
Boron (mg/L)	1.03	0.3	1.0	0.88
Cadmium (mg/L)	0.016	<0.001	<0.01	<.01
Chromium (mg/L)	-	0.001	<0.01	<.01
Copper (mg/L)	0.015	0.001	0.02	0.02
Iron (mg/L)	0.4	0.005	<0.05	0.01
Lead (mg/L)	<0.05	0.001	<0.05	0.1
Manganese (mg/L)	0.245	0.088	0.06	0.11
Mercury (mg/L)[1]	<0.0005	<0.0004	<0.001	-
Selenium (mg/L)[2]	<0.05	<0.01	<0.01	0.002
Silver (mg/L)	-	<0.001	<0.05	<.01
Zinc (mg/L)	0.240	0.031	0.07	0.42
Total iron (mg/L)	-	-	-	0.01
Total manganese (mg/L)	-	-	-	0.12
pH (su)	8.1	7.83	7.9	7.5
Electrical conductivity (EC) (uS/cm)	-	-	-	-
Total disolved soilds (TDS) (mg/L)	9172	8437	7810	9270

Table 18-38: Water Quality at Pictured Cliffs Sandstone Monitoring Well GM-19

Parameter (units)	11/16/1974	8/5/1976	8/8/1977	9/10/1979
Fluoride (mg/L)	1.7	0.76	0.9	1.49
Bicarbonate (mg/L)	1000	-	-	-
Carbonate (mg/L)	-	-	-	-
Chloride (mg/L)	1020	534.8	668	1077
Sulfate (mg/L)	4050	3685	4000	4535
Calcium (mg/L)	43	13.2	200	-
Magnesium (mg/L)	19	3.83	38	-
Potassium (mg/L)	-	-	-	-
Sodium (mg/L)	3040	1610	2200	-
Hydroxide (mg/L)	-	-	-	-
Total akalinity (mg/L)	-	-	-	-
Nitrate (mg/L-N)	-	-	1.2	-
Ion balance (%)	2.4	-	-	-

[1] Wildlife standard for mercury is 0.000012 mg/L, which is below detection limits of the analytical proce

[2] Wildlife standard for total selenium is 0.002 mg/L

*secondary standard

Table 18-39: Water Quality at Pictured Cliffs Sandstone Monitoring Well GM-30A

Parameter (units)	5/19/1976	8/22/1977	9/10/1979
Arsenic (mg/L)	<0.01	<0.01	0.0019
Barium (mg/L)	0.4	<0.5	0.03
Boron (mg/L)	0.46	0.6	0.96
Cadmium (mg/L)	<0.001	<0.01	<.01
Chromium (mg/L)	0.010	<0.01	0.01
Copper (mg/L)	0.007	0.01	<.01
Iron (mg/L)	0.49	<0.05	0.01
Lead (mg/L)	0.20	<0.05	0.13
Manganese (mg/L)	0.07	0.04	<.01
Mercury (mg/L)[1]	<0.0004	<0.001	-
Selenium (mg/L)[2]	<0.01	<0.01	0.002
Silver (mg/L)	<0.001	<0.05	<.01
Zinc (mg/L)	0.09	<0.05	0.16
Total iron (mg/L)	-	-	0.02
Total manganese (mg/L)	-	-	0.05
pH (su)	7.6	7.5	7.5
Electrical conductivity (EC) (uS/cm)	-	-	-
Total disolved solids (TDS) (mg/L)	6573	6930	7070

Table 18-39: Water Quality at Pictured Cliffs Sandstone Monitoring Well GM-30A

Parameter (units)	5/19/1976	8/22/1977	9/10/1979
Fluoride (mg/L)	-	-	-
Bicarbonate (mg/L)	171	210	-
Carbonate (mg/L)	-	-	-
Chloride (mg/L)	1215	1120	1203
Sulfate (mg/L)	422	3100	3105
Calcium (mg/L)	30.8	102	-
Magnesium (mg/L)	17.7	22	-
Potassium (mg/L)	-	-	-
Sodium (mg/L)	2070	2110	-
Hydroxide (mg/L)	-	-	-
Total alkalinity (mg/L)	-	-	-
Nitrate (mg/L-N)	0.51	0.4	-
Ion balance (%)	34	4.5	-

[1] Wildlife standard for mercury is 0.000012 mg/L, which is below detection limits of the analytical procedure

[2] Wildlife standard for total selenium is 0.002 mg/L

(-) analysis not performed for parameter

mg/L - milligram per liter

Table 18:40: Measured and Modeled Recharge Rates

Surface characterization	Recharge range[1] (in/yr)	Mean recharge[1] (in/yr)	Modeled recharge (in/yr)
Badlands	0.002 to 0.01	0.006	
Slopes > 5%			0.002
Slopes: 2 to 5%			0.01
Upland flat	.02 to 0.05	0.03	
Upland flat (slope<1%)			0.03
Upland (slope 1 to 2%)			0.02
Alluvial valley	0.09	0.09	0.09

[1]From Stone 1987

Formation: Pinabete Alluvium

Well Name Ground Surface Elevation 5351.9 ft amsl	Sample Date	Depth to water, TOC, ft; TOC Elevation 5353.8 ft amsl	Total Depth, ft	Field Temperature, F	Lab pH, SU	Lab Conductivity, umho/cm	TDS, 180C, mg/l	Alkalinity, Total as CaCO3, mg/L	Bicarbonate as HCO3, mg/L	Carbonate as CO3, mg/L	Chloride, mg/L	Sulfate, mg/L	Fluoride, mg/L	Boron, dissolved, mg/L
PA-1	12/27/2011	13.25	16.40	58.1	7.7	2020	1330	280	340	ND	9	690	3	0.1
PA-1	2/21/2012	13.40		56.516	7.7	1950	1310	270	340	ND	11	660	2	0.2
PA-1	6/14/2012	13.85		60.98	7.5	2060	1380	290	360	ND	10	750	2.3	0.2
PA-1	9/12/2012	13.56		61.682	7.5	2080	1350	280	340	ND	8	780	2.4	0.2
PA-1	12/6/2012	13.77		13.62	7.6	1940	1330	260	300	8	8	740	2.3	0.2
PA-1	3/14/2013	13.77		56.894	7.4	2080	1080	270	320	ND	10	710	2.1	0.2
PA-1	6/13/2013	14.05		59.72	7.5	2030	1360	280	340	ND	10	800	2	0.2
PA-1	12/11/2013	9.00		57.38	7.5	2160	1490	300	370	ND	14	900	2.4	0.2
PA-1	5/28/2014	12.46		59.54	7.7	2150	1430	270	330	ND	8	840	2.5	0.1
PA-1	12/9/2014	13.75		15.68	7.6	2170	1530	280	340	ND	7	760	2.3	0.1
PA-1	6/23/2015				7.7	2130	1500	280	340	ND	8	787	2.5	0.1
PA-1	12/7/2015	13.10												
PA-1	2/11/2016	13.10												
PA-1	8/11/2016	13.11												
PA-1	11/30/2016	13.11												
PA-1	3/1/2017	13.10												
PA-1	5/16/2017	12.86												
PA-1	8/29/2017	12.90												
PA-1	11/28/2017	12.92												
PA-1	2/27/2018	12.90												
PA-1	5/23/2018	12.91												
PA-1	9/10/2018	dry												
PA-1	12/3/2018	dry												
PA-1	3/14/2019	14.70		43.7	7.8	2100	1340	550	670	ND	197	278	1	0.31
PA-1	6/11/2019	15.00												
PA-1	9/4/2019	14.75		79.16										
PA-1	2/19/2020	dry												
PA-1	5/14/2020	14.90												
PA-1	8/19/2020	dry												
PA-1	11/10/2020	dry												
PA-1	1/27/2021	dry												
PA-1	6/21/2021	dry												
PA-1	8/17/2021	dry												
PA-1	11/17/2021	dry												
PA-1	2/25/2022	dry												
PA-1	5/26/2022	dry												
PA-1	8/18/2022	15.49												
PA-1	10/11/2022	15.95												
PA-1	02/2023	dry												
PA-1	05/2023	dry												
PA-1	8/22/2023	dry												
PA-1	11/8/2023	17.65												
PA-1	2/12/2024	17.70												
PA-1	5/8/2024	16.68												
PA-1	8/12/2024	15.98												
PA-1	11/11/2024	14.75												
PA-1	2/17/2025	17.63												

Calcium, dissolved, mg/L	Iron, dissolved, mg/L	Magnesium, dissolved, mg/L	Manganese, dissolved, mg/L	Potassium, dissolved, mg/L	Selenium, dissolved, mg/L	Sodium, dissolved, mg/L	Iron, Total, mg/L	Manganese, Total, mg/L	A/C, %	Sample Notes
83.2	0.05	12	0.014	1.6	0.009	330			-2	Pump failure. Unable to bail/TDS recorded as (KG/L)
83.4	ND	12.8	ND	1.5	0.007	346			1	cloudy, no odor/TDS recorded as (KG/L)
87.5	0.09	13.4	0.012	1.9	0.01	340			-4	cloudy (lt. brown), no odor/TDS recorded as (KG/L)
							27.4	2.98		
96.5	ND	15	ND	1.6	0.008	376	13.3	0.426	1	slightly turbid
87.3	ND	13.6	ND	1.4	0.008	349	11.9	0.429	-1	
94.9	ND	14.9	ND	1.8	0.008	353	8.9	0.257	2	ghtly turbid; light brown/TDS recorded as (KG/L)
89.5	ND	13.2	ND	1.5	0.008	343	19.6	0.613	-5	oid; light brown, no odor, cloudy/TDS recorded as (KG/L)
94.9	0.09	16.1	0.051	1.1	0.005	386	11.3	0.329	-5	slightly turbid; no odor/TDS recorded as (KG/L)
99.8	1.94	15.5	0.156	2.3	0.009	359	2.8	0.119	-3	Slightly turbid; cloudy/TDS recorded as (KG/L)
102	10	14.1	ND	1.3	0.007	332	10	0.281	-3	
90.9	ND	13.9	0.016	1.2	0.007	342	5.5	0.178	-4	
										Insufficient Volume for sampling/TDS recorded as (KG/L)
										Insufficient Volume for sampling/TDS recorded as (KG/L)
										Insufficient Volume for sampling.
										Insufficient Volume for sampling.
										Insufficient Volume for sampling.
										Insufficient Volume for sampling.
										Insufficient Volume for sampling.
										Insufficient Volume for sampling.
										Insufficient Volume for sampling.
										Insufficient Volume for sampling.
										water levels only
										water levels only
44.9	ND	7.8	0.095	4.2	ND	432	7.59	0.323	-1.56	
										Insufficient Volume for sampling.
										Insufficient Volume for sampling.
										Dry
										Dry
										Dry
										Dry
										Dry
										Dry
										Dry
										Dry
										Dry
										Dry
										no sample
										no sample
										no sample
										no sample
										no sample
										no sample
										no sample
										no sample
										no sample
										no sample
										no sample

Formation: Pinabete Alluvium

Well Name Ground Surface Elevation 5429.89 ft amsl	Sample Date	Depth to water, TOC, ft; TOC Elevation 5431.6 ft amsl	Total Depth, ft	Field Temperature, F	Lab pH, SU	Lab Conductivity, umho/cm	TDS, 180C, mg/l	Alkalinity, Total as CaCO3, mg/L	Bicarbonate as HCO3, mg/L	Carbonate as CO3, mg/L	Chloride, mg/L
PA-2	2/23/2012	9.31	11.80	49.06	7.6	4030	2970	300	360	ND	26
PA-2	6/14/2012	9.45		65.68	7.5	4490	3080	370	450	ND	29
PA-2	9/12/2012	9.19		70.92	7.5	6000	4140	360	440	ND	34
PA-2	12/6/2012	9.53		60.61	7.6	4470	3300	380	410	24	44
PA-2	3/14/2013	9.37		53.13	7.6	4740	3090	350	420	ND	31
PA-2	6/13/2013	9.51		62.06	7.5	5180	3810	450	540	ND	38
PA-2	12/11/2013	8.70		53.60	7.4	14200	10500	450	540	ND	430
PA-2	5/28/2014	6.23		58.28	7.5	12500	10900	290	360	ND	260
PA-2	12/9/2014	10.31		57.56	7.4	11900	9940	320	400	ND	110
PA-2	6/23/2015	9.35		64.40	7.5	9650	7930	330	400	ND	83
PA-2	12/7/2015	dry									
PA-2	2/11/2016	dry									
PA-2	8/16/2016	dry									
PA-2	11/28/2016	dry									
PA-2	3/1/2017	dry									
PA-2	5/17/2017	dry									
PA-2	8/24/2017	dry									
PA-2	11/28/2017	dry									
PA-2	2/26/2018	dry									
PA-2	5/22/2018	dry									
PA-2	9/5/2018	dry									
PA-2	11/21/2018	dry									
PA-2	3/14/2019	10.45		57.38	7.8	7170	5820	340	410	ND	53.9
PA-2	6/11/2019	10.40									
PA-2	9/4/2019	10.50									
PA-2	12/11/2019	10.6		53.96	7.1	8650	7230	650	790	ND	92.4
PA-2	2/25/2020	10.6		51.08	7.7	8390	6830	610	740	ND	82.7
PA-2	5/18/2020	10.6									

PA-2	8/25/2020	10.8	7.3	8660	7050	430	520	ND	78.8
PA-2	11/16/2020	10.7							
PA-2	2/1/2021	10.9							
PA-2	6/23/2021	11							
PA-2	8/18/2021	11.4							
PA-2	11/18/2021	11.6							
PA-2	2/28/2022	11.6							
PA-2	5/26/2022	10.9							
PA-2	8/18/2022	11.1							
PA-2	10/11/2022	11.42							
PA-2	02/2023	dry							
PA-2	05/2023	dry							
PA-2	8/22/2023	11.5							
PA-2	11/8/2023	dry							
PA-2	2/12/2024	dry							
PA-2	5/8/2024	11.39							
PA-2	8/19/2024	11.09							
PA-2	11/13/2024	11.78							
PA-2	2/11/2025	dry							

Sulfate, mg/L	Fluoride, mg/L	Boron, dissolved, mg/L	Calcium, dissolved, mg/L	Iron, dissolved, mg/L	Magnesium, dissolved, mg/L	Manganese, dissolved, mg/L	Potassium, dissolved, mg/L	Selenium, dissolved, mg/L	Sodium, mg/L	Iron, Total, mg/L	Manganese, Total, mg/L	A/C, %
1700	2	0.1	90.5	ND	15.3	0.067	2.5	0.008	850	-	-	-1
1800	2.8	0.2	91.1	0.14	14.8	0.08	3.2	0.007	876	15.6	4.26	-1
3000	2.7	0.2	170	ND	27.1	0.083	4	0.008	1290	4.8	0.561	-2
1800	2.8	0.2	94.3	ND	16.3	0.134	3	0.007	961	7.4	1.76	2
1900	2.3	0.2	104	ND	17.8	0.043	2.9	0.007	946	6	2.23	1
2300	2.2	0.2	109	0.06	18.1	0.231	3.5	0.005	1080	40.9	9.26	-4
8300	2.8	0.3	339	0.12	85.5	0.109	6.6	0.021	3400	6.6	1.28	-6
6900	2.5	0.2	424	0.25	93.3	0.065	5.6	0.03	2910	2.3	0.726	-1
5800	2.5	0.2	347	ND	75.8	0.103	6.5	0.017	2480	1.9	0.846	0
5240	2.6	0.2	284	0.56	61.3	0.141	5	0.013	2070	2.7	0.93	-4
3670	2.6	0.18	191	ND	37.3	0.068	3.2	0.012	1530	0.52	0.084	-3.5
4270	2.4	0.33	181	0.24	39.9	0.34	6.3	0.011	1900	15.6	0.99	-4.83
3940	2.3	0.3	181	0.04	37.7	0.241	5.5	0.012	1990	9.21	0.852	1.16

4380	3	0.32	187	2	37.4	0.137	5.8	0.017	2040	4.12	0.237	-0.43

Sample Notes

brown, no odor

Dk. brown, no odor

black water

Charcoal gray color, no odor

black, no odor, turbid

black, no odor

black, turbid

Sample collected after full purge volume

Dry Well

Insufficient Volume for sampling

Insufficient Volume for sampling.

Insufficient Volume for sampling.

Insufficient Volume for sampling.

Insufficient Volume for sampling.

Insufficient Volume for sampling.

Insufficient Volume for sampling.

Insufficient Volume for sampling.

Insufficient Volume for sampling.

water level only

water level only

cloudy light tan hue, sampled

insufficient volume for sampling; low recharge

no sample
no sample
no sample
no sample
no sample
no sample
no sample
no sample
no sample
no sample
no sample
no sample
no sample
no sample
no sample
no sample
no sample
no sample
no sample

Well Name Ground Surface Elevation 5507.0 ft amsl	Sample Date	Depth to water, TOC, ft; TOC Elevation 5507.83 ft amsl	GWEL	Total Depth, ft	Field Temperature, F	Lab pH, SU	Lab Conductivity, umho/cm	TDS, 180C, mg/l	Alkalinity, Total as CaCO3, mg/L	Bicarbonate as HCO3, mg/L	Carbonate as CO3, mg/L	Chloride, mg/L	Sulfate, mg/L	Fluoride, mg/L	Boron, dissolved, mg/L	Calcium, dissolved, mg/L	Iron, dissolved, mg/L	Iron, Total, mg/L
KF98-02	12/29/2011	145.4	5362.4	232.4	61.88													
KF98-02	2/23/2012	147.0	5360.8		62.92	7.5	5710	3780	960	1200	ND	1100	580	2.5	0.2	129	ND	1.56
KF98-02	6/13/2012	168.3	5339.5		70.56	7.9	6310	4220	1400	1600	23	1200	240	1.3	0.6	47.7	0.5	0.5
KF98-02	9/11/2012	179.8	5328.0		68.31	7.9	6410	3430	1400	1600	28	1300	190	1.5	0.4	129	ND	1.8
KF98-02	12/5/2012	180.9	5327.0		18.07	8	6390	3400	1400	1500	98	1200	170	1.4	0.5	47.7	ND	0.5
KF98-02	3/12/2013	180.7	5327.1		66.88	8	6290	3120	1400	1600	46	1200	220	13	0.5	29.9	ND	0.4
KF98-02	6/12/2013	180.2	5327.6		66.74	7.9	6380	3610	1400	1700	36	1300	220	1.3	0.4	20.8	0.18	32.6
KF98-02	12/11/2013	175.7	5332.1		62.24	8	5980	3450	1400	1700	10	1200	270	1.3	0.4	16	0.11	0.8
KF98-02	5/28/2014	177.6	5330.3		71.60	8	6350	3760	1300	1500	85	1100	170	1.5	0.5	16.1	0.12	0.2
KF98-02	12/2/2014	172.1	5335.7		16.70	8	6490	3610	1400	1300	200	1200	160	1.4	0.4	14.5	ND	0.5
KF98-02	6/23/2015	172.6	5335.2		67.82	7.8	6370	3780	1400	1400	150	1220	169	1.5	0.4	12.5	0.07	1.2
KF98-02	12/8/2015	175.5	5332.3		62.56	7.7	6160	3760	1400	1500	90	1180	183	1.4	0.5	16.1	ND	0.5
KF-98-02	2/18/2016	176.8	5331.0		67.93	7.60	6050	3710	1400	1700	ND	1160	265	1.4	0.5	16.30	0.12	0.20
KF-98-02	8/15/2016	175.9	5331.9		66.70	7.9	6270	3710	1400	1600	79	1220	175	1.5	0.45	20.2		0.85
KF-98-02	12/1/2016	176.2	5331.6		65.08	8	6200	3770	1400	1600	60	1200	140	1.5	0.45	23.60	0.03	0.05
KF-98-02	2/27/2017	175.9	5332.0		64.33	7.9	6030	3590	1300	1500	57	1100	250	1.4	0.44	20.10	0.04	0.39
KF-98-02	5/17/2017	177.3	5330.6		64.17	7.9	5550	3350	1200	1500	ND	950	370	1.3	0.48	21.3	0.1	0.30
KF-98-02	8/28/2017	177.3	5330.5		66.07	8	5890	3560	1300	1500	41	1070	251	1.4	0.4	16.60	2.45	-
KF-98-02	11/29/2017	177.8	5330.0		61.81	7.6	3820	2530	500	610	ND	247	1080	1	0.06	17.20	0.06	6.73
KF-98-02	3/1/2018	176.9	5330.9		62.92	7.6	4510	3020	820	1000	ND	507	751	1.1	0.25	19.00	0.13	0.30
KF-98-02	5/22/2018	176.8	5331.0		65.50	7.6	4180	2910	660	800	ND	375	925	1.1	0.14	31.40	0.06	2.94
KF-98-02	9/6/2018	174.3	5333.5		25.55	8	5910	3690	1300	1300	160	1080	230	1.4	0.42	41.2	0.08	0.28
KF-98-02	11/30/2018	172.0	5335.8		63.14	7.8	4080	2520	550	680	ND	294	1000	0.8	0.09	38.9	0.12	0.47
KF-98-02	3/22/2019	173.7	5334.1		58.46	8.2	6270	3710	1300	1200	180	1100	440	1.3	0.47	19.4	0.02	0.90
KF-98-02	6/11/2019	180.6	5327.2															
KF-98-02	9/11/2019	186.4	5321.4															
KF-98-02	12/11/2019	189.4	5318.4															
KF-98-02	2/26/2020	188.4	5319.4		56.84	8	4410	2880	660	780	12	443	856	1	0.17		ND	0.54
KF-98-02	5/27/2020	187.5	5320.3		51.84	8.3	6290	3860	1400	1700	28	1300	209	1.4	0.48	10.9	0.02	0.13
KF-98-02	8/26/2020	186.1	5321.7			8.1	5830	3520	1200	1000	190	1200	364	1.4	0.43	14.3	0.09	4.22
KF-98-02	11/18/2020	171.0	5336.8															

KF-98-02	2/3/2021	197.8	5310.0		8.1	6300	3760	1300	1500	50	1270	234	1.3	0.56	10.3	0.07	0.7
KF-98-02	6/29/2021	198.0	5309.8														
KF-98-02	8/19/2021	197.4	5310.4														
KF-98-02	11/22/2021	199.1	5308.7														
KF-98-02	2/25/2022	199.2	5308.6														
KF-98-02	5/25/2022	152.5	5355.3														
KF-98-02	8/17/2022	150.08	5357.8														
KF-98-02	10/11/2022	157.02	5350.8														
KF-98-02	2/15/2023	151.28	5356.6														
KF-98-02	5/1/2023	149.95	5357.9														

Magnesium, dissolved, mg/L	Manganese, dissolved, mg/L	Manganese, Total, mg/L	Potassium, dissolved, mg/L	Selenium, dissolved, mg/L	Sodium, dissolved, mg/L	A/C, %	Sample Notes
							Sulfur odor
26.7	0.027	0.048	9.3	0.005	1160	-5	
9.9	0.03	0.5	10	ND	1370	-3	
6.7	0.031	0.062	9.9	0.001	1510	-1	slightly turbid
5.4	0.037	0.046	9.3	ND	1430	-2	
4	0.029	0.035	9.2	ND	1430	-2	Clear, no odor
3.3	0.047	0.632	10.8	ND	1260	-10	
2.9	0.005	0.043	8.3	ND	1400	-5	
3.2	0.022	0.024	8	ND	1460	3	
2.7	0.025	0.035	7.9	ND	1390	-1	
2.7	0.029	0.055	7.7	ND	1370	-1	Sample collected after field parameters stabilize
2.7	0.038	0.045	8.3	ND	1380	-3	Samples taken and preserved
2.9	0.038	0.04	8.2	0.00	1430	-1	
3.03		0.05	8.40	ND	1400	-	
2.88	0.033	0.03	8.2	ND	1430.00	-0.89	
2.9	0.034	0.04	8.1	ND	1390.00	-0.28	Samples taken and preserved.
3.2	0.045	0.10	8.2	ND	1480.00	5.47	Samples taken and preserved.
2.66	0.039	-	7.8	ND	1980	-0.91	Samples taken and preserved.
0.5	0.026	0.46	6.1	0.004	849.00	-1.38	Samples taken and preserved
1.82	0.038	0.05	8.7	0.001	1160.00	6.6	Samples Taken and Perserved
1.14	0.034	0.07	7.1	0.00	945	0.25	Samples taken
2.7	0.038	0.04	7.8	0.009	1320.00	-2.42	
0.79	0.031	0.03	6.9	0.008	874.00	-0.76	
3.53	0.043	0.06	7.6	ND	1320	1.69	
							insufficient volume, slow recharge
							frozen
1.09	0.021	0.026	6.4	0.004	986	0.27	hand bailed
3.17	0.037	0.038	7.7	0.007	1430	-4.3	hand bailed
2.5	0.029	0.176	6.4	ND	1390	-2.59	

3.49	0.064	0.072	8.3	ND	1470	-2.13

no sample
no sample
no sample
no sample
no sample
no sample

Formation: Kirtland, Coal Seam #8

Well Name Ground Surface Elevation 5457.0 ft amsl	Sample Date	Depth to water, TOC, ft; TOC Elevation 5459.96 ft amsl	Groundwater elevation	Total Depth, ft	Field Temperature, F	Lab pH, SU	Lab Conductivity, umho/cm	TDS, 180C, mg/l	Alkalinity, Total as CaCO3, mg/L	Bicarbonate as HCO3, mg/L	Carbonate as CO3, mg/L
KF2007-01	12/29/2011	67.50	5392.40	119.70							
KF2007-01	2/21/2012	67.90	5392.00		60.26	8.3	4260	2780	1600	1900	44
KF2007-01	6/12/2012	67.55	5392.35		71.38	8.2	4360	2710	1800	2000	85
KF2007-01	9/11/2012	67.69	5392.21		65.84	8.2	4350	2820	1800	2000	74
KF2007-01	12/5/2012	67.90	5392.00		59.68	8	4350	2630	1800	1900	140
KF2007-01	3/12/2013	67.60	5392.30		62.92	8.0	4160	2610	1800	2000	63
KF2007-01	6/12/2013	67.71	5392.19		64.04	8.1	4100	2500	1800	2000	59
KF2007-01	12/11/2013	67.50	5392.40		58.10	8.1	4030	2510	1800	2100	40
KF2007-01	5/28/2014	67.90	5392.00		64.58	8.1	4230	2670	1700	1700	200
KF2007-01	12/2/2014	68.00	5391.90		61.70	8.2	4360	2640	1800	1100	510
KF2007-01	6/24/2015	67.90	5392.00		64.40	8.1	4180	2710	1700	1500	290
KF2007-01	12/7/2015	68.18	5391.72		63.28	8.1	4160	2760	1700	1700	200
KF2007-01	2/16/2016	68.22	5391.68		65.03	8.1	4150	2690	1800	1700	230
KF2007-01	8/16/2016	68.22	5391.68		63.64	8.1	4260	2570	1800	1700	200
KF2007-01	11/28/2016	68.54	5391.36		63.07	8.7	4920	3390	1700	1800	150
KF2007-01	2/24/2017	68.21	5391.69		63.43	8.2	4310	2770	1700	1600	250
KF2007-01	5/18/2017	67.42	5392.48		61.95	8.1	4240	2630	1700	1700	200
KF2007-01	8/24/2017	67.53	5392.37		65.05	8.1	4200	2800	1800	1500	310
KF2007-01	11/30/2017	67.63	5392.27		64.45	8.2	4230	2650	1700	1800	120
KF2007-01	2/26/2018	68.34	5391.56		62.28	8.2	1840	1120	730	850	23
KF2007-01	5/21/2018	68.30	5391.60		64.00	8.1	4100	2690	1700	1700	180
KF2007-01	9/5/2018	68.41	5391.49		63.59	8.1	4130	2680	1700	1600	240
KF2007-01	11/21/2018	68.32	5391.58		65.30	8.3	4380	2860	1700	1900	88
KF2007-01	3/18/2019	68.30	5391.60		62.78	8.2	4240	2690	1500	1700	89
KF2007-01	6/10/2019	68.40	5391.50		67.64	8.2	4140	2610	1700	1900	71
KF2007-01	9/9/2019	68.55	5391.35		66.02	8.3	4130	2770	1700	1700	180
KF2007-01	12/2/2019	66.30	5393.60		59.36	8.1	4160	2560	1700	1900	96
KF2007-01	2/25/2020	68.60	5391.30		48.08	8.1	4120	2620	1700	2000	53
KF2007-01	5/18/2020	68.40	5391.50		53.24	8.1	4220	2670	1600	1600	190

KF2007-01	8/25/2020	68.60	5391.30	8.2	4140	2610	1700	2000	67
KF2007-01	11/11/2020	68.50	5391.40	8.1	4000	2720	1700	1900	110
KF2007-01	2/2/2021	68.50	5391.40	8.1	4090	2580	1700	1200	430
KF2007-01	6/28/2021	68.40	5391.50	8.2	4310	2710	1700	1200	420
KF2007-01	8/19/2021	68.30	5391.60	8.1	4290	2690	1700	1400	310
KF2007-01	11/18/2021	68.50	5391.40	8.0	4100	2650	1700	1900	77
KF2007-01	2/23/2022	68.50	5391.40	8.0	4100	2650	1700	1900	77
KF2007-01	5/25/2022	68.50	5391.40	8.1	4070	2550	1700	2100	ND
KF2007-01	8/18/2022	67.92	5391.98	8.0	3910	3000	1700	1800	160
KF2007-01	10/11/2022	68.45	5391.45	8.0	3900	2540	1700	1600	210
KF2007-01	2/15/2023	69.10	5390.80	8.1	3850	2650	1600	1900	39
KF2007-01	5/16/2023	69.22	5390.68	8.2	4470	2680	1900	2300	18
KF2007-01	8/22/2023	69.32	5390.58	8.5	4280	2640	1700	1100	530
KF2007-01	11/9/2023	69.19	5390.71	8.2	4220	2550	1700	1900	110
KF2007-01	2/21/2024	69.20	5390.70	8.0	4120	3640	1600	1900	29
KF2007-01	5/8/2024	68.13	5391.77	8.1	4110	2530	1700	1400	340
KF2007-01	8/19/2024	68.82	5391.08	8.6	4390	2710	1700	1400	340
KF2007-01	11/12/2024	69.25	5390.65	8.2	4290	2610	1800	2100	14
KF2007-01	2/19/2025	68.50	5391.40	8.2	4170	2700	1700	2000	25

Chloride, mg/L	Sulfate, mg/L	Fluoride, mg/L	Boron, dissolved, mg/L	Calcium, dissolved, mg/L	Iron, dissolved, mg/L	Iron, Total, mg/L	Magnesium, dissolved, mg/L	Manganese, dissolved, mg/L	Manganese, Total, mg/L	Potassium, dissolved, mg/L	Selenium, dissolved, mg/L	Sodium, dissolved, mg/L
330	250	3	0.30	5.6	0.07		2.3	0.009		9.2	ND	1070
300	220	2.7	0.4	3.9	ND	0.70	1.8	0.011	0.030	9.6	ND	1060
270	220	2.8	0.40	4.4	ND	0.40	1.70	0.021	0.033	9.1	ND	1140
260	190	2.8	0.4	4.2	ND	0.80	1.8	0.034	0.490	7.2	ND	1060
290	280	2.7	0.40	4.2	0.25	1.00	1.80	0.033	0.049	7.0	ND	1050
280	260	2.7	0.3	4.9	ND	0.70	1.8	0.019	0.030	5.7	ND	1040
300	260	2.6	0.3	4.6	0.15	0.50	1.8	0.017	0.025	5.3	ND	974
290	220	3	0.3	4.6	ND	0.30	1.7	0.017	0.030	4.5	ND	1000
240	170	2.8	0.3	4.4	ND	0.10	1.6	0.007	0.008	5.3	ND	1030
291	221	3.0	0.30	4.3	ND	ND	1.60	0.010	0.010	4.6	ND	1010
292	207	2.9	0.4	4.2	ND	ND	1.6	0.012	0.012	5.3	ND	1040
280	254	2.9	0.4	5.2	0.05	0.10	2	0.012	0.015	5.2	ND	1080
279	271	2.9	0.34	4.5		0.04	1.81		0.011	5.6	0.001	1080
300	580	2.9	0.33	4.9	ND	ND	1.77	0.013	0.012	8.2	ND	1260
290	270	2.9	0.38	4.3	ND	0.02	1.78	0.009	0.009	5.5	0.001	1090
300	280	3	0.36	4.6	0.03	0.06	1.86	0.016	0.016	5.4	0.011	1130
279	238	3	0.33	4.3	ND	0.03	1.69	0.009	0.010	5.2	ND	1050
290	268	3	0.33	4.4	0.03	0.03	1.77	0.017	0.011	5.5	ND	1100
111	86.5	1.8	0.35	4.5	ND	0.03	1.84	0.01	0.009	5.1	ND	1070
290	231	3	0.35	4.3	ND	0.03	1.77	0.007	0.008	4.7	ND	1040
288	247	2.9	0.35	5.2	0.05	0.41	1.75	0.01	0.017	5	ND	1030
299	297	2.7	0.35	5	ND	0.05	1.71	0.004	0.005	6.1	ND	1120
291	306	2.9	0.39	4.1	ND	0.05	1.7	0.002	0.009	5.9	ND	1050
277	213	2.9	0.36	5.5	ND	ND	1.92	0.01	0.009	4.7	ND	1040
267	222	2.7	0.36	4.6	ND	0.03	1.81	0.022	0.023	5.0	ND	1050
293	237	2.9	0.35	6.7	0.15	0.17	2.08	0.014	0.010	5.1	ND	1080
274	234	2.9	0.36	5.5	0.04	0.08	1.83	0.01	0.009	5.3	0.001	1070
287	258	3.0	0.35	4.4	0.02	0.03	1.83	0.010	0.011	5.5	ND	1070

288	254	2.9	0.34	4.7	0.02	1.18	1.80	0.011	0.076	5.5	ND	1090
280	242	2.9	0.35	4.4	0.03	0.04	1.74	0.008	0.008	5.3	ND	1080
266	214	2.8	0.35	5.0	ND	0.03	1.81	0.013	0.008	4.9	ND	1050
263	258	2.9	0.35	5.1	ND	0.04	1.80	0.009	0.007	5.7	ND	1040
257	210	2.9	0.37	5.0	0.02	0.08	1.91	0.009	0.009	4.9	ND	1030
265	206	2.7	0.36	4.3	0.03	0.04	1.78	0.006	0.007	5.1	ND	1070
265	206	2.7	0.36	4.3	0.03	0.04	1.78	0.006	0.007	5.1	ND	1070
285	221	2.9	0.39	4.9	ND	0.03	1.76	0..007	0.008	4.6	ND	1020
291	219	3.0	0.36	4.8	0.03	0.04	1.81	0.004	0.004	4.6	ND	1060
293	228	3.0	0.37	4.6	0.04	0.04	1.80	0.005	0.005	4.4	ND	972
294	237	3.0	0.36	4.4	0.04	0.06	1.78	0.005	0.006	5.0	0.00	1080
293	269	3.1	0.34	4.3	0.03	0.07	1.68	0.006	0.009	5.8	0.00	1050
296	290	3.2	0.36	4.2	0.04	1.64	1.60	0.006	0.032	6.1	<0.001	1060
250	232	3.0	0.35	4.4	0.05	0.22	1.80	0.038	0.038	4.5	<0.001	102
286	218	3.1	0.35	4.9	0.05	0.09	1.80	0.004	0.005	4.4	<0.001	1050
273	209	3.5	0.37	4.6	0.06	0.07	1.80	0.004	0.005	4.9	<0.001	1080
275	263	2.9	0.35	4.5	0.05	0.87	1.70	0.005	0.020	5.7	<0.001	1060
286	253	3.0	0.30	5.5	0.18	0.02	1.80	0.016	0.005	5.7	<0.001	1110
296	222	3.2	0.30	5.0	0.07	0.15	2.00	0.008	0.009	5.1	<0.001	1070

A/C, %	Sample Notes
	Pump failure. Unable to bail
1	
-3	
3.00	clear water
-1	
-5.00	Clear
-3	
-7	
-4	
0	
-3.00	Sample collected and preserved on ice
-1	
-1	
0.7	
-0.18	
0.99	Samples taken and preserved.
-2.01	Samples taken and preserved.
1.4	Samples taken and preserved.
40.9	Samples taken and preserved.
-0.76	Samples taken and preserved.
-2.14	Samples taken and preserved.
0.44	Samples taken and preserved.
0.76	Samples taken and preserved.
-0.55	Samples taken and preserved.
-0.32	Samples taken and preserved.
-0.46	mostly clear, sampled
0.17	
1.06	

0.00
-0.39
-0.09
-1.31
-0.04
1.28
1.28
-3.04
-0.81
-4.87
1.42
-2.95
-3.07
-3.08
1.21
1.01
-1.72
0.13
1.26

Formation: Pictured Cliffs Sandstone

Well Name Ground Surface Elevation 5365.9 ft amsl	Sample Date	Depth to water, TOC, ft; TOC Elevation 5366.1 ft	GWEL	Total Depth, ft	Field Temperature, F	Lab pH (s.u)	Lab Conductivity @ 25 C (umhos/cm)	Solids, Total Dissolved TDS @ 180 C (mg/L)
KPC-98-01	12/27/2011	74.1	5292	131.00				
KPC-98-01	2/22/2012	75.9	5290.2		59.11	7.8	7950	5840
KPC-98-01	6/13/2012	78.79	5287.31		68.29	7.8	8260	6150
KPC-98-01	9/12/2012	80.9	5285.2		62.78	7.80	8200	5340
KPC-98-01	12/5/2012	81.5	5284.6		59.41	7.80	8270	5550
KPC-98-01	3/13/2013	82.5	5283.6		61.00	7.80	8230	5460
KPC-98-01	6/12/2013	83.00	5283.1		62.06	8.00	8590	5590
KPC-98-01	12/11/2013	81.3	5284.8		56.30	7.80	8270	5550
KPC-98-01	5/28/2014	80.3	5285.8		68.00	8.10	8660	6560
KPC-98-01	12/2/2014				57.02	7.70	8000	6090
KPC-98-01	6/24/2015	76.9	5289.2		61.52	7.90	8590	6590
KPC-98-01	12/8/2015	79.58	5286.52		64.47	7.80	8250	6280
KPC-98-01	2/18/2016	79.63	5286.47		60.73	7.60	8110	6270
KPC-98-01	8/11/2016	79.26	5286.84		66.06	7.80	8320	6210
KPC-98-01	11/30/2016	79.85	5286.25		63.55	7.80	8290	6470
KPC-98-01	3/6/2017	76.97	5289.13		59.16	7.80	8300	6320
KPC-98-01	5/16/2017	90.71	5275.39		57.90	7.70	8170	6120
KPC-98-01	8/29/2017	90.77	5275.33		65.82	7.80	8470	6410
KPC-98-01	11/28/2017	91.14	5274.96		60.24	7.70	8000	6090
KPC-98-01	2/27/2018	87.46	5278.64		62.92	7.80	7940	6140
KPC-98-01	5/23/2018	79.28	5286.82		64.15	7.80	8180	6540
KPC-98-01	9/10/2018	80.42	5285.68		68.09	8.50	9480	7120
KPC-98-01	12/3/2018	79.96	5286.14		58.28	7.70	8400	5970
KPC-98-01	3/21/2019	81.55	5284.55		58.10	7.90	8770	6400
KPC-98-01	6/6/2019	97.9	5268.2					
KPC-98-01	9/10/2019	99.85	5266.25		75.74	7.90	8570	6640
KPC-98-01	11/25/2019	102.2	5263.9		56.48	7.90	8320	6590
KPC-98-01	3/9/2020	96.18	5269.92		63.50	7.80	8300	6420
KPC-98-01	5/19/2020	96.12	5269.98		66.20	7.60	8460	6130
KPC-98-01	9/1/2020	86.1	5280			7.60	8420	6520

KPC-98-01	11/16/2020	85.2	5280.9			
KPC-98-01	2/3/2021	84.6	5281.5	7.70	7900	6030
KPC-98-01	6/21/2021	85.8	5280.3			
KPC-98-01	9/23/2021	78.1	5288	8.00	8780	6380
KPC-98-01	12/15/2021	78.2	5287.9	7.70	8380	6440
KPC-98-01	3/2/2022	81.8	5284.3	7.80	8310	6400
KPC-98-01	6/1/2022	78.2	5287.9			
KPC-98-01	8/22/2022	83.45	5282.65	7.60	8020	7700
KPC-98-01	10/12/2022	94.84	5271.26	7.70	7940	6580
KPC-98-01	2/20/2023	91.42	5274.68	7.60	8350	6350
KPC-98-01	5/15/2023	96.30	5269.8	7.60	8860	6280
KPC-98-01	8/21/2023	89.19	5276.91	8.30	8340	6190
KPC-98-01	11/8/2023	86.28	5279.82	7.60	8370	6440
KPC-98-01	2/20/2024	81.95	5284.15	7.70	8470	6290
KPC-98-01	5/8/2024	81.94	5284.16	7.70	8280	6250
KPC-98-01	8/12/2024	80.49	5285.61	7.60	8060	6050
KPC-98-01	11/11/2024	87.12	5278.98	7.70	8260	6110
KPC-98-01	2/22/2025	86.5	5279.6	7.70	8900	6180

A/C Balance (%)	Alkalinity, Total as CaCO3 (mg/L)	Bicarbonate as HCO3 (mg/L)	Carbonate as CO3 (mg/L)	Hydroxide as OH	Chloride (mg/L)	Sulfate (mg/L)	Fluoride (mg/L)	Boron, dissolved (mg/L)	Calcium, dissolved (mg/L)	Iron, dissolved (mg/L)	Iron, Total (mg/L)	Magnesium, dissolved (mg/L)	Manganese, dissolved (mg/L)
1	900	1100	13		210	3000	3	0.7	26	0.36	1.87	8	0.054
1	900	1100	19	ND	230	3000	0.7	0.6	28.9	0.39	3.7	8.5	0.1
3	840	1000	12	ND	180	3100	1.4	0.6	32.6	ND	1.2	8.4	0.047
4.00	870	930	63	ND	190	2900	1.3	0.6	29.8	ND	1.8	8.6	0.07
-1.00	850	990	20	ND	240	3200	1.3	0.7	29	0.28	1.2	8.6	0.062
-7.00	860	1000	25	ND	250	3600	1.2	0.6	25.6	0.08	3.1	7.5	0.06
4.00	870	930	63	ND	190	2900	1.3	0.6	29.8	ND	1.8	8.6	0.07
-2.00	840	990	14	ND	260	3700	1.3	0.6	30.1	16.3	40.7	12.1	0.172
-2.46	820	1000	ND	ND	220	3320	1.4	0.68	39	ND	0.82	11.8	0.007
-2.00	860	970	40	ND	245	3500	1.4	0.7	31.7	4.87	8.8	0.08	0.08
-2.00	840	1000	13	ND	223	3250	1.4	0.6	33.7	0.31	1.3	8.5	0.017
2.00	830	1000	ND	ND	214	3030	1.4	0.7	41.3	ND	0.8	9.6	0.005
	830	1000	ND	ND	214	3460	1.4	0.63	38.5		0.65	9.72	
-0.25	840	1000	8	ND	240	3400	1.4	0.67	34.2	ND	2.71	9.6	0.042
1.48	860	1100	ND	ND	220	3100	1.4	0.66	32.4	ND	0.82	8.7	0.047
-2.65	860	1000	ND	ND	240	3400	1.3	0.68	40.9	0.06	1.77	9.9	0.039
-3.48	860	1000	13	ND	246	3410	1.4	0.61	34.6	ND	0.88	9.1	0.028
-2.46	820	1000	ND	ND	220	3320	1.4	0.68	39	11.8	0.82	11.8	0.007
-2.29	790	970	ND	ND	218	3250	1.4	0.67	36.3	0.02	0.89	9.47	0.003
-2.05	850	980	26	ND	231	3280	1.3	0.7	31.1	0.02	1.56	8.65	0.049
-2.13	1300	1400	70	ND	695	3180	1.4	0.86	27.5	0.02	0.43	15.1	0.035
-3.05	890	1100	ND	ND	227	3290	1	0.74	37.6	0.04	1.11	8.93	0.007
-4.18	890	1100	ND	ND	313	3430	1.2	0.67	32.3	0.03	1.23	9.5	0.049
1.45	920	1100	15	ND	237	3220	1.2	0.7	33.2	0.04	6.72	9	0.03
-4.74	900	1100	ND	ND	260	3700	1.3	0.67	36.8	0.08	8.83	9.08	0.034
-1.04	870	1000	11	ND	248	3290	1.4	0.67	38.6	0.02	1.56	9.57	0.014
-3.71	840	920	52	ND	241	3460	1.3	0.69	39.2	ND	0.41	9.34	0.01
-3.00	910	1100	17	ND	245	3420	1.3	0.68	37.5	0.21	1.49	9.23	0.027

-4.89	780	950	ND	ND	236	3380	1.4	0.65	39.1	0.12	2.6	9.17	0.008
-0.06	910	1100	15	ND	247	3370	1.2	0.65	34.9	ND	5.88	9.4	0.069
2.51	880	1100	ND	ND	217	3250	1.3	0.7	37.2	ND	19.8	10	0.046
2.09	890	1090	<4.0	<4	218	3250	1.1	0.61	31.6	<0.02	14.1	8.9	0.031
-1.42	870	1100	ND	ND	241	3440	1.4	0.71	42.1	ND	10.2	10	0.036
-2.96	850	1000	18	ND	247	3760	1.4	0.68	37.1	ND	19.5	9.4	0.081
-0.63	810	990	<4.0	<4.0	235	3540	1.5	0.65	36.3	<0.02	22.4	8.88	0.011
-4.22	850	1000	<4.0	<4.0	240	3510	1.4	0.65	37.7	<0.02	1.42	9.16	0.007
-2.11	870	1100	<4.0	<4	239	3440	1.4	0.65	41.5	<0.02	0.6	9	0.017
-3.03	820	990	<4.0	<4	250	3550	1.4	0.7	40.2	<0.02	1	10.3	0.027
-1.95	810	980	<4.0	<4.0	249	3410	1.5	0.69	38.1	<0.02	0.02	9	0.028
-0.21	780	950	<4.0	<4.0	227	3340	1.7	0.65	39.4	<0.02	0.42	9.8	0.014
0.08	790	960	<4.0	<4	207	3190	1.8	0.59	43.5	<0.02	2.33	9.7	0.019
2.18	750	920	<4.0	<4	224	3290	1.5	0.55	40.3	<0.02	2.12	9.7	0.017
-4.44	830	1000	<4.0	<4	235	3590	1.4	0.61	40	<0.02	0.66	9.2	0.014

Manganese, Total (mg/L)	Potassium, dissolved (mg/L)	Selenium, dissolved (mg/L)	Sodium, dissolved (mg/L)	Sample Notes
				Pump failure. Unable to bail
0.138	8.2	ND	1970	Clear, no
0.064	9	ND	1980	Sl. Turbid.
0.091	8.2	ND	2050	clear water
0.076	8.1	ND	2040	
0.1	8.7	ND	2000	Clear, no odor
0.091	9.2	ND	1930	Slightly turbid, light brown, no odor
0.421	8.1	ND	2040	Slightly turbid, light brown, no odor
0.024	11.8	ND	2130	light brown, turbid
0.149	7.6	0.001	1940	
0.034	8.9	0.001	2100	Sample collected and preserved
0.021	8.1	ND	1970	Mostly Clear, Very light silt
0.019	8.2	0.001	1990	Samples Taken and Preserved
0.075	8.3	ND	2040	Samples Taken and Preserved
0.068	8.3	ND	2110	Light silt, light white
0.061	7.7	ND	2040	
0.055	7.5	0.006	2010	Duplicates taken.
0.024	7.5	ND	1980	Samples taken and preserved.
0.021	7.6	0.001	1940	Samples taken and preserved.
0.076	7.4	ND	1910	Samples taken and preserved
0.045	7	ND	1970	Samples Taken and Perserved
0.02	7.9	ND	2380	Light
0.066	7.4	ND	1950	Samples
	7.7	ND	2020	Light
0.085	8.1	ND	2130	Mostly clear light blue hue, unable to sample, insufficint volume
0.041	8	ND	2070	
	8.1	ND	2080	slushy slow recharge, sampled
0.021	7.9	ND	1980	
0.053	7.7	ND	2020	

0.059	7.2	ND	1870	
0.123	8.3	ND	2130	
0.44	8.2	ND	2090	
0.32	7.7	<0.001	2070	
				no sample
0.198	7.2	ND	2080	
0.277	7.7	ND	2150	
0.5	8.2	<0.001	2130	
0.025	8.5	<0.001	1980	
0.026	6.6	<0.001	2040	
0.042	7.8	<0.001	2040	
0.05	7.8	<0.001	2020	
0.026	8.7	<0.001	2030	
0.124	7	<0.001	1960	
0.047	7.6	<0.001	2090	
0.037	7.6	<0.001	1990	

Formation: Pictured Cliff Sandstone

Well Name Ground Surface Elevation 5352.8 ft amsl	Sample Date	Depth to water, TOC, ft; TOC Elevation 5355.71 ft amsl	Groundwater elvation	Total Depth, ft
KPC-2007-01	12/29/2011	92.00	5263.71	219.50
KPC-2007-01	2/22/2012	95.50	5260.21	
KPC-2007-01	6/13/2012	95.58	5260.13	
KPC-2007-01	9/12/2012	95.70	5260.01	
KPC-2007-01	12/5/2012	95.73	5259.98	
KPC-2007-01	3/12/2013	95.76	5259.95	
KPC-2007-01	6/12/2013	95.90	5259.81	
KPC-2007-01	12/11/2013	96.20	5259.51	
KPC-2007-01	5/28/2014	95.60	5260.11	
KPC-2007-01	12/2/2014	97.25	5258.46	
KPC-2007-01	6/24/2015	96.95	5258.76	
KPC-2007-01	12/7/2015	97.25	5258.46	
KPC-2007-01	2/16/2016	97.02	5258.69	
KPC-2007-01	8/16/2016	97.74	5257.97	
KPC-2007-01	11/28/2016	97.63	5258.08	
KPC-2007-01	2/24/2017	97.68	5258.03	
KPC-2007-01	5/18/2017	92.16	5263.55	
KPC-2007-01	8/24/2017	92.34	5263.37	
KPC-2007-01	11/30/2017	92.76	5262.95	
KPC-2007-01	2/26/2018	93.88	5261.83	
KPC-2007-01	5/21/2018	94.45	5261.26	
KPC-2007-01	9/5/2018	94.51	5261.20	
KPC-2007-01	11/21/2018	98.97	5256.74	
KPC-2007-01	3/18/2019	98.90	5256.81	
KPC-2007-01	6/10/2019	99.00	5256.71	
KPC-2007-01	9/10/2019	99.60	5256.11	
KPC-2007-01	11/26/2019	99.20	5256.51	
KPC-2007-01	2/19/2020	99.40	5256.31	
KPC-2007-01	5/4/2020	99.40	5256.31	
KPC-2007-01	8/20/2020	99.90	5255.81	
KPC-2007-01	11/10/2020	100.00	5255.71	
KPC-2007-01	1/27/2021	100.00	5255.71	
KPC-2007-01	6/28/2021	100.30	5255.41	
KPC-2007-01	8/17/2021	101.80	5253.91	
KPC-2007-01	11/17/2021	100.60	5255.11	
KPC-2007-01	2/23/2022	100.50	5255.21	
KPC-2007-01	5/24/2022	101.50	5254.21	
KPC-2007-01	8/18/2022	101.05	5254.66	
KPC-2007-01	10/11/2022	100.87	5254.84	
KPC-2007-01	2/15/2023	102.15	5253.56	
KPC-2007-01	5/16/2023	102.15	5253.56	
KPC-2007-01	8/22/2023	102.23	5253.48	

KPC-2007-01	11/9/2023	102.60	5253.11
KPC-2007-01	2/21/2024	102.49	5253.22
KPC-2007-01	5/8/2024	101.75	5253.96
KPC-2007-01	8/19/2024	102.08	5253.63
KPC-2007-01	11/12/2024	102.98	5252.73
KPC-2007-01	2/10/2025	102.60	5253.11

Field Temperature, F	Lab pH, SU	Lab Conductivity, umho/cm	TDS, 180C, mg/l	Alkalinity, Total as CaCO3, mg/L	Bicarbonate as HCO3, mg/L	Carbonate as CO3, mg/L	Chloride, mg/L	Sulfate, mg/L	Fluoride, mg/L
60.80									
61.95	8.7	10100	7520	1300	1400	99.0	1200	2400	3.90
67.77	8.7	10800	7710	1400	1500	97	1100	2300	1.8
67.23	8.8	10300	6520	1300	1400	95	1000	2400	1.80
61.61	8.7	10200	6560	1400	1400	150	1100	2400	1.8
65.48	8.6	10300	7150	1300	1400	95	1100	2600	1.80
65.84	8.6	10400	6660	1300	1400	94	1200	2700	1.8
59.72	8.7	9910	5840	1300	1500	82	1200	2800	1.8
66.38	8.7	10200	7240	1300	1400	94	1100	2300	1.8
62.78	8.4	10900	7350	1200	1200	150	1000	2400	1.8
67.28	8.4	10500	7450	1200	1300	92	1230	2850	2.00
64.85	8.3	10400	7510	1200	1300	84	1240	2780	2
67.26	8.2	10300	7520	1200	1300	68	1210	2810	1.8
67.59	8.3	10600	7420	1200	1300	54	1240	3030	2
65.89	8.2	10600	7360	1300	1400	56	1100	2700	2
64.36	8.8	10400	7240	1400	1500	120	1200	2600	1.8
63.95	8.4	10300	7160	1200	1400	60	1200	2800	1.9
68.77	8.1	10500	7390	1200	1100	200	1190	2820	1.9
64.99	8.3	10400	7440	1100	1200	59	1210	2860	1.9
59.38	8.5	9920	7020	1100	1300	50	1070	2630	1.9
68.04	8.6	10200	7520	1200	1300	84	1180	2740	2.1
72.30	8.6	10400	7520	1200	1400	55	1240	2970	2.1
64.94	8.6	10600	7430	1300	1400	62	1200	2710	1.6
64.58	8.6	10500	7130	1200	1300	62	1200	2890	2
72.50	8.5	10200	7690	1200	1400	44	1100	2520	2
67.64	8	10400	7460	1200	1400	37	1200	2800	1.9
58.82	8.5	10200	7400	1200	1400	43	1280	2990	1.9
59.90	8.6	10100	7340	1300	1400	65	1180	2790	1.9
55.04	8.5	10500	7440	1200	1200	97	1310	3020	1.90
	8.6	10700	7010	1200	1300	90	1200	2690	2.10
	8.4	9980	7160	1200	1400	36	1230	2990	2.00
	8.3	10100	7320	1200	1400	28	1190	2770	2.00
	8.4	10500	7290	1100	910	230	1130	2770	1.90
	8.4	10700	7740	1200	970	220	1140	2750	2.00
	8.7	10500	7390	1300	1400	52	1190	2820	1.90
	8.5	10250	7390	1350	1320	48	1160	2820	1.80
	8.2	10500	7410	1200	1200	130	1230	2940	1.90
	8.3	10100	8100	1200	1400	43	1210	2830	1.90
	8.4	9980	7440	1200	1200	160	1250	3050	2.00
	8.3	9630	7460	1200	1300	74	1220	2900	2.00
	8.5	11100	7280	1200	1400	31	1280	2950	2.20
	8.3	10300	7040	1200	1400	43	1250	2910	2.00

8.4	10600	7520	1200	1400	37	1250	2840	2.00
8.2	10400	7380	1300	1500	39	1210	2870	2.00
8.3	10500	7660	1200	1400	29	1180	2860	2.10
8.3	10500	7180	1200	1100	160	1130	2700	2.00
8.4	10500	7290	1200	1400	21	1200	2770	1.90
8.6	10400	7380	1200	1400	48	1220	2810	2.00

Boron, dissolved, mg/L	Calcium, dissolved, mg/L	Iron, dissolved, mg/L	Magnesium, dissolved, mg/L	Manganese, dissolved, mg/L	Potassium, dissolved, mg/L	Selenium, dissolved, mg/L	Sodium, dissolved, mg/L	Iron, Total, mg/L	Manganese, Total, mg/L
0.60	23.8000	nd	17.30	0.01	11.500	ND	2460.00	0.62	0.017
0.6	10.9	0.08	8	0.013	11.1	ND	2450	0.50	0.022
0.6	13.1	0.06	7.8	0.009	10.8	ND	2490	0.70	0.024
0.6	9.9	ND	8.2	0.008	15.6	ND	2520	0.20	0.015
0.6	10.2	0.08	7.8	0.01	11.9	ND	2520	0.30	0.018
0.6	9.5	ND	7.5	0.01	10.7	ND	2430	0.20	0.013
0.6	9.1	0.08	7.5	0.01	9.9	ND	2470	0.40	0.016
0.6	9	ND	7.2	0.01	9.8	0.001	2510	0.70	0.013
0.6	12.2	ND	7.7	0.017	9.3	ND	2470	3.40	0.284
0.5	15.4	2.1	9.1	0.05	10.9	ND	2640	5.80	0.091
0.6	11.2	0.29	7.6	0.019	9.3	ND	2500	4.00	0.067
0.6	12.9	ND	8.5	0.015	9	ND	2650	1.60	0.037
0.63	11.8		8.61		8.7	ND	2400	0.89	0.020
0.65	10.9	ND	8.4	0.008	8.6	ND	2610	0.31	0.023
0.62	8.2	ND	6.94	0.004	8.9	ND	2620	1.68	0.024
0.66	14.1	0.03	8.4	0.022	9	ND	2650	3.70	0.067
0.61	12.7	ND	8.51	0.013	8.6	ND	2610	7.66	0.106
0.64	11	0.03	8.93	0.015	8.5	0.032	2710	6.36	0.088
0.64	14	0.22	8.64	0.017	10.3	ND	2690	9.05	0.129
0.65	11.7	ND	8.01	0.017	8.8	ND	2510	3.58	0.062
0.63	11.8	0.03	8.3	0.011	9.1	0.007	2500	4.48	0.071
0.66	14	0.05	8.9	0.012	8.5	0.014	2480	2.89	0.051
0.61	10.5	ND	8.2	0.022	8.8	ND	2490	4.12	0.055
0.72	13.1	0.05	8.4	0.014	8.5	0.052	2560	0.51	0.160
0.66	10.8	0.1	7.66	0.011	9	ND	2470	0.20	0.011
0.67	12.6	ND	7.81	0.013	8.8	0.057	2540	0.72	0.021
0.65	11.9	0.05	8.29	0.013	9.8	0.016	2560	4.79	0.075
0.68	11.1	ND	8.29	0.01	9	0.046	2570	0.15	0.011
0.62	13.4	0.02	8.3	0.016	10.1	0.002	2470	0.79	0.022
0.66	12	ND	7.73	0.012	9	0.002	2480	6.15	0.100
0.6	10.9	0.04	8.58	0.01	9.6	0.029	2660	0.09	0.011
0.66	11.1	0.03	8	0.02	9.4	0.05	2480	0.66	0.019
0.65	12	ND	8.2	0.013	9.6	0.032	2590	2.55	0.046
0.63	15	ND	9.2	0.03	10.2	0.017	2500	1.73	0.044
0.58	14	<0.02	8.9	0.029	9.9	0.015	2460	1.66	0.039
0.63	10.5	ND	7.7	0.011	9.1	0.002	2540	0.70	0.020
0.69	11.8	ND	8	0.011	8.6	0.033	2510	3.74	0.011
0.69	12.5	ND	8.4	0.01	9.3	0.012	2680	3.81	0.062
0.65	11	<0.02	8.24	0.009	8.7	0.11	2660	1.23	0.026
0.62	11.2	<0.02	8.05	0.009	9.7	0.095	2510	2.62	0.043
0.6	11	0.02	7.3	0.015	7.1	<0.001	2520	2.12	0.045

0.68	10	<0.02	8.8	0.008	9.9	0.01	2420	1.42	0.040
0.64	12	<0.02	8.3	0.01	8.9	0.047	2500	2.15	0.004
0.68	12	0.02	8.7	0.019	8.7	0.007	2640	2.25	0.048
0.59	11.6	<0.02	8.4	0.012	8.1	0.077	2450	2.19	0.031
0.57	10.2	<0.02	8.3	0.008	8.4	0.006	2630	0.39	0.012
0.6	10	<0.02	8	0.01	9	0.144	2680	0.36	0.015

A/C, %	Sample Notes
	water level only, Pump failure. Unable to bail
18.4	13
1	
2	H2S odor, turbid
1	
-1	H2S
-5	
-4	
3	
2	
-4	Sample collected and preserved
-3	
0	
-	
0.76	
-0.07	
0.21	Samples taken and preserved.
-0.77	Samples taken and preserved.
1.63	Samples taken and preserved
4.86	Samples Taken and Perserved
-1.79	Samples taken
-4.9	Samples taken
-2.71	
-3.49	
1.99	
-3.01	
-4.74	mostly clear, sulfur smell, sampled
-1.64	
-4.05	
-2.27	
-4.99	
1.17	
-1.31	
0.62	
-3.07	
-2.26	
-3.25	
-2.93	
-2.17	
-0.33	
-4.69	
-4.17	

-5.33
-3.91
-0.39
-1.87
0.5
0.49

Formation: No Name Alluvium

Well Name Ground Surface Elevation 5431.63 ft amsl	Sample Date	Depth to water, TOC, ft; TOC Elevation xxxx.xx ft amsl	Total Depth, ft	Field Temperature, F	Lab pH, SU	Lab Conductivity, umho/cm	TDS, 180C, mg/l	Alkalinity, Total as CaCO3, mg/L
NNA-1	3/26/1998	-	-					
NNA-1	3/29/1998	Dry	-					
NNA-1	4/30/1998	Dry	-					
NNA-1	5/12/1998	Dry	-					
NNA-1	6/11/1998	13.7	5417.93					
NNA-1	7/21/1998	13.11	5418.52					
NNA-1	8/20/1998	13.23	5418.4					
NNA-1	9/30/1998	13.34	5418.29					
NNA-1	11/8/1998	13.23	5418.4					
NNA-1	12/17/1998	12.87	5418.76					
NNA-1	8/22/2007	Dry	-					
NNA-1	9/4/2007	Dry	-					
NNA-1	10/4/2007	Dry	-					
NNA-1	11/5/2007	Dry	-					
NNA-1	11/15/2007	-	-					
NNA-1	12/3/2007	-	-					
NNA-1	12/5/2007	Dry	-					
NNA-1	1/17/2008	Dry	-					
NNA-1	2/19/2008	-	-					
NNA-1	2/21/2008	Dry	-					
NNA-1	3/20/2008	Dry	-					
NNA-1	4/24/2008	Dry	-					
NNA-1	5/27/2008	Dry	-					
NNA-1	6/24/2008	Dry	-					
NNA-1	7/24/2008	Dry	-					
NNA-1	8/19/2008	Dry	-					
NNA-1	8/20/2008	Dry	-					
NNA-1	9/30/2008	Dry	-					

Bicarbonate as HCO3, mg/L	Carbonate as CO3, mg/L	Chloride, mg/L	Sulfate, mg/L	Fluoride, mg/L	Boron, dissolved, mg/L	Calcium, dissolved, mg/L	Iron, dissolved, mg/L	Magnesium, dissolved, mg/L	Manganese, dissolved, mg/L

Potassium, dissolved, mg/L	Selenium, dissolved, mg/L	Sodium, dissolved, mg/L	Iron, Total, mg/L	Manganese, Total, mg/L	A/C, %	Sample Notes

Formation: No Name Alluvium

Well Name Ground Surface Elevation 5455.97 ft amsl	Sample Date	Depth to water, TOC, ft; TOC Elevation xxxx.x ft amsl	Total Depth, ft	Field Temperature, F	Lab pH, SU	Lab Conductivity, umho/cm	TDS, 180C, mg/l	Alkalinity, Total as CaCO3, mg/L	Bicarbonate as HCO3, mg/L
NNA-2	3/26/1998	-	-						
NNA-2	3/29/1998	Dry	-						
NNA-2	4/30/1998	Dry	-						
NNA-2	5/12/1998	Dry	-						
NNA-2	6/11/1998	Dry	-						
NNA-2	7/21/1998	Dry	-						
NNA-2	8/20/1998	Dry	-						
NNA-2	9/30/1998	Dry	-						
NNA-2	11/8/1998	Dry	-						
NNA-2	12/17/1998	Dry	-						
NNA-2	8/22/2007	Dry	-						
NNA-2	9/4/2007	Dry	-						
NNA-2	10/4/2007	Dry	-						
NNA-2	11/5/2007	Dry	-						
NNA-2	11/15/2007	-	-						
NNA-2	12/3/2007	-	-						
NNA-2	12/5/2007	Dry	-						
NNA-2	1/17/2008	Dry	-						
NNA-2	2/19/2008	-	-						
NNA-2	2/21/2008	Dry	-						
NNA-2	3/20/2008	Dry	-						
NNA-2	4/24/2008	Dry	-						
NNA-2	5/27/2008	Dry	-						
NNA-2	6/24/2008	Dry	-						
NNA-2	7/24/2008	Dry	-						
NNA-2	8/19/2008	Dry	-						
NNA-2	8/20/2008	Dry	-						
NNA-2	9/30/2008	Dry	-						

Carbonate as CO3, mg/L	Chloride, mg/L	Sulfate, mg/L	Fluoride, mg/L	Boron, dissolved, mg/L	Calcium, dissolved, mg/L	Iron, dissolved, mg/L	Magnesium, dissolved, mg/L	Manganese, dissolved, mg/L	Potassium, dissolved, mg/L

Selenium, dissolved, mg/L	Sodium, dissolved, mg/L	Iron, Total, mg/L	Manganese, Total, mg/L	A/C, %	Sample Notes

Kirtland, Coal Seam #3

Well Name Ground Surface Elevation 5352.7 ft amsl	Sample Date	Depth to water, TOC, ft; TOC Elevation 5354.2 ft amsl	GWEl	Total Depth, ft	Field Temperature, F	Lab pH, SU	Lab Conductivity, umho/cm	TDS, 180C, mg/l
KF-98-04	12/27/2011	dry		65.1				
KF-98-04	2/21/2012	65.00	5289.20					
KF-98-04	6/12/2012	dry						
KF-98-04	9/11/2012	dry						
KF-98-04	3/12/2013	64.80	5289.40					
KF-98-04	6/13/2013	63.70	5290.50					
KF-98-04	12/11/2013	63.70	5290.50					
KF-98-04	5/28/2014	67.70	5286.50					
KF-98-04	6/24/2015	64.80	5289.40					
KF-98-04	12/7/2015	64.51	5289.69					
KF-98-04	2/11/2016	64.47	5289.73					
KF-98-04	8/11/2016	64.85	5289.35					
KF-98-04	11/30/2016	64.58	5289.62					
KF-98-04	3/1/2017	64.58	5289.62					
KF-98-04	5/17/2017	64.44	5289.76					
KF-98-04	8/29/2017	64.52	5289.68					
KF-98-04	11/28/2017	64.57	5289.63					
KF-98-04	2/27/2018	64.60	5289.60					
KF-98-04	5/23/2018	64.38	5289.82					
KF-98-04	9/10/2018	64.38	5289.82					
KF-98-04	12/3/2018	64.43	5289.77					
KF-98-04	6/6/2019	64.6	5289.60					
KF-98-04	9/4/2019	64.55	5289.65					
KF-98-04	12/13/2019	64.55	5289.65					
KF-98-04	3/5/2020	65.50	5288.70					
KF-98-04	5/14/2020	65.90	5288.30					
KF-98-04	8/19/2020	64.50	5289.70					
KF-98-04	11/10/2020	64.60	5289.60					
KF-98-04	1/27/2021	64.70	5289.50					
KF-98-04	6/21/2021	64.80	5289.40					
KF-98-04	8/17/2021	dry						
KF-98-04	11/17/2021	dry						
KF-98-04	2/25/2022	dry						
KF-98-04	5/4/2022	dry						
KF-98-04	8/18/2022	64.50	5289.70					
KF-98-04	10/11/2022	64.80	5289.40					

KF-98-04	02/2023	dry	
KF-98-04	05/2023	dry	
KF-98-04	8/21/2023	dry	
KF-98-04	11/8/2023	dry	
KF-98-04	2/12/2024	dry	
KF-98-04	5/8/2024	65.12	5289.08
KF-98-04	8/12/2024	65.03	5289.17
KF-98-04	11/11/2024	dry	
KF-98-04	2/21/2025	dry	

Alkalinity, Total as CaCO3, mg/L	Bicarbonate as HCO3, mg/L	Carbonate as CO3, mg/L	Chloride, mg/L	Sulfate, mg/L	Fluoride, mg/L	Boron, dissolved mg/L	Calcium, dissolved mg/L	Iron, dissolved mg/L	Iron, Total, mg/L

Magnesium, dissolved mg/L	Manganese, mg/L	Manganese, Total, mg/L	Potassium, dissolved mg/L	Selenium, dissolved mg/L	Sodium, dissolved, mg/L	A/C, %

Sample Notes
water level only, Insufficient water
Insufficient water to bail/pump
Dry hole. No water sample
Dry well.
Too shallow to sample. No purging or sampling performed
Too shallow to sample. No purging or sampling performed
Too shallow to sample. No purging or sampling performed
Insufficient volume to purge or sample. No sample collection
Dry
Insufficient Volume for sampling
Insufficient Volume for sampling
Insufficient Volume for sampling.
Insufficient Volume for sampling.
Insufficient Volume for sampling.
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Insufficient Volume for sampling.
Insufficient Volume for sampling.

no sample
no sample

no sample
no sample

Kirtland, Coal Seam #3

Well Name Ground Surface Elevation 5424.4 ft amsl	Sample Date	Depth to water, TOC, ft; TOC Elevation 5426.5 ft amsl	GWEl	Total Depth, ft	Field Temperature, F	Lab pH, SU	Lab Conductivity, umho/cm	TDS, 180C, mg/l	Alkalinity, Total as CaCO3, mg/L	Bicarbonate as HCO3, mg/L
KF98-03	12/28/2011	129.30	5297.20	134.8						
KF98-03	2/21/2012	134.10	5292.40							
KF98-03	6/12/2012	132.90	5293.60							
KF98-03	9/11/2012	132.12	5294.38							
KF98-03	3/14/2013	132.10	5294.40							
KF98-03	6/13/2013	131.40	5295.10							
KF-98-03	12/10/2013	132.00	5294.50							
KF-98-03	5/28/2014	129.67	5296.83		65.30	10.2	2860	1650	660	260
KF-98-03	6/23/2015	132.90	5293.60		69.98	9.40	2850.00	1790.00	680.00	630.00
KF-98-03	12/7/2015	132.80	5293.70							
KF-98-03	2/11/2016	132.82	5293.68							
KF-98-03	8/16/2016	132.96	5293.54							
KF-98-03	11/28/2016	130.78	5295.72							
KF-98-03	2/24/2017	130.92	5295.58							
KF-98-03	5/16/2017	131.22	5295.28							
KF-98-03	8/24/2017	129.20	5297.30							
KF-98-03	11/30/2017	129.36	5297.14							
KF-98-03	2/28/2018	129.16	5297.34							
KF-98-03	5/21/2018	129.78	5296.72							
KF-98-03	9/5/2018	128.99	5297.51							
KF-98-03	11/21/2018	129.08	5297.42							
KF-98-03	6/11/2019	128.40	5298.10							
KF-98-03	9/11/2019	128.30	5298.20							
KF-98-03	12/16/2019	127.90	5298.60							
KF-98-03	3/5/2020	126.20	5300.30							
KF-98-03	5/18/2020	126.90	5299.60							
KF-98-03	8/25/2020	125.80	5300.70							
KF-98-03	11/11/2020	128.10	5298.40							
KF-98-03	2/4/2021	128.90	5297.60							
KF-98-03	6/23/2021	131.10	5295.40							
KF-98-03	8/18/2021	135.70	5290.80							
KF-98-03	11/18/2021	135.50	5291.00							
KF-98-03	2/28/2022	135.50	5291.00							
KF-98-03	5/4/2022	135.50	5291.00							
KF-98-03	5/25/2022	135.90	5290.60							
KF-98-03	8/18/2022	129.10	5297.40							
KF-98-03	02/2023	130.05	5296.45							
KF-98-03	05/2023	129.95	5296.55							
KF-98-03	8/21/2023	129.90	5296.60							
KF-98-03	11/8/2023	130.36	5296.14							
KF-98-03	2/15/2024	130.18	5296.32							

KF-98-03	5/8/2024	129.24	5297.26
KF-98-03	8/19/2024	129.05	5297.45
KF-98-03	11/13/2024	130.39	5296.11
KF-98-03	2/20/2025	131.76	5294.74

Carbonate as CO3, mg/L	Chloride, mg/L	Sulfate, mg/L	Fluoride, mg/L	Boron, dissolved mg/L	Calcium, dissolvedmg/L	Iron, dissolved mg/L	Iron, Total, mg/L	Magnesium, dissolved mg/L	Manganese, mg/L	Manganese, Total, mg/L	Potassium, dissolved mg/L	Selenium, dissolved mg/L
270	520	42	1.6	0.2	11.0	0.93	7.40	ND	0.008	0.08	22.2	0.00
100.00	460.00	82.00	1.60	0.20	21.50	11.70	20.60	3.00	0.01	0.20	30.10	0.01

Sodium, dissolved, mg/L	A/C, %	Sample Notes
		water level only, coffee water color.
		Insufficient water to bail/pump
		Insufficient water to bail/pump. No water sample
		Need new well cover. Insufficient water to sample.
		Insufficient water to purge, bail, or sample
		Insufficient water to purge, bail, or sample
		Insufficient water to purge, bail, or sample
570	-5	turbid, coffee color, dark brown
597.00	-1.00	
		Insufficient Volume for sampling
		Insufficient Volume for sampling
		Insufficient Volume for sampling.
		Insufficient Volume for sampling.
		Insufficient Volume for sampling.
		Insufficient Volume for sampling.
		Insufficient Volume for sampling.
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		Insufficient Volume for sampling.
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		no sample

no sample
no sample
no sample
no sample

Formation: Pictured Cliff Sandstone

Well Name Ground Surface Elevation 5512.1 ft amsl	Sample Date	Depth to water, TOC, ft; TOC Elevation 5515.06 ft amsl	GWEL	Total Depth, ft	Field Temperature, F
KPC-2007-2	12/29/2011	152.90	5362.16	320.00	
KPC-2007-2	2/22/2012	153.10	5361.96		66.07
KPC-2007-2	6/13/2012	154.90	5360.16		69.73
KPC-2007-2	9/12/2012	153.22	5361.84		68.34
KPC-2007-2	12/5/2012	156.90	5358.16		19.17
KPC-2007-2	3/12/2013	156.65	5358.41		65.98
KPC-2007-2	6/12/2013	154.50	5360.56		68.90
KPC-2007-2	12/11/2013	155.40	5359.66		62.78
KPC-2007-2	5/28/2014	155.16	5359.90		72.68
KPC-2007-2	12/2/2014	154.19	5360.87		18.80
KPC-2007-2	6/24/2015	154.00	5361.06		67.82
KPC-2007-2	12/7/2015	154.56	5360.50		66.76
KPC-2007-2	2/18/2016	156.19	5358.87		67.42
KPC-2007-2	8/17/2016	154.70	5360.36		73.98
KPC-2007-2	12/1/2016	155.12	5359.94		66.63
KPC-2007-2	2/27/2017	155.22	5359.84		66.15
KPC-2007-2	5/17/2017	159.31	5355.75		66.36
KPC-2007-2	8/28/2017	160.14	5354.92		68.20
KPC-2007-2	11/29/2017	160.47	5354.59		67.96
KPC-2007-2	3/1/2018	159.86	5355.20		64.44
KPC-2007-2	5/22/2018	160.02	5355.04		68.20
KPC-2007-2	9/6/2018	158.93	5356.13		69.80
KPC-2007-2	11/26/2018	158.42	5356.64		64.76
KPC-2007-2	3/19/2019	155.90	5359.16		64.94
KPC-2007-2	6/13/2019	156.00	5359.06		78.08
KPC-2007-2	9/11/2019	156.90	5358.16		72.32
KPC-2007-2	12/3/2019	152.40	5362.66		61.70
KPC-2007-2	2/26/2020	155.80	5359.26		64.94
KPC-2007-2	5/27/2020	159.40	5355.66	200.4	55.58
KPC-2007-2	8/26/2020	156.20	5358.86		
KPC-2007-2	11/12/2020	156.30	5358.76		
KPC-2007-2	2/2/2021	156.40	5358.66		
KPC-2007-2	6/29/2021	160.60	5354.46		
KPC-2007-2	8/19/2021	156.80	5358.26		
KPC-2007-2	11/22/2021	157.00	5358.06		
KPC-2007-2	3/1/2022	155.30	5359.76		
KPC-2007-2	5/31/2022	157.60	5357.46		
KPC-2007-2	6/1/2022	157.00	5358.06		
KPC-2007-2	8/18/2022	149.80	5365.26		
KPC-2007-2	10/11/2022	158.29	5356.77		
KPC-2007-2	2/15/2023	157.15	5357.91		
KPC-2007-2	5/16/2023	157.46	5357.60		

KPC-2007-2	8/22/2023	156.84	5358.22
KPC-2007-2	11/9/2023	157.16	5357.90
KPC-2007-2	2/21/2024	156.87	5358.19
KPC-2007-2	5/8/2024	156.71	5358.35
KPC-2007-2	8/19/2024	156.10	5358.96
KPC-2007-2	11/13/2024	156.86	5358.20
KPC-2007-2	2/11/2025	155.25	5359.81

Lab pH, SU	Lab Conductivity, umho/cm	TDS, 180C, mg/l	Alkalinity, Total as CaCO3, mg/L	Bicarbonate as HCO3, mg/L	Carbonate as CO3, mg/L	Chloride, mg/L	Sulfate, mg/L	Fluoride, mg/L	Boron, dissolved, mg/L	Calcium, dissolved, mg/L
8	12200	8740	820	970	12	1900	2600	2	0.5	73.1
8	12200	8200	780	920	16	1800	2500	1.6	0.5	54.1
7.8	12400	7650	760	930	ND	1700	2600	1.3	0.6	56.6
7.8	11800	7120	720	790	47	1700	2700	1.3	0.6	43.1
7.8	12400	8440	760	900	13	1800	3100	1.4	0.6	49.5
7.9	12700	7600	750	880	12	1900	3300	1.3	0.6	50.0
7.8	11200	6810	690	840	ND	1800	3200	1.2	0.6	40.7
7.8	12000	8310	680	820	ND	1800	3400	1.4	0.6	46.2
7.8	12400	8110	690	790	27	1600	2700	1.3	0.6	48.6
7.7	11800	8270	700	790	30	1810	3180	1.3	0.7	42.2
7.6	11700	8270	710	870	ND	1810	2980	1.3	0.6	40.6
7.7	11600	8320	690	840	ND	1810	3130	1.3	0.7	45.3
7.7	11800	8160	700	850	ND	1830	3440	1.3	0.66	43.7
7.7	11500	8130	690	820	9	1700	3000	1.4	0.76	36.5
7.8	11800	8140	680	830	ND	1700	3000	1.4	0.69	36.5
7.7	11600	8180	690	840	ND	1800	3300	1.3	0.71	42.3
7.6	11800	8200	670	810	ND	1750	3120	1.3	0.64	40.2
7.8	11500	8030	630	740	14	1760	3100	1.3	0.71	37.6
7.8	11500	8230	670	810	ND	1670	3010	1.3	0.71	40.5
7.7	11300	8330	640	780	ND	1860	3290	1.3	0.67	36.8
7.7	11600	8330	660	800	ND	1800	3320	1.3	0.71	43.6
7.8	11800	7980	690	840	ND	1760	3000	1	0.74	35.1
7.8	11600	7880	650	790	ND	1770	3250	1.3	0.69	40.9
7.7	11400	7550	650	800	ND	1760	3160	1.2	0.73	35.8
7.7	11500	8150	670	810	ND	1660	2810	1.2	0.71	33.5
7.7	11400	7920	660	810	ND	1700	2860	1.3	0.71	36.3
7.7	11600	8290	670	820	ND	1780	3120	1.3	0.69	35.8
7.8	11500	7370	660	810	ND	1780	3200	1.3	0.66	34.8
7.7	11000	7370	670	820	ND	1740	3120	1.3	0.69	34
7.8	11400	7900	660	800	ND	1680	2870	1.2	0.68	36.8
8	12000	8260	660	760	22	1630	2900	1.3	0.7	37
8.1	12010	8210	670	770	16	1590	2890	1.1	0.66	36
7.8	11800	805	670	11800	<3.0	1750	3150	1.3	0.63	39.8
7.8	11800	8050	670	820	ND	1750	3150	1.3	0.75	39.8
7.7	11300	8670	660	800	ND	1750	3140	1.3	0.69	39.3
7.8	11100	8270	660	790	7	1800	3350	1.4	0.7	37.6
7.7	10600	8130	870	1100	<4.0	1820	3230	1.3	0.68	35.5
7.7	12300	7880	660	800	<4.0	1860	3340	1.4	0.67	33.2

7.7	11400	7730	680	820	<4.0	1820	3140	1.4	0.69	35
8.4	10600	7520	1200	1400	37	1250	2840	2	0.68	37
7.6	11800	9260	640	780	<4.0	1770	3220	1.3	0.68	44
7.7	11600	8760	650	790	<4.0	1740	3190	1.4	0.72	40
7.7	11600	8200	640	780	<4.0	1660	2960	1.4	0.53	35.4
7.7	11700	7950	740	900	<4.0	1740	3030	1.4	0.6	36.3
7.7	11600	7860	660	800	<4.0	1840	3200	1.4	0.7	38

Iron, dissolved, mg/L	Magnesium, dissolved, mg/L	Manganese, dissolved, mg/L	Potassium, dissolved, mg/L	Selenium, dissolved, mg/L	Sodium, dissolved, mg/L	Iron, Total, mg/L	Manganese, Total, mg/L	A/C, %
0.44	16.4	0.099	17.1	0.003	2880		0.284	
0.14	13.3	0.091	15.8	0.002	2750	5	0.137	2
ND	13.7	0.125	14.7	ND	2870	1.1	0.138	6.00
ND	11.8	0.079	14.2	ND	2750	0.5	0.084	2
0.09	13.6	0.102	13.9	ND	2880	0.5	0.105	0.00
0.13	13.4	0.132	13.8	ND	2780	0.8	0.13	
0.2	10.8	0.077	12.8	ND	2660	4.3	0.115	-5
0.05	11.6	0.13	13.3	ND	2850	5.6	0.286	-2
ND	11	0.118	13.2	ND	2650	3.9	0.143	2
0.57	11.9	0.164	12	ND	2780	1.7	0.143	-1.00
0.39	11	0.126	12.8	ND	2780	2	0.138	-1
0.11	11.9	0.106	12.9	ND	2930	0.8	0.103	0
0.69	12.2		12.1	ND	2760	0.69	0.126	
0.05	11.3	0.064	11.5	ND	2760	0.16	0.065	-0.92
0.05	11.2	0.09	12.1	ND	2840	0.65	0.086	0.42
0.06	11.5	0.111	12.2	ND	2890	0.95	0.124	-1.19
ND	11.5	0.094	11.5	ND	2780	0.59	0.104	-1.4
0.03	11.5	0.076	11.2	ND	2830	0.6	0.086	-0.23
0.06	11.6	0.099	11.2	ND	2720	0.69	0.112	-0.69
ND	11.1	0.072	10.8	ND	2730	0.73	0.093	-4.72
0.08	12	0.125	11.3	ND	2720	0.96	0.135	-4.46
0.02	10.5	0.061	10.8	ND	2670	0.38	0.065	-2.86
ND	12	0.106	11.9	ND	2760	0.36	0.113	-2.9
0.04	11.2	0.029	10.9	ND	2720	0.85	0.034	-2.96
0.04	10.8	0.06	11.3	ND	2690	0.45	0.063	0.42
ND	10.9	0.067	11.8	ND	2780	0.99	0.07	1.2
ND	10.8	0.061	10.9	ND	2700	0.35	0.065	-3.39
0.05	10.7	0.063	10.4	ND	2690	1.6	0.148	-4.15
0.05	10.2	0.07	10.5	ND	2680	0.12	0.072	-3.34
ND	11.5	0.087	11.7	ND	2860	0.52	0.096	2.84
ND	11.9	0.068	11.3	ND	2860	0.11	0.068	3.09
<0.02	11.6	0.06	11.1	<0.001	2870	0.1	0.062	2.11
<0.2	11.3	0.001	10	<0.001	2720	0.06	0.007	-2.94
ND	11.3	0.001	10	ND	2720	0.06	0.007	-2.94
0.03	11.4	0.104	10.7	ND	2770	0.35	0.104	-1.62
0.03	11.2	0.076	10.9	ND	2720	0.58	0.113	-4.82
0.1	11.3	0.061	11.4	0.009	2810	0.17	0.057	-4.26
0.09	10.9	0.065	12	0.012	2720	0.12	0.066	-4.61

0.14	10.9	0.087	9.5	<0.001	2660	0.16	0.09	-4.87
0.24	12.2	0.096	11.2	0.002	2540	1.84	0.119	-6.90
0.02	11.9	0.107	12.8	<0.001	2710	1.52	0.15	-3.45
0.31	11.8	0.124	12.7	<0.001	2830	2.58	0.174	-0.91
0.26	11.1	0.062	10.1	<0.001	2560	0.5	0.063	-3.04
0.4	11.7	0.09	11.1	<0.001	2910	0.57	0.091	0.95
0.39	12	0.083	11.5	0.001	2870	0.5	0.084	-1.37

Sample Notes
water level only, pump failure

Pump failure. Unable to bail
turbid, no odor

Clear
Clear

Duplicates Taken
Very Light silt, Very light white tint
Samples taken and preserved.
Samples taken and preserved.
Mostly clear.
Samples taken and preserved
Samples Taken and Perserved
Samples taken
Mostly Clear

light tan hue, sampled

Formation: Pictured Cliff Sandstone

Well Name Ground Surface Elevation 5467.5 ft amsl	Sample Date	Depth to water, TOC, ft; TOC Elevation 5469.2 ft amsl	GWEL	Field Temperature, F	Lab pH, SU	Lab Conductivity, umho/cm	TDS, 180C, mg/l
KPC-2007-03	12/29/2011	126.5	5342.7	61.52	7.4	7940	4750
KPC-2007-03	2/22/2012	126.7	5342.5	62.69	7.3	7650	5550
KPC-2007-03	6/12/2012	126.5	5342.7	65.53	7.2	7740	5850
KPC-2007-03	9/12/2012	126.6	5342.6	63.03	7.5	7650	4780
KPC-2007-03	12/5/2012	126.49	5342.71	17.00	7.5	7840	4870
KPC-2007-03	3/12/2013	126.35	5342.85	63.39	7.5	7630	4560
KPC-2007-03	6/12/2013	126.5	5342.7	65.30	7.7	7690	4890
KPC-2007-03	12/11/2013	126.4	5342.8	65.30	7.5	7350	4530
KPC-2007-03	5/27/2014	127.6	5341.6	64.94			
KPC-2007-03	12/3/2014	127.1	5342.1	15.70	7.8	7890	5220
KPC-2007-03	6/23/2015	126.5	5342.7	71.42	7.8	7540	5510
KPC-2007-03	12/8/2015	126.37	5342.83	62.53	7.6	7450	5350
KPC-2007-03	3/10/2016	126.34	5342.86	62.35	7.8	7300	5380
KPC-2007-03	8/11/2016	126.67	5342.53	68.14	8.2	7530	5210
KPC-2007-03	11/30/2016	126.53	5342.67	64.27	7.7	7450	5290
KPC-2007-03	3/6/2017	126.32	5342.88	57.88	7.9	7460	5490
KPC-2007-03	5/16/2017	126.97	5342.23	59.43	7.8	7480	5240
KPC-2007-03	8/29/2017	127.14	5342.06	65.05	7.6	7530	5210
KPC-2007-03	11/28/2017	127.73	5341.47	60.78	7.9	7400	5130
KPC-2007-03	2/27/2018	126.3	5342.9	61.92	7.8	7400	5310
KPC-2007-03	5/23/2018	126.4	5342.8				
KPC-2007-03	9/10/2018	126.26	5342.94	75.31	7.7	7360	5190
KPC-2007-03	12/3/2018	126.11	5343.09				
KPC-2007-03	9/11/2019	126.6	5342.6				
KPC-2007-03	12/16/2019	125.7	5343.5				
KPC-2007-03	3/5/2020	126.6	5342.6				
KPC-2007-03	5/26/2020	126.3	5342.9				
KPC-2007-03	9/1/2020	126.3	5342.9		7.9	7300	5220
KPC-2007-03	11/16/2020	127.1	5342.1				
KPC-2007-03	2/4/2021	127.8	5341.4				
KPC-2007-03	6/21/2021	127.4	5341.8				
KPC-2007-03	8/20/2021	128.3	5340.9				
KPC-2007-03	11/15/2021	128.6	5340.6				
KPC-2007-03	2/25/2022	130.1	5339.1				
KPC-2007-03	5/25/2022	130.1	5339.1				
KPC-2007-03	8/18/2022	159.29	5309.91				
KPC-2007-03	10/11/2022	159.29	5309.91				
KPC-2007-03	02/2023	128.35	5340.85				
KPC-2007-03	05/2023	127.52	5341.68				
KPC-2007-03	8/21/2023	127.82	5341.38				
KPC-2007-03	11/8/2023	128.12	5341.08				
KPC-2007-03	2/20/2024	127.47	5341.73				
KPC-2007-03	5/8/2024	126.98	5342.22				

KPC-2007-03	8/12/2024	127.05	5342.15
KPC-2007-03	11/13/2024	128.12	5341.08
KPC-2007-03	2/17/2025	129.08	5340.12

Alkalinity, Total as CaCO3, mg/L	Bicarbonate as HCO3, mg/L	Carbonate as CO3, mg/L	Calcium, mg/L	Chloride, mg/L	Sulfate, mg/L	Fluoride, mg/L	Boron, dissolved, mg/L	Iron, dissolved, mg/L	Magnesium, dissolved, mg/L
820	1000	ND	46.4	920	1500	4	0.3	ND	7.7
800	980	ND	57.3	950	2000	3	0.4	2.33	10.8
830	1000	ND	57.7	960	1600	3.2	0.4	0.39	11.2
870	1100	ND	45.2	780	1700	3.6	0.4	0.26	7.9
950	990	80	42.9	750	1600	3.6	0.5	2.41	9.2
890	1100	ND	39.7	820	2000	3.3	0.5	0.18	7.7
900	1100	11	36.2	840	2000	3.4	0.5	ND	6.6
910	1100	ND	31.1	850	2000	3	0.4	0.57	5.6
880	970	49	40.6	790	1900	3.1	0.4	0.05	6
860	960	44	32.8	818	2010	3.4	0.5	0.07	5.8
890	1100	ND	30.5	812	1870	3.2	0.5	ND	6.1
860	1000	ND	31	822	1980	3.1	0.5	0.2	6.9
870	1000	29	32.4	796	2060	3.2	0.58		7.17
880	1000	21	30.8	780	2000	3.2	0.54	0.27	6.9
880	1100	ND	41.4	720	1800	3	0.58	0.04	6.5
890	1100	ND	35.9	790	2000	3.1	0.6	0.27	6.9
910	880	110	28.7	783	1950	3	0.51	0.06	6.35
890	1100	12	29.5	775	1940	2.9	0.55	0.16	6.45
880	1100	ND	31	775	1930	2.9	0.55	0.42	6.52
890	1100	8	27	787	2020	3	0.63	0.15	6.8
850	1000	18	26.7	774	2010	2.8	0.57	0.49	6.03

Manganese, dissolved, mg/L	Potassium, dissolved, mg/L	Selenium, dissolved, mg/L	Sodium, dissolved, mg/L	Iron, Total, mg/L	Manganese, Total, mg/L	A/C, %
0.274	10	ND	1670			1
0.033	13.1	0.001	1760			-2
0.21	13.1	ND	1680	38.2	0.451	-1
0.162	10.8	ND	1800	27.1	0.307	-2
0.178	12.4	ND	1790	16.7	0.238	4
0.139	10.5	ND	1760	4.6	0.169	-2
0.152	9.8	ND	1670	5.6	0.202	-6
0.082	8.3	ND	1720	34.9	0.489	-4
0.055	8.8	ND	1650	33.7	0.435	-2
0.077	8.4	ND	1690	13.8	0.18	-4
0.023	12	ND	1770	5.7	0.125	0
0.028	10.4	ND	1670	2.5	0.053	-4
	10.4	ND	1800	15.1	0.235	-
0.006	9.3	ND	1800	2.77	0.049	-0.02
0.042	8.4	ND	1810	6.27	0.104	3.93
0.043	10.6	0.007	1650	4.22	0.115	-4.53
0.027	8.6	ND	1740	1.01	0.039	-1.91
0.105	11.6	ND	1670	11.2	0.265	-3.5
0.085	8.5	ND	1770	17	0.31	-0.31
0.063	9.7	ND	1650	0.66	0.64	-5.25
0.073	7.7	ND	1680	6.32	0.189	-3.75

Sample Notes
Clear water, increasing turbidity after 10 gallons
slightly turbid, no odor
turbid (smoky), no odor
turbid, no odor

Turbid, light brown, no odor
Slightly turbid, no odor
turbid, no odor
turbid, brown

Sample collected and preserved
Light grey tint, light silt
Mostly Clear
Samples Taken and Preserved
Samples Taken and Preserved
Samples taken and preserved.
Samples taken and preserved.
Samples taken and preserved.
Samples taken and preserved
Samples Taken and Perserved

Samples taken
Light silt, Light tan hue.
water level only
water level only
water level only
water level only

water level only
water level only
water level only
water level only
water level only
water level only
water level only
water level only
water level only
water level only
water level only
water level only
water level only
water level only
water level only

water level only
water level only
water level only

Station Name	Sample Date	Lab pH, s.u.	Lab Conductivity, umhos/cm	Total Suspended Solids, mg/L	Total Setteable Solids, mL/L	Total Dissolved Solids, mg/L	Alkalinity as CaCO3, mg/L
Pinabete Upstream	5/27/2015	7.7	231000				
Pinabete Upstream	11/23/2015	7.6	1180	109000		850	
Pinabete Upstream	10/25/2016	9.2	437	14300		400	200
Pinabete Upstream	11/4/2016	9.3	382	22800		425	400
Pinabete Upstream	8/3/2017	7.4	1210	434000			
Pinabete Upstream	8/3/2017	7.4	904	966000			
Pinabete Upstream	3/12/2019	8.8	567	5700	ND	1500	140
Pinabete Upstream	5/21/2019	8.4	630	19700	ND	1080	210
Pinabete Upstream	7/25/2020	8.1	648	81700	3.2	550	440
Pinabete Upstream	9/10/2020	8.0	1130	116000	ND	810	490
Pinabete Upstream	7/27/2021	9.0	573	35800	4.4	990	320
Pinabete Upstream	10/3/2022	8.0	1260	44600	1.0	980	380
Pinabete Upstream	2023	No Samples					
Pinabete Upstream	2024	No Samples					

Bicarbonate as HCO3, mg/L	Carbonate as CO3, mg/L	Chloride, mg/L	Sulfate, mg/L	Fluoride, mg/L	Hardness as CaCO3, mg/L	Nitrate, as N, mg/L	Aluminum, dissolved, mg/L	Arsenic, dissolved, mg/L
		23	216	ND	4740			
220	9	4.4	75	ND	8	0.02		
480	ND	5.2	63	ND	16	ND		
160	5	12	100	0.1	16	6.87	0.015	0.0012
250	ND	4	151	0.1	17	1.32	0.96	0.0015
540	ND	4	158	ND	503	0.73	42.7	0.0043
590	ND	4	424	ND	98	1.42	0.014	0.0007
370	15	4	150	0.2	17	1.98	0.78	0.0029
470	ND	6	570	0.2	216	2.10	ND	0.0008

Boron, dissolved, mg/L	Cadmium, dissolved, mg/L	Calcium, dissolved, mg/L	Iron, dissolved, mg/L	Lead, dissolved, mg/L	Magnesium, dissolved, mg/L	Manganese, dissolved, mg/L	Mercury, dissolved, ug/L	Potassium, dissolved, mg/L
					ND			1.4
		5.4			0.7			3.2
ND	ND	5.8	ND	ND	ND	ND	0.02	2
ND	ND	5.8	0.55	0.0003	0.6	ND	ND	1.9
ND	0.00130	151	28.4	0.0741	30.4	2.76	0.01	14.5
ND	ND	34.2	ND	ND	3.0	ND	0.04	5.0
ND	ND	6.3	0.37	0.0004	0.41	0.003	0.02	2.2
ND	ND	77.0	ND	ND	5.71	ND	ND	4.3

Selenium, dissolved, mg/L	Sodium, dissolved, mg/L	Aluminum, Total, mg/L	Arsenic, Total, mg/L	Boron, Total, mg/L	Cadmium, Total, mg/L	Iron, Total, mg/L	Lead, Total, mg/L	Manganese, Total, mg/L
		4170				3800		
		2370				2120		
		491	0.0455	0.2	0.002	294	0.268	3.73
	72.2	433	0.269	0.2		331		6.02
		2400				2740		
		2210				2390		
0.004	115	156	0.0135	ND	0.001	95.2	0.0889	1.24
0.002	118	241	0.0272	0.1	0.0013	201	0.156	2.57
0.002	143	1320	0.150	0.3	0.0080	1190	0.986	19.6
0.001	199	1540	0.229	0.6	0.0082	1470	1.06	23.7
0.003	118	808	0.133	0.39	0.0063	730	0.633	12.7
0.004	197	792	0.192	0.37	0.0043	653	0.627	12.4

Mercury, Total Recoverable, ug/L	Selenium, Total, mg/L	A/C Balance, %	
0.63	0.007	-29.7	reanalyzed to verify AC%
0.71	0.004	-43.6	reanalyzed to verify AC%
0.29	0.006	1.8	
0.44	0.003	-14.3	
1.59	0.009	15.2	
3.19	0.016	-27.3	
1.06	0.011	-27.2	
1.4	0.014	-21.0	

Station Name	Sample Date	Lab pH, s.u.	Lab Conductivity, umhos/cm	Total Suspended Solids, mg/l	Total Setteable Solids, mL/L	Total Dissolved Solids, mg/L	Bicarbonate as HCO3, mg/L
Downstream Pinabete	5/27/2015	7.7			183000		
Downstream Pinabete	11/23/2015	7.5	1450	246000			
Downstream Pinabete	10/25/2016	8.8	338	10600		475	280
Downstream Pinabete	8/3/2017	7.8	1200	485000			
Downstream Pinabete	5/21/2019	8.6	468	18400	0.9	880	240
Downstream Pinabete	7/27/2021	9.1	515	62200	23	880	430
Downstream Pinabete	10/3/2022	8.1	964	95200	ND	820	1000
Downstream Pinabete	2023	No Samples					
Downstream Pinabete	2024	No Samples					

Carbonate as CO3, mg/L	Chloride, mg/L	Sulfate, mg/L	Fluoride, mg/L	Hardness as CaCO3, mg/L	Nitrate, as N, mg/L	Aluminum, dissolved, mg/L	Arsenic, dissolved, mg/L	Boron, dissolved, mg/L	Cadmium, dissolved, mg/L
	10	534	ND	9440					
ND	11	25	ND	75	0.71				
ND	4	90	0.1	16	1.48	0.97	0.0017	ND	ND
19	4	127	0.2	20	1.72	1.87	0.0028	ND	ND
ND	4	390	ND	185	1.05	0.005	0.0008	ND	ND

Calcium, dissolved, mg/L	Iron, dissolved, mg/L	Lead, dissolved, mg/L	Magnesium, dissolved, mg/L	Manganese, dissolved, mg/L	Mercury, dissolved, ug/L	Potassium, dissolved, mg/L	Selenium, dissolved, mg/L	Sodium, dissolved, mg/L
27.8			2.2			3.5		68.6
5.7	0.46	0.0003	ND	ND	ND	1.9	0.002	88.4
7.1	0.82	0.0006	0.54	0.005	0.01	2.2	0.002	97.4
66.1	0.04	0.0001	4.94	ND	ND	4.3	0.001	128

Mercury, Total Recoverable, ug/L	Aluminum, Total, mg/L	Arsenic, Total, mg/L	Boron, Total, mg/L	Cadmium, Total, mg/L	Iron, Total, mg/L	Lead, Total, mg/L	Manganese, Total, mg/L	Selenium, Total, mg/L	A/C Balance, %
	3720				3210				
	3800				4140				
0.49	334	0.0609	0.25	0.003	239	0.208	5.5	0.006	-8.47
	5300				5750				
0.6	159	0.021	ND	0.0015	114	0.136	2.76	0.003	-16.7
0.52	1020	0.204	0.43	0.0089	1090	0.925	34.2	0.015	-36.9
3.1	1670	0.330	0.7	0.0096	1500	1.48	26.8	0.023	-45.7

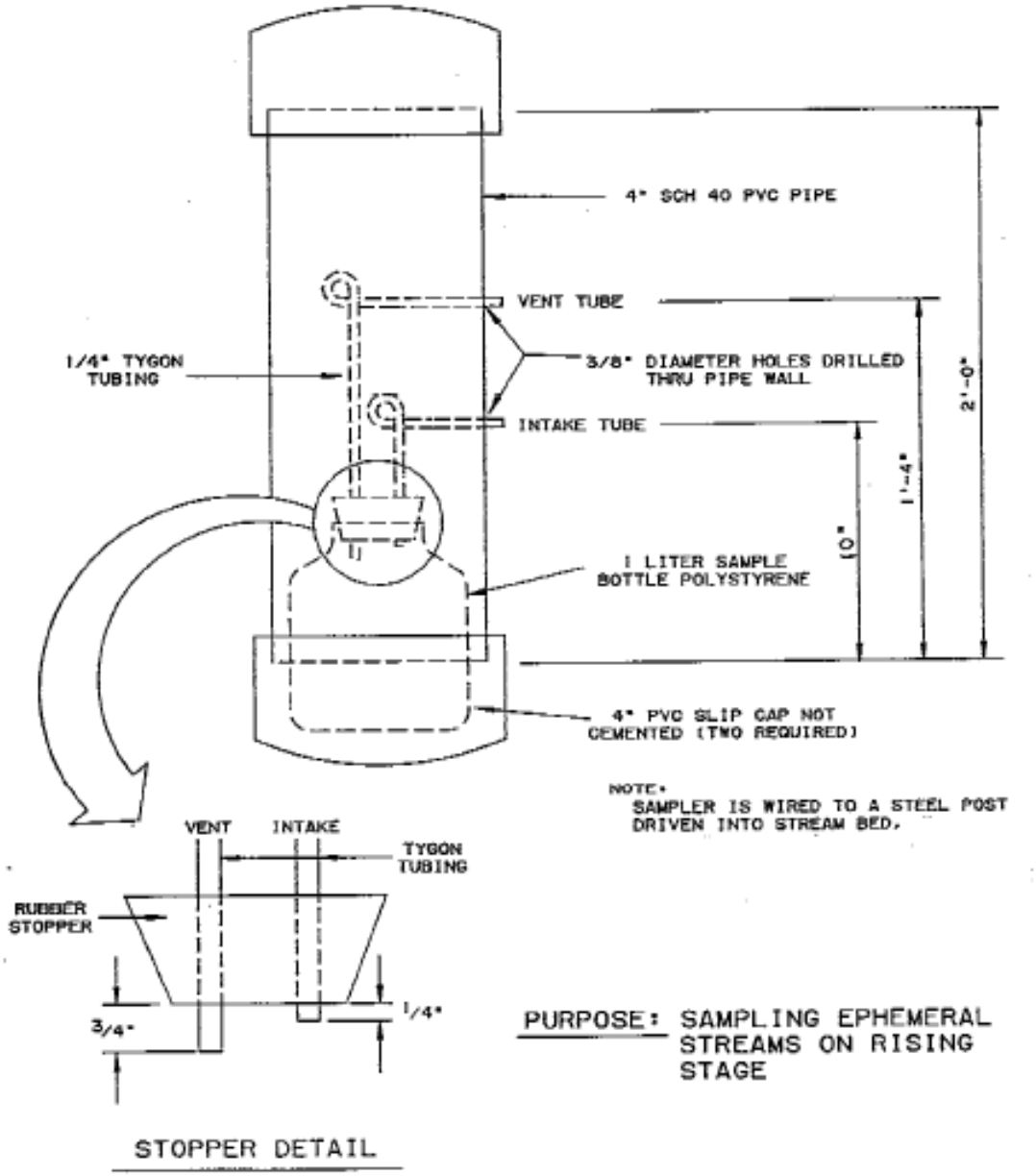


Figure 18-1: Schematic of Single-Stage Sediment Sampler

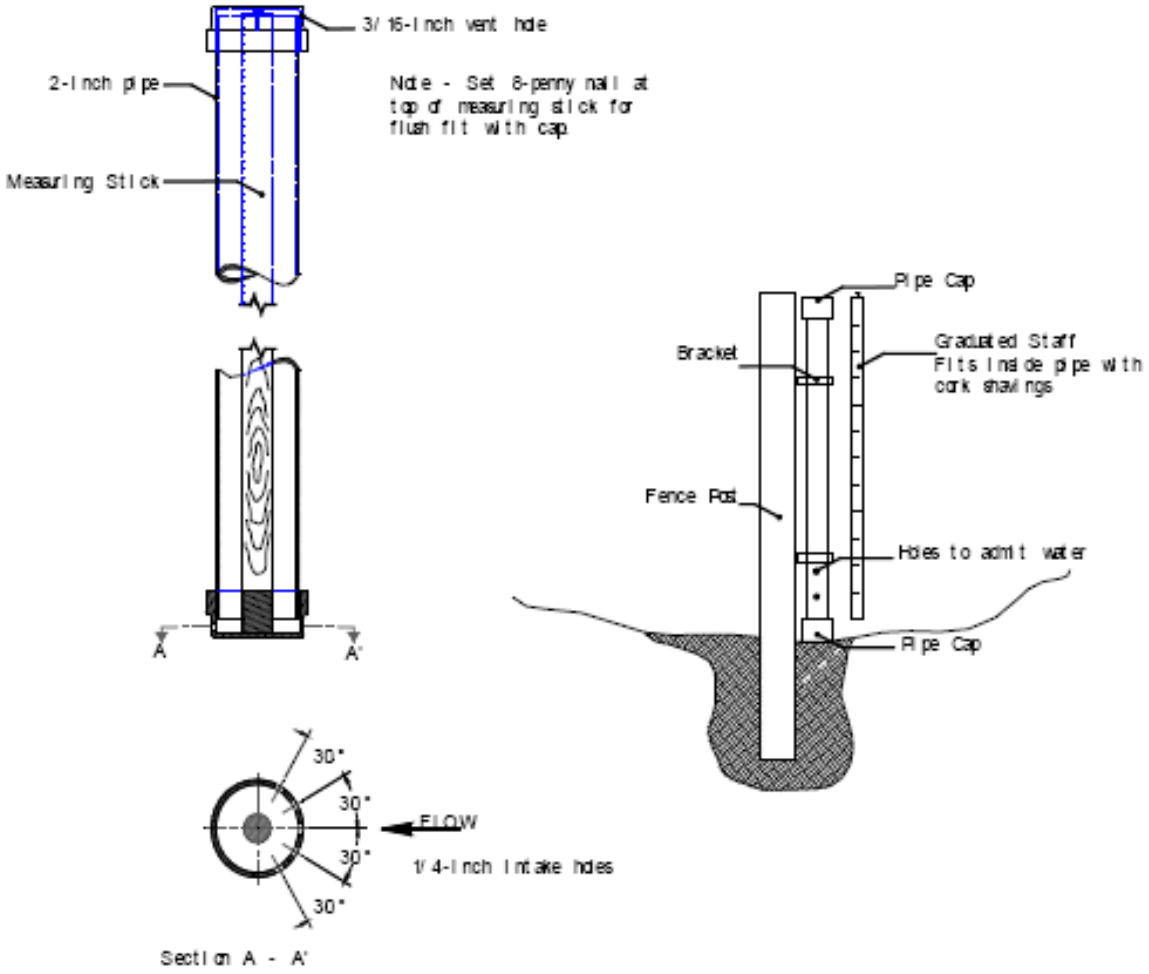
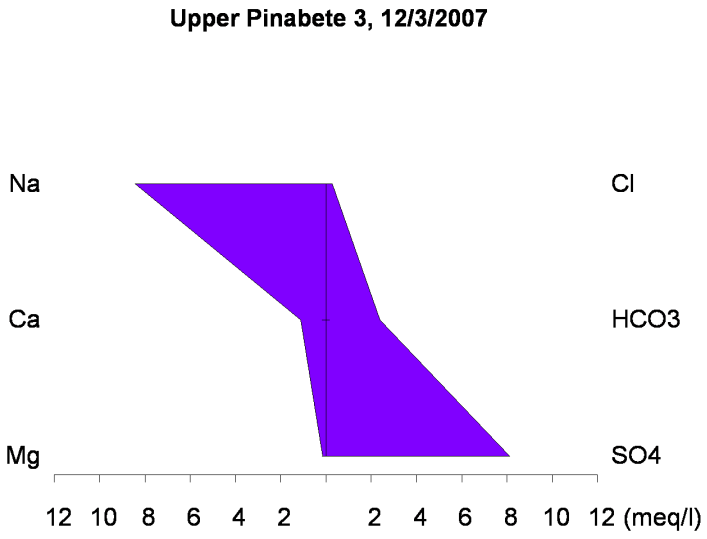


Figure 18-2: Schematic of Crest Gage



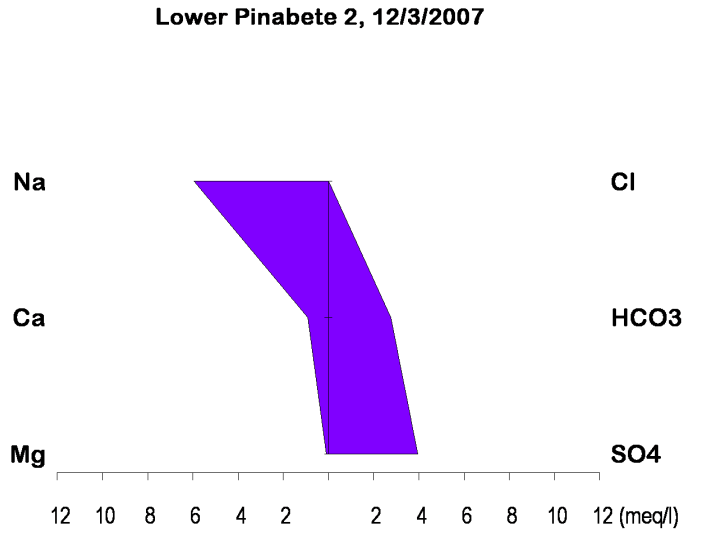


Figure 18-3: Pinabete Arroyo Stiff Diagrams

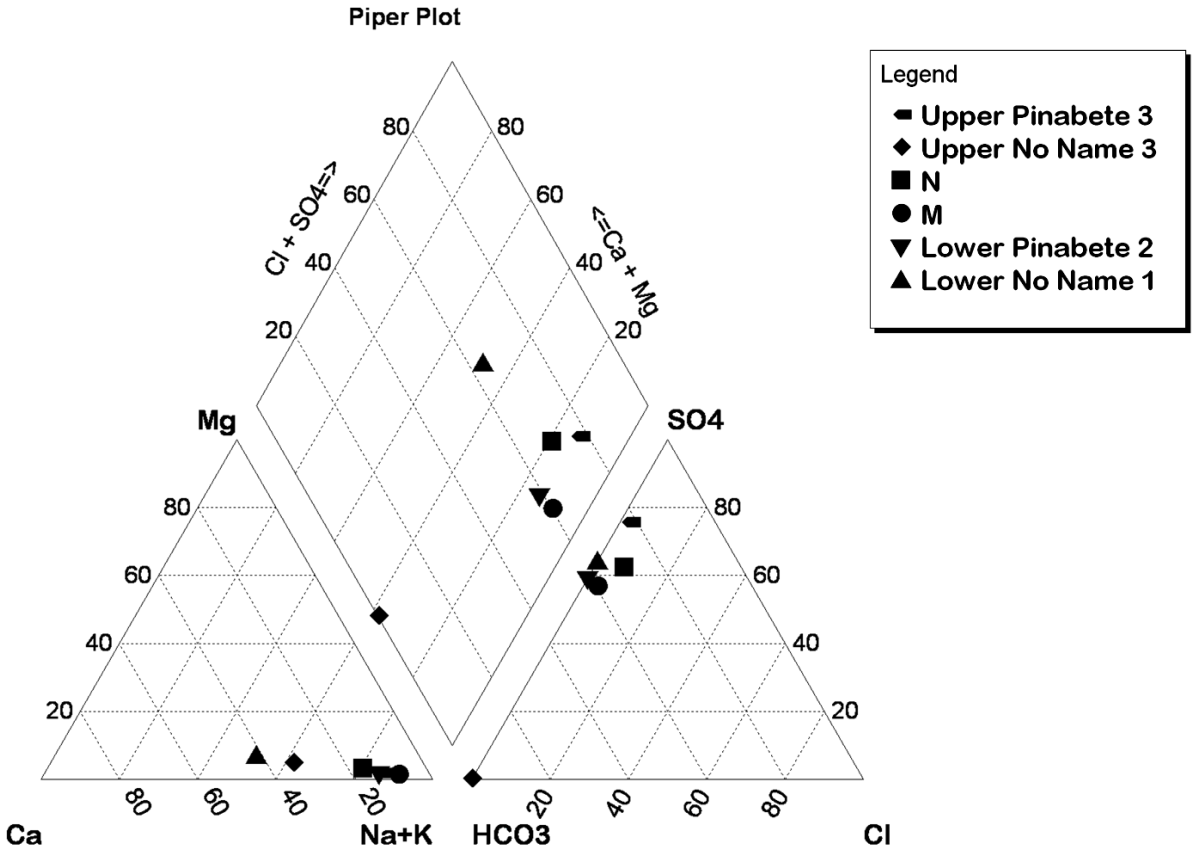


Figure 18-4: Piper Plot Diagram for Surface Water Samples from Pinabete Arroyo, No Name Arroyo, and Brimhall Wash

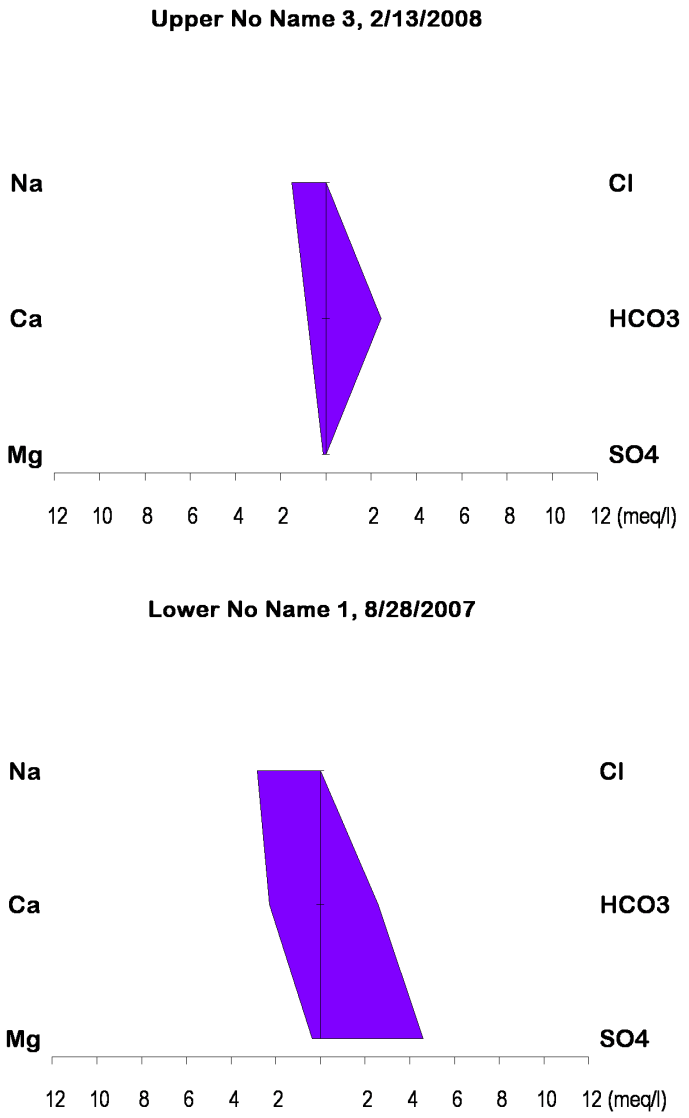


Figure 18-5: No Name Arroyo Stiff Diagrams

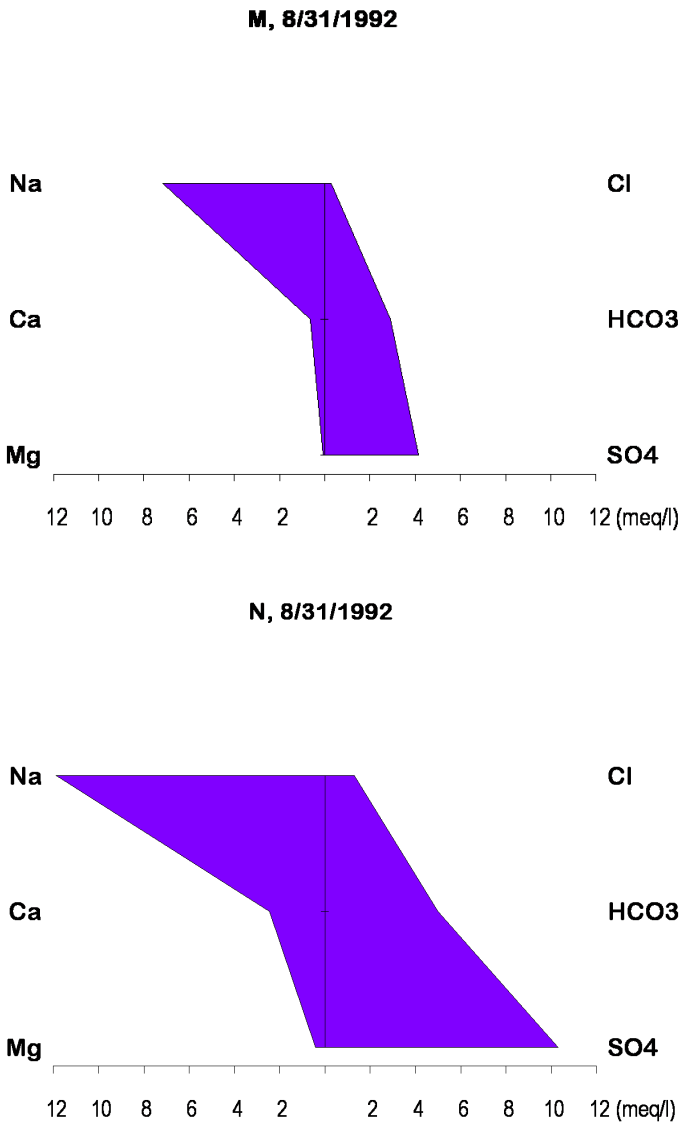


Figure 18-6: Brimhall Wash Stiff Diagrams – Upstream (Site N) and Downstream (Site M).

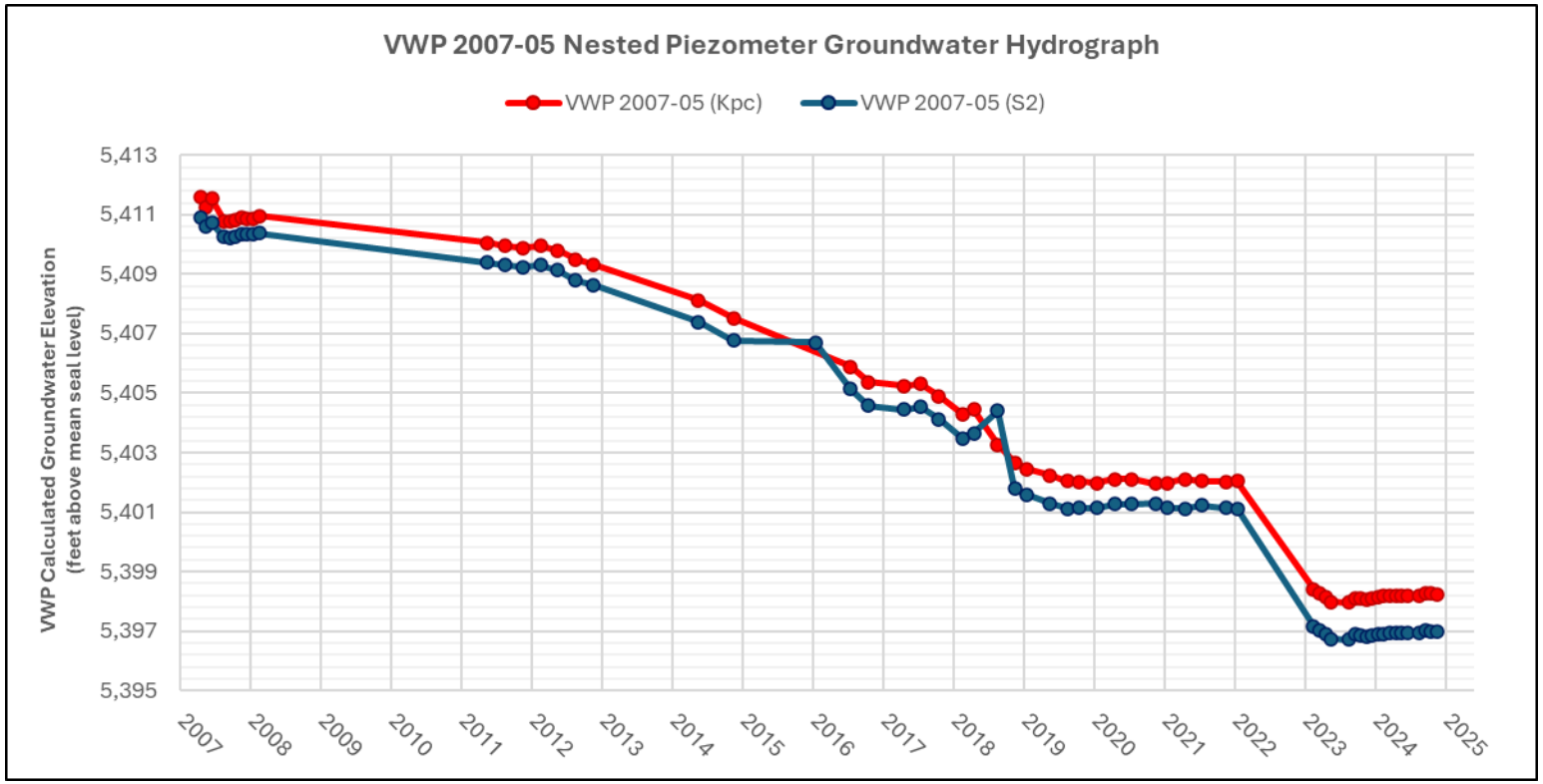


Figure 18-7 Baseline Potentiometric Elevations at Location VWP2007-05

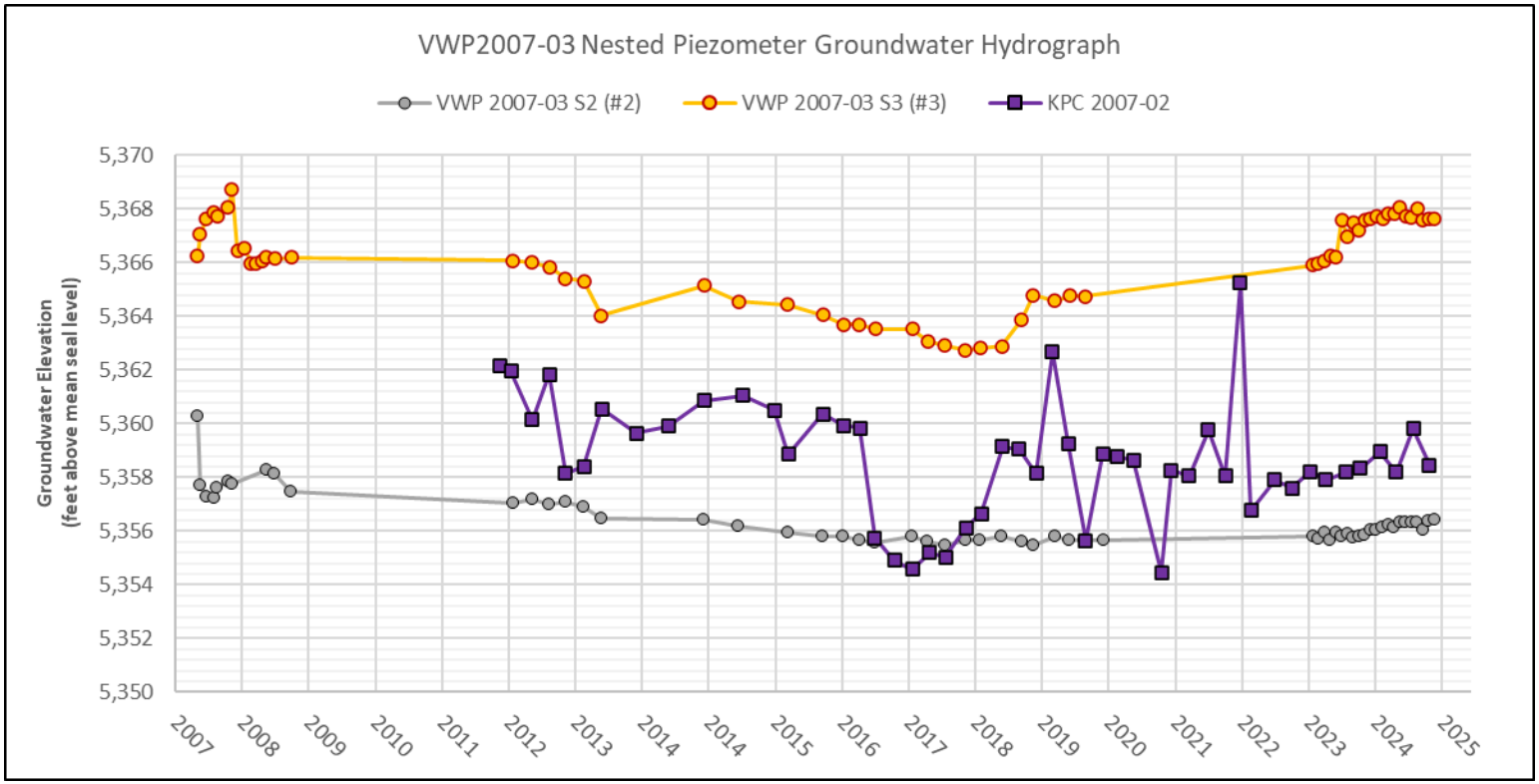


Figure 18-8 Baseline Potentiometric Elevations at Location VWP2007-03

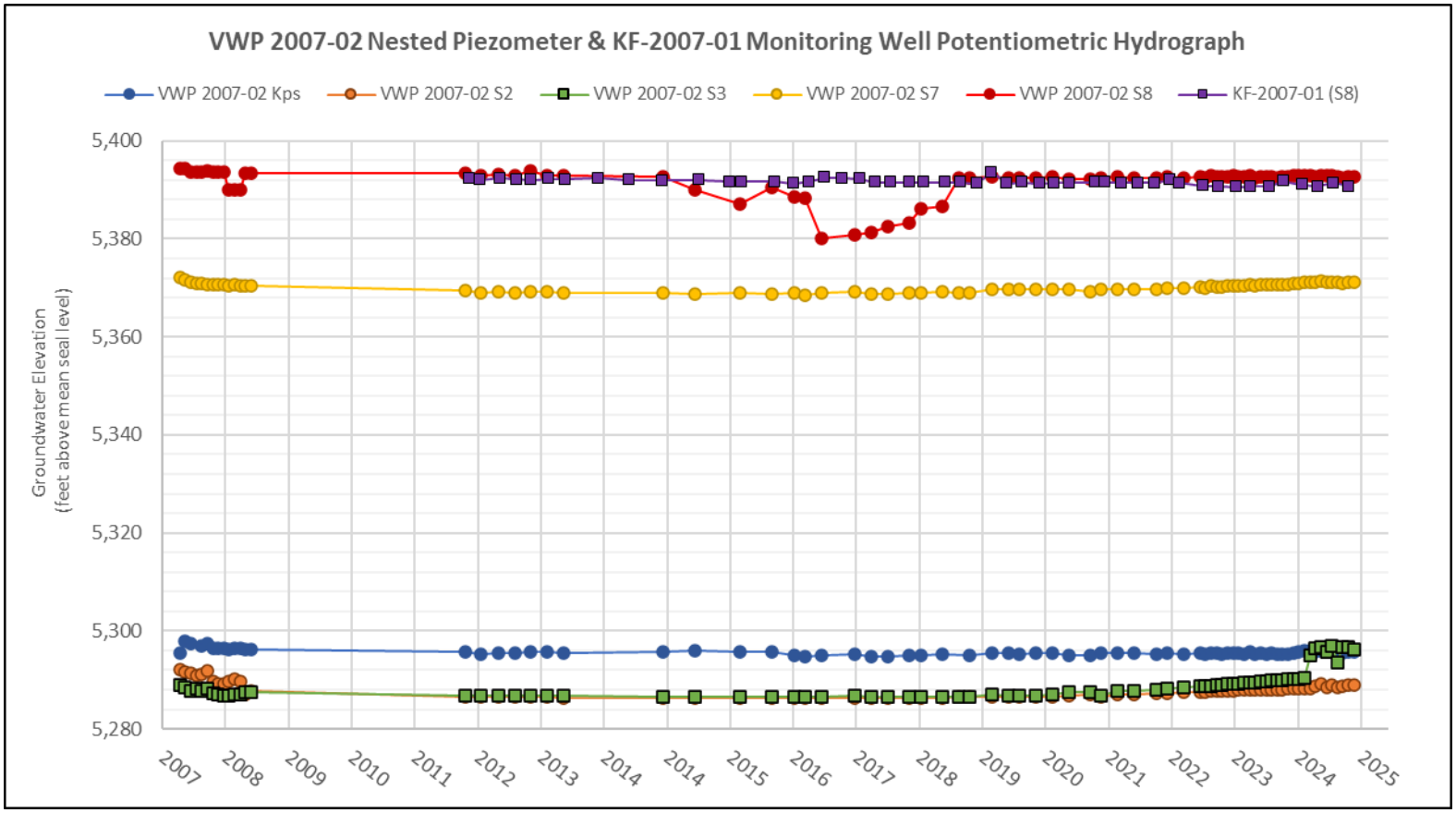


Figure 18-9 Baseline Potentiometric Elevations at Location VWP2007-02

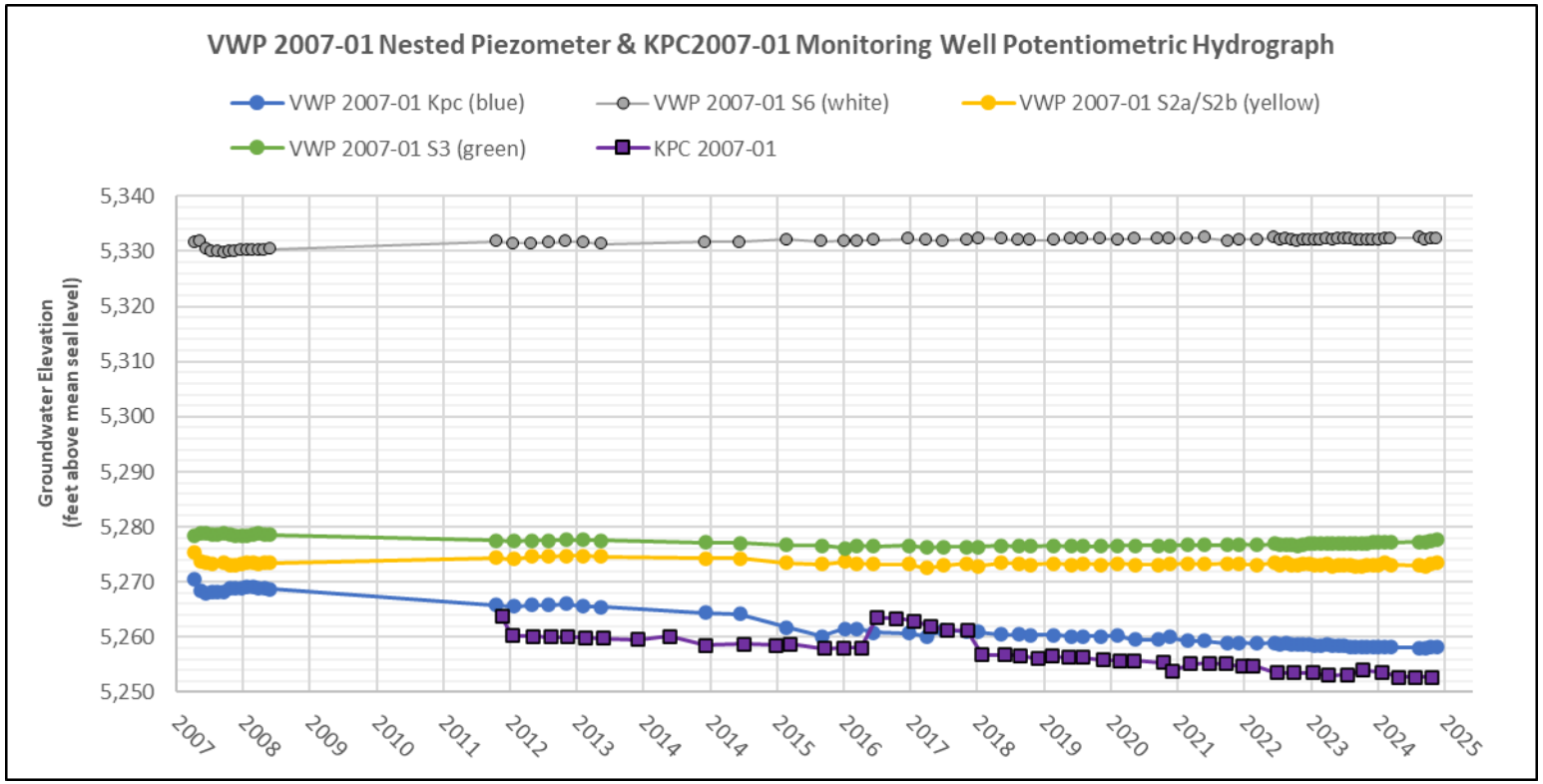


Figure 18-10 Baseline Potentiometric Elevations at Location VWP2007-01

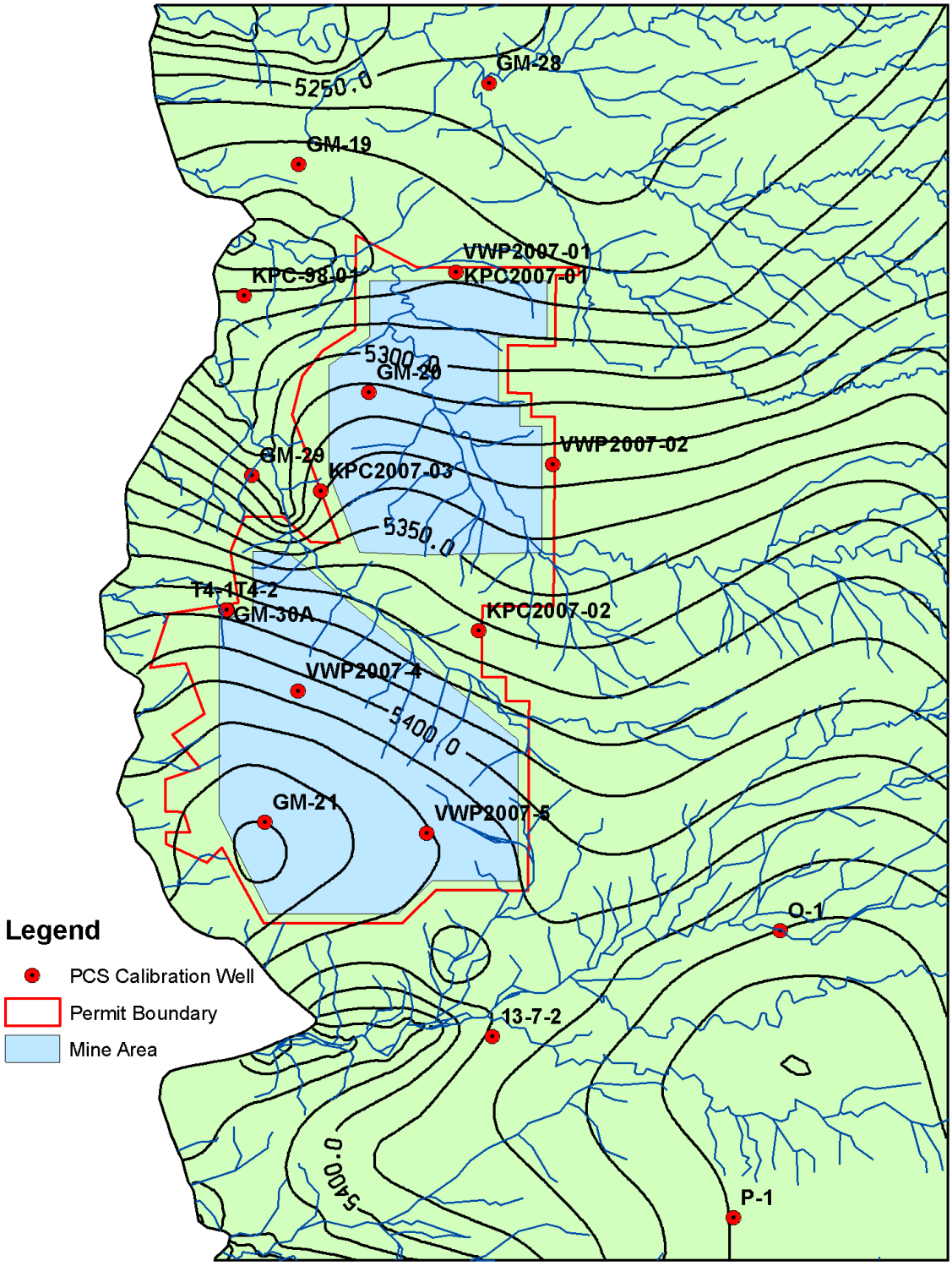


Figure 18-11 Modeled Baseline Potentiometric Surface for the Pictured Cliffs Sandstone

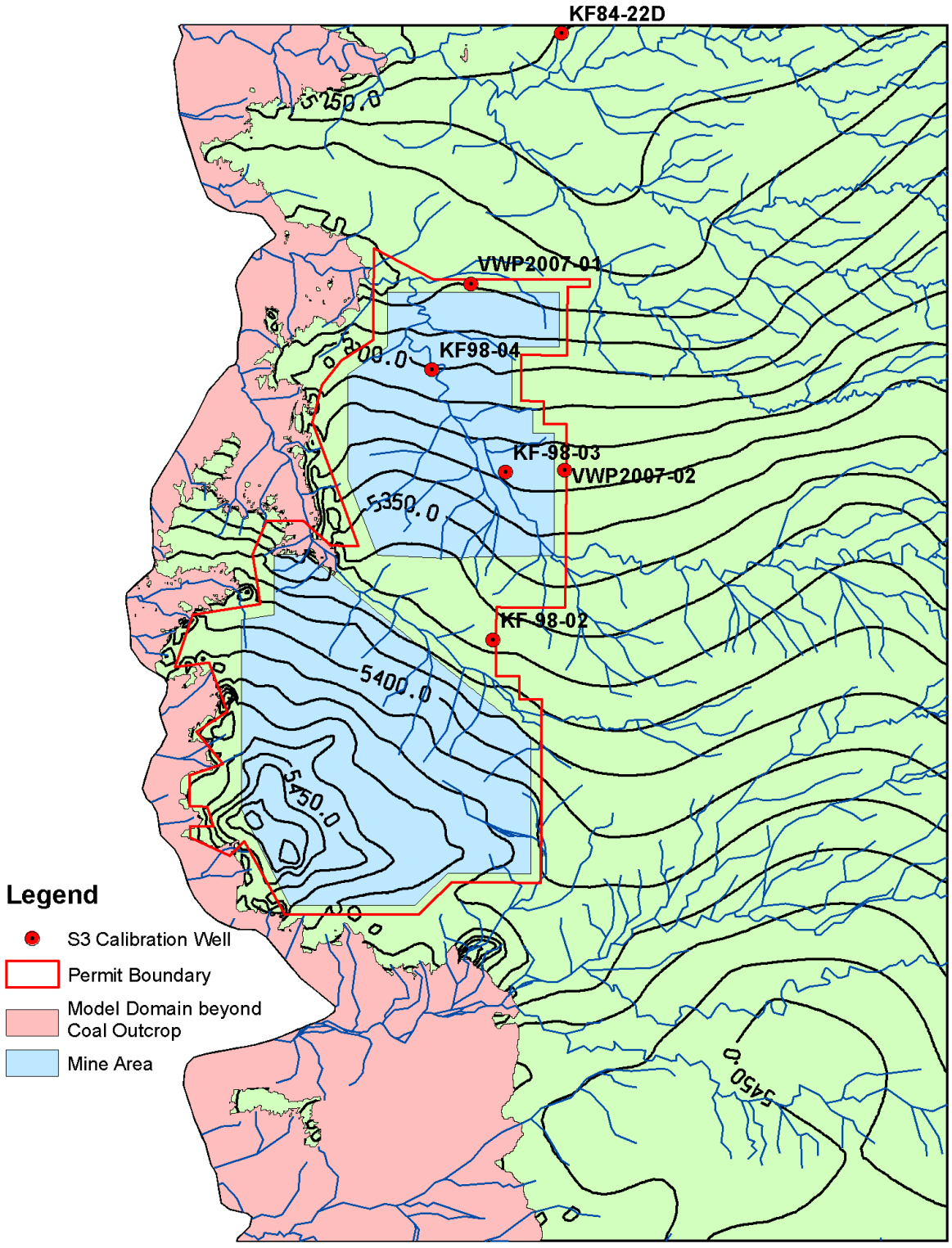


Figure 18-12 Modeled Baseline Potentiometric Surface for the No. 3 Coal Seam

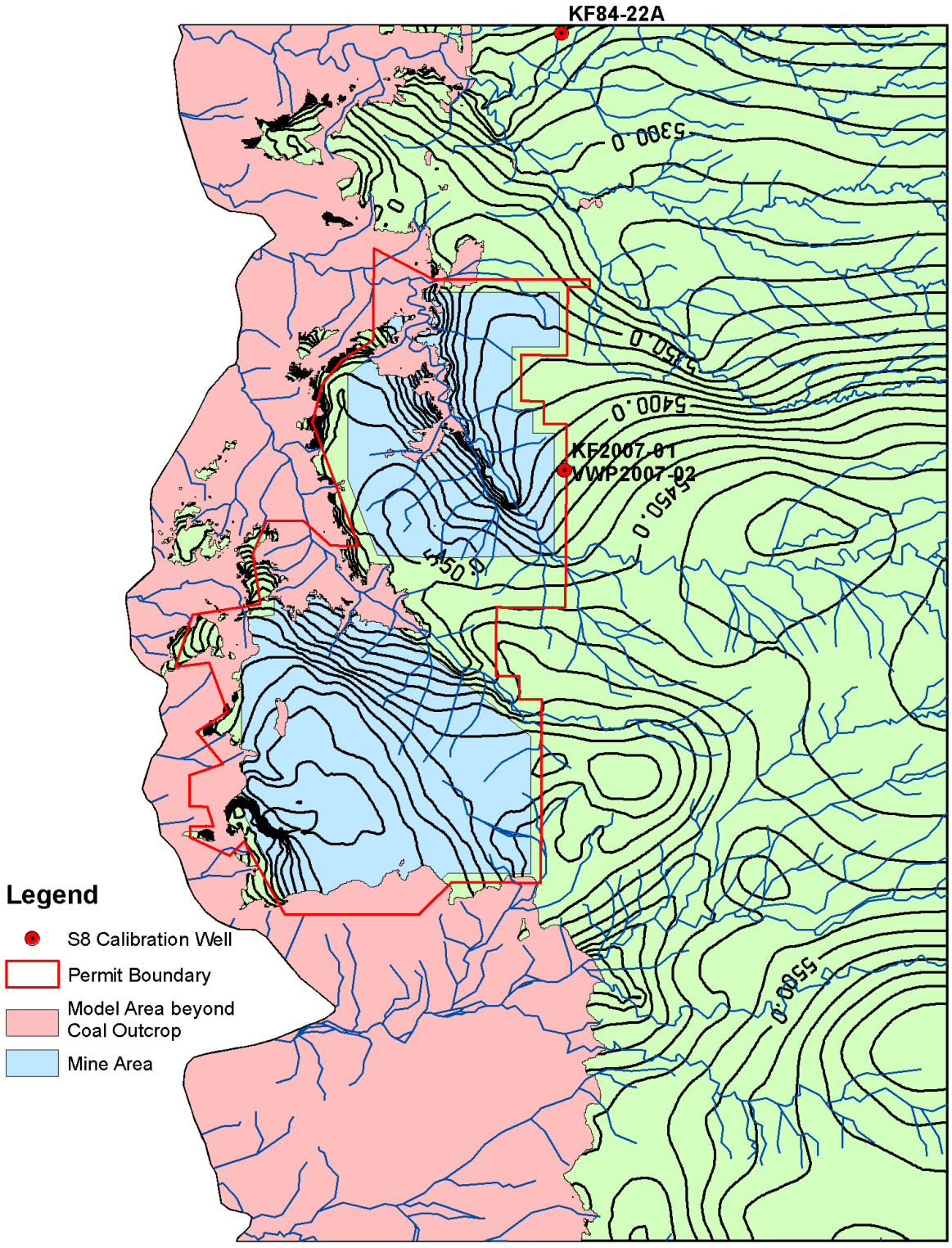


Figure 18-13 Modeled Baseline Potentiometric Surface for the No. 8 Coal Seam

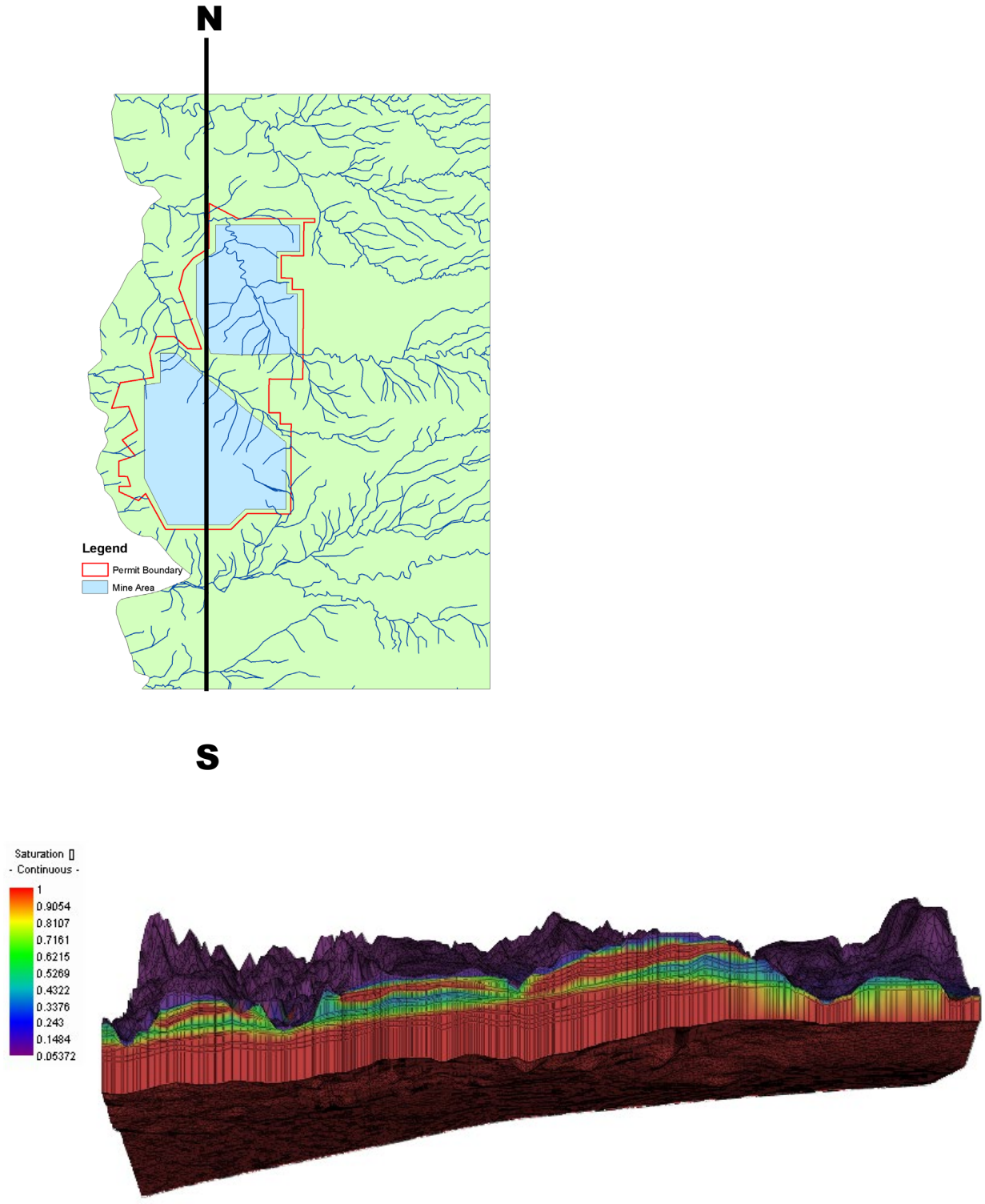


Figure 18-14 Modeled Baseline Saturation for a North-South Section at NNP.

2510000 2520000 2530000 2540000 2550000

2010000 2000000 1990000 1980000 1970000 1960000

Cottonwood Arroyo
Burnham Road
Cottonwood Spring
Well 2
Lower Pinabete
Pinabete
Arroyo
Well 5214
Well
Cottonwood Arroyo Tributary Watershed
Pinabete Arroyo Watershed
Lower No Name
Upper Pinabete
Drill Hole
Chaco River Tributary #3 Watershed
No Name Arroyo Watershed
Upper No Name
Chaco River Tributary #2 Watershed
Watershed for Tributaries to Chaco River
Brimhall Wash Watershed
Burnham Trading Post
Site M
Site N
Landing Strip
Mine
BM 5336
09367938

N A V A J O I N D I A N R E S E R V A T I O N

Coordinate System:
NAD 1927 StatePlane New Mexico West FIPS 3003 Feet
Datum: North American 1927
Units US Feet

0 2,400 4,800 9,600 14,400 Feet
1:18,000

Legend
- NNP Surface Water Monitoring Sites
- Regional SWMonitoring Sites
- Streams
- USGS Monitoring Stations
- Ponds
- Watersheds
- No Name Permit Boundary
- NTEC Lease Boundary

REV. No.	DATE	DRAFT BY	REVISION DESCRIPTION	ENG.	EQD.	PE
				APPROVALS		

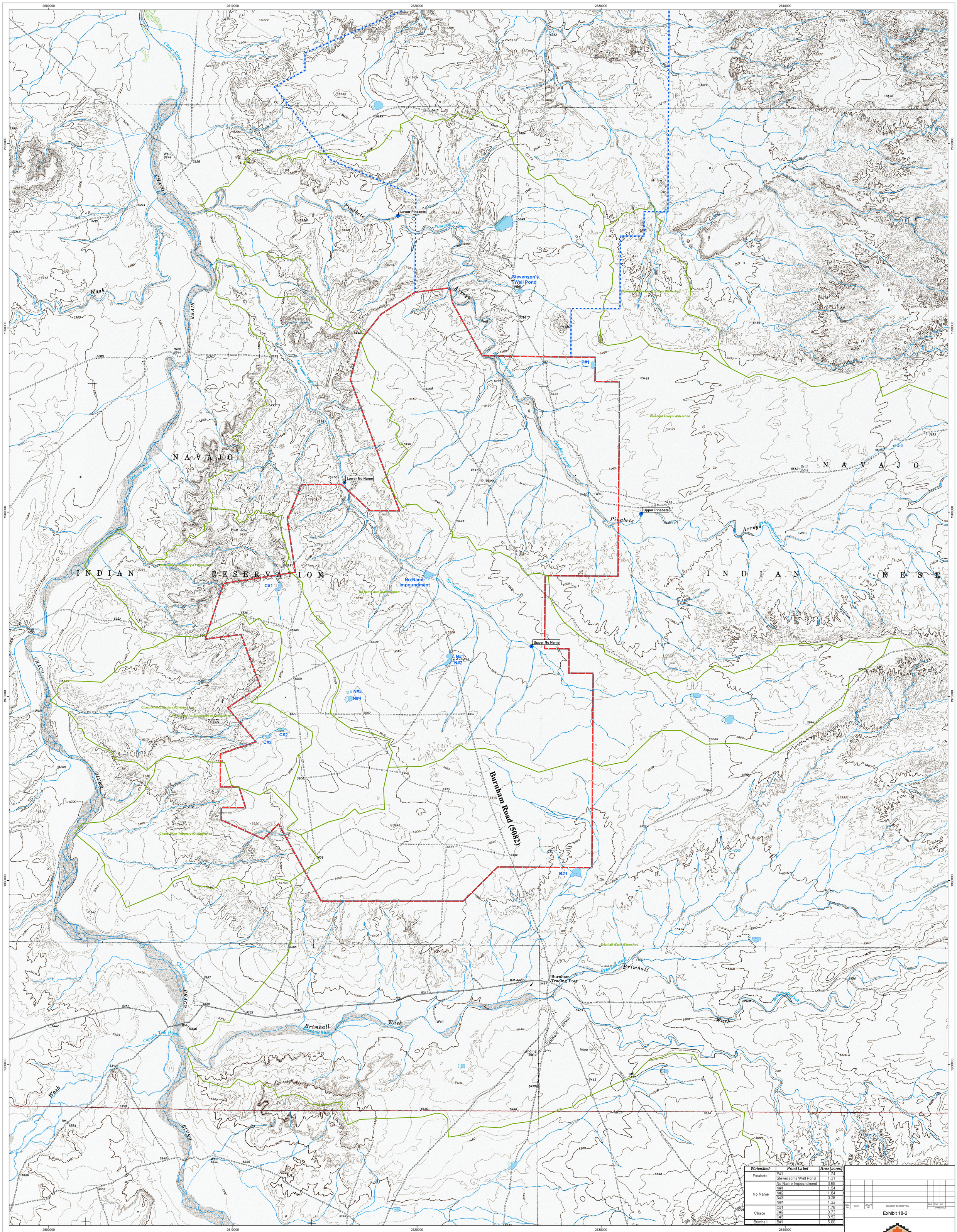
Exhibit 18-1

Navajo Transitional Energy Company

No Name Permit

Regional Surface Water Features and Monitoring Locations

PREPARED BY: TH	DRAWN BY: TH	PAPER SIZE: ARCH E
APPROVED BY: JJ	DATE: 05/23/25	



Watershed	Pond Label	Area (acres)
Pinabete	P#1	1.74
	Stevenson's Well Pond	1.31
No Name	No Name Impoundment	3.68
	N#1	1.54
	N#2	1.84
	N#3	0.26
	N#4	1.22
Chaco	C#1	1.78
	C#2	0.73
	C#3	0.92
Brimhall	B#1	5.00

REV No.	DATE	DRAFT BY	REVISION DESCRIPTION	ENG.	EQG.	PE. APPROVALS

Exhibit 18-2

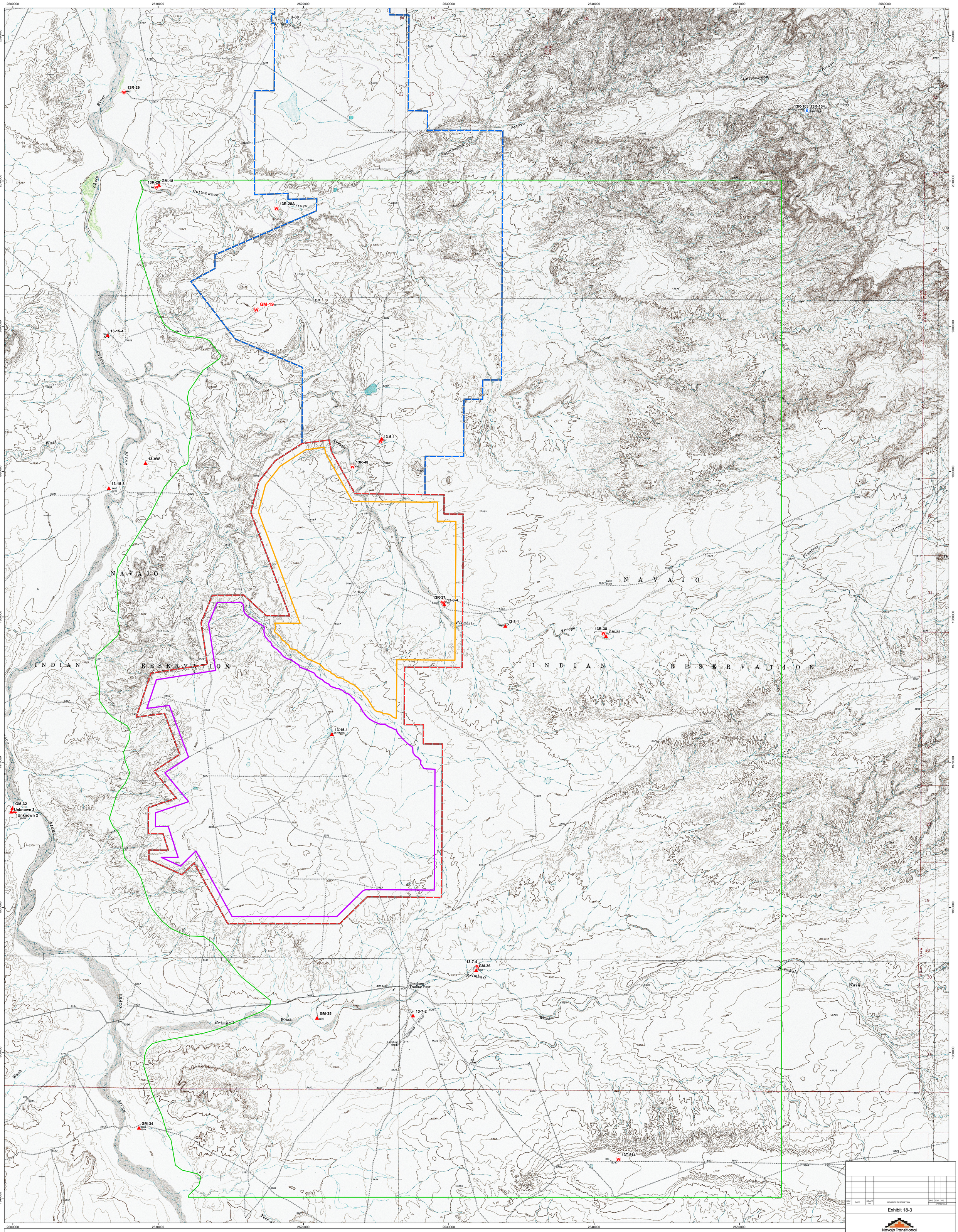
Navajo Transitional Energy Company

No Name Permit

Surface Water Features and Stream Monitoring Locations

(Sheet 1of 1)

PREPARED BY: TH	DRAWN BY: TH	PAPER SIZE: ARCH E
APPROVED BY: JJ	DATE: 5/23/25	



Coordinate System:
NAD 1927 StatePlane New Mexico West FIPS 3003 Feet
Datum: North American 1927
Units US Feet

0 1,000 2,000 4,000 6,000 Feet

1:22,771

Legend

- GM-19 (Permitted Well)
- Spring
- Permitted Well
- Unpermitted Well
- Area 4 South Pit Boundary
- Area 5 Pit Boundary
- No Name Permit Boundary
- NTEC Lease Boundary
- Groundwater Model Boundary

REV No.	DATE	DRAFT BY	REVISION DESCRIPTION	ENG.	EQD.	PE. APPROVALS

Exhibit 18-3

Navajo Transitional Energy Company

No Name Permit
Inventory of Water Wells and Springs

PREPARED BY: TH	DRAWN BY: TH	PAPER SIZE: ARCH E
APPROVED BY: JJ	DATE: 5/23/25	

QACW-1
KF84-21A
KF84-21C
KF84-22A
KF84-22B
KF84-22C
KF84-22D
KF84-22E
QACW-2B
GM-28
GM-19
KPC-98-01
KPC2007-01
VWP2007-01
PA-1
KF-98-04
GM-20
GM-23
GM-29
KPC2007-03
KF-98-03
KF2007-01
VWP2007-02
PA-2
AREA 4S
T4-2
GM-30A
T4-1
NNA-1
NNA-2
KPC2007-02
KF-98-02
VWP2007-03
VWP2007-4
AREA 5
GM-21
VWP2007-5
Chaco
Cottonwood
Arroyo
Pinabete
RIVER
LEASE BOUNDARY
NAVAJO RESERVATION
INDIAN
No Name

LEGEND

- NO NAME PERMIT BOUNDARY
- EXISTING PCS MONITORING WELL
- ABANDONED PCS MONITORING WELL
- EXISTING ALLUVIAL MONITORING WELL
- EXISTING NO.3 COAL MONITORING WELL
- NAVAJO MINE MONITORING WELL
- NO.8 COAL MONITORING WELL
- NESTED VIBRATING WIRE PIEZOMETER
- ABANDONED ALLUVIAL MONITORING WELL
- GROUNDWATER MODEL BOUNDARY

2000' 0 2000'
SCALE IN FEET

N

REV. No.	DATE	DRAFT. BY	REVISION DESCRIPTION	PRE'D BY	E.Q.	P.E.	APPROVED DATE
				APPROVALS			

NORWEST Applied Hydrology

EXHIBIT 18-4

No Name Permit

Navajo Transitional Energy Company

NAVAJO TRANSITIONAL ENERGY COMPANY

GROUND WATER MONITORING WELLS AND PIEZOMETERS

PREPARED BY	APO	DRAWN BY	JLS	SCALE:	1" = 2000'
APPROVED BY		DATE	Sep 09, 2025		

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KF84-22E
5246.9

VWP2007-01 5273.4
5273.1

VWP2007-02
5291.1
5289.3

VWP2007-03
5346.0
5356.3

VWP2007-4

VWP2007-5
5410.6
5396.9

AREA 4S

AREA 5

Chaco

Cottonwood Arroyo

Pinabete Arroyo

No Name Arroyo

RIVER

CHACO

LEASE BOUNDARY LINES

NAVAJO INDIAN RESERVATION

Well

Drill Hole

5350 5375 5400 5325 5350 5375 5400

LEGEND

- NO NAME PERMIT BOUNDARY
- NESTED VIBRATING WIRE PIEZOMETER
- NAVAJO MINE NO.2 COAL MONITORING WELL
- 5500 POTENTIOMETRIC ELEVATION CONTOUR FOR NO.2 COAL
- 5517.9 2007 POTENTIOMETRIC ELEVATION LEVEL IN NO.2 COAL
- 5517.9 2024 POTENTIOMETRIC ELEVATION LEVEL IN NO.2 COAL
- GROUNDWATER MODEL BOUNDARY

2000' 0 2000'
SCALE IN FEET

N

REV. No.	DATE	DRAFT. BY	REVISION DESCRIPTION	PRE'D BY	E.Q.	P.E.	APPROVED DATE

APPROVALS

NORWEST Applied Hydrology

EXHIBIT 18-5

NO NAME PERMIT

Navajo Transitional Energy Company

NAVAJO TRANSITIONAL ENERGY COMPANY

NO. 2 COAL SEAM
POTENTIOMETRIC SURFACE
4TH QUARTER 2007/ 2024

PREPARED BY	APO	DRAWN BY	JLS	SCALE:	1" = 2000'
APPROVED BY		DATE	Sep 09, 2025		

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KF84-22D
5248.2

VWP2007-01 5278.6
5277.2

KF-98-04
5288.4

KF-98-03
5291.9
5296.1

VWP2007-02
5287.8
5296.6

KF-98-02 VWP2007-03 5367.7
5368.0

VWP2007-4

VWP2007-5

AREA 4S

AREA 5

Chaco

Cottonwood Arroyo

Pinabete Arroyo

No Name Arroyo

CHACO RIVER

LEASE BOUNDARY LINES

NAVAJO INDIAN RESERVATION

5250

5275

5300

5325

5350

5375

5400

LEGEND

- NO NAME PERMIT BOUNDARY
- NAVAJO MINE NO.3 COAL MONITORING WELL
- NESTED VIBRATING WIRE PIEZOMETER
- EXISTING NO.3 COAL MONITORING WELL
- 5500 POTENTIOMETRIC ELEVATION CONTOUR FOR NO.3 COAL
- 5517.9 2007 POTENTIOMETRIC ELEVATION LEVEL IN NO.3 COAL
- 5517.9 2024 POTENTIOMETRIC ELEVATION LEVEL IN NO.3 COAL
- GROUNDWATER MODEL BOUNDARY

2000' 0 2000'
SCALE IN FEET

N

REV. No.	DATE	DRAFT. BY	REVISION DESCRIPTION	PRE'D BY	E.Q.	P.E.	APPROVED DATE
09-A	08/10/2009	MPO	PREPARED FOR SUBMITTAL TO OSM FOR REVIEW AND APPROVAL	DLP	BDM		

APPROVALS

NORWEST Applied Hydrology

EXHIBIT 18-6

NO NAME PERMIT

Navajo Transitional Energy Company

NAVAJO TRANSITIONAL ENERGY COMPANY

NO. 3 COAL SEAM
POTENTIOMETRIC SURFACE
4TH QUARTER 2007\ 2024

PREPARED BY	APO	DRAWN BY JLS	SCALE: 1" = 2000'
APPROVED BY		DATE Sep 09, 2025	

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Chaco
Cottonwood
Arroyo
GM – 28
5265.0
GM – 19
5265.0
AREA 4S
5252.7
5261.9
KPC2007 – 01
VWP2007 – 01 5268.1
5258.2
KPC – 98 – 01
5288.9
5279.0
PA – 1
KF – 98 – 04
GM – 20
5333.0
KF – 98 – 03
KF2007 – 01
VWP2007 – 02
5297.4
5296.0
GM – 29
5305.0
5341.1
5339.6
KPC2007 – 03
LEASE BOUNDARY LINES
PA – 2
Pinabete
Arroyo
RIVER
N A V A J O
I N D I A N
T4 – 2
GM – 30A
5387.0
T4 – 1
NNA – 1
NNA – 2
No Name
Arroyo
KPC2007 – 02
KF – 98 – 02
VWP2007 – 03 5346.0
VWP2007-4
5393.8
5414.2
AREA 5
GM – 21
5428.0
5411.6
5398.2
VWP2007-5
5411.6
0 – 1
5422.0

LEGEND

- NO NAME PERMIT BOUNDARY
- PCS MONITORING WELL
- UNPERMITTED WELL
- ABANDONED PCS MONITORING WELL
- EXISTING NO.3 COAL MONITORING WELL
- GROUNDWATER MODEL BOUNDARY
- 5500 POTENTIOMETRIC ELEVATION CONTOUR FOR PCS
- 5517.9 2007 POTENTIOMETRIC ELEVATION LEVEL IN PCS
- 5517.9 2024 POTENTIOMETRIC ELEVATION LEVEL IN PCS
- NO.8 COAL MONITORING WELL
- NESTED VIBRATING WIRE PIEZOMETER
- ALLUVIAL MONITORING WELL

2000’ 0 2000’
SCALE IN FEET

REV. No.	DATE	DRAFT. BY	REVISION DESCRIPTION	PRE'D BY	E.Q.	P.E.	APPROVED DATE
09-A	08/10/2009	MPO	PREPARED FOR SUBMITTAL TO OSM FOR REVIEW AND APPROVAL	DLP	BDM		

APPROVALS

NORWEST Applied Hydrology

EXHIBIT 18-7

NO NAME PERMIT

Navajo Transitional Energy Company

NAVAJO TRANSITIONAL ENERGY COMPANY

PICTURED CLIFFS SANDSTONE
POTENTIOMETRIC ELEVATIONS
4TH QUARTER 2007/2024

PREPARED BY	APO	DRAWN BY JLS	SCALE: 1" = 2000'
APPROVED BY		DATE Sep 09, 2025	

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Appendix 18-A

Baseline Channel Inventories of Pinabete Arroyo and No Name Arroyo
from 1998 (edited 2008) and 2007 (edited 2009)

Appendix 18-A

BASELINE CHANNEL INVENTORIES OF PINABETE ARROYO AND NO NAME ARROYO FROM 1998 (EDITED 2008) AND 2007 (EDITED 2009)

TABLE OF CONTENTS

SECTION	SECTION TITLE	PAGE NUMBER
	Introduction	18.A-1
	Channel Inventory and Evaluation for No Name Arroyo and Pinabete Arroyo 1998, edited 2008	18.A-3
	Introduction	18.A-3
	Methods	18.A-3
	Pinabete Arroyo Inventory	18.A-4
	No Name Arroyo Inventory	18.A-11
	References	18.A-19
	Channel Inventory and Evaluation for No Name Arroyo and Pinabete Arroyo 2007	18.A-20
	Introduction	18.A-20
	Baseline Channel Inventory	18.A-20
	Field Reconnaissance Methodology	18.A-20
	Observations on No Name Arroyo	18.A-21
	Observations on Pinabete Arroyo	18.A-28
	Drainage Density Survey	18.A-31

Appendix 18-A

BASELINE CHANNEL INVENTORIES OF PINABETE ARROYO AND NO NAME ARROYO FROM 1998 (EDITED 2008) AND 2007

LIST OF FIGURES

FIGURE NUMBER **FIGURE TITLE**

Figure 18.A-1 Pinabete Arroyo upstream of location P1, looking upstream
Figure 18.A-2 Pinabete Arroyo location P1, looking downstream
Figure 18.A-3 Pinabete Arroyo location P2, looking upstream
Figure 18.A-4 Coal outcrop on channel bank at Pinabete Arroyo location P2
Figure 18.A-5 Pinabete Arroyo location P3, looking upstream
Figure 18.A-6 Pinabete Arroyo location P4, looking upstream
Figure 18.A-7 Pinabete Arroyo location P5, looking downstream
Figure 18-A.8 Pinabete Arroyo location P6, looking upstream
Figure 18.A-9 No Name Arroyo location NN-1, looking upstream
Figure 18.A-10 No Name Arroyo location NN-2, looking upstream
Figure 18.A-11 Headcut below No Name Arroyo Location NN-2, looking downstream
Figure 18.A-12 No Name Arroyo location NN-3, looking upstream
Figure 18.A-13 Spillway channel below No Name Impoundment, location NN-4, looking upstream
Figure 18.A-14 No Name Arroyo location NN-4, looking upstream
Figure 18.A-15 No Name Arroyo location NN-5, looking downstream
Figure 18.A-16 No Name location NN-6, looking upstream
Figure 18.A-17 No Name Arroyo location NN-7, looking downstream
Figure 18.A-18 No Name Arroyo low flow channel upstream of Burnham Road
Figure 18.A-19 No Name Arroyo shallow concentrated flow area upstream of Burnham Road
Figure 18.A-20 No Name Arroyo upstream of NN-7
Figure 18.A-21 No Name Arroyo ponding area upstream of Burnham Road looking upstream
Figure 18.A-22 No Name Arroyo sandstone outcropping upstream of NN-2
Figure 18.A-23 No Name Arroyo at approximately NN-4
Figure 18.A-24 No Name Arroyo headcut approximately 1,000 feet upstream of NN-2
Figure 18.A-25 No Name Arroyo from NN-2 to NN-1
Figure 18.A-26 Pinabete Arroyo typical channel
Figure 18.A-27 Pinabete Arroyo exposed bedrock between P-1 and P-2

Figure 18.A-28 Pinabete Arroyo typical bend point upstream of Burnham Road
Figure 18.A-28 Pinabete Arroyo typical bend point upstream of Burnham Road
Figure 18.A-29 Pinabete Arroyo near confluence of main tributary channel from Drainage Basin 18
Figure 18.A-30 Main tributary channel from Drainage Basin 18 near confluence with Pinabete Arroyo
Figure 18.A-31 Top segment of Drainage Basin 18 main tributary channel
Figure 18.A-32 Top ridge within Drainage Basin 18 - note increased gravel content
Figure 18.A-33 Center of tributary channel 18R1 in Drainage Basin 18
Figure 18.A-34 Channel 18 on south bank of Pinabete Arroyo
Figure 18.A-35 Bedrock outcrop within main tributary channel of Drainage Basin 18 after rainfall event
Figure 18.A-36 Typical upstream channel segment in Drainage Basin 28
Figure 18.A-37 Typical A-channel in Drainage Basin 28
Figure 18.A-38 Typical A-channel in Drainage Basin 18
Figure 18.A-39 Typical geomorphologic formations within Drainage Basin 28
Figure 18.A-40 Southern boundary of the permit area looking north

Appendix 18.A

BASELINE CHANNEL INVENTORIES OF PINABETE ARROYO AND NO NAME ARROYO FROM 1998 (EDITED 2008) AND 2007

LIST OF EXHIBITS

EXHIBIT NUMBER	EXHIBIT TITLE
18.A-1	Pinabete Arroyo Monitoring Station Information and Channel Characterization 1998
18.A-2	Pinabete Arroyo Cross Sections
18.A-3	No Name Arroyo Monitoring Station Information and Channel Characterization 1998
18.A-4	Lower No Name Arroyo
18.A-5	No Name Arroyo Cross Sections
18.A-6	Navajo Mine Extension Project Field Reconnaissance Map

INTRODUCTION

Appendix 18.A includes two channel reconnaissance memos from 1998 (edited 2008) and 2007 on Pinabete and No Name Arroyos, and five exhibits with cross-section and profile information. Exhibit 18.A-1 is the 1998 survey of Pinabete Arroyo with cross-sections at the upstream and downstream monitoring locations and a channel profile which was drawn between the six channel characterization sites' elevation data. The cross-sections shown on Exhibit 18.A-2 documented the 2007 return to the channel characterization sites on Pinabete and re-survey of cross-sections. Two of the Pinabete Arroyo channel characterization sites, Upper Pinabete Station- B (MID) and P-6B (MID), were also resurveyed in 2008 and are presented on Exhibit 18.A-2. Exhibit 18.A-3 is the 1998 survey of No Name Arroyo with cross-sections at the upstream and downstream monitoring locations and a channel profile which was drawn from one mile upstream of the uppermost site, NN-7, to the confluence with the Chaco River, using elevations acquired at the seven channel characterization sites. Exhibit 18.A-4 is a channel profile of lower No Name between channel characterization site NN-3 and the confluence of No Name with the Chaco River developed from aerial survey with ground truth performed to depict topography with and near the channel at a 1-foot contour interval. Exhibit 18.A-5 shows cross-sections developed during the 2007 channel reconnaissance on the No Name stations.

The 1998 channel reconnaissance survey established six stations on Pinabete and seven stations on No Name to assess channel geomorphology conditions. As noted in the section titled "Channel Inventory and Evaluation for No Name Arroyo and Pinabete Arroyo 1998, Edited 2008", the survey consisted of walking one thousand-foot segments of the channel in the vicinity of the stations to generally characterize the channel. The, extent of scouring and deposition along the stream, the occurrence of bedrock outcrops, bank stability and vegetative stabilization features were documented. A channel cross section was then chosen which most closely characterized the channel reach. Measurements of channel bottom width, top width and channel depth were made at the cross section using a surveyor's tape and staff gage. The upper and lower sites of each channel became established surface water monitoring locations.

The 2007 Channel Inventory and Evaluation for No Name Arroyo and Pinabete Arroyo were performed to acquire more recent geomorphologic data on Pinabete and No Name Arroyos to reflect pre-mine conditions. The evaluation included a channel stability assessment, a sinuosity evaluation, conceptual classification of bed and bank soils and the subsequent Manning's n values, and a drainage density appraisal. The survey generally returned to the 1998 stations, but many of the original survey posts were not found. A GPS unit was utilized to develop the cross-section information. A new site was established on the lower end of Pinabete (P-6) to better reflect conditions near the northwest lease boundary.

The 1998 profiles and cross sections for Pinabete and No Name (Exhibits 18.A-1 and 18.A-3, respectively) include three cross sections at the uppermost and lower most channel geomorphology stations. The

locations of the crest stage gages and single stage sampler were also documented, as these stations became the surface monitoring locations.

The 2007 cross sections for the Pinabete and No Name are presented in Exhibits 18.A-2 and 18.A-5, respectively. When cross sectional information for 1998 was available at the station, it was plotted on the cross section. The 1998 data appeared to be between 0.5 and 6 feet lower in elevation than the 2007 data. Rather than interpreting this as an expression of significant aggradation during the 1998-2007 time interval, best characterized as a drought, it is thought that any gross elevation differences are better described as a shift in the original datum. Substantially better channel information was acquired in 2008, when BHP Navajo Coal Company (BNCC) had the lower 4.3 miles of No Name flown for mapping at a 1-foot contour interval. The topographic map showing a 500-foot average coverage on either side of the channel is displayed on Exhibit 18.A-4. A channel profile was developed from this survey which clearly identifies knickpoints at eight locations as the arroyo passes through badland topography. The largest change is seen at 18,450 feet upstream of the confluence, with a 10-foot drop in elevation. A comparison was made between the cross sections surveyed in 2007 and the ones generated by the 1-foot contour map at the Lower No Name monitoring station and NN-3, and the 2008 elevations averaged 3.5 feet higher than the cross-section information developed in 2007. Again, these differences may be the result of differences in the datum used for the surveys. The general shape of the cross sections is very similar, leading us to believe that the surveys were at approximately the same location. However, the difficulty in comparing channel surveys between the two time periods is the result of obtaining consistent information from different groups of surveyors and establishing accurate datum and permanent channel survey monuments in remote locations.

CHANNEL INVENTORY AND EVALUATION FOR
NO NAME ARROYO AND PINABETE ARROYO
1998, EDITED 2008

Introduction

A stream channel inventory and evaluation was conducted to describe the pre-mining conditions for the main channels of Pinabete Arroyo and No Name Arroyo in 1998. The purpose of this work was to document the channel conditions prior to mining, including the presence of bedrock outcrops, and indicators of channel instabilities such as knickpoints, channel cutbanks, and channel scour or deposition. The composition of the channel bed and bank materials, cross section dimensions, and vegetation type and density were also noted. These characteristics provide indications of the capacity of the stream channels to adjust and recover from potential changes due to mining and reclamation. This inventory also included surveys of channel cross sections and slopes and estimation of Manning roughness coefficients at surface water monitoring locations.

Methods

A stream channel inventory describes the spatial variability in a stream's characteristics at a specific point in time. Prior to the field visit, main channel profiles were plotted from topographic maps featuring 10-ft contour intervals. Locations of convex segments in the channel profile, channel knickpoints, monitoring station locations, and surface water impoundments were identified on the map. Channel inventory locations were selected to include these channel features. Inventory locations were spaced about every mile through the permit area and at a farther spacing downstream of the permit area. There is no defined channel on No Name Arroyo upstream of the permit area and the inventory did not extend beyond the upstream monitoring station on Pinabete Arroyo.

During the field inventory, a 1000-foot segment of the channel was walked at each location to roughly characterize the channel. Features including the vegetation conditions on the channel bottom and banks, the occurrence of steep bank slopes and evidence of bank failure, extent of scouring and deposition along the stream, and the occurrence of bedrock outcrops were documented. A channel cross section was then chosen which most closely characterized the channel reach. Measurements of channel bottom width, top width and channel depth were made at the cross section using a surveyor's tape and staff gage. The composition of the channel bottom and bank were field classified in accordance with the Unified Soil Classification (USC) system. Photographs were taken to document channel conditions at each channel inventory location.

At each of the monitoring station locations, channel cross sections, crest stage gages, and single stage sediment samplers were surveyed and estimates of Manning's roughness coefficients were determined

using the procedure for small channels as described in Gray (1970). Using this procedure the value of Manning's roughness coefficient, n, is estimated from table values for component conditions which affect hydraulic roughness and resistance to flow. These conditions include channel materials, channel vegetation, surface irregularities, variations in channel shape, obstructions, and channel meandering.

The survey of channel cross-sections at the stream monitoring stations was completed on June 2, 1998, before the start of the thunderstorm runoff season, and again on November 30, 1998, at the end of the season. The surveyed sections for both dates are provided in Exhibit 18.A-1 and Exhibit 18.A-3. The channel profiles did not change significantly between the two survey dates but the channel cross sections at the Pinabete Arroyo stations changed due to floods redistributing sediment deposits within the channel. The change in channel cross sections at the No Name Arroyo stations were much less than at the Pinabete station locations.

Pinabete Arroyo Inventory

The main Pinabete Arroyo channel profile shown in Exhibit 18.A-1 exhibits a slightly concave channel profile with channel slopes of 0.55 % or higher at the upstream segment near the eastern permit boundary and decrease to about 0.43 % downstream at the western permit boundary. No knickpoints, or convex segments, are present in the channel profile in the vicinity of the Navajo Mine Extension permit area. Road crossings and monitoring station locations within or near Pinabete Arroyo are also shown on Exhibit 18.A-1. No surface water impoundments are located within the main channel of Pinabete Arroyo within the permit area.

The inventory of channel conditions was conducted at six cross section locations along the main stem of Pinabete Arroyo within or near the permit area. The inventory is presented below. The location descriptions begin with the upstream location and proceed downstream at distances measured along the channel. The cross section locations are shown on Exhibit 18.A-2.

Location P1

This location is at the upstream monitoring station of Pinabete Arroyo. The channel at this location is incised with a trapezoidal shape featuring a bottom width of 24.5 feet, a top width of 42.5 feet, and a depth of 3 feet. Channel bottom materials are sands (SP) with pebbles and stones. Channel banks consist of medium sand (SP) with semi-consolidated sands and gravels that form steep near vertical banks. Bedrock outcrops occur in the channel banks upstream of location P1. Sandstone slabs and fragments have sloughed into the channel from the erosion of the embankments on meander bends as shown in Figure 18.A-1. No vegetation is found on the channel bottom and sparse shrubs grass and tamarisk occur on the channel banks and sand bars as shown in Figure 18.A-2. The channel appears to be in a state of dynamic equilibrium along this reach. The erosion of the channel banks on meander bends is compensated by sand deposition

on the inside of the meanders. The channel slope at this location is about 0.56% and the valley slope about 0.8%.

The value of Manning's roughness coefficient, n, was estimated to be 0.032 using the procedure for small channels described in Gray (1970). The estimated contribution to roughness from component conditions includes:

Channel materials,	0.022
Channel vegetation, negligible	0.000
Surface irregularities,	0.005
Variations in channel section,	0.005
Obstructions, and meandering,	0.000

Figure 18.A-1 Pinabete Arroyo upstream of location P1, looking upstream

Figure 18.A-2 Pinabete Arroyo location P1, looking downstream

Location P2

This location is approximately 7,700 feet down the channel from location P1. The channel at this location is trapezoidal but wider and shallower than P1 with a bottom width of 40 feet, a top width of 58 feet, and a depth of about 2.1 feet. The channel bottom is comprised of fine sand (SP) with sparse coal and rock fragments. The channel banks consist of sand with negligible fines (SW). Salt deposits occur on bed and bank materials due to evaporation of ground water seepage as shown in Figure 18.A-3. The rate of seepage is insufficient to cause surface flow. The No. 8 coal seam outcrop occurs near this cross section location as shown in Figure 18.A-4 and may be the source of seepage. No vegetation occurs on the channel bottom. Dense shrubs and forbs occur on the channel banks and overbanks. The channel slope at this location is about 0.51% and the valley slope about 0.6%.

Figure 18.A-3 Pinabete Arroyo location P2, looking upstream

Figure 18.A-4 Coal outcrop on channel bank at Pinabete Arroyo location P2

Location P3

This location is approximately 5,530 feet down channel from location P2. This location is on a meander bend immediately upstream of the Burnham Road crossing as shown in Figure 18.A-5. The channel at this location is approximately trapezoidal with a 48-foot wide sand bar and the inside of the meander bend. The

bottom width is 24 feet and top width, excluding the sand bar, is 40 feet. The channel is about 2.8 feet deep. The channel bottom and sand bar are comprised of sand with gravel (SW), with a greater gravel fraction on the sand bar. The channel banks are comprised of sand with a higher fine fraction (SP) and are cohesive enough to form steep banks in places. The channel banks are sparsely vegetated and the sand bar and channel bottom are devoid of vegetation as shown in Figure 18.A-5. Shrubs occur on the overbanks. The channel slope at this location is about 0.51% and the valley slope about 0.7%

Figure 18.A-5 Pinabete Arroyo location P3, looking upstream

Location P4

This location is at the road crossing to the dug alluvial well and monitoring well PA-1 and is approximately 5,750 feet down the channel from location P3. The channel at this location exhibits considerable meandering with bedrock outcrops common on the outside of meander bends. The channel at this location is approximately trapezoidal with a bottom width of 54 feet and top width of 65 feet. The channel is about 2.0 feet deep. The channel bed and banks are comprised of medium to coarse sand (SW), with a higher gravel fraction on the sand bars located on the inside of meander bends. The channel banks and overbanks are vegetated with grasses and shrubs while channel bottom is devoid of vegetation as shown in Figure 18.A-6. The channel slope at this location is about 0.51% and the valley slope about 0.9%

Figure 18.A-6 Pinabete Arroyo location P4, looking upstream

Location P5

This location is approximately 6,600 feet down the channel from location P4. The channel at this location exhibits considerable meandering with steep cutbanks on the outside of meander bends. The channel at this location is slightly narrower than at location P4 with a bottom width of 33 feet. The channel is about 3.0 feet deep. The channel bends and banks on the inside of meander beds are comprised of medium sand (SW) with pebbles. The channel banks on the outside of meander bends are comprised of cohesive sand with fines (SP). The channel banks and overbanks are vegetated with grasses and shrubs while channel bottom is devoid of vegetation as shown in Figure 18.A-7. The channel slope at this location is about 0.51% and the valley slope about 1.2%.

Figure 18.A-7 Pinabete Arroyo location P5, looking downstream

Location P6

Location P6 is approximately 16,600 feet downstream of location P5. This location is downstream of the western permit boundary and includes stage crest gages and single stage samplers for the Lower Pinabete Arroyo surface water monitoring station. The channel is approximately trapezoidal in shape with a top width of approximately 115 feet, a bottom width of about 70 to 80 feet, and a channel depth of 4 feet. Channel cross sections associated with the crest stage gages are included on Exhibit 18.A-1. Bottom sediments consist of sand with sparse gravel and rock fragments (SW). Channel banks are sand (SW). A sandstone outcrop occurs on the south bank of the location as shown in Figure 18.A-8. There is no vegetation on the channel bottom and the channel banks are steep with sparse shrub cover. The overbanks have a variable cover of grasses and shrubs. The channel slope at this location is about 0.33 % and the valley slope is about 0.6%.

Manning roughness coefficient for the channel is estimated to be 0.032 using the procedure for small channels described in Gray (1970). The estimated contribution to roughness from component conditions includes:

Channel materials,	0.022
Channel vegetation, negligible	0.000
Surface irregularities,	0.005
Variations in channel section,	0.005
Obstructions, and meandering,	0.000

Figure 18-A.8 Pinabete Arroyo location P6, looking upstream

No Name Arroyo Inventory

An inventory of channel conditions was conducted at nine locations along the main stem of No Name Arroyo within the permit area. The inventory location descriptions begin with the No Name Arroyo downstream monitoring station location (NN-1) and proceed up the channel to the No Name Arroyo upstream monitoring station location (NN-7) (Exhibit 18.A-3). The No Name surface water impoundment is located on the channel just upstream of location NN-4 at the Burnham road crossing as shown on Exhibit 18.A-3. The water quality monitoring station locations within No Name Arroyo are also shown on Exhibit 18.A-3. The main No Name Arroyo channel profile is shown in Exhibit 18.A-3. Knickpoints are present in the channel profile near inventory locations NN-2 and NN-4 as shown on Exhibit 18.A-3. A small knickpoint also occurs at the bedrock outcrop below location NN-1, although this does not show up on the longitudinal profile.

Location NN-1

This location is at the No Name Arroyo downstream monitoring station which is downstream of the western permit boundary. The channel is incised and is approximately trapezoidal in shape with a bottom width of 12 to 15 feet, a top width of 35 to 50 feet and a depth of about 8 feet. Bottom materials are medium to coarse sand with rock fragments (SW). Bank materials are comprised of cohesive silt (MH). No vegetation is found on the channel bottom although the channel is at times partially filled with tumbleweeds as shown in Figure 18-A.9. Shrubs, grass and forbs occur on the channel overbank while the

channel banks are steep and support sparse vegetation. Sandstone bedrock outcrops in the channel just below the monitoring station as shown in Figure 18.A-9. The channel slope at this location is about 1.4% and the valley slope about 1.4%. Manning roughness coefficient for the channel is estimated to be about 0.037 using the procedure for small channels described in Gray (1970). The estimated contribution to roughness from component conditions includes:

Channel materials,	0.022
Channel vegetation, low	0.000
Surface irregularities,	0.010
Variations in channel section,	0.005
Obstructions, and meandering,	0.000

Figure 18.A-9 No Name Arroyo location NN-1, looking upstream

Location NN-2

This location is immediately above a 15-foot head cut on No Name Arroyo approximately 3,000 feet upstream of the location NN-1. The channel upstream of the head cut is approximately parabolic in shape

with a bottom width of about feet, a top width 15 feet, and a depth of about 1 to 1.5 feet. Channel bed and bank materials are comprised cohesive silts (MH) with dense shrubs and grass as shown in Figure 18-A.10. A relatively broad, well-vegetated floodplain occurs on either side of the channel. Downstream of the head cut, the channel is deeply incised with near vertical banks that slough readily as seen in Figure 18-A.11. Bank materials are cohesive silts (MH). The channel bottom and banks are devoid of vegetation and the channel is partially filled with tumbleweeds as shown in Figure 18.A-11. The channel slope at this location is about 0.71% and the valley slope about 1.3%.

Figure 18.A-10 No Name Arroyo location NN-2, looking upstream

Figure 18.A-11 Headcut below No Name Arroyo Location NN-2, looking downstream

Location NN-3

This location is approximately 3,100 feet upstream of the No Name Arroyo location NN-2. The channel is approximately trapezoidal in shape with a bottom width of 5 feet, a top width of approximately 20 feet, and a depth of about 5 feet. The channel bed is composed of medium sand with fine gravel and rock fragments (SP). The channel banks are composed of cohesive silty sand (SM). No vegetation is found on channel bottom but shrubs and grasses are abundant on the channel banks and overbanks as shown in Figure 18-A.12. The channel was partially filled with tumbleweeds as shown in Figure 18.A-12. The channel slope and valley slope at this location are both approximately 0.72%.

Figure 18.A-12 No Name Arroyo location NN-3, looking upstream

Location NN-4

This location is immediately below the No Name impoundment approximately 3,350 feet upstream of the No Name Arroyo location NN-3. A channel section was not measured at this location because of the significant variation in channel conditions. The spillway overflow from the impoundment crosses the Burnham road on the south side and flows down a bedrock lined channel to the valley floor below the impoundment as shown in Figure 18-A.13. A very dense growth of shrubs and tamarisk is present in the valley below the impoundment with channel headcuts occurring at a number of places within the valley floor as shown in Figure 18.A-14. The valley floor soils consist of silt and very fine sand (MH). The valley slope just below the No Name impoundment is about 1.0%.

Figure 18.A-13 Spillway channel below No Name Impoundment, location NN-4, looking upstream

Figure 18.A-14 No Name Arroyo location NN-4, looking upstream

Location NN-5

This location is upstream of the No Name Impoundment and approximately 3,300 feet upstream of location NN-4. The channel is incised 2 to 3 feet and is irregular in shape with several channels terminating in headcuts upstream of NN-5. Channel top widths vary from several feet to approximately 20 feet on the main channel below location NN-5. No distinct channel occurs in the valley bottom for a distance of about 1,000 feet upstream of the headcuts. Channel bed and bank materials consist of cohesive silt and fine sand

(MH). No vegetation is found on the near vertical banks where they occur but dense shrubs and grasses are abundant on the overbank but less dense on the channel bottom. The dimensions of the channel section were not measured at this location because of the widely varying sections. Tumbleweeds were found at numerous places within the channel as shown in Figure 18.A-15. The valley and channel slope at this location are about 0.78%.

Figure 18.A-15 No Name Arroyo location NN-5, looking downstream

Location NN-6

This location is approximately 5,060 feet upstream of the location NN-5. The channel is incised about 2 feet and is irregular in shape as shown in Figure 18-A.16. Small channel headcuts and soil pipes were common around location NN-6. The channel above and below this location occurs intermittently within the valley bottom and is typically associated with channel incision with headcuts and soil pipes. Channel bed and bank materials consist of cohesive silts (MH). Vegetation in these areas is sparse due to the presence of limiting soil conditions. The density of vegetation is greatest in minor depressions where water and windblown soils accumulate but channel erosion or scouring does not occur. A channel section was not measured at this location because of the widely varying sections. Tumbleweeds were found at

numerous places within the channel as shown in Figure 18.A-16. The channel and valley slope at this location is about 0.82%.

Figure 18.A-16 No Name location NN-6, looking upstream

Location NN-7

This location is at the upstream monitoring station on No Name Arroyo located just west of the eastern lease boundary approximately 400 feet upstream of location NN-6. The surface water monitoring station includes one stage crest gage and one single stage sampler. The channel is approximately parabolic in shape with a top width of less than 6 feet and a depth of less than 1 foot and but varies along the channel. The channel does not extend upstream of this location and occurs intermittently downstream. Channel rills are found within the broad flat valley of No Name Arroyo both upstream and downstream of the eastern lease boundary. Channel cross-sections associated with the stage crest gage and sediment sampler are included on Exhibit 18.A-3. Channel bed sediments at this location are fine sands (SM). Channel banks are comprised of cohesive silty sand (ML). Vegetation occurs on the channel bank and overbank but is very sparse on the channel bed as shown in Figure 18.A-17. The channel and valley slope at this location are about 0.82%. The Manning roughness coefficient for the channel is estimated to be about 0.055 using the procedure for small channels described in Gray (1970). The estimated contribution to roughness from component conditions includes:

Channel materials,	0.020
Channel vegetation, moderate	0.010

Surface irregularities,	0.010
Variations in channel section,	0.015
Obstructions, and meandering,	0.000

Figure 18.A-17 No Name Arroyo location NN-7, looking downstream

References

Gray, D.M. 1970. Handbook on the Principles of Hydrology. Water Information Center, Inc.

CHANNEL INVENTORY AND EVALUATION FOR
NO NAME ARROYO AND PINABETE ARROYO
2007, EDITED 2009

Introduction

From August 27 to August 29, 2007, two URS teams independently conducted a baseline channel inventory survey and a drainage density survey on the Pinabete and No Name Arroyos within the Navajo Mine Extension Project (NMEP) Area IV South and Area V. The Pinabete Arroyo is the main drainage path for Area IV South, bisecting the lease by flowing from the southeast corner to the northwest corner. The No Name Arroyo is the main drainage path for Area V, and flows from east to west along its northern boundary, just south of Area IV South. The Pinabete Arroyo is proposed to be diverted into the No Name Arroyo during the mining operation of Area IV South. Exhibit 18.A-6 is a map of the study area.

The baseline channel inventory was performed by the team of Bud Brock and Samrat Mohanty as part of the effort to obtain hydrologic information necessary for evaluation of Probable Hydrologic Consequences (PHC) of the proposed mining operations in Area IV South of the NMEP. The drainage density survey was completed by the team of Briana Gunn and Bill Sabatka to estimate input parameters for the development of the Approximate Original Contours (AOC) for Area IV South.

Baseline Channel Inventory

The specific objectives of the Baseline Channel Inventory effort are:

- Perform reconnaissance of Pinabete Arroyo and No Name Arroyo, including their major tributaries and associated floodplains to describe pre-mining conditions.
- Evaluate channel stability for both the major arroyos.
- Estimate channel characteristics, such as sinuosity and Manning's n values, for use in later modeling efforts.
- Perform limited conceptual classification of bed and bank soils.

Field Reconnaissance Methodology

The URS team performed reconnaissance of the Pinabete Arroyo between the Upper Pinabete Monitoring Station, P-1, and Lower Pinabete Monitoring Station, P-6, and of the No Name Arroyo between Upper No Name Monitoring Station, NN-7, and Lower No Name Monitoring Station, NN-1, as well as their major tributaries and floodplains.

Key channel features identified included road crossings, culverts, dams, tributary junctions, bedrock outcrops, head cuts, bend points, and locations of convex segments within the channel flow path. The conditions of the channels along each course were described, including vegetative conditions in the channel

and on the overbanks, the occurrence of steep bank slopes, evidence of bank failure, extent of scouring and deposition along the stream, and the classification of stream bed sediments. Photographs of the channel conditions were taken as part of the channel baseline survey for future reference during the Surface Water PHC project. A representative sample of the photos is presented in the text.

Limited soil classifications were performed on the channel bed and bank soils. Physical characteristics such as gradation, texture, moisture, plasticity, and density were noted for soils at selected locations. Locations were chosen based on their proximity to the monitoring stations, survey cross-sections, and any location with a perceived change in soil type.

Observations on No Name Arroyo

The No Name Arroyo is a fairly "young" arroyo, currently undergoing significant evolution. Overall, the No Name Arroyo is fairly straight for the reach located within the NMEP and flows in a general northwesterly direction. There are numerous small bends and turns in the channel, but they are minor and have little effect on the overall direction of the stream. The exception is the last major bend in the channel, approximately 900 feet upstream of NN-2. At this location, the channel takes a bend of approximately 30-degrees to the north. From here the channel continues on a north-by-northwesterly direction until the confluence point with Chaco River.

The stream characteristics for No Name Arroyo can be divided into two distinct sections, upstream (east) of Burnham Road and downstream (west) of Burnham Road. For the majority of the stream reach upstream of the Burnham Road, there is a narrow, shallow, and discontinuous low flow channel with the capacity to convey runoff from the frequent storm events (1 to 5 year storm events). The low flow channel varies from 1 to 4 feet in dept and 2 to 10 feet in width. Bends in the channel are up to, and in a few locations exceed, 90-degrees. Flows resultant from the larger storm events overtop the low flow channel and are conveyed in a wide "U" shaped shallow concentrated flow area. The shallow concentrated flow area ranges from approximately 50 to 100 feet wide, with some locations approaching 200 feet. The soil has minimal alluvial deposits consisting primarily of a clayey loam. Vegetation in the shallow concentrated flow area consists of low to medium grass with scattered low to medium brush for an effective ground cover of 60% to 80%. The Manning's n value for the channel is estimated to be 0.04. The two areas where the channel does not conform to these general statements are described below.

Figure 18.A-18 No Name Arroyo low flow channel upstream of Burnham Road

The area from NN-7 to approximately 500 feet downstream, the channel is incised at a depth of 2 to 4 feet and a width of 10 to 20 feet and has significant braiding. With the exception of the rare major storm events, flow is confined to the channel. The vegetation in the channel is consistent with the downstream section; however, the effective ground cover is approximately 50% in the channel resulting in an estimated Manning's n value of 0.035.

Figure 18.A-19 No Name Arroyo shallow concentrated flow area upstream of Burnham Road

Immediately upstream of Burnham Road is the other location where the No Name Arroyo characteristics deviate from the typical channel section described above. Burnham Road acts as a retention structure creating a ponding area on the upstream side of the road. No crossing culverts were found. The gradient of the road slopes downward from north to south with a small dip in the road just south of the effective ponding area before the gradient of the road starts in an upward slope. This dip in the road acts as an overflow location for the ponding area and corresponds to a sandstone outcrop that limits the erosion of the roadway. The ponding area has an effective ponding depth of approximately 4 to 6 feet before flow will inundate the overflow location. It is assumed this ponding area was intentionally created to serve as a cattle watering pond. The bottom of ponding area is covered with clayey soil. There is little to no vegetation in the bottom of the ponding area; however, heavy brush is present on the upstream half of the pond overbanks. This heavy brush extends into and up the channel feeding the pond for approximately 500 feet creating an effective ground cover of almost 100% resulting in an estimated Manning's n value for this part of the channel of 0.15.

Figure 18.A-20 No Name Arroyo upstream of NN-7

Figure 18.A-21 No Name Arroyo ponding area upstream of Burnham Road looking upstream

Vegetation in the overbank area is fairly consistent along the stream reach and is composed primarily of low grass with interspersed low brush covering approximately 5% to 30% of the ground. The soil in the overbank area is fairly consistent with that in the channel, with the exception of the presence of more gravel. There are few medium to large size rocks in the channel or overbank area. The Manning's n value is estimated to be approximately 0.035 for the overbank area.

The overbank areas consist of a gently sloping floodplain area leading to widely spaced rolling hills. The hills range up to approximately 100 feet high and are composed primarily of fractured sandstone gravel intermixed with loose soils. Tributaries in the area are typically shallow concentrated or sheet flow with only a few of the tributaries having incising at the main channel with a head cut depth of 1 to 3 feet. Upstream of the tributary head cut, the flow regime consists of shallow concentrated and sheet flow.

For the majority of the stream reach downstream of Burnham Road, the channel is well defined with incised depths up to 15 feet, steep to vertical side slopes, and bends ranging from 10 to 45-degrees. The soils in the channel banks are collapsible clayey silt. There is a significant amount of fractured sandstone in the bottom of the channel that has washed into the arroyo from the outcroppings to the north or from discrete outcroppings in the channel banks. There are a few scattered locations where fractured sandstone outcroppings are present in the channel banks, almost always on the north side. Sandstone outcroppings were noted in the channel bottom at two locations, approximately 200 feet upstream of NN-2 and approximately 1,500 feet downstream of NN-4. Vegetation in the overbank area is fairly consistent along the stream reach and is composed primarily of low grass with interspersed low brush covering

approximately 5% to 30% of the ground surface. The soil in the overbank area is fairly consistent with that in the channel, with the exception of the presence of more gravel. There are few medium to large size rocks in the channel and overbank areas. The Manning's n value is estimated to be approximately 0.035 for this overbank area. Vegetation and Manning's n values in the channel varies from upstream to downstream and are discussed per section below.

Figure 18.A-22 No Name Arroyo sandstone outcropping upstream of NN-2

Immediately downstream of Burnham Road, the channel is difficult to discern due to the thick vegetation consisting of dense salt cedar, brush, and grass constituting an effective ground cover of approximately 100%. Approximately 500 feet downstream of Burnham Road, the channel flairs out and becomes visible. The channel cross section in this area displays a benched condition. From the channel bank, it drops approximately 8 to 15 feet where it hits a small bench, roughly 5 feet wide. It then drops another 2 to 5 feet to the low flow portion of the channel, which is generally 2 to 5 feet wide. Overall, the channel width varies from approximately 15 to 40 feet wide. This general channel configuration continues downstream for approximately 500 feet to near the location of NN-4. The channel is fairly straight in the area with bends not exceeding 10 to 20 degrees. Due to the thick vegetation, the Manning's n for this portion of the channel is estimated to be 0.15.

From NN-4 to downstream approximately 1,000 feet, the channel is 10 to 12 feet deep and 10 to 20 feet wide. Vegetation in the channel is very thick constituting a ground cover of approximately 80%. Bends are more pronounced and frequent but do not exceed approximately 45 degrees. Due to the thick vegetation, the Manning's n value for this portion of the channel is estimated to be 0.10.

Figure 18.A-23 No Name Arroyo at approximately NN-4

From approximately 1,000 feet downstream of NN-4 to approximately 500 feet downstream of NN-3, the channel is 8 to 10 feet deep and 10 to 20 feet wide. Vegetation in the channel still consists of salt cedar, brush, and low to medium grasses, but the density has decreased to an effective ground cover of approximately 50%. Bends are still fairly frequent but do not exceed approximately 45 degrees. The Manning's n value for this portion of the channel is estimated to be 0.05.

At approximately 500 feet downstream of NN-3, the channel dissipates over the course of approximately 200 feet as it exits a tight meander. The flow regime reverts to shallow concentrated and overland flow for a stretch of approximately 2,000 feet. Where a defined channel exists for this stretch of the arroyo, it is heavily braided, no more than 3 feet deep, and in excess of 30 feet wide. There are stretches where a definitive channel is not present and runoff reverts to sheet flow conditions. Vegetation in the channel and overland flow area is thicker than the downstream channel reaches, consisting of low to medium grasses and weeds, brush, and some salt cedar constituting a ground cover of approximately 50%. The Manning's n value for this portion of the channel is estimated to be 0.04. The overland flow terminates at a major head cut in the channel located approximately 1,000 feet upstream of NN-2. The head cut is approximately 30 feet wide and 12 feet deep. Downstream of the head cut, there is a definable channel as described in the following paragraph.

From the head cut to NN-2, braiding is frequent and the side slopes are vertical. The channel is approximately 8 to 12 feet deep and approximately 10 to 30 feet wide. The top edge of the channel banks tend to be sharp, indicating the channel is relatively new. Bends are fairly minor and range from less than

10 degrees to a maximum of 45 degrees. Vegetation in the channel consists primarily of low grass with some salt cedar and low brush constituting a ground cover of approximately 30%. The Manning's n value for this portion of the channel is estimated to be 0.03.

Figure 18.A-24 No Name Arroyo headcut approximately 1,000 feet upstream of NN-2

Figure 18.A-25 No Name Arroyo from NN-2 to NN-1

From NN-2 to NN-1, the channel banks are vertical or nearly vertical in most locations. In the locations where the channel banks are not vertical, they range to a side slope of approximately 3H:1V. The top edge

of the channel banks have been rounded over by erosion, indicating the incision has been in place for a few years. There is little to no braiding in the channel. Channel depths, widths, vegetative cover, Manning's n value, and bends are consistent with the preceding section.

The overbank areas consist of a gently sloping floodplain area with a varied width from 50 to 200 feet leading to a fairly dense clustering of steep hills. The hills are generally up to approximately 100 feet high and are composed primarily of fractured sandstone overlain by loose soils. The majority of the hills have at least one side consisting of a vertical face of fractured sandstone. Tributaries in the area are typically incised at the main channel and upstream for up to 200 feet with a head cut depth of 2 to 5 feet. Upstream of the tributary head cut, the flow regime consists of shallow concentrated and sheet flow.

Observations on Pinabete Arroyo

The Pinabete Arroyo is a well defined and established channel. The overall trend of the channel is fairly straight through the NMEP area flowing in a general north by northwesterly direction. Right before the channel exits the mine area, there are a series of bends that result in an almost 90 degree change in the overall direction of the channel leaving it flowing in a west-by-northwesterly direction until its confluence with the Chaco River.

The stream characteristics for the Pinabete Arroyo are fairly consistent through the study area. The slope of the channel upstream of the BNCC lease boundary is 0.65% and downstream of the lease boundary in0.31%. Typically, the channel is 4 to 10 feet deep and 20 to 80 feet wide with side slopes in the range of 4H:1V to 10H:1V. At the bend points, the side slopes on the outside of the bend transition to vertical. Vegetation in the channel is almost solely confined to the channel banks and consists of low grass, some small brush, and the occasional salt cedar clump. The soil in the channel is primarily silty sand with very little to no clay content. There are a couple of locations where bedrock is exposed in the channel. These are at Burnham Road and approximately half way between P-1 and P-2. Otherwise, the channel is basically devoid of rock of any size, with the exception of the sandstone outcroppings at the bend points. The estimated Manning's n value for the channel is 0.022.

Although the general trend of the arroyo is fairly straight, the sinuosity of the channel is relatively high. There are numerous bend points with angles greater than 90 degrees, with a large percent of the bends approaching 180 degrees. Typically, between the major bend points the channel is fairly straight or has a gentle meander. There are a few locations on the stream reach where the sinuosity is very high, as one bend ties directly into the next and the bends approach or are in excess of 90 degrees. These areas are from P-1 downstream for 1,500 feet, upstream and downstream of P-3 for approximately 1,500 feet, and a 2,500 stretch of the channel centered approximately half way between P-5 and P-6.

Figure 18.A-26 Pinabete Arroyo typical channel

Figure 18.A-27 Pinabete Arroyo exposed bedrock between P-1 and P-2

Figure 18.A-28 Pinabete Arroyo typical bend point upstream of Burnham Road

Tributaries to the Pinabete Arroyo are typically incised near the confluence point to the main channel. The incising extends up the tributary for no more than approximately 300 feet where it terminates in a small head cut of 2 to 5 feet deep. The overbank area can be divided into two sections, upstream (east) and downstream (west) of Burnham Road. As with the No Name Arroyo, the overbank area upstream of Burnham Road consists primarily of gently rolling hills up to approximately 100 feet high composed primarily of fractured sandstone gravel intermixed with loose soils. The soil in the overbank area is fairly consistent with that in the channel, with the exception of the presence of more gravel. Vegetation is composed primarily of low grass with interspersed low brush covering approximately 5% to 30% of the ground. There are few medium to large size rocks in overbank area. The Manning's n value is estimated to be approximately 0.035 for the overbank area.

Figure 18.A-28 Pinabete Arroyo typical bend point upstream of Burnham Road

Downstream of Burnham Road, the overbank area is also similar to that of the No Name Arroyo. Typically, a gently sloping floodplain area up to 200 feet wide leads to steep hills up to approximately 100 feet high. The hills generally have at least one vertical face of exposed sandstone with the other sides composed of fractured sandstone and soil. The soil in the overbank area is fairly consistent with that in the channel, with the exception of the presence of more gravel. Vegetation is composed primarily of low grass with interspersed low brush covering approximately 5% to 50% of the ground. There are numerous medium to large size rocks in overbank area consisting of sandstone that has eroded off the nearby hills. The Manning's n value is estimated to be approximately 0.05 for this overbank area.

Drainage Density Survey

This 3-day effort included field reconnaissance of the Pinabete and No Name Arroyos and their major tributaries, developing drainage density data by measuring tributary lengths and areas, measurement of A-channel lengths, and head to ridge lengths.

Several drainage areas for the Pinabete and No Name Arroyos were identified prior to field survey where drainage parameters could be estimated. These locations were selected based on identified hydrologic features and soil types, as well as recommendations from environmental staff of BNCC. Pinabete Drainage Basins 18 and 21, and No Name Basin 1 were selected for reconnaissance. Drainage basin designations are based on a SedCAD model developed by BNCC, and are shown on Exhibit 18.A-6.

Figure 18.A-29 Pinabete Arroyo near confluence of main tributary channel from Drainage Basin 18

Day - 1

The URS team performed an overall reconnaissance of the area was performed by driving through the project area from north to south over the watersheds of both the arroyos. The first basin explored was Drainage Basin 18. This drainage basin is located immediately downstream of Burnham Road and drains to the Pinabete Arroyo directly downstream of cross section P-3. A GPS receiver was used to mark the drainage features of the tributary channels within Drainage Basin 18.

The tributary channels within Drainage Basin 18 are fairly flat and narrow, rectangular in shape, have a bottom width varying from less than 1 foot to over 10 feet, and side slopes from 1H:1V to 3H:1V. The main tributary channel within Drainage Basin 18 extends approximately 5,000 feet to the southwest from the confluence with the Pinabete Arroyo. The total length of all the tributary channels within the Drainage Basin 18 is 18,400 feet. The contributing drainage area is estimated to be 322 acres. The estimated drainage density is 60 feet per acre (ft/acre).

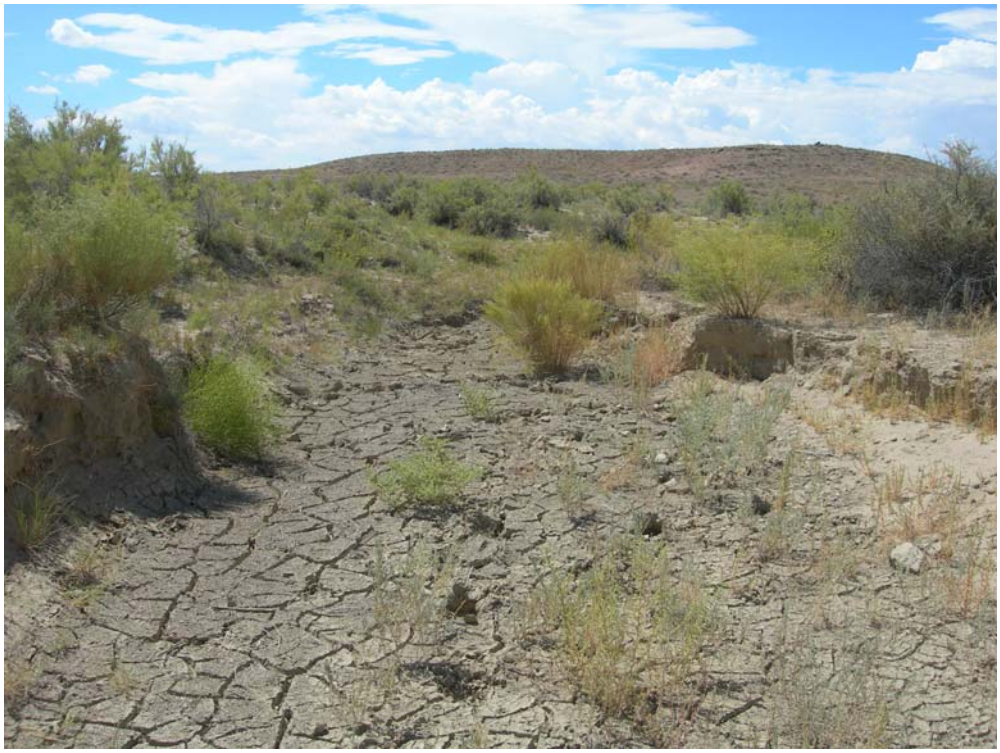


Figure 18.A-30 Main tributary channel from Drainage Basin 18 near confluence with Pinabete Arroyo

Figure 18.A-31 Top segment of Drainage Basin 18 main tributary channel

Figure 18.A-32 Top ridge within Drainage Basin 18 - note increased gravel content

During the field investigation, the team observed that there were very few channels that could be classified as type A or B, with the majority of the channels consistent with type C. For this reason, only a few A-channel lengths were measured within Drainage Basin 18. However, due to the flatness of the area and the small changes in grade between channels, none of the measured head to crest lengths were considered representative of the project area.

The soil within the tributaries is alluvial deposits with very few bedrock outcrops. The channel contains small to large fractured sandstone fragments along the channel bottom, extending into the channel side slopes. The channel bank is unstable, resulting in sustained erosion except for the areas with high rock concentrations.

Day - 2

During the second day, Drainage Basin 22 and the north end of Drainage Basin 21 were identified to have distinct ridges and valleys containing concave to convex channels where A-channel lengths could be evaluated, and the overall terrain contained a greater amount of elevation change.

In these areas, the tributary channel lengths were measured and coordinates were recorded along the tributary alignments to estimate elevation change and A-channel lengths. Within these areas a soil type that was slightly different than that within Drainage Basin 18 was identified. The soil type has less alluvial

sands and a greater volume of gravel. These areas have a more stable channel configuration, which is narrower with a reduced amount of riling. The estimated average A-channel length and head to ridge length are approximately 30 feet and 150 feet, respectively; with one outlying head to ridge length of approximately 650 feet.

Figure 18.A-33 Center of tributary channel 18R1 in Drainage Basin 18

Figure 18.A-34 Channel 18 on south bank of Pinabete Arroyo

Figure 18.A-35 Bedrock outcrop within main tributary channel of Drainage Basin 18 after rainfall event

Towards the end of the second day, the southern portion of Pinabete Drainage Basin 21 and No Name Drainage Basin 1 were examined. Both these areas have fairly flat topography with no measurable ridges and valleys, and were therefore not further evaluated.

An attempt was made to identify additional contributing drainage areas in the Pinabete watershed that would be representative of the surface generated by the Natural Regrade model. During this process, Drainage Basin 28 was identified. This basin is approximately 1 mile downstream of Drainage Basin 18.

Day - 3

On the third day, measurements of the lengths of the tributaries within Drainage Basin 28 were conducted. The tributaries within this basin have slopes varying from 2 to 20 percent, which is steeper than tributaries measured in the preceding basins. The tributaries are narrower in comparison to those within Drainage Basin 18. The tributary channels generally have a trapezoidal shape, a bottom width varying from 0.5 to 4 feet, and 1H:1V to 2H:1V side slopes. The main tributary channel extends approximately 1,080 feet to the confluence with the Pinabete Arroyo. The total length of all tributaries within Drainage Basin 28 is 2,350 feet. The contributing drainage area is approximately 16.8 acres. The estimated drainage density is 140 ft/acre.

Figure 18.A-36 Typical upstream channel segment in Drainage Basin 28

Figure 18.A-37 Typical A-channel in Drainage Basin 28

Figure 18.A-38 Typical A-channel in Drainage Basin 18

The majority of the tributaries were found to contain an A-channel reach with a measurable head to ridge length. Measurements were taken along the tributary channels. The estimated average A-channel length and head to ridge length are approximately 20 and 100 feet, respectively.

The soil type within Drainage Basin 28 is similar to Drainage Basin 22 with a lower amount of alluvial deposits and a large amount of gravel. For the majority of the tributaries, gravel is present at the transition between the concave to convex areas. Overall, this basin appears to be more stable than Drainage Basin 18.

GPS data were recorded at the estimated upstream and downstream elevation of the Pinabete Arroyo in the NMEP to be used as input in the Natural Regrade model. The upstream and downstream elevations are estimated to be 5,440 feet and 5,310 feet (Mean Sea Level), respectively.

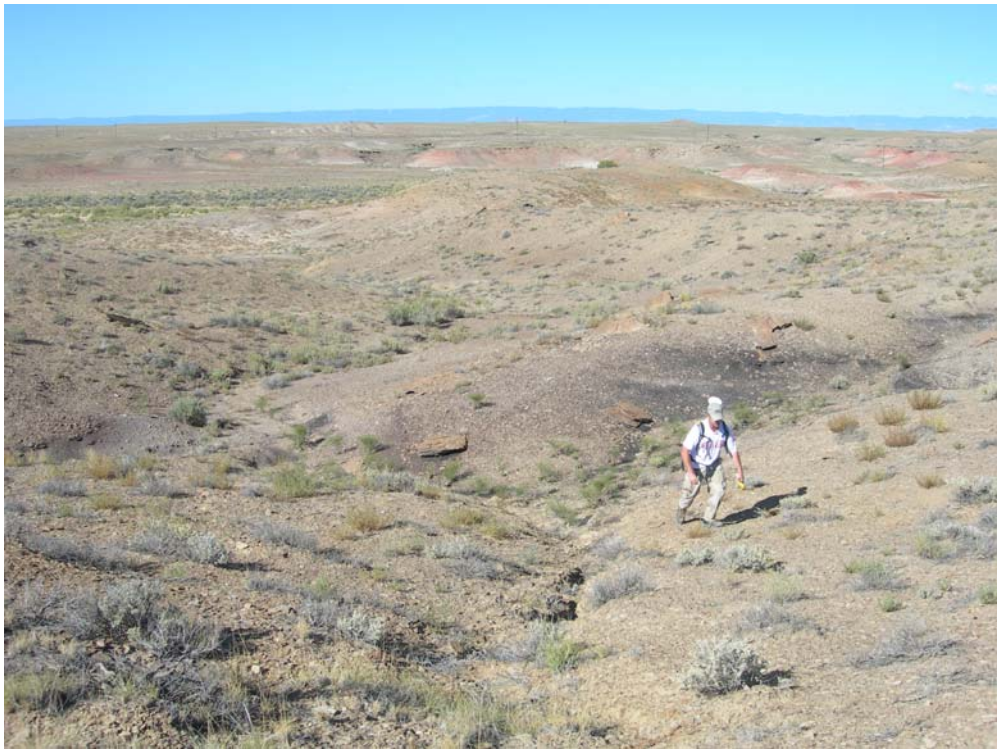
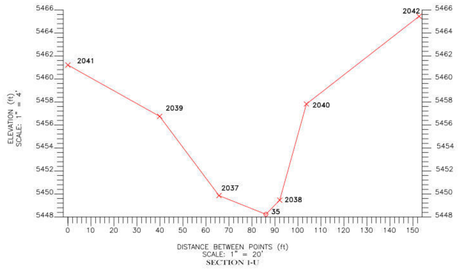
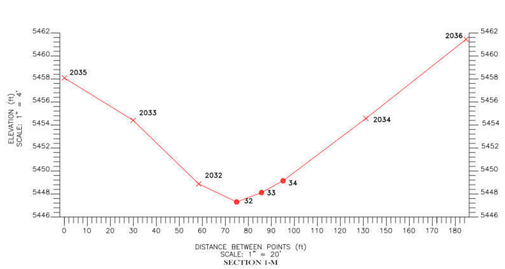
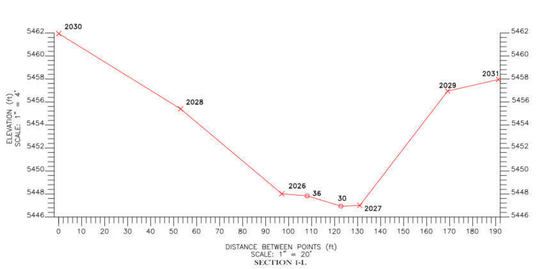


Figure 18.A-39 Typical geomorphologic formations within Drainage Basin 28

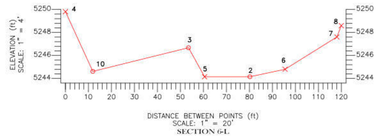
Figure 18.A-40 Southern boundary of the permit area looking north

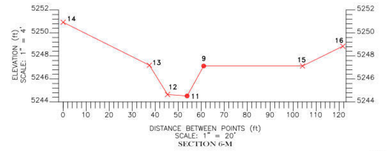


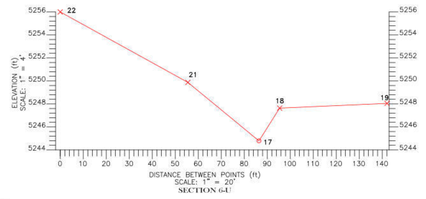




UPSTREAM

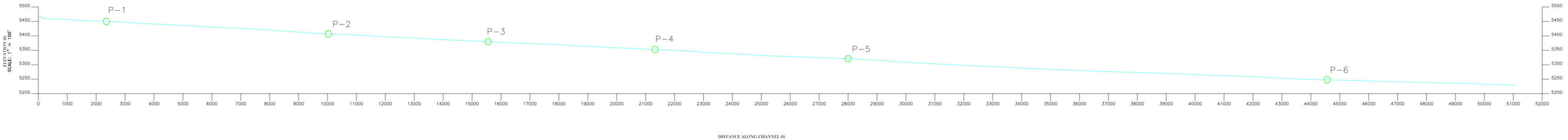




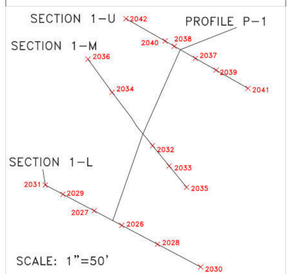


DOWNSTREAM

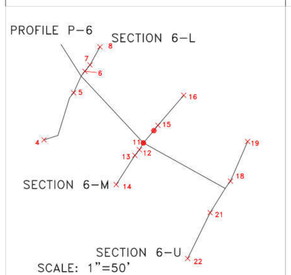
Longitudinal Profile for Pinabete Arroyo

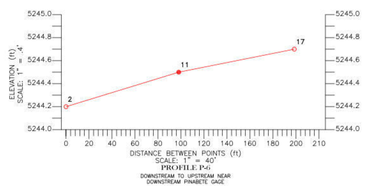


SECTIONS AND PROFILE LOCATIONS AT
PINABETE ARROYO
UPSTREAM MONITORING STATION P-1



SECTIONS AND PROFILE LOCATIONS AT
PINABETE ARROYO
DOWNSTREAM MONITORING STATION P-6





LEGEND

P-7	CHANNEL INVENTORY LOCATION
×	SURVEY POINT
○	CREST STAGE GAGE
●	SINGLE STAGE SAMPLER

REV. No.	DATE	SHEET NO.	REVISION DESCRIPTION	BY	CK'D	P.M.	APPROVED DATE

NORWEST
CORPORATION

EXHIBIT 18.A-1

BHP NAVAJO COAL COMPANY

bhpbilliton

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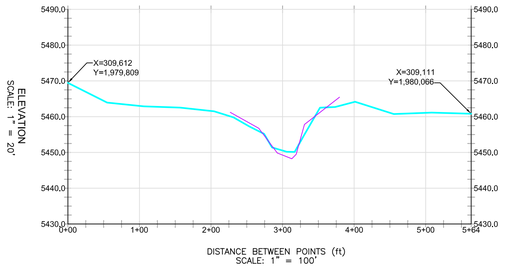
NAVAJO MINE EXTENSION PROJECT

PINABETE ARROYO MONITORING STATION
INFORMATION AND CHANNEL
CHARACTERIZATION 1998

PREPARED BY	APO	DRAWN BY	JLS	SCALE: AS SHOWN
APPROVED BY		DATE	Dec 09, 2008	

Civil 3D (LMS + Profiles) C:\Documents and Settings\jsmith\My Documents\Pinabete Arroyo\Exhibit 18.A-1.dwg, 12/9/2008 8:44:47 AM, jsmith, AutoCAD Map 3D 2008

UPPER PINABETE STATION -A (UPPER)



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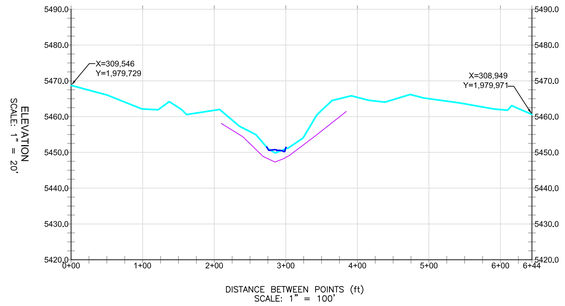

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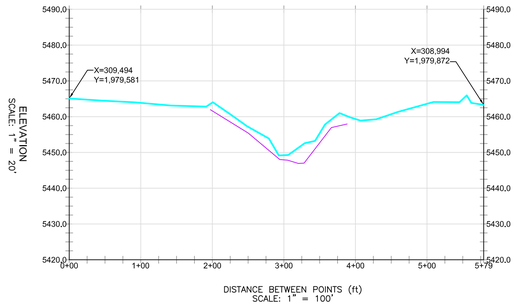
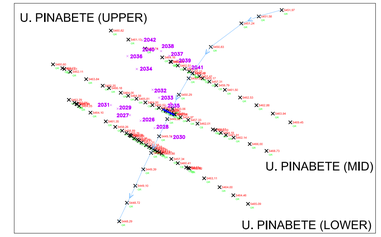


SECTIONS LOCATIONS AT PINABETE ARROYO UPSTREAM MONITORING STATIONS



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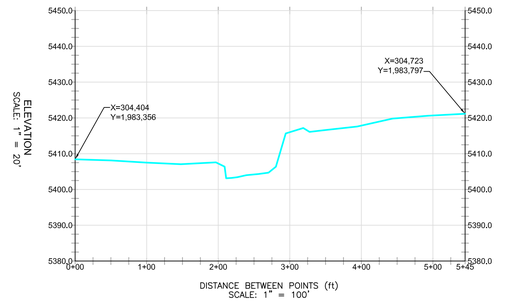

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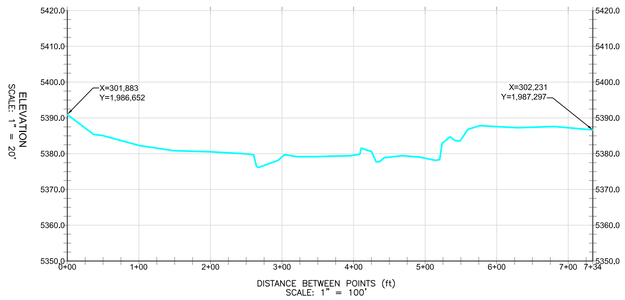

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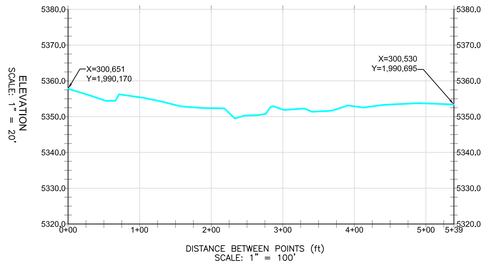

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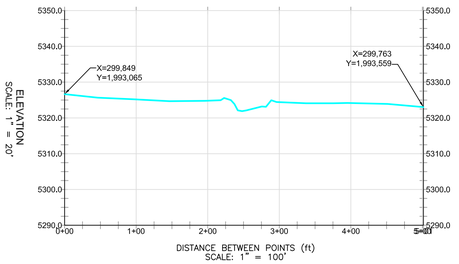

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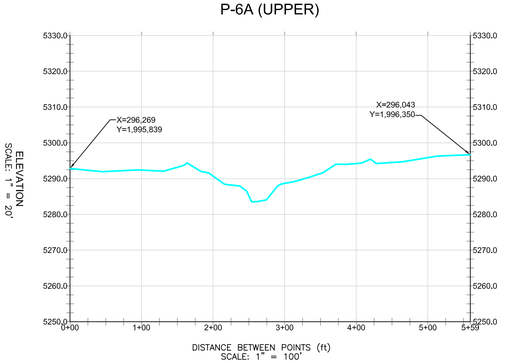

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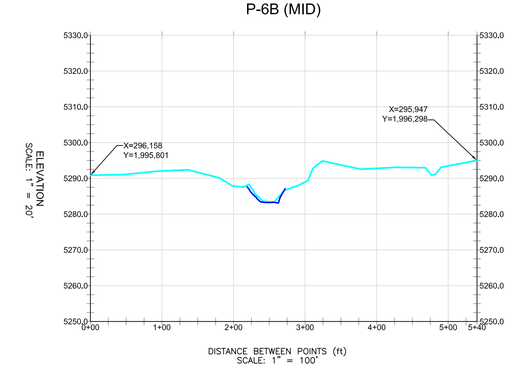

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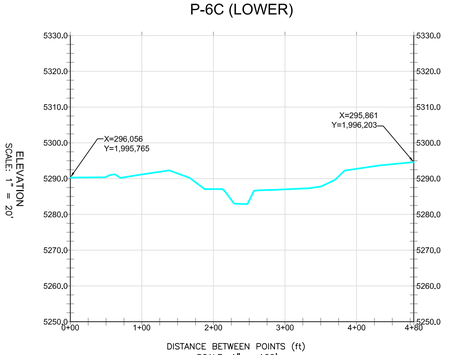
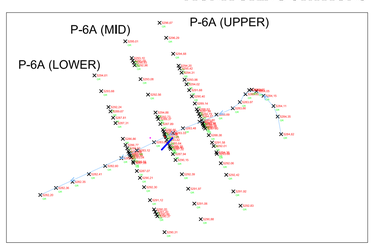


SECTIONS LOCATIONS AT PINABETE ARROYO P-6 MONITORING STATIONS



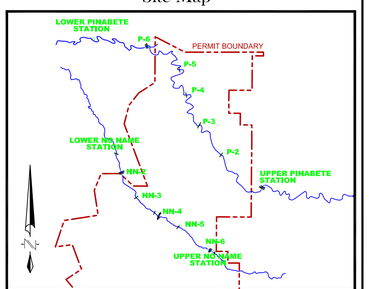
LEGEND

- 2008 SURVEYED SECTION
- 2007 SURVEYED SECTION
- 1998 SURVEYED SECTION

NOTES

- COORDINATE DATUM IS NEW MEXICO STATE PLANE NAD 27 FEET WEST ZONE
- CROSS SECTIONS LOOKING DOWNSTREAM

Site Map



REV. No.	DATE	DRAFT. BY	REVISION DESCRIPTION	PREP'D BY	E.G.	P.E.	APPROVED DATE
				APPROVALS			

NORWEST
Accident Hydrology

EXHIBIT 18.A-2

BHP NAVAJO COAL COMPANY

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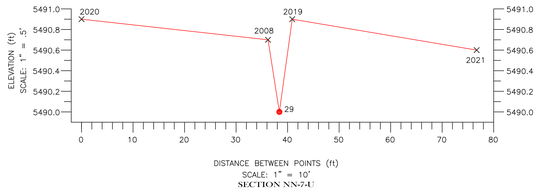
NAVAJO MINE EXTENSION PROJECT

PINABETE ARROYO
CROSS SECTIONS

PREPARED BY APO	DRAWN BY JLS	SCALE: AS SHOWN
APPROVED BY	DATE Dec 09, 2008	

Dec 09, 2008 - 11:02am\\Departments\NMC Business Development\Environmental Management\SMCRA Permitting\NMEP Permit (working)\Part 2\Se



SECTION NN-7-U

SECTIONS AND PROFILE LOCATIONS AT
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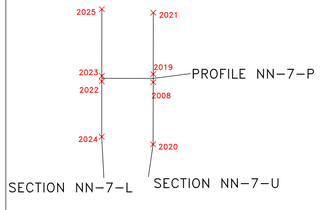
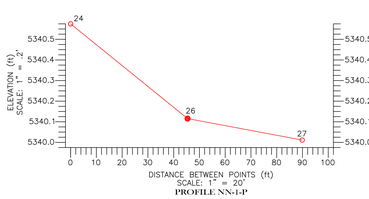
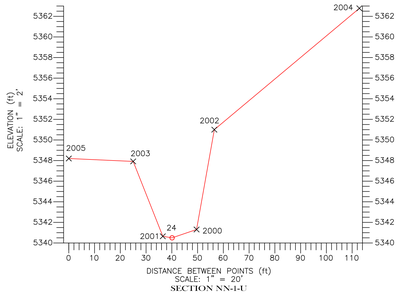
UPSTREAM MONITORING STATION NN-7



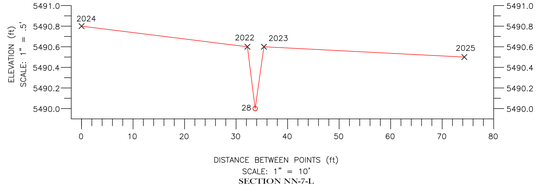


PROFILE NN-1-P



SECTION NN-1-U

SECTION NN-1-L



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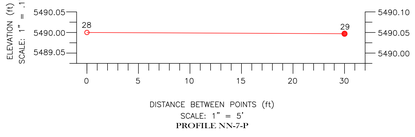

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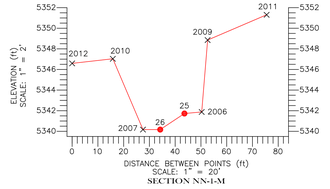
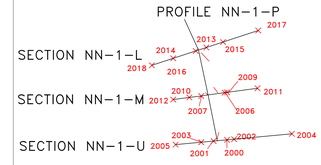
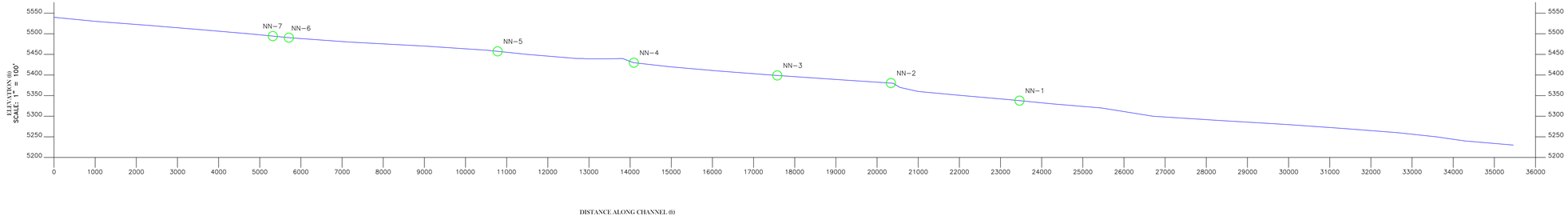


SECTION NN-1-M

SECTIONS AND PROFILE LOCATIONS AT
NO NAME ARROYO
DOWNSTREAM MONITORING STATION NN-1



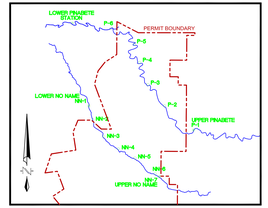
Longitudinal Profile for No Name Arroyo



LEGEND

- NN-7 — CHANNEL INVENTORY LOCATION
- SURVEY POINT
- CREST STAGE GAGE
- SINGLE STAGE SAMPLER

Site Map



REV. No.	DATE	DRAFT. BY	REVISION DESCRIPTION	PREP. BY	R.G.	P.E.	APPROVED DATE

NORWEST
CORPORATION

EXHIBIT 18.A-3

BHP NAVAJO COAL COMPANY

bhpbilliton

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Fax(505)598-4229

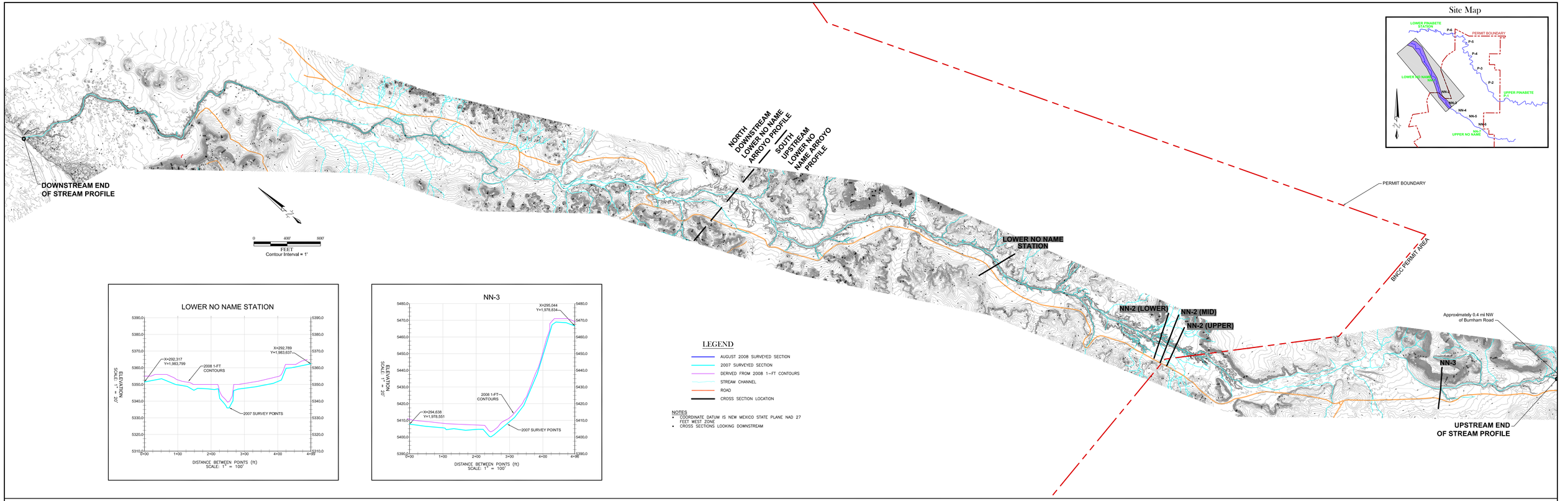
NAVAJO MINE EXTENSION PROJECT

NO NAME ARROYO MONITORING STATION
INFORMATION AND CHANNEL
CHARACTERIZATION 1998

PREPARED BY	APO	DRAWN BY	JLS	SCALE:	AS SHOWN
APPROVED BY		DATE	Dec 09, 2008		

Dec 09, 2008 – 10:53am\\Departments\NMC Business Development\Environmental Management\SMCRA Permitting\NMEP Permit (working)\Part 2\Se

Site Map

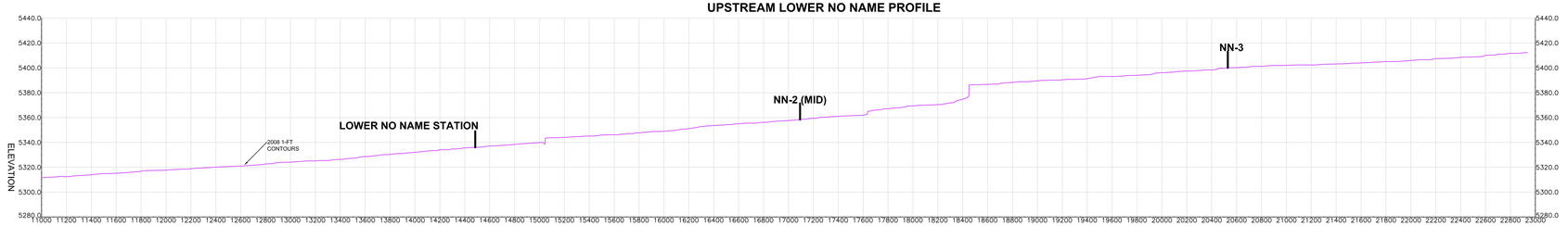


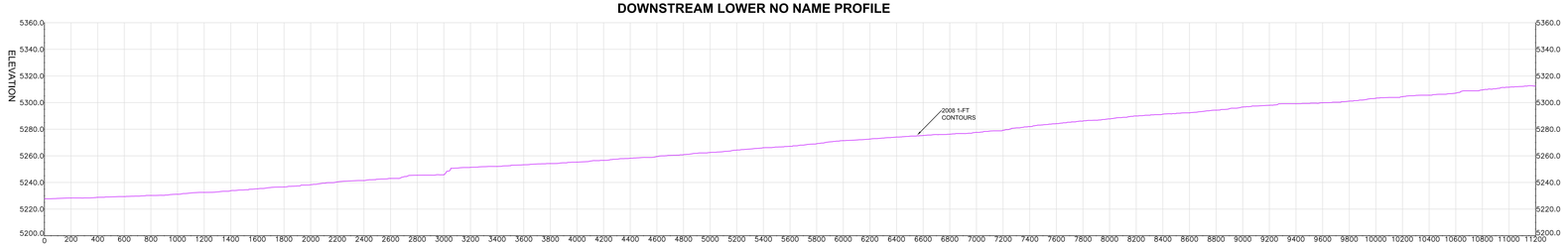
LEGEND

- AUGUST 2008 SURVEYED SECTION
- 2007 SURVEYED SECTION
- DERIVED FROM 2008 1-FT CONTOURS
- STREAM CHANNEL
- ROAD
- CROSS SECTION LOCATION

NOTES

- COORDINATE DATUM IS NEW MEXICO STATE PLANE NAD 27 FEET WEST ZONE
- CROSS SECTIONS LOOKING DOWNSTREAM





REV. No.	DATE	DRAFT. BY	REVISION DESCRIPTION	PREP'D BY	R.G.	P.E.	APPROVED DATE

NORWEST
APPLIED SCIENCES

EXHIBIT 18.A-4

BHP NAVAJO COAL COMPANY

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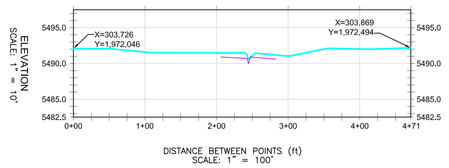
NAVAJO MINE EXTENSION PROJECT

LOWER NO NAME ARROYO

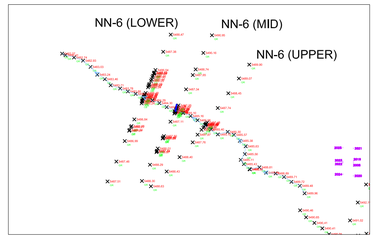
PREPARED BY APO	DRAWN BY JLS	SCALE: 1" = 2000'	
APPROVED BY	DATE Dec 09, 2008		

Dec 09, 2008 – I:\Gis\arcGIS\Departments\NMC Business Development\Environmental Management\SMCRA Permitting\MMEP Permit rewriting\1Part 2\Gre

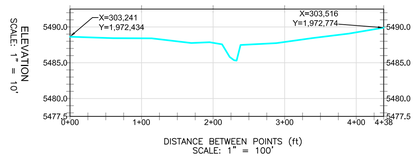
UPPER NO NAME STATION



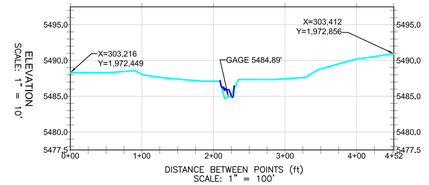
SECTIONS LOCATIONS AT
NO NAME ARROYO NN-6
MONITORING STATIONS



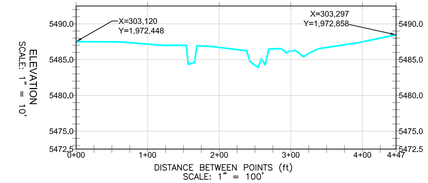
NN-6A (UPPER)



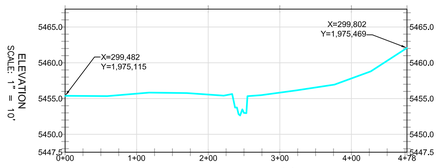
NN-6B (MID)



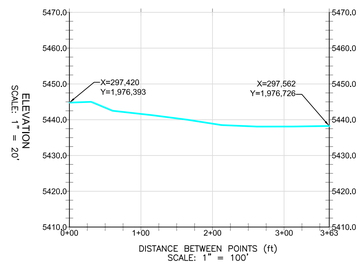
NN-6C (LOWER)



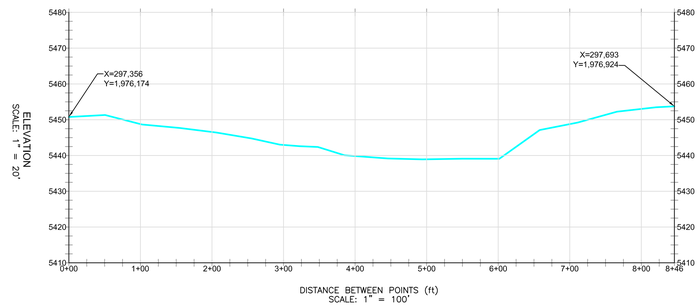
NN-5



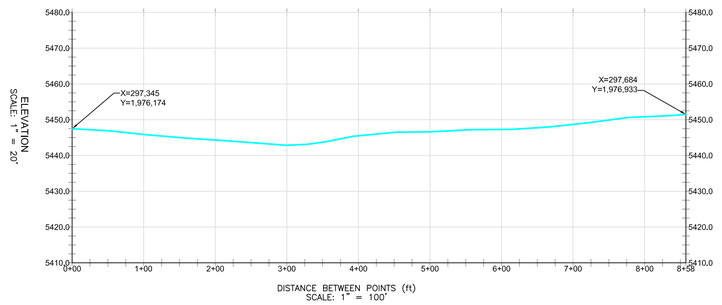
NN-4A (UPPER)



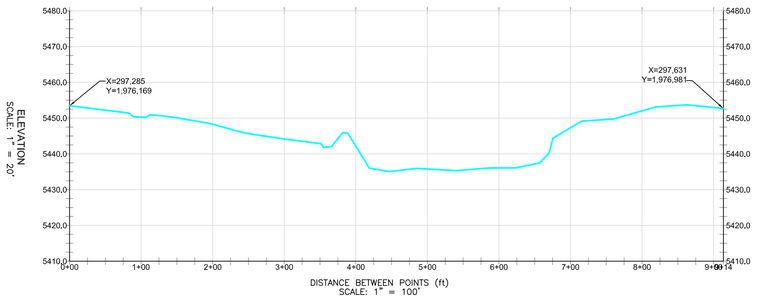
NN-4B (MID)



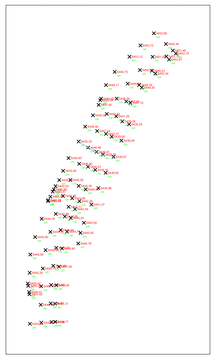
NN-4C (LOWER)



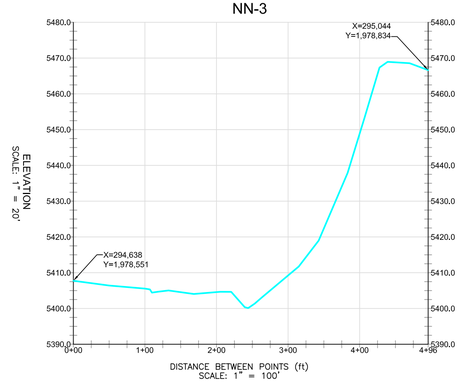
NN-4D (LOWEST)



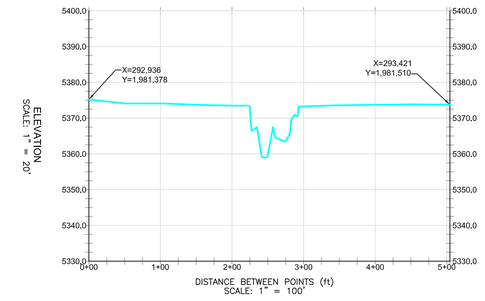
SECTIONS LOCATIONS AT
NO NAME ARROYO NN-4
MONITORING STATIONS



NN-3



NN-2A (UPPER)



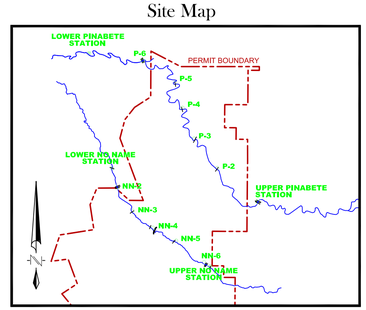
LEGEND

- 2008 SURVEYED SECTION
- 2007 SURVEYED SECTION
- 1998 SURVEYED SECTION

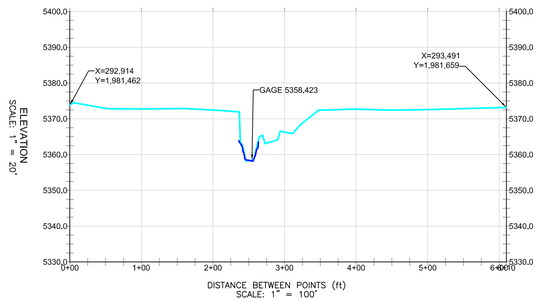
NOTES

- COORDINATE DATUM IS NEW MEXICO STATE PLANE NAD 27 FEET WEST ZONE
- CROSS SECTIONS LOOKING DOWNSTREAM

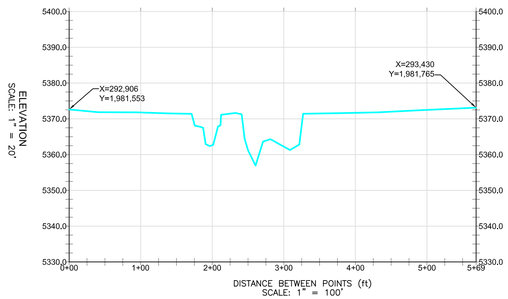
Site Map



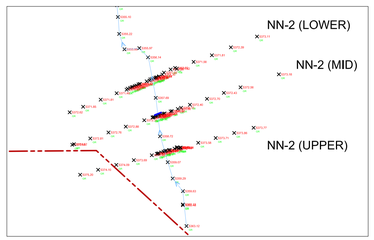
NN-2B (MID)



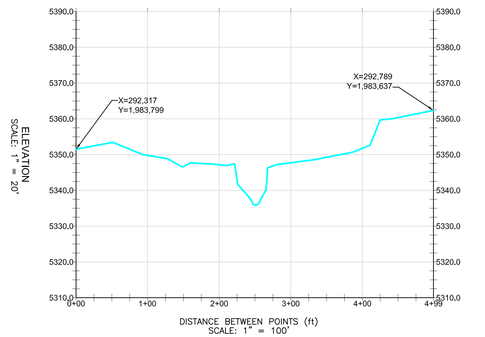
NN-2C (LOWER)



SECTIONS LOCATIONS AT
NO NAME ARROYO NN-2
MONITORING STATIONS



LOWER NO NAME STATION



REV. No.	DATE	DRAFT. BY	REVISION DESCRIPTION	PREP. BY	E.G.	P.E.	APPROVED DATE
				APPROVALS			

NORWEST
Applied Hydrology

EXHIBIT 18.A-5

BHP NAVAJO COAL COMPANY

bhpbilliton

P.O. BOX 1717
FRUITLAND, NEW MEXICO 87416
PHONE(505)598-4200
Fax(505)598-4229

NAVAJO MINE EXTENSION PROJECT

NO NAME ARROYO CROSS SECTIONS

PREPARED BY APO	DRAWN BY JLS	SCALE: AS SHOWN	
APPROVED BY	DATE Dec 09, 2008		

Navajo Mine Area IV North

Area IV South

Area V

Lower Pinabete Monitoring Station

Upper Pinabete Monitoring Station

Lower No Name Monitoring Station

Upper No Name Monitoring Station

Burnham Road

P-1 P-2 P-3 P-4 P-5 P-6

NN-1 NN-2 NN-3 NN-4 NN-5 NN-6 NN-7

34 28 33 29 30 31 27 26 32 25 24 21 23 22 20 19 18 12 17 16 13 12 11 10 16 9 7 6 15 8 3 5 4 2 1

Legend

- No Name Basins
- Pinabete Basins
- Stream Lines
- Survey Cross Sections
- Burnham Road
- AOC Surveyed Basins
- NavExt_LeaseBoundary
- NavExt_MineBlock

Exhibit 18.A-6 Navajo Mine Extension
Project Field Reconnaissance Map

N

0 1,500 3,000 Feet

URS

Appendix 18-C

Laboratory Reports for Pesticide and PCB Analyses of Pond Waters

Green Analytical	Project: BPI	
75 Suttle Street	Project Number: [none]	Reported:
Durango CO, 81303	Project Manager: Debbie Zufelt	04/22/08 14:33

Mid Penabete
T800496-02 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
SunStar Laboratories, Inc.									
Organochiorine Pesticides by EPA Method 8081A									
alpha-BHC	ND	100	ug/l	1	8041660	04/16/08	04/17/08	EPA 8081A	
gamma-BHC (Lindane)	ND	100	"	"	"	"	"	"	
beta-BHC	ND	100	"	"	"	"	"	"	
delta-BHC	ND	100	"	"	"	"	"	"	
Heptachlor	ND	100	"	"	"	"	"	"	
Aldrin	ND	100	"	"	"	"	"	"	
Heptachlor epoxide	ND	100	"	"	"	"	"	"	
gamma-Chlordane	ND	100	"	"	"	"	"	"	
alpha-Chlordane	ND	100	"	"	"	"	"	"	
Endosulfan I	ND	100	"	"	"	"	"	"	
4,4'-DDE	ND	100	"	"	"	"	"	"	
Dieldrin	ND	100	"	"	"	"	"	"	
Endrin	ND	100	"	"	"	"	"	"	
4,4'-DDD	ND	100	"	"	"	"	"	"	
Endosulfan II	ND	100	"	"	"	"	"	"	
4,4'-DDT	ND	200	"	"	"	"	"	"	
Endrin aldehyde	ND	100	"	"	"	"	"	"	
Endosulfan sulfate	ND	100	"	"	"	"	"	"	
Methoxychlor	ND	5.00	"	"	"	"	"	"	
Endrin ketone	ND	100	"	"	"	"	"	"	
Toxaphene	ND	**20.0**	"	"	"	"	"	"	
Surrogate: Tetrachloro-meta-xylene		*73.3 %*	*35-NO*		"	"	"	"	
Polychlorinated Biphenyls by EPA Method 8082									
PCB-1016	ND	200	ug/l	1	8041661	04/16/08	04/17/08	EPA 8082	
PCB-1221	ND	200	"	"	"	"	"	"	
PCB-1232	ND	200	"	"	"	"	"	"	
PCB-1242	ND	200	"	"	"	"	"	"	
PCB-1248	ND	200	"	"	"	"	"	"	
PCB-1254	ND	200	"	"	"	"	"	"	
PCB-1260	ND	200	"	"	"	"	"	"	
Surrogate: Tetrachloro-meta-xylene		*68.4 %*	*35-140*		"	"	"	"	

SunStar Laboratories, Inc.

The results m this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Albert Vargas

Albert Vargas, Senior Project Coordinator

CARDINAL LABORATORIES

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

ANALYTICAL RESULTS FOR
GREEN ANALYTICAL LABORATORIES, INC.
ATTN: DEBBIE ZUFELT
75 SUTTLE STREET
DURANGO, CO 81303
FAX TO: (970) 247-4227

Receiving Date: 08/14/08
Reporting Date: 09/03/08
Project Number: 808-067-02
Project Name: BHP BILLITON NMEP
Project Location: NOT GIVEN
Lab Number: H15736-1
Sample ID: POND EAST OF L. PINABETE

Analysis Date: 08/21/08
Sampling Date: 08/12/08
Sample Type: SURFACE WATER
Sample Condition: COOL & INTACT
Sample Received By: ML
Analyzed By: CK

AROCLORS (PCB's) (mg/L)	Sample Result H15736-1	Method Blank	QC	True Value QC	%IA
PCB 1016	<0.020	<0.020	0.115	0.100	115
PCB 1221	<0.020	<0.020	NR	NR	NR
PCB 1232	<0.020	<0.020	NR	NR	NR
PCB 1242	<0.020	<0.020	0.082	0.100	82.1
PCB 1248	<0.020	<0.020	NR	NR	NR
PCB 1254	<0.020	<0.020	0.079	0.100	79.4
PCB 1260	<0.020	<0.020	0.093	0.100	92.5

	% Recovery
Nitrobenzene-d5	17.1
2-Fluorobiphenyl	22.3
Terphenyl-d14	0.0*

METHOD: SW-846 3510, 8270

*Note: Surrogate outside historical limits due to matrix interference.

Lab Director

09/03/08
Date

H15736PCB GAL

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Green Analytical	Project: GA	
75 Suttle Street	Project Number: [none]	**Reported:**
Durango CO, 81303	Project Manager: Debbie Zufelt	05/20/08 14:45

Pond East of Lower Pinabete
T800629-01 (Water)

SunStar Laboratories, Inc.

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Organochlorine Pesticides by EPA Method 8081A									
alpha-BHC	ND	1.00	ug/l	1	8051408	05/14/08	05/15/08	EPA 8081A	
gamma-BHC (Lindane)	ND	1.00	"	"	"	"	"	"	
beta-BHC	ND	1.00	"	"	"	"	"	"	
delta-BHC	ND	1.00	"	"	"	"	"	"	
Heptachlor	ND	1.00	"	"	"	"	"	"	
Aldrin	ND	1.00	"	"	"	"	"	"	
Heptachlor epoxide	ND	1.00	"	"	"	"	"	"	
gamma-Chlordane	ND	1.00	"	"	"	"	"	"	
alpha-Chlordane	ND	1.00	"	"	"	"	"	"	
Endosulfan I	ND	1.00	"	"	"	"	"	"	
4,4'-DDE	ND	1.00	"	"	"	"	"	"	
Dieldrin	ND	1.00	"	"	"	"	"	"	
Endrin	ND	1.00	"	"	"	"	"	"	
4,4'-DDD	ND	1.00	"	"	"	"	"	"	
Endosulfan II	ND	1.00	"	"	"	"	"	"	
4,4'-DDT	ND	2.00	"	"	"	"	"	"	
Endrin aldehyde	ND	1.00	"	"	"	"	"	"	
Endosulfan sulfate	ND	1.00	"	"	"	"	"	"	
Methoxychlor	ND	5.00	"	"	"	"	"	"	
Endrin ketone	ND	1.00	"	"	"	"	"	"	
Toxaphene	ND	20.0	"	"	"	"	"	"	
Surrogate: Tetrachloro-meta-xylene		*101 %*	*35-140*		"	"	"	"	
Polychlorinated Biphenyls by EPA Method 8082									
PCB-1016	ND	2.00	ug/l	1	8051407	05/14/08	05/15/08	EPA 8082	
PCB-1221	ND	2.00	"	"	"	"	"	"	
PCB-1232	ND	2.00	"	"	"	"	"	"	
PCB-1242	ND	2.00	"	"	"	"	"	"	
PCB-1248	ND	2.00	"	"	"	"	"	"	
PCB-1254	ND	2.00	"	"	"	"	"	"	
PCB-1260	ND	2.00	"	"	"	"	"	"	
Surrogate: Tetrachloro-meta-xylene		*84.7 %*	*35-140*		"	"	"	"	

SunStar Laboratories, Inc.

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Albert Vargas

Albert Vargas, Senior Project Coordinator

CARDINAL LABORATORIES

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

ANALYTICAL RESULTS FOR
GREEN ANALYTICAL LABORATORIES, INC.
ATTN: DEBBIE ZUFELT
75 SUTTLE STREET
DURANGO, CO 81303
FAX TO: (970) 247-4227

Receiving Date: 08/14/08
Reporting Date: 09/03/08
Project Number: 808-067-02
Project Name: BHP BILLITON NMEP
Project Location: NOT GIVEN
Sample ID: POND EAST OF L. PINABETE
Lab Number: H15736-1

Extraction Date: 08/19/08
Analysis Date: 09/02/08
Sampling Date: 08/12/08
Sample Type: SURFACE WATER
Sample Condition: COOL & INTACT
Sample Received By: ML
Analyzed By: CK

PESTICIDES (mg/L)	Sample Result H15736-1	Method Blank	QC	%IA	True Value QC
4,4'-DDE	<0.020	<0.002	0.050	99.1	0.050
4,4'-DDD	<0.050	<0.005	0.044	88.3	0.050
4,4'-DDT	<0.100	<0.010	0.062	124	0.050
Chlordane	<0.200	<0.020	0.091	91.1	0.100

	% Recovery
Nitrobenzene-d5	6.60*
2-Fluorobiphenyl	5.15*
Terphenyl-d14	0.0*

METHODS: EPA SW-846 8270

*Note: Surrogate recovery outside historical limits due to matrix interference and sample dilution.

Chemist

09/03/08
Date

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H15736REVCAL

Green Analytical	Project: BHP	
75 Suttle Street	Project Number: [none]	**Reported:**
Durango CO, 81303	Project Manager: Debbie Zufelt	04/22/08 14:33

Mid No Name
T800496-01 (Water)

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
SunStar Laboratories, Inc.									
Organochlorine Pesticides by EPA Method 8081A									
alpha-BHC	ND	1.00	ug/l	1	8041610	04/16/08	04/17/08	EPA 8081A	
gamma-BHC (Lindane)	ND	1.00	"	"	"	"	"	"	
beta-BHC	ND	1.00	"	"	"	"	"	"	
delta-BHC	ND	1.00	"	"	"	"	"	"	
Heptachlor	ND	1.00	"	"	"	"	"	"	
Aldrin	ND	1.00	"	"	"	"	"	"	
Heptachlor epoxide	ND	1.00	"	"	"	"	"	"	
gamma-Chlordane	ND	1.00	"	"	"	"	"	"	
alpha-Chlordane	ND	1.00	"	"	"	"	"	"	
Endosulfan I	ND	1.00	"	"	"	"	"	"	
4,4'-DDE	ND	1.00	"	"	"	"	"	"	
Dieldrin	ND	1.00	"	"	"	"	"	"	
Endrin	ND	1.00	"	"	"	"	"	"	
4,4'-DDD	ND	1.00	"	"	"	"	"	"	
Endosulfan II	ND	1.00	"	"	"	"	"	"	
4,4'-DDT	ND	2.00	"	"	"	"	"	"	
Endrin aldehyde	ND	1.00	"	"	"	"	"	"	
Endosulfan sulfate	ND	1.00	"	"	"	"	"	"	
Methoxychlor	ND	5.00	"	"	"	"	"	"	
Endrin ketone	ND	1.00	"	"	"	"	"	"	
Toxaphene	ND	20.0	"	"	"	"	"	"	
Surrogate: Tetrachloro-meta-xylene		*70.6 %*	*35-140*		"	"	"	"	
Polychlorinated Biphenyls by EPA Method 8082									
PCB-1016	ND	2.00	ug/l	1	8041611	04/16/08	04/17/08	EPA 8082	
PCB-1221	ND	2.00	"	"	"	"	"	"	
PCB-1232	ND	2.00	"	"	"	"	"	"	
PCB-1242	ND	2.00	"	"	"	"	"	"	
PCB-1248	ND	2.00	"	"	"	"	"	"	
PCB-1254	ND	2.00	"	"	"	"	"	"	
PCB-1260	ND	2.00	"	"	"	"	"	"	
Surrogate: Tetrachloro-meta-xylene		*68.0 %*	*35-140*		"	"	"	"	

SunStar Laboratories, Inc.

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Albert Vargas

Albert Vargas, Senior Project Coordinator

CARDINAL LABORATORIES

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

ANALYTICAL RESULTS FOR
GREEN ANALYTICAL LABORATORIES, INC.
ATTN: DEBBIE ZUFELT
75 SUTTLE STREET
DURANGO, CO 81303
FAX TO: (970) 247-4227

Receiving Date: 08/14/08
Reporting Date: 09/03/08
Project Number: 808-067-06
Project Name: BHP BILLITON NMEP
Project Location: NOT GIVEN
Lab Number: H15736-2
Sample ID: POND ALONG NO NAME

Analysis Date: 08/21/08
Sampling Date: 08/12/08
Sample Type: SURFACE WATER
Sample Condition: COOL & INTACT
Sample Received By: ML
Analyzed By: CK

AROCLORS (PCB's) (mg/L)	Sample Result H15736-2	Method Blank	True Value QC	QC	%IA
PCB 1016	<0.020	<0.020	0.115	0.100	115
PCB 1221	<0.020	<0.020	NR	NR	NR
PCB 1232	<0.020	<0.020	NR	NR	NR
PCB 1242	<0.020	<0.020	0.082	0.100	82.1
PCB 1248	<0.020	<0.020	NR	NR	NR
PCB 1254	<0.020	<0.020	0.079	0.100	79.4
PCB 1260	<0.020	<0.020	0.093	0.100	92.5

	% Recovery
Nitrobenzene-d5	49.2
2-Fluorobiphenyl	99.9
Terphenyl-d14	0.0*

METHOD: SW-846 3510, 8270

*Note: Surrogate outside historical limits due to matrix interference.

Lab Director

09/03/08
Date

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CARDINAL LABORATORIES

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

ANALYTICAL RESULTS FOR
GREEN ANALYTICAL LABORATORIES, INC.
ATTN: DEBBIE ZUFELT
75 SUTTLE STREET
DURANGO, CO 81303
FAX TO: (970) 247-4227

Receiving Date: 08/14/08
Reporting Date: 09/03/08
Project Number: 808-067-12
Project Name: BHP BILLITON NMEP
Project Location: NOT GIVEN
Lab Number: H15736-3
Sample ID: WELL SITE POND

Analysis Date: 08/21/08
Sampling Date: 08/12/08
Sample Type: SURFACE WATER
Sample Condition: COOL & INTACT
Sample Received By: ML
Analyzed By: CK

AROCLORS (PCB's) (mg/L)	Sample Result H15736-3	Method Blank	True Value QC	QC	%IA
PCB 1016	<0.020	<0.020	0.115	0.100	115
PCB 1221	<0.020	<0.020	NR	NR	NR
PCB 1232	<0.020	<0.020	NR	NR	NR
PCB 1242	<0.020	<0.020	0.082	0.100	82.1
PCB 1248	<0.020	<0.020	NR	NR	NR
PCB 1254	<0.020	<0.020	0.079	0.100	79.4
PCB 1260	<0.020	<0.020	0.093	0.100	92.5

	% Recovery
Nitrobenzene-d5	62.2
2-Fluorobiphenyl	95.2
Terphenyl-d14	0.0*

METHOD: SW-846 3510, 8270

*Note: Surrogate outside historical limits due to matrix interference.

Lab Director

09/03/08
Date

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ANALYTICAL RESULTS FOR
GREEN ANALYTICAL LABORATORIES, INC.
ATTN: DEBBIE ZUFELT
75 SUTTLE STREET
DURANGO, CO 81303
FAX TO: (970) 247-4227

Receiving Date: 08/14/08
Reporting Date: 09/03/08
Project Number: 808-067-12
Project Name: BHP BILLITON NMEP
Project Location: NOT GIVEN
Sample ID: WELL SITE POND
Lab Number: H15736-3

Extraction Date: 08/19/08
Analysis Date: 09/02/08
Sampling Date: 08/12/08
Sample Type: SURFACE WATER
Sample Condition: COOL & INTACT
Sample Received By: ML
Analyzed By: CK

PESTICIDES (mg/L)	Sample Result H15736-3	Method Blank	QC	%IA	True Value QC
4,4'-DDE	<0.020	<0.002	0.050	99.1	0.050
4,4'-DDD	<0.050	<0.005	0.044	88.3	0.050
4,4'-DDT	<0.100	<0.010	0.062	124	0.050
Chlordane	<0.200	<0.020	0.091	91.1	0.100

	% Recovery
Nitrobenzene-d5	13.8
2-Fluorobiphenyl	13.0
Terphenyl-d14	0.0*

METHODS: EPA SW-846 8270

*Note: Surrogate recovery outside historical limits due to matrix interference and sample dilution.

Chemist

09/03/08
Date

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H15736 BHP GAL

Laboratory QA/QC Reports

Green Analytical	Project: BHP	
75 Suttle Street	Project Number: [none]	**Reported:**
Durango CO, 81303	Project Manager: Debbie Zufelt	04/22/08 14:33

Organochlorine Pesticides by EPA Method 8081A - Quality Control

SunStar Laboratories, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch 8041610 - EPA 3510C GCMS/ECD										
Blank (8041610-BLK1)				Prepared: 04/16/08 Analyzed: 04/17/08						
Surrogate: Tetrachloro-meta-xylene	*ND*		*ug/l*	*1.00*		*75.3*	*35-140*			
alpha-BHC	ND	1.00	"							
gamma-BHC (Lindane)	ND	1.00	"							
beta-BHC	ND	1.00	"							
delta-BHC	ND	1.00	"							
Heptachlor	ND	1.00	"							
Aldrin	ND	1.00	"							
Heptachlor epoxide	ND	1.00	"							
gamma-Chlordane	ND	1.00	"							
alpha-Chlordane	ND	1.00	"							
Endosulfan I	ND	1.00	"							
4,4'-DDE	ND	1.00	"							
Dieldrin	ND	1.00	"							
Endrin	ND	1.00	"							
4,4'-DDD	ND	1.00	"							
Endosulfan II	ND	1.00	"							
4,4'-DDT	ND	2.00	"							
Endrin aldehyde	ND	1.00	"							
Endosulfan sulfate	ND	1.00	"							
Methoxychlor	ND	5.00	"							
Endrin ketone	ND	1.00	"							
Toxaphene	ND	20.0	"							
LCS (8041610-BS1)				Prepared: 04/16/08 Analyzed: 04/17/08						
Surrogate: Tetrachloro-meta-xylene	*0.827*		*ug/l*	*1.00*		*82.7*	*35-140*			
gamma-BHC (Lindane)	1.53	1.00	"	2.00		76.6	40-120			
Heptachlor	1.67	1.00	"	2.00		83.3	40-120			
Aldrin	1.59	1.00	"	2.00		79.3	40-120			
Dieldrin	1.98	1.00	"	2.00		99.0	40-120			
Endrin	2.10	1.00	"	2.00		105	40-120			
4,4'-DDT	2.01	2.00	"	2.00		101	40-120			

Green Analytical	Project: BHP	
75 Suttle Street	Project Number: [none]	**Reported:**
Durango CO, 81303	Project Manager: Debbie Zufelt	04/22/08 14:33

Organochlorine Pesticides by EPA Method 8081A - Quality Control

SunStar Laboratories, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch 8041610 - EPA 3510C GCMS/ECD										
LCS Dup (8041610-BSD1)				Prepared: 04/16/08 Analyzed: 04/17/08						
Surrogate: Tetrachloro-meta-xylene	*0.903*		*ug/l*	*1.00*		*90.3*	*35-140*			
gamma-BHC (Lindane)	1.63	1.00	"	2.00		81.4	40-120	6.11	20	
Heptachlor	1.71	1.00	"	2.00		85.7	40-120	2.85	20	
Aldrin	1.64	1.00	"	2.00		82.2	40-120	3.60	20	
Dieldrin	2.01	1.00	"	2.00		101	40-120	1.72	20	
Endrin	2.19	1.00	"	2.00		110	40-120	4.12	20	
4,4'-DDT	2.03	2.00	"	2.00		102	40-120	1.03	20	

SunStar Laboratories, Inc.

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Albert Vargas

Albert Vargas, Senior Project Coordinator

CARDINAL LABORATORIES

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

ANALYTICAL RESULTS FOR
GREEN ANALYTICAL LABORATORIES, INC.
ATTN: DEBBIE ZUFELT
75 SUTTLE STREET
DURANGO, CO 81303
FAX TO: (970) 247-4227

Receiving Date: 08/14/08
Reporting Date: 09/03/08
Project Number: 808-067-06
Project Name: BHP BILLITON NMEP
Project Location: NOT GIVEN
Sample ID: POND ALONG NO NAME
Lab Number: H15736-2

Extraction Date: 08/19/08
Analysis Date: 09/02/08
Sampling Date: 08/12/08
Sample Type: SURFACE WATER
Sample Condition: COOL & INTACT
Sample Received By: ML
Analyzed By: CK

PESTICIDES (mg/L)	Sample Result H15736-2	Method Blank	QC	%IA	True Value QC
4,4'-DDE	<0.020	<0.002	0.050	99.1	0.050
4,4'-DDD	<0.050	<0.005	0.044	88.3	0.050
4,4'-DDT	<0.100	<0.010	0.062	124	0.050
Chlordane	<0.200	<0.020	0.091	91.1	0.100

	% Recovery
Nitrobenzene-d5	18.8
2-Fluorobiphenyl	18.1
Terphenyl-d14	31.0

METHODS: EPA SW-846 8270

Chemist

09/03/08
Date

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Green Analytical	Project: BHP	
75 Suttle Street	Project Number: [none]	**Reported:**
Durango CO, 81303	Project Manager: Debbie Zufelt	04/22/08 14:33

Polychlorinated Biphenyls by EPA Method 8082 - Quality Control

SunStar Laboratories, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch 8041611 - EPA 3510C GCMS/ECD										
Blank (8041611-BLK1)				Prepared: 04/16/08 Analyzed: 04/17/08						
Surrogate: Tetrachloro-meta-xylene	*0.650*		*ug/l*	*1.00*		*65.0*	*35-140*			
PCB-1016	ND	2.00	"							
PCB-1221	ND	2.00	"							
PCB-1232	ND	2.00	"							
PCB-1242	ND	2.00	"							
PCB-1248	ND	2.00	"							
PCB-1254	ND	2.00	"							
PCB-1260	ND	2.00	"							
LCS (8041611-BS1)				Prepared: 04/16/08 Analyzed: 04/17/08						
Surrogate: Tetrachloro-meta-xylene	*0.766*		*ug/l*	*1.00*		*76.6*	*40-130*			
PCB-1016	7.55	2.00	"	10.0		75.5	40-130			
PCB-1260	10.8	2.00	"	10.0		108	40-130			
LCS Dup (8041611-BSD1)				Prepared: 04/16/08 Analyzed: 04/17/08						
Surrogate: Tetrachloro-meta-xylene	*0.670*		*ug/l*	*1.00*		*67.0*	*40-130*			
PCB-1016	6.83	2.00	"	10.0		68.3	40-130	9.96	30	
PCB-1260	9.06	2.00	"	10.0		90.6	40-130	17.2	30	

Notes and Definitions

DET	Analyte DETECTED
ND	Analyte NOT DETECTED at or above the reporting limit
NR	Not Reported
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference

Green Analytical	Project: GA	
75 Suttle Street	Project Number: [none]	**Reported:**
Durango CO, 81303	Project Manager: Debbie Zufelt	05/20/08 14:45

Organochlorine Pesticides by EPA Method 8081A - Quality Control

SunStar Laboratories, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch 8051408 - EPA 3510C GCMS/ECD										
Blank (8051408-BLK1)				Prepared: 05/14/08 Analyzed: 05/15/08						
Surrogate: Tetrachloro-meta-xylene	*ND*		*ug/l*	*1.00*		*90.6*	*35-140*			
alpha-BHC	ND	1.00	"							
gamma-BHC (Lindane)	ND	1.00	"							
beta-BHC	ND	1.00	"							
delta-BHC	ND	1.00	"							
Heptachlor	ND	1.00	"							
Aldrin	ND	1.00	"							
Heptachlor epoxide	ND	1.00	"							
gamma-Chlordane	ND	1.00	"							
alpha-Chlordane	ND	1.00	"							
Endosulfan I	ND	1.00	"							
4,4'-DDE	ND	1.00	"							
Dieldrin	ND	1.00	"							
Endrin	ND	1.00	"							
4,4'-DDD	ND	1.00	"							
Endosulfan II	ND	1.00	"							
4,4'-DDT	ND	2.00	"							
Endrin aldehyde	ND	1.00	"							
Endosulfan sulfate	ND	1.00	"							
Methoxychlor	ND	5.00	"							
Endrin ketone	ND	1.00	"							
Toxaphene	ND	20.0	"							
LCS (8051408-BS1)				Prepared: 05/14/08 Analyzed: 05/15/08						
Surrogate: Tetrachloro-meta-xylene	*0.935*		*ug/l*	*1.00*		*93.5*	*35-140*			
gamma-BHC (Lindane)	1.43	1.00	"	2.00		71.6	40-120			
Heptachlor	1.48	1.00	"	2.00		74.2	40-120			
Aldrin	1.40	1.00	"	2.00		70.1	40-120			
Dieldrin	1.69	1.00	"	2.00		84.5	40-120			
Endrin	1.98	1.00	"	2.00		98.8	40-120			
4,4'-DDT	1.82	2.00	"	2.00		90.8	40-120			

Green Analytical	Project: GA	
75 Suttle Street	Project Number: [none]	**Reported:**
Durango CO, 81303	Project Manager: Debbie Zufelt	05/20/08 14:45

Organochlorine Pesticides by EPA Method 8081A - Quality Control

SunStar Laboratories, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch 8051408 - EPA 3510C GCMS/ECD										
Matrix Spike (8051408-MS1)	**Source: T800629-01**			Prepared: 05/14/08 Analyzed: 05/15/08						
Surrogate: Tetrachloro-meta-xylene	*1.06*		*ug/l*	*1.00*		*106*	*35-140*			
gamma-BHC (Lindane)	1.51	1.00	"	2.00	0.10	70.4	20-120			
Heptachlor	1.58	1.00	"	2.00	0.03	77.3	20-120			
Aldrin	1.47	1.00	"	2.00	ND	73.4	20-120			
Dieldrin	1.89	1.00	"	2.00	ND	94.4	20-120			
Endrin	1.97	1.00	"	2.00	ND	98.6	20-120			
4,4'-DDT	1.83	2.00	"	2.00	0.03	90.0	20-120			
Matrix Spike Dup (8051408-MSD1)	**Source: T800629-01**			Prepared: 05/14/08 Analyzed: 05/15/08						
Surrogate: Tetrachloro-meta-xylene	*0.994*		*ug/l*	*1.00*		*99.4*	*35-140*			
gamma-BHC (Lindane)	1.48	1.00	"	2.00	0.10	69.0	20-120	1.81	30	
Heptachlor	1.53	1.00	"	2.00	0.03	75.0	20-120	2.94	30	
Aldrin	1.42	1.00	"	2.00	ND	71.1	20-120	3.26	30	
Dieldrin	1.75	1.00	"	2.00	ND	87.4	20-120	7.69	30	
Endrin	1.85	1.00	"	2.00	ND	92.6	20-120	6.19	30	
4,4'-DDT	1.70	2.00	"	2.00	0.03	83.6	20-120	7.17	30	

Green Analytical	Project: GA	
75 Suttle Street	Project Number: [none]	**Reported:**
Durango CO, 81303	Project Manager: Debbie Zufelt	05/20/08 14:45

Polychlorinated Biphenyls by EPA Method 8082 - Quality Control

SunStar Laboratories, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch 8051407 - EPA 3510C GCMS/ECD										
Blank (8051407-BLK1)				Prepared: 05/14/08 Analyzed: 05/15/08						
Surrogate: Tetrachloro-meta-xylene	*0.731*		*ug/l*	*1.00*		*73.1*	*35-140*			
PCB-1016	ND	2.00	"							
PCB-1221	ND	2.00	"							
PCB-1232	ND	2.00	"							
PCB-1242	ND	2.00	"							
PCB-1248	ND	2.00	"							
PCB-1254	ND	2.00	"							
PCB-1260	ND	2.00	"							
LCS (8051407-BS1)				Prepared: 05/14/08 Analyzed: 05/15/08						
Surrogate: Tetrachloro-meta-xylene	*0.862*		*ug/l*	*1.00*		*86.2*	*40-130*			
PCB-1016	9.82	2.00	"	10.0		98.2	40-130			
PCB-1260	9.58	2.00	"	10.0		95.8	40-130			
Matrix Spike (8051407-MS1)		**Source: T800629-01**		Prepared: 05/14/08 Analyzed: 05/15/08						
Surrogate: Tetrachloro-meta-xylene	*0.753*		*ug/l*	*1.00*		*75.3*	*40-130*			
PCB-1016	9.09	2.00	"	10.0	ND	90.9	40-130			
PCB-1260	9.21	2.00	"	10.0	ND	92.1	40-130			
Matrix Spike Dup (8051407-MSD1)		**Source: T800629-01**		Prepared: 05/14/08 Analyzed: 05/15/08						
Surrogate: Tetrachloro-meta-xylene	*0.819*		*ug/l*	*1.00*		*81.9*	*40-130*			
PCB-1016	9.85	2.00	"	10.0	ND	98.5	40-130	7.97	30	
PCB-1260	9.98	2.00	"	10.0	ND	99.8	40-130	8.02	30	

Notes and Definitions

DET	Analyte DETECTED
ND	Analyte NOT DETECTED at or above the reporting limit
NR	Not Reported
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference

Appendix 18-D

Quality Assurance and Quality Control Results for Baseline

Surface Water Quality Data from 2007 to 2008

Green Analytical Laboratories

DISSOLVED METALS SPIKE AND DUPLICATE DATA

LAB ID#							
708-176	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Aluminum	0.00	2.25	**2.00**	**113**	<0.10	<0.10	**NC**
Arsenic	0.00	0.055	**0.050**	**110**	0.0030	0.0029	**3.39**
Barium	0.00	0.050	**0.050**	**100**	0.5030	0.5030	**0.00**
Boron	0.00	2.0	**2.0**	**100**	0.3	0.3	**0.00**
Cadmium	0.00	0.051	**0.050**	**102**	<0.00005	<0.00005	**NC**
Calcium	0.00	4.9	**5.0**	**98**	90.8	90.5	**0.33**
Chromium	0.00	0.052	**0.050**	**104**	0.005	0.005	**0.00**
Copper	0.00	0.051	**0.050**	**102**	0.0004	0.0004	**0.00**
Iron	0.00	0.98	**1.00**	**98**	<0.05	<0.05	**NC**
Lead	0.00	0.051	**0.050**	**102**	0.0022	0.0020	**9.52**
Magnesium *	0.00	1.4	**1.0**	**140**	16.9	16.4	**3.00**
Manganese	0.00	1.05	**1.00**	**105**	<0.0005	<0.0005	**NC**
Potassium	0.00	1.0	**1.0**	**100**	2.2	2.0	**9.52**
Selenium	0.00	0.278	**0.250**	**111**	0.009	0.009	**0.00**
Silver	0.00	0.053	**0.050**	**106**	<0.00005	<0.00005	**NC**
Sodium	0.00	50.3	**50.0**	**101**	19.3	18.1	**6.42**
Zinc	0.00	0.057	**0.050**	**114**	0.232	0.228	**1.74**

NC=Not calculated due to results less than the detection limit
NA=Data not available.

Green Analytical Laboratories

DISSOLVED METALS SRM AND BLANK DATA

LAB ID#						
709-176	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Aluminum	5.16	5.00	**103**	90-110 %	<0.10	0.10
Arsenic *	0.056	0.050	**112**	90-110 %	<0.0005	0.0005
Barium	0.055	0.050	**110**	90-110 %	<0.0005	0.0005
Boron	5.2	5.0	**104**	90-110 %	<0.1	0.1
Cadmium	0.054	0.050	**108**	90-110 %	<0.00005	0.00005
Calcium	5.0	5.0	**100**	90-110 %	<0.5	0.5
Chromium	0.055	0.050	**110**	90-110 %	<0.001	0.001
Copper	0.051	0.050	**102**	90-110 %	<0.0001	0.0001
Iron	5.04	5.00	**101**	90-110 %	<0.05	0.05
Lead	0.053	0.050	**106**	90-110 %	0.0001	0.0001
Magnesium	4.8	5.0	**96.0**	90-110 %	<0.5	0.5
Manganese	2.53	2.50	**101**	90-110 %	<0.005	0.005
Potassium	9.7	10.0	**97.0**	90-110 %	<0.5	0.5
Selenium *	0.278	0.250	**111**	90-110 %	<0.001	0.001
Silver *	0.058	0.050	**116**	90-110 %	<0.00005	0.00005
Sodium	16.0	16.2	**98.8**	90-110 %	<0.5	0.5
Zinc	0.06	0.05	**110**	90-110 %	<0.001	0.001

NA=Data not available.

Green Analytical Laboratories

TOTAL METALS SPIKE AND DUPLICATE DATA

LAB ID#							
708-176	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Iron-T	0.00	3.99	**4.00**	**99.8**	0.16	0.14	**13.3**
Manganese-T	0.000	2.070	**2.00**	**104**	0.008	0.007	**13.3**
Mercury-T	0.0000	0.0020	**0.0020**	**100**	<0.0002	<0.0002	**NC**

NC=Not calculated due to results less than the detection limit
NA=Data not available.

Green Analytical Laboratories

TOTAL METALS SRM AND BLANK DATA

LAB ID#						
708-176	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Iron-T	5.04	5.00	**101**	90-110 %	<0.05	0.05
Manganese-T	2.53	2.50	**101**	90-110 %	<0.005	0.005
Mercury-T	0.0021	0.0020	**105**	90-110 %	<0.0002	0.0002

NA=Data not available.

Green Analytical Laboratories

WET CHEM SPIKE AND DUPLICATE DATA

LAB ID#							
708-176	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Alkalinity	0	104	**100**	**104**	460	450	**2.20**
Chloride	1	101	**100**	**100**	4800	4750	**1.05**
EC	NMA	NMA	NMA	**NMA**	612	608	**0.66**
Fluoride	0.0	0.9	**1.0**	**90**	0.4	0.4	**0.00**
Nitrate/Nitrite	0.00	1.47	**1.54**	**95.5**	<0.02	<0.02	**NC**
pH	NMA	NMA	NMA	**NMA**	7.91	7.90	**0.13**
Phosphorus-T	0.00	0.29	**0.25**	**116**	0.23	0.21	**9.09**
Sulfate	0	50.0	**50.0**	**100**	410	400	**2.47**
TDS	NMA	NMA	NMA	**NMA**	915	910	**0.55**
TSS	NMA	NMA	NMA	**NMA**	31500	31450	**0.16**

NMA=Data not applicable to Method.
NC=Not calculated due to results less than the detection limit

Green Analytical Laboratories

WET CHEM SRM AND BLANK DATA

LAB ID#						
708-176	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Alkalinity	324	302	**107**	90-110 %	<10	10
Chloride	117	117	**100**	90-110 %	<10	10
EC	528	561	**94.1**	90-110 %	NMA	NMA
Fluoride	1.0	1.0	**100**	90-110 %	<1.0	1.0
Nitrate/Nitrite	0.48	0.50	**96.0**	90-110 %	<0.02	0.02
pH	8.32	8.40	**99.0**	90-110 %	NMA	NMA
Phosphorus-T	0.22	0.20	**110**	90-110 %	<0.05	0.05
Sulfate	335	320	**105**	90-110 %	<10	10
TDS	1235	1210	**102**	90-110 %	<10	10
TSS	173	158	**109**	90-110 %	<10	10

NMA=Data not applicable to Method.

Green Analytical Laboratories

DISSOLVED METALS SPIKE AND DUPLICATE DATA

LAB ID#							
709-094	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Aluminum	0.00	2.11	**2.00**	**106**	0.12	0.12	**0.00**
Arsenic	0.0000	0.050	**0.050**	**100**	0.0399	0.0373	**6.74**
Barium	0.0000	0.050	**0.050**	**100**	0.0013	0.0012	**8.00**
Boron	0.0	2.0	**2.0**	**102**	74.5	74.0	**0.67**
Cadmium	0.00000	0.049	**0.050**	**98**	<0.00005	<0.00005	**NC**
Calcium	0.0	4.9	**5.0**	**98**	428	418	**2.36**
Chromium	0.000	0.050	**0.050**	**100**	0.016	0.016	**0.00**
Copper	0.0000	0.050	**0.050**	**100**	0.0110	0.009	**20.0**
Iron	0.00	0.98	**1.00**	**98**	0.11	0.11	**0.00**
Lead	0.0000	0.050	**0.050**	**100**	0.0030	0.0028	**6.90**
Magnesium	0.0	1.1	**1.0**	**110**	13.5	13.0	**3.77**
Manganese	0.000	1.07	**1.00**	**107**	0.371	0.371	**0.00**
Potassium	0.0	1.0	**1.0**	**100**	269.0	260.0	**3.40**
Selenium	0.000	0.248	**0.250**	**99.2**	0.002	0.002	**0.00**
Silver	0.00000	0.052	**0.050**	**104**	<0.00005	<0.00005	**NC**
Sodium	0.0	49.1	**50.0**	**98.2**	309.0	306.0	**0.98**
Zinc	0.000	0.051	**0.050**	**102**	0.023	0.022	**4.44**

NC=Not calculated due to results less than the detection limit
NA=Data not available.

Green Analytical Laboratories

DISSOLVED METALS SRM AND BLANK DATA

LAB ID#						
709-094	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Aluminum	5.22	5.00	**104**	90-110 %	<0.10	0.10
Arsenic	0.051	0.050	**102**	90-110 %	<0.0005	0.0005
Barium	0.051	0.050	**102**	90-110 %	<0.0005	0.0005
Boron	5.3	5.0	**106**	90-110 %	<0.1	0.1
Cadmium	0.052	0.050	**104**	90-110 %	<0.00005	0.00005
Calcium	4.6	5.0	**92.0**	90-110 %	<0.5	0.5
Chromium	0.050	0.050	**100**	90-110 %	<0.001	0.001
Copper	0.049	0.050	**98.0**	90-110 %	<0.0001	0.0001
Iron	4.63	5.00	**92.6**	90-110 %	<0.05	0.05
Lead	0.051	0.050	**102**	90-110 %	<0.0001	0.0001
Magnesium *	4.3	5.0	**86.8**	90-110 %	<0.5	0.5
Manganese	2.67	2.50	**107**	90-110 %	<0.005	0.005
Potassium	8.9	10.0	**89.0**	90-110 %	<0.5	0.5
Selenium	0.248	0.250	**99.2**	90-110 %	<0.001	0.001
Silver	0.053	0.050	**106**	90-110 %	<0.00005	0.00005
Sodium	7.4	8.1	**91.4**	90-110 %	<0.5	0.5
Zinc	0.048	0.050	**96.0**	90-110 %	<0.001	0.001

NA=Data not available.

Green Analytical Laboratories

TOTAL METALS SPIKE AND DUPLICATE DATA

LAB ID#							
708-094	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Iron-T	0.00	4.15	**4.00**	**104**	<0.02	<0.02	**NC**
Manganese-T	0.000	2.05	**2.00**	**103**	0.042	0.040	**4.88**
Mercury-T	0.0000	0.0021	**0.002**	**105**	<0.0002	<0.0002	**NC**

NC=Not calculated due to results less than the detection limit
NA=Data not available.

Green Analytical Laboratories

TOTAL METALS SRM AND BLANK DATA

LAB ID#						
709-094	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Iron-T	5.25	5.00	**105**	90-110 %	<0.05	0.05
Manganese-T	2.61	2.50	**104**	90-110 %	<0.005	0.005
Mercury-T	0.002	0.002	**100**	90-110 %	<0.0002	0.0002

NA=Data not available.

Green Analytical Laboratories

WET CHEM SPIKE AND DUPLICATE DATA

LAB ID#							
709-094	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Alkalinity	1	101	**100**	**100**	224	220	**1.80**
Chloride	1	102	**100**	**101**	<10	<10	**NC**
EC	NMA	NMA	**NMA**	**NMA**	625	625	**0.00**
Fluoride	0.0	0.9	**1.0**	**90**	0.3	0.3	**0.00**
Nitrate/Nitrite	0.00	1.95	**1.92**	**102**	0.23	0.21	**9.09**
pH	NMA	NMA	**NMA**	**NMA**	8.02	7.95	**0.88**
Phosphorus-T	0.00	0.25	**0.25**	**100**	0.22	0.21	**4.65**
Sulfate	0	55.0	**50.0**	**110**	14600	14400	**1.38**
TDS	NMA	NMA	**NMA**	**NMA**	355	350	**1.42**
TSS	NMA	NMA	**NMA**	**NMA**	33600	32800	**2.41**

NMA=Data not applicable to Method.
NA=Data not available.

Green Analytical Laboratories

WET CHEM SRM AND BLANK DATA

LAB ID#						
709-094	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Alkalinity	280	283	**98.9**	90-110 %	<10	10
Chloride	39	38	**103**	90-110 %	<10	10
EC	514	561	**91.6**	90-110 %	NMA	NMA
Fluoride	1.0	1.0	**100**	90-110 %	<1.0	1.0
Nitrate/Nitrite	0.51	0.50	**102**	90-110 %	<0.02	0.02
pH	8.28	8.40	**98.6**	90-110 %	NMA	NMA
Phosphorus-T	0.21	0.20	**105**	90-110 %	<0.05	0.05
Sulfate	345	320	**108**	90-110 %	<10	10
TDS	1245	1210	**103**	90-110 %	<10	10
TSS *	173	146	**118**	90-110 %	<10	10

NMA=Data not applicable to Method.
NA=Data not available.

Green Analytical Laboratories

DISSOLVED METALS SPIKE AND DUPLICATE DATA

LAB ID#							
709-141	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Aluminum	0.00	0.51	**0.50**	**102**	0.19	0.16	**17.1**
Arsenic	0.0000	0.050	**0.050**	**100**	<0.0005	<0.0005	**NC**
Barium	0.0000	0.049	**0.050**	**98.0**	0.0398	0.0393	**1.26**
Boron	0.0	3.9	**4.0**	**96.3**	0.1	0.1	**0.00**
Cadmium	0.00000	0.0500	**0.050**	**100**	<0.00005	<0.00005	**NC**
Calcium	0.0	5.1	**5.0**	**102**	15.5	15.5	**0.00**
Chromium	0.000	0.050	**0.050**	**100**	0.009	0.009	**0.00**
Copper	0.0000	0.051	**0.050**	**102**	0.0702	0.0700	**0.29**
Iron	0.00	1.05	**1.00**	**105**	154	148	**3.97**
Lead	0.0000	0.049	**0.050**	**98.0**	0.0003	0.0003	**0.00**
Magnesium	0.0	1.1	**1.0**	**107**	3.0	2.9	**3.39**
Manganese	0.000	2.04	**2.00**	**102**	0.090	0.085	**5.71**
Potassium	3.0	3.9	**1.0**	**86.0**	3.0	3.0	**0.00**
Selenium	0.001	0.256	**0.250**	**102**	0.002	0.002	**0.00**
Silver	0.00000	0.051	**0.050**	**102**	<0.00005	<0.00005	**NC**
Sodium	0.0	54.3	**50.0**	**109**	90.2	90.1	**0.11**
Zinc	0.000	0.050	**0.050**	**100**	0.019	0.019	**0.00**

NC=Not calculated due to results less than the detection limit
NA=Data not available.

Green Analytical Laboratories

DISSOLVED METALS SRM AND BLANK DATA

LAB ID#						
709-141	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Aluminum	4.95	5.00	**99.0**	90-110 %	<0.10	0.10
Arsenic	0.052	0.050	**104**	90-110 %	<0.0005	0.0005
Barium	0.051	0.050	**102**	90-110 %	<0.0005	0.0005
Boron	5.1	5.0	**102**	90-110 %	<0.1	0.1
Cadmium	0.050	0.050	**100**	90-110 %	<0.00005	0.00005
Calcium	4.7	5.0	**94.0**	90-110 %	<0.5	0.5
Chromium	0.050	0.050	**100**	90-110 %	<0.001	0.001
Copper	0.050	0.050	**100**	90-110 %	<0.0001	0.0001
Iron	4.77	5.00	**95.4**	90-110 %	<0.05	0.05
Lead	0.050	0.050	**100**	90-110 %	<0.0001	0.0001
Magnesium	4.7	5.0	**94.0**	90-110 %	<0.5	0.5
Manganese	2.57	2.50	**103**	90-110 %	<0.005	0.005
Potassium	9.3	10.0	**93.0**	90-110 %	<0.5	0.5
Selenium	0.254	0.250	**102**	90-110 %	0.001	0.001
Silver	0.054	0.050	**108**	90-110 %	<0.00005	0.00005
Sodium	8.6	8.1	**106**	90-110 %	<0.5	0.5
Zinc	0.050	0.050	**100**	90-110 %	<0.001	0.001

NA=Data not available.

Green Analytical Laboratories

TOTAL METALS SPIKE AND DUPLICATE DATA

LAB ID#							
709-141	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Iron-T	0.00	4.15	**4.00**	**104**	125	124	**0.80**
Manganese-T	0.000	2.050	**2.000**	**103**	7.60	7.31	**3.89**
Mercury-T	0.0000	0.0021	**0.002**	**105**	<0.0002	<0.0002	**NC**

NC=Not calculated due to results less than the detection limit
NA=Data not available.

Green Analytical Laboratories

TOTAL METALS SRM AND BLANK DATA

LAB ID#						
709-141	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Iron-T	5.25	5.00	**105**	90-110 %	<0.05	0.05
Manganese-T	2.61	2.50	**104**	90-110 %	<0.005	0.005
Mercury-T	0.002	0.002	**100**	90-110 %	<0.0002	0.0002

NA=Data not available.

Green Analytical Laboratories

WET CHEM SPIKE AND DUPLICATE DATA

LAB ID#							
	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Alkalinity	0	103	**100**	**103**	139	138	**0.72**
Chloride	0	104	**100**	**104**	<10	<10	**NC**
EC	NMA	NMA	**NMA**	**NMA**	570	560	**1.77**
Fluoride	0.0	0.9	**1.0**	**90.0**	0.2	0.2	**0.00**
Nitrate/Nitrite	0.00	1.84	**1.92**	**95.8**	2.55	2.54	**0.39**
pH	NMA	NMA	**NMA**	**NMA**	7.64	7.61	**0.39**
Phosphorus-T	0.00	0.27	**0.25**	**108**	0.26	0.22	**16.7**
Sulfate	0	53	**50**	**106**	2050	2050	**0.00**
TDS	NMA	NMA	**NMA**	**NMA**	330	320	**3.08**
TSS	NMA	NMA	**NMA**	**NMA**	8700	7700	**12.2**

NMA=Data not applicable to Method.
NA=Data not available.
NC=Not calculated due to results less than the detection limit

Green Analytical Laboratories

WET CHEM SRM AND BLANK DATA

LAB ID#						
709-141	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Alkalinity	296	283	**105**	90-110 %	<10	10
Chloride	40	38	**106**	90-110 %	<10	10
EC *	495	561	**88.2**	90-110 %	NMA	NMA
Fluoride	1.0	1.0	**100**	90-110 %	<1.0	1.0
Nitrate/Nitrite	0.49	0.50	**98.0**	90-110 %	<0.02	0.02
pH	8.38	8.40	**100**	90-110 %	NMA	NMA
Phosphorus-T *	4.30	5.20	**82.7**	90-110 %	<0.05	0.05
Sulfate *	355	320	**111**	90-110 %	<10	10
TDS	1215	1210	**100**	90-110 %	<10	10
TSS *	173	155	**112**	90-110 %	<10	10

NMA=Data not applicable to Method.
NA=Data not available.

Green Analytical Laboratories

DISSOLVED METALS SPIKE AND DUPLICATE DATA

LAB ID#							
071009K001	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Aluminum	0.00	2.04	**2.00**	**102**	<0.1	<0.1	**NC**
Arsenic	0.0000	0.052	**0.050**	**104**	0.0049	0.0048	**2.06**
Barium	0.0000	0.050	**0.050**	**100**	3.80	3.75	**1.32**
Boron	0.0	2.1	**2.00**	**105**	0.3	0.3	**0.00**
Cadmium	0.00000	0.050	**0.050**	**100**	<0.00005	<0.00005	**NC**
Calcium	0.0	5.2	**5.00**	**104**	1.2	1.2	**0.00**
Chromium	0.000	0.051	**0.050**	**102**	0.002	0.002	**0.00**
Copper	0.0000	0.050	**0.050**	**100**	0.0430	0.0400	**7.23**
Iron	0.00	1.06	**1.00**	**106**	102	102	**0.00**
Lead	0.0000	0.050	**0.050**	**100**	<0.0001	<0.0001	**NC**
Magnesium	0.0	1.1	**1.0**	**110**	<0.5	<0.5	**NC**
Manganese	0.000	1.060	**1.0**	**106**	0.069	0.068	**1.46**
Potassium	0.0	1.0	**1.0**	**100**	0.6	0.6	**0.00**
Selenium	0.006	2.67	**2.50**	**107**	0.022	0.022	**0.00**
Silver	0.00000	0.051	**0.050**	**102**	<0.00005	<0.00005	**NC**
Sodium	0.0	1.0	**1.00**	**100**	162	161	**0.62**
Zinc	0.000	0.052	**0.050**	**104**	0.001	0.001	**0.00**

NC=Not calculated due to results less than the detection limit
NA=Data not available.

Green Analytical Laboratories

DISSOLVED METALS SRM AND BLANK DATA

LAB ID#						
071009k001	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Aluminum	5.30	5.00	**106**	90-110 %	<0.10	0.10
Arsenic	0.054	0.050	**108**	90-110 %	<0.0005	0.0005
Barium	0.052	0.050	**104**	90-110 %	<0.0005	0.0005
Boron	5.5	5.000	**110**	90-110 %	<0.1	0.1
Cadmium	0.050	0.050	**100**	90-110 %	<0.00005	0.00005
Calcium	5.0	5.000	**100**	90-110 %	<0.5	0.5
Chromium	0.052	0.050	**104**	90-110 %	<0.001	0.001
Copper	0.050	0.050	**100**	90-110 %	<0.0001	0.0001
Iron	5.18	5.0	**104**	90-110 %	<0.05	0.05
Lead	0.050	0.050	**100**	90-110 %	<0.0001	0.0001
Magnesium	4.9	5.0	**98.0**	90-110 %	<0.5	0.5
Manganese	2.76	2.50	**110**	90-110 %	<0.005	0.005
Potassium	1.0	1.0	**100**	90-110 %	<0.5	0.5
Selenium	0.267	0.250	**107**	90-110 %	0.006	0.001
Silver	0.052	0.050	**104**	90-110 %	<0.00005	0.00005
Sodium	8.2	8.1	**101**	90-110 %	<0.5	0.5
Zinc	0.051	0.050	**102**	90-110 %	<0.001	0.001

NA=Data not available.

Green Analytical Laboratories

TOTAL METALS SPIKE AND DUPLICATE DATA

LAB ID#							
071009k001	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Iron-T	0.00	2.03	**2.00**	**102**	0.15	0.15	**0.00**
Manganese-T	0.000	1.05	**1.00**	**105**	0.080	0.080	**0.00**
Mercury-T	0.0000	0.0022	**0.002**	**110**	<0.0002	<0.0002	**NC**

NC=Not calculated due to results less than the detection limit
NA=Data not available.

Green Analytical Laboratories

TOTAL METALS SRM AND BLANK DATA

LAB ID#						
071009k001	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Iron-T	4.69	5.00	**93.8**	90-110 %	<0.05	0.05
Manganese-T	2.43	2.50	**97.2**	90-110 %	<0.005	0.005
Mercury-T	0.002	0.002	**100**	90-110 %	<0.0002	0.0002

NA=Data not available.

Green Analytical Laboratories

WET CHEM SPIKE AND DUPLICATE DATA

LAB ID#							
071009k001	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Alkalinity	0	106	**100**	**106**	99	99	**0.00**
Chloride	0	101	**100**	**101**	13	13	**0.00**
EC	NMA	NMA	**NMA**	**NMA**	1017	1015	**0.20**
Fluoride	0.0	0.9	**1.0**	**90.0**	<0.2	<0.2	**NC**
Nitrate/Nitrite	0.00	1.76	**1.92**	**91.7**	0.31	0.31	**0.00**
pH	NMA	NMA	**NMA**	**NMA**	8.07	8.05	**0.25**
Phosphorus-T	0.00	0.27	**0.25**	**108**	0.45	0.41	**9.30**
Sulfate	0	55.00	**50.00**	**110**	390	390	**0.00**
TDS	NMA	NMA	**NMA**	**NMA**	605	595	**1.67**
TSS	NMA	NMA	**NMA**	**NMA**	132000	131000	**0.76**

NMA=Data not applicable to Method.
NA=Data not available.
NC=Not calculated due to results less than the detection limit

Green Analytical Laboratories

WET CHEM SRM AND BLANK DATA

LAB ID#						
071009k001	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Alkalinity	290	283	**102**	90-110 %	<10	10
Chloride	39	37.9	**103**	90-110 %	<10	10
EC	514	561	**91.6**	90-110 %	NMA	NMA
Fluoride	1.0	1.0	**100**	90-110 %	<1.0	1.0
Nitrate/Nitrite	0.51	0.50	**102**	90-110 %	<0.02	0.02
pH	8.38	8.40	**100**	90-110 %	NMA	NMA
Phosphorus-T	5.61	5.32	**105**	90-110 %	<0.05	0.05
Sulfate	340	321	**106**	90-110 %	<10	10
TDS	1175	1210	**97.1**	90-110 %	<10	10
TSS	156	173	**90.2**	90-110 %	<10	10

NMA=Data not applicable to Method.
NA=Data not available.

Green Analytical Laboratories

DISSOLVED METALS SPIKE AND DUPLICATE DATA

LAB ID#							
712051326+	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Aluminum	0.00	2.04	**2.00**	**102**	<0.1	<0.1	**NC**
Arsenic	0.0000	0.050	**0.050**	**100**	0.0061	0.0057	**6.78**
Barium	0.0000	0.048	**0.050**	**96.0**	0.0089	0.0085	**4.60**
Boron	0.0	2.1	**2.0**	**104**	<0.1	<0.1	**NC**
Cadmium	0.00000	0.049	**0.050**	**98.0**	<0.00005	<0.00005	**NC**
Calcium	0.0	45.8	**50.0**	**91.6**	22.1	21.6	**2.29**
Chromium	0.000	0.049	**0.050**	**98.0**	0.007	0.007	**0.00**
Copper	0.0000	0.049	**0.050**	**98.0**	0.892	0.732	**19.7**
Iron	0.00	9.48	**10.0**	**94.8**	<0.05	<0.05	**NC**
Lead	0.0000	0.048	**0.050**	**96.0**	0.0001	0.0001	**0.00**
Magnesium	0.0	9.5	**10.0**	**95.0**	1.7	1.7	**0.00**
Manganese	0.000	1.16	**1.00**	**116**	0.017	0.017	**0.00**
Potassium	0.0	9.9	**10.0**	**99.0**	3.7	3.6	**2.74**
Selenium	0.000	0.250	**0.250**	**100**	0.179	0.170	**5.16**
Silver	0.00000	0.0500	**0.050**	**100**	<0.00005	<0.00005	**NC**
Sodium	0.0	481.0	**500**	**96.2**	194	190	**2.08**
Zinc	0.000	0.050	**0.050**	**100**	0.011	0.011	**0.00**

NC=Not calculated due to results less than the detection limit
NA=Data not available.

Green Analytical Laboratories

DISSOLVED METALS SRM AND BLANK DATA

LAB ID#						
0712051326+	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Aluminum	5.16	5.00	**103**	90-110 %	<0.10	0.10
Arsenic	0.0520	0.050	**104**	90-110 %	<0.0005	0.0005
Barium	0.0500	0.050	**100**	90-110 %	<0.0005	0.0005
Boron	5.2	5.0	**104**	90-110 %	<0.1	0.1
Cadmium	0.05100	0.050	**102**	90-110 %	<0.00005	0.00005
Calcium	5.3	5.0	**106**	90-110 %	<0.5	0.5
Chromium	0.050	0.050	**100**	90-110 %	<0.001	0.001
Copper	0.0500	0.050	**100**	90-110 %	<0.0001	0.0001
Iron	5.39	5.0	**108**	90-110 %	<0.05	0.05
Lead	0.0490	0.050	**98.0**	90-110 %	<0.0001	0.0001
Magnesium	5.2	5.0	**104**	90-110 %	<0.5	0.5
Manganese	2.65	2.50	**106**	90-110 %	<0.005	0.005
Potassium	10.9	10.0	**109**	90-110 %	<0.5	0.5
Selenium	0.261	0.250	**104**	90-110 %	<0.001	0.001
Silver *	0.06000	0.050	**120**	90-110 %	<0.00005	0.00005
Sodium	9.0	9.0	**100**	90-110 %	<0.5	0.5
Zinc	0.051	0.050	**102**	90-110 %	<0.001	0.001

NA=Data not available.

Green Analytical Laboratories

TOTAL METALS SPIKE AND DUPLICATE DATA

LAB ID#							
0712051326+	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Iron-T	0.00	4.21	**4.00**	**105**	42.9	40.6	**5.51**
Manganese-T	0.000	2.16	**2.00**	**108**	1.71	1.62	**5.41**
Mercury-T	0.0000	0.0020	**0.0020**	**100**	<0.0002	<0.0002	**NC**

NC=Not calculated due to results less than the detection limit
NA=Data not available.

Green Analytical Laboratories

TOTAL METALS SRM AND BLANK DATA

LAB ID#						
0712051326+	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Iron-T	5.10	5.00	**102**	90-110 %	<0.05	0.05
Manganese-T	2.65	2.50	**106**	90-110 %	<0.005	0.005
Mercury-T	0.0021	0.0020	**105**	90-110 %	<0.0002	0.0002

NA=Data not available.

Green Analytical Laboratories

WET CHEM SPIKE AND DUPLICATE DATA

LAB ID#							
0712051326+	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Alkalinity	0	106	**100**	**106**	224	220	**1.80**
Chloride	0	101	**100**	**101**	210	206	**1.92**
EC	NMA	NMA	**NMA**	**NMA**	708	704	**0.57**
Fluoride	0.0	0.9	**1.0**	**90.0**	<0.2	<0.2	**NC**
Nitrate/Nitrite	0.00	1.90	**1.92**	**99.0**	32.1	31.4	**2.20**
pH	NMA	NMA	**NMA**	**NMA**	8.19	8.10	**1.10**
Phosphorus-T	0.29	0.54	**0.25**	**100**	0.23	0.22	**4.44**
Sulfate	0	54	**50**	**108**	9800	9800	**0.00**
TDS	NMA	NMA	**NMA**	**NMA**	935	930	**0.54**
TSS	NMA	NMA	**NMA**	**NMA**	88000	85200	**3.23**

NMA=Data not applicable to Method.
NA=Data not available.
NC=Not calculated due to results less than the detection limit

Green Analytical Laboratories

WET CHEM SRM AND BLANK DATA

LAB ID#						
0712051326+	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Alkalinity	274	283	**96.8**	90-110 %	<10	10
Chloride	37	37.9	**97.6**	90-110 %	<10	10
EC	556	561	**99.1**	90-110 %	NA	NA
Fluoride	1.0	1.0	**100**	90-110 %	<1.0	1.0
Nitrate/Nitrite	0.50	0.50	**100**	90-110 %	<0.02	0.02
pH	8.30	8.40	**98.8**	90-110 %	NA	NA
Phosphorus-T	5.49	5.32	**103**	90-110 %	<0.05	0.05
Sulfate	350	321	**109**	90-110 %	<10	10
TDS	1205	1210	**99.6**	90-110 %	<10	10
TSS *	18.0	21.9	**82.2**	90-110 %	<10	10

NA=Data not applicable to Method.
NA=Data not available.

Green Analytical Laboratories

DISSOLVED METALS SPIKE AND DUPLICATE DATA

LAB ID#							
802-052	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Aluminum	0.00	2.33	**2.00**	**117**	1.69	1.65	**2.40**
Arsenic	0.0000	0.045	**0.050**	**90.0**	0.0093	0.0093	**0.00**
Barium	0.0000	0.046	**0.050**	**92.0**	0.0344	0.0328	**4.76**
Boron	0.1	2.3	**2.0**	**108**	0.4	0.4	**0.00**
Cadmium	0.00000	0.044	**0.050**	**88.0**	0.00006	0.00005	**18.2**
Calcium *	0.0	6.9	**5.00**	**138**	82.5	82.0	**0.61**
Chromium	0.000	0.044	**0.050**	**88.0**	0.002	0.002	**0.00**
Copper	0.0000	0.046	**0.050**	**92.0**	0.0174	0.0171	**1.74**
Iron *	0.00	1.40	**1.00**	**140**	<0.05	<0.05	**NC**
Lead	0.0000	0.045	**0.050**	**90.0**	0.0001	0.0001	**0.00**
Magnesium *	0.0	1.4	**1.0**	**140**	9.1	9.0	**1.10**
Manganese	0.000	1.20	**1.0**	**120**	0.008	0.008	**0.00**
Potassium *	0.0	1.4	**1.0**	**140**	0.86	0.82	**4.76**
Selenium	0.000	0.217	**0.250**	**86.8**	0.003	0.003	**0.00**
Silver *	0.00000	0.039	**0.050**	**78.0**	0.00005	0.00005	**0.00**
Sodium *	0.0	70.4	**50.0**	**141**	32.7	32.5	**0.61**
Zinc	0.000	0.044	**0.050**	**88.0**	0.006	0.006	**0.00**

NC=Not calculated due to results less than the detection limit
NA=Data not available.

Green Analytical Laboratories

DISSOLVED METALS SRM AND BLANK DATA

LAB ID#						
802.052	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Aluminum	5.43	5.00	**109**	90-110 %	<0.10	0.10
Arsenic	0.049	0.050	**98.0**	90-110 %	<0.0005	0.0005
Barium	0.050	0.050	**100**	90-110 %	<0.0005	0.0005
Boron	5.4	5.0	**108**	90-110 %	0.1	0.1
Cadmium	0.046	0.050	**92.0**	90-110 %	<0.00005	0.00005
Calcium	4.5	5.0	**90.0**	90-110 %	<0.5	0.5
Chromium *	0.042	0.050	**84.0**	90-110 %	<0.001	0.001
Copper	0.050	0.050	**100**	90-110 %	<0.0001	0.0001
Iron	4.91	5.00	**98.2**	90-110 %	<0.05	0.05
Lead	0.049	0.050	**98.0**	90-110 %	<0.0001	0.0001
Magnesium	4.6	5.000	**92.0**	90-110 %	<0.5	0.5
Manganese *	2.78	2.50	**111**	90-110 %	<0.005	0.005
Potassium	9.6	10.0	**96.0**	90-110 %	<0.5	0.5
Selenium	0.244	0.250	**97.6**	90-110 %	<0.001	0.001
Silver	0.045	0.050	**90.0**	90-110 %	<0.00005	0.00005
Sodium	7.9	8.1	**97.5**	90-110 %	<0.5	0.5
Zinc	0.050	0.050	**100**	90-110 %	<0.001	0.001

NA=Data not available.

Green Analytical Laboratories

TOTAL METALS SPIKE AND DUPLICATE DATA

LAB ID#							
802-052	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Iron-T	0.00	3.76	**4.00**	**94.0**	6.00	5.61	**6.72**
Manganese-T	0.000	1.97	**2.00**	**98.5**	1.280	1.270	**0.78**
Mercury-T	0.0000	0.0020	**0.0020**	**100**	<0.0002	<0.0002	**NC**

NC=Not calculated due to results less than the detection limit
NA=Data not available.

Green Analytical Laboratories

TOTAL METALS SRM AND BLANK DATA

LAB ID#						
802-052	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Iron-T	5.21	5.00	**104**	90-110 %	<0.05	0.05
Manganese-T	2.73	2.50	**109**	90-110 %	<0.005	0.005
Mercury-T	0.0017	0.002	**85.0**	90-110 %	<0.0002	0.0002

NA=Data not available.

Green Analytical Laboratories

WET CHEM SPIKE AND DUPLICATE DATA

LAB ID#							
802-052	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Alkalinity	0	102	**100**	**102**	104	100	**3.92**
Chloride	0	110	**100**	**110**	<10	<10	**NC**
EC	NMA	NMA	**NMA**	**NMA**	NA	NA	**NC**
Fluoride	0.0	0.9	**1.0**	**90.0**	0.5	0.5	**0.00**
Nitrate/Nitrite	0.10	1.79	**1.82**	**92.9**	<0.02	<0.02	**NC**
pH	NMA	NMA	**NMA**	**NMA**	8.76	8.67	**1.03**
Phosphorus-T	0.00	0.23	**0.25**	**92.0**	0.13	0.13	**0.00**
Sulfate	0	52	**50**	**104**	255	250	**1.98**
TDS	NMA	NMA	**NMA**	**NMA**	1200	1180	**1.68**
TSS	NMA	NMA	**NMA**	**NMA**	102000	99800	**2.18**

NMA=Data not applicable to Method.
NA=Data not available.
NC=Not calculated due to results less than the detection limit

Green Analytical Laboratories

WET CHEM SRM AND BLANK DATA

LAB ID#						
802-052	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Alkalinity	176	186	**94.6**	90-110 %	<10	10
Chloride	25	25	**101**	90-110 %	<10	10
EC	527	561	**93.9**	90-110 %	NMA	NMA
Fluoride	1.0	1.0	**100**	90-110 %	<1.0	1.0
Nitrate/Nitrite	0.51	0.50	**102**	90-110 %	<0.02	0.02
pH	8.54	8.40	**102**	90-110 %	NMA	NMA
Phosphorus-T *	4.29	5.32	**80.6**	90-110 %	<0.05	0.05
Sulfate	335	321	**104**	90-110 %	<10	10
TDS	1180	1210	**97.5**	90-110 %	<10	10
TSS	97	104	**93.3**	90-110 %	<10	10

NMA=Data not applicable to Method.
NA=Data not available.

Green Analytical Laboratories

METALS SPIKE AND DUPLICATE DATA

LAB ID#							
804-076	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Aluminum-T	0.00	4.22	**4.00**	**106**	1.16	1.14	**1.74**
Arsenic-T	0.0000	0.047	**0.050**	**94.0**	<0.0005	<0.0005	**NC**
Barium-T	0.0000	0.045	**0.050**	**90.0**	0.173	0.156	**10.3**
Boron-D	0.3	2.7	**2.0**	**120**	0.3	0.3	**0.00**
Cadmium-D	0.00000	0.045	**0.050**	**90.0**	<0.00005	<0.00005	**NC**
Chromium-D	0.000	0.048	**0.050**	**96.0**	0.002	0.002	**0.00**
Cobalt-D	0.0000	0.049	**0.050**	**98.0**	0.0028	0.0027	**6.92**
Copper-D	0.0000	0.048	**0.050**	**96.0**	0.148	0.121	**20.1**
Lead-D	0.0000	0.045	**0.050**	**90.0**	0.0001	0.0001	**0.00**
Mercury-T	0.000	0.002	**0.002**	**100**	<0.0002	<0.0002	**NC**
Selenium-T	0.000	0.250	**0.230**	**109**	0.069	0.067	**2.94**
Vanadium-D	0.0000	0.048	**0.050**	**96.0**	<0.0005	<0.0005	**NC**
Zinc-D	0.000	0.043	**0.050**	**86.0**	0.004	0.004	**0.00**

NC=Not calculated due to results less than the detection limit
NA=Data not available.

Green Analytical Laboratories

METALS SRM AND BLANK DATA

LAB ID#						
804-076	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Aluminum-T	5.11	5.00	**102**	90-110 %	<0.10	0.10
Arsenic-T	0.049	0.050	**98.0**	90-110 %	<0.0005	0.0005
Barium-T	0.048	0.050	**96.0**	90-110 %	<0.0005	0.0005
Boron-D	5.0	5.0	**100**	90-110 %	<0.1	0.1
Cadmium-D	0.047	0.050	**94.0**	90-110 %	<0.00005	0.00005
Chromium-D	0.054	0.050	**108**	90-110 %	<0.001	0.001
Cobalt-D	0.054	0.050	**108**	90-110 %	<0.0001	0.0001
Copper-D	0.052	0.050	**104**	90-110 %	<0.0001	0.0001
Lead-D	0.048	0.050	**96.0**	90-110 %	<0.0001	0.0001
Mercury-T	0.002	0.002	**100**	90-110 %	<0.005	0.005
Selenium-T	0.241	0.250	**96.4**	90-110 %	<0.001	0.001
Vanadium-D	0.053	0.050	**106**	90-110 %	<0.00005	0.00005
Zinc-D	0.051	0.050	**102**	90-110 %	<0.001	0.001

NA=Data not available.

Green Analytical Laboratories

METALS SPIKE AND DUPLICATE DATA

LAB ID#							
805-056	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Aluminum-T	0.00	4.27	**4.00**	**107**	0.60	0.50	**18.2**
Arsenic-T *	0.0000	3.18	**4.00**	**79.5**	0.0016	0.0016	**0.00**
Barium-T	0.0007	1.78	**2.00**	**89.0**	0.046	0.046	**0.00**
Boron-D	0.3	2.1	**2.0**	**90.0**	0.4	0.4	**0.00**
Cadmium-D	0.00000	0.049	**0.050**	**98.0**	<0.00005	<0.00005	**NC**
Chromium-D	0.000	0.049	**0.050**	**98.0**	0.002	0.002	**0.00**
Cobalt-D	0.0000	0.051	**0.050**	**102**	0.0001	0.0001	**0.00**
Copper-D	0.0000	0.048	**0.050**	**96.0**	0.001	0.001	**0.00**
Lead-D	0.0000	0.050	**0.050**	**100**	<0.0001	<0.0001	**NC**
Mercury-T	0.000	0.0023	**0.0020**	**115**	<0.0002	<0.0002	**NC**
Selenium-T	0.001	2.98	**3.00**	**99.3**	0.001	0.001	**0.00**
Vanadium-D	0.0000	0.052	**0.050**	**104**	0.0020	0.0020	**0.00**
Zinc-D	0.000	0.046	**0.050**	**92.0**	0.002	0.002	**0.00**

NC=Not calculated due to results less than the detection limit
NA=Data not available.

Green Analytical Laboratories

METALS SRM AND BLANK DATA

LAB ID#						
805-056	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Aluminum-T	5.12	5.00	**102**	90-110 %	<0.10	0.10
Arsenic-T	0.054	0.050	**108**	90-110 %	<0.0005	0.0005
Barium-T	0.052	0.050	**104**	90-110 %	0.0007	0.0005
Boron-D	5.0	5.0	**100**	90-110 %	<0.1	0.1
Cadmium-D	0.055	0.050	**110**	90-110 %	<0.00005	0.00005
Chromium-D	0.054	0.050	**108**	90-110 %	<0.001	0.001
Cobalt-D	0.053	0.050	**106**	90-110 %	<0.0001	0.0001
Copper-D	0.051	0.050	**102**	90-110 %	<0.0001	0.0001
Lead-D	0.055	0.050	**110**	90-110 %	<0.0001	0.0001
Mercury-T *	0.0017	0.0020	**85.0**	90-110 %	<0.005	0.005
Selenium-T	0.260	0.250	**104**	90-110 %	0.001	0.001
Vanadium-D	0.053	0.050	**106**	90-110 %	<0.00005	0.00005
Zinc-D	0.052	0.050	**104**	90-110 %	<0.001	0.001

NA=Data not available.

Green Analytical Laboratories

DISSOLVED METALS SPIKE AND DUPLICATE DATA

LAB ID#							
807-116	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Aluminum	0.00	2.04	**2.00**	**102**	<0.10	<0.10	**NC**
Arsenic	0.0000	0.047	**0.050**	**94.0**	0.0013	0.0013	**0.00**
Barium	0.0000	0.048	**0.050**	**96.0**	0.0198	0.0198	**0.00**
Boron	0.0	2.0	**2.0**	**100**	<0.1	<0.1	**NC**
Cadmium	0.00000	0.048	**0.050**	**96.0**	0.00030	0.00030	**0.00**
Calcium	0.0	5.7	**5.0**	**114**	48.2	48.0	**0.42**
Chromium	0.000	0.048	**0.050**	**96.0**	<0.001	<0.001	**NC**
Copper	0.0000	0.049	**0.050**	**98.0**	0.170	0.170	**0.00**
Iron	0.00	1.16	**1.00**	**116**	0.30	0.29	**3.39**
Lead	0.0000	0.047	**0.050**	**94.0**	0.0013	0.0013	**0.00**
Magnesium	0.0	1.2	**1.0**	**115**	4.6	4.6	**0.00**
Manganese	0.000	1.07	**1.00**	**107**	0.007	0.007	**0.00**
Potassium	0.0	1.0	**1.0**	**100**	6.1	6.1	**0.00**
Selenium	0.000	0.234	**0.250**	**93.6**	0.001	0.001	**0.00**
Silver	0.00000	0.049	**0.050**	**98.0**	<0.00005	<0.00005	**NC**
Sodium	0.0	58.4	**50.0**	**117**	112	111	**0.90**
Zinc	0.000	0.042	**0.050**	**84.0**	0.113	0.108	**4.52**

NC=Not calculated due to results less than the detection limit
NA=Data not available.

Green Analytical Laboratories

DISSOLVED METALS SRM AND BLANK DATA

LAB ID#						
807-116	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Aluminum	5.09	5.00	**102**	90-110 %	<0.10	0.10
Arsenic	0.048	0.050	**96.0**	90-110 %	<0.0005	0.0005
Barium	0.048	0.050	**96.0**	90-110 %	<0.0005	0.0005
Boron	5.2	5.0	**104**	90-110 %	<0.1	0.1
Cadmium	0.050	0.050	**100**	90-110 %	<0.00005	0.00005
Calcium	5.1	5.0	**102**	90-110 %	<0.5	0.5
Chromium	0.050	0.050	**100**	90-110 %	<0.001	0.001
Copper	0.048	0.050	**96.0**	90-110 %	<0.0001	0.0001
Iron	5.46	5.00	**109**	90-110 %	<0.05	0.05
Lead	0.049	0.050	**98.0**	90-110 %	<0.0001	0.0001
Magnesium	5.1	5.0	**102**	90-110 %	<0.5	0.5
Manganese	2.61	2.50	**104**	90-110 %	<0.005	0.005
Potassium	10.4	10.0	**104**	90-110 %	<0.5	0.5
Selenium	0.239	0.250	**95.6**	90-110 %	<0.001	0.001
Silver	0.049	0.050	**98.0**	90-110 %	<0.00005	0.00005
Sodium	8.9	8.1	**110**	90-110 %	<0.5	0.5
Zinc *	0.043	0.050	**86.0**	90-110 %	<0.001	0.001

NA=Data not available.

Green Analytical Laboratories

TOTAL METALS SPIKE AND DUPLICATE DATA

LAB ID#							
807-116	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Iron-T	0.00	4.38	**4.00**	**110**	0.20	0.20	**0.00**
Manganese-T	0.000	2.11	**2.00**	**106**	2.55	2.48	**2.78**
Mercury-T	0.0000	0.0021	**0.0020**	**105**	<0.0002	<0.0002	**NC**

NC=Not calculated due to results less than the detection limit
NA=Data not available.

Green Analytical Laboratories

TOTAL METALS SRM AND BLANK DATA

LAB ID#						
807-116	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Iron-T	5.46	5.00	**109**	90-110 %	<0.05	0.05
Manganese-T	2.61	2.50	**104**	90-110 %	<0.005	0.005
Mercury-T	0.002	0.002	**100**	90-110 %	<0.0002	0.0002

NA=Data not available.

Green Analytical Laboratories

WET CHEM SPIKE AND DUPLICATE DATA

LAB ID#							
807-116	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Alkalinity	0	100	**100**	**100**	212	210	**0.95**
Chloride	0	101	**100**	**101**	<10	<10	**NC**
EC	NMA	NMA	**NMA**	**NMA**	723	721	**0.28**
Fluoride	0.0	1.0	**1.0**	**100**	<0.2	<0.2	**NC**
Nitrate/Nitrite	0.00	0.11	**0.10**	**110**	0.49	0.49	**0.00**
pH	NMA	NMA	**NMA**	**NMA**	7.49	7.47	**0.27**
Phosphorus-T	0.00	0.28	**0.25**	**112**	0.09	0.08	**11.8**
Sulfate	0	50	**50**	**100**	146	138	**5.63**
TDS	NMA	NMA	**NMA**	**NMA**	500	480	**4.08**
TSS	NMA	NMA	**NMA**	**NMA**	NA	NA	**NA**

NMA=Data not applicable to Method.
NA=Data not available.
NC=Not calculated due to results less than the detection limit

Green Analytical Laboratories

WET CHEM SRM AND BLANK DATA

LAB ID#						
807-116	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Alkalinity	362	339	**107**	90-110 %	<10	10
Chloride	25	23	**110**	90-110 %	<10	10
EC	814	829	**98.2**	90-110 %	NMA	NMA
Fluoride	1.0	1.0	**100**	90-110 %	<1.0	1.0
Nitrate/Nitrite	0.50	0.50	**100**	90-110 %	<0.02	0.02
pH	9.09	9.29	**97.8**	90-110 %	NMA	NMA
Phosphorus-T	0.22	0.20	**110**	90-110 %	<0.05	0.05
Sulfate	325	321	**101**	90-110 %	<10	10
TDS	5050	4850	**104**	90-110 %	<10	10
TSS	102	110	**92.7**	90-110 %	<10	10

NMA=Data not applicable to Method.
NA=Data not available.

Green Analytical Laboratories

DISSOLVED METALS SPIKE AND DUPLICATE DATA

LAB ID#							
808-067	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Aluminum	0.00	2.37	**2.00**	**119**	<0.1	<0.1	**NC**
Arsenic	0.0000	0.056	**0.050**	**112**	0.0041	0.0040	**2.47**
Barium	0.0000	0.054	**0.050**	**108**	0.0977	0.0945	**3.33**
Boron	0.0	2.3	**2.00**	**117**	0.1	0.1	**0.00**
Cadmium	0.00000	0.056	**0.050**	**112**	0.00106	0.00100	**5.83**
Calcium	0.0	5.8	**5.0**	**116**	120.0	120.0	**0.00**
Chromium	0.000	0.058	**0.050**	**116**	<0.001	<0.001	**NC**
Cobalt	0.00000	0.056	**0.050**	**112**	0.00079	0.00078	**1.27**
Copper	0.0000	0.056	**0.050**	**112**	0.0068	0.0063	**7.63**
Iron	0.00	1.17	**1.00**	**117**	0.09	0.09	**0.00**
Lead	0.0000	0.054	**0.050**	**108**	0.0015	0.0015	**0.00**
Magnesium	0.0	1.2	**1.00**	**120**	14.8	14.7	**0.68**
Manganese *	0.000	1.23	**1.00**	**123**	0.009	0.009	**0.00**
Potassium	0.0	1.1	**1.00**	**110**	10.8	10.8	**0.00**
Selenium	0.000	0.286	**0.250**	**114**	0.001	0.001	**0.00**
Silver	0.00000	0.059	**0.050**	**118**	<0.00005	<0.00005	**NC**
Sodium	0.0	59.7	**50.0**	**119**	55.1	54.9	**0.36**
Vanadium	0.0000	0.055	**0.050**	**110**	0.0037	0.0037	**0.00**
Zinc	0.000	0.056	**0.050**	**112**	0.009	0.009	**0.00**

NC=Not calculated due to results less than the detection limit
NA=Data not available.

Green Analytical Laboratories

DISSOLVED METALS SRM AND BLANK DATA

LAB ID#						
808-067	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Aluminum	5.19	5.00	**104**	90-110 %	<0.10	0.10
Arsenic	0.047	0.050	**94.0**	90-110 %	<0.0005	0.0005
Barium	0.049	0.050	**98.0**	90-110 %	<0.0005	0.0005
Boron	5.2	5.0	**104**	90-110 %	<0.1	0.1
Cadmium	0.048	0.050	**96.0**	90-110 %	<0.00005	0.00005
Calcium	5.1	5.0	**102**	90-110 %	<0.5	0.5
Chromium	0.050	0.050	**100**	90-110 %	<0.001	0.001
Cobalt	0.049	0.050	**98.0**	90-110 %	<0.00005	0.00005
Copper	0.048	0.050	**96.0**	90-110 %	<0.0001	0.0001
Iron	5.37	5.00	**107**	90-110 %	<0.05	0.05
Lead	0.049	0.050	**98.0**	90-110 %	<0.0001	0.0001
Magnesium	5.0	5.0	**100**	90-110 %	<0.5	0.5
Manganese	2.68	2.50	**107**	90-110 %	<0.005	0.005
Potassium	10.3	10.0	**103**	90-110 %	<0.5	0.5
Selenium	0.239	0.250	**95.6**	90-110 %	<0.001	0.001
Silver	0.051	0.050	**102**	90-110 %	<0.00005	0.00005
Sodium	8.7	8.1	**107**	90-110 %	<0.5	0.5
Vanadium	0.048	0.050	**96.0**	90-110 %	<0.0005	0.0005
Zinc	0.047	0.050	**94.0**	90-110 %	<0.001	0.001

NA=Data not available.

Green Analytical Laboratories

TOTAL METALS SPIKE AND DUPLICATE DATA

LAB ID#							
808-067	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Aluminum-T	0.00	4.34	**4.00**	**109**	3.99	3.63	**9.45**
Arsenic-T	0.00	0.05	**0.05**	**106**	0.002	0.002	**0.00**
Barium-T	0.00	0.05	**0.05**	**98.0**	130	127	**2.33**
Boron-T	0.00	4.40	**4.00**	**110**	0.20	0.20	**0.00**
Iron-T	0.00	3.94	**4.00**	**98.5**	7.07	7.00	**1.00**
Manganese-T	0.000	2.05	**2.00**	**103**	4.35	4.30	**1.16**
Mercury-T	0.0000	0.0020	**0.0020**	**100**	<0.0002	<0.0002	**NC**
Selenium-T	0.000	0.255	**0.250**	**102**	<0.001	<0.001	**NC**

NC=Not calculated due to results less than the detection limit
NA=Data not available.

Green Analytical Laboratories

TOTAL METALS SRM AND BLANK DATA

LAB ID#						
808-067	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Aluminum-T	5.17	5.00	**103**	90-110 %	<0.05	0.05
Arsenic-T	0.050	0.050	**100**	90-110 %	<0.05	0.05
Barium-T	0.051	0.050	**102**	90-110 %	<0.05	0.05
Boron-T	5.30	5.00	**106**	90-110 %	<0.05	0.05
Iron-T	5.08	5.00	**102**	90-110 %	<0.05	0.05
Manganese-T	2.65	2.50	**106**	90-110 %	<0.005	0.005
Mercury-T	0.002	0.002	**100**	90-110 %	<0.0002	0.0002
Selenium-t	0.245	0.250	**98.0**	90-110 %	<0.005	0.005

NA=Data not available.

Green Analytical Laboratories

WET CHEM SPIKE AND DUPLICATE DATA

LAB ID#							
808-067	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Alkalinity	0	106	**100**	**106**	182	180	**1.10**
Chloride	0	105	**100**	**105**	29	27	**7.14**
EC	NMA	NMA	**NMA**	**NMA**	NA	NA	**NA**
Fluoride	0.0	0.9	**1.0**	**90.0**	<0.2	<0.2	**NC**
Nitrate/Nitrite	0.00	0.11	**0.10**	**110**	0.49	0.49	**0.00**
pH	NMA	NMA	**NMA**	**NMA**	6.85	6.83	**0.29**
Phosphorus-T	0.00	0.24	**0.25**	**96.0**	0.21	0.20	**4.88**
Sulfate	0	55	**50**	**110**	840	820	**2.41**
TDS	NMA	NMA	**NMA**	**NMA**	240	225	**6.45**
TSS	NMA	NMA	**NMA**	**NMA**	1250000	1200000	**4.08**

NMA=Data not applicable to Method.
NA=Data not available.
NC=Not calculated due to results less than the detection limit

Green Analytical Laboratories

WET CHEM SRM AND BLANK DATA

LAB ID#						
808-067	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Alkalinity	360	339	**106**	90-110 %	<10	10
Chloride	23	23	**101**	90-110 %	<10	10
EC *	NA	NA	**NA**	90-110 %	NMA	NMA
Fluoride	1.0	1.0	**100**	90-110 %	<1.0	1.0
Nitrate/Nitrite	0.48	0.50	**96.0**	90-110 %	<0.02	0.02
pH	9.03	8.90	**101**	90-110 %	NMA	NMA
Phosphorus-T	4.75	5.32	**89.3**	90-110 %	<0.05	0.05
Sulfate	350	321	**109**	90-110 %	<10	10
TDS	5040	4850	**104**	90-110 %	<10	10
TSS	102	110	**92.7**	90-110 %	<10	10

NMA=Data not applicable to Method.
NA=Data not available.

Green Analytical Laboratories

DISSOLVED METALS SPIKE AND DUPLICATE DATA

LAB ID#							
904-012	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Aluminum	0.00	2.00	**2.0000**	**100**	<0.10	<0.10	**NC**
Arsenic	0.0000	0.0490	**0.0500**	**98.0**	0.0018	0.0017	**5.71**
Barium	0.0000	0.0500	**0.0500**	**100**	0.1011	0.0973	**3.83**
Boron	0.0	2.1	**2.00**	**105**	0.2	0.2	**0.00**
Cadmium	0.00000	0.05200	**0.05200**	**100**	<0.00005	<0.00005	**NC**
Calcium	0.0	24.8	**25.00**	**99.2**	6.5	6.1	**6.35**
Chromium	0.000	0.047	**0.050**	**94.0**	0.011	0.011	**0.00**
Cobalt	0.00000	0.04800	**0.05000**	**96.0**	0.00024	0.00023	**4.26**
Copper	0.0000	0.0450	**0.0500**	**90.0**	0.4630	0.4490	**3.07**
Iron	0.00	5.00	**5.00**	**100**			**NC**
Lead	0.0000	0.0480	**0.0500**	**96.0**	0.0003	0.0003	**0.00**
Magnesium	0.0	4.9	**5.00**	**98.0**	1.1	1.1	**0.00**
Manganese	0.00000	1.10000	**1.00000**	**110**	0.03400	0.03400	**0.00**
Potassium	0.0	4.9	**5.00**	**98.0**	4.5	4.3	**4.55**
Selenium	0.000	0.241	**0.250**	**96.4**	0.017	0.016	**6.06**
Silver	0.00000	0.04900	**0.05000**	**98.0**			**NC**
Sodium	0.0	249.0	**250.00**	**99.6**	603.0	567.0	**6.15**
Vanadium	0.00000	0.04600	**0.05000**	**92.0**	0.00310	0.00290	**6.67**
Zinc	0.000	0.047	**0.050**	**94.0**	0.009	0.009	**0.00**

NC=Not calculated due to results less than the detection limit
NA=Data not available.

Green Analytical Laboratories

DISSOLVED METALS SRM AND BLANK DATA

LAB ID#						
904-012	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Aluminum	5.20	5.00	**104**	90-110 %	<0.10	0.10
Arsenic	0.0500	0.0500	**100**	90-110 %	<0.0005	0.0005
Barium	0.0540	0.0500	**108**	90-110 %	<0.0005	0.0005
Boron	5.2	5.0	**104**	90-110 %	<0.1	0.1
Cadmium	0.05200	0.05000	**104**	90-110 %	<0.00005	0.00005
Calcium	5.1	5.0	**102**	90-110 %	<0.5	0.5
Chromium	0.049	0.050	**98.0**	90-110 %	<0.001	0.001
Cobalt	0.05000	0.05000	**100**	90-110 %	<0.00005	0.00005
Copper	0.0480	0.0500	**96.0**	90-110 %	<0.0001	0.0001
Iron	5.30	5	**106**	90-110 %	<0.05	0.05
Lead	0.0520	0.0500	**104**	90-110 %	<0.0001	0.0001
Magnesium	4.9	5.0	**98.0**	90-110 %	<0.5	0.5
Manganese	2.700	2.500	**108**	90-110 %	<0.005	0.005
Potassium	10.1	10.0	**101**	90-110 %	<0.5	0.5
Selenium	0.256	.25	**102**	90-110 %	<0.001	0.001
Silver	0.04700	0.05000	**94.0**	90-110 %	<0.00005	0.00005
Sodium	8.3	8.1	**102**	90-110 %	<0.5	0.5
Vanadium	0.049	0.050	**98.0**	90-110 %	<0.005	0.005
Zinc	0.051	0.050	**102**	90-110 %	<0.001	0.001

NA=Data not available.

Green Analytical Laboratories

TOTAL METALS SPIKE AND DUPLICATE DATA

LAB ID#							
904-012	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Aluminum-T	0.00	3.72	**4.00**	**93.0**	0.28	0.26	**7.41**
Arsenic-T	0.000	0.047	**0.050**	**94.0**	0.003	0.003	**6.90**
Barium-T	0.000	0.051	**0.050**	**102**	0.272	0.252	**7.63**
Iron-T	0.05	3.60	**4.00**	**88.8**	1.91	1.90	**0.52**
Manganesse-T	0.00	1.90	**2.00**	**95.0**	0.29	0.24	**18.9**
Mercury-T	0.000	0.002	**0.002**	**100**	<0.0002	<0.0002	**NC**
Selenium-T	0.000	8.310	**8.00**	**104**	<0.001	<0.001	**NC**

NC=Not calculated due to results less than the detection limit
NA=Data not available.

Green Analytical Laboratories

TOTAL METALS SRM AND BLANK DATA

LAB ID#						
904-012	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Aluminum-T	5.16	5.00	**103**	90-110 %	<0.005	0.005
Arsenic-T	0.055	0.050	**110**	90-110 %	<0.005	0.005
Barium-T	0.055	0.050	**110**	90-110 %	<0.005	0.005
Iron-T	5.03	5.00	**101**	90-110 %	0.05	0.05
Manganese-T	2.670	2.500	**107**	90-110 %	<0.005	0.005
Mercury-T	0.0021	0.0020	**105**	90-110 %	<0.005	0.005
Selenium-T	7.30	6.70	**109**	90-110 %	<0.0002	0.0002

NA=Data not available.

Green Analytical Laboratories

WET CHEM SPIKE AND DUPLICATE DATA

LAB ID#							
904-012	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Alkalinity	0	105	**100**	**105**	308	306	**0.65**
Chloride	0	100	**100**	**100**	18	18	**0.00**
EC	NMA	NMA	**NMA**	**NMA**	798	798	**0.00**
Fluoride	0.3	1.3	**1.0**	**100**	1.6	1.6	**0.00**
Nitrate/Nitrite	0.00	0.11	**0.10**	**110**	0.17	0.17	**0.00**
pH	NMA	NMA	**NMA**	**NMA**	8.26	8.23	**0.36**
Phosphorus-T	0.00	0.24	**0.25**	**96.0**	0.11	0.10	**9.52**
Sulfate	0	52.00	**50.00**	**104**	6900	6900	**0.00**
TDS	NMA	NMA	**NMA**	**NMA**	1790	1760	**1.69**
TSS	NMA	NMA	**NMA**	**NMA**	11.0	9.7	**12.6**

NMA=Data not applicable to Method.

Green Analytical Laboratories

WET CHEM SRM AND BLANK DATA

LAB ID#						
904-012	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Alkalinity	139	146	**95.2**	90-110 %	<10	10
Chloride	76	76	**100**	90-110 %	<10	10
EC	1515	1470	**103**	90-110 %	NMA	NMA
Fluoride	1.0	1.0	**100**	90-110 %	<1.0	1.0
Nitrate/Nitrite	0.50	0.50	**100**	90-110 %	<0.02	0.02
pH	8.99	9.19	**97.8**	90-110 %	NMA	NMA
Phosphorus-T	0.20	0.20	**100**	90-110 %	<0.05	0.05
Sulfate	335	321	**104**	90-110 %	<10	10
TDS	3795	3770	**101**	90-110 %	<10	10
TSS	123	133	**92.5**	90-110 %	<10	10

NMA=Data not applicable to Method.

Appendix 18-E

Monitoring Well and Vibrating Wire Piezometer Completion Diagrams

KIORWEST
Applied Hydrology

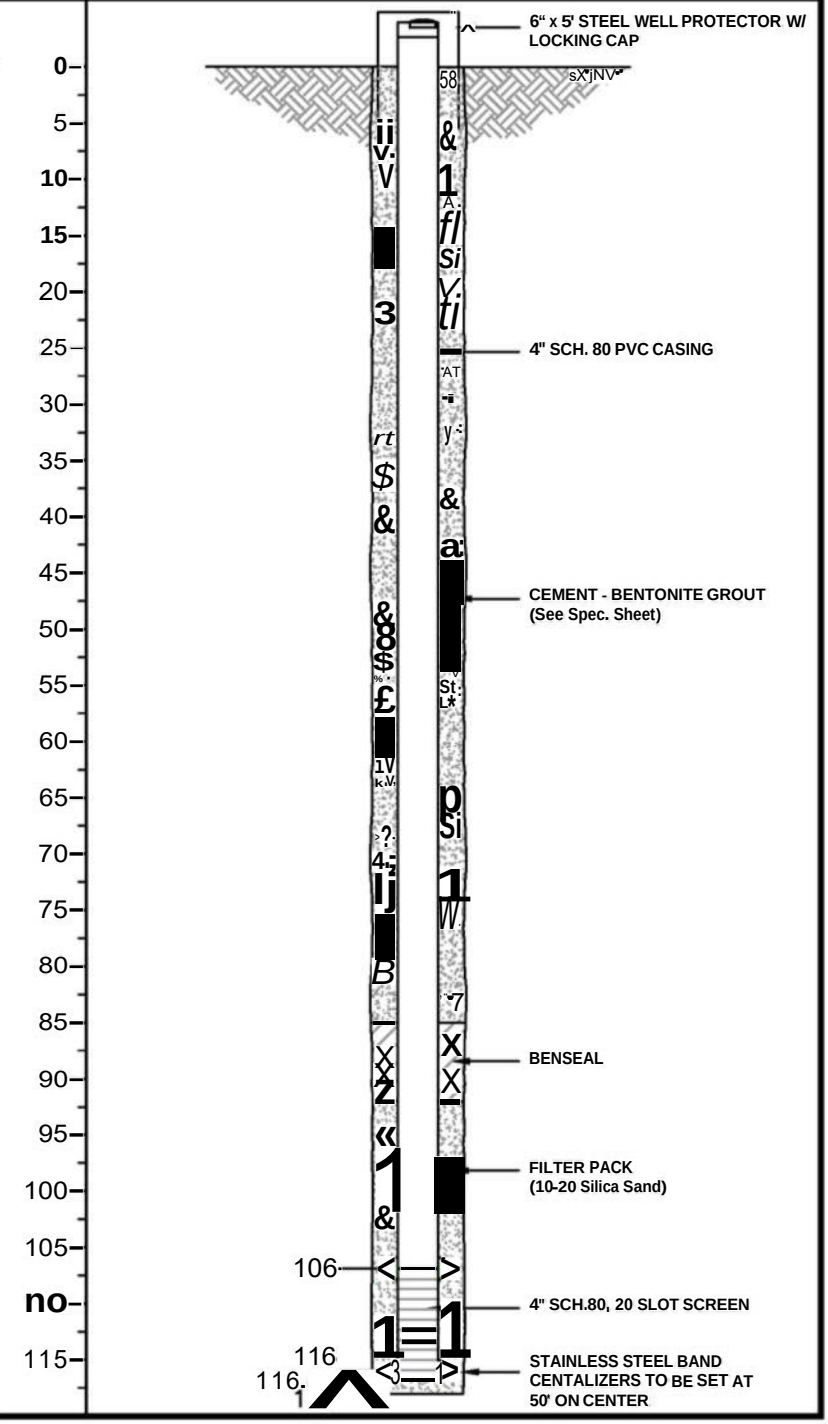
KF2007-01
COMPLETION DIAGRAM & UTHOLOGIC LOG

PROJECT: NAVAJO MINE EXTENSION
DRILLING CO: MQ-TE
DRILLER: JOB
CLIENT SUPERVISED COLLETTE BROWN
GEOLOGIST/SUPERVISOR: JOEL SOBOL
AHA JOB#: 4Q1Q-QQQ60-1Q
DRILLING METHOD: AIR ROTARY
BORING STARTED: 7/28/07

WELL TYPE: MONITOR WELL
WELLHEAD TYPE: PROTECTIVE HEAD COVER
WELL COMPUTED: 7/28/07
WELL DEVELOPED: 7/28/07
DATE SURVEYED: 8/29/07
SCREEN SLOT SIZE: Q.Q2" MILL SLOT
SCREEN TYPE: 4" SCH 80 PVC
FILTER PACK: 10-20 SILICA SAND

CASING DIAMETER:
CASING MATERIAL SCH 80 PVC
BORING DIAMETER: 8-3/4"
TOP OF CASING ELEV. (Ff): 5459.96
GROUND ELEVATION (n): 5457.22
LOCATION: AREA 4 SOUTH
NORTHING frft 1984390.9290
EASTING (in): 307986.0078

LITHOLOGY LOG



NORWEST
Applied Hydrology

KF98-02

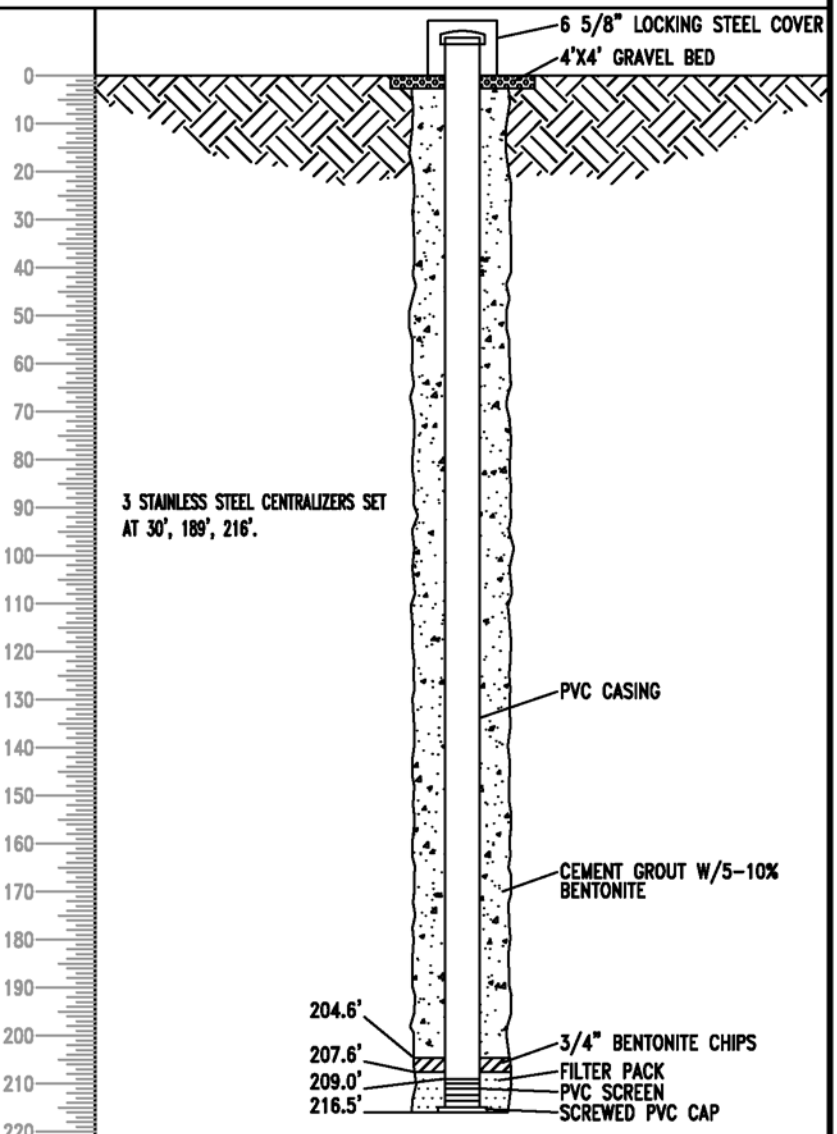
COMPLETION DIAGRAM & LITHOLOGIC LOG

PROJECT: NO NAME
DRILLING CO: SHARPE DRILLING
DRILLER: RUSS SHARPE
CLIENT SUPERVISER: RON VANVALKENBURG
GEOLOGIST/SUPERVISOR: IAN PEARSON
AHA JOB#: 43-4B
DRILLING METHOD: AIR ROTARY
BORING STARTED: 3/22/98

WELL TYPE: MONITORING
WELLHEAD TYPE: STICKUP (1.5')
WELL COMPLETED: 3/23/98
WELL DEVELOPED: 3/28/98
DATE SURVEYED:
SCREEN SLOT SIZE: 0.02" MILL SLOT
SCREEN TYPE: SCH 80 PVC
FILTER PACK: 30-60 SAND

CASING DIAMETER: 4"
CASING MATERIAL: SCH 80 PVC
BORING DIAMETER: 7 7/8"
TOP OF CASING ELEV. (FT): 5507.04
GROUND ELEVATION (FT): 5505.89
LOCATION: AREA 4 SOUTH
NORTHING (FT): 1,974,600.26
EASTING (FT): 303,887.43

LITHOLOGY LOG



* ELEVATION OF WELL CASING IS ESTIMATED. WELL WAS COMPLETED IN 216.5' BORING APPROX. 8' NE OF 272' PILOT TEST HOLE. LITHOLOGY LOG FROM TEST HOLE.

NORWEST
Applied Hydrology

KF98-03

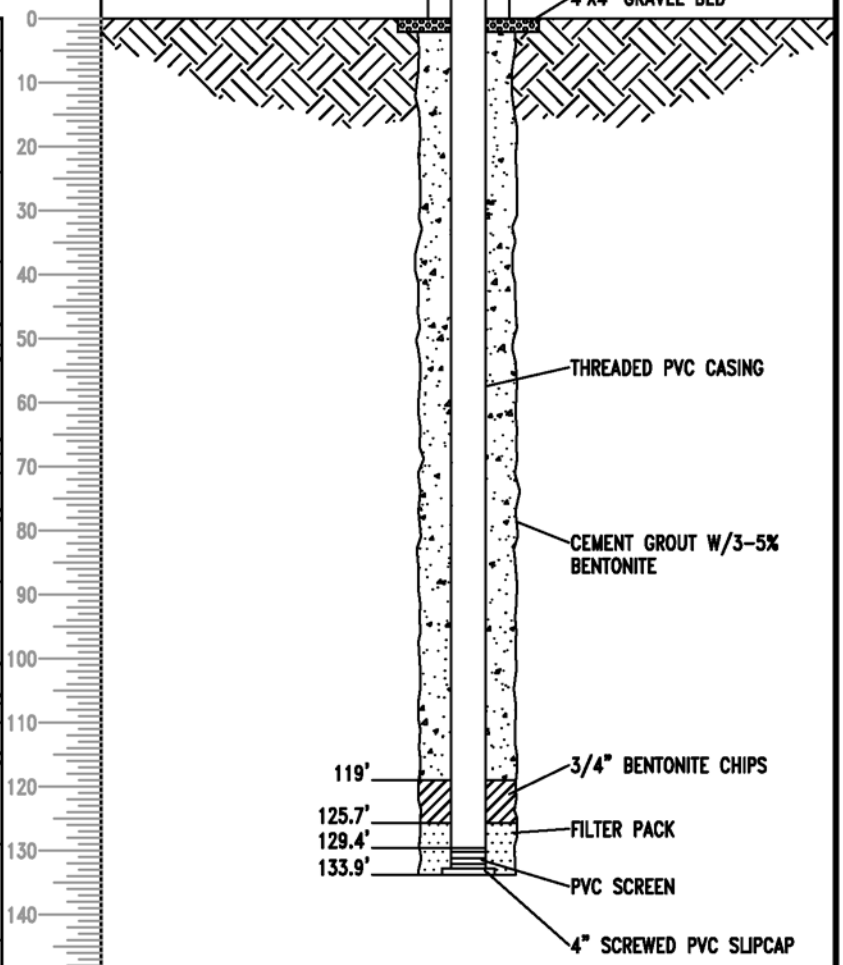
COMPLETION DIAGRAM & LITHOLOGIC LOG

PROJECT: NO NAME
DRILLING CO: SHARPE DRILLING
DRILLER: RUSS SHARPE
CLIENT SUPERVISER: RON VANVALKENBURG
GEOLOGIST/SUPERVISOR: IAN PEARSON
AHA JOB#: 43-4B
DRILLING METHOD: AIR ROTARY
BORING STARTED: 3/25/98

WELL TYPE: MONITORING
WELLHEAD TYPE: STICKUP (2.3')
WELL COMPLETED: 3/27/98
WELL DEVELOPED: 3/28/98
DATE SURVEYED:
SCREEN SLOT SIZE: 0.02" MILL SLOT
SCREEN TYPE: SCH 80 PVC
FILTER PACK: 10-20 SILICA SAND

CASING DIAMETER: 4"
CASING MATERIAL: SCH 80 PVC
BORING DIAMETER: 7 7/8"
TOP OF CASING ELEV. (FT): 5425.53
GROUND ELEVATION (FT): 5423.45
LOCATION: AREA 4 SOUTH
NORTHING (FT): 1,984,271.05
EASTING (FT): 304,599.17

LITHOLOGY LOG



TOP OF CASING ELEVATION IS ESTIMATED. WELL WAS COMPLETED IN 134'. BORING IS APPROXIMATELY 10' NORTH OF 202' PILOT TEST HOLE. LITHOLOGY LOG FROM TEST HOLE. TEMP SURFACE CASING (21', PILOT) (24', WELL BORING) SET TO ISOLATE WATER BEARING ALLUVIUM

NORWEST
Applied Hydrology

KF98-04

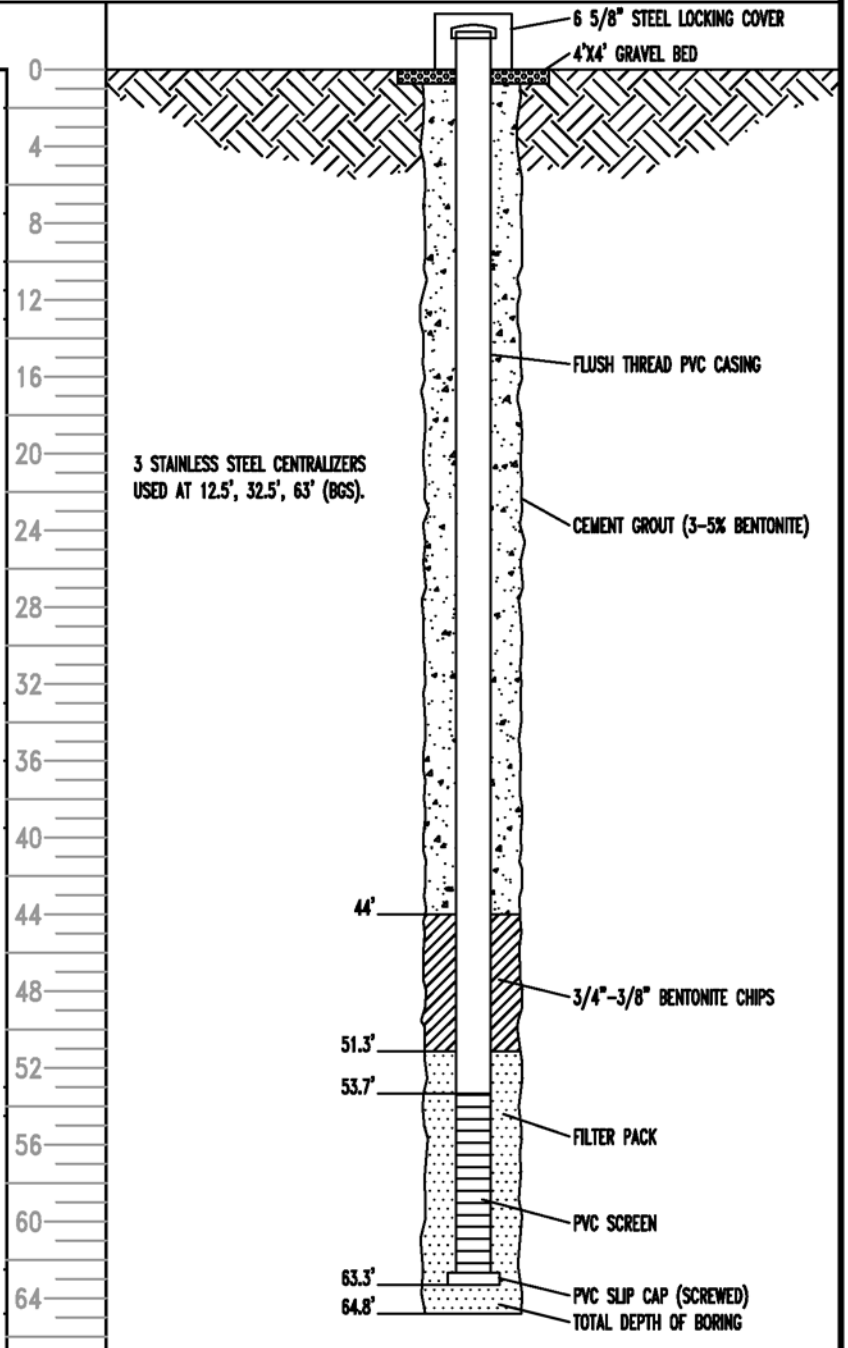
COMPLETION DIAGRAM & LITHOLOGIC LOG

PROJECT: NO NAME
DRILLING CO: SHARPE DRILLING
DRILLER: RUSS SHARPE
CLIENT SUPERVISER: RON VANVALKENBURG
GEOLOGIST/SUPERVISOR: IAN PEARSON
AHA JOB#: 43-4B
DRILLING METHOD: AIR ROTARY
BORING STARTED: 3/27/98

WELL TYPE: MONITORING
WELLHEAD TYPE: STICKUP (1.7')
WELL COMPLETED: 3/28/98
WELL DEVELOPED: 3/28/98
DATE SURVEYED:
SCREEN SLOT SIZE: 0.02" MILL SLOT
SCREEN TYPE: SCH 80 PVC
FILTER PACK: 10-20 SILICA SAND

CASING DIAMETER: 4"
CASING MATERIAL: SCH 80 PVC
BORING DIAMETER: 7 7/8"
TOP OF CASING ELEV. (FT): 5353.38
GROUND ELEVATION (FT): 5351.81
LOCATION: AREA 4 SOUTH
NORTHING (FT): 1,990,163.70
EASTING (FT): 300,368.91

LITHOLOGY LOG



* WELL COORDINATE AND TOC ELEVATION ARE ESTIMATED.

NORWEST
Applied Hydrology

KPC-98-01

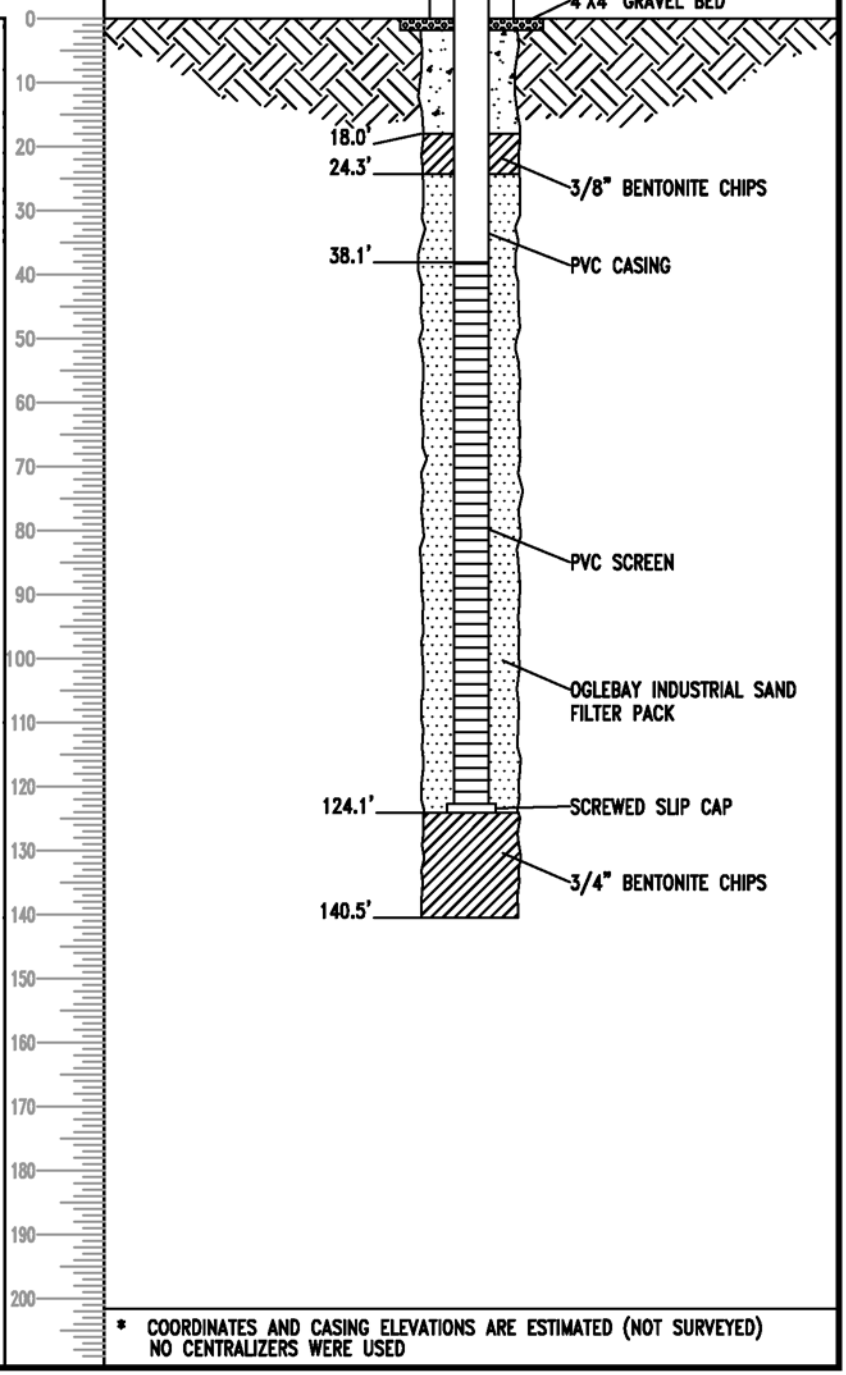
COMPLETION DIAGRAM & LITHOLOGIC LOG

PROJECT: NO NAME
DRILLING CO: SHARPE DRILLING
DRILLER: RUSS SHARPE
CLIENT SUPERVISER: RON VALVALKENBURG
GEOLOGIST/SUPERVISOR: IAN PEARSON
AHA JOB#: 43-4B
DRILLING METHOD: AIR ROTARY
BORING STARTED: 3/20/98

WELL TYPE: MONITORING
WELLHEAD TYPE: STICKUP (1.6')
WELL COMPLETED: 3/21/98
WELL DEVELOPED: 3/28/98
DATE SURVEYED:
SCREEN SLOT SIZE: 0.02" MILL SLOT
SCREEN TYPE: SCH 80 PVC
FILTER PACK: 30-60 SAND

CASING DIAMETER: 4"
CASING MATERIAL: SCH 80 PVC
BORING DIAMETER: 7 7/8"
TOP OF CASING ELEV. (FT): 5366.46
GROUND ELEVATION (FT): 5365.20
LOCATION: AREA 4 SOUTH
NORTHING (FT): 1,993,801.95
EASTING (FT): 290,787.30

LITHOLOGY LOG



* COORDINATES AND CASING ELEVATIONS ARE ESTIMATED (NOT SURVEYED)
NO CENTRALIZERS WERE USED

NORWEST
Applied Hydrology

KPC2007-01

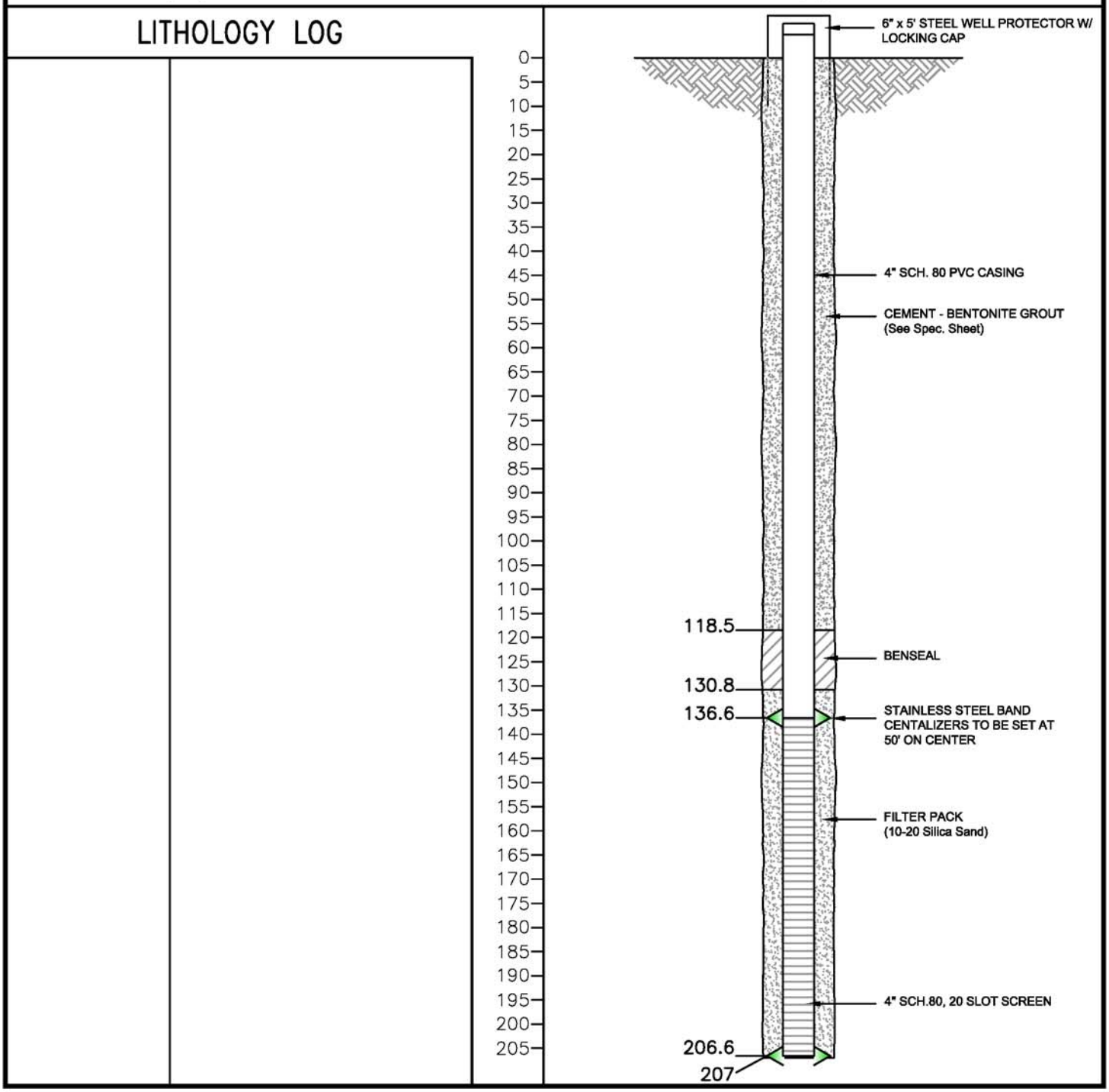
COMPLETION DIAGRAM & LITHOLOGIC LOG

PROJECT: NAVAJO MINE EXTENSION
DRILLING CO: MO-TE
DRILLER: BOB
CLIENT SUPERVISER: COLLETTE BROWN
GEOLOGIST/SUPERVISOR: JOEL SOBOL
AHA JOB#: 4010-00060-10
DRILLING METHOD: AIR ROTARY
BORING STARTED: 7/29/07

WELL TYPE: MONITORING WELL
WELLHEAD TYPE: PROTECTIVE HEAD COVER
WELL COMPLETED: 7/29/07
WELL DEVELOPED: 7/29/07
DATE SURVEYED: 8/29/07
SCREEN SLOT SIZE: 0.02"
SCREEN TYPE: 4" SCH 80 PVC MILL SLOT
FILTER PACK: 10-20 SILICA SAND

CASING DIAMETER: 4"
CASING MATERIAL: 4" SCH 80 PVC
BORING DIAMETER: 8-3/4"
TOP OF CASING ELEV. (FT): 5355.71'
GROUND ELEVATION (FT): 5352.97
LOCATION: AREA 4 SOUTH
NORTHING (FT): 1995102.5555
EASTING (FT): 302595.6035

LITHOLOGY LOG



NORWEST
Applied Hydrology

KPC2007-02

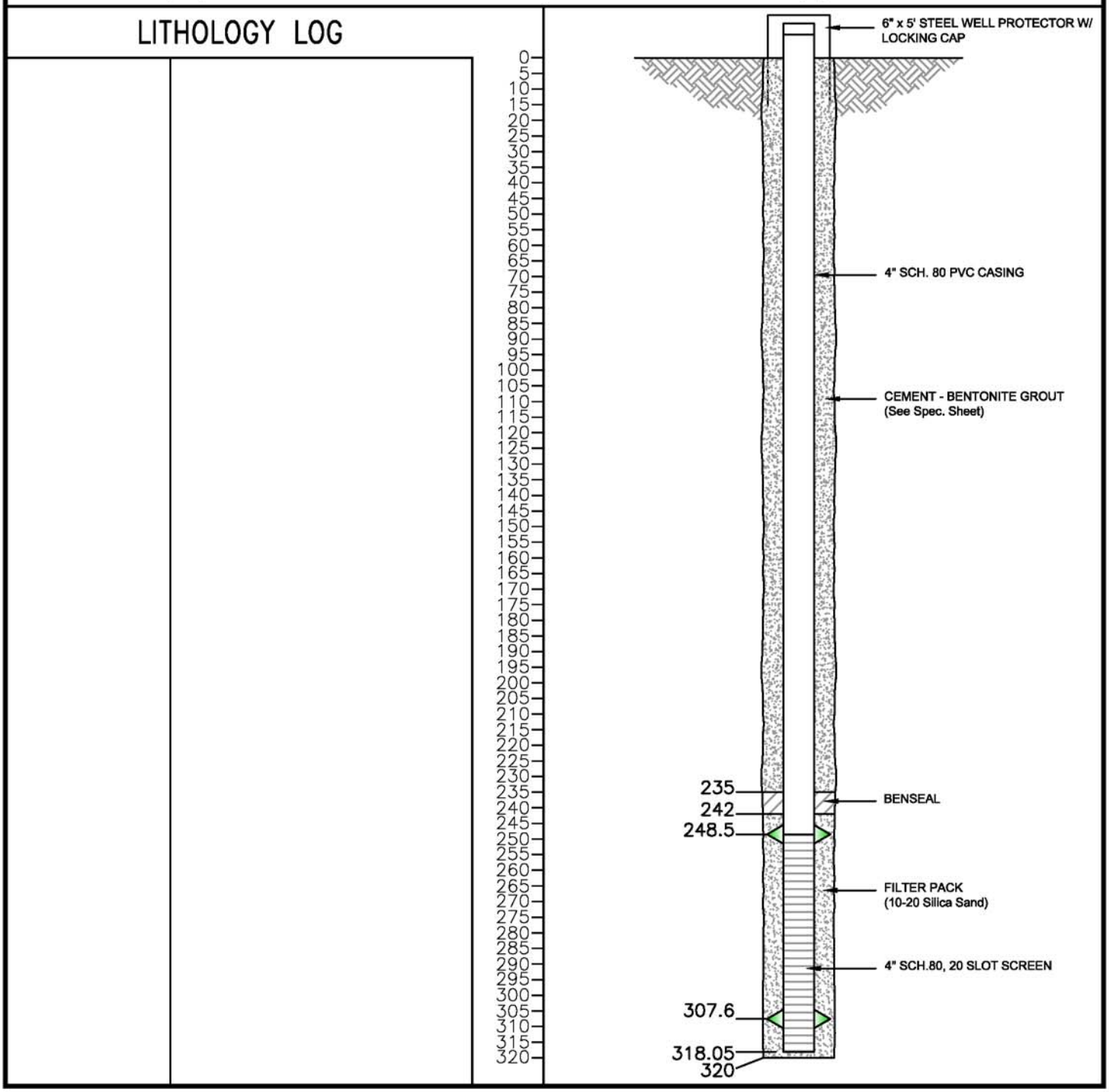
COMPLETION DIAGRAM & LITHOLOGIC LOG

PROJECT: NAVAJO MINE EXTENSION
DRILLING CO: MO-TE
DRILLER: BOB
CLIENT SUPERVISER: COLLETTE BROWN
GEOLOGIST/SUPERVISOR: JOEL SOBOL
AHA JOB#: 4010-00060-10
DRILLING METHOD: AIR ROTARY
BORING STARTED: 7/26/07

WELL TYPE: MONITORING WELL
WELLHEAD TYPE: PROTECTIVE HEAD COVER
WELL COMPLETED: 7/28/07
WELL DEVELOPED: 7/28/07
DATE SURVEYED: 8/29/07
SCREEN SLOT SIZE: 0.02"
SCREEN TYPE: 4" SCH 80 PVC MILL SLOT
FILTER PACK: 10-20 SILICA SAND

CASING DIAMETER: 4"
CASING MATERIAL: 4" SCH 80 PVC
BORING DIAMETER: 8-3/4"
TOP OF CASING ELEV. (FT): 5515.06
GROUND ELEVATION (FT): 5512.18
LOCATION: AREA 4 SOUTH
NORTHING (FT): 1975118.7726
EASTING (FT): 303891.1349

LITHOLOGY LOG



NORWEST
Applied Hydrology

KPC2007-03

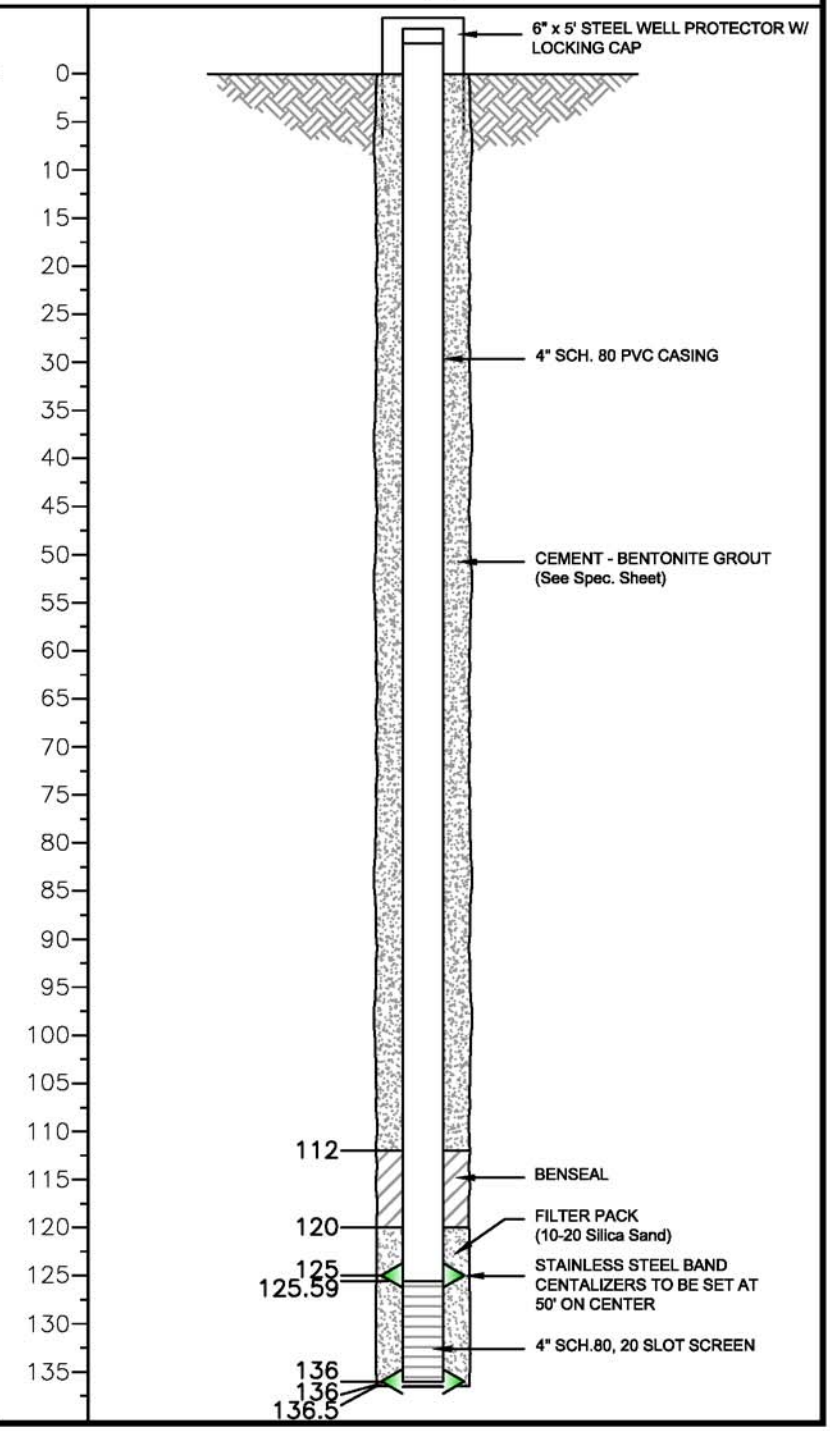
COMPLETION DIAGRAM & LITHOLOGIC LOG

PROJECT: NAVAJO MINE EXTENSION
DRILLING CO: MO-TE
DRILLER: BOB
CLIENT SUPERVISER: COLLETTE BROWN
GEOLOGIST/SUPERVISOR: JOEL SOBOL
AHA JOB#: 4010-00060-10
DRILLING METHOD: AIR ROTARY
BORING STARTED: 7/24/07

WELL TYPE: MONITORING WELL
WELLHEAD TYPE: PROTECTIVE HEAD COVER
WELL COMPLETED: 8/2/07
WELL DEVELOPED: 8/2/07
DATE SURVEYED: 8/29/07
SCREEN SLOT SIZE: 0.02"
SCREEN TYPE: 4" SCH 80 PVC MILL SLOT
FILTER PACK: 10-20 SILICA SAND

CASING DIAMETER: 4"
CASING MATERIAL: 4" SCH 80 PVC
BORING DIAMETER: 8-3/4"
TOP OF CASING ELEV. (FT): 5470.23
GROUND ELEVATION (FT): 5467.83
LOCATION: AREA 4 SOUTH
NORTHING (FT): 1982884.7045
EASTING (FT): 295091.1864

LITHOLOGY LOG



NORWEST
Applied Hydrology

NNA-1

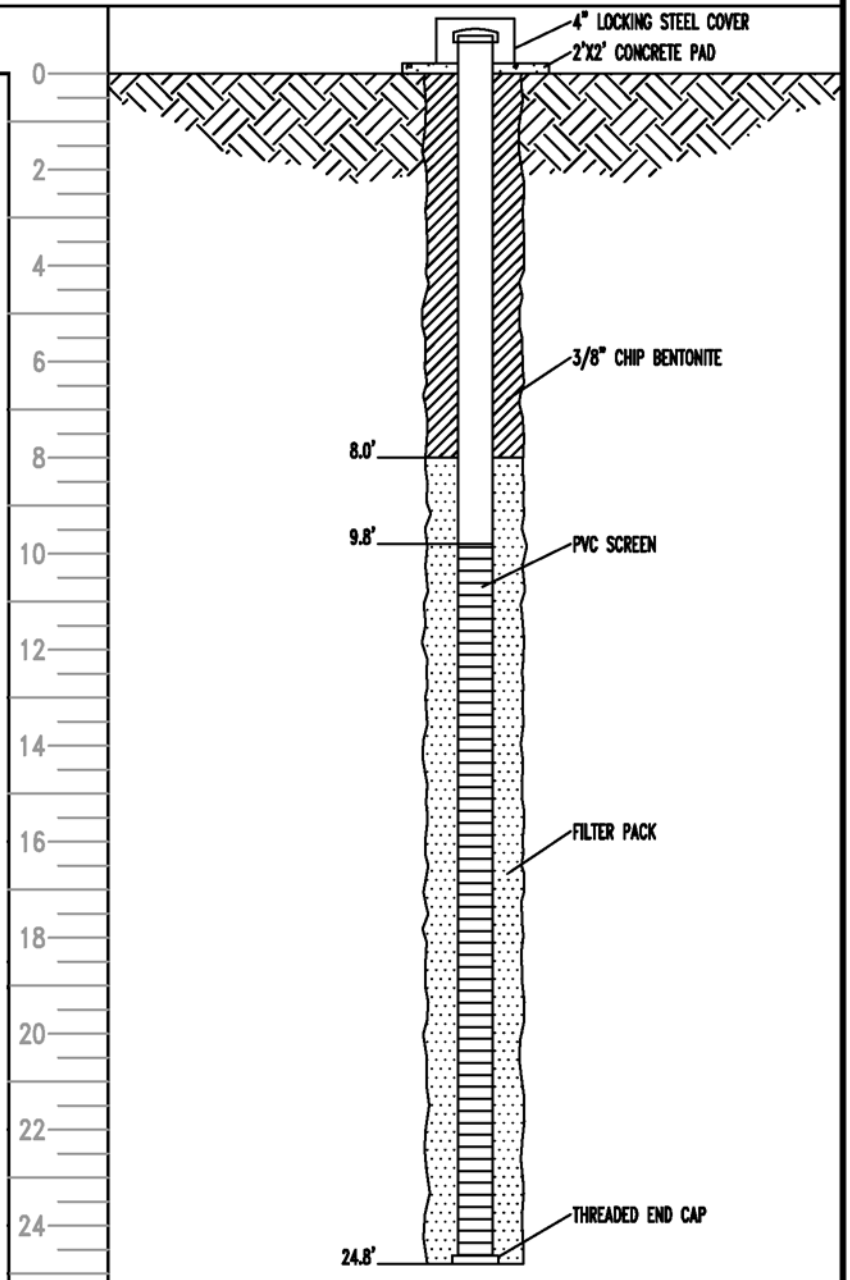
COMPLETION DIAGRAM & LITHOLOGIC LOG

PROJECT: NO NAME
DRILLING CO: PHILIP SERVICES CORP
DRILLER: KELLY PADILLA
CLIENT SUPERVISER: RON VANVALKENBURG
GEOLOGIST/SUPERVISOR: IAN PEARSON
AHA JOB#: 43-4B
DRILLING METHOD: HOLLOW STEM AUGER
BORING STARTED: 3/25/98

WELL TYPE: MONITORING
WELLHEAD TYPE: STICKUP (1.6')
WELL COMPLETED: 3/25/98
WELL DEVELOPED: WELL DRY
DATE SURVEYED:
SCREEN SLOT SIZE: 0.02" MILL SLOT
SCREEN TYPE: SCH 40 PVC
FILTER PACK: 10-20 SILICA SAND

CASING DIAMETER: 2"
CASING MATERIAL: SCH 40 PVC
BORING DIAMETER: 7 1/2"
TOP OF CASING ELEV. (FT): 5431.63
GROUND ELEVATION (FT): 5430.46
LOCATION: AREA 4 SOUTH
NORTHING (FT): 1,976,857.28
EASTING (FT): 296,773.43

LITHOLOGY LOG



* SURVEY COORDINATES AND ELEVATION ARE ESTIMATED. WELL WAS DRY AT COMPLETION AND AS OF 3/30/98

NORWEST
Applied Hydrology

NNA-2

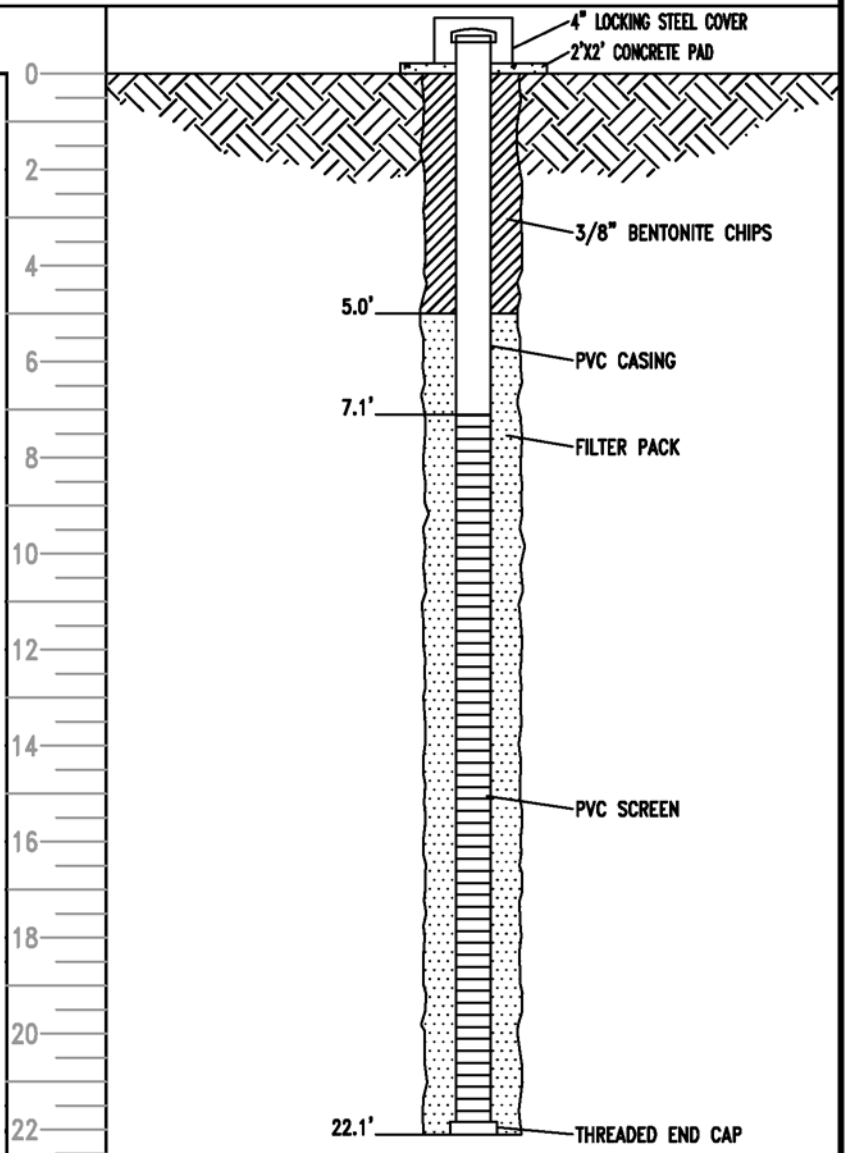
COMPLETION DIAGRAM & LITHOLOGIC LOG

PROJECT: NO NAME
DRILLING CO: PHILIP SERVICES CORP
DRILLER: KELLY PADILLA
CLIENT SUPERVISER: RON VANVALKENBURG
GEOLOGIST/SUPERVISOR: IAN PEARSON
AHA JOB#: 43-4B
DRILLING METHOD: HOLLOW STEM AUGER
BORING STARTED: 3/25/98

WELL TYPE: MONITORING
WELLHEAD TYPE: STICKUP (1.5')
WELL COMPLETED: 3/25/98
WELL DEVELOPED: WELL DRY
DATE SURVEYED:
SCREEN SLOT SIZE: 0.02" MILL SLOT
SCREEN TYPE: SCH 40 PVC
FILTER PACK: 10-20 SILICA SAND

CASING DIAMETER: 2"
CASING MATERIAL: SCH 40 PVC
BORING DIAMETER: 7 1/2"
TOP OF CASING ELEV. (FT): 5455.97
GROUND ELEVATION (FT): 5454.68
LOCATION: AREA 4 SOUTH
NORTHING (FT): 1,975,404.71
EASTING (FT): 299,547.33

LITHOLOGY LOG



* SURVEY COORDINATES AND ELEVATION ARE ESTIMATED. WELL WAS DRY AT COMPLETION AND AS OF 3/30/98

NORWEST
Applied Hydrology

PA-1

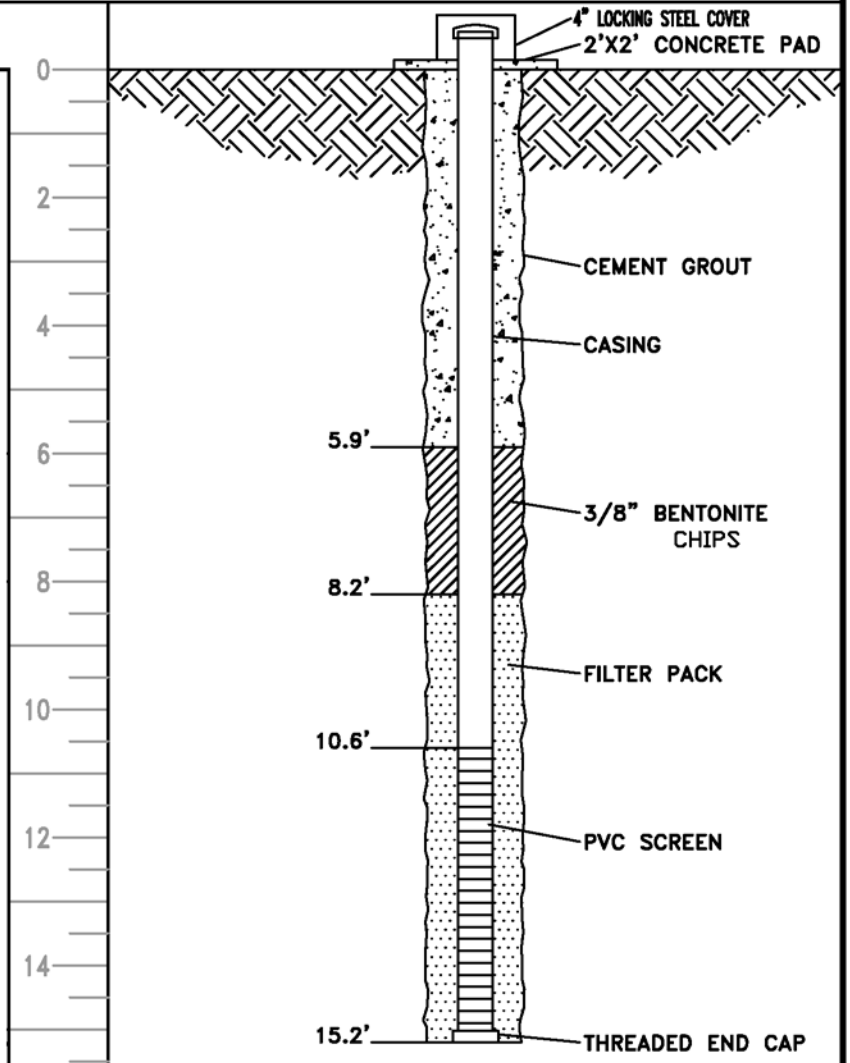
COMPLETION DIAGRAM & LITHOLOGIC LOG

PROJECT: NO NAME
DRILLING CO: PHILIP SERVICES
DRILLER: KELLY PADILLA
CLIENT SUPERVISER: RON VANVALKENBURG
GEOLOGIST/SUPERVISOR: IAN PEARSON
AHA JOB#: 43-4B
DRILLING METHOD: HOLLOW STEM AUGER
BORING STARTED: 3/25/98

WELL TYPE: MONITORING
WELLHEAD TYPE: STICKUP (1.7')
WELL COMPLETED: 3/25/98
WELL DEVELOPED: 3/28/98
DATE SURVEYED:
SCREEN SLOT SIZE: 0.02" MILL SLOT
SCREEN TYPE: SCH 40 PVC
FILTER PACK: 10-20 SILICA SAND

CASING DIAMETER: 2"
CASING MATERIAL: SCH 40 PVC
BORING DIAMETER: 7 1/2"
TOP OF CASING ELEV. (FT): 5352.90
GROUND ELEVATION (FT): 5351.24
LOCATION: AREA 4 SOUTH
NORTHING (FT): 1,990,260.27
EASTING (FT): 300,409.16

LITHOLOGY LOG



* SURVEY COORDINATES AND ELEVATION ARE ESTIMATED
DTW FROM TOC = 11.35' 3/29/98

NORWEST
Applied Hydrology

PA-2

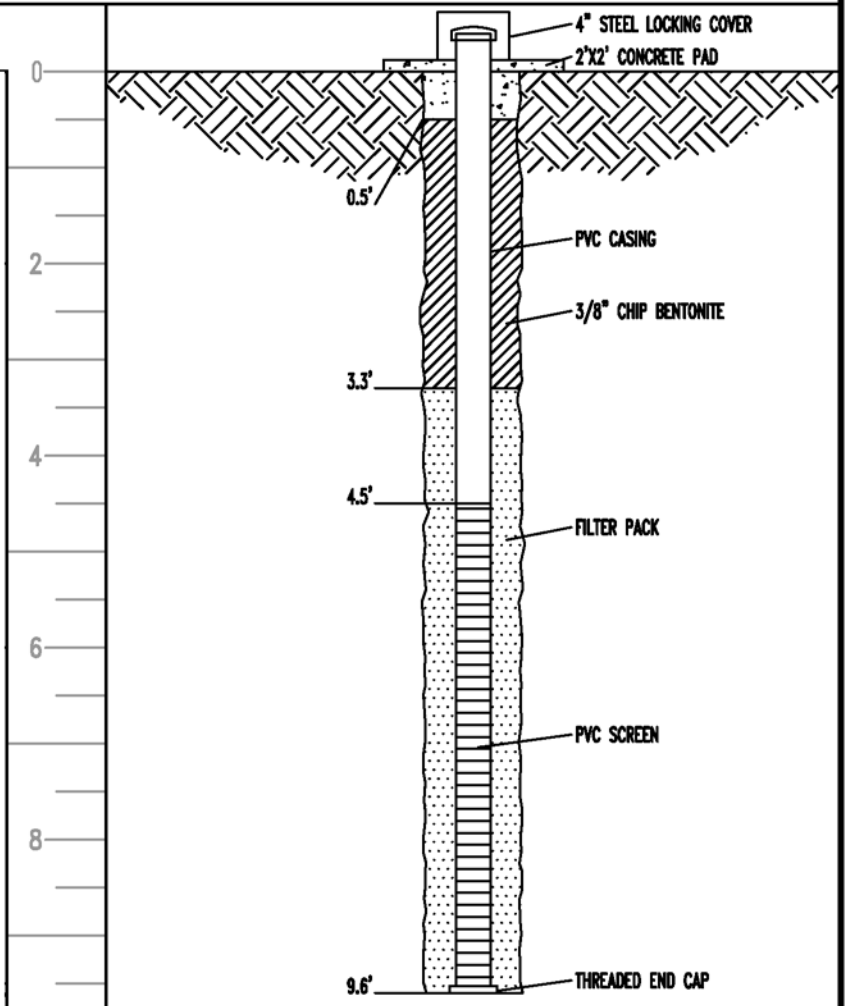
COMPLETION DIAGRAM & LITHOLOGIC LOG

PROJECT: NO NAME
DRILLING CO: PHILIP SERVICES CORP
DRILLER: KELLY PADILLA
CLIENT SUPERVISER: RON VANVALKENBURG
GEOLOGIST/SUPERVISOR: IAN PEARSON
AHA JOB#: 43-4B
DRILLING METHOD: HOLLOW STEM AUGER
BORING STARTED: 3/25/98

WELL TYPE: MONITORING
WELLHEAD TYPE: STICKUP (2.15')
WELL COMPLETED: 3/25/98
WELL DEVELOPED: 3/28/98
DATE SURVEYED:
SCREEN SLOT SIZE: 0.02" MILL SLOT
SCREEN TYPE: SCH 40 PVC
FILTER PACK: 10-20 SILICA SAND

CASING DIAMETER: 2"
CASING MATERIAL: SCH 40 PVC
BORING DIAMETER: 7 1/2"
TOP OF CASING ELEV. (FT): 5431.43
GROUND ELEVATION (FT): 5429.60
LOCATION: AREA 4 SOUTH
NORTHING (FT): 1,980,957.17
EASTING (FT): 306,702.95

LITHOLOGY LOG



* SURVEY COORDINATES AND ELEVATION ARE ESTIMATED
DTW FROM TOC = 7.69' 3/30/98

Appendix 18-F

Aquifer Testing Results from 1998 and 2007

HYDRAULIC TESTING RESULTS FOR NO NAME PERMIT AUGUST 2007

Hydraulic testing of the Pictured Cliffs Sandstone (PCS) and the No. 8 coal seam was performed at BHP Navajo Coal Company's Navajo Mine Extension Project from August 14-18, 2007 on the following wells: Kpc2007-01, Kpc2007-02, Kpc2007-03, and Kf2007-01. The analyses of the test results were performed using codes in the Aqtesolv software package show good agreement with the previous findings.

Results:

Well Kpc2007-01 (Pictured Cliffs Sandstone)

A solution was obtained using the Theis Method, which assumes an extensive and homogeneous confined aquifer. The test was run with an average variable pumping rate of 0.95 gpm, results are attached. The solution indicates a transmissivity of 0.576 ft^2/day and a hydraulic conductivity of 0.0074 ft/day (2.6 $x10^{-6}$ cm/sec)

Well Kpc2007-02 (Pictured Cliffs Sandstone)

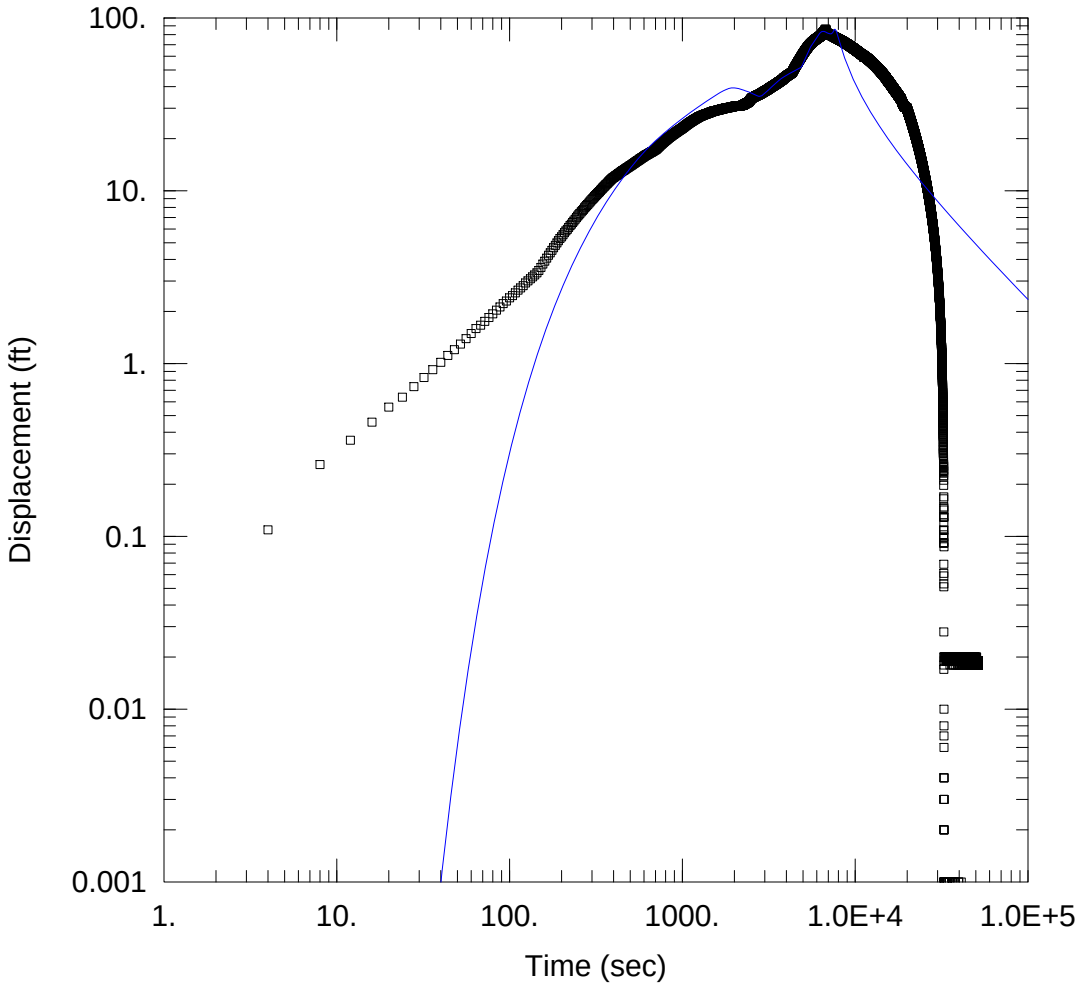
The drawdown rate in this well during pumping exactly matched casing volume dewatering, and recovery after pumping was very slow. Consequently, the results ccould not be interpreted as a pumping test. Instead, the recovery portion was analyzed using the Bouwer-Rice method for slug tests in confined aquifers. The results are attached. The very low hydraulic conductivity value of 0.0001 ft/day (3.51 $x10^{-8}$ cm/sec) was obtained from this test, indicating the formation is either exceptionally tight or the screen interval is compromised by cement. Wet cement was found at the bottom of this well and the pH of the entire water column was 11.8.

Well Kpc2007-03 (Pictured Cliffs Sandstone)

A slug test was performed at this well due to the low yield of the PCS combined with a water column of only 7 feet in the well based on an initial water level measurement of 129 ft. and a total well depth of 136 ft. A slug was made up with two-inch PVC, open at the top and packed with sand, and this was let below the water and later raised above it for falling and rising head tests. The Bouwer-Rice solution obtained the best fit to the data, and gave a hydraulic conductivity of 0.004 ft/day (1.4 $x10^{-6}$ cm/sec); the Hvorslev method gave 0.09 ft/day. The results are attached.

Well Kf2007-01 (No. 8A Seam)

This test showed delayed initial response, an abrupt "catch-up", and a faster than expected recovery. The later portion of the pumping test gave favorable fits to type curves for the Neuman-Witherspoon (leaky aquitard) and Papadopulos-Cooper (including well bore storage). The early pumping and recovery anomalies may be due to poor development and movement of coal fines during pumping, washout or fracturing of coals. The pumping rate was variable but averaged 1.5 gpm. Transmissivities determined for the variable rate interpretations of the Neuman-Witherspoon and Papadopulos-Cooper methods were 1.92 ft^2/day and 1.398 ft^2/day, respectively. A hydraulic conductivity value of 0.056 ft/day (2.0 $x10^{-5}$ cm/sec) was obtained from the Papadopulos-Cooper test results.



WELL TEST ANALYSIS

Data Set: S:\...\Theis_UpdatedFlowRates_Kpc2007-01.aqt
Date: 10/29/08 Time: 08:48:36

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
Kpc2007-01	0	0

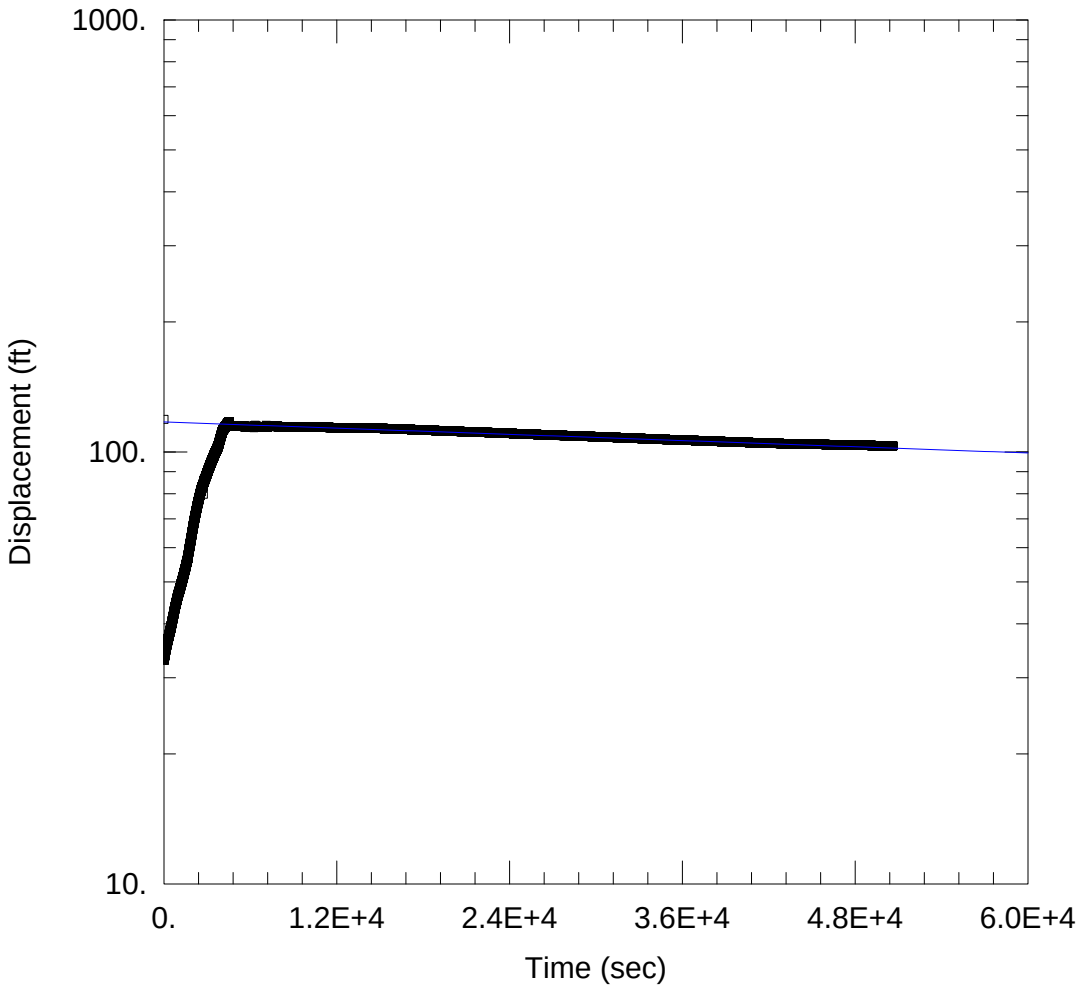
Observation Wells

Well Name	X (ft)	Y (ft)
▫ Kpc2007-01	0	0

SOLUTION

Aquifer Model: Confined
Solution Method: Theis

T = 0.5761 ft^2/day
S = 0.0662
Kz/Kr = 1.
b = 70. ft



WELL TEST ANALYSIS

Data Set: S:\...\BouwerRice_Slug_Kpc2007-02_10-29-08.aqt
Date: 10/29/08 Time: 08:52:45

PROJECT INFORMATION

Test Well: Kpc2007-02
Test Date: 8/17/2007

AQUIFER DATA

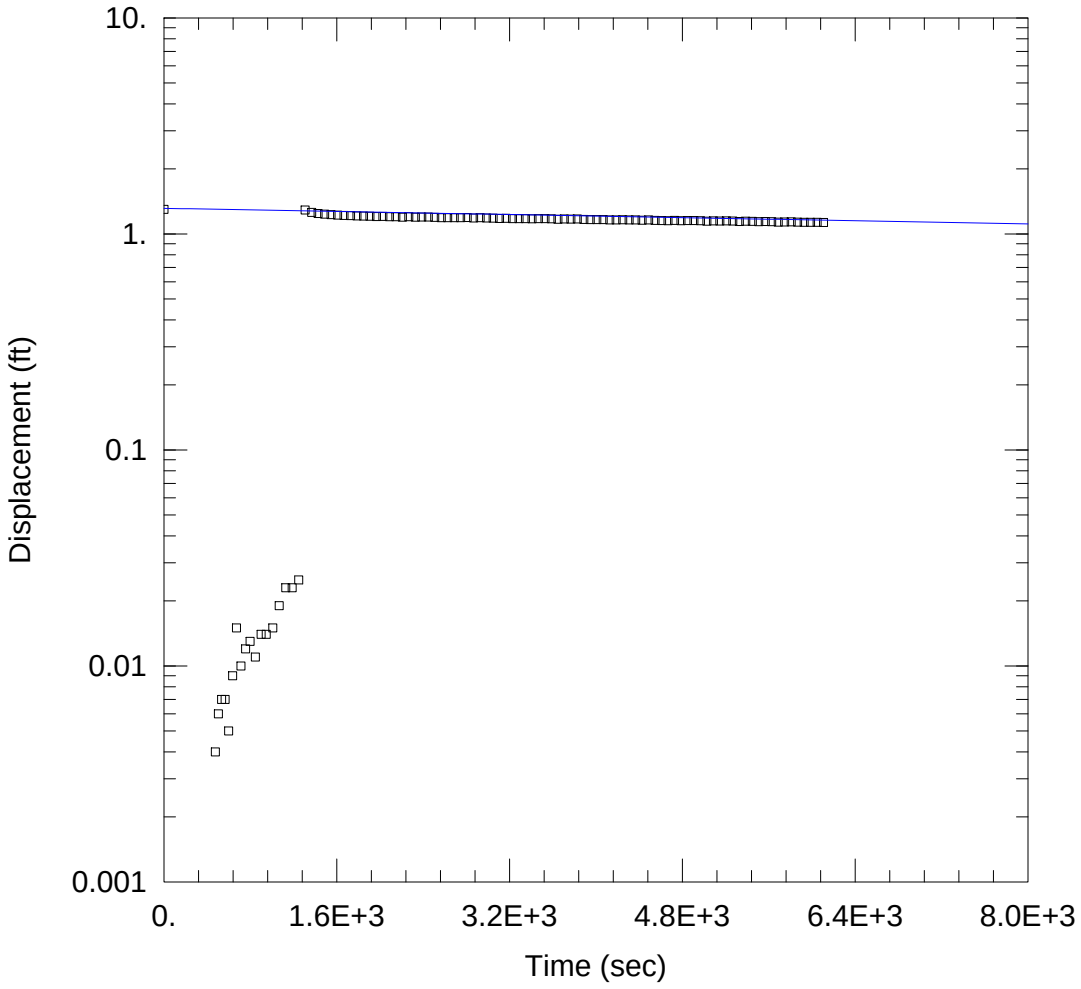
Saturated Thickness: 78. ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (Kpc2007-02)

Initial Displacement: 119. ft
Static Water Column Height: 152.2 ft
Total Well Penetration Depth: 319. ft
Screen Length: 70. ft
Casing Radius: 0.1208 ft
Well Radius: 0.3645 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 0.0001109 ft/day
y0 = 117.3 ft



WELL TEST ANALYSIS

Data Set: S:\...\BouwerRice_Kpc2007-03.aqt
Date: 10/29/08 Time: 08:55:00

PROJECT INFORMATION

Test Well: Kpc2007-03
Test Date: 8/17/2007

AQUIFER DATA

Saturated Thickness: 10. ft Anisotropy Ratio (Kz/Kr): 1.

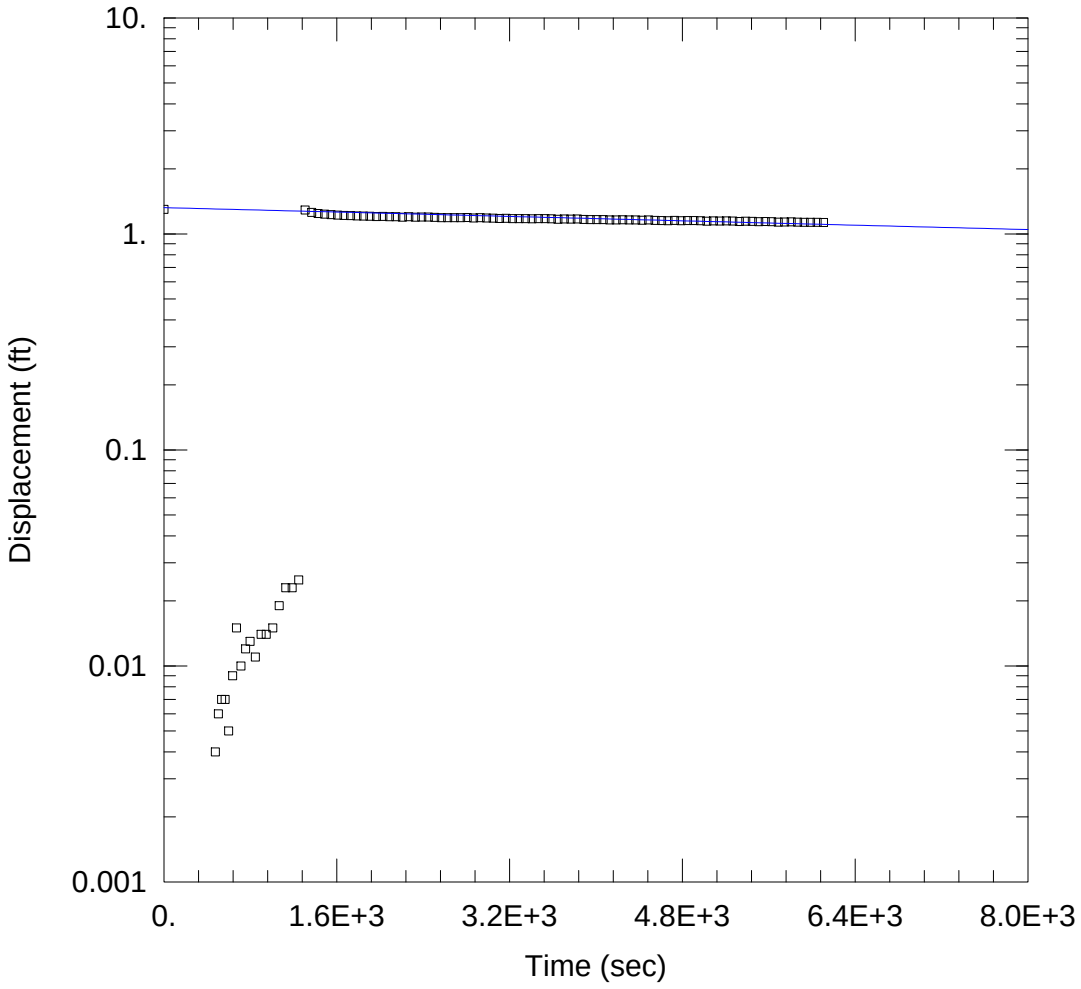
WELL DATA (Kpc2007-03)

Initial Displacement: 1.3 ft
Static Water Column Height: 129.4 ft
Total Well Penetration Depth: 135. ft
Screen Length: 10. ft
Casing Radius: 0.12 ft
Well Radius: 0.364 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 0.004462 ft/day
y0 = 1.314 ft



WELL TEST ANALYSIS

Data Set: S:\...\Hvorslev_Kpc2007-03.aqt
Date: 10/29/08 Time: 08:55:41

PROJECT INFORMATION

Test Well: Kpc2007-03
Test Date: 8/17/2007

AQUIFER DATA

Saturated Thickness: 10. ft Anisotropy Ratio (Kz/Kr): 1.

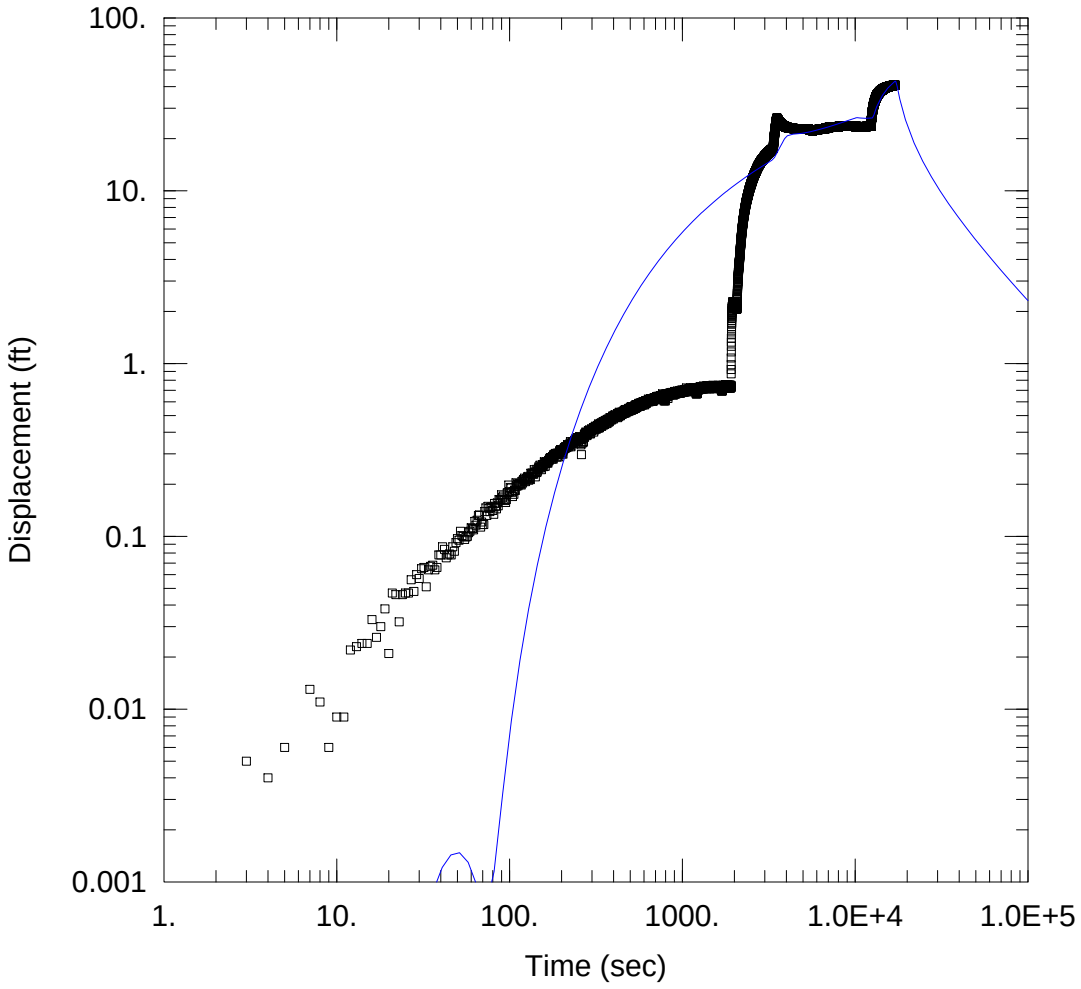
WELL DATA (Kpc2007-03)

Initial Displacement: 1.3 ft
Static Water Column Height: 129.4 ft
Total Well Penetration Depth: 135. ft
Screen Length: 10. ft
Casing Radius: 0.12 ft
Well Radius: 0.364 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 0.008505 ft/day
y0 = 1.323 ft



WELL TEST ANALYSIS

Data Set: S:\...\NeumanWitherspoon_Kf2007-01.aqt
Date: 10/29/08 Time: 08:59:56

PROJECT INFORMATION

Test Well: Kf2007-01
Test Date: 8/17/2007

AQUIFER DATA

Saturated Thickness: 10. ft
Anisotropy Ratio (Kz/Kr): 1.
Aquitard Thickness (b'): 1. ft
Aquitard Thickness (b"): 1. ft

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
Kf2007-01	0	0

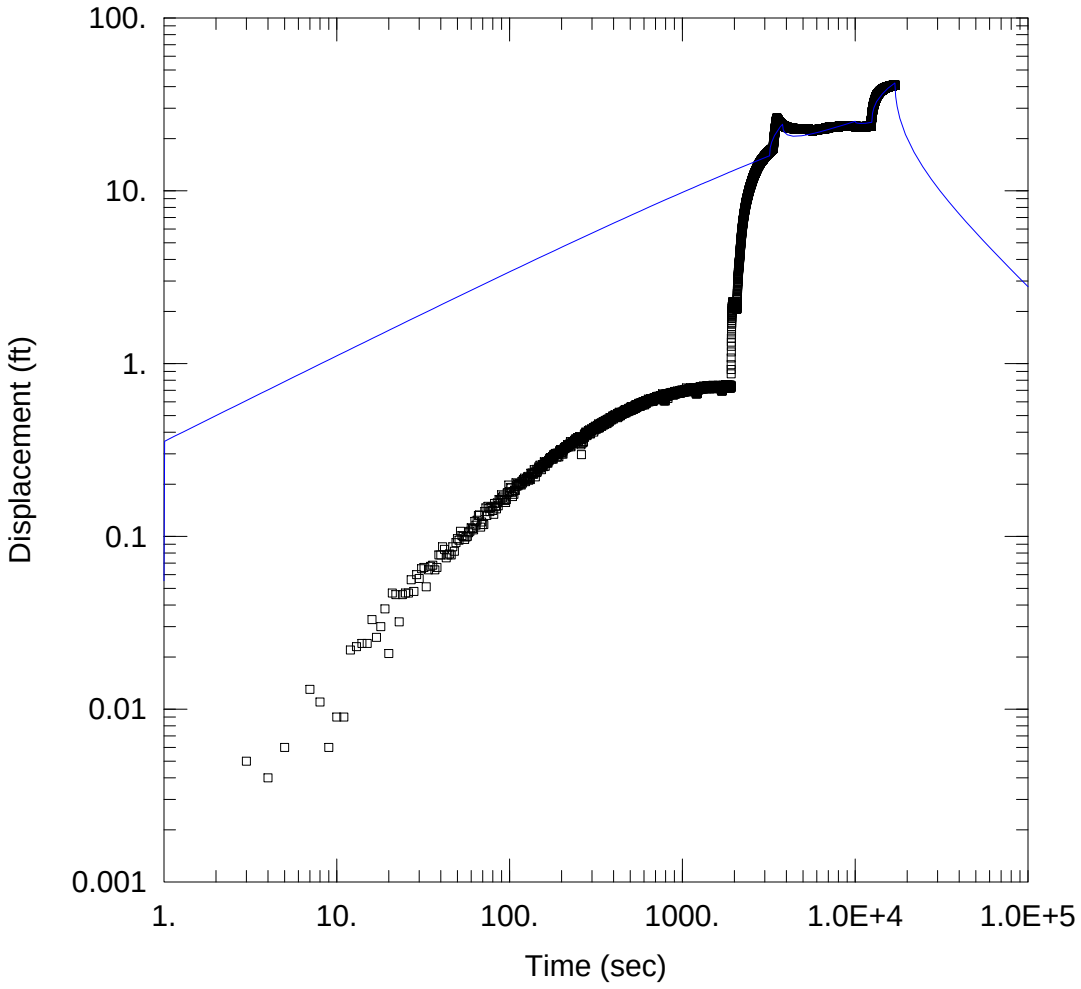
Observation Wells

Well Name	X (ft)	Y (ft)
Kf2007-01	0	0

SOLUTION

Aquifer Model: Leaky
Solution Method: Neuman-Witherspoon

T = 1.92 ft^2/day
S = 0.3391
r/B = 1.0E-5
ß = 1.0E-5
T2 = 1. ft^2/day
S2 = 1.0E-10



WELL TEST ANALYSIS

Data Set: S:\...\PapadopulosCooper_Kf2007-01.aqt
Date: 10/29/08 Time: 09:01:09

PROJECT INFORMATION

Test Well: Kf2007-01
Test Date: 8/17/2007

AQUIFER DATA

Saturated Thickness: 10. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
Kf2007-01	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
▫ Kf2007-01	0	0

SOLUTION

Aquifer Model: Confined Solution Method: Papadopulos-Cooper

T = 1.398 ft^2/day S = 1.
r(w) = 0.364 ft r(c) = 0.12 ft

PUMPING TEST RESULTS FOR PINABETE ALLUVIAL WELLS
MAY 16, 1998

Pumping tests of wells PA-1 and PA-2 completed in Pinabete Alluvium were performed at BHP Navajo Coal Company's Area 4 South on May 16, 1998. The analyses of the test results were performed using codes in the Aqtesolv software package.

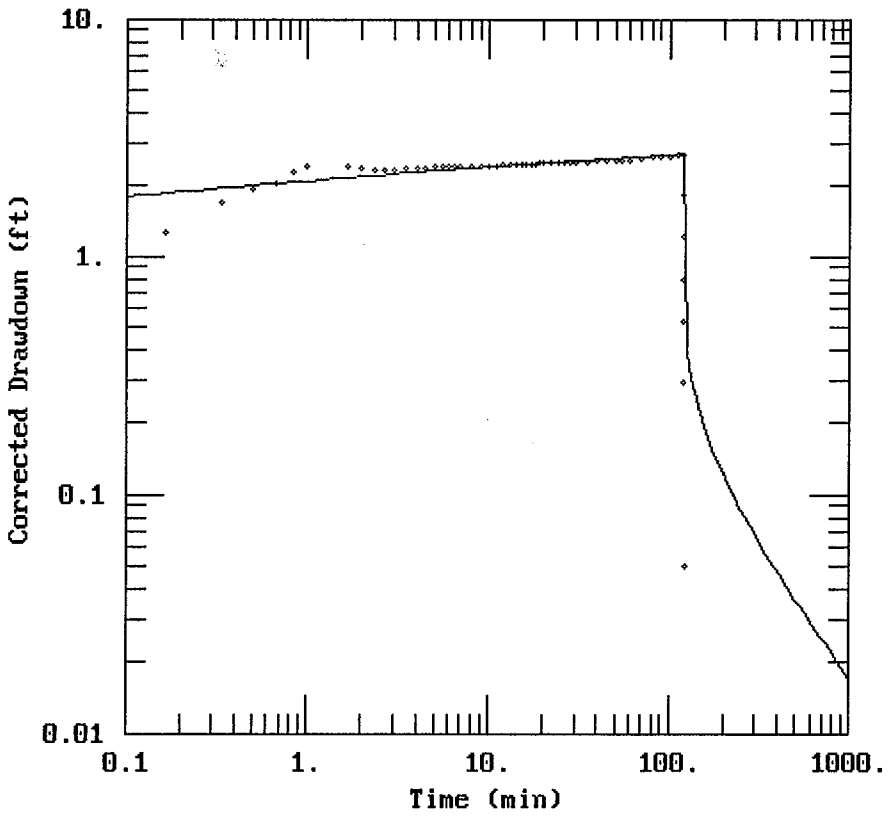
Results:

Well PA-1 (Pinabete Alluvium)

A solution was obtained using the Theis Method. The test was run with a constant pumping rate of 2.0 gpm, results are attached. The solution indicates a transmissivity of 230.7 ft^2/day and a hydraulic conductivity of 51.3 ft/day (1.8 $x10^{-2}$ cm/sec). The results are attached.

Well PA-2 (Pinabete Alluvium)

A solution was obtained using the Theis Method. The test was run with a constant pumping rate of 0.75 gpm, results are attached. The solution indicates a transmissivity of 75.62 ft^2/day and a hydraulic conductivity of 11.5 ft/day (4.1 $x10^{-3}$ cm/sec). The results are attached.



DATA SET:
PA1P&REC.AQT
08/25/98

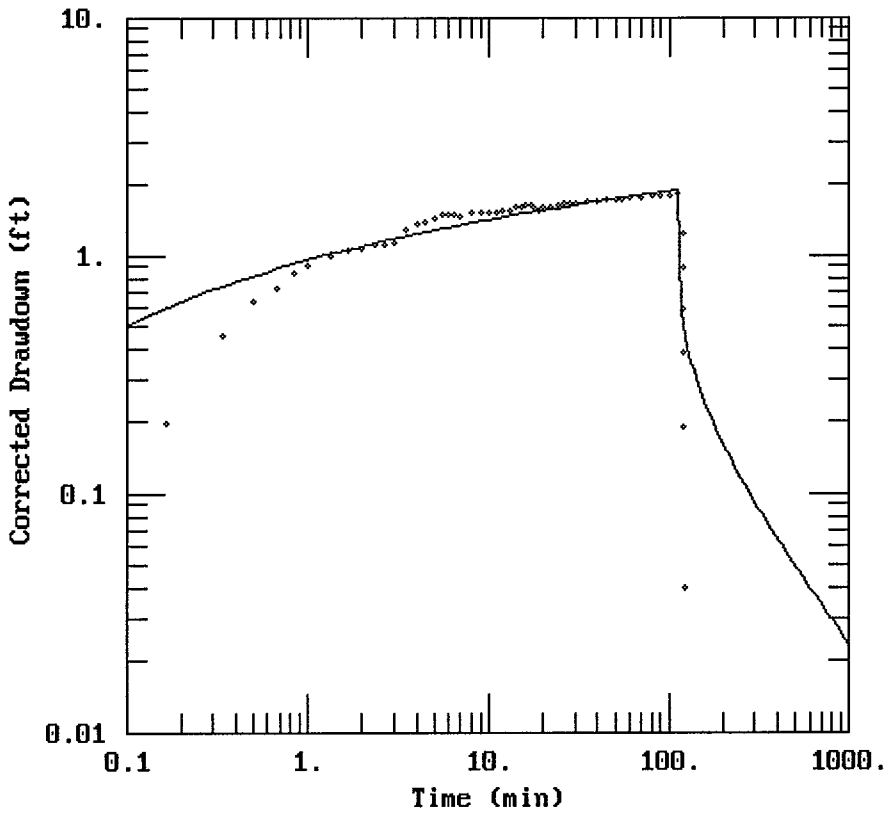
AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Theis

PROJECT DATA:
test date: 5/16/98
test well: PA-1
obs. well: PA-1

TEST DATA:
Q = 0.2674 ft^3/min
r = 0. ft
r_c= 0.08333 ft
r_w= 0.08333 ft
b = 7. ft

PARAMETER ESTIMATES:
T = 230.7 ft^2/day
S = 7.791E-06



DATA SET:
PA2P&REC.AQT
08/25/98

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Theis

PROJECT DATA:
test date: 5/16/98
test well: PA-2
obs. well: PA-2

TEST DATA:
Q = 0.1003 ft^3/min
r = 0. ft
r_c= 0.08333 ft
r_w= 0.08333 ft
b = 7.5 ft

PARAMETER ESTIMATES:
T = 57.62 ft^2/day
S = 0.1073

Appendix 18-G

Quality Assurance and Quality Control Results for Baseline Groundwater Quality Data from 2007 to 2008

Green Analytical Laboratories

DISSOLVED METALS SPIKE AND DUPLICATE DATA

LAB ID#							
708-122	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Arsenic	0.0000	0.049	**0.050**	**98**	0.054	0.054	**0.00**
Barium	0.0000	0.050	**0.050**	**100**	0.052	0.051	**1.94**
Boron	0.0	1.8	**2.0**	**88**	0.3	0.3	**0.00**
Cadmium	0.00000	0.048	**0.050**	**96**	0.052	0.050	**3.92**
Calcium	0.0	5.2	**5.0**	**104**	83.9	83.7	**0.24**
Chromium	0.000	0.052	**0.050**	**104**	0.055	0.052	**5.61**
Copper	0.0000	0.051	**0.050**	**102**	0.054	0.052	**3.77**
Iron	0.00	1.05	**1.00**	**105**	<0.05	<0.05	**NC**
Lead	0.0000	0.051	**0.050**	**102**	0.052	0.052	**0.00**
Magnesium	0.0	1.1	**1.0**	**106**	12.4	12.4	**0.00**
Manganese	0.00000	1.06	**1.00**	**106**	0.030	0.030	**0.00**
Potassium	0.0	1.20	**1.00**	**120**	1.4	1.2	**15.4**
Selenium	0.000	0.245	**0.250**	**98**	0.264	0.255	**3.47**
Silver	0.00000	0.050	**0.050**	**100**	0.052	0.052	**0.00**
Sodium	0.0	53.9	**50.0**	**108**	19.9	19.7	**1.01**
Uranium	0.00000	0.052	**0.050**	**104**	0.054	0.052	**3.77**
Zinc	0.000	0.050	**0.050**	**100**	0.052	0.050	**3.92**

NC=Not calculated due to results less than the detection limit
NA=Data not available.

Green Analytical Laboratories

DISSOLVED METALS SRM AND BLANK DATA

LAB ID#						
708-122	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Arsenic	0.054	0.050	**108**	90-110 %	<0.0005	0.0005
Barium	0.053	0.050	**106**	90-110 %	<0.0005	0.0005
Boron	5.10	5.00	**102**	90-110 %	<0.1	0.1
Cadmium	0.051	0.050	**102**	90-110 %	<0.00005	0.00005
Calcium	5.3	5.0	**106**	90-110 %	<0.5	0.5
Chromium *	0.057	0.050	**114**	90-110 %	<0.001	0.001
Copper	0.054	0.050	**108**	90-110 %	<0.0001	0.0001
Iron	5.45	5.00	**109**	90-110 %	<0.05	0.05
Lead	0.052	0.050	**104**	90-110 %	<0.0001	0.0001
Magnesium	5.20	5.00	**104**	90-110 %	<0.5	0.5
Manganese	2.61	2.50	**104**	90-110 %	<0.005	0.005
Potassium	10.3	10.0	**103**	90-110 %	<0.5	0.5
Selenium	0.269	0.250	**108**	90-110 %	<0.001	0.001
Silver	0.054	0.050	**108**	90-110 %	<0.00005	0.00005
Sodium	8.8	8.1	**109**	90-110 %	<0.5	0.5
Uranium	0.052	0.050	**104**	90-110 %	<0.00001	0.00001
Zinc	0.053	0.050	**106**	90-110 %	<0.001	0.001

NA=Data not available.

Green Analytical Laboratories

TOTAL METALS SPIKE AND DUPLICATE DATA

LAB ID#							
708-122	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Iron-T	0.00	4.20	**4.00**	**105**	1.10	1.10	**0.0**
Manganese-T	0.000	2.20	**2.00**	**110**	0.055	0.053	**3.70**
Mercury-T	0.0000	0.0020	**0.0020**	**100**	<0.0002	<0.0002	**NC**

NC=Not calculated due to results less than the detection limit.
NA=Data not available.

Green Analytical Laboratories

TOTAL METALS SRM AND BLANK DATA

LAB ID#						
708-122	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Iron-T	5.00	5.00	**100**	90-110 %	<0.05	0.05
Manganese-T	2.610	2.500	**104**	90-110 %	<0.005	0.005
Mercury-T	0.002	0.002	**100**	90-110 %	<0.0002	0.0002

NA=Data not available.

Green Analytical Laboratories

WET CHEM SPIKE AND DUPLICATE DATA

LAB ID#							
708-122	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Alkalinity	0	99	**100**	**99**	1820	1800	**1.10**
Chloride	0	99	**100**	**99**	<10	<10	**NC**
EC	NMA	NMA	**NMA**	**NMA**	3570	3560	**0.28**
Fluoride	0.0	1.1	**1.0**	**110**	<0.2	<0.2	**NC**
Nitrate/Nitrite	0.09	0.17	**0.10**	**80**	<0.02	<0.02	**NC**
pH	NMA	NMA	**NMA**	**NMA**	8.20	8.19	**0.12**
Sulfate	0	52	**50**	**104**	520	500	**3.92**
TDS	NMA	NMA	**NMA**	**NMA**	2230	2215	**0.67**

NMA=Data not applicable to Method.
NC=Not calculated due to results less than the detection limit.

Green Analytical Laboratories

WET CHEM SRM AND BLANK DATA

LAB ID#						
708-122	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Alkalinity	332	352	**94.3**	90-110 %	<10	10
Chloride	119	112	**106**	90-110 %	<10	10
EC	527	561	**93.9**	90-110 %	NMA	NMA
Fluoride	1.0	1.0	**100**	90-110 %	<1.0	1.0
Nitrate/Nitrite	0.49	0.50	**98.0**	90-110 %	<0.02	0.02
pH	8.33	8.40	**99.2**	90-110 %	NMA	NMA
Sulfate	330	320	**103**	90-110 %	<10	10
TDS	1290	1220	**106**	90-110 %	<10	10

NMA=Data not applicable to Method.

Green Analytical Laboratories

DISSOLVED METALS SPIKE AND DUPLICATE DATA

LAB ID#							
708-154	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Arsenic	0.0000	0.049	**0.050**	**98.0**	<0.0005	<0.0005	**NC**
Barium	0.1130	0.159	**0.050**	**92.0**	0.1130	0.1120	**0.89**
Boron	0.0	2.0	**2.0**	**100**	0.3	0.3	**0.00**
Cadmium	0.00000	0.047	**0.050**	**94.0**	<0.00005	<0.00005	**NC**
Calcium	0.0	5.6	**5.0**	**112**	200.0	195.0	**2.53**
Chromium	0.000	0.048	**0.050**	**96.0**	0.005	0.005	**0.00**
Copper	0.1050	0.150	**0.050**	**90.0**	0.1090	0.1050	**3.74**
Iron	0.00	1.14	**1.00**	**114**	0.64	0.61	**4.80**
Lead	0.0000	0.049	**0.050**	**98.0**	0.0030	0.0030	**0.00**
Magnesium *	0.0	1.6	**1.0**	**161**	21.1	20.2	**4.36**
Manganese	0.00000	1.050	**1.000**	**105**	0.00800	0.00700	**13.3**
Potassium	0.0	1.1	**1.0**	**110**	13.7	13.5	**1.47**
Selenium	0.000	0.263	**0.250**	**105**	<0.001	<0.001	**NC**
Silver	0.00000	0.049	**0.050**	**98**	<0.00005	<0.00005	**NC**
Sodium	0.0	57.7	**50.0**	**115**	58.5	56.7	**3.13**
Uranium	0.00000	0.047	**0.050**	**94**	0.00069	0.00069	**0.00**
Zinc	0.000	0.051	**0.050**	**102**	<0.001	<0.001	**NC**

NC=Not calculated due to results less than the detection limit
NA=Data not available.

Green Analytical Laboratories

DISSOLVED METALS SRM AND BLANK DATA

LAB ID#						
708-154	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Arsenic	0.052	0.050	**104**	90-110 %	<0.0005	0.0005
Barium	0.048	0.050	**96.0**	90-110 %	<0.0005	0.0005
Boron	5.2	5.0	**104**	90-110 %	<0.1	0.1
Cadmium	0.049	0.050	**98.0**	90-110 %	<0.00005	0.00005
Calcium	5.4	5.0	**108**	90-110 %	<0.5	0.5
Chromium	0.053	0.050	**106**	90-110 %	<0.001	0.001
Copper	0.052	0.050	**104**	90-110 %	<0.0001	0.0001
Iron	5.46	5.00	**109**	90-110 %	<0.05	0.05
Lead	0.053	0.050	**106**	90-110 %	<0.0001	0.0001
Magnesium	5.2	5.0	**104**	90-110 %	<0.5	0.5
Manganese	2.53	2.50	**101**	90-110 %	<0.005	0.005
Potassium	11.0	10.0	**110**	90-110 %	<0.5	0.5
Selenium	0.273	0.250	**109**	90-110 %	<0.001	0.001
Silver	0.048	0.050	**96.0**	90-110 %	<0.00005	0.00005
Sodium	17.2	16.2	**106**	90-110 %	<0.5	0.5
Uranium	0.055	0.050	**110**	90-110 %	<0.00001	0.00001
Zinc	0.049	0.050	**98.0**	90-110 %	<0.001	0.001

NA=Data not available.

Green Analytical Laboratories

TOTAL METALS SPIKE AND DUPLICATE DATA

LAB ID#							
708-154	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Iron-T	0.00	2.08	**2.00**	**104**	0.16	0.14	**13.3**
Manganese-T	0.000	1.05	**1.00**	**105**	0.008	0.007	**13.3**
Mercury-T	0.0000	0.0020	**0.0020**	**100**	<0.0002	<0.0002	**NC**

NC=Not calculated due to results less than the detection limit.
NA=Data not available.

Green Analytical Laboratories

TOTAL METALS SRM AND BLANK DATA

LAB ID#						
708-154	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Iron-T	5.04	5.00	**101**	90-110 %	<0.05	0.05
Manganese-T	2.53	2.50	**101**	90-110 %	<0.005	0.005
Mercury-T	0.002	0.002	**100**	90-110 %	<0.0002	0.0002

NA=Data not available.

Green Analytical Laboratories

WET CHEM SPIKE AND DUPLICATE DATA

LAB ID#							
708-154	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Alkalinity	0	102	**100**	**102**	312	310	**0.64**
Chloride	0	99	**100**	**99**	15	15	**0.00**
EC	NMA	NMA	**NMA**	**NMA**	1370	1370	**0.00**
Fluoride	0.5	1.5	**1.0**	**100**	0.8	0.8	**0.00**
Nitrate/Nitrite	0.00	0.10	**0.10**	**100**	<0.02	<0.02	**NC**
pH	NMA	NMA	**NMA**	**NMA**	9.55	9.55	**0.00**
Sulfate	0	50	**50**	**100**	3900	3900	**0.00**
TDS	NMA	NMA	**NMA**	**NMA**	530	520	**1.90**

NMA=Data not applicable to Method.
NC=Not calculated due to results less than the detection limit.

Green Analytical Laboratories

WET CHEM SRM AND BLANK DATA

LAB ID#						
708-154	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Alkalinity	340	352	**96.6**	90-110 %	<10	10
Chloride	119	112	**106**	90-110 %	<10	10
EC	519	561	**92.5**	90-110 %	NMA	NMA
Fluoride	1.0	1.0	**100**	90-110 %	<1.0	1.0
Nitrate/Nitrite	0.46	0.50	**92.0**	90-110 %	<0.02	0.02
pH	8.31	8.40	**98.9**	90-110 %	NMA	NMA
Sulfate	335	320	**105**	90-110 %	<10	10
TDS	1240	1220	**102**	90-110 %	<10	10

NMA=Data not applicable to Method.

Green Analytical Laboratories

DISSOLVED METALS SPIKE AND DUPLICATE DATA

LAB ID#							
0711161252+	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Arsenic	0.0000	0.051	**0.050**	**102**	<0.0005	<0.0005	**NC**
Barium	0.0000	0.050	**0.050**	**100**	0.229	0.229	**0.00**
Boron	0.0	2.3	**2.0**	**115**	0.3	0.3	**0.00**
Cadmium	0.00000	0.050	**0.050**	**100**	0.00007	0.00006	**15.4**
Calcium	0.0	5.2	**5.0**	**104**	23.7	23.7	**0.00**
Chromium	0.000	0.050	**0.050**	**100**	0.002	0.002	**0.00**
Copper	0.0000	0.051	**0.050**	**102**	2.43	2.40	**1.24**
Iron	0.00	1.06	**1.00**	**106**	4.83	4.82	**0.21**
Lead	0.0000	0.050	**0.050**	**100**	0.0008	0.0008	**0.00**
Magnesium	0.0	1.1	**1.0**	**110**	4.8	4.7	**2.11**
Manganese	0.00000	1.04	**1.00**	**104**	3.68	3.51	**4.73**
Potassium	0.0	1.0	**1.0**	**100**	4.7	4.6	**2.15**
Selenium	0.000	0.255	**0.250**	**102**	<0.005	<0.005	**NC**
Silver	0.00000	0.052	**0.050**	**104**	<0.00005	<0.00005	**NC**
Sodium	0.0	52.9	**50.0**	**106**	242	240	**0.83**
Uranium	0.00000	0.051	**0.050**	**102**	0.00021	0.00021	**0.00**
Zinc	0.000	0.051	**0.050**	**102**	0.079	0.076	**3.87**

NC=Not calculated due to results less than the detection limit
NA=Data not available.

Green Analytical Laboratories

DISSOLVED METALS SRM AND BLANK DATA

LAB ID#						
0711161252+	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Arsenic	0.049	0.050	**98.0**	90-110 %	<0.0005	0.0005
Barium	0.050	0.050	**100**	90-110 %	<0.0005	0.0005
Boron	5.10	5.00	**102**	90-110 %	<0.1	0.1
Cadmium	0.053	0.050	**106**	90-110 %	<0.00005	0.00005
Calcium	5.0	5.0	**100**	90-110 %	<0.5	0.5
Chromium	0.049	0.050	**98.0**	90-110 %	<0.001	0.001
Copper	0.050	0.050	**100**	90-110 %	<0.0001	0.0001
Iron	5.11	5.00	**102**	90-110 %	<0.05	0.05
Lead	0.049	0.050	**98.0**	90-110 %	<0.0001	0.0001
Magnesium	4.8	5.0	**96.0**	90-110 %	<0.5	0.5
Manganese	2.57	2.50	**103**	90-110 %	<0.005	0.005
Potassium	9.8	10.0	**98.0**	90-110 %	<0.5	0.5
Selenium	0.256	0.250	**102**	90-110 %	<0.001	0.001
Silver	0.054	0.050	**108**	90-110 %	<0.00005	0.00005
Sodium	8.3	8.1	**102**	90-110 %	<0.5	0.5
Uranium	0.055	0.050	**110**	90-110 %	<0.00001	0.00001
Zinc	0.053	0.050	**106**	90-110 %	<0.001	0.001

NA=Data not available.

Green Analytical Laboratories

TOTAL METALS SPIKE AND DUPLICATE DATA

LAB ID#							
0711161252+	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Iron-T	0.00	3.74	**4.00**	**93.5**	8.99	8.69	**3.39**
Manganese-T	0.000	1.820	**2.00**	**91.0**	4.78	4.64	**2.97**
Mercury-T	0.0000	0.0020	**0.0020**	**100**	<0.0002	<0.0002	**NC**

NC=Not calculated due to results less than the detection limit.
NA=Data not available.

Green Analytical Laboratories

TOTAL METALS SRM AND BLANK DATA

LAB ID#						
0711161252+	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Iron-T	5.11	5.00	**102**	90-110 %	<0.05	0.05
Manganese-T	2.57	2.50	**103**	90-110 %	<0.005	0.005
Mercury-T	0.002	0.002	**100**	90-110 %	<0.0002	0.0002

NA=Data not available.

Green Analytical Laboratories

WET CHEM SPIKE AND DUPLICATE DATA

LAB ID#							
0711161252+	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Alkalinity	0	103	**100**	**103**	1750	1750	**0.00**
Chloride	0	99	**100**	**99**	308	304	**1.31**
EC	NMA	NMA	**NMA**	**NMA**	644	643	**0.16**
Fluoride	0.2	1.1	**1.0**	**92**	1.0	1.0	**0.00**
Nitrate/Nitrite	0.04	0.13	**0.10**	**90**	<0.02	<0.02	**NC**
pH	NMA	NMA	**NMA**	**NMA**	9.56	9.56	**0.00**
Sulfate	0	54	**50**	**108**	2500	2500	**0.00**
TDS	NMA	NMA	**NMA**	**NMA**	5820	5730	**1.56**

NMA=Data not applicable to Method.
NC=Not calculated due to results less than the detection limit.

Green Analytical Laboratories

WET CHEM SRM AND BLANK DATA

LAB ID#						
0711161252+	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Alkalinity	276	283	**97.5**	90-110 %	<10	10
Chloride	39	37.9	**103**	90-110 %	<10	10
EC	568	561	**101**	90-110 %	NMA	NMA
Fluoride	2.0	2.0	**100**	90-110 %	<1.0	1.0
Nitrate/Nitrite	0.50	0.50	**100**	90-110 %	<0.02	0.02
pH	8.34	8.40	**99.3**	90-110 %	NMA	NMA
Sulfate	325	321	**101**	90-110 %	<10	10
TDS	1240	1210	**102**	90-110 %	<10	10

NMA=Data not applicable to Method.

Green Analytical Laboratories

DISSOLVED METALS SPIKE AND DUPLICATE DATA

LAB ID#							
0711060903+	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Arsenic	0.0000	0.051	**0.050**	**102**	0.0050	0.0050	**0.00**
Barium	0.0000	0.050	**0.050**	**100**	0.0530	0.0500	**5.83**
Boron	0.0	0.5	**0.5**	**100**	0.5	0.5	**0.00**
Cadmium	0.00000	0.052	**0.050**	**104**	<0.005	<0.005	**NC**
Calcium	0.0	2.4	**2.5**	**96.0**	91.4	91.3	**0.11**
Chromium	0.000	0.047	**0.050**	**94.0**	0.002	0.002	**0.00**
Copper	0.0000	0.050	**0.050**	**100**	0.0100	0.0090	**10.5**
Iron	0.00	0.50	**0.50**	**100**	<0.05	<0.05	**NC**
Lead	0.0000	0.052	**0.050**	**104**	0.0002	0.0002	**0.00**
Magnesium	0.0	0.5	**0.5**	**100**	13.1	13.1	**0.00**
Manganese	0.00000	0.285	**0.250**	**114**	2.10000	2.10000	**0.00**
Potassium	0.0	0.5	**0.5**	**100**	1.4	1.4	**0.00**
Selenium	0.000	0.254	**0.250**	**102**	0.006	0.006	**0.00**
Silver	0.00000	0.057	**0.050**	**114**	<0.00005	<0.00005	**NC**
Sodium	0.0	25.4	**25.0**	**102**	16.4	16.4	**0.00**
Uranium	0.00000	0.053	**0.050**	**106**	0.00274	0.00270	**1.47**
Zinc	0.000	0.052	**0.050**	**104**	0.011	0.010	**9.52**

NC=Not calculated due to results less than the detection limit
NA=Data not available.

Green Analytical Laboratories

DISSOLVED METALS SRM AND BLANK DATA

LAB ID#						
0711060903+	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Arsenic	0.052	0.050	**104**	90-110 %	<0.0005	0.0005
Barium	0.052	0.050	**104**	90-110 %	<0.0005	0.0005
Boron	5.000	5.000	**100**	90-110 %	<0.1	0.1
Cadmium	0.052	0.050	**104**	90-110 %	<0.00005	0.00005
Calcium	5.000	5.000	**100**	90-110 %	<0.5	0.5
Chromium	0.047	0.050	**94.0**	90-110 %	<0.001	0.001
Copper	0.051	0.050	**102**	90-110 %	<0.0001	0.0001
Iron	5.160	5.000	**103**	90-110 %	<0.05	0.05
Lead	0.050	0.050	**100**	90-110 %	0.0001	0.0001
Magnesium	4.850	5.000	**97.0**	90-110 %	<0.5	0.5
Manganese	2.560	2.500	**102**	90-110 %	<0.005	0.005
Potassium	9.900	10.000	**99.0**	90-110 %	<0.5	0.5
Selenium	0.255	0.250	**102**	90-110 %	<0.001	0.001
Silver	0.055	0.050	**110**	90-110 %	<0.00005	0.00005
Sodium	8.200	8.100	**101**	90-110 %	<0.5	0.5
Uranium	0.052	0.050	**104**	90-110 %	<0.00001	0.00001
Zinc	0.050	0.050	**100**	90-110 %	<0.001	0.001

NA=Data not available.

Green Analytical Laboratories

TOTAL METALS SPIKE AND DUPLICATE DATA

LAB ID#							
0711060903+	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Iron-T	0.00	3.75	**4.00**	**93.8**	46.9	45.3	**3.47**
Manganese-T *	0.000	1.960	**2.00**	**98.0**	14.4	11.7	**20.7**
Mercury-T	0.0000	0.0020	**0.0020**	**100**	0.0002	0.0002	**0.00**

NC=Not calculated due to results less than the detection limit.
NA=Data not available.

Green Analytical Laboratories

TOTAL METALS SRM AND BLANK DATA

LAB ID#						
0711060903+	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Iron-T	4.97	5.00	**99.4**	90-110 %	<0.05	0.05
Manganese-T	2.59	2.50	**104**	90-110 %	<0.005	0.005
Mercury-T	0.002	0.002	**100**	90-110 %	<0.0002	0.0002

NA=Data not available.

Green Analytical Laboratories

WET CHEM SPIKE AND DUPLICATE DATA

LAB ID#							
0711060903+	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Alkalinity	0	104	**100**	**104**	111	109	**1.82**
Chloride	0	103	**100**	**103**	152	150	**1.32**
EC	NMA	NMA	**NMA**	**NMA**	1250	1250	**0.00**
Fluoride	0.0	0.9	**1.0**	**90**	0.2	0.2	**0.00**
Nitrate/Nitrite	0.16	0.24	**0.10**	**80**	1.97	1.92	**2.57**
pH	NMA	NMA	**NMA**	**NMA**	7.53	7.51	**0.27**
Sulfate	0	54	**50**	**108**	96	94	**2.11**
TDS	NMA	NMA	**NMA**	**NMA**	415	405	**2.44**

NMA=Data not applicable to Method.
NC=Not calculated due to results less than the detection limit.

Green Analytical Laboratories

WET CHEM SRM AND BLANK DATA

LAB ID#						
0711060903+	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Alkalinity	290	283	**102**	90-110 %	<10	10
Chloride	36	37.9	**95.0**	90-110 %	<10	10
EC	580	561	**103**	90-110 %	NMA	NMA
Fluoride	1.0	1.0	**100**	90-110 %	<1.0	1.0
Nitrate/Nitrite	0.52	0.50	**104**	90-110 %	<0.02	0.02
pH	8.36	8.40	**100**	90-110 %	NMA	NMA
Sulfate	340	321	**106**	90-110 %	<10	10
TDS	1200	1210	**99.2**	90-110 %	<10	10

NMA=Data not applicable to Method.

Green Analytical Laboratories

DISSOLVED METALS SPIKE AND DUPLICATE DATA

LAB ID#							
0712051332+	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Arsenic	0.0000	0.050	**0.050**	**100**	0.0060	0.0060	**0.00**
Barium	0.0000	0.048	**0.050**	**96.0**	0.0090	0.0090	**0.00**
Boron	0.8	2.8	**2.00**	**100**	<0.1	<0.1	**NC**
Cadmium	0.00000	0.049	**0.050**	**98.0**	<0.00005	<0.00005	**NC**
Calcium	0.0	45.8	**50.0**	**91.6**	22.1	21.6	**2.29**
Chromium	0.000	0.049	**0.050**	**98.0**	0.007	0.007	**0.00**
Copper	0.0000	0.049	**0.050**	**98.0**	0.0890	0.0730	**19.8**
Iron	0.00	9.48	**10.0**	**94.8**	48.60	45.10	**7.47**
Lead	0.0000	0.048	**0.050**	**96.0**	0.0001	0.0001	**0.00**
Magnesium	0.0	9.5	**10.0**	**95.1**	1.7	1.7	**0.00**
Manganese	0.00000	1.150	**1.00**	**115**	51.10000	50.00000	**2.18**
Potassium	0.0	9.9	**10.0**	**99.3**	3.7	3.6	**2.74**
Selenium	0.000	0.250	**0.250**	**100**	0.179	0.170	**5.16**
Silver	0.00000	0.050	**0.050**	**100**	<0.00005	<0.00005	**NC**
Sodium	0.0	481	**500**	**96.2**	194.0	190.0	**2.08**
Uranium	0.00000	0.049	**0.050**	**98.0**	0.01400	0.01400	**0.00**
Zinc	0.000	0.051	**0.050**	**102**	0.011	0.011	**0.00**

NC=Not calculated due to results less than the detection limit
NA=Data not available.

Green Analytical Laboratories

DISSOLVED METALS SRM AND BLANK DATA

LAB ID#						
0712051332+	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Arsenic	0.052	0.050	**104**	90-110 %	<0.0005	0.0005
Barium	0.051	0.050	**102**	90-110 %	<0.0005	0.0005
Boron *	5.7	5.0	**114**	90-110 %	<0.1	0.1
Cadmium	0.052	0.050	**104**	90-110 %	<0.00005	0.00005
Calcium	5.3	5.0	**106**	90-110 %	<0.5	0.5
Chromium	0.051	0.050	**102**	90-110 %	<0.001	0.001
Copper	0.050	0.050	**100**	90-110 %	<0.0001	0.0001
Iron	5.39	5.0	**108**	90-110 %	<0.05	0.05
Lead	0.049	0.050	**98.0**	90-110 %	<0.0001	0.0001
Magnesium	5.2	5.0	**104**	90-110 %	<0.5	0.5
Manganese *	2.91	2.50	**116**	90-110 %	<0.005	0.005
Potassium	10.9	10.0	**109**	90-110 %	<0.5	0.5
Selenium	0.261	0.250	**104**	90-110 %	<0.001	0.001
Silver *	0.061	0.050	**122**	90-110 %	<0.00005	0.00005
Sodium *	9.0	8.1	**111**	90-110 %	<0.5	0.5
Uranium	0.051	0.050	**102**	90-110 %	<0.00001	0.00001
Zinc	0.052	0.050	**104**	90-110 %	<0.001	0.001

NA=Data not available.

Green Analytical Laboratories

TOTAL METALS SPIKE AND DUPLICATE DATA

LAB ID#							
0712051332+	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Iron-T	0.00	4.20	**4.00**	**105**	42.9	40.6	**5.51**
Manganese-T	0.000	2.170	**2.000**	**109**	1.71	1.62	**5.41**
Mercury-T	0.0000	0.0020	**0.0020**	**100**	<0.0002	<0.0002	**NC**

NC=Not calculated due to results less than the detection limit.
NA=Data not available.

Green Analytical Laboratories

TOTAL METALS SRM AND BLANK DATA

LAB ID#						
0712051332+	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Iron-T	5.10	5.00	**102**	90-110 %	<0.05	0.05
Manganese-T	2.650	2.500	**106**	90-110 %	<0.005	0.005
Mercury-T	0.002	0.002	**100**	90-110 %	<0.0002	0.0002

NA=Data not available.

Green Analytical Laboratories

WET CHEM SPIKE AND DUPLICATE DATA

LAB ID#							
0712051332+	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Alkalinity	0	106	**100**	**106**	138	137	**0.73**
Chloride	0	101	**100**	**101**	210	206	**1.92**
EC	NMA	NMA	**NMA**	**NMA**	12400	12400	**0.00**
Fluoride	0.2	1.1	**1.0**	**89**	<0.2	<0.2	**NC**
Nitrate/Nitrite	0.04	0.13	**0.10**	**90**	0.07	0.06	**15.4**
pH	NMA	NMA	**NMA**	**NMA**	7.05	7.04	**0.14**
Sulfate	0		**50**	**0**	9800	9800	**0.00**
TDS	NMA	NMA	**NMA**	**NMA**	355	350	**1.42**

NMA=Data not applicable to Method.
NC=Not calculated due to results less than the detection limit.

Green Analytical Laboratories

WET CHEM SRM AND BLANK DATA

LAB ID#						
0712051332+	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Alkalinity	274	283	**96.8**	90-110 %	<10	10
Chloride	37	37.9	**97.6**	90-110 %	<10	10
EC	556	561	**99.1**	90-110 %	NMA	NMA
Fluoride	2.2	2.0	**110**	90-110 %	<1.0	1.0
Nitrate/Nitrite	0.54	0.50	**108**	90-110 %	<0.02	0.02
pH	8.22	8.40	**97.9**	90-110 %	NMA	NMA
Sulfate	350	321	**109**	90-110 %	<10	10
TDS	1360	1210	**112**	90-110 %	<10	10

NMA=Data not applicable to Method.

Green Analytical Laboratories

DISSOLVED METALS SPIKE AND DUPLICATE DATA

LAB ID#							
0712070915+	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Calcium	0.0	45.8	**50.0**	**91.6**	22.6	22.1	**2.24**
Iron	0.00	9.49	**10.0**	**94.9**	48.6	45.1	**7.47**
Magnesium	0.0	9.5	**10.0**	**95.0**	1.7	1.7	**0.00**
Potassium	0.0	9.9	**10.0**	**99.3**	3.7	3.6	**2.74**
Sodium	0.0	481	**500**	**96.2**	194.0	190.0	**2.08**

NC=Not calculated due to results less than the detection limit.
NA=Data not available.

Green Analytical Laboratories

DISSOLVED METALS SRM AND BLANK DATA

LAB ID#						
0712070915+	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Calcium	5.3	5.0	**105**	90-110 %	<0.5	0.5
Iron	5.40	5.0	**108**	90-110 %	<0.05	0.05
Magnesium	5.2	5.0	**104**	90-110 %	<0.5	0.5
Potassium	10.9	10.0	**109**	90-110 %	<0.5	0.5
Sodium *	9.0	8.1	**111**	90-110 %	<0.5	0.5

NA=Data not available.

Green Analytical Laboratories

WET CHEM SPIKE AND DUPLICATE DATA

LAB ID#							
0712070915+	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Alkalinity	0	104	**100**	**104**	212	210	**0.95**
Chloride	0	100	**100**	**100**	<10	<10	**NC**
EC	NMA	NMA	**NMA**	**NMA**	702	700	**0.29**
Fluoride	0.0	1.0	**1.0**	**100**	0.5	0.5	**0.00**
Nitrate/Nitrite	NA	NA	**NA**	**NA**	NA	NA	**NA**
pH	NMA	NMA	**NMA**	**NMA**	5.28	5.25	**0.57**
Sulfate	0	53	**50**	**106**	600	590	**1.68**
TDS	NMA	NMA	**NMA**	**NMA**	335	325	**3.03**

NMA=Data not applicable to Method.
NC=Not calculated due to results less than the detection limit.
NA=Data not available.

Green Analytical Laboratories

WET CHEM SRM AND BLANK DATA

LAB ID#						
0712070915+	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Alkalinity	272	283	**96.1**	90-110 %	<10	10
Chloride	38	37.9	**100**	90-110 %	<10	10
EC	547	561	**97.5**	90-110 %	NMA	NMA
Fluoride	1.0	1.0	**100**	90-110 %	<1.0	1.0
Nitrate/Nitrite	NA	NA	**NA**	90-110 %	NA	NA
pH	8.30	8.40	**98.8**	90-110 %	NMA	NMA
Sulfate	330	321	**103**	90-110 %	<10	10
TDS *	1010	1210	**83.5**	90-110 %	<10	10

NMA=Data not applicable to Method.
NA=Data not available.

Green Analytical Laboratories

DISSOLVED METALS SPIKE AND DUPLICATE DATA

LAB ID#							
802-077	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Arsenic	0.0000	0.045	**0.050**	**90.0**	0.051	0.048	**6.06**
Barium	0.0000	0.046	**0.050**	**92.0**	0.054	0.051	**5.71**
Boron	0.1	2.3	**2.0**	**108**	0.4	0.4	**0.00**
Cadmium	0.00000	0.047	**0.050**	**94.0**	0.047	0.047	**0.00**
Calcium *	0.0	6.9	**5.0**	**138**	82.5	82.0	**0.61**
Chromium	0.000	0.044	**0.050**	**88.0**	0.050	0.045	**10.5**
Copper	0.0000	0.045	**0.050**	**90.0**	0.059	0.054	**8.85**
Iron *	0.00	1.40	**1.00**	**140**	<0.05	<0.05	**NC**
Lead	0.0000	0.045	**0.050**	**90.0**	0.047	0.046	**2.15**
Magnesium *	0.0	1.4	**1.0**	**140**	9.1	9.0	**1.10**
Manganese *	0.00000	1.20	**1.00**	**120**	0.008	0.008	**0.00**
Potassium *	0.0	1.4	**1.00**	**140**	0.9	0.8	**11.8**
Selenium	0.000	0.216	**0.250**	**86.4**	0.250	0.233	**7.04**
Silver	0.00000	0.040	**0.050**	**80.0**	0.046	0.043	**6.74**
Sodium *	0.1	70.4	**50.0**	**141**	32.7	32.5	**0.61**
Uranium	0.00000	0.049	**0.050**	**98.0**	0.050	0.047	**6.19**
Zinc	0.000	0.044	**0.050**	**88.0**	0.051	0.048	**6.06**

NC=Not calculated due to results less than the detection limit
NA=Data not available.

Green Analytical Laboratories

DISSOLVED METALS SRM AND BLANK DATA

LAB ID#						
802-077	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Arsenic	0.049	0.050	**98.0**	90-110 %	<0.0005	0.0005
Barium	0.052	0.050	**104**	90-110 %	<0.0005	0.0005
Boron	5.4	5.0	**108**	90-110 %	0.1	0.1
Cadmium	0.047	0.050	**94.0**	90-110 %	<0.00005	0.00005
Calcium	4.5	5.0	**90.0**	90-110 %	<0.5	0.5
Chromium	0.046	0.050	**92.0**	90-110 %	<0.001	0.001
Copper	0.055	0.050	**110**	90-110 %	<0.0001	0.0001
Iron	4.91	5.00	**98.2**	90-110 %	<0.05	0.05
Lead	0.049	0.050	**98.0**	90-110 %	<0.0001	0.0001
Magnesium	4.6	5.0	**92.0**	90-110 %	<0.5	0.5
Manganese	2.70	2.50	**108**	90-110 %	<0.005	0.005
Potassium	9.7	10.0	**97.0**	90-110 %	<0.5	0.5
Selenium	0.239	0.250	**95.6**	90-110 %	<0.001	0.001
Silver	0.045	0.050	**90.0**	90-110 %	<0.00005	0.00005
Sodium	7.9	8.1	**97.5**	90-110 %	<0.5	0.5
Uranium	0.053	0.050	**106**	90-110 %	<0.00001	0.00001
Zinc	0.046	0.050	**92.0**	90-110 %	<0.001	0.001

NA=Data not available.

Green Analytical Laboratories

TOTAL METALS SPIKE AND DUPLICATE DATA

LAB ID#							
802-077	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Iron-T	0.20	3.70	**4.00**	**87.5**	9.60	9.40	**2.11**
Manganese-T	0.020	1.90	**2.00**	**94.0**	5.100	5.000	**1.98**
Mercury-T	0.0000	0.0020	**0.0020**	**100**	<0.0002	<0.0002	**NC**

NC=Not calculated due to results less than the detection limit.
NA=Data not available.

Green Analytical Laboratories

TOTAL METALS SRM AND BLANK DATA

LAB ID#						
802-077	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Iron-T	5.24	5.00	**105**	90-110 %	<0.05	0.05
Manganese-T	2.700	2.500	**108**	90-110 %	<0.005	0.005
Mercury-T	0.002	0.002	**100**	90-110 %	<0.0002	0.0002

NA=Data not available.

Green Analytical Laboratories

WET CHEM SPIKE AND DUPLICATE DATA

LAB ID#							
802-077	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Alkalinity	0	101	**100**	**101**	1320	1290	**2.30**
Chloride	0	109	**100**	**109**	10	10	**0.00**
EC	NMA	NMA	**NMA**	**NMA**	NA	NA	**NA**
Fluoride	0.0	0.9	**1.0**	**90**	1.0	1.0	**0.00**
Nitrate/Nitrite	0.03	0.12	**0.10**	**90**	11.80	11.50	**2.58**
pH	NMA	NMA	**NMA**	**NMA**	8.11	8.08	**0.37**
Sulfate	0	48	**50**	**96**	90	88	**2.25**
TDS	NMA	NMA	**NMA**	**NMA**	460	450	**2.20**

NMA=Data not applicable to Method.
NC=Not calculated due to results less than the detection limit.
NA=Data not available.

Green Analytical Laboratories

WET CHEM SRM AND BLANK DATA

LAB ID#						
802-077	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Alkalinity	179	186	**96.2**	90-110 %	<10	10
Chloride	27	24.7	**109**	90-110 %	<10	10
EC	536	561	**95.5**	90-110 %	NMA	NMA
Fluoride	2.0	2.0	**100**	90-110 %	<1.0	1.0
Nitrate/Nitrite	0.52	0.50	**104**	90-110 %	<0.02	0.02
pH	8.35	8.40	**99.4**	90-110 %	NMA	NMA
Sulfate	340	321	**106**	90-110 %	<10	10
TDS	1320	1210	**109**	90-110 %	<10	10

NMA=Data not applicable to Method.
NA=Data not available.

Green Analytical Laboratories

DISSOLVED METALS SPIKE AND DUPLICATE DATA

LAB ID#							
802-089	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Arsenic	0.0000	0.043	**0.050**	**86.0**	0.0011	0.0010	**9.52**
Barium	0.0000	0.044	**0.050**	**88.0**	0.0151	0.0150	**0.66**
Boron	0.1	2.3	**2.0**	**110**	0.4	0.4	**0.00**
Cadmium	0.00000	0.044	**0.050**	**88.0**	<0.00005	<0.00005	**NC**
Calcium *	0.0	6.9	**5.0**	**138**	82.5	82.0	**0.61**
Chromium	0.000	0.041	**0.050**	**82.0**	0.005	0.005	**0.00**
Copper	0.0000	0.047	**0.050**	**94.0**	0.0161	0.0161	**0.00**
Iron *	0.00	1.40	**1.00**	**140**	<0.05	<0.05	**NC**
Lead	0.0000	0.043	**0.050**	**86.0**	0.0001	0.0001	**0.00**
Magnesium *	0.0	1.4	**1.0**	**140**	9.1	9.0	**1.10**
Manganese	0.00000	1.200	**1.00**	**120**	0.00800	0.00800	**0.00**
Potassium *	0.0	1.4	**1.0**	**140**	0.9	0.8	**11.8**
Selenium	0.000	0.222	**0.250**	**88.8**	0.012	0.012	**0.00**
Silver	0.00000	0.041	**0.050**	**82.0**	<0.00005	<0.00005	**NC**
Sodium *	0.1	70.4	**50.0**	**141**	32.7	32.5	**0.61**
Uranium	0.00000	0.045	**0.050**	**90.0**	0.02240	0.02140	**4.57**
Zinc	0.000	0.042	**0.050**	**84.0**	0.075	0.074	**1.34**

NC=Not calculated due to results less than the detection limit
NA=Data not available.

Green Analytical Laboratories

DISSOLVED METALS SRM AND BLANK DATA

LAB ID#						
802-089	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Arsenic	0.048	0.050	**96.0**	90-110 %	<0.0005	0.0005
Barium *	0.044	0.050	**88.0**	90-110 %	<0.0005	0.0005
Boron	5.4	5.0	**108**	90-110 %	0.1	0.1
Cadmium	0.049	0.050	**98.0**	90-110 %	<0.00005	0.00005
Calcium	4.5	5.0	**90.0**	90-110 %	<0.5	0.5
Chromium	0.046	0.050	**92.0**	90-110 %	<0.001	0.001
Copper *	0.043	0.050	**86.0**	90-110 %	<0.0001	0.0001
Iron	5.24	5.00	**105**	90-110 %	<0.05	0.05
Lead *	0.044	0.050	**88.0**	90-110 %	<0.0001	0.0001
Magnesium	4.6	5.0	**92.0**	90-110 %	<0.5	0.5
Manganese	2.73	2.50	**109**	90-110 %	<0.005	0.005
Potassium	9.7	10.0	**97.0**	90-110 %	<0.5	0.5
Selenium	0.261	0.250	**104**	90-110 %	<0.001	0.001
Silver	0.050	0.050	**100**	90-110 %	<0.00005	0.00005
Sodium	7.9	8.1	**97.3**	90-110 %	<0.5	0.5
Uranium	0.048	0.050	**96.0**	90-110 %	<0.00001	0.00001
Zinc	0.050	0.050	**100**	90-110 %	<0.001	0.001

NA=Data not available.

Green Analytical Laboratories

TOTAL METALS SPIKE AND DUPLICATE DATA

LAB ID#							
802-089	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Iron-T	0.00	3.70	**4.00**	**92.5**	9.60	9.40	**2.11**
Manganese-T	0.020	1.90	**2.00**	**94.0**	5.10	5.00	**1.98**
Mercury-T	0.0000	0.002	**0.002**	**100**	<0.0002	<0.0002	**NC**

NC=Not calculated due to results less than the detection limit.
NA=Data not available.

Green Analytical Laboratories

TOTAL METALS SRM AND BLANK DATA

LAB ID#						
802-089	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Iron-T	5.24	5.00	**105**	90-110 %	<0.05	0.05
Manganese-T	2.73	2.50	**109**	90-110 %	<0.005	0.005
Mercury-T	0.002	0.002	**100**	90-110 %	<0.0002	0.0002

NA=Data not available.

Green Analytical Laboratories

WET CHEM SPIKE AND DUPLICATE DATA

LAB ID#							
802-089	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Alkalinity	0	101	**100**	**101**	226	222	**1.79**
Chloride	0	109	**100**	**109**	32	32	**0.00**
EC	NMA	NMA	**NMA**	**NMA**	NA	NA	**NA**
Fluoride	0.0	0.9	**1.0**	**90**	0.3	0.3	**0.00**
Nitrate/Nitrite	0.03	0.13	**0.10**	**100**	11.8	11.5	**2.58**
pH	NMA	NMA	**NMA**	**NMA**	5.90	5.86	**0.68**
Sulfate	0	48	**50**	**96**	90	88	**2.25**
TDS	NMA	NMA	**NMA**	**NMA**	460	450	**2.20**

NMA=Data not applicable to Method.
NC=Not calculated due to results less than the detection limit.
NA=Data not available.

Green Analytical Laboratories

WET CHEM SRM AND BLANK DATA

LAB ID#						
802-089	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Alkalinity	179	186	**96**	90-110 %	<10	10
Chloride	27	24.7	**109**	90-110 %	<10	10
EC	539	561	**96**	90-110 %	NMA	NMA
Fluoride	1.0	1.0	**100**	90-110 %	<1.0	1.0
Nitrate/Nitrite	0.52	0.50	**104**	90-110 %	<0.02	0.02
pH	8.35	8.40	**99**	90-110 %	NMA	NMA
Sulfate	340	321	**106**	90-110 %	<10	10
TDS	1320	1210	**109**	90-110 %	<10	10

NMA=Data not applicable to Method.

Green Analytical Laboratories

DISSOLVED METALS SPIKE AND DUPLICATE DATA

LAB ID#							
802-039	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Arsenic	0.0000	0.045	**0.050**	**90.0**	0.0005	0.0005	**0.00**
Barium	0.0000	0.044	**0.050**	**88.0**	0.0080	0.0080	**0.00**
Boron *	0.0	2.0	**2.0**	**100**	0.17	0.13	**26.7**
Cadmium	0.00000	0.045	**0.050**	**90.0**	0.00011	0.00010	**9.52**
Calcium	0.0	51.3	**50.0**	**103**	110.0	109.0	**0.91**
Chromium	0.000	0.046	**0.050**	**92.0**	<0.001	<0.001	**NC**
Copper	0.0001	0.047	**0.050**	**93.8**	0.0060	0.0060	**0.00**
Iron	0.00	9.76	**10.0**	**97.6**	0.08	0.08	**0.00**
Lead	0.0001	0.042	**0.050**	**83.8**	0.0007	0.0007	**0.00**
Magnesium	0.0	9.7	**10.0**	**97.0**	7.3	7.3	**0.00**
Manganese	0.00000	1.110	**1.00**	**111**	0.00900	0.00800	**11.8**
Potassium	0.0	9.6	**10.0**	**96.0**	1.7	1.7	**0.00**
Selenium	0.000	0.226	**0.250**	**90.4**	<0.001	<0.001	**NC**
Silver	0.00000	0.044	**0.050**	**88.0**	<0.0005	<0.0005	**NC**
Sodium	0.0	484	**500**	**96.8**	320.0	314.0	**1.89**
Uranium	0.00000	0.044	**0.050**	**88.0**	0.00030	0.00030	**0.00**
Zinc	0.000	0.045	**0.050**	**90.0**	0.023	0.023	**0.00**

NC=Not calculated due to results less than the detection limit
NA=Data not available.

Green Analytical Laboratories

DISSOLVED METALS SRM AND BLANK DATA

LAB ID#						
802-039	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Arsenic	0.045	0.050	**90.0**	90-110 %	<0.0005	0.0005
Barium	0.049	0.050	**98.0**	90-110 %	<0.0005	0.0005
Boron	5.1	5.0	**102**	90-110 %	<0.1	0.1
Cadmium	0.049	0.050	**98.0**	90-110 %	<0.00005	0.00005
Calcium	5.2	5.00	**104**	90-110 %	<0.5	0.5
Chromium	0.049	0.050	**98.0**	90-110 %	<0.001	0.001
Copper	0.049	0.050	**98.0**	90-110 %	0.0001	0.0001
Iron	5.19	5.00	**104**	90-110 %	<0.05	0.05
Lead	0.045	0.050	**90.0**	90-110 %	0.0001	0.0001
Magnesium	4.8	5.0	**96.0**	90-110 %	<0.5	0.5
Manganese	2.65	2.50	**106**	90-110 %	<0.005	0.005
Potassium	10.1	10.0	**101**	90-110 %	<0.5	0.5
Selenium	0.233	0.250	**93.2**	90-110 %	<0.001	0.001
Silver	0.044	0.050	**88.0**	90-110 %	<0.00005	0.00005
Sodium	8.8	8.1	**109**	90-110 %	<0.5	0.5
Uranium	0.048	0.050	**96.0**	90-110 %	<0.00001	0.00001
Zinc	0.049	0.050	**98.0**	90-110 %	<0.001	0.001

NA=Data not available.

Green Analytical Laboratories

TOTAL METALS SPIKE AND DUPLICATE DATA

LAB ID#							
802-039	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Iron-T	0.00	3.76	**4.00**	**94.0**	6.01	5.61	**6.88**
Manganese-T	0.000	1.97	**2.00**	**98.5**	1.29	1.27	**1.56**
Mercury-T	0.0000	0.0020	**0.0020**	**100**	<0.0002	<0.0002	**NC**

NC=Not calculated due to results less than the detection limit.
NA=Data not available.

Green Analytical Laboratories

TOTAL METALS SRM AND BLANK DATA

LAB ID#						
802-039	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Iron-T	5.21	5.00	**104**	90-110 %	<0.05	0.05
Manganese-T	2.730	2.500	**109**	90-110 %	<0.005	0.005
Mercury-T *	0.002	0.002	**118**	90-110 %	<0.0002	0.0002

NA=Data not available.

Green Analytical Laboratories

WET CHEM SPIKE AND DUPLICATE DATA

LAB ID#							
802-039	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Alkalinity	0	102	**100**	**102**	308	306	**0.65**
Chloride	0	101	**100**	**101**	<10	<10	**NC**
EC	NMA	NMA	**NMA**	**NMA**	NA	NA	**NA**
Fluoride	1.7	2.7	**1.0**	**106**	0.5	0.5	**0.00**
Nitrate/Nitrite	0.17	0.27	**0.10**	**100**	6.03	5.91	**2.01**
pH	NMA	NMA	**NMA**	**NMA**	7.44	7.41	**0.40**
Sulfate	0		**50**	**0**	104	104	**0.00**
TDS	NMA	NMA	**NMA**	**NMA**	1200	1180	**1.68**

NMA=Data not applicable to Method.
NC=Not calculated due to results less than the detection limit.
NA=Data not available.

Green Analytical Laboratories

WET CHEM SRM AND BLANK DATA

LAB ID#						
802-039	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Alkalinity	176	186	**94.6**	90-110 %	<10	10
Chloride	25	24.7	**101**	90-110 %	<10	10
EC	527	561	**93.9**	90-110 %	NMA	NMA
Fluoride	2.0	2.0	**100**	90-110 %	<1.0	1.0
Nitrate/Nitrite	0.50	0.50	**100**	90-110 %	<0.02	0.02
pH	8.36	8.40	**100**	90-110 %	NMA	NMA
Sulfate	320	321	**99.7**	90-110 %	<10	10
TDS	1180	1210	**97.5**	90-110 %	<10	10

NMA=Data not applicable to Method.

Green Analytical Laboratories

DISSOLVED METALS SPIKE AND DUPLICATE DATA

LAB ID#							
805-117	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Arsenic	0.0000	0.053	**0.050**	**106**	<0.0005	<0.0005	**NC**
Barium	0.0000	0.046	**0.050**	**92.0**	0.0250	0.0240	**4.08**
Boron	0.0	2.0	**2.0**	**100**	0.7	0.7	**0.00**
Cadmium	0.00000	0.050	**0.050**	**100**	<0.00005	<0.00005	**NC**
Calcium	0.0	5.5	**5.0**	**110**	89.8	89.7	**0.11**
Chromium	0.000	0.050	**0.050**	**100**	0.004	0.004	**0.00**
Copper	0.0000	0.050	**0.050**	**100**	0.4300	0.4030	**6.48**
Iron	0.00	1.09	**1.00**	**109**	<0.05	<0.05	**NC**
Lead	0.0000	0.050	**0.050**	**100**	0.0003	0.0003	**0.00**
Magnesium	0.0	1.1	**1.0**	**110**	13.1	13.1	**0.00**
Manganese	0.00000	1.060	**1.00**	**106**	0.05100	0.05100	**0.00**
Potassium	0.0	1.0	**1.0**	**100**	0.8	0.8	**0.00**
Selenium *	0.000	0.261	**0.250**	**104**	0.007	0.005	**33.3**
Silver	0.00000	0.047	**0.050**	**94.0**	0.00006	0.00005	**18.2**
Sodium	0.0	54.7	**50.0**	**109**	52.0	51.8	**0.39**
Uranium	0.00000	0.050	**0.050**	**100**	0.01060	0.00950	**10.9**
Zinc	0.000	0.054	**0.050**	**108**	0.024	0.022	**8.70**

NC=Not calculated due to results less than the detection limit.
NA=Data not available.

Green Analytical Laboratories

DISSOLVED METALS SRM AND BLANK DATA

LAB ID#						
805-117	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Arsenic	0.053	0.050	**106**	90-110 %	<0.0005	0.0005
Barium	0.053	0.050	**106**	90-110 %	<0.0005	0.0005
Boron	5.1	5.0	**102**	90-110 %	<0.1	0.1
Cadmium	0.051	0.050	**102**	90-110 %	<0.00005	0.00005
Calcium	5.1	5.00	**102**	90-110 %	<0.5	0.5
Chromium	0.051	0.050	**102**	90-110 %	<0.001	0.001
Copper	0.050	0.050	**100**	90-110 %	<0.0001	0.0001
Iron	5.42	5.00	**108**	90-110 %	<0.05	0.05
Lead	0.051	0.050	**102**	90-110 %	<0.0001	0.0001
Magnesium	5.0	5.0	**100**	90-110 %	<0.5	0.5
Manganese	2.54	2.50	**102**	90-110 %	<0.005	0.005
Potassium	10.3	10.0	**103**	90-110 %	<0.5	0.5
Selenium	0.257	0.250	**103**	90-110 %	<0.001	0.001
Silver *	0.059	0.050	**118**	90-110 %	<0.00005	0.00005
Sodium	8.7	8.1	**107**	90-110 %	<0.5	0.5
Uranium	0.052	0.050	**104**	90-110 %	<0.00001	0.00001
Zinc	0.050	0.050	**100**	90-110 %	<0.001	0.001

NA=Data not available.

Green Analytical Laboratories

TOTAL METALS SPIKE AND DUPLICATE DATA

LAB ID#							
805-117	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Iron-T	0.00	3.96	**4.00**	**99.0**	4.13	4.09	**0.97**
Manganese-T	0.000	1.94	**2.00**	**97.0**	0.035	0.034	**2.90**
Mercury-T	0.0000	0.0022	**0.0020**	**110**	<0.0002	<0.0002	**NC**

NC=Not calculated due to results less than the detection limit.
NA=Data not available.

Green Analytical Laboratories

TOTAL METALS SRM AND BLANK DATA

LAB ID#						
805-117	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Iron-T	5.23	5.00	**105**	90-110 %	0.06	0.05
Manganese-T	2.540	2.500	**102**	90-110 %	<0.005	0.005
Mercury-T	0.002	0.002	**100**	90-110 %	<0.0002	0.0002

NA=Data not available.

Green Analytical Laboratories

WET CHEM SPIKE AND DUPLICATE DATA

LAB ID#							
805-117	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Alkalinity	0	108	**100**	**108**	238	238	**0.00**
Chloride	0	99	**100**	**99**	11	11	**0.00**
EC	NMA	NMA	**NMA**	**NMA**	515	510	**0.98**
Fluoride	0.0	1.0	**1.0**	**100**	1.3	1.3	**0.00**
Nitrate/Nitrite	0.04	0.13	**0.10**	**90**	0.07	0.06	**15.4**
pH	NMA	NMA	**NMA**	**NMA**	7.79	7.75	**0.51**
Sulfate	0	54	**50**	**108**	3300	3300	**0.00**
TDS	NMA	NMA	**NMA**	**NMA**	3120	3080	**1.29**

NMA=Data not applicable to Method.
NC=Not calculated due to results less than the detection limit.

Green Analytical Laboratories

WET CHEM SRM AND BLANK DATA

LAB ID#						
805-117	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Alkalinity	187	186	**101**	90-110 %	<10	10
Chloride	25	24.7	**101**	90-110 %	<10	10
EC	826	829	**100**	90-110 %	NMA	NMA
Fluoride	0.9	1.0	**90.0**	90-110 %	<1.0	1.0
Nitrate/Nitrite	0.51	0.50	**102**	90-110 %	<0.02	0.02
pH	9.11	9.29	**98.1**	90-110 %	NMA	NMA
Sulfate	325	321	**101**	90-110 %	<10	10
TDS	1100	1170	**94.0**	90-110 %	<10	10

NMA=Data not applicable to Method.

Green Analytical Laboratories

DISSOLVED METALS SPIKE AND DUPLICATE DATA

LAB ID#							
805-126	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Arsenic	0.0000	0.053	**0.050**	**106**	<0.0005	<0.0005	**NC**
Barium	0.0000	0.046	**0.050**	**92.0**	0.0250	0.0240	**4.08**
Boron	0.0	2.0	**2.0**	**100**	0.7	0.7	**0.00**
Cadmium	0.00000	0.050	**0.050**	**100**	<0.00005	<0.00005	**NC**
Calcium	0.0	5.4	**5.0**	**108**	89.8	89.7	**0.11**
Chromium	0.000	0.050	**0.050**	**100**	0.004	0.004	**0.00**
Copper	0.0000	0.050	**0.050**	**100**	0.0432	0.0430	**0.46**
Iron	0.00	1.09	**1.00**	**109**	<0.05	<0.05	**NC**
Lead	0.0000	0.050	**0.050**	**100**	0.0003	0.0003	**0.00**
Magnesium	0.0	1.1	**1.0**	**110**	13.1	13.1	**0.00**
Manganese	0.00000	1.060	**1.00**	**106**	0.05100	0.05100	**0.00**
Potassium	0.0	1.0	**1.0**	**100**	0.8	0.8	**0.00**
Selenium *	0.000	0.261	**0.250**	**104**	0.007	0.005	**33.3**
Silver	0.00000	0.047	**0.050**	**94.0**	0.00006	0.00005	**18.2**
Sodium	0.0	54.7	**50.0**	**109**	52.0	51.8	**0.39**
Uranium	0.00000	0.050	**0.050**	**100**	0.01060	0.00950	**10.9**
Zinc	0.000	0.054	**0.050**	**108**	0.024	0.022	**8.70**

NC=Not calculated due to results less than the detection limit.
NA=Data not available.

Green Analytical Laboratories

DISSOLVED METALS SRM AND BLANK DATA

LAB ID#						
805-126	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Arsenic	0.053	0.050	**106**	90-110 %	<0.0005	0.0005
Barium	0.053	0.050	**106**	90-110 %	<0.0005	0.0005
Boron	5.1	5.0	**102**	90-110 %	<0.1	0.1
Cadmium	0.051	0.050	**102**	90-110 %	<0.00005	0.00005
Calcium	5.1	5.0	**102**	90-110 %	<0.5	0.5
Chromium	0.051	0.050	**102**	90-110 %	<0.001	0.001
Copper	0.050	0.050	**100**	90-110 %	<0.0001	0.0001
Iron	5.42	5.00	**108**	90-110 %	<0.05	0.05
Lead	0.051	0.050	**102**	90-110 %	<0.0001	0.0001
Magnesium	5.0	5.0	**100**	90-110 %	<0.5	0.5
Manganese	2.54	2.50	**102**	90-110 %	<0.005	0.005
Potassium	10.3	10.0	**103**	90-110 %	<0.5	0.5
Selenium	0.257	0.250	**103**	90-110 %	<0.001	0.001
Silver *	0.059	0.050	**118**	90-110 %	<0.00005	0.00005
Sodium	8.7	8.1	**107**	90-110 %	<0.5	0.5
Uranium	0.052	0.050	**104**	90-110 %	<0.00001	0.00001
Zinc	0.052	0.050	**104**	90-110 %	<0.001	0.001

NA=Data not available.

Green Analytical Laboratories

TOTAL METALS SPIKE AND DUPLICATE DATA

LAB ID#							
805-126	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Iron-T	0.00	4.18	**4.00**	**105**	1.32	1.30	**1.53**
Manganese-T	0.000	1.06	**1.00**	**106**	0.051	0.051	**0.00**
Mercury-T	0.0000	0.0022	**0.0020**	**110**	<0.0002	<0.0002	**NC**

NC=Not calculated due to results less than the detection limit.
NA=Data not available.

Green Analytical Laboratories

TOTAL METALS SRM AND BLANK DATA

LAB ID#						
805-126	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Iron-T	5.05	5.00	**101**	90-110 %	<0.05	0.05
Manganese-T	2.660	2.500	**106**	90-110 %	<0.005	0.005
Mercury-T	0.002	0.002	**100**	90-110 %	<0.0002	0.0002

NA=Data not available.

Green Analytical Laboratories

WET CHEM SPIKE AND DUPLICATE DATA

LAB ID#							
805-126	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Alkalinity	0	108	**100**	**108**	238	238	**0.00**
Chloride	0	99	**100**	**99**	11	11	**0.00**
EC	NMA	NMA	**NMA**	**NMA**	515	510	**0.98**
Fluoride	0.0	1.0	**1.0**	**100**	1.3	1.3	**0.00**
Nitrate/Nitrite	0.04	0.13	**0.10**	**90**	0.08	0.08	**0.00**
pH	NMA	NMA	**NMA**	**NMA**	7.79	7.75	**0.51**
Sulfate	0	54	**50**	**108**	3300	3300	**0.00**
TDS	NMA	NMA	**NMA**	**NMA**	3120	3080	**1.29**

NMA=Data not applicable to Method.
NC=Not calculated due to results less than the detection limit.

Green Analytical Laboratories

WET CHEM SRM AND BLANK DATA

LAB ID#						
805-126	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Alkalinity	187	186	**101**	90-110 %	<10	10
Chloride	25	24.7	**101**	90-110 %	<10	10
EC	826	829	**100**	90-110 %	NMA	NMA
Fluoride	0.9	1.0	**90**	90-110 %	<1.0	1.0
Nitrate/Nitrite	0.51	0.50	**102**	90-110 %	<0.02	0.02
pH	9.11	9.29	**98**	90-110 %	NMA	NMA
Sulfate	325	321	**101**	90-110 %	<10	10
TDS	1100	1170	**94**	90-110 %	<10	10

NMA=Data not applicable to Method.

Green Analytical Laboratories

DISSOLVED METALS SPIKE AND DUPLICATE DATA

LAB ID#							
808-094	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Arsenic	0.0000	0.053	**0.050**	**106**	0.0042	0.0040	**4.88**
Barium	0.0000	0.049	**0.050**	**98.0**	0.0977	0.0945	**3.33**
Boron	0.0	2.3	**2.0**	**117**	0.1	0.1	**0.00**
Cadmium	0.00000	0.051	**0.050**	**102**	0.00107	0.00100	**6.76**
Calcium	0.0	5.8	**5.0**	**116**	120.0	120.0	**0.00**
Chromium	0.000	0.052	**0.050**	**104**	<0.001	<0.001	**NC**
Copper	0.0000	0.052	**0.050**	**104**	0.0068	0.0063	**7.63**
Iron	0.00	1.17	**1.00**	**117**	0.10	0.09	**10.5**
Lead	0.0000	0.056	**0.050**	**112**	0.0016	0.0015	**3.28**
Magnesium	0.0	1.2	**1.0**	**120**	14.7	14.6	**0.68**
Manganese *	0.00000	1.24	**1.00**	**124**	0.00900	0.00900	**0.00**
Potassium	0.0	1.1	**1.0**	**106**	10.8	10.8	**0.00**
Selenium	0.000	0.276	**0.250**	**110**	0.001	<0.001	**NC**
Silver	0.00000	0.052	**0.050**	**104**	<0.00005	<0.00005	**NC**
Sodium	0.0	59.7	**50.0**	**119**	55.1	54.9	**0.36**
Uranium	0.00000	0.056	**0.050**	**112**	0.00427	0.00427	**0.00**
Zinc	0.000	0.056	**0.050**	**112**	0.009	0.009	**0.00**

NC=Not calculated due to results less than the detection limit.
NA=Data not available.

Green Analytical Laboratories

DISSOLVED METALS SRM AND BLANK DATA

LAB ID#						
808-094	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Arsenic	0.047	0.050	**94.0**	90-110 %	<0.0005	0.0005
Barium	0.049	0.050	**98.0**	90-110 %	<0.0005	0.0005
Boron	5.3	5.0	**106**	90-110 %	<0.1	0.1
Cadmium	0.048	0.050	**96.0**	90-110 %	<0.00005	0.00005
Calcium	5.1	5.0	**102**	90-110 %	<0.5	0.5
Chromium	0.050	0.050	**100**	90-110 %	<0.001	0.001
Copper	0.048	0.050	**96.0**	90-110 %	<0.0001	0.0001
Iron	5.38	5.00	**108**	90-110 %	<0.05	0.05
Lead	0.049	0.050	**98.0**	90-110 %	<0.0001	0.0001
Magnesium	5.0	5.0	**100**	90-110 %	<0.5	0.5
Manganese	2.69	2.50	**108**	90-110 %	<0.005	0.005
Potassium	10.3	10.1	**102**	90-110 %	<0.5	0.5
Selenium	0.239	0.250	**95.6**	90-110 %	<0.001	0.001
Silver	0.051	0.050	**102**	90-110 %	<0.00005	0.00005
Sodium	8.7	8.1	**107**	90-110 %	<0.5	0.5
Uranium	0.049	0.050	**98.0**	90-110 %	<0.00001	0.00001
Zinc	0.047	0.050	**94.0**	90-110 %	<0.001	0.001

NA=Data not available.

Green Analytical Laboratories

TOTAL METALS SPIKE AND DUPLICATE DATA

LAB ID#							
808-094	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Iron-T	0.00	3.94	**4.00**	**98.5**	7.10	7.00	**1.42**
Manganese-T	0.000	2.05	**2.00**	**103**	4.400	4.300	**2.30**
Mercury-T	0.0000	0.0022	**0.0020**	**110**	<0.0005	<0.0005	**NC**

NC=Not calculated due to results less than the detection limit.
NA=Data not available.

Green Analytical Laboratories

TOTAL METALS SRM AND BLANK DATA

LAB ID#						
808-094	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Iron-T	5.09	5.00	**102**	90-110 %	<0.05	0.05
Manganese-T	2.65	2.50	**106**	90-110 %	<0.005	0.005
Mercury-T	0.002	0.002	**100**	90-110 %	<0.0002	0.0002

NA=Data not available.

Green Analytical Laboratories

WET CHEM SPIKE AND DUPLICATE DATA

LAB ID#							
808-094	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Alkalinity	0	106	**100**	**106**	182	180	**1.10**
Chloride	0	105	**100**	**105**	1210	1180	**2.51**
EC	NMA	NMA	**NMA**	**NMA**	386	385	**0.26**
Fluoride	0.0	0.9	**1.0**	**90**	3.1	2.9	**6.67**
Nitrate/Nitrite	0.00	0.11	**0.10**	**110**	0.04	0.04	**0.00**
pH	NMA	NMA	**NMA**	**NMA**	7.79	7.78	**0.13**
Sulfate	0	54	**50**	**108**	3050	2950	**3.33**
TDS	NMA	NMA	**NMA**	**NMA**	240	225	**6.45**

NMA=Data not applicable to Method.
NC=Not calculated due to results less than the detection limit.

Green Analytical Laboratories

WET CHEM SRM AND BLANK DATA

LAB ID#						
808-094	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Alkalinity	360	339	**106**	90-110 %	<10	10
Chloride	23	22.8	**101**	90-110 %	<10	10
EC *	NA	NA	**NA**	90-110 %	NMA	NMA
Fluoride	1.0	1.0	**100**	90-110 %	<1.0	1.0
Nitrate/Nitrite	0.50	0.50	**100**	90-110 %	<0.02	0.02
pH	9.05	8.90	**102**	90-110 %	NMA	NMA
Sulfate	340	321	**106**	90-110 %	<10	10
TDS	5040	4850	**104**	90-110 %	<10	10

NMA=Data not applicable to Method.
NA=Data not available.

Green Analytical Laboratories

DISSOLVED METALS SPIKE AND DUPLICATE DATA

LAB ID#							
808-103	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Arsenic	0.0000	0.053	**0.050**	**106**	0.0042	0.0040	**4.88**
Barium	0.0000	0.049	**0.050**	**98.0**	0.0977	0.0945	**3.33**
Boron	0.0	2.3	**2.000**	**117**	0.1	0.1	**0.00**
Cadmium	0.00000	0.051	**0.050**	**102**	0.00107	0.00100	**6.76**
Calcium	0.0	5.8	**5.0**	**116**	120.0	120.0	**0.00**
Chromium	0.000	0.052	**0.050**	**104**	<0.001	<0.001	**NC**
Copper	0.0000	0.052	**0.050**	**104**	0.0068	0.0063	**7.63**
Iron	0.00	1.17	**1.00**	**117**	0.10	0.09	**10.5**
Lead	0.0000	0.056	**0.050**	**112**	0.0016	0.0015	**3.28**
Magnesium	0.0	1.2	**1.0**	**120**	14.7	14.6	**0.68**
Manganese *	0.00000	1.24	**1.00**	**124**	0.00900	0.00900	**0.00**
Potassium	0.0	1.1	**1.0**	**110**	10.8	10.8	**0.00**
Selenium	0.000	0.276	**0.250**	**110**	0.001	<0.001	**NC**
Silver	0.00000	0.052	**0.050**	**104**	<0.00005	<0.00005	**NC**
Sodium	0.0	59.7	**50.0**	**119**	55.1	54.9	**0.36**
Uranium	0.00000	0.056	**0.050**	**112**	0.00427	0.00427	**0.00**
Zinc	0.000	0.056	**0.050**	**112**	0.009	0.009	**0.00**

NC=Not calculated due to results less than the detection limit.
NA=Data not available.

Green Analytical Laboratories

DISSOLVED METALS SRM AND BLANK DATA

LAB ID#						
808-103	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Arsenic	0.047	0.050	**94.0**	90-110 %	<0.0005	0.0005
Barium	0.049	0.050	**98.0**	90-110 %	<0.0005	0.0005
Boron	5.3	5.0	**106**	90-110 %	<0.1	0.1
Cadmium	0.048	0.050	**96.0**	90-110 %	<0.00005	0.00005
Calcium	5.1	5.0	**102**	90-110 %	<0.5	0.5
Chromium	0.050	0.050	**100**	90-110 %	<0.001	0.001
Copper	0.048	0.050	**96.0**	90-110 %	<0.0001	0.0001
Iron	5.38	5.00	**108**	90-110 %	<0.05	0.05
Lead	0.049	0.050	**98.0**	90-110 %	<0.0001	0.0001
Magnesium	5.0	5.0	**100**	90-110 %	<0.5	0.5
Manganese	2.69	2.50	**108**	90-110 %	<0.005	0.005
Potassium	10.3	10.0	**103**	90-110 %	<0.5	0.5
Selenium	0.239	0.250	**95.6**	90-110 %	<0.001	0.001
Silver	0.051	0.050	**102**	90-110 %	<0.00005	0.00005
Sodium	8.7	8.1	**107**	90-110 %	<0.5	0.5
Uranium	0.049	0.050	**98.0**	90-110 %	<0.00001	0.00001
Zinc	0.047	0.050	**94.0**	90-110 %	<0.001	0.001

NA=Data not available.

Green Analytical Laboratories

TOTAL METALS SPIKE AND DUPLICATE DATA

LAB ID#							
808-103	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Iron-T	0.00	3.94	**4.00**	**98.5**	7.10	7.00	**1.42**
Manganese-T	0.000	2.05	**2.00**	**103**	4.40	4.30	**2.30**
Mercury-T	0.0000	0.0022	**0.0020**	**110**	<0.0002	<0.0002	**NC**

NC=Not calculated due to results less than the detection limit.
NA=Data not available.

Green Analytical Laboratories

TOTAL METALS SRM AND BLANK DATA

LAB ID#						
808-103	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Iron-T	5.09	5.00	**102**	90-110 %	<0.05	0.05
Manganese-T	2.65	2.50	**106**	90-110 %	<0.005	0.005
Mercury-T	0.002	0.002	**100**	90-110 %	<0.0002	0.0002

NA=Data not available.

Green Analytical Laboratories

WET CHEM SPIKE AND DUPLICATE DATA

LAB ID#							
808-103	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Alkalinity	0	111	**100**	**111**	405	400	**1.24**
Chloride	0	105	**100**	**105**	1210	1180	**2.51**
EC	NMA	NMA	**NMA**	**NMA**	894	885	**1.01**
Fluoride	0.0	0.9	**1.0**	**90**	3.1	2.9	**6.67**
Nitrate/Nitrite	0.00	0.11	**0.10**	**110**	0.04	0.04	**0.00**
pH	NMA	NMA	**NMA**	**NMA**	8.07	8.07	**0.00**
Sulfate	0	54	**50**	**108**	3400	3300	**2.99**
TDS	NMA	NMA	**NMA**	**NMA**	255	255	**0.00**

NMA=Data not applicable to Method.
NC=Not calculated due to results less than the detection limit.

Green Analytical Laboratories

WET CHEM SRM AND BLANK DATA

LAB ID#						
808-103	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Alkalinity	348	339	**103**	90-110 %	<10	10
Chloride	23	22.8	**101**	90-110 %	<10	10
EC	NA	NA	**NA**	90-110 %	NMA	NMA
Fluoride	1.0	1.0	**100**	90-110 %	<1.0	1.0
Nitrate/Nitrite	0.50	0.50	**100**	90-110 %	<0.02	0.02
pH	9.02	8.90	**101**	90-110 %	NMA	NMA
Sulfate	340	321	**106**	90-110 %	<10	10
TDS	1060	1170	**90.6**	90-110 %	<10	10

NMA=Data not applicable to Method.
NA=Data not available.

Green Analytical Laboratories

DISSOLVED METALS SPIKE AND DUPLICATE DATA

LAB ID#							
811-106	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Arsenic	0.0000	0.051	**0.050**	**102**	0.0019	0.0016	**17.1**
Barium	0.0000	0.050	**0.050**	**100**	0.1310	0.1260	**3.89**
Boron	0.0	2.1	**2.0**	**105**	1.2	1.2	**0.00**
Cadmium	0.00000	0.049	**0.050**	**98.0**	<0.00005	<0.00005	**NC**
Calcium	0.0	5.8	**5.0**	**116**	85.5	85.4	**0.12**
Chromium	0.000	0.049	**0.050**	**98.0**	0.010	0.010	**0.00**
Copper	0.0000	0.050	**0.050**	**100**	0.0066	0.0063	**4.65**
Iron	0.00	1.16	**1.00**	**116**	0.40	0.40	**0.00**
Lead	0.0000	0.050	**0.050**	**100**	0.0018	0.0017	**5.71**
Magnesium	0.0	0.9	**1.0**	**90.0**	15.0	14.9	**0.67**
Manganese	0.00000	1.06	**1.00**	**106**	0.08000	0.08000	**0.00**
Potassium	0.0	1.2	**1.0**	**120**	0.3	0.3	**0.00**
Selenium	0.000	0.250	**0.250**	**100**	0.030	0.029	**3.39**
Silver	0.00000	0.053	**0.050**	**106**	<0.00005	<0.00005	**NC**
Sodium	0.0	58.7	**50.0**	**117**	27.8	27.8	**0.00**
Uranium	0.00000	0.049	**0.050**	**98.0**	0.00409	0.00394	**3.74**
Zinc	0.000	0.052	**0.050**	**104**	0.310	0.299	**3.61**

NC=Not calculated due to results less than the detection limit.
NA=Data not available.

Green Analytical Laboratories

DISSOLVED METALS SRM AND BLANK DATA

LAB ID#						
811-106	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Arsenic	0.048	0.050	**96.0**	90-110 %	<0.0005	0.0005
Barium	0.050	0.050	**100**	90-110 %	<0.0005	0.0005
Boron	5.2	5.0	**104**	90-110 %	<0.1	0.1
Cadmium	0.048	0.050	**96.0**	90-110 %	<0.00005	0.00005
Calcium	5.1	5.0	**102**	90-110 %	<0.5	0.5
Chromium	0.046	0.050	**92.0**	90-110 %	<0.001	0.001
Copper	0.050	0.050	**100**	90-110 %	<0.0001	0.0001
Iron	5.41	5.00	**108**	90-110 %	<0.05	0.05
Lead	0.050	0.050	**100**	90-110 %	<0.0001	0.0001
Magnesium	5.0	5.0	**100**	90-110 %	<0.5	0.5
Manganese	2.62	2.50	**105**	90-110 %	<0.005	0.005
Potassium	10.8	10.0	**108**	90-110 %	<0.5	0.5
Selenium	0.246	0.250	**98.4**	90-110 %	<0.001	0.001
Silver	0.055	0.050	**110**	90-110 %	<0.00005	0.00005
Sodium	8.6	8.1	**106**	90-110 %	<0.5	0.5
Uranium	0.050	0.050	**100**	90-110 %	<0.00001	0.00001
Zinc	0.052	0.050	**104**	90-110 %	<0.001	0.001

NA=Data not available.

Green Analytical Laboratories

TOTAL METALS SPIKE AND DUPLICATE DATA

LAB ID#							
811-106	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Iron-T	0.00	4.01	**4.00**	**100**	6.60	5.60	**16.4**
Manganese-T	0.000	2.12	**2.00**	**106**	0.121	0.112	**7.73**
Mercury-T	0.0000	0.0021	**0.0020**	**105**	<0.0002	<0.0002	**NC**

NC=Not calculated due to results less than the detection limit.
NA=Data not available.

Green Analytical Laboratories

TOTAL METALS SRM AND BLANK DATA

LAB ID#						
811-106	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Iron-T	4.94	5.00	**98.8**	90-110 %	<0.05	0.05
Manganese-T	2.62	2.50	**105**	90-110 %	<0.005	0.005
Mercury-T	0.002	0.002	**100**	90-110 %	<0.0002	0.0002

NA=Data not available.

Green Analytical Laboratories

WET CHEM SPIKE AND DUPLICATE DATA

LAB ID#							
811-106	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Alkalinity	0	102	**100**	**102**	1580	1570	**0.63**
Chloride	0	96	**100**	**96**	580	560	**3.51**
EC	NMA	NMA	**NMA**	**NMA**	711	709	**0.28**
Fluoride	0.0	1.0	**1.0**	**100**	0.5	0.5	**0.00**
Nitrate/Nitrite	0.00	0.12	**0.10**	**120**	0.66	0.65	**1.53**
pH	NMA	NMA	**NMA**	**NMA**	8.01	8.00	**0.12**
Sulfate	0	51	**50**	**102**	1850	1800	**2.74**
TDS	NMA	NMA	**NMA**	**NMA**	310	310	**0.00**

NMA=Data not applicable to Method.
NC=Not calculated due to results less than the detection limit.

Green Analytical Laboratories

WET CHEM SRM AND BLANK DATA

LAB ID#						
811-106	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Alkalinity	186	179	**104**	90-110 %	<10	10
Chloride	48	47.5	**101**	90-110 %	<10	10
EC *	NA	NA	**NA**	90-110 %	NMA	NMA
Fluoride	1.0	1.0	**100**	90-110 %	<1.0	1.0
Nitrate/Nitrite	0.52	0.50	**104**	90-110 %	<0.02	0.02
pH	7.37	7.40	**100**	90-110 %	NMA	NMA
Sulfate	325	321	**101**	90-110 %	<10	10
TDS	3340	3100	**108**	90-110 %	<10	10

NMA=Data not applicable to Method.
NA=Data not available.

Green Analytical Laboratories

DISSOLVED METALS SPIKE AND DUPLICATE DATA

LAB ID#							
811-115	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Arsenic	0.0000	0.045	**0.050**	**90.0**	0.0008	0.0008	**0.00**
Barium	0.0000	0.049	**0.050**	**98.0**	0.0174	0.0167	**4.11**
Boron	0.0	2.2	**2.0**	**110**	0.3	0.2	**8.33**
Cadmium	0.00000	0.050	**0.050**	**100**	<0.00005	<0.00005	**NC**
Calcium	0.0	5.1	**5.0**	**102**	101.0	101.0	**0.00**
Chromium	0.000	0.052	**0.050**	**104**	<0.001	<0.001	**NC**
Copper	0.0000	0.049	**0.050**	**98.0**	0.0091	0.0079	**14.1**
Iron	0.00	1.00	**1.00**	**100**	<0.05	<0.05	**NC**
Lead	0.0000	0.048	**0.050**	**96.0**	0.0000	0.0000	**0.00**
Magnesium	0.0	1.0	**1.0**	**100**	16.5	16.4	**0.61**
Manganese	0.00000	1.080	**1.00**	**108**	<0.005	<0.005	**NC**
Potassium	0.0	1.0	**1.0**	**100**	1.8	1.7	**5.71**
Selenium	0.000	0.235	**0.250**	**94.0**	0.006	0.006	**0.00**
Silver	0.00000	0.049	**0.050**	**98.0**	<0.00005	<0.00005	**NC**
Sodium	0.0	53.1	**50.0**	**106**	445.0	444.0	**0.22**
Uranium	0.00000	0.048	**0.050**	**96.0**	0.01230	0.01200	**2.47**
Zinc	0.000	0.049	**0.050**	**98.0**	0.007	0.007	**0.00**

NC=Not calculated due to results less than the detection limit.
NA=Data not available.

Green Analytical Laboratories

DISSOLVED METALS SRM AND BLANK DATA

LAB ID#						
811-115	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptence Range	Blank Result	Reporting Limit
Arsenic	0.048	0.050	**96.0**	90-110 %	<0.0005	0.0005
Barium	0.050	0.050	**100**	90-110 %	<0.0005	0.0005
Boron	5.1	5.0	**102**	90-110 %	<0.1	0.1
Cadmium *	0.056	0.050	**112**	90-110 %	<0.00005	0.00005
Calcium	5.0	5.0	**100**	90-110 %	<0.5	0.5
Chromium	0.050	0.050	**100**	90-110 %	<0.001	0.001
Copper	0.052	0.050	**104**	90-110 %	<0.0001	0.0001
Iron	5.30	5.00	**106**	90-110 %	<0.05	0.05
Lead	0.051	0.050	**102**	90-110 %	<0.0001	0.0001
Magnesium	4.9	5.0	**98.0**	90-110 %	<0.5	0.5
Manganese	2.59	2.50	**104**	90-110 %	<0.005	0.005
Potassium	10.6	10.0	**106**	90-110 %	<0.5	0.5
Selenium	0.256	0.250	**102**	90-110 %	<0.001	0.001
Silver	0.055	0.050	**110**	90-110 %	<0.00005	0.00005
Sodium	8.5	8.1	**105**	90-110 %	<0.5	0.5
Uranium	0.049	0.050	**98.0**	90-110 %	<0.00001	0.00001
Zinc	0.047	0.050	**94.0**	90-110 %	<0.001	0.001

NA=Data not available.

Green Analytical Laboratories

TOTAL METALS SPIKE AND DUPLICATE DATA

LAB ID#	Spike Data				Duplicate Data		
811-115							
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Iron-T	0.00	3.97	**4.00**	**99.3**	4.40	3.90	**12.0**
Manganese-T	0.000	2.08	**2.00**	**104**	0.100	0.100	**0.00**
Mercury-T	0.0000	0.0020	**0.0020**	**100**	<0.0002	<0.0002	**NC**

NC=Not calculated due to results less than the detection limit.
NA=Data not available.

Green Analytical Laboratories

TOTAL METALS SRM AND BLANK DATA

LAB ID#	SRM Data				Blank Data	
811-115						
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Iron-T	4.89	5.00	**97.8**	90-110 %	<0.05	0.05
Manganese-T	2.59	2.50	**104**	90-110 %	<0.005	0.005
Mercury-T	0.002	0.002	**100**	90-110 %	<0.0002	0.0002

NA=Data not available.

Green Analytical Laboratories

WET CHEM SPIKE AND DUPLICATE DATA

LAB ID#							
811-115	Spike Data				Duplicate Data		
PARAMETER	Sample Result	Spike Result	Spike Conc.	Spike % Recovery	Sample Result	Duplicate Result	RPD %
Alkalinity	0	102	**100**	**102**	1580	1570	**0.63**
Chloride	0	103	**100**	**103**	23	22	**4.44**
EC	NMA	NMA	**NMA**	**NMA**	626	624	**0.32**
Fluoride	0.0	1.0	**1.0**	**100**	1.5	1.5	**0.00**
Nitrate/Nitrite	0.00	0.12	**0.10**	**120**	0.66	0.65	**1.53**
pH	NMA	NMA	**NMA**	**NMA**	7.78	7.76	**0.26**
Sulfate	0	52	**50**	**104**	9600	9400	**2.11**
TDS	NMA	NMA	**NMA**	**NMA**	5620	5560	**1.07**

NMA=Data not applicable to Method.
NC=Not calculated due to results less than the detection limit.

Green Analytical Laboratories

WET CHEM SRM AND BLANK DATA

LAB ID#						
811-115	SRM Data				Blank Data	
PARAMETER	SRM Result	True Value	SRM % Rec	Acceptance Range	Blank Result	Reporting Limit
Alkalinity	186	179	**104**	90-110 %	<10	10
Chloride	23	20.9	**110**	90-110 %	<10	10
EC *	NA	NA	**NA**	90-110 %	NMA	NMA
Fluoride	1.0	1.0	**100**	90-110 %	<1.0	1.0
Nitrate/Nitrite	0.52	0.50	**104**	90-110 %	<0.02	0.02
pH	7.37	7.40	**100**	90-110 %	NMA	NMA
Sulfate	345	321	**107**	90-110 %	<10	10
TDS	3340	3100	**108**	90-110 %	<10	10

NMA=Data not applicable to Method.
NA=Data not available.

Appendix 18-H

Energy Laboratories Inc. Corporate Quality Assurance Manual

ENERGY LABORATORIES, INC.
CORPORATE QUALITY ASSURANCE MANUAL

Revision February 10, 2025

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ELI COMMITMENT

Energy Laboratories, Inc. Strives Toward:

1. Being highly skilled in the field of analytical chemistry.
2. Delivering quality and service with integrity.
3. Encouraging the professional development of our staff.
4. Offering our employees a safe and positive work environment.
5. Being profitable and using resources wisely for a sustainable future.

INTRODUCTION

Energy Laboratories, Inc. provides chemical, industrial hygiene, and environmental analytical services to private industry, agricultural industry, engineering consultants, government agencies, and private individuals. Analytical services include: analysis of waters and soils for inorganic and organic constituents, aquatic toxicity testing, hazardous waste analysis, radiochemistry, industrial hygiene, microbiology, soils and water physical parameters, and petroleum analysis.

Founded in 1952, Energy Laboratories currently incorporates four separate testing laboratories. The corporate headquarters are located in Billings, MT, with laboratories located in Casper, WY; Gillette, WY; and Helena, MT.

ELI, as a coordinated company of four participating laboratories, has developed a QA program that takes into account the various method types and EPA programs, while also considering sample matrices, to develop a single comprehensive set of QA guidance. Scientific approaches, Good Laboratory Practices, EPA Methods and Guidance documents, and accreditation audit guidance are used to develop our overall QA Program.

The Quality Assurance Program establishes acceptable performance criteria for all routine analytical procedures being performed by laboratory personnel. The Quality Assurance Assessment Program provides a formal system for evaluating the quality of data being generated and reported. The ELI Laboratory Safety Manual & Chemical Hygiene Plan defines the safety and monitoring procedures used by laboratory personnel in laboratory operations. These, in addition to the experience and expertise of our analysts, provide a comprehensive Quality Assurance Program. Individual State approval for RCRA and CWA (NPDES) is managed through the Federal/State DMRQA program or through reciprocal certifications when required by a specific state. Copies of current ELI certificates are maintained on ELI's website: www.energylab.com.

Energy Laboratories, Inc., in Billings, Montana, is certified under the Safe Drinking Water Act by Region VIII EPA for Wyoming, and the State of Montana. Individual state approval for SDWA is managed through reciprocal certifications when required by a specific state. ELI-Billings also holds accreditation for Clean Water Act, Safe Drinking Water Act and Resource Conservation Recovery Act (RCRA) parameters through the National Environmental Laboratory Accreditation Program (NELAP) managed by TNI (The NELAC Institute), which is supported by the USEPA. The primary NELAP certification is maintained through the state of Florida. Individual State approval for SDWA, RCRA and CWA (NPDES) is managed through the Federal/State DMRQA program or through reciprocal certifications when required by a specific state. ELI obtains these certifications either through reciprocal recognition of ELI's primary Montana State, NELAP, or ISO/IEC 17025/DoD certifications. Department of Defense (DoD) and international lab certification under ISO/IEC

17025 and DoD requirements is provided through ANSI ASQ National Accreditation Board (ANAB). To perform radon testing, ELI is certified under the National Radon Proficiency Program (NRPP) administered by the National Environmental Health Association.

The Casper, Wyoming laboratory is certified under the Safe Drinking Water Act by Region VIII EPA. Individual state approval for SDWA is managed through reciprocal certifications when required by a specific state. ELI-Casper also holds accreditation for Clean Water Act, Safe Drinking Water Act and Resource Conservation Recovery Act (RCRA) parameters through the National Environmental Laboratory Accreditation Program (NELAP), which is supported by the EPA. The NELAP certification is maintained through the state of Florida. ELI-Casper also maintains a United States Nuclear Regulatory Commission (USNRC) Materials License and therefore conducts all radiological effluent and environmental monitoring of licensed facility's samples in accordance with the guidelines set forth in *REGULATORY GUIDE 4.15 - QUALITY ASSURANCE FOR RADIOLOGICAL MONITORING PROGRAMS (INCEPTION THROUGH NORMAL OPERATIONS TO LICENSE TERMINATION) EFFLUENT STREAMS AND THE ENVIRONMENT.* This Quality Assurance Manual contains the above guidance document's QA program elements that ensure the quality of the data for radiological effluent and environmental monitoring programs.

The Gillette, Wyoming laboratory is certified under the Safe Drinking Water Act by Region VIII EPA.

The Helena, Montana laboratory is certified under the Safe Drinking Water Act by the State of Montana, and reciprocity is recognized by Region VIII EPA for Wyoming and tribal waters.

The ELI Quality Assurance Manual and the ELI Professional Services Guide together are used to outline the ELI Quality Assurance/Quality Control Program. This Quality Assurance Manual is applicable to all departments of Energy Laboratories, Inc. The procedures discussed or referenced in this manual describe the day-to-day laboratory practices and adhere to USEPA Safe Drinking Water Act, and TNI (The NELAC Institute) requirements as well as Good Laboratory Practices (GLPs). Information on all ELI laboratories', applicable accreditations and certifications are maintained on the ELI website at www.energylab.com. Where possible, ELI uses EPA, AOAC, ASTM, APHA, NIOSH, OSHA, or published analytical methods and follows the procedures with strict adherence to described protocol and recommended QA/QC parameters. The analytical methods approved and in use are described in Standard Operating Procedures and are available for review at the laboratory. Vital parts of our Quality Assurance Program, Quality Control and Quality Assessment programs are outlined in Chapters One and Two of this manual.

To generate data that will meet project-specific requirements, it is necessary to define the type of decisions that will be made and identify the intended use of the data. Data Quality Objectives (DQOs) are an integrated set of specifications that define data quality requirements and the intended use of the data. Project-specific DQOs will be established as needed for both field and lab operations. Through the DQO process, appropriate reporting limits, extraction/digestion methods, clean-up methods, analytical methods, target analytes, method quality control samples, sample security requirements, method validation criteria, quality control acceptance ranges, corrective action procedures, validation procedures, reporting formats and reporting limits can be specified. Professional laboratory project managers are available to assist clients in specifying appropriate laboratory analyses and reporting procedures necessary to meet project requirements.

Client-specific DQOs can be coordinated with the laboratory through Project Managers via quotations or contracts, or with relevant documentation provided to the laboratory prior to (or at

time of) sample receipt. Client-specific requirements are communicated to analysts and final report validators through the laboratory LIMS system. By default, methods, analytes, and QC parameters are set up to meet the DQOs specified in the referenced method and/or federal/state regulations. ELI encourages clients to provide ELI documentation of any client-specific, regulatory or project monitoring requirements.

Project samples requiring analysis under DoD accreditation are managed as having project specific requirements to meet client DQO requirements in addition to Quality System and method requirements as specified within the DoD Quality System Manual (QSM) Version 5.4. Projects requiring DoD accreditation must be submitted and managed via the Billings laboratory.

Certain types of requests may not be suitable to standardized analytical methods. These custom requests are handled individually with laboratory management and staff scientists. Project-specific methods and reporting packages are available. Attention to documentation of the analytical procedure and use of suitable QC parameters is maintained according to good scientific discipline and Good Laboratory Practice guidelines.

The applicable laboratory Director, or the designee, will evaluate all new contracts to determine that the laboratory is capable of performing the requested work. This process includes ensuring that the laboratory maintains the required accreditation, equipment and resources. In the event that sample analysis is not performed at the designated location, clients are notified on the laboratory analytical report if the work is subcontracted to a qualified ELI laboratory or an outside laboratory (See Subcontracting Policy – Chapter 6 in this QA Manual).

This Quality Manual and related quality documentation meet requirements of the National Environmental Laboratory Accreditation Program (NELAP), which is an EPA approved accreditation program, and on a project specific basis include additional Department of Defense DoD accreditation requirements as specified in their Quality System Manual Version 6.0 (DoD QSM 6.0, 2023) or current approved version.

CHAPTER 1 – QUALITY CONTROL PROGRAM

Quality Policy Statement

Energy Laboratories, Inc. is committed to producing laboratory data of known and documented quality that is scientifically valid, meets method specifications, satisfies regulatory requirements, and accomplishes the data quality objectives of the client and project. ELI's Management and Quality Systems ensure that the laboratory maintains current certifications and maintains compliance with accreditation and regulatory requirements through USEPA, Federal and State, NELAP/TNI, and DoD/ ISO/IEC-17025 accreditations. Those method, regulatory, and client requirements (as well as the policies, procedures, and all referenced documents) are incorporated into our Quality Assurance Program; which is outlined within this Quality Assurance Manual. The Quality Systems are designed to comply with the standards as defined by the most current approved version of the NELAC accreditation standards (TNI 2016) and includes procedures to manage risk and requirements as discussed in ISO/IEC 17025-2017. To ensure compliance with these standards, all laboratory personnel are required to be familiar with quality documentation and implement those policies and procedures in their work. ELI is dedicated to the continual improvement of the management system's effectiveness by providing appropriate corporate resources to set objectives, offering training opportunities, and monitoring the quality performance of our testing. ELI also provides facilities, resources, and equipment adequate and appropriate to these objectives.

Quality Assurance Program

The purpose of the Quality Assurance Program is to ensure that the analytical services provided by Energy Laboratories are of high quality, data is within established accuracy and precision limits (required by the referenced method or Standard Operating Procedure), and each analytical result produced meets or exceeds our accreditation requirements. Management ensures that the integrity of the management system is maintained. The Technical Director, or their designee, ensures that changes to the management system are planned, implemented and documented.

Management establishes and maintains data integrity by providing the following to ELI's data integrity system:

1) Data Integrity Training (Including the highest standards of ethical behavior)
2) Periodic review of data integrity procedural documentation
3) Annual review of data integrity procedures with updates as needed
4) Periodic, in-depth monitoring of data integrity
5) Maintenance of signed data integrity documentation for all laboratory employees

All employees are expected to implement and follow the policies contained within the Quality Assurance Program.

The quality systems in the program consist of the policies and procedures, and all referenced documents, described in this Quality Assurance Manual. The Quality Control Program also functions to maintain the laboratory's compliance with accreditations through USEPA, State Agencies, NELAP, and ANSI-ASQ National Accreditation Board (ANAB) for DoD and ISO/IEC-17025 accreditation.

The Quality Control Program requires that the following points be met for each applicable analytical method:

- Performance of any analytical method requires that the proper equipment and instrumentation are available. A list of major equipment is listed in Appendix E. The procedure for operation of an analytical instrument is described in the equipment manufacturer's operating manual and may also be supplemented with a specific Standard Operating Procedure (SOP) for the instrument and/or the method.

- Specific SOPs cover operation of the instrument including the sequence of operations involved in instrument start-up, calibration, analysis, and shut down. Chapter 13 of this manual includes recommended preventative maintenance, and/or a list of parameters used to identify other types of maintenance. Instrument specific preventative maintenance and routine maintenance is documented in the Instrument Maintenance Module. SOPs outline any special safety precautions for operation of the instrumentation.

- SOPs of detailed EPA, AWWA Standard Methods, ASTM, NIOSH, APHA, OSHA, or other published procedures include, as appropriate, a list of any method-specific items or variances, a list of QC parameters and their recommended method performance ranges, recommended or example analytical sequences, specific or unique safety information, method references, and a signed signature page. SOPs details, and format of method SOPs, follow NELAP requirements. Detailed SOPs may be prepared for those procedures that do not have published methods. Further details of SOP format and information required in method SOPs can be found in the ELI SOP, *Preparation, Numbering, Use, and Revision of Standard Operating Procedures.* Written Standard Operating Procedures referenced within this manual are available at the laboratory for review. ELI SOPs are considered confidential proprietary information.

- For radiochemical analysis performed at the ELI-Casper Laboratory, each method undergoes Method Validation as outlined in EPA's specific method and/or the Multi-Agency Radiological Laboratory Analytical Protocols Manual (MARLAP), Chapter 6.

- The required detection level (RDL) for radiochemical analysis of drinking water samples is calculated based on the requirements in 40 CFR 141.25(c), which is a sample specific determination. The equation is specific for each method and noted in the method-specific SOP where appropriate.

- The initial test method evaluation for referenced EPA procedures, or new instrument setups applied to a procedure for chemical analysis involves Method Detection Limit (MDL) studies, including confirmation of the Limit of Detection (LOD)(as applicable) and the Limit of Quantitation (LOQ) and evaluation of method performance by successful completion of an Initial Demonstration of Capability (refer to ELI SOP, *Method, Instrument and Software Validation and Method Modifications* and *Personnel Training and Training Records)*, the successful completion of appropriate Performance Evaluation (PT) studies (when available), evaluation of the method selectivity and sensitivity, and any additional method or client-specific requirements.

- ELI demonstrates that laboratory staff is qualified and capable of performing the method. Analysts are assigned duties based on their skills and experience. Training records are maintained for all analysts. Curricula vitae of key management and personnel are described in Appendix D.

- It is the responsibility of the analyst to become thoroughly familiar with the methodology and instrument operation before performing the analysis. It is the responsibility of the person providing training to monitor all laboratory results generated for a reasonable time. The amount of time necessary may vary depending on the method and the experience of the analyst. At a minimum, the analyst's performance is to be monitored until the analyst demonstrates the ability to generate results of acceptable accuracy and precision according to the method.

- All analysts are required to demonstrate and maintain a record of proof of competency by routinely analyzing quality control samples appropriate to the analytical procedures they perform. These QCS samples may include LCS/LFB/ICV, MS/MSD, Duplicates, or proficiency testing samples. Proof of competency is documented in analysts' training files per NELAP requirements (for more information, see ELI SOP, *Personnel Training and Training Records*. For those analyses where external proficiency testing (PT) samples are not routinely analyzed, competency is documented by including the results of routine analysis of method-specific quality control samples (prepared by laboratory staff) and/or a verifying statement of procedural review by a supervisor or trained analyst.

- Each analytical method is subjected to quality control monitoring. The purpose is to demonstrate that results generated meet acceptable accuracy and precision criteria for the method. Precision and bias are determined for standard and non-standard methods. Precision and bias are determined for standard methods through control charting of data from quality control samples. Precision and bias using non-standard, modified standard or laboratory-developed methods are compared to the criteria established by the client (when requested), the method, or the laboratory.

- Quality control requirements are outlined in the methods and ELI, at a minimum, follows the guidelines specified in the methods used. Additional QC requirements are also added as appropriate. Statistical method performance is periodically evaluated against method requirements using control charts.

- Quality control monitoring to measure accuracy for each method generally requires that five to ten percent of all samples analyzed be fortified (spiked) with a known concentration of target analytes tested by the method. The percent recovery is then calculated. This provides a means for monitoring method accuracy and evaluating sample matrix effects. Where appropriate, surrogates are included in the method to monitor method performance on each individual sample. Blank spike samples replace matrix spike samples for certain methods, or when there is insufficient sample for a matrix spike analysis. Historical, routine batch QC sample performance can be used to estimate the precision and accuracy of the method.

- Quality control monitoring to measure precision for each method requires replicate samples be prepared and analyzed when appropriate. Actual requirements are outlined in the specific SOP. When replicate samples or matrix spike duplicates are analyzed, relative percent difference is calculated and used to monitor precision of the method. In instances where there are no specific method requirements, it is the policy of this laboratory to analyze five to ten percent of all samples in duplicate. Duplicate test results must be within the control limits established for each analysis type or data is qualified. Acceptance limits generally follow specifications listed in the method. Matrix spike duplicates replace sample duplicates for most methods.

- When not defined in the method, and as appropriate, method blanks and/or instrument blanks are analyzed one in every 20 samples at a minimum. Method blanks are used to verify that contamination from laboratory reagents and glassware is not present in the analytical sample process. Generally, the method blank should be less than the reporting limit, Less than the LOQ for DoD samples, or 10 times less than the concentration amount in the sample, for the analytical parameter being tested, whichever is greater. Drinking water analysis has a more stringent requirement that the method blank concentration must be less than the associated reporting limit before acceptance of sample results.

- When method spike frequency is not defined in the method and as appropriate, method spikes (blank spikes) are analyzed, at a minimum one in every 20 samples.

- Calibration standards are analyzed, and calibration curves are developed for all applicable methods. For additional information on instrument calibration, see Chapter 7 of this QA manual.

- The initial calibration is continuously monitored by analyzing a continuing calibration standard every 10 to 20 samples, or within a specified time frequency, and at the end of each analytical sequence; depending on the method and instrumentation. Results must be within an established range as described by the method SOP. Initial calibrations are verified against a standard from a second source.

- Proficiency testing samples and further quality control check samples may be required for various methods. Refer to Chapter 2 of this QA manual for further details.

Estimation of Uncertainty

The estimation of uncertainty consists of the sum of the uncertainties of the individual steps or processes of an analytical procedure and the field sampling variabilities. The variability of the sampling plan, sample heterogeneity, extraction procedure, instrument calibration, instrument drift, systematic bias, and many other factors all contribute to the uncertainty of a measurement or sample result.

ELI estimates uncertainty utilizing Confidence Intervals defined as ±2σ (95%) and ±3σ (99%) where σ is the standard deviation of the recovery of quality control samples. The confidence intervals calculated from these QC samples are based on the spike level concentrations for each method. For most procedures, uncertainty at the reporting limit or Limit of Quantitation (LOQ) is determined by Limit of Quantitation spike recovery studies or by MDL study spike recovery evaluations. LOQ/MDL verifications are also performed quarterly to verify ongoing method accuracy, precision and sensitivity. LCS limits are used to set method accuracy and precision overall. PT Acceptance criteria are also a guide for evaluating interlaboratory method accuracy, and the reasonableness of ELI assigned method QC limits. Real world samples, depending on matrix interferences, may have a greater amount of uncertainty associated. Due to limitations in assessing the uncertainty for each matrix type, the confidence intervals calculated from method QC samples provides an estimate of laboratory method uncertainty.

Energy Laboratories, Inc. uses the procedures outlined in ELI SOP, *Control Chart Generation and Maintenance*, for the purpose of evaluating estimation of uncertainty for chemical analyses and

uses the determination of uncertainty on a sample-specific basis for all radiochemistry measurements. These estimates of uncertainty have formulas documented in the individual SOP.

Maintenance of Performance Records

All quality control monitoring is recorded and documented. Quality control data is recorded in laboratory notebooks, electronic summary files, and/or analysis sheets. Generally, review of QC data and trends is managed within the Laboratory LIMS system. QC data management and control chart generation, maintenance, and usage are described in ELI SOP, *Control Chart Generation and Maintenance and Method Statistically Set Limits*. It is the responsibility of the analyst to see that all results are recorded in a timely manner.

All quality control data is filed and available for inspection and assessment by analysts, supervisors, management, and quality control personnel.

Method Quality Control Specifications

A template of Quality Assurance/Quality Control specifications is outlined in Appendix B. These types of method QC Element tables are available upon request for clients to use in the preparation of Quality Assurance Project Plans (QAPPs). Exact details of method QC can be found in the applicable method SOPs.

CHAPTER 2 – QUALITY ASSESSMENT PROGRAM

The function of the Quality Assessment Program is to provide formal evaluation of the quality of data being generated and reported by the laboratory. External and internal quality control measures are used in this assessment. These measures include proficiency testing samples, laboratory quality control check samples, and routine internal and external audits on methodology and documentation procedures.

Proficiency Testing (PT) Samples

PT samples are supplied by an outside entity and contain known amounts of constituents. The laboratory does not have access to known values of the samples. Only the PT provider has knowledge of constituent levels prior to the formal publishing of the test results.

PT samples are received on a routine basis, with results sent to the providing entity for evaluation. Proficiency Testing (PT) samples for USEPA, NELAP and various State certifications are Water Pollution Study samples (WP or DMRQA), Water Supply Study samples (WS), and Soil PT samples provided by NELAP approved PT providers.). Routine participation in Soil, WS and WP PT sample studies is used to maintain certifications for Safe Drinking Water Act (SDWA), Clean Water Act (CWA), National Pollutant Discharge Elimination System (NPDES), Discharge Monitoring Report Quality Assurance (DMRQA), permit monitoring analyses, Resource Conservation and Recovery Act (RCRA) analyses, as well as for other states and projects requiring method accredited parameter analyses. The samples are analyzed in the same manner as any routine sample in the laboratory. Acceptable results are those that fall within a defined range as determined by the vendor; based on multi-laboratory study results in accordance with PT provider accreditation requirements and relevant regulatory program requirements. The provider sends results to the appropriate certifying agencies as requested by the laboratory. PT study results are posted on the ELI website www.energylab.com.

A copy of the laboratory's primary certifications issued by the USEPA and NELAP are maintained on the ELI website at www.energylab.com. The EPA certification includes a list of parameters/methods for which drinking water certification has been granted.

The NELAP certificate for Billings and Casper also includes RCRA methods used for hazardous waste characterizations and CWA parameters/methods which are used for NPDES monitoring permits. Reciprocal accreditation in other states is based on either of these, or both, depending on specific state certification requirements/parameters. ISO/IEC 17025/DoD certification is maintained for Department of Defense and international projects requiring that accreditation.

ELI also participates in the Federal/State DMRQA programs for clients which require/request this with their NPDES permits. Reciprocal accreditation in other states is based on either of these, or both, depending on the specific state certification requirements for accreditations.

Proficiency testing samples for Radon Proficiency testing are from approved NRPP PT providers. Energy Laboratories radon sampling canisters are submitted for known levels of radon exposure. Acceptable results are those that fall within a defined range based on multi-laboratory study results.

Blind Quality Control Check Samples are samples submitted as regular lab samples and are processed through the system in the same manner as any other routine environmental sample. The analysts do not know the true values of these samples when performing the analyses. Method

performance reports are returned to the analysts. Clients occasionally submit these types of samples for their QAPP.

Inter-Laboratory comparison samples are samples containing known or unknown concentrations of analytes that are split and analyzed by more than one laboratory.

Quality Control Check Samples

Quality Control Check Samples are performance evaluation samples used for routine method performance monitoring. As appropriate, analytical procedures include the analysis of a quality control sample with every sample batch analyzed. The materials are obtained from a commercial source when available, or they may be prepared in-house. Acceptable results are within a defined range based on certified ranges, or against statistically-determined control limits, method-defined criteria, or client-defined Data Quality Objectives. Routinely used methods not subjected to PT sample monitoring are evaluated with Quality Control Check Samples, as appropriate.

QC samples are processed through the system in the same manner as any other sample, except the analyst is aware of the source, concentration, and acceptance ranges of target analytes and calculates analyte recoveries to evaluate method performance in real time.

Quality Assurance Audits

Quality Assurance Audits consist of internal and external laboratory inspections designed to monitor adherence to Quality Systems and quality control requirements. These audits check general laboratory operations, overall Quality Systems, adherence to QA program requirements, sample tracking procedures, sample holding times, storage requirements, adherence to procedures during analysis, calculations, completion of required quality control samples within the group surrounding the sample, and proper record-keeping.

Internal quality control audits are conducted or coordinated by the Quality Assurance Manager of the laboratory. See ELI SOP, *Internal Audits*, for further information. ELI conducts internal inspections on a regular basis to monitor adherence to quality control requirements. Results of formal audits are given to management with recommendations for corrective action in the event any discrepancies are found. As necessary, a follow-up review is conducted to determine that identified problems have been addressed. Annually, the overall quality systems of the laboratory are reviewed and a summary report is prepared.

In accordance with current NELAP/ISO/IEC 17025- requirements, the management of the laboratory will conduct an annual review of the Management System, including policies, procedures and environmental testing activities in a meeting with key laboratory management and supervisory staff. This is performed to ensure the continuing suitability and effectiveness of the QA systems, as well as provide the opportunity to introduce necessary changes or improvements. The review shall take into account, at a minimum, the following:

- Changes in internal and external issues that are relevant to the laboratory
- Fulfilment of objectives
- The suitability of policies and procedures
- Status of Actions from previous management review reports from managerial and supervisory personnel
- Outcome of recent internal audits

- Corrective and preventative actions
- Assessments by external bodies
- The results of inter-laboratory comparisons or proficiency tests
- Changes in the volume and type of work
- Client and personnel feedback
- Complaints
- Recommendations for improvement and effectiveness of any implemented improvements
- Results of risk identification
- Other relevant factors, such as quality control monitoring activities, data integrity, data accuracy and precision, risks to impartiality, resources, and staff training

The findings from management reviews and the corrective actions that arise from these findings shall be recorded. The management shall ensure that any corrective actions are carried out within an appropriate, pre-determined time frame and with provision of required resources.

ELI welcomes external Quality Assurance Audits, by qualified outside auditors, for review and comment on the overall QA program. To maintain certifications, accrediting authorities from the State of Montana, ANAB, and NELAP conduct periodic comprehensive external audits. External audits to meet Quality Assurance Project Plans (QAPPs), as applicable to environmental remediation projects, or for major industries, are conducted as requested. For more information, see ELI SOP, *External Quality Assurance Audits*.

CHAPTER 3 – LABORATORY FACILITIES

The facility for Energy Laboratories, Inc. – Billings, MT consists of multiple buildings located at 1120 South 27th Street, Billings MT 59101.

The phone number for the Billings laboratory is (406) 252-6325 and the email address is eli@energylab.com.

The facility for Energy Laboratories, Inc. – Casper, WY consists of three buildings located at 2393 Salt Creek Highway, Casper, WY 82601.

The phone number for the Casper laboratory is (307) 235-0515 and the email address is casper@energylab.com.

The facility for Energy Laboratories, Inc. – Gillette, WY consists of one building located at 400 West Boxelder, Gillette, WY, 82718.

The phone number for the Gillette laboratory is (307) 686-7175 and the email address is gillette@energylab.com.

The facility for Energy Laboratories, Inc. – Helena, MT consists of multiple buildings located at 3161 East Lyndale, Helena, MT 59601.

The phone number for the Helena laboratory is (406) 442-0711 and the email address is Helena@energylab.com.

Laboratory space includes adequate bench top and floor space to accommodate periods of peak workload. Working space includes sufficient bench top area for processing samples; storage space for reagents, chemicals, glassware, bench and portable equipment items; floor space for stationary equipment; and adequate associated area for cleaning glassware. Laboratory departments are organized, and the facilities are designed for specific laboratory operations in order to protect the safety of analysts and to minimize potential sources of contamination between and within department areas (for more information, see the branch specific ELI SOP, *Facility Description, Access, and Security*.

The laboratory is appropriately ventilated, illuminated, and is not subject to excessive temperature changes. Specific laboratory areas are temperature and humidity controlled as required. Ample cabinets, drawers and shelves are available for storage and protection of glassware. Exhaust fume hoods are available as needed for use during preparation, extraction, and analysis of samples. Employee exposure monitoring is conducted to provide a safe working environment.

To maintain security, all visitors must enter their name on the ELI sign-in log at the front desk and wear a visitor's badge, undergo safety awareness training, and are escorted when appropriate.

The laboratory has provisions for the disposal of chemical and microbiological wastes. These provisions are described in Standard Operating Procedures as well as outlined in the Laboratory Safety Manual & Chemical Hygiene Plan along with other safety and health guidelines. For more information, see the branch specific ELI SOP, *General Laboratory Waste Disposal*.

CHAPTER 4 – PERSONNEL REQUIREMENTS AND LABORATORY ORGANIZATION

Relationship between Management, Technical Operations, Support Services and the Quality System

Laboratory Organization

The corporate organization of the four ELI laboratories located in Montana (2), and Wyoming (2), is provided in Appendix C. Corporate functions are located in various branches based on where the expertise is located. Each laboratory is managed and operated individually under the supervision of a Laboratory Manager/Director. All ELI laboratories have fiscal and QA/QC responsibilities to the corporate office, as well as general operating policies and goals. This Corporate Quality Assurance Manual is applicable to all laboratories.

The corporate organization chart is included in Appendix C. Individual branch laboratory's organizational structure is available upon request and is documented on the server for each laboratory. Curricula vitae of key ELI personnel is maintained in Appendix D of this manual. Job descriptions are maintained by the Human Resources Department.

Quality Assurance receives direct support from senior management. Laboratory Quality Assurance Officers report directly to the Corporate Quality Assurance Manager as well as their Laboratory Director. Quality Assurance Managers provide independent oversight of Quality Systems within the overall Energy Laboratories structure. When Quality Assurance Managers fill more than one role within the organization, they operate independently of direct environmental data generation while fulfilling quality assurance responsibilities. Quality Assurance Managers facilitate development of and maintain the Quality Assurance Manual, provide assistance to personnel on quality assurance / quality control issues, maintain a quality assurance training program, and review quality documentation including SOPs.

Management ensures the development and implementation of programs and policies to continuously improve the effectiveness of ELI's QA Program and Management Systems. Management performs an annual review of the laboratory's Quality System (policies, procedures, work instructions) to assure their continuing suitability and effectiveness (See ELI SOP, *Management Reviews*, for detailed procedures. As appropriate, management identifies and implements any necessary changes or improvements. Corrective and preventive actions are detailed in a Corrective Action Report and filed with the QA Department. (Refer to ELI SOP, *Nonconformance, Root Cause Analysis and Corrective Action Process and Risk Analysis,* for detailed procedures.) In addition, management performs meetings with supervisory and key staff members throughout the year. Supervisors and QA personnel provide input on their specific areas of responsibility and evaluate the following:

1) Client-Related Items
2) Internal and External Audit Reports
3) Proficiency Testing Results
4) Review of Performance by Department
5) Corrective and Preventive Actions
6) Personnel Training Needs
7) Quality System Policies and Procedures
8) Resources including Personnel, Equipment and Facilities

Laboratory Management Review findings are compiled into a summary report. The report includes deficiencies identified and areas for improvement. The QA department ensures items from the Management Review are tracked, including actions that must be addressed, assignment of parties responsible for the actions to be taken, and recommendations on improvements to the Quality System. The Technical Director, Laboratory Director, Quality Assurance Manager or designee, shall assign specific persons to address management review findings and establish deadlines for their completion. The Technical Director, Laboratory Director, Quality Assurance Manager or designee, reviews and approves all QA documents issued to personnel in the laboratory as part of the management system. The Technical Director, or designee, has overall responsibility for the technical operations of the laboratory. Any procedural deviations to SOPs that are client- or project-specific must receive approval either from the Technical Director, Laboratory Director, or Quality Assurance Manager. Work is stopped when identification of any of the following is made: unapproved departures from the management system, unauthorized deviations from the procedures for performing tests and/or calibrations, and data quality or data integrity issues. The Technical Director, Laboratory Director, QA Manager, or designee, is responsible for providing authorization for the work to resume once the identified issue has been addressed.

Personnel Requirements

ELI maintains experienced staff and management. Below is a summary of the primary roles, responsibilities and qualifications for the designated positions. Laboratory experience can be substituted for academic requirements. At ELI's smaller laboratory operations, the technical director may serve multiple roles. Detailed job descriptions are maintained by the Human Resources department. Specific titles of employees are at the discretion of the Laboratory Director.

Laboratory Director

The Laboratory Manager/Director is required to have education and/or experience equivalent to a Bachelor of Science degree in Chemistry or a related science. Five years of relevant laboratory experience is required.

The Laboratory Director is responsible for all operations, client management, analysis scheduling, and equipment acquisition, as well as compliance with all employment, safety, environmental and NELAP /ISO/IEC17025 regulations. The Laboratory Director may delegate daily activities of these work aspects to appropriate personnel. The Laboratory Director reports directly to the Corporate Director of Operations. All Laboratory Directors have both technical and management responsibilities.

Quality Assurance Manager

The Quality Assurance Manager is required to have an education and/or experience equivalent to a Bachelor's of Science degree in Chemistry or a related science. Five years of relevant laboratory experience is preferred.

The Quality Assurance Manager is responsible for quality systems development, implementation, and management. The Quality Assurance Manager is also responsible for maintaining and improving compliance with all applicable state and federal regulations as well as maintaining compliance with NELAP/ISO/IEC17025 regulations regarding Quality Systems. The Quality Assurance Manager or his/her designee with the help of the Laboratory Director manages the laboratory's certification programs to meet government regulatory and specific client requirements. The QA program is implemented in cooperation with all levels of management and staff. Quality Assurance Managers report directly to the Corporate Quality Assurance Manager. The Laboratory Director will direct daily laboratory-specific QA/QC requirements. The Corporate Quality Assurance Manager reports directly to the ELI President.

Technical Director

The Technical Director is required to have a Bachelor of Science degree in Chemistry or a related science and meet all applicable education requirement listed in the current NELAP standard for NELAP accredited laboratories. Five years of relevant laboratory experience is preferred.

The Technical Director is responsible for ensuring compliance with all laboratory policies and that the analyses conducted under their supervision are compliant with all state, EPA, and NELAC/ISO17025 required standards and regulations. Technical Directors report directly to the Laboratory Director.

The Technical Director may serve multiple roles. Laboratory Directors may serve as one of the laboratory Technical Directors.

Laboratory Supervisor

A Laboratory Supervisor is required to have education and/or experience equivalent to a Bachelor of Science degree in Chemistry or related science. Two years of relevant laboratory experience is required.

ELI's Laboratory Supervisors are responsible for the day-to-day operation of the laboratories: scheduling testing, assigning work, and completing the technical review of laboratory data. Supervisors are responsible for ensuring compliance with all laboratory policies and ensure that the analyses conducted under their supervision are compliant with all state, EPA, and NELAC/ISO17025 standards and client- or project-specific requirements. They report directly to the Laboratory Director.

Analysts

Laboratory Analysts are required to have an education equivalent to a Bachelor of Science degree in Chemistry (or related science), or a High School diploma with experience as an analyst in training. New analysts require on-the-job training, under direct supervision of a qualified analyst until authorized by management to perform assigned tasks. The training shall be relevant to the present and anticipated tasks required and the effectiveness of the training must be evaluated (for more information, see ELI SOP, *Personnel Training and Training Records)*. After the initial training period, and on a continuing basis thereafter, the analyst must demonstrate acceptable skills through the successful participation in the analysis of applicable performance evaluation and quality control samples.

Analysts perform the following duties: Preparation of samples and reagents, analysis and preliminary data input, as well as various other tasks assigned by the supervisor. Analysts are responsible for complying with all laboratory policies and procedures.

Laboratory Technicians

Laboratory Technicians are required to have a High School Diploma or equivalent. Laboratory Technicians work under the supervision of the primary analyst performing general laboratory tests.

Under the supervision of a primary analyst, Laboratory Technicians perform the following duties: preparation of samples and reagents, analysis, and preliminary data input, as well as various other tasks assigned by the supervisor.

Laboratory Technicians are responsible for complying with all laboratory policies and procedures.

Approved Signatories

Signatures for policies are based on individual roles and responsibilities as determined by the policy being reviewed and approved. A list of significant signatories is included below. Additional signatures may be required for specific procedures.

- Laboratory Director
- Technical Director
- Quality Assurance Manager
- Corporate Officer - ELI Board of Directors
- Radiation Safety Officer (RSO)

A master list including signatures and initials for all employees is maintained for reference and signature verification.

CHAPTER 5 – SAMPLING PROCEDURES

Private individuals or companies, who are responsible for using proper collection procedures, collect most of the samples processed in this laboratory. Members of the staff are acquainted with proper sample collection and handling procedures and advise those who need help in this area. Instructions and forms for initiating Chain-of-Custody are available from ELI. Laboratory procedures for logging in samples for analysis and maintaining Chain-of-Custody are described in ELI SOP, *Sample Receipt, Login, and Labeling*.

This laboratory provides proper sample containers and preservatives as specified for the procedure. Certified sample bottles may be ordered upon request with advanced notice. Sample containers, preservatives, coolers for shipping, re-sealable plastic bags for ice containment, trip blanks for monitoring contamination during shipping, temperature blanks for accurately monitoring sample receiving temperatures, Chain-of-Custody forms, Chain-of-Custody seals, sample bottle labels, instructions for sampling, sample labeling, sample preservation, and sample packaging/shipping are provided upon request. Container traceability is available upon pre-arranged request. Sample container type, sample volume, preservation requirements, and maximum holding times, are detailed for each analyte/method in the ELI Professional Services Guide.

Energy Laboratories maintains a strict Sample Acceptance Policy (see Appendix G). The client is notified via email the night of sample receipt. The email notification includes the COC, requested analytical parameters and sample receipt conditions. If there is any doubt concerning the sample's suitability for testing, the receipt condition sheet includes documentation of:

- Samples out of temperature compliance;
- Samples received in unacceptable containers;
- Samples not been properly preserved;
- Samples labels or chain-of-custody procedures that are incomplete;
- Samples cannot be analyzed within method recommended holding time; or
- The custody seal has been broken.

If there are receipt conditions which may impact sample integrity and the samples must be analyzed the day of receipt, the client is immediately notified.

Samples not collected or documented properly may be rejected for any regulatory-based analysis with re-sampling recommended. If re-sampling is not possible, or the client cannot be contacted, the sample may be analyzed, and if analyzed, the sample will be clearly qualified in the data package.

Sample preservation should be performed immediately upon sample collection. For composite samples, each aliquot should be preserved at collection. Refer to ELI Professional Services Guide for detailed information on sample preservation requirements per applicable method and regulatory requirements.

The laboratory will preserve samples at the time of sample login if samples are unpreserved and preservation is required by the methodology. Aqueous samples for volatile analysis (and methods not suitable for preservation check at sample receipt) are checked for preservation at the time of analysis. For these tests, preservation issues are documented as part of the sample analysis

comments in the Analytical Report. Samples for microbiological analysis are collected in pre-sterilized 120 mL plastic bottles containing sodium thiosulfate.

The laboratory initiates a sample condition report titled Work Order Receipt Checklist at the time of sample receipt. The sample condition report contains Chain-of-Custody procedures, sample preservation status, carrier used for sample shipment, sample receipt temperature, and general comments concerning sample condition. Samples that have not been properly preserved are noted. The sample condition report is provided with the analytical data report package. For more information, see ELI SOP, *Sample Receipt, Login, and Labeling*.

Notification of sample receipt condition is available through the final report, Energy Source, Email, telephone, and/or voice.

When any sample is shipped by common carrier or sent through the United States Mail, it must comply with the Department of Transportation Hazardous Materials Regulations (49 CFR Part 172). The person offering such material for transportation is responsible for ensuring such compliance. For the preservation requirements as described in the ELI Professional Services Guide, the Office of Hazardous Materials, Material Transportation Bureau, and Department of Transportation have determined the Federal Hazardous Materials Regulations do not apply to the following:

A) Hydrochloric Acid - (HCl) in water solutions of 0.04 % by weight or less (pH of 1.96 or greater).
B) Nitric Acid - (HNO_3) in water solutions of 0.15 % by weight or less (pH of 1.62 or greater).
C) Sulfuric Acid - (H_2SO_4) in water solutions of 0.35% by weight or less (pH of 1.15 or greater).
D) Sodium Hydroxide - (NaOH) in water solutions of 0.080% by weight or less (pH of 12.30 or less).

For regulatory compliance monitoring, it is required that all samples be analyzed within the prescribed holding times. Holding times are the maximum times allowed between sampling and extraction/analysis for results to still be considered valid. Samples should be delivered to the laboratory as soon as possible following collection to assure that holding times can be met. Samples are analyzed as soon as possible after sample receipt. When maximum holding times cannot be met, re-sampling is requested. If samples are analyzed out of hold, data is appropriately qualified.

To ensure that drinking water analysis requirements for radiochemistry analyses are met, the requirements for sample handling, preservation, and instrumentation for radiochemical analysis are included in ELI SOP, *Sample Receipt, Log In and Labeling*. (For additional information, refer to "Manual for the Certification of Laboratories Analyzing Drinking Water", Table VI-2: Sample Handling, Preservation, and Instrumentation, EPA 5th Edition, January 2005).

CHAPTER 6 – SAMPLE HANDLING

All ELI laboratories utilize a sample tracking policy that includes client-initiated chain of custody. Upon receipt, the security of the samples is maintained by the implementation of the laboratory access and security policies. See ELI SOP, *Facility Description, Access and Security*.

Sample Receipt

All samples arriving at the laboratory are logged in the Laboratory Information Management System (LIMS). Each sample container is given a unique laboratory sample number. The sample receipt checklist documents Chain-of-Custody procedures, sample preservation status, carrier used for sample shipment, sample temperature, sample receipt conditions and provides general comments concerning sample condition. The completed checklist is provided with the analytical report package. Chain-of-Custody forms are checked for pertinent information. If necessary information has been omitted, the collector is notified, if possible, and the missing information is requested.

Samples requiring preservation are checked to determine if the client performed preservation. If requested, ELI staff will preserve or filter samples as appropriate. Samples that degrade quickly or cannot be opened (such as aqueous samples for volatiles) are not checked for preservation, and cannot preserved at the time of sample login. If samples are improperly preserved, or the maximum holding times are exceeded upon arrival at the laboratory, the client is notified, and re-sampling may be recommended.

Samples are stored per method specifications, or as method/parameter storage requirements are updated per the current promulgated EPA guidance in Federal Regulations posted in 40 CFR Part 136 and 40 CFR Part 141.

During sample login, all sample information such as sample description, client name and address, analyses requested, special requirements, etc. are entered into the computer database of the Laboratory Information Management System (LIMS). Requested analytical parameters and special requirements are communicated to the analysts via their LIMS work lists. Project-specific requirements are maintained in the LIMS for any samples received from a special project. This process ensures that individual requirements are maintained.

Chain-of-Custody

For all sample sets received by ELI, sample identification information on the sample containers is compared to the custody report form. The sample is inspected and information regarding the condition of the sample and seal (if used) is recorded on a report form; the method of shipping is also documented on the report form. A copy of the report form is kept with the sample data file, included in sample receipt notification email, and a copy is sent to the client with the analysis report. ELI's routine COC policy is maintained at the laboratory level through our laboratory access and security policies. See ELI SOP, *Facility Description, Access, and Security* and applicable branch specific Sample Receiving and Login SOPs.

Evidence level internal chain-of-custody (COC) procedures are available on a project-specific basis. Advance arrangements with the laboratory are required. For these procedures, internal COC sample custody is maintained down to the individual analyst level. When transferring the possession of the samples, the transferee must sign and record the date and time on the chain-of-

custody record. Every person who takes custody must fill in the appropriate section of the chain-of-custody record. Internal chain-of-custody forms are used, when appropriate to document the progress of the sample through the laboratory.

Sample Tracking

Samples are tracked through the analytical process by the LIMS. Completed analyses, which have been approved by the appropriate reviewer as valid data, are reported in the LIMS. When all analyses are complete, the data is reviewed comprehensively to ensure results pass data quality checks. The completed report is signed by an approved signatory. The signed report is sent to the client via requested delivery format. Generation of the invoice automatically completes the work order in the LIMS and removes the samples from the status report. For more information, see ELI SOP, *Laboratory Records, Notebooks, and Document Management, Control and Archiving*.

Holding Time Evaluation

Sample holding times for methods are evaluated based on the hold time specified in the associated analytical method. For a test method with a maximum holding time of less than 7 days, the holding time is evaluated to the minute of analysis in relation to the client specified collection time. For test methods with a maximum holding time greater than 7 days, the holding time is evaluated to the by the day.

Sample Disposal

For samples which exhibit hazardous characteristics, or is classified as hazardous by the client, it is preferred that remaining hazardous sample material be returned to the originator (client) for disposal. When this is not possible or reasonable, ELI will dispose of remaining hazardous sample materials with a waste disposal surcharge added to the cost of the analysis.

The disposal of laboratory wastes will be performed in accordance with local, state, and federal regulations which apply to such activities. Each method SOP addresses waste minimization and management specific to the method procedure. See ELI SOP, *General Laboratory Waste Disposal,* for more information.

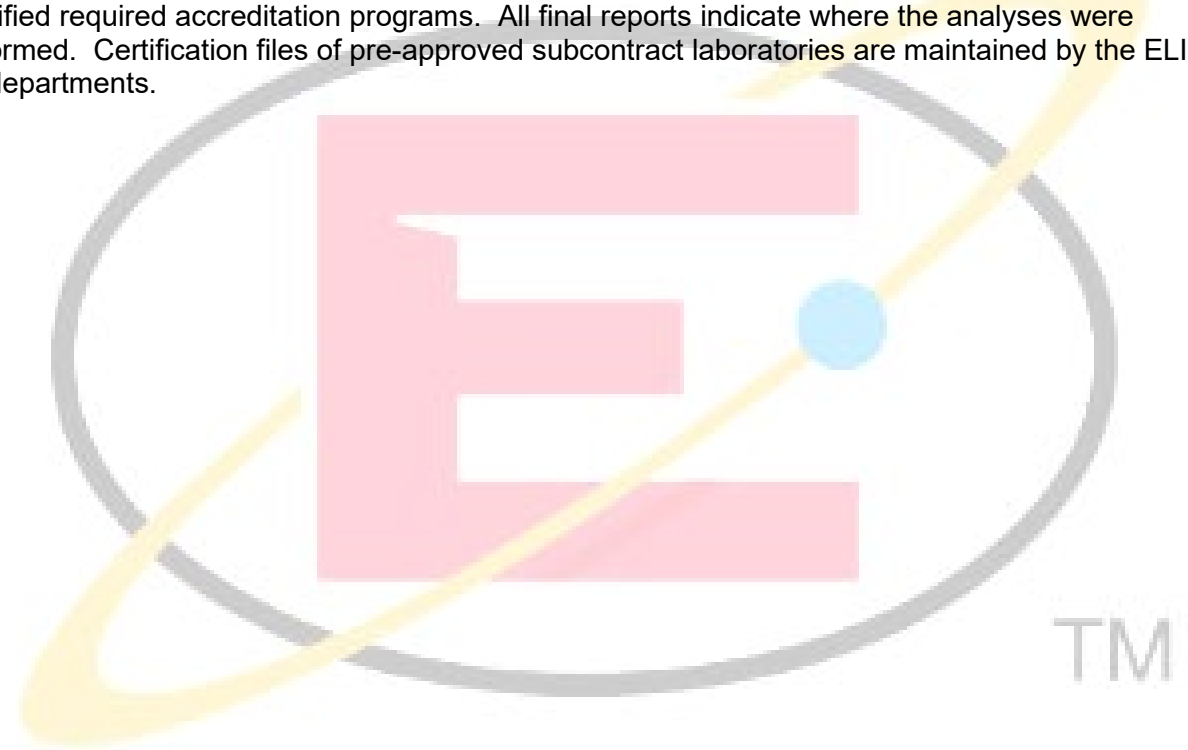
Subcontracting Policy

Energy Laboratories utilizes the expanded ELI branch laboratory capability and expertise to provide comprehensive analytical services. This occurs when the laboratory is requested to perform an analysis outside of the laboratory's capabilities: if sample overload is experienced, if equipment is out of service, or when the laboratory is not accredited for the particular analysis. Upon completion of the analyses, the subcontracted ELI laboratories report the sample results, and their quality control package, to the primary laboratory. The results are reviewed before being reported.

All ELI laboratories are certified to perform drinking water analysis in their state and in select neighboring states. Samples are forwarded to our branch laboratories only if the laboratory is certified in the state from which the sample originated per the individual state certification requirements. Individual ELI laboratory Quality Assurance Programs are consistent with the Corporate Quality Assurance Program and are monitored through internal laboratory audits.

Current accreditation certificates for all ELI laboratories are available on the Energy Laboratories website at www.energylab.com.

In the event that ELI is dependent on the service of an outside laboratory for analyses not available through our facility or our other branch laboratories, the client is notified that their samples are subcontracted to a pre-approved outside laboratory. The outside laboratory reports the results to ELI and these results are incorporated into the final report. Any external or internal subcontracted analyses that require accredited analyses will be performed by a laboratory accredited for those parameters as required in the state from which the sample originated and/or to meet client-specified required accreditation programs. All final reports indicate where the analyses were performed. Certification files of pre-approved subcontract laboratories are maintained by the ELI QA departments.



CHAPTER 7 – INSTRUMENT OPERATION AND CALIBRATION

Laboratory instruments and equipment are operated and calibrated according to the manufacturer's instructions and according to the requirements of the method being used. Exact calibration procedures are outlined in the appropriate SOP. For most instruments, a calibration curve composed of three to five standards covering the concentration range of the samples is prepared. The acceptance criteria for the calibration curves are listed in the individual methods. Unless otherwise specified in the method, at least one of the standards is at or below the reporting limit (RL) of the method. Routine RLs for each method are provided in the ELI Professional Services Guide. Calibration standards are routinely compared to second source calibration standards to verify accuracy. These second source standard results must fall within an established range, as described by the SOP, to be considered acceptable. Whenever possible, the laboratory uses calibration standards prepared from certified stock standards. Initial instrument calibration curves are verified and routinely monitored by analyzing a continuing calibration standard every 10 to 20 samples (or within a specified time frequency) and at the end of every analytical sequence, depending on the analysis method and instrumentation. When applicable to the method, high-level samples, which produce an analytical response outside the calibrated range of the instrument, are diluted (or reduced in mass) and re-analyzed until a response within the calibrated range is obtained and/or the result is appropriately qualified.

System cleanliness is verified through the analysis of reagent/instrument blanks prior to analysis, between highly contaminated samples, and at regular intervals during the analysis.

Use of measuring equipment and reagents (glassware, water, chemical reagents, and industrial gases) conform to Good Laboratory Practice guidelines. Good Laboratory Practices (GLPs) are laboratory guidelines which were established by the Food and Drug Administration and published in the Federal Register (21 CFR, part 58). The GLP guidelines were adopted by the Environmental Protection Agency. SOPs are developed in accordance with GLP and NELAP guidelines. Laboratory volumetric glassware conforms to National Institute of Standards and Technology (NIST/SI), American Society for Testing and Materials (ASTM) Class A or B standards. All mechanical pipettes are calibrated at least quarterly. Laboratory balances are serviced and calibrated by certified technicians annually. Calibration checks of balances are performed each day of use, using ASTM Class 1 or 2 weights. Laboratory thermometers are calibrated annually against a reference thermometer traceable to the International System of Units (SI) through a national metrological institute, such as NIST. For DoD certified laboratories, hand-held infrared are calibrated quarterly, and liquid and electronic thermometers calibrated annually. Laboratory drying ovens, incubators, freezers, refrigerators, and water bath temperatures are monitored and recorded each working day, or at frequencies as described in the specific SOP. Laboratory pure water is generated by commercial water purification systems and is monitored and documented each working day in accordance with specifications needed for applicable methods. The routine analysis of laboratory blanks is used to verify laboratory water quality and the suitability of sampling containers. Chemical reagents and gases meet or exceed purity requirements for their intended uses. Laboratory stock and working standards are derived from ISO/IEC 17025 and/or ISO 17034 (or equivalent-certified) commercially available primary standards whenever possible. Standard preparation records document the reagent/standard type, source, purity, content, concentrations, preparation date, and analyst. All calibration standards are documented in each the analytical records such that they are uniquely identified and traceable to stock standards and their source.

Standard Operating Procedures (SOPs) detail the sequence of operations involved in instrument start-up, calibration, analysis, shut-down, and routine maintenance. Suggestions for corrective

action are included with the SOPs and parameters are identified which dictate certain types of maintenance. Instrument and method detection limit studies are performed at the method required frequency or whenever there is a significant change in instrumentation. Method Detection Limits are determined according to EPA guidelines found in 40 CFR, part 136, Appendix B for general chemistry and 40 CFR 141.25 (c) for radiochemistry (except for methods that are not amenable to MDLs). Refer to ELI's Professional Services Guide for routine method reporting limits. Acceptable instrument response/performance criteria are based upon the manufacturer or the analytical method specifications.

Instrument logbooks and/or electronic logbooks are used to document instrument maintenance and repairs. Instruments that are no longer being utilized are documented in the applicable instrument logbook as "out-of-service" with the date the instrument was taken out of use noted. All out-of-service instruments are labeled with an out-of-service tag that identifies the effective date the instrument was taken out of use and the analyst initials documenting who removed it from service.

Laboratory analysts record and document all instrumental sequences in Laboratory Instrument Logbooks, LIMS system, or computer files. Instrument Logbooks and/or dated computer files record instrument performance data, analytical sequences, instrument maintenance, calibration standards data, and any other additional information pertinent to operation of the instrument.

CHAPTER 8 – RECORDS AND REPORTING

Document Management

Energy Laboratories Inc. manages three types of documents: 1) controlled, 2) approved, and 3) obsolete.

A CONTROLLED document is one that is uniquely identified, issued, tracked, and kept current as part of the Quality or Management System. Controlled documents may be internal documents or external documents. Controlled documents are considered to be all documents issued to personnel in the laboratory as part of the management system such as accreditation standards, forms, test and/or calibration methods, and company policies and procedures. All internal ELI controlled documents are written and reviewed by personnel technically competent to perform the procedure and are approved for use by the Laboratory Director, or Director's designee(s).

APPROVED document is one that has been reviewed and approved for use by authorized personnel prior to issue. Approval of these documents is indicated by inclusion in the controlled document list.

OBSOLETE document is a document that has been superseded by more recent versions or is no longer being used. Obsolete documents are retained for legal use or historical knowledge preservation. Old or archived SOPs are available for review using the laboratory's electronic document system. ELI's OBSOLETE document records are maintained for at least ten years.

Documents are reviewed on a routine basis to ensure their contents are suitable and in compliance with the current quality systems requirements, and accurately describe current operations. SOPs include a Record of Revision page, which details revisions or reviews. The Quality Assurance Manager maintains a master list of controlled documents.

Procedures for identification, collection, access, filing, storage, and disposal of records are found in ELI SOP, *Laboratory Records, Notebooks, and Document Management, Control and Archiving*.

Laboratory Notebooks

Several different types of Laboratory Notebooks are maintained at the ELI Laboratory. These include, but are not limited to, the following:

Method/Parameter Notebooks
Project Notebooks
Instrument/Equipment Use and Maintenance Notebooks
Standard Preparation Logbooks
Balance Calibration Logbooks
Pipet Calibration Logbooks
General Logbooks

The general purpose of maintaining each of these Laboratory Notebooks is to record the details that may be important in repeating a procedure, interpreting data, or documenting certain operations. Entries in the notebook may include data such as standard and sample weights, pH measurements, instrument operating parameters, preparation of calibration curves, analytical sequences, calculations, recording of instrument operating parameters, sample condition, etc. The

analyst's notebook is particularly important in documenting analyses that deviate in any way from routine or standard practices. It can also be an important training record. All pertinent data is to be recorded directly in the notebook. Most notebooks or data records are maintained in electronic format (LIMS, spreadsheets, or databases). Electronic data records are duplicated using hardcopy and/or alternate electronic backup techniques.

It is the responsibility of each analyst to maintain a laboratory notebook according to Good Laboratory Practices (GLP) Guidelines. All physical laboratory notebooks are assigned a unique logbook control number and are assigned to an analyst and/or supervisor. These notebooks remain the responsibility of the ELI staff member to whom they are assigned until they are formally transferred to another staff member, until they are completely filled and returned to the ELI QA Department for archiving, or until the staff member resigns and returns them as a part of the check-out process. ELI staff members, other than the individual to whom the laboratory notebook is issued to, may make entries in the notebook as long as those entries are consistent with the intended use of the notebook and such entries are initialed and dated. Procedures for use and maintenance of laboratory notebooks are detailed in ELI SOP, *Laboratory Records, Notebooks, and Document Management, Control and Archiving*.

Records

The laboratory maintains records of all chemical analyses, including all quality control records, for a minimum of ten years. In the event that Energy Laboratories, Inc., or any individual laboratory transfers ownership or goes out of business, the records will be transferred to the new owners. If an ELI laboratory is closed, records will be maintained by Energy Laboratories Corporate office in Billings, Montana. Energy Laboratories, Inc. reserves the right to offer the records to the clients in the event of complete closure. Details are described in ELI SOP, *Laboratory Records, Notebooks, and Document Management, Control and Archiving*.

Data Reduction

Data reduction refers to the process of converting raw data to reportable units. The reporting units used and analytical methods performed are described in the ELI Professional Services Guide.

Wherever possible, the instrument is calibrated to read out directly in the units reported. In this case, the value is recorded directly into a laboratory notebook, logbook, bench sheet, or electronic file and presented for review.

In cases such as titration, gravimetric measurements, or other techniques that require calculation prior to reporting, raw data is recorded in the appropriate laboratory notebook or electronic file, or on the appropriate laboratory form. The calculations specified in the methods are used to determine the reported value. That value is also entered into the laboratory notebook or bench sheet. Most calculations are automated to minimize the risk of arithmetic or transcription errors. Calculations are verified, and access to edit the calculation is restricted to authorized personnel.

Wherever possible, electronic data results are transmitted throughout the laboratory via the LIMS computer network. This process is intended to minimize manual data transcriptions within the laboratory. Additional advantages include the opportunity for rapid comprehensive data validation by supervisors, and more rapid data reporting.

Validation

Data validation includes the procedures used to ensure that the reported values are consistent with the raw data, calculated values, sample type, sample history, and other analysis parameters requested. Data validation also includes a review that client specific DQO's are met.

The data recorded is validated with several review steps. The analyst who submits the analytical results checks all the values reported for omissions and accuracy. Elements of this review also evaluate all instrument and method QC results. Automated data management programs are designed with an interactive step allowing data review by the analyst. Results to be reported are approved by the analyst or supervisor.

The report is reviewed for the suitability of the data according to project and method performance specifications. Analytical results for each requested parameter may be evaluated against other requested parameters, project specifications, other samples within the set, historical files associated with the project/client, and/or any other information provided with the sample.

The reports are generated, proofread, and reviewed by designated reporting staff.

The Laboratory Director, project managers, supervisors, Quality Assurance Manager or their designees, may also examine the data included in the final report.

Internal and external laboratory audits review selected sets of data to ensure that the analytical results are correct and accurate, analytical methods are appropriate, documentation and record keeping procedures are complete, and that there is compliance to the overall objectives of the Quality Assurance Program. Data integrity is monitored on an on-going basis. See ELI SOP, *Assessment of Data Integrity*, for details.

All controlled automated programs used to process and report data are initially verified using manually calculated results. Whenever a modification is performed to a program, re-verification of overall software function is performed.

One step of the Quality Control process involves data outlier detection; data that falls outside of established limits. If an outlier is observed, corrective action is taken as appropriate, to investigate and/or correct the cause. Actions to correct these causes may include, but are not limited to, inspection of the instrumentation, checking calibrations, checking sample numbers or dilutions, re-analyzing samples or calibrations.

Reporting

One copy of the report is distributed to the client, via requested delivery format, after the report is validated and signed. A standardized report format is used unless otherwise specified. Client-specified report formats are available upon request. Results are sent as a pdf, and may include additional EDDs, via email to specified client contacts. Additional distribution options include physical media, website FTP and/or FAX when requested by the client. Energy Laboratories, Inc. offers its clients access to electronic records through our Energy Source Portal.

Various levels of data reporting are available. Appendix G contains a table of the reporting tiers, and associated documents provided with each tier. Additional documentation for data validation packages may be available upon consultation with a project manager. All analytical results, regardless of the level of reporting used, have record keeping procedures which allow an appropriate "data validation package" to be produced. Note that a comprehensive "data validation

package" is most easily generated at the time of sample analysis. Example data packages are available upon request. Maximum contaminate limits and/or decision rules per applicable regulation may be included on analytical reports per type of regulatory analysis being requested.

Safe Drinking Water Act (SDWA) compliance monitoring samples for microbiological and chemistry samples that exceed the SDWA maximum contaminant level (MCL) may require notification to the appropriate state agencies. Generally, notification to the client, and to the state, of any SDWA MCL exceedance must be within 24 hours of completion of analysis and all associated review steps, or by noon the next business day. If requested by the client, additional copies of the report will be sent to a specified address or person.

The final copy of a completed report is maintained in an electronic format. An electronic copy of this file is available upon request. Energy Source is a client resource of ELI that provides secure online access for clients to view their data and documents. Clients may access their electronic files through ELI's secure website at *https://energysource.energylab.com.* For more information, see ELI SOP, *Laboratory Records, Notebooks, and Document Management, Control and Archiving*.

In addition to traditional ink signatures, Energy Laboratories has approved the use of electronic signatures within our company-produced PDF documents. These signatures comply with Title 15 of the US Code Chapter 96 regarding legal requirements of a digital signature.

Electronic signatures verify that the document has not changed after it was produced. Upon opening the document, notifications automatically display to inform the recipient of the validity of the sender's electronic signature and all included certificates. Should any changes be detected, an alert message is automatically displayed, noting that the signatures cannot be validated due to changes made to the document. Detailed instruction on how to view/validate ELI's electronic signatures is available.

CHAPTER 9 – GENERAL LABORATORY PRACTICES

Chemicals and Reagents

When available and appropriate, chemicals used in the laboratory are ACS (American Chemical Society) analytical reagent grade chemicals purchased from reliable suppliers, preferably ISO accredited suppliers, and which meet referenced method specifications. Reagents are prepared, standardized, and made fresh as mandated by the method, their stability, and according to Good Laboratory Practices. Procedures for purchasing of materials may be found in ELI SOP, *Property Procurement, Inventory, and Control*.

Normalized standards are checked regularly against independently prepared reference materials.

All standards and reagents are dated when received, opened, or prepared, and each is labeled with an expiration date when applicable. Standards and reagents are checked for discoloration or signs of degradation and are discarded if these are observed.

Certified primary standards are obtained from ISO accredited commercial sources when available. Standards used for calibration are verified against second source standards. Secondary and working standards are accurately prepared with volumetric flasks, or other calibrated labware, from primary standards and stored in appropriate containers.

ELI has determined twenty years to be a reasonable expiration date for stable salts where the manufacturer does not supply such information. Reagents which are reactive or may be unstable should have an initial expiration date appropriate to the shelf life of the compound, with a suggested maximum of 1 year. Titrants, standards, and other solutions used for analytical purposes are frequently standardized upon preparation with certified or traceable standards. Method SOPs specify if standardization is necessary. The date and analyst's initials must be recorded on the container whenever re-standardized and these records are maintained in a laboratory notebook or in the LIMS.

Individual SOPs may also provide additional details for reagent requirements.

Reagent Interference

To determine the extent of reagent interference, method blanks are analyzed prior to sample analysis whenever appropriate.

If any interference cannot be eliminated, the magnitude of the interference is considered when calculating the concentration of the specific constituent in the sample, but only when permitted within the applicable method.

If reagents, materials, or solvents contain substances that interfere with a particular determination, they are replaced.

Individual method SOPs may also provide additional requirements for handling reagent interferences.

Glassware Preparation

All glassware used for inorganic and radiochemical analysis is washed in warm detergent solution and thoroughly rinsed in tap water. Glassware is then rinsed well three times with laboratory-purified water. This cleaning procedure is sufficient for many analytical needs, but individual SOPs detail additional procedures when necessary.

All glassware used for organic analysis is washed in warm synthetic detergent solution and thoroughly rinsed in tap water. The glassware is then rinsed well with laboratory-purified water, followed by rinses with acetone to remove any residual organics. Prior to use, the glassware is rinsed three times with the organic solvent and/or acid washed, where defined by method.

All glassware used for microbiological analysis is washed in warm detergent solution. The detergent must be proven to contain no bacteriostatic or inhibiting substances. The glassware is rinsed thoroughly with laboratory-purified water. Specific details are described in method specific SOPs.

Disposable, glassware/plastic ware is preferred for many procedures in the laboratory. The cleanliness and suitability of disposable glassware/plastic ware is continuously evaluated for each test with the routine analysis of method blanks.

All volumetric glassware used in precise measurements of volume is Class A or laboratory calibrated.

Laboratory Purified Water

Laboratory-purified water is used in the laboratory for dilution, preparation of reagent solutions and final rinsing of glassware. For organic analysis, organic-free water is prepared and used. Energy Laboratories, Inc. uses water purification systems that are designed to produce deionized water that meets the requirements of the methods. Use and maintenance of laboratory reagent water systems are described in branch specific SOPs pertaining to their respective water system(s).

Water quality is monitored for acceptability in the procedure in which it is used. Specific details are listed in the appropriate SOPs.

Employee Training

All new ELI employees and contract personnel are given an initial general orientation and tour of the laboratory facilities. Personnel are shown the locations of safety equipment such as safety showers, eye wash fountains, fire extinguishers, and first aid supplies. Personal protective equipment such as lab coats, disposable gloves, and safety glasses (if applicable) are issued during the initial orientation.

Safety considerations are a vital part of the training process. All hazards associated with the performance of a procedure or with the operation of an instrument are to be understood by the trainee before training can be considered complete. General laboratory safety procedures are a part of the new and current employee training. Specific safety procedures are outlined in SOPs and in instrument Operator's Manuals. Training in use of protective clothing, eye protection, ventilation, and general safety are provided to each employee. Each employee is required to read and sign the *Laboratory Safety Manual & Chemical Hygiene Plan*.

All new and existing employees must demonstrate capability prior to performing an analytical procedure independently (see Chapter One). Method performance on Quality Control Samples is

used to document employee training and work quality. Employees are required to read the Quality Assurance Manual and all appropriate SOPs. Employees are required to sign, for all applicable Manuals and SOPs, a Record of Acknowledgement Form that states they have read, understood, and agree to abide by the Manual/SOP.

Employees also receive training on general laboratory policies including ethics and conflict of interest. All employees are required to read, understand and comply with the Corporate Compliance & Ethics Manual. Data integrity training is provided for all employees initially upon hire and annually thereafter. In addition to the *Corporate Compliance & Ethics Manual*, the ELI Quality Assurance department maintains a *Laboratory Ethics & Data Integrity Manual*, which supplements the corporate manual and provides specific training on data integrity. All employees are required to read, understand and comply with the ELI *Laboratory Ethics & Data Integrity Manual*. An annual Ethics training course is given to all laboratory employees. Attendance is required and is recorded with a signature attendance sheet or other form of documentation that demonstrates all staff members have participated and understand their obligations related to data integrity and ethics policies. For details pertaining to ethics training and additional ethical procedures and policies refer to ELI SOP, *Personnel Training and Training Records*.

ELI encourages attendance at courses, workshops and other forms of continuing education available from on-site seminars, webinars, private institutions, local schools, and State and Federal regulatory agencies. Staff and department meetings are held routinely to communicate company policies and procedures. All training on procedures and policies is documented, per NELAP guidelines, in employee training files. For more information see ELI SOP, *Personnel Training and Training Records*.

Data Integrity

To provide data of known quality Energy Laboratories Inc. activities, policies, and procedures are structured and managed to safeguard impartiality. To provide for the security and integrity of ELI and client data, the laboratory has multiple controls on the network, LIMS and applications used. These controls limit access to and the ability to change data as well as provide for redundancy in case of loss.

These include but are not limited to:

- Users connecting to ELI computer systems are authenticated through a two factor authentication process, including user name and password combination.
- Passwords are required to be changed on a regular basis.
- Permissions within ELI applications are role based with different roles having various levels of access and control. Users (analysts, supervisors, and Directors) are assigned these roles.
- In the LIMS, analytical data locks after a period of time and cannot be modified without special handling.
- Certain information has been identified for additional tracking and logging. Changes to this information is not only tracked in an audit log but also reported to select personnel.
- Information on ELI servers including the ELI LIMS system is backed up and recoverable.

Standard Operating Procedures

Laboratory operations and procedures are documented in Standard Operating Procedures (SOPs). SOPs provide information regarding the consistent and safe operation of the laboratory. For analytical methods, SOPs provide information on the details of the analysis that may not be specified in the published reference analytical method(s). All method SOPs follow NELAP and EPA requirements including the 12 QC elements listed in 40 CFR Part 136.7. Additionally, SOPs for DOD accredited methods incorporate additional DOD requirements. For routine procedures other than analytical methods, SOPs define the steps required in accomplishing a given task. All SOPs are reviewed and updated periodically to reflect any changes in laboratory operations. For more information on generation and distribution of SOPs, see ELI SOP, *Preparation, Numbering, Use, and Revision of Standard Operating Procedures*.

Impartiality

Objectivity is managed via procedures and processes to avoid conflict of interest, freedom from bias or risks to impartiality. Laboratory activities are evaluated for the potential risk to conflict of interest or impartiality. Relationships of the laboratory, including personnel, which may pose a risk for impartiality should be disclosed to branch management for evaluation and mitigation of potential risks. This is reviewed annually as part of the annual ethics refresher training.

Client Confidentiality

Each employee has the responsibility to maintain confidentiality in all matters pertaining to clients, samples submitted, and Energy Laboratories, Inc. Information obtained during employment with this laboratory, regarding the specific business of this laboratory, or its clients shall at no time be revealed to any outside sources without permission from the owner of the data.

Sample submittal, analysis and the report contents are considered confidential information of the client. When requested to provide results (either in person, via telephone or email), the employees shall verify that the requestor is either the person associated with the project, on the COC, or on a list provided by the client who are authorized to receive data. If a person who is not associated with the project personnel (or is not on the approved list), the base client will be contacted to inquire about authorization to release data. These contacts are documented and associated with the work order in the LIMS system to provide archival proof of authorization to release data. If the client does not authorize a release of data, the requestor will be contacted and informed of this decision.

Client confidentially is maintained electronically through the use of password-protected logins on all laboratory computer systems. Additionally, the laboratory maintains network security such as anti-virus programs and firewalls that prevent any unauthorized outside access. All copies of the original report are stored on the laboratory's document archival system, which is also protected from unauthorized use by the network security systems. Raw data, reports, and LIMS records are kept in a secure location of the laboratory or off-site. All client confidential paper waste, including printouts, is shredded.

When the laboratory is required by law or authorized by contractual arrangements to release confidential information, the customer or individual concerns shall, unless prohibited by law, be notified of the information provided. For example, samples provided for Safe Drinking Water Act compliance monitoring, as per individual state regulatory requirements, may also need to be reported to the applicable state agency.

An individual acting on the laboratory's behalf shall keep confidential all information. Information about the customer obtained from sources other than the customer (e.g. complainant, regulators) shall be confidential between the customer and the laboratory. The provider (source) of this information shall be confidential to the laboratory and shall not be shared with the customer unless agreed by the source.

CHAPTER 10 – QUALITY CONTROL MONITORING

Routine Monitoring

Temperatures of incubators, water baths, refrigerators, and ovens are checked and recorded according to a prescribed schedule and using an automated continuous monitoring system. In the event that the automated monitoring system is inoperable, the temperatures will be recorded manually on instrument specific forms.

Conductivity of the laboratory-purified water is continuously monitored using an automated monitoring system and as method blanks in routine analytical sequences.

Reagents are dated and initialed at the time of receipt. Expiration dates are assigned as a fundamental component of their receipt and/or preparation. Reagents are not used after manufacturer's expiration date is exceeded.

Analytical balances are checked daily, when in use, against primary ASTM Class 1 or 2 reference weights traceable to the International System of Units (SI) through a national metrological institute, such as NIST or secondary weights with documented direct comparison to primary weights and are calibrated and serviced annually by certified technicians.

Method SOPs are reviewed annually for accuracy. Non-method SOPs are reviewed on a 3-year cycle.

Laboratory Notebooks are reviewed periodically for correctness and accuracy by supervisors and by internal and external auditing.

Proficiency Testing (PT) Samples are analyzed as required (See Chapter 2 of this QA Manual).

Quality Control Check Samples are analyzed with each analytical batch.

Internal and external audits are performed as specified or requested (See Chapter 2 of this QA Manual).

Additional monitoring requirements may also be specified in individual SOPs.

The Laboratory maintains an active fraud protection program that is implemented through the laboratory ethics policy. Additionally, the potential of fraud is monitored through analyst supervision, management supervision, regular internal audits, PT study participation, and an active quality assurance program.

Instruments/Methods

Calibration is performed as outlined in Chapter 7 of this QA Manual.

Generally, and depending on method requirements, the standard curve is verified with a known second source reference sample. The reference sample results must fall within the appropriate target range for the calibration to be considered acceptable.

In most cases, the calibration stability is checked by analyzing a continuing calibration standard every 10 to 20 samples, depending on the analysis and instrumentation. The verification standard results must fall within an established range as described by the SOP. Corrective actions steps are defined by SOP or by project specific requirements.

All laboratory instruments are subjected to preventive maintenance schedules. Preventive maintenance schedules are specified in instrument maintenance logbooks.

As appropriate, instrument and/or method detection limits are determined or verified annually, or more frequently if changes in instrument performance are noted or per method requirements. Procedures for the determination of instrument detection and method detection limits are described in branch specific ELI SOP, regarding Determination of Method Detection Limits (MDL) and Quantitation Limits. For all applicable procedures, ELI follows DOD QSM 6.0 guidance/requirements and definitions for performing MDL, LOQ, and LOD analysis. The detection limits for radiochemical analysis are calculated based on the requirements in 40 CFR 141.25(c). If within assigned accuracy acceptance criteria, LOQ analyses may be done at levels lower than the RL and closer to the MDL and/or LOD (as applicable).

Precision and accuracy requirements for each method are specified in the SOPs. General guidelines are given below.

- Each analytical batch will contain QC samples to measure the accuracy of the method. Each QC sample result is monitored to be within QC specifications of the method. Results of blank spiked sample analysis must be within the established control limits. Quality Control Limits are specified in the SOPs and meet recommended QC limits as described in the referenced method.

- Each analytical batch will contain QC samples to measure the precision of the method. (See Chapter One for discussion on duplicate sample analysis.) Criteria for duplicate sample acceptance are found in the SOP and are generally taken from the referenced method.

- Each analytical batch will contain QC samples to measure the performance of the method on the sample matrix. These are typically identified as a matrix spike analysis and may be performed in duplicate to assess method precision. Typically, the sample is fortified with a known amount of target analyte and spike recoveries are calculated. Results outside of method QC guidance are flagged. Quality control limits and appropriate corrective actions steps are specified in the method SOP or by client-specific project requirements.

- Several methods are considered to be concurrent methods in that they are either nearly identical or are identical to a method with a different citation. Even if two methodologies are identical in procedure, slight differences in the QC requirements might be the only difference between the two methodologies. These types of methods may also be

considered "concurrent" if the procedures are identical and the more stringent of the two method criteria are used. During data reduction and reporting, the referenced method specifications and criteria will always take priority.

As appropriate, the performance trends of QC sample results are evaluated with Quality Control Charts. Suitability of existing QC limits is evaluated and possibly adjusted, but not to exceed method specification.

CHAPTER 11 – CORRECTIVE ACTION

When the quality control checks indicate that an analysis is not within the established control limits, corrective action is needed. This section gives general guidelines for corrective action. Corrective actions for each method or instrument are detailed in individual SOPs. Records are maintained of non-conformances requiring corrective action to show that the root cause(s) was investigated, and includes the results of the investigation. The Quality Assurance Manager will monitor implementation and documentation of the corrective action to assure that the corrective actions were effective.

Method QC samples that fail to fall within QC control limits may be analyzed again to verify if a problem exists. However, matrix spike or matrix spike duplicate QC samples are not required to be re-analyzed if the performance can be attributed to matrix effects; data results are then reported and properly qualified.

If the repeat analysis is not within control limits, the particular instrument or procedure is checked according to the specific protocols outlined in the method or according to the instrument manufacturer's guidelines. Results within acceptable control limits must be reestablished before the instrument can continue analysis. Analysis of all samples that were analyzed while the procedure was out of control must be repeated. In the case of radiochemical analysis, the term "analyze again" means to recount the final sample on the same (or different) detector.

If the analyst is unable to achieve acceptable results after following the corrective action guidelines detailed in the SOP, or by project specifications, a supervisor and/or technical director is consulted. If necessary, the appropriate service personnel are contacted if the problem is determined to be due to instrument error and cannot be resolved. It is also possible that the result is due to statistical variation of the results based on the tolerable error rate that has been determined for the analysis (usually 0.05). In certain cases, where control limits are exceeded, it is possible that problems cannot be corrected to satisfy QC criteria. This could be due to problems such as matrix interference, instrument problems, lack of sufficient sample, missed holding times, high blank contamination, etc. If all possible solutions available to correct the problem are examined and the sample results are still considered valid, qualifying comments are attached to the sample report describing the non-compliance and probable cause.

In the case of a single radiochemistry detector being returned to service, this refers only to the samples counted on that detector. For example, an individual gas proportional counter instrument may have up to 16 detectors; if only one does not pass the QC check the others are still valid and sample analyses performed on the others do not need to be repeated.

In the event that a QC audit or other informational review shows an analysis report to be incorrect, incomplete, or adversely compromised, a revised report and explanation is submitted to the client within fifteen business days unless otherwise communicated to the client with another time period. The report will clearly be identified as a revised report. As appropriate, an explanation submitted to the client should give a detailed review of the problem and document any unapproved deviations from the regulations, standard operating procedures, or project- specific scope of work that may have caused it. The explanation to the client may include, but not be limited to, the following components:

1) What actions have been taken regarding the affected data set(s),
2) Identification of the cause, and

3) Corrective action(s) taken to prevent future occurrence.

In the event a work stoppage occurs due to a QC audit or information review, the laboratory manager or approved delegate has the authority to authorize the of resumption of work.

If a QC check fails, the analyst will follow the procedures outlined in the QA/QC summary of the SOP.

Quality Control Checks for each method or instrument may vary. Energy Laboratories Inc. follows the QC checks set by each governing method. Due to the wide variations between methods, specifics are listed within each SOP for the given method. Please reference the SOP for specific QC checks for the given method. The QC checks may include: ICV, MB, CCV, CCB, LCS, LCSD, LOD, MS, MSD or others specific to that method.

A general summary of Quality Assurance/Quality Control specifications is outlined in Appendix A. Exact details of method QC requirements can be found in the applicable method SOPs and is available upon request.

Procedure for Dealing with Complaints

DEFINITIONS

Complaint: For the purposes of this procedure, a complaint is an expression of dissatisfaction from a client, a user of our data, or employee. The complaint might cover issues about the quality of data, sample turnaround time, method used, pricing, or other expectations and for which a response is expected.

Client: The client is a person or company that ordered and paid for the services.

Procedure: The staff person receiving the complaint exercises judgment in deciding the severity and disposition of every complaint. The judgment must be used to decide whom, if anyone, is alerted to the complaint and what actions are appropriate. The complaint issued should be handled with a high degree of discretion and tact by the supervisor or Director involved. The individual handling the complaint is instructed to follow ELI's guidelines provided in this section on how to handle the complaint. This involves listening to the client and documenting adequate information so the complaint can be investigated and resolved. The appropriate laboratory staff are notified and a response plan is made with a timeline for action, which is communicated to the client. Records are maintained regarding the complaint and of the investigations and corrective actions being taken.

After the complaint is investigated or resolved, as necessary, the client is made aware of the results and determination is made as to what further actions are needed. Complaints and investigations may result in the need to submit a revised report or invoice. Complaints that are straightforward and can be resolved using the resources available to the person handling the complaint should be resolved there. These include such things as minor revisions of reports or invoices. If other decisions need to be made, the appropriate person should be contacted.

It may be appropriate to initiate or prepare a corrective action report. This report should be completed with the intention of informing the affected staff about the problem so that all relevant staff can use it as a learning opportunity, update procedures, improve our service and minimize risk of reoccurrence. A procedure to document corrective action reports is in ELI SOP, *Nonconformance, Root Cause Analysis and Corrective Action Procedures.*

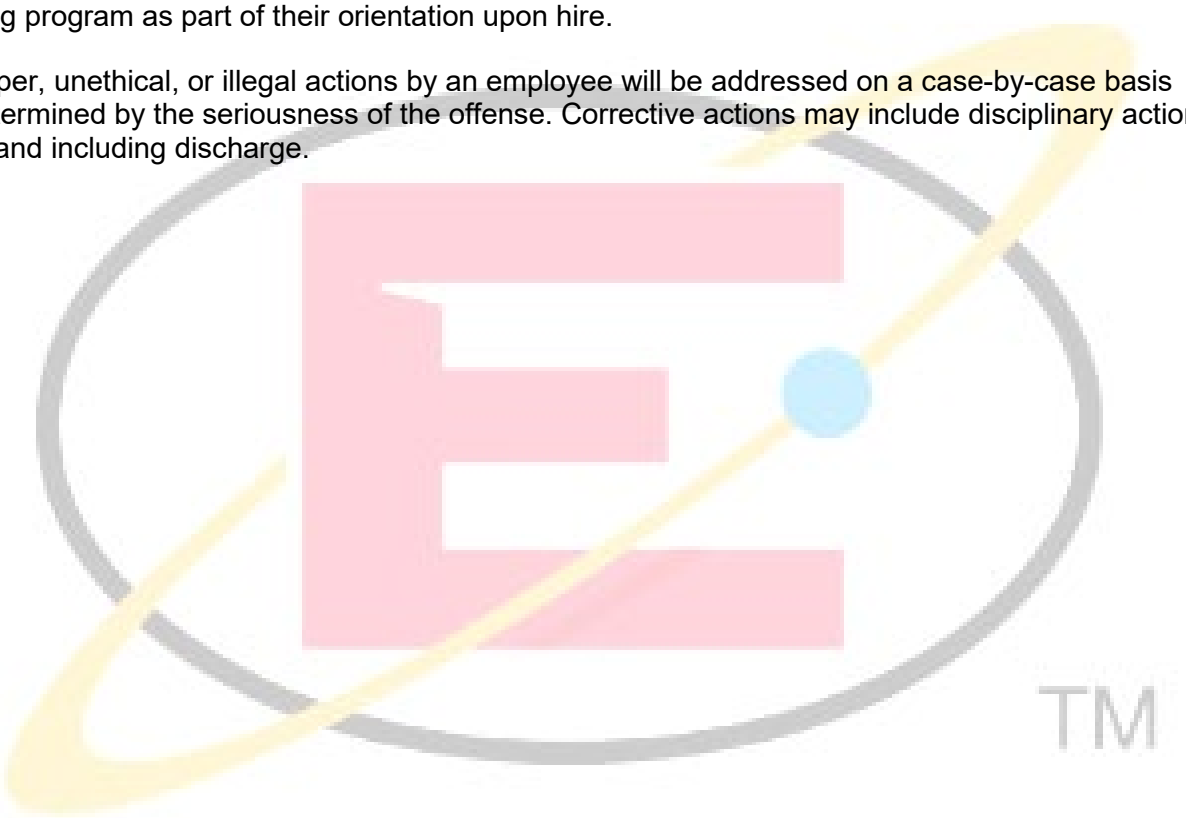
If an employee sees an issue, they are encouraged to report concerns regarding Quality Systems, unethical behavior, and/or financial mismanagement. This issue should initially be brought to the attention of their supervisor. The supervisor will take appropriate action to resolve the concern. If the employee is uncomfortable with approaching their supervisor or feels that the issue was not properly addressed, they may approach higher levels of management with their issue.

Energy Laboratories, Inc. has also implemented a program to facilitate confidential reporting to upper management. This tool allows employees to report situations or behaviors that they consider to be unethical, immoral, or improper. It also allows the reporting of suggestions or comments. The program has been implemented at ELI so that anyone reporting a situation can be assured that there will not be retaliation for reporting. It is meant to encourage parties to communicate with upper management when there appears to be no alternative for resolving the types of issues already described. Access to the program is available on the ELI internal website as well as through a 24-hour telephone hotline number (844-965-3447). Complaints, suggestions or comments from clients, vendors, auditors, and other interested parties can be submitted directly to project or laboratory management who will initiate the process ending with a resolution.

Penalty for Improper, Unethical or Illegal Actions

Energy Laboratories, Inc. employees are expected to work in an ethical, proper, and legal manner. They are expected to perform laboratory analyses according to the cited method(s) and in conjunction with the SOP and the Quality Assurance Plan. Employees are expected and required to report any violations of this policy. All employees are mandated to participate in an ethics-training program as part of their orientation upon hire.

Improper, unethical, or illegal actions by an employee will be addressed on a case-by-case basis as determined by the seriousness of the offense. Corrective actions may include disciplinary action up to and including discharge.



CHAPTER 12 – MANAGEMENT OF CHANGE

Management of change is the process used to review and manage proposed changes to materials, technology, equipment, procedures, personnel and facility operations. These changes may be permanent or temporary depending on circumstances. Change is managed, communicated, and documented as appropriate to the level of change, by the Laboratory Director, QA Manager, and Supervisors of each department. Significant revisions to controlled documents may require employees to sign a record of acknowledgement.

- New Equipment Validation – Documented in the Instrument Maintenance Module. Supporting studies are documented in the LIMS.
- Implementation of new test methods and method updates – Documented in the method SOP and the Instrument Maintenance Module. Supporting studies are documented in the LIMS.
- The QA Manual and SOPs – Documented in the Record of Revision and stored in the Document Control Software.
- Work order changes - Documented in the work order report and stored in the LIMS or Document Control Software.
- LIMS changes - Documented in a version control repository.
- Personnel changes - Documented in employee training records or personnel records.

CHAPTER 13 – MAJOR EQUIPMENT AND METHODS

A summarized listing of major instrumentation utilized in the laboratory is included in Appendix E. Refer to ELI's Professional Services Guide, located on the ELI website at www.energylab.com, for a complete list of available analytes and methods supported by ELI.

CHAPTER 14 – PREVENTIVE MAINTENANCE

Preventive maintenance is performed on laboratory equipment according to the manufacturer's guidelines and our operational experience. Repairs and maintenance are accomplished in-house by experienced laboratory personnel whenever possible. Other than consumable equipment items, an inventory of spare parts is not maintained. Spare parts are available from outside vendors on an as needed basis. (To ensure method capability, some methods have more than one instrument available). An example of maintenance performed follows:

Instrument	**Maintenance**	**Frequency – Note that Daily is based on use.**
Balances	Check with appropriate Class weights	Daily
	Perform Internal Calibration	As needed – when daily check does not meet acceptance criteria
	Independent Calibration and Service	Annually
Thermometers	Calibration Verification	Annually-Liquid/Digital
Pipettes	Check volume	Quarterly, DoD daily prior to use
Ion Chromatography	Replace Analytical Column	As Needed
	Calibrate	Monthly, after maintenance, or as needed
	Clean Stator Plate	Annually
	Replace tubing	As needed
	Calibrate Conductivity Cell	Every 6 months
ICP-Atomic Emission	Check Pump Tubing	Daily
	Check Coolant Levels	Monthly
	Lubricate Autosampler	As needed
	Air Filter	Quarterly
	Optics Servicing	As needed
ICP-Mass Spectrometry	Check Pump Tubing	Daily
	Check Coolant Levels	Monthly
	Check Electron Multiplier	Daily
	Lubricate Autosampler	As needed
	Air Filter	Quarterly
Gas Chromatograph	Replace Septum	As needed/per # of injections
	Check Injection Liner	Daily
	Clean Detector	As needed
	Change Gas Cylinders	At 200 psi
	Change Column	As needed
Auto Analyzers		
	Check For Leaks	Daily
	Change Tubing	When wear is visible
	Lubricate Pumps	Annually
	Lubricate Sampler	Annually
Metrohm Auto-titrator	Visually inspect all probes/ stirrer/ thermometer and fill probes	Daily/As needed
	Flush pH probe/ Fluoride probe	Every 15 days
	Calibrate sample dosing pump	Quarterly
	Replace Tubing	Annually/ As needed
	Clean out titration vessel and rinse station	Quarterly/ As needed
	Clean buret	Quarterly
	Calibrate buret	Monthly
	Replace pH/ Fluoride probe	As needed
	Replace Tubing	As needed

Instrument	**Maintenance**	**Frequency – Note that Daily is based on use.**
	Replace Lip seals gland washers on dosing pump	As needed
Metrohm-automated pH, conductivity, ion electrode analyzer	Visually inspect all probes/ stirrer/ thermometer and fill probes	Daily/As needed
	Flush pH probe/ change storage solution	Monthly/ As needed
	Replace Tubing	As needed
	Calibrate buret	Monthly
	Replace pH probe	As needed
Mass Spectrometers	Monitor Vacuum Pressures	Daily
	Monitor Background Levels	Daily
	Monitor Electron Multiplier	Daily
	Change Pump Oil	As Needed
Microbiology	Monitor Room Temperature	Twice daily
	Monitor Incubator Temperature	Twice daily
	Autoclave Maintenance	Annually
	Monitor Water Bath Temperature	Twice daily
Reagent Water Systems	Change/Check Cartridges	Quarterly, or as needed
Compressed Gases	Change Gas Cylinders	At 200 psi, monitor daily
Liquid Chromatograph	Flush System	Daily
	Replace Filters	As needed
	Replace Seals	As needed
Continuous Temperature Monitoring Systems	Check Temperatures	Daily, calibrate annually
TOXBOX	Replace sample chamber septa	As needed – indicated by poor performance
	Inspect/replace pyrolysis tube	Semi-annually
Solid-Phase extractors	Maintenance per manufacturer specification	As needed

CHAPTER 15 - REFERENCES

ANSI N42.23-1996, American National Standard Measurement and Associated Instrument Quality Assurance for Radioassay Laboratories.

ASTM Annual Book of Standards, Part 31 (water), American Society for Testing and Materials.

ASTM D 7282-06 Standard Practices for Set-up, Calibration, and Quality Control of Instruments Used for Radioactive Measurements.

Handbook for Analytical Quality Control in Water and Wastewater Laboratories, Environmental Protection Agency. EPA 600/4-79-019

ELI Professional Services Guide (Fee Schedule), Current Revision, Energy Laboratories, Inc.

Manual for the Certification of Laboratories Analyzing Drinking Water, 5th Ed., EPA 815-R-05-004, 2005.

Manual for the Certification of Laboratories Analyzing Drinking Water, Supplement to 5th Ed., EPA 815-F-08-006, June 2008.

Methods for Chemical Analysis of Water and Wastes Environmental Protection Agency, 600/4-79-020.

Methods for the Determination of Metals in Environmental Samples – Supplement I, EPA/600/R-94-111, May 1994.

Methods for the Determination of Inorganic Substances in Environmental Samples, EPA/600/R-93-100, August 1993.

Methods for the Determination of Organic Compounds in Drinking Water, EPA/600/4-88/039, December 1998.

Methods for the Determination of Organic Compounds in Drinking Water – Supplement I, EPA/600/4-90/020, July 1990.

Methods for the Determination of Organic Compounds in Drinking Water – Supplement II, EPA/600/R-92/129, August 1992.

NELAC Chapter 5: Quality System Standard, 2003, 2009, or 2016, most current version approved by Florida and Texas NELAC Accreditation program.

NELAP, National Environmental Laboratory Accreditation Program, The NELAC Institute (TNI) https://nelac-institute.org/index.php

Standard Methods for the Examination of Water and Wastewater; 20th, 21st 22nd, 23rd and 24th Editions, APHA.

Technical Notes on Drinking Water Methods, EPA/600/R-94/173, October 1994.

Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (SW846), Environmental Protection Agency. https://www.epa.gov/hw-sw846

Management and Technical Requirements for Laboratories Performing Environmental Analysis, TNI Standard, Volume 1 (EL-V1-2009), The NELAC Institute.

Management and Technical Requirements for Laboratories Performing Environmental Analysis, TNI Standard, Volume 1 EL-V1-2016 Rev2.1, ELV1M4-2017-Rev2.2, The NELAC Institute.

DoD Quality System Manual (QSM) for Environmental Laboratories, Version 6.0, U.S. Department of Defense, December 2023.

General requirements for the competence of testing and calibration laboratories, ISO/IEC 17025, Second edition, 2005; Third edition 2017-11

Risk Management – Guidelines, ISO 31000, 2nd Edition 2018-02

CHAPTER 16 – GLOSSARY OF TERMS

Acceptance Criteria - Specified limits placed on characteristics of an item, process, or service defined in requirement documents.

Accreditation - The process by which an agency or organization evaluates and recognizes a laboratory as meeting certain predetermined qualifications or standards, thereby accrediting the laboratory.

Accuracy - The degree of agreement between an observed value and an accepted reference value. Accuracy includes a combination of random error (precision) and systematic error (bias) components that are due to sampling and analytical operations; a data quality indicator.

Aliquot - A discrete, measured, representative portion of a sample taken for analysis.

Alpha Particle- A particle emitted from an atom's nucleus during radioactive decay that consists of two protons and two neutrons.

Analyte - A substance, organism, physical parameter, property, or chemical constituent(s) for which an environmental sample is being analyzed. The specific chemicals or components for which a sample is analyzed; it may be a group of chemicals that belong to the same chemical family and are analyzed together.

Analyst - The designated individual who performs the "hands-on" analytical methods and associated techniques and who is the one responsible for applying required laboratory practices and other pertinent quality controls to meet the required level of quality.

Analytical Method - A formal process that identifies and may quantify the substance, organism, physical parameter, property, or chemical constituent of interest (target analytes) in a sample.

Analytical Sample - Any solution or media introduced into an instrument on which an analysis is performed, excluding QC samples such as: instrument calibration, initial calibration verification, initial calibration blank, continuing calibration verification, and continuing calibration blank.

Annually – A period not to exceed 13 months.

Assessment - The evaluation process used to measure or establish the performance, effectiveness, and conformance of an organization and/or its systems to defined criteria (to the standards and requirements of laboratory accreditation).

Audit - A systematic and independent examination of facilities, equipment, personnel, training, procedures, record keeping, data validation, data management, and reporting aspects of a system to determine whether QA/QC and technical activities are being conducted as planned and whether these activities will effectively achieve quality objectives.

Batch - Environmental samples that are prepared and/or analyzed together with the same process and personnel, using the same lot(s) of reagents. A preparation batch is composed of one (1) to twenty (20) environmental samples of the same quality systems matrix, meeting the above mentioned criteria and with a maximum time between the start of processing of the first and last sample in the batch to be twenty-four (24) hours unless otherwise specified by method SOP. An

analytical batch is composed of prepared environmental samples (extracts, digestates or concentrates) which are analyzed together as a group. An analytical batch can include prepared samples originating from various quality system matrices and can exceed twenty (20) samples.

Beta Particle- A particle emitted from an atom's nucleus during radioactive decay that consists of either an electron or a positron, depending on the mechanics of the radioactive decay.

Bias - The systematic or persistent distortion of a measurement process which causes errors in one direction; the difference between the mean value of the measurements and the true value of the measurand.

Blank (BLK) - A sample of clean matrix that is a negative control sample, which accompanies the samples through different aspects of sampling and/or sample preparation. It is used to monitor contamination during sampling, transport, storage or analysis. The blank is subjected to the usual analytical and measurement process to establish a zero baseline or background value. There are various types of blanks: equipment blank, field blank, instrument blank, method blank, and reagent blank.

> **Initial Calibration Blank (ICB) -** A sample of laboratory purified water, solvent or matrix similar to the calibration standards that has been treated exactly as a sample in which no analytes of interest are present at concentrations that impact results. Evaluates overall method including possible contamination in reagents and glassware.
>
> **Method Blank** - A sample of a matrix similar to the batch of associated samples (when available) that is free from the analytes of interest and is processed simultaneously with and under the same conditions as samples through all steps of the analytical procedures, and in which no target analytes or interferences are present at concentrations that impact the analytical results for sample analyses.
>
> **Trip Blank** - One type of Field Blank. An aliquot of analyte-free water or solvent transported to the field in a sealed container and returned to the laboratory with the sample containers.

Blank Spike - See Laboratory Fortified Blank.

Blind QC Check Samples - Samples whose analyte concentrations are not known to the analyst. That the sample is a QC check sample may or may not be known to the analyst.

Calibration - A set of operations that establish, under specified conditions, the relationship between values of quantities indicated by a measuring instrument or measuring system, or values represented by a material measure or a reference material, and the corresponding values realized by standards.

> 1) In calibration of support equipment, the values realized by standards are established through the use of reference standards that are traceable to the International System of Units (SI).
> 2) In calibration according to methods, the values realized by standards are typically established through the use of Reference Materials that are either purchased by the laboratory with a certificate of analysis or purity, or prepared by the laboratory using support equipment that has been calibrated or verified to meet specifications.

Calibration Check Standard - See Check Standard.

Calibration Curve - The mathematical relationship between the known values, such as concentrations, of a series of calibration standards and their instrument response.

Calibration Range - The range of values (concentrations) between the lowest and highest calibration standards of a multi-level calibration curve. For metals analysis with a single-point calibration, the low-level calibration check standard and the high standard establish the linear calibration range, which lies within the linear dynamic range.

Calibration Standard - A substance or reference material used for calibration.

Certified Reference Material - Reference material, accompanied by a certificate, having a value, measurement uncertainty, and stated metrological traceability chain to a National Metrology Institute.

Chain of Custody Form - Record that documents the possession of the samples from the time of collection to receipt in the laboratory. This record generally includes: the number and types of containers; the mode of collection; the collector; time of collection; preservation; and requested analyses. See also Legal Chain of Custody Protocols.

Check Standard - A material of known composition that is analyzed concurrently with test samples to evaluate a measurement process.

Clean Water Act - Public Law PL 92-500. Found at 40 CFR 100-140 and 400-470. The act regulates the discharge of pollutants into surface waters.

Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) - The enabling legislation (42 USC 9601 - 9675 et seq., as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), 42 USC 9601 et seq.), to eliminate the health and environmental threats posed by hazardous waste sites.

Confirmation - Verification of the identity of a component through the use of an approach with a different scientific principle from the original method. These may include, but are not limited to: second column confirmation, alternate wavelength, derivatization, mass spectral interpretation, or alternative detectors. Includes verification of the identity and quantity of the analyte being measured by another means.

Constant Weight - The repeated process of drying, cooling, desiccating, and weighing a sample until readings are ≤4% of the previous weight or does not vary more than ≤0.5mg.

Continuing Calibration Blank (CCB) – A sample of laboratory purified water or matrix similar to calibration standards, in which no analytes of interest are present at concentrations that impact results, measured periodically throughout an analytical run. Evaluates baseline drift, contamination in the analytical system, and analyte carryover.

Continuing Calibration Verification (CCV) - A mid-range calibration standard measured periodically throughout an analytical run that evaluates instrument drift throughout analytical run. The verification of the initial calibration. Continuing calibration verification applies to both external

standard and internal standard calibration techniques, as well as to linear and non-linear calibration models.

Control Limits - A range within which specified measurement results must fall to be compliant.

Control Standard - See Check Standard.

Correction - Action taken to eliminate a detected non-conformity.

Corrective Action (CA) - An action taken to eliminate the causes of an existing nonconformity, defect, or other undesirable situation in order to prevent recurrence.

CPM - Counts per minute; a unit of radioactivity.

Crosstalk – The re-classified identification of a count measured by a gas proportional counter. The degree and type of crosstalk (bleed-over) depends on which type of radiation whether alpha or beta, and how the discriminator is set after a plateau is run. This normally occurs at a proportional rate between 20 to 25 percent for alpha counts in the beta channel, while on the other hand beta into alpha crosstalk (bleed-over) occurs at a proportional rate of less than 1% in typical windowed gas proportional counters. Gas proportional counters must be set so crosstalk is either automatically corrected prior to the displaying of alpha and beta counts for a final result, or through the software corrections in ELI's Radiochem Database.

Data Integrity - The condition that exists when data are sound, correct, and complete, and accurately reflect activities and requirements.

Data Reduction - The process of transforming the number of data items by arithmetic or statistical calculation, standard curves, and concentration factors, and collating them into a more useful form.

Data Quality Objectives (DQO) - An integrated set of specifications that define data quality requirements and the intended use of the data.

Decision Rule – Rule that describes how measurement uncertainty is accounted for when stating conformity with a specific requirement.

Definitive Data - Analytical data of known quantity and quality. The levels of data quality on precision and bias meet the requirements for the decision to be made. Data that is suitable for final decision-making.

Demonstration of Capability - A procedure to establish the ability of the analyst to perform Analyses and generate analytical results by a specific method that meet measurement quality objectives including accuracy and precision.

Detectability – For radiochemical analysis, detectability as a Lower Limit Detection (LLD) or Minimum Detection Concentration (MDC), is assessed based on the requirements of 40 CFR 141.25(c) and is a sample-specific determination. The equation is specific for each method and noted in the method SOP.

Detection Limit - See Practical Quantitation Limit and Method Detection Limit. Reporting of detection in radiochemistry is based on specific formulas identified in individual procedures. Single

activity point standards are used for efficiency calibration. When required, multiple energy emitters are used for energy calibration.

Document - Written component of the laboratory management system (e.g., policy, procedure, and instruction).

Document Control - The act of ensuring that documents and revisions are proposed, reviewed for accuracy, approved for release by authorized personnel, distributed properly and controlled to ensure use of the correct version at the location where the prescribed activity is performed.

DoD – Department of Defense

DPM - Disintegrations per minute; a measure of radioactivity.

Duplicate (DUP) - A second aliquot of a sample that is treated the same as the original sample to determine the precision of the method.

Duplicate Sample - See Duplicate.

Efficiency – The ability of a detector to measure the radioactivity of interest using the following relationship:

cpm/dpm = Efficiency
Where:
cpm = Counts Per Minute Observed in the detection system
dpm = Disintegrations Per Minute determined for the calibrated source being measured

Electronic Data Deliverables (EDD) - Electronic copies of lab reports in Excel, CSV or client specified format that is emailed to clients.

Extracted Internal Standard - Isotopically labeled analogs of analytes of interest added to all standards, blanks and samples analyzed. Added to samples and preparation batch QC samples before the first step of sample extraction and to standards and instrument blanks before analysis. Used for isotope dilution methods.

Field of Accreditation - Those matrix, technology/method, and analyte combinations for which the accreditation body offers accreditation.

Finding - An assessment conclusion referenced to a laboratory accreditation standard and supported by objective evidence that identifies a deviation from a laboratory accreditation standard requirement.

Fortified Sample - See Matrix Spike.

Gamma Particle - Photons of electromagnetic radiation emitted by the nucleus following radioactive decay.

Holding Times (Maximum Allowable Holding Times) - The maximum time that can elapse between two (2) specified activities. Sample holding time is based on Date/Time of Collection and Date/Time of the beginning of sample analysis. Time is based on hour/minute by default or by the

accreditation requirements for a project. The maximum time is the longest time period that samples may be held prior to analysis and still be considered valid or not compromised.

Impartiality - The presence of objectivity which is managed by procedures and processes to avoid conflict of interest, freedom from bias, lack of prejudice, neutrality, fairness, open-mindedness, even handedness, detachment and balance so as not to adversely influence subsequent activities of the laboratory.

In-depth Data Monitoring - When used in the context of data integrity activities, a review and evaluation of documentation related to all aspects of the data generation process that includes items such as preparation, equipment, software, calculations, and quality controls. Such monitoring shall determine if the laboratory uses appropriate data handling, data use and data reduction activities to support the laboratory's data integrity policies and procedures.

Internal Standard - A known amount of standard added to a test portion of a sample as a reference for evaluating and controlling the precision and bias of the applied analytical method.

Initial Calibration Verification (ICV) - A sample of known concentration, from a source other than that of the calibration standards, analyzed following calibration to demonstrate validity of the calibration and standards used.

Instrument Blank - See Calibration Blank.

Internal Standard – A known amount of standard added to a test portion of a sample as a reference for evaluating and controlling the precision and bias of the applied analytical method.

Laboratory Control Sample (however named, such as laboratory fortified blank, spiked blank, Initial calibration verification (ICV) or QC check sample) - A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes and taken through all sample preparation and analytical steps of the procedure unless otherwise noted in a reference method. It is generally used to establish intra-laboratory or analyst specific precision and bias or to assess the performance of all or a portion of the measurement system.

Laboratory Control Sample Duplicate (LCSD) - A second laboratory control sample of known concentration and similar matrix as samples. Evaluates overall method accuracy/bias and precision for the batch.

Laboratory Fortified Blank (LFB) – A sample of laboratory purified water or matrix similar to the calibration standards to which a known amount of target analyte(s) is added. Evaluates spiking technique and when prepared from a source independent of the calibration standards can also be used to measure method performance.

Laboratory Inter-comparison Sample - A sample, typically a performance evaluation sample of same or similar composition, analyzed by two or more laboratories in accordance with predetermined conditions. Acceptance criteria are often based statistically on the analysis results.

Laboratory Intra-comparison Sample - A sample, of same or similar composition, analyzed within the same laboratory with predetermined conditions. Sample may be used for evaluation of new instruments or methodology.

Legal Chain of Custody Protocols - Procedures employed to record the possession of samples from the time of sampling through the retention time specified by the client or program. These procedures are performed at the special request of the client and include the use of a Chain of Custody Form that documents the collection, transport, and receipt of compliance samples by the laboratory. In addition, these protocols document all handling of the samples within the laboratory.

Limit of Detection (LOD) - The lowest concentration empirically determined to consistently provide a response meeting identification and minimum signal requirements for a specific analyte-matrix method combination. This is an estimation of the smallest concentration of an analyte that shall be present in order to be detected with a result at or above the DL with 99% confidence (false negative, Type II, error of 1%). The LOD is the lowest concentration for reliably reporting a non-detect of an analyte.
Limit of Detection (LOD) Verification – Analysis to verify the LOD. The LOD is initially spiked at or above the MDL. The verification is made by repeating the LOD spike process at a concentration that is greater than or equal to half the current LOD and less than or equal to double the current LOD (i.e., 1/2x LOD ≤ Ongoing LOD Spike ≤ 2x LOD) provided the ongoing spike concentration is greater than or equal to the DL. The Ongoing LOD verification shall meet the same acceptance criteria as the Initial LOD verification for signal-to-noise and analyte identification.

Limit of Quantitation (LOQ) – For chemical analysis, the LOQ is the smallest concentration that produces a quantitative result with known and recorded precision and bias. The LOQ shall be set at or above the concentration of the lowest non-zero initial calibration standard and within the calibration range.

LIMS - Laboratory Information Management System.

Linear Dynamic Range - Concentration range where the instrument provides a linear response.

Lot - A definite amount of material produced during a single manufacturing cycle and intended to have uniform character and quality.

Mass Attenuation - Refer to Solids Self-Attenuation

Matrix – The substrate of a test sample.

Matrix Duplicate - A replicate matrix prepared in the laboratory and analyzed to obtain a measure of precision. (Also see MSD)

Matrix Spike (spiked sample or fortified sample) - A sample prepared, taken through all sample preparation and analytical steps of the procedure unless otherwise noted in a referenced method, by adding a known amount of target analyte to a specified amount of sample for which an independent test result of target analyte concentration is available. Matrix spikes are used, for example, to determine the effect of the matrix on a method's recovery efficiency. Generally, for valid recovery calculations the parameter spike level should be greater than 1-4X of the sample parameter level.

Matrix Spike Duplicate (spiked sample or fortified sample duplicate) - A replicate matrix spike prepared in the laboratory and analyzed to obtain a measure of the precision of the recovery for each analyte.

Maximum Contaminant Level (MCL) – Regulatory action level for a contaminant of concern.

Measurement System - A method, as implemented at a particular laboratory, and which includes the equipment used to perform the test and the operator(s).

Measurement Uncertainty - The expression of the statistically derived range of values that contain the true value of a measurand within a certain confidence level. The uncertainty generally includes many components which may be evaluated by statistical analysis of measured quantity values obtained under defined measurement conditions or by standard deviations evaluated from assumed probability distributions based on experience or other information. For the purpose of this standard, the laboratory's analytical uncertainty, may be reported as measurement uncertainty.

Method - A body of procedures and techniques for performing an activity (e.g., sampling, chemical analysis, quantification), systematically presented in the order in which they are to be executed.

Method Detection Limit (MDL) - A measure of the limit of detection for an analytical method determined according to the procedure given in 40 CFR Part 136 Appendix B. The MDL is the minimum concentration of a substance that can be reported with 99% confidence that the measured concentration is distinguishable from a zero or blank concentration. At the MDL the false positive rate (Type I error) is 1%. This MDL is referred to as the DL (Detection Limit) by DoD.

Method Reporting Limit (MRL) – Refer to Report Limit.

Method Validation - The confirmation by examination and the provision of objective evidence that the particular requirements for a specific intended use are fulfilled (NELAC 2003) (MARLAP 2004 for radiochemical methods).

Metrological Traceability – Property of a measurement result whereby the result can be related to a reference through a documented unbroken chain of calibrations, each contributing to the measurement uncertainty.

NELAC - National Environmental Laboratory Accreditation Conference.

NELAP - National Environmental Laboratory Accreditation Program (Now TNI).

National Institute of Standards and Technology (NIST) - A federal agency of the US Department of Commerce's Technology Administration that is designated as the United States national metrology institute (NMI). SI is the international metrological traceability term which NIST includes.

NPDES - National Pollutant Discharge Elimination System- A discharge permit system authorized under the Clean Water Act.

Papervision (PVE/PV) – An archival database that allows the lab to store and organize electronic documents.

Performance Evaluation (PE) Sample - A sample with a composition unknown to the analyst that is provided to test whether the analyst/laboratory can produce analytical results within specified acceptance limits.

Physical Parameter - A measurement of a physical characteristic or property of a sample as distinguished from the concentrations of chemical or biological components.

Practical Quantitation Limit (PQL) – See LOQ definition.

Precision - The degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves; a data quality indicator. Precision is usually expressed as standard deviation, variance or range, in either absolute or relative terms.

Preservation - Refrigeration and/or reagents added at the time of sample collection to maintain the chemical and/or biological integrity of the sample.

Preventative Action – A pro-active process to identify opportunities for improvement rather than a reaction to the identification of problems or complaints.

Proficiency Testing - A means of evaluating a laboratory's performance under controlled conditions relative to a given set of criteria through analysis of unknown samples provided by an external source.

Proficiency Testing Program - The aggregate of providing rigorously controlled and standardized environmental samples to a laboratory for analysis, reporting of results, statistical evaluation of the results and the collective demographics and results summary of all participating laboratories.

Proficiency Testing (PT) Sample - A sample with a composition unknown to the analyst/laboratory which is provided to test whether the analyst/laboratory can produce analytical results within specified acceptance criteria.

Protocol - A detailed, written procedure for field and/or laboratory operation (e.g., sampling, analysis) which must be strictly followed.

Qualitative Analysis - Analysis designed to identify the components of a substance or mixture.

Quality Assurance (QA) - An integrated system of management activities involving planning, implementation, assessment, reporting, and quality improvement to ensure that a process, item, or service is of the type and quality needed and expected by the client.

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Quality Assurance Project Plan (QAPP) - A formal document describing the detailed quality control procedures pertaining to a specific project. For environmental clean-up projects, this is typically produced by an engineering firm with references to include a laboratory's Quality Assurance Manual.

Quality Control (QC) - The overall system of technical activities that measures the attributes and performance of a process, item, or service against defined standards to verify that they meet the stated requirements established by the customer; operational techniques and activities that are used to fulfill requirements for quality; also the system of activities and checks used to ensure that

measurement systems are maintained within prescribed limits, providing protection against “out of control” conditions and ensuring that the results are of acceptable quality.

Quality Control Sample - A sample used to assess the performance of all or a portion of the measurement system. One of any number of samples, such as Certified Reference Materials, a quality system matrix fortified by spiking, or actual samples fortified by spiking, intended to demonstrate that a measurement system or activity is in control.

Quality Manual - A document stating the management policies, objectives, principles, organizational structure and authority, responsibilities, accountability, and implementation of an agency, organization, or laboratory, to ensure the quality of its product and the utility of its product to its users.

Quality System - A structured and documented management system describing the policies, objectives, principles, organizational authority, responsibilities, accountability, and implementation plan of an organization for ensuring quality in its work processes, products (items), and services. The quality system provides the framework for planning, implementing, and assessing work performed by the organization and for carrying out required QA and QC activities.

Quality System Matrix - These matrix definitions are to be used for purposes of batch and QC requirements:

Air and Emissions: Whole gas or vapor samples including those contained in flexible or rigid wall containers and the extracted concentrated analytes of interest from a gas or vapor that are collected with a sorbent tube, impinger solution, filter, or other device.
Aqueous: Any aqueous sample excluded from the definition of Drinking Water or Saline/Estuarine. Includes surface water, ground water effluents, and TCLP or other extracts.
Biological Tissue: Any sample of a biological origin such as fish tissue, shellfish, or plant material. Such samples shall be grouped according to origin.
Chemical Waste: A product or by-product of an industrial process that results in a matrix not previously defined.
Drinking Water: Any aqueous sample that has been designated a potable or potential potable water source.
Non-Aqueous Liquid: Any organic liquid with <15% settleable solids.
Saline/Estuarine: Any aqueous sample from an ocean or estuary, or other salt water source such as the Great Salt Lake.
Solids: Includes soils, sediments, sludges, and other matrices with >15% settleable solids.

Raw Data - The documentation generated during sampling and analysis. This documentation includes, but is not limited to, field notes, electronic data, magnetic tapes, tabulated sample results, QC sample results, print outs of chromatograms, instrument outputs, and handwritten records.

Reference Material - Material or substance, one or more of whose property values are sufficiently homogeneous and well established to be used for the calibration of an apparatus, the assessment of a measurement method, or for assigning values to materials.

Reference Method - To be used to determine the extent of method validation in Modules 3-7. A reference method is a published method issued by an organization generally recognized as competent to do so. (When the ISO language refers to a “standard method”, that term is equivalent to “reference method”). When a laboratory is required to analyze an analyte by a specified method

due to a regulatory requirement, the analyte/method combination is recognized as a reference method. If there is not a regulatory requirement for the analyte/method combination, the analyte/method combination is recognized as a reference method if it can be analyzed by another reference method of the same matrix and technology.

Reference Standard - Standard used for the calibration of working measurement standards in a given organization or at a given location.

Replicate - See Duplicate.

Reporting Limit (RL) – The lowest level of concentration reported for an analyte.

Resource Conservation and Recovery Act (RCRA) - The enabling legislation under 42 USC 321 et seq. (1976) that gives EPA the authority to control hazardous waste.

Request for Quote/Proposal (RFQ/RFP) – A request from a client for a quotation of analytical services. It may be a verbal, facsimile, email or via third-party vendor. This details the scope and requirements of a work proposal.

Safe Drinking Water Act (SDWA) - The enabling legislation, 42 USC 300f et seq. (1974), which requires the USEPA to protect the quality of drinking water in the U.S. by setting maximum allowable contaminant levels, monitoring, and enforcing violations.

Sampling - Activity related to obtaining a representative sample of the object of conformity assessment, according to a procedure.

Sample (SAMP) - A portion of material to be analyzed.

Selectivity - The ability to analyze, distinguish, and determine a specific analyte from another component that may be a potential interferent or that may behave similarly to the target analyte within the measurement system.

Sensitivity – The capability of a method or instrument to discriminate between measurement responses representing different levels (e.g. concentrations) of a variable of interest.

Signal to Noise Ratio - S/N is a measure of signal strength relative to background noise. The average strength of the noise of most measurements is constant and independent of the magnitude of the signal. Thus, as the quantity being measured (producing the signal) decreases in magnitude, S/N decreases and the effect of noise on the relative error of a measurement increases.

Spiked Sample – See Matrix Spike.

Standardization - See Calibration.

Standard Operating Procedures (SOPs) - A written document that details the method for an operation, analysis, or action, with a thorough description of techniques and steps. SOPs are officially approved as the methods for performing certain routine or repetitive tasks.

Surrogate - A substance with properties that mimic the analyte of interest. It is unlikely to be found in environmental samples and is added to them for quality control purposes.

Technology - A specific arrangement of analytical instruments, detection systems, and/or preparation techniques

TNI – The NELAC Institute

Traceability - The ability to trace the history, application, or location of an entity by means of recorded identifications. In a calibration sense, traceability relates measuring equipment to national or international standards, primary standards, basic physical constants or properties, or reference materials. In a data collection sense, it relates calculations and data generated throughout the project back to the requirements for the quality of the project.

Validation – The confirmation by examination and provision of objective evidence that the particular requirements for a specific intended use are fulfilled.

Verification - Confirmation by examination and objective evidence that specified requirements have been met. Regarding instrumentation and measuring equipment, verification is a confirmation the difference between measured values and known values are within maximum allowable error as defined by a method, regulation or specification for the instrument.

Acronyms and Abbreviations

AA	-	Accrediting Authority
AB	-	Accrediting Body
ANSI	-	American National Standards Institute
AOAC	-	The Scientific Association Dedicated to Analytical Excellence
APHA	-	American Public Health Association
ASQC	-	American Society for Quality Control
ASTM	-	American Society for Testing and Materials
Bq	-	Becquerel
BLK	-	Blank
Bg	-	Background
°C	-	Degrees Celsius
Cal	-	Calibration
CAS	-	Chemical Abstract Service
CCB	-	Continuing Calibration Blank
CCV	-	Continuing Calibration Verification
COC	-	Chain of Custody
DOC	-	Demonstration of Capability
DO	-	Dissolved Oxygen
DoD	-	Department of Defense
DQO	-	Data Quality Objectives
DMRQA	-	NPDES Discharge Monitoring Report Quality Assurance
DUP	-	Duplicate
ELI	-	Energy Laboratories, Inc.
EPA	-	Environmental Protection Agency
FDA	-	Food and Drug Administration
g/L	-	Grams per Liter
GC	-	Gas Chromatography
GC-MS	-	Gas Chromatography-Mass Spectrometry
ICP-AES	-	Inductively Coupled Plasma Atomic Emission Spectrophotometry/Spectroscopy
ICP-MS	-	Inductively Coupled Plasma-Mass Spectrometry
ICV	-	Initial Calibration Verification
ISO	-	International Organization for Standardization
LCS	-	Laboratory Control Sample
LFB	-	Laboratory Fortified Blank
LIMS	-	Laboratory Information Management System
LLD	-	Low Limit Detection
LOD	-	Limit of Detection
LOQ	-	Limit of Quantitation
MDC	-	Minimum Detection Concentration
MDL	-	Method Detection Limit
MBLK	-	Method Blank
MS/MSD	-	Matrix Spike/Matrix Spike Duplicate
NEHA	-	National Environmental Health Association
NELAC	-	National Environmental Laboratory Accreditation Conference
NELAP	-	National Environmental Laboratory Accreditation Program
NIOSH	-	National Institute for Occupational Safety and Health
NIST	-	National Institute of Standards and Technology
NPDES	-	National Pollutant Discharge Elimination System
OSHA	-	Occupational Safety and Health Administration
pCi/L	-	Picocuries per Liter
PT	-	Proficiency Testing
QA/QC	-	Quality Assurance / Quality Control
QS	-	Quality Systems

QAM	-	Quality Assurance Manual
QAPP	-	Quality Assurance Project Plan
RCRA	-	Resource Conservation and Recovery Act
RL	-	Reporting Limit
RPD	-	Relative Percent Difference
RSD	-	Relative Standard Deviation
SOP	-	Standard Operating Procedure
SPK	-	Spike
SI	-	International System of Units
SVOC	-	Semi-Volatile Organic Compound
TNI	-	The NELAC Institute
ug/L	-	Micrograms Per Liter
UV/VIS	-	Ultraviolet/Visible Spectroscopy
VOC	-	Volatile Organic Compound
WET	-	Whole Effluent Toxicity

APPENDIX A

Laboratory Certifications and Accreditations

Current certificates are available at www.energylab.com website:

	Agency	Number
Billings, MT	Alaska	17-023
	California	3087
	Colorado	MT00005
	Department of Defense (DoD)/ISO17025	ADE-2588
	Florida (Primary NELAP)	E87668
	Idaho	MT00005
	Louisiana	5079
	Montana	CERT0044
	Nebraska	NE-OS-13-04
	Nevada	NV-OS-13-04
	North Dakota	R-007
	National Radon Proficiency	109383-RMP
	Oregon	4184
	South Dakota	ARSD 74:04:07
	Texas	TX-C24-0032
	US EPA Region VIII	Reciprocal
	USDA Soil Permit	P330-20-00170
	Washington	C1039
Casper, WY	Alaska	20-006
	California	3021
	Colorado	WY00002
	Florida (Primary NELAP)	E87641
	Idaho	WY00002
	Louisiana	05083
	Montana	CERT0002
	Nebraska	NE-OS-08-04
	Nevada	NV-C24-00245
	North Dakota	R-125
	Oregon	WY200001
	South Dakota	WY00002
	Texas	T104704181-22-19
	US EPA Region VIII	WY00002
	USNRC License	49-26846-01
	Washington	C1012
Gillette, WY	US EPA Region VIII	WY00006
Helena, MT	Colorado	MT00945
	Montana	CERT0079
	US EPA Region VIII	Reciprocal
	Nevada	NV-C24-00119
	USDA Soil Permit	P330-20-00090

APPENDIX B

Quality Assurance / General Quality Control Specifications

The following is a generic template for QA/QC parameters. Method specific QA/QC parameter tables are available upon request.

Method QA/QC Parameters				
QA SAMPLE/ SAMP TYPE CODE	**FREQUENCY**	**ACCEPTANCE CRITERIA**	**CORRECTIVE ACTION**	**COMMENTS**
Instrument Calibration (ICAL)	At least X (Per method, annually at minimum) After maintenance or when needed due to peak shifts or QC failures.	R or $R^2 \geq X$ (As specified by method) RE = Generally same as CCV requirements. Lowest point may be set statistically. Number of Calibration points: Ave RF = 4 Linear = 5 Quadratic = 6 Cubic = 7 Polynomial = 3 + #equation factors (min 7)	1) Re-pour standards and recalibrate 2) Prepare/purchase new standards 3) Perform instrument maintenance 4) Calibration points can be removed per specific guidance in the Calibration SOP.	Establishes calibration curve over a range of analyte concentrations to quantify analytes of interest. The zero concentration (blank) point in the curve is not included in the required number of calibration points. RE (Residual Error) = Calculated as % Recovery in Omega
Linear Calibration Range (LCR)	Initially, then every 6 months, as required by method.	RE = Generally same as CCV requirements.	1) Evaluate alternate non-linear calibration models, especially for lowest and highest calibration points.	LCR is the linear portion of a calibration curve. Must use a minimum of a blank and 3 standards RE (Residual Error) = Calculated as % Recovery in Omega
Linear Dynamic Range (LDR)	Initially, then every 6 months.	RE = Generally same as CCV requirements.	1) Re-establish/verify LDR 2) Dilute samples within the calibration range.	Sets the upper limits of the calibration range. Must include at least 3 points, with one outside the upper range of the curve. RE (Residual Error) = Calculated as % Recovery in Omega
Retention Time (RT) window position establishment	Initially with instrument set up. Recommend verifying annually.	Position shall be set using the midpoint standard of the ICAL curve when ICAL is performed. On days when ICAL is not performed, the initial CCV is used.	1) For shifting retention times, adjust according to initial CCV (mid-range). 2) Follow method requirements.	Calculated for each analyte.

Method QA/QC Parameters

QA SAMPLE/ SAMP TYPE CODE	FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION	COMMENTS
Retention Time (RT) window width	Initially with instrument set up. Recommend verifying annually.	IC: RT width is ±3x standard deviation for each analyte RT from the 24-hour period. GC and HPLC: RT width is ±3x standard deviation for each analyte RT from the 72-hour period. GC/MS: RT of each reported analyte within ± 0.06 RT units.	1) For shifting retention times, adjust according to initial CCV (mid-range). 2) Follow method requirements.	Calculated for each analyte.
Initial Calibration Verification (ICV)	Immediately following calibration, daily when used as Analytical Sequence LCS for analyses without prep.	%Rec = X (Limits may be set statistically depending on method.)	1) Re-pour or re-inject. 2) Re-digest/re-prepare all QC and samples. 3) Recalibrate.	Evaluates calibration accuracy and method performance. Must be prepared from second source standard.
Initial Calibration Blank (ICB/MBLK)	Immediately follows ICV	< Lowest reporting limit	1) Re-pour or re-inject. 2) Re-digest/re-prepare all QC and samples. 3) Qualify sample data.	Evaluates calibration accuracy, reagent/ glassware contamination, and instrument carryover.
Continuing Calibration Verification (CCV)	Run every 10 samples and at end of run. (Methods with internal standards do not require and ending CCV.)	%Rec = X (Limits may be set statistically depending on method.)	1) Re-pour or re-inject if CCV failure impacts only the CCV, the reason for the failure is known and documented and a second acceptable CCV is analyzed immediately. 2) Re-digest/re-prepare all QC and samples since last valid CCV 3) Recalibrate.	Evaluates instrument drift throughout analytical sequence. Concentration must be equal to or less than half the highest calibration concentration.
Continuing Calibration Blank (CCB)	Run after every CCV	< Lowest reporting limit	1) Re-pour or re-inject. 2) Re-digest/re-prepare all QC and samples. 3) Qualify sample data.	Evaluates baseline drift, contamination in the analytical system, and analyte carryover.

Method QA/QC Parameters

QA SAMPLE/ SAMP TYPE CODE	FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION	COMMENTS
Instrument Blank	Daily prior to sample analysis.	< Lowest reporting limit	1) Re-pour and rerun. 2) Perform instrument maintenance.	Evaluates baseline drift, contamination in the analytical system, and analyte carryover. The method blank may be substituted; not required for methods with CCB criteria. Generally necessary for organics methods. Not necessarily imported to Omega.
Method Blank (MBLK)	1/batch	< Lowest reporting limit	1) Re-pour or re-inject. 2) Re-digest/re-prepare all QC and samples. 3) Qualify sample data.	Evaluates overall method including possible contamination in reagents and glassware utilized in preparatory batch.
Laboratory Control Sample (LCS/LCSD)	1/ batch	%Rec = X (Limits may be set statistically depending on method.)	1) Re-pour or re-inject. 2) Re-digest/re-prepare all QC and samples since last valid CCV 3) Recalibrate.	Evaluates overall method accuracy/bias for the Preparatory Batch. Must be second source. If prepared the same as MS/MSD will evaluate the spiking technique.
Laboratory Fortified Blank (LFB/LFBD)	1/daily sequence	%Rec = X (Limits may be set statistically depending on method.)	1) Re-pour or re-inject. 2) Re-digest/re-prepare all QC and samples since last valid CCV 3) Recalibrate.	If prepared the same as MS/MSD will evaluate the spiking technique. Can be primary or secondary source depending on the method. LCS or ICV are preferred QC Types.
Duplicate Sample (DUP)	1/X samples	% RPD ≤ X (Appropriate limits must be evaluated for each method.)	1) Rerun sample pair, evaluate for sample homogeneity or 2) Report with qualifiers.***	Evaluates method precision. MSD duplicate analyses preferred on some methods.

Method QA/QC Parameters

QA SAMPLE/ SAMP TYPE CODE	FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION	COMMENTS
Matrix Spike (MS/MSD)	1/X samples	%Rec = X %RPD ≤ X	LCS/LFB/ICV must be passing. 1) If matrix interference suspected report as found, or 2) Re-analyze and re-spike if no matrix interference suspected, or 3) Use "A" qualifier for sample amount > 4X spike level.	Evaluates effect of matrix on method performance. MSD also evaluates method precision.
Post Digestion Spike (PDS/PDSD)	1/X samples	%Rec = X %RPD ≤ X	LCS/LFB/ICV must be passing. 1) If matrix interference suspected report as found, or 2) Re-analyze and re-spike if no matrix interference suspected, or 3) Use "A" qualifier for sample amount > 4X spike level.	Evaluates effect of matrix on method performance. PDSD also evaluates method precision. Use the same solution and concentration as LFB.
Internal Standards (IS)	All samples and QC	Per method and analyte requirements	Per method and analyte requirements.	Mimics the analyte of interest without interfering. Used for some GC, GC/MS, HPLC, ICP/MS analyses to help quantify analytes of interest.
Surrogates (organics) or Tracers (radiochemistry)	All samples and QC	Per method and analyte requirements	Per method and analyte requirements.	Evaluates method performance in each sample.
Laboratory Performance Check Sample (LPC)	Per method requirements	Per method requirements	Per method requirements.	Monitors instrument sensitivity, column performance, and chromatographic performance.
Tune	Per method requirements	Per method requirements	Per method requirements.	Evaluates mass sensitivity, mass resolution, isotope ratio, and baseline threshold.
Batch Definition	20 samples or as defined by method	Must pass all method QC criteria	Re-analyze batch or qualify results.	A group of samples and associated QC

Method QA/QC Parameters

QA SAMPLE/ SAMP TYPE CODE	FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION	COMMENTS
MDL	**Initial MDL:** Samples: Analyze at least 7 MDL samples over at least 3 calendar days. Study: Initial study required for new method and whenever method changes might reasonably be expected to affect sensitivity. **Ongoing MDL:** Samples: Analyze at least 2 ongoing MDL spikes for each quarter samples are analyzed. Must have at least 7 MDL spikes per year. Study: Annually, recalculate MDL spike and MDL blank from overall historical data.	MDL Samples: All results are quantitative (above zero and meet the qualitative identification criteria of the method; e.g., recognizable spectra, signal to noise requirements, and presence of qualifier ions). MDL Studies: MDL = whichever is higher of MDL spike or MDL blank. < RL	1) If the result for any individual analyte from the MDL spiked samples does not meet the method qualitative criteria or does not provide a numerical result greater than zero, repeat the spiked samples at a higher concentration. 2) Repeat initial MDL spike and MDL blank study or adjust reporting limit to > 2X of calculated MDL.	Per 40 CFR Part 136 The minimum measured concentration of a substance that can be reported with 99% confidence that the measured concentration is distinguishable from method blank results.
LOQ Verification	**Initial LOQ:** Samples: Analyze at least 7 LOQ samples over at least 3 calendar days. Verification: Initial verification required for new method and whenever method changes might reasonably be expected to affect sensitivity. **Ongoing LOQ:** Samples: Analyze at least 1 ongoing MDL spikes for each quarter samples are analyzed. Study: Annually, verify that acceptance criteria is met.	LOQ Sample: Quantitative (above zero and meet the qualitative identification criteria of the method; e.g., recognizable spectra, signal to noise requirements, and presence of qualifier ions). % Rec = Statistical or set LOQ Verification: > Calculated MDL	1) Correct method or instrument performance and repeat the verification. 2) Evaluate and correct established statistical acceptance criteria. 3) Adjust reporting limit.	**If MDL samples meet the LOQ acceptance criteria, the MDL samples can be used as LOQ Samples.**

Method QA/QC Parameters

QA SAMPLE/ SAMP TYPE CODE	FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION	COMMENTS
LOD Verification (for DOD certified methods only)	Required for each analyte/method certified by DOD to verify calculated MDL. Initially spiked at or above MDL. Verify quarterly.	Signal/Noise ratio at lease three, where appropriate or three standard deviations greater than mean MBLK. Meet method requirements for analyte identification	1) Examine method or preparatory steps. 2) Verify MDL study. 3) Repeat analysis. 4) Consult QA.	1/2x LOD ≤ Ongoing LOD Spike ≤ 2x LOD
External PT Samples	WS, WP, and Soil studies performed biannually.	PT sample defined acceptance limits (Must pass 2 out of last 3 PT studies.)	1) Complete corrective action report 2) Repeat with another make-up study (for failure of 2 out of 3).	External review of analytical method accuracy.
Control Charting	Annual statistical review of method. Quarterly for DoD Methods.	Data statistically within control limits.	1) Trend Analysis/ Method Review 2) Correct method/instrument problem. 3) Replace analyst.	For statistical process control.
Demonstration of Capability (DOC)	Initially for each new analyst, annually thereafter	4 passing LCS (or other second source QC), passing PT study results, or qualifying statement from supervisor. Method requirements for initial DOCs and ongoing DOCs must be met.	1) Provide additional training 2) Replace analyst.	Demonstrates proficiency to perform the method and obtain acceptable results for each analyst.

The 12 QC elements per 40 CFR Part 136.7, if not applicable or required per method, are deleted from the table in individual SOPs.

*** DUP Qualifier (Canned Comment) for use when values are low and the % RPD criteria does not apply.
Since the difference between the analytical result for the sample and its duplicate is less than the reporting limit, the RPD variance is not considered significant.

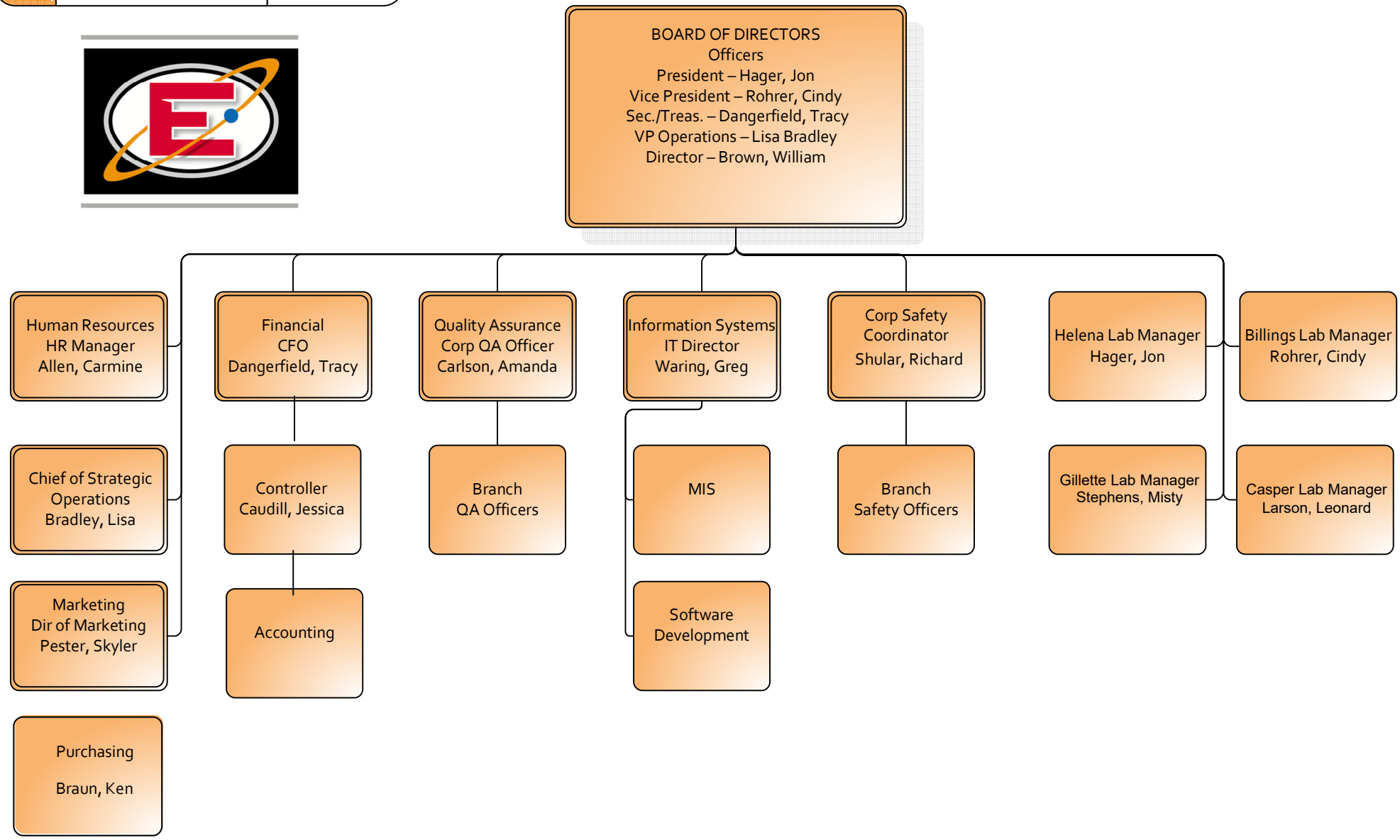
APPENDIX C

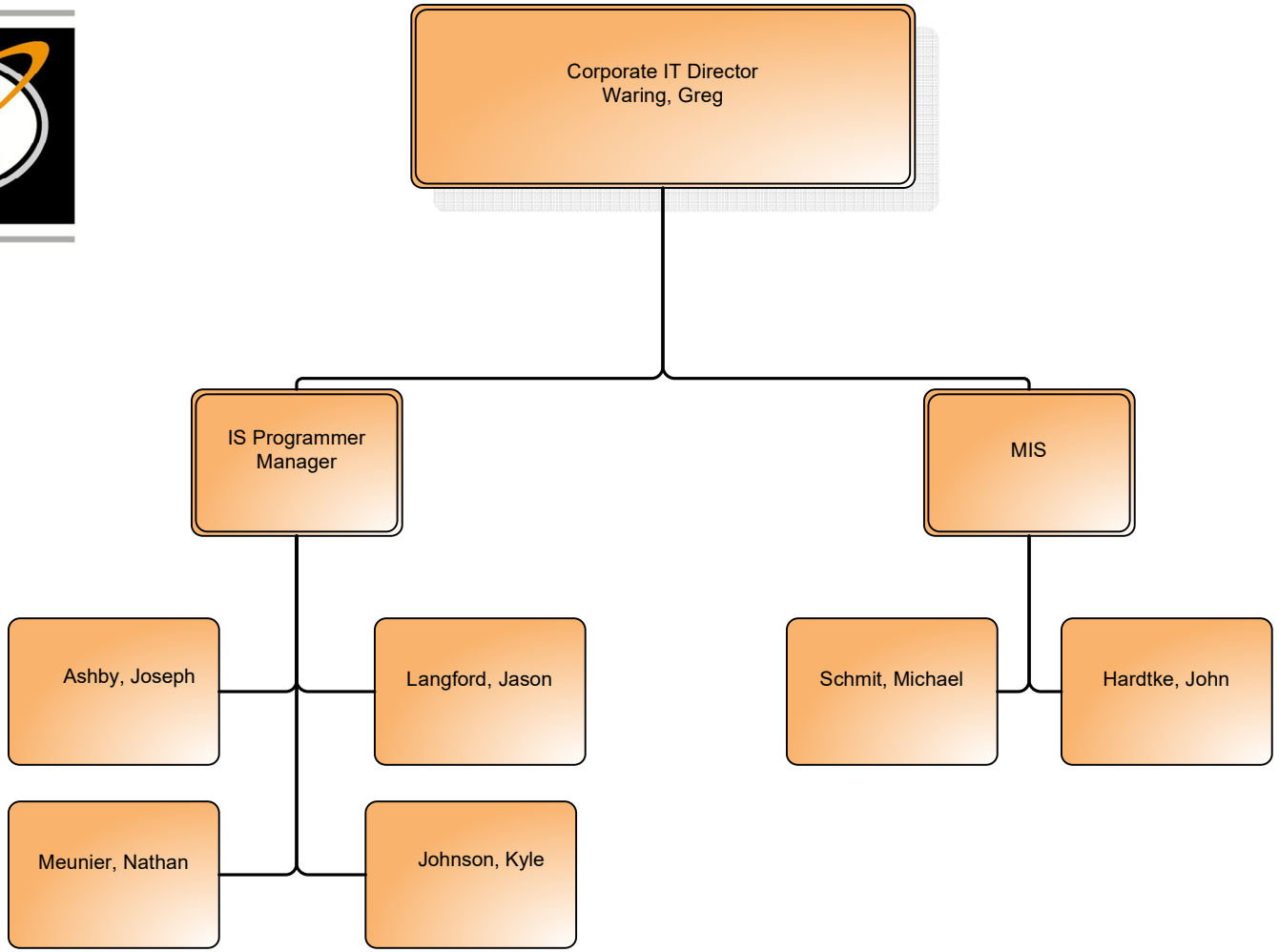
Organizational Charts

Corporate Organizational Chart

Energy Laboratories	
Corp Org	1/24/2025

Energy Laboratories / Corporate Structure

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IS Programmer Manager
MIS
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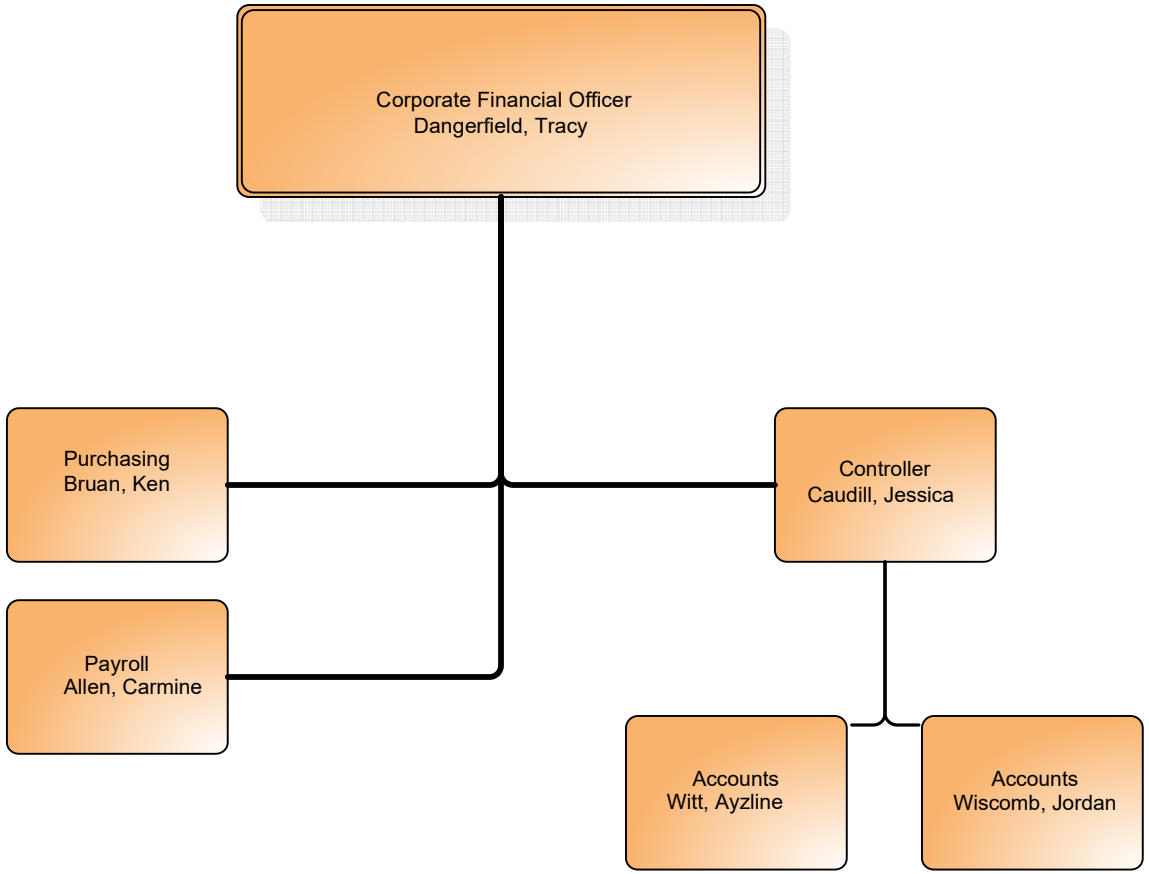
Langford, Jason
Schmit, Michael
Hardtke, John
Meunier, Nathan
Johnson, Kyle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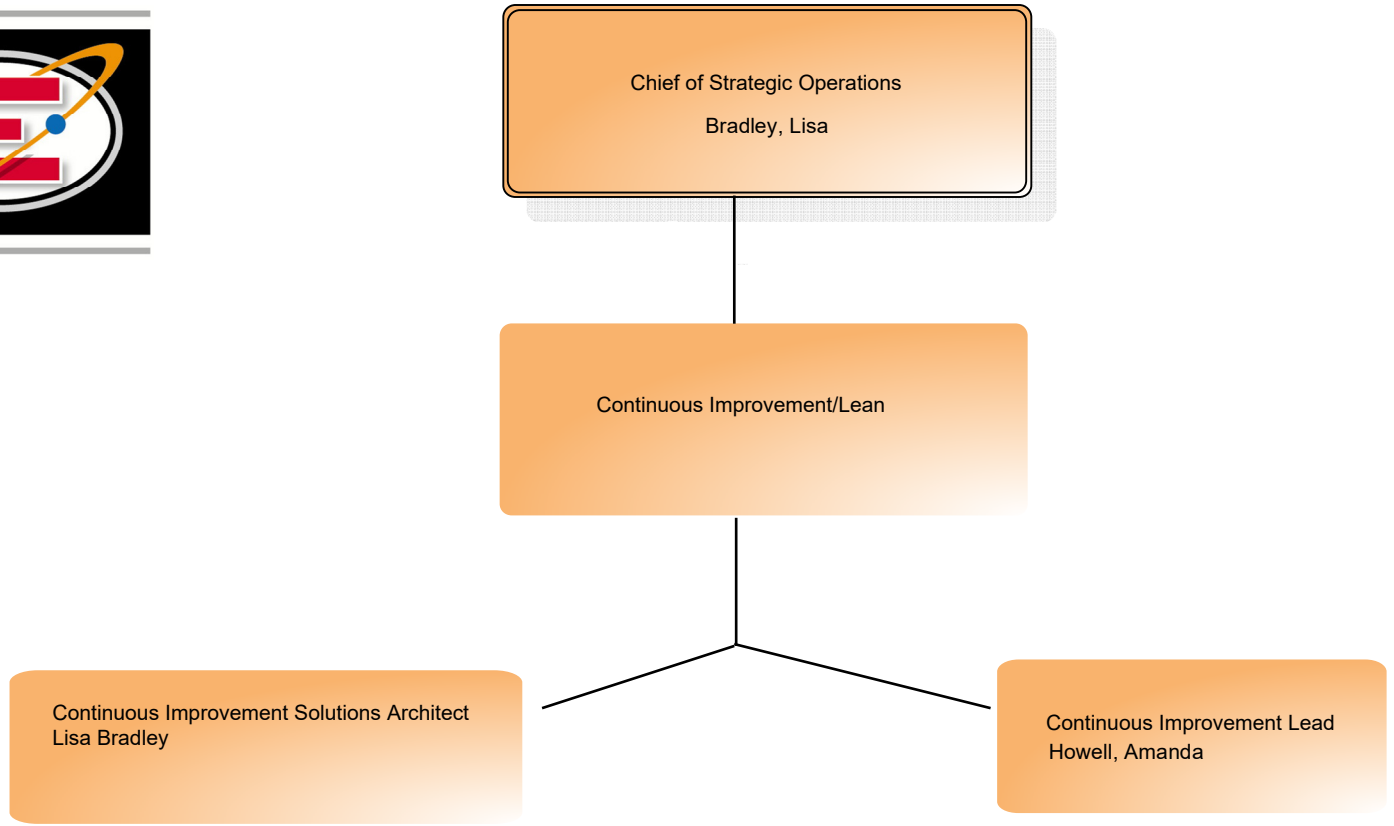
Purchasing
Bruan, Ken
Payroll
Allen, Carmine
Controller
Caudill, Jessica
Accounts
Witt, Ayzline
Accounts
Wiscomb, Jordan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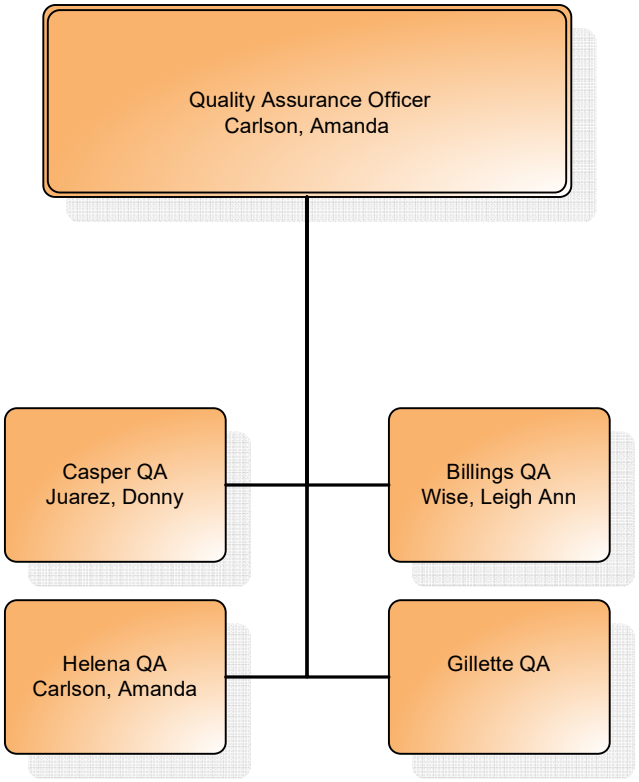
Bradley, Lisa
Continuous Improvement/Lean
Continuous Improvement Solutions Architect
Lisa Bradley
Continuous Improvement Lead
Howell, Amanda


Quality Assurance Officer
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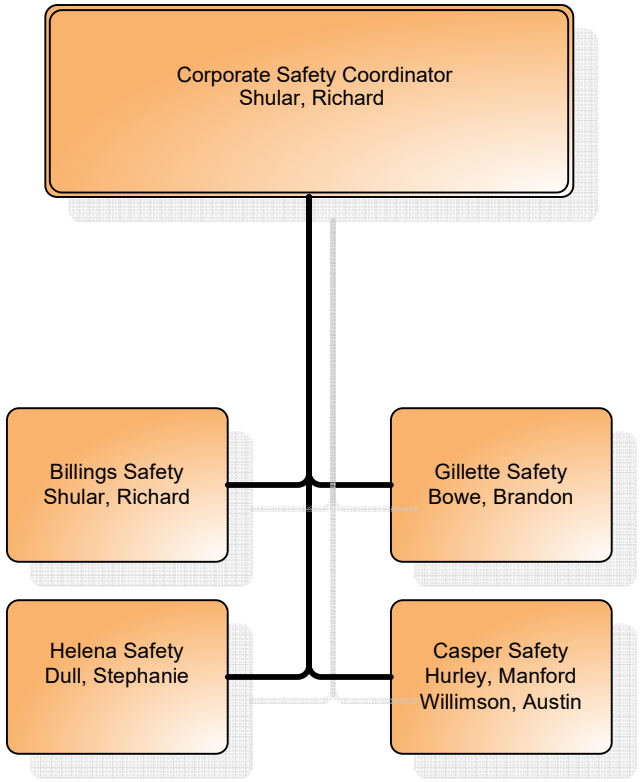
Casper QA
Juarez, Donny
Billings QA
Wise, Leigh Ann
Helena QA
Carlson, Amanda
Gillette QA


Corporate Safety Coordinator
Shular, Richard
Billings Safety
Shular, Richard
Gillette Safety
Bowe, Brandon
Helena Safety
Dull, Stephanie
Casper Safety
Hurley, Manford
Willimson, Austin

HR Manager
Allen, Carmine

APPENDIX D

Curricula Vitae of Key Laboratory Personnel

JONATHAN D. HAGER

President / Helena Laboratory Manager

Academic Training

Bachelor of Arts in Biology, Chemistry Minor, Carroll College, Helena, MT, May 2003

Professional Experience

May, 2001-Present: Laboratory Manager -Energy Laboratories, Inc., Helena, Montana.

Responsible for ensuring work is performed with ethics, quality and safety as a primary concern. Encourages a quality-oriented and cooperative atmosphere that promotes collaboration and company-wide success. Responsible for development and oversight of operations for Energy Laboratories, Inc.

Coordinates laboratory analysis with client contracts. Responsible for direction, training, and supervision of the analytical laboratory staff. Involved in new procedural and equipment development, quality assurance program, client relations, and report preparation.

Experienced in the analysis of soils and water in a variety of applications.

Technical Training:

GC/MS Training Seminar, Restek 8 hour seminar, Sept 2005.
Interaction Management, 40 hr class, Billings, MT, 2008.
Leadership Helena, Helena Chamber of Commerce, 2018
Lean 6 Sigma Training-50 hr class, 2023

Professional Organizations

American Chemical Society
Treasure State Resource Industry Association
Alaska Miners Association
Soil Society of America

CINDY ROHRER

Vice President/Billings Laboratory Director

Academic Experience
Bachelor of Science, Rocky Mountain College, Billings, Montana, 2000

Professional Experience
Experienced in supervision and management of staff, training analysts, technical review of data reports, and performing the following analyses: anion, alkalinity, acidity, metals analysis (ICP-MS), mercury analysis, metals digestions, Flame FAA, UV, solids and pH.

2020 – Present: Vice President, Energy Laboratories, Inc. - Responsible for development and oversight of operations for Energy Laboratories, Inc.

2014 – Present: Laboratory Manager, Energy Laboratories, Inc., Billings, MT
Supervises department operation, staff training, and maintains QA/QC criteria. Oversees audits, coordinates tasks with other departments, and performs data validation.

2011 – 2014: Inorganics and Aquatic Toxicology Supervisor, Energy Laboratories, Inc., Billings, MT
Responsible for daily operations and management of Inorganics and aquatic toxicology department. Responsibilities include supervision of Inorganics and Aquatic Toxicology staff, maintain QA/QC criteria, oversee audits, review and improve Inorganics and Aquatic Toxicology department operations, coordinate tasks with other departments, and proofing data.

2008 – 2014: Inorganics Supervisor, Energy Laboratories, Inc., Billings, MT
Responsible for daily operations and management of Inorganics department. Responsibilities include supervision of Inorganics staff, maintain QA/QC criteria, oversee audits, review and improve Inorganics department operations, coordinate tasks with other departments, and proofing data.

2006 – 2007: Inorganics Assistant Supervisor, Energy Laboratories, Inc., Billings, MT
Responsibilities included training of new analysts, QC method development, oversee audits, and management of samples.

1999: Montana State University, Billings, MT
Researched SOD mimetics, studied SOD mimetic activity of Copper Kinetin. Ran UV Spectrometry, pH meter, Mass Spec, and Flame AA.

Technical Training
Radon Measurement Provider Certification 2019
Interaction Management Training 2008
Dale Carnegie Course 2004

TRACY A. DANGERFIELD, CPA, MBA

Treasurer and Chief Financial Officer

Experienced in business leadership, management and strategic development. Extensive background in accounting, finance and organizational development.

Education
Master of Business Administration, University of Montana, Missoula, MT 2013
Certified Public Accountant, 1992
Bachelor of Science, Business Administration, Minor in Accounting, Eastern Montana College, Billings, MT 1989

Lean 6 Sigma Training-50 hr class, 2023

Professional Experience
1989-Present, Chief Financial Officer-Energy Laboratories, Inc., Billings, Montana.
Responsible for initiating, developing, and directing administrative operations including finance, human resources, taxation and marketing. . Steered the implementation of an Employee Stock Ownership Plan, transacted the ensuing 30% purchase of ELI, and continues to serve as Plan Trustee.

1985 -1989 Office Management-Energy Laboratories, Inc., Billings, Montana.
Responsible for daily office operations and management of staff.

LISA A BRADLEY PH.D.

Chief of Strategic Operations

Responsible for development and oversight of technical operations for Energy Laboratories, Inc.

Experience: Interim laboratory manager, supervisor of inorganic analysis, supervisor of elemental analysis, senior elemental analyst, research assistant, laboratory environmental technician. Experienced in atomic absorption spectroscopy (AA), inductively coupled plasma optical emission (ICPOES), and mass spectrometry (ICP-MS).

Education

Ph.D., Analytical Chemistry, Indiana University - Bloomington, Indiana, 1996
Bachelor of Science, Chemistry, Montana State University, Bozeman, Montana, 1990

Professional Experience

2007-Present, Vice President/Chief of Strategic Operations- Energy Laboratories, Inc., Billings, MT.

2005-2008, Supervisor, Inorganics Dept.- Energy Laboratories, Inc., Billings, MT: Responsible for supervision and management of inorganics laboratory.

2000-2005-Supervisor, Metals Dept- Energy Laboratories, Inc., Billings, MT: Supervised metals department; performed chemical analyses using laboratory instrumentation.

1996- 2000, Analytical Chemist - Energy Laboratories, Inc., Billings, Montana: Performed atomic absorption spectroscopy (AA), inductively coupled plasma optical emission (ICP-OES), and mass spectrometry (ICP-MS) analyses.

October 1990-1995, Research Assistant/Department of Chemistry - Indiana University, Bloomington, Indiana.

August, 1990-December, 1992, Associate Instructor of Chemistry - Indiana University, Bloomington, Indiana.

1989, Laboratory Technician - Intermountain Laboratory, Bozeman, Montana.

1986-1990, Undergraduate Research Assistant - Montana State University, Bozeman, Montana

AMANDA B. CARLSON

Corporate Quality Assurance Manager/ Helena Assistant Laboratory Director

Academic Experience

Bachelor of Arts in Chemistry, Carroll College, Helena, MT, May 2004

Professional Experience

June 2019-Present Corporate Quality Assurance Manager, Energy Laboratories, Inc.. Responsible for Quality Assurance procedures and monitoring. Assists with method development, prepares and updates standard operating procedures, performs technical training, and involved with special projects.

Jan 2013-Present Assistant Laboratory Manager-Helena, Montana. Assists in the supervision of the daily operations of the laboratory while promoting collaboration and communication between analysts. Supervise Inorganics Department.

January 2008-Present-Quality Assurance Manager Helena, Montana

Ensures the laboratory maintains client satisfaction by meeting quality requirements. Maintains training records for employees and provide ongoing training of QAQC topics. Maintains a general knowledge of methods performed in the laboratory and the appropriate method corrective actions.

Coordinate client relations from bottle preparation and sample receipt through reporting and invoicing, and data review of technical reports issued to clients.

May 2004-2008 Inorganics and Organics Analyst-Energy Laboratories, Inc. Helena Montana. Certified analyst for total coliform and E.Coli in both public and private water samples.

Professional Organizations

American Water Works Association
American Chemical Society
TNI

Technical Training

GC/MS Training Seminar, Restek 8 hour seminar, Sept 2005.
Interaction Management, 40 hr class, Billings, MT, 2008.
Contaminant Vapor Migration and Intrusion, 13 hr class, Helena, MT, Feb 2013.
Small Laboratory TNI Standard Implementation, 21 hour course, 2017
Basic Assessor Training-TNI Standard 2016, 3 day course, 2019
Lean 6 Sigma Training-50 hr class, 2023

LEONARD J. LARSON

Casper Laboratory Director

Education
Natrona County High School, Casper, Wy
Graduate

Casper College, Casper, Wy
Political Science major

Professional Experience
September 2024- Present ENERGY LABORATORIES, INC., Casper, Wyoming
Laboratory Director - Supervises laboratory operation, facilitates staff hiring and training, maintains QA/QC criteria, conducts internal assessments, performs data analysis, evaluation and validation.

2020 - 2024 ENERGY LABORATORIES, INC., Casper, Wyoming
Organics Department Manager/ HPLC analyst – Supervised and managed the daily operation of the volatiles, semi-volatiles, and HPLC departments. Responsibilities included performing HPLC analysis for determination of pesticides and herbicides, Gasoline Range Organics analysis, Diesel Range Organics extractions, instrument maintenance and repairs, purchase, installation and setup of new analytical instrumentation, training and mentoring of staff, maintaining quality control/assurance compliance, data review and validation, as well as technical review of standard operating procedures.

2008 – 2020 ENERGY LABORATORIES, INC., Casper, Wyoming
Wet Chemistry Department Manager – Oversaw the daily operation of the Wet Chemistry Department. Responsibilities included, but not limited to, training and mentoring staff, performing instrument maintenance and repair, overseeing and implementing new method development and installation of new analytical instrumentation and equipment, data review and validation, sample management including monitoring hold and turnaround times, sample and waste disposal, as well as writing, editing and reviewing standard operating procedures for the department.

2006 – 2008 ENERGY LABORATORIES, INC., Casper, Wyoming
Inorganics Analyst – Performed sample analysis on various inorganic methods and instrumentation, beginning with basic bench chemistry such as Chloride, Alkalinity, Acidity and Sulfide by titration, Sulfate by turbidimetry, TDS, TSS, BOD, in addition to Nitrite, Hexavalent Chromium, Residual Chlorine and Surfactants by spectrophotometry, progressing to automated instrumentation analysis such as pH, Conductivity, Anions by Ion Chromatography, Alkalinity and Fluoride by auto-titration, Nitrate+Nitrite, Ammonia, Ortho Phosphate, Phosphate, and TKN via FIA.

1996 – 2005 Standard Laboratories, Casper, Wyoming
Prep Department Supervisor – Managed the preparation department and performed preparation of coal samples for analysis of constituents such as moisture, ash, BTUs, sulfur, mercury, etc.

MISTY A. STEPHENS

Gillette Operations Manager

Education

HS Graduate, General Studies-Business Courses, Campbell County High School, Gillette, WY 1995
Attended Gillette College General Studies/Business 1997-1998

Professional Experience

2023 – Present: Operations Manager, Energy Laboratories, Inc., Gillette, WY
Responsible for and ensuring work is performed ethically and promptly. Quality and safety being a primary concern. Client services, including sample receipt and login, sample container shipping, data reporting, and project management.

2021 – 2023: Project Manager, Energy Laboratories, Inc., Gillette, WY
Client services, including sample receipt and login, sample container shipping, data reporting, EDD generation, and managing project based on client needs.

2019 – 2021: Lead Login, Energy Laboratories, Inc., Gillette, WY
Client services, including sample receipt and login, sample container shipping. Responsible for making sure samples are logged correctly and to the lab in a timely manner.

2013 – 2019: Inorganics, Organics, Crude Oil Analyst, Energy Laboratories, Inc., Gillette, WY
Responsible for and ensuring work is performed ethically and promptly. Recording data to maintaining equipment. Responsible for various tasks that follow strict guidelines and regulations, including protecting the accuracy and efficiency of experiments while keeping labs organized.

2008 – 2013: Login Technician, Energy Laboratories, Inc., Gillette, WY
Responsibilities included client relations, sample login, fulfilling bottle orders, and shipping/receiving

LEIGH ANN WISE

Billings Laboratory Quality Assurance Manager

Academic Experience
Bachelor of Science, Chemistry, Montana State University, Billings, Montana, 2003
Bachelor of Science, Biology, Montana State University, Billings, Montana, 2000

Professional Experience
2019 – Present: Quality Assurance Manager, Energy Laboratories, Inc., Billings, MT
Coordinates and monitors the laboratory quality assurance (QA) program. Works closely with supervisors to schedule and implement QA related activities and ensures the laboratory meets all accreditation requirements. Coordinates or performs QA performance audits through proficiency testing programs and method internal audits. Reviews and approves laboratory reports and provides ongoing training of QA topics.

2013 – 2019: Co-Supervisor Organics Department, Supervisor of Semi Volatile Drinking Water and Volatile Organic Analysis Energy Laboratories, Inc., Billings, MT. Supervises the various areas of the Billings Organics Department, encourages the professional development of staff and continually maintains and refines quality assurance and control criteria. Oversees audits, sample load, technically reviews data and reports, and assists with the requirements and maintenance of laboratory certifications.

2009 – 2013: Supervisor of Semi Volatile Drinking Water Analysis, Energy Laboratories, Inc., Billings, MT
Coached staff and managed sample load and analysis. Developed modules and guidelines for training, employee performances, and compensation reviews. Provided goals and expectations to staff and monitored the progress. Managed department and laboratory issues as they arose and addressed employee performance as needed. Maintained method standard operating procedures and technically reviewed data and reports.

2000 – 2009: Chemist, Energy Laboratories, Inc., Billings, MT
Certified in the analysis of volatile organic, semi volatile organic, pesticide, herbicide, and polychlorinated biphenyl compounds in various sample matrices. Maintained and operated various types of instrumentation including Gas Chromatography, Gas Chromatography/Mass Spectrometry, Electron Capture Detector, Chemical Ionization, and Purge and Trap. Managed sample loads, maintained quality assurance and control criteria, and performed method development and improvements.

Technical Training
Interaction Management Essentials of Leadership, Billings, MT 2012
Excelling as a Manager or Supervisor, SkillPath Seminar, Billings, MT 2010
GC/MS Training Seminar, Restek 8 hour seminar, Butte, MT 2005

DONNY C. JUAREZ

Casper Laboratory Quality Assurance Manager / Assistant Lab Manager

Education
Casper College, Casper, Wyoming
A.S., Chemistry, 2017

Professional Experience

September 2024-Present Assistant Laboratory Manager, Energy Laboratories, Inc., Casper, Wyoming. Assists in the supervision of the daily operations of the laboratory while promoting collaboration and communication between analysts.

June 2014 – Present Quality Assurance Manager, Energy Laboratories, Inc., Casper, Wyoming Maintains laboratory certifications, quality assurance and control criteria. Responsible for annual employee ethics training. Maintains employees training folders. Manages Quality Systems of laboratory including annual reviews of Standard Operating Procedures, QA Manual and employee training folders. Technically reviews data and reports. Well-versed in NELAC, EPA, SW-846, Clean Water Act, and Safe Drinking Water Act regulations and guidelines.

2012 – May 2014 Quality Assurance Assistant, Energy Laboratories, Inc., Casper, Wyoming Assisted in management of quality and client service standards, implemented and maintained quality initiatives, and assessed quality system performance. Was actively involved with peer auditing of branch laboratories and assisted with the development of internal test method assessments.

2006 – 2012 Soils and Semi-Volatile Organics Dept. Supervisor, Energy Laboratories, Inc., Casper, Wyoming. Performed supervisory duties pertaining to the Agronomic Soils and Semi Volatile Organics Departments. Responsibilities included; prioritization of sample analyses, sample scheduling, ordering, data review and report generation. Managed sample loads, maintained quality assurance and control criteria, and performed method development and improvements.

1995 – 2006 Semi-Volatile Organic and Agronomic Soils Analyst, Energy Laboratories, Inc., Casper, Wyoming. Responsibilities included analysis of samples for semi-volatile organics using Gas Chromatographs, routine maintenance, optimization of instrument performance, data documentation and review, and report generation. Instrumentation included various HP Gas Chromatographs equipped with FIDs to include automated injectors, trays, and controllers. Proficient in analytical and preparation methods including EPA 8015B DRO, 3510, 3550, 1010A, and 1664. As Soil Analyst, responsibilities included analysis, and data review for agronomic and mining samples utilizing various agronomic testing methods.

SPECIAL TRAINING
Supervisor Interaction Management Training, 2009 Energy Laboratories, Inc., Lean Training, 2012 Manufacturing-Works, Environmental Laboratory Assessment
Basic Assessor Training – TNI Standard
Testing Requirements in EPA Regulations, TNI Webinar, 10/9/2015

APPENDIX E

Equipment and Methods List

Major Equipment and Methods-Billings, MT

Equipment	Quantity	Methods
Gas Chromatograph - FID with auto sampler	7	MA-EPH, DRO, SW8015C
Gas Chromatograph - PID/FID with purge and trap and auto sampler	4	MA-VPH, GRO, SW8015C, SW8021B
Gas Chromatograph-Manual injection	1	RSK-175
Gas Chromatograph-TCD/FID-Manual injection	2	NGA, SF6, extended gas analysis
Gas Chromatograph - Dual ECD with auto sampler	6	SW8011, SW8081B, SW8082A, SW8151A, E504.1, 515.4, E552.2, E608.3
Carle	1	LPG
Gas Chromatograph - Mass Spectrometer with auto sampler	6	SW8270E, E525.2, E507Mod, E548.1, E625.1
Gas Chromatograph - Mass Spectrometer with purge and trap and auto sampler	5	SW8260B/D, E524.2, E624.1
Liquid Chromatography/Tandem Mass Spectrometry	1	E537.1, E1633
Closed Cup Flashpoint Analyzer	1	SW1010B
Ion Chromatography System (IC)	3	E300.0
Inductively Coupled Atomic Emission Spectrophotometer (ICP-AES)	2	E200.7, SW6010B/D
Inductively Coupled Mass Spectrometer (ICPMS)	3	E200.8, SW6020/B
Block Digestors	7	E200.2, SW3010A, SW3050B, SW7471B
Cold Vapor Atomic Absorption (CVAA) Analyzer	2	E245.1, SW7470A, SW7471B, SM3112 B
Direct Mercury Analyzer	1	SW7473
Flow Injection Analyzer (FIA)	2	E350.1, E351.2, E353.2, E365.1, A4500-CN L
TOC Analyzer	1	A5310, SW9060A
Total Kjeldahl Nitrogen (TKN) Block Digestor	2	E351.2
Total Phosphorus Block Digestor	1	E365.1
AutoAnalyzer	1	E353.2, E365.1
Segmented Flow Analyzer (SFA)	3	A4500-CN G, SW9012, Kelada-01, E335.4, A4500-CN-F, D2036C, E420.4, E353.2, E365.1
Automatic Titrator	2	A2310 B, A2320 B, A4500-F C
Turbidimeter	2	A2130 B
Automated pH/SC	1	A2510 B, A4500-H B, E150.1
pH /Conductivity/DO/ISE meters and probes	multiple	A2510 B, A4500-H B, A4500-O G, A4500-F C, A4500-CN-F
Automated Biochemical Oxygen Demand (BOD) Analyzer	1	A5210 B, A5210 C
UV-Vis Spectrophotometer	2	A3500-CR B, A4500-S D, N3500M, A4500-CN M, A5550 B, A5540 C

Leco Carbon Sulfur Analyzer	2	D1552, Leco
Balances	multiple	A2540 C, A2540 D, A2540 G, A2540 B
Autoclave, Ovens, Incubators	multiple	
Serial numbers and associated support equipment are located in the ELI Instrument Module.		

Major Equipment and Methods – Casper, WY

Equipment	Quantity	Methods
Gas Chromatograph-FID with auto sampler	4	EPA 8015 DRO, GRO
Ion Chromatograph	1	EPA 300.0
Conductivity and pH	1	SM 2510 B, SM 4500-H+- B
Turbidimeter	1	SM 2130 B
Auto Titrator / ISE	1	SM 2320B, SM 4500-F C
Manual Solid-Phase Extractor	1	EPA 1664 A
Spectrophotometer	3	SM 4500-NO2 B
Autoanalyzer (FIA)	1	EPA 353.2, EPA 365.1, EPA 350.1
TOC Analyzer	2	SM 5310 C
Liquid Chromatography (HPLC)	4	EPA 549.2, EPA 531.1, EPA 547
Liquid Scintillation Counter	2	EPA 906.0, EPA 909.0, ASTM D5072 92
Alpha / Beta Gas Proportional Counters Detectors	3 48	EPA 900.0, EPA 903.0, EPA 905.0, EPA Ra-05
Gamma Ray Spectrometers (2 HPGe, 3 Nal(TI))	5	EPA 901.1
Alpha Spectrometers Detectors	6 48	EPA 908.0, SM 7500-U C
BOD/DO Analyzer	1	SM 5210 B
Serial numbers and associated support equipment are located in the ELI Instrument Module.		
Additional Methods: SM 2330 B, SM 2340 B, SM 2540 C, SM 2540 D		

Major Equipment and Methods -Helena, MT

Equipment	Quantity	Methods
Gas Chromatograph-FID with auto sampler	2	DRO, MA-EPH, SW8015
Gas Chromatograph-PID/FID with purge and trap and auto sampler	2	GRO, MA-VPH E602, SW8021, SW8015
Gas Chromatograph-Mass Spectrometer with purge and trap and auto sampler	2	E524.2, SW 8260B
Inductively Coupled Argon Plasma Spectrophotometer	2	E200.7,SW 6010
ICP-MS Collision Cell	2	E200.8, SW6020
Leco Sulfur Analyzer	1	ASA29-3, E3.2.3
Lachat Flow Analyzer	1	E350.1, E353.2, ASA38-3, ASA10-3, E365.1
Seal Segmented Flow Analyzer	2	EPA 365.1, EPA 350.1, EPA 353.2, SM 4500N Org
Environmental Express Digestion Block	1	E351.2
Incubator	2	SM9223, Colilert Quanti-Tray
TDS/TSS Oven	3	SM2540 C, SM2540D
UV-Visual Spectrophotometer	2	E410.4, SM3500-Cr B
Ion Chromatography System	1	E300.0,E 300.1
Cold Vapor Atomic Absorption (CVAA) Analyzer)	2	SW7470, SW7471, E245.1
Cold Vapor Atomic Fluorescence (CVAFS) Analyzer	1	E245.7
Direct Mercury Analyzer	1	SW7473
Autotitrator	3	SM2320B, , USDA23c
pH/Conductivity/DO/ISE meters and probes	Multiple	SM2510B, SM4500-H B, SM4500-O G, SM4500-F C
Hach 2100N Turbidimeter	1	SM2130B
HPLC	2	E1632, SM10200 H
Quanti-Tray Sealer	1	SM9223 B
Digestion Blocks	4	SW3050B, SW3010,E 200.2
Automated Biochemical Oxygen Demand (BOD) Analyzer	1	SM5210B
Moisture retention curve system, 15bar	1	
Serial numbers and associated support equipment are located in the ELI Instrument Module.		

Major Equipment and Methods – Gillette, WY

Equipment	Quantity	Methods
Dionex Anion Chromatograph	2	EPA 300.0
Man-Tech Auto-Titrator	1	SM 2320B
Horizon Solid Phase Extractors	7	EPA 1664A
Metrohm 855 Robotic Titrosampler	1	SM 2510B, 4500-H^+ B
Mitsubishi Organic Halogens by Microcoulometry (TOXBOX)	1	SW 9076, 9020B, 9023
YSI 5100 Dissolved Oxygen Meter	1	SM 5210B
Hach Odyssey DR 2500 Spectrophotometer	1	Hach 8000
Hach 2100P Turbidimeter	1	SM 2130B
Hach Pocket Colorimeter II	1	SM 4500-Cl G
Pensky-Martens Closed Cup Flashpoint Tester	1	SW1010A/B
Thermo Orion Star A215 pH/SC	1	SM 2510B, 4500-H^+ B
Serial numbers and associated support equipment are located in the ELI Instrument Module.		

APPENDIX F

Sample Acceptance Policy

SAMPLE ACCEPTANCE POLICY

Energy Laboratories, Inc. reserves the right to refuse acceptance of any sample that does not comply with the Sample Acceptance Policy or that may be deemed as a health or safety hazard. The Sample Acceptance Policy has been established to ensure the validity of your data.

- Complete documentation shall accompany the sample. This includes sample identification, location, date and time of collection, collector's name, preservation type, sample type, required analysis and any special remarks concerning the sample. Accepted samples not meeting these criteria will be qualified.
- Sample containers and/or Chain of Custody forms shall be appropriately labeled with the type of preservation used if samples are preserved chemically.
- The sample shall be properly labeled with a unique identification using durable labels and indelible ink.
- The sample must be collected in an appropriate container. Sample containers not supplied by the laboratory may not be appropriate for use.
- The sample shall be received within specified holding times for the requested analysis. Samples with less than 4 hours holding time remaining upon receipt cannot be guaranteed to be analyzed within holding time, however every effort will be made to meet established holding times.
- Lab measurement of analytes considered field parameters that require analysis within 15 minutes of sampling such as pH, Dissolved Oxygen and Residual Chlorine, are qualified as being analyzed outside of recommended holding time.
- Adequate sample volume shall be provided.
- The sample shall be received appropriately chemically and/or thermally preserved.
- Samples showing signs of damage or contamination will not be analyzed without explicit direction from the person requesting the analysis.
- Samples originating from an USDA quarantine zone need to be in the appropriate containers and shipped with the applicable USDA permit.
- Uranium clients sending in source material must call the lab prior to sending.
- DOD Projects – Shipping must be pre-arranged with the project manager. Shipping container must be clearly identified as DOD project samples and labeled with the designated DOD Custody Seals.

The client shall be contacted if:

There is any doubt concerning the sample's suitability for testing.

The sample does not conform to the description provided.

The test required is not fully specified.

The test required appears inappropriate (i.e. drinking water sample for hazardous waste analysis).

An email is sent to project contact(s) the evening of receipt documenting sample receipt conditions and analytical request. Contact the laboratory if there is a documented receipt issue which requires follow-up or for modifications to the analytical request.

Please call Energy Laboratories, Inc. if you have any questions regarding our Sample Acceptance Policy.

APPENDIX G

Standard Reporting Tiers

LEVEL I **Base Report-Consolidated**	**LEVEL II** **Base Report-Consolidated**	**LEVEL III** **+10% Base Cost** **Base Report-Consolidated**	**LEVEL IV** **+30% Base Cost** **BaseReport-Details-MDL-Dil**	**DoD** **+30% Base Cost** **BaseReport-Details-LOD-LOQ-BetaReportingRequired**
Cover Sheet	Cover Sheet	Cover Sheet	Cover Sheet	Cover Sheet
Case Narrative	Case Narrative	Case Narrative	Case Narrative	Case Narrative
Chain of Custody	Chain of Custody	Chain of Custody	Chain of Custody	Chain of Custody
Sample Receipt Checklist	Sample Receipt Checklist	Sample Receipt Checklist	Sample Receipt Checklist	Sample Receipt Checklist
Sample Results Form	Sample Results Form	Sample Results Form	Sample Results Form	Sample Results Form
Surrogate recoveries, where appropriate	Surrogate recoveries, where appropriate	Surrogate recoveries, where appropriate	Surrogate recoveries, where appropriate	Surrogate recoveries, where appropriate
	Method Blank	Method Blank	Method Blank	Method Blank
	Laboratory Control Sample (LCS)	Laboratory Control Sample (LCS)	Laboratory Control Sample (LCS)	Laboratory Control Sample (LCS)
	Laboratory Control Sample Duplicate (LCSD), where appropriate	Laboratory Control Sample Duplicate (LCSD), where appropriate	Laboratory Control Sample Duplicate (LCSD), where appropriate	Laboratory Control Sample Duplicate (LCSD), where appropriate
	Matrix Spike (MS)	Matrix Spike (MS)	Matrix Spike (MS)	Matrix Spike (MS)
	Matrix Spike Duplicate (MSD) or Duplicate sample, where appropriate	Matrix Spike Duplicate (MSD) or Duplicate sample, where appropriate	Matrix Spike Duplicate (MSD) or Duplicate sample, where appropriate	Matrix Spike Duplicate (MSD) or Duplicate sample, where appropriate
	Preceding Continuing Calibration Verification (CCV)	Preceding and Bracketing Continuing Calibration Verification (CCV)	Preceding and Bracketing Continuing Calibration Verification (CCV)	Preceding and Bracketing Continuing Calibration Verification (CCV)
	Sample chromatograms for EPH, VPH, DRO, and GRO	Sample chromatograms for EPH, VPH, DRO, and GRO	Sample chromatograms for EPH, VPH, DRO, and GRO	Sample chromatograms for EPH, VPH, DRO, and GRO
		GC/MS Tune, Performance Checks	GC/MS Tune, Performance Checks	GC/MS Tune, Performance Checks
			Table of Contents	Table of Contents
			Dates Summary Report	Dates Summary Report
			Validation Package includes:	**Validation Package includes:**
			Preparation and analytical batch reports and instrument sequences	Preparation and analytical batch reports and instrument sequences
			Instrument forms including tune, degradation and interference check summaries, serial dilution and post digestion spike reports, and internal standard recoveries	Instrument forms including tune, degradation and interference check summaries, serial dilution and post digestion spike reports, and internal standard recoveries
			Initial calibration including curve type, concentrations, individual and average response factors, abundances, correlation coefficients and linear dynamic range results	Initial calibration including calibration type, concentrations, individual and average response factors, abundances, correlation coefficients and linear dynamic range results
			Graphic reports including chromatograms, ion spectral chromatography, ion ration and library match scores	Graphic reports including chromatograms, ion spectral chromatography, ion ration and library match scores
				Manual integration summaries with reasons
				Standards traceability including vendor certificates of analysis

*Client specific requests will be evaluated by Project Manager and managed via Quote.
**Alternate report formats may be available. Contact project manager for alternate format. Managed via Quote

Appendix 18-B

SEDCAD™4 Modeling of Baseline Flood Flows and Sediment Yields

APPENDIX 18-B

SEDCAD™4 MODELING OF BASELINE FLOOD FLOWS AND SEDIMENT YIELDS

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	Subwatershed Designation and Slopes	2
	Time of Concentration	2
	Rainfall Duration, Frequency, and Distribution	2
	Curve Number	3
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	Sedimentology Evaluation	3
	Erodible Particle Size Distributions	3
	Erodibiltiy Factor (K)	4
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APPENDIX 18-B

SEDCAD™4 MODELING OF BASELINE FLOOD FLOWS AND SEDIMENT YIELDS

LIST OF TABLES

TABLE NUMBER	TABLE TITLE
18-B-1	SEDCAD™ Model Input Factors Based on Erodible Particle Size Distribution Texture Class
18-B-2	Pinabete Arroyo SEDCAD™ Model Erodible Particle Size Distribution Input
18-B-3	No Name Arroyo SEDCAD™ Model Erodible Particle Size Distribution Input
18-B-4	Chaco River Unnamed Tributaries 1-3 SEDCAD™ Model Erodible Particle Size Distribution Input
18-B-5	Brimhall Wash SEDCAD™ Model Erodible Particle Size Distribution Input
18-B-6	Cover Factor Canopy and Surface Cover Interpolation

APPENDIX 18-B

SEDCAD™4 MODELING OF BASELINE FLOOD FLOWS AND SEDIMENT YIELDS

LIST OF EXHIBITS

EXHIBIT NUMBER	EXHIBIT TITLE
18-B-1	SEDCAD™4 Subwatersheds

APPENDIX 18-B

SEDCAD™4 MODELING OF BASELINE FLOOD FLOWS AND SEDIMENT YIELDS

LIST OF ATTACHMENTS

ATTACHMENT NUMBER	ATTACHMENT TITLE
18-B-1	Eroded and Parent Soil Particle Size Distribution Analysis February 2008 (edited March 2009)
18-B-2	Baseline K-factor Laboratory Determination January 2008
18-B-3	Pinabete Arroyo Baseline Hydrology and Sedimentology SEDCAD™ Model Output
18-B-4	No Name Arroyo Baseline Hydrology and Sedimentology SEDCAD™ Model Output without Impoundment
18-B-5	No Name Arroyo Baseline Hydrology and Sedimentology SEDCAD™ Model Output with Impoundment
18-B-6	Chaco River Unnamed Tributary 1 Baseline Hydrology and Sedimentology SEDCAD™ Model Output
18-B-7	Chaco River Unnamed Tributary 2 Baseline Hydrology and Sedimentology SEDCAD™ Model Output
18-B-8	Chaco River Unnamed Tributary 3 Baseline Hydrology and Sedimentology SEDCAD™ Model Output
18-B-9	Brimhall Wash Baseline Hydrology and Sedimentology SEDCAD™ Model Output

SEDCAD™4 MODELING OF BASELINE FLOOD FLOWS AND SEDIMENT YIELDS

The SEDCAD™4 (SEDCAD) hydrology model has been used to determine flood flows and sediment yields for the pre-mine baseline watersheds of Pinabete Arroyo, No Name Arroyo, tributaries to the Chaco River, and Brimhall Wash. Application of the SEDCAD program involves subdividing the drainage area into subwatersheds. Designation of subwatersheds with relatively uniform soil and vegetation characteristics helps in the estimation of model parameters required by SEDCAD. Information is required for physical structures located along the channel that may affect flow and sediment routing within the stream channels. SEDCAD null structures are also established at appropriate locations along the channel network where flow and sedimentology predictions are needed. This model was developed in support of a previous project referred to as the Navajo Mine Extension Project. The No Name Permit area encompasses all of the area previously considered for the Navajo Mine Extension Project. When a reference to the Navajo Mine Extension Project is noted, the area in attention is now considered the No Name Permit area.

The SEDCAD input parameters and output results for the 2-year, 10-year, 25-year, 50-year and 100-year, 6-hour precipitation events and the 10-year 24-hour precipitation event are provided as attachments to this appendix. There are two models for pre-mine conditions on No Name Arroyo. The Burnham Road crosses No Name Arroyo in Area 5. The road embankment created the No Name Impoundment. As discussed in Section 18, this impoundment has been used as a livestock pond. As part of this baseline evaluation, two SEDCAD models were developed for No Name Arroyo, one with the impoundment and one without the impoundment. The No Name Arroyo model with the impoundment reflects current existing baseline conditions.

Soil erosion by water for a specific watershed is usually calculated using the well known empirical Revised Universal Soil Loss Equation (RUSLE) (Renard et al. 1997) and is given by the following expression:

$$A = RKLSCP$$

A is the average soil loss per unit area, expressed in units selected for *K* and the time period specified by *R*. Normal English units are tons/acre/year.

R is the rainfall/runoff factor, which is the number of rainfall units for rainfall energy and runoff, plus the factor for runoff from snowmelt.

K is the soil erodibility factor, which is the rate of soil loss per unit of *R* for a given soil on a slope of 9% with slope length of 72.6 ft (22.1 m).

L is the slope length factor, which is the ratio of soil loss from a defined slope length relative to that from a slope length of 72.6 ft (22.1 m).

S is the slope steepness factor, which is the ratio of soil loss from a slope with a given steepness relative to that from a 9% slope.

C is the cover and management factor, which is the ratio of soil loss from an area with a known cover and management. And,
P is the supporting conservation practice factor.

SEDCAD requires these types of inputs be developed for each watershed being analyzed. To follow is a discussion on how the necessary parameter inputs were developed and calculated for the No Name Permit (NNP).

Runoff Modeling

Subwatershed Designation and Slopes

The SEDCAD subwatershed designations and drainage configuration for the watersheds of interest are shown on Exhibit 18-B-1. The subwatershed information was developed using Carlson Civil Suite 2008, AutoCAD®, and ArcGIS® software. The base mapping used to develop these subwatersheds is a combination of 10-ft contoured aerial flight and digital elevation model (DEM) data. The DEM images were based on digital raster graphics, representing U.S. Geologic Survey (USGS) 7.5 minute topographic quadrangle maps (NMRGIS 2009 and USGS 2009). All DEM analysis was performed utilizing the Spatial Analyst extension for ArcGIS® on DEM images projected to the North American Datum of 1927- State Plane New Mexico West coordinate system and in standard units (ft) of measure.

A more detailed analysis was prepared for subwatesheds within the lease boundary because they will be influenced by mining and reclamation activities. The 11.5-sq-mi No Name Arroyo was divided into 19 subwatersheds. The 59.1-sq-mi Pinabete Arroyo watershed was divided into 52 subwatersheds as shown on Exhibit 18-B-1. The three unnamed tributaries to the Chaco River having watersheds of 3.4, 2.78, and 2.21 square miles were divided into 4, 3, and 3 subwatersheds, respectively (Exhibit 18-B-1). The 85.2-sq-mi Brimhall Wash watershed was divided into 15 subwatersheds (Exhibit 18-B-1). Only a small portion of the watershed of Brimhall is within the permit boundary so the model required fewer subwatersheds. Subwatershed parameters required by the SEDCAD program were determined as described below.

Time of Concentration

The time of concentration for each subwatershed was calculated by the SEDCAD program from the length and slope of the longest flow path that was input from the topographic map using AutoCAD® software.

Rainfall Duration, Frequency, and Distribution

For evaluation purposes, peak flows were estimated for the 6-hour rainfall event at the 2-year, 10-year, 25-year, 50-year, and 100-year frequencies and the 24-hour 10-year storm event. Storm precipitation values provided in Section 18 for the various return periods were obtained from the National Oceanic and Atmospheric Administration (NOAA) online frequency estimates (Bonnin et al. 2006) for a location between

Area 4 South and Area 5 from Atlas 14, New Mexico for the location of the No Name Arroyo and Pinabete Arroyo watersheds. A Soil Conservation Service (SCS) Type II-70 rainfall distribution was applied to all storms, which is consistent with the rainfall distribution used by Navajo Mine.

Curve Number

Hydrologic group for the various soil types within each watershed was obtained from the Soil Survey of San Juan County, Eastern Part (Keetch 1980) for lands outside the NTEC lease area and from the baseline soils study (Section 14) for lands inside the NTEC lease area. These soil surveys classified soil types into four hydrologic group ratings: A, B, C, and D. Runoff curve numbers were developed from the "SEDCAD™4 User Manual" and software (Warner et al. 1998) and from SCS Engineering Division Technical Release Urban Hydrology for Small Watersheds, Table 2-2d, page 2-8, "Runoff curve numbers for arid and semiarid rangelands" (USDA 1986), for each hydrologic soil group assuming a land use/condition between "Herbaceous" and "Desert Shrub" each with a poor cover condition. From this information, runoff curve numbers were derived for each of the four surface texture types. The curve numbers derived for each texture type are summarized in Table 18-B-1. The runoff curve number for a subwatershed was calculated as a weighted average based on the overall surface texture proportions determined for that watershed.

Hydrologic Response Class

A medium hydrologic response class was applied to all subwatersheds. The hydrologic response class determines the shape of the unit hydrograph used in the SEDCAD model. The medium class is typical of agricultural and semiarid rangeland conditions and was determined to be representative of site conditions.

Sedimentology Evaluation

The SEDCAD sedimentology analysis relies on a rainfall factor, erodible particle size data, a soil's erodibility factor, the watershed's topography and the resulting distance of overland flow, cover values and cultural practices at the site. Data for all of these parameters are entered for each subwatershed within the model.

Erodible Particle Size Distributions

NTEC obtained information about soils within and adjacent to the permit area as part of the baseline soils investigation for NNP. This information came from site-specific studies (Section 14) and regional soil survey data (Keetch 1980). Soil mapping units were categorized into four surface textures to provide a basis for developing values for sedimentology parameters used in the SEDCAD model. These surface texture classes included: fine, fine loamy, coarse loamy, and sandy. ArcGIS® software was used to overlay the pre-mine subwatersheds with the baseline soils information to produce a database file that contained the areas corresponding to each soil type within each subwatershed. Textures were linked to the soil types, and an evaluation of the percentage of each texture within each watershed was calculated as a function of area. This surface texture distribution was used to calculate the remaining factors needed for SEDCAD modeling.

Erodible particle size distributions (EPSD) were developed for each of the four surface texture classes in a study conducted by Dr. Richard Warner of the Biosystems and Agricultural Engineering Department at the University of Kentucky (Attachment 18-B-1). The SEDCAD modeling software has a maximum of 20 ESPD per watershed model. For some watershed models, there were more subwatersheds than the number of ESPDs allowed by SEDCAD. In these cases, average or representative EPSDs were used. This data was entered into the model, and the specific particle size distribution referenced for each structure. These particle size distributions are specific to each watershed model and are uniquely numbered. Due to formatting difficulties with the SEDCAD output, BNCC has reproduced the particle size distributions for the major model runs in supplemental tables to completely document the assumptions incorporated by the sedimentology analysis. Twenty particle size distributions were utilized to represent Pinabete Arroyo subwatershed conditions as summarized on Table 18-B-2. The 15 particle size distributions for No Name Arroyo are summarized on Table 18-B-3. The 10 particle size distributions for tributaries to the Chaco River are summarized on Table 18-B-4, and the 13 particle size distributions for Brimhall Wash are summarized on Table 18-B-5.

Erodibiltiy Factor (K)

The RUSLE K-factor is a measure of a soil's resistance to erosive powers of rainfall energy and runoff. Practically, soil erodibility is an integration of the impacts of rainfall and runoff on soil loss for a given soil. Experimentally, soil loss erodibility is the soil loss per unit rainfall index on a standard erosion plot. K-factor can be obtained through three different sources: published data, the Wischmeier nomograph developed from data collected on 55 different Midwestern USA agricultural soils, or the analytical approximation of the Wischmeier nomograph (Renard et al. 1997). Inter-Mountain Labs (IML) determined the K-factor for the four soil texture types using the analytical approximation of the Wischmeier nomograph, which is given by the following relationship:

$$K = \frac{2.1\times10^{-4}(12-OM)M^{1.14} + 3.25(S_1-2) + 2.5(P_1-3)}{100}$$

K is the soil erodibility factor in tons per acre per unit rainfall index (ton/ac/unit rainfall)
Unit rainfall index is in hundreds of feet · tons-force · inches per hour (100s ft tonsf in/hr)
OM is the percentage organic matter,
P_1 is the permeability index (1 to 4),
S_1 is the soil structure index (1 to 6)
M is a parameter that depends on the parent particle size distribution and is given by the following and is valid for values of *%MS* + *%VFS* less than 70:

$$M = (\%MS + \%VFS)(100 - \%CL)$$

%CL is percentage clay (size < 0.002 mm in diameter),
%MS is percentage silt (0.002 – 0.05 mm) and
%VFS is percentage very fine sand (0.05 – 0.1 mm).

The percentages clay, silt, and very fine sand are obtained directly from the parent particle size distribution, using American Society for Testing and Materials (ASTM) D422 – "Standard Test Method for Particle-Size Analysis of Soils" (ASTM 2000). The percentage of organic matter (*OM*) was determined using the Wakley-Black (WB) method (Nelson and Sommers 1982). IML also determined *OM* using the loss on ignition (LOI) described by Nelson and Sommers (1996). The results of these analyses are provided in Attachment 18-B-2. The K-factors for each texture type are summarized in Table 18-B-1. The K-factor for a subwatershed was then calculated as a weighted average based on overall the surface texture distribution determined for that watershed.

Cover Factor (C)

Representative vegetative cover and surface cover information was derived for each of the EPSD texture classes from baseline vegetation surveys (Section 15). This information was integrated with the EPSD texture class information using ArcGIS® to generate canopy cover and surface cover values for each of the four soil textures. Between 104 and 131 transects were used to determine the mean percent total vegetative cover (canopy cover) and mean percent surface cover for each of the four EPSD texture classes. The canopy cover and surface cover derived for each texture type are summarized in Table 18-B-1. The canopy cover versus surface cover tables for rangeland contained within SEDCAD were expanded through linear interpolation to provide cover factors for subwatersheds based on the surface texture distribution. The average cover values were calculated for subwatersheds as a weighted average based on area. These values were used to determine the cover factor through interpolation in Table 18-B-6.

Results

The results of the hydrology and sedimentology models for each of the watersheds are provided as attachments. Each attachment contains the summary output from SEDCAD including: storm information, structure networking, structure routing details, EPSD for each structure, subwatershed hydrology details, subwatershed sedimentology details, subwatershed time of concentration details, subwatershed Muskingum routing details. The subwatershed structure networking is shown on Exhibit 18-B-1. The attachments also contain structure summaries for the following storm events: 10-year 24-hour, 2-year 6-hour, 10-year 6-hour, 25-year 6-hour, 50-year 6-hour, and 100-year 6-hour.

The Pinabete Arroyo summary is presented in Attachment 18-B-3. The No Name Arroyo summary without the impoundment is presented in Attachment 18-B-4. The summary for No Name Arroyo with the

impoundment, the current baseline condition, is presented in Attachment 18-B-5. The summary for Chaco River unnamed tributary 1 is presented in Attachment 18-B-6. The summary for Chaco River unnamed tributary 2 is presented in Attachment 18-B-7. The summary for Chaco River unnamed tributary 3 is presented in Attachment 18-B-8. The Brimhall Wash summary is presented in Attachment 18-B-9.

Peak flows and sediment yields calculated from the aforementioned SEDCAD models for the 24-hour 10-year and 6-hour rainfall events on 2-year, 10-year, 25-year, 50-year, and 100-year frequencies are reported in Section 18-1 in Table 18-5 for each of the surface water monitoring stations on Pinabete and No Name Arroyos, Brimhall Wash at the confluence with the Chaco River, and the unnamed tributaries to Chaco at the confluence.

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Attachment 18-B-1

Eroded and Parent Soil Particle Size Distribution Analysis

February 2008 (edited March 2009)

ERODED AND PARENT SOIL PARTICLE SIZE DISTRIBUTION ANALYSIS

BHP NAVAJO COAL COMPANY
NAVAJO MINE EXTENSION PROJECT

FEBRUARY 2008

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1. INTRODUCTION

The Parent Soil and Eroded Particle Size Distribution (EPSD) analysis conducted on four different composite sediment samples from the BHP Navajo Coal Company Navajo Extension Project (NMEP) area was complete and the results are presented herein. The analysis was completed using the composite samples that were forwarded to the University of Kentucky.

The report contains analysis for:

1. Eroded particle size analysis (rainfall simulator, wet sieve and particle size analyzer) based on 3 replicates per sediment sample.
2. Standard soil particle analysis (Mechanical sieving washing material finer than 0.106 mm. Disperse particles finer than 0.075 mm then use particle size analyzer) based on three replicates per sediment sample.
3. Organic material.

2. SEDIMENT CHARACTERIZATION

Soil samples, representing specific land uses and spatial distributions, were collected from designated locations around the NMEP site. Each group of sample locations were selected to obtain a composite sample that is a reasonable representation of the sediment characteristics found in that particular watershed or area of interest. The particular sampling locations, used to make up the composite samples, were chosen by BNCC consultants.

3. METHODOLOGY

The rainfall simulator developed at the University of Kentucky for erosion studies was utilized to generate the rainfall necessary to obtain the EPSD data from the soil samples. The simulator is approximately 6 meters by 3 meters and rainfall nozzles were located 3 meters above the soil samples to develop the proper rainfall distribution, drop size and raindrop velocity (see Figure 1). Nozzles were operated at 7 pounds per square inch (psi). The calibration consisted of a trade off between rainfall intensity and on/off pulse time while maintaining approximately a 7 psi pressure at the nozzles. Based on these calibrations a 2 seconds on, 3 seconds off pulse was utilized generating approximately a 2 inches per hour (in/hr) or 50 millimeters per hour (mm/hr) rainfall rate. The approximate 2 in/hr rate (50 mm/hr) was based on the rainfall intensity for a 10-year 24-hour (Type II-70 rainfall distribution) design storm. The experiments were conducted for 1 hour to generate runoff that produced a large enough quantity of sediment to conduct analysis. The soil samples used for the rainfall simulator were located in rectangular containers (see Figure A3) with a surface area of approximately 0.53 square feet (ft^2) (6 ¾ in. wide by 11 ¼ in. long). Each container has a 9% slope inclination. Sediment-laden runoff was

directed to a series of sieve trays that were located in an 18.75 liters (L) bucket and wet sieving was conducted. Rainfall was precluded from entering the buckets through protection afforded by plexiglass covers (see Figures 23 to 25 in Appendix A). The sediment that passed the 200 sieve was processed through the X-Ray particle size analyzer. No dispersion agent was used.

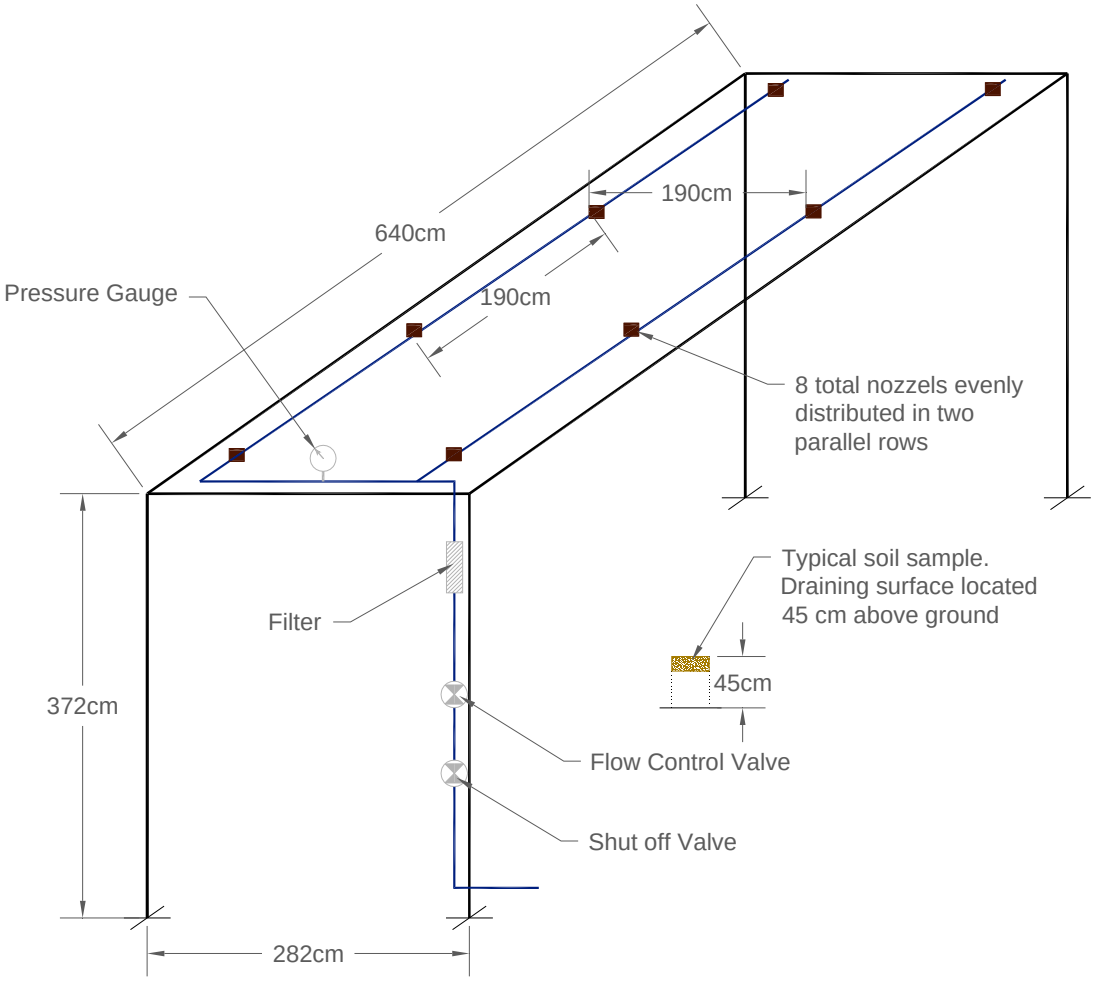


Figure 1: Schematic of the Rainfall Simulator used to obtain the EPSD of the soil samples.

3.1 Procedure

3.1.1 Eroded Particle Size Distribution

The three replicates of each soil sample are rained on for approximately one hour or until enough runoff containing sufficient sediment particles has been collected. The runoff is then sieved using a mechanical/pneumatic wet sieving device to obtain the portion of the particle distribution that is retained in the set of sieves #60 (0.250 mm), #100 (0.150 mm), #140 (0.106 mm) and #200 (0.075 mm). The wet sieve test procedure used in this case is an alternative from the standard test found in ASTM D1140 (American Standard for Testing Materials). The portion of the EPSD retained above 0.075 mm is then obtained by weighting the dried soil retained in each of the sieves. Once the wet sieving is complete, the finer portion of the sediments in the runoff is dried to retrieve the particles finer than 0.075 mm and an X-Ray particle size analyzer is used to obtain the remainder spectrum of the EPSD curve.

The particle size analyzer used for this analysis is a SEDIGRAPH 5100 from MICROMERITICS owned by the University of Kentucky (see Figure 2). This particle size analyzer uses the sedimentation technique, which measures the gravity-induced settling rates of different size particles in a liquid of known properties.

The SediGraph 5100 uses a narrow, horizontally collimated beam of X-rays to directly measure the relative mass concentration of particles in the liquid medium. This is accomplished by first measuring the intensity of a reference X-ray beam which is projected through the clear liquid medium prior to the introduction of the sample. A homogeneously dispersed mixture of solid sample and liquid is next circulated through the cell. The solid particles absorb (and scatter) some of the X-ray energy, which again is measured, this time to establish a value for full scale attenuation. Agitation of the mixture is ceased and the dispersion is allowed to settle while X-ray intensity is monitored. During the sedimentation process, the largest particles are first to fall below the measuring level, and each mass measurement represents the cumulative mass fraction of the remaining fine particles. Gradually, finer and finer particles settle out, ultimately clearing the measuring zone of suspended particles and allowing the X-ray beam to again pass through the cell unattenuated. The particle size analyzer determines particle size from velocity measurements by applying Stokes law under the known conditions of liquid density and viscosity and particle density. Settling velocity is determined at each relative mass measurement from knowledge of the distance the X-ray beam is from the top of the sample cell and the time at which the mass measurement was taken. From the velocity equals distance divided by time relationship, it can determine the maximum velocity of all particles remaining above the measurement zone, these velocities being associated with the finer particles. A sequence of closely-spaced measurements provides a distribution of mass fraction remaining in suspension versus velocity or size class or, as more commonly termed, cumulative mass percent finer. Finally, the SediGraph 5100 can measure particles from 300 to 0.10 micrometers or microns (µm) equivalent spherical diameter.

The Sedigraph 5100 was maintained/tuned and calibrated by University of Kentucky personnel prior to the present ESPD analysis. The equipment was last calibrated on the 19th of April, 2007 following Micromeritics guidelines.

Figure 2: SediGraph 5100 Particle Size Analyzer

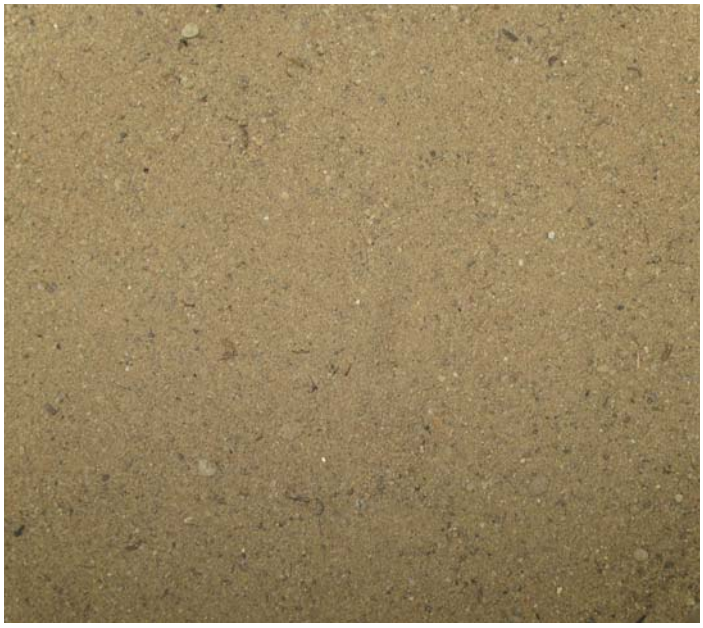
3.1.2 Parent Particle Size Distribution (PPSD)

The soil material is first air dried. The portion of dry soil passing sieve # 10 was then grinded to break up all clumps. A sample of approximately 500 g is obtained by quartering. The sample is then introduced to a rack of 7 different sieves with openings of decreasing size from top to bottom (a pan is placed below the stack to collect the finer portion). The rack of sieves is shaken using a mechanical powered shaker (see Figure A4 on Appendix A) for at least 10 minutes. The sieves used to obtain the spectrum of the PPSD above 0.075 mm were 8 in. (203 mm) in diameter and with openings of 2.000 mm, 0.595 mm, 0.425 mm, 0.250 mm, 0.150 mm, 0.106 mm and 0.075 mm (corresponding to sieves # 10, 30, 40, 60, 100, 140 and 200, respectively). After the sample is shaken, the mass of soil retained on sieves # 10, 30, 40, 60 and 100 are determined. The material collected in sieves # 140 and # 200 was washed through the sieves to remove all the remaining fines. In this case, portions retained on those two sieves are collected separately and oven-dried before the retained mass is measured in grams (g).

The soil particles that passed through sieve #200 are first chemically dispersed using sodium hexametaphosphate dispersant and then analyzed using the X-Ray particle size analyzer.

4. Results

4.1 Sample NMA: "Sandy"



Average total sediment mass yielded during rainfall simulator test: 28.32 g
Average mass of EPSD coarser than 0.250 mm: 14.02 g

4.1.1 Parent Soil Description

a) Texture: sand with few fine gravels.
b) Color: brown.
c) Fine fraction (< 0.075 mm): 3.255%
d) USDA Textural Classification: SAND

4.1.2 Organic Material Calculation

Organic Material: 0.854%
Percent Silt + Very Fine Sand (0.002 – 0.1 mm): 5.475%
Percent Sand (0.1 – 2 mm): 93.370 %

4.1.3 Parent Particle Size Distribution

Table 1: Parent Particle Size Distribution for Sample NMA

Diameter (mm)	Average Percent Finer (%)
2	99.496
0.6	91.745
0.425	82.640
0.25	46.119
0.15	12.976
0.106	6.126
0.075	3.255
0.07079	2.957
0.06683	2.860
0.0631	2.745
0.05957	2.616
0.05623	2.474
0.05309	2.324
0.05012	2.170
0.04732	2.018
0.04467	1.870
0.04217	1.731
0.03981	1.603
0.03758	1.490
0.03548	1.390
0.0335	1.306
0.03162	1.237
0.02985	1.177
0.02818	1.130
0.02661	1.092
0.02512	1.060
0.02371	1.032
0.02239	1.008
0.02113	0.986
0.01995	0.966
0.01884	0.945
0.01778	0.927
0.01679	0.911
0.01585	0.897
0.01496	0.884
0.01413	0.873
0.01334	0.862
0.01259	0.852
0.01189	0.846
0.01122	0.838
0.01059	0.833
0.01	0.828
0.009441	0.823
0.008913	0.821
0.008414	0.819
0.007943	0.816
0.007499	0.815
0.007079	0.815
0.006683	0.813
0.00631	0.810
0.005957	0.809
0.005623	0.806
0.005309	0.801
0.005012	0.796
0.004732	0.788
0.004467	0.779
0.004217	0.771
0.003981	0.759
0.003758	0.747
0.003548	0.736
0.00335	0.721
0.003162	0.708
0.002985	0.697
0.002818	0.684
0.002661	0.676
0.002512	0.668
0.002371	0.664
0.002239	0.659
0.002113	0.656
0.001995	0.651
0.001884	0.648
0.001778	0.641
0.001679	0.636
0.001585	0.628
0.001496	0.623
0.001413	0.615
0.001334	0.606
0.001259	0.600
0.001189	0.592
0.001122	0.586
0.001059	0.577
0.001	0.567
0.000944	0.556
0.000891	0.544
0.000841	0.531
0.000794	0.520
0.00075	0.506
0.000708	0.493
0.000668	0.483
0.000631	0.473
0.000596	0.460
0.000562	0.450
0.000531	0.439
0.000501	0.426
0.000473	0.412
0.000447	0.400
0.000422	0.386
0.000398	0.374
0.000376	0.362
0.000355	0.351
0.000335	0.341
0.000316	0.334
0.000299	0.325
0.000282	0.318
0.000266	0.310
0.000251	0.301

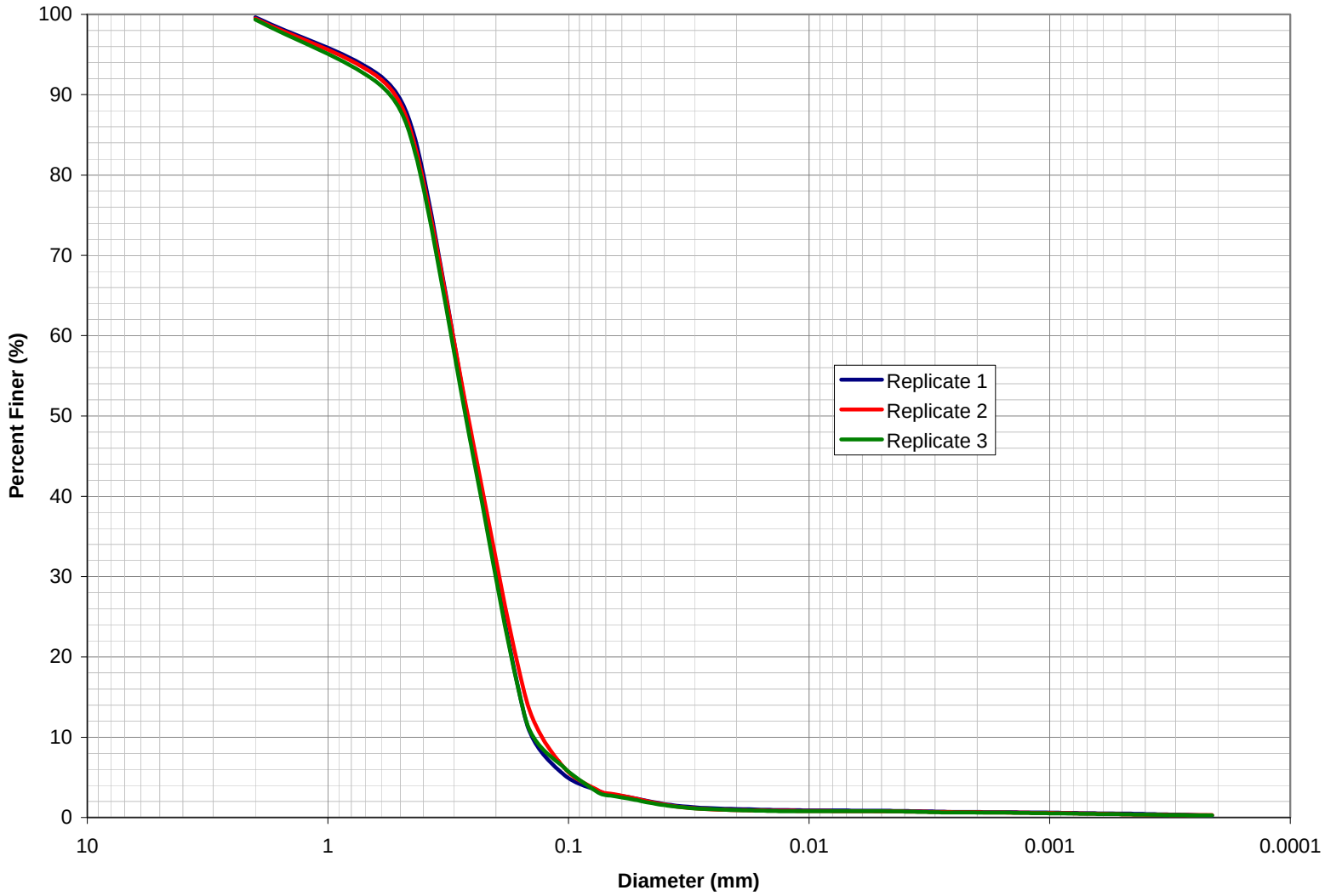


Figure 3: Parent Particle Size Distributions Chart for Sample NMA

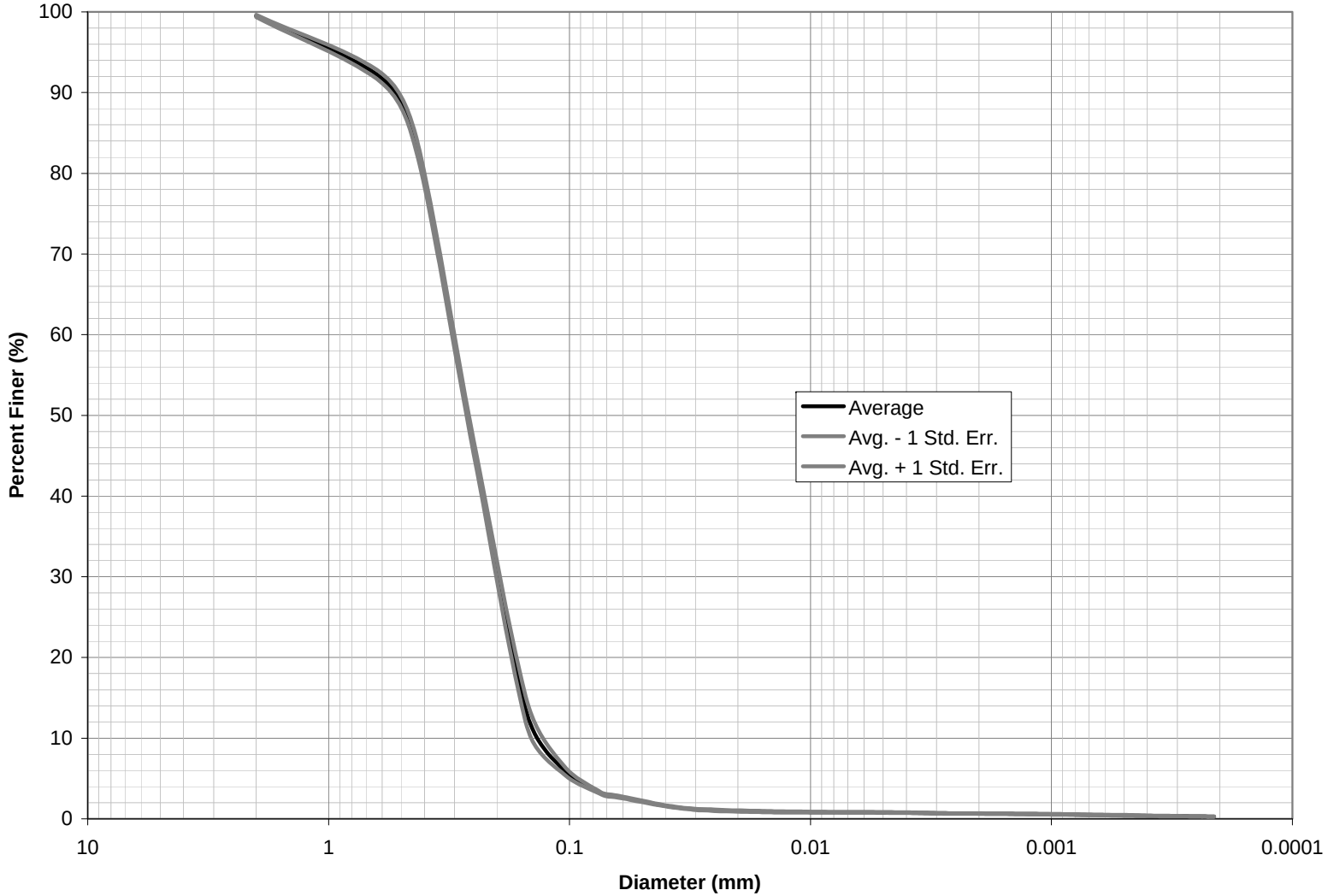


Figure 4: Average Parent Particle Size Distribution Chart for Sample NMA

4.1.4 Eroded Particle Size Distribution

Table 2: Eroded Particle Size Distribution for Sample NMA

Diameter (mm)	Average Percent Finer (%)
0.25	50.527
0.15	33.896
0.106	31.867
0.075	31.272
0.07079	31.272
0.06683	31.272
0.0631	31.272
0.05957	31.272
0.05623	31.272
0.05309	31.272
0.05012	31.272
0.04732	31.272
0.04467	31.272
0.04217	31.272
0.03981	31.272
0.03758	31.272
0.03548	31.272
0.0335	31.188
0.03162	31.104
0.02985	30.997
0.02818	30.905
0.02661	30.814
0.02512	30.714
0.02371	30.630
0.02239	30.529
0.02113	30.446
0.01995	30.362
0.01884	30.261
0.01778	30.178
0.01679	30.077
0.01585	29.929
0.01496	29.757
0.01413	29.543
0.01334	29.297
0.01259	29.026
0.01189	28.713
0.01122	28.354
0.01059	27.939
0.01	27.491
0.009441	27.005
0.008913	26.486
0.008414	25.897
0.007943	25.254
0.007499	24.514
0.007079	23.679
0.006683	22.783
0.00631	21.768
0.005957	20.684
0.005623	19.540
0.005309	18.344
0.005012	17.120
0.004732	15.916
0.004467	14.786
0.004217	13.728
0.003981	12.790
0.003758	11.976
0.003548	11.319
0.00335	10.810
0.003162	10.392
0.002985	10.082
0.002818	9.848
0.002661	9.653
0.002512	9.496
0.002371	9.371
0.002239	9.254
0.002113	9.163
0.001995	9.064
0.001884	8.997
0.001778	8.931
0.001679	8.890
0.001585	8.841
0.001496	8.816
0.001413	8.775
0.001334	8.758
0.001259	8.733
0.001189	8.716
0.001122	8.683
0.001059	8.666
0.001	8.625
0.000944	8.583
0.000891	8.559
0.000841	8.543
0.000794	8.527
0.00075	8.504
0.000708	8.480
0.000668	8.448
0.000631	8.409
0.000596	8.369
0.000562	8.322
0.000531	8.283
0.000501	8.235
0.000473	8.188
0.000447	8.141
0.000422	8.094
0.000398	7.929
0.000376	7.714
0.000355	7.483
0.000335	7.218
0.000316	6.945
0.000299	6.664
0.000282	6.349
0.000266	6.035
0.000251	5.712
0.000237	5.381
0.000224	5.033
0.000211	4.661

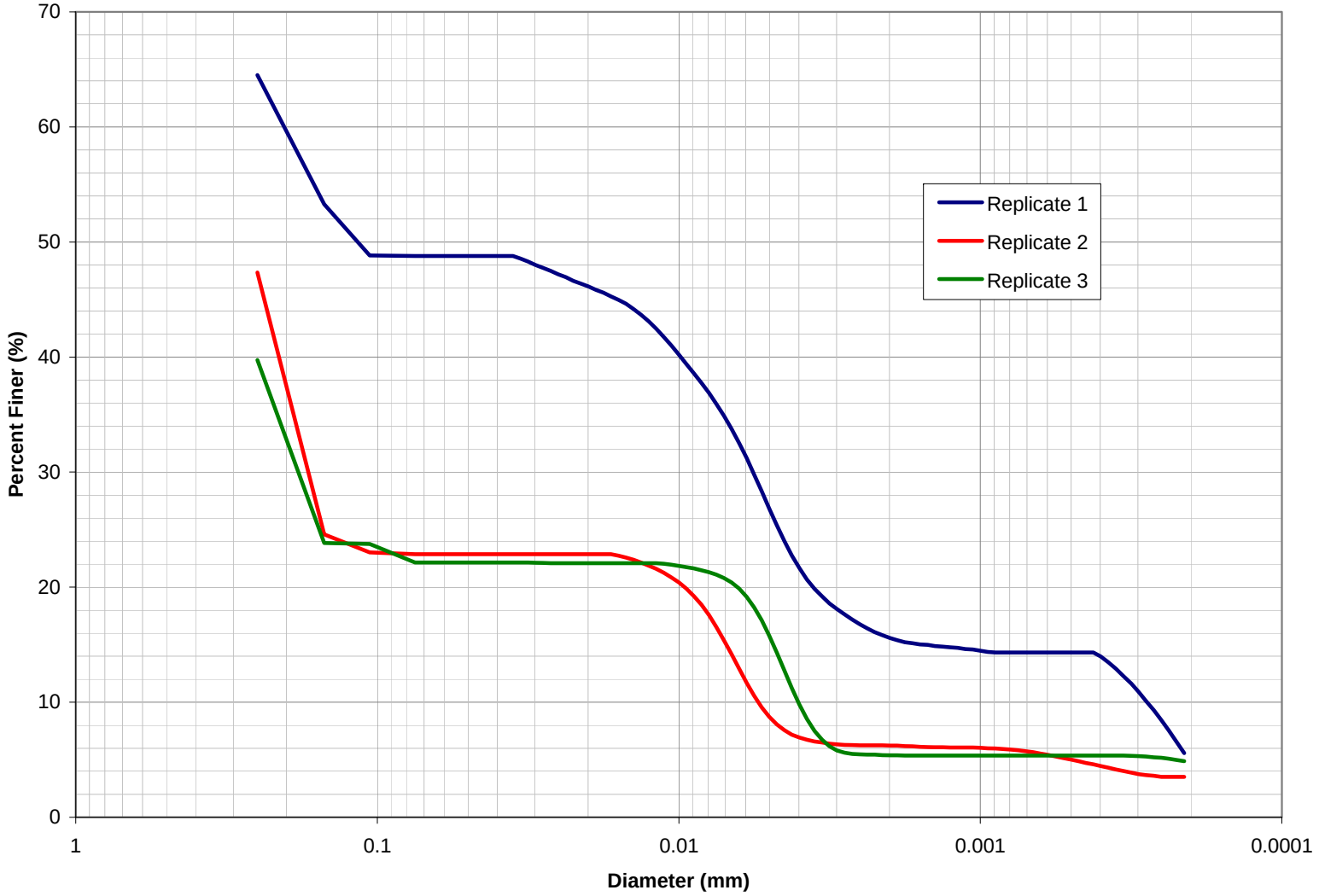


Figure 5: Eroded Particle Size Distributions Chart for Sample NMA

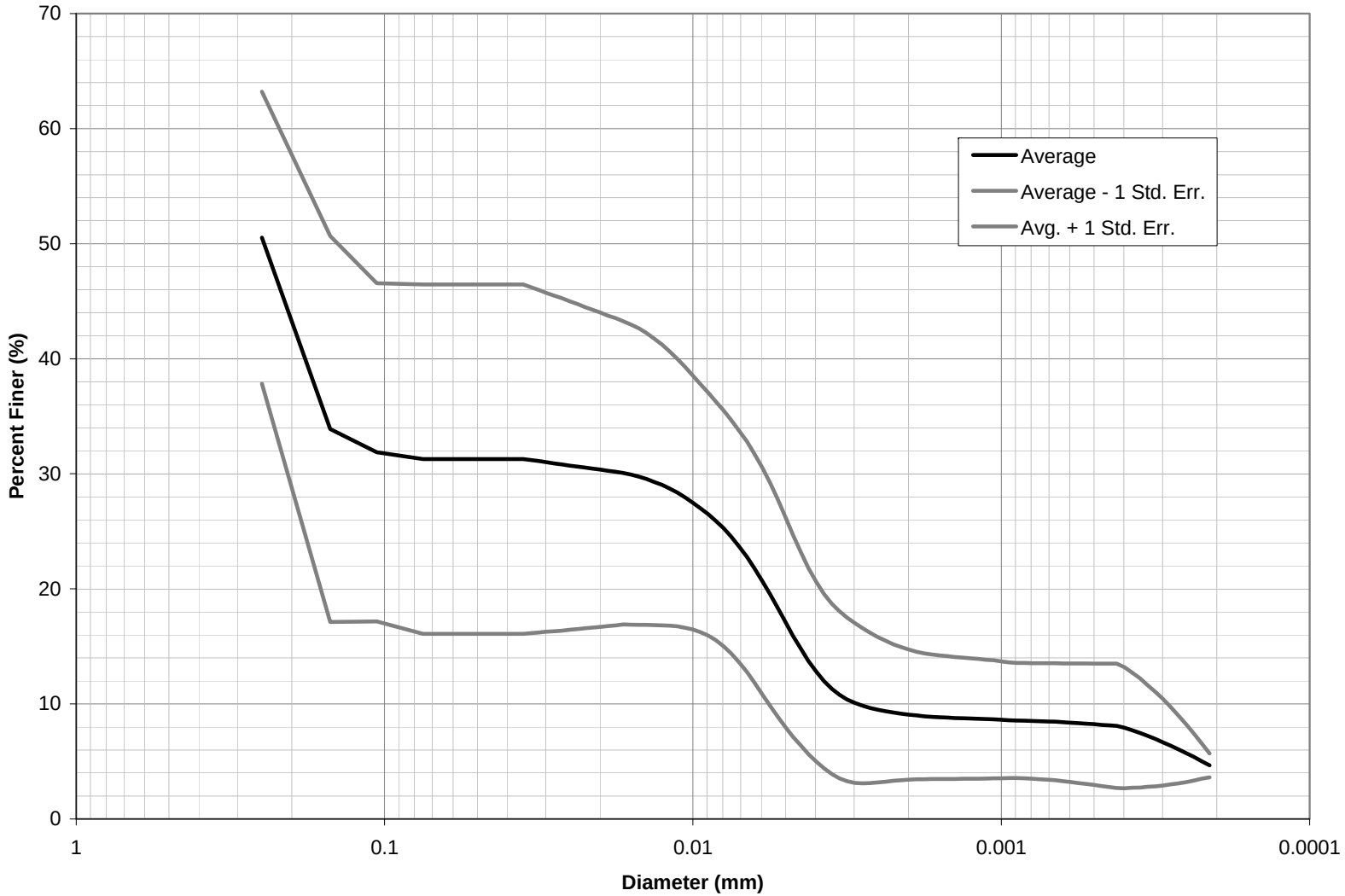


Figure 6: Average Eroded Particle Size Distribution Chart for Sample NMA

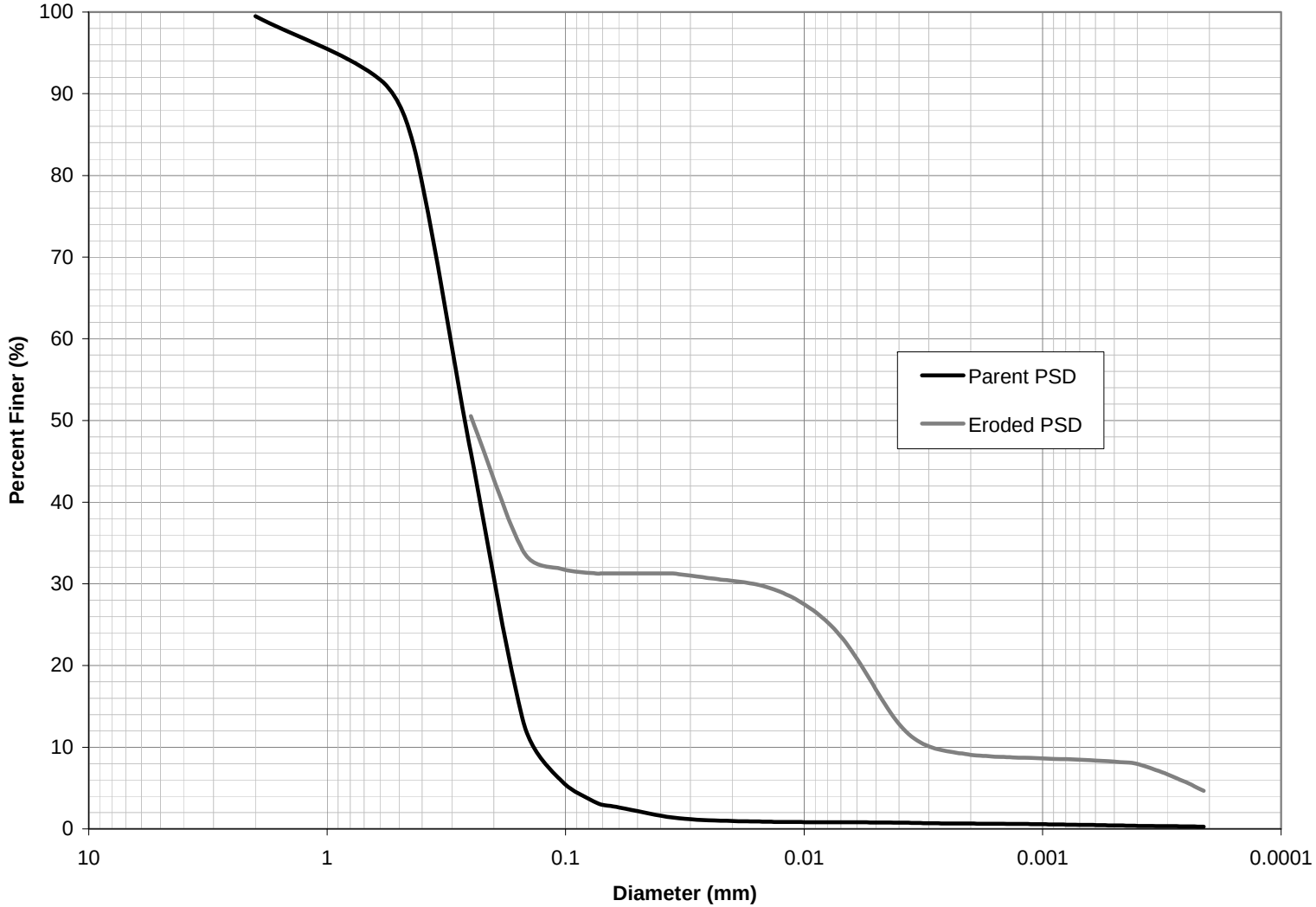


Figure 7: Combined Particle Size Distributions Chart for Sample NMA

4.2 Sample NMB: "Fine"

Average total sediment mass yielded during rainfall simulator test: 30.31g
Average mass of EPSD coarser than 0.250 mm: 4.36g

4.2.1 Description

a) Texture: fine sand with silts and fine gravels.
b) Color: grey.
c) Fine fraction (< 0.075%): 15.937%
d) USDA Textural Classification: LOAMY SAND

4.2.2 Organic Material Calculation

Organic Material: 6.445%
Percent Silt + Very Fine Sand (0.002 – 0.1 mm): 15.100%
Percent Sand (0.1 – 2 mm): 75.114%

4.2.3 Parent Particle Size Distribution

Table 3: Parent Particle Size Distribution for Sample NMB

Diameter (mm)	Average Percent Finer (%)
2	93.744
0.6	73.095
0.425	63.904
0.25	43.103
0.15	21.889
0.106	18.629
0.075	15.937
0.07079	15.565
0.06683	15.420
0.0631	15.233
0.05957	15.013
0.05623	14.751
0.05309	14.456
0.05012	14.128
0.04732	13.784
0.04467	13.414
0.04217	13.033
0.03981	12.657
0.03758	12.281
0.03548	11.910
0.0335	11.551
0.03162	11.213
0.02985	10.885
0.02818	10.584
0.02661	10.294
0.02512	10.021
0.02371	9.769
0.02239	9.532
0.02113	9.301
0.01995	9.091
0.01884	8.887
0.01778	8.683
0.01679	8.500
0.01585	8.318
0.01496	8.135
0.01413	7.964
0.01334	7.797
0.01259	7.631
0.01189	7.475
0.01122	7.336

Diameter (mm)	Average Percent Finer (%)
0.01059	7.207
0.01	7.088
0.009441	6.986
0.008913	6.895
0.008414	6.815
0.007943	6.740
0.007499	6.665
0.007079	6.595
0.006683	6.525
0.00631	6.449
0.005957	6.363
0.005623	6.277
0.005309	6.191
0.005012	6.094
0.004732	5.997
0.004467	5.890
0.004217	5.783
0.003981	5.664
0.003758	5.557
0.003548	5.429
0.00335	5.305
0.003162	5.177
0.002985	5.037
0.002818	4.882
0.002661	4.710
0.002512	4.528
0.002371	4.319
0.002239	4.083
0.002113	3.821
0.001995	3.531
0.001884	3.230
0.001778	2.925
0.001679	2.614
0.001585	2.330
0.001496	2.072
0.001413	1.846
0.001334	1.664
0.001259	1.513
0.001189	1.400
0.001122	1.304

Diameter (mm)	Average Percent Finer (%)
0.001059	1.228
0.001	1.174
0.000944	1.126
0.000891	1.083
0.000841	1.057
0.000794	1.030
0.00075	1.014
0.000708	0.997
0.000668	0.987
0.000631	0.976
0.000596	0.965
0.000562	0.944
0.000531	0.922
0.000501	0.896
0.000473	0.869
0.000447	0.843
0.000422	0.811
0.000398	0.784
0.000376	0.768
0.000355	0.752
0.000335	0.735
0.000316	0.724
0.000299	0.707
0.000282	0.696
0.000266	0.685
0.000251	0.674

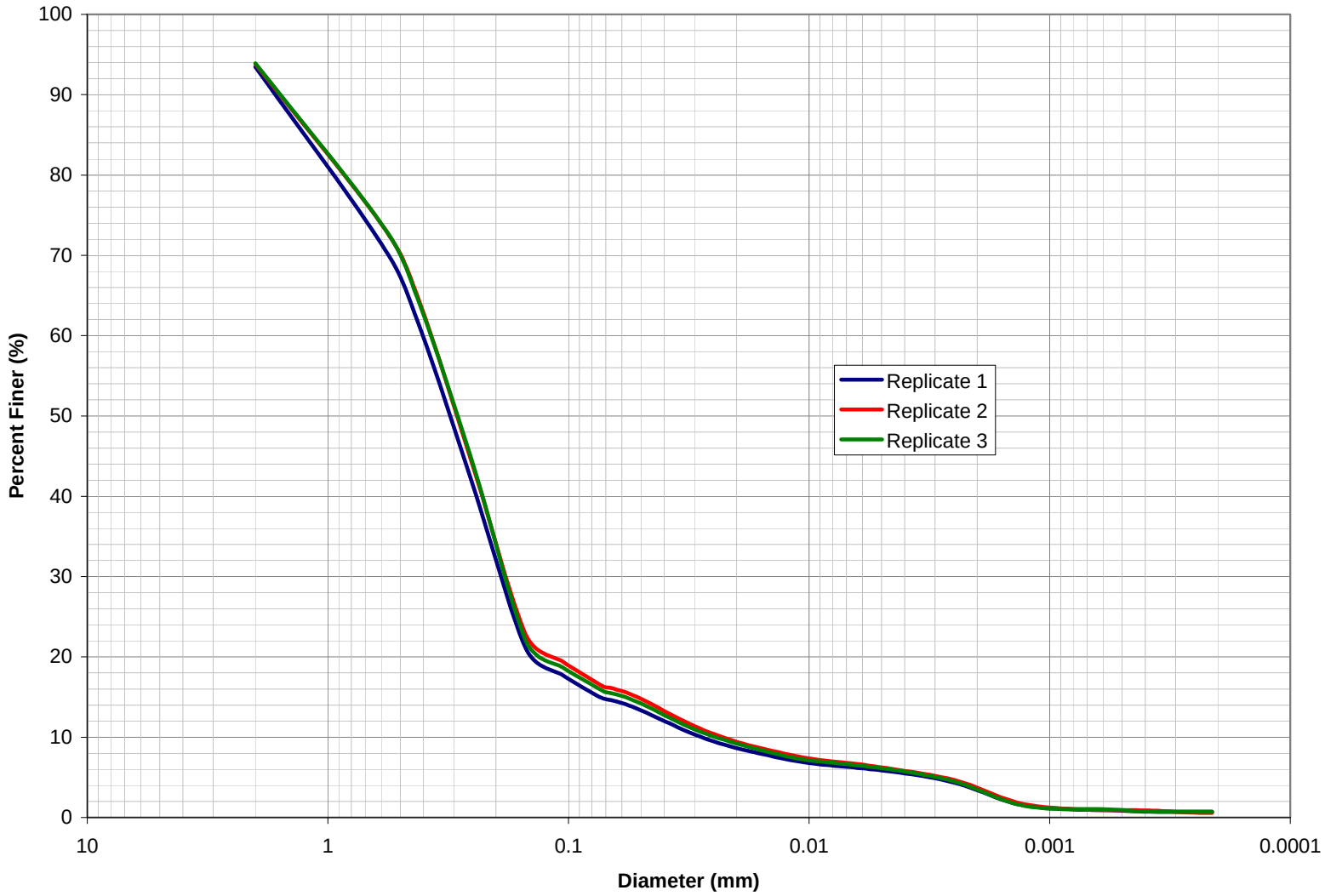


Figure 8: Parent Particle Size Distributions Chart for Sample NMB

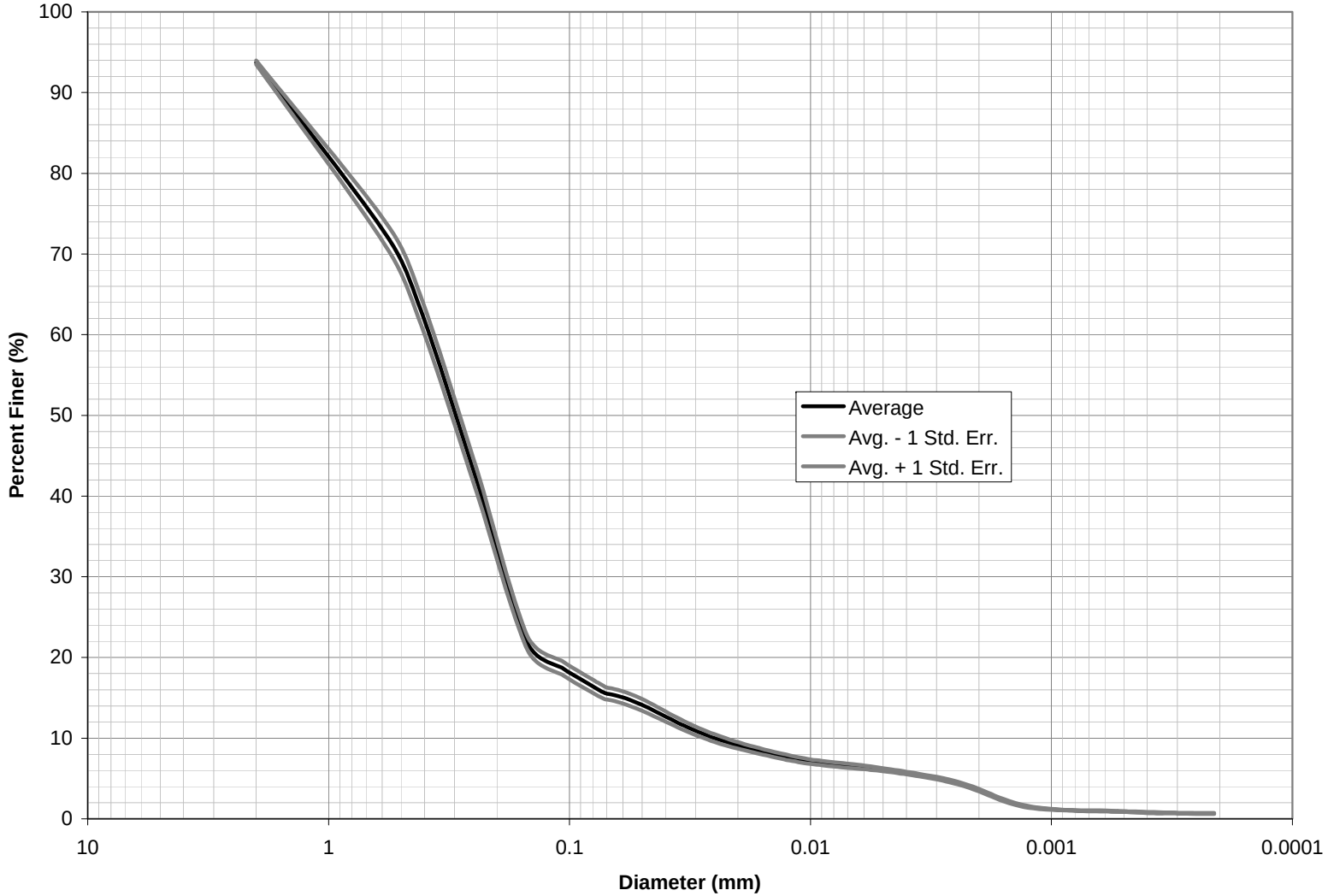


Figure 9: Average Parent Particle Size Distribution Chart for Sample NMB

4.2.4 Eroded Particle Size Distribution

Table 4: Eroded Particle Size Distribution for Sample NMB

Diameter (mm)	Average Percent Finer (%)
0.25	85.662
0.15	72.479
0.106	65.122
0.075	58.342
0.07079	58.110
0.06683	58.052
0.0631	57.974
0.05957	57.897
0.05623	57.820
0.05309	57.722
0.05012	57.605
0.04732	57.468
0.04467	57.312
0.04217	57.096
0.03981	56.862
0.03758	56.627
0.03548	56.372
0.0335	56.078
0.03162	55.786
0.02985	55.532
0.02818	55.259
0.02661	54.967
0.02512	54.659
0.02371	54.311
0.02239	53.924
0.02113	53.461
0.01995	52.939
0.01884	52.360
0.01778	51.704
0.01679	50.969
0.01585	50.138
0.01496	49.288
0.01413	48.303
0.01334	47.224
0.01259	46.007
0.01189	44.656
0.01122	43.054
0.01059	41.199
0.01	39.091
0.009441	36.710
0.008913	34.035
0.008414	31.104
0.007943	28.034
0.007499	24.920
0.007079	21.841
0.006683	18.973
0.00631	16.376
0.005957	14.130
0.005623	12.273
0.005309	10.807
0.005012	9.694
0.004732	8.875
0.004467	8.271
0.004217	7.843
0.003981	7.494
0.003758	7.224
0.003548	7.030
0.00335	6.857
0.003162	6.722
0.002985	6.586
0.002818	6.528
0.002661	6.469
0.002512	6.411
0.002371	6.392
0.002239	6.374
0.002113	6.335
0.001995	6.297
0.001884	6.258
0.001778	6.220
0.001679	6.162
0.001585	6.125
0.001496	6.087
0.001413	6.049
0.001334	6.030
0.001259	6.030
0.001189	6.030
0.001122	6.030
0.001059	6.030
0.001	6.030
0.000944	5.991
0.000891	5.951
0.000841	5.894
0.000794	5.856
0.00075	5.779
0.000708	5.723
0.000668	5.667
0.000631	5.592
0.000596	5.516
0.000562	5.441
0.000531	5.366
0.000501	5.291
0.000473	5.197
0.000447	5.122
0.000422	5.047
0.000398	4.953
0.000376	4.840
0.000355	4.745
0.000335	4.651
0.000316	4.556
0.000299	4.441
0.000282	4.286
0.000266	4.149
0.000251	4.011
0.000237	3.910
0.000224	3.810
0.000211	3.729

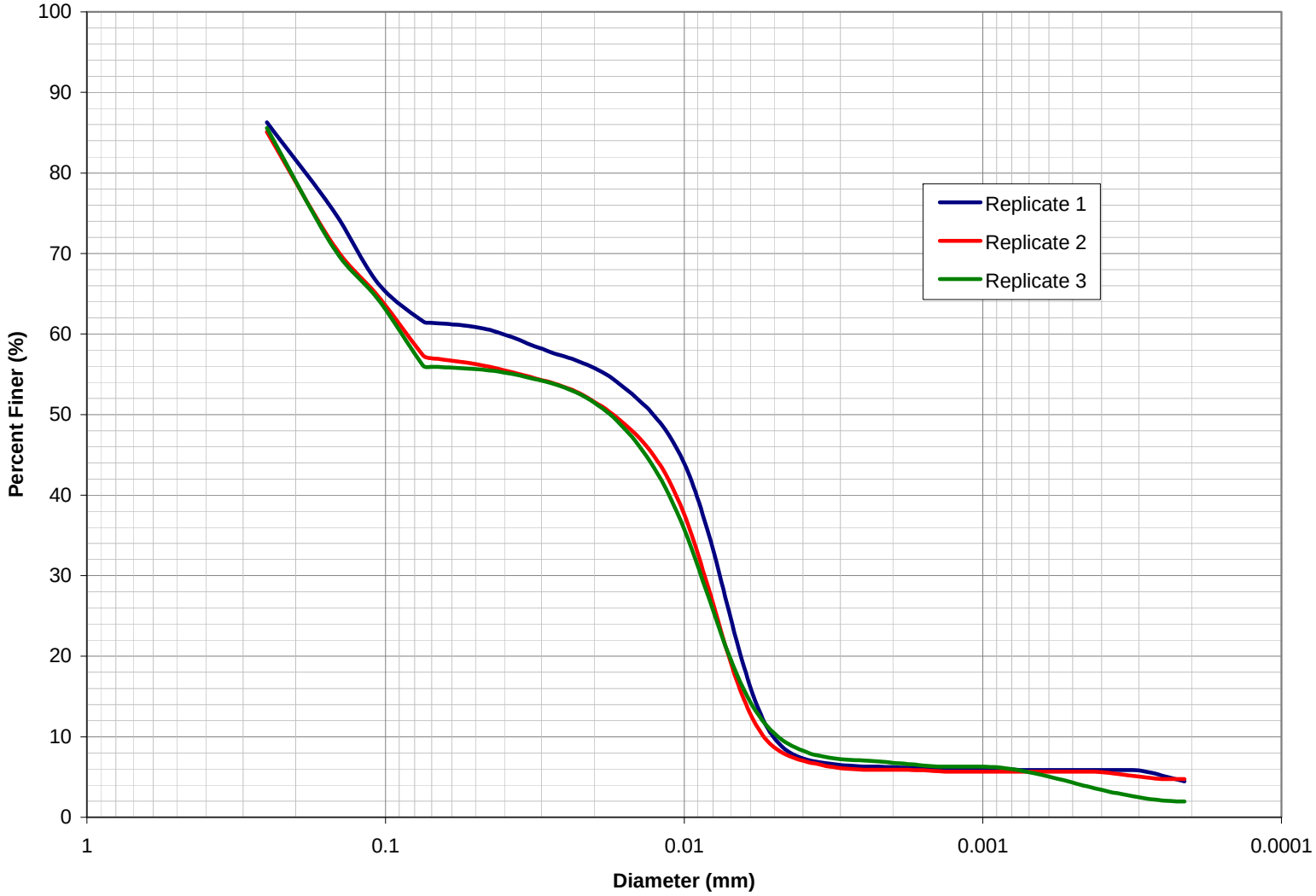


Figure 10: Eroded Particle Size Distributions Chart for Sample NMB

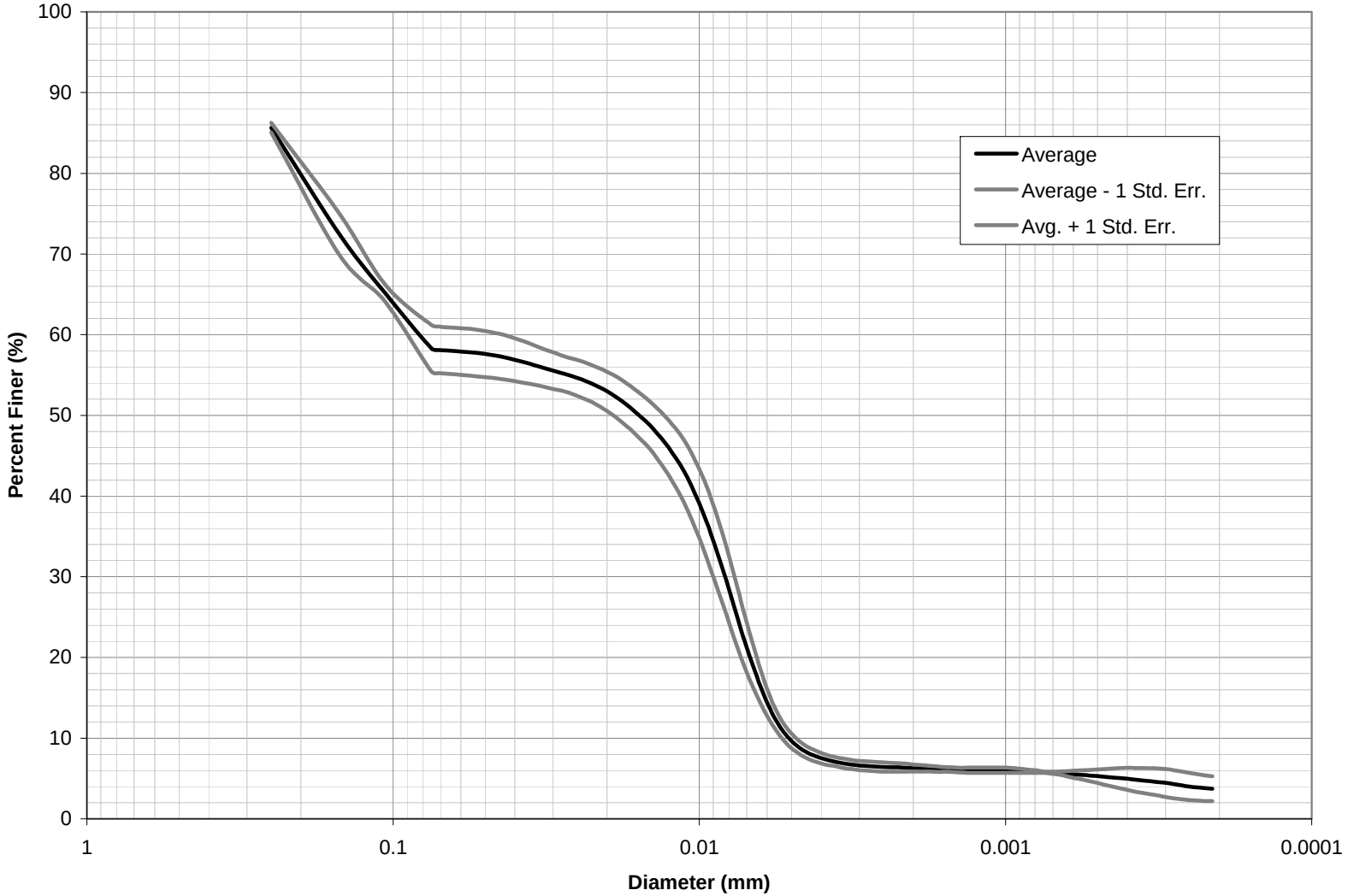


Figure 11: Average Eroded Particle Size Distribution Chart for Sample NMB

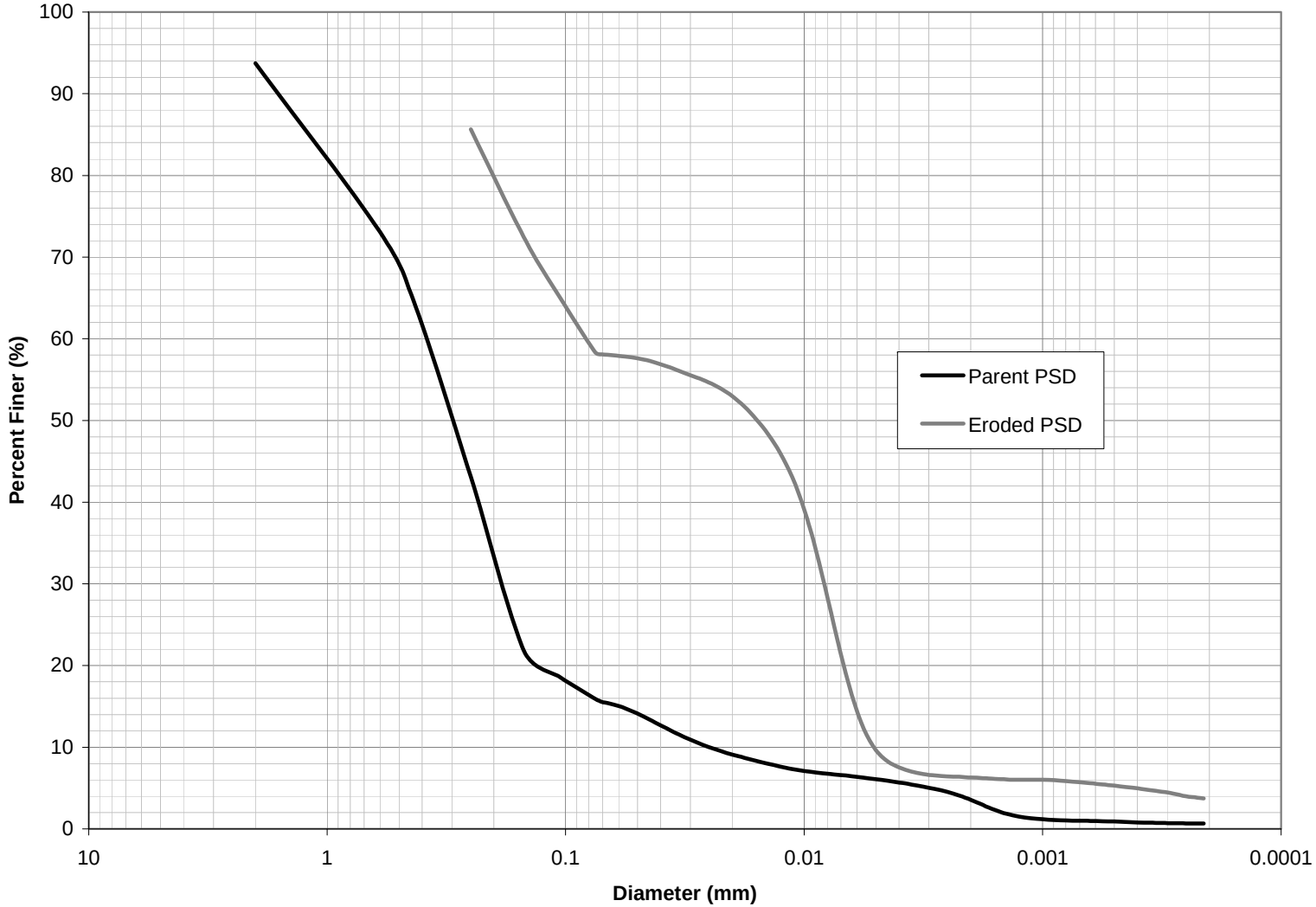


Figure 12: Combined Particle Size Distributions Chart for Sample NMB

4.3 Sample NMC: "Fine Loamy"

Average total sediment mass yielded during rainfall simulator test: 29.547g
Average mass of EPSD coarser than 0.250 mm: 6.71g

4.3.1 Description

a) Texture: fine sand with fine gravels.
b) Color: light grey.
c) Fine fraction (< 0.075%): 15.196%
d) USDA Textural Classification: LOAMY SAND

4.3.2 Organic Material Calculation

Organic Material: 2.860%
Percent Silt + Very Fine Sand (0.002 – 0.1 mm): 15.90%
Percent Sand (0.1 – 2 mm): 74.84%

4.3.3 Parent Particle Size Distribution

Table 5: Parent Particle Size Distribution for Sample NMC

Diameter (mm)	Average Percent Finer (%)
2	94.392
0.6	76.394
0.425	67.811
0.25	49.075
0.15	25.542
0.106	19.553
0.075	15.196
0.07079	14.591
0.06683	14.372
0.0631	14.108
0.05957	13.801
0.05623	13.448
0.05309	13.059
0.05012	12.628
0.04732	12.192
0.04467	11.729
0.04217	11.277
0.03981	10.825
0.03758	10.393
0.03548	9.976
0.0335	9.592
0.03162	9.238
0.02985	8.910
0.02818	8.618
0.02661	8.338
0.02512	8.094
0.02371	7.859
0.02239	7.646
0.02113	7.443
0.01995	7.257
0.01884	7.086
0.01778	6.915
0.01679	6.765
0.01585	6.619
0.01496	6.485
0.01413	6.361
0.01334	6.253
0.01259	6.144
0.01189	6.040
0.01122	5.942
0.01059	5.854
0.01	5.765
0.009441	5.687
0.008913	5.609
0.008414	5.531
0.007943	5.469
0.007499	5.401
0.007079	5.350
0.006683	5.283
0.00631	5.221
0.005957	5.164
0.005623	5.097
0.005309	5.030
0.005012	4.962
0.004732	4.884
0.004467	4.795
0.004217	4.707
0.003981	4.613
0.003758	4.514
0.003548	4.410
0.00335	4.311
0.003162	4.212
0.002985	4.119
0.002818	4.025
0.002661	3.947
0.002512	3.864
0.002371	3.796
0.002239	3.722
0.002113	3.649
0.001995	3.571
0.001884	3.487
0.001778	3.404
0.001679	3.320
0.001585	3.232
0.001496	3.143
0.001413	3.060
0.001334	2.976
0.001259	2.893
0.001189	2.814
0.001122	2.741
0.001059	2.668
0.001	2.594
0.000944	2.526
0.000891	2.448
0.000841	2.380
0.000794	2.307
0.00075	2.234
0.000708	2.161
0.000668	2.083
0.000631	2.010
0.000596	1.932
0.000562	1.854
0.000531	1.781
0.000501	1.713
0.000473	1.645
0.000447	1.583
0.000422	1.521
0.000398	1.470
0.000376	1.423
0.000355	1.371
0.000335	1.330
0.000316	1.289
0.000299	1.253
0.000282	1.232
0.000266	1.212
0.000251	1.212

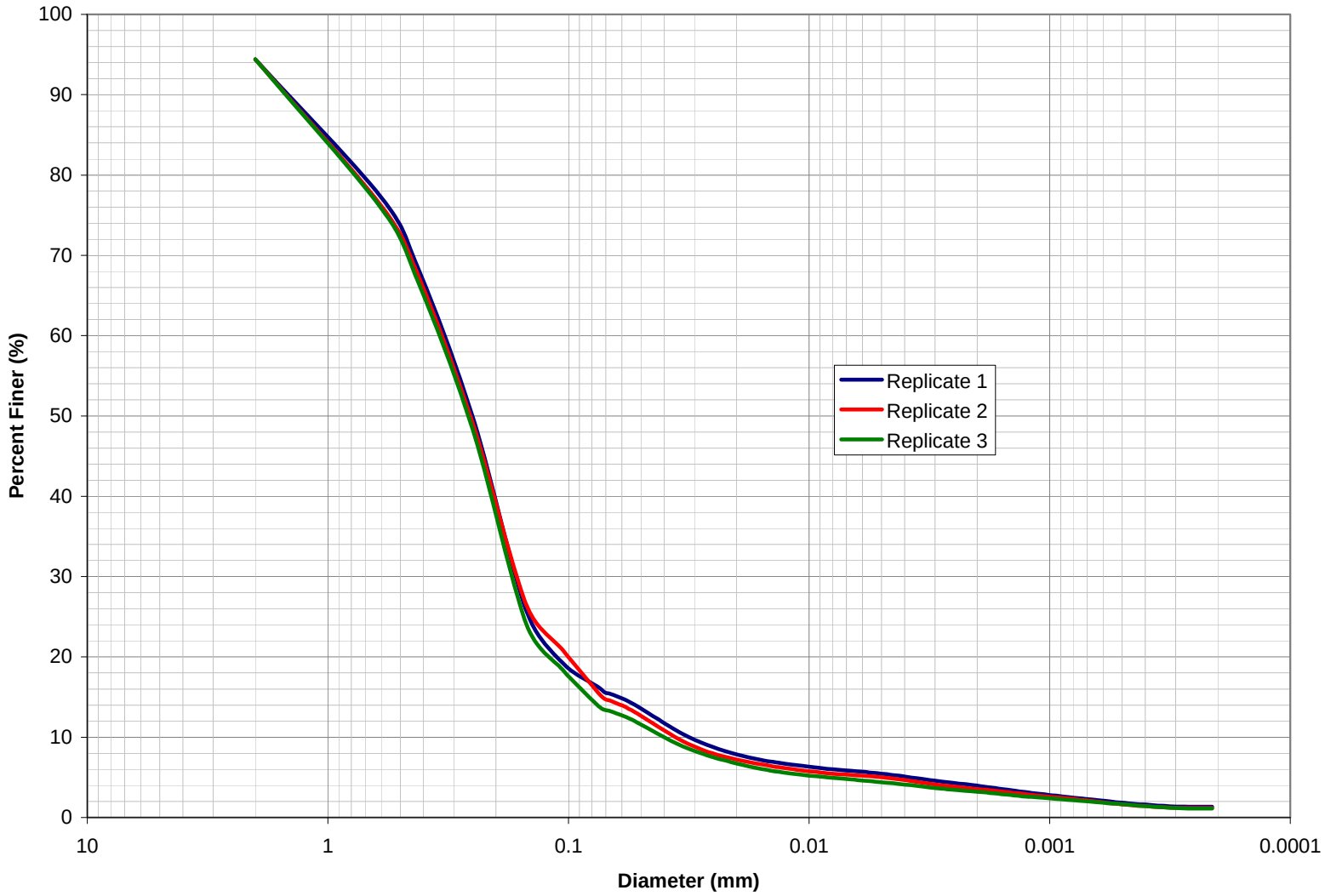


Figure 13: Parent Particle Size Distributions Chart for Sample NMC

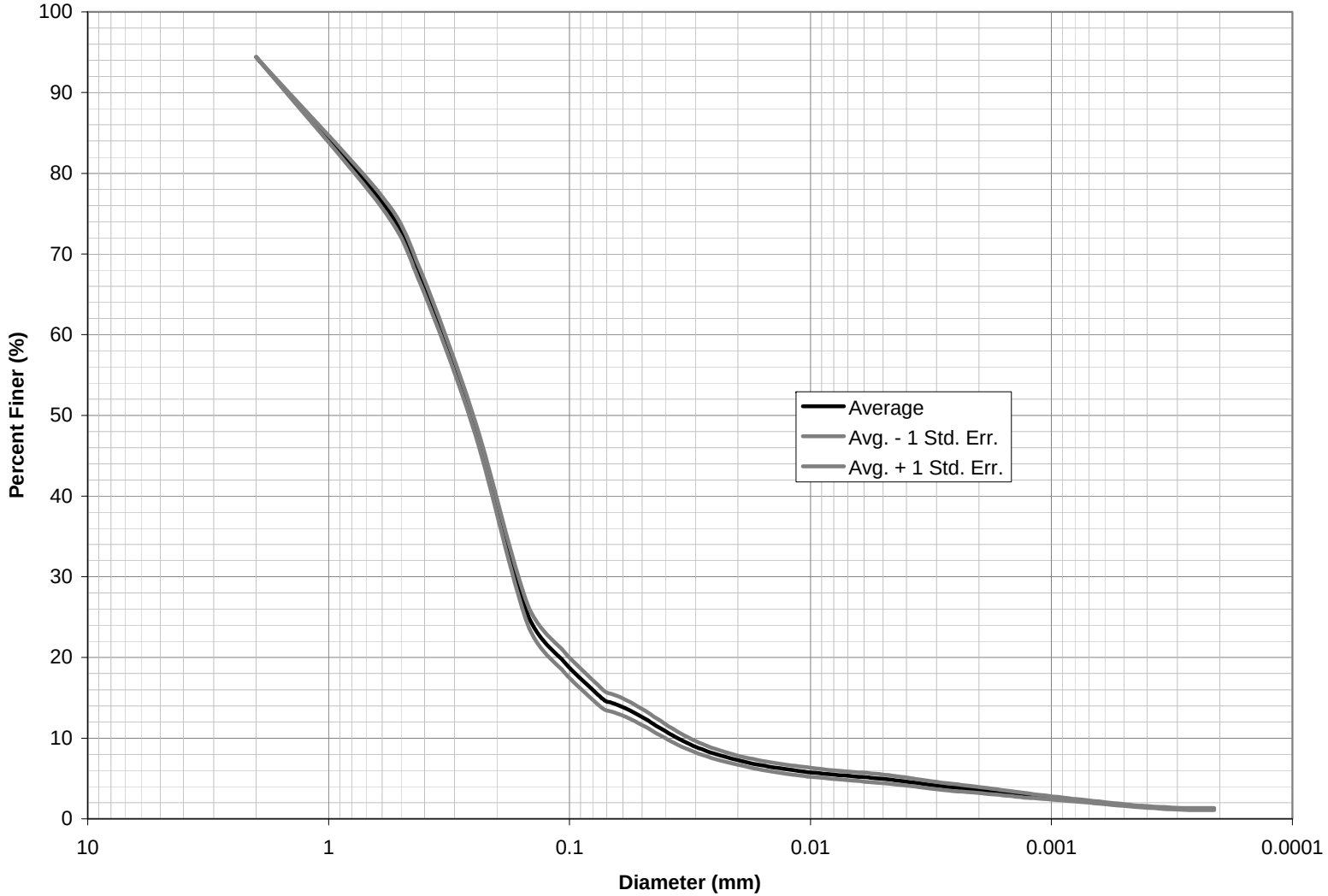


Figure 14: Average Parent Particle Size Distribution Chart for Sample NMC

4.3.4 Eroded Particle Size Distribution

Table 6: Eroded Particle Size Distribution for Sample NMC

Diameter (mm)	Average Percent Finer (%)
0.25	77.102
0.15	57.325
0.106	46.724
0.075	38.620
0.07079	38.515
0.06683	38.450
0.0631	38.384
0.05957	38.306
0.05623	38.175
0.05309	38.031
0.05012	37.887
0.04732	37.704
0.04467	37.495
0.04217	37.313
0.03981	37.104
0.03758	36.870
0.03548	36.675
0.0335	36.429
0.03162	36.181
0.02985	35.922
0.02818	35.662
0.02661	35.376
0.02512	35.051
0.02371	34.700
0.02239	34.322
0.02113	33.905
0.01995	33.437
0.01884	32.916
0.01778	32.332
0.01679	31.642
0.01585	30.862
0.01496	29.965
0.01413	28.911
0.01334	27.701
0.01259	26.281
0.01189	24.679
0.01122	22.907
0.01059	20.965
0.01	18.931
0.009441	16.871
0.008913	14.836
0.008414	12.958
0.007943	11.237
0.007499	9.749
0.007079	8.498
0.006683	7.520
0.00631	6.737
0.005957	6.151
0.005623	5.708
0.005309	5.382
0.005012	5.122
0.004732	4.926
0.004467	4.744
0.004217	4.601
0.003981	4.484
0.003758	4.380
0.003548	4.275
0.00335	4.210
0.003162	4.158
0.002985	4.119
0.002818	4.119
0.002661	4.106
0.002512	4.106
0.002371	4.106
0.002239	4.093
0.002113	4.093
0.001995	4.067
0.001884	4.028
0.001778	3.963
0.001679	3.885
0.001585	3.807
0.001496	3.716
0.001413	3.638
0.001334	3.559
0.001259	3.507
0.001189	3.493
0.001122	3.480
0.001059	3.480
0.001	3.480
0.000944	3.480
0.000891	3.480
0.000841	3.480
0.000794	3.480
0.00075	3.480
0.000708	3.480
0.000668	3.480
0.000631	3.480
0.000596	3.480
0.000562	3.480
0.000531	3.480
0.000501	3.480
0.000473	3.480
0.000447	3.467
0.000422	3.454
0.000398	3.401
0.000376	3.336
0.000355	3.245
0.000335	3.166
0.000316	3.089
0.000299	3.011
0.000282	2.908
0.000266	2.793
0.000251	2.666
0.000237	2.527
0.000224	2.350
0.000211	2.148

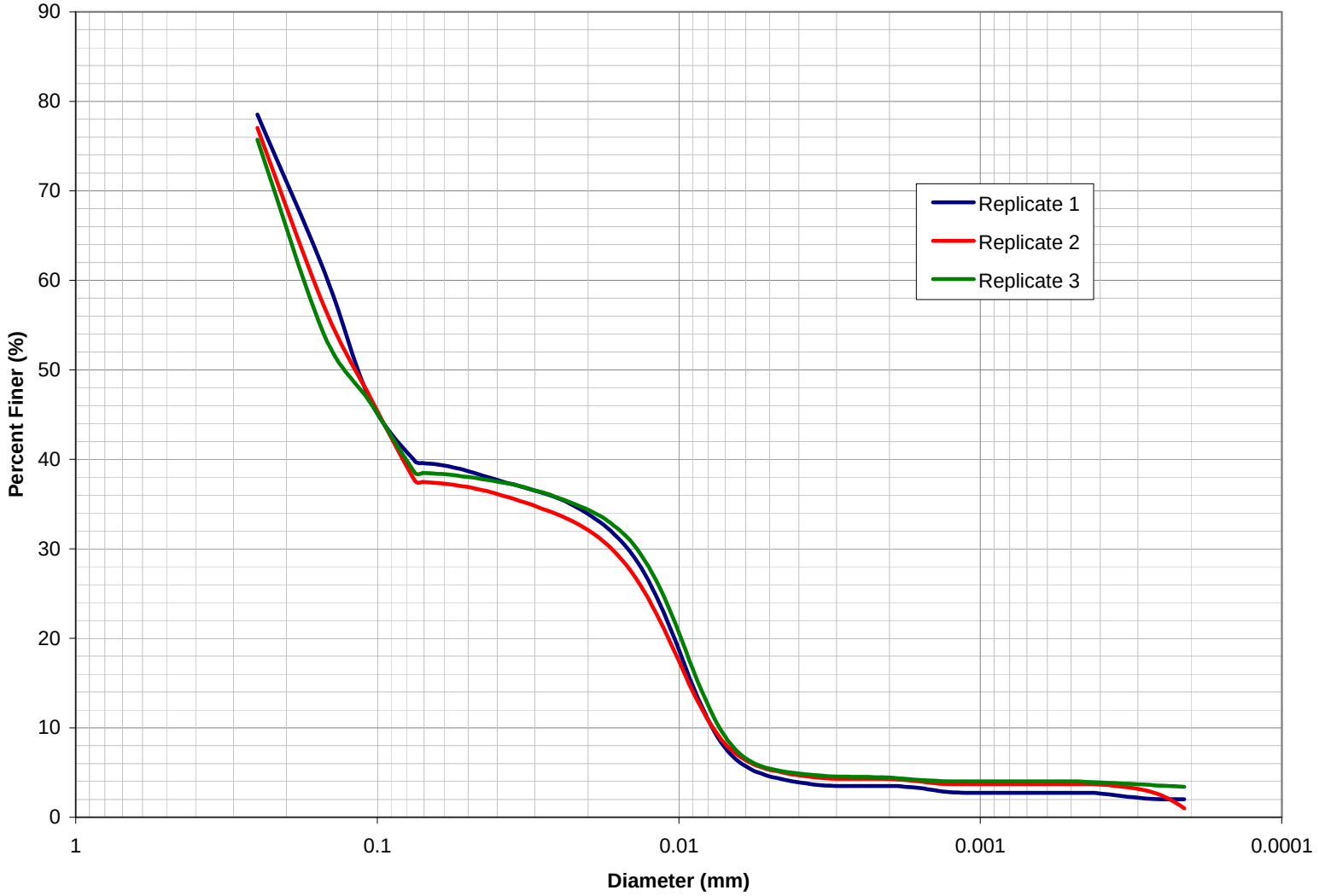


Figure 15: Eroded Particle Size Distributions Chart for Sample NMC

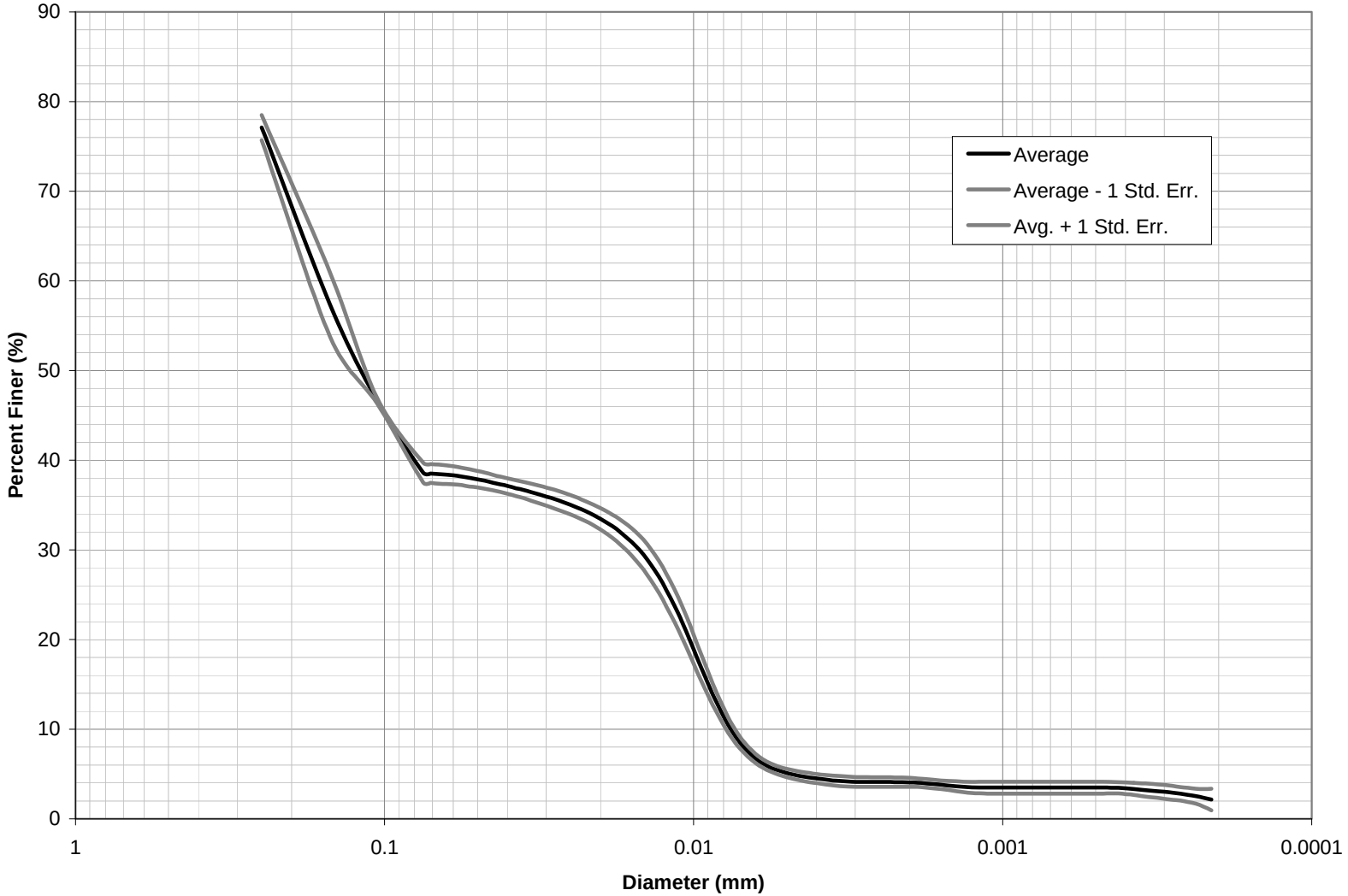


Figure 16: Average Eroded Particle Size Distribution Chart for Sample NMC

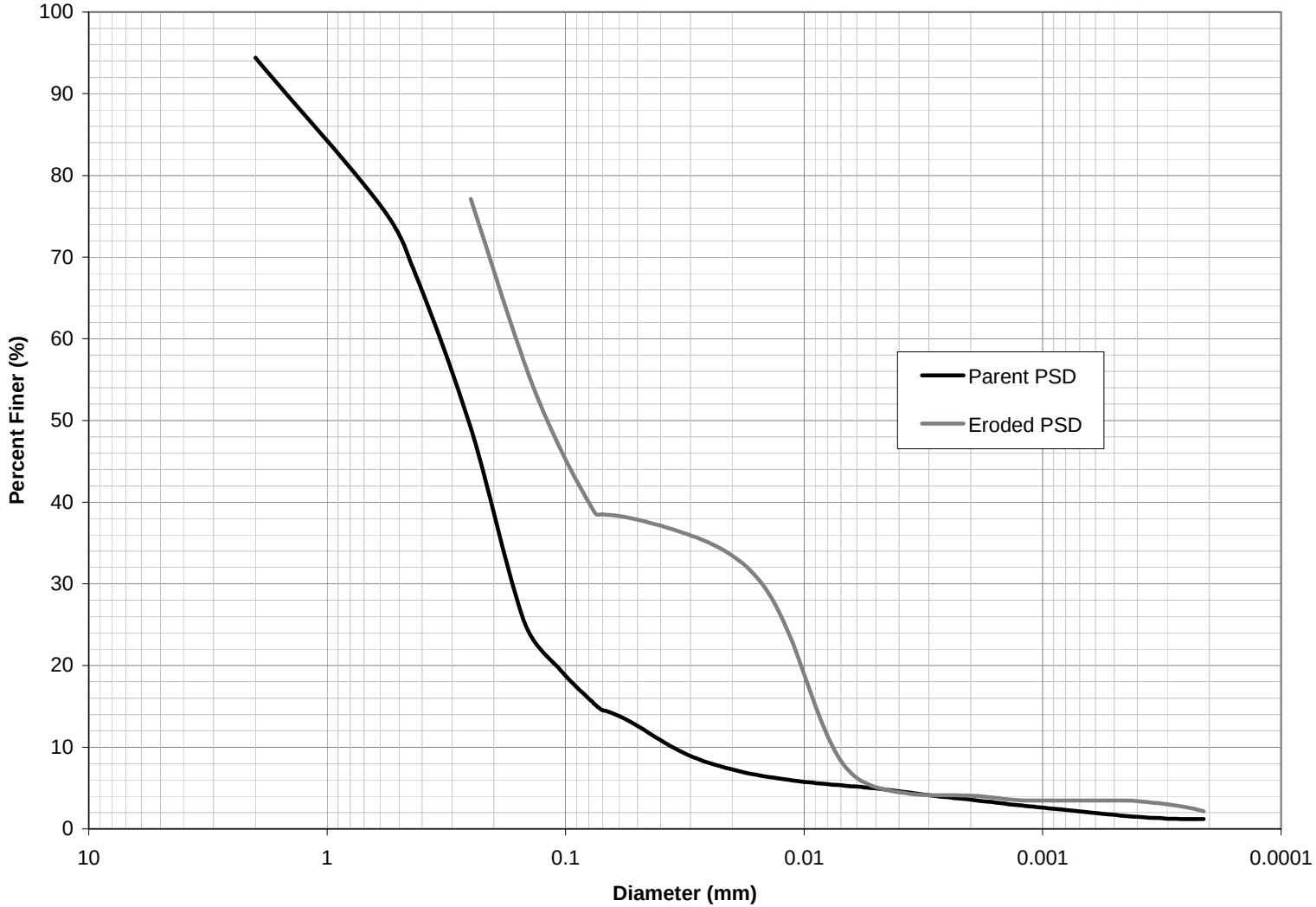


Figure 17: Combined Particle Size Distributions Chart for Sample NMC

4.4 Sample NMD: "Coarse Loamy"

Average total sediment mass yielded during rainfall simulator test: 54.46g
Average mass of EPSD coarser than 0.250 mm: 14.38g

4.4.1 Description

a) Texture: fine sand with silts and fine gravels.
b) Color: light brown.
c) Fine fraction (< 0.075%): 12.687%
d) USDA Textural Classification: SAND

4.4.2 Organic Material Calculation

Organic Material: 1.812%
Percent Silt + Very Fine Sand (0.002 – 0.1 mm): 15.0%
Percent Sand (0.1 – 2 mm): 79.86%

4.4.3 Parent Particle Size Distribution

Table 7: Parent Particle Size Distribution for Sample NMD

Diameter (mm)	Average Percent Finer (%)
2	97.568
0.6	89.006
0.425	82.521
0.25	57.564
0.15	23.865
0.106	17.704
0.075	12.687
0.07079	11.997
0.06683	11.753
0.0631	11.456
0.05957	11.120
0.05623	10.727
0.05309	10.308
0.05012	9.863
0.04732	9.401
0.04467	8.935
0.04217	8.469
0.03981	8.033
0.03758	7.620
0.03548	7.237
0.0335	6.889
0.03162	6.580
0.02985	6.306
0.02818	6.067
0.02661	5.854
0.02512	5.667
0.02371	5.493
0.02239	5.336
0.02113	5.192
0.01995	5.062
0.01884	4.944
0.01778	4.826
0.01679	4.726
0.01585	4.626
0.01496	4.534
0.01413	4.447
0.01334	4.369
0.01259	4.295
0.01189	4.221
0.01122	4.156
0.01059	4.091
0.01	4.043
0.009441	3.991
0.008913	3.948
0.008414	3.913
0.007943	3.878
0.007499	3.847
0.007079	3.816
0.006683	3.790
0.00631	3.759
0.005957	3.729
0.005623	3.690
0.005309	3.646
0.005012	3.598
0.004732	3.546
0.004467	3.481
0.004217	3.411
0.003981	3.342
0.003758	3.263
0.003548	3.190
0.00335	3.107
0.003162	3.037
0.002985	2.967
0.002818	2.906
0.002661	2.854
0.002512	2.810
0.002371	2.771
0.002239	2.731
0.002113	2.697
0.001995	2.662
0.001884	2.622
0.001778	2.570
0.001679	2.518
0.001585	2.452
0.001496	2.391
0.001413	2.322
0.001334	2.248
0.001259	2.183
0.001189	2.122
0.001122	2.061
0.001059	1.999
0.001	1.947
0.000944	1.886
0.000891	1.838
0.000841	1.781
0.000794	1.720
0.00075	1.668
0.000708	1.607
0.000668	1.546
0.000631	1.481
0.000596	1.416
0.000562	1.355
0.000531	1.290
0.000501	1.225
0.000473	1.169
0.000447	1.121
0.000422	1.074
0.000398	1.035
0.000376	0.996
0.000355	0.970
0.000335	0.943
0.000316	0.912
0.000299	0.881
0.000282	0.837
0.000266	0.788
0.000251	0.730

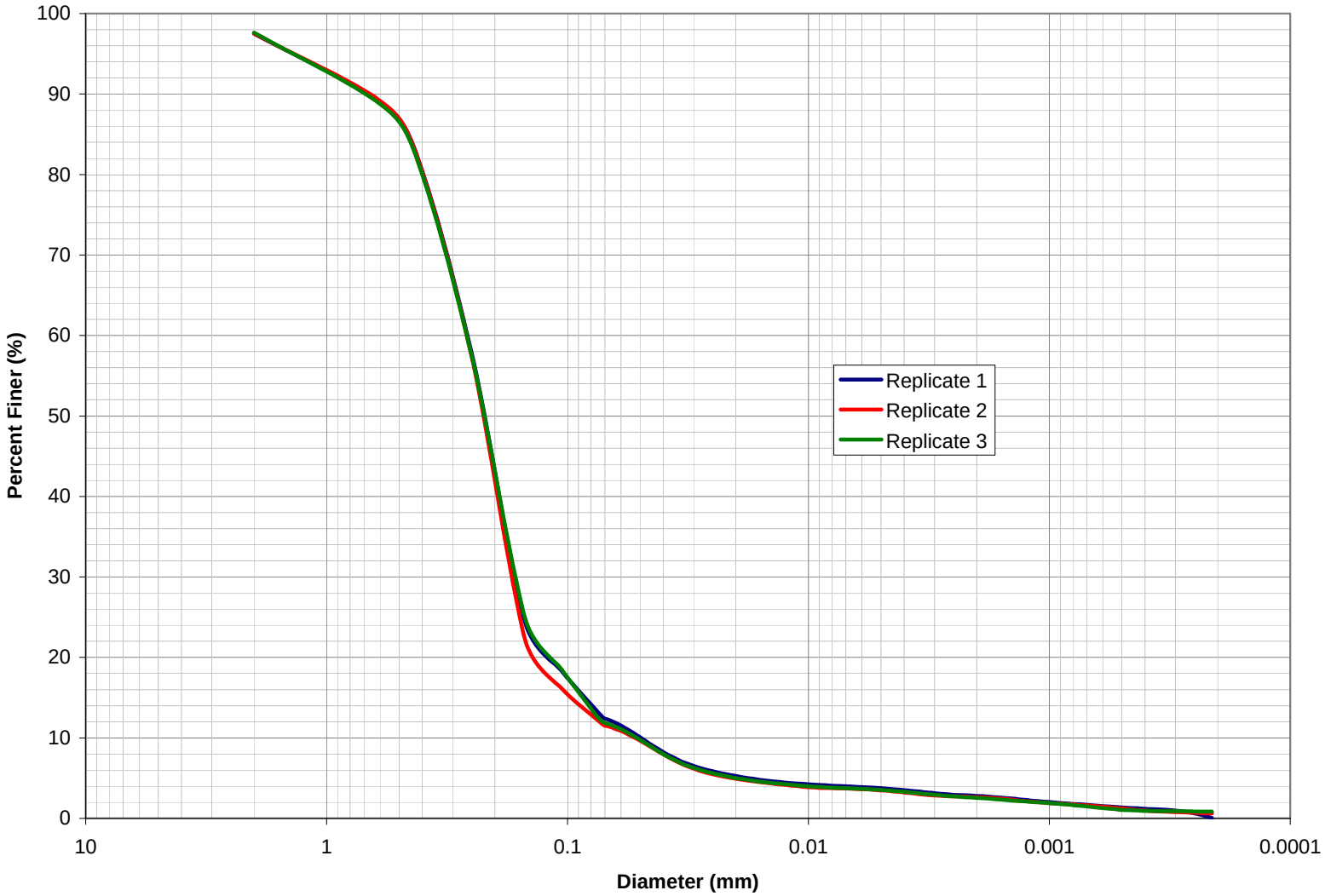


Figure 18: Parent Particle Size Distributions Chart for Sample NMD

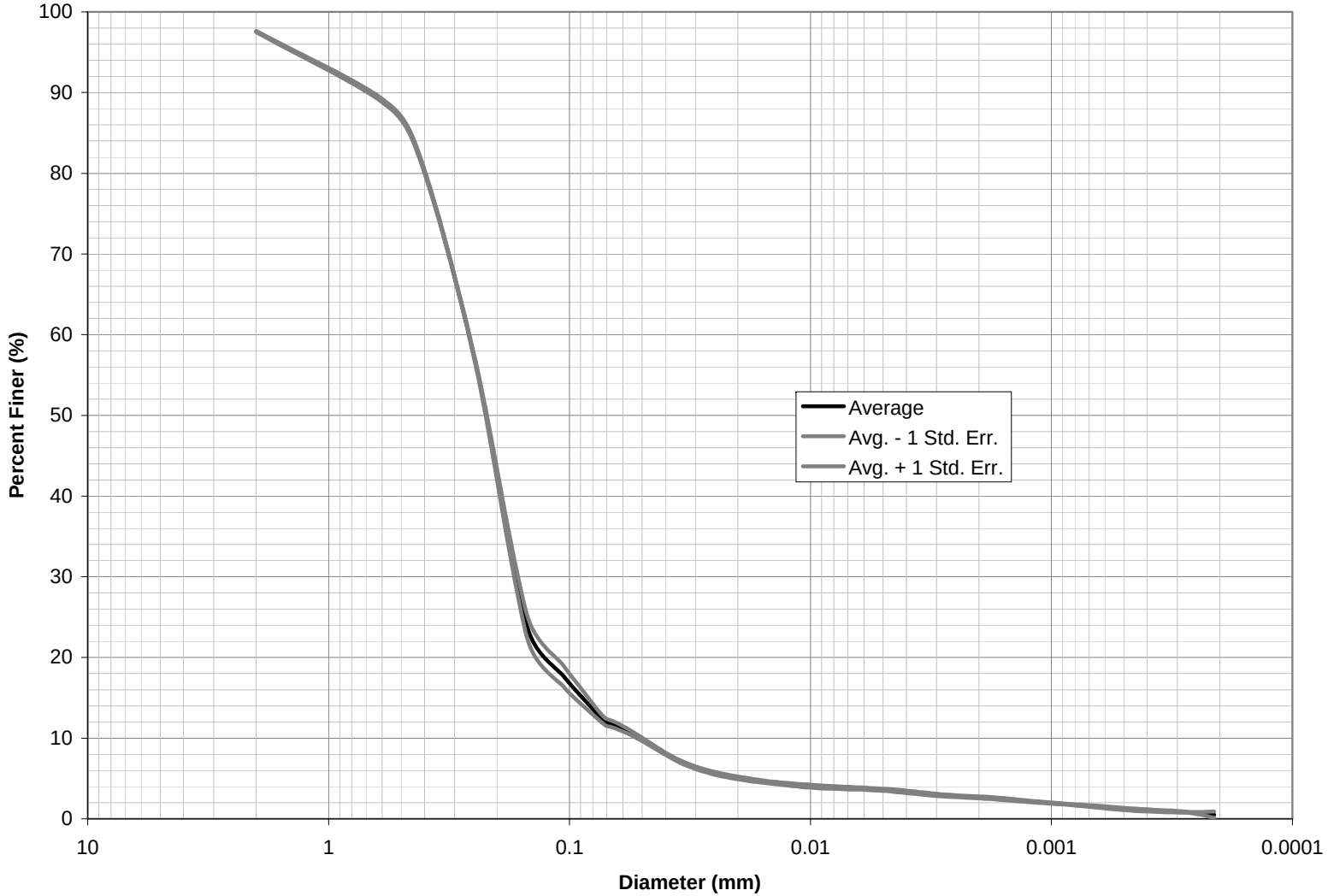


Figure 19: Average Parent Particle Size Distribution Chart for Sample NMD

4.4.4 Eroded Particle Size Distribution

Table 8: Eroded Particle Size Distribution for Sample NMD

Diameter (mm)	Average Percent Finer (%)
0.25	70.762
0.15	45.246
0.106	37.534
0.075	32.679
0.07079	32.669
0.06683	32.659
0.0631	32.640
0.05957	32.621
0.05623	32.582
0.05309	32.534
0.05012	32.467
0.04732	32.390
0.04467	32.289
0.04217	32.166
0.03981	32.052
0.03758	31.928
0.03548	31.818
0.0335	31.694
0.03162	31.608
0.02985	31.508
0.02818	31.421
0.02661	31.325
0.02512	31.215
0.02371	31.100
0.02239	30.980
0.02113	30.837
0.01995	30.684
0.01884	30.532
0.01778	30.365
0.01679	30.165
0.01585	29.955
0.01496	29.727
0.01413	29.455
0.01334	29.141
0.01259	28.765
0.01189	28.318
0.01122	27.808
0.01059	27.171
0.01	26.409
0.009441	25.501
0.008913	24.412
0.008414	23.111
0.007943	21.599
0.007499	19.885
0.007079	17.989
0.006683	15.969
0.00631	13.910
0.005957	11.902
0.005623	10.027
0.005309	8.362
0.005012	6.956
0.004732	5.810
0.004467	4.963
0.004217	4.323
0.003981	3.907
0.003758	3.631
0.003548	3.453
0.00335	3.345
0.003162	3.288
0.002985	3.246
0.002818	3.212
0.002661	3.203
0.002512	3.193
0.002371	3.183
0.002239	3.174
0.002113	3.164
0.001995	3.145
0.001884	3.126
0.001778	3.097
0.001679	3.058
0.001585	3.020
0.001496	2.963
0.001413	2.897
0.001334	2.831
0.001259	2.775
0.001189	2.728
0.001122	2.704
0.001059	2.690
0.001	2.690
0.000944	2.690
0.000891	2.690
0.000841	2.690
0.000794	2.690
0.00075	2.690
0.000708	2.690
0.000668	2.690
0.000631	2.690
0.000596	2.690
0.000562	2.690
0.000531	2.690
0.000501	2.690
0.000473	2.690
0.000447	2.690
0.000422	2.690
0.000398	2.690
0.000376	2.681
0.000355	2.662
0.000335	2.643
0.000316	2.624
0.000299	2.562
0.000282	2.477
0.000266	2.392
0.000251	2.283
0.000237	2.169
0.000224	2.042
0.000211	1.928

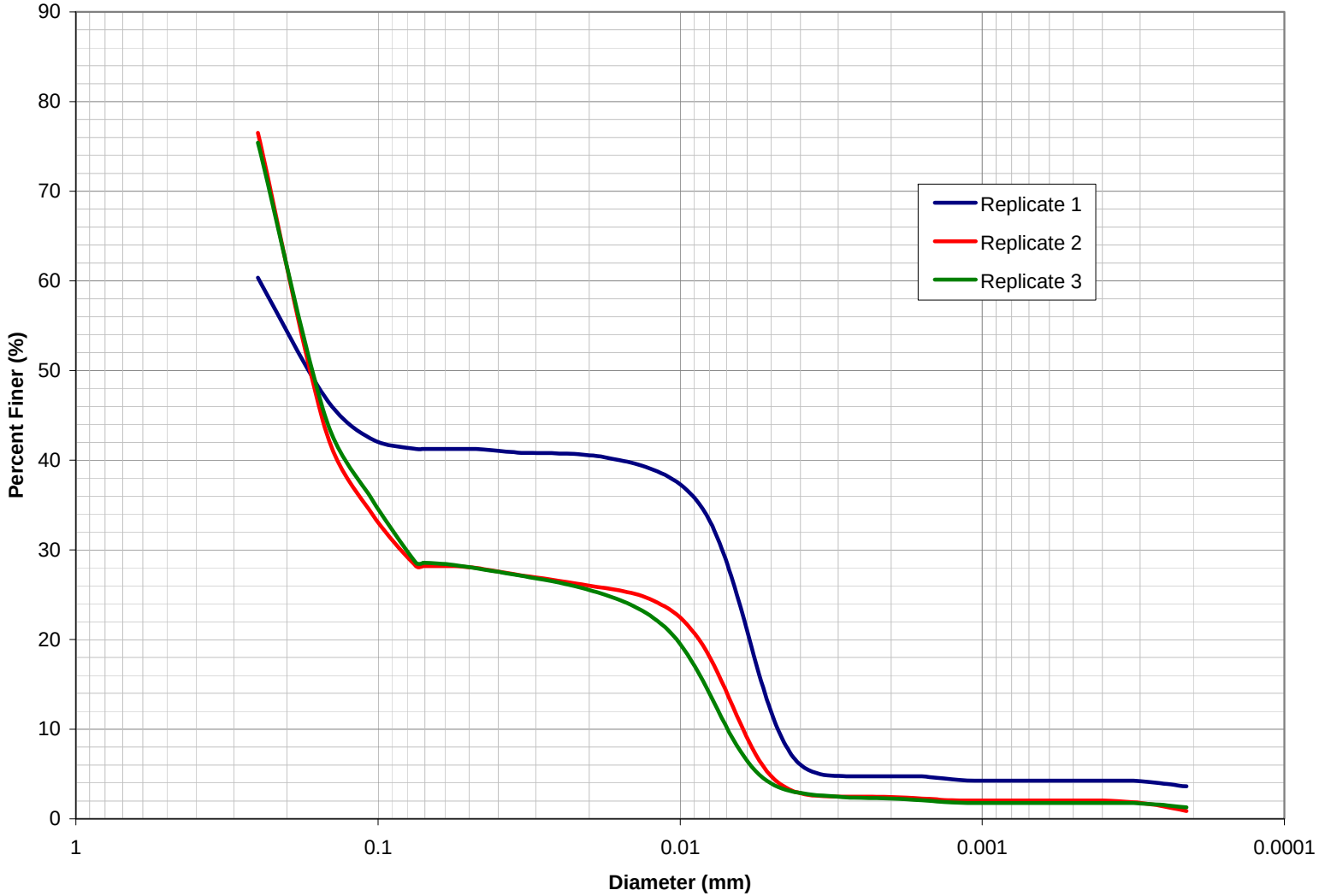


Figure 20: Eroded Particle Size Distributions Chart for Sample NMD

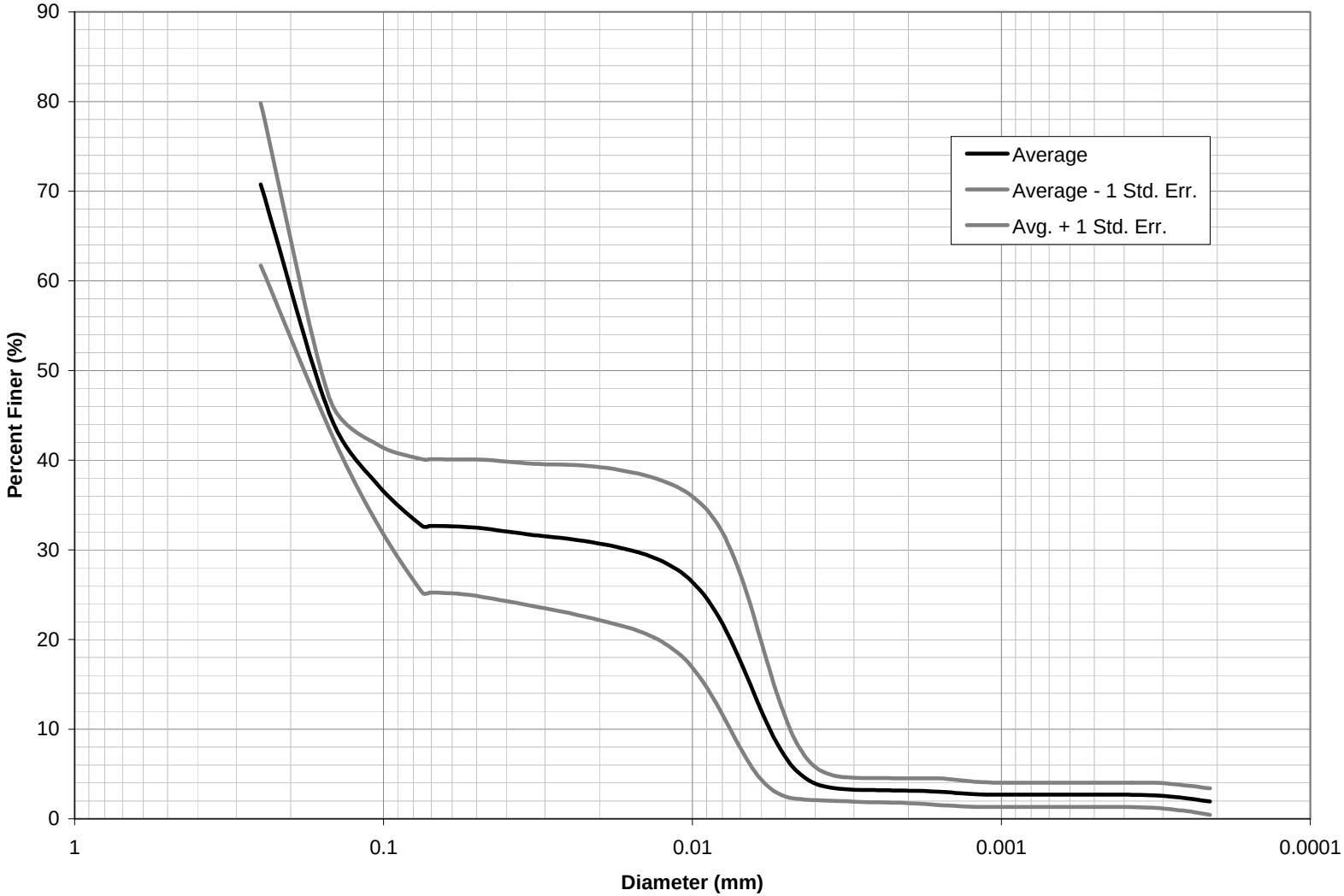


Figure 21: Average Eroded Particle Size Distribution Chart for Sample NMD

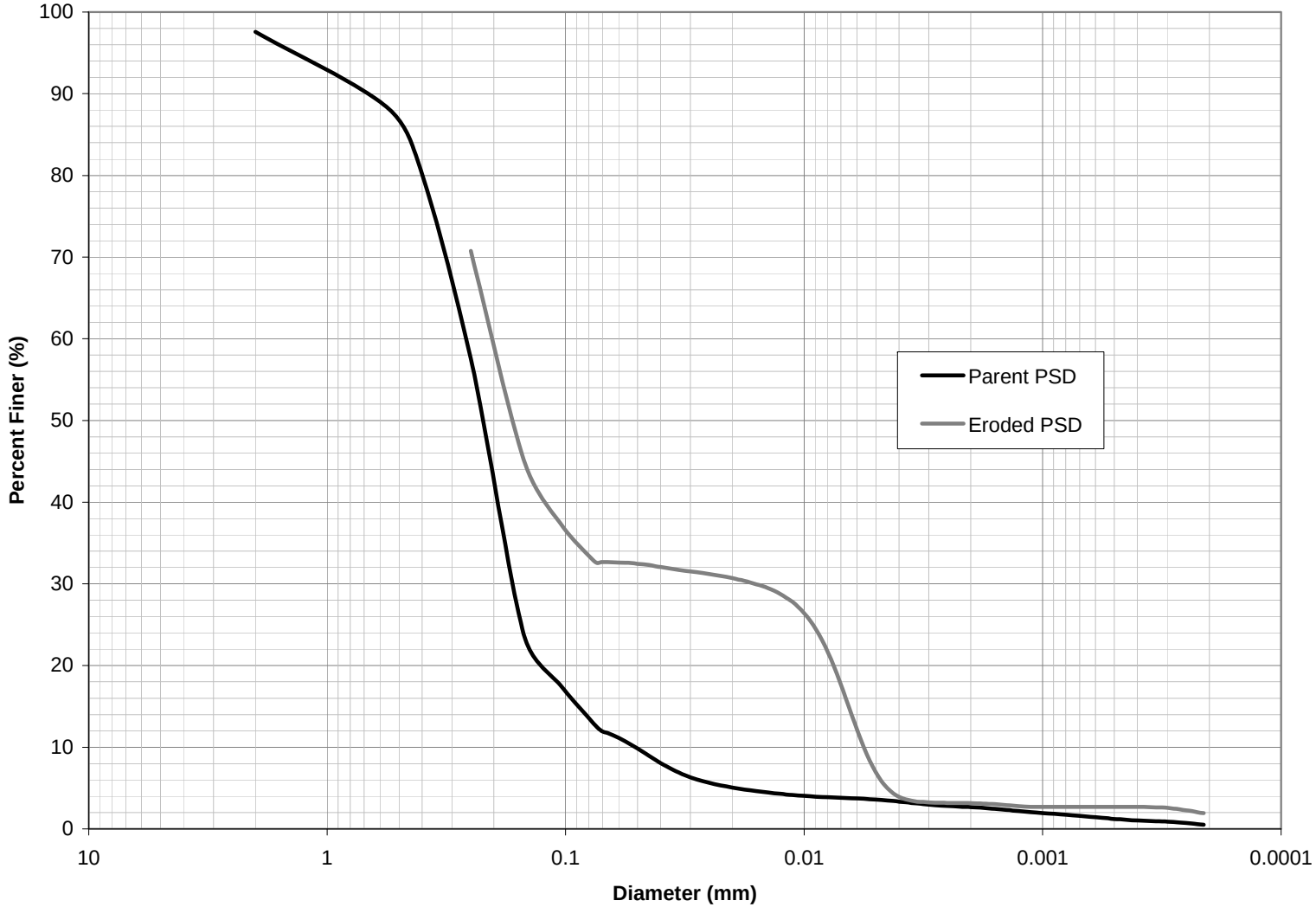


Figure 22: Combined Particle Size Distributions Chart for Sample NMD

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2. Toy, T.J., Foster, G.R. Guidelines for the Use of the Revised Universal Soil Loss Equation (RUSLE) Version 1.06 on Mined Lands, Constructed Sites, and Reclaimed Lands. Office of Surface Mining, 1998.

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APPENDIX A: PHOTOS TAKEN DURING EPSD TESTING

Figure 23: Rainfall Simulator – General View

Figure 24: Rainfall Simulator – Soil Samples

Figure 25: Rainfall Simulator – Soil Samples (details)

Figure 26: Wet Sieve Test

Figure 27: Dry Sieve Test

Attachment 18-B-2

Baseline K-factor Laboratory Determination

January 2008

Inter-Mountain Labs, Inc
1673 Terra Ave, Sheridan, Wyoming, 82801
(307) 672-8945

Soil Analysis Report
BHP Billiton
300 W Arrington, Suite 200
Farmington, NM 87401

Project ID: NMEP Erodibility
Date Received: 1/10/2008

Report ID: S0801141001
Date Reported: 1/30/2008
Work Order: S0801141

Lab ID	Sample ID	Organic Matter %	Sand %	Silt %	Clay %	Very Fine Sand %	Texture	K-factor (t.ac.h/100acft.tf.in)	Structure s	Permeability p	M	Description
S0801141-001	Fine	4.7	39.0	31.0	30.0	9.3	Clay Loam	0.19	3	4	2821.0	OM - Walkley/Black
S0801141-002	Fine Loamy	1.1	53.0	26.0	21.0	12.6	Sandy Clay Loam	0.27	3	4	3049.4	OM - Walkley/Black
S0801141-003	Sandy	0.1	85.0	7.0	8.0	8.1	Loamy Sand	0.10	3	2	1389.2	OM - Walkley/Black
S0801141-004	Coarse Loamy	0.5	70.0	16.0	14.0	15.5	Sandy Loam	0.21	3	2	2709.0	OM - Walkley/Black
S0801141-001	Fine	4.5	39.0	31.0	30.0	9.3	Clay Loam	0.19	3	4	2821.0	OM - Walkley/Black w/o coal
S0801141-002	Fine Loamy	1.0	53.0	26.0	21.0	12.6	Sandy Clay Loam	0.27	3	4	3049.4	OM - Walkley/Black
S0801141-003	Sandy	0.1	85.0	7.0	8.0	8.1	Loamy Sand	0.10	3	2	1389.2	OM - Walkley/Black
S0801141-004	Coarse Loamy	0.5	70.0	16.0	14.0	15.5	Sandy Loam	0.21	3	2	2709.0	OM - Walkley/Black
S0801141-001	Fine	4.7	39.0	31.0	30.0	9.3	Clay Loam	0.19	3	4	2821.0	OM - LOI
S0801141-002	Fine Loamy	1.8	53.0	26.0	21.0	12.6	Sandy Clay Loam	0.26	3	4	3049.4	OM - LOI
S0801141-003	Sandy	0.6	85.0	7.0	8.0	8.1	Loamy Sand	0.10	3	2	1389.2	OM - LOI
S0801141-004	Coarse Loamy	1.2	70.0	16.0	14.0	15.5	Sandy Loam	0.19	3	2	2709.0	OM - LOI
S0801141-001	Fine	3.4	39.0	31.0	30.0	9.3	Clay Loam	0.21	3	4	2821.0	OM - LOI w/o coal
S0801141-002	Fine Loamy	1.6	53.0	26.0	21.0	12.6	Sandy Clay Loam	0.26	3	4	3049.4	OM - LOI
S0801141-003	Sandy	0.5	85.0	7.0	8.0	8.1	Loamy Sand	0.10	3	2	1389.2	OM - LOI
S0801141-004	Coarse Loamy	0.9	70.0	16.0	14.0	15.5	Sandy Loam	0.20	3	2	2709.0	OM - LOI

These Results apply only to the samples tested.

Reviewed by:

Chris Johnston, Soil Scientist

Attachment 18-B-3

Pinabete Arroyo Baseline Hydrology and Sedimentology SEDCAD™ Model Output

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General Information

Storm Information:

Storm Type:	Type II-70
Design Storm:	10 yr - 24 hr
Rainfall Depth:	1.700 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	#2	1.674	0.331	
Null	#2	==>	#5	4.188	0.295	
Null	#3	==>	#4	1.961	0.319	
Null	#4	==>	#5	3.103	0.304	
Null	#5	==>	#6	1.300	0.273	
Null	#6	==>	#7	0.995	0.281	EAST LEASE BNDY
Null	#7	==>	#8	2.793	0.277	
Null	#8	==>	#9	2.630	0.259	WEST LEASE BNDY
Null	#9	==>	End	0.000	0.000	

Structure Routing Details:

Stru #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	8. Large gullies, diversions, and low flowing streams	1.24	250.00	20,136.00	3.34	1.674
#1	**Muskingum K:**					**1.674**
#2	8. Large gullies, diversions, and low flowing streams	0.67	245.00	36,791.00	2.44	4.188
#2	**Muskingum K:**					**4.188**

Stru #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#3	8. Large gullies, diversions, and low flowing streams	0.99	210.00	21,118.00	2.99	1.961
#3	**Muskingum K:**					**1.961**
#4	8. Large gullies, diversions, and low flowing streams	0.77	227.00	29,388.00	2.63	3.103
#4	**Muskingum K:**					**3.103**
#5	8. Large gullies, diversions, and low flowing streams	0.47	45.00	9,601.00	2.05	1.300
#5	**Muskingum K:**					**1.300**
#6	8. Large gullies, diversions, and low flowing streams	0.54	42.00	7,845.00	2.19	0.995
#6	**Muskingum K:**					**0.995**
#7	8. Large gullies, diversions, and low flowing streams	0.49	105.00	21,218.00	2.11	2.793
#7	**Muskingum K:**					**2.793**
#8	8. Large gullies, diversions, and low flowing streams	0.37	64.00	17,238.00	1.82	2.630
#8	**Muskingum K:**					**2.630**

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Particle Size Distribution(s) at Each Structure

Structure #3:

Size (mm)	In/Out
0.4250	100.000%
0.2500	100.000%
0.1500	99.259%
0.0750	91.911%
0.0159	88.676%
0.0100	74.957%
0.0050	29.096%
0.0020	16.176%
0.0010	14.669%
0.0004	13.838%

Structure #4:

Size (mm)	In/Out
0.4250	100.000%
0.2500	100.000%
0.1500	100.000%
0.0750	97.132%
0.0159	92.310%
0.0100	80.309%
0.0050	32.210%
0.0020	18.271%
0.0010	16.676%
0.0004	15.488%

Structure #1:

Size (mm)	In/Out
0.4250	100.000%
0.2500	100.000%
0.1500	100.000%
0.0750	99.764%
0.0159	92.546%

Size (mm)	In/Out
0.0100	78.308%
0.0050	26.859%
0.0020	15.680%
0.0010	14.425%
0.0004	13.154%

Structure #2:

Size (mm)	In/Out
0.4250	100.000%
0.2500	100.000%
0.1500	100.000%
0.0750	100.000%
0.0159	96.270%
0.0100	86.845%
0.0050	31.346%
0.0020	18.868%
0.0010	17.610%
0.0004	15.515%

Structure #5:

Size (mm)	In/Out
0.4250	100.000%
0.2500	100.000%
0.1500	100.000%
0.0750	98.899%
0.0159	97.137%
0.0100	86.893%
0.0050	30.817%
0.0020	18.355%
0.0010	17.054%
0.0004	15.188%

Structure #6 (EAST LEASE BNDY):

Size (mm)	In/Out
0.4250	100.000%
0.2500	100.000%
0.1500	100.000%
0.0750	100.000%
0.0159	100.000%
0.0100	98.333%

Size (mm)	In/Out
0.0050	35.089%
0.0020	20.966%
0.0010	19.497%
0.0004	17.329%

Structure #7:

Size (mm)	In/Out
0.4250	100.000%
0.2500	100.000%
0.1500	100.000%
0.0750	100.000%
0.0159	99.658%
0.0100	99.268%
0.0050	36.673%
0.0020	21.873%
0.0010	20.339%
0.0004	18.093%

Structure #8 (WEST LEASE BNDY):

Size (mm)	In/Out
0.4250	100.000%
0.2500	100.000%
0.1500	99.583%
0.0750	97.493%
0.0159	96.053%
0.0100	93.300%
0.0050	41.006%
0.0020	24.427%
0.0010	22.693%
0.0004	20.240%

Structure #9:

Size (mm)	In/Out
0.4250	100.000%
0.2500	100.000%
0.1500	100.000%
0.0750	97.786%
0.0159	95.993%
0.0100	93.435%
0.0050	41.510%

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Size (mm)	In/Out
0.0020	24.717%
0.0010	22.955%
0.0004	20.486%

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Structure Detail:

Structure #3 (Null)

Structure #4 (Null)

Structure #1 (Null)

Structure #2 (Null)

Structure #5 (Null)

Structure #6 (Null)

EAST LEASE BNDY

Structure #7 (Null)

Structure #8 (Null)

WEST LEASE BNDY

Structure #9 (Null)

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#3	1	791.300	1.145	1.181	0.350	80.800	M	137.26	21.870
	2	1,079.100	0.915	0.596	0.351	80.800	M	223.54	29.835
	3	450.300	0.571	0.319	0.355	81.300	M	138.88	12.992
	4	742.600	0.625	0.000	0.000	78.500	M	162.13	16.799
	5	915.400	1.119	0.000	0.000	78.800	M	131.60	21.280
	Σ	**3,978.700**						**440.83**	**102.777**
#4	1	546.400	0.726	1.710	0.319	81.700	M	147.20	16.285
	2	441.200	0.503	1.429	0.318	86.000	M	224.45	18.445
	3	889.400	0.815	0.998	0.318	82.100	M	228.19	27.379
	4	1,339.100	0.919	0.000	0.000	84.000	M	373.16	47.965
	Σ	**7,194.800**						**603.73**	**212.850**
#1	1	1,242.300	1.349	1.345	0.354	80.800	M	188.55	34.327
	2	1,662.000	1.465	0.849	0.360	80.300	M	224.08	44.015
	3	1,434.000	1.573	1.241	0.357	81.100	M	197.43	40.634
	4	842.700	1.102	0.977	0.364	81.000	M	153.76	23.683
	5	676.100	1.067	1.113	0.365	81.600	M	134.22	19.974
	6	1,223.200	0.778	0.596	0.352	81.800	M	315.94	36.750
	7	743.100	0.745	0.530	0.354	83.600	M	233.83	25.797
	8	654.500	0.801	0.000	0.000	92.200	M	397.48	42.811
	Σ	**8,477.900**						**932.74**	**267.991**
#2	1	609.500	0.668	1.219	0.340	85.700	M	249.70	24.903
	2	537.100	0.610	1.436	0.329	91.600	M	374.99	33.711
	3	455.000	0.546	1.288	0.324	82.000	M	154.39	13.898
	4	627.000	0.634	0.852	0.324	87.900	M	320.25	30.151
	5	653.100	0.452	0.453	0.315	91.200	M	527.57	39.848
	6	957.200	0.984	0.000	0.000	89.600	M	407.82	52.057
	Σ	**12,316.800**						**1,096.38**	**462.559**
#5	1	763.100	0.682	3.507	0.293	84.100	M	267.48	27.555
	2	983.300	1.117	2.231	0.289	89.200	M	367.53	51.945
	3	1,022.000	0.996	1.587	0.291	92.000	M	521.33	65.927
	4	688.700	1.908	1.255	0.291	80.800	M	78.28	19.028
	5	754.300	2.307	1.084	0.287	86.200	M	119.98	31.953
	6	628.400	0.538	0.595	0.301	93.000	M	524.05	43.517
	7	654.500	0.560	0.000	0.000	91.500	M	478.48	40.785
	Σ	**25,005.900**						**1,684.50**	**956.120**
#6	1	901.400	1.151	1.896	0.315	81.100	M	160.40	25.547
	2	1,011.200	1.871	0.166	0.287	83.500	M	151.23	34.801

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
	3	1,166.700	1.126	0.000	0.000	92.800	M	575.99	79.576
	Σ	**28,085.200**						**1,694.12**	**1,096.044**
#7	1	963.500	0.819	0.665	0.285	82.900	M	265.26	31.644
	2	1,513.200	2.587	0.000	0.000	75.000	M	69.93	24.541
	3	194.900	0.596	0.000	0.000	72.600	M	21.05	2.452
	Σ	**30,756.800**						**1,698.39**	**1,154.681**
#8	1	386.400	0.538	2.912	0.280	93.000	M	322.23	26.759
	2	569.700	0.734	2.659	0.279	92.400	M	373.20	37.816
	3	647.700	0.853	2.311	0.280	87.600	M	260.78	30.470
	4	754.800	1.690	2.328	0.277	76.200	M	57.58	13.788
	5	532.600	0.740	1.423	0.277	79.500	M	113.85	13.178
	6	309.700	0.436	1.168	0.285	85.600	M	166.21	12.570
	7	158.300	0.448	0.938	0.279	83.800	M	71.65	5.586
	8	304.300	0.648	0.566	0.296	80.600	M	80.17	8.278
	9	211.900	0.480	0.921	0.320	83.000	M	85.52	7.027
	10	711.200	0.890	0.436	0.300	83.300	M	190.68	24.108
	11	168.200	0.283	0.000	0.000	83.300	M	92.56	5.727
	Σ	**35,511.600**						**1,701.48**	**1,339.988**
#9	1	466.200	0.574	2.401	0.265	89.000	M	277.79	24.314
	2	427.200	0.633	2.204	0.256	84.900	M	169.55	16.405
	3	361.200	0.686	1.864	0.256	84.900	M	135.39	13.872
	4	573.300	0.655	0.983	0.255	85.800	M	240.22	23.605
	5	473.100	0.668	0.000	0.000	84.600	M	176.01	17.771
	Σ	**37,812.600**						**1,693.81**	**1,435.955**

Subwatershed Sedimentology Detail:

Stru #	SWS #	Soil K	L (ft)	S (%)	C	P	PS #	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc (ml/l)	24VW (ml/l)
#3	1	0.150	100.00	9.10	0.3050	1.0000	18	517.9	28,671	8.11	4.88
	2	0.181	100.00	10.10	0.3050	1.0000	13	1,178.3	48,541	17.28	10.19
	3	0.151	200.00	5.50	0.3050	1.0000	18	316.4	31,264	13.05	7.40
	4	0.183	130.00	7.60	0.3160	1.0000	12	550.1	42,933	16.42	9.09
	5	0.185	100.00	8.30	0.2760	1.0000	6	481.0	28,197	6.04	3.53
	Σ							**2,338.6**	**27,282**	**6.12**	**3.73**
#4	1	0.173	130.00	7.00	0.2850	1.0000	7	403.2	30,444	11.52	6.82
	2	0.148	100.00	12.00	0.2220	1.0000	5	682.7	44,554	17.59	10.60
	3	0.185	75.00	13.60	0.2740	1.0000	17	1,316.9	58,425	20.84	12.39

Stru #	SWS #	Soil K	L (ft)	S (%)	C	P	PS #	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc (ml/l)	24VW (ml/l)
	4	0.213	100.00	10.60	0.2330	1.0000	6	1,973.6	49,931	15.56	9.28
	Σ							**4,860.9**	**43,257**	**7.92**	**3.05**
#1	1	0.220	280.00	2.20	0.2960	1.0000	13	354.5	12,409	3.41	2.08
	2	0.202	240.00	3.30	0.2960	1.0000	13	568.5	15,494	3.87	2.36
	3	0.206	280.00	2.60	0.2960	1.0000	13	434.9	12,696	3.05	1.90
	4	0.188	200.00	5.10	0.2960	1.0000	13	527.8	27,112	8.72	5.22
	5	0.124	240.00	3.60	0.3130	1.0000	18	192.8	11,797	3.62	2.17
	6	0.178	130.00	7.90	0.2850	1.0000	7	1,127.3	38,034	13.98	8.19
	7	0.191	100.00	9.20	0.2540	1.0000	6	825.2	39,345	13.70	8.09
	8	0.199	75.00	15.10	0.1510	1.0000	2	1,562.1	42,372	11.59	7.24
	Σ							**4,565.8**	**34,225**	**6.95**	**2.52**
#2	1	0.188	130.00	7.30	0.2120	1.0000	5	578.5	28,165	9.86	5.93
	2	0.199	75.00	12.60	0.1510	1.0000	2	1,048.1	36,015	11.47	7.19
	3	0.200	100.00	8.60	0.2020	1.0000	11	346.9	31,127	9.19	5.37
	4	0.193	75.00	12.30	0.1730	1.0000	4	970.3	38,511	12.11	7.35
	5	0.187	75.00	14.00	0.1590	1.0000	3	1,581.0	46,771	17.49	10.75
	6	0.198	75.00	13.70	0.1680	1.0000	4	1,730.8	38,951	9.35	5.80
	Σ							**7,497.7**	**34,701**	**4.87**	**1.66**
#5	1	0.213	130.00	6.30	0.2330	1.0000	6	688.3	29,563	10.84	6.67
	2	0.209	130.00	7.10	0.1680	1.0000	4	930.8	20,627	4.23	2.68
	3	0.191	100.00	8.40	0.1500	1.0000	2	1,120.2	19,452	4.36	2.78
	4	0.235	200.00	4.90	0.2870	1.0000	9	373.4	22,778	4.39	2.78
	5	0.220	240.00	3.70	0.1900	1.0000	16	260.3	9,212	0.56	0.37
	6	0.200	130.00	7.30	0.1410	1.0000	1	847.6	22,769	7.65	4.77
	7	0.204	200.00	4.70	0.1560	1.0000	2	714.9	20,930	6.93	4.24
	Σ							**16,003.7**	**27,738**	**3.87**	**1.72**
#6	1	0.228	280.00	2.70	0.2870	1.0000	9	331.5	15,627	4.99	3.03
	2	0.226	280.00	2.40	0.2330	1.0000	6	276.0	9,268	1.14	0.72
	3	0.200	200.00	4.20	0.1460	1.0000	1	952.6	13,808	2.56	1.63
	Σ							**15,104.2**	**23,367**	**1.56**	**0.68**
#7	1	0.197	280.00	2.70	0.2330	1.0000	5	347.3	13,550	3.91	2.32
	2	0.204	420.00	1.80	0.3270	1.0000	19	163.4	7,759	0.31	0.20
	3	0.171	280.00	2.40	0.3380	1.0000	10	22.7	13,087	3.58	1.86
	Σ							**14,905.2**	**22,598**	**1.37**	**0.58**
#8	1	0.200	280.00	2.70	0.1410	1.0000	1	216.6	9,168	3.08	1.99
	2	0.204	280.00	2.30	0.1550	1.0000	3	277.0	8,371	2.60	1.67
	3	0.173	280.00	3.00	0.2220	1.0000	6	310.3	11,965	4.25	2.65
	4	0.204	280.00	3.00	0.3180	1.0000	19	144.3	12,459	1.51	0.93
	5	0.187	200.00	5.90	0.2960	1.0000	12	366.8	34,625	12.51	7.31

Stru #	SWS #	Soil K	L (ft)	S (%)	C	P	PS #	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc (ml/l)	24VW (ml/l)
	6	0.167	200.00	4.20	0.2740	1.0000	8	264.4	25,618	12.49	7.48
	7	0.215	100.00	9.40	0.2650	1.0000	20	219.1	48,298	23.28	13.69
	8	0.201	100.00	8.10	0.2960	1.0000	13	240.3	36,721	15.14	8.70
	9	0.208	280.00	2.70	0.2120	1.0000	15	76.1	13,686	5.07	2.94
	10	0.225	200.00	4.50	0.2540	1.0000	14	548.6	27,795	10.17	6.07
	11	0.198	100.00	9.20	0.2450	1.0000	6	210.9	47,825	22.37	12.48
	Σ							**14,698.1**	**47,845**	**4.55**	**0.79**
#9	1	0.206	130.00	7.80	0.1800	1.0000	16	600.7	28,616	11.28	7.10
	2	0.189	100.00	11.10	0.2450	1.0000	6	692.7	49,867	19.18	11.75
	3	0.177	100.00	8.30	0.2330	1.0000	6	310.5	26,790	9.96	6.07
	4	0.161	100.00	10.00	0.2220	1.0000	5	664.6	33,921	12.01	7.25
	5	0.175	200.00	5.90	0.2450	1.0000	6	428.6	29,984	11.21	6.57
	Σ							**15,678.9**	**32,341**	**3.04**	**0.79**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	2.99	22.00	736.00	1.720	0.118
		8. Large gullies, diversions, and low flowing streams	0.63	66.00	10,511.00	2.370	1.231
#1	**1**	**Time of Concentration:**					**1.349**
#1	2	5. Nearly bare and untilled, and alluvial valley fans	1.02	8.00	785.00	1.000	0.218
		8. Large gullies, diversions, and low flowing streams	1.48	242.00	16,353.00	3.640	1.247
#1	**2**	**Time of Concentration:**					**1.465**
#1	3	5. Nearly bare and untilled, and alluvial valley fans	0.88	10.00	1,136.10	0.930	0.339
		8. Large gullies, diversions, and low flowing streams	1.31	200.00	15,244.00	3.430	1.234
#1	**3**	**Time of Concentration:**					**1.573**
#1	4	5. Nearly bare and untilled, and alluvial valley fans	1.85	10.00	542.00	1.350	0.111
		8. Large gullies, diversions, and low flowing streams	1.62	220.00	13,595.00	3.810	0.991
#1	**4**	**Time of Concentration:**					**1.102**
#1	5	5. Nearly bare and untilled, and alluvial valley fans	1.23	10.00	812.00	1.100	0.205
		8. Large gullies, diversions, and low flowing streams	1.41	156.00	11,049.00	3.560	0.862
#1	**5**	**Time of Concentration:**					**1.067**
#1	6	5. Nearly bare and untilled, and alluvial valley fans	3.12	22.00	706.00	1.760	0.111

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
		8. Large gullies, diversions, and low flowing streams	2.85	346.00	12,152.00	5.060	0.667
#1	**6**	**Time of Concentration:**					**0.778**
#1	7	5. Nearly bare and untilled, and alluvial valley fans	4.66	43.00	922.01	2.150	0.119
		8. Large gullies, diversions, and low flowing streams	2.67	295.00	11,057.38	4.900	0.626
#1	**7**	**Time of Concentration:**					**0.745**
#1	8	5. Nearly bare and untilled, and alluvial valley fans	7.46	65.00	871.00	2.730	0.088
		8. Large gullies, diversions, and low flowing streams	2.61	324.00	12,433.00	4.840	0.713
#1	**8**	**Time of Concentration:**					**0.801**
#2	1	5. Nearly bare and untilled, and alluvial valley fans	6.24	30.00	481.00	2.490	0.053
		8. Large gullies, diversions, and low flowing streams	3.34	406.00	12,141.00	5.480	0.615
#2	**1**	**Time of Concentration:**					**0.668**
#2	2	5. Nearly bare and untilled, and alluvial valley fans	3.16	30.00	950.00	1.770	0.149
		8. Large gullies, diversions, and low flowing streams	4.22	432.00	10,229.00	6.160	0.461
#2	**2**	**Time of Concentration:**					**0.610**
#2	3	5. Nearly bare and untilled, and alluvial valley fans	2.65	10.00	378.00	1.620	0.064
		8. Large gullies, diversions, and low flowing streams	2.72	234.00	8,592.00	4.950	0.482
#2	**3**	**Time of Concentration:**					**0.546**
#2	4	5. Nearly bare and untilled, and alluvial valley fans	3.07	25.00	815.00	1.750	0.129
		8. Large gullies, diversions, and low flowing streams	3.32	330.00	9,931.00	5.460	0.505
#2	**4**	**Time of Concentration:**					**0.634**
#2	5	5. Nearly bare and untilled, and alluvial valley fans	7.45	45.00	604.00	2.720	0.061
		8. Large gullies, diversions, and low flowing streams	3.78	310.00	8,210.00	5.820	0.391
#2	**5**	**Time of Concentration:**					**0.452**
#2	6	5. Nearly bare and untilled, and alluvial valley fans	9.10	80.00	879.00	3.010	0.081
		8. Large gullies, diversions, and low flowing streams	2.32	344.00	14,831.00	4.560	0.903
#2	**6**	**Time of Concentration:**					**0.984**
#3	1	5. Nearly bare and untilled, and alluvial valley fans	1.29	15.00	1,163.00	1.130	0.285
		8. Large gullies, diversions, and low flowing streams	2.37	338.00	14,280.00	4.610	0.860
#3	**1**	**Time of Concentration:**					**1.145**
#3	2	5. Nearly bare and untilled, and alluvial valley fans	3.04	33.00	1,087.00	1.740	0.173

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
		8. Large gullies, diversions, and low flowing streams	2.06	238.00	11,527.00	4.310	0.742
#3	**2**	**Time of Concentration:**					**0.915**
#3	3	5. Nearly bare and untilled, and alluvial valley fans	5.02	45.00	897.00	2.230	0.111
		8. Large gullies, diversions, and low flowing streams	3.09	270.00	8,741.00	5.270	0.460
#3	**3**	**Time of Concentration:**					**0.571**
#3	4	5. Nearly bare and untilled, and alluvial valley fans	7.41	28.00	378.00	2.720	0.038
		8. Large gullies, diversions, and low flowing streams	3.43	402.00	11,736.00	5.550	0.587
#3	**4**	**Time of Concentration:**					**0.625**
#3	5	5. Nearly bare and untilled, and alluvial valley fans	3.39	30.00	885.00	1.840	0.133
		8. Large gullies, diversions, and low flowing streams	2.58	442.00	17,121.00	4.820	0.986
#3	**5**	**Time of Concentration:**					**1.119**
#4	1	5. Nearly bare and untilled, and alluvial valley fans	3.59	62.00	1,729.00	1.890	0.254
		8. Large gullies, diversions, and low flowing streams	2.09	154.00	7,372.00	4.330	0.472
#4	**1**	**Time of Concentration:**					**0.726**
#4	2	5. Nearly bare and untilled, and alluvial valley fans	6.83	25.00	366.00	2.610	0.038
		8. Large gullies, diversions, and low flowing streams	2.36	182.00	7,708.00	4.600	0.465
#4	**2**	**Time of Concentration:**					**0.503**
#4	3	5. Nearly bare and untilled, and alluvial valley fans	19.03	47.00	247.00	4.360	0.015
		8. Large gullies, diversions, and low flowing streams	2.13	268.00	12,586.00	4.370	0.800
#4	**3**	**Time of Concentration:**					**0.815**
#4	4	5. Nearly bare and untilled, and alluvial valley fans	14.08	50.00	355.00	3.750	0.026
		8. Large gullies, diversions, and low flowing streams	2.46	372.00	15,119.00	4.700	0.893
#4	**4**	**Time of Concentration:**					**0.919**
#5	1	5. Nearly bare and untilled, and alluvial valley fans	12.55	65.00	518.00	3.540	0.040
		8. Large gullies, diversions, and low flowing streams	1.92	184.00	9,592.00	4.150	0.642
#5	**1**	**Time of Concentration:**					**0.682**
#5	2	5. Nearly bare and untilled, and alluvial valley fans	5.10	30.00	588.00	2.250	0.072
		8. Large gullies, diversions, and low flowing streams	1.77	266.00	15,016.00	3.990	1.045
#5	**2**	**Time of Concentration:**					**1.117**
#5	3	5. Nearly bare and untilled, and alluvial valley fans	1.90	20.00	1,050.00	1.380	0.211

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
		8. Large gullies, diversions, and low flowing streams	2.19	274.00	12,532.00	4.430	0.785
#5	**3**	**Time of Concentration:**					**0.996**
#5	4	5. Nearly bare and untilled, and alluvial valley fans	2.78	32.00	1,152.00	1.660	0.192
		8. Large gullies, diversions, and low flowing streams	0.99	182.00	18,415.00	2.980	1.716
#5	**4**	**Time of Concentration:**					**1.908**
#5	5	5. Nearly bare and untilled, and alluvial valley fans	2.52	23.00	911.00	1.580	0.160
		8. Large gullies, diversions, and low flowing streams	1.07	256.00	23,965.00	3.100	2.147
#5	**5**	**Time of Concentration:**					**2.307**
#5	6	5. Nearly bare and untilled, and alluvial valley fans	6.36	25.00	393.00	2.520	0.043
		8. Large gullies, diversions, and low flowing streams	2.39	198.00	8,272.00	4.640	0.495
#5	**6**	**Time of Concentration:**					**0.538**
#5	7	5. Nearly bare and untilled, and alluvial valley fans	9.66	28.00	290.00	3.100	0.025
		8. Large gullies, diversions, and low flowing streams	2.12	179.00	8,427.00	4.370	0.535
#5	**7**	**Time of Concentration:**					**0.560**
#6	1	5. Nearly bare and untilled, and alluvial valley fans	31.83	120.00	377.00	5.640	0.018
		8. Large gullies, diversions, and low flowing streams	1.38	198.00	14,361.00	3.520	1.133
#6	**1**	**Time of Concentration:**					**1.151**
#6	2	5. Nearly bare and untilled, and alluvial valley fans	4.25	40.00	941.00	2.060	0.126
		8. Large gullies, diversions, and low flowing streams	0.96	176.00	18,407.00	2.930	1.745
#6	**2**	**Time of Concentration:**					**1.871**
#6	3	5. Nearly bare and untilled, and alluvial valley fans	4.35	25.00	575.00	2.080	0.076
		8. Large gullies, diversions, and low flowing streams	1.57	224.00	14,223.00	3.760	1.050
#6	**3**	**Time of Concentration:**					**1.126**
#7	1	5. Nearly bare and untilled, and alluvial valley fans	2.51	10.00	399.00	1.580	0.070
		8. Large gullies, diversions, and low flowing streams	1.11	95.00	8,524.00	3.160	0.749
#7	**1**	**Time of Concentration:**					**0.819**
#7	3	5. Nearly bare and untilled, and alluvial valley fans	2.14	14.00	655.00	1.460	0.124
		8. Large gullies, diversions, and low flowing streams	1.07	56.00	5,255.00	3.090	0.472
#7	**3**	**Time of Concentration:**					**0.596**
#8	1	5. Nearly bare and untilled, and alluvial valley fans	1.97	5.00	254.00	1.400	0.050

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
		8. Large gullies, diversions, and low flowing streams	1.64	111.00	6,755.00	3.840	0.488
#8	**1**	**Time of Concentration:**					**0.538**
#8	2	5. Nearly bare and untilled, and alluvial valley fans	2.49	8.00	321.00	1.570	0.056
		8. Large gullies, diversions, and low flowing streams	1.16	91.00	7,866.00	3.220	0.678
#8	**2**	**Time of Concentration:**					**0.734**
#8	3	5. Nearly bare and untilled, and alluvial valley fans	3.58	25.00	698.00	1.890	0.102
		8. Large gullies, diversions, and low flowing streams	1.12	96.00	8,579.00	3.170	0.751
#8	**3**	**Time of Concentration:**					**0.853**
#8	4	5. Nearly bare and untilled, and alluvial valley fans	0.85	10.00	1,181.00	0.920	0.356
		8. Large gullies, diversions, and low flowing streams	0.90	123.00	13,645.00	2.840	1.334
#8	**4**	**Time of Concentration:**					**1.690**
#8	5	5. Nearly bare and untilled, and alluvial valley fans	6.53	39.00	597.00	2.550	0.065
		8. Large gullies, diversions, and low flowing streams	1.42	123.00	8,678.00	3.570	0.675
#8	**5**	**Time of Concentration:**					**0.740**
#8	6	5. Nearly bare and untilled, and alluvial valley fans	1.45	5.00	344.00	1.200	0.079
		8. Large gullies, diversions, and low flowing streams	2.21	127.00	5,746.00	4.460	0.357
#8	**6**	**Time of Concentration:**					**0.436**
#8	7	5. Nearly bare and untilled, and alluvial valley fans	2.98	12.00	403.00	1.720	0.065
		8. Large gullies, diversions, and low flowing streams	1.97	114.00	5,796.00	4.200	0.383
#8	**7**	**Time of Concentration:**					**0.448**
#8	8	5. Nearly bare and untilled, and alluvial valley fans	20.11	105.00	522.00	4.480	0.032
		8. Large gullies, diversions, and low flowing streams	1.77	157.00	8,849.00	3.990	0.616
#8	**8**	**Time of Concentration:**					**0.648**
#8	9	5. Nearly bare and untilled, and alluvial valley fans	43.35	75.00	173.00	6.580	0.007
		8. Large gullies, diversions, and low flowing streams	1.57	100.00	6,387.00	3.750	0.473
#8	**9**	**Time of Concentration:**					**0.480**
#8	10	5. Nearly bare and untilled, and alluvial valley fans	1.85	40.00	2,159.00	1.360	0.440
		8. Large gullies, diversions, and low flowing streams	1.53	92.00	6,011.00	3.710	0.450
#8	**10**	**Time of Concentration:**					**0.890**
#8	11	5. Nearly bare and untilled, and alluvial valley fans	4.84	24.00	496.00	2.190	0.062

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
		8. Large gullies, diversions, and low flowing streams	2.79	111.00	3,980.20	5.000	0.221
#8	**11**	**Time of Concentration:**					**0.283**
#9	1	5. Nearly bare and untilled, and alluvial valley fans	7.42	25.00	337.00	2.720	0.034
		8. Large gullies, diversions, and low flowing streams	1.50	107.00	7,136.00	3.670	0.540
#9	**1**	**Time of Concentration:**					**0.574**
#9	2	5. Nearly bare and untilled, and alluvial valley fans	11.19	15.00	134.00	3.340	0.011
		8. Large gullies, diversions, and low flowing streams	1.96	184.00	9,391.00	4.190	0.622
#9	**2**	**Time of Concentration:**					**0.633**
#9	3	5. Nearly bare and untilled, and alluvial valley fans	3.14	25.00	796.00	1.770	0.124
		8. Large gullies, diversions, and low flowing streams	1.68	132.00	7,862.00	3.880	0.562
#9	**3**	**Time of Concentration:**					**0.686**
#9	4	5. Nearly bare and untilled, and alluvial valley fans	12.82	35.00	273.00	3.580	0.021
		8. Large gullies, diversions, and low flowing streams	1.93	183.00	9,495.00	4.160	0.634
#9	**4**	**Time of Concentration:**					**0.655**
#9	5	5. Nearly bare and untilled, and alluvial valley fans	2.66	15.00	564.00	1.630	0.096
		8. Large gullies, diversions, and low flowing streams	1.68	135.00	8,020.00	3.890	0.572
#9	**5**	**Time of Concentration:**					**0.668**

Subwatershed Muskingum Routing Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	8. Large gullies, diversions, and low flowing streams	1.89	378.00	19,958.00	4.120	1.345
#1	**1**	**Muskingum K:**					**1.345**
#1	2	8. Large gullies, diversions, and low flowing streams	2.11	282.00	13,337.00	4.360	0.849
#1	**2**	**Muskingum K:**					**0.849**
#1	3	8. Large gullies, diversions, and low flowing streams	2.02	384.00	19,036.00	4.260	1.241
#1	**3**	**Muskingum K:**					**1.241**
#1	4	8. Large gullies, diversions, and low flowing streams	2.28	364.00	15,948.82	4.530	0.977
#1	**4**	**Muskingum K:**					**0.977**
#1	5	8. Large gullies, diversions, and low flowing streams	2.33	428.00	18,360.00	4.580	1.113
#1	**5**	**Muskingum K:**					**1.113**

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	6	8. Large gullies, diversions, and low flowing streams	1.82	158.00	8,675.00	4.040	0.596
#1	**6**	**Muskingum K:**					**0.596**
#1	7	8. Large gullies, diversions, and low flowing streams	1.89	149.00	7,868.00	4.120	0.530
#1	**7**	**Muskingum K:**					**0.530**
#2	1	8. Large gullies, diversions, and low flowing streams	1.44	228.00	15,800.00	3.600	1.219
#2	**1**	**Muskingum K:**					**1.219**
#2	2	8. Large gullies, diversions, and low flowing streams	1.19	202.00	16,912.00	3.270	1.436
#2	**2**	**Muskingum K:**					**1.436**
#2	3	8. Large gullies, diversions, and low flowing streams	1.10	160.00	14,568.00	3.140	1.288
#2	**3**	**Muskingum K:**					**1.288**
#2	4	8. Large gullies, diversions, and low flowing streams	1.09	104.00	9,576.00	3.120	0.852
#2	**4**	**Muskingum K:**					**0.852**
#2	5	8. Large gullies, diversions, and low flowing streams	0.93	44.00	4,715.00	2.890	0.453
#2	**5**	**Muskingum K:**					**0.453**
#3	1	8. Large gullies, diversions, and low flowing streams	1.75	294.00	16,845.00	3.960	1.181
#3	**1**	**Muskingum K:**					**1.181**
#3	2	8. Large gullies, diversions, and low flowing streams	1.79	154.00	8,609.00	4.010	0.596
#3	**2**	**Muskingum K:**					**0.596**
#3	3	8. Large gullies, diversions, and low flowing streams	1.93	92.00	4,778.00	4.160	0.319
#3	**3**	**Muskingum K:**					**0.319**
#4	1	8. Large gullies, diversions, and low flowing streams	1.01	186.00	18,477.00	3.000	1.710
#4	**1**	**Muskingum K:**					**1.710**
#4	2	8. Large gullies, diversions, and low flowing streams	0.98	150.00	15,281.00	2.970	1.429
#4	**2**	**Muskingum K:**					**1.429**
#4	3	8. Large gullies, diversions, and low flowing streams	0.98	104.00	10,645.00	2.960	0.998
#4	**3**	**Muskingum K:**					**0.998**
#5	1	8. Large gullies, diversions, and low flowing streams	0.64	195.00	30,309.00	2.400	3.507
#5	**1**	**Muskingum K:**					**3.507**
#5	2	8. Large gullies, diversions, and low flowing streams	0.60	113.00	18,717.00	2.330	2.231
#5	**2**	**Muskingum K:**					**2.231**
#5	3	8. Large gullies, diversions, and low flowing streams	0.63	85.00	13,541.00	2.370	1.587
#5	**3**	**Muskingum K:**					**1.587**
#5	4	8. Large gullies, diversions, and low flowing streams	0.63	67.00	10,710.00	2.370	1.255

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#5	**4**	**Muskingum K:**					**1.255**
#5	5	8. Large gullies, diversions, and low flowing streams	0.59	53.00	8,978.00	2.300	1.084
#5	**5**	**Muskingum K:**					**1.084**
#5	6	8. Large gullies, diversions, and low flowing streams	0.74	41.00	5,528.00	2.580	0.595
#5	**6**	**Muskingum K:**					**0.595**
#6	1	8. Large gullies, diversions, and low flowing streams	0.94	186.00	19,797.00	2.900	1.896
#6	**1**	**Muskingum K:**					**1.896**
#6	2	8. Large gullies, diversions, and low flowing streams	0.58	8.00	1,372.00	2.290	0.166
#6	**2**	**Muskingum K:**					**0.166**
#7	1	8. Large gullies, diversions, and low flowing streams	0.57	31.00	5,417.00	2.260	0.665
#7	**1**	**Muskingum K:**					**0.665**
#8	1	8. Large gullies, diversions, and low flowing streams	0.53	120.00	22,753.13	2.170	2.912
#8	**1**	**Muskingum K:**					**2.912**
#8	2	8. Large gullies, diversions, and low flowing streams	0.51	106.00	20,587.00	2.150	2.659
#8	**2**	**Muskingum K:**					**2.659**
#8	3	8. Large gullies, diversions, and low flowing streams	0.53	95.00	18,060.00	2.170	2.311
#8	**3**	**Muskingum K:**					**2.311**
#8	4	8. Large gullies, diversions, and low flowing streams	0.50	88.00	17,689.00	2.110	2.328
#8	**4**	**Muskingum K:**					**2.328**
#8	5	8. Large gullies, diversions, and low flowing streams	0.50	54.00	10,815.00	2.110	1.423
#8	**5**	**Muskingum K:**					**1.423**
#8	6	8. Large gullies, diversions, and low flowing streams	0.57	54.00	9,503.00	2.260	1.168
#8	**6**	**Muskingum K:**					**1.168**
#8	7	8. Large gullies, diversions, and low flowing streams	0.51	37.00	7,229.00	2.140	0.938
#8	**7**	**Muskingum K:**					**0.938**
#8	8	8. Large gullies, diversions, and low flowing streams	0.68	34.00	5,017.00	2.460	0.566
#8	**8**	**Muskingum K:**					**0.566**
#8	9	8. Large gullies, diversions, and low flowing streams	1.01	101.00	9,985.00	3.010	0.921
#8	**9**	**Muskingum K:**					**0.921**
#8	10	8. Large gullies, diversions, and low flowing streams	0.72	29.00	4,009.00	2.550	0.436
#8	**10**	**Muskingum K:**					**0.436**
#9	1	8. Large gullies, diversions, and low flowing streams	0.41	68.00	16,597.51	1.920	2.401
#9	**1**	**Muskingum K:**					**2.401**

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#9	2	8. Large gullies, diversions, and low flowing streams	0.36	51.00	14,207.00	1.790	2.204
#9	**2**	**Muskingum K:**					**2.204**
#9	3	8. Large gullies, diversions, and low flowing streams	0.36	43.00	12,015.00	1.790	1.864
#9	**3**	**Muskingum K:**					**1.864**
#9	4	8. Large gullies, diversions, and low flowing streams	0.35	22.00	6,269.00	1.770	0.983
#9	**4**	**Muskingum K:**					**0.983**

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#3	3,978.700	3,978.700	440.83	102.78	2,338.6	27,282	6.12	3.73
#4	3,216.100	7,194.800	603.73	212.85	4,860.9	43,257	7.92	3.05
#1	8,477.900	8,477.900	932.74	267.99	4,565.8	34,225	6.95	2.52
#2	3,838.900	12,316.800	1,096.38	462.56	7,497.7	34,701	4.87	1.66
#5	5,494.300	25,005.900	1,684.50	956.12	16,003.7	27,738	3.87	1.72
#6	3,079.300	28,085.200	1,694.12	1,096.04	15,104.2	23,367	1.56	0.68
#7	2,671.600	30,756.800	1,698.39	1,154.68	14,905.2	22,598	1.37	0.58
#8	4,754.800	35,511.600	1,701.48	1,339.99	14,698.1	47,845	4.55	0.79
#9	2,301.000	37,812.600	1,693.81	1,435.96	15,678.9	32,341	3.04	0.79

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#3	3,978.700	3,978.700	54.16	11.47	213.2	19,166	1.80	1.28
#4	3,216.100	7,194.800	98.76	29.58	588.8	31,016	3.41	1.60
#1	8,477.900	8,477.900	154.53	42.61	702.9	27,435	3.84	1.69
#2	3,838.900	12,316.800	330.94	91.74	1,663.8	30,443	3.50	1.52
#5	5,494.300	25,005.900	410.43	194.41	2,430.5	16,075	1.29	0.74
#6	3,079.300	28,085.200	406.03	228.76	2,250.6	13,061	0.63	0.35
#7	2,671.600	30,756.800	402.61	234.65	2,227.6	14,438	0.62	0.30
#8	4,754.800	35,511.600	395.69	274.47	2,146.9	38,785	2.40	0.36
#9	2,301.000	37,812.600	391.10	294.15	2,361.0	24,665	1.71	0.41

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#3	3,978.700	3,978.700	265.53	49.06	1,165.5	23,780	4.29	3.13
#4	3,216.100	7,194.800	377.17	107.10	2,542.2	37,709	5.84	2.68
#1	8,477.900	8,477.900	592.57	139.16	2,551.3	31,257	5.38	2.30
#2	3,838.900	12,316.800	789.79	255.55	4,558.0	31,911	4.07	1.66
#5	5,494.300	25,005.900	1,134.22	531.95	8,678.6	22,705	2.22	1.17
#6	3,079.300	28,085.200	1,124.25	614.41	8,093.3	18,945	1.13	0.58
#7	2,671.600	30,756.800	1,117.71	641.23	7,966.0	18,866	1.03	0.50
#8	4,754.800	35,511.600	1,099.20	745.76	7,808.1	43,083	3.70	0.66
#9	2,301.000	37,812.600	1,085.26	799.67	8,366.3	28,502	2.47	0.66

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#3	3,978.700	3,978.700	466.46	83.38	2,147.3	25,470	5.50	4.05
#4	3,216.100	7,194.800	639.40	175.00	4,501.6	40,588	7.18	3.31
#1	8,477.900	8,477.900	985.54	222.07	4,256.2	32,523	6.32	2.72
#2	3,838.900	12,316.800	1,143.70	389.57	6,994.1	32,748	4.40	1.76
#5	5,494.300	25,005.900	1,730.17	806.73	14,677.0	25,793	3.17	1.63
#6	3,079.300	28,085.200	1,714.72	926.63	13,702.7	21,689	1.39	0.70
#7	2,671.600	30,756.800	1,705.83	973.65	13,442.9	20,981	1.23	0.59
#8	4,754.800	35,511.600	1,677.53	1,130.54	13,103.4	44,100	4.07	0.78
#9	2,301.000	37,812.600	1,655.79	1,211.78	13,932.0	29,937	2.73	0.77

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#3	3,978.700	3,978.700	658.49	115.93	3,130.7	26,537	6.27	4.65
#4	3,216.100	7,194.800	888.09	238.37	6,403.9	42,242	8.00	3.70
#1	8,477.900	8,477.900	1,354.95	298.86	5,899.3	33,228	7.05	3.06
#2	3,838.900	12,316.800	1,488.15	511.26	9,343.7	33,523	4.68	1.86
#5	5,494.300	25,005.900	2,272.37	1,055.73	20,386.0	27,512	4.04	2.07
#6	3,079.300	28,085.200	2,252.50	1,208.91	19,063.8	23,337	1.56	0.77
#7	2,671.600	30,756.800	2,241.50	1,275.49	18,665.9	22,547	1.37	0.65
#8	4,754.800	35,511.600	2,203.65	1,479.73	18,151.3	44,954	4.31	0.86
#9	2,301.000	37,812.600	2,174.95	1,585.49	19,233.8	30,979	2.92	0.84

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#3	3,978.700	3,978.700	890.75	154.95	4,359.5	27,516	6.97	5.19
#4	3,216.100	7,194.800	1,185.76	313.49	8,748.1	43,827	8.76	4.06
#1	8,477.900	8,477.900	1,795.71	389.46	7,899.2	33,914	7.74	3.38
#2	3,838.900	12,316.800	1,954.05	652.91	12,353.8	34,587	5.03	2.01
#5	5,494.300	25,005.900	2,905.07	1,345.19	27,274.7	28,823	4.66	2.39
#6	3,079.300	28,085.200	2,879.25	1,536.56	25,543.8	24,483	1.88	0.93
#7	2,671.600	30,756.800	2,865.67	1,626.91	24,968.3	23,757	1.49	0.70
#8	4,754.800	35,511.600	2,816.87	1,886.12	24,239.3	45,637	4.52	0.93
#9	2,301.000	37,812.600	2,780.20	2,020.17	25,625.9	31,941	3.08	0.90

Attachment 18-B-4

No Name Arroyo Baseline Hydrology and Sedimentology SEDCAD™ Model Output without Impoundment

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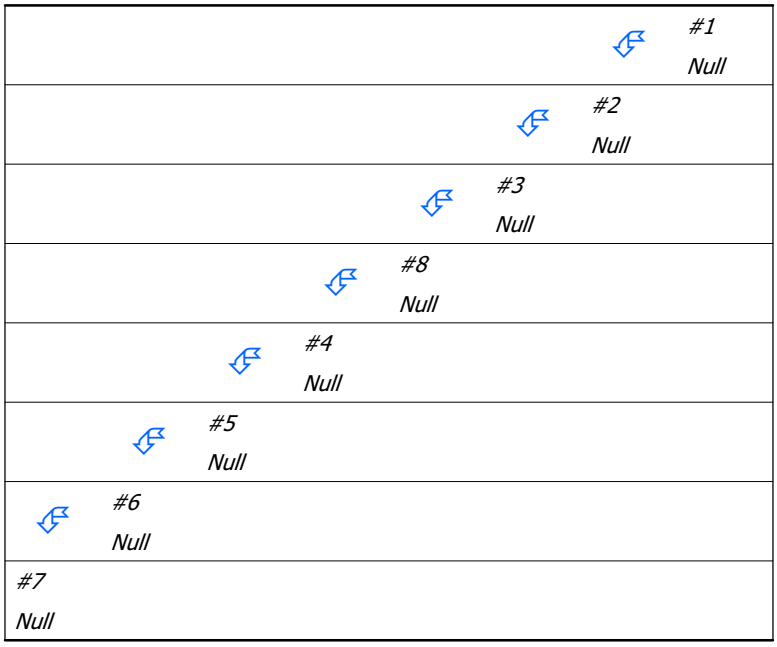
General Information

Storm Information:

Storm Type:	NRCS TYPE II-70
Design Storm:	10 yr - 24 hr
Rainfall Depth:	1.700 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	#2	0.814	0.291	SWS01
Null	#2	==>	#3	0.656	0.345	SWS02
Null	#3	==>	#8	0.000	0.000	SWS03, 04, 05
Null	#4	==>	#5	0.096	0.358	SWS06, 07
Null	#5	==>	#6	0.681	0.307	SWS08
Null	#6	==>	#7	1.027	0.307	SWS09, 10, 11, 12, 13, 14
Null	#7	==>	End	0.000	0.000	SWS15, 16, 17, 18, 19
Null	#8	==>	#4	0.604	0.309	S03 Impoundment Area



Structure Routing Details:

Stru #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	8. Large gullies, diversions, and low flowing streams	0.62	43.00	6,923.00	2.36	0.814
#1	**Muskingum K:**					**0.814**
#2	8. Large gullies, diversions, and low flowing streams	1.59	142.00	8,936.00	3.78	0.656
#2	**Muskingum K:**					**0.656**
#4	8. Large gullies, diversions, and low flowing streams	2.03	30.00	1,480.00	4.27	0.096
#4	**Muskingum K:**					**0.096**

Stru #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#5	8. Large gullies, diversions, and low flowing streams	0.82	54.00	6,623.00	2.70	0.681
#5	**Muskingum K:**					**0.681**
#6	8. Large gullies, diversions, and low flowing streams	0.82	82.00	10,027.00	2.71	1.027
#6	**Muskingum K:**					**1.027**

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Particle Size Distribution(s) at Each Structure

Structure #1 (SWS01):

Size (mm)	In/Out
0.4250	100.000%
0.2500	100.000%
0.1500	100.000%
0.0750	100.000%
0.0159	87.633%
0.0100	65.880%
0.0050	28.144%
0.0020	17.046%
0.0010	15.702%
0.0004	14.553%

Structure #2 (SWS02):

Size (mm)	In/Out
0.4250	100.000%
0.2500	100.000%
0.1500	100.000%
0.0750	100.000%
0.0159	94.592%
0.0100	70.816%
0.0050	28.706%
0.0020	17.854%
0.0010	16.303%
0.0004	15.212%

Structure #3 (SWS03, 04, 05):

Size (mm)	In/Out
0.4250	100.000%
0.2500	100.000%
0.1500	100.000%
0.0750	97.877%
0.0159	92.230%

Size (mm)	In/Out
0.0100	76.761%
0.0050	25.622%
0.0020	16.083%
0.0010	14.500%
0.0004	13.543%

Structure #8 (S03 Impoundment Area):

Size (mm)	In/Out
0.4250	100.000%
0.2500	100.000%
0.1500	100.000%
0.0750	97.877%
0.0159	92.230%
0.0100	76.761%
0.0050	25.622%
0.0020	16.083%
0.0010	14.500%
0.0004	13.543%

Structure #4 (SWS06, 07):

Size (mm)	In/Out
0.4250	100.000%
0.2500	100.000%
0.1500	100.000%
0.0750	91.615%
0.0159	86.011%
0.0100	76.336%
0.0050	23.361%
0.0020	14.325%
0.0010	12.926%
0.0004	11.968%

Structure #5 (SWS08):

Size (mm)	In/Out
0.4250	100.000%
0.2500	100.000%
0.1500	99.810%
0.0750	93.331%
0.0159	86.940%
0.0100	76.363%

Size (mm)	In/Out
0.0050	23.079%
0.0020	14.112%
0.0010	12.756%
0.0004	11.765%

Structure #6 (SWS09, 10, 11, 12, 13, 14):

Size (mm)	In/Out
0.4250	100.000%
0.2500	100.000%
0.1500	99.151%
0.0750	90.981%
0.0159	86.749%
0.0100	78.947%
0.0050	22.775%
0.0020	13.661%
0.0010	12.414%
0.0004	11.310%

Structure #7:

Size (mm)	In/Out
0.4250	100.000%
0.2500	100.000%
0.1500	98.085%
0.0750	93.580%
0.0159	89.264%
0.0100	79.577%
0.0050	22.691%
0.0020	13.507%
0.0010	12.286%
0.0004	11.166%

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Structure Detail:

Structure #1 (Null)

SWS01

Structure #2 (Null)

SWS02

Structure #3 (Null)

SWS03, 04, 05

Structure #8 (Null)

S03 Impoundment Area

Structure #4 (Null)

SWS06, 07

Structure #5 (Null)

SWS08

Structure #6 (Null)

SWS09, 10, 11, 12, 13, 14

Structure #7 (Null)

SWS15, 16, 17, 18, 19

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	999.370	1.261	0.000	0.000	81.700	M	162.56	29.766
	Σ	**999.370**						**162.56**	**29.766**
#2	1	856.430	1.610	0.000	0.000	85.700	M	167.83	34.941
	Σ	**1,855.800**						**280.33**	**64.707**
#3	1	925.920	1.675	0.409	0.297	88.800	M	230.14	47.520
	2	1,019.220	1.106	0.193	0.261	87.000	M	299.75	45.846
	3	428.940	0.766	0.000	0.000	87.400	M	169.66	19.891
	Σ	**4,229.880**						**611.92**	**177.964**
#8	Σ	**4,229.880**						**611.92**	**177.964**
#4	1	551.860	0.790	0.364	0.292	86.200	M	192.60	23.387
	2	516.780	0.565	0.000	0.000	88.400	M	271.74	25.785
	Σ	**5,298.520**						**681.43**	**227.135**
#5	1	233.280	0.469	0.000	0.000	87.900	M	131.66	11.232
	Σ	**5,531.800**						**693.15**	**238.368**
#6	1	126.980	0.164	0.545	0.308	86.900	M	101.83	5.787
	2	235.630	0.327	0.427	0.341	86.700	M	144.93	10.409
	3	258.380	0.416	0.365	0.294	88.300	M	161.17	12.840
	4	180.930	0.449	0.176	0.301	86.700	M	94.53	7.968
	5	189.850	0.326	0.146	0.330	86.800	M	117.89	8.448
	6	172.360	0.753	0.000	0.000	88.300	M	74.40	8.537
	Σ	**6,695.930**						**729.05**	**292.357**
#7	1	91.450	0.220	0.854	0.310	86.800	M	65.92	4.081
	2	286.490	0.566	0.642	0.312	87.100	M	134.68	12.994
	3	75.280	0.179	0.610	0.308	86.800	M	58.49	3.393
	4	128.700	0.157	0.270	0.325	86.800	M	102.47	5.822
	5	67.060	0.333	0.000	0.000	82.000	M	27.39	2.057
	Σ	**7,344.910**						**737.87**	**320.705**

Subwatershed Sedimentology Detail:

Stru #	SWS #	Soil K	L (ft)	S (%)	C	P	PS #	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc (ml/l)	24VW (ml/l)
#1	1	0.233	280.00	2.40	0.2650	1.0000	1	308.7	12,523	3.66	2.22
	Σ							**308.7**	**12,523**	**3.66**	**2.22**
#2	1	0.245	420.00	1.40	0.2450	1.0000	2	236.1	7,888	2.53	1.60
	Σ							**494.6**	**8,847**	**2.26**	**1.44**
#3	1	0.235	280.00	2.20	0.2330	1.0000	3	399.8	9,626	3.28	2.12
	2	0.204	280.00	2.30	0.2330	1.0000	4	410.4	10,604	3.76	2.33
	3	0.158	240.00	3.80	0.2110	1.0000	5	198.1	12,102	4.07	2.45
	Σ							**1,239.2**	**8,405**	**1.82**	**1.10**
#8	Σ							**1,239.2**	**8,405**	**1.82**	**1.10**
#4	1	0.150	200.00	6.00	0.2320	1.0000	6	433.9	22,402	7.69	4.65
	2	0.183	100.00	9.10	0.1990	1.0000	7	662.4	31,375	12.99	7.74
	Σ							**2,024.4**	**27,253**	**6.05**	**1.45**
#5	1	0.170	100.00	10.10	0.1890	1.0000	8	294.8	32,531	12.94	7.60
	Σ							**2,226.3**	**28,294**	**6.25**	**1.51**
#6	1	0.160	100.00	11.50	0.1990	1.0000	9	207.4	44,285	21.06	12.35
	2	0.145	100.00	12.00	0.2110	1.0000	15	360.7	43,171	18.39	10.71
	3	0.171	100.00	8.20	0.1850	1.0000	10	246.1	23,504	9.41	5.60
	4	0.150	75.00	12.10	0.2110	1.0000	11	215.6	33,725	13.34	7.79
	5	0.143	75.00	13.30	0.2110	1.0000	15	271.8	40,504	17.28	9.97
	6	0.164	75.00	13.90	0.1850	1.0000	12	225.3	31,654	9.95	6.04
	Σ							**3,144.8**	**28,310**	**5.83**	**1.62**
#7	1	0.143	100.00	10.40	0.2110	1.0000	15	110.9	33,271	15.18	9.02
	2	0.162	75.00	15.20	0.2220	1.0000	13	527.1	48,820	18.88	11.36
	3	0.143	75.00	20.10	0.2110	1.0000	15	180.8	64,982	30.56	18.04
	4	0.143	100.00	8.10	0.2110	1.0000	15	113.6	24,801	11.77	6.76
	5	0.215	100.00	8.20	0.2760	1.0000	14	61.3	39,773	19.09	10.40
	Σ							**3,729.9**	**35,233**	**7.02**	**1.69**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	1.30	9.00	692.00	1.140	0.168
		8. Large gullies, diversions, and low flowing streams	1.35	186.00	13,736.00	3.490	1.093
#1	**1**	**Time of Concentration:**					**1.261**
#2	1	5. Nearly bare and untilled, and alluvial valley fans	1.06	11.00	1,041.00	1.020	0.283

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
		8. Large gullies, diversions, and low flowing streams	0.41	37.00	9,125.00	1.910	1.327
#2	**1**	**Time of Concentration:**					**1.610**
#3	1	5. Nearly bare and untilled, and alluvial valley fans	0.13	1.00	743.49	0.360	0.573
		8. Large gullies, diversions, and low flowing streams	0.79	84.00	10,596.69	2.670	1.102
#3	**1**	**Time of Concentration:**					**1.675**
#3	2	5. Nearly bare and untilled, and alluvial valley fans	3.79	40.00	1,056.00	1.940	0.151
		8. Large gullies, diversions, and low flowing streams	1.20	135.00	11,282.00	3.280	0.955
#3	**2**	**Time of Concentration:**					**1.106**
#3	3	5. Nearly bare and untilled, and alluvial valley fans	1.48	14.00	945.00	1.210	0.216
		8. Large gullies, diversions, and low flowing streams	1.68	129.00	7,691.00	3.880	0.550
#3	**3**	**Time of Concentration:**					**0.766**
#4	1	5. Nearly bare and untilled, and alluvial valley fans	0.96	7.00	731.00	0.970	0.209
		8. Large gullies, diversions, and low flowing streams	1.94	169.00	8,725.00	4.170	0.581
#4	**1**	**Time of Concentration:**					**0.790**
#4	2	5. Nearly bare and untilled, and alluvial valley fans	4.40	43.00	978.00	2.090	0.129
		8. Large gullies, diversions, and low flowing streams	2.35	170.00	7,224.00	4.600	0.436
#4	**2**	**Time of Concentration:**					**0.565**
#5	1	5. Nearly bare and untilled, and alluvial valley fans	2.11	22.00	1,044.00	1.450	0.200
		8. Large gullies, diversions, and low flowing streams	3.14	162.00	5,158.00	5.310	0.269
#5	**1**	**Time of Concentration:**					**0.469**
#6	1	5. Nearly bare and untilled, and alluvial valley fans	4.94	12.00	243.00	2.220	0.030
		8. Large gullies, diversions, and low flowing streams	4.62	144.00	3,117.00	6.440	0.134
#6	**1**	**Time of Concentration:**					**0.164**
#6	2	5. Nearly bare and untilled, and alluvial valley fans	4.52	46.00	1,017.00	2.120	0.133
		8. Large gullies, diversions, and low flowing streams	3.40	132.00	3,879.00	5.530	0.194
#6	**2**	**Time of Concentration:**					**0.327**
#6	3	5. Nearly bare and untilled, and alluvial valley fans	2.83	23.00	813.00	1.680	0.134
		8. Large gullies, diversions, and low flowing streams	2.68	134.00	4,999.00	4.910	0.282
#6	**3**	**Time of Concentration:**					**0.416**
#6	4	5. Nearly bare and untilled, and alluvial valley fans	4.43	28.00	632.00	2.100	0.083

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
		8. Large gullies, diversions, and low flowing streams	2.77	182.00	6,575.00	4.990	0.366
#6	**4**	**Time of Concentration:**					**0.449**
#6	5	5. Nearly bare and untilled, and alluvial valley fans	6.63	41.00	618.00	2.570	0.066
		8. Large gullies, diversions, and low flowing streams	2.36	102.00	4,321.00	4.600	0.260
#6	**5**	**Time of Concentration:**					**0.326**
#6	6	5. Nearly bare and untilled, and alluvial valley fans	0.41	4.00	979.00	0.630	0.431
		8. Large gullies, diversions, and low flowing streams	2.88	170.00	5,907.00	5.080	0.322
#6	**6**	**Time of Concentration:**					**0.753**
#7	1	5. Nearly bare and untilled, and alluvial valley fans	18.35	60.00	327.00	4.280	0.021
		8. Large gullies, diversions, and low flowing streams	3.36	133.00	3,954.00	5.500	0.199
#7	**1**	**Time of Concentration:**					**0.220**
#7	2	5. Nearly bare and untilled, and alluvial valley fans	2.42	20.00	826.00	1.550	0.148
		8. Large gullies, diversions, and low flowing streams	2.59	188.00	7,257.00	4.820	0.418
#7	**2**	**Time of Concentration:**					**0.566**
#7	3	5. Nearly bare and untilled, and alluvial valley fans	10.34	74.00	716.00	3.210	0.061
		8. Large gullies, diversions, and low flowing streams	4.74	132.00	2,785.00	6.530	0.118
#7	**3**	**Time of Concentration:**					**0.179**
#7	4	5. Nearly bare and untilled, and alluvial valley fans	17.05	37.00	217.00	4.120	0.014
		8. Large gullies, diversions, and low flowing streams	3.52	102.00	2,899.00	5.620	0.143
#7	**4**	**Time of Concentration:**					**0.157**
#7	5	5. Nearly bare and untilled, and alluvial valley fans	0.95	2.00	211.00	0.970	0.060
		8. Large gullies, diversions, and low flowing streams	1.06	32.00	3,028.00	3.080	0.273
#7	**5**	**Time of Concentration:**					**0.333**

Subwatershed Muskingum Routing Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#3	1	8. Large gullies, diversions, and low flowing streams	0.68	25.00	3,656.00	2.480	0.409
#3	**1**	**Muskingum K:**					**0.409**
#3	2	8. Large gullies, diversions, and low flowing streams	0.39	5.00	1,298.00	1.860	0.193
#3	**2**	**Muskingum K:**					**0.193**

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#4	1	8. Large gullies, diversions, and low flowing streams	0.64	20.00	3,139.00	2.390	0.364
#4	**1**	**Muskingum K:**					**0.364**
#6	1	8. Large gullies, diversions, and low flowing streams	0.82	44.00	5,337.00	2.720	0.545
#6	**1**	**Muskingum K:**					**0.545**
#6	2	8. Large gullies, diversions, and low flowing streams	1.47	82.00	5,593.07	3.630	0.427
#6	**2**	**Muskingum K:**					**0.427**
#6	3	8. Large gullies, diversions, and low flowing streams	0.66	21.00	3,199.00	2.430	0.365
#6	**3**	**Muskingum K:**					**0.365**
#6	4	8. Large gullies, diversions, and low flowing streams	0.74	12.00	1,631.00	2.570	0.176
#6	**4**	**Muskingum K:**					**0.176**
#6	6	8. Large gullies, diversions, and low flowing streams	0.00	0.00	0.00	0.000	0.000
#6	**6**	**Muskingum K:**					**0.000**
#7	1	8. Large gullies, diversions, and low flowing streams	0.86	73.00	8,524.00	2.770	0.854
#7	**1**	**Muskingum K:**					**0.854**
#7	2	8. Large gullies, diversions, and low flowing streams	0.89	58.00	6,527.00	2.820	0.642
#7	**2**	**Muskingum K:**					**0.642**
#7	3	8. Large gullies, diversions, and low flowing streams	0.83	50.00	5,997.00	2.730	0.610
#7	**3**	**Muskingum K:**					**0.610**
#7	4	8. Large gullies, diversions, and low flowing streams	1.11	34.00	3,071.00	3.150	0.270
#7	**4**	**Muskingum K:**					**0.270**
#7	5	8. Large gullies, diversions, and low flowing streams	0.00	0.00	0.00	0.000	0.000
#7	**5**	**Muskingum K:**					**0.000**

SEDCAD 4 for Windows - 10-Year 24-Hour Storm Summary

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#1	999.370	999.370	162.56	29.77	308.7	12,523	3.66	2.22
#2	856.430	1,855.800	280.33	64.71	494.6	8,847	2.26	1.44
#3	2,374.080	4,229.880	611.92	177.96	1,239.2	8,405	1.82	1.10
#8	0.000	4,229.880	611.92	177.96	1,239.2	8,405	1.82	1.10
#4	1,068.640	5,298.520	681.43	227.14	2,024.4	27,253	6.05	1.45
#5	233.280	5,531.800	693.15	238.37	2,226.3	28,294	6.25	1.51
#6	1,164.130	6,695.930	729.05	292.36	3,144.8	28,310	5.83	1.62
#7	648.980	7,344.910	737.87	320.70	3,729.9	35,233	7.02	1.69

SEDCAD 4 for Windows - 2-Year 6-Hour Storm Summary

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#1	999.370	999.370	24.54	4.06	35.1	8,569	1.37	1.01
#2	856.430	1,855.800	54.18	10.99	68.8	5,906	0.91	0.70
#3	2,374.080	4,229.880	162.83	37.32	242.2	6,598	1.12	0.81
#8	0.000	4,229.880	162.83	37.32	242.2	6,598	1.12	0.81
#4	1,068.640	5,298.520	184.02	48.38	413.6	22,630	4.06	1.12
#5	233.280	5,531.800	187.35	51.00	457.2	23,063	4.00	1.14
#6	1,164.130	6,695.930	198.53	63.15	649.4	22,914	3.78	1.24
#7	648.980	7,344.910	201.76	69.18	767.4	28,608	4.36	1.24

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#1	999.370	999.370	102.78	14.94	162.3	10,997	2.81	2.03
#2	856.430	1,855.800	184.74	34.40	271.1	7,706	1.69	1.26
#3	2,374.080	4,229.880	431.44	100.54	736.4	7,513	1.50	1.07
#8	0.000	4,229.880	431.44	100.54	736.4	7,513	1.50	1.07
#4	1,068.640	5,298.520	482.25	128.96	1,216.8	24,685	5.00	1.40
#5	233.280	5,531.800	489.89	135.53	1,339.9	25,479	5.10	1.45
#6	1,164.130	6,695.930	516.87	166.75	1,900.8	25,548	4.74	1.54
#7	648.980	7,344.910	523.87	182.85	2,253.7	31,814	5.63	1.59

SEDCAD 4 for Windows - 25-Year 6-Hour Storm Summary

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#1	999.370	999.370	172.71	24.46	286.1	11,847	3.37	2.44
#2	856.430	1,855.800	297.02	53.97	461.0	8,420	2.09	1.56
#3	2,374.080	4,229.880	643.53	150.86	1,161.2	7,904	1.65	1.18
#8	0.000	4,229.880	643.53	150.86	1,161.2	7,904	1.65	1.18
#4	1,068.640	5,298.520	716.55	192.81	1,900.8	25,592	5.50	1.55
#5	233.280	5,531.800	727.98	202.42	2,090.1	26,518	5.66	1.61
#6	1,164.130	6,695.930	766.65	248.48	2,957.5	26,507	5.28	1.73
#7	648.980	7,344.910	776.05	272.55	3,508.0	33,080	6.35	1.80

SEDCAD 4 for Windows - 50-Year 6-Hour Storm Summary

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#1	999.370	999.370	238.50	33.34	407.6	12,383	3.74	2.70
#2	856.430	1,855.800	400.79	71.89	644.6	8,870	2.36	1.75
#3	2,374.080	4,229.880	833.00	195.96	1,557.5	8,153	1.78	1.27
#8	0.000	4,229.880	833.00	195.96	1,557.5	8,153	1.78	1.27
#4	1,068.640	5,298.520	925.53	249.91	2,536.1	26,223	5.88	1.66
#5	233.280	5,531.800	941.08	262.21	2,787.4	27,237	6.08	1.74
#6	1,164.130	6,695.930	988.90	321.44	3,935.3	27,254	5.69	1.87
#7	648.980	7,344.910	1,000.26	352.63	4,668.1	33,908	6.85	1.95

SEDCAD 4 for Windows - 100-Year 6-Hour Storm Summary

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#1	999.370	999.370	317.38	43.86	557.8	12,883	4.07	2.94
#2	856.430	1,855.800	522.95	92.86	868.3	9,277	2.60	1.92
#3	2,374.080	4,229.880	1,050.99	247.96	2,028.7	8,385	1.92	1.37
#8	0.000	4,229.880	1,050.99	247.96	2,028.7	8,385	1.92	1.37
#4	1,068.640	5,298.520	1,165.55	315.66	3,287.9	26,769	6.25	1.78
#5	233.280	5,531.800	1,185.81	331.03	3,612.0	27,859	6.49	1.86
#6	1,164.130	6,695.930	1,244.10	405.34	5,090.3	27,832	6.08	2.00
#7	648.980	7,344.910	1,257.44	444.71	6,038.5	34,529	7.32	2.10

Attachment 18-B-5

No Name Arroyo Baseline Hydrology and Sedimentology SEDCAD™ Model Output with Impoundment

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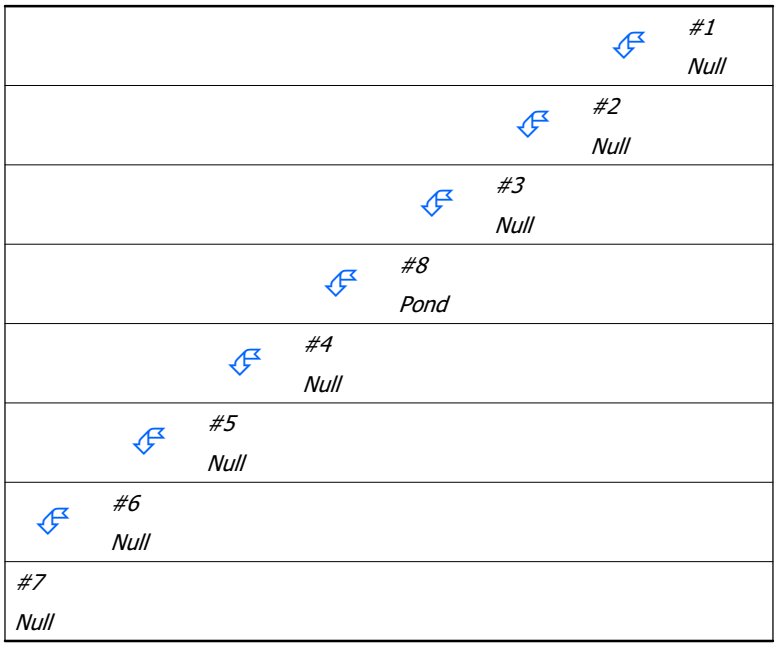
General Information

Storm Information:

Storm Type:	NRCS TYPE II-70
Design Storm:	10 yr - 24 hr
Rainfall Depth:	1.700 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	#2	0.814	0.291	SWS01
Null	#2	==>	#3	0.656	0.345	SWS02
Null	#3	==>	#8	0.000	0.000	SWS03, 04, 05
Null	#4	==>	#5	0.096	0.358	SWS06, 07
Null	#5	==>	#6	0.681	0.307	SWS08
Null	#6	==>	#7	1.027	0.307	SWS09, 10, 11, 12, 13, 14
Null	#7	==>	End	0.000	0.000	SWS15, 16, 17, 18, 19
Pond	#8	==>	#4	0.604	0.309	S03 Impoundment Area



Structure Routing Details:

Stru #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	8. Large gullies, diversions, and low flowing streams	0.62	43.00	6,923.00	2.36	0.814
#1	**Muskingum K:**					**0.814**
#2	8. Large gullies, diversions, and low flowing streams	1.59	142.00	8,936.00	3.78	0.656
#2	**Muskingum K:**					**0.656**
#4	8. Large gullies, diversions, and low flowing streams	2.03	30.00	1,480.00	4.27	0.096
#4	**Muskingum K:**					**0.096**

Stru #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#5	8. Large gullies, diversions, and low flowing streams	0.82	54.00	6,623.00	2.70	0.681
#5	**Muskingum K:**					**0.681**
#6	8. Large gullies, diversions, and low flowing streams	0.82	82.00	10,027.00	2.71	1.027
#6	**Muskingum K:**					**1.027**

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Particle Size Distribution(s) at Each Structure

Structure #1 (SWS01):

Size (mm)	In/Out
0.4250	100.000%
0.2500	100.000%
0.1500	100.000%
0.0750	100.000%
0.0159	87.633%
0.0100	65.880%
0.0050	28.144%
0.0020	17.046%
0.0010	15.702%
0.0004	14.553%

Structure #2 (SWS02):

Size (mm)	In/Out
0.4250	100.000%
0.2500	100.000%
0.1500	100.000%
0.0750	100.000%
0.0159	94.592%
0.0100	70.816%
0.0050	28.706%
0.0020	17.854%
0.0010	16.303%
0.0004	15.212%

Structure #3 (SWS03, 04, 05):

Size (mm)	In/Out
0.4250	100.000%
0.2500	100.000%
0.1500	100.000%
0.0750	97.877%
0.0159	92.230%

Size (mm)	In/Out
0.0100	76.761%
0.0050	25.622%
0.0020	16.083%
0.0010	14.500%
0.0004	13.543%

Structure #8 (S03 Impoundment Area):

Size (mm)	In	Out
0.4250	100.000%	100.000%
0.2500	100.000%	100.000%
0.1500	100.000%	100.000%
0.0750	97.877%	100.000%
0.0159	92.230%	100.000%
0.0100	76.761%	100.000%
0.0050	25.622%	34.158%
0.0020	16.083%	21.441%
0.0010	14.500%	19.331%
0.0004	13.543%	18.055%

Structure #4 (SWS06, 07):

Size (mm)	In/Out
0.4250	100.000%
0.2500	100.000%
0.1500	100.000%
0.0750	90.443%
0.0159	84.645%
0.0100	75.204%
0.0050	28.223%
0.0020	17.306%
0.0010	15.616%
0.0004	14.459%

Structure #5 (SWS08):

Size (mm)	In/Out
0.4250	100.000%
0.2500	100.000%
0.1500	99.774%
0.0750	92.709%
0.0159	85.990%
0.0100	75.443%

Size (mm)	In/Out
0.0050	27.397%
0.0020	16.752%
0.0010	15.142%
0.0004	13.966%

Structure #6 (SWS09, 10, 11, 12, 13, 14):

Size (mm)	In/Out
0.4250	100.000%
0.2500	100.000%
0.1500	99.349%
0.0750	90.724%
0.0159	85.928%
0.0100	79.191%
0.0050	25.810%
0.0020	15.481%
0.0010	14.068%
0.0004	12.817%

Structure #7:

Size (mm)	In/Out
0.4250	100.000%
0.2500	100.000%
0.1500	97.978%
0.0750	93.104%
0.0159	88.810%
0.0100	79.800%
0.0050	25.172%
0.0020	14.985%
0.0010	13.630%
0.0004	12.388%

Structure Detail:

Structure #1 (Null)

SWS01

Structure #2 (Null)

SWS02

Structure #3 (Null)

SWS03, 04, 05

Structure #8 (Pond)

S03 Impoundment Area

Pond Inputs:

Initial Pool Elev:	5,441.01 ft
Initial Pool:	0.00 ac-ft
*Sediment Storage:	0.00 ac-ft
Dead Space:	5.00 %

**No sediment capacity defined*

Pond Results:

Peak Elevation:	5,448.48 ft
H'graph Detention Time:	1.10 hrs
Pond Model:	CSTRS
Dewater Time:	1.31 days
Trap Efficiency:	24.99 %

Dewatering time is calculated from peak stage to lowest spillway

Elevation-Capacity-Discharge Table

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)	
5,441.00	0.000	0.000	0.000		Top of Sed. Storage
5,441.01	0.011	0.000	0.000		
5,442.00	1.075	0.394	0.001		
5,443.00	2.094	1.950	0.001		
5,444.00	2.823	4.399	0.001		
5,445.00	4.127	7.854	0.001		
5,446.00	5.827	12.807	0.001		
5,447.00	7.996	19.691	55.000	26.25	

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)	
5,448.00	10.478	28.900	300.000	3.95	
5,448.48	12.103	34.593	571.922	1.35	Peak Stage
5,449.00	13.565	40.888	872.600		
5,450.00	16.428	55.862	1,000.000		

Detailed Discharge Table

Elevation (ft)	User-input discharge (cfs)	Combined Total Discharge (cfs)
5,441.00	0.000	0.000
5,441.01	0.000	0.000
5,442.00	0.001	0.001
5,443.00	0.001	0.001
5,444.00	0.001	0.001
5,445.00	0.001	0.001
5,446.00	0.001	0.001
5,447.00	55.000	55.000
5,448.00	300.000	300.000
5,449.00	872.600	872.600
5,450.00	1,000.000	1,000.000

Structure #4 (Null)

SWS06, 07

Structure #5 (Null)

SWS08

Structure #6 (Null)

SWS09, 10, 11, 12, 13, 14

Structure #7 (Null)

SWS15, 16, 17, 18, 19

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	999.370	1.261	0.000	0.000	81.700	M	162.56	29.766
	Σ	**999.370**						**162.56**	**29.766**
#2	1	856.430	1.610	0.000	0.000	85.700	M	167.83	34.941
	Σ	**1,855.800**						**280.33**	**64.707**
#3	1	925.920	1.675	0.409	0.297	88.800	M	230.14	47.520
	2	1,019.220	1.106	0.193	0.261	87.000	M	299.75	45.846
	3	428.940	0.766	0.000	0.000	87.400	M	169.66	19.891
	Σ	**4,229.880**						**611.92**	**177.964**
#8	Σ	**4,229.880**						**611.92**	**177.964**
#4	1	551.860	0.790	0.364	0.292	86.200	M	192.60	23.387
	2	516.780	0.565	0.000	0.000	88.400	M	271.74	25.785
	Σ	**5,298.520**						**620.07**	**214.321**
#5	1	233.280	0.469	0.000	0.000	87.900	M	131.66	11.232
	Σ	**5,531.800**						**624.80**	**225.554**
#6	1	126.980	0.164	0.545	0.308	86.900	M	101.83	5.787
	2	235.630	0.327	0.427	0.341	86.700	M	144.93	10.409
	3	258.380	0.416	0.365	0.294	88.300	M	161.17	12.840
	4	180.930	0.449	0.176	0.301	86.700	M	94.53	7.968
	5	189.850	0.326	0.146	0.330	86.800	M	117.89	8.448
	6	172.360	0.753	0.000	0.000	88.300	M	74.40	8.537
	Σ	**6,695.930**						**642.03**	**279.543**
#7	1	91.450	0.220	0.854	0.310	86.800	M	65.92	4.081
	2	286.490	0.566	0.642	0.312	87.100	M	134.68	12.994
	3	75.280	0.179	0.610	0.308	86.800	M	58.49	3.393
	4	128.700	0.157	0.270	0.325	86.800	M	102.47	5.822
	5	67.060	0.333	0.000	0.000	82.000	M	27.39	2.057
	Σ	**7,344.910**						**652.74**	**307.890**

Subwatershed Sedimentology Detail:

Stru #	SWS #	Soil K	L (ft)	S (%)	C	P	PS #	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc (ml/l)	24VW (ml/l)
#1	1	0.233	280.00	2.40	0.2650	1.0000	1	308.7	12,523	3.66	2.22
	Σ							**308.7**	**12,523**	**3.66**	**2.22**
#2	1	0.245	420.00	1.40	0.2450	1.0000	2	236.1	7,888	2.53	1.60
	Σ							**494.6**	**8,847**	**2.26**	**1.44**
#3	1	0.235	280.00	2.20	0.2330	1.0000	3	399.8	9,626	3.28	2.12
	2	0.204	280.00	2.30	0.2330	1.0000	4	410.4	10,604	3.76	2.33
	3	0.158	240.00	3.80	0.2110	1.0000	5	198.1	12,102	4.07	2.45
	Σ							**1,239.2**	**8,405**	**1.82**	**1.10**
#8	Σ							**1,239.2**	**8,405**	**1.82**	**1.10**
#4	1	0.150	200.00	6.00	0.2320	1.0000	6	433.9	22,402	7.69	4.65
	2	0.183	100.00	9.10	0.1990	1.0000	7	662.4	31,375	12.99	7.74
	Σ							**1,675.7**	**26,789**	**6.05**	**1.29**
#5	1	0.170	100.00	10.10	0.1890	1.0000	8	294.8	32,531	12.94	7.60
	Σ							**1,875.5**	**27,699**	**6.19**	**1.36**
#6	1	0.160	100.00	11.50	0.1990	1.0000	9	207.4	44,285	21.06	12.35
	2	0.145	100.00	12.00	0.2110	1.0000	15	360.7	43,171	18.39	10.71
	3	0.171	100.00	8.20	0.1850	1.0000	10	246.1	23,504	9.41	5.60
	4	0.150	75.00	12.10	0.2110	1.0000	11	215.6	33,725	13.34	7.79
	5	0.143	75.00	13.30	0.2110	1.0000	15	271.8	40,504	17.28	9.97
	6	0.164	75.00	13.90	0.1850	1.0000	12	225.3	31,654	9.95	6.04
	Σ							**2,775.0**	**27,766**	**5.64**	**1.48**
#7	1	0.143	100.00	10.40	0.2110	1.0000	15	110.9	33,271	15.18	9.02
	2	0.162	75.00	15.20	0.2220	1.0000	13	527.1	48,820	18.88	11.36
	3	0.143	75.00	20.10	0.2110	1.0000	15	180.8	64,982	30.56	18.04
	4	0.143	100.00	8.10	0.2110	1.0000	15	113.6	24,801	11.77	6.76
	5	0.215	100.00	8.20	0.2760	1.0000	14	61.3	39,773	19.09	10.40
	Σ							**3,362.1**	**34,942**	**6.86**	**1.57**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	1.30	9.00	692.00	1.140	0.168
		8. Large gullies, diversions, and low flowing streams	1.35	186.00	13,736.00	3.490	1.093
#1	**1**	**Time of Concentration:**					**1.261**
#2	1	5. Nearly bare and untilled, and alluvial valley fans	1.06	11.00	1,041.00	1.020	0.283

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
		8. Large gullies, diversions, and low flowing streams	0.41	37.00	9,125.00	1.910	1.327
#2	**1**	**Time of Concentration:**					**1.610**
#3	1	5. Nearly bare and untilled, and alluvial valley fans	0.13	1.00	743.49	0.360	0.573
		8. Large gullies, diversions, and low flowing streams	0.79	84.00	10,596.69	2.670	1.102
#3	**1**	**Time of Concentration:**					**1.675**
#3	2	5. Nearly bare and untilled, and alluvial valley fans	3.79	40.00	1,056.00	1.940	0.151
		8. Large gullies, diversions, and low flowing streams	1.20	135.00	11,282.00	3.280	0.955
#3	**2**	**Time of Concentration:**					**1.106**
#3	3	5. Nearly bare and untilled, and alluvial valley fans	1.48	14.00	945.00	1.210	0.216
		8. Large gullies, diversions, and low flowing streams	1.68	129.00	7,691.00	3.880	0.550
#3	**3**	**Time of Concentration:**					**0.766**
#4	1	5. Nearly bare and untilled, and alluvial valley fans	0.96	7.00	731.00	0.970	0.209
		8. Large gullies, diversions, and low flowing streams	1.94	169.00	8,725.00	4.170	0.581
#4	**1**	**Time of Concentration:**					**0.790**
#4	2	5. Nearly bare and untilled, and alluvial valley fans	4.40	43.00	978.00	2.090	0.129
		8. Large gullies, diversions, and low flowing streams	2.35	170.00	7,224.00	4.600	0.436
#4	**2**	**Time of Concentration:**					**0.565**
#5	1	5. Nearly bare and untilled, and alluvial valley fans	2.11	22.00	1,044.00	1.450	0.200
		8. Large gullies, diversions, and low flowing streams	3.14	162.00	5,158.00	5.310	0.269
#5	**1**	**Time of Concentration:**					**0.469**
#6	1	5. Nearly bare and untilled, and alluvial valley fans	4.94	12.00	243.00	2.220	0.030
		8. Large gullies, diversions, and low flowing streams	4.62	144.00	3,117.00	6.440	0.134
#6	**1**	**Time of Concentration:**					**0.164**
#6	2	5. Nearly bare and untilled, and alluvial valley fans	4.52	46.00	1,017.00	2.120	0.133
		8. Large gullies, diversions, and low flowing streams	3.40	132.00	3,879.00	5.530	0.194
#6	**2**	**Time of Concentration:**					**0.327**
#6	3	5. Nearly bare and untilled, and alluvial valley fans	2.83	23.00	813.00	1.680	0.134
		8. Large gullies, diversions, and low flowing streams	2.68	134.00	4,999.00	4.910	0.282
#6	**3**	**Time of Concentration:**					**0.416**
#6	4	5. Nearly bare and untilled, and alluvial valley fans	4.43	28.00	632.00	2.100	0.083

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
		8. Large gullies, diversions, and low flowing streams	2.77	182.00	6,575.00	4.990	0.366
#6	**4**	**Time of Concentration:**					**0.449**
#6	5	5. Nearly bare and untilled, and alluvial valley fans	6.63	41.00	618.00	2.570	0.066
		8. Large gullies, diversions, and low flowing streams	2.36	102.00	4,321.00	4.600	0.260
#6	**5**	**Time of Concentration:**					**0.326**
#6	6	5. Nearly bare and untilled, and alluvial valley fans	0.41	4.00	979.00	0.630	0.431
		8. Large gullies, diversions, and low flowing streams	2.88	170.00	5,907.00	5.080	0.322
#6	**6**	**Time of Concentration:**					**0.753**
#7	1	5. Nearly bare and untilled, and alluvial valley fans	18.35	60.00	327.00	4.280	0.021
		8. Large gullies, diversions, and low flowing streams	3.36	133.00	3,954.00	5.500	0.199
#7	**1**	**Time of Concentration:**					**0.220**
#7	2	5. Nearly bare and untilled, and alluvial valley fans	2.42	20.00	826.00	1.550	0.148
		8. Large gullies, diversions, and low flowing streams	2.59	188.00	7,257.00	4.820	0.418
#7	**2**	**Time of Concentration:**					**0.566**
#7	3	5. Nearly bare and untilled, and alluvial valley fans	10.34	74.00	716.00	3.210	0.061
		8. Large gullies, diversions, and low flowing streams	4.74	132.00	2,785.00	6.530	0.118
#7	**3**	**Time of Concentration:**					**0.179**
#7	4	5. Nearly bare and untilled, and alluvial valley fans	17.05	37.00	217.00	4.120	0.014
		8. Large gullies, diversions, and low flowing streams	3.52	102.00	2,899.00	5.620	0.143
#7	**4**	**Time of Concentration:**					**0.157**
#7	5	5. Nearly bare and untilled, and alluvial valley fans	0.95	2.00	211.00	0.970	0.060
		8. Large gullies, diversions, and low flowing streams	1.06	32.00	3,028.00	3.080	0.273
#7	**5**	**Time of Concentration:**					**0.333**

Subwatershed Muskingum Routing Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#3	1	8. Large gullies, diversions, and low flowing streams	0.68	25.00	3,656.00	2.480	0.409
#3	**1**	**Muskingum K:**					**0.409**
#3	2	8. Large gullies, diversions, and low flowing streams	0.39	5.00	1,298.00	1.860	0.193
#3	**2**	**Muskingum K:**					**0.193**

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#4	1	8. Large gullies, diversions, and low flowing streams	0.64	20.00	3,139.00	2.390	0.364
#4	**1**	**Muskingum K:**					**0.364**
#6	1	8. Large gullies, diversions, and low flowing streams	0.82	44.00	5,337.00	2.720	0.545
#6	**1**	**Muskingum K:**					**0.545**
#6	2	8. Large gullies, diversions, and low flowing streams	1.47	82.00	5,593.07	3.630	0.427
#6	**2**	**Muskingum K:**					**0.427**
#6	3	8. Large gullies, diversions, and low flowing streams	0.66	21.00	3,199.00	2.430	0.365
#6	**3**	**Muskingum K:**					**0.365**
#6	4	8. Large gullies, diversions, and low flowing streams	0.74	12.00	1,631.00	2.570	0.176
#6	**4**	**Muskingum K:**					**0.176**
#6	6	8. Large gullies, diversions, and low flowing streams	0.00	0.00	0.00	0.000	0.000
#6	**6**	**Muskingum K:**					**0.000**
#7	1	8. Large gullies, diversions, and low flowing streams	0.86	73.00	8,524.00	2.770	0.854
#7	**1**	**Muskingum K:**					**0.854**
#7	2	8. Large gullies, diversions, and low flowing streams	0.89	58.00	6,527.00	2.820	0.642
#7	**2**	**Muskingum K:**					**0.642**
#7	3	8. Large gullies, diversions, and low flowing streams	0.83	50.00	5,997.00	2.730	0.610
#7	**3**	**Muskingum K:**					**0.610**
#7	4	8. Large gullies, diversions, and low flowing streams	1.11	34.00	3,071.00	3.150	0.270
#7	**4**	**Muskingum K:**					**0.270**
#7	5	8. Large gullies, diversions, and low flowing streams	0.00	0.00	0.00	0.000	0.000
#7	**5**	**Muskingum K:**					**0.000**

Structure Summary:

		Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#1		999.370	999.370	162.56	29.77	308.7	12,523	3.66	2.22
#2		856.430	1,855.800	280.33	64.71	494.6	8,847	2.26	1.44
#3		2,374.080	4,229.880	611.92	177.96	1,239.2	8,405	1.82	1.10
#8	In	0.000	4,229.880	611.92	177.96	1,239.2	8,405	1.82	1.10
	Out			571.92	165.15	929.5	6,960	0.41	0.24
#4		1,068.640	5,298.520	620.07	214.32	1,675.7	26,789	6.05	1.29
#5		233.280	5,531.800	624.80	225.55	1,875.5	27,699	6.19	1.36
#6		1,164.130	6,695.930	642.03	279.54	2,775.0	27,766	5.64	1.48
#7		648.980	7,344.910	652.74	307.89	3,362.1	34,942	6.86	1.57

Structure Summary:

		Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#1		999.370	999.370	24.54	4.06	35.1	8,569	1.37	1.01
#2		856.430	1,855.800	54.18	10.99	68.8	5,906	0.91	0.70
#3		2,374.080	4,229.880	162.83	37.32	242.2	6,598	1.12	0.81
#8	In	0.000	4,229.880	162.83	37.32	242.2	6,598	1.12	0.81
	Out			93.21	24.51	115.9	5,833	0.21	0.12
#4		1,068.640	5,298.520	101.16	35.56	234.9	19,908	4.55	1.10
#5		233.280	5,531.800	113.85	38.19	290.0	21,442	5.04	1.31
#6		1,164.130	6,695.930	163.52	50.34	537.0	23,458	5.41	1.80
#7		648.980	7,344.910	173.96	56.37	664.8	28,570	6.13	1.85

Structure Summary:

		Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#1		999.370	999.370	102.78	14.94	162.3	10,997	2.81	2.03
#2		856.430	1,855.800	184.74	34.40	271.1	7,706	1.69	1.26
#3		2,374.080	4,229.880	431.44	100.54	736.4	7,513	1.50	1.07
#8	In	0.000	4,229.880	431.44	100.54	736.4	7,513	1.50	1.07
	Out			382.13	87.73	532.0	6,367	0.36	0.25
#4		1,068.640	5,298.520	411.91	116.15	958.8	23,926	5.10	1.29
#5		233.280	5,531.800	415.11	122.72	1,080.4	24,656	5.14	1.34
#6		1,164.130	6,695.930	436.61	153.94	1,634.7	24,988	4.84	1.50
#7		648.980	7,344.910	459.56	170.04	2,019.5	31,828	6.13	1.67

Structure Summary:

		Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#1		999.370	999.370	172.71	24.46	286.1	11,847	3.37	2.44
#2		856.430	1,855.800	297.02	53.97	461.0	8,420	2.09	1.56
#3		2,374.080	4,229.880	643.53	150.86	1,161.2	7,904	1.65	1.18
#8	In	0.000	4,229.880	643.53	150.86	1,161.2	7,904	1.65	1.18
	Out			603.72	138.05	901.9	6,632	0.39	0.29
#4		1,068.640	5,298.520	655.72	179.99	1,593.4	25,101	5.51	1.42
#5		233.280	5,531.800	660.92	189.61	1,781.2	25,958	5.63	1.49
#6		1,164.130	6,695.930	679.87	235.67	2,626.8	26,001	5.16	1.62
#7		648.980	7,344.910	684.67	259.74	3,161.3	32,691	6.12	1.67

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Structure Summary:

		Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#1		999.370	999.370	238.50	33.34	407.6	12,383	3.74	2.70
#2		856.430	1,855.800	400.79	71.89	644.6	8,870	2.36	1.75
#3		2,374.080	4,229.880	833.00	195.96	1,557.5	8,153	1.78	1.27
#8	In	0.000	4,229.880	833.00	195.96	1,557.5	8,153	1.78	1.27
	Out			794.10	183.15	1,247.6	6,840	0.58	0.43
#4		1,068.640	5,298.520	863.16	237.10	2,179.5	25,893	5.80	1.50
#5		233.280	5,531.800	870.11	249.40	2,427.5	26,767	5.95	1.58
#6		1,164.130	6,695.930	894.70	308.63	3,552.4	26,816	5.48	1.72
#7		648.980	7,344.910	894.21	339.81	4,251.4	33,481	6.45	1.76

Structure Summary:

		Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#1		999.370	999.370	317.38	43.86	557.8	12,883	4.07	2.94
#2		856.430	1,855.800	522.95	92.86	868.3	9,277	2.60	1.92
#3		2,374.080	4,229.880	1,050.99	247.96	2,028.7	8,385	1.92	1.37
#8	In	0.000	4,229.880	1,050.99	247.96	2,028.7	8,385	1.92	1.37
	Out			934.11	235.15	1,646.4	7,047	0.73	0.53
#4		1,068.640	5,298.520	1,010.93	302.85	2,775.0	26,217	5.95	1.52
#5		233.280	5,531.800	1,021.67	318.22	3,091.3	27,184	6.14	1.60
#6		1,164.130	6,695.930	1,068.25	392.52	4,543.6	27,354	5.75	1.78
#7		648.980	7,344.910	1,114.89	431.90	5,564.1	34,562	7.33	1.99

Attachment 18-B-6

Chaco River Unnamed Tributary 1 Baseline Hydrology and Sedimentology SEDCAD™ Model Output

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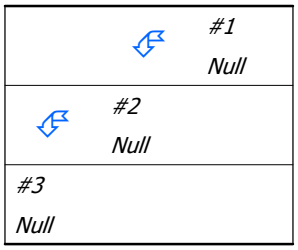
General Information

Storm Information:

Storm Type:	Type II-70
Design Storm:	10 yr - 24 hr
Rainfall Depth:	1.700 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	#2	0.195	0.373	
Null	#2	==>	#3	0.616	0.336	
Null	#3	==>	End	0.000	0.000	



Structure Routing Details:

Stru #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	8. Large gullies, diversions, and low flowing streams	2.78	98.00	3,527.00	5.00	0.195
#1	**Muskingum K:**					**0.195**
#2	8. Large gullies, diversions, and low flowing streams	1.35	104.00	7,726.00	3.48	0.616
#2	**Muskingum K:**					**0.616**

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Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#1	1,130.000	1,130.000	252.42	47.75	346.4	10,055	3.10	1.64
#2	308.400	1,438.400	269.56	61.36	838.9	46,632	15.71	3.35
#3	738.200	2,176.600	315.00	86.40	1,723.8	57,374	16.51	4.16

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Particle Size Distribution(s) at Each Structure

Structure #1:

Size (mm)	In/Out
0.4250	100.000%
0.2500	100.000%
0.1500	100.000%
0.0750	84.888%
0.0159	76.513%
0.0100	64.268%
0.0050	19.215%
0.0020	11.175%
0.0010	9.859%
0.0004	9.377%

Structure #2:

Size (mm)	In/Out
0.4250	100.000%
0.2500	100.000%
0.1500	91.419%
0.0750	76.823%
0.0159	71.182%
0.0100	60.871%
0.0050	16.822%
0.0020	9.582%
0.0010	8.620%
0.0004	7.924%

Structure #3:

Size (mm)	In/Out
0.4250	100.000%
0.2500	100.000%
0.1500	99.340%
0.0750	83.665%
0.0159	77.479%

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Size (mm)	In/Out
0.0100	67.332%
0.0050	20.543%
0.0020	11.640%
0.0010	10.620%
0.0004	9.703%

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Structure Detail:

Structure #1 (Null)

Structure #2 (Null)

Structure #3 (Null)

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	554.900	0.848	0.767	0.329	85.800	M	192.46	22.829
	2	575.100	0.956	0.000	0.000	86.500	M	193.40	24.924
	Σ	**1,130.000**						**252.42**	**47.753**
#2	1	308.400	0.366	0.000	0.000	86.700	M	198.59	13.603
	Σ	**1,438.400**						**269.56**	**61.356**
#3	1	738.200	0.569	0.000	0.000	83.300	M	273.63	25.045
	Σ	**2,176.600**						**315.00**	**86.401**

Subwatershed Sedimentology Detail:

Stru #	SWS #	Soil K	L (ft)	S (%)	C	P	PS #	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc (ml/l)	24VW (ml/l)
#1	1	0.178	280.00	2.00	0.2427	1.0000	1	173.8	9,230	3.31	2.00
	2	0.178	280.00	2.70	0.2630	1.0000	2	259.9	12,602	5.04	3.05
	Σ							**346.4**	**10,055**	**3.10**	**1.64**
#2	1	0.147	75.00	15.50	0.2106	1.0000	3	593.4	54,361	23.27	13.50
	Σ							**838.9**	**46,632**	**15.71**	**3.35**
#3	1	0.173	75.00	13.50	0.2539	1.0000	4	1,189.1	59,540	22.52	12.96
	Σ							**1,723.8**	**57,374**	**16.51**	**4.16**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	2.64	30.00	1,135.00	1.620	0.194
		8. Large gullies, diversions, and low flowing streams	0.87	57.00	6,569.00	2.790	0.654
#1	**1**	**Time of Concentration:**					**0.848**
#1	2	5. Nearly bare and untilled, and alluvial valley fans	1.16	10.00	861.00	1.070	0.223
		8. Large gullies, diversions, and low flowing streams	1.32	120.00	9,080.00	3.440	0.733
#1	**2**	**Time of Concentration:**					**0.956**
#2	1	5. Nearly bare and untilled, and alluvial valley fans	2.99	20.00	669.00	1.720	0.108

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
		8. Large gullies, diversions, and low flowing streams	3.24	163.00	5,025.00	5.400	0.258
#2	**1**	**Time of Concentration:**					**0.366**
#3	1	5. Nearly bare and untilled, and alluvial valley fans	3.08	10.00	325.00	1.750	0.051
		8. Large gullies, diversions, and low flowing streams	3.11	307.00	9,872.00	5.290	0.518
#3	**1**	**Time of Concentration:**					**0.569**

Subwatershed Muskingum Routing Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	8. Large gullies, diversions, and low flowing streams	1.19	108.00	9,039.00	3.270	0.767
#1	**1**	**Muskingum K:**					**0.767**

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#1	1,130.000	1,130.000	252.42	47.75	346.4	10,055	3.10	1.64
#2	308.400	1,438.400	269.56	61.36	838.9	46,632	15.71	3.35
#3	738.200	2,176.600	315.00	86.40	1,723.8	57,374	16.51	4.16

SEDCAD 4 for Windows - 2-Year 6-Hour Storm Summary

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#1	1,130.000	1,130.000	61.26	9.82	65.1	8,002	2.04	1.24
#2	308.400	1,438.400	66.47	12.74	165.1	40,469	11.54	2.69
#3	738.200	2,176.600	74.91	16.77	289.6	44,070	8.84	2.52

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#1	1,130.000	1,130.000	173.84	26.87	204.2	9,039	2.63	1.62
#2	308.400	1,438.400	186.45	34.62	501.3	42,785	13.57	3.35
#3	738.200	2,176.600	216.06	47.76	988.4	51,024	13.22	3.89

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#1	1,130.000	1,130.000	264.60	40.45	324.1	9,466	2.86	1.78
#2	308.400	1,438.400	282.68	52.00	788.2	44,029	14.59	3.66
#3	738.200	2,176.600	330.44	72.82	1,609.3	53,742	15.06	4.49

SEDCAD 4 for Windows - 50-Year 6-Hour Storm Summary

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#1	1,130.000	1,130.000	346.12	52.60	436.1	9,766	3.03	1.89
#2	308.400	1,438.400	369.13	67.56	1,053.7	44,695	15.19	3.86
#3	738.200	2,176.600	433.26	95.44	2,195.4	55,234	16.17	4.88

SEDCAD 4 for Windows - 100-Year 6-Hour Storm Summary

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#1	1,130.000	1,130.000	440.16	66.62	569.1	10,031	3.19	1.99
#2	308.400	1,438.400	468.81	85.48	1,367.1	45,209	15.68	4.04
#3	738.200	2,176.600	553.70	121.63	2,902.5	56,631	17.23	5.26

Attachment 18-B-7

Chaco River Unnamed Tributary 2 Baseline Hydrology and Sedimentology SEDCAD™ Model Output

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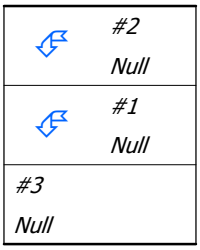
General Information

Storm Information:

Storm Type:	Type II-70
Design Storm:	10 yr - 24 hr
Rainfall Depth:	1.700 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	#3	0.770	0.336	
Null	#2	==>	#3	0.806	0.339	
Null	#3	==>	End	0.000	0.000	



Structure Routing Details:

Stru #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	8. Large gullies, diversions, and low flowing streams	1.34	129.00	9,631.00	3.47	0.770
#1	**Muskingum K:**					**0.770**
#2	8. Large gullies, diversions, and low flowing streams	1.42	147.00	10,368.00	3.57	0.806
#2	**Muskingum K:**					**0.806**

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Particle Size Distribution(s) at Each Structure

Structure #2:

Size (mm)	In/Out
0.4250	100.000%
0.2500	100.000%
0.1500	84.303%
0.0750	65.712%
0.0159	57.206%
0.0100	45.642%
0.0050	11.965%
0.0020	7.155%
0.0010	6.672%
0.0004	5.774%

Structure #1:

Size (mm)	In/Out
0.4250	100.000%
0.2500	100.000%
0.1500	86.801%
0.0750	69.316%
0.0159	62.348%
0.0100	52.340%
0.0050	20.488%
0.0020	11.234%
0.0010	10.472%
0.0004	9.549%

Structure #3:

Size (mm)	In/Out
0.4250	100.000%
0.2500	100.000%
0.1500	97.321%
0.0750	79.042%
0.0159	68.710%

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Size (mm)	In/Out
0.0100	54.180%
0.0050	15.525%
0.0020	9.150%
0.0010	8.376%
0.0004	7.549%

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#2	1	289.700	0.235	0.000	0.000	88.600	M	255.47	14.812
	Σ	**289.700**						**255.47**	**14.812**
#1	1	450.500	0.414	0.000	0.000	79.000	M	137.81	10.705
	Σ	**450.500**						**137.81**	**10.705**
#3	1	1,037.500	0.754	0.000	0.000	87.500	M	453.74	48.462
	Σ	**1,777.700**						**509.61**	**73.980**

Subwatershed Sedimentology Detail:

Stru #	SWS #	Soil K	L (ft)	S (%)	C	P	PS #	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc (ml/l)	24VW (ml/l)
#2	1	0.172	75.00	12.20	0.1802	1.0000	6	524.6	43,382	19.47	11.52
	Σ							**524.6**	**43,382**	**19.47**	**11.52**
#1	1	0.176	130.00	6.40	0.2851	1.0000	5	286.1	36,163	14.28	7.68
	Σ							**286.1**	**36,163**	**14.28**	**7.68**
#3	1	0.181	100.00	8.80	0.2219	1.0000	7	1,317.5	32,847	12.43	7.48
	Σ							**2,063.4**	**32,440**	**12.50**	**7.82**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	1.41	10.00	707.00	1.180	0.166
		8. Large gullies, diversions, and low flowing streams	4.02	216.00	5,371.00	6.010	0.248
#1	**1**	**Time of Concentration:**					**0.414**
#2	1	5. Nearly bare and untilled, and alluvial valley fans	4.02	21.00	522.00	2.000	0.072
		8. Large gullies, diversions, and low flowing streams	3.55	118.00	3,325.00	5.650	0.163
#2	**1**	**Time of Concentration:**					**0.235**
#3	1	5. Nearly bare and untilled, and alluvial valley fans	10.96	25.00	228.00	3.310	0.019
		8. Large gullies, diversions, and low flowing streams	2.35	285.00	12,151.00	4.590	0.735

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Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#3	**1**	**Time of Concentration:**					**0.754**

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#2	289.700	289.700	255.47	14.81	524.6	43,382	19.47	11.52
#1	450.500	450.500	137.81	10.70	286.1	36,163	14.28	7.68
#3	1,037.500	1,777.700	509.61	73.98	2,063.4	32,440	12.50	7.82

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#2	289.700	289.700	83.25	3.63	127.4	38,593	15.97	10.55
#1	450.500	450.500	14.63	1.02	21.9	24,740	6.06	3.83
#3	1,037.500	1,777.700	131.44	15.66	425.7	29,143	9.74	6.62

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#2	289.700	289.700	191.34	8.80	333.2	40,059	17.47	11.99
#1	450.500	450.500	82.98	4.93	139.6	31,349	11.31	7.43
#3	1,037.500	1,777.700	355.90	41.83	1,271.9	30,761	11.55	8.31

SEDCAD 4 for Windows - 25-Year 6-Hour Storm Summary

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#2	289.700	289.700	272.06	12.73	499.2	40,973	18.25	12.67
#1	450.500	450.500	147.14	8.61	262.7	33,300	12.97	8.65
#3	1,037.500	1,777.700	537.85	62.72	1,999.0	31,788	12.43	9.07

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#2	289.700	289.700	341.38	16.18	648.4	41,523	18.73	13.11
#1	450.500	450.500	207.49	12.13	385.9	34,347	13.87	9.34
#3	1,037.500	1,777.700	701.94	81.46	2,660.8	32,115	12.79	9.47

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#2	289.700	289.700	418.81	20.11	821.1	41,988	19.13	13.49
#1	450.500	450.500	279.12	16.39	539.2	35,182	14.59	9.92
#3	1,037.500	1,777.700	891.87	103.10	3,364.8	32,089	12.71	9.53

Attachment 18-B-8

Chaco River Unnamed Tributary 3 Baseline Hydrology and Sedimentology SEDCAD™ Model Output

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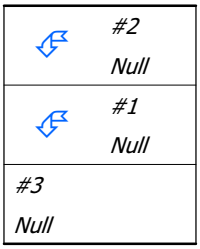
General Information

Storm Information:

Storm Type:	Type II-70
Design Storm:	10 yr - 24 hr
Rainfall Depth:	1.700 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	#3	0.660	0.333	
Null	#2	==>	#3	0.547	0.341	
Null	#3	==>	End	0.000	0.000	



Structure Routing Details:

Stru #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	8. Large gullies, diversions, and low flowing streams	1.28	103.00	8,056.00	3.39	0.660
#1	**Muskingum K:**					**0.660**
#2	8. Large gullies, diversions, and low flowing streams	1.48	106.00	7,172.00	3.64	0.547
#2	**Muskingum K:**					**0.547**

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Particle Size Distribution(s) at Each Structure

Structure #2:

Size (mm)	In/Out
0.4250	100.000%
0.2500	100.000%
0.1500	73.793%
0.0750	57.125%
0.0159	51.559%
0.0100	43.856%
0.0050	14.768%
0.0020	7.783%
0.0010	7.135%
0.0004	6.589%

Structure #1:

Size (mm)	In/Out
0.4250	100.000%
0.2500	100.000%
0.1500	82.528%
0.0750	63.498%
0.0159	56.057%
0.0100	45.492%
0.0050	15.077%
0.0020	8.499%
0.0010	7.818%
0.0004	7.135%

Structure #3:

Size (mm)	In/Out
0.4250	100.000%
0.2500	100.000%
0.1500	99.187%
0.0750	83.546%
0.0159	74.834%

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Size (mm)	In/Out
0.0100	61.887%
0.0050	18.772%
0.0020	10.135%
0.0010	9.185%
0.0004	8.510%

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Structure Detail:

Structure #2 (Null)

Structure #1 (Null)

Structure #3 (Null)

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#2	1	157.200	0.256	0.000	0.000	80.700	M	72.96	4.337
	Σ	**157.200**						**72.96**	**4.337**
#1	1	400.000	0.337	0.000	0.000	83.100	M	199.74	13.411
	Σ	**400.000**						**199.74**	**13.411**
#3	1	856.400	0.642	0.000	0.000	84.000	M	310.59	30.693
	Σ	**1,413.600**						**376.22**	**48.441**

Subwatershed Sedimentology Detail:

Stru #	SWS #	Soil K	L (ft)	S (%)	C	P	PS #	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc (ml/l)	24VW (ml/l)
#2	1	0.147	100.00	9.20	0.2851	1.0000	9	136.6	42,535	19.66	10.56
	Σ							**136.6**	**42,535**	**19.66**	**10.56**
#1	1	0.174	100.00	10.10	0.2539	1.0000	8	563.3	54,313	24.32	13.60
	Σ							**563.3**	**54,313**	**24.32**	**13.60**
#3	1	0.135	130.00	6.20	0.2741	1.0000	10	582.8	23,829	9.14	5.32
	Σ							**1,023.6**	**26,067**	**8.50**	**5.03**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	2.56	10.00	390.00	1.600	0.067
		8. Large gullies, diversions, and low flowing streams	4.13	245.00	5,934.00	6.090	0.270
#1	**1**	**Time of Concentration:**					**0.337**
#2	1	5. Nearly bare and untilled, and alluvial valley fans	4.83	10.00	207.00	2.190	0.026
		8. Large gullies, diversions, and low flowing streams	4.31	222.00	5,156.00	6.220	0.230
#2	**1**	**Time of Concentration:**					**0.256**
#3	1	5. Nearly bare and untilled, and alluvial valley fans	2.22	8.00	361.00	1.480	0.067
		8. Large gullies, diversions, and low flowing streams	2.65	268.00	10,105.00	4.880	0.575

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Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#3	**1**	**Time of Concentration:**					**0.642**

SEDCAD 4 for Windows - 10-Year 24-Hour Storm Summary

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#2	157.200	157.200	72.96	4.34	136.6	42,535	19.66	10.56
#1	400.000	400.000	199.74	13.41	563.3	54,313	24.32	13.60
#3	856.400	1,413.600	376.22	48.44	1,023.6	26,067	8.50	5.03

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#2	157.200	157.200	11.21	0.52	14.7	33,425	12.63	7.68
#1	400.000	400.000	39.69	2.12	81.0	43,413	16.19	10.36
#3	856.400	1,413.600	71.05	7.91	132.5	18,116	3.76	2.55

SEDCAD 4 for Windows - 10-Year 6-Hour Storm Summary

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#2	157.200	157.200	47.73	2.11	72.0	38,365	17.05	11.00
#1	400.000	400.000	135.39	7.00	314.8	48,997	21.02	13.97
#3	856.400	1,413.600	247.39	25.51	554.1	21,973	6.23	4.50

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#2	157.200	157.200	78.36	3.54	126.8	39,397	18.09	11.95
#1	400.000	400.000	212.31	11.13	525.2	50,430	22.36	15.13
#3	856.400	1,413.600	396.85	40.31	949.1	24,005	7.62	5.45

SEDCAD 4 for Windows - 50-Year 6-Hour Storm Summary

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#2	157.200	157.200	106.13	4.88	180.0	39,907	18.63	12.50
#1	400.000	400.000	283.93	14.94	728.6	51,762	23.44	15.97
#3	856.400	1,413.600	535.69	53.89	1,334.9	25,350	8.54	6.09

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#2	157.200	157.200	138.65	6.48	245.0	40,410	19.12	12.99
#1	400.000	400.000	367.11	19.41	974.2	52,915	24.37	16.71
#3	856.400	1,413.600	698.88	69.81	1,803.4	26,430	9.33	6.65

Attachment 18-B-9

Brimhall Wash Baseline Hydrology and Sedimentology SEDCAD™ Model Output

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General Information

Storm Information:

Storm Type:	Type II-70
Design Storm:	10 yr - 24 hr
Rainfall Depth:	1.700 inches

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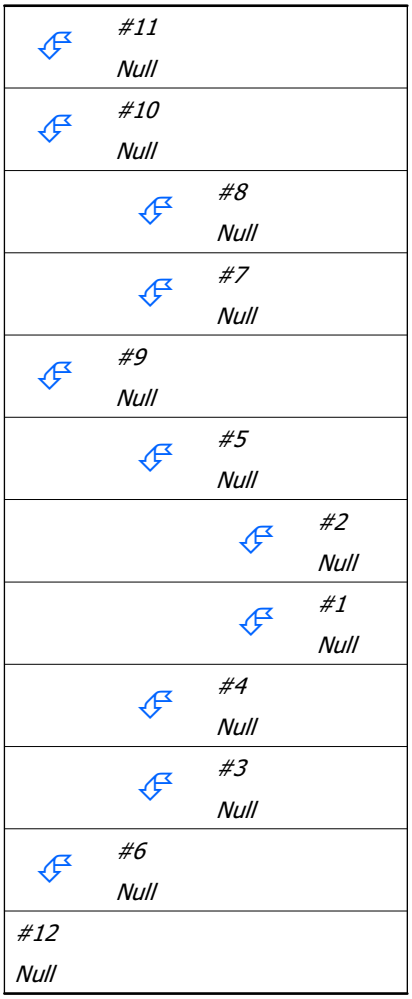
Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	#4	7.026	0.289	
Null	#2	==>	#4	6.888	0.289	
Null	#3	==>	#6	2.906	0.256	
Null	#4	==>	#6	1.008	0.263	
Null	#5	==>	#6	0.075	0.263	
Null	#6	==>	#12	3.138	0.266	
Null	#7	==>	#9	1.050	0.280	
Null	#8	==>	#9	0.683	0.314	
Null	#9	==>	#12	2.860	0.269	
Null	#10	==>	#12	1.670	0.267	
Null	#11	==>	#12	1.194	0.263	
Null	#12	==>	End	0.000	0.000	



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Structure Routing Details:

Stru #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	8. Large gullies, diversions, and low flowing streams	0.60	354.00	58,687.00	2.32	7.026
#1	**Muskingum K:**					**7.026**
#2	8. Large gullies, diversions, and low flowing streams	0.61	350.00	57,784.38	2.33	6.888
#2	**Muskingum K:**					**6.888**
#3	8. Large gullies, diversions, and low flowing streams	0.35	66.00	18,623.02	1.78	2.906
#3	**Muskingum K:**					**2.906**
#4	8. Large gullies, diversions, and low flowing streams	0.40	27.00	6,828.00	1.88	1.008
#4	**Muskingum K:**					**1.008**
#5	8. Large gullies, diversions, and low flowing streams	0.39	2.00	509.00	1.88	0.075
#5	**Muskingum K:**					**0.075**
#6	8. Large gullies, diversions, and low flowing streams	0.42	92.00	21,916.00	1.94	3.138
#6	**Muskingum K:**					**3.138**
#7	8. Large gullies, diversions, and low flowing streams	0.52	43.00	8,206.00	2.17	1.050
#7	**Muskingum K:**					**1.050**
#8	8. Large gullies, diversions, and low flowing streams	0.92	65.00	7,064.00	2.87	0.683
#8	**Muskingum K:**					**0.683**
#9	8. Large gullies, diversions, and low flowing streams	0.44	89.00	20,387.00	1.98	2.860
#9	**Muskingum K:**					**2.860**
#10	8. Large gullies, diversions, and low flowing streams	0.43	50.00	11,726.07	1.95	1.670
#10	**Muskingum K:**					**1.670**
#11	8. Large gullies, diversions, and low flowing streams	0.40	32.00	8,087.00	1.88	1.194
#11	**Muskingum K:**					**1.194**

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Particle Size Distribution(s) at Each Structure

Structure #11:

Size (mm)	In/Out
0.4250	100.000%
0.2500	100.000%
0.1500	100.000%
0.0750	78.443%
0.0159	70.274%
0.0100	59.153%
0.0050	18.545%
0.0020	9.880%
0.0010	8.950%
0.0004	8.278%

Structure #10:

Size (mm)	In/Out
0.4250	100.000%
0.2500	100.000%
0.1500	96.293%
0.0750	74.607%
0.0159	67.386%
0.0100	57.556%
0.0050	19.260%
0.0020	10.343%
0.0010	9.407%
0.0004	8.690%

Structure #8:

Size (mm)	In/Out
0.4250	100.000%
0.2500	100.000%
0.1500	100.000%

Size (mm)	In/Out
0.0750	88.192%
0.0159	77.274%
0.0100	61.266%
0.0050	19.643%
0.0020	10.926%
0.0010	9.690%
0.0004	9.315%

Structure #7:

Size (mm)	In/Out
0.4250	100.000%
0.2500	100.000%
0.1500	100.000%
0.0750	100.000%
0.0159	89.813%
0.0100	64.996%
0.0050	21.662%
0.0020	13.769%
0.0010	12.381%
0.0004	11.599%

Structure #9:

Size (mm)	In/Out
0.4250	100.000%
0.2500	100.000%
0.1500	100.000%
0.0750	93.265%
0.0159	82.119%
0.0100	60.876%
0.0050	19.900%
0.0020	12.270%
0.0010	11.014%
0.0004	10.347%

Structure #5:

Size (mm)	In/Out
0.4250	100.000%
0.2500	100.000%

Size (mm)	In/Out
0.1500	100.000%
0.0750	100.000%
0.0159	100.000%
0.0100	100.000%
0.0050	56.735%
0.0020	32.384%
0.0010	30.012%
0.0004	27.081%

Structure #2:

Size (mm)	In/Out
0.4250	100.000%
0.2500	100.000%
0.1500	100.000%
0.0750	100.000%
0.0159	100.000%
0.0100	100.000%
0.0050	40.426%
0.0020	23.075%
0.0010	21.385%
0.0004	19.296%

Structure #1:

Size (mm)	In/Out
0.4250	100.000%
0.2500	100.000%
0.1500	100.000%
0.0750	100.000%
0.0159	100.000%
0.0100	100.000%
0.0050	33.256%
0.0020	18.805%
0.0010	17.471%
0.0004	15.526%

Structure #4:

Size (mm)	In/Out
0.4250	100.000%

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Size (mm)	In/Out
0.2500	100.000%
0.1500	100.000%
0.0750	100.000%
0.0159	100.000%
0.0100	100.000%
0.0050	50.016%
0.0020	28.083%
0.0010	26.043%
0.0004	23.505%

Structure #3:

Size (mm)	In/Out
0.4250	100.000%
0.2500	100.000%
0.1500	100.000%
0.0750	100.000%
0.0159	100.000%
0.0100	100.000%
0.0050	49.029%
0.0020	29.298%
0.0010	27.565%
0.0004	23.997%

Structure #6:

Size (mm)	In/Out
0.4250	100.000%
0.2500	100.000%
0.1500	100.000%
0.0750	100.000%
0.0159	100.000%
0.0100	100.000%
0.0050	49.800%
0.0020	29.045%
0.0010	27.131%
0.0004	24.007%

Structure #12:

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Size (mm)	In/Out
0.4250	100.000%
0.2500	100.000%
0.1500	100.000%
0.0750	98.995%
0.0159	98.196%
0.0100	96.796%
0.0050	46.480%
0.0020	27.168%
0.0010	25.314%
0.0004	22.476%

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Structure Detail:

Structure #11 (Null)

Structure #10 (Null)

Structure #8 (Null)

Structure #7 (Null)

Structure #9 (Null)

Structure #5 (Null)

Structure #2 (Null)

Structure #1 (Null)

Structure #4 (Null)

Structure #3 (Null)

Structure #6 (Null)

Structure #12 (Null)

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#11	1	130.300	0.220	0.378	0.366	76.900	M	45.60	2.563
	2	497.600	0.677	0.000	0.000	84.400	M	180.11	18.398
	Σ	**627.900**						**208.51**	**20.961**
#10	1	179.800	0.284	0.426	0.348	78.000	M	61.98	3.908
	2	441.400	0.558	0.000	0.000	84.200	M	179.65	16.068
	Σ	**621.200**						**203.32**	**19.976**
#8	1	782.600	1.122	0.000	0.000	83.400	M	176.74	26.725
	Σ	**782.600**						**176.74**	**26.725**
#7	1	791.100	1.267	0.448	0.311	90.100	M	287.84	44.592
	2	857.100	1.460	0.000	0.000	83.100	M	151.98	28.576
	Σ	**1,648.200**						**416.52**	**73.168**
#9	1	652.600	0.936	0.000	0.000	86.400	M	221.16	28.077
	Σ	**3,083.400**						**501.77**	**127.971**
#5	1	7,064.500	6.361	0.000	0.000	83.500	M	364.87	243.103
	Σ	**7,064.500**						**364.87**	**243.103**
#2	1	6,633.800	3.130	0.000	0.000	83.000	M	609.44	219.407
	Σ	**6,633.800**						**609.44**	**219.407**
#1	1	4,622.300	2.422	0.000	0.000	84.700	M	618.35	174.694
	Σ	**4,622.300**						**618.35**	**174.694**
#4	1	12,415.200	9.741	0.000	0.000	81.600	M	370.95	365.237
	Σ	**23,671.300**						**1,395.56**	**759.338**
#3	1	9,427.600	4.941	0.000	0.000	86.200	M	770.69	399.334
	Σ	**9,427.600**						**770.69**	**399.334**
#6	1	7,063.800	5.356	0.000	0.000	89.000	M	678.40	367.720
	Σ	**47,227.200**						**1,836.38**	**1,769.496**
#12	1	2,976.500	3.747	0.000	0.000	86.700	M	324.14	130.891
	Σ	**54,536.200**						**1,866.78**	**2,069.294**

Subwatershed Sedimentology Detail:

Stru #	SWS #	Soil K	L (ft)	S (%)	C	P	PS #	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc (ml/l)	24VW (ml/l)
#11	1	0.176	200.00	4.60	0.3157	1.0000	10	69.2	37,730	18.00	9.37
	2	0.140	130.00	7.40	0.2520	1.0000	13	364.8	24,715	8.92	5.22
	Σ							**379.8**	**22,864**	**7.93**	**4.59**
#10	1	0.184	200.00	4.70	0.2962	1.0000	9	104.8	36,611	16.68	8.88
	2	0.139	130.00	6.50	0.2630	1.0000	13	309.9	24,384	9.53	5.50
	Σ							**339.6**	**20,430**	**7.33**	**4.45**
#8	1	0.173	280.00	2.40	0.2851	1.0000	7	242.9	11,089	3.68	2.21
	Σ							**242.9**	**11,089**	**3.68**	**2.21**
#7	1	0.243	280.00	2.00	0.2006	1.0000	5	357.5	9,302	3.52	2.22
	2	0.209	280.00	2.70	0.2762	1.0000	6	301.9	12,642	3.53	2.16
	Σ							**618.9**	**9,602**	**2.91**	**1.88**
#9	1	0.212	240.00	3.70	0.2445	1.0000	8	422.4	18,178	6.95	4.21
	Σ							**1,283.5**	**17,533**	**5.87**	**2.46**
#5	1	0.180	200.00	4.30	0.2445	1.0000	12	2,119.8	9,202	0.35	0.25
	Σ							**2,119.8**	**9,202**	**0.35**	**0.25**
#2	1	0.179	100.00	8.40	0.2427	1.0000	12	3,642.3	18,568	0.98	0.65
	Σ							**3,642.3**	**18,568**	**0.98**	**0.65**
#1	1	0.164	100.00	8.00	0.2219	1.0000	1	2,507.5	16,355	0.97	0.63
	Σ							**2,507.5**	**16,355**	**0.97**	**0.63**
#4	1	0.170	200.00	4.70	0.2651	1.0000	3	3,004.9	8,421	0.17	0.13
	Σ							**9,122.4**	**15,079**	**0.66**	**0.41**
#3	1	0.190	100.00	10.30	0.1857	1.0000	2	6,612.5	17,732	0.79	0.55
	Σ							**6,612.5**	**17,732**	**0.79**	**0.55**
#6	1	0.200	130.00	6.50	0.1727	1.0000	4	3,549.2	10,278	0.49	0.34
	Σ							**21,385.5**	**13,137**	**0.58**	**0.40**
#12	1	0.196	200.00	4.80	0.2219	1.0000	11	1,542.4	12,918	0.76	0.51
	Σ							**24,877.7**	**16,430**	**1.11**	**0.62**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	3.13	25.00	799.00	1.760	0.126

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
		8. Large gullies, diversions, and low flowing streams	1.77	581.00	32,907.00	3.980	2.296
#1	**1**	**Time of Concentration:**					**2.422**
#2	1	5. Nearly bare and untilled, and alluvial valley fans	4.24	25.00	589.00	2.060	0.079
		8. Large gullies, diversions, and low flowing streams	1.47	585.00	39,874.00	3.630	3.051
#2	**1**	**Time of Concentration:**					**3.130**
#3	1	5. Nearly bare and untilled, and alluvial valley fans	5.58	30.00	538.00	2.360	0.063
		8. Large gullies, diversions, and low flowing streams	1.41	876.00	62,341.00	3.550	4.878
#3	**1**	**Time of Concentration:**					**4.941**
#4	1	5. Nearly bare and untilled, and alluvial valley fans	2.90	40.00	1,380.00	1.700	0.225
		8. Large gullies, diversions, and low flowing streams	0.88	855.00	96,614.00	2.820	9.516
#4	**1**	**Time of Concentration:**					**9.741**
#5	1	5. Nearly bare and untilled, and alluvial valley fans	1.19	13.00	1,096.00	1.080	0.281
		8. Large gullies, diversions, and low flowing streams	0.93	590.00	63,262.00	2.890	6.080
#5	**1**	**Time of Concentration:**					**6.361**
#6	1	5. Nearly bare and untilled, and alluvial valley fans	5.43	45.00	829.00	2.320	0.099
		8. Large gullies, diversions, and low flowing streams	1.03	597.00	57,726.00	3.050	5.257
#6	**1**	**Time of Concentration:**					**5.356**
#7	1	5. Nearly bare and untilled, and alluvial valley fans	2.18	25.00	1,147.00	1.470	0.216
		8. Large gullies, diversions, and low flowing streams	0.94	103.00	10,979.00	2.900	1.051
#7	**1**	**Time of Concentration:**					**1.267**
#7	2	5. Nearly bare and untilled, and alluvial valley fans	0.73	8.00	1,097.00	0.850	0.358
		8. Large gullies, diversions, and low flowing streams	1.02	122.00	11,984.00	3.020	1.102
#7	**2**	**Time of Concentration:**					**1.460**
#8	1	5. Nearly bare and untilled, and alluvial valley fans	1.08	5.00	465.00	1.030	0.125
		8. Large gullies, diversions, and low flowing streams	1.19	140.00	11,748.00	3.270	0.997
#8	**1**	**Time of Concentration:**					**1.122**
#9	1	5. Nearly bare and untilled, and alluvial valley fans	1.20	5.00	417.00	1.090	0.106
		8. Large gullies, diversions, and low flowing streams	1.38	145.00	10,519.00	3.520	0.830
#9	**1**	**Time of Concentration:**					**0.936**

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#10	1	5. Nearly bare and untilled, and alluvial valley fans	2.98	25.00	839.01	1.720	0.135
		8. Large gullies, diversions, and low flowing streams	3.86	122.00	3,162.01	5.890	0.149
#10	**1**	**Time of Concentration:**					**0.284**
#10	2	5. Nearly bare and untilled, and alluvial valley fans	2.92	20.00	686.00	1.700	0.112
		8. Large gullies, diversions, and low flowing streams	2.26	164.00	7,248.00	4.510	0.446
#10	**2**	**Time of Concentration:**					**0.558**
#11	1	5. Nearly bare and untilled, and alluvial valley fans	1.30	5.00	386.00	1.130	0.094
		8. Large gullies, diversions, and low flowing streams	4.01	110.00	2,743.00	6.000	0.126
#11	**1**	**Time of Concentration:**					**0.220**
#11	2	5. Nearly bare and untilled, and alluvial valley fans	0.71	5.00	706.00	0.840	0.233
		8. Large gullies, diversions, and low flowing streams	3.10	262.00	8,453.00	5.280	0.444
#11	**2**	**Time of Concentration:**					**0.677**
#12	1	5. Nearly bare and untilled, and alluvial valley fans	2.61	20.00	766.00	1.610	0.132
		8. Large gullies, diversions, and low flowing streams	0.49	134.00	27,333.00	2.100	3.615
#12	**1**	**Time of Concentration:**					**3.747**

Subwatershed Muskingum Routing Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#7	1	8. Large gullies, diversions, and low flowing streams	0.87	39.00	4,508.00	2.790	0.448
#7	**1**	**Muskingum K:**					**0.448**
#10	1	8. Large gullies, diversions, and low flowing streams	1.70	102.00	6,003.17	3.910	0.426
#10	**1**	**Muskingum K:**					**0.426**
#11	1	8. Large gullies, diversions, and low flowing streams	2.40	152.00	6,329.00	4.640	0.378
#11	**1**	**Muskingum K:**					**0.378**

SEDCAD 4 for Windows - 10-Year 24-Hour Storm Summary

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#11	627.900	627.900	208.51	20.96	379.8	22,864	7.93	4.59
#10	621.200	621.200	203.32	19.98	339.6	20,430	7.33	4.45
#8	782.600	782.600	176.74	26.72	242.9	11,089	3.68	2.21
#7	1,648.200	1,648.200	416.52	73.17	618.9	9,602	2.91	1.88
#9	652.600	3,083.400	501.77	127.97	1,283.5	17,533	5.87	2.46
#5	7,064.500	7,064.500	364.87	243.10	2,119.8	9,202	0.35	0.25
#2	6,633.800	6,633.800	609.44	219.41	3,642.3	18,568	0.98	0.65
#1	4,622.300	4,622.300	618.35	174.69	2,507.5	16,355	0.97	0.63
#4	12,415.200	23,671.300	1,395.56	759.34	9,122.4	15,079	0.66	0.41
#3	9,427.600	9,427.600	770.69	399.33	6,612.5	17,732	0.79	0.55
#6	7,063.800	47,227.200	1,836.38	1,769.50	21,385.5	13,137	0.58	0.40
#12	2,976.500	54,536.200	1,866.78	2,069.29	24,877.7	16,430	1.11	0.62

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#11	627.900	627.900	39.18	3.44	58.2	17,936	4.70	3.24
#10	621.200	621.200	38.42	3.12	48.7	16,623	4.96	3.41
#8	782.600	782.600	33.56	4.34	34.6	8,286	1.77	1.25
#7	1,648.200	1,648.200	113.92	16.57	122.6	7,363	1.61	1.19
#9	652.600	3,083.400	132.12	26.79	237.7	14,085	3.46	1.60
#5	7,064.500	7,064.500	73.33	39.86	313.6	7,833	0.20	0.15
#2	6,633.800	6,633.800	113.63	34.28	502.8	14,498	0.63	0.46
#1	4,622.300	4,622.300	133.84	31.90	410.7	12,882	0.67	0.49
#4	12,415.200	23,671.300	270.45	115.58	1,266.2	12,144	0.42	0.30
#3	9,427.600	9,427.600	191.59	82.36	1,252.9	15,120	0.54	0.40
#6	7,063.800	47,227.200	412.18	330.38	3,665.3	10,612	0.38	0.30
#12	2,976.500	54,536.200	424.62	391.77	4,305.0	12,528	0.66	0.43

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#11	627.900	627.900	67.51	5.70	101.4	18,643	5.50	3.83
#10	621.200	621.200	65.73	5.27	85.5	16,709	5.52	3.91
#8	782.600	782.600	57.95	7.25	62.7	8,954	2.27	1.60
#7	1,648.200	1,648.200	170.31	24.62	195.6	7,863	1.91	1.41
#9	652.600	3,083.400	199.85	40.87	389.4	14,841	4.04	1.90
#5	7,064.500	7,064.500	123.61	66.40	559.0	8,413	0.25	0.19
#2	6,633.800	6,633.800	197.62	58.11	921.2	15,751	0.73	0.54
#1	4,622.300	4,622.300	219.05	51.15	704.9	13,820	0.75	0.55
#4	12,415.200	23,671.300	458.59	197.77	2,308.6	13,053	0.49	0.34
#3	9,427.600	9,427.600	297.49	126.68	2,040.0	16,038	0.62	0.46
#6	7,063.800	47,227.200	644.62	524.34	6,165.1	11,518	0.44	0.34
#12	2,976.500	54,536.200	662.27	618.78	7,214.3	13,441	0.77	0.50

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#11	627.900	627.900	220.69	17.43	353.5	21,295	7.25	5.04
#10	621.200	621.200	214.79	16.55	315.0	18,926	6.70	4.92
#8	782.600	782.600	186.07	22.23	225.5	10,447	3.38	2.40
#7	1,648.200	1,648.200	434.97	62.38	578.9	9,129	2.68	2.00
#9	652.600	3,083.400	525.00	108.42	1,199.1	16,496	5.38	2.64
#5	7,064.500	7,064.500	383.17	202.37	1,966.0	9,748	0.36	0.27
#2	6,633.800	6,633.800	641.49	182.01	3,376.0	18,514	0.96	0.71
#1	4,622.300	4,622.300	648.78	146.59	2,334.9	16,001	0.94	0.68
#4	12,415.200	23,671.300	1,438.75	629.63	8,423.8	15,145	0.65	0.45
#3	9,427.600	9,427.600	807.15	338.30	6,184.0	18,252	0.80	0.59
#6	7,063.800	47,227.200	1,783.33	1,487.05	19,898.7	13,571	0.59	0.44
#12	2,976.500	54,536.200	1,824.37	1,740.68	23,161.2	15,731	1.04	0.66

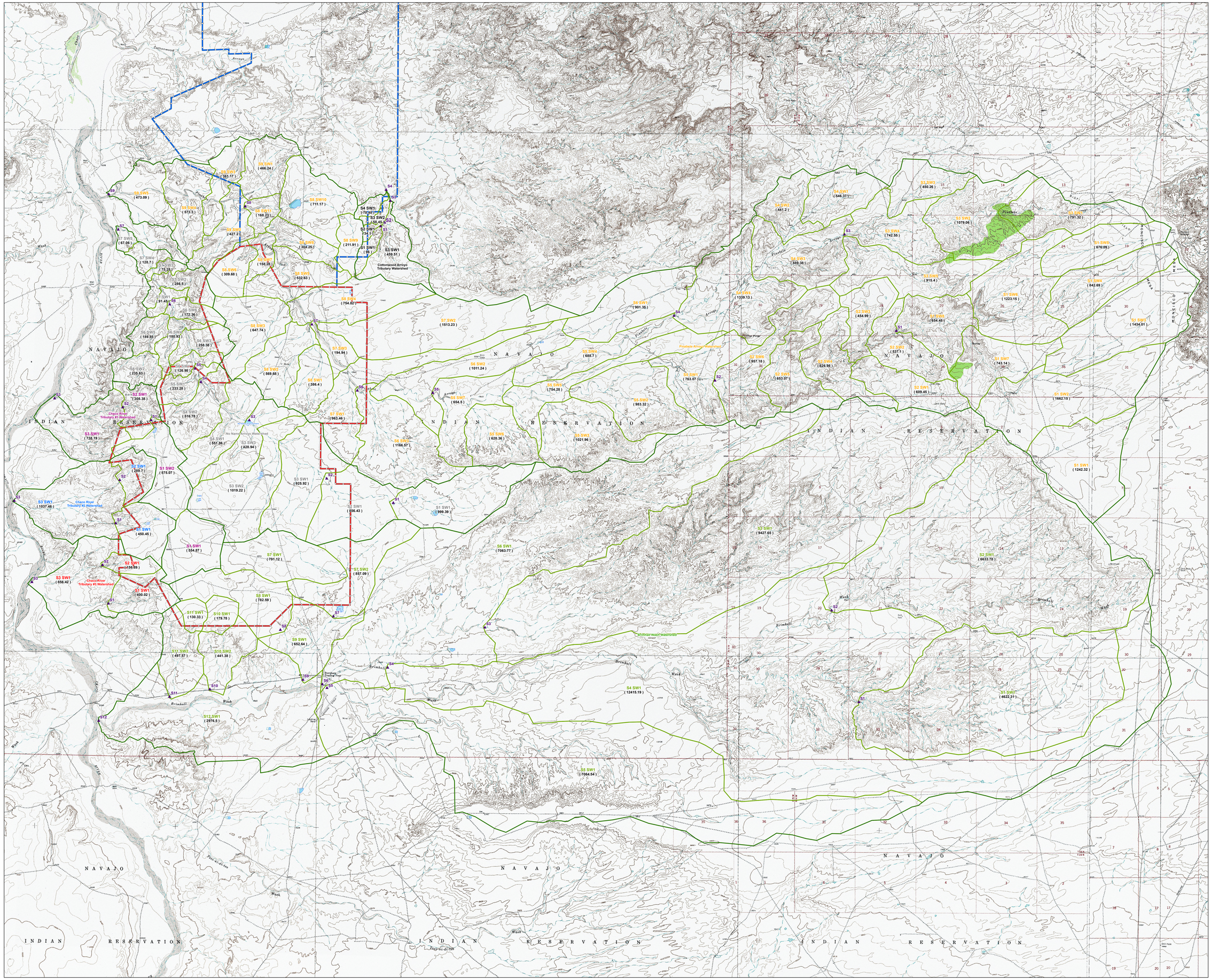
Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#11	627.900	627.900	298.09	23.33	493.0	22,125	7.71	5.37
#10	621.200	621.200	291.44	22.27	443.1	19,771	7.09	5.21
#8	782.600	782.600	250.44	29.73	313.4	10,828	3.66	2.61
#7	1,648.200	1,648.200	560.86	80.32	775.8	9,509	2.91	2.17
#9	652.600	3,083.400	681.42	140.96	1,619.1	16,986	5.75	2.85
#5	7,064.500	7,064.500	513.70	270.38	2,724.9	10,120	0.39	0.29
#2	6,633.800	6,633.800	867.47	244.49	4,715.9	19,263	1.03	0.75
#1	4,622.300	4,622.300	861.22	193.44	3,195.9	16,594	0.99	0.72
#4	12,415.200	23,671.300	1,933.76	848.67	11,760.3	15,718	0.70	0.48
#3	9,427.600	9,427.600	1,052.85	439.85	8,312.7	18,878	0.85	0.62
#6	7,063.800	47,227.200	2,355.31	1,960.16	27,134.8	14,129	0.63	0.47
#12	2,976.500	54,536.200	2,390.53	2,290.64	31,496.6	16,362	1.11	0.70

SEDCAD 4 for Windows - 100-Year 6-Hour Storm Summary

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#11	627.900	627.900	389.65	30.26	663.6	22,863	8.12	5.68
#10	621.200	621.200	381.81	29.01	599.9	20,504	7.43	5.47
#8	782.600	782.600	325.87	38.53	419.9	11,167	3.91	2.80
#7	1,648.200	1,648.200	705.27	100.93	1,009.6	9,853	3.12	2.32
#9	652.600	3,083.400	862.62	178.52	2,120.0	17,421	6.09	3.04
#5	7,064.500	7,064.500	666.78	350.03	3,644.0	10,459	0.42	0.31
#2	6,633.800	6,633.800	1,133.66	317.89	6,346.0	19,941	1.08	0.79
#1	4,622.300	4,622.300	1,108.68	247.90	4,230.2	17,131	1.04	0.75
#4	12,415.200	23,671.300	2,515.25	1,106.60	15,820.3	16,243	0.74	0.51
#3	9,427.600	9,427.600	1,336.36	556.86	10,841.8	19,452	0.90	0.66
#6	7,063.800	47,227.200	3,044.36	2,510.61	35,822.8	14,635	0.67	0.49
#12	2,976.500	54,536.200	3,047.08	2,929.89	41,272.4	16,877	1.17	0.74



Legend

- SEDCAD Structures
- Major Watersheds
- Subwatersheds
- No Name Permit Boundary
- NTEC Lease Boundary
- Ponds

N

0 1,250 2,500 5,000 7,500 Feet

1:30,000

Coordinate System:
NAD 1983 StatePlane New Mexico West FIPS 3003 Feet
Datum: North American 1983
Units: US Feet

NORWEST Applied Hydrology

REV NO.	DATE	DRAFT BY	REVISION DESCRIPTION	ENG.	ECO	PE
				APPROVAL		

Exhibit 18.B-1

Navajo Transitional Energy Company

No Name Permit

SEDCAD4 Subwatersheds

(Sheet 1 of 1)

PREPARED BY: TH	DRAWN BY: TH	PAPER SIZE: ARCH E
APPROVED BY: JJ	DATE: 6/1/2025	

Table 18-B-1: SEDCAD™ Model Input Factors Based on Erodible Particle Size Distribution Texture Class.

EPSD texture	K-factor	Run-off curve number	Canopy cover	Surface cover
Fine	0.20	93.0	4.7	30.8
Fine loamy	0.27	92.4	9.2	18.1
Coarse loamy	0.10	81.9	14.5	7.9
Sandy	0.20	65.6	13.9	1.6

EPSD Designation Diameter (mm)	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
0.450	100.000	100.000	100.000	100.000	100.000	100.000	100.000	100.000	100.000	100.000
0.250	85.529	83.954	83.494	79.684	74.336	71.800	68.824	73.040	66.130	59.234
0.150	72.267	70.070	68.714	64.718	55.514	53.158	47.671	50.320	47.750	40.272
0.075	58.134	56.187	54.477	51.673	42.977	40.816	35.579	35.798	36.084	33.795
0.01585	49.962	48.376	46.844	44.689	37.721	35.600	31.445	31.104	31.122	31.492
0.01000	38.953	37.808	36.471	35.083	30.403	28.065	25.380	24.310	23.407	28.022
0.005012	9.675	9.683	9.177	10.018	9.205	9.529	8.929	6.708	10.343	13.538
0.001995	6.279	6.204	5.875	6.237	5.303	5.591	4.938	3.770	6.209	7.108
0.001000	6.010	5.917	5.567	5.908	4.905	5.155	4.462	3.276	5.698	6.676
0.000398	4.942	4.914	4.659	5.035	4.387	4.686	4.216	3.184	5.329	6.156

Note: Values reported as percent of sample passing through sieve with corresponding diameter
EPSD- erodible particle size distribution

EPSD Designation Diameter (mm)	P11	P12	P13	P14	P15	P16	P17	P18	P19	P20
0.450	100.000	100.000	100.000	100.000	100.000	100.000	100.000	100.000	100.000	100.000
0.250	71.599	65.531	66.688	69.479	71.446	76.546	69.115	68.866	61.049	69.805
0.150	57.036	45.088	46.416	50.980	55.482	60.175	48.743	45.562	42.198	50.039
0.075	47.507	34.380	34.657	38.320	44.594	46.743	36.650	33.437	33.563	36.737
0.01585	42.049	30.640	30.363	32.920	39.040	40.133	32.221	30.098	30.211	31.517
0.01000	34.448	25.007	23.816	24.755	31.086	30.717	25.703	25.355	24.943	23.611
0.005012	12.666	10.180	9.557	9.532	11.375	9.459	9.189	8.126	12.221	8.675
0.001995	7.405	5.608	5.458	5.794	6.757	5.929	5.194	4.149	6.769	5.233
0.001000	7.069	5.126	4.956	5.304	6.368	5.532	4.723	3.674	6.286	4.726
0.000398	6.144	4.829	4.693	4.918	5.635	4.866	4.420	3.561	5.868	4.456

Note: Values reported a
EPSD- erodible particle

EPSD Designation Diameter (mm)	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10
0.450	100.000	100.000	100.000	100.000	100.000	100.000	100.000	100.000	100.000	100.000
0.250	67.238	70.939	74.655	74.155	77.281	75.578	77.393	77.993	77.038	78.922
0.150	49.361	52.171	54.870	54.074	57.254	54.286	57.877	59.294	57.936	60.447
0.075	37.563	37.728	38.718	39.358	43.405	40.591	43.197	45.545	44.741	46.776
0.01585	32.342	31.597	32.157	33.572	37.974	35.722	37.191	39.656	39.265	40.830
0.01000	24.314	22.169	22.246	25.073	30.556	29.049	28.724	31.575	31.827	32.779
0.005012	10.387	8.316	6.741	7.496	7.842	7.567	7.539	8.344	8.573	8.418
0.001995	6.291	5.386	4.536	4.624	4.493	4.182	4.580	4.932	4.921	4.949
0.001000	5.795	4.854	4.004	4.140	4.097	3.764	4.153	4.551	4.545	4.587
0.000398	5.371	4.575	3.806	3.867	3.665	3.448	3.748	4.009	4.014	3.998

Note: Values reported as percent of sample passing through sieve with corresponding diameter
EPSD- erodible particle size distribution

EPSD Designation Diameter (mm)	N11	N12	N13	N14	N15
0.450	100.000	100.000	100.000	100.000	100.000
0.250	76.892	78.922	76.672	68.115	77.333
0.150	57.043	60.447	56.704	49.351	57.313
0.075	43.798	46.776	42.929	37.400	44.056
0.01585	38.581	40.830	37.514	32.436	38.895
0.01000	31.549	32.779	30.059	24.922	32.007
0.005012	8.280	8.418	7.941	9.925	8.186
0.001995	4.655	4.949	4.571	5.882	4.556
0.001000	4.275	4.587	4.167	5.396	4.184
0.000398	3.798	3.998	3.743	5.013	3.706

Note: Values reported a
EPSD- erodible particle

Table 18-B-4: Chaco River Unnamed Tributaries 1-3 SEDCAD™ Model Erodible Particle Size Distribution Input

EPSD Designation Diameter (mm)	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
0.450	100.000	100.000	100.000	100.000	100.000	100.000	100.000	100.000	100.000	100.000
0.250	73.959	73.616	76.935	71.698	66.758	79.271	76.186	71.332	69.252	72.826
0.150	53.513	51.156	56.809	52.203	47.867	61.614	56.371	51.737	48.234	50.060
0.075	39.786	36.094	43.470	40.227	38.225	48.027	42.009	39.807	37.339	37.063
0.01585	34.594	31.049	38.314	35.500	34.382	41.810	36.270	35.142	33.701	33.090
0.01000	27.184	23.672	31.377	28.812	28.863	33.358	28.141	28.519	28.666	27.663
0.005012	7.949	6.458	8.122	9.441	11.298	8.745	7.683	9.452	9.653	7.592
0.001995	4.615	3.761	4.540	5.331	6.195	5.229	4.600	5.328	5.087	3.938
0.001000	4.166	3.257	4.157	4.909	5.775	4.876	4.165	4.901	4.664	3.500
0.000398	3.847	3.172	3.703	4.467	5.266	4.220	3.790	4.473	4.307	3.302

Note: Values reported as percent of sample passing through sieve with corresponding diameter
EPSD- erodible particle size distribution

EPSD Designation Diameter (mm)	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10
0.450	100.000	100.000	100.000	100.000	100.000	100.000	100.000	100.000	100.000	100.000
0.250	74.410	76.157	69.997	79.508	76.475	69.135	70.448	73.216	64.912	63.749
0.150	55.605	59.686	50.748	64.050	57.775	49.241	48.380	53.670	45.705	43.918
0.075	43.516	47.428	39.813	50.694	41.347	36.360	35.105	39.285	36.176	34.808
0.01585	38.456	41.399	35.485	43.752	34.236	31.386	30.759	33.457	32.518	31.586
0.01000	31.531	33.052	29.389	34.156	23.595	23.861	24.387	24.817	27.095	26.802
0.005012	9.472	10.126	10.232	9.667	6.873	8.915	7.819	7.936	11.353	11.435
0.001995	5.356	6.051	5.668	6.037	4.758	5.288	4.349	4.929	6.238	6.147
0.001000	4.976	5.693	5.255	5.694	4.247	4.786	3.857	4.440	5.789	5.695
0.000398	4.422	4.956	4.771	4.879	3.949	4.512	3.708	4.138	5.346	5.293

Note: Values reported as percent of sample passing through sieve with corresponding diameter
EPSD- erodible particle size distribution

EPSD Designation Diameter (mm)	B11	B12	B13
0.450	100.000	100.000	100.000
0.250	74.634	71.793	73.540
0.150	55.269	53.049	51.760
0.075	41.168	41.322	38.936
0.01585	35.392	36.426	34.666
0.01000	27.046	29.501	28.853
0.005012	8.087	9.853	8.011
0.001995	4.915	5.624	4.260
0.001000	4.462	5.212	3.840
0.000398	4.085	4.703	3.548

Note: Values reported a
EPSD- erodible particle

	Cover that Contacts the Surface																								
Canopy Cover (%)	0%	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%	13%	14%	15%	16%	17%	18%	19%	20%	21%	22%	23%	24%	25%
0%	0.45	0.438	0.425	0.413	0.4	0.388	0.375	0.363	0.35	0.338	0.325	0.313	0.3	0.288	0.275	0.263	0.25	0.238	0.225	0.213	0.2	0.195	0.19	0.185	0.18	0.175
1%	0.446	0.434	0.422	0.409	0.397	0.385	0.372	0.36	0.347	0.335	0.323	0.31	0.298	0.285	0.273	0.261	0.248	0.236	0.224	0.211	0.199	0.194	0.189	0.184	0.179	0.174
2%	0.443	0.431	0.418	0.406	0.394	0.382	0.369	0.357	0.345	0.332	0.32	0.308	0.296	0.283	0.271	0.259	0.247	0.234	0.222	0.21	0.198	0.193	0.188	0.183	0.178	0.173
3%	0.439	0.427	0.415	0.403	0.391	0.379	0.366	0.354	0.342	0.33	0.318	0.306	0.294	0.281	0.269	0.257	0.245	0.233	0.221	0.209	0.196	0.192	0.186	0.182	0.177	0.172
4%	0.436	0.424	0.412	0.4	0.388	0.376	0.363	0.351	0.339	0.327	0.315	0.303	0.291	0.279	0.267	0.255	0.243	0.231	0.219	0.207	0.195	0.19	0.185	0.181	0.176	0.171
5%	0.432	0.42	0.408	0.396	0.384	0.373	0.361	0.349	0.337	0.325	0.313	0.301	0.289	0.277	0.265	0.254	0.242	0.23	0.218	0.206	0.194	0.189	0.184	0.18	0.175	0.17
6%	0.428	0.417	0.405	0.393	0.381	0.37	0.358	0.346	0.334	0.322	0.311	0.299	0.287	0.275	0.263	0.252	0.24	0.228	0.216	0.205	0.193	0.188	0.183	0.179	0.174	0.169
7%	0.425	0.413	0.401	0.39	0.378	0.367	0.355	0.343	0.332	0.32	0.308	0.297	0.285	0.273	0.262	0.25	0.238	0.227	0.215	0.203	0.192	0.187	0.181	0.177	0.173	0.168
8%	0.421	0.41	0.398	0.387	0.375	0.364	0.352	0.34	0.329	0.317	0.306	0.294	0.283	0.271	0.26	0.248	0.237	0.225	0.213	0.202	0.19	0.186	0.18	0.176	0.172	0.167
9%	0.418	0.406	0.395	0.383	0.372	0.361	0.349	0.338	0.326	0.315	0.303	0.292	0.281	0.269	0.258	0.246	0.235	0.223	0.212	0.201	0.189	0.185	0.179	0.175	0.171	0.166
10%	0.414	0.403	0.391	0.38	0.369	0.358	0.346	0.335	0.324	0.312	0.301	0.29	0.278	0.267	0.256	0.245	0.233	0.222	0.211	0.199	0.188	0.183	0.178	0.174	0.17	0.165
11%	0.41	0.399	0.388	0.377	0.366	0.355	0.343	0.332	0.321	0.31	0.299	0.287	0.276	0.265	0.254	0.243	0.232	0.22	0.209	0.198	0.187	0.182	0.176	0.173	0.169	0.164
12%	0.407	0.396	0.385	0.374	0.363	0.352	0.34	0.329	0.318	0.307	0.296	0.285	0.274	0.263	0.252	0.241	0.23	0.219	0.208	0.197	0.186	0.181	0.175	0.172	0.168	0.163
13%	0.403	0.392	0.381	0.37	0.359	0.349	0.338	0.327	0.316	0.305	0.294	0.283	0.272	0.261	0.25	0.239	0.228	0.217	0.206	0.195	0.184	0.18	0.174	0.171	0.166	0.162
14%	0.4	0.389	0.378	0.367	0.356	0.346	0.335	0.324	0.313	0.302	0.291	0.281	0.27	0.259	0.248	0.237	0.226	0.216	0.205	0.194	0.183	0.179	0.173	0.17	0.165	0.161
15%	0.396	0.385	0.375	0.364	0.353	0.343	0.332	0.321	0.31	0.3	0.289	0.278	0.268	0.257	0.246	0.236	0.225	0.214	0.203	0.193	0.182	0.178	0.172	0.169	0.164	0.16
16%	0.392	0.382	0.371	0.361	0.35	0.34	0.329	0.318	0.308	0.297	0.287	0.276	0.265	0.255	0.244	0.234	0.223	0.213	0.202	0.191	0.181	0.176	0.17	0.168	0.163	0.159
17%	0.389	0.378	0.368	0.357	0.347	0.337	0.326	0.316	0.305	0.295	0.284	0.274	0.263	0.253	0.242	0.232	0.221	0.211	0.201	0.19	0.18	0.175	0.169	0.167	0.162	0.158
18%	0.385	0.375	0.365	0.354	0.344	0.334	0.323	0.313	0.302	0.292	0.282	0.271	0.261	0.251	0.24	0.23	0.22	0.209	0.199	0.189	0.178	0.174	0.168	0.166	0.161	0.157
19%	0.382	0.371	0.361	0.351	0.341	0.331	0.32	0.31	0.3	0.29	0.279	0.269	0.259	0.249	0.239	0.228	0.218	0.208	0.198	0.187	0.177	0.173	0.167	0.164	0.16	0.156
20%	0.378	0.368	0.358	0.348	0.338	0.328	0.317	0.307	0.297	0.287	0.277	0.267	0.257	0.247	0.237	0.227	0.216	0.206	0.196	0.186	0.176	0.172	0.165	0.163	0.159	0.155
21%	0.374	0.364	0.354	0.344	0.334	0.325	0.315	0.305	0.295	0.285	0.275	0.265	0.255	0.245	0.235	0.225	0.215	0.205	0.195	0.185	0.175	0.171	0.164	0.162	0.158	0.154
22%	0.371	0.361	0.351	0.341	0.331	0.322	0.312	0.302	0.292	0.282	0.272	0.262	0.252	0.243	0.233	0.223	0.213	0.203	0.193	0.183	0.174	0.169	0.163	0.161	0.157	0.153
23%	0.367	0.357	0.348	0.338	0.328	0.319	0.309	0.299	0.289	0.28	0.27	0.26	0.25	0.241	0.231	0.221	0.211	0.202	0.192	0.182	0.172	0.168	0.162	0.16	0.156	0.152
24%	0.364	0.354	0.344	0.335	0.325	0.316	0.306	0.296	0.287	0.277	0.267	0.258	0.248	0.239	0.229	0.219	0.21	0.2	0.19	0.181	0.171	0.167	0.16	0.159	0.155	0.151
25%	0.36	0.351	0.341	0.332	0.322	0.313	0.303	0.294	0.284	0.275	0.265	0.256	0.246	0.237	0.227	0.218	0.208	0.199	0.189	0.18	0.17	0.166	0.162	0.158	0.154	0.15
50%	0.26	0.254	0.247	0.241	0.234	0.228	0.221	0.215	0.208	0.202	0.195					0.163					0.13					0.115
75%	0.17	0.167	0.163	0.16	0.156	0.153	0.149	0.146	0.142	0.139	0.135					0.118					0.1					0.09

Developed from SedCAD Tables
Blue text is from SedCAD Table, Black Text is linear interpolation calculation

	Cover that Contacts the Surface																							
Canopy Cover (%)	26%	27%	28%	29%	30%	31%	32%	33%	34%	35%	36%	37%	38%	39%	40%	45%	50%	55%	60%	61%	62%	65%	80%	95%
0%	0.17	0.165	0.16	0.155	0.15	0.145	0.14	0.135	0.13	0.125	0.12	0.115	0.11	0.105	0.1	0.086	0.071	0.057	0.042	0.041	0.039	0.035	0.013	0.003
1%	0.169	0.164	0.159	0.154	0.149	0.144	0.139							0.105	0.1				0.042	0.04	0.039			
2%	0.168	0.163	0.158	0.153	0.148	0.143	0.139							0.104	0.099				0.042	0.04	0.039			
3%	0.167	0.162	0.157	0.152	0.148	0.143	0.138							0.104	0.099				0.042	0.04	0.039			
4%	0.166	0.161	0.156	0.152	0.147	0.142	0.137							0.103	0.098				0.041	0.04	0.038			
5%	0.165	0.16	0.156	0.151	0.146	0.141	0.136							0.103	0.098				0.041	0.04	0.038			
6%	0.164	0.159	0.155	0.15	0.145	0.14	0.136							0.102	0.098				0.041	0.04	0.038			
7%	0.163	0.159	0.154	0.149	0.144	0.14	0.135							0.102	0.097				0.041	0.039	0.038			
8%	0.162	0.158	0.153	0.148	0.144	0.139	0.134							0.101	0.097				0.041	0.039	0.038			
9%	0.161	0.157	0.152	0.147	0.143	0.138	0.134							0.101	0.096				0.041	0.039	0.038			
10%	0.16	0.156	0.151	0.147	0.142	0.137	0.133							0.101	0.096				0.04	0.039	0.038			
11%	0.159	0.155	0.15	0.146	0.141	0.137	0.132							0.1	0.096				0.04	0.039	0.037			
12%	0.158	0.154	0.149	0.145	0.14	0.136	0.131							0.1	0.095				0.04	0.039	0.037			
13%	0.158	0.153	0.149	0.144	0.14	0.135	0.131							0.099	0.095				0.04	0.038	0.037			
14%	0.157	0.152	0.148	0.143	0.139	0.134	0.13							0.099	0.094				0.04	0.038	0.037			
15%	0.156	0.151	0.147	0.142	0.138	0.134	0.129							0.098	0.094				0.04	0.038	0.037			
16%	0.155	0.15	0.146	0.142	0.137	0.133	0.128							0.098	0.094				0.039	0.038	0.037			
17%	0.154	0.149	0.145	0.141	0.136	0.132	0.128							0.098	0.093				0.039	0.038	0.036			
18%	0.153	0.148	0.144	0.14	0.136	0.131	0.127							0.097	0.093				0.039	0.038	0.036			
19%	0.152	0.148	0.143	0.139	0.135	0.131	0.126							0.097	0.092				0.039	0.038	0.036			
20%	0.151	0.147	0.142	0.138	0.134	0.13	0.126							0.096	0.092				0.039	0.037	0.036			
21%	0.15	0.146	0.142	0.137	0.133	0.129	0.125							0.096	0.092				0.039	0.037	0.036			
22%	0.149	0.145	0.141	0.137	0.132	0.128	0.124							0.095	0.091				0.038	0.037	0.036			
23%	0.148	0.144	0.14	0.136	0.132	0.128	0.123							0.095	0.091				0.038	0.037	0.035			
24%	0.147	0.143	0.139	0.135	0.131	0.127	0.123							0.094	0.09				0.038	0.037	0.035			
25%	0.146	0.142	0.138	0.134	0.13	0.126	0.122	0.118	0.114	0.11	0.106	0.102	0.098	0.094	0.09	0.077	0.064	0.051	0.038	0.037	0.035	0.032	0.012	0.003
50%					0.1					0.085					0.07	0.061	0.053	0.044	0.035			0.029	0.012	0.003
75%					0.08					0.07					0.06	0.053	0.046	0.038	0.031			0.026	0.011	0.003

Developed from SedCAD Tables
Blue text is from SedCAD Table, Black Text is linear interpolation calculation