FINAL

Site Investigation Report

Smoky Canyon Mine, Caribou County, Idaho

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APPENDIX E

DRAFT

TECHNICAL MEMORANDUM No. 1

FALL 2003 GROUNDWATER INVESTIGATIONS

SMOKY CANYON MINE
SITE INVESTIGATION

January 2003

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1.0 INTRODUCTION

In September and October 2003, Simplot completed several of the tasks associated with the groundwater investigation for the Smoky Canyon Mine Site Investigation (SI). The groundwater investigation tasks were described in the Field Sampling Plan (FSP) (MFG, 2003) and subsequent modifications to the FSP (letter from S. Werner to J. Jones dated September 15, 2003) as follows:

- identify, survey and sample groundwater discharges into Sage Valley
- identify and sample existing water wells or springs used for drinking water supply
- install 7 new groundwater monitoring wells (5 shallow in surficial deposits and 2 deep in the upper Wells Formation)
- perform quarterly groundwater monitoring at the 7 new wells and 4 existing wells for a period of one year

The first two tasks were initiated in September 2003 and will be completed during the summer of 2004. Figure 1 displays the locations where springs were identified in Sage Valley and where springs and water supply wells were sampled.

The third task and the first quarterly groundwater monitoring event were completed in October 2003. The locations of the new monitoring wells and the four existing wells used for monitoring in September and October 2003 are identified on Figure 2.

In addition to the groundwater investigations, a comprehensive surface water sampling program, including stream-segment gain-loss investigations, was conducted concurrently. Additional surface water sampling is scheduled for winter and spring of 2004. Portions of the gain/loss study will be repeated in the spring of 2004 to aide future analyses of groundwater flow and mass transport. Some of the surface water information is considered in this preliminary Technical Memorandum. The remaining October 2003 surface water data will be presented and described in the SI Report, which is scheduled for submission in the fall of 2004.

The purpose of this Technical Memorandum is to provide the new groundwater data to the lead agency (U.S. Forest Service) along with a preliminary interpretation of those data for consideration in identifying any remaining data needs for the groundwater investigation

component of the Smoky Canyon Mine SI. A primary focus of the preliminary data interpretation is groundwater quality and flow in the Wells Formation aquifer. The Technical Memorandum describes the field activities completed to date for the groundwater investigation, presents the new data collected in September and October 2003 and provides a discussion of those data related to the Wells Formation in light of the conceptual model for groundwater flow and transport at the Smoky Canyon Mine that was presented earlier in the SI Work Plan (MFG, 2003a). Additional data collected as part of the baseline studies for the Manning Creek and Deer Creek Environmental Impact Statement are also considered.

2.0 FALL 2003 GROUNDWATER INVESTIGATIONS

The fall 2003 groundwater investigations began on September 17 and ended on October 31. The investigations included field surveys to identify locations of groundwater discharge (i.e., seeps, springs, gaining stream reaches), sampling of domestic water supplies within a 5-mile radius about the mine area, installation of new monitoring wells and water level measurements and groundwater sampling at locations specified by the FSP. These activities are described in detail below.

2.1 Groundwater Discharge and Water Supply Well Survey

On September 17, 2003, the west flank of Sage Valley was surveyed for springs with particular focus along the surface trace of the West Sage Valley Branch Fault. The survey began at the Roberts Creek drainage and extended south to Hoopes Springs and springs in South Fork Sage Creek.

Originally, seep and spring areas were to be identified by noting the areas that contained unusually lush vegetation. These areas would normally stand out at the end of summer with vegetation in seep and spring areas remaining green while surrounding vegetation dried out. However, fresh snow cover on September 17 made identification of springs or seeps based on vegetation type and vigor difficult. One spring area was newly identified along the west side of Sage Valley. This area is identified as Sage Valley Spring #1 (SVS-1) on Figure 1. Water was present at this location on September 17 and sampled on October 29. The survey will be repeated in the summer of 2004 when emerging vegetation may better serve as an indicator for groundwater discharge along the west side of Sage Valley.

On September 18, 2003, the floor of Sage Valley was also surveyed for springs and pond locations that may intercept shallow groundwater flow. Four potential spring areas (SVS-2, SVS-3, SVS-4 and NSV-4) and four ponded-water areas (SVP-1, SVP-2, SVP-3 and NSV-1) were identified in Sage Valley; these locations are displayed on Figure 1. On September 18, water was present at NSV-4, SVS-4 and SVP-1. The NSV-1 location is a pond in northern Sage Valley that was sampled in May 2002, and the NSV-4 location is a fenced, spring-fed pond on the east side of Sage Valley that was sampled in May and October 2002. SVP-3, located in Sage Valley just west of the Peterson Homestead Ranch house (Figure 1), is an area where

several dry ponds are currently present. Some or all of the ponds may have been fed by irrigation water rather than by shallow groundwater. Additional insight as to the water source may be obtained during the irrigation survey planned for next spring/summer.

The domestic water supply (springs and wells) survey was conducted September 17 and 18, 2003. The survey resulted in the collection of water from one domestic well (DW-3) and three springs (BSS-1, DW-2 and DW-4); all are located within 5 miles of the mine and are either currently in use or have previously been used as domestic water supplies. Samples were collected from two ranches along Crow Creek, the Hartman Ranch spring (DW-2) and the Lagomarsino Ranch well (DW-3). The DW-3 sample was collected from an outdoor frost-free faucet. The DW-4 sample was collected from the Peterson Homestead Ranch house spring located in Sage Valley (DW-4). The spring is located in the gulch just east of the house, but the sample was collected from a garden hose that was watering the lawn at the time of sample collection. The spring referred to as the "Boy Scout Spring" (BSS-1) is located west of the mine at a former Boy Scout's camp, as shown on Figure 1. Water from this spring reportedly was used in the past as a water supply for the camp.

On September 17, the mine panel areas were surveyed to identify any seeps or springs that have not been previously sampled. Seep or spring areas were newly identified at two of the mine panels. One spring was identified in the northwest portion of Panel E1 (ES-1) and one along the western portion of Panel C (CS-1). These two springs are also displayed on Figure 1. Both springs were flowing towards the panels from the west and were channeled into diversion ditches away from the panel areas. Ponded water was also present directly below CS-1. Samples were collected from these two springs on October 27.

2.2 Borehole Drilling and Well Installation

Drilling, well installation and well development activities for the Smoky Canyon Mine SI were initiated on September 23 and were completed on October 23, 2003. Seven new monitoring wells and one shallow well point were installed in accordance with the FSP (MFG, 2003b). Borehole drilling, well construction and well development were completed by Thomas Drilling of Afton, WY and supervised and recorded by staff from Maxim Technologies.

At the same time, a new deep monitoring well was installed in the South Fork Sage Creek drainage (MC-MW-1) just southwest of the E Panel. This well screens the upper Wells Formation and provides (1) baseline data in support of environmental impact studies for the Manning Creek lease area and (2) Wells Formation groundwater characterization data in the vicinity of Panel E.

In July 2003, Simplot installed a new deep monitoring well just north of the planned C Panel. This well is referred to as the "Consent Order" well (GW-CO), in reference to the April 2002 IDEQ Consent Order that specifies groundwater monitoring requirements for the Panels B and C operations. The well is screened in the upper Wells Formation and provides baseline groundwater characterization data for the C Panel area. The well will also be used for groundwater monitoring during the SI and eventually for long-term compliance monitoring associated with the Panels B and C operations.

Also considered is newly installed deep well DC-MW-5, which is located approximately 5 miles southwest of the Smoky Canyon Mine adjacent to the proposed Panel G in the Deer Creek lease area. This well was installed to monitor the upper Wells Formation as part of the baseline water resources studies associated with the Deer Creek EIS. Although not directly related to the AOC investigations, this well provides additional insight as to the physical and geochemical properties of the upper Wells Formation in the vicinity of active operations at the Smoky Canyon Mine. Although some information about the well construction, development and monitoring at DC-MW-5 are provided here, additional details will be included in the baseline study reports prepared for the Deer Creek EIS.

All new monitoring well locations are shown on Figure 2, and well construction details are provided on Table 1. The field boring logs, well construction summaries and well development reports for the nine wells and one well point, all installed between July through October 2003, are attached for reference.

2.3 Groundwater Sampling

Groundwater samples were collected on two occasions during the fall of 2003. On September 16, MFG collected water samples from the Culinary Well (GW-CW) and the Consent Order monitoring well (GW-CO). Between October 29 and 31, MFG collected water samples from seven new wells (GW-15, GW-16, GW-18, GW-19A, GW-19B, GW-20 and MC-MW-1) and two

existing wells (GW-IW and GW-11). The September samples were collected as part of Simplot's routine groundwater monitoring program. The October samples were collected in accordance with the procedures in the FSP for the SI. The groundwater monitoring locations are shown on Figure 2.

2.4 Deviations from the FSP

There were two deviations from the FSP during well installation, as described below. These deviations were related to field conditions and were discussed by phone with the USFS Project Manager for approval prior to implementation.

The original location for GW-19 was moved north to GW-19B near the Peterson ranch (Figure 2), and a previously unplanned well point was installed at GW-19A close to the original GW-19 location upstream of the Hoopes Spring confluence. Both GW-19A and GW-19B are screened across saturated alluvial deposits.

GW-19B was installed and constructed in accordance with the specifications included in the FSP for GW-19. GW-19A was installed as a "sand-point" or "well point" using a truck-mounted hydraulic-push rig. Because this well was installed by pushing the screen and casing assembly directly into the ground, the well point had to be constructed of steel casing and slotted-steel screen. The well point is 15 feet deep, and the screened interval is 5 feet long. The well does not extend into underlying bedrock.

The shallow monitoring well planned for the South Fork Sage Creek drainage upstream of Panel E, GW-22 (refer to letter from S. Werner, MFG, to J. Jones, USFS, dated September 15, 2003), could not be installed because there was no access for truck-mounted drilling equipment and no success at hand augering a borehole at that location. Additionally, drilling at a nearby location in South Fork Sage Creek, MC-MW-1, indicated that the thickness of alluvial deposits along this reach of South Fork Sage Creek is minimal (less than 8 feet) and the alluvial deposits are dominantly gravel.

There was one other deviation from the FSP associated with the first round of groundwater sampling. Samples were collected from the Culinary Well (GW-CW) and the Consent Order well (GW-CO) during September and approximately 6 weeks before samples were collected

from the other wells included in the SI groundwater monitoring task. These samples were collected to satisfy requirements of Simplot's environmental monitoring programs and not specifically in support of the SI. As a result, the analyses of the groundwater samples from GW-CO and GW-CW correspond to those associated with environmental monitoring programs, which are not the same as those for the SI. Simplot had planned to collect an additional sample from GW-CW in October but the water level in that well dropped below the depth of the down-well pump during that time. Therefore, GW-CW was not sampled in October, and only the September monitoring data are currently available to describe water quality at GW-CW and GW-CO during the first quarter of the year-long SI monitoring period.

2.5 Other Field Investigations in Support of SI

Gain-loss surveys were conducted during October along South Fork Sage Creek, Sage Creek in Lower Sage Valley and upper Pole Canyon Creek. The South Fork Sage Creek and Lower Sage Valley surveys included the collection of samples for water quality analyses; the upper Pole Canyon Creek survey only included flow measurements. The flow measurement locations used during the October gain/loss surveys are identified on Figure 3.

The South Fork Sage Creek gain-loss survey was conducted on October 26, 2003, from the upper sampling location USS to the mouth (see Figure 3). The Lower Sage Valley gain-loss survey was performed on October 27, 2003, from just below the confluence of Sage Creek and North Fork Sage Creek to just above the Crow Creek Road. The gain-loss survey along upper Pole Canyon Creek was performed on October 28, 2003, from the headwater springs to the upstream (western) toe of the overburden disposal area.

At the same time as the gain-loss surveys, Simplot performed routine surface water monitoring associated with their Comprehensive Environmental Monitoring Program and the additional surface water monitoring associated with the SI (MFG, 2003b). The complete results from these other monitoring tasks will be transmitted to the agencies and reported in the SI Report, which is scheduled for completion in the fall of 2004.

The October flow data, and accompanying surface water quality data, will be used in conjunction with the new groundwater data to evaluate surface water/groundwater interactions along these drainages.

3.0 INITIAL FINDINGS/RESULTS

The following data are currently available from the fall 2003 groundwater investigations: drilling logs, well construction details, well development records, water level measurements, field data for groundwater samples, laboratory analyses of groundwater samples from the upper Wells Formation and flow measurements from the gain/loss surveys. These data are described in detail below.

In addition, preliminary results from a portion of Simplot's Manning Creek and Deer Creek baseline studies were available for review and consideration in interpreting the findings of the Smoky Canyon SI work. The baseline water resources studies were performed in late summer and fall of 2003, at the same time as the groundwater investigations at Smoky Canyon. Those data will be reported in the upcoming Water Resources Baseline Study Report for the Manning Creek and Deer Creek lease areas (Panels F and G).

3.1 Drilling Logs, Well Construction and Water Level Data

Lithologic logs were recorded during drilling at each of the new well locations. These logs describe the subsurface lithology, geologic structures and groundwater encountered at each location and are attached for reference.

Well construction and well development details were also recorded and are attached for reference. The well construction forms describe the well-screen depth interval, well casing, filter, seal and stabilizing materials and dimensions. Well development records describe the methods used and the time, water levels and general water chemistry when the well was developed.

Water levels were measured and recorded at each new well before and after well development and again during the quarterly monitoring event immediately prior to sampling. Between October 29 and 31 the water levels were measured and groundwater samples were collected (where water was present) at the eight new wells (GW-15, GW-16, GW-17, GW-18, GW-19B, GW-20, GW-21 and MC-MW-1), one new well point (GW-19A) and three existing wells (GW-C1, GW-10 and GW-11). It was not possible to obtain a static water level measurement from GW-IW (Industrial Well) at the same time because the well was being pumped to supply water for

mine operations. The most-recent water level measurement available for the Industrial Well was from the summer of 2003 following a 12-hour period when the well pump was turned off. Table 1 lists the static water level measurements obtained from new and existing monitoring wells visited during late October; the summer 2003 water level at GW-IW is also included.

New information obtained during drilling, development and water level monitoring are described separately below for each new well location.

3.1.1 Pole Canyon Area (Wells GW-15 and GW-16)

Drilling at two locations downslope of the Pole Canyon overburden disposal area, GW-15 and GW-16, encountered the Wells Formation under approximately 35 feet of alluvial deposits. At GW-16, the deeper well, the total depth of drilling was 290 feet, and the Wells Formation was the only bedrock unit encountered to that depth. Here the upper Wells Formation is described as calcareous sandstone with interbeds of limestone and dolomite. The relative abundance of sandstone, limestone and dolomite varies with depth, and fracturing of limestone and dolomite beds is noted at several depths and especially from 110 to 124 feet, 132 to 147 feet and 189 to 198 feet below ground surface (bgs). The fractured zones likely correspond to subsurface deformation associated with the West Sage Valley Branch Fault, the surface expression of which is located approximately 300 feet east of the drilling location.

GW-16 screens the upper Wells Formation from 230 to 280 feet bgs. The screened interval is predominantly sandstone with dolomite interbeds. The depth at which water was first encountered during drilling (10/8/03) was approximately 240 feet bgs. A water level of 220 feet bgs was measured in late October.

GW-15 is a shallow well installed in the alluvial deposits that overlie the Wells Formation. The well screens alluvial materials from 15 to 45 feet bgs. The depth at which water was encountered during drilling was approximately 45 feet bgs. A water level of 39 feet bgs was measured in late October. This water level elevation is roughly 40 feet lower than the streambed of Pole Canyon Creek. This water level is consistent with observations that Pole Canyon Creek quickly loses flow as it enters the northern portion of Sage Valley near GW-15.

3.1.2 Hoopes Spring Area (Wells GW-17 and GW-18)

Approximately 24 to 33 feet of surficial deposits cover the Wells Formation at the two wells (GW-17 and GW-18) located just northwest of Hoopes Spring. Here the upper two feet of the Wells Formation is described as sandstone, but at greater depth the Wells Formation is dolomite interbedded with limestone. At GW-18, the deeper well location, the total depth of drilling was 105 feet, and the Wells Formation was the only bedrock unit encountered to that depth. Fractures were noted in the Wells Formation from its upper contact with overlying alluvium to the final depth of the borehole at 105 feet bgs. Fractures are likely associated with subsurface deformation along the West Sage Valley Branch Fault, the surface expression of which is located approximately 350 feet to the east.

GW-18 screens the upper Wells Formation from 55 to 105 feet bgs. The screened interval is predominantly interbedded dolomite with limestone and is described as heavily fractured. Water was first encountered during drilling (10/2/03) at a depth of approximately 51 feet bgs. A water level of 45 feet bgs was measured in late October.

GW-17 is a shallow well that screens colluvial deposits between 0.5 and 35 feet bgs. The colluvial deposits were dry at this location during October.

3.1.3 South Fork Sage Creek Drainage Wells (GW-21 and MC-MW-1)

Two wells were installed along the South Fork Sage Creek drainage south of E Panel. GW-21 is a shallow well located south of the E Panel overburden disposal area (Figure 2). The depth of the borehole for GW-21 was 25 feet. At this location, 17 feet of alluvium covers the Wells Formation, and the top 8 feet of Wells Formation is described as sandstone. GW-21 screens the base of the alluvial deposits and upper portion of the Wells Formation from 4.5 to 24.5 feet bgs. The screened interval at GW-21, including alluvial deposits and the top 8 feet of the underlying Wells Formation, was dry during October.

MC-MW-1 is a deeper well located along South Fork Sage Creek southwest of Panel E and west of GW-21. The depth of the borehole at this location was 210 feet. Here, only 8 feet of alluvial material covers the Wells Formation, which is described as medium-grained, calcareous sandstone with dolomite interbeds. The well screens the upper Wells Formation from 160 to

210 feet bgs. The depth at which water was first encountered during drilling was approximately 146 feet bgs. After development a water level of 145.2 feet bgs was measured.

3.1.4 Sage Valley (Wells GW-19A, GW-19B and GW-20)

Two shallow wells and one well point were installed in the central portion of Sage Valley. GW-19A is the well point, and it is located along Sage Creek upstream of the Hoopes Spring confluence; GW-19B is farther upstream near the Peterson Ranch in northern Sage Valley; GW-20 is located down valley from Hoopes Spring, along the South Fork Sage Creek tributary to Sage Creek (Figure 2). Each of these wells is screened across Quaternary alluvial deposits that fill Sage Valley and overlie older bedrock units.

The alluvial deposits encountered during drilling generally increase in thickness toward the center of Sage Valley. At drilling locations along the valley's western edge, GW-15, GW-17 and GW-21 (refer to previous sections above), the thickness of the surficial deposits ranges from 17 to 39 feet. In the central portion of Sage Valley (GW-19B), the surficial deposits are 49 feet thick. Farther down valley, at GW-20 along lower South Fork Sage Creek, the deposits are 67 feet thick.

The alluvium in the central and southern portions of Sage Valley was deposited on either the Tertiary Salt Lake Formation or Triassic Thaynes Formation bedrock. The Salt Lake Formation unconformably overlies the much older Jurassic units, and due to vertical displacement of strata along the West Sage Valley Thrust Fault, the bedrock units present under Sage Valley are stratigraphically higher, or younger, than the Permian Phosphoria and Wells Formations that outcrop in the area of the Smoky Canyon Mine. These stratigraphic relationships and structural displacements are illustrated on Figures 2-3 and 4-4 of the SI Work Plan.

Dark grey limestone, most likely the Upper Portneuf Limestone Member of the Triassic Thaynes Formation, was encountered during drilling into bedrock at both GW-19B and GW-20. Weathered Salt Lake Formation may overlie the Thaynes Formation at GW-19B where 17 feet of clayey gravel interbedded with grey clay were observed under the alluvial deposits.

The well point GW-19A (see Section 2.4 for explanation) is 15 feet deep with the screened interval extending from 10 to 15 feet bgs. The well does not extend to the top of bedrock. GW-

19B is 52 feet deep, and the depth to the top of bedrock is 49 feet at this location. The well is screened from 12 to 52 feet bgs, and the well screen includes the top 3 feet of limestone bedrock (Thaynes Formation). GW-20 is 69 feet deep, and the depth to the top of bedrock is 67 feet. The well is screened from 18 to 69 feet bgs, and the well screen includes the top 2 feet of limestone bedrock.

The water levels in Sage Valley alluvial deposits ranged from approximately 5 feet bgs at GW-19A to approximately 20 feet bgs at GW-19B. At GW-20 the water level was approximately 9 feet bgs. As discussed further below, GW-19A is located along a reach of Sage Creek where flow gains slightly; GW-19B is located along a reach where no gain or loss is routinely observed; and GW-20 is located along a gaining reach of South Fork Sage Creek.

3.1.5 Smoky Canyon/Panel C (Well GW-CO)

GW-CO is located approximately one mile north of the mine's Culinary and Industrial wells (GW-CW and GW-IW). Drilling at GW-CO, immediately north of the C Panel (Figure 2), encountered Dinwoody, Phosphoria and then the upper Wells Formation bedrock with increasing depth. The total depth of the borehole was 720 feet bgs, and the depth to the top of the Wells Formation is 510 feet bgs. At this location, the upper Wells Formation is described as quartz sandstone, often with calcareous cement, with dolomite interbeds and minor clay beds. At the greatest depth of drilling, the Wells Formation was predominantly weakly cemented (friable) sandstone.

GW-CO screens the upper portion of the Wells Formation at depths from 599 to 650 bgs. The depth at which water was first encountered during drilling (in mid July) was approximately 574 feet bgs. The water level dropped to 587 feet bgs in late October.

3.1.6 Deer Creek Lease Area (Well DC-MW-5)

In September 2003, Simplot installed a deep well (DC-MW-5) to monitor the upper Wells Formation within the Deer Creek lease area. A drilling log and well construction diagram for DC-MW-5 are attached for reference. This well is located approximately 4 miles southwest of well MC-MW-1 (Figure 2) at an elevation of over 7000 feet amsl. Drilling at this location encountered the Rex Chert and Meade Peak members of the Phosphoria Formation (325 feet),

the Grandeur member of the Park City Formation (60 feet thick) and then the upper Wells Formation. The total depth of the borehole was 500 feet, and the depth to the top of the Wells Formation is 385 feet bgs. At this location, the upper Wells Formation is described as medium- to coarse-grained sandstone, with siltstone and dolomite interbeds. The sandstone is iron-stained and contains minor amounts of pyrite.

DC-MW-5 screens the base of the Grandeur Limestone and top of Wells Formation from depths of 380 to 390 feet bgs and the upper portion of the Wells Formation at depths from 400 to 420, 442 to 452, and 473 to 483 feet bgs. The depth at which water was first encountered during drilling (mid July) was approximately 300 feet bgs. The water level measured in early October was 302 feet bgs.

3.2 Stream Flow Gain-Loss Surveys

On October 26 and 27, MFG completed a series of closely spaced flow measurements along upper Pole Canyon Creek, South Fork Sage Creek and the main stem of Sage Creek. The resultant flow measurements are reported on Table 2 and are displayed on Figure 3. The water-level elevations measured at shallow groundwater monitoring wells are posted on Figure 4.

<u>Upper Pole Canyon Creek</u>

The Pole Canyon Creek channel above the overburden disposal area was dry from the uppermost measuring location (UP-A, Figure 3) to just above the spring area denoted by location UP-C. The spring area around UP-C consists of numerous springs emanating from the base of the Thaynes Formation, which outcrops on the side slopes along this reach. The springs eventually flow into the Pole Canyon Creek channel. These springs accounted for approximately 0.03 cfs of flow to the creek. The only tributary inflow along the survey reach entered the creek between locations UP-E and UP-F. The tributary entered from the south and increased the flow in Pole Canyon Creek from 0.041 cfs at UP-E to 0.067 cfs at UP-F. Flow was lost from the creek around the routine monitoring location UP, but was regained between the UP location and the location just upstream of the overburden disposal area (location UP-H) where the creek flows over the lower Dinwoody Formation and upper Phosphoria Formation (Cherty Shale and Rex Chert members). Most of the creek flow was then lost between UP-H

and LP-1 where Pole Canyon Creek flows across the Wells Formation outcrop area that lies under the overburden disposal area. Flow at LP-1 was 0.01 cfs (Table 2).

South Fork Sage Creek

On South Fork Sage Creek, the uppermost survey location, USS, is upstream of a Wells Formation outcrop area (Figure 3). A small amount of flow (approximately 0.02 cfs) was present at USS, but the water was quickly lost to infiltration into the downstream creek bed. The creek bed remained dry across the entire subcrop area of the Wells Formation downstream to the spring area at LSS-SP1/LSS-SP2. Farther downstream, discharges from the Lower South Sage spring area accounted for the entire flow (approximately 4.4 cfs) at the LSS sampling location. The South Fork Sage springs originate along the surface trace of the West Sage Valley Branch Fault and appear to discharge predominately from the upper Wells Formation, as discussed further below. A small amount of surface flow was lost below LSS, but was regained before the confluence with Sage Creek where shallow groundwater apparently discharges to the stream channel from valley-filling alluvial/colluvial deposits (Figure 3).

Sage Valley and lower Sage Creek

In northern Sage Valley, the northern tributary to Sage Creek gains flow. The flow gain between NSV-5 (0.083 cfs) and NSV-6 (0.154 cfs) appears to originate from shallow-groundwater discharge rather than from surface flow because no surface inflows were observed into the tributary during the October monitoring event. The flow at the upper-most gain-loss survey location on Sage Creek (LSV-1) was 0.6 cfs (Figure 3), and most of that flow originated from the main stem of Sage Creek rather than from the tributary that enters from northern Sage Valley.

Within lower Sage Valley, the flow in Sage Creek increases to more than 12 cfs above its confluence with Crow Creek. Two tributaries, Hoopes Spring (about 6.3 cfs) and South Fork Sage Creek (about 4 cfs), are the primary flow contributors to Sage Creek. During low flow conditions, the water in both of these tributaries originates primarily from two spring areas on the west side of Sage Valley, Hoopes Spring and the South Fork Sage Creek springs; both discharge from the Wells Formation. Therefore, these two spring areas supply the majority of water to lower Sage Creek during low-flow conditions.

Much smaller flow gains were also measured along Sage Creek above and below the Hoopes Spring tributary confluence, along the reach between LSV-1 and LSV-2 (Figure 3). This is the same reach where flow gains were observed in May 2003. Last May, Sage Creek also gained

flow between LSV-3a and LSV-4. However in October, flow was lost from the creek between LSV-2 and LSV-2a and downstream of the lower canyon between LSV-3a and LSV-4 (Figure 3). Given these results together with results from previous flow measurements on Sage Creek, the stream reach where discharge from up-valley shallow alluvial deposits appears to routinely contribute to Sage Creek flow extends from just above the confluence with Hoopes Spring downstream to the South Fork of Sage Creek confluence.

3.3 Shallow Flow System Groundwater Quality

During October 2003, groundwater samples were collected from the shallow flow system at GW-15, GW-19A, GW-19B, and GW-20 (GW-17 and GW-21 were dry). These samples, paired with surface water samples collected at nearby locations along Pole Canyon Creek (LP-1) and Sage Creek (NSV-6 and LSV-1), can be used to describe groundwater quality in the shallow flow system and to evaluate groundwater and surface water interactions along transport pathways downstream of the mine's source areas.

Results from chemical analyses of the shallow groundwater samples are compiled on Table 3.

3.3.1 Major Ion Chemistry

In general, the major-ion composition of groundwater collected from the shallow flow system in Sage Valley is not distinguishable from the composition of surface water from the Sage Valley. The major-ion composition of water samples collected in October is represented on Figure 5, which is referred to as a "Piper diagram." Piper diagrams are designed to graphically display the relative abundances of each of the major cations and ions in solution and also reflect the total dissolved solids content of each individual water sample. These diagrams are commonly used to compare the chemical composition of different waters, identify chemically distinct waters that may originate from distinct sources and also evaluate possible mixing relationships between chemically distinct waters or other open-system chemical reactions that produce chemically distinct waters. In this case, Figure 5 illustrates the chemical similarity of shallow groundwater and most surface water samples collected from Sage Valley.

Typical Sage Valley waters, represented by LSV-1 and LSV-3 on Figure 5, and shallow groundwater from wells GW-19A, GW-19B, GW-20 plot together on the Piper diagram. Surface

water from lower Pole Canyon Creek is chemically distinct, and groundwater from alluvial deposits along lower Pole Canyon Creek and surface water in the northern tributary to Sage Creek below Pole Canyon, NSV-6, are intermediate in composition between lower Pole Canyon Creek and typical Sage Valley waters. The primary distinction among these waters is their sulfate content. GW-19B and NSV-5 are also distinguished from other waters by their relatively higher sodium and potassium contents.

Groundwater at GW-19B and surface water at NSV-5 are likely to originate primarily from areas east of Sage Valley. The geologic units present east of Sage Valley are different than those on the west, and the differences in local geology may result in variations in major-ion chemistry for waters entering into Sage Valley from its east and west sides.

The wider chemical variation observed between water from the lower Pole Canyon area and the rest of Sage Valley cannot be explained by local geologic variation. Those variations are consistent with the preliminary interpretation of shallow groundwater flow presented earlier in the SI Work Plan however, in which lower Pole Canyon Creek water, which has interacted with overburden in the Pole Canyon disposal area, migrates into subsurface alluvial deposits and then downgradient towards the northern tributary to Sage Creek. The intermediate chemical composition of groundwater from GW-15 is consistent with local input from lower Pole Canyon Creek to the shallow flow system around Pole Canyon. Similarly, the intermediate composition of surface water at NSV-6 is consistent with input to the northern Sage Creek tributary water (e.g., NSV-5) from shallow groundwater (GW-15) flow across northern Sage Valley.

3.3.2 Constituents of Potential Concern

Cadmium and selenium are the constituents of potential concern (COPCs) that are detected, in the dissolved form, in groundwater from the shallow flow system downgradient of the mine area. The highest dissolved cadmium and selenium concentrations in shallow groundwater were measured in the sample from alluvial deposits located immediately downgradient of the Pole Canyon overburden disposal area (GW-15).

The dissolved selenium concentration at GW-15, 0.311 mg/L (Table 3), is less than in lower Pole Canyon Creek (0.723 mg/L) and less than in groundwater from the underlying Wells Formation (0.464 mg/L at GW-16). The dissolved selenium concentrations in shallow

groundwater from other locations in Sage Valley (0.0009 to 0.00071 mg/L, see Table 3) are much lower than observed near Pole Canyon but slightly higher than dissolved selenium concentrations in surface water from northern Sage Valley (<0.0002 mg/L). For comparison, dissolved selenium concentrations in surface water from lower Sage Valley ranged from 0.0011 mg/L above Hoopes Spring (LSV-1 and LSV-1a) to 0.008 mg/L below Hoopes Spring (LSV-2a).

3.4 Upper Wells Formation Groundwater Quality

During September and October 2003, groundwater samples were collected from six different wells that screen the upper Wells Formation, one well screened in the Phosphoria Formation (GW-11), and four wells screened in surficial deposits. The results from analyses of the six Wells Formation groundwater samples are summarized on Table 4 and described below. Results are also available for a sample collected in October 2003 from DC-MW-5, the deep well in the Deer Creek lease area.

3.4.1 Major Ion Chemistry

Major ion compositions of groundwater samples from the upper Wells Formation are reported on Table 4 and plotted on a Piper diagram (Figure 6) along with data from October 2003 samples from Hoopes Spring (station HS), the South Fork Sage springs (LSS-SP1) and Pole Canyon Creek below the overburden disposal area (LP-1). The lower Pole Canyon Creek water is included in this comparison because it represents water available for recharge to the Wells Formation that has interacted with overburden materials.

The major ion compositions of these waters range from lowest TDS waters at MC-MW-1, South Fork Sage springs and upper Wells Formation groundwater from DC-MW-5 (5 miles south in Deer Creek area) to highest TDS water in lower Pole Canyon Creek. Two groups of water samples are intermediate between these two end members: (1) groundwater from GW-18, GW-IW and Hoopes Spring water and (2) groundwater from GW-16 and GW-CW. Mixing of water from any of the overburden disposal areas with water in the upper Wells Formation aquifer could produce the intermediate major-ion compositions observed in groundwater from GW-16, GW-CW, GW-IW, GW-18 and Hoopes Spring.

3.4.2 Selenium Concentrations in Wells Formation Groundwater

Of particular interest are the selenium concentrations in samples from new and existing monitoring wells in the upper Wells Formation, which are summarized on Table 5 below.

For comparison, previous selenium concentrations measured at the Culinary Well have been as high as 31 μg/L but average about 13 μg/L. The total selenium concentrations have varied between approximately 3 and 12 μg/L in Hoopes Spring water and between 4 and 8 μg/L in the lower South Fork Sage Creek springs during previous fall sampling events.

Table 5. Selenium Concentrations in Groundwater from the Upper Wells Formation

Well ID	Location	Sample Date	Total Selenium (μg/L)	Dissolved Selenium (μg/L)
GW-IW	Industrial Well	8/16/03	14.4	not measured
		10/31/03	10.5	9.6
GW-CO	North of C Panel	9/16/03	3.5	not measured
GW-CW	Culinary Well	9/16/03	13.6	not measured
GW-16	Below Pole Canyon	10/29/03	447	464
GW-18	At Hoopes Spring	10/29/03	4.0	4.1
MC-MW-1	South Fork Sage Creek	10/30/03	0.42	0.49
DC-MW-5	Deer Creek Panel G	10/10/03	14.2	14.3
Spring Discharges from Wells Formation				
HS	Hoopes Spring	10/28/03	9.6	12.5
LSS-SP1	South Fork Sage spring	10/27/03	1.5	1.4
LSS-SP2	South Fork Sage spring	10/27/03	1.6	1.4

Note: Although the total selenium concentration is often reported less than the dissolved concentration, the relative differences between total and dissolved concentrations are generally within the project's control limits for precision of duplicate selenium analyses (+/- 20% relative percent difference). This is the level of precision considered acceptable for the project's data uses.

3.5 Water Quality at Domestic Water Supplies

None of the water supply wells or springs sampled in September contains selenium at a concentration at or above the drinking water standard of 50 μg/L. The water chemistry data for the one well and three spring samples are listed on Table 6. The highest total selenium concentration measured in these samples is 0.4 μg/L. Note that none of these water supplies

originates in the Wells Formation. Instead they represent water supplies from other aquifers in the vicinity of the Smoky Canyon Mine.

4.0 PRELIMINARY INTERPRETATION OF SURFACE WATER AND GROUNDWATER INTERACTIONS

An important component of the groundwater transport pathway described as part of the conceptual site model presented in the SI Work Plan (MFG, 2003a) is potential COPC transport by groundwater flow and discharge to the surface downgradient of the source areas. Several of the field investigation elements of the SI were designed to provide additional information regarding groundwater and surface water interactions in the immediate vicinity and also downgradient of the source areas.

Flow measurements from Pole Canyon Creek, South Fork Sage Creek and Sage Creek and the paired groundwater level data collected at new wells along those same drainages can now be used together to evaluate surface water and groundwater interactions.

Flow measurements obtained in October 2003 identified gaining and losing reaches on upper Pole Canyon Creek, South Fork Sage Creek and Sage Creek. The gaining, losing and dry stream reaches are shown on Figure 3 and described below.

4.1 Pole Canyon Creek Drainage

Upper Pole Canyon Creek (i.e., above the overburden disposal area) is mainly a gaining stream with most of its water originating from springs that discharge from the Thaynes and Dinwoody Formations west of the mine. Comparison of flow upstream and downstream of the Pole Canyon overburden disposal area indicates that flow is lost where the creek flows over the area of Wells Formation subcrop underneath and east of the overburden dump. The recharge to the Wells Formation in this area is confirmed by groundwater chemistry at GW-16 (Table 4), at the base of Pole Canyon overburden disposal area, where groundwater from the Wells Formation contains a component of water that is chemically similar to Pole Canyon Creek. There is no evidence for surface discharge of groundwater from the Wells Formation in the vicinity of Pole Canyon Creek. Groundwater flow directions in the Wells Formation are described in greater detail below in Section 5.1 - *Groundwater Flow Directions in the Vicinity of Smoky Canyon Mine*.

In October 2003, the Pole Canyon Creek flow below the overburden disposal area was approximately 0.01 cfs, and all flow was lost before reaching the western edge of Sage Valley.

Groundwater from the shallow well installed in the alluvial deposits along Pole Canyon Creek, GW-15, has chemical characteristics intermediate between the lower Pole Canyon Creek water and other alluvial groundwaters (refer to Figure 5 and data reported on Table 3). As discussed above in Section 3.3, the chemical data indicate that the alluvial groundwater likely contains a component of water from lower Pole Canyon Creek.

Although surface flow from the Pole Canyon disposal area to Sage Valley was not observed in October, groundwater flow in alluvial deposits remains a potential transport pathway into Sage Valley. The chemical characteristics of water collected at the lower Pole Canyon monitoring point (LP-1), GW-15 and in northern Sage Valley (NSV-6) appear to reflect varying proportions of chemically distinct input from the Pole Canyon overburden disposal area. In addition, flow measurements in northern Sage Valley indicate minor gains in the northern Sage Creek tributary. The gain observed between NSV-5 and NSV-6 apparently originated from the adjacent alluvial deposits. Surface tributaries were dry and no runoff occurred during the October 2003 monitoring event. These results are all consistent with the presence of a shallow, subsurface flow pathway within alluvial deposits along Pole Canyon Creek and valley-filling alluvial deposits of northern Sage Valley.

4.2 Lower Sage Valley Drainage

As noted above, the northern tributary to Sage Creek provided minimal stream flow (<0.5 cfs) to Sage Creek in October. Although the main stem of Sage Creek has significant flow upstream of the valley floor (i.e., west of Sage Valley), most of that surface flow is diverted for irrigation use before it reaches the west side of Sage Valley. Sage Creek had little flow above the Hoopes Spring confluence and showed minor gains in northern Sage Valley. Sage Creek gained most of its flow from the Hoopes Spring and South Fork Sage Creek tributaries. Hoopes Spring emanates from the west side of Sage Valley along the surface trace of the West Sage Valley Branch Fault and represents the most significant source of water to Sage Creek during low-flow conditions (October 2003 combined Hoopes Spring flow approximately 6 cfs). A previous geochemical investigation attributed this flow to discharge from the Wells Formation aquifer, possibly combined with discharge from the local shallow groundwater flow system (Mayo, 2000); hydrological investigations (e.g., Ralston, 1979) have also concluded that Hoopes Springs discharge predominantly from the Wells Formation. New groundwater data collected this fall are consistent with that interpretation for the source for Hoopes Spring water.

Other areas of lesser flow gains were also present along Sage Creek. Between locations LSV-1 and LSV-2, Sage Creek exhibits gains in flow both upstream and downstream of the Hoopes Spring inflow. Those gains have been observed during both high-flow and low-flow conditions. A recent water level measurement at GW-19A indicates that the shallow groundwater level is higher in elevation than the surface water elevation in Sage Creek. Therefore, alluvial and colluvial deposits present in this part of Sage Valley are likely to discharge groundwater to Sage Creek. Analyses of shallow groundwater from these deposits will help evaluate the effects of these groundwater discharges on surface water quality in Sage Creek.

4.3 South Fork Sage Creek Drainage

In October, South Fork Sage Creek was dry from west of the E Panel to the springs that discharge just southeast of the E Panel overburden disposal area (Figure 3). During low-flow conditions, the South Fork Sage Creek springs contribute almost all of the flow present at downstream locations on South Fork Sage Creek (October 2003 combined spring flow approximately 4 cfs). Those springs emanate along the West Sage Valley Branch Fault trace and appear to represent discharge from the upper portion of the Wells Formation as the alluvial deposits along this reach (at GW-21) were dry in October. Lesser gains in South Fork Sage Creek were also observed just above the confluence with Sage Creek (Figure 3). Discharges from alluvial deposits are the likely source of this additional flow in South Fork Sage Creek. Discharge of interflow from the stream banks to the channel was observed along this reach during an August 2003 field reconnaissance of the drainage. The shallow groundwater level at GW-20, which is located along this reach, was slightly higher than the elevation of the creek level.

4.4 Summary

In summary, findings of the groundwater/surface water investigations completed during low-flow conditions indicate that:

- Pole Canyon Creek supplies recharge water to the Wells Formation where it flows under the overburden disposal area.
- Pole Canyon Creek loses its remaining water to surficial deposits seasonally when it flows into northern Sage Valley.

- Shallow alluvial groundwater flows from the Pole Canyon area into Sage Valley via the shallow groundwater flow system in valley-filling surficial deposits and may eventually discharge to the northern tributary of Sage Creek (north fork of Sage Creek).
- Because the South Fork Sage Creek is dry across the Wells Formation outcrop area during low-flow conditions (i.e., October 2003), it provides only limited recharge to the Wells Formation.
- Wells Formation groundwater discharges at Hoopes Spring and flows to Sage Creek.
- Wells Formation groundwater discharges at South Fork Sage springs and flows into South Fork Sage Creek and on to Sage Creek.
- Shallow groundwater discharges from Sage Valley alluvial deposits into Sage Creek between LSV-1 and LSV-2.
- Shallow groundwater discharges from alluvial deposits into South Fork Sage Creek below LSS-2a.

Although several locations have been identified where groundwater discharges to surface water, including discharges from alluvial deposits that fill Sage Valley, groundwater discharges at the Hoopes Spring source and South Fork Sage springs contribute the largest proportion of water to the lower Sage Creek drainage (approximately 10.3 cfs of the 12.4 cfs Sage Creek flow measured below South Fork Sage Creek during low-flow conditions). The groundwater discharged at both of these locations originates primarily from the Wells Formation flow system.

5.0 PRELIMINARY INTERPRETATION OF GROUNDWATER FLOW IN THE WELLS FORMATION

Both the new water level and water quality data provide valuable information about the groundwater flow system in the upper Wells Formation. These data, and the other information used to develop a preliminary conceptual model for groundwater flow within the Wells Formation in the vicinity of the Smoky Canyon Mine, are described in greater detail below.

Figure 7 displays the static water level elevations measured in wells that screen the upper Wells Formation along with elevation contours for the potentiometric surface inferred from those data. The potentiometric surface contours shown reflect an interpretation that integrates the water level elevations measured in October as well as other influences on groundwater flow in the Wells Formation, including the local and regional topography, the elevation of Wells Formation recharge and discharge areas (including gaining and losing stream reaches), local stratigraphy and geologic structures and groundwater quality at each monitoring location.

The following factors, which have been described through previous investigations at the Smoky Canyon Mine and other mines in the southeast Idaho phosphate-mining district (e.g., Mayo, 2001; Ralston, 1979; Ralston, 1987), were considered in the interpretation of water level data from the Wells Formation aquifer:

- Surface drainages lose water to the subsurface where they flow over the Wells Formation (outcrop or subcrop below alluvial deposits).
- Where the Wells Formation outcrops (or subcrops below alluvium) it receives recharge from incident precipitation and surface water flow.
- The Wells Formation outcrops in the vicinity of the Smoky Canyon Mine along the core of the Boulder Creek Anticline.
- Higher elevation outcrop and recharge areas for the Wells Formation are present along Freeman Ridge approximately 4 miles west of the mine and in the Manning Creek and Deer Creek areas south of the mine.
- The Phosphoria Formation (including the Meade Peak Member) overlies the Wells Formation west of the Smoky Canyon Mine.
- Surface drainages do not lose water where they flow over the Phosphoria Formation.

- Where the Phosphoria Formation overlies the Wells Formation, the rate of recharge into the Wells Formation is limited by the relatively lower hydraulic conductivity of the Meade Peak Member.
- There are no apparent differences between the major-ion chemistries of Hoopes Spring water and groundwater from the upper Wells Formation.
- Radiogenic isotope data indicate that groundwater in the upper Wells Formation at the Culinary Well (GW-CW) originates from recent, or local, recharge to the aquifer.
- Radiogenic isotope data indicate that Hoopes Spring contains a component of recent, or local, recharge and also a component of much older recharge to the aquifer.
- The West Sage Valley Branch Fault appears to act as a hydraulic barrier for eastward flow in the Wells Formation (Ralston, 1979).

In addition, recent drilling, water level measurements and groundwater sampling and analysis at new deep well locations provide the following new information that must also be considered:

- Highs in the upper Wells Formation potentiometric surface elevation correspond to topographic highs associated with Wells Formation outcrop area.
- The shape of the potentiometric surface is controlled primarily by the local elevation of the Wells Formation area, which follows a north-south axis through the mine area, and the locations of spring discharge (i.e., Hoopes Spring and South Fork Sage springs). Focused recharge (e.g. Pole Canyon area) and groundwater pumping (i.e., GW-IW) also have small-scale effects on the potentiometric surface.
- The presence of springs that represent major discharges from the Wells Formation along the West Sage Valley Branch fault are consistent with the interpretation that a more-conductive zone of fractured bedrock follows the fault surface allowing for groundwater flow parallel to the fault surface. The relatively high conductivity along the fault zone against the relatively low conductivity of bedrock east of the fault zone has the effect of a barrier to further eastward groundwater flow in the upper Wells Formation across the West Sage Valley Branch Fault.
- The potentiometric surface has a higher elevation south of South Fork Sage Creek (monitoring well DC-MW-5) than at Smoky Canyon Mine.
- The selenium concentrations are lowest in upper Wells Formation groundwater from MC-MW-1, south of the Smoky Canyon Mine E Panel.

- The selenium concentrations in the upper Wells Formation below Pole Canyon are distinctly higher than at any other location monitored.
- Hoopes Spring and South Fork Sage Creek springs have selenium concentrations (1.4 to 12.5 μg/L) intermediate between upper Wells Formation groundwater from below Pole Canyon (GW-18, Se = 464 μg/L) and south of E Panel (MC-MW-5, Se <1 μg/L).

Given these new observations, several flow diagrams were prepared to evaluate flow pathways in the upper Wells Formation at (1) Pole Canyon and (2) Hoopes Spring. The purpose of these conceptual flow diagrams is to utilize all existing geologic, hydrogeologic and hydrologic data to identify the likely groundwater flow paths in the upper Wells Formation aquifer. In order to develop the conceptual flow model for a given portion of an aquifer, the boundary conditions for flow must be described. Based on previous studies of local hydrogeologic setting, the following simplifying conditions were adopted:

- The Wells Formation is a homogeneous, isotropic and permeable medium.
- The Phosphoria Formation has relatively lower permeability, conductivity and transmissivity and acts as a hydraulic boundary over the Wells Formation
- Where exposed or present under alluvial/colluvial deposits, the Wells Formation receives recharge vertically downward from the ground surface.

Figures 8 through 10 present three flow diagrams, two for the Pole Canyon area and one for the E Panel/Hoopes Spring area. In Figure 8, a cross-sectional view of the Pole Canyon area, the fracture zone in the Wells Formation, on the west side of the West Sage Valley Branch Fault, is considered a relatively permeable pathway for groundwater flow whereas the Phosphoria units displaced along the east side of the fault have lower relative permeability. As depicted on this cross section, the Wells Formation receives recharge water where it outcrops west of the mine along Freeman Ridge and at the mine along the core of the Boulder Creek Anticline, especially where stream drainages cross that outcrop area, and also in areas where overburden is placed directly over Wells Formation outcrop. The result is a series of flow pathways from recharge areas, including overburden disposal areas, toward the West Sage Valley Branch Fault. At GW-16, the elevation potential of the Wells Formation groundwater is less than the ground surface elevation, and no discharge from the Wells Formation takes place. Instead, groundwater flows

essentially parallel to the fault zone, i.e., either north or south along the fault, and remains in the subsurface.

Very different groundwater flow paths would be expected in the absence of a hydraulic barrier (i.e., preferential flow through the fault zone and restricted flow into less permeable units across the fault zone) across the West Sage Valley Branch Fault. The flow diagram presented in Figure 9 was prepared to illustrate the general flow paths that would be expected if structural deformation and displacement along the fault did not result in such a barrier. The flow paths shown on Figure 9 direct groundwater vertically downward and away from the Pole Canyon area. If this were the groundwater flow pattern in the vicinity of Pole Canyon, then substantially elevated selenium concentrations would not be expected in the upper Wells Formation at the monitoring location GW-16 immediately down slope from the overburden disposal area. Therefore, the available water quality data from this location support the interpretation of the West Sage Valley Branch Fault as a hydraulic barrier to eastward flow of groundwater in the upper Wells Formation.

Figure 10 is a cross-sectional view of the Hoopes Spring and E Panel area. In this flow diagram, the West Sage Valley Branch Fault was again assumed to act as a barrier to further eastward flow in the upper Wells Formation. Again, the Wells Formation receives recharge from local outcrop areas and more distant and higher elevation outcrop areas to the west. However, in this case the potentiometric surface elevation is lower and intersects the ground surface at Hoopes Spring, a known discharge from the Wells Formation. South Fork Sage springs have a similar setting where the potentiometric surface elevation for the upper Wells Formation intersects the ground surface elevation in the South Fork Sage Creek drainage valley.

5.1 Groundwater Flow Directions in Vicinity of Smoky Canyon Mine

The potentiometric surface map presented as Figure 7 generally reflects the conceptual flow pathways shown on Figures 8 and 10. Figure 7 identifies the outcrop, or subcrop, areas of the Wells Formation in the vicinity of the Smoky Canyon Mine. These are the areas where the Wells Formation can receive recharge from incident precipitation or flow in surface drainages, when present. The core of the Boulder Creek Anticline roughly coincides with the local Wells Formation outcrops that have the highest topographic elevation. Therefore, the potentiometric

surface has a local high that roughly coincides with the axis of the Boulder Creek Anticline. That local ridge in the potentiometric surface appears to be a relatively minor feature of the regional flow system, and the magnitude of that local high is not sufficient to drive groundwater flow west from the Smoky Canyon Mine because the regional potentiometric surface would slope eastward from the higher elevation Freeman Ridge area west of Smoky Canyon Mine toward Sage Valley. For the same reason, higher recharge areas for the Wells Formation south of Smoky Canyon Mine likely result in a northward sloping potentiometric surface that would direct groundwater flow from the Manning Creek basin area northeast toward Sage Valley.

The residual effects of groundwater pumping from the Wells Formation at the Industrial Well (GW-IW), and to a lesser extent from the Culinary Well (GW-CW), are also shown on Figure 7. GW-IW has a water level that is slightly lower than expected given the elevations of regional and local groundwater recharge areas. The well is used as a water supply to the mine's mill and is routinely pumped. Mine operations personnel indicate that the Industrial Well pump was turned off for approximately 12 hours and the water level had substantially recovered when the water level posted on Figure 7 was measured. However, the apparent depression in the potentiometric surface at the Industrial Well (Figure 7) indicates that water levels in the Wells Formation may not have not fully recovered during the 12-hour pump shut off.

The potentiometric surface map and flow diagram figures can be used to describe general groundwater flow directions from the Smoky Canyon Mine source areas. Although the predominant flow direction in the upper Wells Formation is from west to east across the mine area, there are local variations within that general pattern.

Local recharge to the Wells Formation occurs across its outcrop area (shown on Figure 7), especially along losing stream reaches that cross the outcrop area. The resultant local ridge in the potentiometric surface directs groundwater flow to the north from the A Panel area, to the west and east from backfilled-pit and external overburden disposal areas and to the south from the E Panel area. The component of local recharge to the Wells Formation that flows west from that ridge is eventually directed either northeast or southeast by the larger scale, eastward-sloping hydraulic gradient. Pole Canyon Creek and, to a lesser extent, Sage Creek and South Fork Sage Creek lose flow to the Wells Formation, which also produces smaller-scale highs in the potentiometric surface.

Wells Formation groundwater flowing from west to east across the area where overburden sources are currently present migrates generally east to the West Sage Valley Branch Fault, either along a relatively direct west to east flow path, such as in the vicinity of Pole Canyon, or to the south and then east, such as in the vicinity of backfilled E Panel pits. When groundwater encounters the fault zone associated with the West Sage Valley Branch Fault, it then flows either north or south along that fault zone. In the vicinity of Pole Canyon Creek, Wells Formation groundwater flows either north or south along the fault. Groundwater that flows south along the fault is directed, at depth, toward Hoopes Spring. Groundwater that flows north along the fault is much lower than the ground surface and does not have the potential for discharge at springs. In the Panel D and E areas, groundwater flows either east or southeast from the existing mine disturbed areas toward the large area of discharge formed by Hoopes Spring and the springs in lower South Fork Sage Creek.

The conceptual flow model described above and depicted in Figures 7, 8 and 10 is consistent with the observed water quality conditions within the upper Wells Formation. The highest concentrations of constituents associated with overburden weathering (e.g., selenium, manganese, sulfate) are present in groundwater from the GW-16, which is installed downgradient of the Panel A and D overburden disposal areas, including Pole Canyon. The lowest concentrations of these constituents are present in groundwater from MC-MW-1 and the South Fork Sage springs, both of which are supplied mainly by groundwater flow from undisturbed areas south and west of Smoky Canyon Mine. Hoopes Spring and groundwater at GW-18 have intermediate water quality. Groundwater present in the Wells Formation at these locations originates both locally and from distant recharge areas, and some of the local recharge area coincides with areas of overburden disposal. At the Culinary and Industrial Wells (GW-CW and GW-IW) groundwater originates mainly from local recharge, a component of which passes through the A Panel backfill area.

5.2 Relationship to Groundwater Flow in Manning Creek and Deer Creek Areas

The interpretation of groundwater levels, and groundwater flow directions, in the upper Wells Formation can be extended south of South Fork Sage Creek using preliminary data from the Manning Creek and Deer Creek (Panels F and G) EIS baseline studies. For the purpose of the Smoky Canyon Site Investigation, it is important to understand the likely origin and chemical characteristics of groundwater that discharges from the Wells Formation at both Hoopes Spring

and South Fork Sage Creek springs. Inclusion of water level and water quality data from the new monitoring wells installed south of the Smoky Canyon Mine, MC-MW-1 and DC-MW-5, may provide a better understanding of the Wells Formation groundwater flow system and the likely sources of groundwater flow to these important spring discharges.

The water level at DC-MW-5 (6,905 feet amsl in October 2003) is higher than any of the other water levels measured in deep wells around the Smoky Canyon Mine. A higher water level at this location is consistent with the much higher elevation of the Wells Formation outcrop area in the vicinity of Deer Creek. This water level was considered in interpretation of groundwater data from Smoky Canyon Mine and preparation of the potentiometric surface map shown on Figure 7.

Published geologic maps (Derkey et al., 1985; Mansfield, 1927) were used to identify the outcrop areas for the Wells Formation in the Manning Creek and Deer Creek areas. These areas are shown on Figure 7. Wells Formation outcrops have highest elevations west of the planned F and G Panels along Freeman Ridge and south to Snowdrift Mountain. Recharge to the Wells Formation in these elevated outcrop areas likely drives the hydraulic gradient across the Manning Creek and Deer Creek areas. As a result, the general direction of groundwater flow in the Wells Formation south of Smoky Canyon Mine is expected to be from west to east and also northeast across the Panels F and G areas toward the southern extension of the West Sage Valley Branch Fault. However, as at the Smoky Canyon Mine, local variations in flow directions are expected where local geologic structures (i.e., folds and faults) are present.

A number of the springs identified in the Manning Creek and Deer Creek areas are shown on Figure 7. These are the springs that discharge either from the Wells Formation or along fault structures that offset the Wells Formation at depth. When there are data available to confirm that a spring originates from the Wells Formation, the spring elevation may be used to describe the elevation of the potentiometric surface in the Wells Formation.

Springs south of Deer Canyon, in Wells Canyon and the Stewart ranch area, discharge at elevations of approximately 7200 to 7000 feet amsl from the base of the Wells Formation, along the Wells/Brazer Limestone contact. The flows measured from these springs were approximately 0.14 to 0.03 cfs at the Wells Canyon location and 1.0 cfs at Stewart ranch during the summer of 2003 (memo from B. Buck, JBR, December 8, 2003). Deer Creek also appears

to gain flow by discharge from the lower section of the Wells Formation (memo from B. Buck, JBR, December 8, 2003).

Books Spring and the "Reide" spring discharge within the outcrop/subcrop area of the Brazer Limestone, which underlies the Wells Formation, at elevations of approximately 6600 feet amsl. These springs have significant flow year round and discharge along east-west trending strike slip faults on the west side of the Crow Creek valley. Flows measured at Books Spring in summer 2003 were 1.74 cfs and 2.19 cfs (memo from B. Buck, JBR, December 8, 2003), which appears to represent a significant source of flow to Crow Creek. Flow was not measured at the Reide spring during the summer of 2003.

The two sets of groundwater discharges occur at distinctly different elevations and may represent either (1) separate discharges from one large regional flow system in the Wells Formation or (2) distinct discharges from separate flow systems. The higher-elevation Wells Canyon and Stewart ranch springs likely originate from a flow system in the Wells Formation, whereas the springs along the west side of Crow Creek valley may originate from: the Wells Formation, other deeper stratigraphic units or some combination of those sources. Further investigation of the springs, including comparison of their water chemistry to evaluate their sources, is ongoing and will be completed as part of the baseline study of water resources in this area.

As at the Smoky Canyon Mine, the occurrence of perennial springs along the West Sage Valley Branch Fault indicate that the fault likely acts as a hydraulic barrier to further eastward groundwater flow and provides a focus for groundwater discharge from the Wells Formation. Two local northwest-trending strike-slip faults, the Deer Creek Fault and the Wells Canyon Fault, may also exert control on locations of discharge from the Wells Formation. Books Spring discharges along the Deer Creek Fault near its intersection with the Sage Valley Branch Fault, and springs also discharge along the Wells Canyon Fault.

5.3 Groundwater Flow Velocities

The available information can be utilized to develop a range of flow characteristics in the upper Wells Formation. In particular, flow velocities (i.e., the rate of groundwater movement) within the upper Wells Formation are of interest with respect to COPC migration from source areas.

Groundwater flow velocity is a function of three primary variables: (1) gradient, or potentiometric surface slope, across a given area (denoted by the dimensionless variable i); (2) the hydraulic conductivity of the aquifer (denoted by the variable K, in units of length per time); and (3) the porosity of the aquifer (denoted by the variable n, as a percent or unitless). Using Darcy's Law, these variables are combined as follows to calculate average linear groundwater flow velocity:

$$\text{average linear flow velocity } (v) = Ki/n$$

When calculating average linear flow velocities for groundwater systems, it is important to understand the variability associated with each of the input variables. Gradients for specific flow paths can be obtained from potentiometric surface maps, yet those maps are themselves interpretations based on typically sparse water level measurements. For most aquifers, porosity can range from a few percent up to 40 to 45 percent. The hydraulic conductivity of the aquifer is the most wide-ranging of the variables needed to calculate average linear flow velocities for groundwater. The hydraulic conductivity of natural materials ranges over 13 orders of magnitude, and therefore calculation of hydraulic conductivity based on aquifer test data are typically order-of-magnitude estimates. The variability in these inputs is exacerbated by the natural heterogeneity and anisotropy of aquifers though, as previously discussed, it has been assumed here, for simplicity, that the upper Wells Formation is homogeneous and isotropic Overall, the variability in input parameters, in conjunction with aquifer heterogeneity and anisotropy, result in estimates of groundwater flow velocities that should be considered as approximate and occurring within a range.

Approximately average hydraulic gradients for specific flow paths of interest in the Smoky Canyon Mine area can be taken from the potentiometric surface map depicted in Figure 7 by dividing the head difference between two equipotential lines by the linear distance that separates them. Data are not currently available to estimate a typical porosity for the upper Wells Formation; therefore, typical values for sandstone may be used (e.g., 5 to 30 percent; Freeze and Cherry, 1979). Data from a three-day pumping test of the Culinary Well in 1981 (Ralston, 1981) resulted in a transmissivity estimate of 3,600 gallons per day per square foot (gal/day/ft^2). Transmissivity is the product of aquifer's hydraulic conductivity and its saturated thickness; therefore, dividing the estimated transmissivity by the saturated thickness of the upper Wells Formation will provide an estimate of its hydraulic conductivity. This is complicated by two factors: (1) the Culinary Well does not fully penetrate the saturated portion of the upper Wells Formation and (2) the Culinary Well is screened in two intervals (a 60-foot section, 330-

390 feet bgs, that screens the Meade Peak Member of the Phosphoria Formation; and a 230-foot section, 710-940 feet bgs, that screens both Meade Peak Member and Wells Formation). For estimation purposes, it is therefore assumed that the saturated thickness is the sum of the lengths of screened intervals (290 feet). Dividing the estimated transmissivity (3,600 gallons/day/ ft^2) by these distances, and using appropriate conversion factors, results in an estimated hydraulic conductivity of 1.7 ft/day. This estimate reflects an aggregate hydraulic conductivity for a portion of the upper Wells Formation including a portion of the Meade Peak Member.

6.0 SUMMARY OF FINDINGS AND REMAINING DATA NEEDS FOR THE SI

The findings from preliminary groundwater investigations completed in the fall of 2003 provide a better understanding of the groundwater flow systems at the Smoky Canyon Mine.

The findings related to groundwater and surface water interactions can be generally summarized as follows:

- Pole Canyon Creek supplies recharge water to the Wells Formation where it flows under the overburden disposal area.
- Lower Pole Canyon Creek water is also lost to alluvial deposits, seasonally, below the overburden disposal area.
- South Fork Sage Creek was mostly dry across the Wells Formation outcrop area in October 2003 and would supply less recharge to the Wells Formation than the other local streams during low-flow conditions.
- Wells Formation groundwater discharges at Hoopes Spring and flows to Sage Creek.
- Wells Formation groundwater discharges at South Fork Sage springs and flows into South Fork Sage Creek and eventually Sage Creek.
- Shallow groundwater discharges from Sage Valley alluvial deposits into Sage Creek between LSV-1 and LSV-2.
- Shallow groundwater discharges from alluvial deposits into South Fork Sage Creek below LSS-2a.

The findings related to groundwater flow in the Wells Formation aquifer can be generally summarized as follows:

- Upper Wells Formation groundwater generally flows from west to east across the mine site
- The topographic surface and local geologic structures (Boulder Creek Anticline and West Sage Valley Branch Fault) both have effects on local flow directions within the upper Wells Formation.
- Water quality data from the Wells Formation support the interpretation of the West Sage Valley Branch Fault as a barrier to further eastward flow in the upper Wells Formation.
- The area around Hoopes Spring and South Fork Sage Creek is the location of major groundwater discharge from the Wells Formation, and groundwater flowing from the Smoky Canyon Mine area south of Pole Canyon flows to this area.

- Groundwater flowing from the Smoky Canyon Mine area north of Pole Canyon flows north and east at depth and does not discharge to the ground surface.
- Other points of groundwater discharge from the Wells Formation are likely present along the southern extension of the West Sage Valley Branch Fault in the vicinity of Deer Canyon.

These findings are generally consistent with previous conceptual flow models for the Smoky Canyon Mine area. However, the recent investigations have provided the additional data needed to clarify flow directions in the vicinity of overburden source areas and in the vicinity of the West Sage Valley Branch Fault.

As the SI continues and additional surface water, groundwater, seep, spring, and irrigation-water data are collected in accordance with the FSP, this characterization of groundwater flow conditions and groundwater flow pathways will continue to improve. However, two data gaps remain. First, the fate of shallow alluvial groundwater in the vicinity of the Pole Canyon overburden disposal area is not known. Second, confirmation that the West Sage Valley Branch Fault is the boundary for eastward flow in the upper Wells Formation is still needed.

Recommendations for filling these data gaps are as follows. First, install a monitoring well in Sage Valley to characterize groundwater quality in the shallow alluvial aquifer downgradient of Pole Canyon. The location for this well should be selected after completion of the planned irrigation survey in the summer of 2004 because that survey will help to identify the surface flow paths for Pole Canyon Creek water in Sage Valley. Second, drill a borehole into the bedrock units that underlie Quaternary alluvial deposits and Tertiary Salt Lake Formation in Sage Valley to determine the geologic unit for and the depth to the first bedrock flow system encountered. Depending on the formation encountered, the boring may or may not be completed as a monitoring well. Third, perform additional aquifer testing in the upper Wells Formation by using the Industrial Well (GW-IW) for pumping and monitoring effects on water levels, during either pumping or recovery from pumping at GW-IW, in nearby wells such as the Culinary Well (GW-CW), Consent Order well (GW-CO) and the new deep well below Pole Canyon (GW-16).

7.0 REFERENCES

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TABLES

TABLE 1 - DRAFT

SMOKY CANYON MINE SITE INVESTIGATION: MONITORING WELL DETAILS

Well ID	Description	Total Depth of Borehole (feet bgs)	Depth to Bedrock (feet bgs)	Screen Depth (feet bgs)	Unit Screened	Estimated Depth to Water During Drilling (feet bgs)	Elevation at Top of Inside Casing (feet amsl)	Date of Water Level Measurement	Water Depth From Top of Inside Casing	Static Water Level Elevation (feet amsl)
Panels B&C Area										
GW-IW	Industrial Well	1320	15	650-980	Wells Fm	483	7234	summer 2003*	not recorded	6637*
GW-CW	Culinary Well	1000	NA	330-940	Wells Fm	NA	7203	10/31/2003	below pump**	---
GW-CO	Consent Order Well	722	24	599-650	Wells Fm	574	7231	10/31/2003	588.28	6642.7
GW-10	External overburden well	154	NA	NA	Wells Fm	NA	7940	10/30/2003	dry	dry
GW-11	A Pit backfill well	134	NA	NA	backfill and Meade Peak	NA	7610	10/30/2003	100.25	7509.8
Smoky Canyon Site Investigation Wells										
GW-15	Pole Canyon, shallow	45	39	15-45	alluvium	45	6854.2	10/29/03	38.83	6815.3
GW-16	Pole Canyon, deep	280	34	230-280	Wells Fm	240	6854.4	10/29/03	220.21	6634.2
GW-17	Hoopes Spring, shallow	35	33	0.5-35	alluvium	dry	6677.4	10/30/03	dry	---
GW-18	Hoopes Spring, deep	105	24	55-105	Wells Fm	51	6675.6	10/30/03	44.91	6630.7
GW-19A	Peterson Ranch, shallow well point	17	<17	9.5-14.5	alluvium	measurement pending	NA	10/30/03	8.15	
GW-19B	Peterson Ranch, shallow	52	49	12-52	alluvium	16	6640.1	10/29/03	18.19	6621.9
GW-20	lower South Sage, shallow	72	67	18-69	alluvium	23	6539.9	10/30/03	11.03	6528.9
GW-21	upper South Sage, shallow	25	17	4.5-24.5	alluvium	dry	6696.4	10/30/03	dry	---
South Fork Sage Creek/Manning Creek & Deer Creek EIS										
DC-MW-5	Deer Creek lease area, deep	500	NA	380-483	Grandeur Limestone and Wells Fm	300	7205.1	10/10/03	302.95	6902.2
MC-MW-1	Upper South Sage, deep	210	8	160-210	Wells Fm	146	6780.1	10/30/03	148.11	6632.0

Notes:

NA = not available
NM = not measured
*reported by Simplot; measurement taken after pump turned off for 12 hours
**water level measured at Culinary Well on 9/17/03 was 475 feet bgs, 6728 feeet amsl, Industrial Well pump on at time of measurement

TABLE 2 - DRAFT

Flows Measured During October 2003 (Low Flow) Gain/Loss Survey

Location	Description	Date	Time	Flow	pH	Specific Conductance
				cfs	Std. Units	µS
Pole Canyon Creek						
UP-A	Upper Pole Canyon Creek at small spring near headwaters	10/28/2003	15:50	DRY	---	---
UP-B	Upper Pole Canyon Creek just upstream of large spring area	10/28/2003	15:55	DRY	---	---
UP-C	Upper Pole Canyon Creek spring area containing numerous springs	10/28/2003	16:25	springs	---	---
UP-D	Upper Pole Canyon Creek just downstream of large spring area	10/28/2003	16:25	0.030	---	---
UP-E	Upper Pole Canyon Creek just upstream of north and south tributaries located approximately 0.75 miles upstream of the pile	10/28/2003	16:30	0.041	---	---
UP-F	Upper Pole Canyon Creek just downstream of north and south tributaries located approximately 0.75 miles upstream of the pile	10/28/2003	16:35	0.067	---	---
UP-G	Upper Pole Canyon Creek approximately 500 feet upstream of the UP station	10/28/2003	16:45	0.075	---	---
UP	Upper Pole Canyon Creek	10/28/2003	17:00	0.047	8.43	220
UP-H	Upper Pole Canyon Creek approximately 150 feet upstream of the pile	10/28/2003	17:30	0.092	---	---
LP-1	Lower Pole Canyon Creek where creek emanates from toe of pile	10/28/2003	14:05	0.010	7.25	---
South Fork Sage Creek						
USS	Upper South Fork Sage Creek	10/26/2003	17:00	0.02	8.47	246
LSS-1C	South Fork Sage Creek downstream of historic tributary located within the E-Panel mine	10/26/2003	9:50	DRY	---	---
LSS-1B	South Fork Sage Creek approximately 500 feet upstream of road leading up to Panel E	10/26/2003	10:00	DRY	---	---
LSS-1A	South Fork Sage Creek just upstream of spring area	10/26/2003	10:30	DRY	---	---
LSS-SP1A	Spring on northern side of South Fork Sage Creek just downstream of fence	10/26/2003	11:20	0.003	7.36	263
LSS-SP1B	Spring on southern side of South Fork Sage Creek located southeast of LSS-SP1a	10/26/2003	11:20	0.25	7.33	263
LSS-SP1	Lower South Fork Sage Creek Spring	10/26/2003	11:40	0.3	7.42	269
LSS-SP2	Lower South Fork Sage Creek Spring	10/26/2003	11:50	0.15	7.38	278
LSS	Lower South Fork Sage Creek	10/26/2003	13:00	4.44	7.87	262
LSS-2A	Lower South Fork Sage Creek approximately 0.25 miles downstream of LSS	10/26/2003	14:30	4.48	8.08	260
LSS-2B	Lower South Fork Sage Creek approximately 0.25 miles upstream of the mouth	10/26/2003	15:20	4.11	8.21	255
LSS-2	Lower South Fork Sage Creek just upstream of the mouth	10/26/2003	16:15	4.64	8.41	259

TABLE 2 - DRAFT

Flows Measured During October 2003 (Low Flow) Gain/Loss Survey

Location	Description	Date	Time	Flow	pH	Specific Conductance
				cfs	Std. Units	µS
Sage Creek						
NSV-5	North Sage Creek above most Pole Creek inflow (historical site ST188)	10/28/2003	12:30	0.083	8.09	800
NSV-6	North Sage Creek above ranch and below most Pole Creek inflow (historical site ST187)	10/28/2003	11:45	0.154	8.27	350
LSV	Sage Creek just downstream of the Sage Creek and North Fork Sage Creek confluence	10/27/2003	7:30	0.63	7.91	335
LSV-1	Lower Sage Creek below North Fork Sage Creek	10/27/2003	8:30	0.6	8.26	336
ID-1	Irrigation Ditch inflow to Sage Creek upstream of Hoopes Spring inflow	10/27/2003	8:45	0.21	8.40	318
LSV-1A	Lower Sage Valley Sage Creek just upstream of Hoopes Spring Creek	10/27/2003	9:35	0.47	8.47	338
HS-3	Hoopes Spring Creek at the mouth just upstream of Sage Creek	10/27/2003	9:55	6.09	8.50	294
LSV-1B	Lower Sage Valley Sage Creek just downstream of Hoopes Spring Creek	10/27/2003	10:55	7.25	8.41	293
LSV-2	Lower Sage Creek below Hoopes Spring	10/27/2003	12:05	7.57	8.57	285
LSV-SP1	Lower Sage Valley Spring #1	10/27/2003	12:35	0.16	7.36	330
LSV-SP2	Lower Sage Valley Spring #2	10/27/2003	12:40	0.04	7.47	311
LSV-2A	Lower Sage Valley Sage Creek just upstream of South Fork Sage Creek	10/27/2003	13:40	6.83	8.59	276
LSV-3	Lower Sage Creek below South Fork Sage Creek	10/27/2003	14:45	12.41	8.56	265
LSV-T1	Tributary #1 to Lower Sage Valley Sage Creek along road leading to Crow Creek	10/27/2003	17:20	0.06	8.17	252
LSV-T2	Tributary #2 to Lower Sage Valley Sage Creek along road leading to Crow Creek	10/27/2003	17:25	DRY	---	---
LSV-T3	Tributary #3 to Lower Sage Valley Sage Creek along road leading to Crow Creek	10/27/2003	17:25	0.01	8.16	253
LSV-3A	Lower Sage Valley Sage Creek downstream of southern tributaries	10/27/2003	17:10	12.13	8.33	276
LSV-4	Lower Sage Creek just above bridge for main Crow Creek road	10/27/2003	18:20	10.26	8.30	286

TABLE 3 - DRAFT

October 2003 Shallow Groundwater Monitoring Results

Parameter	Units	Shallow Wells					
		GW-15	GW-17	GW-19A	GW-19B	GW-20	GW-21
		10/29/03	10/30/03	10/30/03	10/29/03	10/30/03	10/30/03
		8:20	13:45	17:30	16:45	19:10	20:00
Field Parameters							
Depth to Water BTOC	ft	38.83	DRY	8.15	18.19	11.03	DRY
pH	S.U.	7.62		7.46	7.8	6.9	
Specific Conductance	µS	462		331	290	380	
Temperature	C	7		7.3	5.9	6.8	
Dissolved Oxygen	mg/L	7.6		6.91	3.99	2.24	
Turbidity	NTU	>1000		>1000	>1000	8.8	
Oxidation-Reduction Pot.	mV	93.3		20.4	144.8	148.5	
Eh	mV	295.7		222.8	347.2	350.9	
Metals							
Aluminum, dissolved	mg/L	0.0097 U	No Sample	0.0097 U	0.0097 U	0.0097 U	No Sample
Cadmium, dissolved	mg/L	0.00007 B		0.00006 U	0.00006 U	0.00006 U	
Cadmium, total	mg/L	0.0019		0.0015	0.0009	0.00006 U	
Chromium, dissolved	mg/L	0.0003 U		0.0003 U	0.0011 B	0.0003 U	
Chromium, total	mg/L	0.0645		0.0536	0.0375	0.00042 B	
Copper, dissolved	mg/L	0.0026 U		0.0026 U	0.0026 U	0.0026 U	
Copper, total	mg/L	0.0562		0.0405	0.029	0.0026 U	
Iron, dissolved	mg/L	0.0045 U		0.0045 U	0.0074 B	0.0045 U	
Manganese, dissolved	mg/L	0.0663		0.0054	0.0021	0.0012 B	
Nickel, dissolved	mg/L	0.0036 B		0.0174	0.0036 B	0.001 U	
Selenium, dissolved	mg/L	0.311		0.0009 B	0.00083	0.00071 B	
Selenium, total	mg/L	0.309		0.0016	0.0016	0.00083 B	
Vanadium, dissolved	mg/L	0.00025 B		0.00042 B	0.00052 B	0.0008 B	
Zinc, dissolved	mg/L	0.0018 B		0.0018 U	0.0018 U	0.0018 U	
Major Ions and Other Constituents							
Calcium, dissolved	mg/L	110		76	63.1	87	
Magnesium, dissolved	mg/L	21.7		17.1	10.4	21.1	
Chloride	mg/L	3.86		3.96	3.82	4.72	
Fluoride	mg/L	0.166		0.108	0.1 U	0.185	
Potassium, dissolved	mg/L	2.23		0.959 B	0.802 B	0.753 B	
Sodium, dissolved	mg/L	5.36		7.96	8.15	6.98	
Sulfate	mg/L	147		30.5	22.8	23.6	
Nitrate/Nitrite, as N	mg/L	0.34		0.25	0.96	0.46	
Total Phosphorus	mg/L	4.23		2.31	1.92	0.07	
Total Dissolved Solids	mg/L	475		298	282	307	
Total Alkalinity	mg/L	218		236	195	289	
Bicarbonate as CaCO3	mg/L	218		236	195	289	
Carbonate as CaCO3	mg/L	<1		<1	<1	<1	
Hydroxide as CaCO3	mg/L	<1		<1	<1	<1	

Notes:

1. U indicates the reported method detection limit for results less than detection,
   B indicates the result in below the Practical Quantification Limit and H indicates.
   the analysis was performed after the recommended holding time expired.
2. Oxidation-Reduction Pot. refers to oxidation-reduction potential.
3. A Zobells reference solution measured an Oxidation Reduction Potential of 202.4 mV.

4. Although the total selenium concentration is often reported less than the dissolved concentration, the relative differences between total and dissolved concentrations are generally within the project's control limits for precision of duplicate selenium analyses (+/- 20% relative percent difference). This is the level of precision considered acceptable for the project's data uses.

TABLE 4 - DRAFT

Fall 2003 Wells Formation Groundwater and Spring Water Quality Data

Parameter	Units	Wells Fm Monitoring Wells							Springs		
		GW-CO	GW-IW	GW-CW	GW-16	GW-18	MC-MW-1	DC-MW-5	Hoopes Spring	LSS-SP1	LSS-SP2
		09/16/03	10/31/03	09/16/03	10/29/03	10/30/03	10/30/03	10/10/03	10/28/03	10/26/03	10/26/03
		17:00	9:20	14:10	14:15	14:40	11:15		9:15	11:40	11:50
Field Parameters											
pH	S.U.	7.68	7.47	7.48	8.21	7.91	7.85	8.15	7.55	7.42	7.38
Specific Conductance	µS	379	308	538	453	298	239	397	260	269	278
Temperature	C	8.2	9.4	9	4.7	9.7	6.3	8.1	11.8	11.9	11.9
Dissolved Oxygen	mg/L	-	4.75	-	10.19	5.08	7.04	7.24	5.4	6.11	5.01
Turbidity	NTU	-	1.27	-	31.5	6.3	145	-	0.25	0.42	0.52
Oxidation-Reduction Potential	mV	-	91.2	-	144.8	128.3	102.5	-100	-	-	-
Eh	mV	-	293.6		347.2	330.7	304.9		-	-	-
Ferrous Iron (Fe2+)	mg/L	-	0.02	-	0.24	0.05	0.84	-	-	-	-
Total Iron	mg/L	-	0.04	-	0.38	0.06	0.97	-	-	-	-
Metals (ug/L)											
Aluminum, dissolved	ug/L	na	11.5 B	na	10.8 B	9.7 U	12.5 B	17.6	8.6 U	9.7 U	9.7 U
Cadmium, dissolved	ug/L	0.77 B	0.10	1.7 B	0.06 U	0.06 U	0.06 U	0.16	0.06 U	0.06 U	0.06 U
Cadmium, total	ug/L	0.2 U	0.11 M	0.82 B	0.12 W	0.06 U	0.14	0.34			
Chromium, dissolved	ug/L	3.2 B	0.30 U	0.3 B	0.38 B	0.41 B	0.3 U	0.3 U	0.33 B	0.52 B	0.33 B
Chromium, total	ug/L	3.7 B	0.33 B	0.58 B	1.7 B	1.3 B	10.3	1.2 U			
Copper, dissolved	ug/L	2.6 U	2.6 U	2.6 U	2.6 U	2.6 U	2.6 U	2.6 U	1.1 U	2.6 U	2.6 U
Copper, total	ug/L	2.6 U	2.6 U	2.6 U	2.6 U	2.6 U	4.4	2.6 U			
Iron, dissolved	ug/L	na	4.5 U	na	4.5 U	4.5 U	4.5 U	4.5 U	3.5 U	4.5 U	4.5 U
Manganese, dissolved	ug/L	2.5	2.6	23.6	41.6	4.6	3.4	18	0.3 U	4.2	0.7 U
Nickel, dissolved	ug/L	na	3.4 B	na	3.4 B	2.6 B	2.0 B	13.3	1.1 U	1 U	2.6 U
Selenium, dissolved	ug/L	3.5	11.5	10.6	464	4.1	0.49 B	14.3	12.5 N	1.4	1.4
Selenium, total	ug/L	3.5	10.5	13.6 N	447	4.0	0.42	14.2	9.6 N	1.5	1.6
Vanadium, dissolved	ug/L	na	9.6	na	0.2 U	1.0 B	0.29 B	1.3 B	1.7 B	0.33 B	0.51 B
Zinc, dissolved	ug/L	na	13.6	na	2.0 B	1.8 U	6.6	37	1.7 U	1.8 U	1.8 U
Major Ions and Other Constituents (mg/L)											
Calcium, dissolved	mg/L		55.5		85.1	54.6	48.1	60.4 total	59.7	47.6	47.4
Magnesium, dissolved	mg/L		22.8		24.2	19.9	14.0	16.9 total	22.3	20.3	20.6
Chloride	mg/L		2.49		3.06	6.63	1.06	1.72	8.04	6.75	6.82
Fluoride	mg/L	0.178	0.11	0.2	0.11	0.26	<0.1	0.34	0.4	0.37	0.32
Potassium, dissolved	mg/L		0.53 B		2.16	0.74	0.73 B	0.68 total	0.851	0.867	0.895
Sodium, dissolved	mg/L		2.93		13.3	6.78	3.01	2.85 total	7.2	5.36	5.35
Sulfate	mg/L	8.14	31.4	78.1	157	36.7	8.47	14.2	44.1	14.4	15.9
Nitrate/Nitrite, as N	mg/L		0.10		0.45	0.19	<0.02	0.15	0.17	0.16	0.17

TABLE 4 - DRAFT

Fall 2003 Wells Formation Groundwater and Spring Water Quality Data

Parameter	Units	Wells Fm Monitoring Wells							Springs		
		GW-CO	GW-IW	GW-CW	GW-16	GW-18	MC-MW-1	DC-MW-5	Hoopes Spring	LSS-SP1	LSS-SP2
		09/16/03	10/31/03	09/16/03	10/29/03	10/30/03	10/30/03	10/10/03	10/28/03	10/26/03	10/26/03
		17:00	9:20	14:10	14:15	14:40	11:15		9:15	11:40	11:50
Total Phosphorus	mg/L		0.02		0.11	<0.01	0.26	0.022	<0.01 ortho	<0.01 ortho	<0.01 ortho
Total Dissolved Solids	mg/L	196	245	316	432	254	236	248	252	221	224
Total Alkalinity	mg/L		222		192	197	184	208	198	202	205
Bicarbonate as CaCO3	mg/L		222		192	197	184	208	198	202	205
Carbonate as CaCO3	mg/L		<1		<1	<1	<1	<1	<1	<1	<1
Hydroxide as CaCO3	mg/L		<1		<1	<1	<1	<1	<1	<1	<1

Notes:

1. Laboratory qualifiers applied:

B not detected above quantitation limit but present above method detection limit
M duplicate precision goal not met
U not detected above method detection limit
W post-digestion spike recovery out of control limits

2. Although the total selenium concentration is often reported less than the dissolved concentration, the relative differences between total and dissolved concentrations are generally within the project's control limits for precision of duplicate selenium analyses (+/- 20% relative percent difference). This is the level of precision considered acceptable for the project's data uses.

TABLE 6 - DRAFT

September 2003 Domestic Water Supply Sampling Results

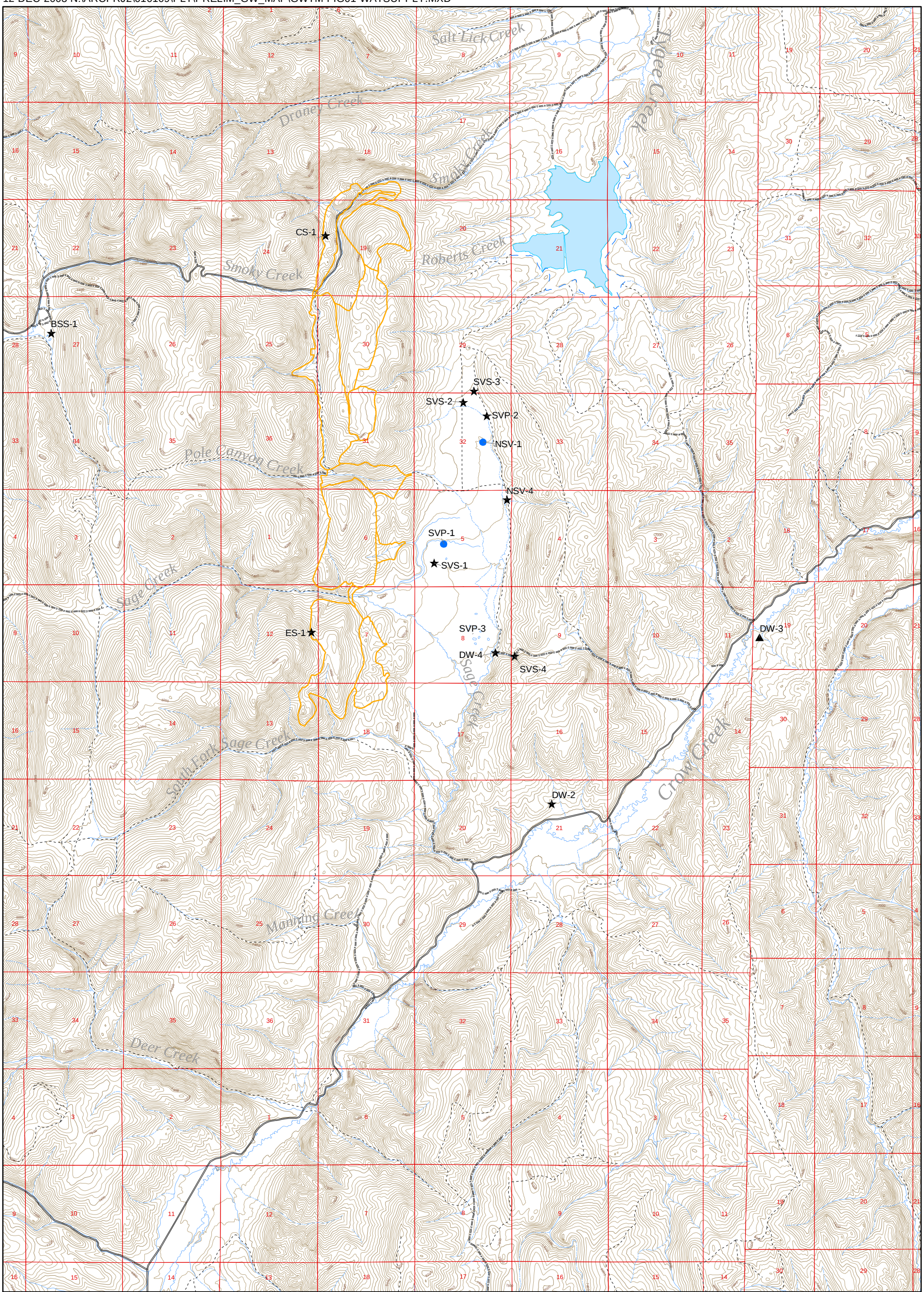
Parameter	Units	Domestic Water Supply Wells and Springs							
		BSS-1		DW-2		DW-3		DW-4	
		09/17/03		09/18/03		09/18/03		09/18/03	
		spring		spring		well		spring	
Field Parameters									
Flow	cfs	0.053		-		-		-	
pH	S.U.	6.79		7.32		7.90		7.72	
Specific Conductance	µS	276		379		317		482	
Temperature	C	5.5		8.2		12.8		10.5	
Dissolved Oxygen	mg/L	5.08		5.99		5.31		2.94	
Turbidity	NTU	0.82		0.20		0.23		0.15	
Oxidation Reduction Potential	mV	54.6		60.3		98.9		105.3	
Eh	mV	257		262.7		301.3		307.7	
Ferrous Iron (Fe^{2+})	mg/L	0.00		0.00		0.00		0.00	
Total Iron	mg/L	0.00		0.00		0.01		0.03	
Metals									
Aluminum, dissolved	mg/L	<0.0097	U	<0.0097	U	<0.0097	U	0.0128	B
Cadmium, dissolved	mg/L	<0.0001	U	<0.0001	U	<0.0001	U	<0.0001	U
Cadmium, total	mg/L	<0.0001	U	<0.0001	U	<0.0001	U	<0.0001	U
Chromium, dissolved	mg/L	0.00034	B	0.00057	B	<0.0003	U	<0.0003	U
Chromium, total	mg/L	0.00044	B	0.00056	B	<0.0003	U	<0.0003	U
Copper, dissolved	mg/L	<0.0026	U	<0.0026	U	<0.0026	U	<0.0026	U
Copper, total	mg/L	<0.0026	U	<0.0026	U	0.0029	B	<0.0026	U
Iron, dissolved	mg/L	<0.0045	U	<0.0045	U	<0.0045	U	<0.0045	U
Manganese, dissolved	mg/L	0.0029		0.0022		0.0015	B	0.0045	
Nickel, dissolved	mg/L	0.0024	B	0.0023	B	0.0027	B	0.0037	B
Selenium, dissolved	mg/L	<0.0002	U	0.00026	B	0.00035	B	<0.0002	U
Selenium, total	mg/L	<0.0002	U	0.00023	B	0.00042	B	<0.0002	U
Vanadium, dissolved	mg/L	<0.0002	U	0.0013	B	0.0024	B	0.00044	B
Zinc, dissolved	mg/L	<0.0018	U	<0.0018	U	0.021		<0.0018	U
Major Ions and Other Constituents									
Alkalinity,CaCO3	mg/L	191		200		216		174	
Calcium, dissolved	mg/L	46.5		71.2		52.5		82.3	
Chloride	mg/L	1.53		29.6		9.7		8.66	
CO3, CaCO3	mg/L	<1.0	U	<1.0	U	<1.0	U	<1.0	U
Fluoride	mg/L	0.147		0.146		0.19		0.188	
HCO3, CaCO3	mg/L	191		200		216		174	
Magnesium, dissolved	mg/L	18.4		9		21.7		33	
NO2+NO3-N	mg/L	0.1		0.16		0.59		0.06	
Phosphorus	mg/L	<0.01	U	0.02		0.02		<0.01	U
Potassium, dissolved	mg/L	0.784	B	1.08		1.06		0.977	B
Sodium, dissolved	mg/L	5.5		22		6.94		11.5	
Sulfate, SO4	mg/L	15.5		32.9		9.21		192	
Total Dissolved Solids (TDS)	mg/L	202		294		232		451	

Notes:

1. U indicates the reported method detection limit for results less than detection
2. B indicates the result in below the Practical Quantification Limit.
3. A Zobells reference solution measured an Oxidation Reduction Potential of 202.4 mV.
4. Although the total selenium concentration is reported less than the dissolved concentration for some samples, the relative differences between total and dissolved concentrations are generally within the project's control limits for precision of duplicate selenium analyses (+/- 20% relative percent difference). This is the level of precision considered acceptable for the project's data uses.

FIGURES

12-DEC-2003 N:\ARCPRJ2\010109\PLT\PRELIM_GW_MAP\GWTM-FIG01-WATSUPPLY.MXD



LEGEND

Sampling Location Type

- Pond
- Spring
- Well
- Mine Disturbance Areas

Notes:
September 2003 Survey;
October 2003 Sampling

DRAFT

N

0 3,000 6,000
Feet

J.R. SIMPLOT COMPANY
SMOKY CANYON MINE

FIGURE 1

LOCATIONS OF DOMESTIC WATER SUPPLIES AND POTENTIAL GROUNDWATER DISCHARGE IDENTIFIED SEPTEMBER 2003

PROJECT: 010109	DATE: DEC 12, 2003	
REV: 0	BY: MCP	CHECKED: KJT

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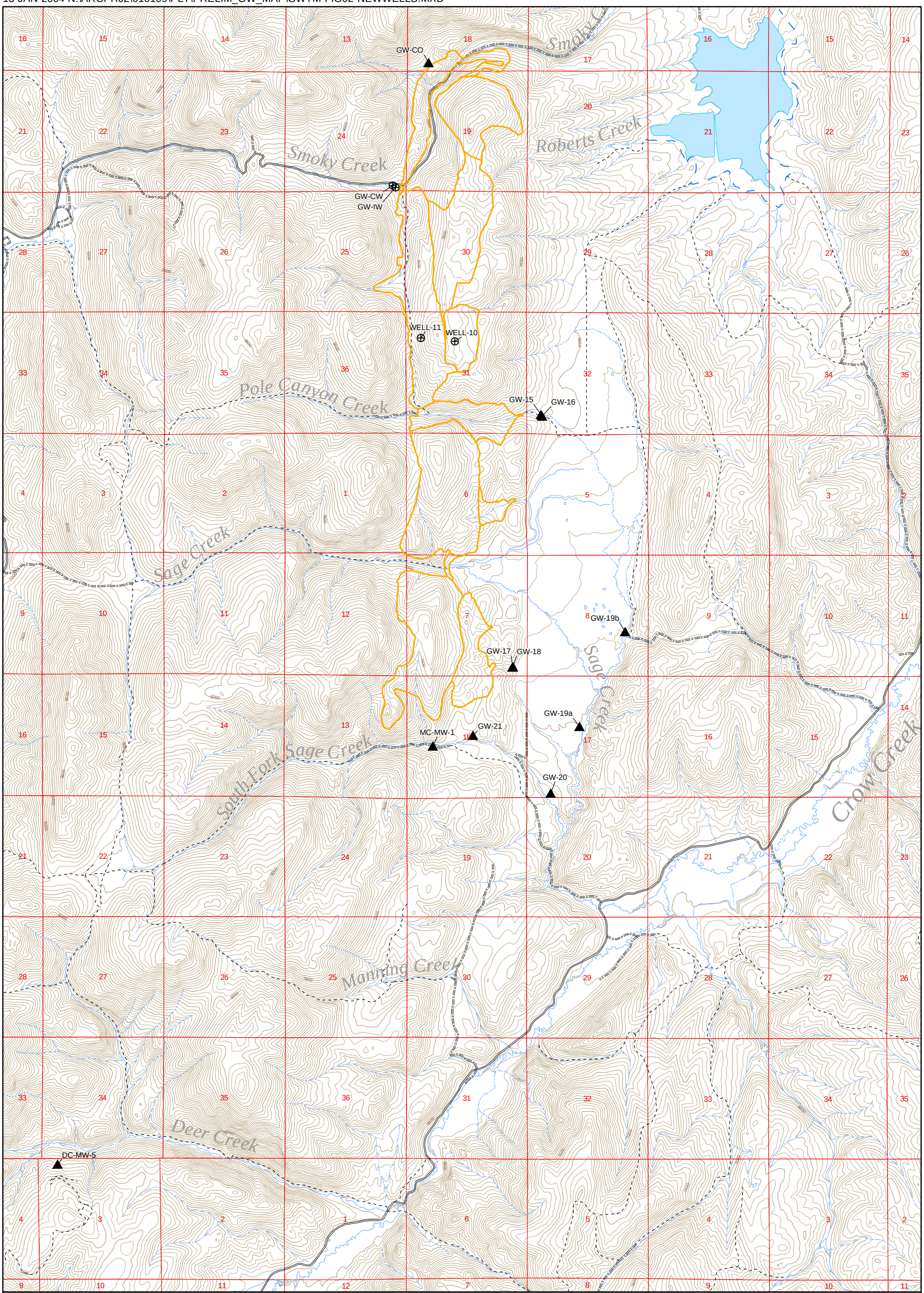
13-JAN-2004 N:\ARCPRJ2\010109\PLT\PRELIM_GW_MAP\GWTM-FIG02-NEWWELLS.MXD



LEGEND

Mine Disturbance Areas

▲ New Monitoring Wells

⊕ Existing Monitoring Wells

Note:
Location shown for DC-MW-5 is approximate.

DRAFT

N

0 3,000 6,000
Feet

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SMOKY CANYON MINE

FIGURE 2

NEW MONITORING WELL LOCATIONS

PROJECT: 010109	DATE: JAN 13, 2004	
REV: 0	BY: MCP	CHECKED: KJT

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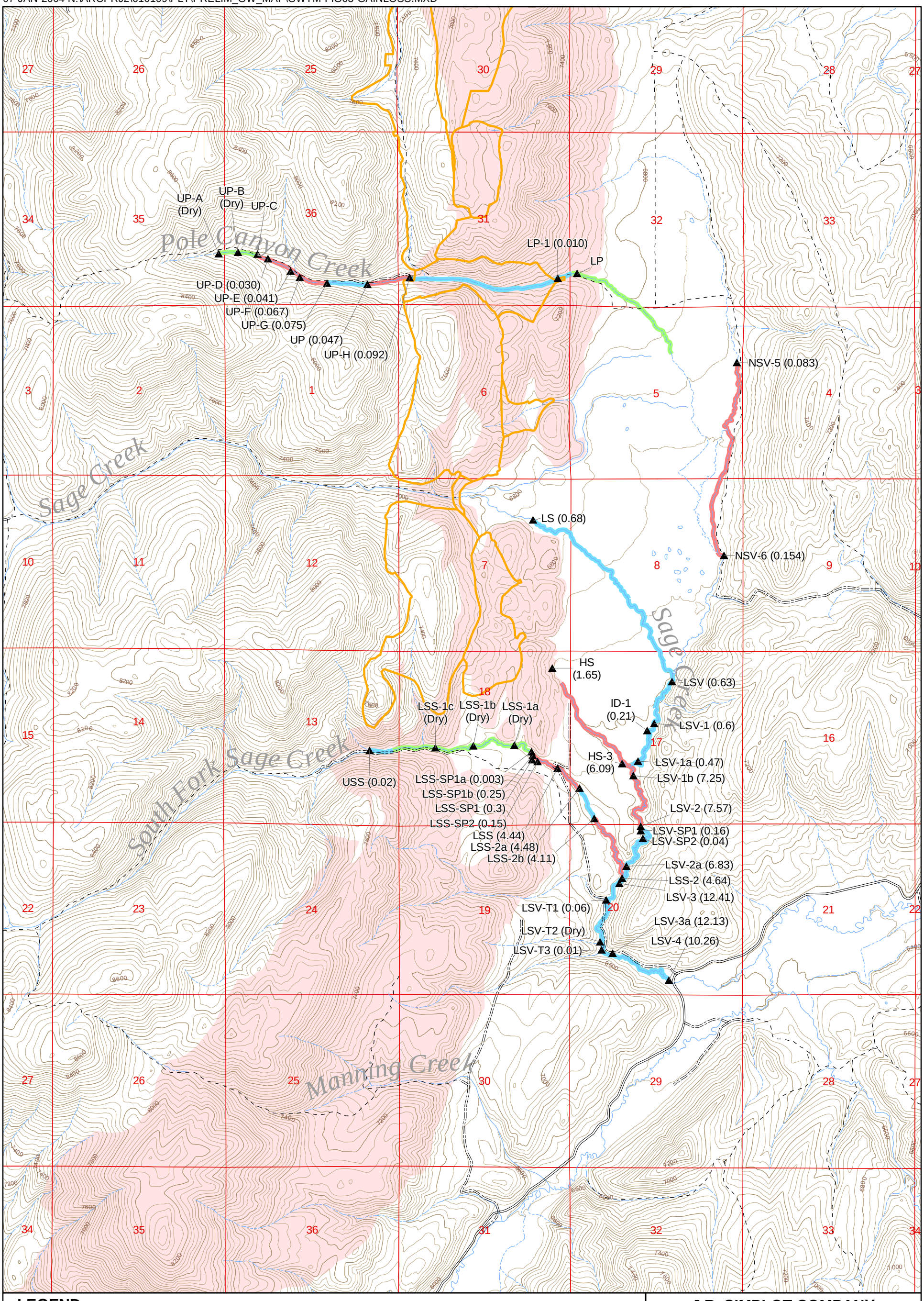
07-JAN-2004 N:\ARCPRJ2\010109\PLT\PRELIM_GW_MAP\GWTM-FIG03-GAINLOSS.MXD



LEGEND

Mine Disturbance Areas

Stream Flow

Dry

Gaining Flow

Losing Flow

PPpw - Wells Formation

Notes:
LSV-D1 NOT SHOWN.
STREAMFLOW SHOWN IN (CFS).

DRAFT

N

0 3,000 6,000
Feet

J.R. SIMPLOT COMPANY
SMOKY CANYON MINE

FIGURE 3

OCTOBER 2003 GAIN/LOSS SURVEY DATA

PROJECT: 010109	DATE: JAN 07, 2004	
REV: 0	BY: MCP	CHECKED: KJT

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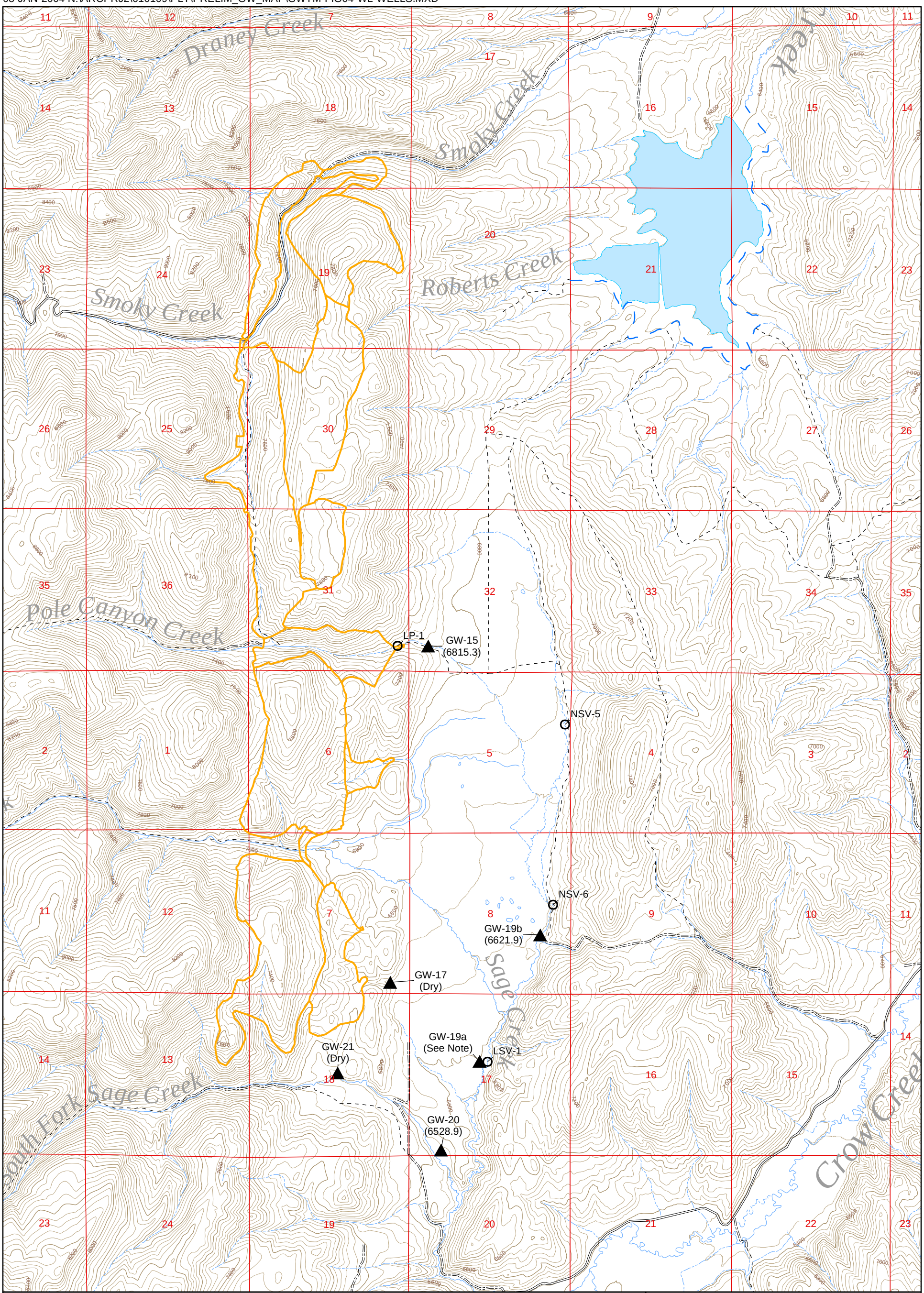
08-JAN-2004 N:\ARCPRJ2\010109\PLT\PRELIM_GW_MAP\GWTM-FIG04-WL-WELLS.MXD



LEGEND

- Mine Disturbance Areas
- ▲ New Monitoring Wells
- ○ Surface Water Monitoring Location

Notes:
MEASURED WATER LEVEL IS APPROXIMATELY 5 FEET BGS AT GW-19a.

MEASURING POINT ELEVATION AT GW-19a IS PENDING.

N

DRAFT

0 3,000 6,000
Feet

J.R. SIMPLOT COMPANY
SMOKY CANYON MINE

FIGURE 4

WATER LEVEL ELEVATIONS IN SHALLOW MONITORING WELL LOCATIONS

PROJECT: 010109	DATE: JAN 08, 2004	
REV: 0	BY: MCP	CHECKED: KJT

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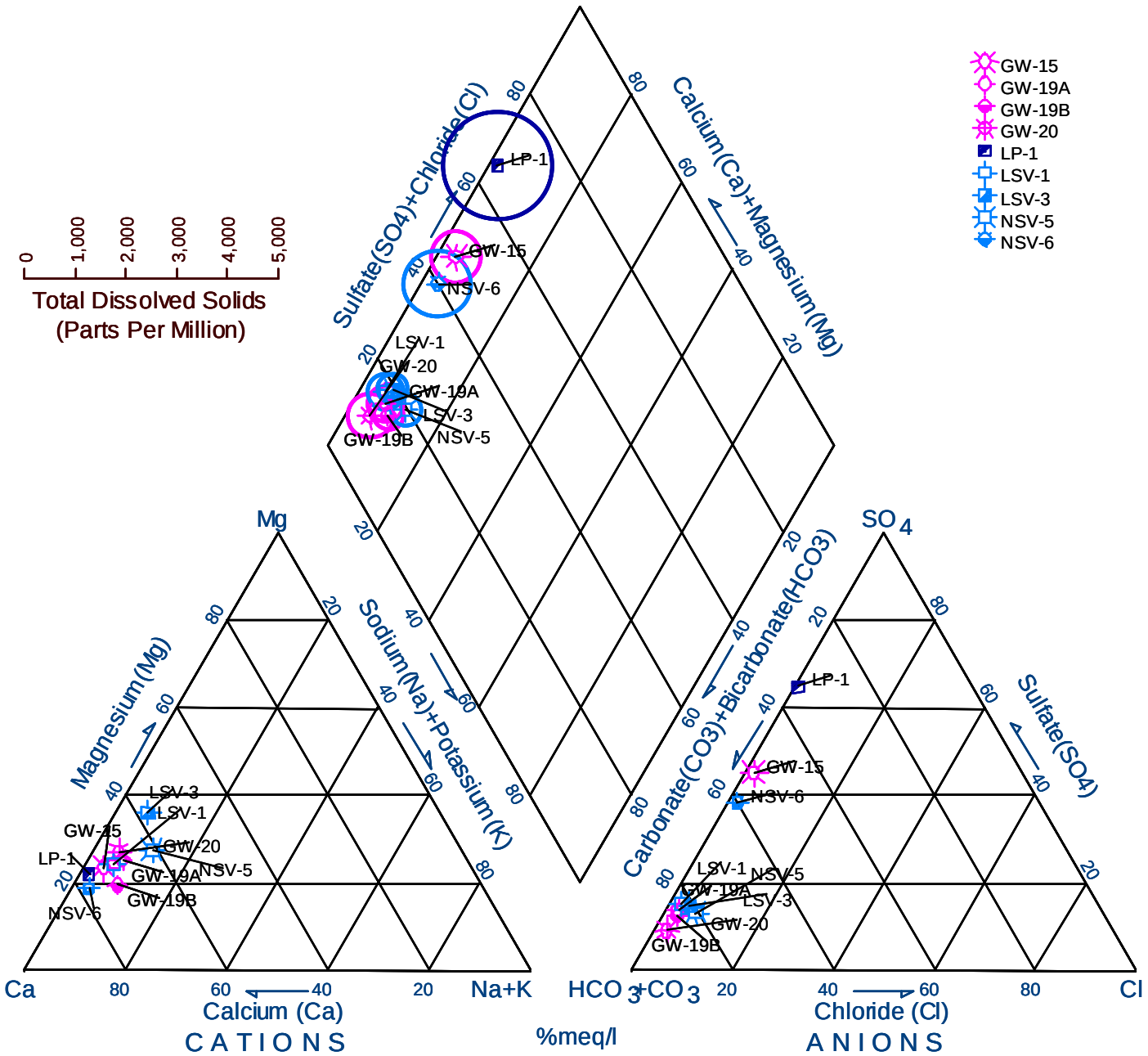
Shallow Groundwater and Surface Water Samples

October 2003



LEGEND

Notes:

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FIGURE 5

SHALLOW GROUNDWATER AND SURFACE WATER CHEMISTRY OCTOBER 2003

PROJECT: 010109	DATE: JAN 08, 2004	
REV: 0	BY: MCP	CHECKED: KJT

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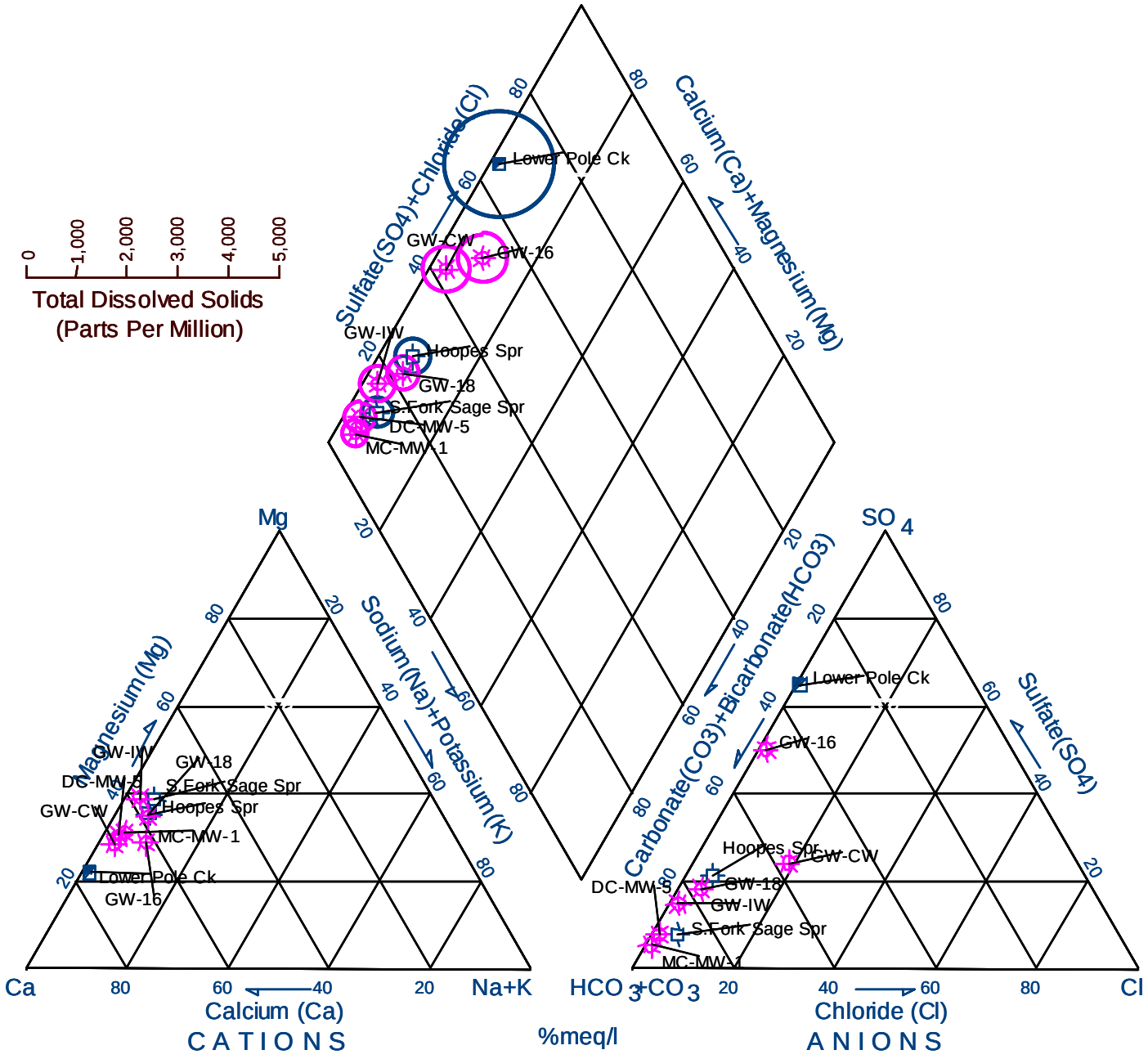
Wells Formation Groundwater/Spring Samples

October 2003



LEGEND

Notes:

Lower Pole Canyon Creek water is included on plot as an example of water that has interacted with overburden materials in the source areas at Smoky Canyon Mine

DRAFT

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FIGURE 6

WELLS FORMATION GROUNDWATER CHEMISTRY OCTOBER 2003

PROJECT: 010109	DATE: JAN 08, 2004	
REV: 0	BY: MCP	CHECKED: KJT

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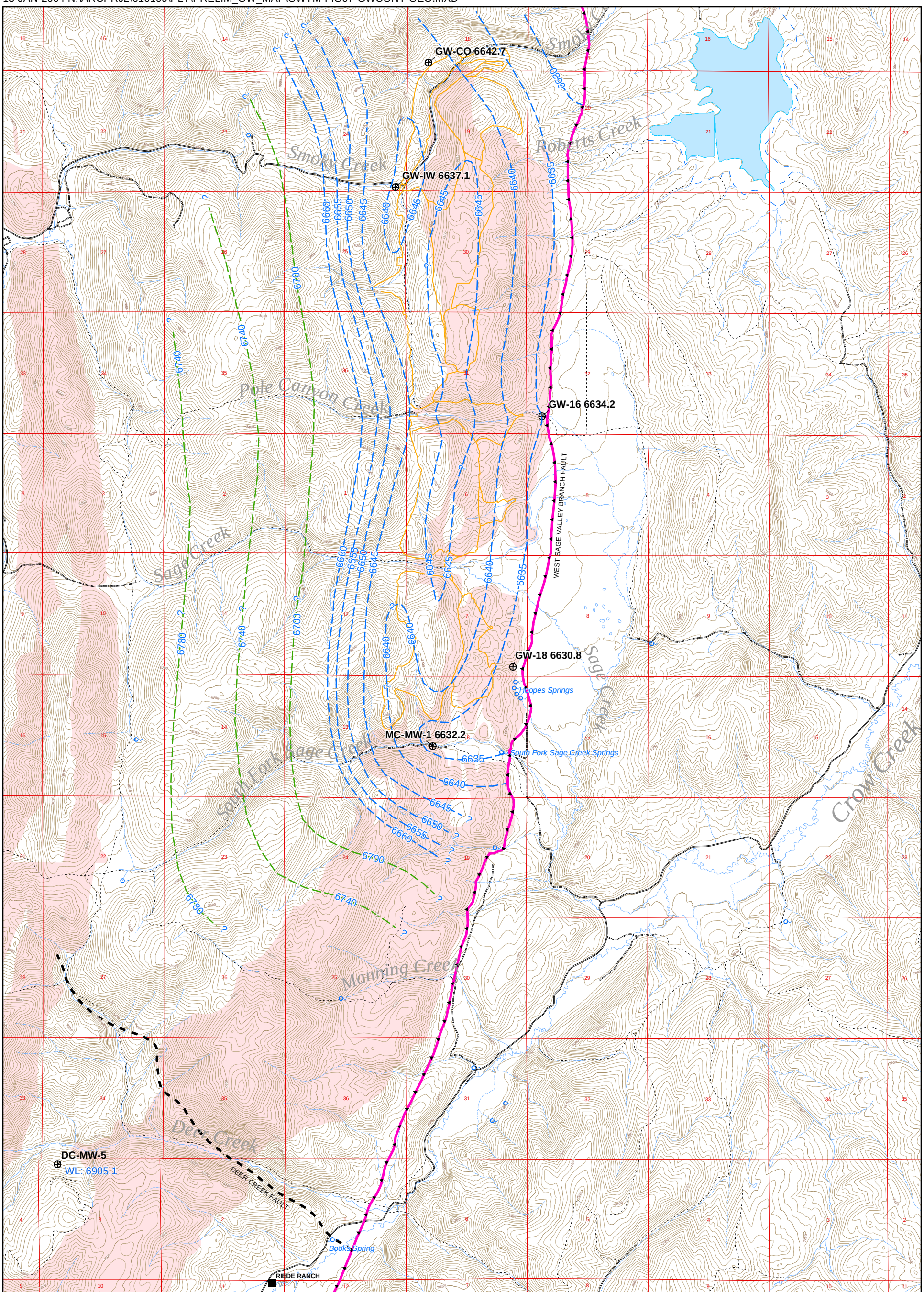
13-JAN-2004 N:\ARCPRJ2\010109\PLT\PRELIM_GW_MAP\GWTM-FIG07-GWCONT-GEO.MXD



LEGEND

Selected Geology

PPpw - Wells Formation

Springs

Groundwater Well
GW-16 6634.2 (Well ID and water level elevation in feet)

Inferred Potentiometric Surface Elevation Contour (5 ft); ? where most uncertain

Inferred Potentiometric Surface Elevation Contour (40 ft); ? where most uncertain

Notes:
Water levels measured in October 2003.
Location shown for DC-MW-5 is approximate.

WORKING DRAFT

N

0 3,000 6,000
Feet

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SMOKY CANYON MINE

FIGURE 7

WELLS FORMATION POTENTIOMETRIC SURFACE MAP OCTOBER 2003

PROJECT: 010109	DATE: JAN 13, 2004	
REV: 0	BY: MCP	CHECKED: KJT

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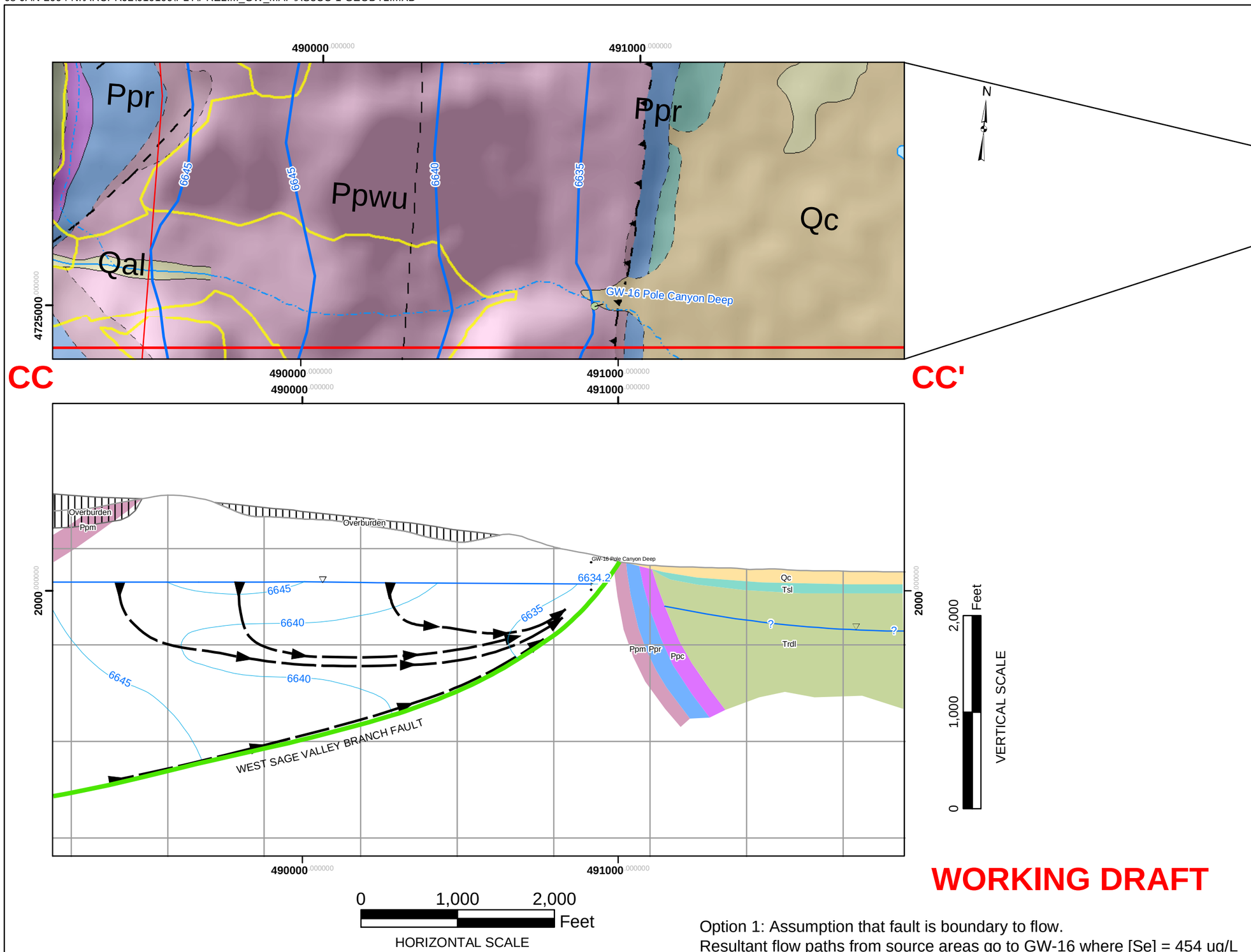
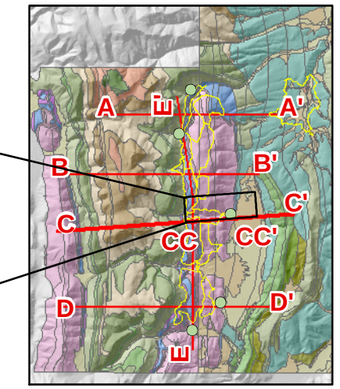
08-JAN-2004 N:\ARCPRJ2\010109\PLT\PRELIM_GW_MAP\XS3CC-1-GEODTL.MXD



Location Map



LEGEND

WORKING DRAFT

Option 1: Assumption that fault is boundary to flow.
Resultant flow paths from source areas go to GW-16 where [Se] = 454 ug/L

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SMOKY CANYON MINE SITE

FIGURE 8

FLOW DIAGRAM FOR POLE CANYON CREEK AREA: NO FLOW ACROSS FAULT

PROJECT: 010109.30	DATE: JAN 08, 2004	
REV: 0	BY: MCP	CHECKED:

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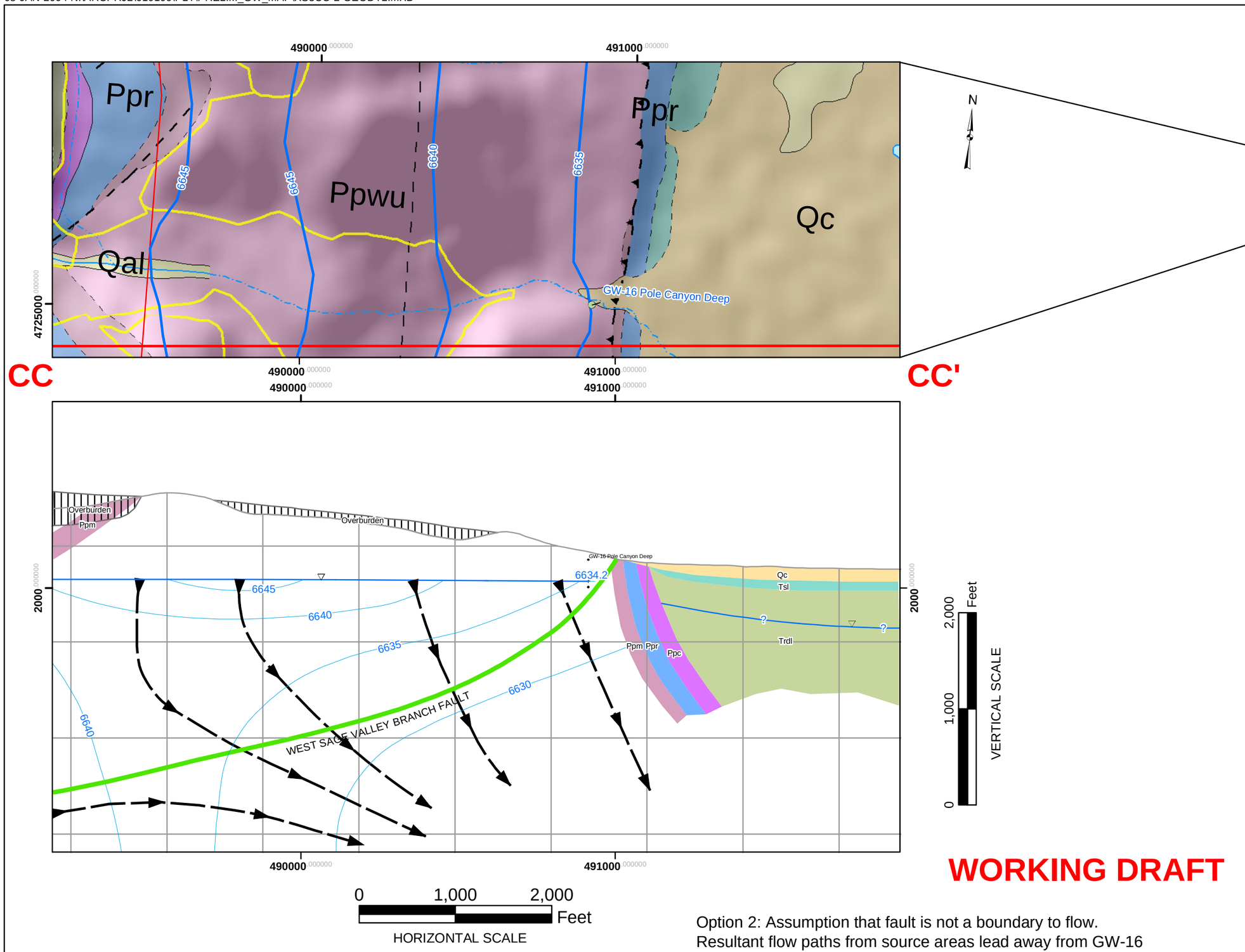
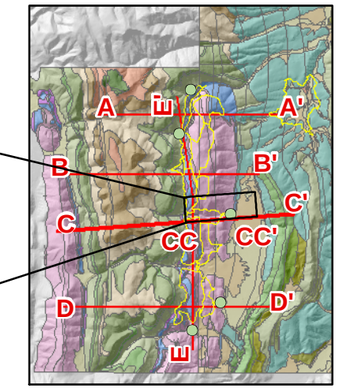


WORKING DRAFT

Option 2: Assumption that fault is not a boundary to flow.
Resultant flow paths from source areas lead away from GW-16

Location Map



LEGEND

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SMOKY CANYON MINE SITE

FIGURE 9

FLOW DIAGRAM FOR POLE CANYON CREEK AREA: FLOW ACROSS FAULT

PROJECT: 010109.30	DATE: JAN 08, 2004	
REV: 0	BY: MCP	CHECKED:

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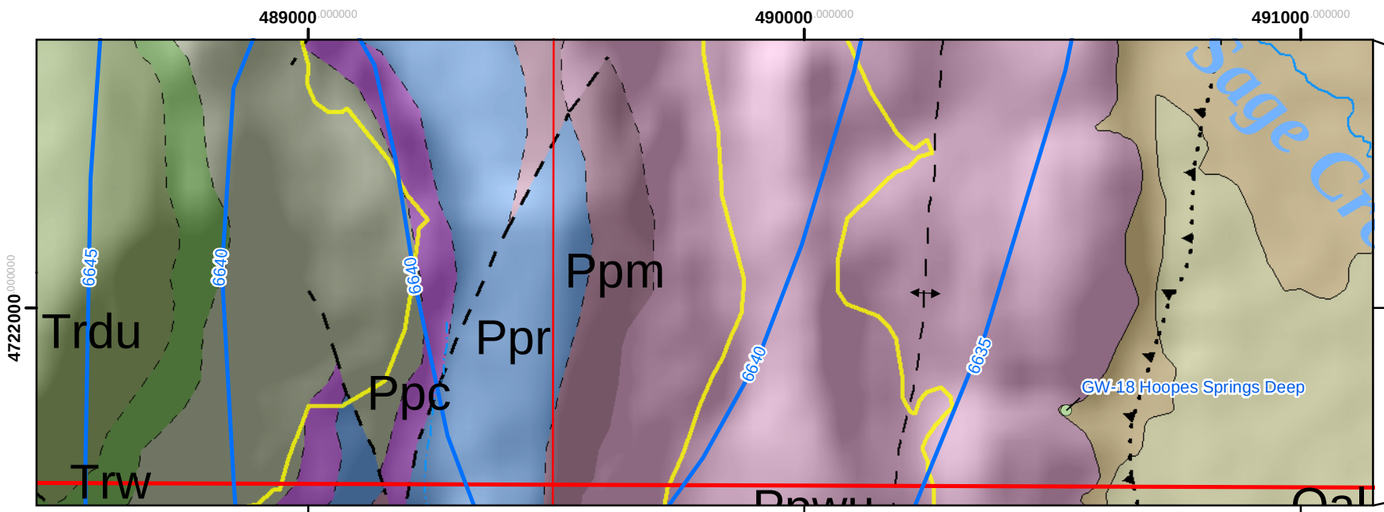
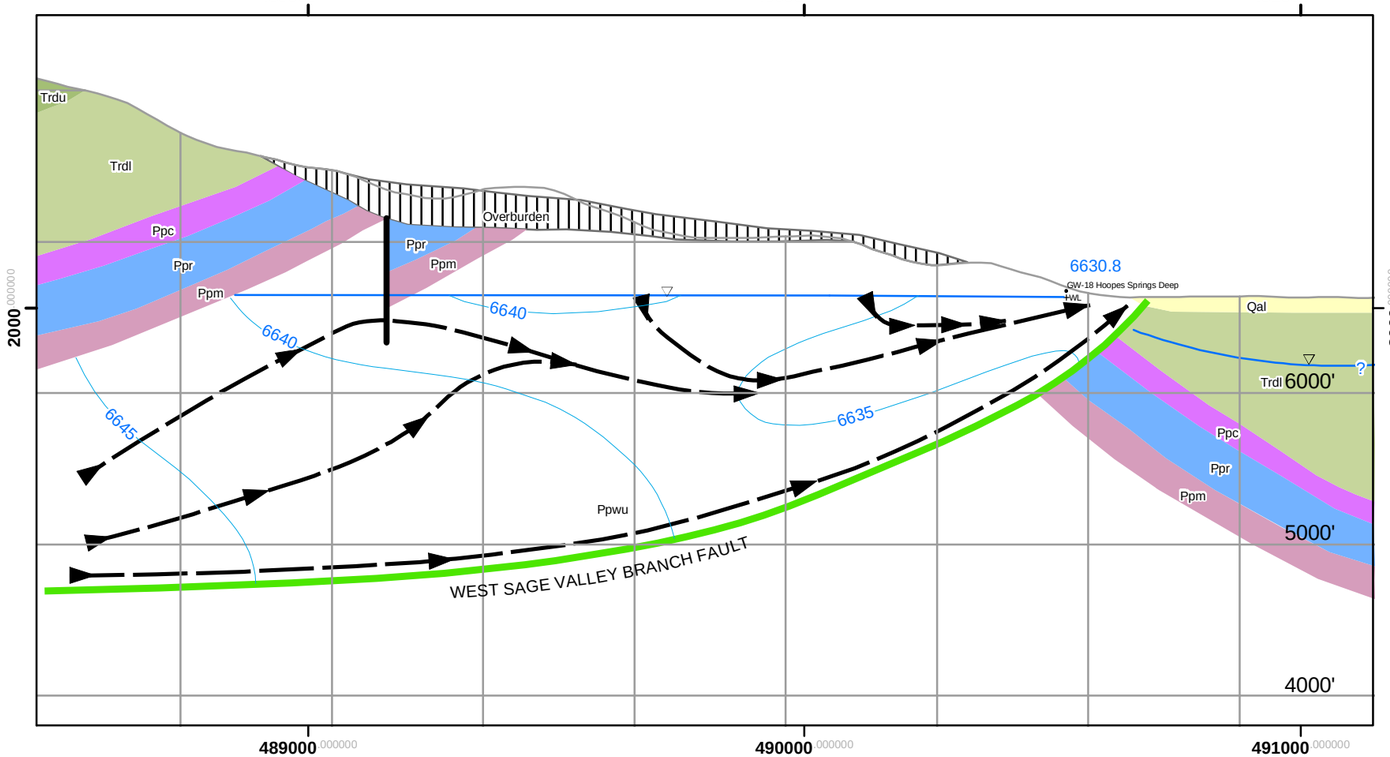
08-JAN-2004 N:\ARCPRJ2\010109\PLT\PRELIM_GW_MAP\XS4DD-1-GEODTL.MXD



DD

DD'



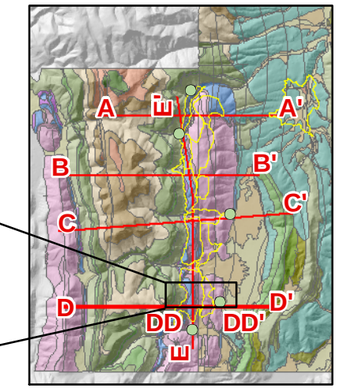
0 1,000 2,000 Feet

HORIZONTAL SCALE

0 1,000 2,000 Feet

VERTICAL SCALE

Location Map



LEGEND

WORKING DRAFT

Option 1: Assumption that fault is boundary to flow.

J.R. SIMPLOT COMPANY

SMOKY CANYON MINE SITE

FIGURE 10

FLOW DIAGRAM FOR E PANEL/HOOPES SPRING AREA

PROJECT: 010109.30	DATE: JAN 08, 2004	
REV: 0	BY: MCP	CHECKED:

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ATTACHMENTS

Well Drilling Logs, Well Construction Diagrams, Well Development Records

LOG OF BORING BY CUTTINGS

BORING NO: GW-15

SITE NAME: Simplot Smoky Canyon Mine – AOC Sage Valley	**PROJECT NO.:** 010109.30	**BORING LOCATION:** Pole Canyon Below Dump
DRILLING COMPANY: Thomas Drilling	**DRILLER:** Tyson Thomas	**ELEVATION AND DATUM:** 6854.2 ft (at top of inside casing)
DRILLING METHOD: Air Rotary with Foam		**DATE STARTED:** 10/02/03 / **DATE FINISHED:** 10/03/03
SITE & TYPE OF CASING: 10-in diameter steel (0-4.5 ft); 4-in sch-80 PVC (0-45 ft); screen (15-45 ft)		**DRILL BIT:** 9 7/8 hammer / **COMPLETION DEPTH:** 45 feet
SAMPLER METHOD: Sieve from grab drill cuttings; bucket samples at 5-ft intervals		**LOGGED BY:** Deb Schiavone / **CHECKED BY:** Doug Rogness
DEPTH TO GROUNDWATER: Initially dry (10-3-03); 34 ft below GS (10-23-03); PVC casing stkup = 2.6 ft (approx.)		

DRILLING TIME RECORD					DEPTH (ft)		DRILLING ACTION	CALC. CONTENT	DESCRIPTION AND DRILLERS NOTES: (material, color, texture, hardness and other notes)
DEPTH		TIME							
FROM	TO	FROM	TO	MIN	FROM	TO			
0	5	13:00	13:30	30	0	7	EI	N	SOIL-ALLUVIUM. Silty sand; fine-coarse grained; dry; brown; trace gravel.
5	10	13:30	14:00	30	7	12.5	CI	S	ALLUVIUM. Gravel with sand and silt, dry, brown, fine-medium grained sand.
10	15	09:30	09:45	15	12.5	26	E	N	ALLUVIUM. Sandy clay with gravel; moist; brown; fine-coarse grained sand.
15	20	09:45	10:00	15	26	30.5	EI	N	ALLUVIUM. Sandy silt; moist; trace gravel; brown; fine-coarse grained sand.
20	25	10:00	10:15	15	30.5	39	DI	N	ALLUVIUM. Silty sand; moist; trace gravel; brown; fine-coarse grained sand.
25	30	10:15	10:45	30	39	45	R	N	BEDROCK – WELLS FORMATION. Sandstone; orange-brown; fine-medium grained.
30	35	10:45	11:15	30					
35	40	11:15	11:45	30					
40	45	11:45	12:15	30					
									Note: Did not encounter groundwater during drilling.

ABBREVIATIONS:

DRILLING ACTION		CALC. CONTENT
E: even, smooth	r: Slightly rough	N: Non-calc.
C: Crunchy	R: Moderately rough	S: Slightly
I: Intermittently rough	R: Very rough	M: Moderately
		V: Very

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FAX: (303) 447-1836

WELL CONSTRUCTION SUMMARY

WELL NO. GW-15

SITE NAME: Simplot Smoky Canyon Mine – AOC Sage Valley

PROJECT NO: 010109.30

WELL LOCATION: Pole Canyon Below Dump

DRILLING SUMMARY

Total Depth: 45 ft | **Borehole Dia**: 10-in

Drilling Co: Thomas Drilling | **Driller Name**: Tyson Thomas

Drill Rig: Air Rotary | **Bit(s)**: Hammer

Drilling Fluid(s): Air, water, foam

Ground Elev: | **Top Casing Elev**: 6854.2 ft

WELL DESIGN

Basis: Geologic Log X Geophysical Log _____

Casing Strings: (C = casing; S = screen)

From:	To:	Diam.	From:	To:	Diam.
+3.0 ft	4.5 ft	10" C1			
+2.6	15	4" C2			
15	45	4" S1			

Casing:	C1	10-in black steel blank
	C2	4-in Sch 80 PVC blank
	S1	4-in Sch 80 PVC (0.020" slot factory)

Centralizers: 5 ft, 44 ft.

Filter Material: Silica sand 8-12 mesh (0.093-0.055 in) @ 13-45 ft (40 bags).

Grout/Cement: Bentonite crumbles (hydrated) @ 12-13 ft; Cement grout @ 0-12 ft (9 bags).

Other:

CONSTRUCTION TIME LOG

TASK	START		FINISH	
Drilling:				
10"	10-2-03	13:00	10-2-03	14:30
9 7/8"	10-3-03	09:30	10-3-03	13:30
Casing:				
10"	10-2-03	13:00	10-2-03	14:30
4"	10-3-03	13:30	10-3-03	14:00
Filter:	10-3-03	14:00	10-3-03	15:00
Seal:	10-3-03	15:00	10-3-03	15:30
Develop	10-23-03			
Other:				
Surface	10-3-03			

Decontamination: High pressure wash rig and equipment before and after drilling & well install

Development: See Well Development Record

Water Yield:

None during drilling. Developed with bailer <1 gpm.

Comments:

Depth to water approx. 34 ft bgs on 10-23-03

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Boulder, Colorado 80301-6118
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LOG OF BORING BY CUTTINGS

BORING NO: GW-16

SITE NAME: Simplot Smoky Canyon Mine – AOC Sage Valley	**PROJECT NO.:** 010109.30	**BORING LOCATION:** Pole Canyon Below Dump; near GW-15
DRILLING COMPANY: Thomas Drilling	**DRILLER:** Tyson Thomas	**ELEVATION AND DATUM:** 6854.4 ft (at top of inside casing)
DRILLING METHOD: Air Rotary with Foam		**DATE STARTED:** 10/04/03 / **DATE FINISHED:** 10/08/03
SITE & TYPE OF CASING: 10-in steel (0-100 ft); 8-in steel (0-180 ft); 4-in sch-80 PVC (0-280 ft); screen (230-280 ft)		**DRILL BIT:** 9 7/8 hammer / **COMPLETION DEPTH:** 280 feet
SAMPLER METHOD: Sieve from grab drill cuttings; bucket samples at 5-ft intervals		**LOGGED BY:** Deb Schiavone / **CHECKED BY:** Doug Rogness
DEPTH TO GROUNDWATER: Initially 240 ft; 217.5 ft below GS (10-20-03); PVC casing stkup = 2.9 ft (approx.)		

DRILLING TIME RECORD					DEPTH (ft)		DRILLING ACTION	CALC. CONTENT	DESCRIPTION AND DRILLERS NOTES: (material, color, texture, hardness and other notes)
DEPTH		TIME							
FROM	TO	FROM	TO	MIN	FROM	TO			
0	15	10:00	10:20	20	0	6	E	N	SOIL-ALLUVIUM. Sand with gravel and silt; dry, brown, fine-coarse grained sand.
15	40	10:20	11:00	40	6	13	E	N	ALLUVIUM. Clay with sand; slightly moist; brown; v. fine-medium grained sand; trace gravel.
40	60	11:00	12:00	60	13	34	EI	S	ALLUVIUM. Gravel with clay and sand; moist; brown.
60	80	12:45	14:00	120	34	65	R	S/M	BEDROCK – WELLS FORMATION. Sandstone (calcareous) with dolomite; interbedded; yellow-gray; slightly weathered.
80	100	14:00	16:00	120	65	92	C	S	WELLS FORMATION. Same; softer; more weathered.
100	125	10:00	13:00	180	92	110	R	S/M	WELLS FORMATION. Same; firmer; less weathered; hole not staying open 102-110 ft.
125	150	13:00	16:00	180	110	124	RR	V/M	WELLS FORMATION. Limestone; fractured; gray; quartz inclusions.
150	170	08:30	09:45	75	124	132	R	S/M	WELLS FORMATION. Sandstone; calcareous; yellow; slightly weathered to weathered.
170	190	09:45	11:00	75	132	173	RR	M	WELLS FORMATION. Limestone; fractured; gray; dolomite interbeds; sandstone at 147-155 ft; yellow; soft; sandstone lenses at 155-173 ft.
190	210	11:00	12:00	60	173	214	R	M/V	WELLS FORMATION. Limestone; orange-brown; weathered; fractured at 185-189 ft; less broken 189-198 ft; soft 198-205 ft; harder with soft weathered zones at 205-214 ft.
210	230	12:00	13:00	60	214	290	Rr	M/V	WELLS FORMATION. Sandstone; slightly fractured and weathered; brown; limestone and dolomite interbeds at 224-228 ft; gray-dark gray; dolomite interbeds at 248-290 ft; gray.
230	250	13:00	14:14	75					
250	270	14:15	15:00	45					Note: Water yield difficult to discern; started yielding water at about 240 ft; seems to yield about 10-20 gpm after drilling.
270	290	15:00	16:30	90					

ABBREVIATIONS:

DRILLING ACTION		CALC. CONTENT
E: even, smooth	r: Slightly rough	N: Non-calc.
C: Crunchy	R: Moderately rough	S: Slightly
I: Intermittently rough	R: Very rough	M: Moderately
		V: Very

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Boulder, Colorado 80301-6118
(303) 447-1823
FAX: (303) 447-1836

WELL CONSTRUCTION SUMMARY

WELL NO. GW-16

SITE NAME: Simplot Smoky Canyon Mine – AOC Sage Valley

PROJECT NO: 010109.30

WELL LOCATION: Pole Canyon Below Dump; near GW-15

DRILLING SUMMARY

Total Depth: 280 ft | **Borehole Dia**: 10-in

Drilling Co: Thomas Drilling | **Driller Name**: Tyson Thomas

Drill Rig: Air Rotary | **Bit(s)**: Hammer

Drilling Fluid(s): Air, water, foam

Ground Elev: | **Top Casing Elev**: 6854.4 ft

WELL DESIGN

Basis: Geologic Log X Geophysical Log _____

Casing Strings: (C = casing; S = screen)

From:	To:	Diam.	From:	To:	Diam.
+3.2 ft	100 ft	10" C1			
0.0	180	8" C2			
+2.9	230	4" C3			
230	280	4" S1			

Casing:	C1	10-in black steel blank
	C2	8-in black steel blank
	C3	4-in Sch 80 PVC blank
	S1	4-in Sch 80 PVC (0.020" slot factory)

Centralizers: 100 ft, 180 ft, 280 ft.

Filter Material: Silica sand 8-12 mesh (0.093-0.055 in) @ 225-280 ft (107 bags).

Grout/Cement: Bentonite grout (25% solids) @ 30-225 ft; Cement grout @ 0-30 ft (32 bags).

Other:

CONSTRUCTION TIME LOG

TASK	START		FINISH	
Drilling:				
0-100'	10-4-03	10:00	10-4-03	16:00
100-150	10-6-03	10:00	10-6-03	16:00
150-280	10-7-03	08:00	10-7-03	16:30
Casing:				
10"	10-4-03	10:00	10-4-03	16:00
8"	10-6-03	10:00	10-6-03	16:00
4"	10-8-03	11:00	10-8-03	12:00
Filter:	10-8-03	12:00	10-8-03	14:00
Seal:	10-8-03	14:00	10-8-03	15:00
Develop	10-20-03			
Other:				
Surface	10-8-03			

Decontamination: High pressure wash rig and equipment before and after drilling & well install

Development: See Well Development Record

Water Yield:

15-20 gpm during development

Comments:

Depth to water approx. 217.5 ft bgs on 10-20-03

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LOG OF BORING BY CUTTINGS

BORING NO: GW-17

SITE NAME: Simplot Smoky Canyon Mine – AOC Sage Valley	**PROJECT NO.:** 010109.30	**BORING LOCATION:** Slightly uphill from Hoopes Spring
DRILLING COMPANY: Thomas Drilling	**DRILLER:** Tyson Thomas	**ELEVATION AND DATUM:** 6677.4 ft (at top of inside casing)
DRILLING METHOD: Air Rotary with Foam		**DATE STARTED:** 9/27/03 / **DATE FINISHED:** 9/27/03
SITE & TYPE OF CASING: 10-in diameter steel (0-3 ft); 4-in sch-80 PVC (0-35 ft); screen (5-35 ft)		**DRILL BIT:** 9 7/8 hammer / **COMPLETION DEPTH:** 35 feet
SAMPLER METHOD: Sieve from grab drill cuttings; bucket samples at 5-ft intervals		**LOGGED BY:** Deb Schiavone / **CHECKED BY:** Doug Rogness
DEPTH TO GROUNDWATER: Dry; PVC casing stkup = 2.8 ft (approx.)		

DRILLING TIME RECORD					DEPTH (ft)		DRILLING ACTION	CALC. CONTENT	DESCRIPTION AND DRILLERS NOTES: (material, color, texture, hardness and other notes)
DEPTH		TIME							
FROM	TO	FROM	TO	MIN	FROM	TO			
0	5	11:15	11:25	10	0	6	EI	N	SOIL-ALLUVIUM. Silty clay with sand; dry; brown.
5	10	11:25	11:35	10	6	11.5	C	N	ALLUVIUM. Silty, clayey sand with gravel, slightly moist; brown; fine-coarse grained sand.
10	15	11:35	11:45	10	11.5	17	E	N	ALLUVIUM. Sandy silt with gravel; moist; orange.
15	20	11:45	12:00	15	17	22	E	N	ALLUVIUM. Silty clay with sand; moist; fine-medium grained sand; orange.
20	25	12:00	12:10	10	22	26.5	EI	N	ALLUVIUM. Silty sand; moist; fine-grained sand; orange.
25	30	12:10	12:30	20	26.5	33	EI	N	ALLUVIUM. Sand with silt; moist; fine-medium grained; tan-orange.
30	35	12:30	12:45	15	33	35	r	N	BEDROCK – WELLS FORMATION. Sandstone; fine-medium grained; orange.
									Note: Did not encounter groundwater during drilling.

ABBREVIATIONS:

DRILLING ACTION		CALC. CONTENT
E: even, smooth	r: Slightly rough	N: Non-calc.
C: Crunchy	R: Moderately rough	S: Slightly
I: Intermittently rough	R: Very rough	M: Moderately
		V: Very

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WELL CONSTRUCTION SUMMARY

WELL NO. GW-17

SITE NAME: Simplot Smoky Canyon Mine – AOC Sage Valley

PROJECT NO: 010109.30

WELL LOCATION: Slightly uphill of Hoopes Spring

DRILLING SUMMARY

Total Depth: 35 ft | **Borehole Dia**: 10-in

Drilling Co: Thomas Drilling | **Driller Name**: Tyson Thomas

Drill Rig: Air Rotary | **Bit(s)**: Hammer

Drilling Fluid(s): Air, water, foam

Ground Elev: | **Top Casing Elev**: 6677.4 ft

WELL DESIGN

Basis: Geologic Log X Geophysical Log _____

Casing Strings: (C = casing; S = screen)

From:	To:	Diam.	From:	To:	Diam.
+3.0 ft	3.0 ft	10" C1			
+2.8	5	4" C2			
5	35	4" S1			

Casing:	C1	10-in black steel blank
	C2	4-in Sch 80 PVC blank
	S1	4-in Sch 80 PVC (0.020" slot factory)

Centralizers: 5 ft, 35 ft.

Filter Material: Silica sand 8-12 mesh (0.093-0.055 in) @ 3-35 ft (38 bags).

Grout/Cement: Cement grout (25% solids) @ 0-3 ft (2 bags).

Other:

CONSTRUCTION TIME LOG

TASK	START		FINISH	
Drilling:				
10"	9-27-03	11:00	9-27-03	13:00
Casing:				
10"	9-27-03	11:00	9-27-03	13:00
4"	9-27-03	13:00	9-27-03	13:30
Filter:	9-27-03	13:30	9-27-03	14:30
Seal:	9-27-03	14:30	9-27-03	15:00
Develop				
Other:				
Surface	9-27-03			

Decontamination: High pressure wash rig and equipment before and after drilling & well install

Development: None

Water Yield:

None during drilling.

Comments:

Checked water level two weeks later; still dry.

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LOG OF BORING BY CUTTINGS

BORING NO: GW-18

SITE NAME: Simplot Smoky Canyon Mine – AOC Sage Valley	**PROJECT NO.:** 010109.30	**BORING LOCATION:** Slightly uphill of Hoopes Spring; near GW-17
DRILLING COMPANY: Thomas Drilling	**DRILLER:** Tyson Thomas	**ELEVATION AND DATUM:** 6675.6 ft (at top of inside casing)
DRILLING METHOD: Air Rotary with Foam		**DATE STARTED:** 9/27/03 / **DATE FINISHED:** 10/02/03
SITE & TYPE OF CASING: 10-in steel (0-7 ft); 4-in sch-80 PVC (0-105 ft); screen (55-105 ft)		**DRILL BIT:** 9 7/8 hammer / **COMPLETION DEPTH:** 105 feet
SAMPLER METHOD: Sieve from grab drill cuttings; bucket samples at 5-ft intervals		**LOGGED BY:** Deb Schiavone / **CHECKED BY:** Doug Rogness
DEPTH TO GROUNDWATER: Initially 51 ft (10-2-03); 42.1 ft below GS (10-22-03); PVC casing stkup = 2.7 ft (approx.)		

DRILLING TIME RECORD					DEPTH (ft)		DRILLING ACTION	CALC. CONTENT	DESCRIPTION AND DRILLERS NOTES: (material, color, texture, hardness and other notes)
DEPTH		TIME							
FROM	TO	FROM	TO	MIN	FROM	TO			
0	20	15:30	16:00	30	0	11	E	N	SOIL-ALLUVIUM. Gravel with sand and clay; slightly moist; brown.
20	40	16:00	17:00	60	11	16	E	N	ALLUVIUM. Sandy clay with gravel; moist; brown.
40	60	10:00	11:00	60	16	19	EI	S	ALLUVIUM. Sand with silt; trace coarse sand; slightly moist; orange-brown.
60	80	11:00	13:00	120	19	22	R	S/M	ALLUVIUM. Silty sand; fine-grained; moist; trace coarse sand; orange.
80	105	08:30	10:30	120	22	24	C	S	ALLUVIUM. Gravelly clay with sand; moist; orange-brown.
					24	105	R	S/M	BEDROCK - WELLS FORMATION. Weathered dolomite; very fractured; light gray-white; interbedded limestone; very calcareous; gray inclusions.
									Note: Started yielding water at about 51 ft; yielding >50 gpm after drilling.

ABBREVIATIONS:

DRILLING ACTION		CALC. CONTENT
E: even, smooth	r: Slightly rough	N: Non-calc.
C: Crunchy	R: Moderately rough	S: Slightly
I: Intermittently rough	R: Very rough	M: Moderately
		V: Very

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WELL CONSTRUCTION SUMMARY

WELL NO. GW-18

SITE NAME: Simplot Smoky Canyon Mine – AOC Sage Valley

PROJECT NO: 010109.30

WELL LOCATION: Slightly uphill from Hoopes Spring; near GW-17

DRILLING SUMMARY

Total Depth: 105 ft | **Borehole Dia**: 10-in

Drilling Co: Thomas Drilling | **Driller Name**: Tyson Thomas

Drill Rig: Air Rotary | **Bit(s)**: Hammer

Drilling Fluid(s): Air, water, foam

Ground Elev: | **Top Casing Elev**: 6675.6 ft

WELL DESIGN

Basis: Geologic Log X Geophysical Log _____

Casing Strings: (C = casing; S = screen)

From:	To:	Diam.	From:	To:	Diam.
+3.1 ft	7.1 ft	10" C1			
+2.7	55	4" C2			
55	105	4" S1			

Casing:	C1	10-in black steel blank
	C2	4-in Sch 80 PVC blank
	S1	4-in Sch 80 PVC (0.020" slot factory)

Centralizers: 50 ft, 104 ft.

Filter Material: Silica sand 8-12 mesh (0.093-0.055 in) @ 50-105 ft (108 bags).

Grout/Cement: Bentonite grout (25% solids) @ 20-50 ft; Cement grout @ 0-20 ft.

Other:

CONSTRUCTION TIME LOG

TASK	START		FINISH	
Drilling:				
0-20'	9-27-03	15:30	9-27-03	17:30
20-60	9-29-03	10:00	9-29-03	14:00
60-105	10-1-03	08:30	10-1-03	11:30
Casing:				
10"	9-27-03	15:30	9-27-03	17:30
4"	10-1-03	11:30	10-1-03	12:30
Filter:	10-1-03	12:30	10-2-03	09:30
Seal:	10-2-03	09:30	10-2-03	11:30
Develop	10-22-03			
Other:				
Surface	10-2-03			

Decontamination: High pressure wash rig and Equipment before and after drilling & well install

Development: See Well Development Record

Water Yield: >50 gpm during development

Comments: Depth to water approx. 42.1 ft on 10-22-03. Ran out of sand on 10-1; finish filter placement 10-2.

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LOG OF BORING BY CUTTINGS

BORING NO: GW-19A

PAGE __1__ OF _1_

SITE NAME: Simplot Smoky Canyon Mine – AOC Sage Valley	**PROJECT NO.:** 010109.30	**BORING LOCATION:** East side of Sage Valley
DRILLING COMPANY: Thomas Drilling	**DRILLER:** Tyson Thomas	**ELEVATION AND DATUM:** 6600 ft (est. from topo map)
DRILLING METHOD: Sand Point Driver on Tractor		**DATE STARTED:** 10/23/03 / **DATE FINISHED:** 10/23/03
SITE & TYPE OF CASING: 2-in diameter steel (0-9.5 ft); 2-in stainless steel screen (9.5-14.5 ft)		**DRILL BIT:** Sand Point / **COMPLETION DEPTH:** 14.5 feet
SAMPLER METHOD: None		**LOGGED BY:** Deb Schiavone / **CHECKED BY:** Doug Rogness
DEPTH TO GROUNDWATER: Approx. 3 ft below GS (10-23-03); steel casing stkup = 3.0 ft (approx.)		

DRILLING TIME RECORD					DEPTH (ft)		DRILLING ACTION	CALC. CONTENT	DESCRIPTION AND DRILLERS NOTES: (material, color, texture, hardness and other notes)
DEPTH		TIME							
FROM	TO	FROM	TO	MIN	FROM	TO			
0	14.5	11:00	13:00	120	0	14.5			ALLUVIUM. No return of lithologic samples due to driving sand-point casing.

ABBREVIATIONS:

DRILLING ACTION		CALC. CONTENT
E: even, smooth	r: Slightly rough	N: Non-calc.
C: Crunchy	R: Moderately rough	S: Slightly
I: Intermittently rough	R: Very rough	M: Moderately
		V: Very

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WELL CONSTRUCTION SUMMARY

WELL NO. GW-19A

SITE NAME: Simplot Smoky Canyon Mine – AOC Sage Valley

PROJECT NO: 010109.30

WELL LOCATION: East Edge of Sage Valley

DRILLING SUMMARY

Total Depth: 15 ft | **Borehole Dia**: 2-in

Drilling Co: Thomas Drilling | **Driller Name**: Tyson Thomas

Drill Rig: Sand Point Driver | **Bit(s)**: Sand Point

Drilling Fluid(s): None

Ground Elev: 6600 ft (est) | **Top Casing Elev**:

WELL DESIGN

Basis: Geologic Log _____ Geophysical Log _____

Casing Strings: (C = casing; S = screen)

From:	To:	Diam.	From:	To:	Diam.
+3.0 ft	9.5 ft	2" C1			
9.5	14.5	2" S1			

Casing:	C1	2-in black steel blank
	S1	2-in stainless steel screen (0.020" slot)

Centralizers: None

Filter Material: None

Grout/Cement: None

Other:

CONSTRUCTION TIME LOG

TASK	START		FINISH	
Drilling:				
Casing:				
2"	10-23-03	11:00	10-23-03	13:00
Filter:				
Seal:				
Develop				
Other:				
Surface				

Decontamination:

Development: Bailed

Water Yield: <5 gpm

Comments:

Depth to water approx. 3 ft on 10-23-03

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WELL CONSTRUCTION SUMMARY

WELL NO. GW-19B

SITE NAME: Simplot Smoky Canyon Mine – AOC Sage Valley

PROJECT NO: 010109.30

WELL LOCATION: Near Peterson Barn in Sage Valley

DRILLING SUMMARY

Total Depth: 52 ft	**Borehole Dia**: 10-in
Drilling Co: Thomas Drilling	**Driller Name**: Tyson Thomas
Drill Rig: Air Rotary	**Bit(s)**: Hammer
Drilling Fluid(s): Air, water, foam	
Ground Elev:	**Top Casing Elev**: 6640.1 ft

WELL DESIGN

Basis: Geologic Log X Geophysical Log _____

Casing Strings: (C = casing; S = screen)

From:	To:	Diam.	From:	To:	Diam.
+2.7 ft	3.5 ft	10" C1			
+2.4	12	4" C2			
12	52	4" S1			

Casing:	C1	10-in black steel blank
	C2	4-in Sch 80 PVC blank
	S1	4-in Sch 80 PVC (0.020" slot factory)

Centralizers: 50 ft.

Filter Material: Silica sand 8-12 mesh (0.093-0.055 in) @ 10-52 ft (45 bags).

Grout/Cement: Bentonite crumbles (hydrated) @ 8-10 ft; Cement grout @ 0-8 ft.

Other:

CONSTRUCTION TIME LOG

TASK	START		FINISH	
Drilling:				
10"	10-9-03	12:30	10-9-03	15:00
Casing:				
10"	10-9-03	12:30	10-9-03	13:30
4"	10-9-03	15:00	10-9-03	15:30
Filter:	10-9-03	15:30	10-9-03	16:30
Seal:	10-9-03	16:30	10-10-03	10:00
Develop	10-21-03			
Other:				
Surface	10-10-03			

Decontamination: High pressure wash rig and equipment before and after drilling & well install

Development: See Well Development Record

Water Yield: 5 to 10 gpm

Comments:

Depth to water approx. 16.1 ft bgs on 10-21-03

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LOG OF BORING BY CUTTINGS

BORING NO: GW-19B

SITE NAME: Simplot Smoky Canyon Mine – AOC Sage Valley	**PROJECT NO.:** 010109.30	**BORING LOCATION:** Near Peterson Barn in Sage Valley
DRILLING COMPANY: Thomas Drilling	**DRILLER:** Tyson Thomas	**ELEVATION AND DATUM:** 6640.1 ft (at top of inside casing)
DRILLING METHOD: Air Rotary with Foam		**DATE STARTED:** 10/09/03 / **DATE FINISHED:** 10/10/03
SITE & TYPE OF CASING: 10-in diameter steel (0-3.5 ft); 4-in sch-80 PVC (0-52 ft); screen (12-52 ft)		**DRILL BIT:** 9 7/8 hammer / **COMPLETION DEPTH:** 52 feet
SAMPLER METHOD: Sieve from grab drill cuttings; bucket samples at 5-ft intervals		**LOGGED BY:** Deb Schiavone / **CHECKED BY:** Doug Rogness
DEPTH TO GROUNDWATER: 16.1 ft below GS (10-21-03); PVC casing stkup = 2.4 ft (approx.)		

DRILLING TIME RECORD					DEPTH (ft)		DRILLING ACTION	CALC. CONTENT	DESCRIPTION AND DRILLERS NOTES: (material, color, texture, hardness and other notes)
DEPTH		TIME							
FROM	TO	FROM	TO	MIN	FROM	TO			
0	5	12:30	12:45	15	0	3	E	N	SOIL-ALLUVIUM. Sandy clay with gravel; dry; brown; fine-medium grained sand.
5	10	12:45	13:00	15	3	18	E	N	ALLUVIUM. Silty clay; moist; brown; trace gravel; clayey silt at 8.5 ft; grayish-brown.
10	15	13:00	13:15	15	18	32	EI	V	ALLUVIUM. Clayey gravel; wet; brown; trace sand and gravel; calcareous.
15	20	13:15	13:30	15	32	49	C	V	ALLUVIUM. Clayey gavel with clay interbeds; grayish.
20	25	13:30	13:45	15	49	52	r	V	BEDROCK. Limestone; gray and brown; slightly weathered.
25	30	13:45	14:15	30					
30	35	14:15	14:30	15					
35	40	14:30	14:45	15					
40	45	14:45	15:00	15					
									Note: Groundwater encountered during drilling at about 18 ft; seems to be making about 5 to 10 gpm after drilling.

ABBREVIATIONS:

DRILLING ACTION		CALC. CONTENT
E: even, smooth	r: Slightly rough	N: Non-calc.
C: Crunchy	R: Moderately rough	S: Slightly
I: Intermittently rough	R: Very rough	M: Moderately
		V: Very

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WELL CONSTRUCTION SUMMARY

WELL NO. GW-20

SITE NAME: Simplot Smoky Canyon Mine – AOC Sage Valley

PROJECT NO: 010109.30

WELL LOCATION: Lower South Fork Sage Creek and Sage Valley

DRILLING SUMMARY

Total Depth: 69 ft	**Borehole Dia**: 10-in
Drilling Co: Thomas Drilling	**Driller Name**: Tyson Thomas
Drill Rig: Air Rotary	**Bit(s)**: Hammer
Drilling Fluid(s): Air, water, foam	
Ground Elev:	**Top Casing Elev**: 6539.9 ft

WELL DESIGN

Basis: Geologic Log X Geophysical Log _____

Casing Strings: (C = casing; S = screen)

From:	To:	Diam.	From:	To:	Diam.
+3.0 ft	4.0 ft	10" C1			
+2.9	18	4" C2			
19	69	4" S1			

Casing:	C1	10-in black steel blank
	C2	4-in Sch 80 PVC blank
	S1	4-in Sch 80 PVC (0.020" slot factory)

Centralizers: 19 ft and 68 ft.

Filter Material: Silica sand 8-12 mesh (0.093-0.055 in) @ 17-69 ft (61 bags).

Grout/Cement: Bentonite crumbles (hydrated) @ 15-17 ft; Cement grout @ 0-15 ft (10 bags).

Other:

CONSTRUCTION TIME LOG

TASK	START		FINISH	
Drilling:				
0-57'	9-25-03	10:30	9-25-03	13:00
57-69'	9-26-03	09:30	9-26-03	11:30
Casing:				
10"	9-25-03	10:30	9-25-03	12:00
4"	9-26-03	11:00	9-26-03	11:45
Filter:	9-26-03	11:45	9-26-03	12:45
Seal:	9-26-03	12:45	9-26-03	14:00
Develop	10-21-03			
Other:				
Surface	9-26-03			

Decontamination: High pressure wash rig and equipment before and after drilling & well install

Development: See Well Development Record

Water Yield: Approx. 50 gpm

Comments:

Depth to water approx. 7.8 ft on 10-21-03

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LOG OF BORING BY CUTTINGS

BORING NO: GW-20

SITE NAME: Simplot Smoky Canyon Mine – AOC Sage Valley	**PROJECT NO.:** 010109.30	**BORING LOCATION:** Lower South Fork Sage Ck & Sage Valley
DRILLING COMPANY: Thomas Drilling	**DRILLER:** Tyson Thomas	**ELEVATION AND DATUM:** 6539.9 ft (at top of inside casing)
DRILLING METHOD: Air Rotary with Foam		**DATE STARTED:** 9/25/03 / **DATE FINISHED:** 9/26/03
SITE & TYPE OF CASING: 10-in diameter steel (0-4 ft); 4-in sch-80 PVC (0-69 ft); screen (19-69 ft)		**DRILL BIT:** 9 7/8 hammer / **COMPLETION DEPTH:** 69 feet
SAMPLER METHOD: Sieve from grab drill cuttings; bucket samples at 5-ft intervals		**LOGGED BY:** Deb Schiavone / **CHECKED BY:** Doug Rogness
DEPTH TO GROUNDWATER: 7.8 ft below GS (10-21-03); PVC casing stkup = 2.7 ft (approx.)		

DRILLING TIME RECORD					DEPTH (ft)		DRILLING ACTION	CALC. CONTENT	DESCRIPTION AND DRILLERS NOTES: (material, color, texture, hardness and other notes)
DEPTH		TIME							
FROM	TO	FROM	TO	MIN	FROM	TO			
0	10	10:30	10:45	15	0	12	E	N	SOIL-ALLUVIUM. Gravelly clay with sand; moist; brown.
10	20	10:45	11:00	15	12	23	E	N	ALLUVIUM. Silty clay with sand; no gravel; moist; brown.
20	30	11:00	11:15	15	23	30	EI	N	ALLUVIUM. Clayey sand with interbedded gravel seams; brown.
30	40	11:15	11:30	15	30	67	EI	V	ALLUVIUM. Gravelly clay with sand; brown; seams of limestone.
40	50	11:30	11:45	15	67	69	r	V	BEDROCK. Limestone; dark gray; fractured; slightly weathered.
50	60	11:45	12:00	15					
60	69	12:00	12:20	20					
									Note: Groundwater encountered during drilling at 23.5 feet; seems to be making about 50 gpm at end of drilling.

ABBREVIATIONS:

DRILLING ACTION		CALC. CONTENT
E: even, smooth	r: Slightly rough	N: Non-calc.
C: Crunchy	R: Moderately rough	S: Slightly
I: Intermittently rough	R: Very rough	M: Moderately
		V: Very

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LOG OF BORING BY CUTTINGS

BORING NO: GW-21

SITE NAME: Simplot Smoky Canyon Mine – AOC Sage Valley	**PROJECT NO.:** 010109.30	**BORING LOCATION:** North side of South Fork Sage Creek
DRILLING COMPANY: Thomas Drilling	**DRILLER:** Tyson Thomas	**ELEVATION AND DATUM:** 6696.4 ft (at top of inside casing)
DRILLING METHOD: Air Rotary with Foam		**DATE STARTED:** 9/24/03 / **DATE FINISHED:** 9/24/03
SITE & TYPE OF CASING: 10-in diameter steel (0-3 ft); 4-in sch-80 PVC (0-24.5 ft); screen (45-24.5 ft)		**DRILL BIT:** 9 7/8 hammer / **COMPLETION DEPTH:** 24.5 feet
SAMPLER METHOD: Sieve from grab drill cuttings; bucket samples at 5-ft intervals		**LOGGED BY:** Deb Schiavone / **CHECKED BY:** Doug Rogness
DEPTH TO GROUNDWATER: Dry; PVC casing stkup = 3.4 ft (approx.)		

DRILLING TIME RECORD					DEPTH (ft)		DRILLING ACTION	CALC. CONTENT	DESCRIPTION AND DRILLERS NOTES: (material, color, texture, hardness and other notes)
DEPTH		TIME							
FROM	TO	FROM	TO	MIN	FROM	TO			
0	5	10:15	10:25	10	0	6.6	E	N	SOIL-ALLUVIUM. Gravel with silt & sand; slightly moist; brown.
5	10	10:25	10:35	10	6.5	13	E	N	ALLUVIUM. Sandy clay with gravel, slightly moist; brown; fine-coarse grained sand.
10	15	10:35	10:45	10	13	17	I	N	ALLUVIUM. Sand with gravel; weathered and fractured Wells Fm; light brown; fine-medium grained sand.
15	20	10:45	11:00	15	17	25	r	N	BEDROCK – WELLS FORMATION. Sandstone; fine-medium grained; light brown.
20	25	11:00	11:15	15					
									Note: Did not encounter groundwater during drilling.

ABBREVIATIONS:

DRILLING ACTION		CALC. CONTENT
E: even, smooth	r: Slightly rough	N: Non-calc.
C: Crunchy	R: Moderately rough	S: Slightly
I: Intermittently rough	R: Very rough	M: Moderately
		V: Very

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WELL CONSTRUCTION SUMMARY

WELL NO. GW-21

SITE NAME: Simplot Smoky Canyon Mine – AOC Sage Valley

PROJECT NO: 010109.30

WELL LOCATION: North side of South Fork Sage Creek

DRILLING SUMMARY

Total Depth: 24.5 ft | **Borehole Dia**: 10-in

Drilling Co: Thomas Drilling | **Driller Name**: Tyson Thomas

Drill Rig: Air Rotary | **Bit(s)**: Hammer

Drilling Fluid(s): Air, water, foam

Ground Elev: | **Top Casing Elev**: 6696.4 ft

WELL DESIGN

Basis: Geologic Log X Geophysical Log _____

Casing Strings: (C = casing; S = screen)

From:	To:	Diam.	From:	To:	Diam.
+3.7 ft	3.0 ft	10" C1			
+3.4	4.5	4" C2			
4.5	24.5	4" S1			

Casing:	C1	10-in black steel blank
	C2	4-in Sch 80 PVC blank
	S1	4-in Sch 80 PVC (0.020" slot factory)

Centralizers: None.

Filter Material: Silica sand 8-12 mesh (0.093-0.055 in) @ 3-24.5 ft (32 bags).

Grout/Cement: Bentonite pellets (hydrated) @ 2-3 ft (2 bags). Cement grout (25% solids) @ 0-2 ft (2 bags).

Other:

CONSTRUCTION TIME LOG

TASK	START		FINISH	
Drilling:				
10"	9-24-03	10:15	9-24-03	11:30
Casing:				
10"	9-24-03	10:30	9-24-03	11:30
4"	9-24-03	11:30	9-24-03	12:00
Filter:	9-24-03	12:00	9-24-03	13:00
Seal:	9-24-03	13:00	9-24-03	14:15
Develop				
Other:				
Surface	9-24-03			

Decontamination: High pressure wash rig and equipment before and after drilling & well install

Development: None

Water Yield:

None during drilling.

Comments:

Checked water level two weeks later; still dry.

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LOG OF BORING BY CUTTINGS

BORING NO: MC-MW-1

SITE NAME: Simplot Manning Creek Lease – Panel F	**PROJECT NO.:** 2560432	**BORING LOCATION:** Along South Fork Sage Creek NE Panel F
DRILLING COMPANY: Thomas Drilling	**DRILLER:** Tyson Thomas	**ELEVATION AND DATUM:** 6780.1 ft (top of inside casing)
DRILLING METHOD: Air Rotary with Foam		**DATE STARTED:** 10/15/03 / **DATE FINISHED:** 10/17/03
SITE & TYPE OF CASING: 10-in diameter steel (0-10 ft); 4-in sch-80 PVC (0-210 ft); screen (160-210 ft)		**DRILL BIT:** 9 7/8 hammer / **COMPLETION DEPTH:** 210 feet
SAMPLER METHOD: Sieve from grab drill cuttings; bucket samples at 5-ft intervals		**LOGGED BY:** Deb Schiavone / **CHECKED BY:** Doug Rogness
DEPTH TO GROUNDWATER: 145.1 ft below GS (10-19-03); PVC casing stkup = 3.0 ft (approx.)		

DRILLING TIME RECORD					DEPTH (ft)		DRILLING ACTION	CALC. CONTENT	DESCRIPTION AND DRILLERS NOTES: (material, color, texture, hardness and other notes)
DEPTH		TIME							
FROM	TO	FROM	TO	MIN	FROM	TO			
0	10	15:30	16:00	30	0	4	E	M	SOIL-ALLUVIUM. Sandy clay with gravel; dry; brown; fine-medium grained sand.
10	30	08:30	09:30	60	4	8	CI	S	ALLUVIUM. Gravel with sand; dry; brown; trace clay; fine-coarse grained sand.
30	50	09:30	10:30	60	8	93	EI	N	WELLS FORMATION. Sandstone; dry; light brown; slightly calcareous 18-22 ft; crunchy light gray limestone interbeds 22-38 ft; slightly weathered; very calcareous; light brown-gray calcareous sandstone 38-82 ft; slightly weathered; light gray dolomite interbeds 82-93 ft.
50	70	10:30	11:30	60	93	210	Rr	M-V	WELLS FORMATION. Sandstone; light gray-brown; slightly weathered & fractured; dolomite interbeds 114-135 ft; light gray; occasional limestone interbeds; dolomite interbeds 173-193 ft; light gray; moderately calcareous.
70	90	11:30	12:30	60					
90	110	12:30	13:30	60					
110	130	13:30	14:30	60					
130	150	14:30	16:00	90					Note: Encountered groundwater at depth of about 160 feet; appears to be making about 30-40 gpm after drilling.
150	170	16:00	17:00	60					
170	190	09:00	10:30	90					
190	210	10:30	12:00	90					

ABBREVIATIONS:

DRILLING ACTION		CALC. CONTENT
E: even, smooth	r: Slightly rough	N: Non-calc.
C: Crunchy	R: Moderately rough	S: Slightly
I: Intermittently rough	R: Very rough	M: Moderately
		V: Very

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WELL CONSTRUCTION SUMMARY

WELL NO. MC-MW-1

SITE NAME: Simplot Manning Creek Lease – Panel F

PROJECT NO: 2560432

WELL LOCATION: Along South Fork Sage Creek NE Panel F

DRILLING SUMMARY

Total Depth: 210 ft

Borehole Dia: 10-in

Drilling Co: Thomas Drilling

Driller Name: Tyson Thomas

Drill Rig: Air Rotary

Bit(s): Hammer

Drilling Fluid(s): Air, water, foam

Ground Elev:

Top Casing Elev: 6780.1 ft

WELL DESIGN

Basis: Geologic Log X Geophysical Log _____

Casing Strings: (C = casing; S = screen)

From:	To:	Diam.	From:	To:	Diam.
+3.2 ft	10 ft	10" C1			
+3.0	160	4" C2			
160	210	4" S1			

Casing:	C1	10-in black steel blank
	C2	4-in Sch 80 PVC blank
	S1	4-in Sch 80 PVC (0.020" slot factory)

Centralizers: 100 ft; 150 ft; 205 ft.

Filter Material: Silica sand 8-12 mesh (0.093-0.055 in) @ 155-210 ft (81 bags).

Grout/Cement: Bentonite grout (25% solids) @ 30-155 ft (58 bags). Cement grout @ 0-30 ft (12 bags).

Other:

CONSTRUCTION TIME LOG

TASK	START		FINISH	
Drilling:				
0-10'	10-15-03	15:30	10-15-03	16:00
10-170'	10-16-03	08:30	10-16-03	17:00
170-210	10-17-03	09:00	10-17-03	12:00
Casing:				
10"	10-15-03	15:30	10-15-03	16:00
4"	19-17-03	12:00	10-17-03	13:30
Filter:	10-17-03	13:30	10-17-03	15:00
Seal:	10-17-03	15:00	10-18-03	16:00
Develop	10-19-03	08:00	10-19-03	14:30
Other:				
Surface	10-18-03			

Decontamination: High pressure wash rig and equipment before and after drilling & well install

Development: See Well Development Record

Water Yield: 30 – 40 gpm

Comments:

Depth to water 145.1 ft bgs on 10-19-03

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LOG OF BORING BY CUTTINGS

BORING NO.: C-1 | **PAGE 1 OF 3**

SITE NAME: Simplot Smoky Creek Mine	**PROJECT NO.:** 2560432	**BORING LOCATION:** NE of Mine Site Panel C
DRILLING COMPANY: Thomas Drilling	**DRILLER:** Tyson Thomas	**ELEVATION AND DATUM:** 7218'
DRILLING METHOD: Air Rotary with Foam & Hammered Casing		**DATE STARTED:** 07/01/03 / **DATE FINISHED:** 07/23/03
SITE & TYPE OF CASING: 16" Diameter Steel (0-31') 10" steel (0-500') 4" steel (0-660')		**DRILL BIT:** 12 7/8 hammer / **COMPLETION DEPTH:** 660 feet BGS
SAMPLER METHOD: Sieve from drill cuttings		**LOGGED BY:** Ann Stewart / **CHECKED BY:** Paul Spillers
DEPTH TO GROUNDWATER: 574.08'		

DRILLING TIME RECORD					SIMPLOT LITHOLOGICAL CODE	DRILLING ACTION	CALC. CONTENT	DESCRIPTION AND DRILLERS NOTES: (material, color, texture, hardness and other notes)
DEPTH		TIME						
FROM	TO	FROM	TO	MIN				
0	20	1200	1230	30	Soil	E	S	SOIL Clayey silt and lean clay, low to medium plasticity, with silt and fine sand, some gravel & boulders
20	24	1355	1410	10	Soil	I/E	S	SOIL Clayey silt and lean clay with increasing gravel content
24	30.6	1410	1420	10	251		S	DINWOODY FORMATION Shale
30.6	45	1705	1720	15	251		S	PHOSPHORIA FORMATION Cherty shale, shale contains chert gravel, shale goes from softer to harder zones, shale is gray to greenish gray.
45	73	725	750	25	251	I		Shale, gray to green, with chert pebbles.
73	190	750	1030	160	101	R	S	Cherty Shale Member, shale with black chert, fractured, many intervals of lost circulation, likely due to fractures 104-125 no recovery, fractured; 145-155 no recovery, fractured; 175-180 poor recovery, fractured; 185-190 poor recovery, fractured; 205-210 poor recovery.
190	265	1030 1355	1115	45	100		V	Rex Chert Member Black and gray chert, some limestone
265	290				100		S	Black and gray chert interbedded with black mudstone
290	320		1605	130	100; 201; 250		V	Chert, black and gray, in brown mud (mud may be first show of the Meade Peak member, with delayed recovery of chert cuttings)
320	335	1605			302	E	V	Meade Peak Member, hanging wall mud, brown fine grained mud.
335	405		1715	70	250	R	M to V	Black shale interbedded with black mudstone. One zone of brown mud or mudstone 345-350
405	431	850			250	R	S	Black shale and mudstone, hard. Foam is black to dark brown.

ABBREVIATIONS:

DRILLING ACTION		CALC. CONTENT
E: even, smooth	r: Slightly rough	N: Non-calc.
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I: Intermittently rough	R: Very rough	M: Moderately
		V: Very

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FIGURE SOP-23-2. FIELD LOG OF BOREHOLE BY CUTTINGS (Page 1 of 2)

LOG OF BORING BY CUTTINGS

BORING NO.: C-1 | **PAGE __2__ OF _3_**

SITE NAME: Simplot Smoky Creek Mine	**PROJECT NO.:** 2560432	**BORING LOCATION:** NE of Mine Site Panel C
DRILLING COMPANY: Thomas Drilling	**DRILLER:** Tyson Thomas	**ELEVATION AND DATUM:** 7218'
DRILLING METHOD: Air Rotary with Foam & Hammered Casing	**DATE STARTED:** 07/01/03	**DATE FINISHED:** 07/23/03
SITE & TYPE OF CASING: 16" Diameter Steel (0-31') 10" steel (0-500') 4" steel (0-660')	**DRILL BIT:** 12 7/8 hammer	**COMPLETION DEPTH:** 660 feet BGS
SAMPLER METHOD: Sieve from drill cuttings	**LOGGED BY:** Ann Stewart, Mary Garner	**CHECKED BY:** Paul Spillers
DEPTH TO GROUNDWATER: 574.08'		

DRILLING TIME RECORD					SIMPLOT LITHOLOGICAL CODE	DRILLING ACTION	CALC. CONTENT	DESCRIPTION AND DRILLERS NOTES: (material, color, texture, hardness and other notes)
DEPTH		TIME						
FROM	TO	FROM	TO	MIN.				
431	440				250	E	S	Mud seams within the black shale.
440	445				250, 302	R	S	Black shale (dark brown foam)
445	450				250	E/R	S	Mud seam, black shale
450	465				250	R	S	Black shale with interbedded mud seams (<1 foot thick seams)
465	485				201		N	Gray siltstone
485	500		1240	350	350	R	V	GRANDEUR LIMESTONE Light gray limestone
500	510	1400	1405	5	light gray sandstone, 352	I	S	White fine grained quartz sandstone with calcite cement. Well sorted, moderately well rounded with small amount of sericite and pyrite. Sandstone interbedded with gray-brown sandy dolomite.
510	592	1405	1620	135	400, gray sandstone	E	S	WELLS FORMATION Yellow-gray quartz sandstone, fine to medium grained with variable cement (some calcite, some quartz). Well sorted moderately well rounded with >5% sericite and pyrite.
592	625	1620	1645	25	400; 352	I/R	N/M	Yellow-white sandstone as above with gray sandy dolomite interbeds (interbeds make up 10% of total interval). Dolomite is recrystallized with stringers of calcite.
625	639	1645	1655	10	400; 403; yellow clay	R	N	Oxidized zone, sandstone is iron stained to red-orange with numerous stringers of hematite. Dark yellow clay zone at approximately 635 feet, clay is plastic with no obvious laminations.
639	670	1655 0825	1715 0925	20 60	400; 352	I/R	S	Yellow white sandstone with sandy dolomite interbeds (interbeds vary from 0% to 50% of total). Thin gray clay unit in 652-653 interval.

ABBREVIATIONS:

DRILLING ACTION		CALC. CONTENT
E: even, smooth	r: Slightly rough	N: Non-calc.
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I: Intermittently rough	R: Very rough	M: Moderately
		V: Very

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FIGURE SOP-23-2. FIELD LOG OF BOREHOLE BY CUTTINGS (Page 2 of 3)

LOG OF BORING BY CUTTINGS

BORING NO.: C-1 | **PAGE __3__ OF _3_**

SITE NAME: Simplot Smoky Creek Mine	**PROJECT NO.:** 2560432	**BORING LOCATION:** NE of Mine Site Panel C
DRILLING COMPANY: Thomas Drilling	**DRILLER:** Tyson Thomas	**ELEVATION AND DATUM:** 7218'
DRILLING METHOD: Air Rotary with Foam & Hammered Casing	**DATE STARTED:** 07/01/03	**DATE FINISHED:** 07/23/03
SITE & TYPE OF CASING: 16" Diameter Steel (0-31') 10" steel (0-500') 4" steel (0-660')	**DRILL BIT:** 12 7/8 hammer	**COMPLETION DEPTH:** 660 feet BGS
SAMPLER METHOD: Sieve from drill cuttings	**LOGGED BY:** Mary Garner	**CHECKED BY:** Paul Spillers
DEPTH TO GROUNDWATER: 574.08'		

DRILLING TIME RECORD					SIMPLOT LITHOLOGICAL CODE	DRILLING ACTION	CALC. CONTENT	DESCRIPTION AND DRILLERS NOTES: (material, color, texture, hardness and other notes)
DEPTH		TIME						
FROM	TO	FROM	TO	MIN.				
670	690	0920	0930	10	white sandstone: 400	E	N	White-yellow sandstone, medium grained, very weakly cemented (can break apart fragments with hand pressure). Drilling very rapid, no dolomite interbeds.
690	720	0930	1010	40	400; white sandstone; 352	E	N/S	Yellow-white sandstone with gray sandy dolomite interbeds (50% of total).

ABBREVIATIONS:

DRILLING ACTION		CALC. CONTENT
E: even, smooth	r: Slightly rough	N: Non-calc.
C: Crunchy	R: Moderately rough	S: Slightly
I: Intermittently rough	R: Very rough	M: Moderately
		V: Very

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FIGURE SOP-23-2. FIELD LOG OF BOREHOLE BY CUTTINGS (Page 3 of 3)

WELL CONSTRUCTION SUMMARY

WELL NO. C-1 (deep well)

SITE NAME:
Simplot Smoky Canyon Mine – Panel C

PROJECT NO:
2560432

WELL LOCATION:
North end of C-Panel

DRILLING SUMMARY

Total Depth: 722 ft

Borehole Dia: 16-in

Drilling Co: Thomas Drilling

Driller Name: Tyson Thomas

Drill Rig: Air Rotary

Bit(s): Tri-cone & Hammer

Drilling Fluid(s): Air, water, foam

Ground Elev: 7218 ft (GPS)

Top Casing Elev:

WELL DESIGN

Basis: Geologic Log X Geophysical Log _____

Casing Strings: (C = casing; S = screen)

From:	To:	Diam.	From:	To:	Diam.
+1.5 ft	31 ft	16” C1			
+1.0	500	10” C2			
+0.5	539	4” C3			
539	599	4” C4			
599	650	4” S1			
650	660	4” C4			

Casing:	C1	16-in black steel blank
	C2	10-in black steel blank
	C3	4-in black steel blank
	C4	4-in stainless steel blank
	S1	4-in stainless steel (0.020” slot factory)

Centralizers: 396 ft, 437 ft, 477 ft, 517 ft, 558 ft, 619 ft, 639 ft, 659 ft.

Filter Material: Silica sand 8-12 mesh (0.093-0.055 in) @ 589-662 ft; 6-9 mesh, 10-20 mesh, & 20-40 mesh @ 572-589 ft

Grout/Cement: Bentonite grout (25% solids) @ 40-572 ft; Cement grout @ 0-40 ft

Other:

CONSTRUCTION TIME LOG

TASK	START		FINISH	
Drilling:				
16”	7-1-03	12:00	7-1-03	12:30
10”	7-1-03	17:00	7-2-03	17:15
9 7/8”	7-3-03	08:30	7-17-03	10:00
Casing:				
16”	7-1-03	13:00	7-1-03	14:00
10”	7-7-03	12:00	7-10-03	13:40
4”	7-19-03	11:40	7-19-03	17:50
Filter:	7-20-03	06:00	7-20-03	16:00
Seal:	7-20-03	16:00	7-21-03	18:00
Develop	7-21-03		7-23-03	
Other:				
Surface	7-23-03		7-23-03	

Decontamination: High pressure wash rig and equipment before and after drilling & well install

Development: Surge with drill rig compressor; pump with submersible

Water Yield:

Based on development, well yield estimate = 15 gpm

Comments:
Depth to water approx. 575 ft on 7-23-03

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