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Appendix 7-7

Supplemental Alluvial Valley Floor Information

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Supplemental Information for Utah Division of Oil, Gas and Mining Alluvial Valley Floor Finding for the Proposed Coal Hollow Mine

27 August 2009

Alton Coal Development, LLC
Cedar City, Utah

PETERSEN HYDROLOGIC, LLC
CONSULTANTS IN HYDROGEOLOGY

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Supplemental Information for Utah Division of Oil, Gas and Mining Alluvial Valley Floor Finding for the Proposed Coal Hollow Mine

27 August 2009

Alton Coal Development, LLC
Cedar City, Utah

Prepared by:

Erik C. Petersen, P.G.
Senior Hydrogeologist
Utah P.G. No. 5373615-2250

PETERSEN HYDROLOGIC
CONSULTANTS IN HYDROGEOLOGY

2695 N. 600 E.
LEHI, UTAH 84043
(801) 766-4006
PETERSEN@RELIA.NET

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Supplemental Information for
Utah Division of Oil, Gas and Mining
Alluvial Valley Floor Finding for the
Proposed Coal Hollow Mine

1.0 Introduction

Alton Coal Development, LLC has made an application for a Utah State coal mining permit from the Utah Division of Oil, Gas and Mining (Division) to mine coal at the proposed Coal Hollow Mine permit area. The proposed Coal Hollow Mine permit area is located on private lands in the Alton Coal Field of south-central Utah, approximately three miles south of the town of Alton, Utah (Figure 1).

In its 27 August 2007 Administrative Completeness Review and 4 August 2008 Technical Review, the Division requested more information from Alton Coal Development, LLC to make alluvial valley floor findings for the permit and adjacent areas. The purpose of this document is to provide the additional information requested by the Division.

This document is organized according to the R645 Rules cited by the Division as the basis for the information request. The information requested by the Division is presented in the following sections of this document.

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2.0 R645-302-321.210

2.1 Alluvial sediment deposition

Sink Valley is an upland area located at approximately 7,000 feet elevation, situated at the base of the precipitous Paunsaugunt Plateau escarpment. In such geomorphologic settings, alluvial fan deposition in the arid western United States is common. The alluvial fan system in Sink Valley consists of a series of coalesced fans derived from sediments shed from the adjacent highland regions on the Paunsaugunt Plateau. Sediment deposition processes in Sink Valley include deposition by unconcentrated runoff, sheet floods, mudflows, and debris flows. The sediments near the distal portions of the fan complex in Sink Valley (as observed in drill holes, surface outcrops, and soils pits within the Coal Hollow Project area) are dominated by fine-grained materials including silts, clays, and fine-grained sands (see Chapters 6 and 7, Coal Hollow Project MRP). Coarser sediments are observed in surface exposures nearer the apex of the alluvial fans along the base of the precipitous Paunsaugunt Plateau escarpment. Coarse-grained sediments, including boulders, gravels, and coarse-grained sands were generally not identified in drill holes and surface exposures over most of the proposed Coal Hollow Mine permit area. As indicated on Drawing 7-15b and described in Appendix 7-10, coarse-grained alluvial sediments were identified in an isolated area along the eastern margin of the mining area (adjacent to Pit 15.)

As stated in the OSM alluvial valley floor identification and study guidelines (1983), the SMCRA definition of an alluvial valley floor "does not include upland areas which are generally overlain by a thin veneer of colluvial deposits composed chiefly of debris from sheet erosion, deposits formed by unconcentrated runoff or slope wash, together with talus, or other mass-movement accumulations and windblown deposits" (OSM, page II-5). Further, an alluvial valley floor is defined by the existence of flood plains and terraces underlain by unconsolidated stream-laid deposits (page II-11). Included in the AVF definition are only those areas characterized as being "within that valley, those surface

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landforms that are either flood plains or terraces if these landforms are underlain by unconsolidated deposits...Alluvial valley floors are not merely those valleys filled with alluvium".

Upper Sink Valley Wash is situated in an upland area that is isolated from the flood plain and terrace complex. The associated flood plain and terrace complex is located a considerable distance from the proposed permit area. As indicated in its 26 March 2009 Technical Analysis, the Division determined that "upper Sink Valley Wash, where the mine is proposed, consists of alluvial fan deposits, with no floodplain and terrace complex" (page 33). As defined in R645-100-200, an alluvial valley floor means:

> *the unconsolidated stream-laid deposits holding streams with water availability sufficient for subirrigation or flood irrigation agricultural activities* ***but does not include upland areas*** *which are generally overlain by a thin veneer of colluvial deposits composed chiefly of debris from sheet erosion, deposits formed by unconcentrated runoff or slope wash, together with talus, or other mass-movement accumulations and windblown deposits. (emphasis added)*

As defined in R645-100-200 "Upland Areas" are defined as follows:

> *"Upland Areas" means, with respect to ALLUVIAL VALLEY FLOORS,* ***those geomorphic features located outside the floodplain and terrace complex such as isolated higher terraces, alluvial fans,*** *pediment surfaces, landslide deposits, and surfaces covered with residuum, mud flows, or debris flows, as well as highland areas underlain by bedrock as covered by residual weathered material or debris deposited by sheetwash, rillwash, or windblown material. (emphasis added)*

Based on these definitions and the Division's determinations that the area consists of alluvial fan deposits, with no floodplain and terrace complex, it is readily apparent that an alluvial valley floor is not present.

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2.2 Lack of continuous stream channel

The locations of existing stream channels in the Coal Hollow Project and adjacent area are plotted on an infrared aerial photograph in Plate 1. Spring discharges are also plotted on Plate 1. It is apparent in this plate, and based on field investigations, that although there are many discontinuous drainage segments in the area, there is no continuous stream channel through Sink Valley. The lack of a continuous stream channel in Sink Valley is likely largely attributable to the manner of sediment deposition in the valley (i.e. mudflows, debris flows, and sheet floods). It should be noted that the various historical activities of landowners in the valley may have influenced surface drainage patterns to some extent. However, it seems likely that prior to the settlement and agricultural development of the valley by humans, conditions in the valley similar to those currently present likely prevailed as a result of the fan depositional regime.

It should also be noted that the greater Sink Valley Wash and Kanab Creek drainages appear to currently be in unstable condition. Significant down-cutting of stream channels is currently occurring throughout large portions of these drainages. The Lower Robinson Creek drainage is deeply incised throughout the extent of the proposed Coal Hollow Project permit area. In several locations in the project area, the Lower Robinson Creek stream bed has been incised several tens of feet below the surrounding topography. Based on recent observations, it is apparent that stream channel down-cutting and erosion/collapse of the steep arroyo walls adjacent to Lower Robinson Creek is actively ongoing at present. As shown on Plate 1, the unstable, incised stream channel in the Lower Robinson Creek drainage (located north of Sink Valley) is continuous through the northern portion of the project.

It is also evident that active head-cutting in the Sink Valley Wash drainage is currently occurring near the southern extent of Sink Valley in the northwest corner of Section 32, T39S, R5W, near Alluvial Groundwater Discharge Area B (see Appendix 7-1 in Chapter 7 of Coal Hollow Project MRP). As the drainage channels become increasingly incised and

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migrate northward further into Sink Valley, water levels in alluvial groundwaters adjacent to these drainages channels will likely decline (i.e. the incised drainages will act as drains).

2.3 USGS 7.5 minute topographic maps

On the 7.5 minute Alton, Utah USGS topographic map, a continuous stream channel is shown for Sink Valley Wash from its headwaters area to the southern extents of Sink Valley. However, field surveys of stream drainages in Sink Valley indicate that the stream channels are ***not*** continuous through the valley, but rather exist as a series of discontinuous drainage segments. It is not uncommon for inaccuracies of this sort to exist on USGS topographic maps, as these maps are commonly constructed using large-scale aerial photographs and photogrammetric mapping techniques. Ground truthing of all mapped features is not routinely performed. In the absence of ground truthing of the stream drainages in Sink Valley and adjacent areas, it is not unexpected that the delineation of continuous stream channels in Sink Valley has been incorrectly delineated on the topographic map. Field investigations in the Lower Robinson Creek drainage indicate that this drainage is continuous through the Coal Hollow Project and adjacent area.

2.4 Flood plains and terraces

No flood plains or stream terrace deposits have been identified by studies in the Coal Hollow Project area. Consequently, a map showing the locations of flood plains and terraces in the project area has not been prepared. A drawing showing surface drainage patterns, including the flow from springs is provided as Plate 1.

As shown on the USGS 7.5 minute Alton, Utah quadrangle topographic map, the surface morphology of Sink Valley is moderately convex in cross-fan section and consists of several lobes formed by sediment deposition derived from several different drainages. A drawing showing examples of valley cross-sections showing some possible relations in valley

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alluvium (with terracing) is shown in Figure 2. The surface morphology in Sink Valley is typical of an alluvial fan system. In contrast, a flood plain is, by definition, a planar feature. "Stream terraces are flat surfaces along the valley sides of stream courses marking the level of former valleys. They are vestiges of former flood plains formed by streams which were higher in elevation than the present stream" (OSM, 1983). No such stream terraces are observed in Sink Valley. The lack of a characteristic flood plain, the convex cross-fan surface topography, and the lack of a continuous stream channel through Sink Valley, are all inconsistent with both the scientific and the regulatory definitions of an alluvial valley floor.

2.5 Surface water drainages

A map showing the extent and details for all watersheds that can contribute runoff to the Coal Hollow Project and adjacent area is presented in Plate 2.

2.6 Alluvial groundwater systems potentiometric information

A map showing potentiometric levels in alluvial groundwater systems in the Coal Hollow Project and adjacent area has been previously provided as Drawing 7-13 in Chapter 7 of the Coal Hollow Project MRP. This map was created using the elevations of springs and Alluvial Groundwater Discharge Areas A and B and the elevations of waters encountered in the Sink Valley Wash stream channel. Additional information on alluvial groundwater systems, including the approximate directions of shallow groundwater flow has been provided as Figure 21 in Appendix 7-1 to Chapter 7 of the Coal Hollow Project MRP. Long-term seasonal variability in water levels in alluvial groundwater systems in the project area is documented with historic monitoring data at alluvial monitoring wells and springs in Appendix 7-1 of Chapter 7 of the Coal Hollow Project MRP and in baseline water monitoring data submitted to the Utah Division of Oil, Gas and Mining on-line hydrology database (UDOGM, 2008). Information on depth below the ground surface of potentiometric levels measured in existing and newly constructed alluvial monitoring wells in and around

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the Coal Hollow Project area during 2007 is presented in Table 1. These data are plotted in a series of hydrographs in Figure 3. It should be noted that the water levels measured in the piezometers are representative of the potentiometric pressure in the piezometer screened intervals. Where confined groundwater conditions exist in the alluvial groundwater system, the water levels measured in the piezometers are generally not the same as the depth at which groundwater would first be encountered in an excavated hole (or the depth at which a plant's roots may encounter water). For example, the shut-in potentiometric head measured at well Y-61 is several feet above the ground surface at the well site. However, an excavated hole near the well may not encounter groundwater in the shallow subsurface, due to groundwater confinement by low-permeability strata overlying the strata with artesian pressure.

To facilitate the evaluation of climatic effects on potentiometric levels in the alluvial groundwater systems, an updated plot of the Palmer Hydrologic Drought Index (PHDI) for the region (Utah Region 4) is provided as Figure 4. A description of the use and interpretation of PHDI data is provided in Appendix 7-1 of Chapter 7 of the Coal Hollow Project MRP.

A perhaps more meaningful measurement of the depth to first water in the shallow alluvial sediments is provided in Table 2 and Figure 5. Table 2 includes hydrologic and soils information obtained from 60 soils pits dug in the Coal Hollow Project and adjacent area. Included in Table 2 and Figure 5 for each soils pit are the depth below the ground surface at which groundwater was first encountered in the soils pit, the uppermost extent of any soil mottling (red or gray coloration in cracks or pores in the soil matrix resulting from iron precipitation related to changing redox conditions with changes in soil water saturation) observed, and the uppermost extent of the presence of any aquic soils observed in the pit. The construction of an isopach map of the depth to groundwater was not created using these data. This is because of the significant heterogeneity of the alluvial groundwater system in the Coal Hollow Project area. Groundwater was encountered in some of the soil pits while other nearby pits were dry. Additionally, groundwater in the alluvial system in many locations in and around the Coal Hollow Project area occurs under perched conditions. Consequently, extrapolation of observed saturation conditions in a soils pit or monitoring

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well to surrounding areas where saturation data are not available would be arbitrary and not meaningful. Under such groundwater conditions, the direction of groundwater flow is largely constrained by the geometry of permeable and lower-permeability sediments and local microtopography and is not readily predictable. Given these conditions, it is not possible to create a meaningful potentiometric surface map in these areas, or to infer shallow groundwater flow directions and, consequently, no such attempt has been made to do so herein.

The drilling of the shallow exploration boreholes referenced in Appendix 5-1 of Chapter 5 of the Coal Hollow Project MRP occurred during seasonal high-flow runoff conditions in late February and early March 2007. At the time of the drilling of these boreholes, copious amounts of snowmelt water was running over the ground surface and ponding on the low-permeability clayey sediments. While appreciable shallow groundwater was noted during drilling, the groundwater encountered was likely shallow in origin and most likely occurred under perched conditions. Within several weeks of the drilling of the exploration boreholes, the conditions in the soils and shallow alluvial sediments were found to have dried out appreciably and little groundwater was found to be present. This information suggests that, while seasonal snowmelt and shallow perched groundwater was present in the area of the exploration boreholes at the time of the drilling, a continuously saturated alluvial groundwater system through which appreciable groundwater flow was occurring was not present.

2.7 Alluvial groundwater systems maps and cross-sections

A series of six east-west cross-sections through the alluvial sediments in and around the proposed Coal Hollow Mine permit area are presented in Figure 6. A map showing the

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locations of the cross-sections in Figure 6 is presented in Figure 7. A map showing the locations of streams, ponds, springs, and wells in relation to the surface geology is presented in Figure 8. The locations of proposed disturbances and mine pit locations are also shown on the map in Figure 8. It should be noted that in Figure 6, extrapolation of potentiometric levels between some monitoring wells was not performed. This is because, as discussed previously, alluvial groundwaters in many parts of the Coal Hollow Project area occur under perched conditions with discontinuous zones of saturation. Consequently, the extrapolation of potentiometric levels between distant monitoring wells under such conditions would be incorrect. In other areas, particularly near the eastern margins of Sink Valley, where a more continuous artesian alluvial groundwater system exists, some extrapolation of hydraulic head between piezometers is more meaningful.

In the various field investigations conducted in the Coal Hollow Project, specific correlation between seasonal variation in alluvial water levels and vegetation changes have not been noted.

Additional geologic information on the stratigraphy and hydrostratigraphy of the alluvial sediments, Tropic Shale overburden, the Smirl Coal Zone, and the Dakota Formation underburden is provided in Appendix 6-1 in Chapter 6 of the Coal Hollow Project MRP.

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3.0 R645-302-321.220

3.1 Land type map

The locations of undeveloped rangeland, "improved" rangeland and pasture lands are shown on the Vegetation Map, Drawing 3-1 in Chapter 3 of the Coal Hollow Mine MRP. A table correlating the vegetative type map units shown on Drawing 3-1 and the land type as requested by the Division under R645-302-321.220 is provided below.

Drawing 3-1 map unit	R645-302-321.220 description
P-J (Pinyon/Juniper)	Undeveloped rangeland
S/G (Sagebrush / Grass)	Undeveloped rangeland
SB (Sagebrush)	Undeveloped rangeland
SB (chipped P-J)	Improved rangeland for sage-grouse habitat
RB/SB (Rabbitbrush / Sagebrush)	Undeveloped rangeland
P (Pasture Land)	Crop lands and pastures
M (Meadow)	Undeveloped Rangeland
OB (Oak Brush)	Undeveloped rangeland

3.2 Productivity measurements

Annual biomass productivity measurements of the plant communities of the area are provided in Section 321.200 and summarized in Table 3-34 of Chapter 3 of the Coal Hollow Project MRP.

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3.3 Subirrigated pasture map

The locations of subirrigated lands are shown in Drawing 7-7 of Chapter 7 of the Coal Hollow Project MRP.

It should be noted that some small areas that may potentially be subirrigated lands, which are identified as dry meadows in the western portion of the project area in Drawing 3-1 in Chapter 3 of the Coal Hollow Project MRP, are not marked as subirrigated lands on Drawing 7-7. The land areas of these dry meadows are small, and conditions in which these dry meadows occur may be at least in part due to microtopgraphy.

3.4 Depth to groundwater information

Potentiometric data from piezometers including the season of use (April – November) in the alluvial groundwater systems in the project area in and near the pastures are provided in Table 1. This information together with additional water level information in the alluvial groundwater systems has been submitted to the Division's on-line hydrology database (UDOGM 2008). Depth to groundwater information in excavated soils pits is provided in Table 2 and Figure 5. Additional characterization of conditions in the soils pits is provided in Chapter 2 of the Coal Hollow Project MRP. Generally, the depths to alluvial groundwater in the subirrigated areas are within several inches to a few feet below the ground surface and are seasonally variable, with water levels typically declining gradually during the summer and fall months. Depths to groundwater in the pastureland areas in the southern portions of the proposed permit area range from about one to two feet under high-flow conditions, and up to several feet below the ground surface during low-flow conditions (see Table 1). During 2007, the depths to shallow groundwater in the subirrigated areas were least during the early winter season and declined gradually during the remainder of the year (Table 1). In most other areas, where subirrigation is not occurring, the depths to alluvial groundwater below the ground surface were generally greater.

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Discharge monitoring of seeps SP-28, SP-29, SP-30, SP-31, and SP-32 in lower Sink Valley demonstrate the seasonal variability of the alluvium in this location. Visible discharges were observed in all of these seeps in June 2005, which was a particularly wet year (Figure 4). By August of 2005 all of these seeps were dry as alluvial water levels dropped below the elevations of the spring discharge locations (see Appendix B of Appendix 7-1 of Chapter 7 of the Coal Hollow Project MRP).

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4.0 R645-302-321.230

4.1 Locations of flood irrigated or subirrigated lands

The locations of historically flood irrigated and subirrigated lands are shown on Drawing 7-7 in Chapter 7 of the Coal Hollow Project MRP.

The subirrigated lands are located in the meadow areas east of the Tropic Shale ridge that bisects the Coal Hollow Project area (see Drawing 7-7 in the Chapter 7 of the Coal Hollow Project MRP). These areas have been identified as subirrigated based on considerations of alluvial groundwater conditions, water quality, soil moisture, rooting depth, soil mottling, the water requirements of vegetation, and from analysis of the infrared imagery of the region. Additionally, some areas of dry meadow located west of the Tropic Shale ridge in the project area also have also been identified as having localized subirrigation potential. These areas are of limited extent (see "Meadows (dry)" in Drawing 3-1 in Chapter 3 of the Coal Hollow Project MRP. However, based on recent observations, it is apparent that these dry meadows are wet only early in the year and the soils dry out rapidly during the spring. The early-season wet conditions in the dry meadows may be at least in part due to microtopography. Consequently, although there is some potential for these lands to be subirrigated, they are not delineated as subirrigated in Drawing 7-7 of Chapter 7 of the Coal Hollow Project MRP).

The delineation of historically flood irrigated lands in the Coal Hollow Project area is problematic. Historically, attempts at irrigated crop production in the area have occurred in a few homestead locations in and around the Coal Hollow Project area (personal communication, Darlynn Sorensen, 2008). Most of the flood irrigation at these locations was probably of relatively small scale, consisting primarily of irrigation of domestic gardens (personal communication, Darlynn Sorensen, 2008). Some limited flood irrigation occurred at the Swapp Ranch and Pugh Homesteads historically, although there is no indication that any flood irrigation at these properties has occurred in the past several years. Irrigation and crop production on a larger scale has occurred on the Darlynn Sorensen property (discussed

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below). With the exception of the crop production at the Sorensen property, none of the other attempts at irrigation and crop production were ultimately successful and all have since been abandoned.

Historically, the most significant use of flood irrigation in the Coal Hollow Project area has occurred at the Sorensen property (Drawing 7-7 in Chapter 7 of Coal Hollow Project MRP). Crops (hay and grain) in these fields were periodically flood irrigated using surface water from Swapp Hollow creek stored temporarily in pond 29-7 (see Drawing 7-7 in the Coal Hollow Project MRP). Flood irrigation at the Sorensen property has typically consisted of the application of a single watering event to the fields in the springtime during wet years when adequate water was available for use. The application of the single springtime irrigation watering resulted in improved hay or grain crop yield relative to the yield in years when no irrigation water could be applied (personal communication, Darlynn Sorensen, 2008). During years with dryer climatic conditions, there was not sufficient surface water available to flood irrigate the lands. Recently (for the past many years) the quantity of water in Swapp Hollow creek has not been sufficient to allow flood irrigation. During this many year period, flood irrigation of the Sorensen property has occurred on only one occasion (during the very wet year 2005). During other recent years, adequate water for useful irrigation of the fields has not been available and flood irrigation of Mr. Sorensen's fields has not been performed (personal communication, Darlynn Sorensen, 2008).

It should be noted that the lack of appreciable flood irrigation currently in Sink Valley and the failures of historic flood irrigation attempts is a direct result of the lack of a reliable supply of water in sufficient quantities to irrigate useful acreage of agricultural lands in the valley.

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4.2 General construction and use of water holding ponds

The water holding ponds identified in Drawing 7-7 in the Coal Hollow Project MRP have the appearance of having been constructed as simple earthen embankments. Discussions with the local property owners support this conclusion (personal communication, Darlynn Sorensen, 2008). The earthen embankments for the water holding ponds are typically situated across the bottoms of surface water drainages and are intended to store surface-water runoff. Most of the water holding ponds are used to impound water for stock watering use. A few water holding ponds have also been equipped with water outlet control devices to facilitate the release of the stored water for irrigation or other use. The outlet control structure typically consists of a pipe buried near the base of the pond which is equipped with a control valve to regulate the flow from the pond. The water holding ponds that are equipped with water outlet controls to facilitate irrigation releases include the following:

Water holding ponds equipped with outlet structure for irrigation use

Pond	Water source	Use
29-7	Swapp Hollow creek	Stock watering and flood irrigation of the Sorensen property irrigated lands
20-1	Groundwater diversion from Water Canyon high elevation spring (via some sections of irrigation pipe and some sections of unlined earthen ditches)	Stock watering and historic flood irrigation of Pugh Homestead
29-3	Groundwater from alluvial spring SP-20	Stock watering and historic flood irrigation of Swapp Ranch
24-1 25-1	Kanab Creek	Stock watering and flood irrigation of lands in Kanab Creek drainage (not in project area)

See Drawing 7-7 in the Coal Hollow Project MRP for pond locations

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4.3 Conveyance systems between ponds

For most of the ponds in the Coal Hollow Project area, there are no constructed conveyance systems between ponds. Rather, pond overflow or bypass typically runs down the surface drainage to a pond lower in the same drainage (if any). The conveyance systems for the water holding ponds used either currently or historically for irrigation consist of unlined earthen ditches as shown in Drawing 7-7 in Chapter 7 of the Coal Hollow Project MRP.

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5.1 Subirrigation potential (groundwater monitoring)

Monitoring information from shallow groundwater systems in the proposed Coal Hollow Project and adjacent area has been submitted electronically to the Division's on-line hydrology database (UDOGM, 2008). These data have been analyzed and a characterization of the shallow groundwater systems in the area is provided in Appendix 7-1 of Chapter 7 of the Coal Hollow Project MRP. Potentiometric data from alluvial monitoring wells as monitored during 2007 is presented in Table 1. Depth to water hydrographs for these wells are presented in Figure 3. Additional information pertinent to alluvial saturation levels in near-surface sediments in the Coal Hollow Project area is provided in Table 2 and Figure 5.

5.2 Subirrigation potential (water quality)

As described previously, subirrigated lands in the Coal Hollow Project area include lands in two regions. Both of these regions are located east of the north-south trending Tropic Shale bedrock ridge that bisects the Coal Hollow Project area into eastern and western regions (see Appendix 7-1 of the Coal Hollow Project MRP for information on the hydrogeologic influence of the Tropic Shale ridge). To characterize the suitability of shallow groundwater for subirrigation use in these two areas, the average water quality characteristics of two nearby alluvial springs is evaluated here. Spring SP-8 discharges to the surface from the artesian alluvial groundwater system in the vicinity of the northern potentially subirrigated area. Spring SP-6 discharges to the surface from the alluvial groundwater system in the vicinity of the southern potentially subirrigated area. Water quality characteristics of shallow groundwaters in the northern and southern subirrigation areas, as represented by groundwaters from springs SP-8 and SP-6, respectively, are presented in Table 3. These data have also been submitted electronically to the Division's on-line hydrology database

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(UDOGM, 2008). Water quality suitability criteria for irrigation use as presented in the OSM Alluvial Valley Floor Identification and Study Guidelines (1983) are used in this analysis. The water quality suitability for the northern and southern subirrigation areas are depicted on Figure 9.

5.2.1 Northern subirrigation area water quality

It is apparent from Figure 9 that the shallow groundwater available for subirrigation in the northern subirrigation area plots near the boundary between C2-S1 and C3-S1 class waters on the SAR – conductivity classification of irrigation water (OSM, 1983). This indicates a medium to high salinity hazard with low sodium danger. As a result of the medium to high salinity hazard, the groundwater could be used if a moderate amount of leaching occurs. Waters falling in the C3-S1 area indicate that waters in this class cannot be used on soils with restricted drainage. Special management for salinity control may be required and plants with good salt tolerance should be selected. Shallow alluvial groundwater from the northern subirrigation area as represented by SP-8, averages 424 mg/L (Table 3). Based on the dissolved-solids hazard for irrigation water (Table B-5, OSM, 1983) as a result of irrigation using this water, no detrimental effects will usually be noticed, and the salinity hazard is low. Using the criteria shown on Table B-6 (OSM, 1983), which considers boron, SAR, chloride, sulfate, specific conductance, and TDS levels, the water in the northern subirrigation area is a Class I, which is excellent to good for overall soil/climate management, and suitable for irrigation of all or most plants, including boron-sensitive species.

5.2.2 Southern subirrigation area water quality

It is apparent from Figure 9 that the shallow groundwater available for subirrigation in the southern subirrigation area plots near the boundary between C3-S1 and C4-S1 class waters on the SAR – conductivity classification of irrigation water (Figure B-5, OSM, 1983). This indicates a high to very high salinity hazard with a low sodium danger. Waters classified as C3-S1 indicate that the water cannot be used on soils with restricted drainage. Special management for salinity control may be required and plants with good salt tolerance should be selected. Waters falling in the C4-S1 area contain very high salinity water, which is not

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suitable for irrigation under normal conditions. Shallow alluvial groundwater from the northern subirrigation area averages 1,330 mg/L (Table 3). Based on the dissolved-solids hazard for irrigation water (Table B-5, OSM, 1983) irrigation with this water can have detrimental effects on sensitive crops. Using the criteria shown on Table B-6 (OSM, 1983), which considers boron, SAR, chloride, sulfate, specific conductance, and TDS levels, the water in the northern subirrigation area is a Class II water, which is good to injurious; harmful under certain conditions of soil, climate, and practices. Irrigation with Class II water is not suitable for most salinity- and boron-sensitive plants, but is suitable for all tolerant and many semitolerant species.

It should be noted that shallow alluvial groundwaters in areas west of the subirrigated lands in the Coal Hollow Project and adjacent area commonly contain water that is appreciably elevated in dissolved solids concentrations (UDOGM, 2008). Shallow alluvial groundwaters were sampled from trenches in the alluvial system in the eastern ¼ of Section 30 T39S, R5W in April 2006. Locations and chemical information for these trenches is provided in Appendix 7-1 of Chapter 7 of the Coal Hollow Project MRP and has been submitted electronically to the Division's on-line hydrology database. Alluvial groundwater sampled from these trenches had specific conductance values ranging from 1,142 to 3,700 uS/cm with TDS concentrations ranging from 903 to 3,608 mg/L. This information suggests that shallow groundwater in some of these areas may not be suitable for subirrigation.

Monitoring of alluvial seeps SP-28, SP-29, SP-30, SP-31, and SP-32 in the southern end of Sink Valley near the southern subirrigation area indicate that the quality of shallow groundwater potentially available for subirrigation in this area is of poor quality, with measured specific conductance values ranging from 2,110 to 4,150 uS/cm, and averaging about 2,900 uS/cm. Waters of this quality are classified as high-salinity waters and are not usually useful for crop irrigation.

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5.3 Subirrigation potential (soil moisture)

Qualitative soil moisture evaluations were performed in excavated soils pits by qualified soil scientists. Information on soil moisture is provided in Chapter 2 of the Coal Hollow Project MRP. This information has been utilized in performing the analysis of alluvial systems presented in this document.

5.4 Subirrigation potential (soil mottling, rooting depth, soil moisture)

Root size and density (abundance) data was collected at each soil pit as part of the description of the soils. Data for each individual soil pit was provided on the profile description sheets of the soil survey report (MRP Appendix 2-1). Summarized depths of roots including sizes, densities and mottles of the major soil types (named) for each soil map unit (by plant community) was evaluated and has been presented in Table 4.

The parameters for root density and size are described in the Field Book for Describing Soils, version 2 (Schoeneberger et. al., 2002). Table 5 defines the terms used to describe roots in the Coal Hollow Project soil survey.

5.4.1 Soil Mottles

The presence of soil mottles suggests that the soil depths where they appear were saturated with water at some time. Groundwater studies in the Coal Hollow Project area indicated that the periods of highest groundwater elevations are during late winter and early spring before the plants' consumptive use of water is at their peak. In addition, lab analysis of the groundwater indicated that it has TDS values that may diminish the benefit of the water to plants.

Figure 10 and Figure 11 illustrate the relationship of average root density and size versus depth for each plant community identified in the MRP for the Coal Hollow Project area. The

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figures also compare root density and size with the depth to soil mottles for specific plant communities when mottling was the dominant condition. The *dominant condition* is justified in the "Notes" on Table 4. This data evaluation was limited by the variety of soil pit depths.

5.4.2 Results of the Root Data Evaluation by Plant Community

The **meadow** (M) plant community was characterized by sedges, rushes, and wild iris. There were "many" roots in the upper 11 inches of the soil profile. The root density was "common" from 11 inches down to 37 inches and a "few" roots extended down to 52 inches. The depth of the "many" roots zone corresponds closely with the average depth to soil mottles of 10 inches. The meadow plant community is analogous to soil map unit 7. *Coarse* roots were not "common" in these soils, but *medium* roots extended down to 39 inches. *Fine* roots extended to 44 inches and *very fine* roots to 49 inches. This soil type and plant community could be classified as sub-irrigated.

The **dry meadow** [M(dry)] plant community had characteristics of both meadow and upland (pasture and sagebrush/grass) plant communities. Delineations of this plant community and soil type were in micro-depressions where off-site surface runoff collects and perches on deep clay horizons. The dominant vegetation consisted of upland grasses with scattered shrubs and some meadow vegetation. There were "many" roots in the upper 8 inches of the soil profile. "Common" roots extended from 8 to 18 inches. A "few" roots extended from 18 inches to 79 inches. *Coarse* roots from shrubs were limited to the upper 8 inches. *Medium* roots extended to 18 inches. *Fine* roots extended to 72 inches and *very fine* roots to 80 inches. The depth to soil mottles ranged from 6 to 58 inches with an average of 36 inches. The average soil mottle depth corresponds with depth of "common" root density. This soil type and plant community demonstrates characteristics of potential sub-irrigation in localized area, but it is of limited extent in the Coal Hollow Project area.

The **oak brush** (OB) plant community had roots that extended to 90 inches. "Many" roots were limited to the upper 3 inches. "Common" roots extended from 3 to 35 inches. A "few"

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roots extended to 91 inches. *Coarse* roots from the oak brush extended to 69 inches. *Medium* and *fine* roots extended to 78 inches. *Very fine* roots reached to 90 inches. One of two data points representing this plant community had a few soil mottles at 15 inches, but none in the other soil pit. The dominant soils and vegetation for this plant community indicate that it is not sub-irrigated.

The **pasture land** (P) plant community was dominated by introduced upland grass species. "Many" roots were limited to the upper 3 inches. "Common" roots extended from 3 to 23 inches. A "few" roots extended to 65 inches. Only one of the 16 soil data points had *coarse* roots (limited to upper the 10 inches at that soil pit). *Medium* roots extended to 18 inches. *Fine* roots extended to 46 inches. *Very fine* roots reached to 64 inches. Only seven of the 16 soil data points had any soil mottles (average 50 inches for the seven soil pits). Soil and vegetation characteristics suggest that this plant community is not sub-irrigated. Small localized areas within the pasture land community may have potential for sub-irrigation.

The **pinyon-juniper** (PJ) plant community was dominated by pinyon pine and Utah juniper. The average soil depth was 41 inches to Tropic Shale. "Common" roots were in the upper 15 inches. A "few" roots extended to 30 inches. *Coarse* roots occurred in the upper 14 inches. *Medium* roots extended to 18 inches. *Fine* roots extended to 24 inches. *Very fine* roots reached 30 inches. Soil mottles occurred in one of five pits, but were most likely the result of moisture perching in the very fine clay textures (greater than 60 percent clay). Soil and native vegetation suggest that this plant community is not sub-irrigated.

The **rabbitbrush/sagebrush** (RB/SB) plant community was limited to disturbed areas. It was of very limited extent in the Coal Hollow Project area and there was only one soil data point. This soil type and plant and soil community does not exhibit any characteristics of being sub-irrigated.

The **sagebrush/grass** (S/G) plant community was dominated by big sagebrush and upland grasses. "Many" roots were in the upper 4 inches. "Common" roots were from 4 to 18 inches. A "few" roots reached to 57 inches. *Coarse* roots were in the upper 7 inches. *Medium* roots

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extended to 17 inches. *Fine* roots extended to 34 inches. *Very fine* roots extended to 57 inches. Soil mottles occurred in only 5 of 20 soil data points (average 52 inches for the 5 soil pits). Soils and native vegetation indicate this plant community is not sub-irrigated.

5.4.3 Soil Map Units

Soil map unit 7 had characteristics of sub-irrigation (Table 6). Soil mottling was identified within one foot of the soil surface. The presence of water is usually at or near the soil surface during the spring and early summer depending on the annual precipitation. Occasional seasonal localized ponding may also occur in this map unit.

Map units 6 and 13 have localized potential for sub-irrigation depending on the soil type. Upland soils comprise 80 percent of the soil map unit. Aquic soils occurred in micro-depressions and may be the result of localized runoff water perching on top of deep clay layers.

5.4.4 Summary

Table 7 identifies the plant communities that exhibit soil and plant characteristics of sub-irrigation. Only the meadow and dry meadow plant communities exhibit characteristics of sub-irrigation in the major soil types of the associated soil map units.

5.5 Subirrigation potential (water requirements of pasture and meadow vegetation)

The areas called "pasture lands" in the Coal Hollow Project area are plant communities that have been altered to increase herbaceous cover and productivity for domestic livestock.

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Prior to pasture lands, these communities were probably native sagebrush/grass plant communities. Like the native and unaltered plant communities in the area, and because they are not irrigated, the water requirements for the pasture lands in the study area are solely dependent on the annual precipitation regime (which averages about 16 inches per year; see MRP Chapter 7, Section 724.400) and other environmental variables described below.

Native plant communities called "meadows" are also present in and adjacent to the project area. Dry meadows are located on the west side of the permit area and wetter meadows can be found on the east side. Factors that influence establishment and survival of these meadows are local climatic conditions as well as other environmental variables such as: exposure to light, soil texture, salinity and permeability, hydrologic regimes, saturation periods in the growing season, stratigraphy, topography, morphological, physiological and reproductive adaptations of the plant species present, and evapotranspiration rates. For specific onsite quantitative data and other applicable information regarding the above environmental conditions at the Coal Hollow Project area, refer to MRP Chapter 2 (soils), Chapter 3 (vegetation) and Chapter 7 (hydrology and climate).

Published information regarding water requirements of selected plant types for Alton, Utah area is presented in Table 8.

6.0 Mapping of Subirrigated Lands in Section 32, T39S, R5W

At the request of the Division, the valley areas in Section 32 T39S, R5W that are situated south of the proposed Coal Hollow Mine permit area were investigated by Dr. Patrick

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Collins of Mt. Nebo Scientific, Inc, and Mr. Robert Long, CPSS of Long Resource Consultants, Inc. on 15 August 2009. It should be noted that while the primary focus of the field investigation was to evaluate potential subirrigation areas in Section 32, T39S, R5W, the lands in the southwest corner of Section 29 T39S, R5W (which have previously been evaluated for subirrigation potential) were also revisited on the 15 August 2009 field visit. The purpose of the field investigation was to map the extent of subirrigated lands in these areas. Dr. Collins and Mr. Long did not find evidence of subirrigated lands in these areas. The conclusion that subirrigation was not present in these areas was based largely on field observations of plant species present and the soil conditions observed by digging soil auger holes. Moderately deep to deep, well-drained soils were observed in auger holes throughout these areas. Indications of soil saturation at depth were not observed. Although soil mottling was sometimes observed in the top few inches of the soils pits, mottles were uncommon at greater depths, suggesting that subirrigation was not occurring. Narrow zones of increased hydrophytic vegetation were observed in areas downslope from impounded surface waters. Soil moisture observations in areas with hydrophytic vegetation were typically slightly moist in the surface few inches and dry below the surface in the paralithic (shale) or lithic (sandstone) contacts. Weathered shale was observed on the sides of eerosion channels on the Sorensen property. Sandstone outcrops were observed near the Sorensen-Johnson property line. Based on field observations at these sites, it was determined that these zones were most likely due increased water supply to plants resulting from seepage from the surface water impoundments and not from subirrigation processes.

Based on the follow up field investigations on the "potential" subirrigated areas, the lack of this condition was also observed in an area previously mapped on Drawing 7-7 as subirrigated. This area was located near the border of Sections 29 and 30, T39S, R5W. As a result, the delineation of subirrigated areas has been correspondingly modified on Drawing 7-7.

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7.1 Flood irrigation potential (streamflow and water yield)

The potential for successful flood irrigation of lands in the Coal Hollow Project area is directly limited by the amount of water available for that use. Discharge and water quality data for waters that could potentially be utilized for flood irrigation in the Coal Hollow Project and adjacent area are presented in Table 9. Baseline monitoring data including discharge and water quality measurements for these potential sources of flood irrigation water have been submitted electronically to the Division's on-line hydrology database (UDOGM, 2008). Each of the potential surface water sources for flood irrigation in the Coal Hollow Project and adjacent area is discussed below.

7.1.1 Swapp Hollow creek

The largest source of surface water for potential flood irrigation use in the Coal Hollow Project area is from Swapp Hollow creek. Monitoring on Swapp Hollow creek has been performed at monitoring site SW-8 (see Drawing7-10 in Chapter 7 of the Coal Hollow Project MRP). Historical discharge and water quality data for Swapp Hollow creek are provided in Table 9. Discharge measurements performed at SW-8 indicate considerable seasonal and climatic variability. The long-term average instantaneous discharge in the creek as monitored at SW-8 is 55 gpm (0.12 cfs). Flow has been present during all monitoring events at SW-8. Assuming an average discharge of 55 gpm, an annual yield of 88.7 acre-feet is calculated.

Assuming an alfalfa plant evapotranspiration requirement of 27.2 inches over the irrigation season (May – early September; Table 8) and an average precipitation during the same irrigation period of about 5 inches, it was calculated that about 1.85 acre-feet per acre of alfalfa is required for the growing season. Thus, during an average year a total of about 48 acres of alfalfa could be irrigated, assuming that ***all*** of the water that flowed in the creek could successfully be applied to the irrigated crop. Similarly, the requirement for pasture irrigation is 23.31 inches in the Alton area over the irrigation season (April through September; Table 8). Thus, assuming a seasonal irrigation requirement of 1.35 acre-feet per

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acre of irrigated pasture, and assuming average precipitation occurred during the growing period, it is calculated that about 66 acres of pasture could be irrigated assuming that ***all*** of the water flowing through Swapp Hollow creek during an average year could be efficiently applied to the pasture vegetation. However, for several reasons, both of these approximations likely considerably overestimate the actual acreage that could be flood irrigated. Using a commonly used "rule-of-thumb" approximation, about 50 percent of the flood irrigation water transmitted through an earthen ditch from the point of diversion to the point of application to the crops is lost in transmission. Consequently, a more realistic estimate of the amount of flood irrigation that could be accomplished using the entire annual yield from Swapp Hollow creek is about half of that estimated above, or about 24 acres of alfalfa, or about 33 acres of pasture land using all of the average annual yield for flood irrigation. Additionally, it should be noted that groundwater and surface-water resources in the region are fully appropriated by the State of Utah. Consequently, no new water rights are available that could be used for this potential flood irrigation. Much of the water in Swapp Hollow creek is currently being used for stock watering use and would not be available for flood irrigation. Thus, the acreage that could be irrigated is likely appreciably less than that estimated above. Additionally, it should be noted that these calculations are based on the *average* annual yield from Swapp Hollow creek. The annual yield in the drainage will fluctuate year to year because of climatic variability. Because there is no excess capacity in the creek, the actual amount of land that could be flood irrigated will vary correspondingly. Such conditions are not conducive to agricultural planning and successful flood irrigation in the area.

The results of these calculations are not intended to provide specific flood irrigation requirements for crop irrigation in the Coal Hollow Project area. Rather these calculations are presented to demonstrate the very limited potential for flood irrigation in the Coal Hollow Project and adjacent area.

The other potential sources of flood irrigation waters in the Coal Hollow Project area include the Lower Robinson Creek/Dry Canyon drainage, Section 21 canyon drainage, the spring diversion in upper Water Canyon, and Sink Valley Wash. Discharge measurements from

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these waters are listed in Table 9. Additionally, while not surface-water related, spring discharge from some alluvial groundwater systems has historically provided limited quantities of water for irrigation use. None of these sources of flood irrigation water are as significant as that in Swapp Hollow creek and none of these are deemed as acceptable sources for successful flood irrigation of lands in the Coal Hollow Project area. The streamflow and water yield characteristics of these potential sources are described below.

7.1.2 Lower Robinson Creek/Dry Canyon

Discharge in the Lower Robinson Creek/Dry Canyon drainage occurs only in direct response to torrential precipitation events or substantial snowmelt. Discharge measurements from Lower Robinson Creek (below the confluence with Dry Canyon) have been performed historically at monitoring site SW-4 (see Drawing 7-10 in Chapter 7 of the Coal Hollow Project MRP). Monitoring site SW-101 is also located on this drainage. During baseline monitoring at the project area, discharge has been monitored at SW-4 only during a snowmelt event in May of 2005, which was a very wet year (Figure 4). Additionally, in direct response to a torrential thunderstorm event, surface water in the drainage at SW-101 was monitored. It should be noted that the duration of the surface flow at that time was only a few minutes. On all other monitoring events, this stream has been dry. Consequently, the Lower Robinson Creek/Dry Canyon drainage is not considered a reasonably potential source for flood irrigation activities in the Coal Hollow Project and adjacent area.

7.1.3 Section 21 canyon drainage

Discharge has not been observed in Section 21 canyon during the period of baseline monitoring (as monitored at baseline monitoring site SW-7). This drainage is not considered a reasonably potential source for flood irrigation activities in the Coal Hollow Project and adjacent area.

7.1.4 Upper Water Canyon spring diversion

Historically, water from a spring in the upper reaches of the Water Canyon drainage about two miles east of the Coal Hollow Project area has been conveyed to pond 20-1 (see Drawing 7-7 of Chapter 7 of the Coal Hollow Project MRP). Discharge is monitored in this diversion

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at site RID-1, located near the USDA Forest Service boundary above pond 29-1 (see Drawing 7-10 of Chapter 7 of the Coal Hollow Project MRP). Discharge and water quality data for this site are presented in Table 9. Discharge at RID-1 averages 21.7 gpm or 35.0 acre feet per year. As discussed above (see Swapp Hollow creek discussion), quantities of water on this scale are not sufficient to sustain appreciable flood irrigation activities in the Coal Hollow Project area.

7.1.5 Sink Valley Wash

Sink Valley Wash is monitored at site SW-6 (see Drawing 7-10 in Chapter 7 of the Coal Hollow Project MRP). Discharge data for SW-6 are presented in Table 9. It is apparent that discharge in Sink Valley Wash is not useful for subirrigation purposes in the Coal Hollow Project area. During baseline monitoring activities, flowing water has only been observed on one occasion at SW-6 during March of 2006. On this occasion, sheet floods were occurring in Sink Valley in direct response to the copious melting of snow in the valley. It is noteworthy that on this occasion the waters in the fields above SW-6 were not flowing through any discernable stream drainage. Rather the surface flow was running down the valley over a large upstream area in an unconcentrated sheet flood.

7.1.6 Alluvial groundwater spring discharges

Historically, some small-scale domestic flood irrigation (likely domestic flood irrigation of gardens for family use) of lands near the historic homestead locations has occurred using water from alluvial springs in the Coal Hollow Project and adjacent area. Currently, groundwater from spring SP-20 gravity flows from the spring discharge area to pond 29-3. At the current time, when available, water from this pond overtops the water holding pond and runs into the field below the pond and is lost to evapotranspiration. The water is used currently for stock watering, and is not used for irrigation. The discharge from alluvial spring SP-20 averages about 6 gpm. Groundwater from spring SP-8 is currently collected in a spring box and conveyed via a buried pipe to the Swapp Ranch house for domestic use. Surplus water from SP-8 is piped to a newly constructed water holding pond (pond 29-5; see drawing 7-7 of the Coal Hollow Project MRP) adjacent to the ranch house. The water in the

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pond is not currently used for irrigation. Discharge from spring SP-8 averages about 13.8 gpm, or about 22.3 acre-feet per year.

7.2 Flood irrigation potential (water quality)

Groundwater discharge data for all streams that may potentially provide surface water for flood irrigation in Sink Valley have been submitted electronically to the Division's on-line hydrology database. Discharge and water quality data for streams that could potentially be used for flood irrigation are presented in Table 9. As described above, the two streams with the greatest annual discharge, and consequently the best potential for flood irrigation use in the project area are Swapp Hollow creek and the Water Canyon spring diversion. The water quality characteristics of these two sources are described below.

7.2.1 Swapp Hollow creek

Surface water at Swapp Hollow creek is monitored at site SW-8 (see Drawing 7-10 in Chapter 7 of the Coal Hollow Project MRP). It is apparent from Figure 12 that the surface water in Swapp Hollow creek is a C2-S1 class water on the SAR – conductivity classification of irrigation water (Figure B-5, OSM, 1983). This indicates medium-salinity water. The water may be used for flood irrigation if a moderate amount of leaching occurs. The sodium hazard is low. The surface water in Swapp Hollow creek averages 311 mg/L (Table 9). Based on the dissolved-solids hazard for irrigation water (Table B-5, OSM, 1983) irrigation with this water will not usually result in detrimental effects. Using the criteria shown on Table B-6 (OSM, 1983), which considers boron, SAR, chloride, sulfate, specific conductance, and TDS levels, the Swapp Hollow water is a Class I water. This indicates excellent to good water with a low salinity hazard that is suitable for most conditions. It is suitable for irrigation of all or most plants, including salinity- and boron-sensitive species.

7.2.2 Water Canyon spring diversion

Waters in the Water Canyon spring diversion are monitored at site RID-1 (see Drawing 7-10 in Chapter 7 of the Coal Hollow Project MRP). It is apparent from Figure 12 that waters in

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the Water Canyon spring diversion are C2-S1 class waters on the SAR – conductivity classification of irrigation water (Figure B-5, OSM, 1983). This indicates medium-salinity water. The water may be used for flood irrigation if a moderate amount of leaching occurs. The sodium hazard is low. The waters in the Water Canyon spring diversion average 248 mg/L (Table 9). Based on the dissolved-solids hazard for irrigation water (Table B-5, OSM, 1983) irrigation with this water will not usually result in detrimental effects. Using the criteria shown on Table B-6 (OSM, 1983), which considers boron, SAR, chloride, sulfate, specific conductance, and TDS levels, the Water Canyon spring diversion waters are Class I waters. This indicates excellent to good water with a low salinity hazard that is suitable for most conditions. The water in this class is suitable for irrigation of all or most plants, including salinity- and boron-sensitive species.

7.2.3 Alluvial groundwater springs

A characterization of the water quality characteristics of alluvial groundwater systems from which spring discharges could potentially be used for flood irrigation (SP-20 and SP-8) is presented in Section 5.2.1 above. In that analysis, the water quality conditions at spring SP-8 were characterized. The water quality characteristics of springs SP-8 and SP-20 are similar to each other and to other springs originating in Alluvial Groundwater Discharge Area A (see Appendix 7-1 in Chapter 7 of the Coal Hollow Project MRP). Water quality data for springs and wells in the alluvial groundwater system in this area have been submitted electronically to the Division's on-line hydrology database (UDOGM, 2008).

7.3 Flood irrigation potential (soils measurements)

Information on soil characteristics in the Coal Hollow Project area are provided in Chapter 2 of the Coal Hollow Project MRP. This information includes physical and chemical properties of the soils sampled in 60 soils pits excavated and surveyed by qualified soils scientists. Also included in Chapter 2 are qualitative evaluations of prevailing soil moisture conditions in the shallow subsurface in the project area.

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7.4 Flood irrigation potential (topographic characteristics)

The topographic characteristics of the land surface in the Coal Hollow Project have been documented using high-accuracy aerial surveys. A contour map depicting this information is provided in Drawing 5-1 in Chapter 5 of the Coal Hollow Project MRP. The surface topography of the Coal Hollow Project and adjacent area is also shown on a digitally shaded USGS topographic map in Figure 1. Based on this information, it is apparent that the topographic characteristics of most lands in the project and adjacent area are compatible with flood irrigation techniques. This conclusion is based on the fact that 1) the streams entering the project area originate in upland areas with hydraulic head appreciably greater than the elevations in the project area, and 2) consequently, based on the surface topography, it is apparent that conveyance ditches could be constructed that could convey surface waters from the highland areas in the east to most locations within the project area. Areas that could not reasonably be irrigated by flood irrigation techniques include the steep, isolated hills located mostly in the western portions of the project area.

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8.1 Aerial photographs and infrared imagery

Aerial photographs of the Coal Hollow Project and adjacent area are provided in Plates 3 and 4. The late summer/fall infrared imagery has been analyzed extensively in the analysis of the valley floor in Sink Valley. The infrared imagery has been utilized by researchers in each of the various scientific disciplines and was an important investigative tool in developing the conclusions presented in this report

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Several botanical, soils and hydrologic studies prepared for this document utilized aerial photographs for their analyses. Color and infrared imageries flown at different times of the year were used for this work.

In the botanical studies, the infrared and color aerial photographs were used extensively for mapping the plant communities within and adjacent to the permit area. For preliminary mapping, the images were first used in the office. They were later utilized in the field for site-specific verifications in the "ground-truthing" process. Seasonal changes reflected in the infrared photographs were used to delineate the differences in the plant community types including the dry and wet meadows. The ground-truthing methods confirmed similarities or declared differences in the composition and structure of the vegetation and therefore helped drive the process in selecting the sample locations in areas where quantitative data were collected.

Infrared photographs were also utilized for mapping the areas where sub-irrigation was possible. Similar to mapping the plant communities described above, areas that appeared to have vigorous plant growth later in the growing season were more likely to be sub-irrigated. These areas were first delineated on a field map, followed by the ground-truthing process onsite where the plant species were identified, soil pits were dug and soil descriptions were made.

Color and infrared images were also employed in the soils studies to map contrasting soil types by identifying different vegetation types and densities. Aerial photo images were also used to identify the different vegetation types and then to determine soil pit locations. Stereo pairs of the natural color images were used to delineate areas by geomorphology and slope.

Information obtained from aerial photographs was also used extensively in various hydrological studies in the Coal Hollow Permit and adjacent areas. Analysis of color infrared images was utilized to evaluate alluvial groundwater discharge areas and to assist in the spring and seep survey in the area. Shallow groundwater flow patterns were also evaluated using color infrared imagery.

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8.2 Analysis of a series of aerial photographs

A comparative analysis of a series of aerial photographs including color infrared imagery flown at a time of year to show any late summer and fall differences between upland and valley floor vegetative growth has been performed as part of this investigation. The results of this comparative analysis are presented below.

The color infrared image presented in Plate 3 was taken during the summertime (15 July 2006) and shows conditions in the proposed Coal Hollow Mine permit and surrounding areas. The color infrared image shown in Plate 4 was taken during the fall time of year (2 November 2007) and shows approximately the same region. Both of the infrared images were produced and provided in digital format from Olympus Aerial Surveys, Inc. of Salt Lake City, Utah.

It is readily apparent when comparing Plate 3 and Plate 4 that there was considerably more vegetative growth activity (as represented by the intensity of the red colors on the infrared image) during the summertime than there was in the fall time of year. When comparing Plates 3 and 4, it is apparent that the most pronounced variability between the two seasons is apparent in the Sink Valley area. While much of this area appears red on Plate 3, a much more muted shade of grayish-red is evident in these same areas on Plate 4, suggesting a marked decrease in vegetative growth/vigor in these areas during the fall. This conclusion is consistent with field observations made in the region during the past five years. In field observations it has been noted that the overall wetness of the land surface in Sink Valley area declines markedly in the summer and fall months relative to conditions in the springtime. Vegetative growth also wanes markedly during the late summer and fall. The pronounced decline in vegetative growth in the Sink Valley area during the fall time of year suggests that, while water is available to vegetation early in the growing season, a persistent and reliable source of water is apparently not readily available to vegetation in these areas during the fall.

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Some of the decline in vegetative growth is also likely attributable to the decreased vegetative growth that naturally occurs in the fall time of the year. The upland pinyon and juniper vegetation present in areas surrounding Sink Valley shows a much lesser degree of variability in vegetative growth activity between the summer and fall (as indicated by the similar intensity of the red colors on the two infrared images). Where upland vegetation is present in other areas in the proposed permit and surrounding area, decreases in vegetative growth between the July and November images are also apparent.

In the context of a preliminary alluvial valley floor assessment, this information is useful to assist the Division in determining whether vegetation adjacent to a stream is receiving water in greater quantities or for a longer duration in the growing season than is adjacent upland vegetation. The availability of a persistent source of water to the vegetation may allow vegetative growth in plants to continue into the fall months after the early season water is gone. The noted decrease in vegetative growth in the fall suggests that water is not continuously available to plants in these areas late in the growing season. It is also apparent that some degree of vegetative growth (as indicated by the muted red-gray colors) in Sink Valley in Plate 4 is still present in the November image. Upland pinyon and juniper vegetation does not show a marked decline from summer to fall while vegetative growth in other upland vegetation species appears to decline noticeably from the summer to the fall.

9.0 Supplemental AVF Information for Adjacent Areas

In its 4 August 2008 technical review of the Coal Hollow Mine permit application, the Division of Oil, Gas and Mining suggested that alluvial valley floors are present to the west of the permit area along Kanab Creek, and to the south of the area in lower Sink Valley Wash. Supplemental information is provided in this section to assist the Division in making a determination regarding the presence or absence of alluvial valley floors in these areas. The supplemental information for the Kanab Creek and lower Sink Valley Wash probable AVF areas are presented separately below.

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9.1 Kanab Creek probable AVF area

9.1.1 Mapping the extent of probable AVF

An area of probable alluvial valley floor has been delineated in the Kanab Creek drainage west of the Coal Hollow Mine permit area as shown in Plate 5. The probable AVF encompasses portions of Section 24, 25, 26, 35, and 36, T39S, R6W. The area consists predominantly of relatively flat fields situated on benches adjacent to Kanab Creek. The land has been used historically for hay production and for cattle grazing. Irrigation of these lands is performed exclusively using surface water diverted from Kanab Creek. The water is diverted from the creek into ditches that convey water into irrigation holding ponds as shown on Plate 5. Water from the ponds is conveyed to the fields and applied using sub-ditches, berms, and dikes (not shown on Plate 5).

In reconnaissance-level surveys of the alluvial sediments in the Kanab Creek stream banks adjacent to the probable AVF, stream channel deposits have been identified. The lateral extents of the stream channel deposits in the subsurface in locations further away from the Kanab Creek stream channel are not known. The land surface in the area has the appearance of containing flood plains and terraces. Subirrigation of the flood-irrigated fields is not readily apparent.

9.1.2 Land productivity

Based on vegetative investigations and conversations with landowners and land managers in the Kanab Creek probable AVF area, productivity information for the Kanab Creek probable AVF area lands are provided here. The landowners and managers contacted include Mrs. Lorene Lamb, Mr. Brigham Johnson, and Mr. Brian Lamb.

The agricultural fields in the Kanab Creek probable AVF area are currently used primarily for livestock grazing (personal communications, Brigham Johnson, Brian Lamb, 2008). The lands are irrigated when sufficient water for irrigation activities is available in Kanab Creek. Typically, water for irrigation has been available in the spring and early summer only. Historically, alfalfa and grass hay has been produced on these lands. However, no hay

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production has occurred in the Kanab Creek probable AVF in the past seven years because there has not been sufficient water for irrigation (personal communication, Brigham Johnson and Brian Lamb, 2008). Mr. Johnson and Mr. Lamb both indicated their belief that the decrease in water availability in Kanab Creek is largely because of changes in the irrigation practices of upstream Kanab Creek water users. They suggested that much of the water that previously flowed to their Kanab Creek diversions during the irrigation season was derived from flood irrigation return flows from upstream irrigated lands. When the upstream irrigated lands transitioned from flood irrigation to sprinkler irrigation techniques, the irrigation return flows were diminished. Consequently, because of the inadequate water supply currently available for irrigation, hay production and cutting is not occurring presently.

When the lands in the Kanab Creek probable AVF were utilized for hay production, the quantity of hay produced on the lands was largely a function of the water availability in Kanab Creek. Mr. Johnson indicated that in the approximately 100 acre hay field he worked in the northern portion of the Kanab Creek probable AVF area, a crop of approximately 75 tons was produced in the single cutting. This equates with a production of 1,500 pounds per acre for the early season alfalfa. For the fields of the southern portion of the probable AVF, Mr. Lamb provided a rough estimate of production at about 94 to 113 tons per cutting on fields of roughly similar size. This equates with a production of approximately 1,880 to 2,260 pounds per acre, which is a somewhat higher estimate than that provided for the northern field. Mr. Lamb also indicated that they were sometimes able to get two hay cuttings per year during wet years when adequate water in Kanab Creek was available for irrigation. During the years that hay cutting was occurring on these lands, the fields were commonly also used as pastures for livestock grazing for part of the year after the hay crop was harvested. Production from the pasture lands during the growing season after the hay cutting had occurred may have yielded perhaps an additional 800 to 1,000 pounds per acre (personal communication, Patrick Collins, 2008). It should be noted that the estimates of hay production by both Mr. Johnson and Mr. Lamb were based on recollection from memory and should be considered as approximate values.

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In recent years, when sufficient soil moisture for hay production was unavailable through normal precipitation patterns, the fields were irrigated to increase the vegetative production of the pasture land, which is currently dominated by pasture grasses. In dryer years, lesser or no irrigation of the pastures has occurred. Productivity information for various vegetative types in the Coal Hollow Project area is provided in Section 321.200, Table 3-34 of the Coal Hollow Mine MRP. As indicated in Table 3-34, the productivity of unirrigated pasture in the area is about 1,100 pounds per acre. The productivity of pasture lands with limited irrigation in the area is probably about 2,100 pounds per acre (personal communication, Patrick Collins, 2008).

9.1.3 Potential for impacts to the Kanab Creek probable AVF

Proposed mining and reclamation activities at the Coal Hollow Mine will not cause or present and unacceptable risk of causing material damage to the quantity or quality of surface or groundwater that supplies the lower Sink Valley Wash probable AVF.

The water source for the Kanab Creek probable AVF is surface water from Kanab Creek. As described in the Coal Hollow Mine MRP, the Kanab Creek stream channel and adjacent valley bottom will not be disturbed by mining and reclamation activities at the proposed Coal Hollow Mine. The recharge areas for Kanab Creek are located considerable distances upstream of the mining area and will likewise not be disturbed or impacted by mining-related activities at the Coal Hollow Mine. Consequently, the potential for mining and reclamation activities to cause material damage to the quantity or quality of the water supply for the Kanab Creek probable AVF is essentially nonexistent.

It should be noted that there are no irrigation diversions from Lower Robinson Creek to the Kanab Creek probable AVF and water from Lower Robinson Creek is not a supply to the probable AVF. The discharge in Lower Sink Valley (as monitored at site SW-5; DOGM 2007) is usually meager and not sufficient for appreciable irrigation of the lands in the Kanab

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Creek probable AVF. Appreciable discharge in the drainage occurs only during the snowmelt event and in direct response to torrential rainfall events. As indicated in the statement of probable hydrologic consequences for the Coal Hollow Mine (see section 728 of Chapter 7 of the Coal Hollow Mine MRP) adverse impacts to groundwater or surface water availability and to water quality in the Lower Robinson Creek drainage are considered unlikely.

The rate at which alluvial groundwater will be intercepted by the proposed Coal Hollow Mine will be variable by location and time in permit area. Because of the heterogeneity inherent in most alluvial deposits, the quantifying of precise aquifer parameters in the various mining areas is not straightforward. Additionally, the geometry of the mine openings including the horizontal lengths and heights of mine pit faces adjacent to saturated groundwater systems that are exposed at any point in time are dynamic variables in the surface mining environment. Consequently, precise quantifications of mine groundwater interception rates are not readily obtainable. However, using the estimated mine pit groundwater inflow rates presented as discharge per linear foot of open pit in Table 7-9 of Chapter 7 of the Coal Hollow Mine MRP, it is considered likely that mine interception will be on the order of a few tens of gallons per minute in dry areas and at times when open pit sizes are small, to several hundred gallons per minute in wetter areas and at times when the open pit size is large. It is important to note that inflows into individual pit areas will be short lived, as the individual pits will commonly remain open for a few weeks to a few months.

As described above, the quantity of water currently used for flood irrigation in the Kanab Creek probable AVF area is highly variable. During wet years, several applications of flood irrigation water may be applied to all or portions of the irrigated fields. During dry years, little or no irrigation of the lands may occur. As an order of magnitude estimate, using the monthly water requirements for alfalfa and pasture lands in the Alton area in Table 8, it is calculated that to fully irrigate 200 acres of land for pasture or alfalfa would require about 305 and 370 acre-feet of irrigation water per year for pasture and alfalfa production, respectively (assuming a typical precipitation during the growing season of 5 inches). This

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equates with an average continuous usage of about 190 and 240 gpm for pasture land and alfalfa land, respectively (averaged over the entire year). This approximation represents a maximum usage when all lands are irrigated and ample irrigation water is present. When water availability is lower, the amount of water usage will, accordingly, be lower and less acreage could be irrigated or fewer irrigation applications could be applied.

It is important to note that the above provided estimates of water usage at the Kanab Creek probable AVF represent water diverted exclusively from Kanab Creek. None of the water utilized for irrigation of the Kanab Creek probable AVF area is derived from or transits through the proposed Coal Hollow Mine permit area.

9.2 Lower Sink Valley Wash probable AVF area

9.2.1 Mapping the extent of probable AVF

An area of probable alluvial valley floor has been delineated in the lower Sink Valley Wash area south of the Coal Hollow Mine permit area as shown in Plate 5. The mapped probable AVF encompasses portions of Sections 5 and 6, T40S, R5W. Similar valley features extend further down Sink Valley Wash below the area delineated in Plate 5, but these are not evaluated herein. The land in the lower Sink Valley Wash probable AVF area consists predominantly of relatively flat or gently sloping lands situated on a bench adjacent to the deeply incised (>20 feet) lower Sink Valley Wash stream channel (Plate 5). The land surface in the lower Sink Valley Wash probable AVF area is vegetated mostly with grasses and sagebrush. It was apparent in field reconnaissance that the land in this area has been used primarily for livestock grazing on undeveloped range land. There was no indication that flood irrigation or appreciable crop production has occurred in this area in the recent past. The Sink Valley Wash stream channel in this area is incised by more than 20 feet below the surrounding land surface. Surface-water monitoring at site SW-9 on Sink Valley Wash within the probable AVF area indicates the scarcity of water in the drainage. On only two of the 17 monitoring events at SW-9 from June 2005 to August 2008 was any water present in the drainage (see UDOGM hydrology database, 2008). During March 2006, a flow of 10.6 gpm was measured. During March 2008, a flow of 182 gpm was measured.

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In reconnaissance-level surveys of the alluvial sediments in the lower Sink Valley Wash steam banks adjacent to the probable AVF, stream channel deposits have been identified. The lateral extents of the stream channel deposits in the subsurface at locations further away from the Sink Valley Wash stream channel are not known. The land surface in the area has the appearance of containing flood plains.

It is notable that there is a marked change in the geomorphology of the alluvial sediments in lower Sink Valley Wash that occurs near the County Road 136 crossing of Sink Valley Wash in Section 5, T40S, R5W (Plate 5). The Sink Valley Wash canyon bottom above the county road crossing is characterized by a narrow-bottomed valley with only a minor associated alluvial system and discontinuous stream channels. Below the county road crossing, the channel widens significantly, a flood plain becomes apparent, and stream channel deposits are visible in stream banks.

The area designated as probable AVF in lower Sink Valley Wash on Plate 5 is so designated based on several observed valley characteristics that are consist with the definition of probable alluvial valley floors. Namely, 1) it is a topographic valley holding a continuous stream channel, 2) there is the probable existence of stream laid deposits in the subsurface, and 3) the land area appears capable of being flood irrigated based on topography. However, the absence of any reasonable source of water that could be used to irrigate the valley floor or used for subirrigation seems to limit its potential for current or future agricultural activity.

9.2.2 Land Productivity

The land surface in the lower Sink Valley Wash AVF area is dominated by sagebrush and grass vegetation. Under normal conditions, the annual biomass productivity of the lower Sink Valley bottomlands that are dominated by basin big sagebrush, rubber rabbitbrush plant communities and have loamy soils have been estimated at 1,500 pounds per acre (USDA, 1990).

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9.2.3 Potential for impacts to the lower Sink Valley Wash probable AVF

Proposed mining and reclamation activities will not cause or present any unacceptable risk of causing material damage to the quantity or quality of surface or groundwater that supplies the lower Sink Valley Wash probable AVF. Currently, there is no reasonably dependable water source for irrigation or subirrigation activities at the lower Sink Valley Wash probable AVF. Because there is no appreciable baseflow discharge component to the wash, the limited water that is available periodically is derived from rainfall or snowmelt runoff water. The potential for adverse impacts to water quantity or water quality in the lower Sink Valley Wash area as a result of mining and reclamation activities at the Coal Hollow Mine is considered very low (see section 728.334 of the Coal Hollow Mine MRP).

The volume of water currently used in the lower Sink Valley probable AVF for irrigation or subirrigation is zero. As described above, there is very little water available in the drainage that could potentially be used for irrigation.

The proposed mining and reclamation activities will not discontinue or preclude farming at the lower Sink Valley Wash probable AVF. Currently, no farming operations are present in this probable AVF. No irrigation of the lands in the lower Sink Valley probably AVF is presently occurring, nor is subirrigation of these lands apparent. As stated above, adverse impacts to water quantity or quality in lower Sink Valley Wash are not anticipated. Consequently, the potential for discontinuing or precluding farming at the lower Sink Valley Wash probable AVF is considered remote.

As discussed in Section 8.1.3 above, the rate of interception of alluvial groundwater by the Coal Hollow Mine is anticipated to be on the order of a few tens of gallons per minute in dry portions of the mine and when the exposed mine pit area is small, to several hundreds of gallons per minute in wet areas and when the exposed pit areas are large. Based on reconnaissance investigations in the lower Sink Valley Wash probable AVF area, there appears to have been no water utilized there for irrigation in the recent past.

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10.0Seasonal Variability and Depth to Water Information

As requested by the Division, additional information regarding seasonal variability in groundwater systems in the Coal Hollow Mine permit and surrounding areas is provided herein. A map showing contoured values of seasonal variation in wells in the alluvial groundwater systems is provided as Figure 14. A map showing contoured values of typical depths to groundwater below the land surface in alluvial wells in the permit and surrounding area is provided as Figure 13.

11.0 Deep Alluvial Groundwater Discharge

Monitoring well SS-75 is located on the southern permit boundary of the proposed Coal Hollow Mine permit area (see Drawing 7-2 in the Coal Hollow Mine MRP). Alluvial wells SS-15 and SS-30 are also located at this approximate surface location. Well SS-75 is approximately 75 feet deep and is screened from 54 to 74 feet below the ground surface (See Table 7-2 in the Coal Hollow Mine MRP) in a zone likely influenced by burned, oxidized, or eroded coal. A zone of burned or eroded coal has been mapped in the south-central portion of Sink Valley (see Figure 8 in Appendix 7-1 of the Coal Hollow Mine MRP). The exact discharge locations for groundwaters in the burned or eroded coal zone have not been identified. However, it is likely that groundwaters from this groundwater system discharge in the southern end of Sink Valley where the burned or eroded coal zone intersects the ground surface as seeps, springs, or diffuse seepage to the surface.

12.0 Potential Recharge to Alluvial Groundwater Systems Through the Colluvium

Recharge to the alluvial groundwater systems in Sink Valley likely occurs primarily from mountain-front recharge mechanisms along the base of the adjacent Paunsagunt Plateau escarpment. Mountain-front recharge is generally understood to include infiltration of

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meteoric water from ephemeral and perennial streams into the coarse-grained sediments that are commonly present along the bases of mountain ranges. Discharge from bedrock groundwater systems in the mountain block to the adjacent alluvial sediments may also contribute to mountain-front recharge. Accordingly, it is likely that most of the recharge to the Sink Valley alluvial groundwater systems occurs adjacent to the mountainous areas to the north and east of the proposed mine permit area. Field observations of the unconsolidated sediments in these areas indicate the abundant presence of coarse-grained sediments.

Fine-grained, clayey sediments dominate the near-surface sediments in Sink Valley in the proposed Coal Hollow Mine permit and adjacent area. In Sink Valley east of the proposed permit area, these low-permeability sediments form a confining layer that creates flowing artesian conditions in the deeper alluvial sediments. Consequently, groundwater flow conditions in these sediments are likely dominated by horizontal flow occurring preferentially through laterally continuous zones of increased permeability. The pervasiveness of the near-surface low-permeability sediments in these areas likely also limits the potential for appreciable groundwater recharge to the alluvial systems through downward vertical migration through any saturated colluvial sediments along the surrounding low-lying hillsides. Consequently, the potential for appreciable recharge to the deeper alluvial groundwater systems through percolation from adjacent colluvial sediments is likely not substantial, although the local infiltration of torrential precipitation and snowmelt waters likely contributes to near-surface soil moisture and localized perched alluvial groundwater systems.

13.0 Discharge and water-level variability in early part of Y-61 pump test.

Water level and discharge data were collected from monitoring wells and springs in the proposed Coal Hollow Mine permit and adjacent area in conjunction with the pumping test of well Y-61 in January 2007. These measurements were performed prior to the commencement of pumping, during the 28-hour pumping period, and during the well

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recovery period. It should be noted that the pump test was performed during wintertime conditions with appreciable snow cover in January of 2007. Water level and spring discharge measurements were performed during both daylight and nighttime hours with nighttime air temperatures dipping to near 0 degrees Fahrenheit during the data collection period.

Discharge measured at SP-8 immediately prior to and during the first four hours of the pump test ranged from 19.25 to 19.78 gallons per minute. Although it is possible that other factors are responsible for this modest (2.7%) discharge variability early in the pump test, it is considered most likely that the observed differences in the measured discharge rates are a reflection of the inherent error of the measurement technique (time-to-fill in a calibrated container), particularly as performed under the less-than-ideal field conditions.

Water levels in monitoring wells SS-30 and C2-40 varied somewhat in the time period prior to and during the first approximately four hours of the pump test. Depth to water measurements in well SS-30 ranged from 2.77 to 2.81 feet during this period, which represents a difference of 0.04 feet, or about ½ inch. Similarly, depth to water measurements in well C2-40 ranged from 8.32 to 8.34 feet during this period, which represents a difference of 0.02 feet, or about ¼ inch. While the variability in the measured water levels may be reflective of other factors, it is considered likely that these small fluctuations are primarily reflective of the inherent error associated with the measurement technique, particularly in the less-than-ideal field conditions.

14.0 References Cited

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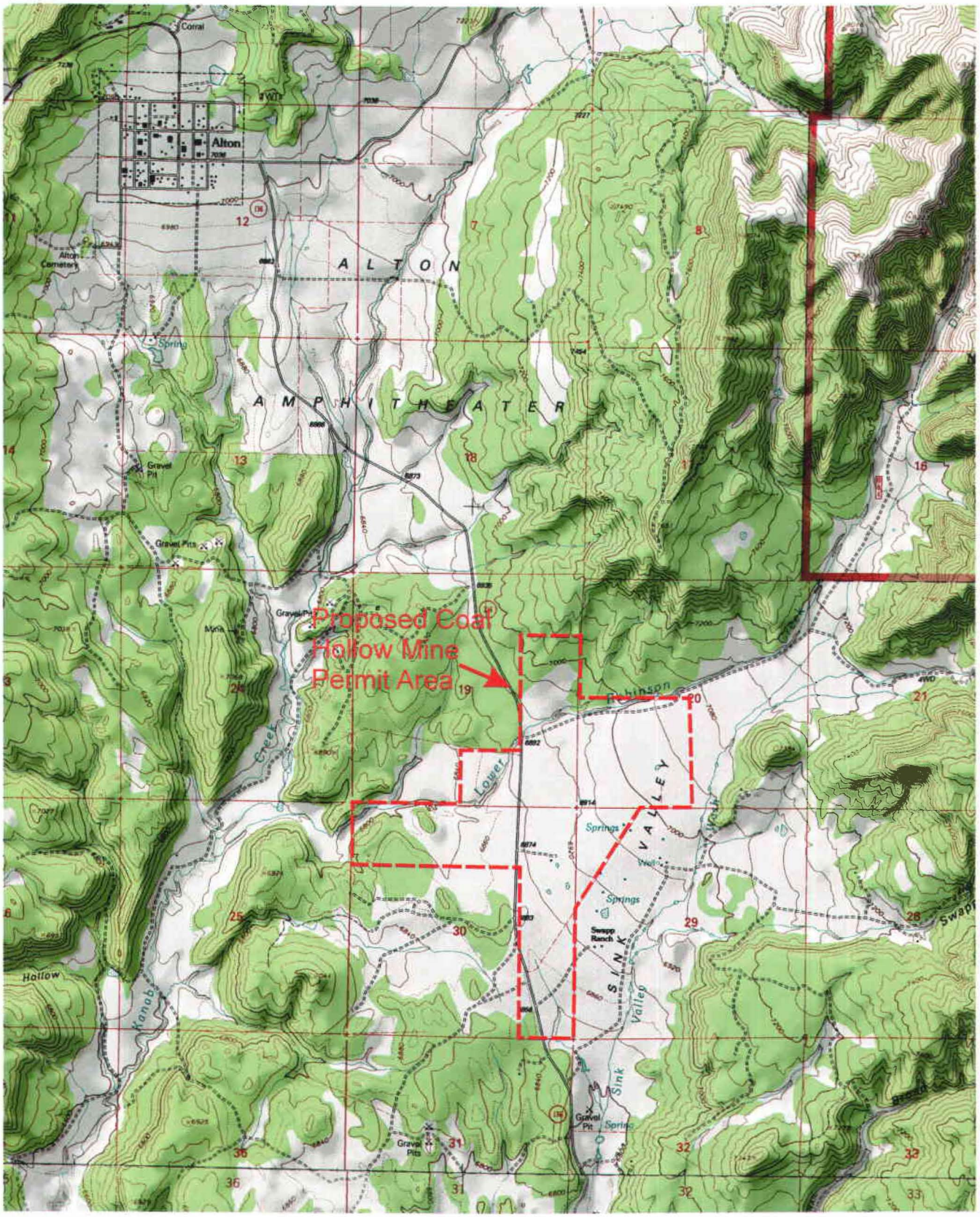

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Figure 1 Location map of proposed Coal Hollow Mine permit and adjacent area and the town of Alton, Utah.

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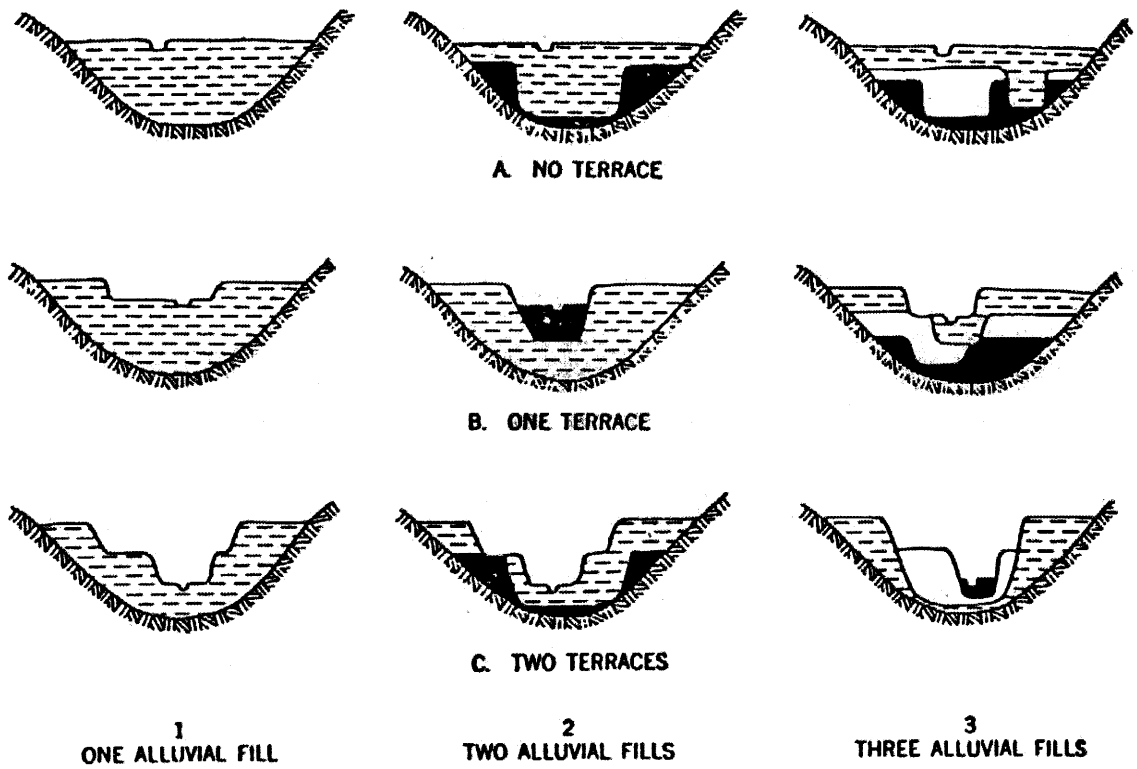

Figure 2 Examples of valley cross-sctions showing some possible relations in valley alluvium (from OSM, 1983).

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Figure 3

Depth to groundwater hydrographs for alluvial piezometers for 2007.

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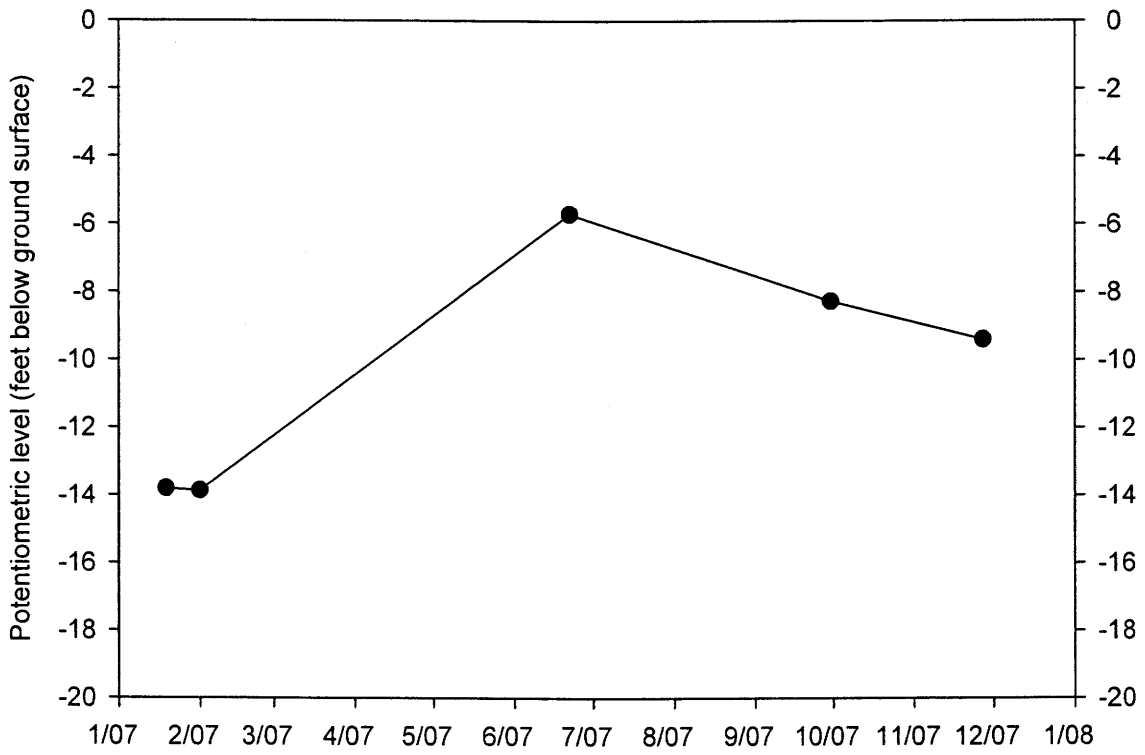

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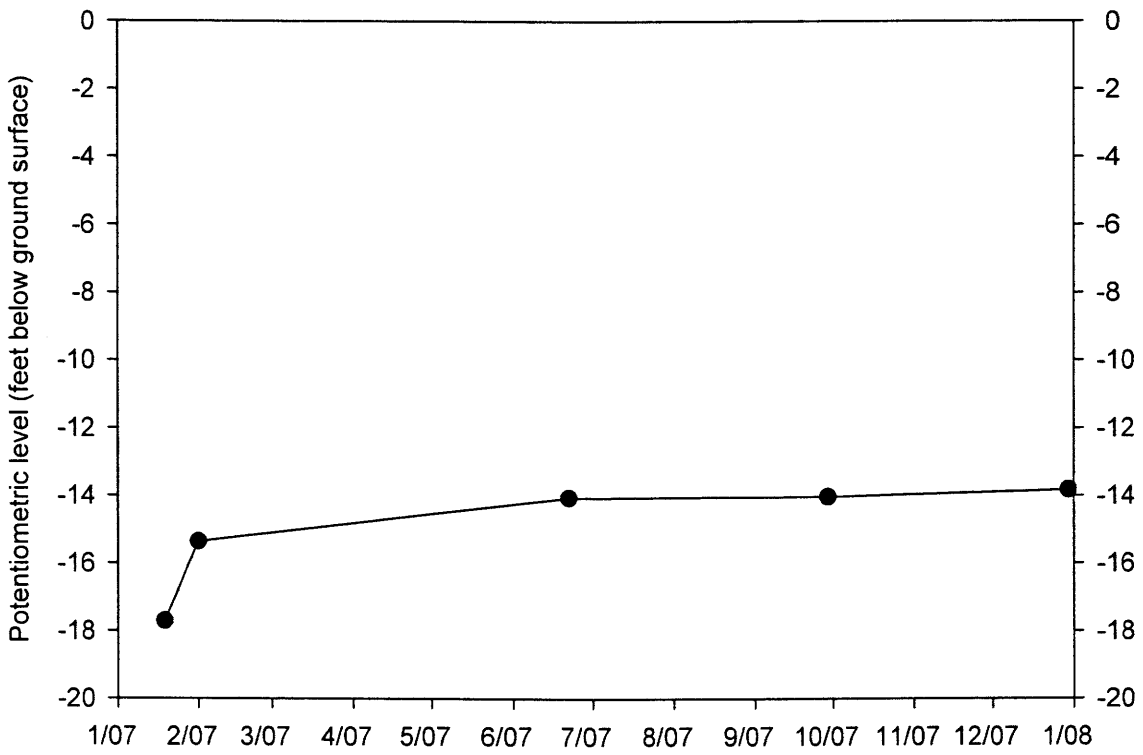

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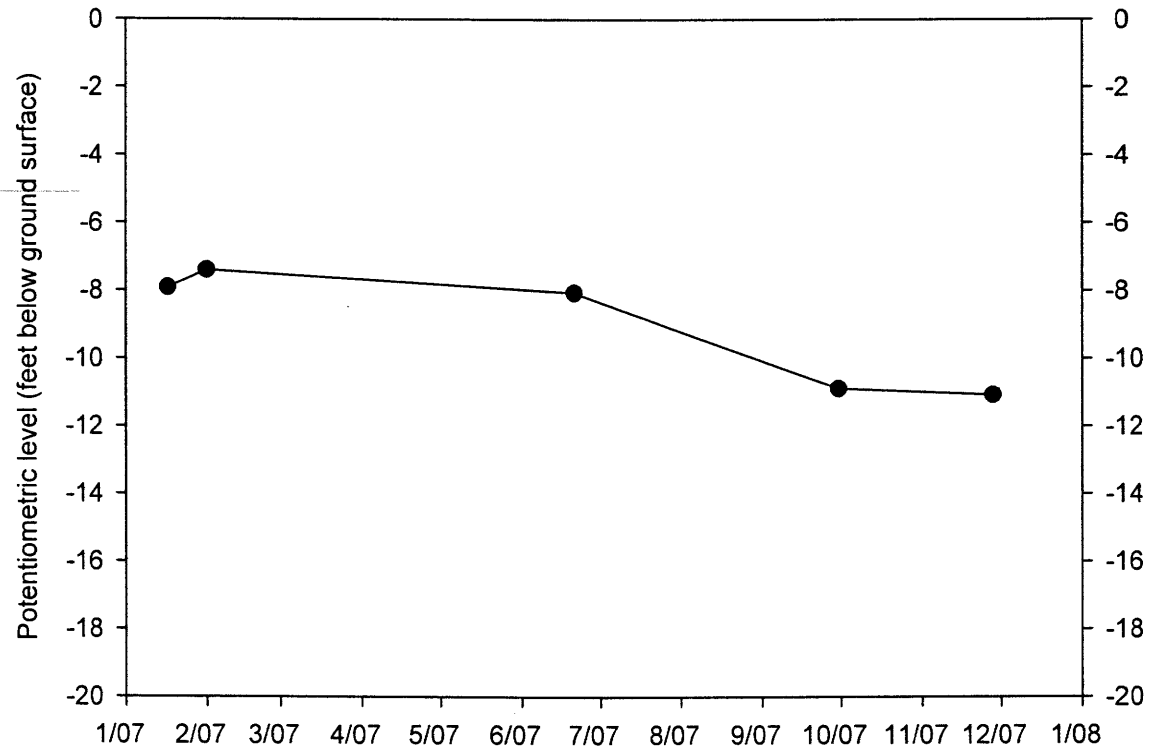

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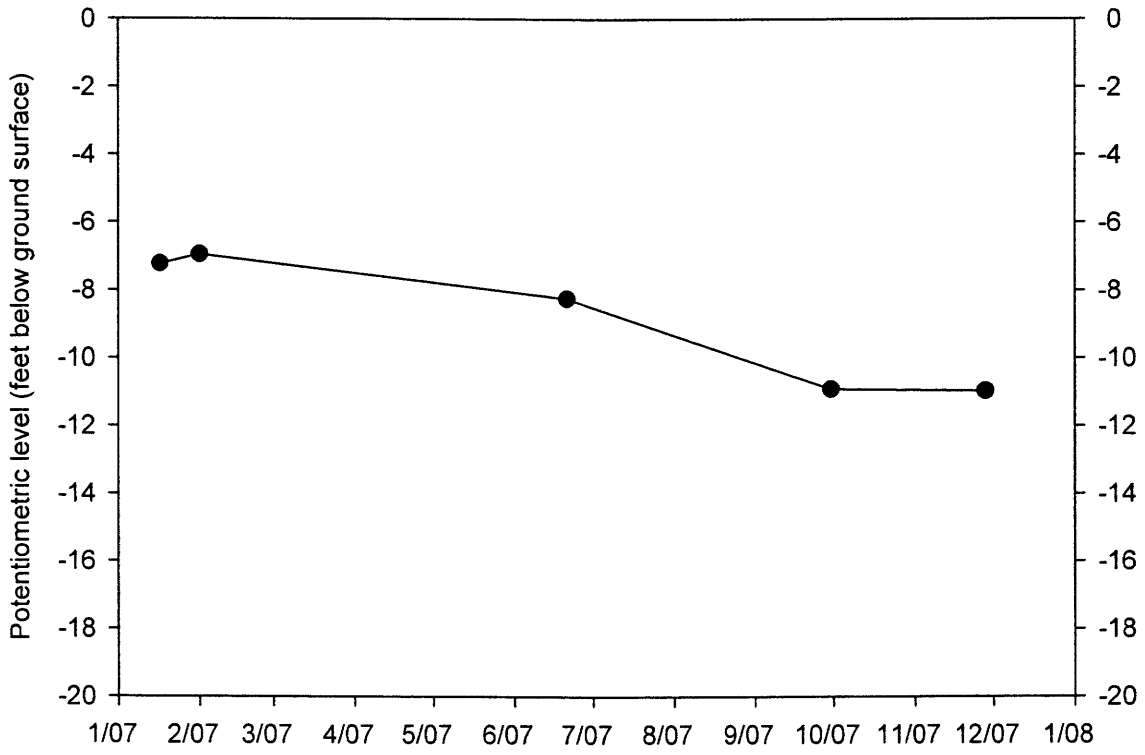

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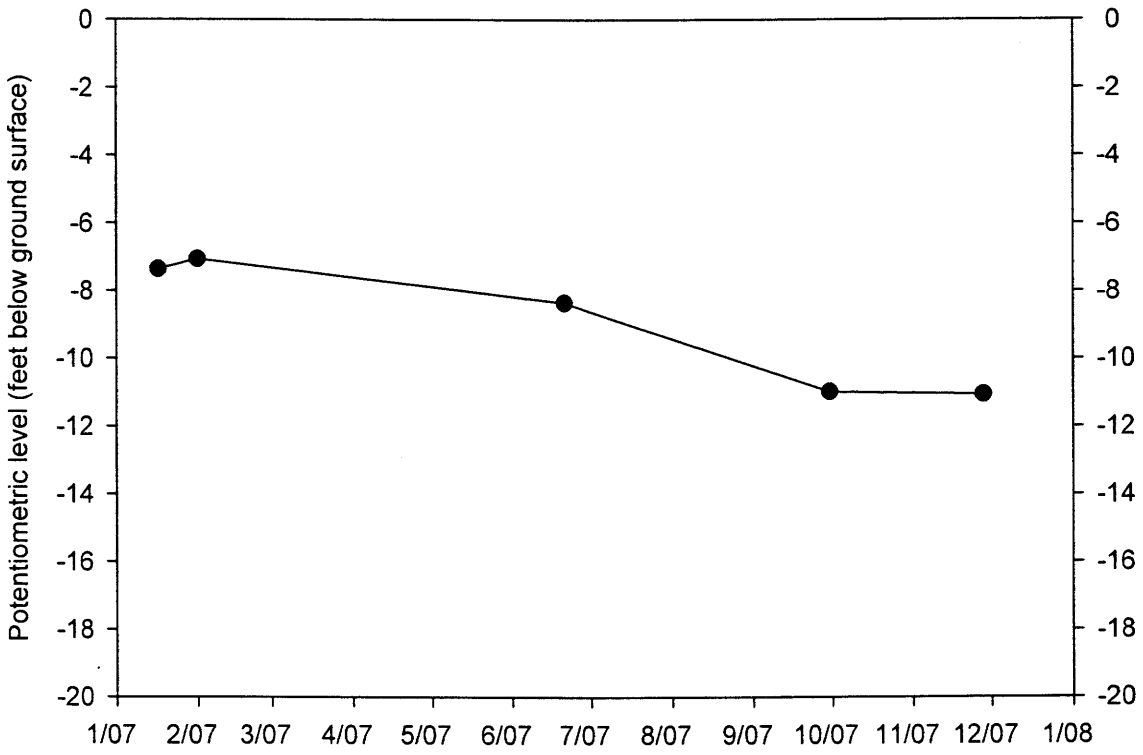

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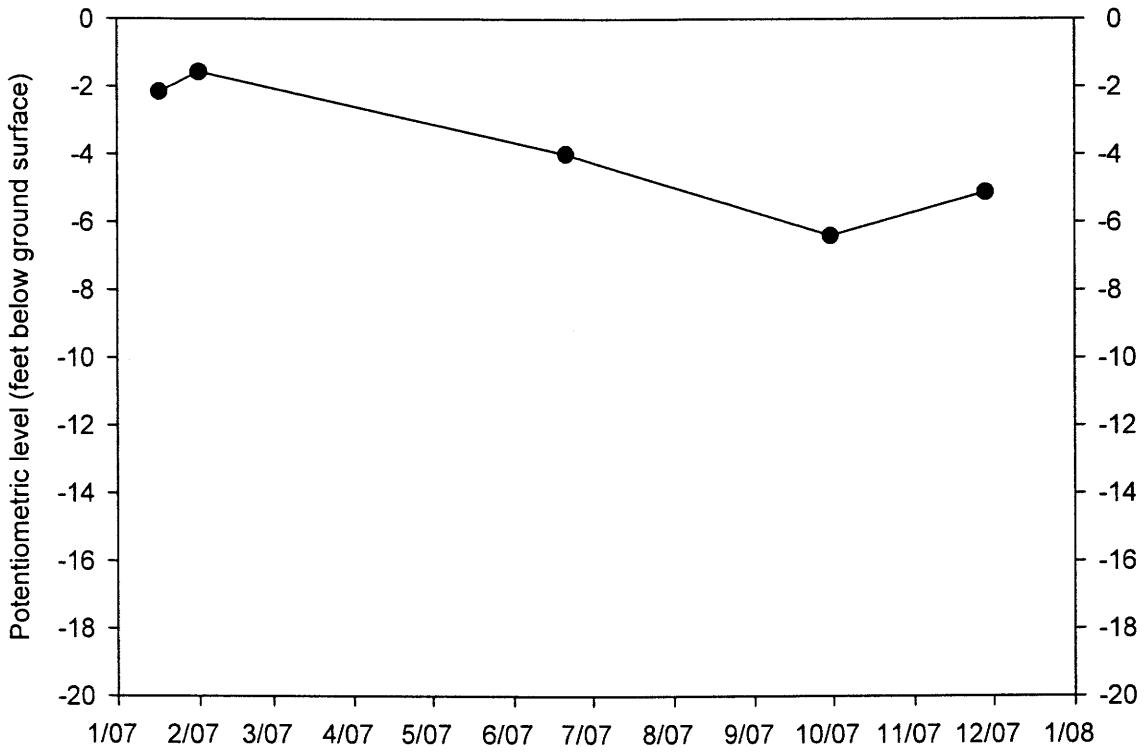

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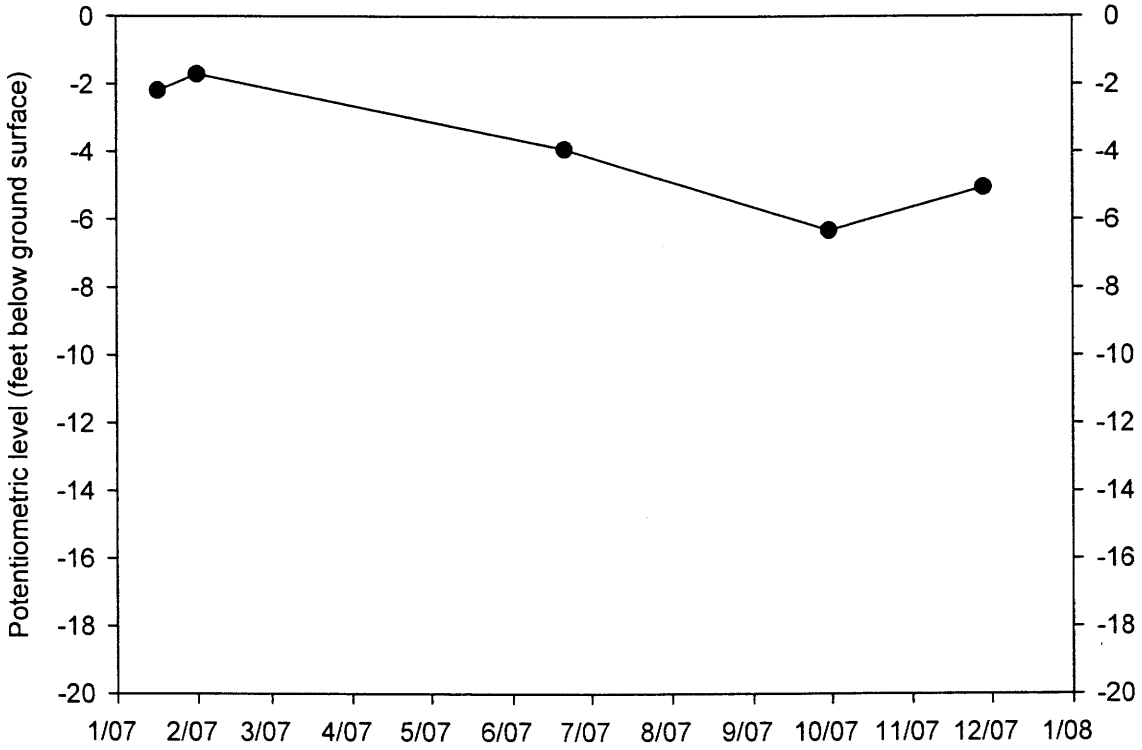

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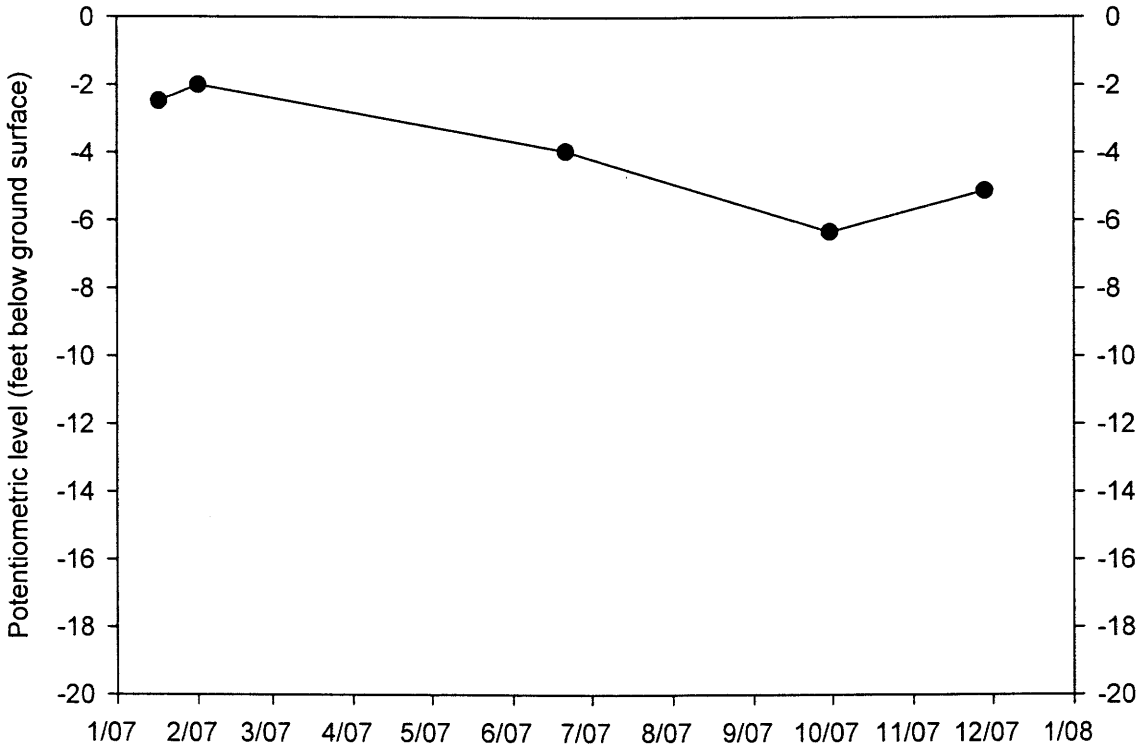

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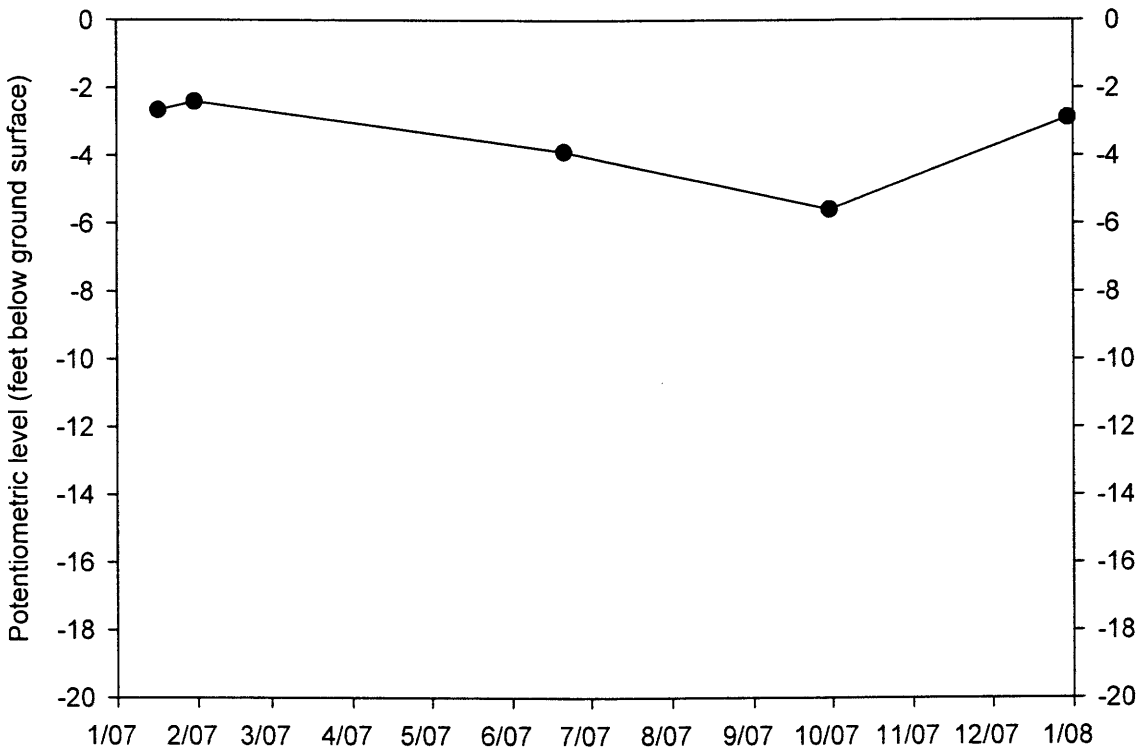

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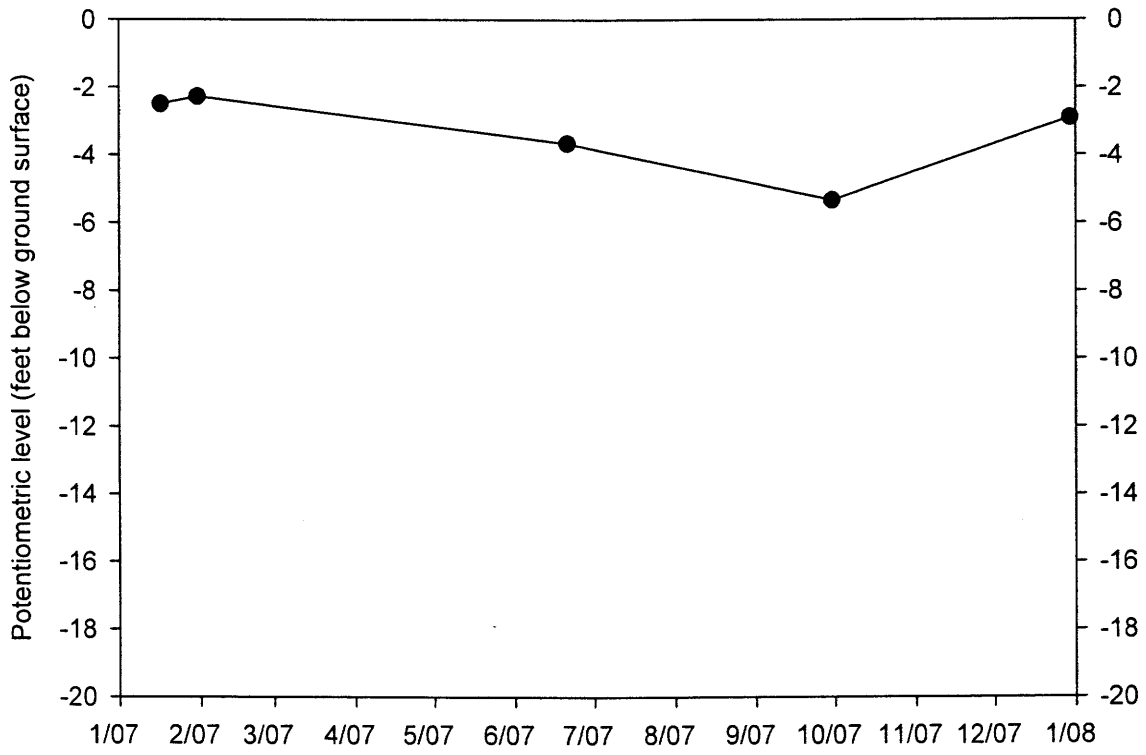

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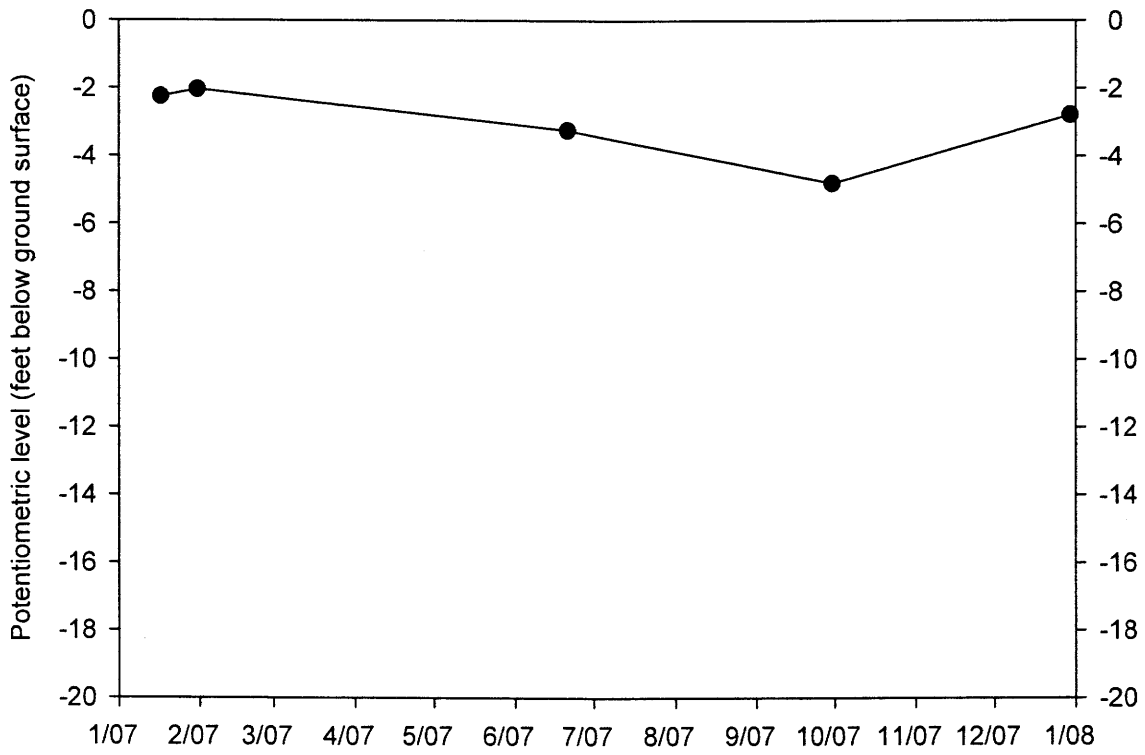

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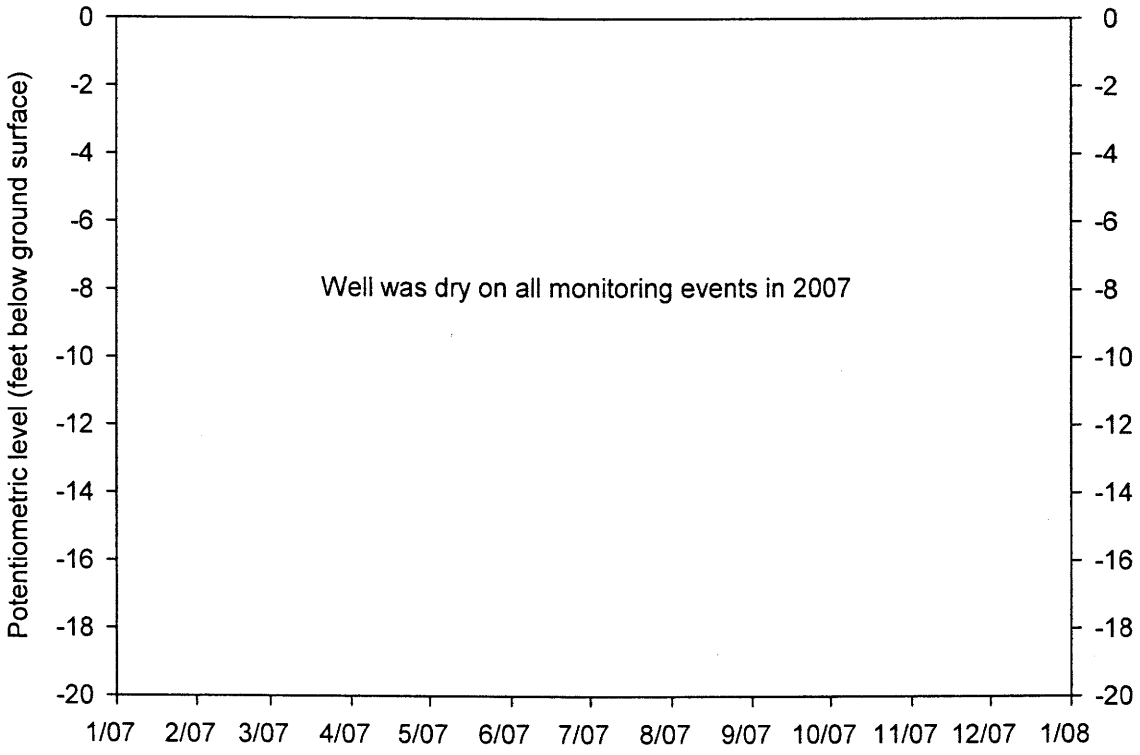
C6-15



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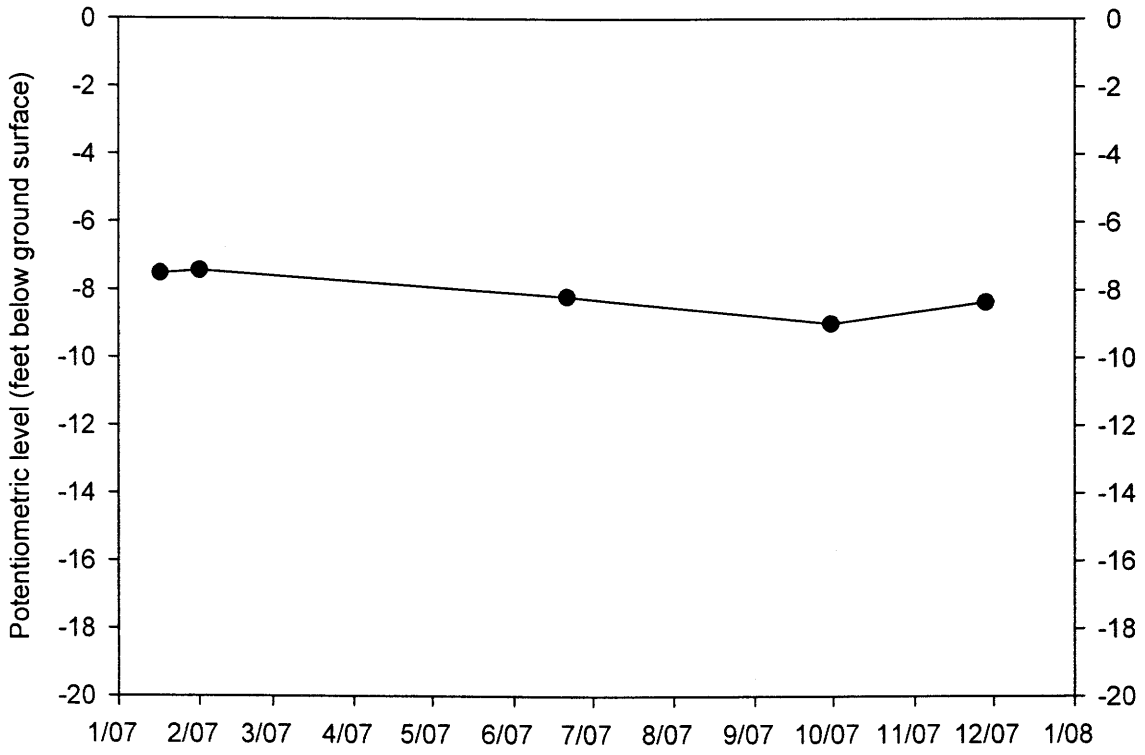

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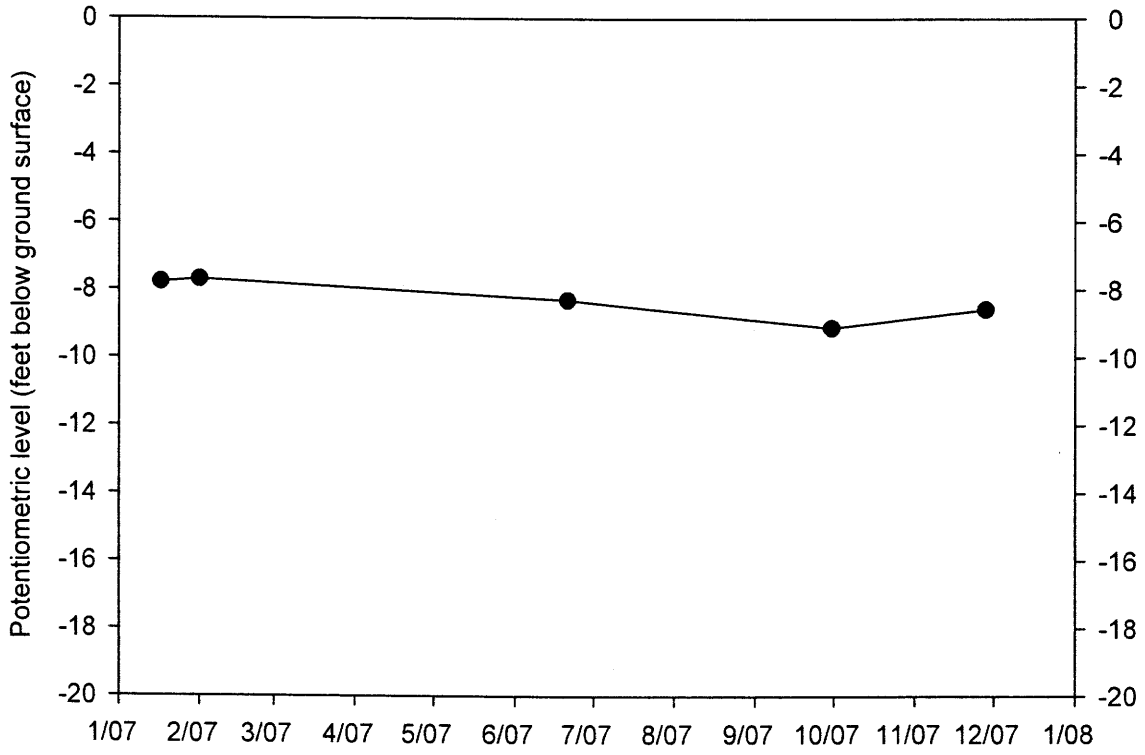

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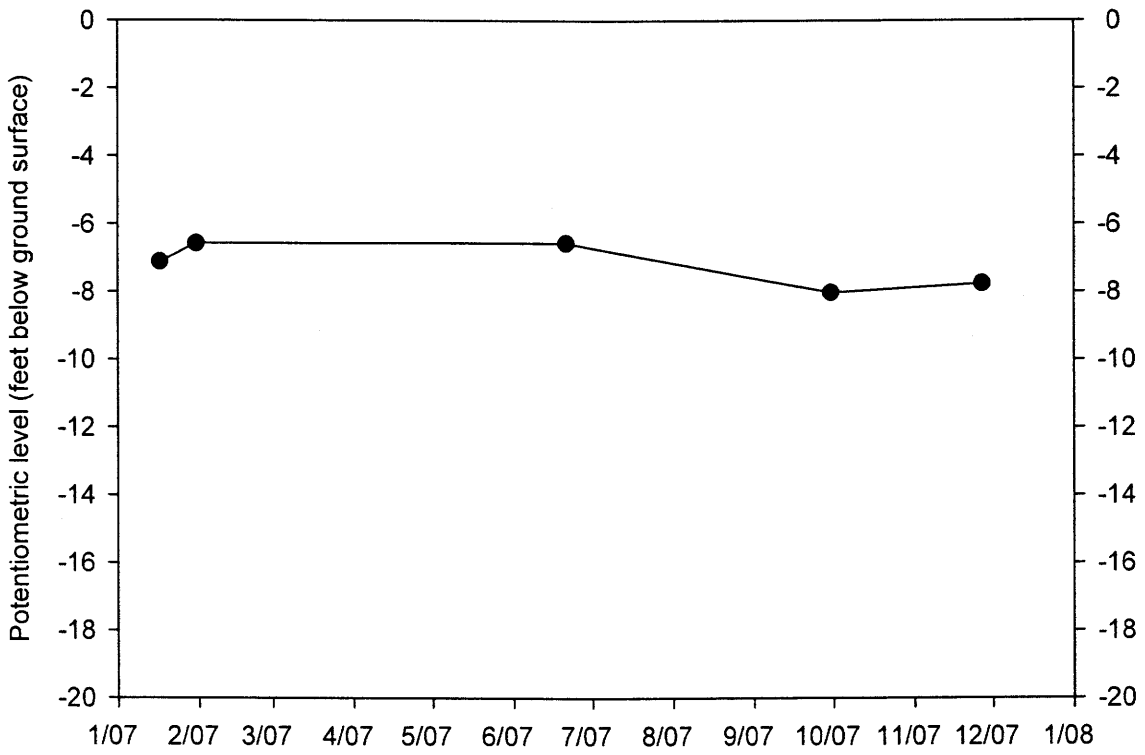

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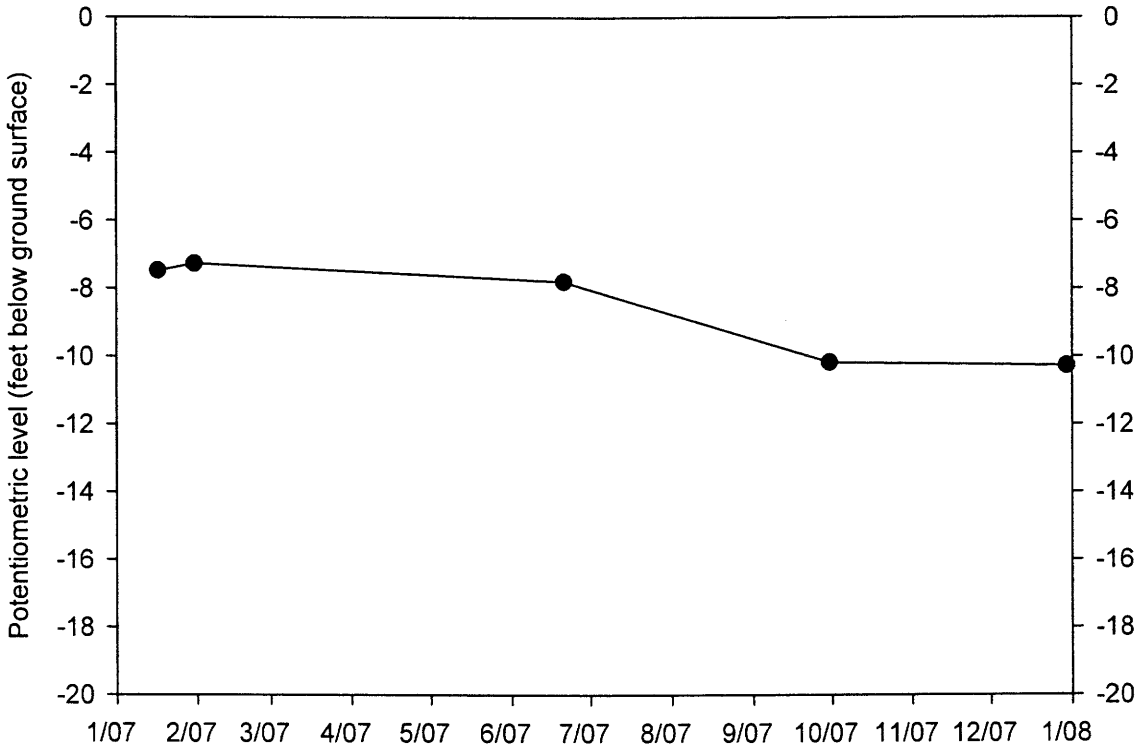

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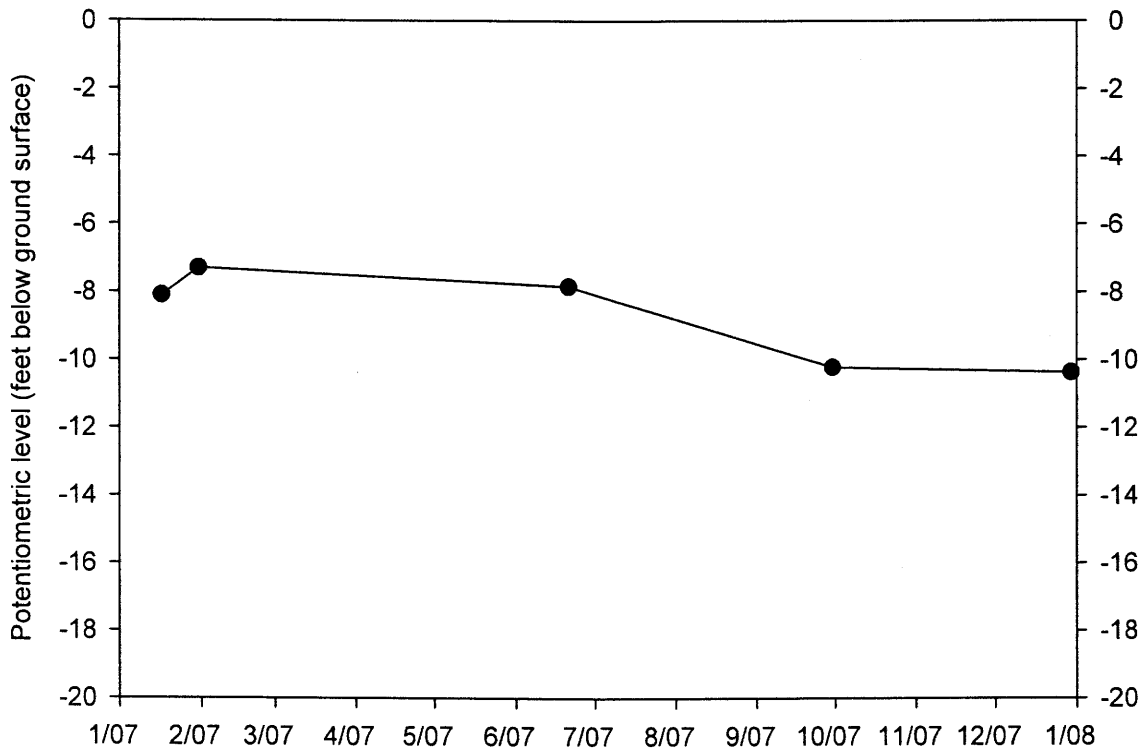

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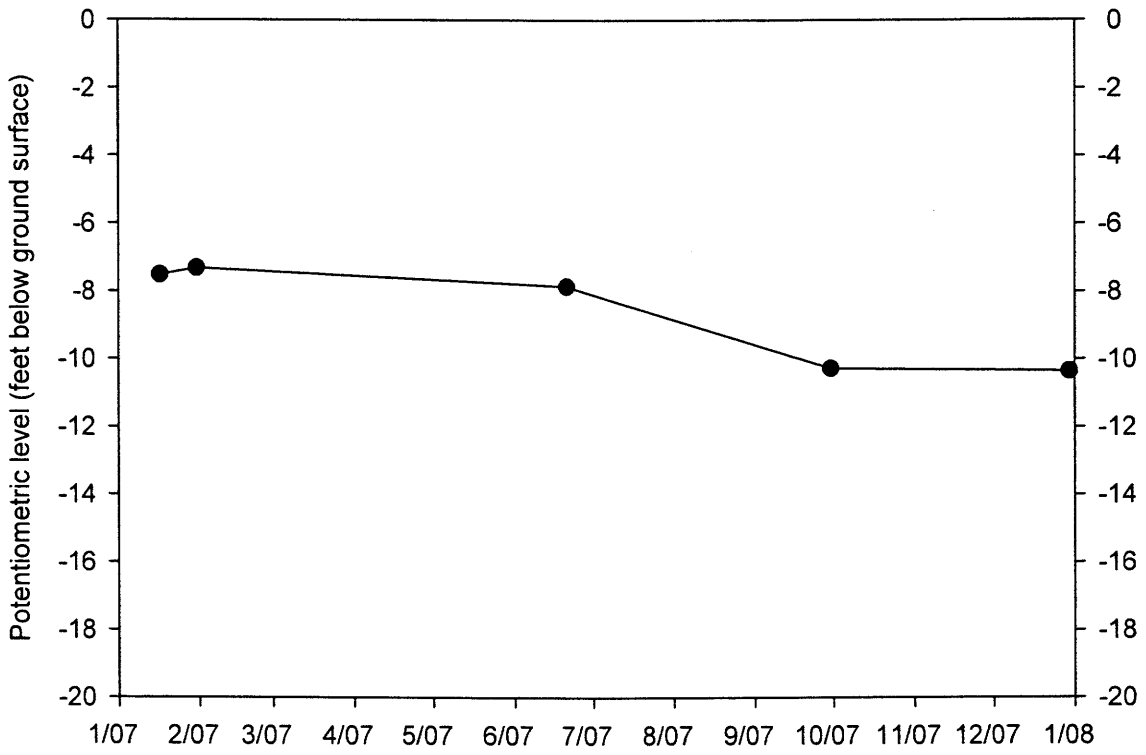
C9-40



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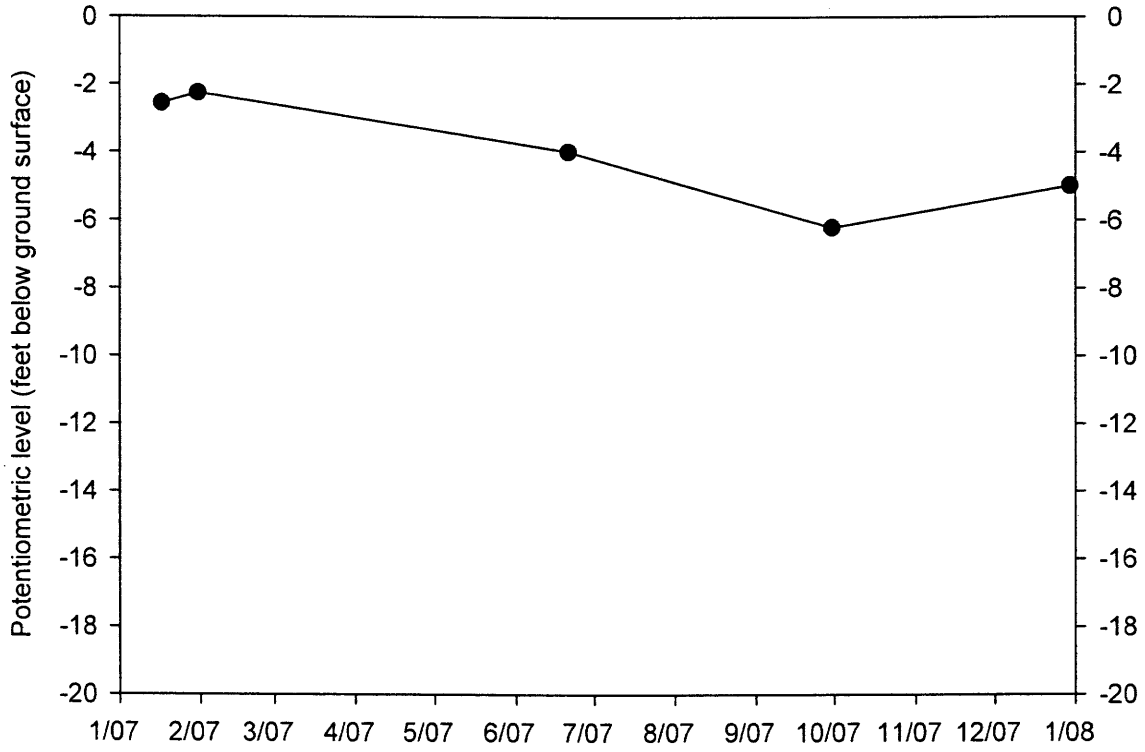
SS-15



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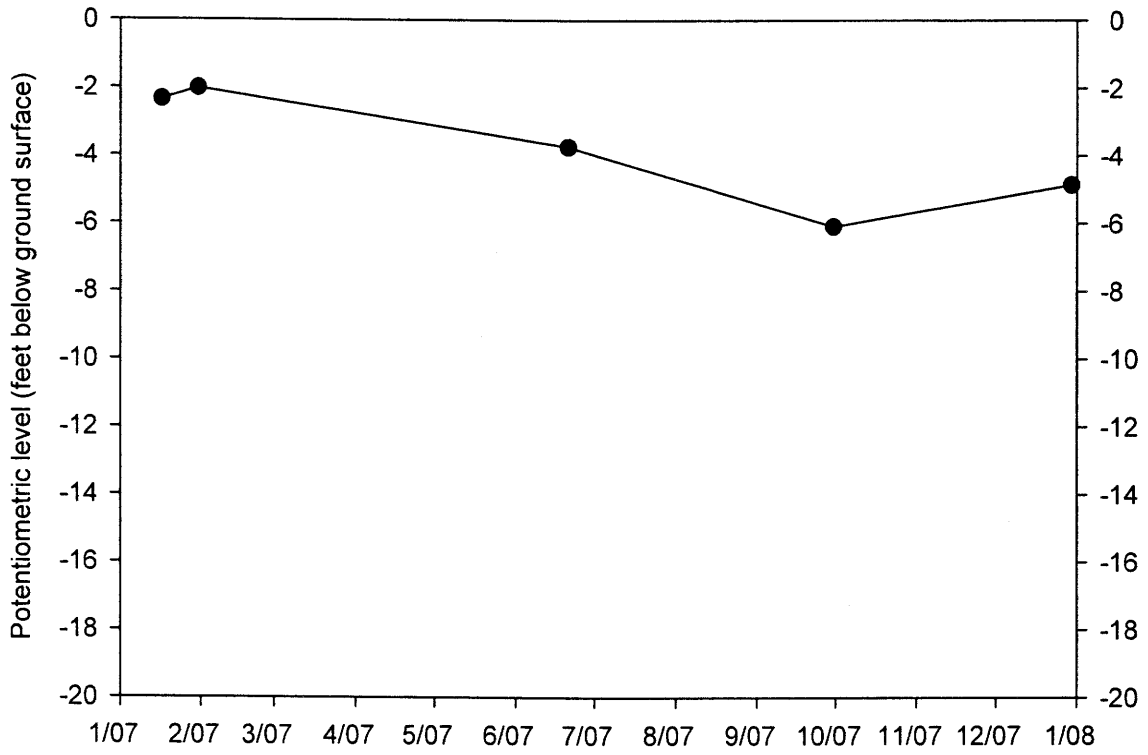

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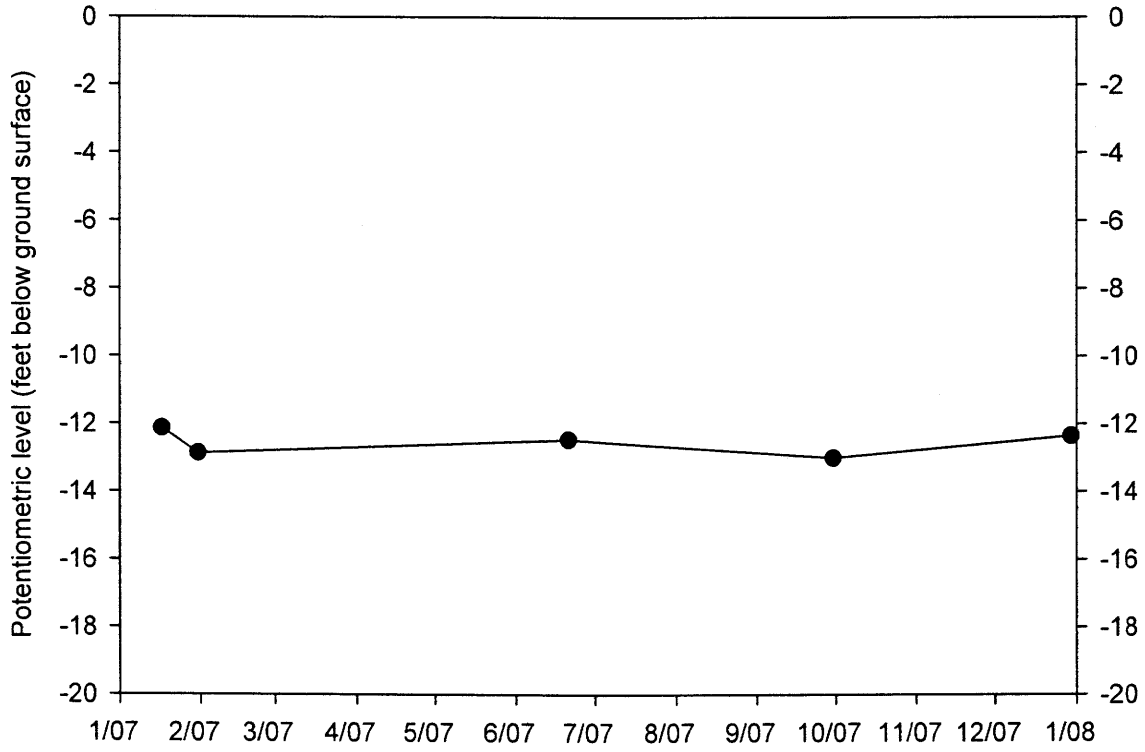
SS-75



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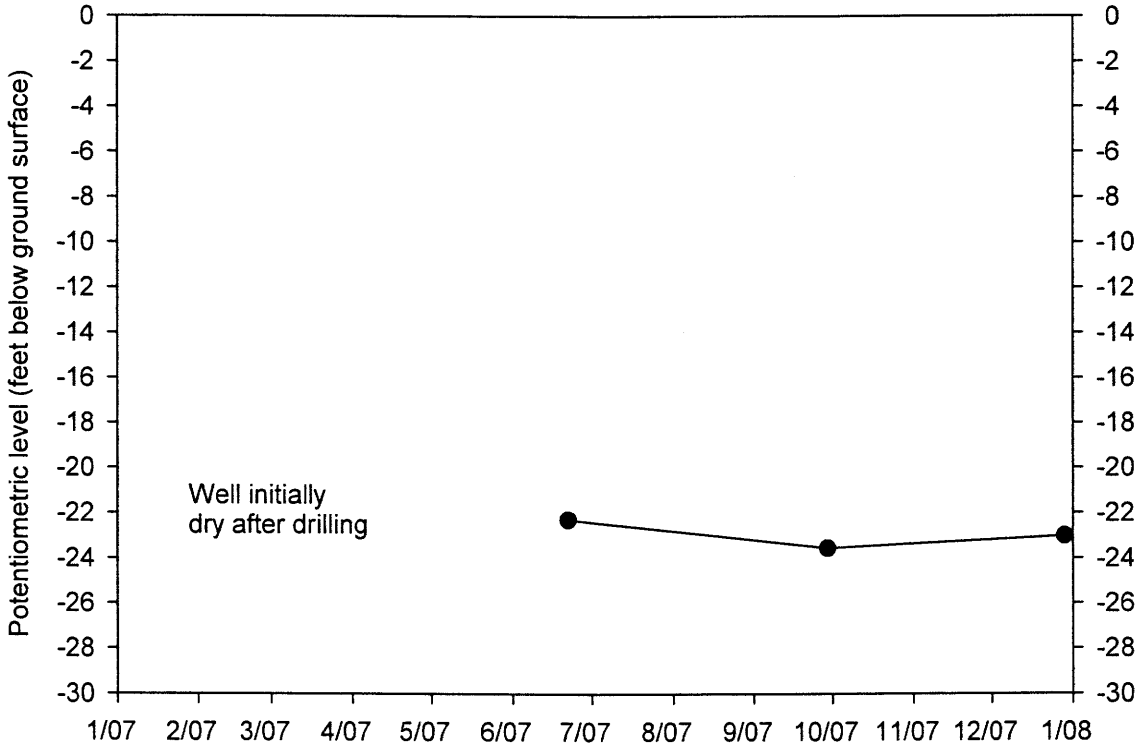

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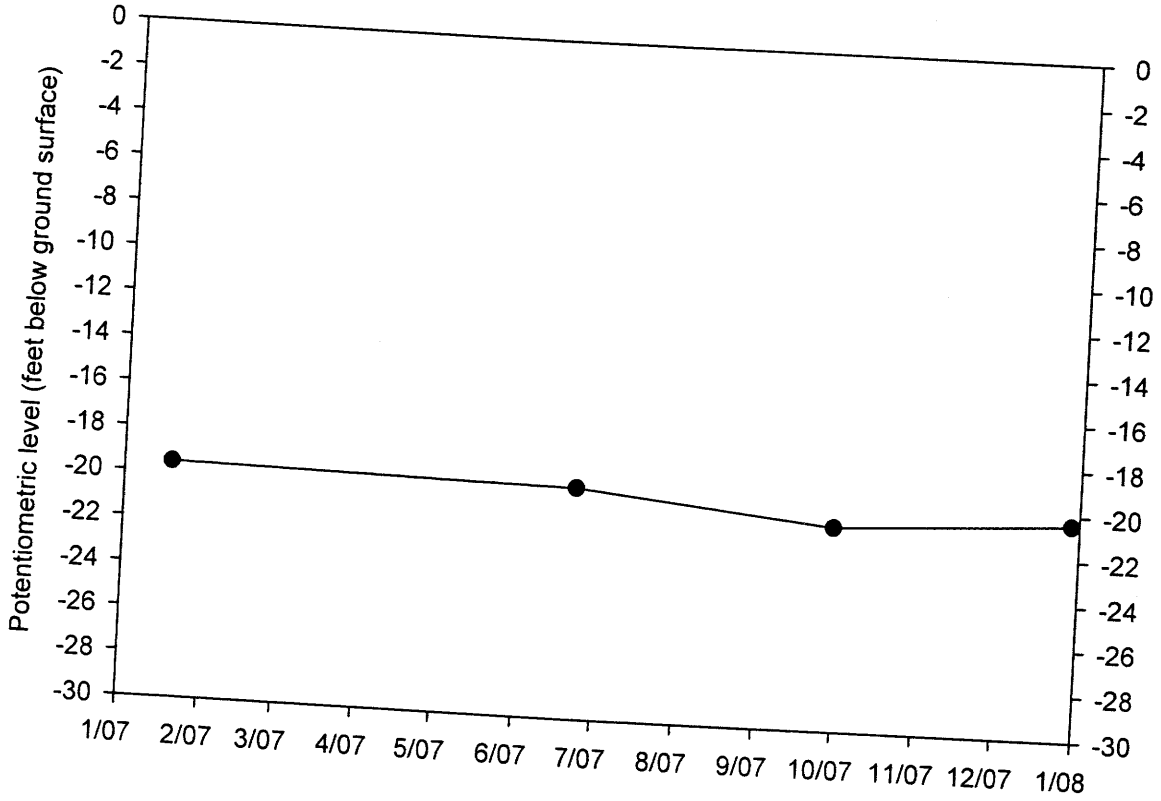
UR-70



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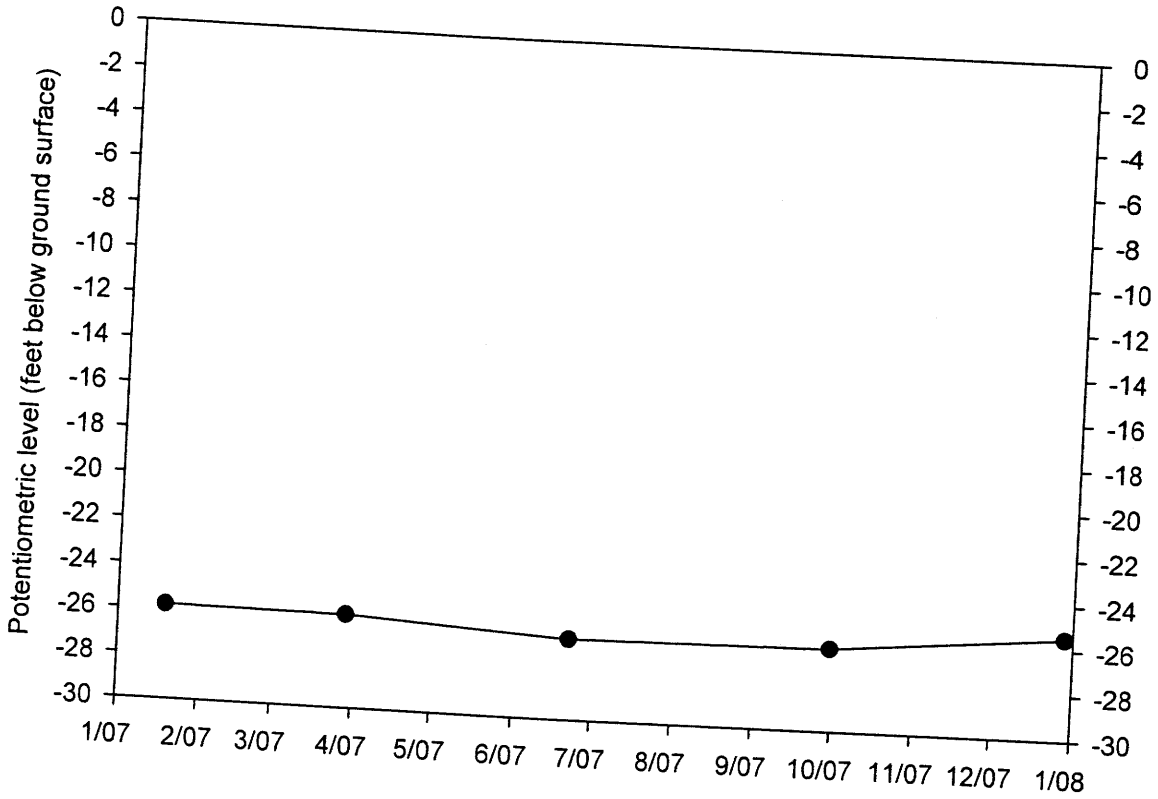

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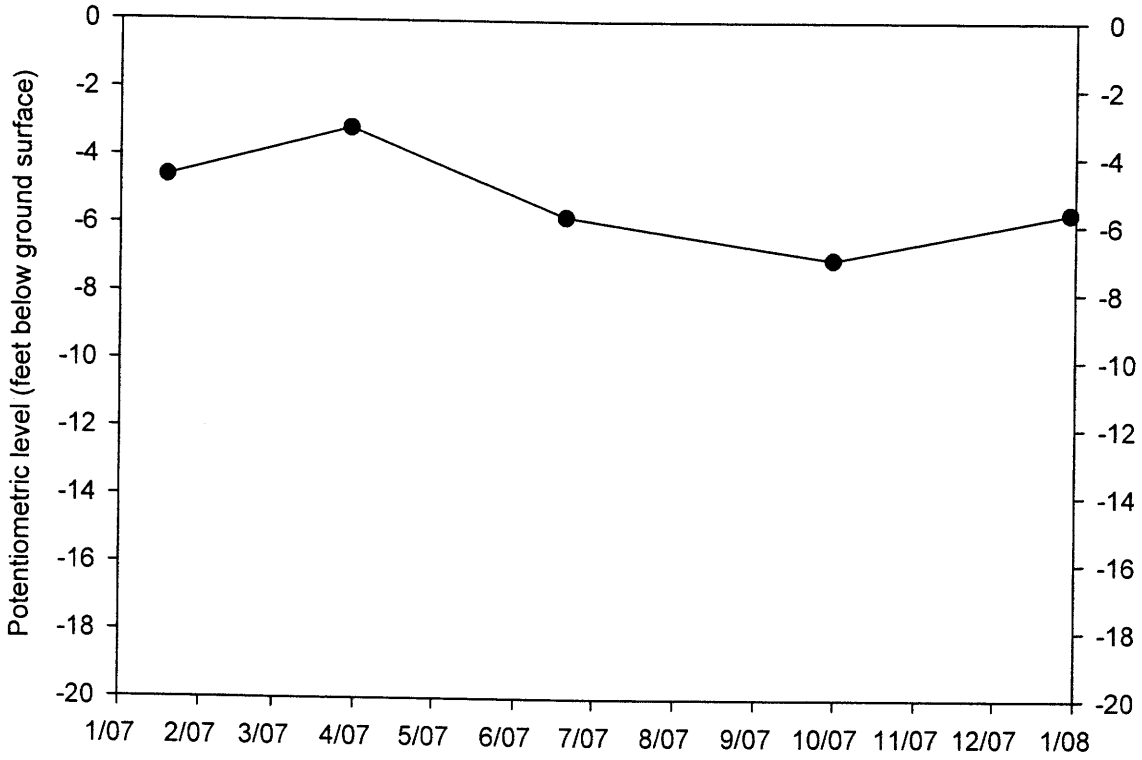

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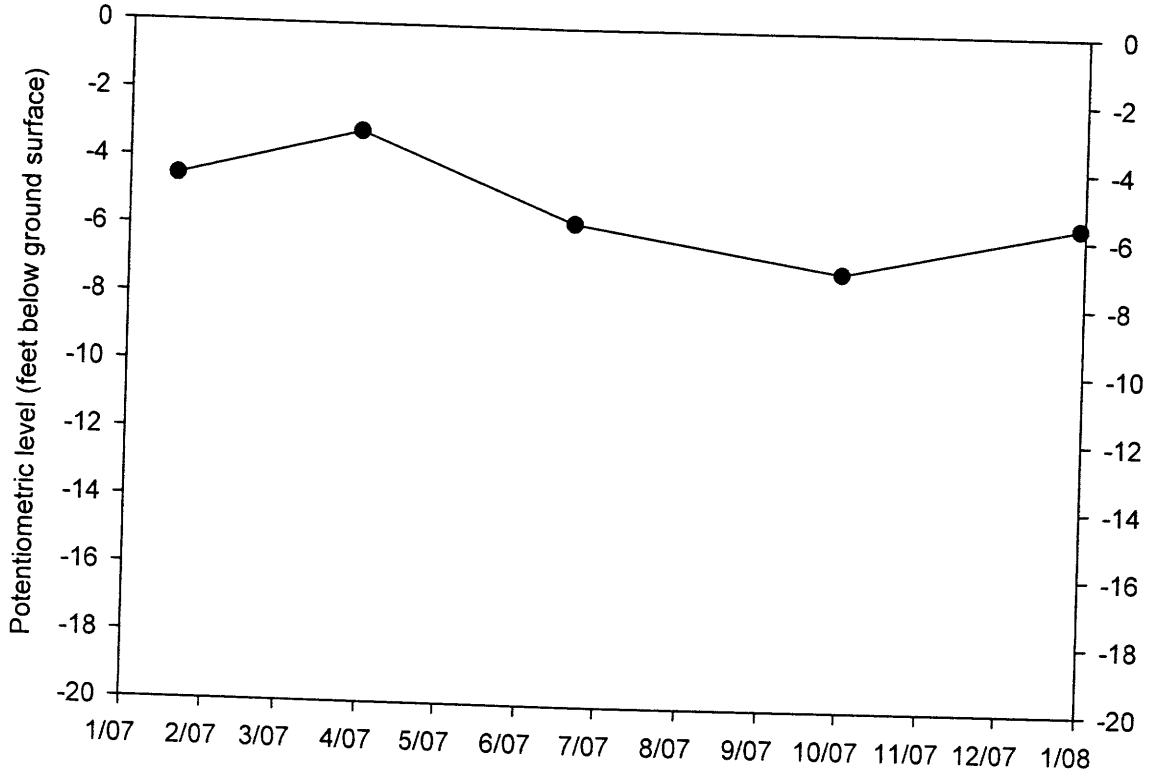
LS-28



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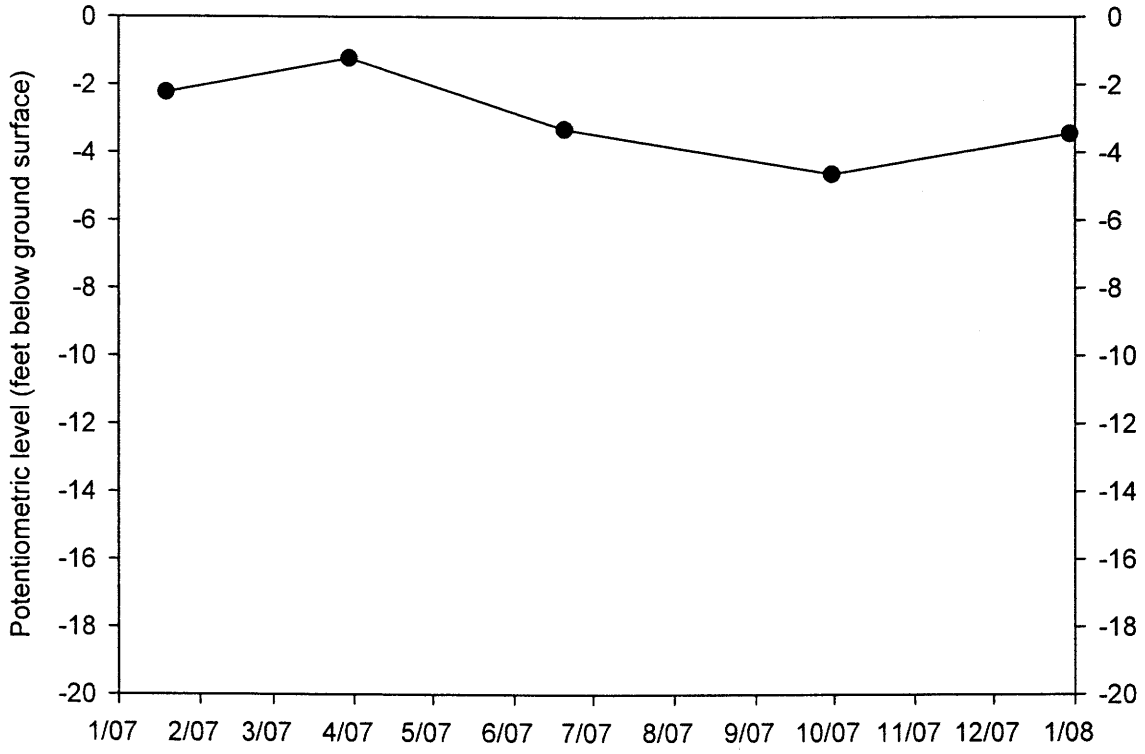

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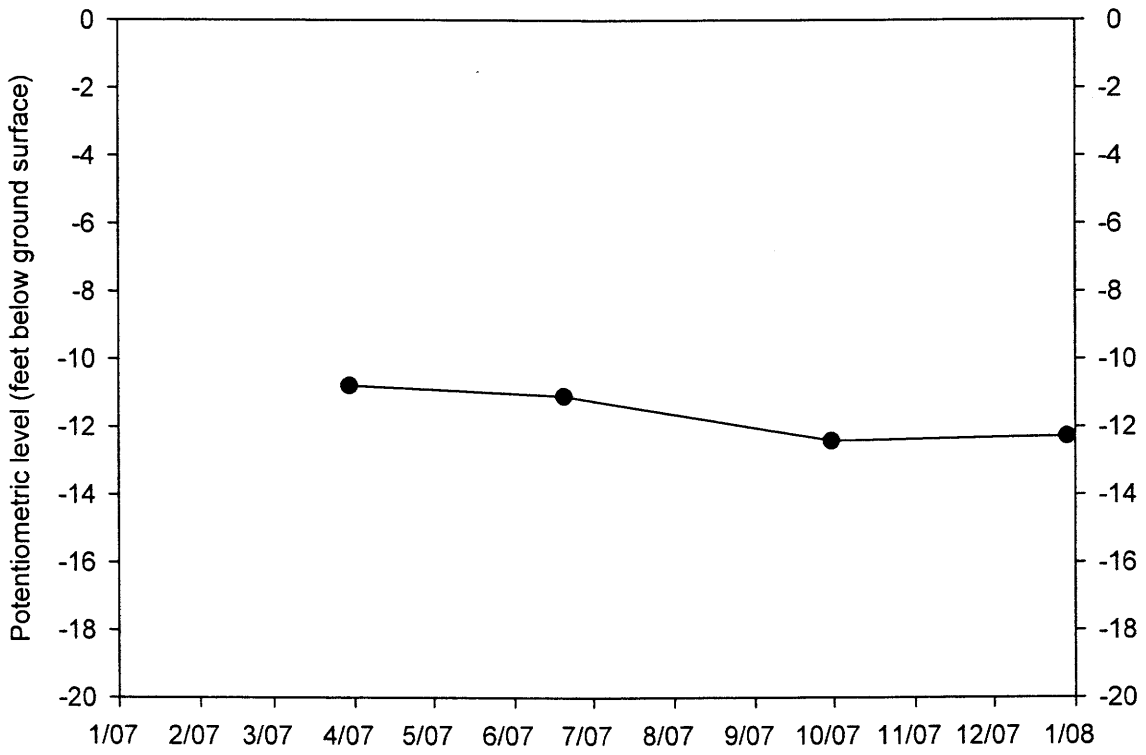
Y-63



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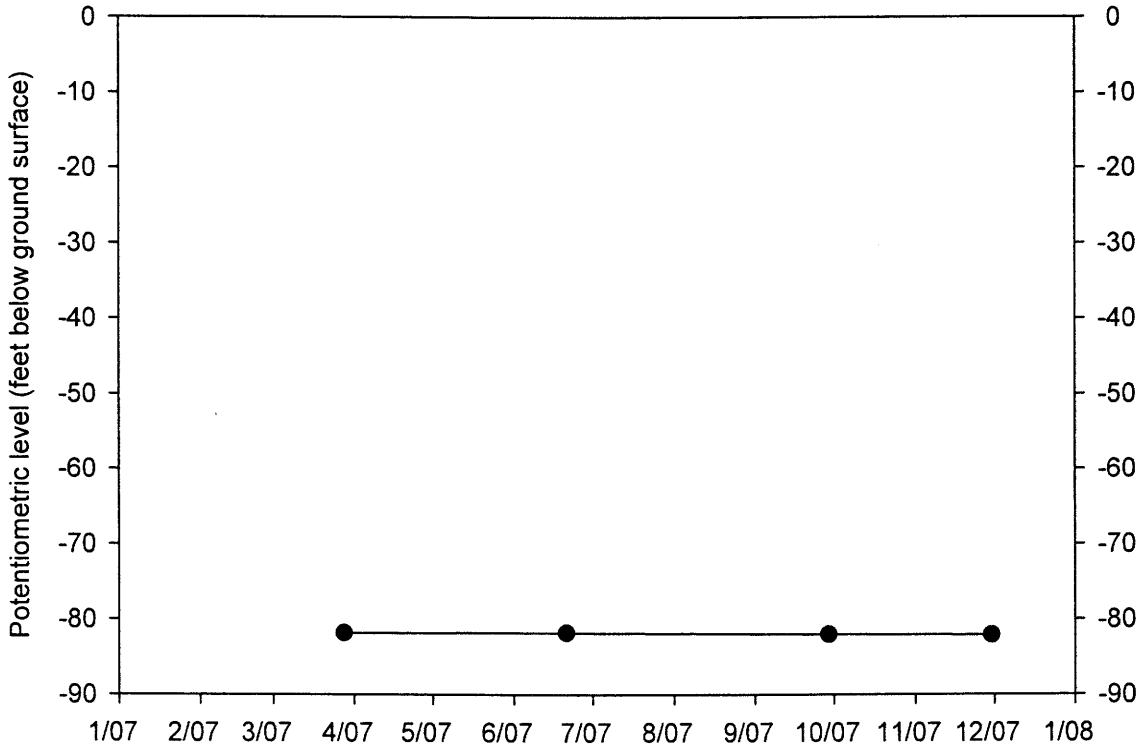

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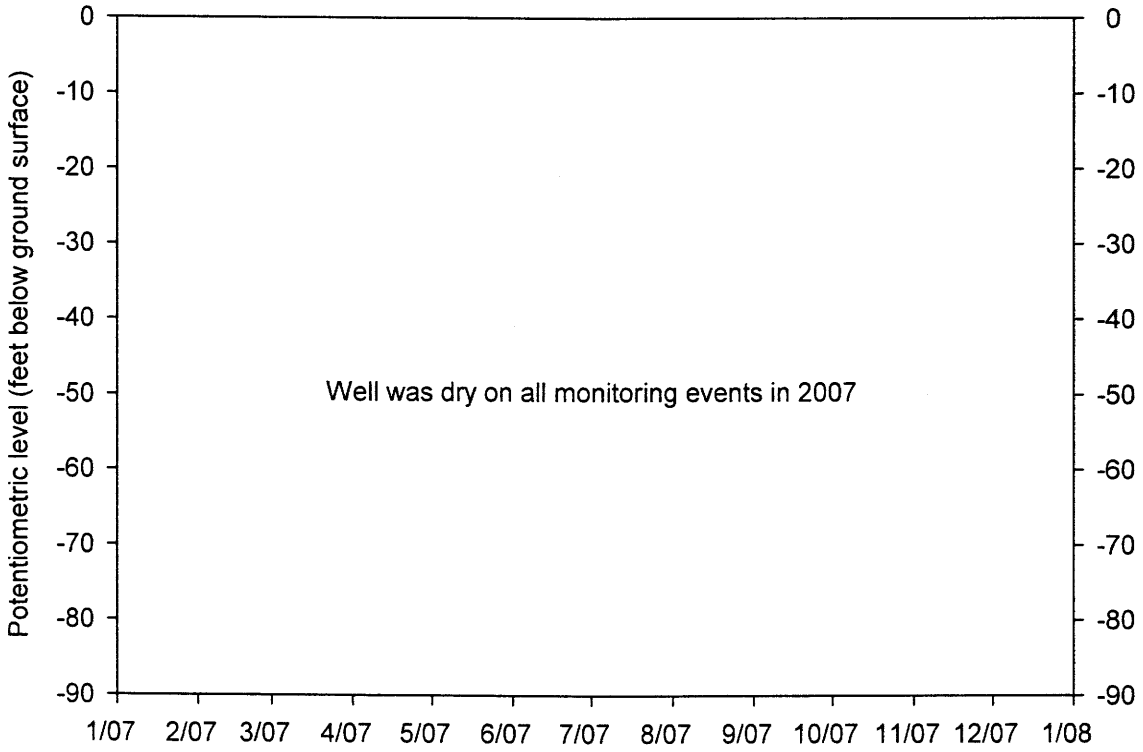

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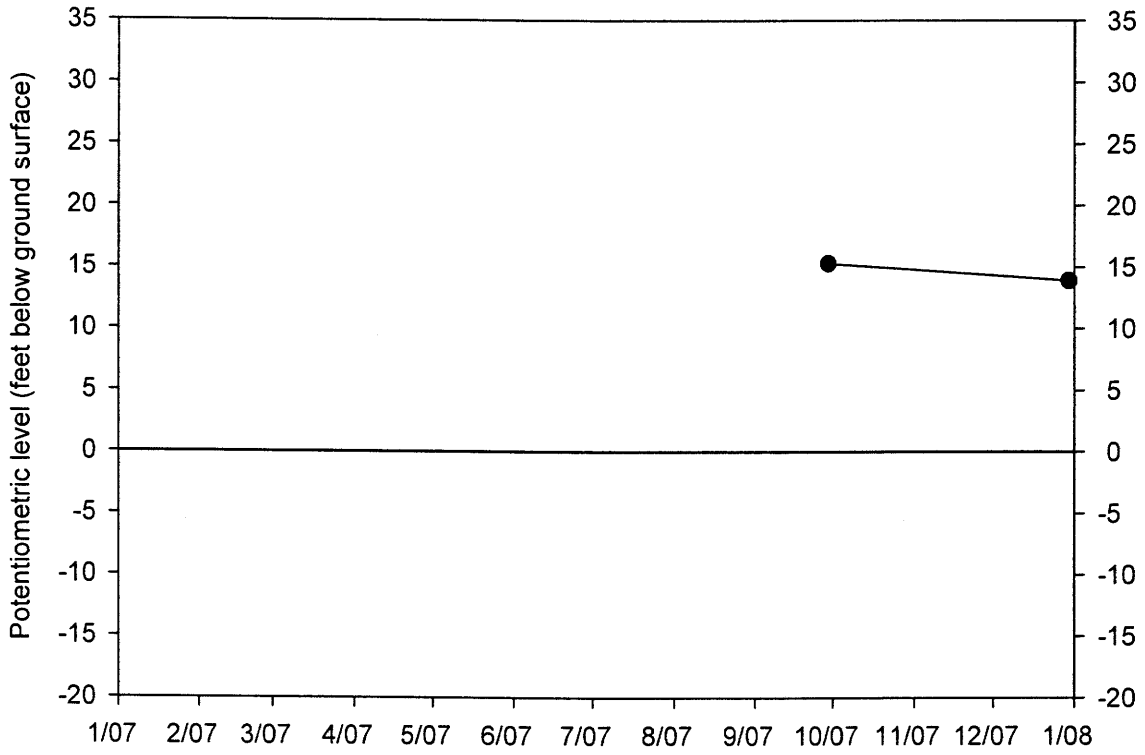

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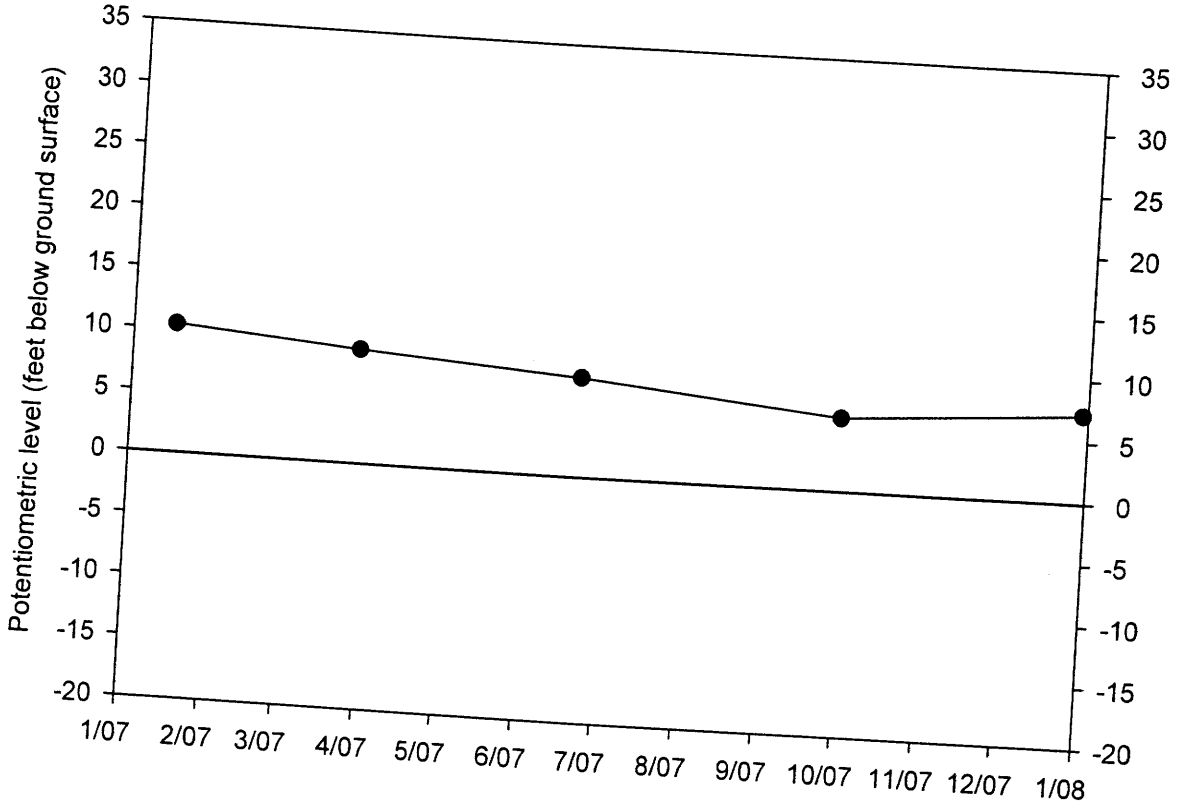

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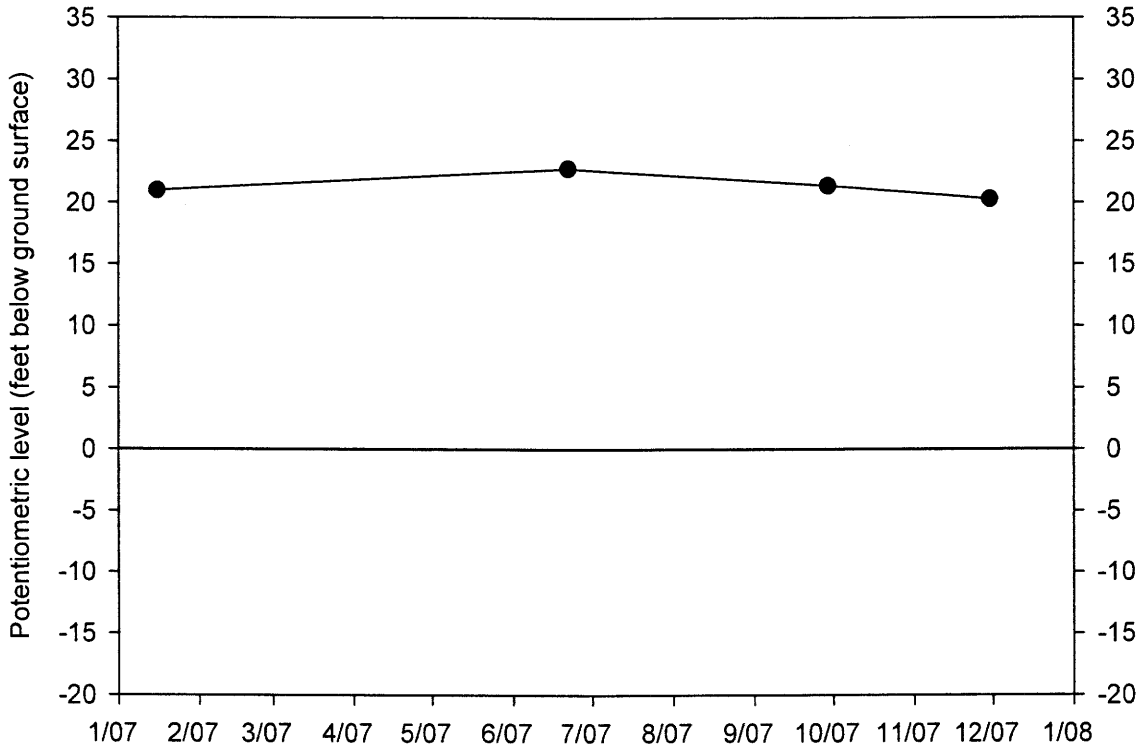

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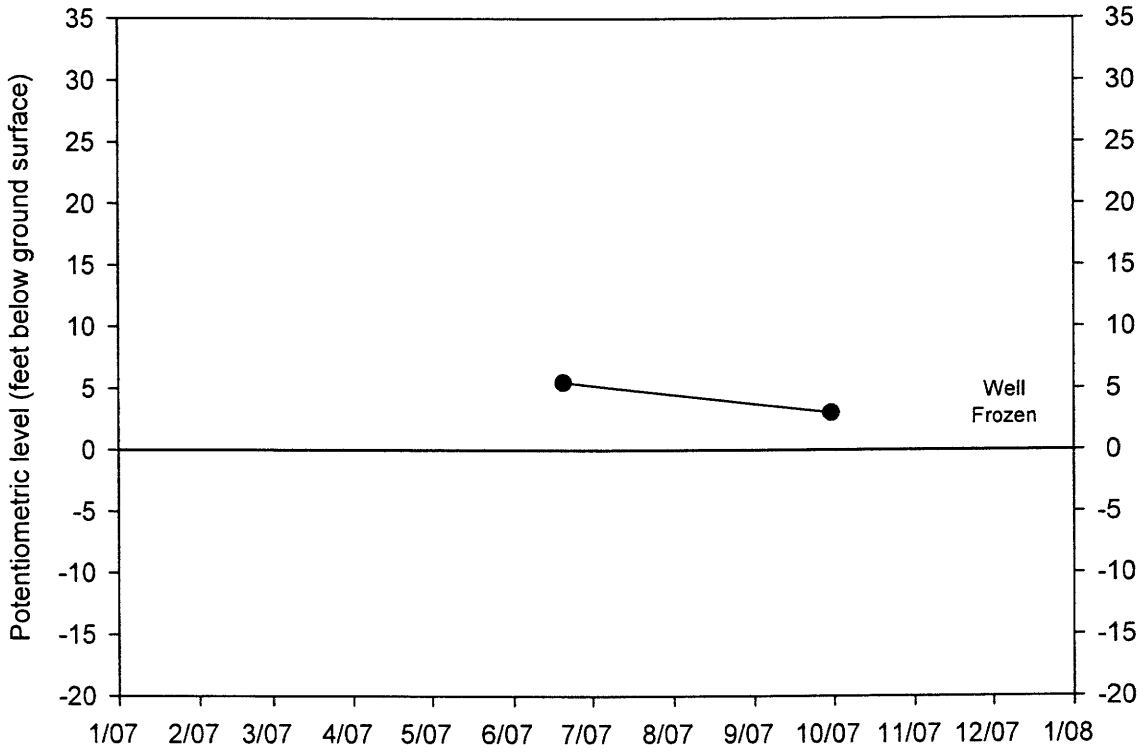

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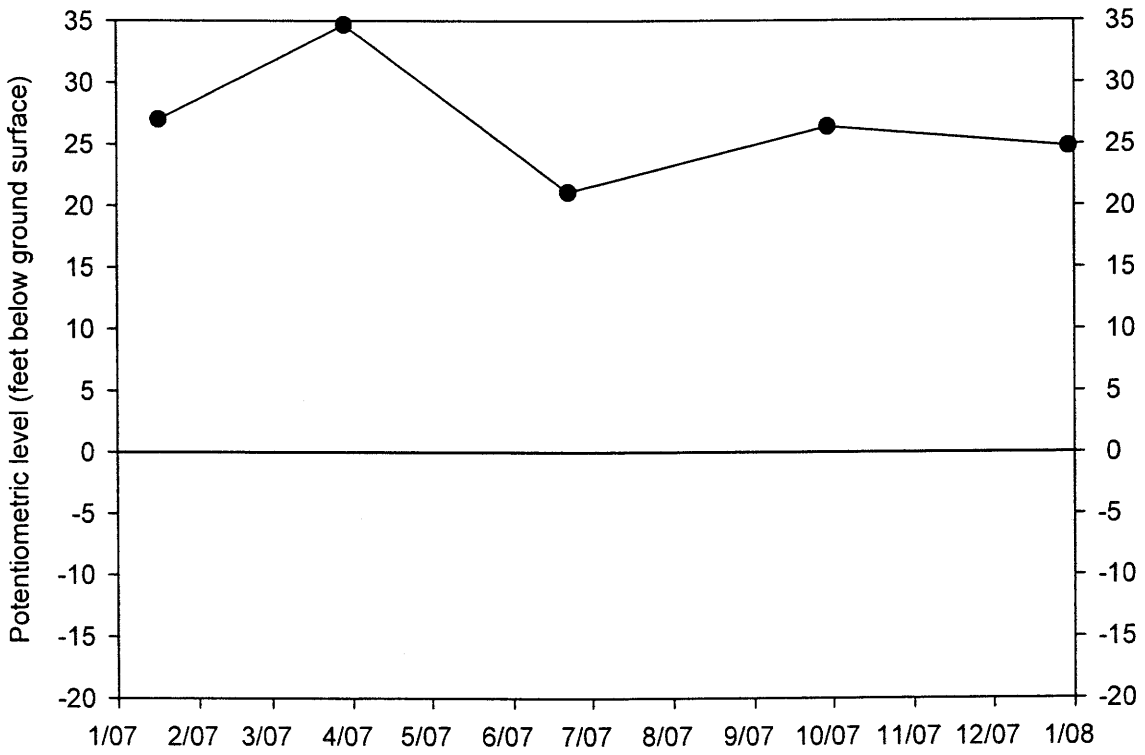
C5-130



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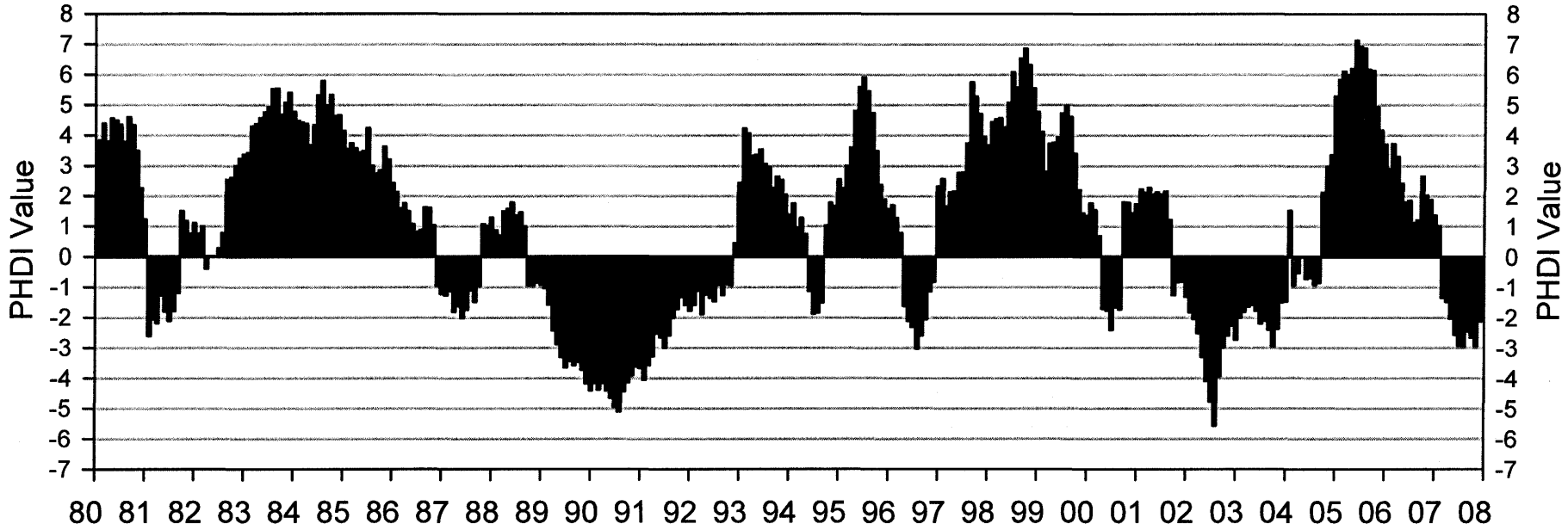

-1 to -2	Mild Drought	1 to 2	Mild Wet Spell
-2 to -3	Moderate Drought	2 to 3	Moderate Wet Spell
-3 to -4	Severe Drought	3 to 4	Severe Wet Spell
-4 to -5	Extreme Drought	4 to 5	Extreme Wet Spell

Figure 4 Plot of Palmer Hydologic Drought Index for Utah Region 4.

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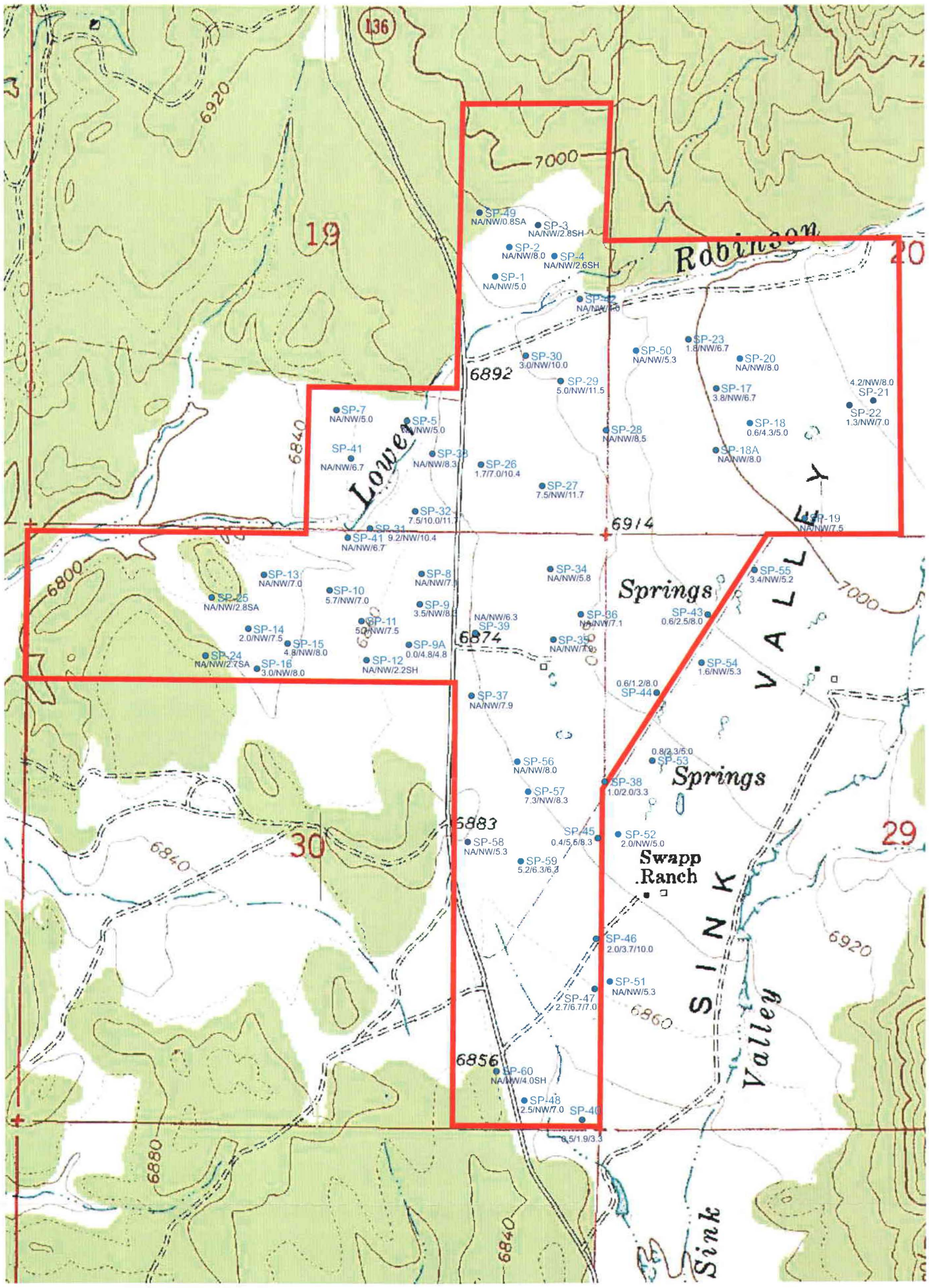

Legend

● SP-60	Soil pit location
NA/NW/4.0SH	Depth to aquic soil (ft) /Depth to soil mottling (ft) /depth of pit (ft) (SS=sandstone bedrock in pit bottom; SH = shale bedrock in pit bottom)

0 — 1,000 feet — 2,000 feet

North

Figure 5 Depth to aquic soils and soil mottling in soils pits in the Coal Hollow Project area.

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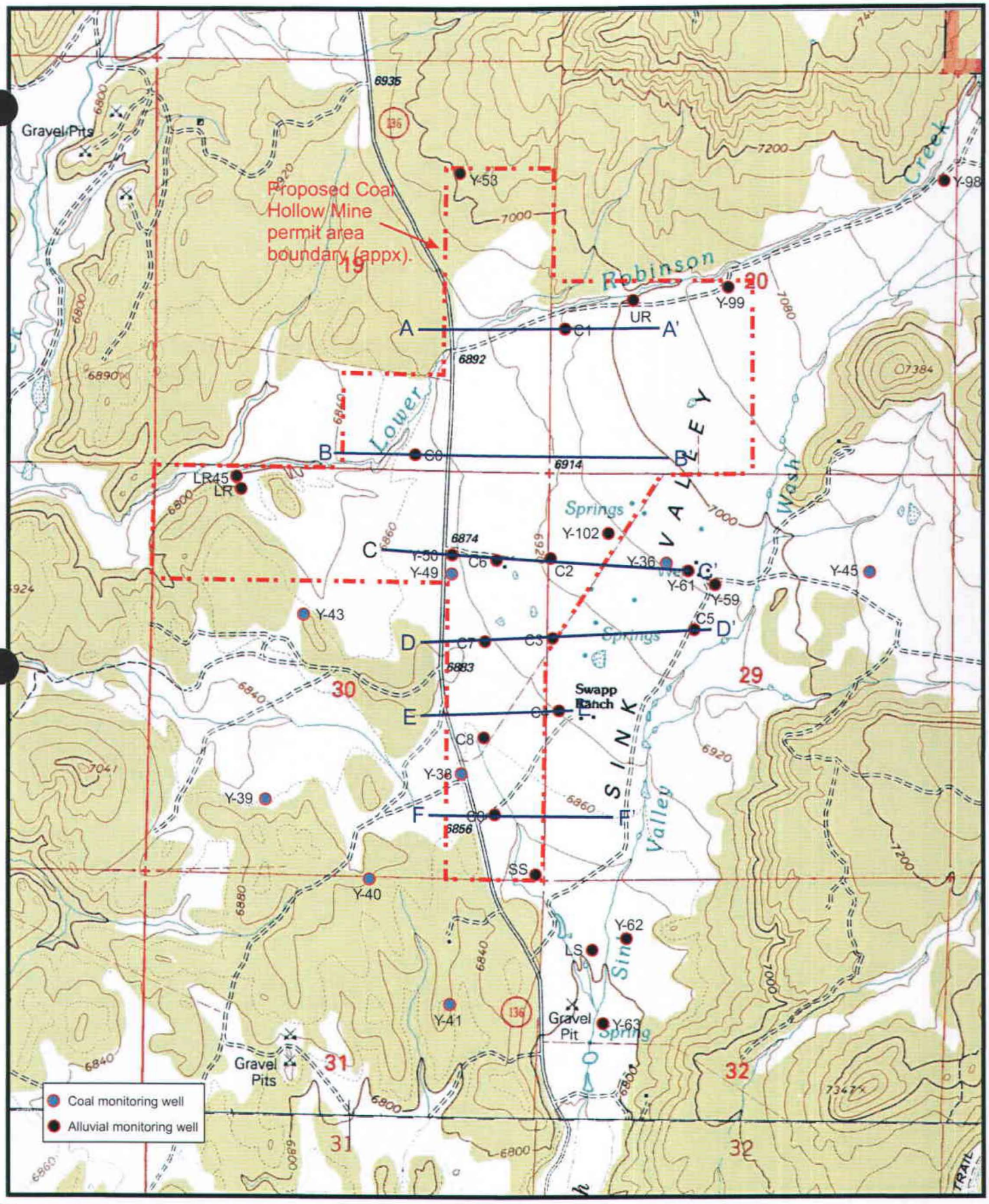

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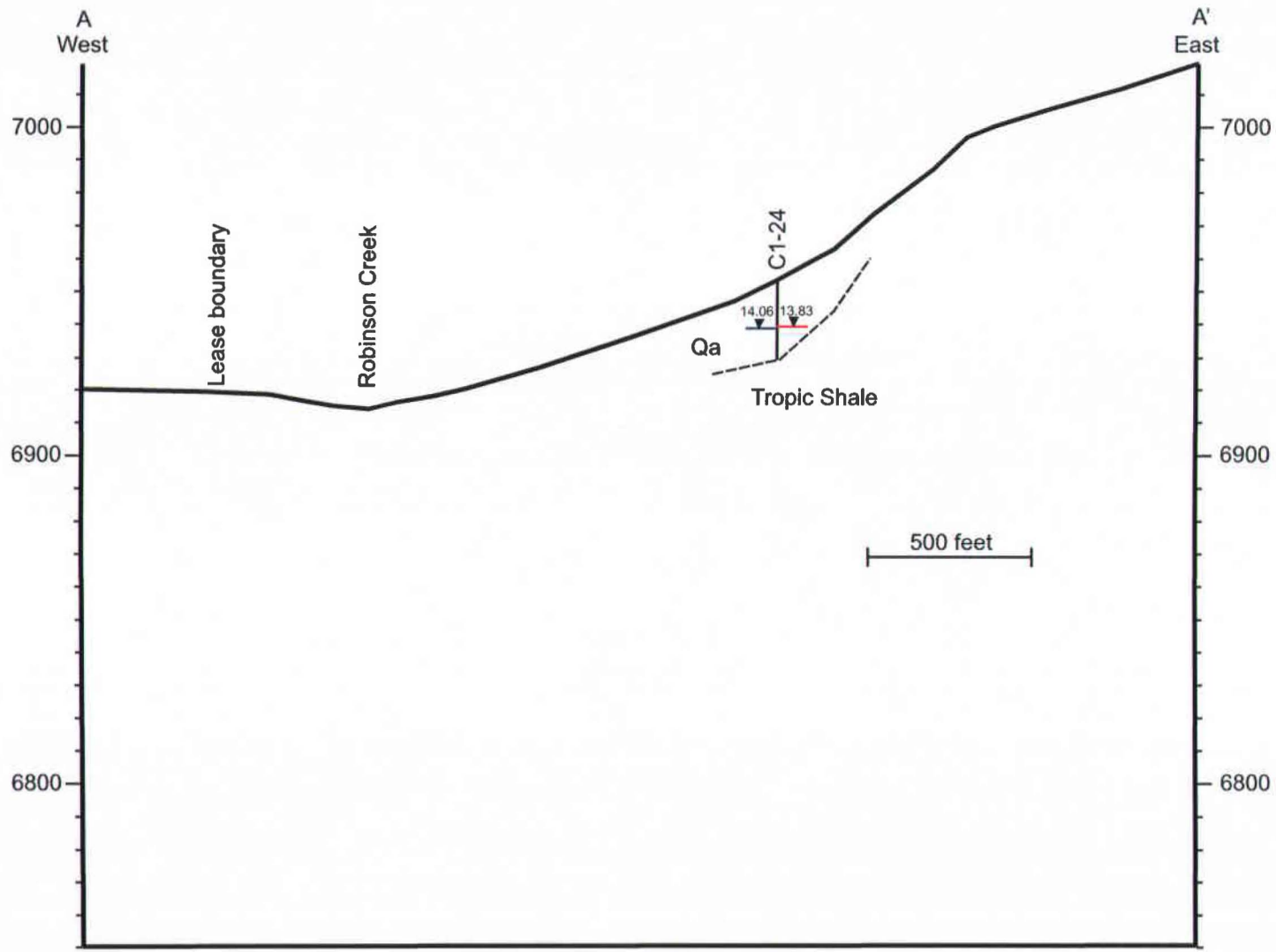
Figure 6a Cross-sections location map.



7.79 Depth to water below ground surface June 2007

10.28 Depth to water below ground surface Nov/Dec 2007

500 feet

Figure 6b Cross-section A - A'

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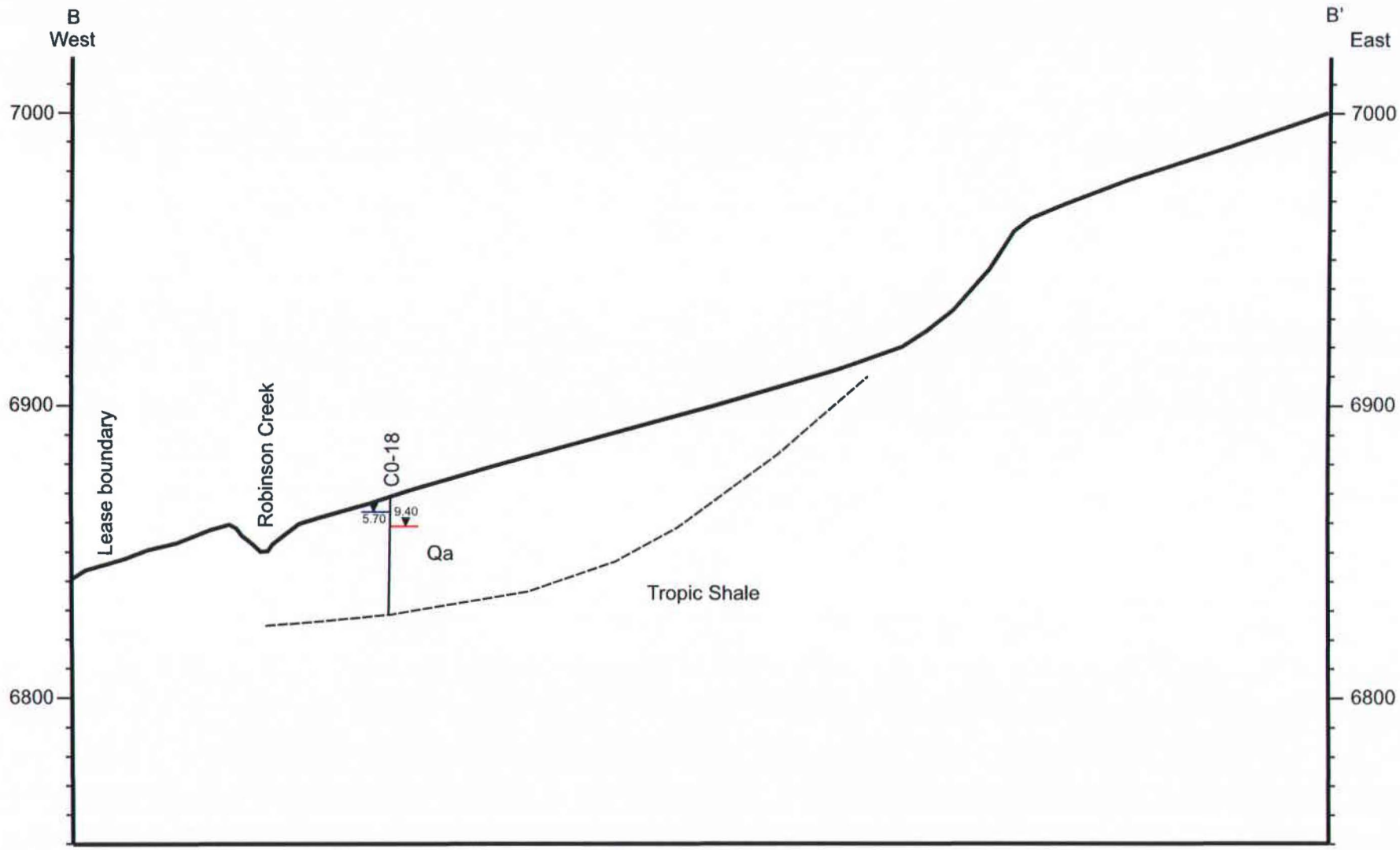

7.79 Depth to water below ground surface June 2007

10.28 Depth to water below ground surface Nov/Dec 2007

500 feet

Figure 6c Cross-section B - B'

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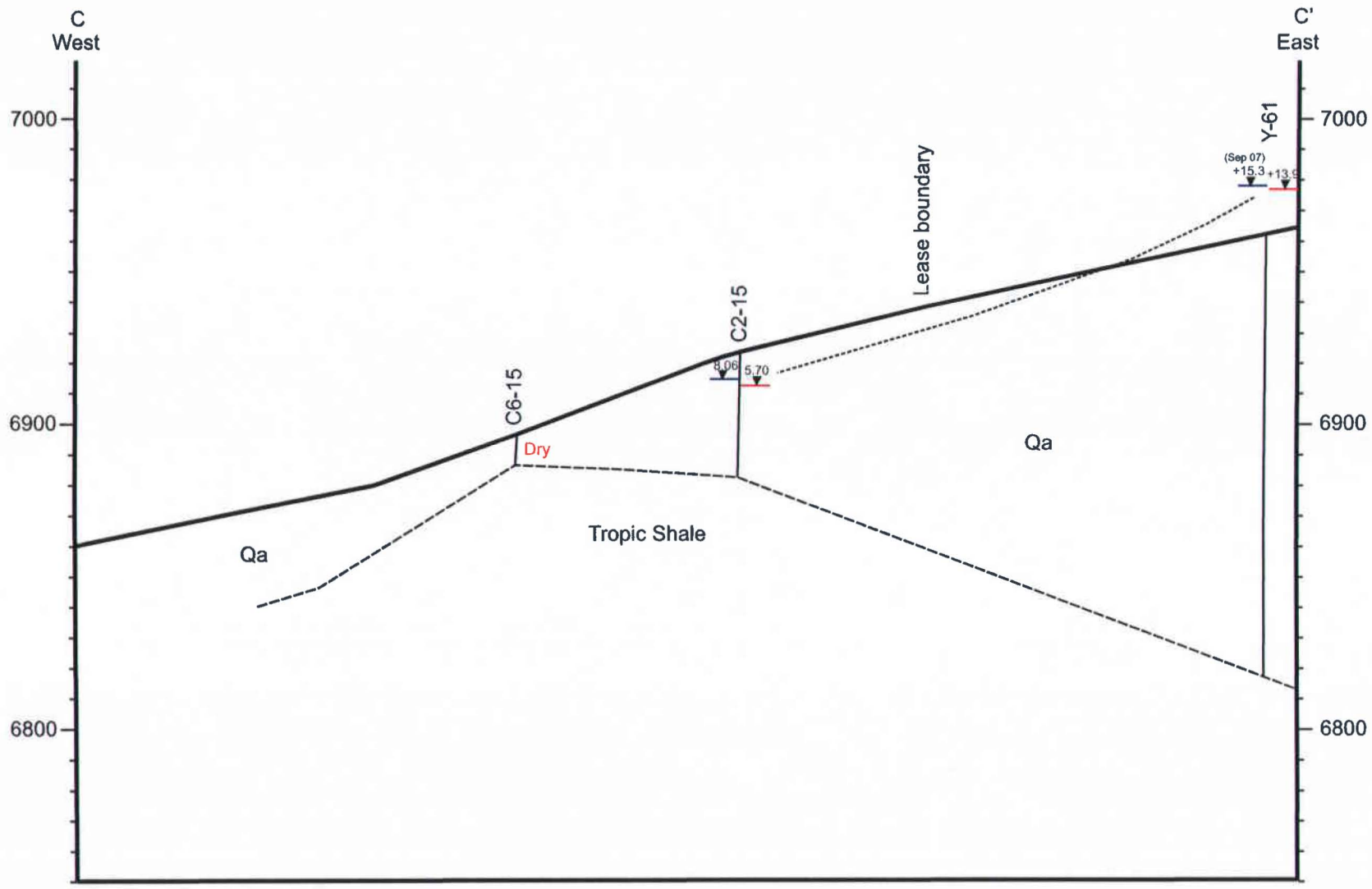

7.79 Depth to water below ground surface June 2007

10.28 Depth to water below ground surface Nov/Dec 2007

500 feet

Figure 6d Cross-section C - C'

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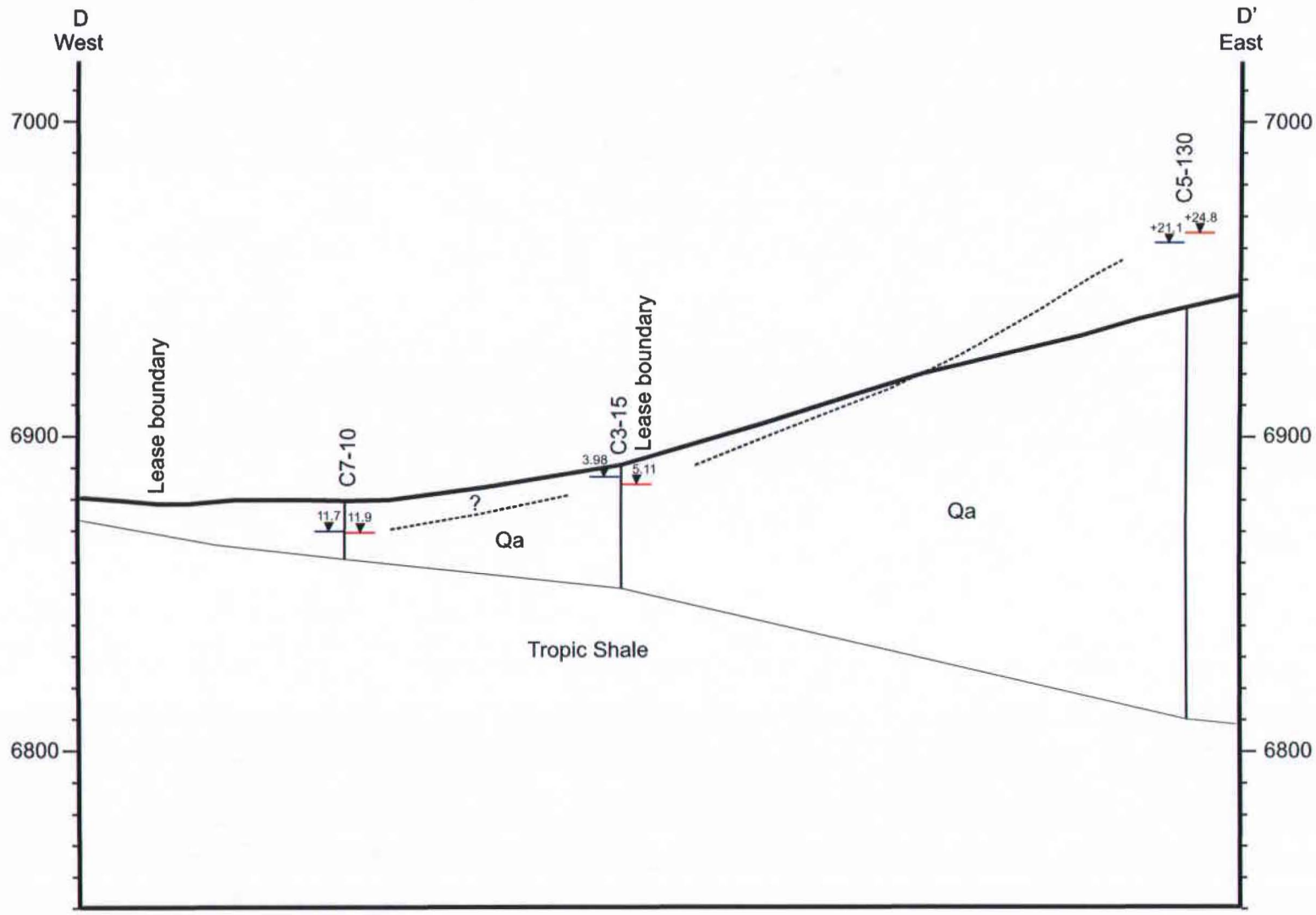

7.79 Depth to water below ground surface June 2007

10.28 Depth to water below ground surface Nov/Dec 2007

500 feet

Figure 6e Cross-section D - D'

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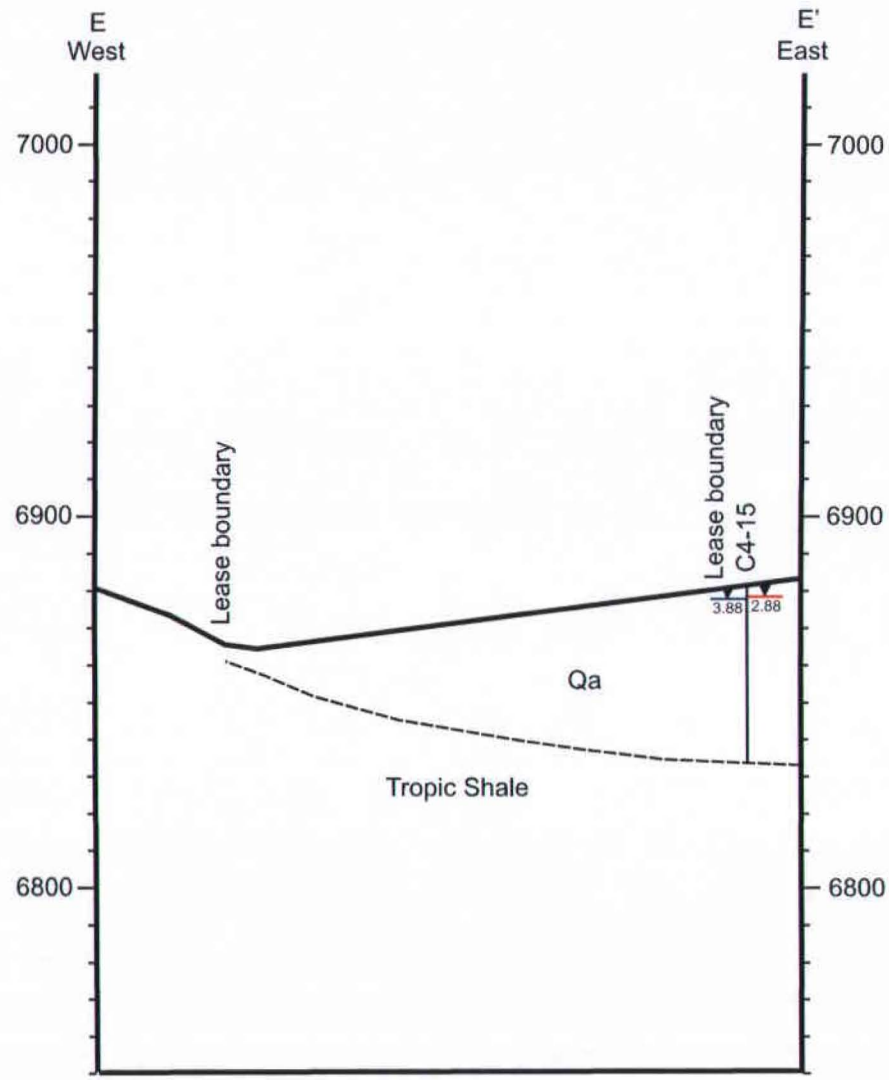

7.79 Depth to water below ground surface June 2007

10.28 Depth to water below ground surface Nov/Dec 2007

500 feet

Figure 6f Cross-section E - E'

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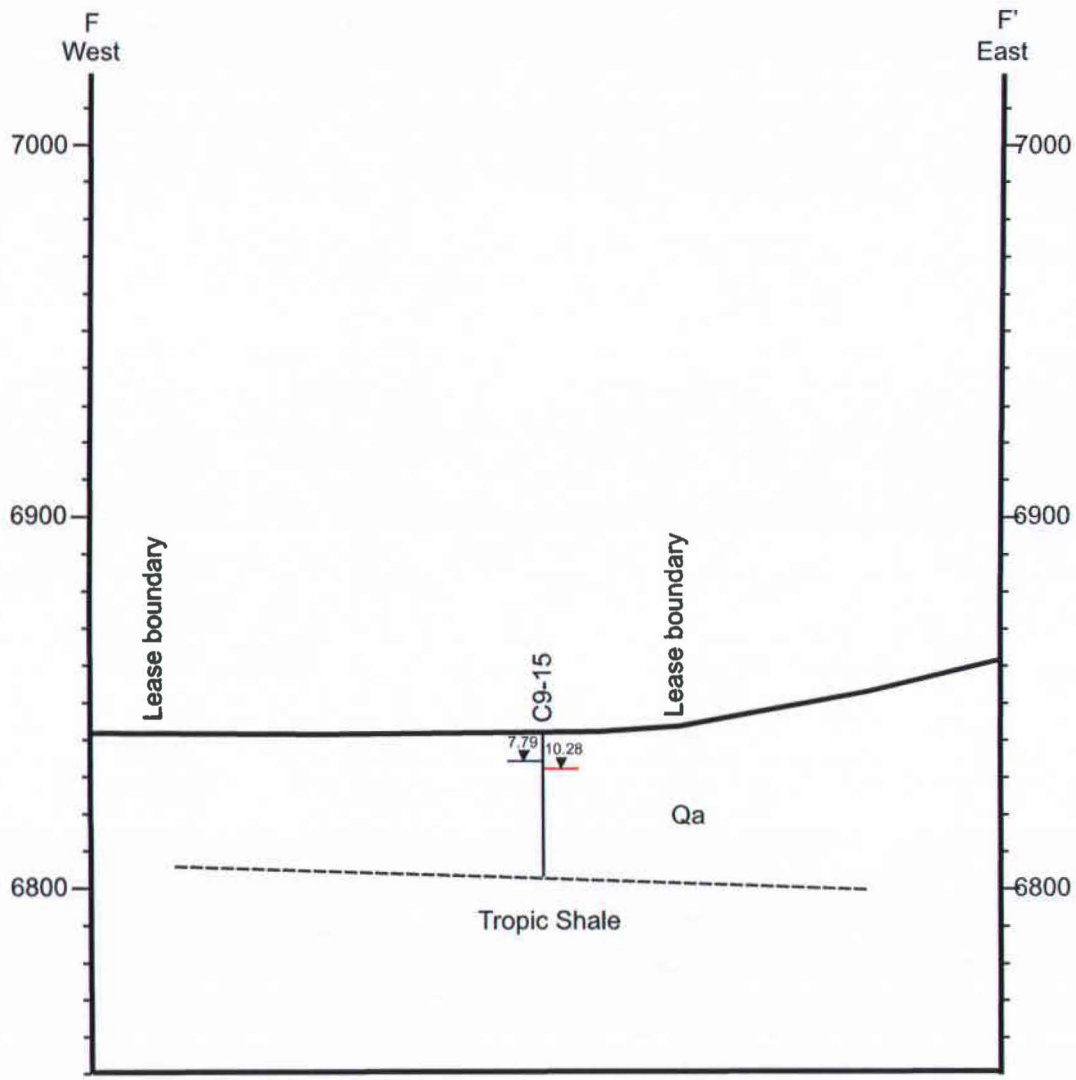

7.79 Depth to water below ground surface June 2007

10.28 Depth to water below ground surface Nov/Dec 2007

500 feet

Figure 6g Cross-section F - F'

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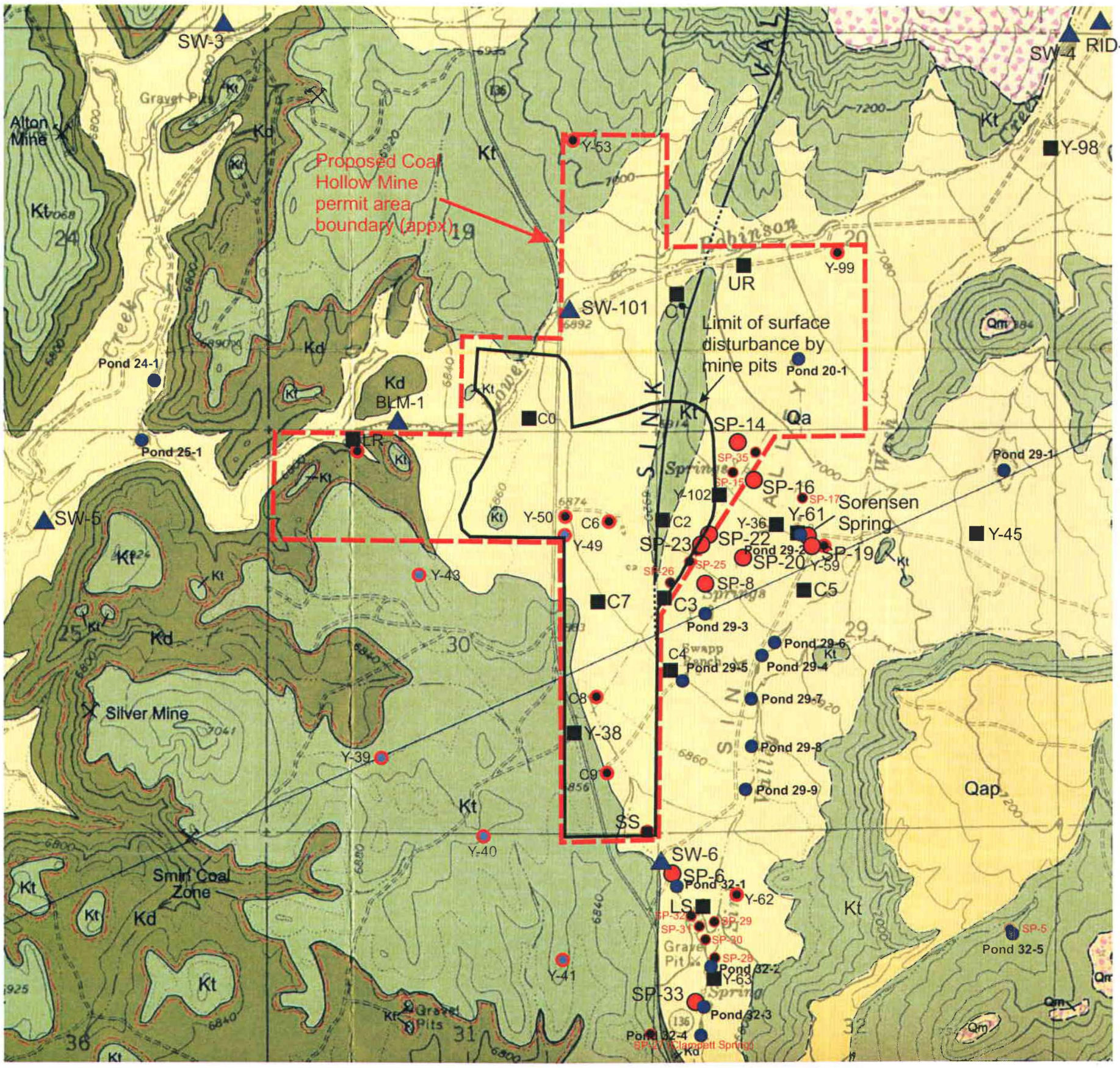

Springs

Monitored springs

spring and seep survey

Ponds

Stream monitoring station

Monitoring wells

Alluvial well

Coal well

Baseline monitoring well

North

1 Mile

See Appendix 6-3 for geologic legend

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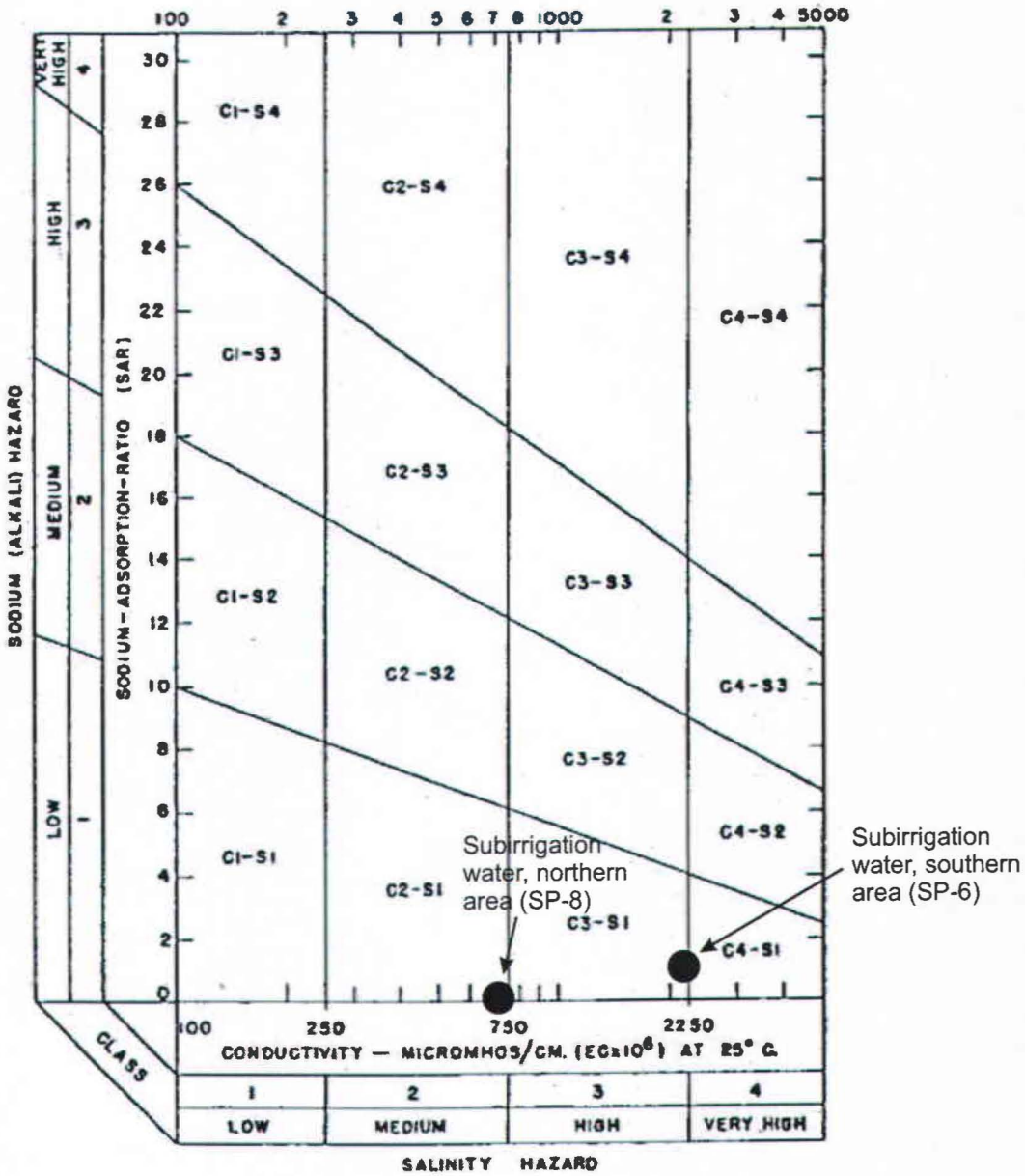
Figure 8 Locations of streams, ponds, springs and wells in relation to surface geology.



After OSM (1983)

Conductivity

C1 Low-salinity water: Can be used for irrigation with most crops on most soils with little likelihood that soil salinity will develop.
C2 Medium-salinity water: Can be used in a moderate amount of leaching occurs.
C3 High-salinity water: Cannot be used on soils with restricted drainage. With adequate drainage, special management for salinity control may be required and plants with good salt tolerance should be selected.
C4 Very high salinity water: Is not suitable for irrigation under ordinary conditions.

Sodium

S1 Low-sodium water: Can be used for irrigation on almost all soils with little danger of the development of harmful levels of exchangeable sodium.
S2 Medium-sodium water: Will present an appreciable sodium hazard in fine-textured soils having a high cation-exchange capacity, especially under low-leaching conditions.
S3 High-sodium water: May produce harmful levels of exchangeable sodium in most soils and will require special management – good drainage, high leaching, and organic matter additions.
S4 Very high sodium water: Is generally unsatisfactory for irrigation purposes except at low and perhaps medium salinity.

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Figure 9 Water quality suitability criteria for potential subirrigation waters.

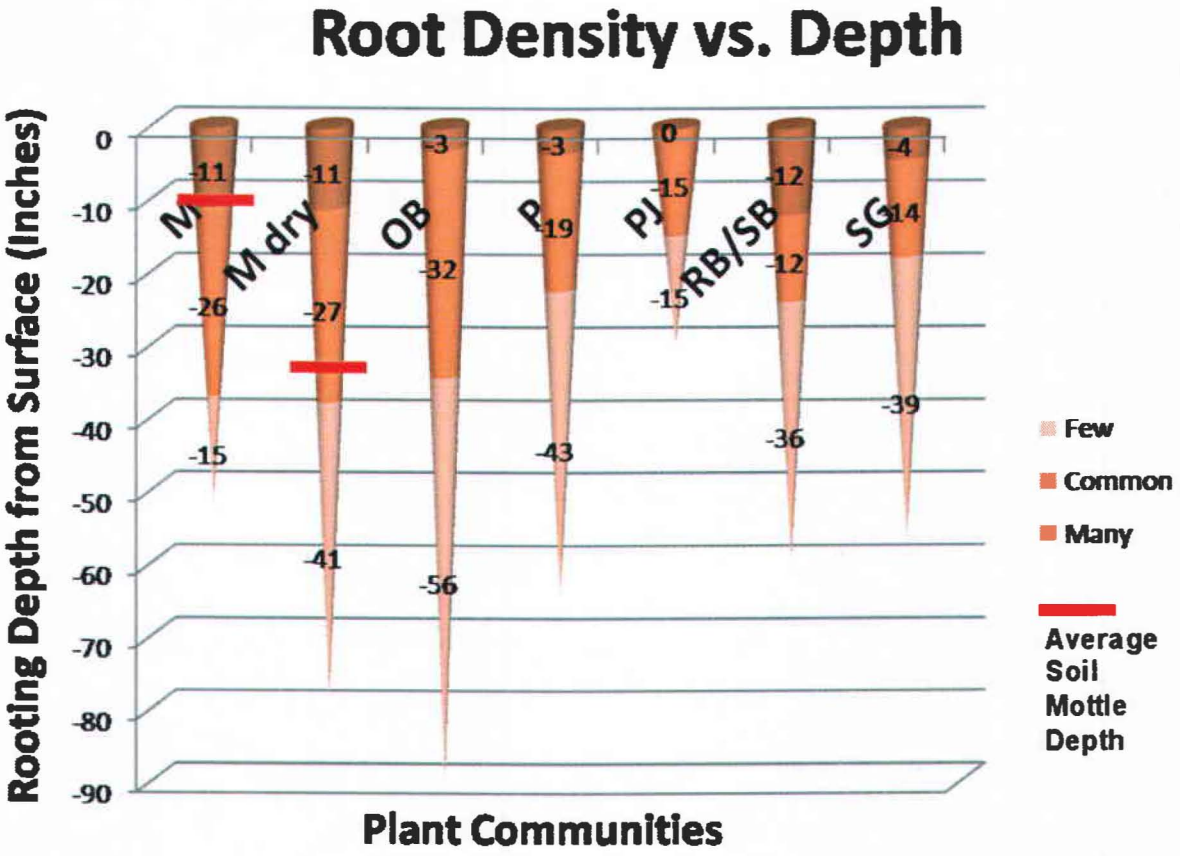

Figure 10 Root density versus depth and depth of soil mottles. (depth of mottles are shown only in those plant communities where they were the dominant condition).

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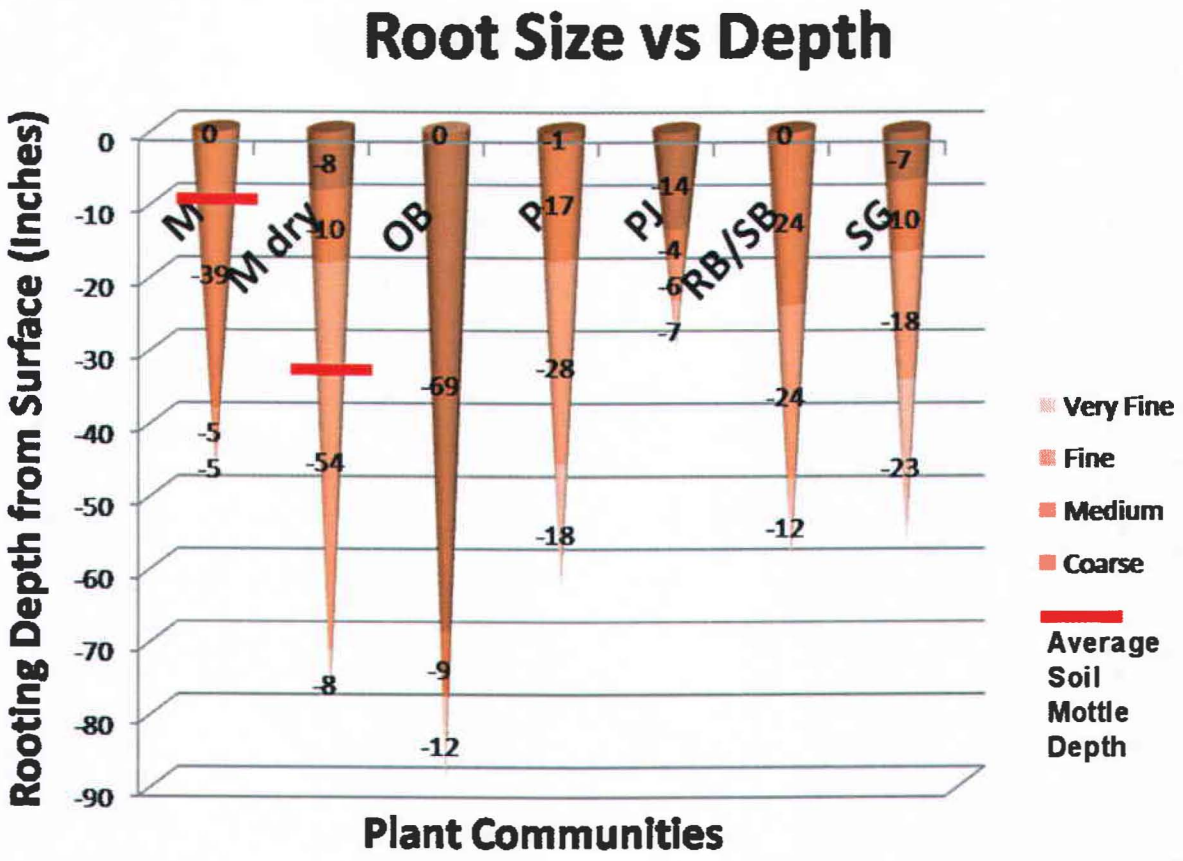

Figure 11 Root size versus depth and depth of soil mottles (depth of mottles are shown only in those plant communities where they were the dominant condition).

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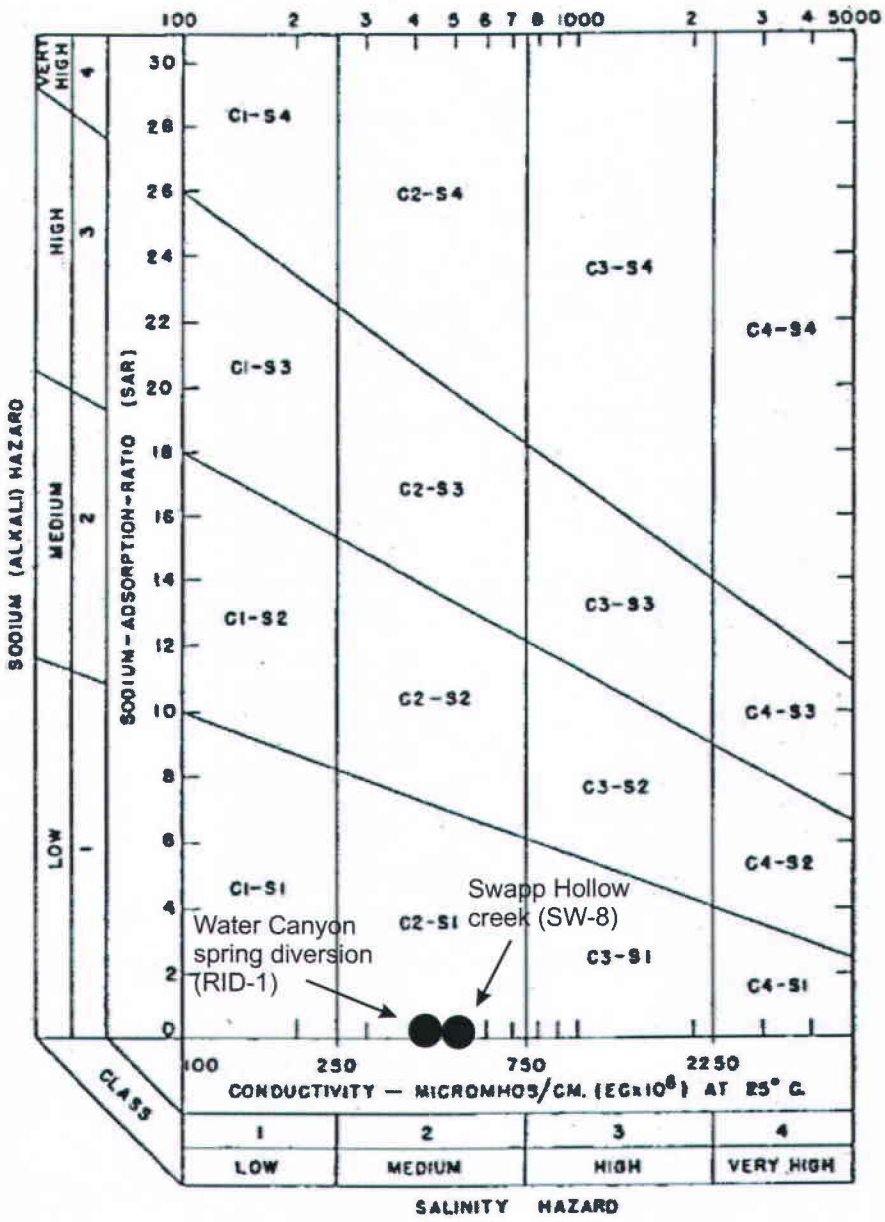

After OSM (1983)

Conductivity

C1 Low-salinity water: Can be used for irrigation with most crops on most soils with little likelihood that soil salinity will develop.
C2 Medium-salinity water: Can be used in a moderate amount of leaching occurs.
C3 High-salinity water: Cannot be used on soils with restricted drainage. With adequate drainage, special management for salinity control may be required and plants with good salt tolerance should be selected.
C4 Very high salinity water: Is not suitable for irrigation under ordinary conditions.

Sodium

S1 Low-sodium water: Can be used for irrigation on almost all soils with little danger of the development of harmful levels of exchangeable sodium.
S2 Medium-sodium water: Will present an appreciable sodium hazard in fine-textured soils having a high cation-exchange capacity, especially under low-leaching conditions.
S3 High-sodium water: May produce harmful levels of exchangeable sodium in most soils and will require special management – good drainage, high leaching, and organic matter additions.
S4 Very high sodium water: Is generally unsatisfactory for irrigation purposes except at low and perhaps medium salinity.

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Figure 12 Water quality suitability criteria for potential flood irrigation waters.

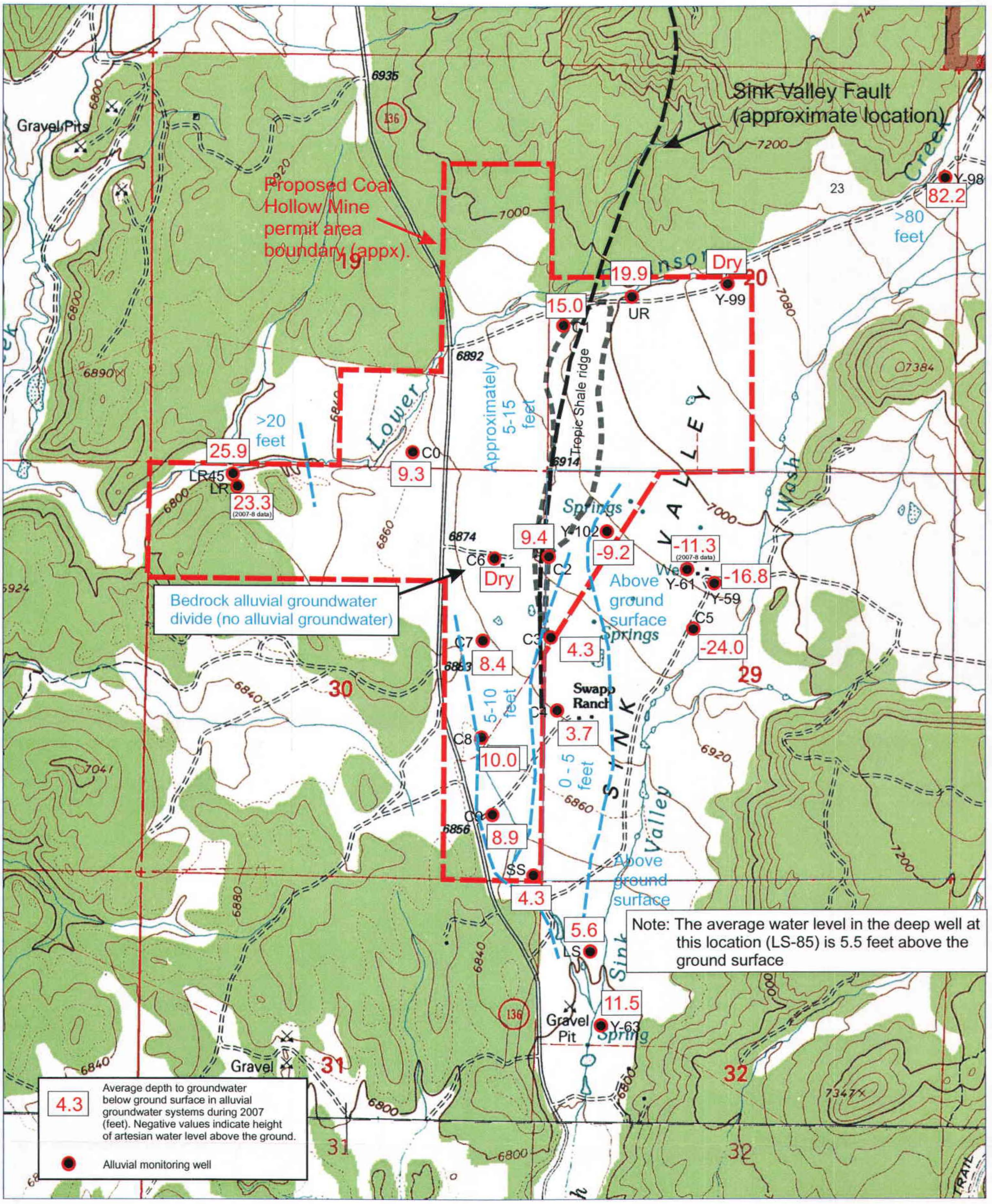

Figure 13 Average depths to groundwater relative to ground surface in the alluvial groundwater systems in the Coal Hollow Mine permit and surrounding area during 2007.

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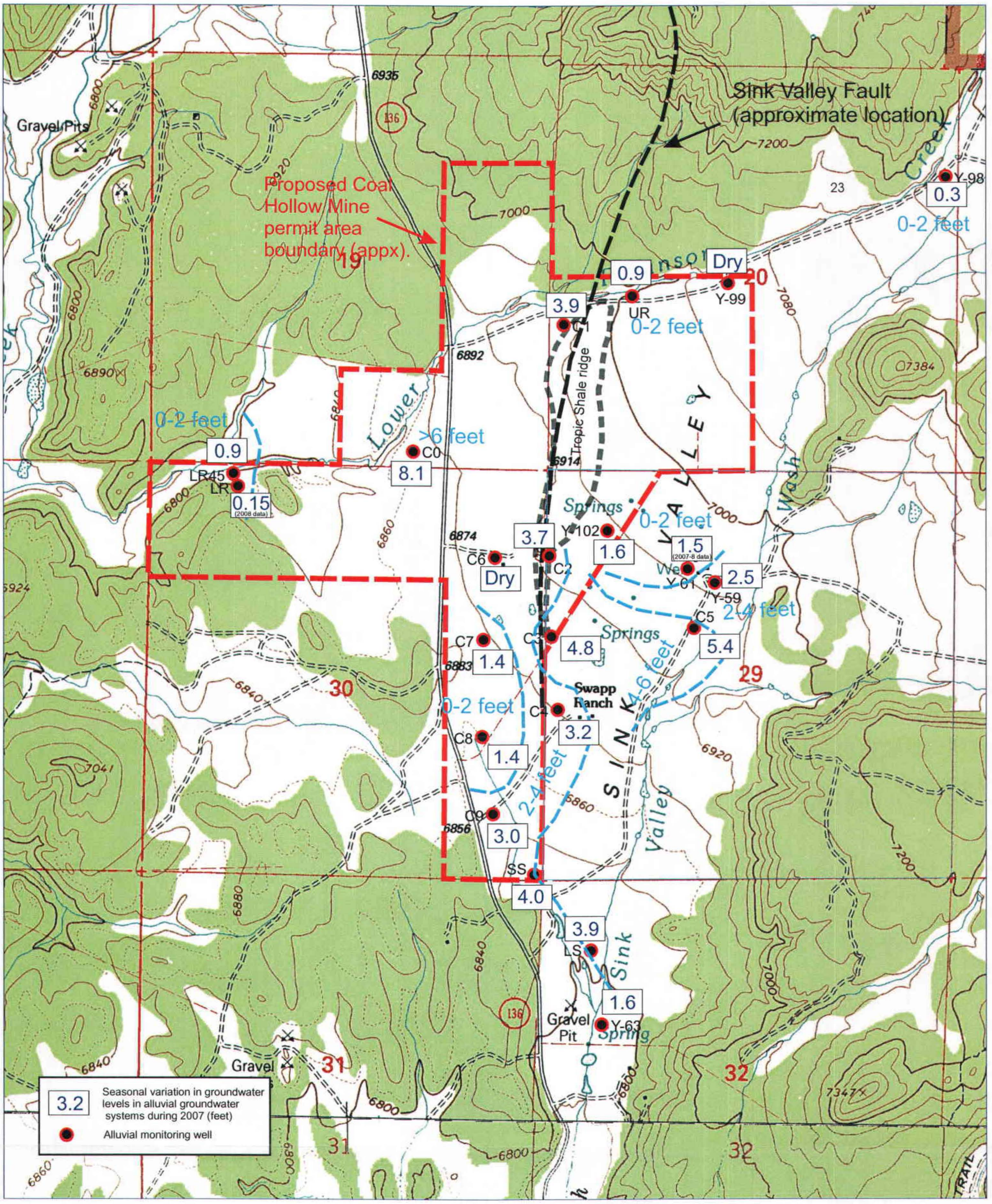

North

0 1,000 2,000

Note: The values presented here represent the difference between the maximum and minimum water level value measured for each well during 2007. Water levels in most wells declined from springtime to fall. Water levels in some wells increased during the early winter, likely in response to the seasonal decrease in the evapotranspiration rate. For specific information for each well, see Figure 3 and Table 1.

Figure 14 Seasonal variation in groundwater levels in the alluvial groundwater systems in the Coal Hollow Mine permit and surrounding area during 2007.

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ERIK CARL PETERSEN
No. 5373615-2250
8/27/09
STATE OF UTAH

Pond

Spring or seep

Mine pit area

Mine disturbance boundary

0 ¼ ½ Mile

0 1000 2000 Feet

North

Figure 15 Locations of springs, seeps, ponds, alluvial groundwater discharge areas, Tropic Shale ridge, Sink Valley Fault, mine pit areas, and the extent of the mine disturbance.

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ERIK CARL PETERSEN
No. 5373615-2250
8/27/09
STATE OF UTAH

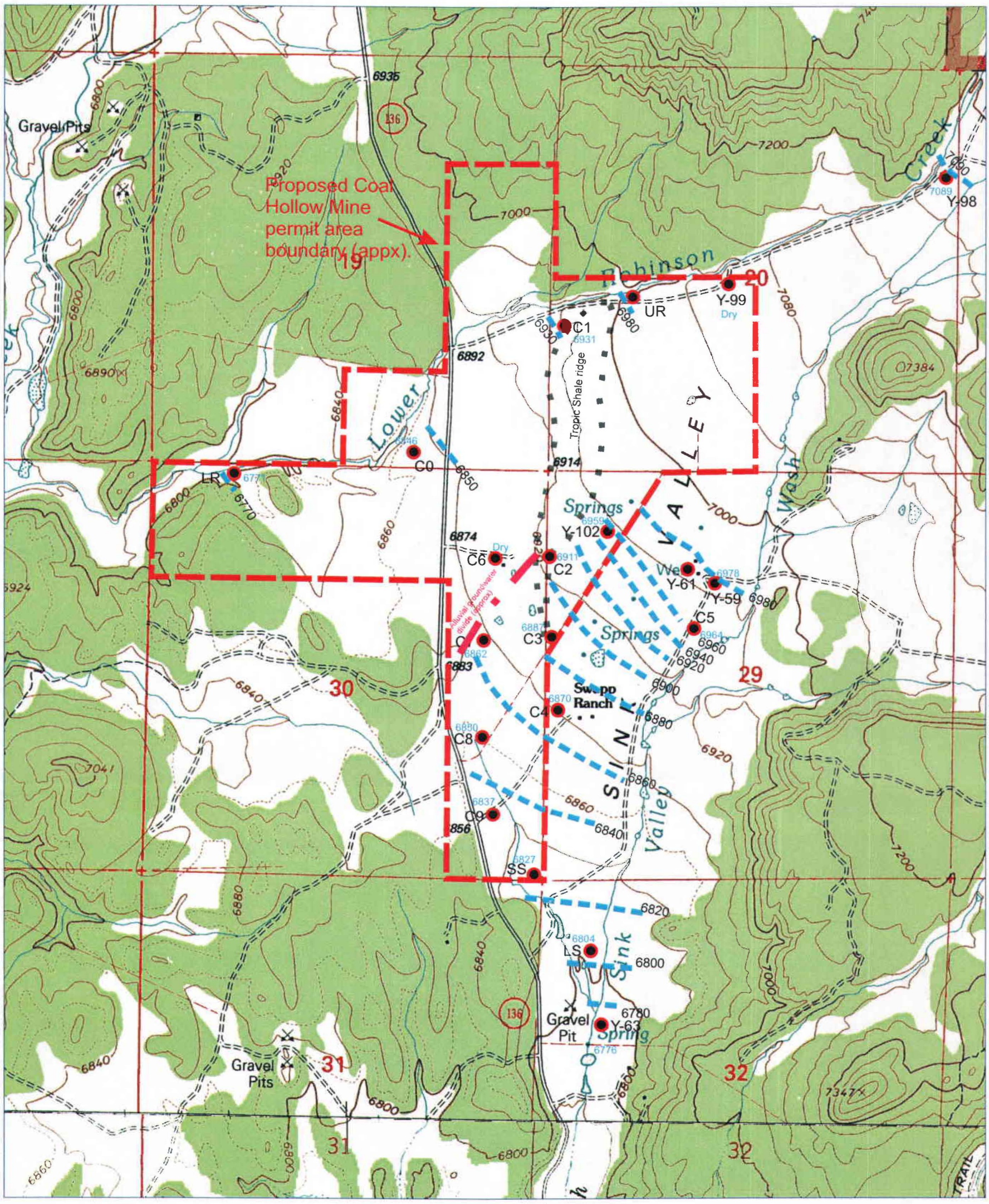

Figure 16a January-February 2007 alluvial groundwater levels.

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ERIK CARL PETERSEN
No. 5373815-2250
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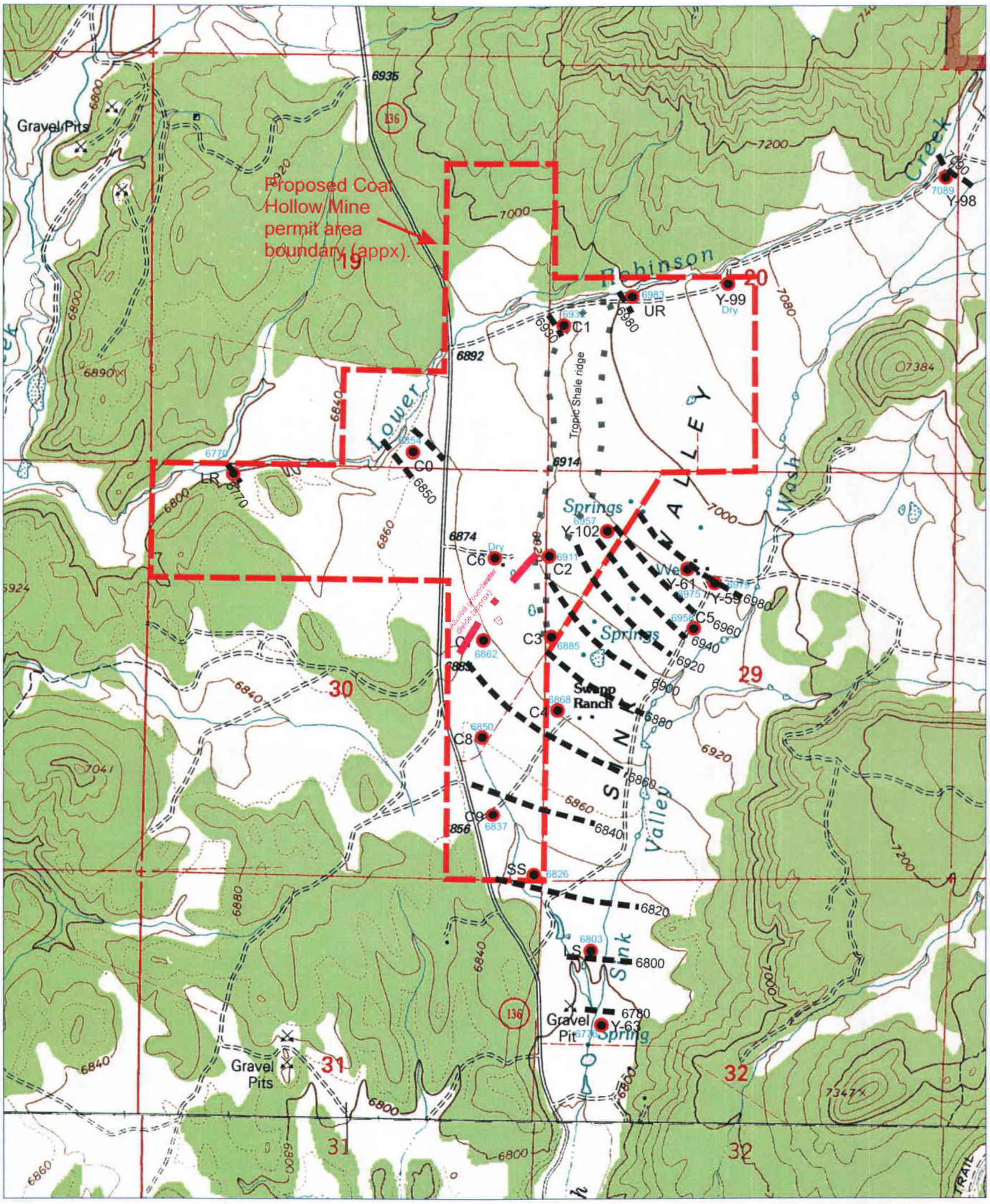

Alluvial monitoring well

6975 Alluvial groundwater elevation (feet above sea level)

0 1,000 2,000

North

Figure 16b June 2007 alluvial groundwater levels.

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ERIK CARL PETERSEN
No. 5373615-2250
8/27/09
STATE OF UTAH

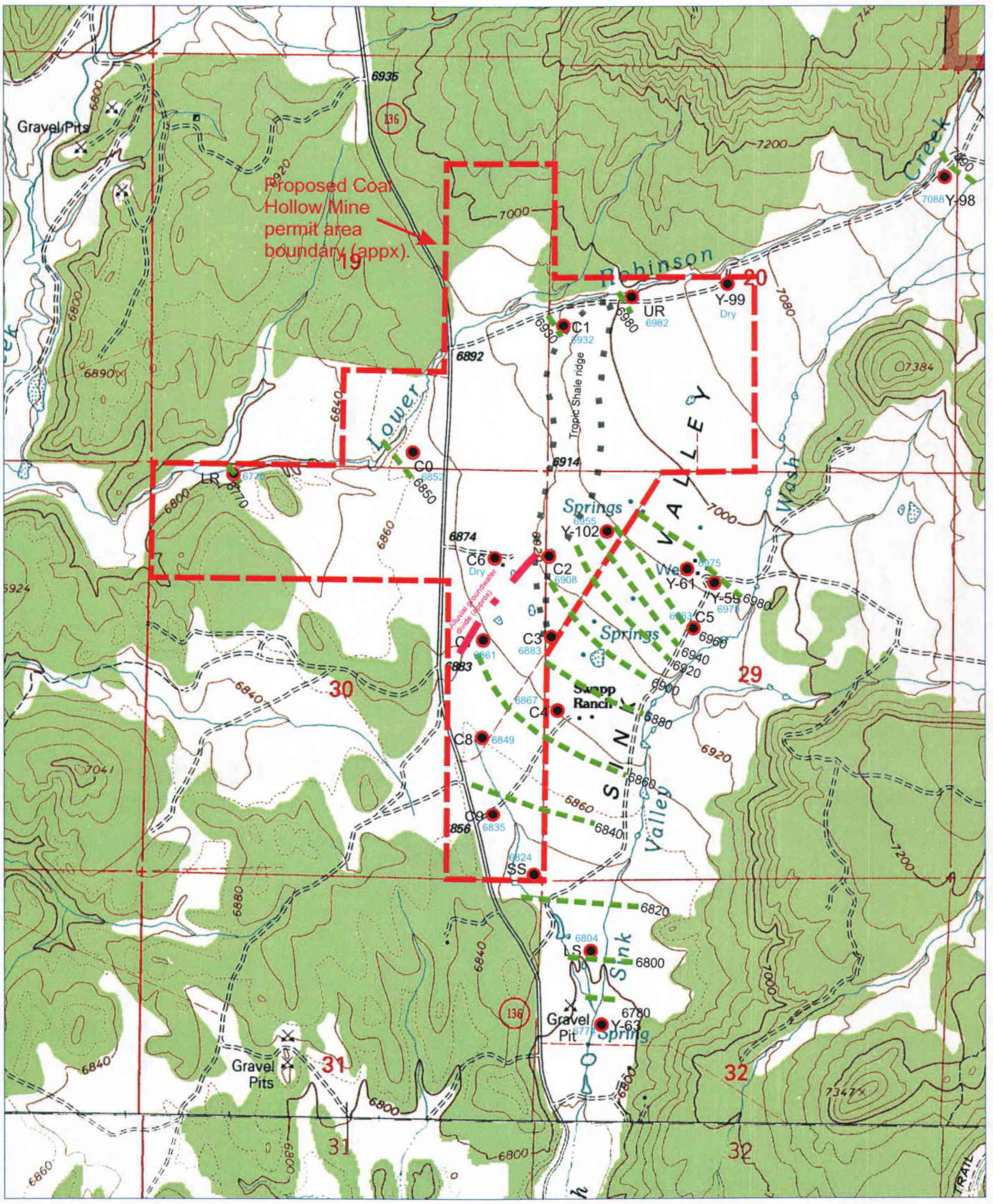

Figure 16c September 2007 alluvial groundwater levels.

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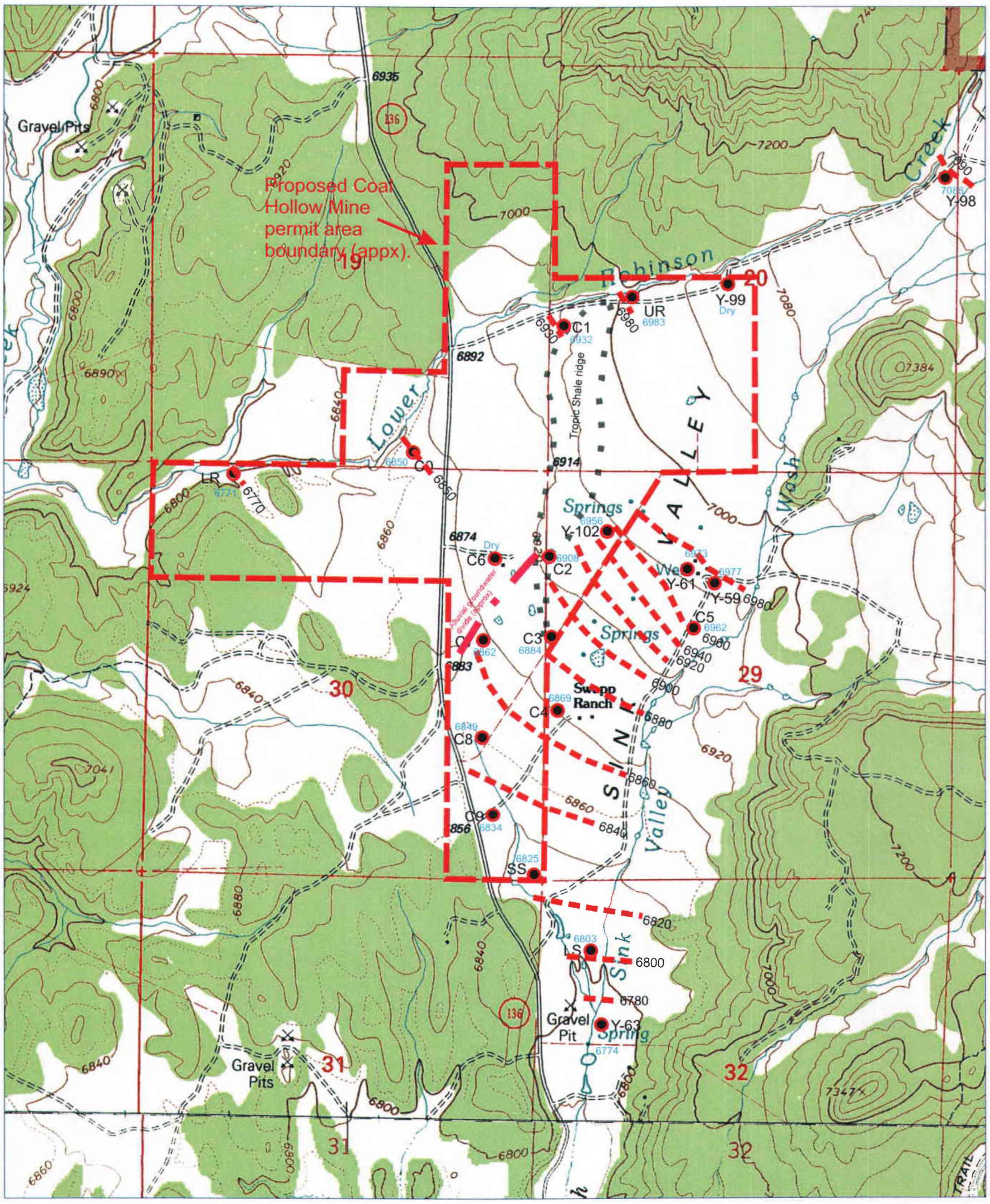

Figure 16d November-December 2007 alluvial groundwater levels.

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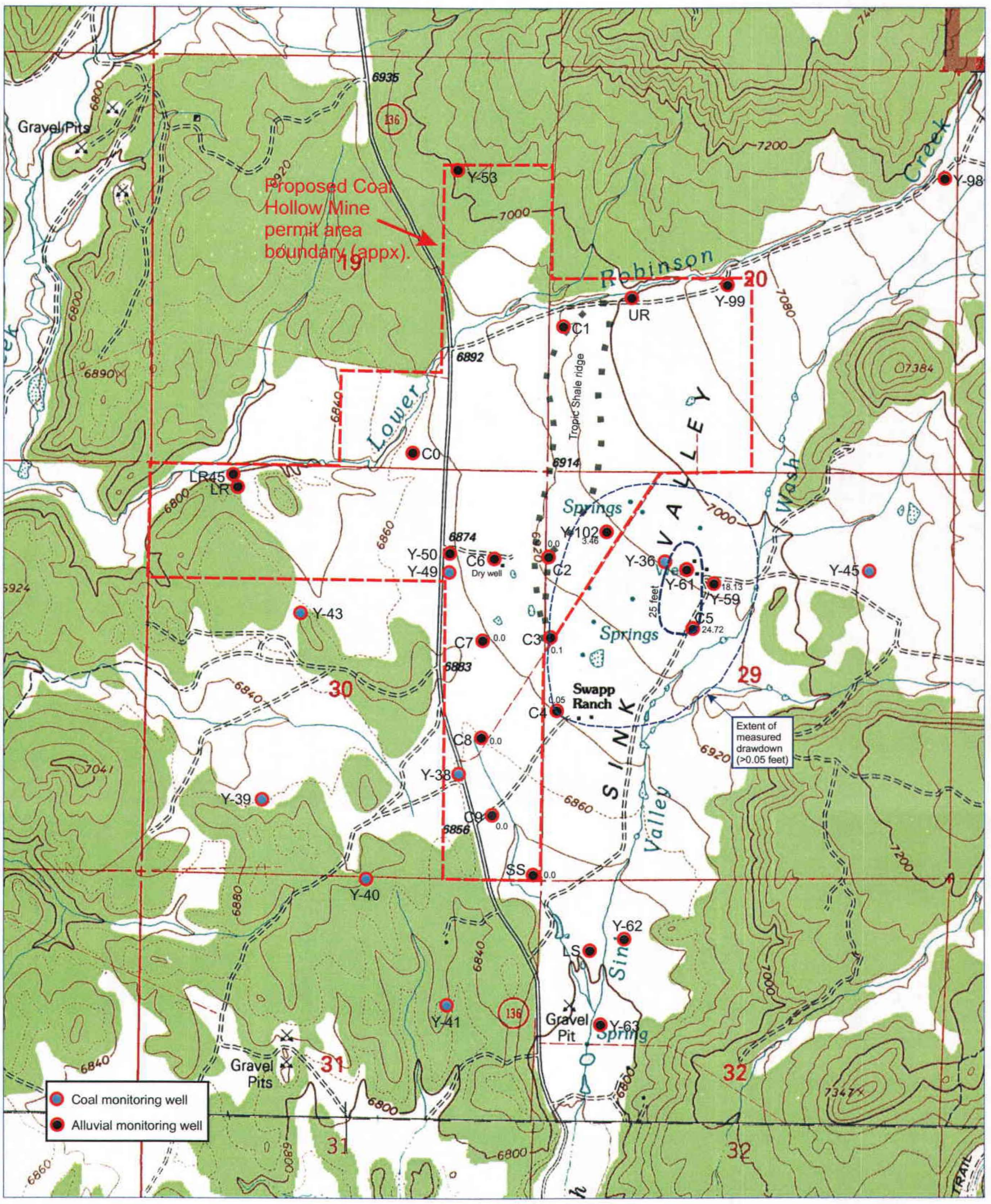

North

0 ¼ ½ Mile

0 1000 2000 Feet

LICENSED PROFESSIONAL GEOLOGIST
ERIK CARL PETERSEN
No. 5373615-2250
08/27/09
STATE OF UTAH

Figure 17 Approximate water level drawdown contour map for the January 2007 pump test of alluvial well Y-61 after 28 hours of pumping. The outer contour shows the limit of measurable drawdown (>0.05 feet). The inner contour shows 25 feet of drawdown. The measured drawdowns are posted next to the monitoring well locations.

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Table 1 Coal Hollow Project alluvial monitoring well depth to water information for 2007.

Well	Collar elevation (feet)	Stick-up (feet)	Date	Depth to water (feet below top of casing)	Depth to water (feet below ground surface)
C0-18	6864.14	4.32	19-Jan-07	18.13	13.81
C0-18	6864.14	4.32	1-Feb-07	18.19	13.87
C0-18	6864.14	4.32	22-Jun-07	10.02	5.70
C0-18	6864.14	4.32	30-Sep-07	12.59	8.27
C0-18	6864.14	4.32	27-Nov-07	13.72	9.40
C1-24	6949.19	2.92	19-Jan-07	20.63	17.71
C1-24	6949.19	2.92	1-Feb-07	18.29	15.37
C1-24	6949.19	2.92	22-Jun-07	16.98	14.06
C1-24	6949.19	2.92	29-Sep-07	16.96	14.04
C1-24	6949.19	2.92	30-Dec-07	16.75	13.83
C2-15	6920.28	1.69	17-Jan-07	9.60	7.91
C2-15	6920.28	1.69	1-Feb-07	9.09	7.40
C2-15	6920.28	1.69	21-Jun-07	9.75	8.06
C2-15	6920.28	1.69	30-Sep-07	12.58	10.89
C2-15	6920.28	1.69	28-Nov-07	12.77	11.08
C2-28	6919.81	1.21	17-Jan-07	8.43	7.22
C2-28	6919.81	1.21	1-Feb-07	8.15	6.94
C2-28	6919.81	1.21	21-Jun-07	9.45	8.24
C2-28	6919.81	1.21	30-Sep-07	12.12	10.91
C2-28	6919.81	1.21	28-Nov-07	12.18	10.97
C2-40	6919.58	0.98	17-Jan-07	8.34	7.36
C2-40	6919.58	0.98	1-Feb-07	8.04	7.06
C2-40	6919.58	0.98	21-Jun-07	9.33	8.35
C2-40	6919.58	0.98	30-Sep-07	11.96	10.98
C2-40	6919.58	0.98	28-Nov-07	12.04	11.06
C3-15	6890.41	1.12	17-Jan-07	3.27	2.15
C3-15	6890.41	1.12	1-Feb-07	2.69	1.57
C3-15	6890.41	1.12	21-Jun-07	5.10	3.98
C3-15	6890.41	1.12	30-Sep-07	7.52	6.40
C3-15	6890.41	1.12	28-Nov-07	6.23	5.11
C3-30	6890.77	1.49	17-Jan-07	3.67	2.18
C3-30	6890.77	1.49	1-Feb-07	3.19	1.70
C3-30	6890.77	1.49	21-Jun-07	5.40	3.91
C3-30	6890.77	1.49	30-Sep-07	7.81	6.32
C3-30	6890.77	1.49	28-Nov-07	6.54	5.05
C3-40	6890.73	1.45	17-Jan-07	3.92	2.47
C3-40	6890.73	1.45	1-Feb-07	3.45	2.00
C3-40	6890.73	1.45	21-Jun-07	5.39	3.94
C3-40	6890.73	1.45	30-Sep-07	7.78	6.33
C3-40	6890.73	1.45	28-Nov-07	6.56	5.11

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Well	Collar elevation (feet)	Stick-up (feet)	Date	Depth to water (feet below top of casing)	Depth to water (feet below ground surface)
C4-15	6873.92	1.64	17-Jan-07	4.29	2.65
C4-15	6873.92	1.64	31-Jan-07	4.04	2.40
C4-15	6873.92	1.64	21-Jun-07	5.52	3.88
C4-15	6873.92	1.64	30-Sep-07	7.22	5.58
C4-15	6873.92	1.64	30-Dec-07	4.52	2.88
C4-30	6873.91	1.62	17-Jan-07	4.11	2.49
C4-30	6873.91	1.62	31-Jan-07	3.89	2.27
C4-30	6873.91	1.62	21-Jun-07	5.27	3.65
C4-30	6873.91	1.62	30-Sep-07	6.95	5.33
C4-30	6873.91	1.62	30-Dec-07	4.52	2.90
C4-50	6873.52	1.24	17-Jan-07	3.48	2.24
C4-50	6873.52	1.24	31-Jan-07	3.27	2.03
C4-50	6873.52	1.24	21-Jun-07	4.47	3.23
C4-50	6873.52	1.24	30-Sep-07	6.03	4.79
C4-50	6873.52	1.24	30-Dec-07	4.02	2.78
C5-130	6938.92	2.13	17-Jan-07	10.75 psi	+27.0
C5-130	6938.92	2.13	29-Mar-07	14.1 psi	+34.7
C5-130	6938.92	2.13	22-Jun-07	8.2 psi	+21.1
C5-130	6938.92	2.13	29-Sep-07	10.5 psi	+26.4
C5-130	6938.92	2.13	30-Dec-07	9.8 psi	+24.8
C6-15	6897.63	1.84	19-Jan-07	dry	---
C6-15	6897.63	1.84	21-Jun-07	dry	---
C6-15	6897.63	1.84	30-Sep-07	dry	---
C6-15	6897.63	1.84	28-Nov-07	dry	---
C7-10	6873.77	3.54	17-Jan-07	11.05	7.51
C7-10	6873.77	3.54	1-Feb-07	10.97	7.43
C7-10	6873.77	3.54	21-Jun-07	11.73	8.19
C7-10	6873.77	3.54	30-Sep-07	12.53	8.99
C7-10	6873.77	3.54	28-Nov-07	11.9	8.36
C7-20	6872.89	2.66	17-Jan-07	10.44	7.78
C7-20	6872.89	2.66	1-Feb-07	10.36	7.70
C7-20	6872.89	2.66	21-Jun-07	10.96	8.30
C7-20	6872.89	2.66	30-Sep-07	11.78	9.12
C7-20	6872.89	2.66	28-Nov-07	11.23	8.57
C8-25	6859.70	2.69	17-Jan-07	9.80	7.11
C8-25	6859.70	2.69	31-Jan-07	9.26	6.57
C8-25	6859.70	2.69	21-Jun-07	9.25	6.56
C8-25	6859.70	2.69	30-Sep-07	10.71	8.02
C8-25	6859.70	2.69	27-Nov-07	10.44	7.75
C9-15	6846.77	2.02	17-Jan-07	9.50	7.48
C9-15	6846.77	2.02	31-Jan-07	9.29	7.27
C9-15	6846.77	2.02	21-Jun-07	9.81	7.79
C9-15	6846.77	2.02	30-Sep-07	12.19	10.17

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Well	Collar elevation (feet)	Stick-up (feet)	Date	Depth to water (feet below top of casing)	Depth to water (feet below ground surface)
C9-15	6846.77	2.02	30-Dec-07	12.3	10.28
C9-25	6846.36	1.61	17-Jan-07	9.71	8.10
C9-25	6846.36	1.61	31-Jan-07	8.91	7.30
C9-25	6846.36	1.61	21-Jun-07	9.44	7.83
C9-25	6846.36	1.61	30-Sep-07	11.83	10.22
C9-25	6846.36	1.61	30-Dec-07	11.98	10.37
C9-40	6846.94	2.19	17-Jan-07	9.71	7.52
C9-40	6846.94	2.19	31-Jan-07	9.51	7.32
C9-40	6846.94	2.19	21-Jun-07	10.04	7.85
C9-40	6846.94	2.19	30-Sep-07	12.47	10.28
C9-40	6846.94	2.19	30-Dec-07	12.55	10.36
SS-15	6831.57	1.57	17-Jan-07	4.13	2.56
SS-15	6831.57	1.57	31-Jan-07	3.82	2.25
SS-15	6831.57	1.57	21-Jun-07	5.54	3.97
SS-15	6831.57	1.57	30-Sep-07	7.78	6.21
SS-15	6831.57	1.57	30-Dec-07	6.55	4.98
SS-30	6830.47	0.47	17-Jan-07	2.81	2.34
SS-30	6830.47	0.47	31-Jan-07	2.48	2.01
SS-30	6830.47	0.47	21-Jun-07	4.21	3.74
SS-30	6830.47	0.47	30-Sep-07	6.56	6.09
SS-30	6830.47	0.47	30-Dec-07	5.33	4.86
SS-75	6832.06	2.06	17-Jan-07	14.20	12.14
SS-75	6832.06	2.06	31-Jan-07	14.93	12.87
SS-75	6832.06	2.06	21-Jun-07	14.52	12.46
SS-75	6832.06	2.06	30-Sep-07	15.07	13.01
SS-75	6832.06	2.06	30-Dec-07	14.42	12.36
UR-29	7004.14	0.97	17-Jan-07	dry	---
UR-29	7004.14	0.97	22-Jun-07	23.27	22.30
UR-29	7004.14	0.97	29-Sep-07	24.53	23.56
UR-29	7004.14	0.97	29-Dec-07	24.00	23.03
UR-70	7005.14	1.97	19-Jan-07	21.51	19.54
UR-70	7005.14	1.97	22-Jun-07	21.69	19.72
UR-70	7005.14	1.97	29-Sep-07	22.9	20.93
UR-70	7005.14	1.97	29-Dec-07	22.38	20.41
LR-45	6798.41	1.71	19-Jan-07	27.51	25.80
LR-45	6798.41	1.71	29-Mar-07	27.56	25.85
LR-45	6798.41	1.71	22-Jun-07	28.12	26.41
LR-45	6798.41	1.71	30-Sep-07	28.03	26.32
LR-45	6798.41	1.71	29-Dec-07	27.2	25.49
LS-15	6810.28	1.79	19-Jan-07	6.38	4.59
LS-15	6810.28	1.79	30-Mar-07	4.96	3.17
LS-15	6810.28	1.79	20-Jun-07	7.56	5.77

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Well	Collar elevation (feet)	Stick-up (feet)	Date	Depth to water (feet below top of casing)	Depth to water (feet below ground surface)
LS-15	6810.28	1.79	30-Sep-07	8.79	7.00
LS-15	6810.28	1.79	30-Dec-07	7.43	5.64
LS-28	6810.23	1.74	19-Jan-07	6.27	4.53
LS-28	6810.23	1.74	30-Mar-07	4.89	3.15
LS-28	6810.23	1.74	20-Jun-07	7.47	5.73
LS-28	6810.23	1.74	30-Sep-07	8.79	7.05
LS-28	6810.23	1.74	30-Dec-07	7.36	5.62
LS-60	6810.35	1.85	19-Jan-07	4.07	2.22
LS-60	6810.35	1.85	30-Mar-07	3.06	1.21
LS-60	6810.35	1.85	20-Jun-07	5.15	3.30
LS-60	6810.35	1.85	30-Sep-07	6.47	4.62
LS-60	6810.35	1.85	30-Dec-07	5.29	3.44
LS-85	6810.53	2.03	20-Jun-07	1.5 psi	+5.5
LS-85	6810.53	2.03	30-Sep-07	0.42 psi	+3.00
LS-85	6810.53	2.03	30-Dec-07	frozen	---
Y-59	6959.06	2.50	16-Jan-07	8.00 psi	+21.0
Y-59	6959.06	2.50	22-Jun-07	8.8 psi	+22.8
Y-59	6959.06	2.50	29-Sep-07	8.2 psi	+21.4
Y-59	6959.06	2.50	30-Nov-07	7.7 psi	+20.3
Y-61	6962.10	2.80	29-Sep-07	5.4 psi	+15.3
Y-61	6962.10	2.80	30-Dec-07	4.8 psi	+13.9
Y-63-62	6789.34	2.67	30-Mar-07	13.45	10.78
Y-63-62	6789.34	2.67	20-Jun-07	13.76	11.09
Y-63-62	6789.34	2.67	30-Sep-07	15.09	12.42
Y-63-62	6789.34	2.67	29-Dec-07	14.95	12.28
Y-98 (A1)	7173.50	3.00	28-Mar-07	84.84	81.84
Y-98 (A1)	7173.50	3.00	21-Jun-07	84.79	81.79
Y-98 (A1)	7173.50	3.00	29-Sep-07	85.02	82.02
Y-98 (A1)	7173.50	3.00	30-Nov-07	85.13	82.13
Y-99 (A2)	7055.54	3.00	28-Mar-07	dry	---
Y-99 (A2)	7055.54	3.00	21-Jun-07	dry	---
Y-99 (A2)	7055.54	3.00	29-Sep-07	dry	---
Y-99 (A2)	7055.54	3.00	30-Nov-07	dry	---
Y-102 (A4)	6950.06	1.41	17-Jan-07	3.9 psi	+10.4
Y-102 (A4)	6950.06	1.41	28-Mar-07	3.4 psi	+9.26
Y-102 (A4)	6950.06	1.41	21-Jun-07	2.9 psi	+8.1
Y-102 (A4)	6950.06	1.41	29-Sep-07	2.0 psi	+6.0
Y-102 (A4)	6950.06	1.41	30-Dec-07	2.5 psi	+7.2

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Table 2 Depth to aquic soil conditions and water table in Coal Hollow Project soils pits.

Soil Pit	Depth to Aquic Soil Conditions	Depth to Water Table	Pit Depth	Soil Pit	Depth to Aquic Soil Conditions	Depth to Water Table	Pit Depth	Soil Pit	Depth to Aquic Soil Conditions	Depth to Water Table	Pit Depth
	Inches	Inches	Inches		Inches	Inches	Inches		Inches	Inches	Inches
1	NA	NW	60	20	NA	NW	96	41	NA	NW	80
2	NA	NW	96	21	50	NW	96	42	NA	NW	48
3	NA	NW	33 sh	22	15	NW	84	43	7	30	96
4	NA	NW	31 sh	23	22	NW	80	44	7	14	96
5	NA	NW	60	24	NA	NW	32 sa	45	5	66	100
6	NA	NW	60	25	NA	NW	33 sa	46	24	44	120
7	NA	NW	60	26	20	84	125	47	32	80	84
8	NA	NW	85	27	90	NW	140	48	30	NW	84
9A	42	NW	100	28	NA	NW	102	49	NA	NW	10 sa
9B	Surface	57	57	29	60	NW	138	50	NA	NW	19 sh
10	68	NW	84	30	36	NW	120 sh	51	NA	NW	64
11	NA	NW	90	31	110	NW	125	52	24	NW	60
12	NA	NW	26 sh	32	90	120	140	53	9	27	60
13	NA	NW	84	33	NA	NW	100	54	19	NW	64
14	24	NW	90	34	NA	NW	70	55	41	NW	62
15	58	NW	96	35	NA	NW	95	56	NA	NW	96
16	36	NW	96	36	NA	NW	85	57	88	NW	100
17	45	NW	80	37	NA	NW	90	58	NA	NW	64
18A	7	51	60	38	12	24	40	59	62	75	76
18B	NA	NW	96	39	NA	NW	75	60	NA	NW	48 sh
19	NA	NW	90	40	6	23	40				

NA No Aquic conditions
NW No Water Table
sh Shale bedrock
sa Sandstone bedrock

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Table 3 Discharge and water quality information for shallow alluvial groundwater in subirrigated areas.

	Date	discharge (gpm)	T (°C)	pH	Cond. (µS/cm)	TDS (mg/L)	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	HCO_3 (mg/L)	CO_3 (mg/L)	SO_4 (mg/L)	Cl (mg/L)	Cl (meq/L)	B (mg/L)	SAR
SP-6	3-Jul-87	Seep	18.8		3485												
SP-6	5-Aug-87	Seep	19.1		2900												
SP-6	17-Sep-87	Seep	12.0		3140	2280	32	426	156		1268	<5	798	56	1.58	0.47	1.59
SP-6	28-Oct-87	Seep	12.3		2520												
SP-6	17-Nov-87	Seep	7.9		2830												
SP-6	9-Dec-87	Seep	6.1		2385	1638	19	371	95		1069	<5	492	44	1.24	0.31	1.04
SP-6	15-Jan-88	Seep	5.6		2350												
SP-6	15-Feb-88	Frozen	---	---	---												
SP-6	11-Mar-88	Seep	3.0		2265	1598	14	334	72		913	<5	572	46	1.30	0.20	0.83
SP-6	24-Sep-05	Seep	16.0	7.41	1310	707	84.1	98.1	33	7.87	602	<5	112	6	0.17	0.10	0.58
SP-6	3-Nov-05	Seep	10.5	7.76	1602	1083	84.5	133	81.3	18.8	612	<5	301	44	1.24	0.14	1.28
SP-6	3-Nov-05		10.5	7.76	1602	1083	84.5	133	81.3	18.8	746.16	<5.	301	44	1.24	0.14	1.28
SP-6	29-May-06	0	25.2	8.12	1475	944	63.4	162	55.6	5.58	948.55	<5.	139	6	0.17	0.21	0.84
SP-6	7-Sep-06	<0.05	15.4	7.53	1038	666	71.06	89.43	38.5	10.14	587.66	<5.	126	23	0.65	0.1	0.72
SP-6	30-Dec-06	<0.05	5.6	7.91	1175	935	81.17	152.19	46.92	4.08	657.16	<5.	300	19	0.54	0.09	0.71
SP-6	30-Mar-07	0	2.2	8.46	2920	2365	13.3	505	113	4.52	1569.1	<5.	807	52	1.47	0.25	1.07
SP-8	3-Jul-87	10.0	10.9		785												
SP-8	5-Aug-87	8.6	10.7		795												
SP-8	18-Sep-87	10.0	11.2	7.25	725	386	81	56	6	2	308	<5	76	5	0.14	<0.02	0.13
SP-8	27-Oct-87	10.7	10.8		750												
SP-8	15-Nov-87	10.0	7.5		715												
SP-8	9-Dec-87	10.0	10.0	6.8	765	420	88	60	6	2	329	<5	76	5	0.14	<0.02	0.12
SP-8	9-Jan-88	15.9	12.0		685												
SP-8	18-Feb-88	15.4	7.8		675												
SP-8	18-Mar-88	12.2	10.1	7.4	725	438	77	50	6	2	324	<5	82	5	0.14	<0.02	0.13
SP-8	27-May-05	17.6	10.3	7.89	642	456	73.6	54.5	7.44	1.37	328	<5	77	4	0.11	0.02	0.16
SP-8	24-Sep-05	9.1	9.6	7.27	704	426	83.7	54.5	6.87	1.60	338	<5	71	3	0.08	0.02	0.14
SP-8	27-May-05	17.6	10.3	7.89	642	456	73.6	54.5	7.44	1.37	399.9	<5.	77	4	0.11	0.02	0.16
SP-8	24-Sep-05	9.1	9.6	7.27	704	426	83.7	54.5	6.87	1.6	412.09	<5.	71	3	0.08	0.02	0.14
SP-8	4-Nov-05	12.8	9.6	7.48	706	413	80.1	47.7	6.47	1.43	406	<5.	65	2	0.06	0.02	0.14
SP-8	31-Mar-06	20.3	9.3	7.1	716	407	79.7	49.4	6.55	1.47	335	<5	74	4	0.11	0.02	0.14
SP-8	31-Mar-06	20.3	9.3	7.1	716	407	79.7	49.4	6.55	1.47	408.44	<5.	74	4	0.11	0.02	0.14
SP-8	29-May-06	14.3	10.5	7.75	701	432	83.8	52.4	6.99	1.67	410.88	<5.	69	4	0.11	0.03	0.15
SP-8	30-Dec-06	19.3	8.1	7.79	668	417	85.06	50.96	6.98	1.34	413.31	<5.	72	3	0.08	0.02	0.15
SP-8	29-Mar-07	19.6	9.4	7.5	696	433	81.8	51.4	7.02	1.38	413.31	<5.	75	4	0.11	0.02	0.15

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Table 4. Average root density and size by depth for plant communities in the Coal Hollow project area.

	Plant Community						
	M	M dry	OB	P	PJ	RB/SB	SG
	Soil Depth to Bottom of Root Feature (Inches)						
Root Density							
Many	11	11	3	3	0	12	4
Common	37	38	35	23	15	24	18
Few	52	79	90	65	30	60	57
Root Size							
Coarse	0	8	69	1	14	0	7
Medium	39	18	78	18	18	24	17
Fine	44	72	78	46	24	48	34
Very Fine	48	79	90	64	30	60	57
Soil Features							
Bedrock					31		
Depth to Mottles	11	36	Note 1	Note 2	Note 3		Note 4
Hole Depth	65	85	90	93	41	84	85

Notes

1 One of two soil data points in the oak brush (OB) plant community had soil mottles (15 inches in soil pit 22).

2 Seven of sixteen soil data points in the pasture (P) plant community had soil mottles (50 inch average depth for the seven soil data points).

3 One of five soil data points in the pinyon-juniper (PJ) plant community had soil mottles at 30 inches, but these were most likely the result of infiltrating surface water perching within the very dense clay subsoil.

4 Five of twenty soil data points in the sage-grass (SG) plant community had soil mottles (52 inch average depth for the five soil data points).

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Table 5. Definitions of root density and size terms used in soil pit descriptions (Schoeneberger et. al., 2002).

Root Density		Root Size	
Many	>5 roots per unit area	Coarse	5 to 10 mm
Common	1 to 5 roots per unit area	Medium	2 to 5 mm
Few	<1 root per unit area	Fine	1 to 2 mm
		Very fine	<1 mm

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Table 6. Soil map units that exhibit soil characteristics of potential sub-irrigation.

Soil Map Unit	Soil map Unit Name[1]	Sub-Irrigated[2]
1	A family – Wapiti Family complex, 3 to 8% slopes	No
2	M Family – Calendar family – D Family complex, 3 to 8% slopes	No
3	Cibeque Family – Wapiti Family complex, 3 to 8% slopes	No
4	Jonale Family – Graystone cobbly substratum Family – Wapiti Family complex, 3 to 8% slopes	No
5	Calendar Family – M Family – Drifity Family complex, 8 to 25% slopes	No
6	Graystone – Cookcan – Jonale family complex, 1 to 5% slopes	Localized Potential[3]
7	Happyhollow Family – Alamosa complex, 1 to 5% slopes	Yes
8	Brumley – Graystone – Snilloc complex, 3 to 8% slopes	No
9	D Family – Deacon complex, 5 to 30% slopes	No
10	Zigzag clay, 8 to 25% slopes	No
11	A Family clay, 8 to 25% slopes	No
12	Manzanst Taxadjunct Family clay, 3 to 12% slopes	No
13	A Family – Happyhollow Family complex, 1 to 5% slopes	Localized Potential[3]

Footnotes:

1 Soil map unit descriptions are available in section 2 of the Coal Hollow soil survey report (Appendix 2-1 of MRP).
2 Potential for sub-irrigation is based on the taxonomic classification of the soil components in each map unit.
3 Localized potential occurs when one major soil component has the potential for sub-irrigation.

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Table 7 Plant communities that exhibit soil and vegetation characteristics of sub-irrigation based on the dominant conditions.

Plant Community	Sub-Irrigated
Meadow (M)	Yes
Meadow – dry (M dry)	Localized Potential
Oak brush (OB)	No
Pasture (P)	No
Pinyon Juniper (PJ)	No
Rabbitbrush – sagebrush (RB/SB)	No
Sagebrush – grass (S/B)	No

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Table 8 Monthly water requirements (evapotranspiration) for plants in Alton, Utah (after Hill and Heaton, 2001).

	Monthly Crop Evapotranspiration (inches)						
Plant	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Season Total**
Alfalfa	---	4.96	8.31	6.26	7.11	0.51	27.16
Pasture	0.61	4.01	5.4	5.59	4.85	2.85	23.31
Sp. Grain	0.30	3.13	8.05	8.28	1.97	---	21.73
Turf	1.06	3.72	4.65	4.82	4.18	2.89	

Adapted from: Consumptive Use of Irigated Crops in Utah, Utah Agricultural Experiment Station Research Report No. 145. Oct. 1994.

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Table 9 Discharge and water-quality information for surface waters that could potentially be used for flood irrigation.

	Date	discharge (gpm)	T (°C)	pH	Cond. (µS/cm)	TDS (mg/L)	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	HCO_3 (mg/L)	CO_3 (mg/L)	SO_4 (mg/L)	Cl (mg/L)	Cl (meq/L)	B (mg/L)	SAR
Section 21 Canyon drainage																	
SW-7	2-Jul-87	Dry															
SW-7	4-Aug-87	Dry															
SW-7	6-Sep-87	Dry															
SW-7	27-Oct-87	Dry															
SW-7	15-Nov-87	Dry															
SW-7	4-Dec-87	Dry															
SW-7	5-Jan-88	Dry															
SW-7	16-Feb-88	Dry															
SW-7	18-Mar-88	Dry															
SW-7	4-Nov-05	Dry															
SW-7	7-Sep-06	Dry															
SW-7	21-Dec-06	Dry															
SW-7	28-Mar-07	Dry															
SW-7	21-Jun-07	Dry															
SW-7	29-Sep-07	Dry															
SW-7	30-Nov-07	Dry															
Swapp Hollow																	
SW-8	6-Jul-87	36	10.3	8.5	490	286	37	38	7.00	1	228	<5	31	10	0.28	<0.01	0.19
SW-8	6-Aug-87	22	14.1	8.4	490	262	44	36	5.00	1	241	<5	14	3	0.08	<0.02	0.14
SW-8	17-Sep-87	40	7.1	8.5	480	245	51	40	4.00	1	232	<5	21	3	0.08	<0.02	0.10
SW-8	28-Oct-87	36	18.2	8.2	430	256	48	38	5.00	1	241	<5	27	4	0.11	<0.02	0.13
SW-8	17-Nov-87	40	9	8.2	525	302	49	36	4.00	1	243	<5	29	3	0.08	<0.02	0.11
SW-8	15-Dec-87	13	0.8	7.7	585	338	57	40	6.00	1	300	<5	33	7	0.20	<0.02	0.15
SW-8	13-Jan-88	40	0.3	8.2	550	306	47	38	4.00	1	250	<5	33	7	0.20	<0.02	0.11
SW-8	17-Feb-88	49	-0.3	8.1	565	324	61	40	4.00	1	273	<5	31	3	0.08	<0.02	0.10
SW-8	21-Mar-88	49	1.5	8.2	610	290	56	38	4.00	1	263	<5	29	<1		<0.02	0.10
SW-8	18-Jun-05	290	17.5	8.38	566	366	59.2	44.1	6.75	1.03	368	<5.	34	5	0.14	0.02	0.16
SW-8	12-Aug-05	130	17.8	8.41	493	274	51.4	37.7	6.63	1.03	243	<5	38	4	0.11	0.02	0.17
SW-8	24-Sep-05	69	14.0	8.36	536	298	48.4	38.9	6.09	0.99	250	<5	33	4	0.11	<0.02	0.16
SW-8	24-Sep-05	69	14	8.36	536	298	48.4	38.9	6.09	0.99	305	<5.	33	4	0.11	0.02	0.16
SW-8	4-Nov-05	71	6.2	8.63	555	321	59.8	39	7.95	1.04	265	<5	49	4	0.11	0.01	0.20
SW-8	30-May-06	35	23.2	8.89	586	350	44.7	39.4	11.7	1.22	274	<5.	69	7	0.20	0.03	0.31
SW-8	7-Sep-06	50.7	12.5	8.01	576	331	47.48	39.92	17.75	1.75	288	<5.	89	7	0.20	0.02	0.46
SW-8	20-Dec-06	32.1	10.1	8.84	553	337	64.07	39.43	8.45	0.91	335	<5.	46	5	0.14	0.64	0.20
SW-8	29-Mar-07	33.6	2.2	8.68	524	324	59.6	36.4	9.2	0.96	322	<5.	49	5	0.14	0.01	0.23

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	Date	discharge (gpm)	T (°C)	pH	Cond. (µS/cm)	TDS (mg/L)	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	HCO_3 (mg/L)	CO_3 (mg/L)	SO_4 (mg/L)	Cl (mg/L)	Cl (meq/L)	B (mg/L)	SAR
SW-8	22-Jun-07	13.8	20.2	8.66	566	356	55.1	41.0	10.5	6.52	328	<5	45	8	0.23		0.26
SW-8	29-Sep-07	10.4	13.6	8.70	561	353	58.7	42.6	9.94	1.94	334	<5	56	6	0.17		0.24
SW-8	30-Nov-07	12.5	0.4	8.16	445												
Sink Valley																	
SW-6	17-Sep-87	Dry	11.0	8.70	860	556	34	98	29.00	11	292	40	140	18	0.51	0.21	0.57
SW-6	15-Dec-87	Dry	0.8	8.3	1840	1212	51	209	73.00	9	602	37	418	41	1.16	0.21	1.01
SW-6	11-Mar-88	Dry	1.5	8.4	1600	992	45	182	63.00	5	590	<5	344	34	0.96	0.16	0.93
SW-6	17-Jun-05	Dry															
SW-6	30-Mar-06	58	13.8	8.91	1352	1028	58.9	161	31.30	12.5	436	47	361	22	0.62	0.17	0.48
SW-6	16-May-06	Dry															
SW-6	29-May-06	Dry															
SW-6	7-Sep-06	Dry															
SW-6	30-Dec-06	Dry															
SW-6	20-Jun-07	Dry															
SW-6	30-Sep-07	Dry															
SW-6	30-Dec-07	Dry															
Robinson Creek																	
SW-4	2-Jul-87	Dry															
SW-4	4-Aug-87	Dry															
SW-4	6-Sep-87	Dry															
SW-4	27-Oct-87	Dry															
SW-4	15-Nov-87	Dry															
SW-4	4-Dec-87	Dry															
SW-4	5-Jan-88	Dry															
SW-4	16-Feb-88	Dry															
SW-4	18-Mar-88	Dry															
SW-4	27-May-05	539	19.1	8.4	453	283	47.7	35.8	2.23	0.6	297.49	<5.	18	2		0.01	0.06
SW-4	4-Nov-05	Dry															
SW-4	16-May-06	Dry															
SW-4	8-Sep-06	Dry															
SW-4	21-Dec-06	Dry															
SW-4	28-Mar-07	Dry															
SW-4	29-Mar-07	Dry															
SW-4	21-Jun-07	Dry															
SW-4	29-Sep-07	Dry															
SW-4	29-Dec-07	Dry															
SW-5	10-Aug-87	13.5	27.5	8.65	1680	984	39	160	69	7	433	49	403	24	0.68	0.17	1.09

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	Date	discharge (gpm)	T (°C)	pH	Cond. (µS/cm)	TDS (mg/L)	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	HCO_3 (mg/L)	CO_3 (mg/L)	SO_4 (mg/L)	Cl (mg/L)	Cl (meq/L)	B (mg/L)	SAR
SW-5	14-Sep-87	13.5	9.0	8.65	1480	1008	49	162	61	5	444	12	368	3	0.08	0.11	0.94
SW-5	29-Oct-87	58	12.5	8.10	1070	666	42	105	49	4	290	<5	298	19	0.54	0.08	0.92
SW-5	18-Nov-87	Puddle	1.2	8.00	1305	886	54	129	58	4	402	16	350	21	0.59	0.06	0.98
SW-5	11-Feb-88	36	0.0	8.00	665	446	46	59	23	6	204	<5	163	10	0.28	0.02	0.53
SW-5	17-Mar-88	4.5	9.1	8.20	1670	876	54	104	55	5	378	<5	344	21	0.59	0.06	1.01
SW-5	17-Mar-88	4.5	9.1	8.2	1670												
SW-5	27-May-05	410	18	8.46	721	469	63	60.6	20.2	1.84	405	8.3	144	6	0.17	0.04	0.44
SW-5	25-Sep-05	Dry															
SW-5	30-May-06	5.37	11.4	8.88	1543	1205	69.8	148	85.2	5.67	513	<5.	503	26	0.73	0.16	1.32
SW-5	7-Sep-06	4.96	13.7	8.36	1394	1081	59.04	143.68	83.11	6.02	456	<5.	474	27	0.76	0.16	1.33
SW-5	30-Dec-06	Dry															
SW-5	29-Mar-07	Dry															
SW-5	22-Jun-07	Dry															
SW-5	29-Sep-07	14.1	9.6	8.56	960	751	75.3	95.7	38.3	6.57	372	<5	300	15	0.42		0.69
SW-5	29-Dec-07	Dry															
SW-101	27-May-05	734	17.7	8.41	495	309	54.2	36	4.67	1.02	421	13	45	4	0.11	0.02	0.12
SW-101	31-Mar-06	20.8	8.6	8.62	3120	3013	356	148	282	16.4	820	<5	1899	47	1.33	0.19	3.17
SW-101	21-May-06	Dry															
SW-101	25-Sep-05	Dry															
SW-101	3-Nov-05	Dry															
SW-101	21-Dec-06	Dry															
SW-101	30-Dec-06	Dry															
SW-101	20-Jun-07	Dry															
SW-101	30-Sep-07	Dry															
SW-101	26-Dec-07	Dry															
Water Canyon																	
RID-1	4-Nov-05	64.7	1.0	8.73	376	250	47.5	36.8	1.76	0.87	290	<5	16	2	0.06	<0.01	0.05
RID-1	29-May-06	48.6	10.4	8.89	412	265	36.3	36.1	1.9	0.88	267	<5	17	3	0.08	0.01	0.05
RID-1	8-Sep-06	31.0	18.3	8.37	440	222	43.8	34.9	1.64	0.9	271	<5	17	3	0.08	<0.01	0.04
RID-1	21-Dec-06	6.2	0.1	8.87	470	273	54.32	35.8	1.85	0.9	295	18	19	2	0.06	<0.01	0.05
RID-1	28-Mar-07	12.8	1.5	8.83	412	254	43.7	32.6	1.69	0.64	272	20	17	2	0.06		0.05
RID-1	21-Jun-07	3.45	14.2	8.97	359	224	24.9	37.1	2.28	1.21	218	17	18	2	0.06		0.07
RID-1	29-Sep-07	6.64	12.7	8.81	416	245	41.4	37.5	1.83	1.12	257	27	19	2	0.06		0.05
RID-1	29-Dec-07	Dry															

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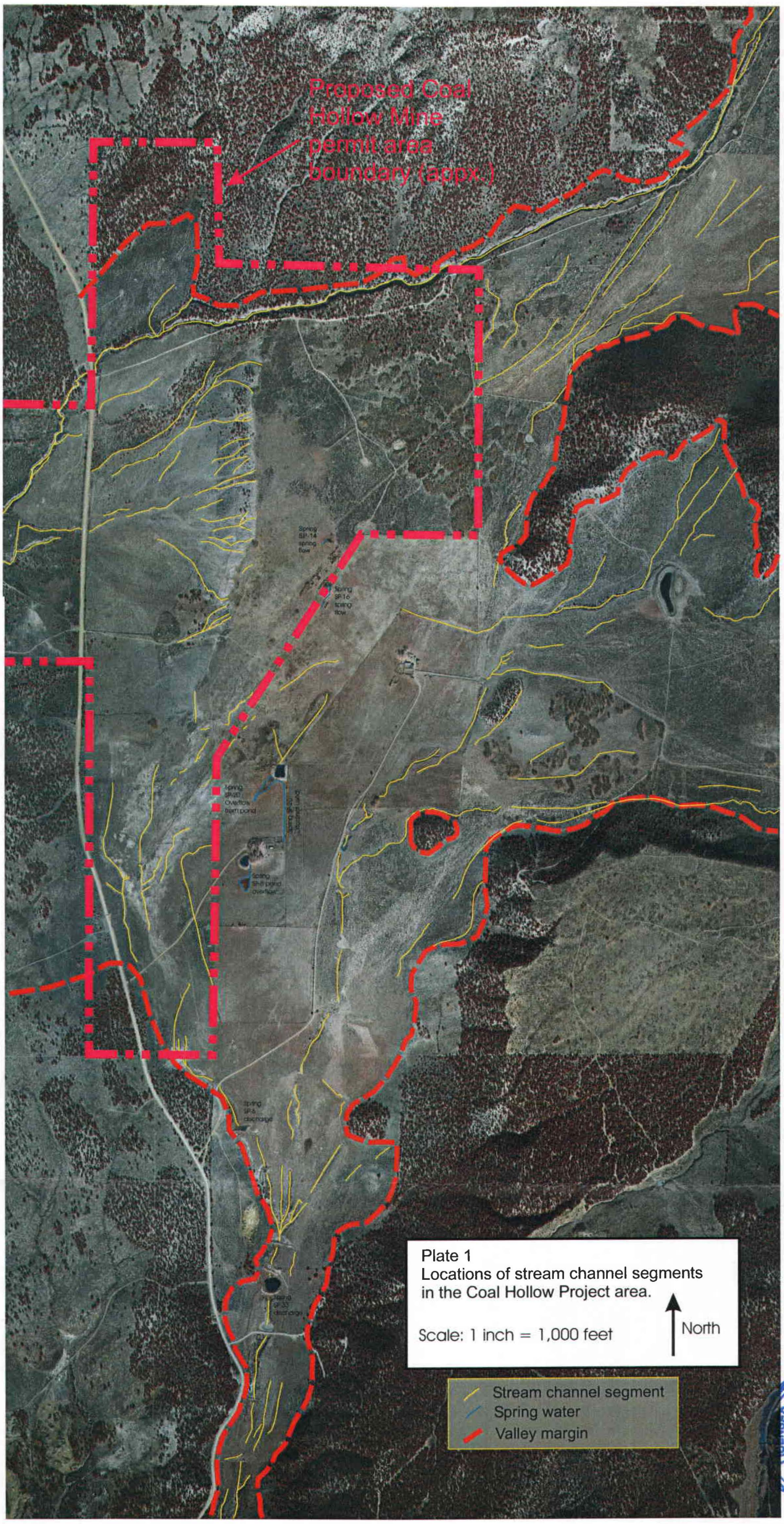

Plate 1
Locations of stream channel segments in the Coal Hollow Project area.

Scale: 1 inch = 1,000 feet

North

LICENSED PROFESSIONAL GEOLOGIST
ERIK CARL PETERSEN
No. 5373615-2250
8/27/09
STATE OF UTAH

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Appendix 7-7: Exhibit 1

Subirrigation Investigation - Field Notes
for
Valley Area of Section 32 T39S, R5W
and
Southwest Corner of Section 29 T39S, R5W

By: Patrick D. Collins, Mt. Nebo Scientific, Inc.
Robert E. Long, Long Resource Consultants, Inc.

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ALTON AREA FIELD NOTES

Stop	1	UTM Zone NAD	12 1927		0371745 E. 4138165 N.
Notes:	Upland area, no evidence of sub-irrigation. Correlate to soil pit 51.				
Horizon	Depth (cm)	Texture	CaCO3	Redox	Notes
A	0-20	SL	---	---	
Bt	20-35	CL	---	---	
Btk	35-55+	CL	10% fine carbonate masses	---	
Vegetation:	Juar/Agcr Community (50:50)				

Investigator(s): R.E. Long, P.D. Collins

Photo(s)

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ALTON FIELD NOTES

Stop	2	UTM Zone NAD	12 1927	0371819 E. 4138133 N.	
Notes:	Concave area at similar elevation as stop 1; surface runoff water appears to have perched on clays when water ponds on surface. Correlate to soil pit 40.				
Horizon	Depth (cm)	Texture	CaCO3	Redox	Notes
A	0-10	CL			
Bt	10-28	C			
B	28-42	C		12% fine and medium distinct mottles	
Vegetation:	Juar Community				

Investigator(s): R.E. Long, P.D. Collins

Photo(s)

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ALTON FIELD NOTES

Stop	3	UTM Zone NAD	12 1927	0371953 E. 4137889 N.

Notes: This stop was at the south edge of an artesian well wet area. Soil moisture appears to be the result of water from adjacent artesian well perching in the heavy textured Bt horizon. Deeper moisture is likely result of underlying sandstone (described at stops 4 and 5).

Horizon	Depth (cm)	Texture	CaCO3	Redox	Notes
A	0-15	SL		---	Dry
Bt	15-22	CL		6% faint fine mottles	Dry
C1	22-58	SCL	12% fine carbonate masses	---	Dry
C2	58-65	SL		2% faint fine mottles	Slightly moist

Vegetation: Cami/Agst/Juar Community (40:40:20)

Investigator(s): R.E. Long, P.D. Collins

Photo(s)

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ALTON FIELD NOTES

Stop	4	UTM Zone NAD	12 1927		0371937 E. 4137877 N.
Notes:	Surface runoff from the adjacent artesian well appears to perch at the surface on top of the subsoil.				
Horizon	Depth (cm)	Texture	CaCO3	Redox	Notes
A	0-8	SCL		4% distinct fine and medium mottles	Dark brown.
Bw	8-25	SCL		---	Yellowish brown.
Cr	25-36	SCL		---	Black weathered shale; slight effervescence.
2Cr	36-60	L	Carbonates disseminated throughout	---	White sandstone; violent effervescence.
2R	60+	---		---	Sandstone.
Vegetation:	Carex sp. Community				

Investigator(s): R.E. Long, P.D. Collins

Photo(s)

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ALTON FIELD NOTES

Stop	5	UTM Zone NAD	12 1927		371893 E. 4137839 N.
Notes:	Profile on east side of erosion cut. No evidence of soil mottles.				
Horizon	Depth (cm)	Texture	CaCO3	Redox	Notes
A & B	0-53	SL		---	Estimated 16% clay.
C1	53-80	---		---	Weathered Mancos shale
Cr	80-98	---			Weathered sandstone
R	98-106	---			Harder sandstone, augering more difficult
Vegetation:	Artr/Brin Community (on channel bank)				

Investigator(s): R.E. Long, P.D. Collins

Photo(s)

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APPENDIX 7-9

Alluvial Water Contingency Plan

By: Erik Petersen, Petersen Hydrologic and
Chris McCourt, Alton Coal Development, LLC

8-26-09

REGISTERED PROFESSIONAL ENGINEER
275875-2202
CHRIS R. MCCOURT
8-26-09
STATE OF UTAH

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Coal Hollow Mine – Alluvial Water Contingency Plan

Introduction

As a method to minimize disturbance to the hydrologic balance in the permit and adjacent area, Alton Coal Development, LLC (ACD) has developed a contingency plan to address the potential for coal mining operations to intersect the distal fringes of an alluvial groundwater system centered to the east of proposed mining areas. This alluvial groundwater system exists in coarse-grained alluvial sediments and in some areas exists under marginally-flowing artesian conditions. Projections of the locations of the coarse-grained sediments associated with this alluvial groundwater system suggest that the westernmost fringes of the system might be intersected by the easternmost extent of the mine workings in mine Pit 15. This contingency plan has been designed to address the "worst case scenario" related to this circumstance and provides a step by step process for minimizing the impacts to the hydrologic balance that could potentially occur.

This plan has been developed using all available geologic and hydrogeologic data, including borehole geologic data, surface geologic mapping, and monitoring well potentiometric information. The data and information have been thoroughly evaluated by Erik Petersen (Hydrogeologist, Petersen Hydrologic) and Chris McCourt (Mine Engineer, Alton Coal Development). Information from the hydrogeologic evaluation has been used to develop a practical contingency plan that is designed to prevent excessive groundwater discharge from the coarse-grained alluvial groundwater system and to prevent the flooding of the mine pit should these circumstances occur.

This report outlines this evaluation and the resulting contingency plan.

Summary

ACD acquired the consulting expertise of Erik Petersen, hydrogeologist beginning in 2005. Mr. Petersen has been commissioned to investigate both the geology and hydrology of Sink Valley and the surrounding areas. Mr. Petersen has extensive experience performing these types of investigations in both practical and coal regulatory settings. He has had 18 years of experience performing detailed hydrogeologic and geologic investigations in coal mining environments in Utah. Investigations performed in the Coal Hollow Mine project area include characterizations of groundwater recharge and discharge mechanisms, determinations of aquifer parameters through pump testing and slug testing analysis, characterization of subsurface sediments and stratigraphy, investigations of groundwater and surface water solute and isotope geochemistry, performance of spring and seep surveys and baseline hydrologic monitoring, and surficial geologic mapping. As a result of this extensive study, Mr. Petersen has acquired an in-depth understanding of both the geology and hydrology of Sink Valley.

Using the considerable quantity of subsurface hydrostratigraphic data available from drilling programs performed by ACD and previous investigators in the Sink Valley area, detailed east-west hydrogeologic cross-sections showing the subsurface geology have been created as requested by the Utah Division of Oil, Gas and Mining (UDOGM) . Subsurface zones that are believed to have significant potential to contain coarse-grained alluvial sediments associated

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with the artesian alluvial groundwater system are also shown. It should be noted that areas identified on the cross-sections as "potential coarse-grained zone" are meant to delineate zones associated with an elevated probability of containing coarse-grained water-bearing alluvium. While the delineation of these zones is based on detailed drilling data, these zones do not necessarily indicate continuous sedimentary layers and are not intended for use in stratigraphic interpretation.

A plan view of the cross-section locations, and the plotted cross-sections are provided in Drawings 7-15 and 7-15B, respectively. In these cross-sections, the alluvium has been divided into two zones, an upper fine-grained alluvium zone and the potential coarse grained alluvium zone discussed above. The potential coarse grained alluvium zone has potential for transporting significant quantities of groundwater because of relatively high hydraulic conductivity. The hydraulic conductivity of the saturated upper fined-grained alluvium zone is much lower than is the coarse-grained zone. Consequently, the potential groundwater flow rates through the fine-grained clayey alluvium are likely orders of magnitude less than that in the deeper coarse-grained zone. Because of the low hydraulic conductivity of the clayey fine-grained alluvium, drainage of large amounts of water through these clayey sediments such that result in adverse impacts to the overall hydrologic balance in Sink Valley would not be anticipated. Accordingly, the focus of this contingency plan is on the coarse-grained alluvial sediments that could potentially be in good hydraulic communication with the alluvial artesian groundwater system centered east of proposed mining areas. Uncontrolled, sustained flows of groundwater from this system could potentially impact the hydrologic balance in the alluvial groundwater system while this drainage persists.

In order to evaluate the potential of the mining process to intersect the coarse-grained alluvium zone, an overlay of the pits on the land surface has been provided in Drawings 7-15 and 7-15B. It is apparent in the review of these cross-sections that the potential to intersect the coarse-gravel zone is isolated to the Pit 15 area. Therefore, the mining process in Pit 15 is the main subject for this plan.

Even though there is the potential for the mining operations to come in contact with the coarse-grained alluvial groundwater system, the following conditions make it practical to minimize potential impacts:

A) The area of potential intersection is isolated to Pit 15.

B) The zone of potential coarse-grained alluvium is within 50 feet of the ground surface where intersection may occur.

C) The coarse-grained alluvium zone is expected to be from 0 to about 30 feet in thickness where it could potentially be contacted.

D) Pit 15 is on the fringe of the probable location of the coarse-grained sediments. Mining equipment will likely first contact thinner distal gravely layers, giving an initial indication of the presence of the coarse-grained system prior to contacting large thicknesses of gravel or large quantities of water.

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E) In the worst case, the bench level in Pit 15 at which the alluvium exists daylights to natural surface topography to the south providing a route to discharge water to Pond 4 until the flows can be controlled. This flow path is shown on Plate 1.

F) The Tropic shale has a high clay content, very low hydraulic conductivity (10^{-8} range), and good compactions characteristics that make it an optimal material for constructing barriers that will impede water flow.

G) The large mining equipment that will be on site is capable of constructing compacted barriers and ditching in a highly efficient and effective manner.

Because of these factors, it is believed that the amounts of water that could reasonably be anticipated to be contacted in the system should be readily manageable as discussed below.

Based on these conditions and the mining process, the following steps have been developed as an action plan should the coarse-grained alluvial groundwater system be intersected:

1) When removing overburden on the initial bench (alluvium) in Pit 15, the shovel operators and operation supervisors will be instructed to proceed with caution, watching for gravels and/or coarse alluvium with water.

2) If the operators contact a gravel layer with a large associated outflow of groundwater (generally considered to be about 1 cubic foot per second (cfs) or more in the initial exposure), the operator will take immediate steps to place shale across the exposed gravel layer to slow the flow.

3) Once the flow is slowed, the operator will contact the operations supervision.

4) The shovel will progress no further to the east and dozers will then be utilized to push the alluvium above the gravel layer to the shovel.

5) Once the dozers have pushed the alluvium down to within approximately five feet of the coarse-gravel supported alluvial groundwater system, removal of overburden will then cease.

6) An excavator will then be placed on the bench that the dozers have created above the system and near the toe of the highwall. The excavator will dig a trench through the coarse alluvium to the Tropic shale. As the trench advances, the excavator will also be used to backfill the trench with shale, using the bucket to compact the shale backfill. This compacted shale will be used as a temporary cutoff wall to impede water flow while mining is completed in Pit 15.

7) Once the trench and the shale barrier have been constructed, mining of Pit 15 will be completed.

8) A permanent barrier will then be constructed as part of the pit backfilling process. Details for this permanent barrier can be viewed in Appendix 7-10.

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A cross sectional view of this step by step process can be viewed on Plate 2 of this appendix. Specifics related to this process are explained further in the Details section of this report and on Plates 1 and 2.

Details

Data Analysis for Cross Sections

The first step toward developing a detailed contingency plan included analysis of all available data to determine where and to what extent the coarse-grained alluvial groundwater system may be intersected. Large amounts of geologic and hydrogeologic data are available for the Sink Valley area. This information has been collected in conjunction with mine permitting activities carried out over the last four years by ACD and also by Utah International as part of previous investigative activities in the area during the 1980's. The geologic and hydrologic information utilized in the development of this contingency plan includes the following:

a) Geologic logs for 35 drill borings located in and adjacent to the permit area

b) Groundwater potentiometric monitoring data from 8 wells in and adjacent to the permit area

c) Groundwater discharge location information

d) Surface geologic mapping and flight photo information

e) Photogrammetric surface topography and gradient information

Five cross-sections showing the details of the geology and hydrology of the Sink Valley area on and adjacent to the proposed Coal Hollow Mine permit area were constructed from this information. Each cross-section extends across Sink Valley west to east, spaced 1,000 feet apart in the north to south direction starting in the center of Pit 15. The cross-section locations can be viewed on Drawing 7-15 and the sections can be viewed on Drawing 7-15B. The proposed mining pits were superimposed onto the cross-sections so that potential impacts to the system associated with mining could be evaluated.

The artesian, coarse-grained alluvial groundwater system in Sink Valley is generally isolated to the deeper portions of the alluvium in the valley. The upper portions of the alluvium are generally comprised of fine-grained sediments, including clays, silts, and fine-grained sands. These two hydrostratigraphic zones are identified on the cross-sections in Figure 7-15B.

The fine-grained alluvium zone is mostly saturated in the pit 15 area, but the potential flux rate through these clayey and silty sediments is low because of the overall low hydraulic conductivity of these sediments. Flowing artesian conditions are generally not observed in wells screened in the fine-grained alluvium zone.

The potential coarse-grained zone is also saturated in the pit 15 area and is typically situated at or shortly above the contact with the underlying Tropic Shale bedrock formation. The coarse-grained system contains gravels and other coarse materials, typically with generally minor clay content. Because of the higher hydraulic conductivity values associated with the coarse-grained sediments, this layer has capacity for high outflows of groundwater where it is exposed in mine

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openings near the base of the alluvium. Based on the current knowledge of the groundwater systems in the area, mining operations will advance cautiously in those areas where reasonable potential for intersection of the mine workings with this coarse-grained zone has been defined.

The mapped locations of subsurface zones considered to have an appreciable probability of containing coarse-grained alluvial sediments that could be in good hydraulic communication with the artesian alluvial groundwater system in Sink Valley are shown on the cross-sections in Drawing 7-15B. The locations of potential coarse-grained alluvium were mapped using all available geologic data. Because of the inherent uncertainties associated with mapping the internal structure of alluvial sediments, conservative assumptions were utilized in the plotting of the locations of the probable coarse-grained alluvium zones (i.e., the lateral extents of the probable coarse-grained zones are generally projected as far to the west as could reasonably be extrapolated based on the drillhole data). The cross-sections were utilized to determine where the coarse-grained sediments were most likely to exist and to determine the best methods to control the flows should the coarse-grained artesian system be contacted in the mine workings.

The cross-sections show that the area with appreciable potential for the intersection of the mine workings and the coarse-grained zone is in the upper bench in Pit 15 (Refer to Drawings 7-15 and 7-15B). This area of focus makes the plan achievable and practical for the planned operations.

Contingency Plan Steps

Mining at the Coal Hollow Mine will be conducted using primarily truck and shovel equipment. This equipment will move overburden from over the coal in benches that are approximately 40 feet in height. These benches are the width of each designed pit (refer to Plate 1 to see numbered pits) which is approximately 200 feet wide. A cross section showing the general steps for this benching process is shown on Plate 2.

The area of concern for contacting the coarse-grained artesian groundwater system is limited to the first bench because the successive benches are located in the Tropic Shale which is highly impermeable. This will allow the equipment to operate at the top of the Tropic Shale when removing the alluvium layer. This provides a solid layer beneath the equipment.

The shovel will advance the overburden face in general from west to east. When moving the alluvium layer in Pit 15 the shovel operator(s) will be instructed to proceed with caution, regularly observing the face for gravel layers that contain water. If a gravel layer is encountered that has a flow of at least 1 cfs, the shovel advance will stop the advance and the operator will take immediate steps to place shale across the exposed gravels to slow the flow. The operations supervision will then be contacted to begin organizing the subsequent steps.

The next step is to place dozers on the fine-grained alluvium overlying the coarse gravels/artesian system. These dozers will push the material in a benched manner to the shovel. This will prevent additional disturbance to the artesian system by allowing the shovel to not excavate through the gravels but still remove the fine-grained alluvium over the system so that a cutoff wall can be installed across the coarse grained/gravel alluvium layer. The dozers will move the fine alluvium to within approximately 5 feet of the gravels.

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This process has now resulted in a fine-grained alluvium bench overlying the coarse grained layer. The remaining fine-grained alluvium combined with the coarse-grained layer are now a thickness that an excavator can excavate through the layers and into the top of the Tropic Shale. The excavator is placed as close to the toe of the now existing alluvium highwall as can be safely accomplished. The excavator will then begin digging a trench approximately 10 feet in width that, as described above, will transect through the alluvium layers down into the top of the shale. As the excavator digs this trench, the truck and shovel fleet will haul Tropic Shale that will be piled next to the excavation. As the excavator advances the trench, it will use the Tropic Shale to backfill the trench, compacting the shale with the bucket. This will construct a cutoff wall across the artesian system that will significantly minimize flows from the system. This trench will be constructed the length of the pit in which the artesian system is present.

Once the cutoff wall is in place, minimizing the flows, the truck and shovel will then proceed with moving the remaining alluvium, leaving a buffer along the cutoff wall. This buffer of alluvium along the cutoff wall will be at minimum 10 feet wide at the top of wall and the slope down to the top of the shale will be at minimum a 1.5:1 slope or the angle of repose for the alluvium.

The truck and shovel fleet will then proceed with removing the Tropic Shale above the coal seam. The highwall below the cutoff wall and the alluvium will be adjusted as necessary to provide a sufficient bench (minimum 40 feet wide) at the alluvium/shale contact elevation. Once the overburden is removed in the steps shown on the Plate 2 cross section, the coal is then mined for Pit 15.

Following the mining of coal, backfill of the Pit 15 will follow. As part of the backfill process, a permanent barrier will constructed along the highwall to prevent or minimize the flow of water from the artesian system into the pit backfill. The details for this permanent barrier are provided in Appendix 7-10.

It should be noted that the primary purpose of this contingency plan is to minimize the potential for any large-scale depletion of the important coarse-grained alluvial groundwater resource in Sink Valley centered east of the proposed mine workings. Groundwater inflows into the mine openings from alluvial horizons that are not in good hydraulic communication with the primary coarse-grained alluvial system are anticipated. Discharges from such hydraulically isolated systems might initially be appreciable, but discharge rates will gradually decline after interception and flows from such systems will likely not persist for long periods of time. The prevention of such inflows is not the intended purpose of this contingency plan. The drainage of saturated alluvial sediments that may exist under perched or hydraulically isolated conditions within and immediately adjoining the mine pit areas is not unanticipated.

Conclusions

Alton Coal Development, LLC with the assistance of Erik Petersen has performed a thorough investigation of the hydrogeology of Sink Valley. From this evaluation a practical contingency plan has been developed for the "worst case scenario" of the mine workings intercepting an appreciable thickness of coarse-grained alluvial sediments that are in good hydraulic communication with the alluvial artesian groundwater system centered east of proposed mining areas. This plan will minimize the impacts to the alluvial artesian water system that is present in

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the valley during the active mining process. The permanent barrier described in Appendix 7-10 will provide a long term barrier to prevent or minimize long-term flows from the alluvial artesian groundwater system into the backfilled pits.

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APPENDIX 7-10

Permanent Shale Barrier

By: Erik Petersen, Petersen Hydrologic
Chris McCourt, Alton Coal Development, LLC and
Alan O. Taylor, Taylor Geo-Engineering, LLC

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TAYLOR GEO-ENGINEERING, LLC

2650 NORTH 180 EAST
LEHI, UTAH 84043
TELEPHONE NUMBER 801-400-9784
FAX NUMBER 801-766-3246

August 26, 2009

Mr. Chris McCourt
Alton Coal Development
463 North 100 West, Suite 1
Cedar City, Utah 84721

Subject: **Contingency Temporary Cutoff Wall and Permanent Barrier for Pit 15**
Alton Coal Development Coal Hollow Project
Alton, Utah
TGE Project No. 307001-2

Dear Mr. McCourt,

As requested, Taylor Geo-Engineering, LLC (TGE) has completed seepage and stability calculations for the proposed contingency cutoff wall and permanent barrier plan for Pit 15. TGE understands that a contained groundwater system is present to the east or up-gradient to the proposed Pit 15. A previous investigation and report by Peterson Hydrologic, LLC (2007) indicated that alluvial groundwater system is characterized by a thick saturated gravel layer contained by impervious shale below the gravel and a less permeable silt and clay layer above the gravel. Hydraulic gradients in the area indicate artesian pressure east of Pit 15 that dissipates to below the surface in the vicinity of pit 15.

The following was provided to TGE: (1) Hydraulic gradients in relation to Pit 15 and east of Pit 15; (2) The stratigraphy of the subsurface through Pit 14 and 15; and, (3) The proposed course of action or contingency plan if the gravel stratum east of Pit 15 is encountered. The purpose of the analysis by TGE was to determine short term seepage through the temporary cut and cutoff wall on the east side of Pit 15 and seepage through the long term barrier as proposed by Alton Coal Development. Additionally TGE was to determine the embankment profile to be used during mining operations that would be located west of the cutoff trench. The results of our analysis are provided below.

Contingency Plan

Alton Coal Development has proposed a contingency plan if the groundwater system located east of Pit 15 is encountered. As part of the plan, a cutoff trench would be installed along the east side of Pit 15. The cutoff trench is to be installed by excavating down 40 feet to the base of the

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alluvium, and then cut a 10-foot wide trench. The trench is be backfilled with Tropic shale. After the cutoff trench is installed, the mining operations would continue as planned. During backfilling operations of the pit, a permanent 50-foot wide barrier be installed. The barrier will consist of Tropic shale placed to at least 90 percent compaction as per ASTM D698 and extend from the existing shale bench up to the surface. The Tropic shale, located above the coal bed, will be derived from mining operations.

Analysis and Conclusions

For analysis purposes, the coefficients of permeability from Boring C-2 as presented by Peterson Hydrologic (2007) Tables 7 and 8 were used for the overburden alluvium silt and clay layers and the water bearing gravel layer. A sample of the Tropic shale obtained from previous investigations was provided to TGE. The sample tested was derived from CH-5-05 at a depth of 55 feet. The sample was delivered to RBG Engineering for a permeability test. The sample was crushed, remolded, moisture conditions to optimum moisture content and compacted to 90.6 percent of the maximum dry density as per ASTM D698 (see attached lab results). The coefficients of permeability from the Peterson report and from the recent laboratory test is provided in the table below.

Location of Sample	Coefficient of Permeability (cm/sec)
C-2 – Clay Alluvium	1×10^{-5}
C-2 – Silty Alluvium	5.3×10^{-3}
C-2 – Gravel	6.0×10^{-2}
C-5-5 – 55 feet - Remolded Tropic Shale 55 feet	8.24×10^{-8}

Using the coefficients of permeability indicated above, water table elevations, and depth of cuts, TGE determined seepage rates for the various proposed conditions. The results of the analysis indicated that the maximum seepage rate from the alluvium after the cut is complete is 46.8 gpm per 100 lineal feet of open cut. The seepage downstream of the cutoff wall after the cut is complete will be .01 gpm or 15.72 gpd per 100 lineal feet of open cut. These are maximum rates that will decrease as the phreatic surface slowly decreases during mining operations. These flow rates are slightly higher than predicted by Peterson Hydrologic since they are maximum seepages rates used by TGE for stability purposes.

The seepage rate through the 50 foot thick permanent barrier will be 0.08 gpm or 101 gpd per 100 lineal feet of barrier. This seepage rate is based on post mining conditions when the water table has returned to pre-mining activities or when the hydraulic gradient is at its maximum. It is TGE's opinion that this flow rate would classify the barrier as fairly impermeable.

Based on seepage forces, the slope profile downstream of the cutoff trench should consist of a 1.5H:1V slope with a 10-foot flat bench between the top of slope and the cutoff wall. Based on this profile, the cut will have a F.S. of 2.0 from lateral movement. For short term basis, it is TGE's opinion that this will provide safe conditions during mining operations.

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The temporary cut in the alluvium will need monitored during cut activities. The rate of cut may need to be slowed to as much as 2 feet per day to prevent slope failure due to seepage pressure. The alluvium slope on the east side of Pit 15 will probably vary from 3H:1V to 5H:1V. If the slope is not saturated, then slope recommendations previously provided by TGE may be steepened to 2V:1H. The 5V:1H slope will be required if excessive sloughing is reported. This can be monitored by TGE if the contingency plan is needed.

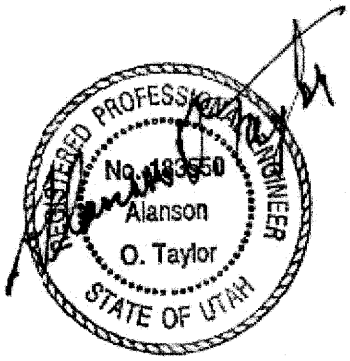
The permanent barrier did not need any stability analysis based on seepage since it will be bounded by backfill up to current surface grades.

Closure

TGE appreciates the opportunity to be of service to Alton Coal Mine. The results of the analysis are based on information provided by Alton Coal Mine, Peterson Hydrologic and laboratory data collected by TGE. Any changes to the proposed contingency plan may require additional analysis by TGE.

If you have any questions, please feel free to contact the undersigned. The opportunity to be of service on this project is appreciated.

Respectfully submitted,
TAYLOR GEO-ENGINEERING, LLC



Alanson O. Taylor, P.E.
Principal

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REFERENCES

Peterson Hydrologic, LLC, June 12, 2007, "Investigation of groundwater and surface-water systems in the proposed coal hollow mine permit and adjacent area."

Alton Coal Development, Sheet A7-10 Plate 2, "Coal Hollow Project," August 15, 2009.

Alton Coal Development, Sheet 7-15, "Coal Hollow Project," August 4, 2009.

Alton Coal Development, Draft Sheet 7-15B, "Coal Hollow Project," November 20, 2008.

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RB&G ENGINEERING, INC.
1435 West 820 North, Provo, Utah 84601
801 374-5771 Provo ▮ 801 521-5771 SLC ▮ 801 374-5773 Fax
AASHTO Accredited Laboratory

Project no.	200908-010
Report no.	908059
Sheet	1 of 1

Coefficient of Permeability

Project	TAYLOR GEO-ENGINEERING, LLC
Location	Lehi, Utah
Sample no.	Tropic Shale
Description of soil	Fat clay
Date Tested	8-18-09
Report by	J. Boone/K. Bradford
Staff position	Lab Manager/Materials Technician

Results

Date Cast	Date Tested	Location	Description of Soil	Permeability (cm/sec)	% Moisture
	8-18/8-19-2009		Fat clay	k = 8.24×10^{8}	20.5

Comments

TECHNICAL RESPONSIBILITY: Bradford E. Price, PE, principal; Jacob Boone, materials laboratory manager
DISTRIBUTION LIST:
CLIENT/CLIENT REP: TAYLOR GEO-ENGINEERING LLC/Alan O. Taylor, P.E.
DATE PRINTED: 08/26/2009

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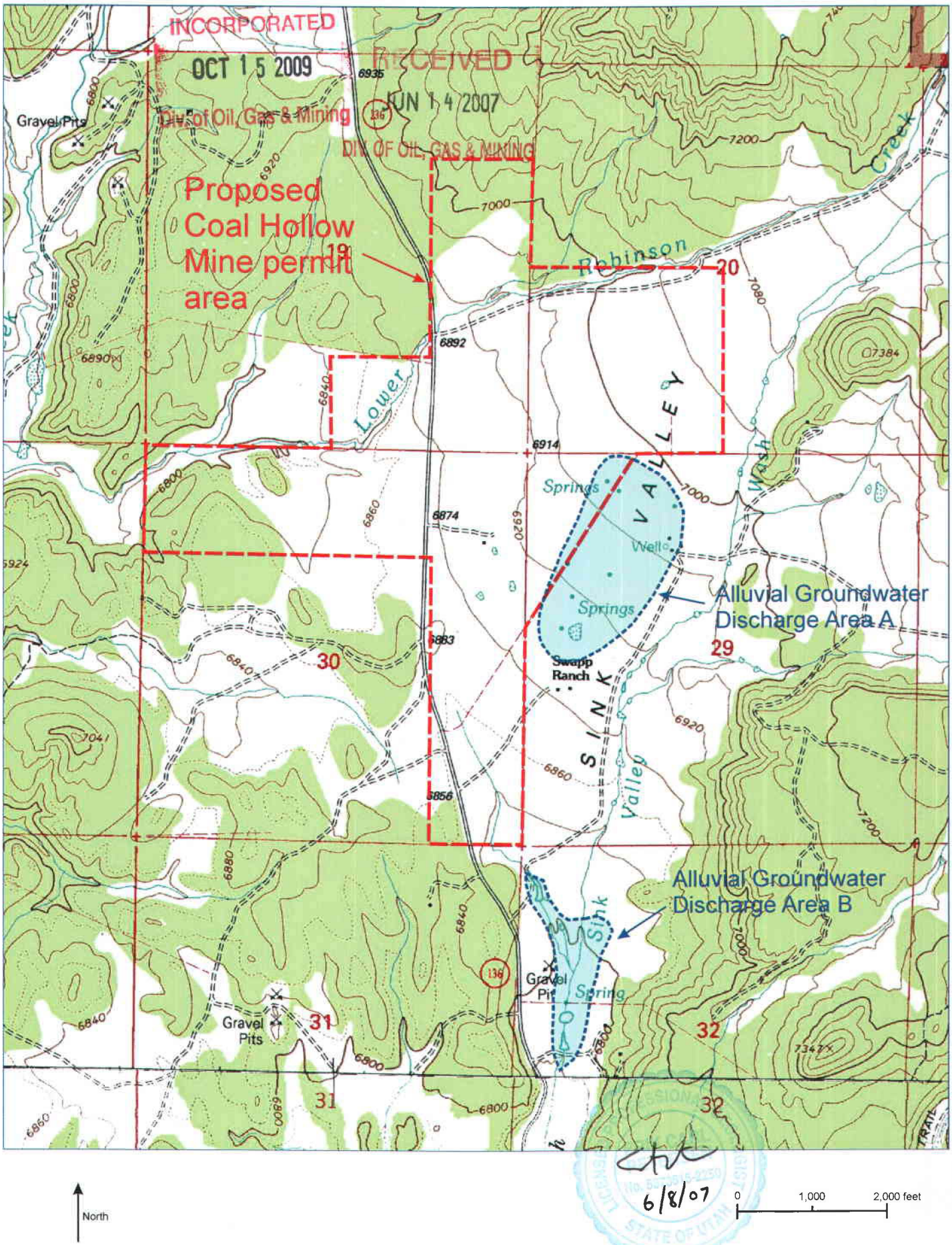
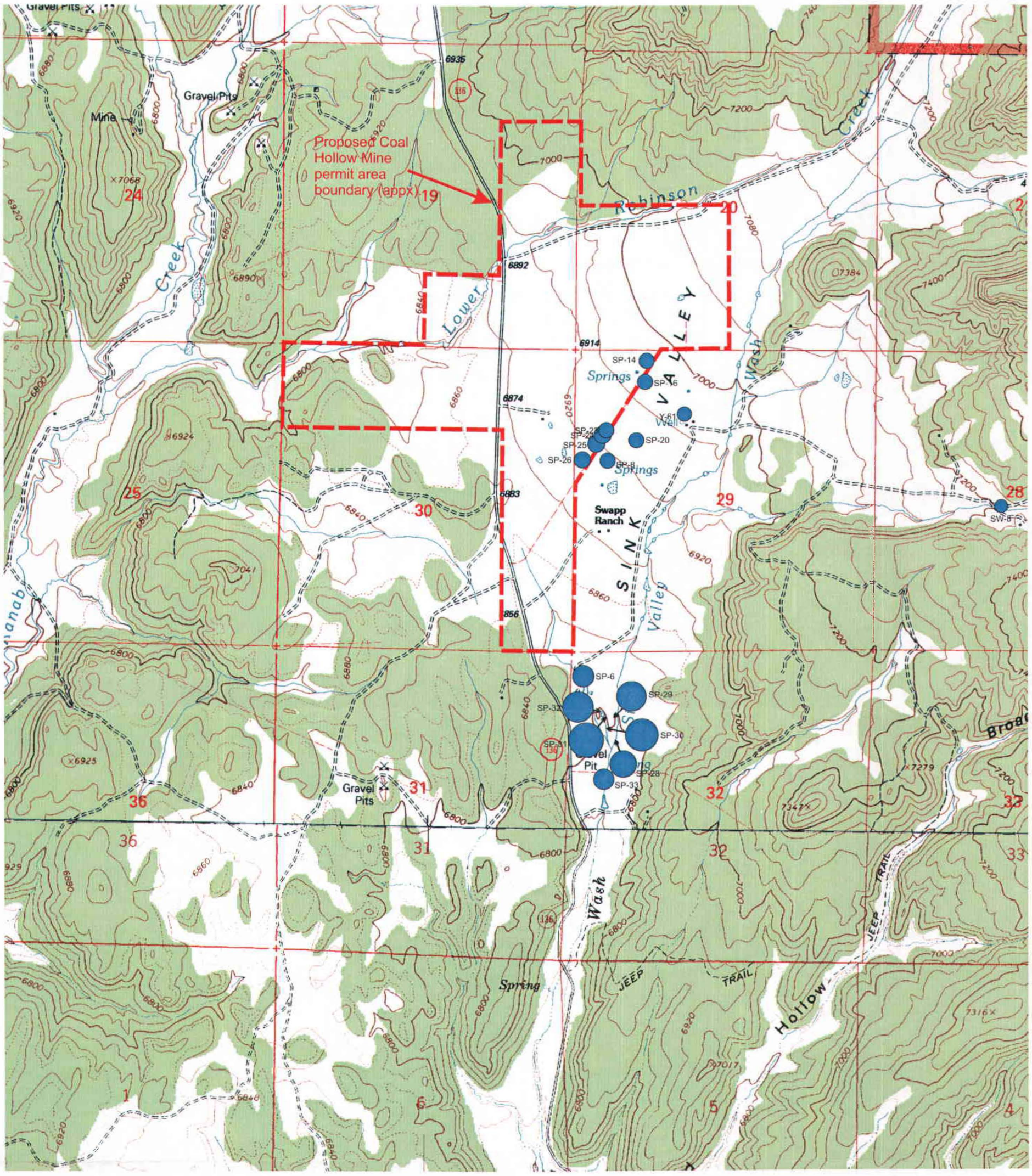


Drawing 7-4 Alluvial groundwater discharge areas.



500 uS/cm

1000 uS/cm

2000 uS/cm

3000 uS/cm

4000 uS/cm

North

0 1,000 2,000

Feet

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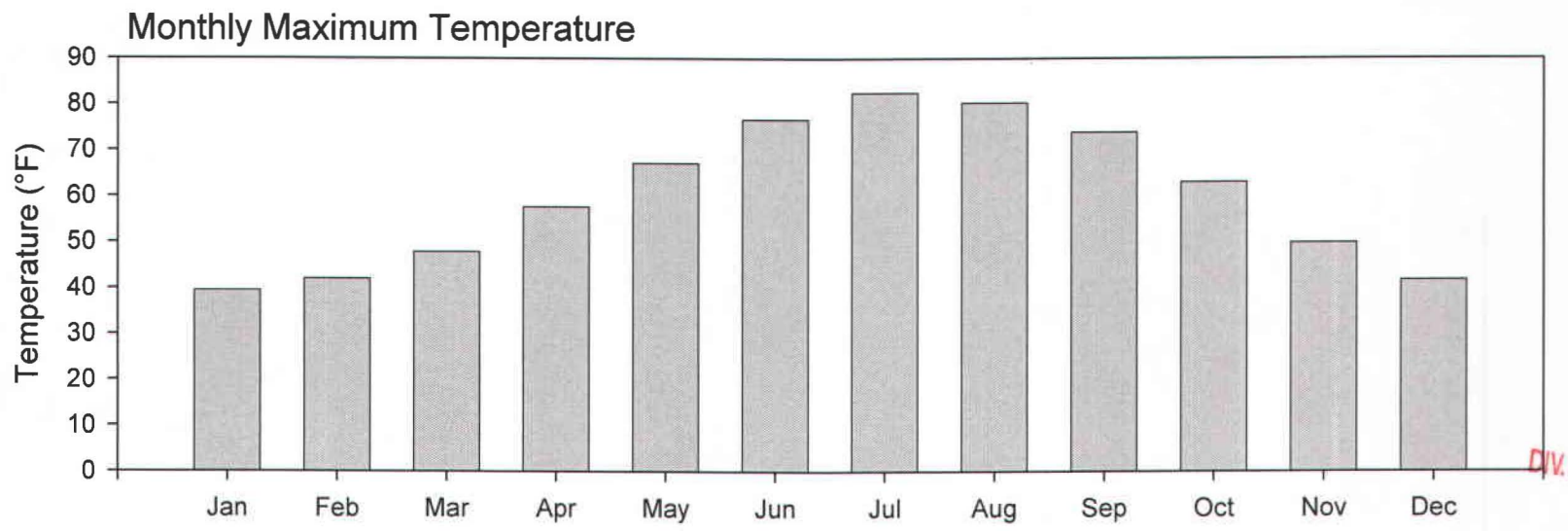
LICENSED PROFESSIONAL GEOLOGIST
ERIK CARL PETERSEN
No. 5370917-2250
STATE OF UTAH
20 Dec 08

Drawing 7-5 Map of specific conductance of alluvial groundwater in Sink Valley.



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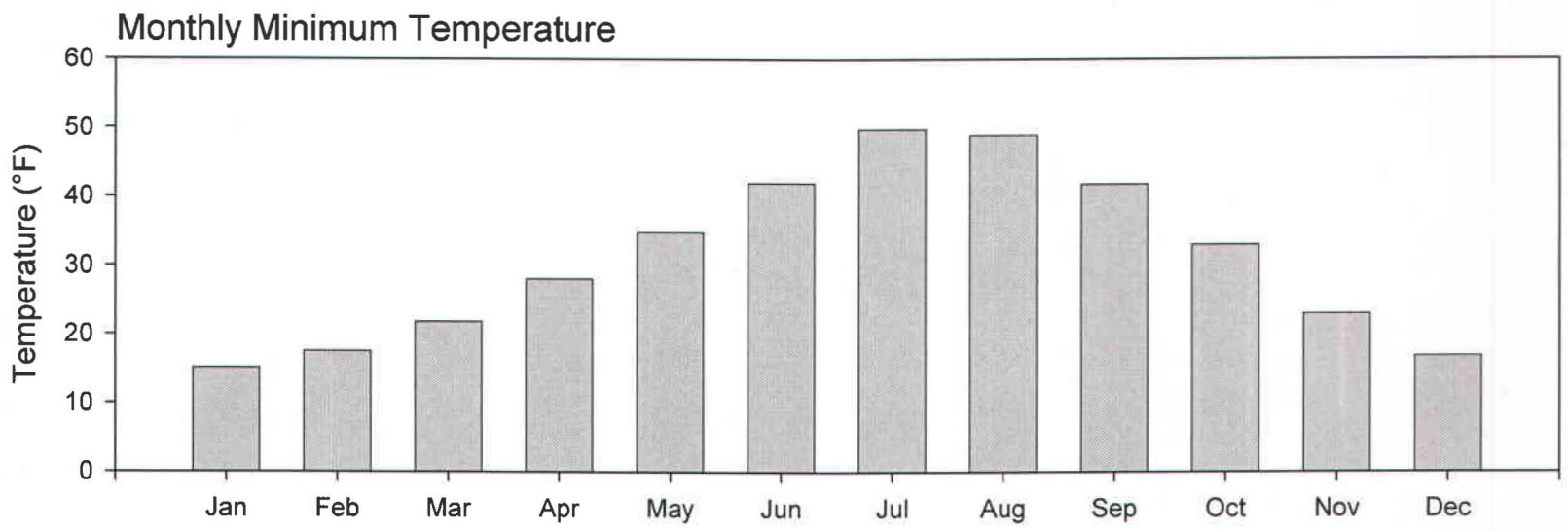

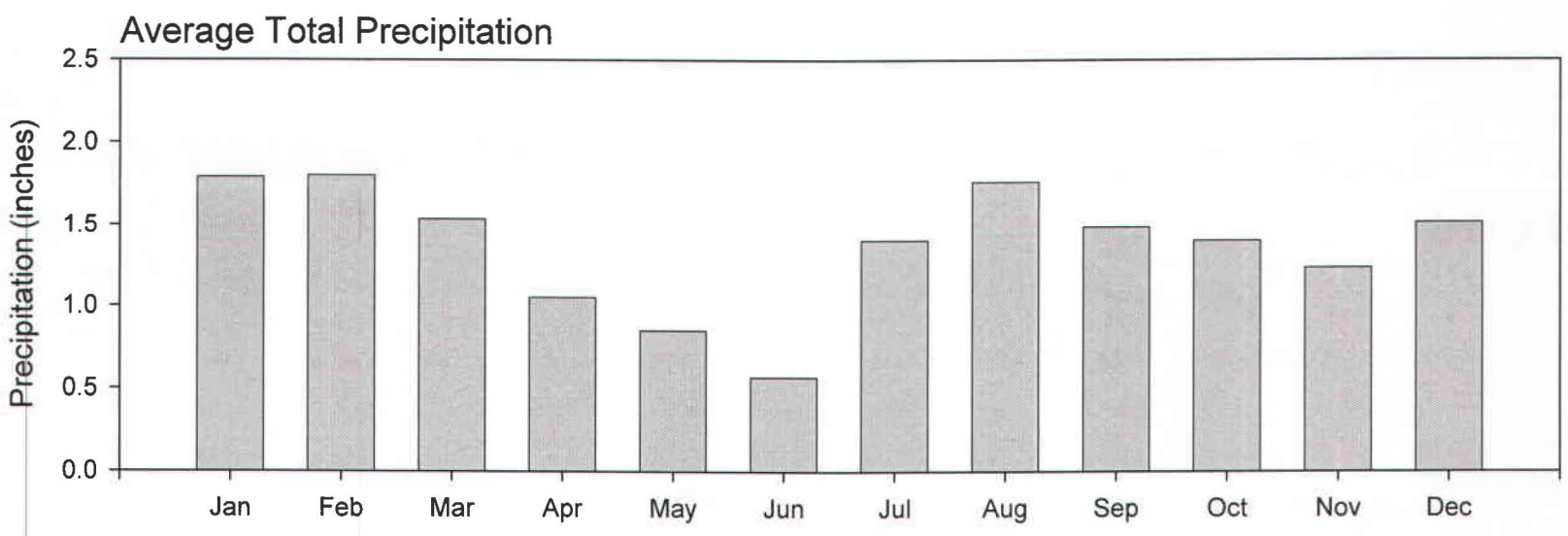

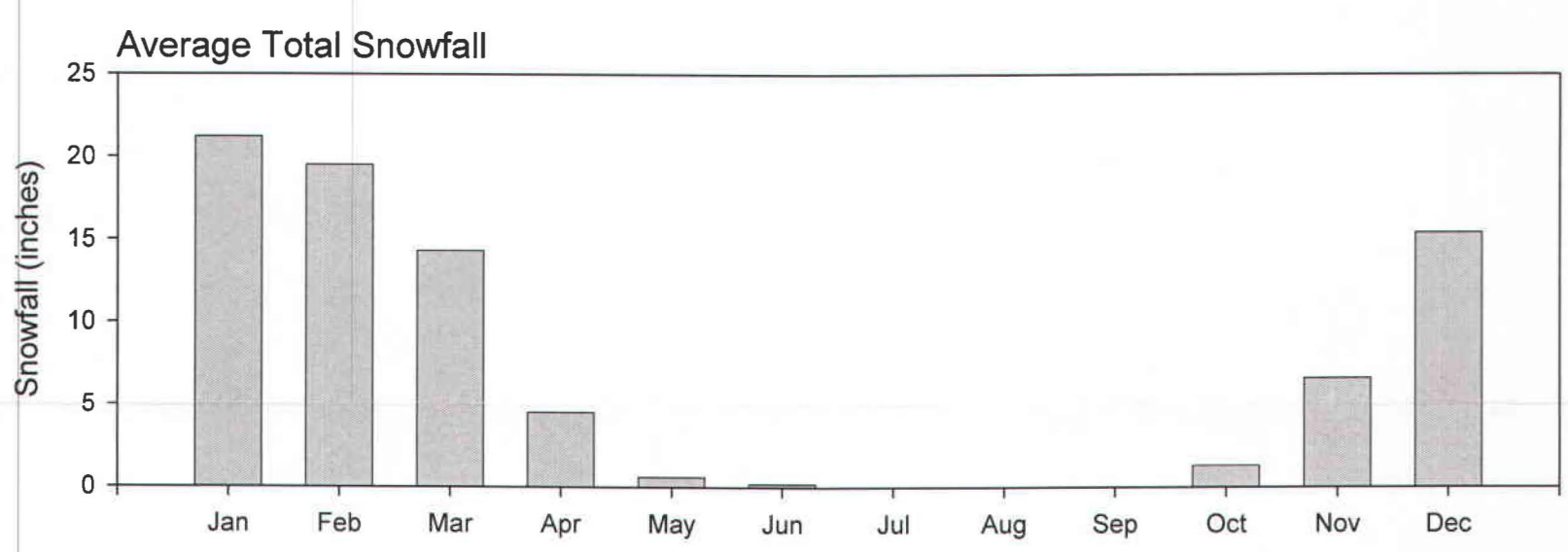

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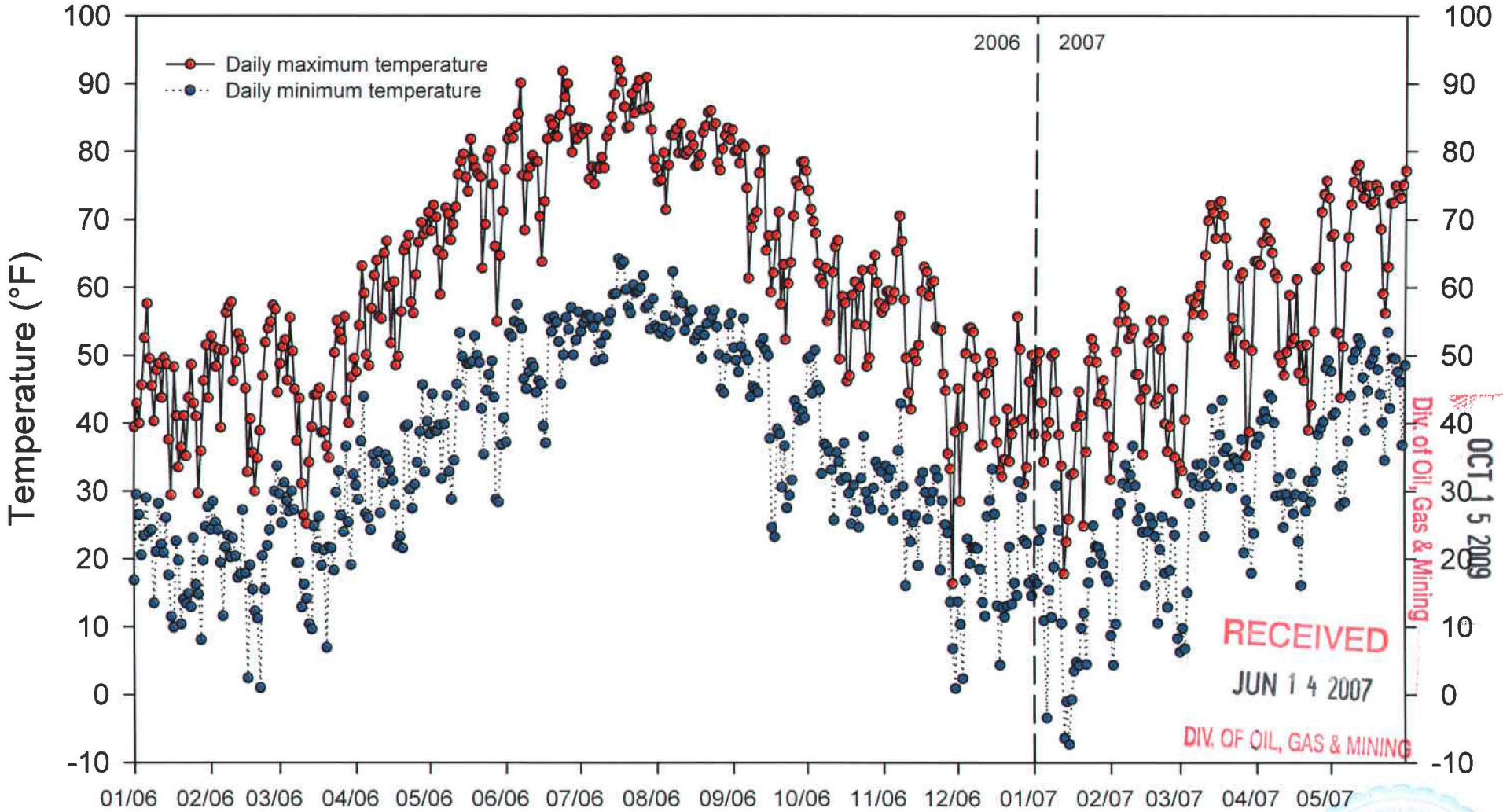
Drawing 7-8A Plots of climatologic information from the Alton, Utah weather station (420086), 1928-2005.



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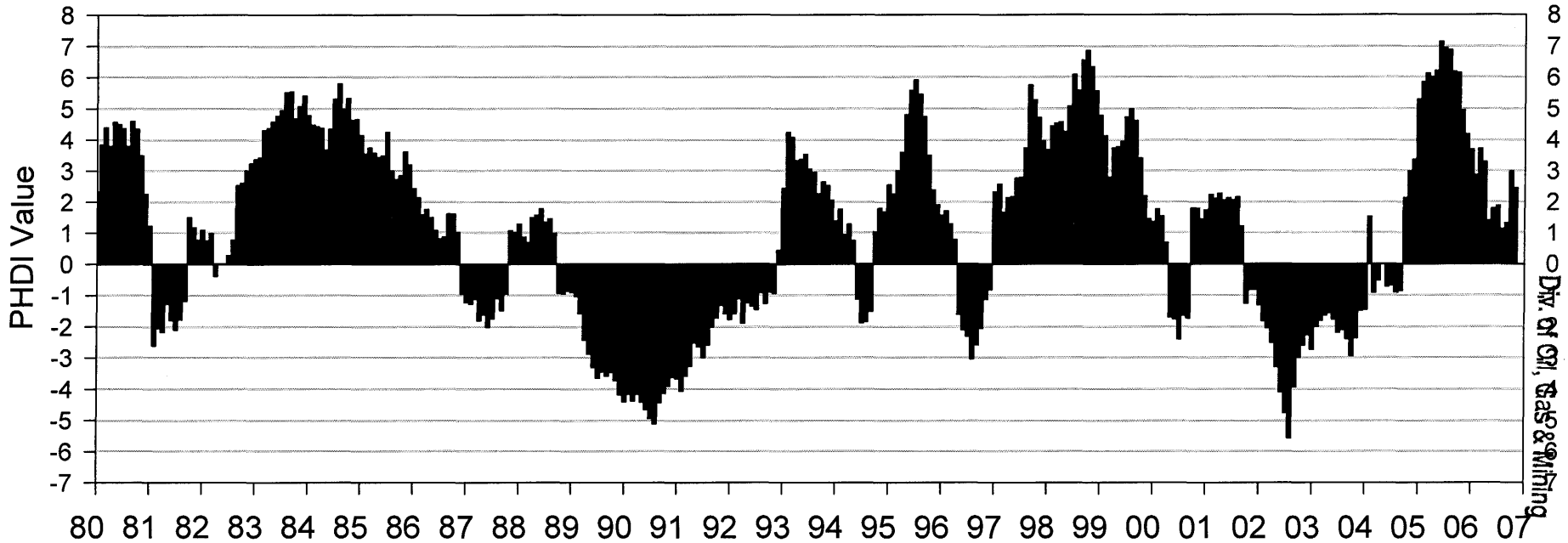
Drawing 7-8B Plot of daily maximum and minimum temperatures at the Coal Hollow Project weather station, January 2006 - May 2007.



-1 to -2	Mild Drought	1 to 2	Mild Wet Spell
-2 to -3	Moderate Drought	2 to 3	Moderate Wet Spell
-3 to -4	Severe Drought	3 to 4	Severe Wet Spell
-4 to -5	Extreme Drought	4 to 5	Extreme Wet Spell

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Drawing 7-9 Plot of Palmer Hydologic Drought Index for Utah Region 4.

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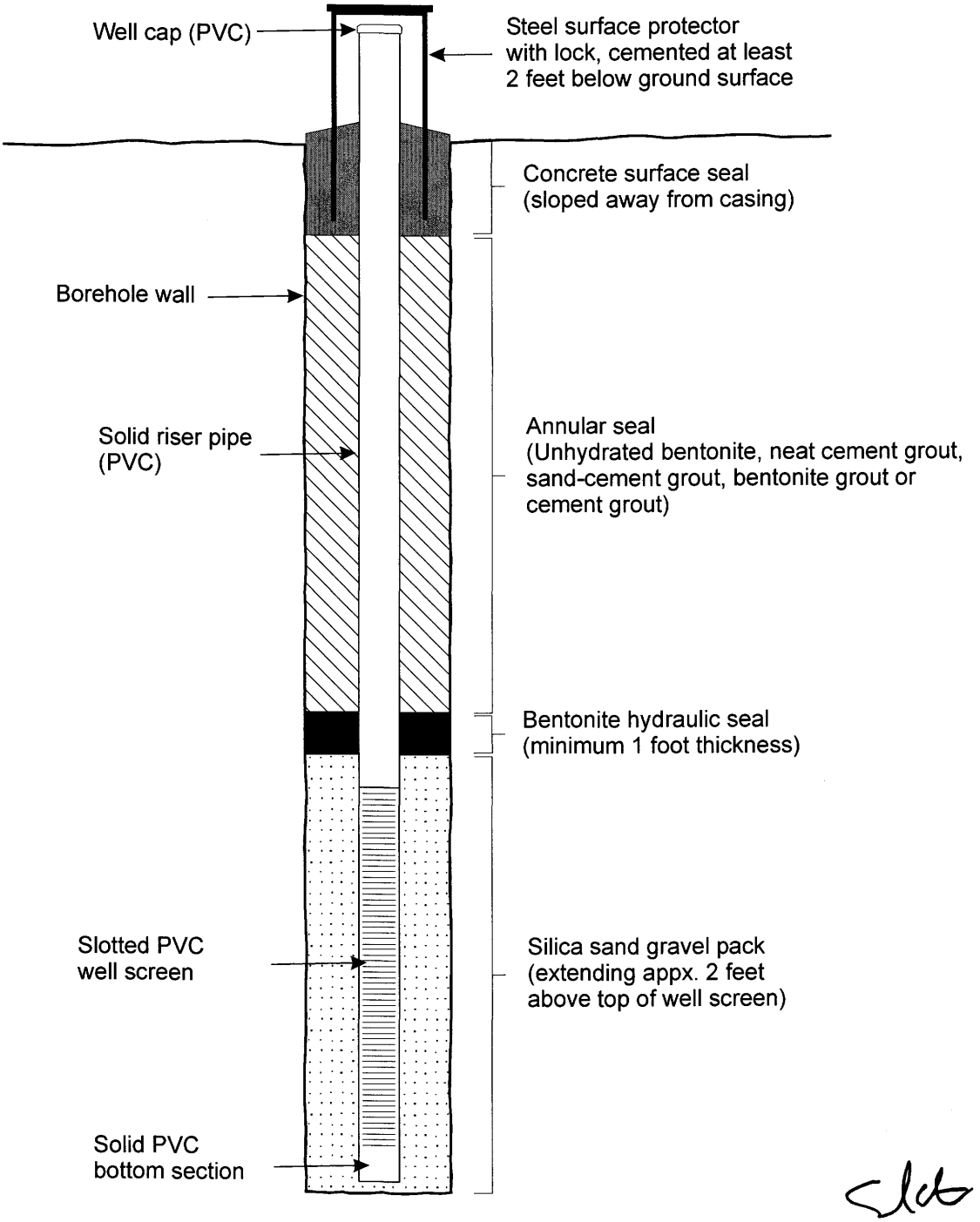

Not to scale

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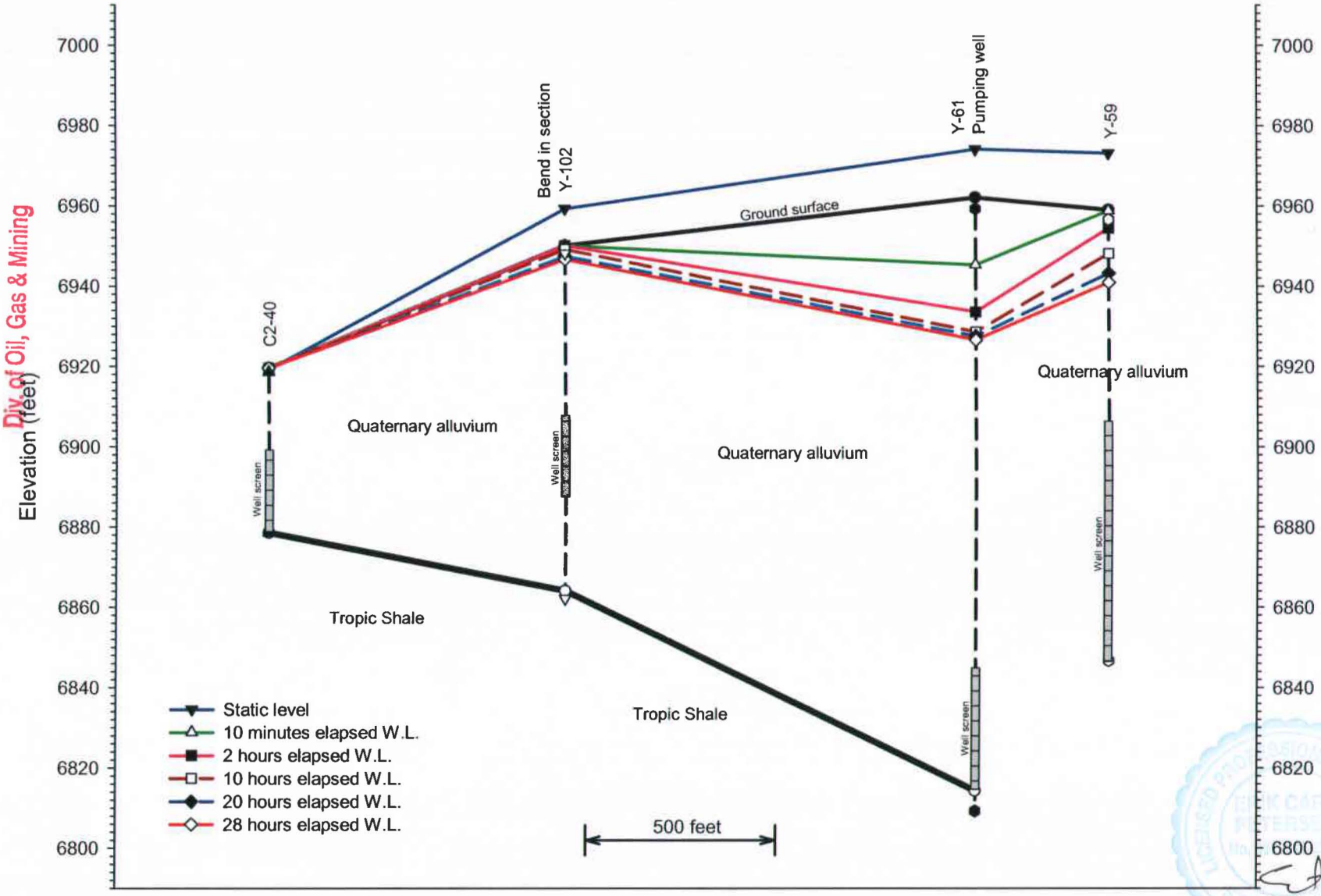
Drawing 7-11 Typical monitoring well construction.



Drawing 7-14 Water levels in pumping and observation wells for January 2007 Y-61 pump test. See Drawing 7-12 for well locations.

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CHAPTER 8

BONDING AND INSURANCE

R645-301-800

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Bonding and Insurance

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None	

APPENDICES No.	DESCRIPTION
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DRAWING No.	DESCRIPTION
None	

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CHAPTER 8

R645-301-800. BONDING AND INSURANCE

820. REQUIREMENT TO FILE A BOND

820.100 The Operator Agrees to File a Bond.

After the permit application is approved, but before the permit is issued, the applicant will file with the Division, on a form prescribed and furnished by the Division, a bond or bonds conditioned upon performance of all requirements of the State Program, the permit and the reclamation bond.

820.110-111 Area to be Covered by the Performance Bond

The disturbed area at the Coal Hollow Project will be bonded. The disturbed areas are identified on Drawing 5-3. The area to be mined is also identified on Drawing 5-3.

820.112-114 Incremental Bonding

Not applicable at this time.

820.120 Acceptance of Bond

The applicant agrees not to commence operations until the Division approves a performance bond for the Coal Hollow Project.

820.130 Coverage of Bond

The applicant will provide a performance bond for the disturbed area within the permit.

820.200 Form of the Performance Bond

820.223 Surety Bond

Alton Coal Development, LLC is proposing to submit a surety bond consistent with the requirements of R645-301-860.100 and any additional requirements in the State Program.

830. DETERMINATION OF BOND AMOUNT

830.100 Determined by the Division

The amount of the bond required will be determined by the Division.

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830.140 Detailed Estimated Costs

The bonding amount for final reclamation will depend upon the approved permit and reclamation plan (R645-301-830.120). Estimates have been completed for the individual mining phases shown in Drawings 5-17, 5-18 and 5-19. These estimates are provided as Appendix 8-1. These cost calculations are based on the specific details shown on these drawings. As requested by the Division, a separate bond estimate is completed for all three phases shown in the drawings and in general, each stage is representative of the expected reclamation liability for years 1, 2 and 3, respectively. The bond estimate by year is the following:

Phase 1:	$5,346,000
Phase 2:	$10,859,000
Phase 3:	$10,889,000

A summary and supporting calculations for these cost estimates is provided in Appendix 8-1.

840. GENERAL TERMS AND CONDITIONS OF THE BOND

General terms and conditions of the bond as stated at R645-301-840 through R645-301-840.520 will be met by Alton Coal Development, LLC

850. BOND REQUIREMENTS FOR UNDERGROUND COAL MINING

Not Applicable

860. FORM OF BOND

860.100 Surety Bond

The applicant will submit a surety bond as defined under R645-100-200 and meet all the requirements under R645-301-860.110 to .120.

870. REPLACEMENT OF BONDS

Equivalent bond coverage will be provided if Alton Coal Development, LLC replaces the surety bond.

880. REQUIREMENT TO RELEASE PERFORMANCE BONDS

Upon completion of reclamation operations, the applicant will apply for bond release and meet the requirements of R645-301-880.

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890. TERMS AND CONDITIONS FOR LIABILITY INSURANCE

890.100 Certificate of Liability Insurance

A copy of the Certificate of Liability Insurance is provided in Appendix 1-3. Alton Coal Development, LLC will meet the requirements of R645-301-890 prior to commencing any mining operations.

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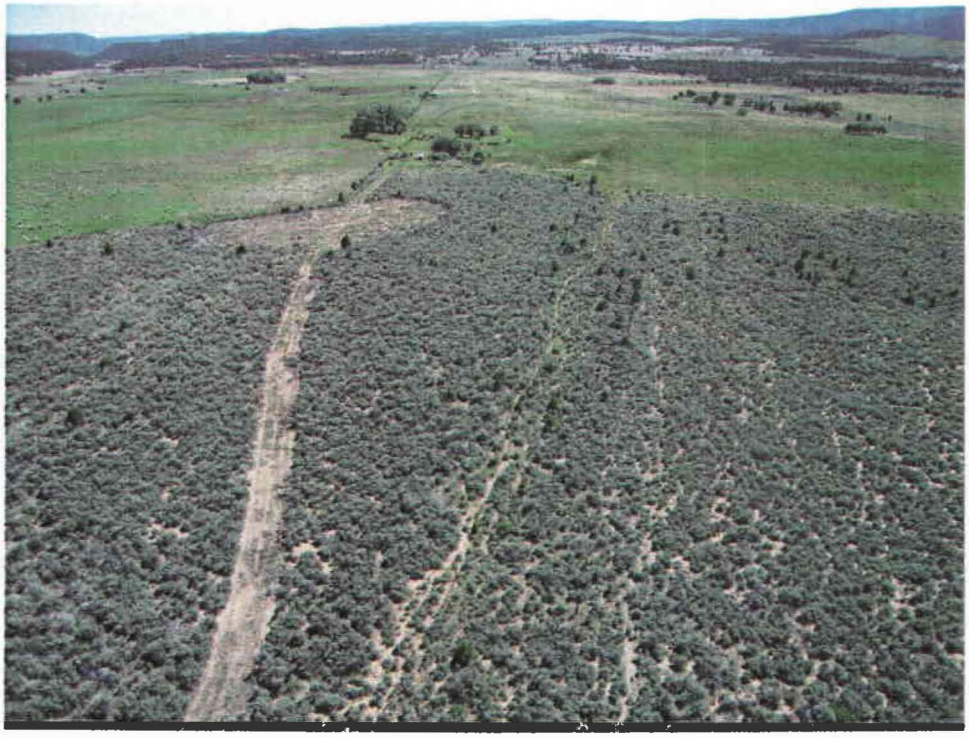
View looking north at groundwater discharge area B in Sink Valley.
Note that proposed mining locations are north and west of Area B.



View looking southwest at groundwater discharge area A in Sink Valley.
Note that proposed mining locations are west of Area A.

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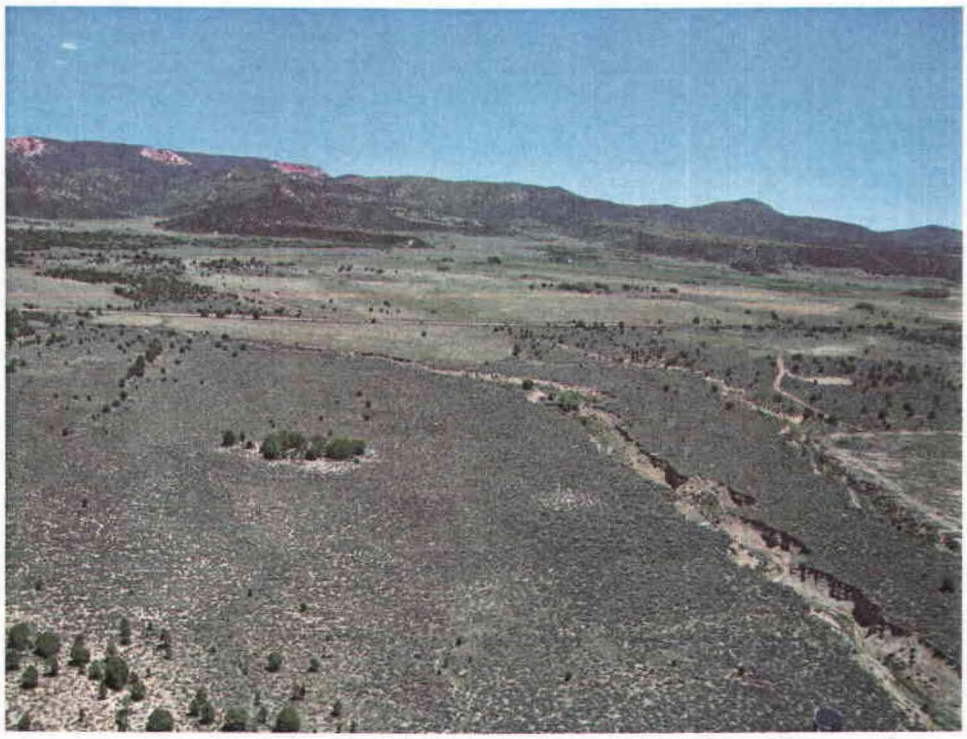

View looking east in Lower Robinson Creek drainage in proposed mining area (in foreground).

View looking south down Sink Valley Wash below proposed mining areas.

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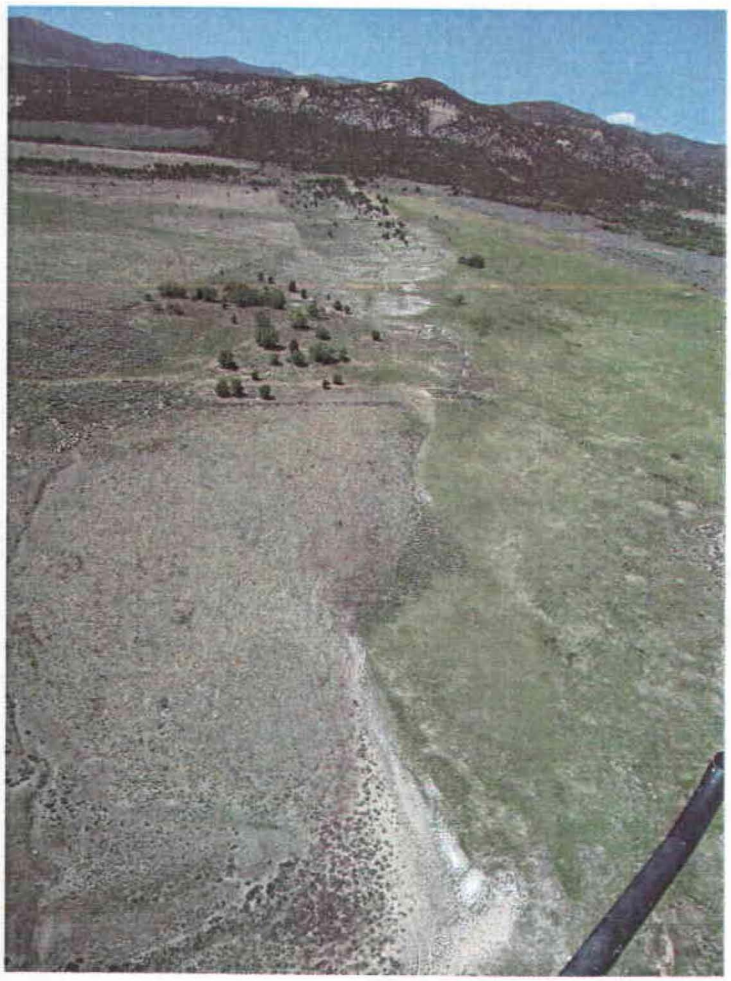

View looking north at Tropic Shale ridge
and Sink Valley Fault.

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APPENDIX 8-1

COST ESTIMATE
And CALCULATIONS
COAL HOLLOW MINE

Estimate By: Alton Coal Development, LLC

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BONDING

Introduction

The purpose of this appendix is to provide a reclamation bond estimate as required by R645-301-830.140. As requested in the Division's Technical Analysis (TA) dated March 26, 2009, this bond estimate is calculated in a manner that allows for incremental bonding at the Coal Hollow mine in accordance with the requirements of R645-301-820.111, 820.112 through 820.133.

Based on the request in the Division's TA, there are three separate bond cost estimates for the three general stages of mining as detailed in the Mining and Reclamation Plan. These stages of mine development, are shown on Drawings 5-17, 5-18, 5-19 and fully described in Chapter 5 text. The drawings in combination with the text describe the anticipated status of reclamation and the size of the open coal pit at each stage. In the following cost estimate, the stages of mine development are referred to as Phase 1, Phase 2 and Phase 3. Because concurrent (or contemporaneous) reclamation will be implemented, these estimates are not meant to be cumulative (or added together) as the mine progresses through the different stages but instead is meant as the total reclamation liability during each individual phase. Therefore, each phase cost estimate is meant as the total bond amount to be applied while in each development stage.

This appendix includes the following details:

- Bond Estimate Summary

- Mine Facilities - Reclamation Estimate
  - a) Estimate Details

- Phase 1 Reclamation - Reclamation Estimate
  - a) Estimate Details
  - b) Pit Backfill - Dozer Simulation
  - c) Pit Backfill - Truck/Shovel, Fleet Production and Cost Analysis (FPC)
  - d) Subsoil - Truck/Shovel, Fleet Production and Cost Analysis (FPC)
  - e) Topsoil - Truck/Shovel, Fleet Production and Cost Analysis (FPC)

- Phase 2 Reclamation - Reclamation Estimate
  - a) Estimate Details
  - b) Pit Backfill - Dozer Simulation
  - c) Pit Backfill - Truck/Shovel, Fleet Production and Cost Analysis (FPC)
  - d) Subsoil - Truck/Shovel, Fleet Production and Cost Analysis (FPC)
  - e) Topsoil - Truck/Shovel, Fleet Production and Cost Analysis (FPC)

- Phase 3 Reclamation - Reclamation Estimate
  - a) Estimate Details
  - b) Pit Backfill - Truck/Shovel, Fleet Production and Cost Analysis (FPC)

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c) Subsoil - Truck/Shovel, Fleet Production and Cost Analysis (FPC)
d) Topsoil - Truck/Shovel, Fleet Production and Cost Analysis (FPC)

All material volume and surface area calculations were performed utilizing Carlson Civil and Mining software.

Cost data sources include:

- RSMeans Heavy Cost Construction 2009
- RSMeans Construction Cost Data 2009
- CostMine Coal Cost Guide 2009
- CostMine Mine and Mill Equipment Cost Data, 2008 (latest version available)

These sources are applied where appropriate in each of the cost estimates. Each line item in the estimate lists specifies which source is utilized for cost data.

Summary

In agreement with the Division's assessment, Alton Coal Development has developed this cost estimate in an incremental phase approach. The facilities reclamation cost, including building demolition/disposal, earthwork and seeding/mulching, is calculated separately and then added to each phase to provide an overall total. In addition, reclamation of the ponds and Lower Robinson Creek are also separated in the calculations and applied to the total costs for each phase as appropriate. The main categories for the cost estimate are:

- Mine Facilities
- Specialized Reclamation Areas
- Phase 1 Mine Development
- Phase 2 Mine Development
- Phase 3 Mine Development

The following is a brief summary of the information and methods used to calculate the costs for each category:

Mine Facilities
This section includes demolition, disposal, earthwork and land reclamation costs for the entire facilities area, including ponds and ditches. The calculations for this section is based on the facilities and pond drawings in the current version of the Mining and Reclamation Plan. These drawings are all provided in Chapter 5 as Drawings 5-3 through 5-8C. The RSMeans Cost data is applied to this estimate. The overall cost estimate for the facilities reclamation is approximately $1,395,000.

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Specialized Reclamation Areas
The specialized reclamation areas include ponds 2, 3 and 4 along with the Lower Robinson Creek reconstruction. The calculations for these specific areas are provided separately and applied to each phase of development as appropriate. The overall cost estimate for these areas varies depending on the mine development phase.

Phase 1
The details for this phase of mine development is shown on Drawing 5-17. At this point of mine development, Pits 1 through 8 have been mined. A 2.7 million yard excess spoil pile has been constructed and pits 1 through 6 have been backfilled, subsoil/topsoil placed and the surface graded to the approximate original contour (AOC). This estimate includes rehandle of the entire excess spoil pile to backfill Pits 7 and 8 which are open at this point. This requires a combination of dozers and truck/shovel operations to backfill these pits to the AOC. Once the pit is backfilled, the subsoil and topsoil is then placed followed by seeding and mulching. RSMeans Cost Data is used for everything except material handling. The data supplied by RSMeans for material handling is mainly reflective of construction type projects and is not representative of the mass volumes of material handling required for this project. Therefore, this cost estimate utilizes dozer and truck/shovel simulations to develop production rate estimates. Cost data from CostMine's Coal Cost Guide and Mine/Mill Equipment Cost Data are then applied to the production rates to develop overall cost estimates. The software packages Dozsim and Fleet Production /Cost Analysis (FPC) are utilized to perform the necessary calculations.

Once the overall cost for the material handling is estimated using this process, contractor overhead/profit, engineering/supervision and mobilization costs are then added to the total.

The overall cost estimate for Phase 1 including facilities, specialized reclamation areas, and mine reclamation using this process is approximately $5,345,000.

Phase 2
The detail for this phase of mine development is shown on Drawing 5-18. At this point, Pits 1 through 15 have been mined. The excess spoil pile/fill above AOC now contains approximately 8.6 million cubic yards of spoil. Pits 1 through 14 have been backfilled and graded. The estimate for this phase includes rehandling of the excess spoil to backfill Pit 15 which is the open pit at this point. This requires material handling of approximately 7 million yards by a combination of dozers and truck/shovel equipment to complete. Same methods described above in Phase 1 are also used in Phase 2 to calculate the cost estimate

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The overall cost estimate for Phase 2 including facilities, specialized reclamation areas, and mine reclamation using this process is approximately $10,859,000.

Phase 3

The detail for this phase of mine development is shown on Drawing 5-19. At this point, Pits 1 through 30 have been mined. Pits 1 through 23 have been backfilled and graded. The excess spoil pile/fill above approximate original contour contains approximately 8.6 million yards of spoil. The estimate for this phase includes rehandling of the excess spoil to backfill pits 24 through 30 which are the open pits. This requires material handling of approximately 6.6 million cubic yards by a combination of dozers and truck/shovel equipment to complete. The same methods described above in Phase 1 are also used in Phase 3 to calculate the cost estimate.

The overall cost estimate for Phase 3 including facilities, specialized reclamation areas, and mine reclamation using this process is approximately $10,889,000.

The following documentation provides the details for each of these bond estimates.

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Mine Facilities - Reclamation Estimate

Estimate Details

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Facilities Reclamation Cost Estimate

Concrete Demolition

Item	Unit	Quantity	Unit Cost ($)	Cost	**Cost Data Reference
Office (footer)	lft	500	$24.50	$12,250	RSMeans Building Constr., 02 41 16.17 1140
Shop (footer)	lft	616	$29.40	$18,110	RSMeans Building Constr., 02 41 16.17 1140 & 1220
Shop (foundation)	ft^2	3,080	$2.87	$8,840	RSMeans Building Constr., 02 41 16.17 2100 & 2200
Shop (floor)	ft^2	20,000	$7.30	$146,000	RSMeans Building Constr., 02 41 16.17 0440
Wash Bay (footer)	lft	244	$29.40	$7,174	RSMeans Building Constr., 02 41 16.17 1140 & 1220
Wash Bay (foundation)	ft^2	660	$2.87	$1,894	RSMeans Building Constr., 02 41 16.17 2100 & 2200
Wash Bay (floor & sump)	ft^2	3,100	$7.30	$22,630	RSMeans Building Constr., 02 41 16.17 0440
Fuel Storage (slab)	yd^3	111	$137.00	$15,222	RSMeans Heavy Constr., 03 05 05.10 0060
Fuel Storage (containment wall)	yd^3	9	$137.00	$1,218	RSMeans Heavy Constr., 03 05 05.10 0060
Oil Storage (slab)	yd^3	89	$137.00	$12,178	RSMeans Heavy Constr., 03 05 05.10 0060
Oil Storage (containment wall)	yd^3	12	$137.00	$1,674	RSMeans Heavy Constr., 03 05 05.10 0060
Coal Hopper/Feeder Breaker (Tunnel Access)	yd^3	95	$137.00	$12,990	RSMeans Heavy Constr., 03 05 05.10 0060
Coal Hopper/Feeder Breaker (Hopper Supports)	yd^3	190	$137.00	$25,979	RSMeans Heavy Constr., 03 05 05.10 0060
Coal Hopper/Feeder Breaker (Belt Tunnel)	yd^3	133	$137.00	$18,185	RSMeans Heavy Constr., 03 05 05.10 0060
Crusher Building (Footer)	lft	80	$29.40	$2,352	RSMeans Building Constr., 02 41 16.17 1140 & 1220
Feed Conveyor (Support Footers)	lft	30	$29.40	$882	RSMeans Building Constr., 02 41 16.17 1140 & 1220
Reclaim Belt (Support Footers)	lft	25	$29.40	$735	RSMeans Building Constr., 02 41 16.17 1140 & 1220
Loadout (Footers)	lft	72	$29.40	$2,117	RSMeans Building Constr., 02 41 16.17 1140 & 1220
Loadout (Scale Footer)	lft	60	$29.40	$1,764	RSMeans Building Constr., 02 41 16.17 1140 & 1220

Concrete Disposal

*Concrete Disposal (All Facilities)	yd^3	1,551	$15.50	$24,036	RSMeans Building Constr., 02 41 16.17 4250
Subtotal Concrete Demolition & Disposal				**$336,230**	

*Concrete is disposed of on site (in pits) within five miles of facilities

**All cost data is from the 2009 additions of either the RS Means Heavy Construction or Building Construction Cost Data Manuals

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Facilities Reclamation Cost Estimate

Structure Demolition & Disposal

Item	*Unit	Quantity	Unit Cost ($)	Cost	**Cost Data Reference
Office	ft^3	150,000	$0.33	$49,500	RSMeans Heavy Constr., 02 41 16.13 0100
Office (Sewage Tank)	Ea.	1	$3,775.00	$3,775	RSMeans Heavy Constr., 02 65 10.30 1233 & 1213
Shop	ft^3	1,000,000	$0.31	$310,000	RSMeans Heavy Constr., 02 41 16.13 0020
Wash Bay	ft^3	150,000	$0.31	$46,500	RSMeans Heavy Constr., 02 41 16.13 0020
Fuel Storage (3 tanks)	Ea.	3	$2,776.00	$8,328	RSMeans Heavy Constr., 02 65 10.30 0130 & 1029
Coal Hopper/Feeder Breaker (Demolition)	Ton	64	$328.00	$20,992	RSMeans Heavy Constr., 05 05 05.10 0260
Coal Hopper/Feeder Breaker (Disposal)	yd^3	570	$16.80	$9,576	RSMeans Heavy Constr., 02 41 19.23 5000
Crusher (structure)	ft^3	9,200	$0.31	$2,852	RSMeans Heavy Constr., 02 41 16.13 0020
Crusher (equipment demolition)	Ton	60	$328.00	$19,680	RSMeans Heavy Constr., 05 05 05.10 0260
Crusher (equipment disposal)	yd^3	150	$16.80	$2,520	RSMeans Heavy Constr., 02 41 19.23 5000
Coal Reclaim System (demolition)	Ton	50	$328.00	$16,400	RSMeans Heavy Constr., 05 05 05.10 0260
Coal Reclaim System (disposal)	yd^3	233	$16.80	$3,914	RSMeans Heavy Constr., 02 41 19.23 5000
Loadout (structure)	ft^3	19,000	$0.31	$5,890	RSMeans Heavy Constr., 02 41 16.13 0020
Loadout (equipment demolition)	Ton	68	$328.00	$22,304	RSMeans Heavy Constr., 05 05 05.10 0260
Loadout (equipment disposal)	yd^3	185	$16.80	$3,108	RSMeans Heavy Constr., 02 41 19.23 5000
Conveyors	ft	545	$141.00	$76,845	CostMine - Mine and Mill Equipment Costs (Estimated as 25% of Construction Cost)
Water System (tanks)	Ea.	2	$1,276.00	$2,552	RSMeans Heavy Constr., 02 65 10.30 1029
Subtotal Structure Demolition & Disposal				**$604,736**	

Exact makes and models of equipment are not currently known, therefore estimates are included for weights and yardages of equipment

** RS Means does not have direct cost data references for some specific items. Where needed, reasonable substitutues are utilized.

All cost data is from the 2009 additions of either the RS Means Heavy Construction or Building Construction Cost Data Manuals except where specifically noted

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Facilities Reclamation Cost Estimate

Facilities Earthwork and Land Reclamation

Item	*Unit	Quantity	Unit Cost ($)	Cost	**Cost Data Reference
Pond 1 backfill from embankment	yd^3	1,156	$1.88	$2,173	RSMeans Heavy Constr., 31 23 23.17 0020
Pond 1 backfill from subsoil pile	yd^3	3,200	$5.87	$18,784	RSMeans Heavy Constr., 31 23 23.20 3014 & 31 23 16.42 1300 & 31 23 23.17 0020
Pond 1B backfill from embankment	yd^3	146	$1.88	$274	RSMeans Heavy Constr., 31 23 23.17 0020
Pond 1B backfill from subsoil pile	yd^3	794	$5.87	$4,661	RSMeans Heavy Constr., 31 23 23.20 3014 & 31 23 16.42 1300 & 31 23 23.17 0020
Ditch 3 recontouring	yd^3	11,556	$1.88	$21,725	RSMeans Heavy Constr., 31 23 23.17 0020
Ripping of roads and compacted surfaces	yd^3	9,600	$2.17	$20,832	RSMeans Heavy Constr., 31 23 16.32 2310
Grading of reclamation surface	yd^2	164,000	$0.17	$27,880	RSMeans Heavy Constr., 31 22 16.10 3300
Topsoil reclamation surface	yd^3	36,000	$5.87	$211,320	RSMeans Heavy Constr., 31 23 23.20 3014 & 31 23 16.42 1300 & 31 23 23.17 0020
Seeding	M.S.F	1,481	$39.00	$57,759	RS Means Heavy Constr., 32 92 19.14 3700
Mulching	M.S.F	1,481	$60.00	$88,860	RS Means Heavy Constr., 32 91 13.16 0350
Subtotal Facilities Earthwork and Land Reclamation				**$454,269**	

Total Facilities Reclamation Cost Estimate	**$1,395,235**

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Phase 1 - Reclamation Estimate

Estimate Details

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Phase 1 Mine Reclamation Cost Estimate

Phase 1 Specialized Reclamation Areas

Item	*Unit	Quantity	Unit Cost ($)	Cost	**Cost Data Reference
Pond 2 backfill from embankment	yd^3	160	$1.88	$301	RSMeans Heavy Constr., 31 23 23.17 0020
Pond 2 backfill from excess spoil	yd^3	7122	$5.87	$41,806	RSMeans Heavy Constr., 31 23 23.20 3014 & 31 23 16.42 1300 & 31 23 23.17 0020
Pond 2 topsoil	yd^3	860	$5.87	$5,048	RSMeans Heavy Constr., 31 23 23.20 3014 & 31 23 16.42 1300 & 31 23 23.17 0020
Pond 2 seeding	M.S.F	35	$39.00	$1,365	RS Means Heavy Constr., 32 92 19.14 3700
Pond 2 mulching	M.S.F	35	$60.00	$2,100	RS Means Heavy Constr., 32 91 13.16 0350
Pond 2 Subtotal				**$50,620**	
Pond 3 backfill from embankment	yd^3	4767	$1.88	$8,962	RSMeans Heavy Constr., 31 23 23.17 0020
Pond 3 backfill from excess spoil pile	yd^3	6107	$5.87	$35,848	RSMeans Heavy Constr., 31 23 23.20 3014 & 31 23 16.42 1300 & 31 23 23.17 0020
Pond 3 topsoil	yd^3	3011	$5.87	$17,675	RSMeans Heavy Constr., 31 23 23.20 3014 & 31 23 16.42 1300 & 31 23 23.17 0020
Pond 3 seeding	M.S.F	122	$39.00	$4,758	RS Means Heavy Constr., 32 92 19.14 3700
Pond 3 mulching	M.S.F	122	$60.00	$7,320	RS Means Heavy Constr., 32 91 13.16 0350
Pond 3 Subtotal				**$74,563**	
Robinson Creek Topsoil	yd^3	3520	$5.87	$20,661	RSMeans Heavy Constr., 31 23 23.20 3014 & 31 23 16.42 1300 & 31 23 23.17 0020
Robinson Creek Rip-Rap	yd^3	562	$60.00	$33,709	RS Means Heavy Constr., 31 37 13.10 0100
Robinson Creek Grass Matting	yd^2	2189	$7.95	$17,402	RS Means Heavy Constr., 31 25 13.10 0120
Robinson Creek seeding	M.S.F	188	$39.00	$7,332	RS Means Heavy Constr., 32 92 19.14 3700
Robinson Creek mulching	M.S.F	142	$60.00	$8,520	RS Means Heavy Constr., 32 91 13.16 0350
Robinson Creek Subtotal				**$87,623**	
Phase 1 Specialized Reclamation Areas Total				**$162,195**	

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Phase 1 Mine Reclamation Cost Estimate

Phase 1 Pit Backfill and Land Reclamation

Item	*Unit	Quantity	Unit Cost ($)	Cost	**Cost Data Reference
Pit Backfill Rehandle Excess Spoil Pile - Dozer	yd^3 (Loose)	1,411,521	$0.84	$1,188,501	Production from Dozsim Software, Cost data from CostMine Coal Cost Guide 2009
Pit Backfill Rehandle Excess Spoil Pile - Excavator	yd^3 (Loose)	1,329,479	$0.94	$1,253,508	Production from Fleet Production and Cost Analysis Software, Cost data from CostMine Coal Cost Guide 2009
Topsoil	yd^3 (Loose)	81,874	$0.95	$77,754	Production from Fleet Production and Cost Analysis Software, Cost data from CostMine Coal Cost Guide 2009
Subsoil	yd^3 (Loose)	188,222	$0.97	$183,333	Production from Fleet Production and Cost Analysis Software, Cost data from CostMine Coal Cost Guide 2009
Seeding	M.S.F	3,310	$39.00	$129,090	RS Means Heavy Constr., 32 92 19.14 3700
Mulching	M.S.F	3,310	$60.00	$198,600	RS Means Heavy Constr., 32 91 13.16 0350
Subtotal				**$3,030,786**	
Mobilization/Demobolization (5%)				$151,539	
Project Management/Engineering (5%)				$151,539	
Contractor Profit/Overhead (15%)				$454,618	
Phase 1 Mine Reclamation Total				**$3,788,482**	

Phase 1 Reclamation Bond Summary

Facilities Reclamation	$1,395,235
Specialized Areas Reclamation	$162,195
Mine Reclamation	$3,788,482
Phase 1 Overall Bond Total	**$5,345,912**

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Phase 1 Mine Reclamation Material Handling Summary

Equipment Description	Production Rate (BCY)	Production Rate (LCY)	Cost/BCY	Cost/LCY	Total Volume (BCY)	Total Volume (LCY)	Total Cost
Rehandle with Dozer	152.7	203.1	$1.12	$0.84	1,061,294	1,411,521	$1,188,501
Rehandle with Truck/Shovel	447.7	595.4	$1.25	$0.94	999,608	1,329,479	$1,253,508
Topsoil	456.7	562.7	$1.17	$0.95	66,456	81,874	$77,754
Subsoil	446.4	550.0	$1.20	$0.97	153,026	188,222	$183,333
Total Phase 1 Material Handling							$2,703,096

Rehandle with Dozer Quantity	1,411,521	Loose Cubic Yards
Rehandle with Truck/Shovel Quantity	1,329,479	Loose Cubic Yards
Total Rehandle Quantity	2,741,000	Loose Cubic Yards

Software Overburden Swell Factor	33%
Software Topsoil Swell Factor	23%
Software Subsoil Swell Factor	23%

Topsoil Area	76 acres
Subsoil Area (Open Pit)	35 acres

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Equipment Cost Data (Cost Mine 2009 Coal Cost Guide/2008 Mine and Mill Equipment Costs)

Equipment Description	$/hr
7 yd. Excavator	$116.40
25 Ton Haul Truck	$40.03
5,000 Gal. Water Truck	$31.25
14 Grader	$54.15
D10 Dozer	$140.17
D7 Dozer	$79.19
13 yd. Excavator	$264.49
40 Ton Haul Truck	$97.73

Manpower Type	$/hr (46% burden)
Excavator Operator	$32.31
Truck Drivers	$32.46
Heavy Equipment Operators	$31.33
Utility Operators	$32.89

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Phase 1 - Reclamation Estimate

Pit Backfill - Dozer
Dozer Simulation

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Machine Properties

Select Machine: D10N

Shoe Width: 24 / 28 / 31.5 inch

Blade: U / SU / Coal

Capacity - yd³: 28.7

Dual Tilt: Yes / No

Forward Gear: 1st Only / 2nd Only / System Select

Reverse Gear: 1st Only / 2nd Only / System Select

%Avail: 100% – 25% — 85 %

Weight: +15% – -15% — 150191 lb

Cost/Hr: $250 – $1 — $171

Material Properties

Shale

Density / Swell — Select Calculated

Loose	Bank	Swell
2107 lb/LCY	2798 lb/BCY	33 %

Dozability: Easy – Hard — Factor 1.06

Derating Factors

Altitude: 0 – 15,000 — Feet 6900

Visibility: Poor – Excellent — Factor 0.95

Job Efficiency: 0 Min – 60 Min — 54 Min/Hr — Percent 90

Skill Level: Poor – Excellent — Factor 0.95

Input Values

Average Push Distance: 50 ft – 1500 ft — Feet 842

Average Push Slope: -55 % – 55 % — % -8

Volumes

Bank Moved	1,061,294	yd³
Loose Moved	1,411,521	yd³

☑ Slot Dozing

Disclaimer

Due to the many variables involved and the consequent possibility of inadvertant errors or omissions in preparing reports of this character, neither Caterpillar Inc. nor the dealer can or does represent or warrant, expressly or implicitly, either the accuracy of this report or that the Caterpillar equipment referred to in the report will in fact achieve the performance indicated on the job to which the report relates.

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Output Values

Gear: Fwd 1 / Rev 2

Productivity

Bank: 152.7 yd/hr — $1.120 $/yd

Loose: 203.1 yd/hr — $0.842 $/yd

Totals

Hours	6,951.00
Cost	$1,188,620.18

Print

Exit

CATERPILLAR® | DOZSIM Quick-Calc | Oct 6, 2009 | Phase 1 Dozer Push.qcf

TRACK-TYPE TRACTORS DIVISION

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Phase 1 - Reclamation Estimate

Pit Backfill - Truck and Shovel
Fleet Production and Cost Analysis (FPC)

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Fleet Production and Cost Analysis

Phase 1 Truck-Shovel
Alton Coal Development, LLC **Coal Hollow Mine** **10-8-09**

Pit Backfill Haul

Description:	Haul from excess pile to pit
Material Qty (BCY)	999,608
lbs per BCY	2,798
lbs per LCY	2,107

1950 feet

Distance feet	Rolling Resistance %	Grade %	Haul mph Limit	Return mph Limit	Description
100	4.00	0.00	15.00	15.00	Leaving excavator location
1,850	4.00	3.00	25.00	25.00	Haul to open pit

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Fleet Production and Cost Analysis

Phase 1 Truck-Shovel | **Pit Backfill Haul** | **FLEET1**

Alton Coal Development, LLC | **Coal Hollow Mine** | **10-8-09**

Operating Schedule

Operator Efficiency (%)	84.75
Sched Hrs per Year	6,240.00

Fleet Estimates

Fleet Availability (%)	86.17
BCY per Sched Hr	447.70
Total BCY	999,608.00
Sched Hrs Required	2,232.77
Total $	1,253,903.41
$ per BCY	1.25
BCY per Year	2,793,644.50
Years Required	0.36

	1 385C LME	4 769C
Loader Fill Factor % (7.25 CY)		90.00
Tons/Pass (2107 lbs/LCY):		6.87
System Passes per Hauler:		3.27
Hauler Payload in Tons		22.51
Percent of Max GVW		95.91
Loader Cycle Time (Min)		0.25
First Bucket Dump (Min)		0.05
Hauler Exchange Time (Min)		0.70
HAULER CYCLE TIMES		
Load with Exchange		1.50
Haul		1.45
Dump and Maneuver		0.60
Return		1.06
Potential Cycle Time		4.61
Wait on Slow Hauler		0.00
Wait TMPH		0.00
Wait to Load, Bunching AVG		1.69
Total Cycle Time		6.30
POTENTIAL PRODUCTION		
BCY per Hour	643.66	837.78
Avg mph		9.61

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Fleet Production and Cost Analysis

Phase 1 Truck-Shovel | **Pit Backfill Haul** | **FLEET1**

Alton Coal Development, LLC | **Coal Hollow Mine** | **10-8-09**

Fleet Composition

	Qty
Loader	
385C LME	1
Haulers	
769C	4

Potential Production

	Model	BCY per Hour	Avg mph
1	385C LME	644	
2	769C	838	9.6

Fleet Availability (%)	76.50
BCY per Scheduled hour	447.70
Total BCY	999,608.00
Scheduled Hours Required	2,232.77
Total $	1,253,903.41
$ per BCY	1.25
BCY per Year	2,793,644.50
Years Required	0.36

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Fleet Production and Cost Analysis

Phase 1 Truck-Shovel | **Pit Backfill Haul** | **FLEET1**

Alton Coal Development, LLC | **Coal Hollow Mine** | **10-8-09**

999,608 BCY

	Qty	Model	Machine Code	Hourly Cost Each Unit	Operating Hours	$ Total	$ per BCY
Loaders:	1	385C LME		149.56	2,009	300,539	0.301
Haulers:	4	769C	C202	72.49	7,591	550,301	0.551
Totals	4				7,591	550,301	0.551
Support:	1	14 Grader		87.04	893	77,736	0.078
	1	Water Truck		64.14	893	57,284	0.057
	1	D10 Dozer		171.50	1,563	268,044	0.268
Totals	3				3,349	403,063	0.403
Fleet Totals	8				12,950	1,253,903	1.254

Note: TMPH limits have been exceeded on the following Fleet/Course Combinations:

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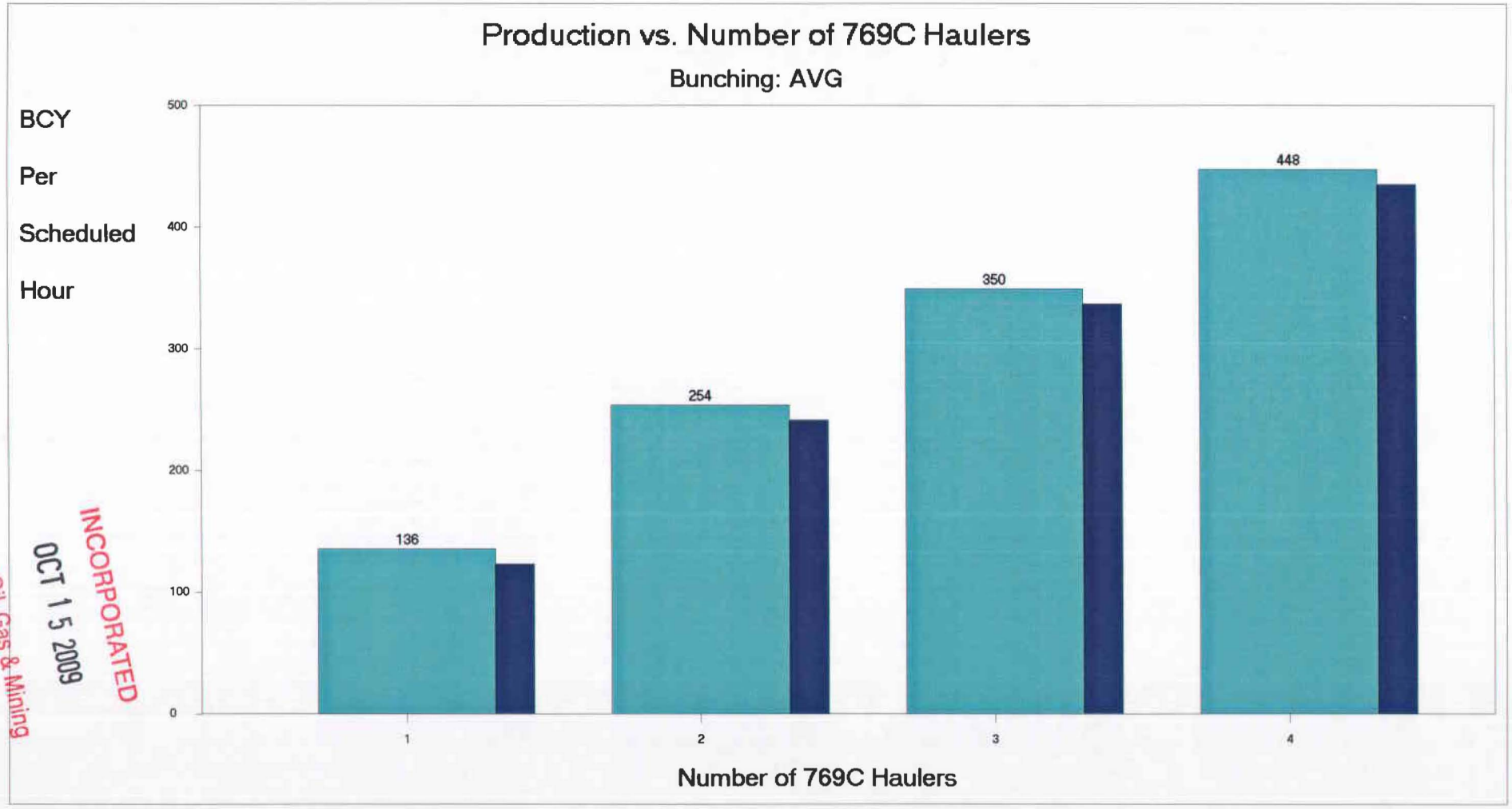
Fleet Production and Cost Analysis

Phase 1 Truck-Shovel | **Pit Backfill Haul** | **FLEET1**

Alton Coal Development, LLC | **Coal Hollow Mine** | **10-8-09**

Loader:	1 385C LME	Availability: 90%	85 % Operator Efficiency
Haulers:	4 769C	Availability: 85%	6240 Sched Hours per Year
			AVG Bunching



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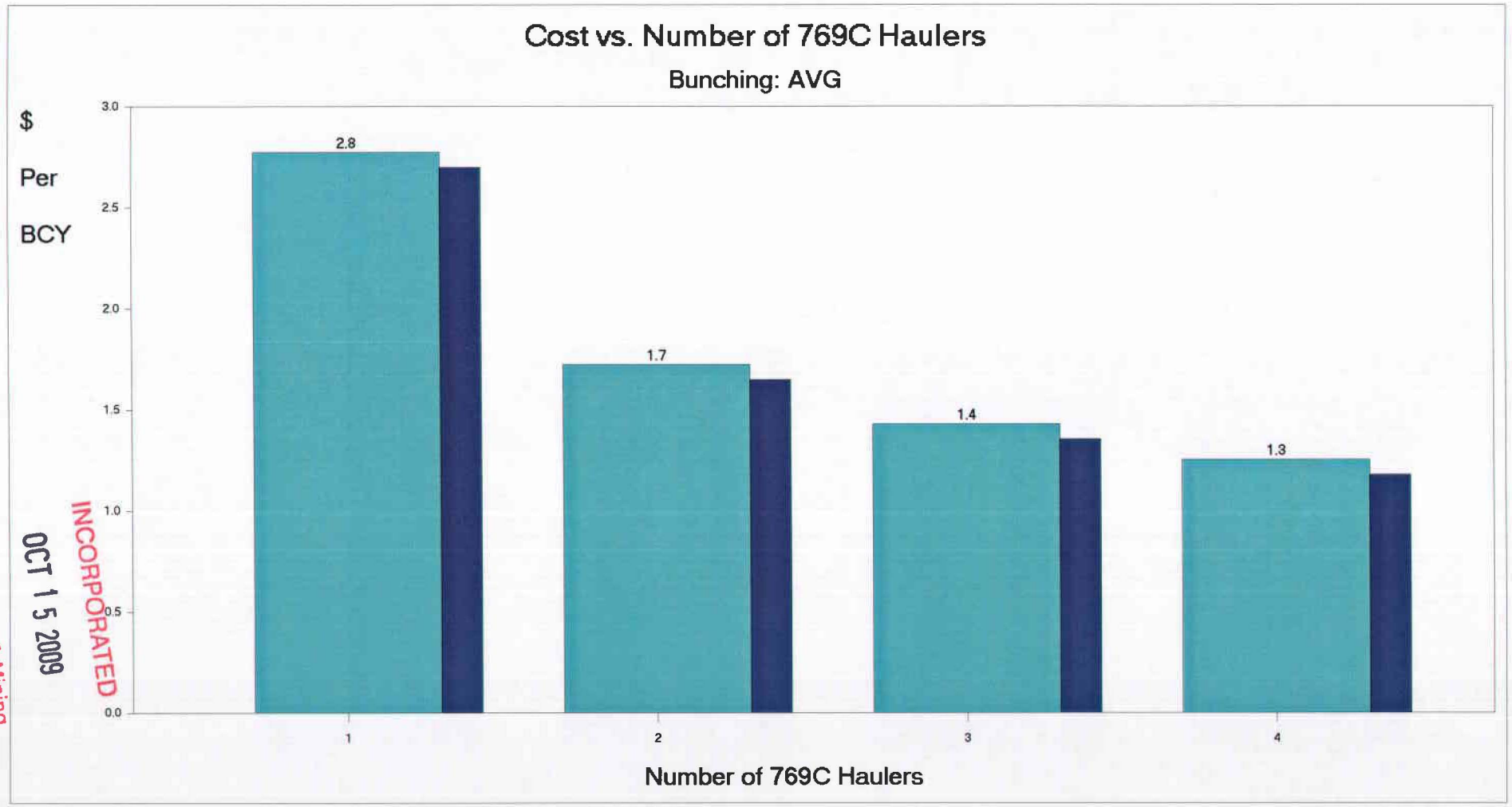
Fleet Production and Cost Analysis

Phase 1 Truck-Shovel | **Pit Backfill Haul** | **FLEET1**

Alton Coal Development, LLC | **Coal Hollow Mine** | **10-8-09**

Loader:	1 385C LME	Availability: 90%	85 % Operator Efficiency
Haulers:	4 769C	Availability: 85%	6240 Sched Hours per Year
			AVG Bunching



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Phase 1 - Reclamation Estimate

Subsoil
Fleet Production and Cost Analysis

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Fleet Production and Cost Analysis

Phase 1 Subsoil
Alton Coal Development, LLC **Coal Hollow Mine** **10-8-09**

Subsoil Haul

Description:	Subsoil Pile to Phase 1 Reclamation
Material Qty (BCY)	153,026
lbs per BCY	2,596
lbs per LCY	2,107

4200 feet

Distance feet	Rolling Resistance %	Grade %	Haul mph Limit	Return mph Limit	Description
100	4.00	0.00	15.00	15.00	Leaving Excavator
250	4.00	-3.00	25.00	25.00	Segment 1
1,550	4.00	-6.00	25.00	25.00	Segment 2
2,300	4.00	-1.50	25.00	25.00	Segment 3

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Fleet Production and Cost Analysis

Phase 1 Subsoil | **Subsoil Haul** | **FLEET1**

Alton Coal Development, LLC | **Coal Hollow Mine** | **10-8-09**

Operating Schedule

Operator Efficiency (%)	86.50
Sched Hrs per Year	6,240.00

Fleet Estimates

Fleet Availability (%)	76.50
BCY per Sched Hr	446.37
Total BCY	153,026.00
Sched Hrs Required	342.82
Total $	183,222.50
$ per BCY	1.20
BCY per Year	2,785,360.09
Years Required	0.05

	1 385C LME	4 769C
Loader Fill Factor % (7.25 CY)		90.00
Tons/Pass (2107 lbs/LCY):		6.87
System Passes per Hauler:		4.31
Hauler Payload in Tons		29.63
Percent of Max GVW		107.54
Loader Cycle Time (Min)		0.25
First Bucket Dump (Min)		0.05
Hauler Exchange Time (Min)		0.70
HAULER CYCLE TIMES		
Load with Exchange		1.75
Haul		2.09
Dump and Maneuver		0.60
Return		2.31
Potential Cycle Time		6.75
Wait on Slow Hauler		0.00
Wait TMPH		0.00
Wait to Load, Bunching AVG		1.37
Total Cycle Time		8.12
POTENTIAL PRODUCTION		
BCY per Hour	782.58	811.81
Avg mph		14.15

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Fleet Production and Cost Analysis

Phase 1 Subsoil | **Subsoil Haul** | **FLEET1**

Alton Coal Development, LLC | **Coal Hollow Mine** | **10-8-09**

Fleet Composition

	Qty
Loader	
385C LME	1
Haulers	
769C	4

Potential Production

	Model	BCY per Hour	Avg mph
1	385C LME	783	
2	769C	812	14.1

Fleet Availability (%)	76.50
BCY per Scheduled hour	446.37
Total BCY	153,026.00
Scheduled Hours Required	342.82
Total $	183,222.50
$ per BCY	1.20
BCY per Year	2,785,360.09
Years Required	0.05

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Fleet Production and Cost Analysis

Phase 1 Subsoil | **Subsoil Haul** | **FLEET1**

Alton Coal Development, LLC | **Coal Hollow Mine** | **10-8-09**

153,026 BCY

	Qty	Model	Machine Code	Hourly Cost Each Unit	Operating Hours	$ Total	$ per BCY
Loaders:	1	385C LME		149.56	309	46,145	0.302
Haulers:	4	769C	C202	72.49	1,166	84,494	0.552
Totals	4				1,166	84,494	0.552
Support:	1	14 Grader		87.04	69	5,968	0.039
	1	Water Truck		64.14	137	8,795	0.057
	1	D7 Dozer		110.32	343	37,820	0.247
Totals	3				549	52,583	0.344
Fleet Totals	8				2,023	183,222	1.197

Note: TMPH limits have been exceeded on the following Fleet/Course Combinations:

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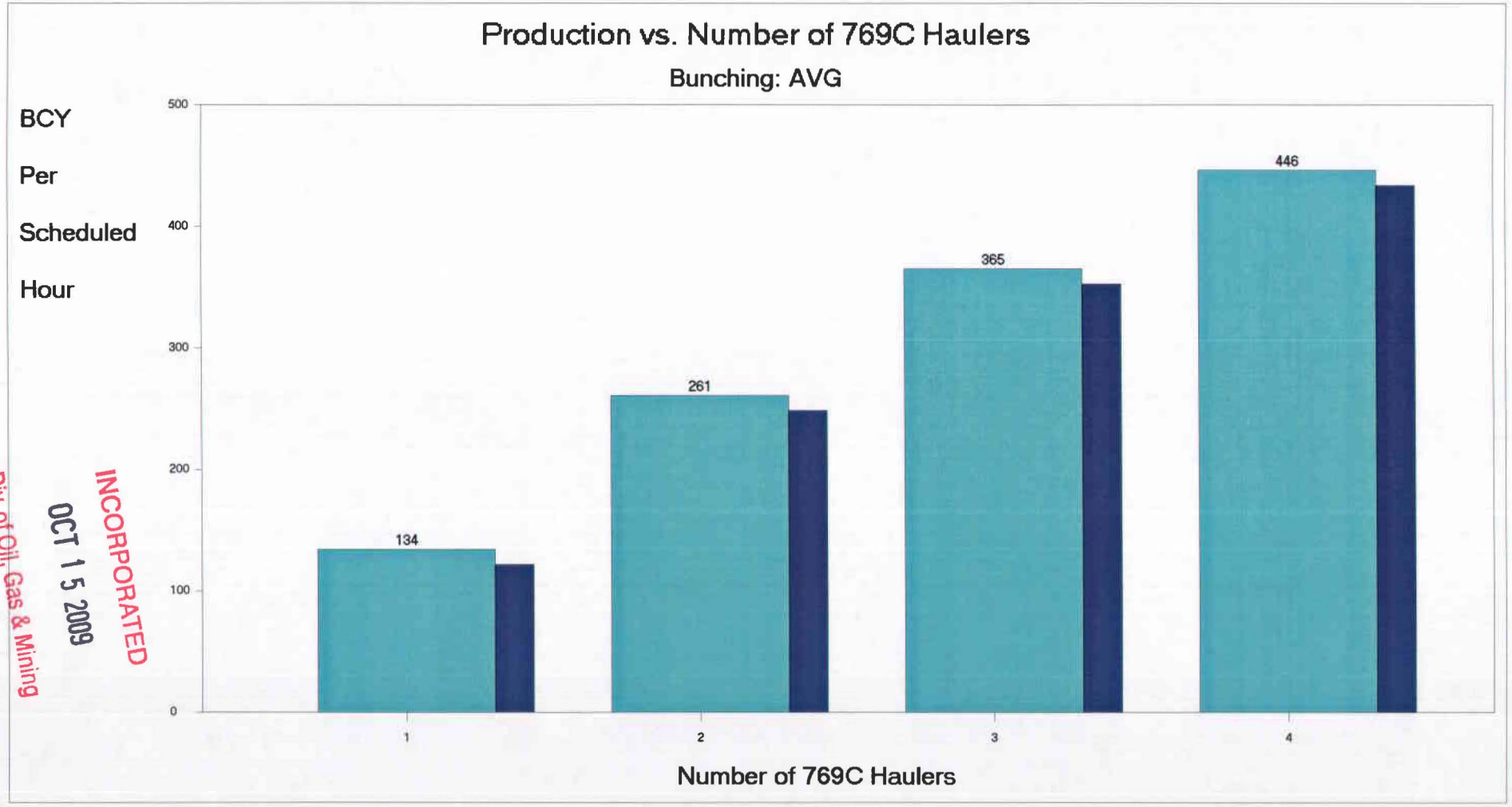
Fleet Production and Cost Analysis

Phase 1 Subsoil | **Subsoil Haul** | **FLEET1**

Alton Coal Development, LLC | **Coal Hollow Mine** | **10-8-09**

Loader:	1 385C LME	Availability: 90%	86 % Operator Efficiency
Haulers:	4 769C	Availability: 85%	6240 Sched Hours per Year
			AVG Bunching



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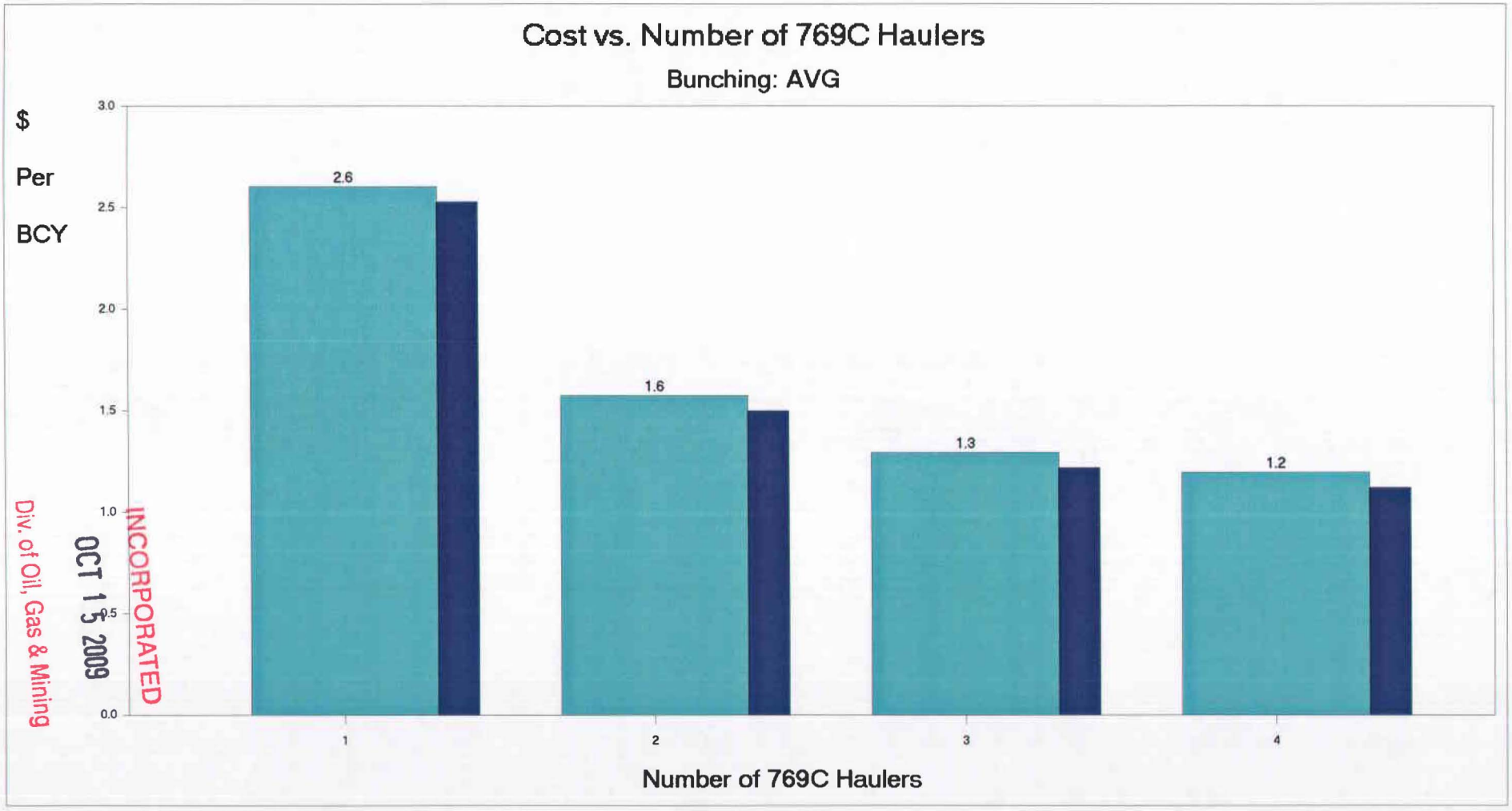
Fleet Production and Cost Analysis

Phase 1 Subsoil | **Subsoil Haul** | **FLEET1**

Alton Coal Development, LLC | **Coal Hollow Mine** | **10-8-09**

Loader:	1 385C LME	Availability: 90%	86 % Operator Efficiency
Haulers:	4 769C	Availability: 85%	6240 Sched Hours per Year
			AVG Bunching



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Phase 1 - Reclamation Estimate

Topsoil
Fleet Production and Cost Analysis

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Fleet Production and Cost Analysis

Phase 1 Topsoil
Alton Coal Development, LLC **Coal Hollow Mine** **10-8-09**

Topsoil Haul

Description:	Topsoil Pile to Phase 1 Reclamation
Material Qty (BCY)	66,456
lbs per BCY	2,596
lbs per LCY	2,107

3950 feet

Distance feet	Rolling Resistance %	Grade %	Haul mph Limit	Return mph Limit	Description
100	4.00	0.00	15.00	15.00	Leaving Excavator
1,550	4.00	-6.00	25.00	25.00	Segment 1
2,300	4.00	-1.50	25.00	25.00	Segment 2

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Fleet Production and Cost Analysis

Phase 1 Topsoil | **Topsoil Haul** | **FLEET1**

Alton Coal Development, LLC | **Coal Hollow Mine** | **10-8-09**

Operating Schedule

Operator Efficiency (%)	86.50
Sched Hrs per Year	6,240.00

Fleet Estimates

Fleet Availability (%)	76.50
BCY per Sched Hr	456.73
Total BCY	66,456.00
Sched Hrs Required	145.50
Total $	77,765.41
$ per BCY	1.17
BCY per Year	2,849,985.62
Years Required	0.02

	1 385C LME	4 769C
Loader Fill Factor % (7.25 CY)		90.00
Tons/Pass (2107 lbs/LCY):		6.87
System Passes per Hauler:		4.31
Hauler Payload in Tons		29.63
Percent of Max GVW		107.54
Loader Cycle Time (Min)		0.25
First Bucket Dump (Min)		0.05
Hauler Exchange Time (Min)		0.70
HAULER CYCLE TIMES		
Load with Exchange		1.75
Haul		1.96
Dump and Maneuver		0.60
Return		2.15
Potential Cycle Time		6.46
Wait on Slow Hauler		0.00
Wait TMPH		0.00
Wait to Load, Bunching AVG		1.47
Total Cycle Time		7.94
POTENTIAL PRODUCTION		
BCY per Hour	782.58	847.69
Avg mph		13.89

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Fleet Production and Cost Analysis

Phase 1 Topsoil | **Topsoil Haul** | **FLEET1**

Alton Coal Development, LLC | **Coal Hollow Mine** | **10-8-09**

Fleet Composition

	Qty
Loader	
385C LME	1
Haulers	
769C	4

Potential Production

	Model	BCY per Hour	Avg mph
1	385C LME	783	
2	769C	848	13.9

Fleet Availability (%)	76.50
BCY per Scheduled hour	456.73
Total BCY	66,456.00
Scheduled Hours Required	145.50
Total $	77,765.41
$ per BCY	1.17
BCY per Year	2,849,985.62
Years Required	0.02

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Fleet Production and Cost Analysis

Phase 1 Topsoil | **Topsoil Haul** | **FLEET1**

Alton Coal Development, LLC | **Coal Hollow Mine** | **10-8-09**

66,456 BCY

	Qty	Model	Machine Code	Hourly Cost Each Unit	Operating Hours	$ Total	$ per BCY
Loaders:	1	385C LME		149.56	131	19,585	0.295
Haulers:	4	769C	C202	72.49	495	35,862	0.540
Totals	4				495	35,862	0.540
Support:	1	14 Grader		87.04	29	2,533	0.038
	1	Water Truck		64.14	58	3,733	0.056
	1	D7 Dozer		110.32	146	16,052	0.242
Totals	3				233	22,318	0.336
Fleet Totals	8				858	77,765	1.170

Note: TMPH limits have been exceeded on the following Fleet/Course Combinations:

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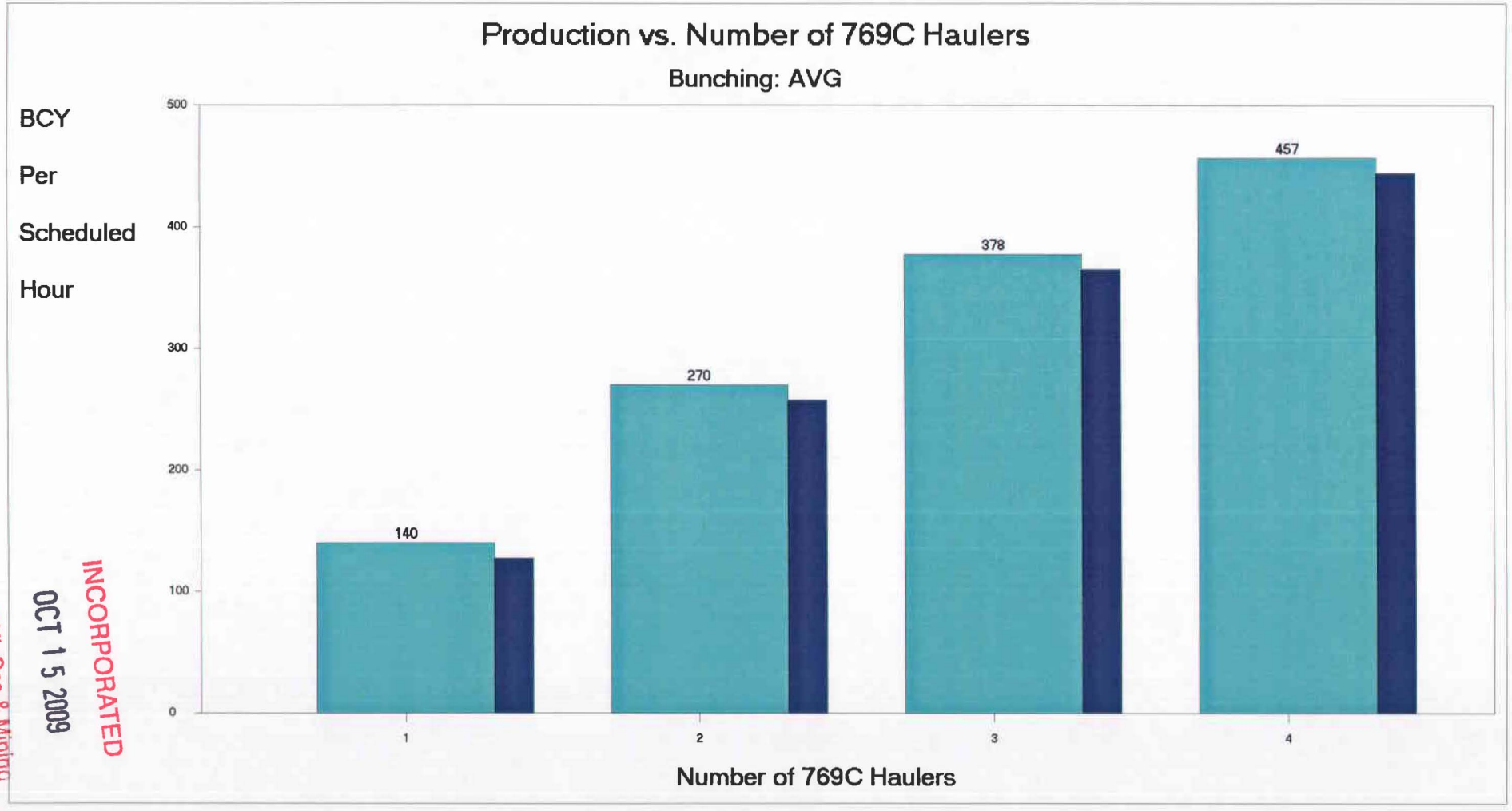
Fleet Production and Cost Analysis

Phase 1 Topsoil | **Topsoil Haul** | **FLEET1**

Alton Coal Development, LLC | **Coal Hollow Mine** | **10-8-09**

Loader:	1 385C LME	Availability: 90%	86 % Operator Efficiency
Haulers:	4 769C	Availability: 85%	6240 Sched Hours per Year
			AVG Bunching



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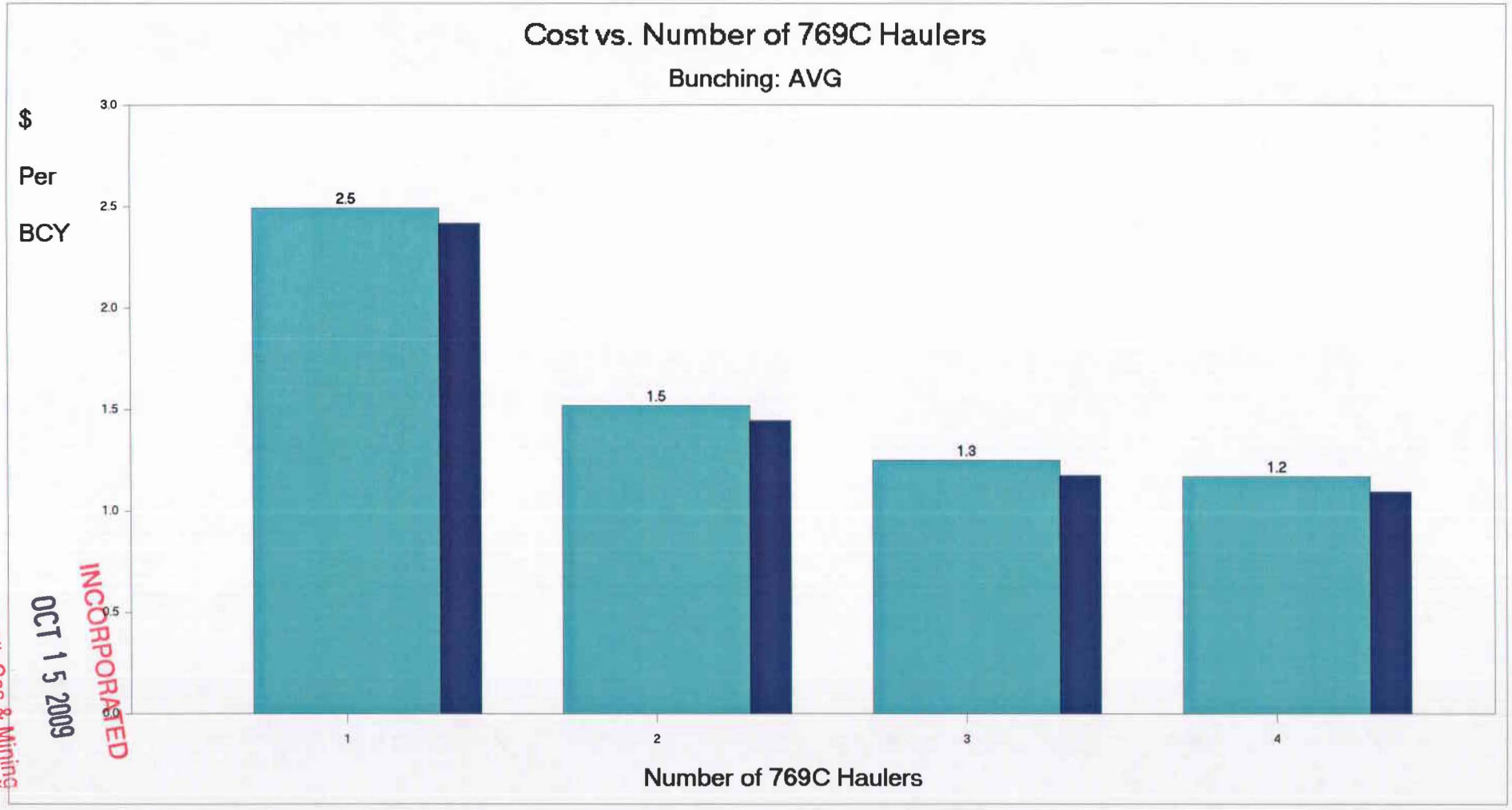
Fleet Production and Cost Analysis

Phase 1 Topsoil | **Topsoil Haul** | **FLEET1**

Alton Coal Development, LLC | **Coal Hollow Mine** | **10-8-09**

Loader:	1 385C LME	Availability: 90%	86 % Operator Efficiency
Haulers:	4 769C	Availability: 85%	6240 Sched Hours per Year
			AVG Bunching



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Phase 2 - Reclamation Estimate

Estimate Details

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Phase 2 Mine Reclamation Cost Estimate

Phase 2 Specialized Reclamation Areas

Item	*Unit	Quantity	Unit Cost ($)	Cost	**Cost Data Reference
Pond 2 backfill from embankment	yd^3	160	$1.88	$301	RSMeans Heavy Constr., 31 23 23.17 0020
Pond 2 backfill from excess spoil	yd^3	7,122	$5.87	$41,806	RSMeans Heavy Constr., 31 23 23.20 3014 & 31 23 16.42 1300 & 31 23 23.17 0020
Pond 2 topsoil	yd^3	860	$5.87	$5,048	RSMeans Heavy Constr., 31 23 23.20 3014 & 31 23 16.42 1300 & 31 23 23.17 0020
Pond 2 seeding	M.S.F	35	$39.00	$1,365	RS Means Heavy Constr., 32 92 19.14 3700
Pond 2 mulching	M.S.F	35	$60.00	$2,100	RS Means Heavy Constr., 32 91 13.16 0350
Pond 2 Subtotal				**$50,620**	
Pond 3 backfill from embankment	yd^3	4,767	$1.88	$8,962	RSMeans Heavy Constr., 31 23 23.17 0020
Pond 3 backfill from excess spoil pile	yd^3	6,107	$5.87	$35,848	RSMeans Heavy Constr., 31 23 23.20 3014 & 31 23 16.42 1300 & 31 23 23.17 0020
Pond 3 topsoil	yd^3	3,011	$5.87	$17,675	RSMeans Heavy Constr., 31 23 23.20 3014 & 31 23 16.42 1300 & 31 23 23.17 0020
Pond 3 seeding	M.S.F	122	$39.00	$4,758	RS Means Heavy Constr., 32 92 19.14 3700
Pond 3 mulching	M.S.F	122	$60.00	$7,320	RS Means Heavy Constr., 32 91 13.16 0350
Pond 3 Subtotal				**$74,563**	
Pond 4 backfill from embankment	yd^3	1,410	$1.88	$2,651	RSMeans Heavy Constr., 31 23 23.17 0020
Pond 4 backfill from excess spoil pile	yd^3	14,692	$5.87	$86,242	RSMeans Heavy Constr., 31 23 23.20 3014 & 31 23 16.42 1300 & 31 23 23.17 0020
Pond 4 topsoil	yd^3	2,055	$5.87	$12,065	RSMeans Heavy Constr., 31 23 23.20 3014 & 31 23 16.42 1300 & 31 23 23.17 0020
Pond 4 seeding	M.S.F	188	$39.00	$7,332	RS Means Heavy Constr., 32 92 19.14 3700
Pond 4 mulching	M.S.F	142	$60.00	$8,520	RS Means Heavy Constr., 32 91 13.16 0350
Pond 4 Subtotal				**$116,810**	
Phase 2 Specialized Reclamation Areas Total				**$191,381**	

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Phase 2 Mine Reclamation Cost Estimate

Phase 2 Pit Backfill and Land Reclamation

Item	*Unit	Quantity	Unit Cost ($)	Cost	**Cost Data Reference
Pit Backfill Rehandle Excess Spoil Pile - Dozer	yd^3 (Loose)	3,055,350	$0.93	$2,832,309	Production from Dozsim Software, Cost data from CostMine Coal Cost Guide 2009
Pit Backfill Rehandle Excess Spoil Pile - Excavator	yd^3 (Loose)	3,987,754	$0.93	$3,717,906	Production from Fleet Production and Cost Analysis Software, Cost data from CostMine Coal Cost Guide 2009
Topsoil	yd^3 (Loose)	153,787	$0.80	$123,579	Production from Fleet Production and Cost Analysis Software, Cost data from CostMine Coal Cost Guide 2009
Subsoil	yd^3 (Loose)	303,970	$0.80	$244,262	Production from Fleet Production and Cost Analysis Software, Cost data from CostMine Coal Cost Guide 2009
Seeding	M.S.F	5,053	$39.00	$197,065	RS Means Heavy Constr., 32 92 19.14 3700
Mulching	M.S.F	5,053	$60.00	$303,178	RS Means Heavy Constr., 32 91 13.16 0350
Subtotal				**$7,418,299**	
Mobilization/Demobolization (5%)				$370,915	
Project Management/Engineering (5%)				$370,915	
Contractor Profit/Overhead (15%)				$1,112,745	
Phase 2 Mine Reclamation Total				**$9,272,874**	

Phase 2 Reclamation Bond Summary

Facilities Reclamation	$1,395,235
Specialized Areas Reclamation	$191,381
Mine Reclamation	$9,272,874
Phase 2 Overall Bond Total	**$10,859,490**

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Phase 2 Mine Reclamation Material Handling Summary

Equipment Description	Production Rate (BCY)	Production Rate (LCY)	Cost/BCY	Cost/LCY	Total Volume (BCY)	Total Volume (LCY)	Total Cost
Rehandle with Dozer	138.8	184.6	$1.23	$0.927	2,297,256	3,055,350	$2,832,309
Rehandle with Truck/Shovel	502.3	668.1	$1.24	$0.932	2,998,311	3,987,754	$3,717,906
Topsoil	541.0	666.5	$0.99	$0.80	124,827	153,787	$123,579
Subsoil	542.5	668.4	$0.99	$0.80	247,130	303,970	$244,262
Total Phase 2 Material Handling							$6,918,056

Rehandle with Dozer Quantity	3,055,350	Loose Cubic Yards
Rehandle with Truck/Shovel Quantity	3,987,754	Loose Cubic Yards
Total Rehandle Quantity	7,043,104	Loose Cubic Yards

Software Overburden Swell Factor	33%
Software Topsoil Swell Factor	23%
Software Subsoil Swell Factor	23%

Topsoil Area	116	acres
Subsoil Area (Open Pit)	46	acres

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Equipment Cost Data (Cost Mine 2009 Coal Cost Guide/2008 Mine and Mill Equipment Costs)

Equipment Description	$/hr
7 yd. Excavator	$116.40
25 Ton Haul Truck	$40.03
5,000 Gal. Water Truck	$31.25
14 Grader	$54.15
D10 Dozer	$140.17
D7 Dozer	$79.19
13 yd. Excavator	$264.49
40 Ton Haul Truck	$97.73

Manpower Type	$/hr (46% burden)
Excavator Operator	$32.31
Truck Drivers	$32.46
Heavy Equipment Operators	$31.33
Utility Operators	$32.89

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Phase 2 - Reclamation Estimate

Pit Backfill - Dozer
Dozer Simulation

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Machine Properties

Select Machine: D10N

Shoe Width: 24 / 28 / 31.5 inch

Blade: U / SU / Coal

Capacity - yd³: 28.7

Dual Tilt: Yes / No

Forward Gear: 1st Only / 2nd Only / System Select

Reverse Gear: 1st Only / 2nd Only / System Select

%Avail: 100% – 25% — 85 %

Weight: +15% – -15% — 150191 lb

Cost/Hr: $250 – $1 — $171

Material Properties

Shale

Density / Swell — Select Calculated

Loose	Bank	Swell
2107 lb/LCY	2798 lb/BCY	33 %

Dozability: Easy – Hard — Factor 1.06

Derating Factors

Altitude: 0 – 15,000 — Feet 6900

Visibility: Poor – Excellent — Factor 0.95

Job Efficiency: 0 Min – 60 Min — 54 Min/Hr — Percent 90

Skill Level: Poor – Excellent — Factor 0.95

Input Values

Average Push Distance: 50 ft – 1500 ft — Feet 800

Average Push Slope: -55 % – 55 % — % 0

Volumes

Bank Moved	2,297,256	yd³
Loose Moved	3,055,350	yd³

☑ Slot Dozing

Disclaimer

Due to the many variables involved and the consequent possibility of inadvertant errors or omissions in preparing reports of this character, neither Caterpillar Inc. nor the dealer can or does represent or warrant, expressly or implicitly, either the accuracy of this report or that the Caterpillar equipment referred to in the report will in fact achieve the performance indicated on the job to which the report relates.

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Output Values

Gear: Fwd 1 / Rev 2

Productivity

Bank	138.8	yd/hr
	$1.232	$/yd
Loose	184.6	yd/hr
	$0.927	$/yd

Totals

Hours	16,555.67
Cost	$2,831,020.09

Print

Exit

CATERPILLAR® | DOZSIM Quick-Calc | Oct 10, 2009 | Phase 2 Dozer Push.qcf

TRACK-TYPE TRACTORS DIVISION

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Phase 2 - Reclamation Estimate

Pit Backfill - Truck and Shovel
Fleet Production and Cost Analysis (FPC)

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Fleet Production and Cost Analysis

Phase 2 Truck-Shovel
Alton Coal Development, LLC **Coal Hollow Mine** **10-8-09**

Pit Backfill Haul

Description:	Haul from excess pile to pit
Material Qty (BCY)	2,998,311
lbs per BCY	2,798
lbs per LCY	2,107

2650 feet

Distance feet	Rolling Resistance %	Grade %	Haul mph Limit	Return mph Limit	Description
100	4.00	0.00	15.00	15.00	Leaving excavator location
2,550	4.00	2.00	25.00	25.00	Haul to open pit

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Fleet Production and Cost Analysis

Phase 2 Truck-Shovel | **Pit Backfill Haul** | **FLEET1**

Alton Coal Development, LLC | **Coal Hollow Mine** | **10-8-09**

Operating Schedule

Operator Efficiency (%)	90.00
Sched Hrs per Year	6,240.00

Fleet Estimates

Fleet Availability (%)	89.07
BCY per Sched Hr	502.35
Total BCY	2,998,311.00
Sched Hrs Required	5,968.54
Total $	3,719,643.17
$ per BCY	1.24
BCY per Year	3,134,681.03
Years Required	0.96

	1 385C LME	5 769C
Loader Fill Factor % (7.25 CY)		90.00
Tons/Pass (2107 lbs/LCY):		6.87
System Passes per Hauler:		3.27
Hauler Payload in Tons		22.51
Percent of Max GVW		95.91
Loader Cycle Time (Min)		0.25
First Bucket Dump (Min)		0.05
Hauler Exchange Time (Min)		0.70
HAULER CYCLE TIMES		
Load with Exchange		1.50
Haul		1.74
Dump and Maneuver		0.60
Return		1.39
Potential Cycle Time		5.23
Wait on Slow Hauler		0.00
Wait TMPH		0.00
Wait to Load, Bunching AVG		2.48
Total Cycle Time		7.70
POTENTIAL PRODUCTION		
BCY per Hour	643.66	923.88
Avg mph		11.53

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Fleet Production and Cost Analysis

Phase 2 Truck-Shovel | **Pit Backfill Haul** | **FLEET1**

Alton Coal Development, LLC | **Coal Hollow Mine** | **10-8-09**

Fleet Composition

	Qty
Loader	
385C LME	1
Haulers	
769C	5

Potential Production

	Model	BCY per Hour	Avg mph
1	385C LME	644	
2	769C	924	11.5

Fleet Availability (%)	76.50
BCY per Scheduled hour	502.35
Total BCY	2,998,311.00
Scheduled Hours Required	5,968.54
Total $	3,719,643.17
$ per BCY	1.24
BCY per Year	3,134,681.03
Years Required	0.96

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Fleet Production and Cost Analysis

Phase 2 Truck-Shovel | **Pit Backfill Haul** | **FLEET1**

Alton Coal Development, LLC | **Coal Hollow Mine** | **10-8-09**

2,998,311 BCY

	Qty	Model	Machine Code	Hourly Cost Each Unit	Operating Hours	$ Total	$ per BCY
Loaders:	1	385C LME		149.56	5,372	803,389	0.268
Haulers:	5	769C	C202	72.49	25,366	1,838,802	0.613
Totals	5				25,366	1,838,802	0.613
Support:	1	14 Grader		87.04	2,387	207,801	0.069
	1	Water Truck		64.14	2,387	153,129	0.051
	1	D10 Dozer		171.50	4,178	716,523	0.239
Totals	3				8,953	1,077,452	0.359
Fleet Totals	9				39,691	3,719,643	1.241

Note: TMPH limits have been exceeded on the following Fleet/Course Combinations:

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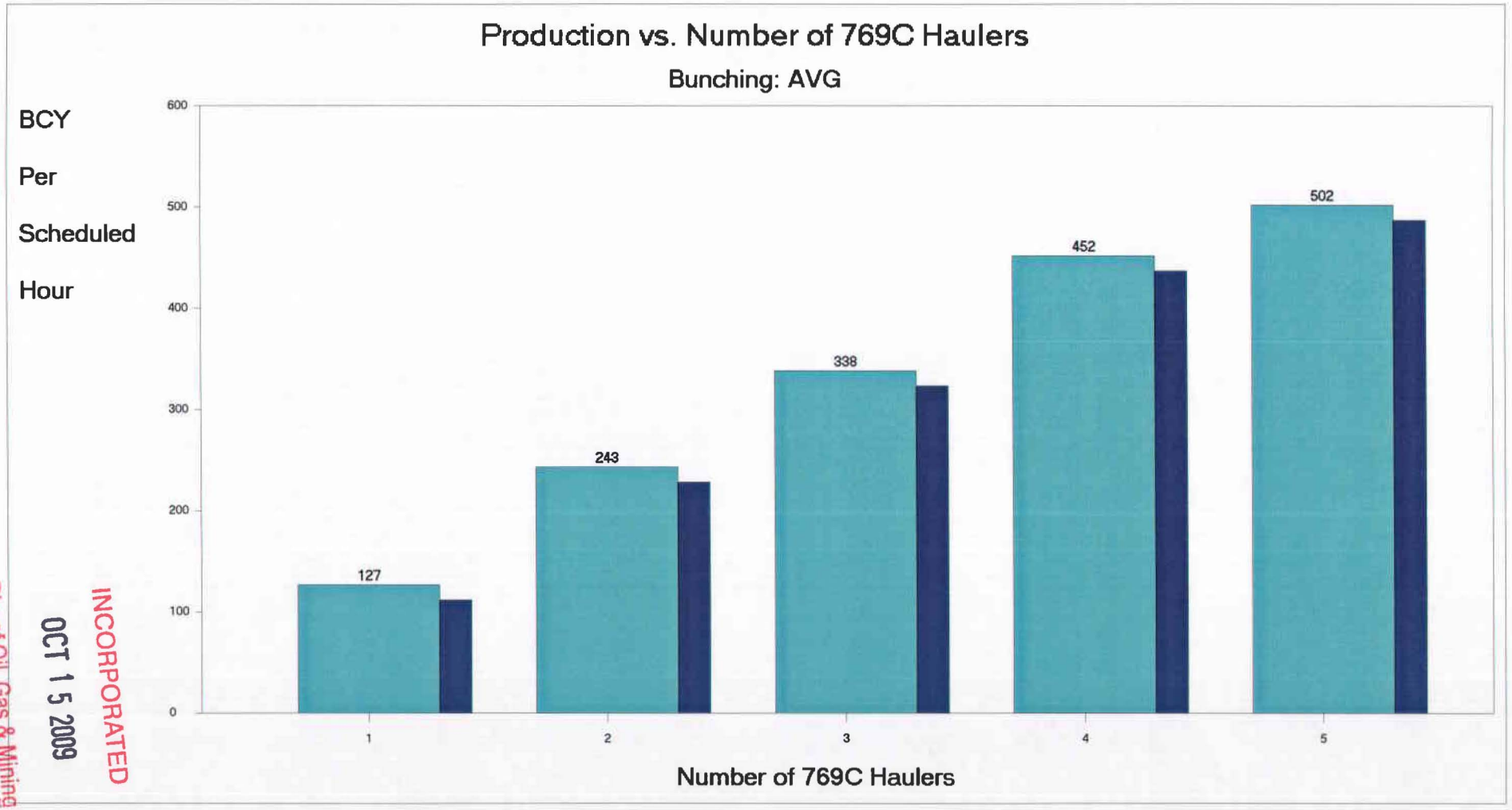
Fleet Production and Cost Analysis

Phase 2 Truck-Shovel | **Pit Backfill Haul** | **FLEET1**

Alton Coal Development, LLC | **Coal Hollow Mine** | **10-8-09**

Loader:	1 385C LME	Availability: 90%	90 % Operator Efficiency
Haulers:	5 769C	Availability: 85%	6240 Sched Hours per Year
			AVG Bunching



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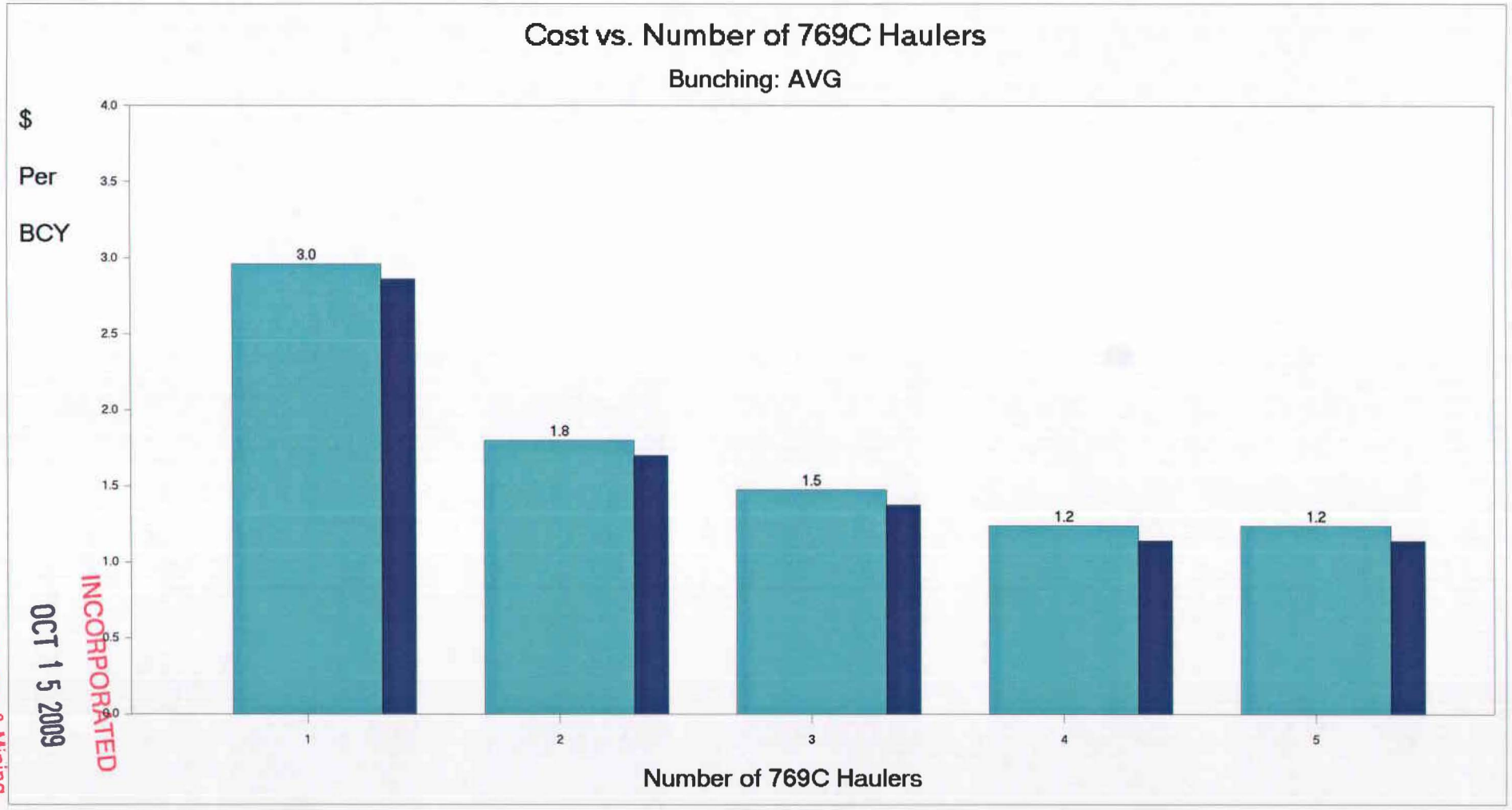
Fleet Production and Cost Analysis

Phase 2 Truck-Shovel | **Pit Backfill Haul** | **FLEET1**

Alton Coal Development, LLC | **Coal Hollow Mine** | **10-8-09**

Loader:	1 385C LME	Availability: 90%	90 % Operator Efficiency
Haulers:	5 769C	Availability: 85%	6240 Sched Hours per Year
			AVG Bunching



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Phase 2 - Reclamation Estimate

Subsoil
Fleet Production and Cost Analysis

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Fleet Production and Cost Analysis

Phase 2 Subsoil
Alton Coal Development, LLC **Coal Hollow Mine** **10-8-09**

Subsoil Haul

Description:	Subsoil Pile to Phase 1 Reclamation
Material Qty (BCY)	153,026
lbs per BCY	2,596
lbs per LCY	2,107

3100 feet

Distance feet	Rolling Resistance %	Grade %	Haul mph Limit	Return mph Limit	Description
100	4.00	0.00	15.00	15.00	Leaving Excavator
250	4.00	-3.00	25.00	25.00	Segment 1
1,550	4.00	-6.00	25.00	25.00	Segment 2
1,200	4.00	-1.50	25.00	25.00	Segment 3

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Fleet Production and Cost Analysis

Phase 2 Subsoil | **Subsoil Haul** | **FLEET1**

Alton Coal Development, LLC | **Coal Hollow Mine** | **10-8-09**

Operating Schedule

Operator Efficiency (%)	86.50
Sched Hrs per Year	6,240.00

Fleet Estimates

Fleet Availability (%)	86.17
BCY per Sched Hr	542.45
Total BCY	153,026.00
Sched Hrs Required	282.10
Total $	150,770.48
$ per BCY	0.99
BCY per Year	3,384,884.30
Years Required	0.05

	1 385C LME	4 769C
Loader Fill Factor % (7.25 CY)		90.00
Tons/Pass (2107 lbs/LCY):		6.87
System Passes per Hauler:		4.31
Hauler Payload in Tons		29.63
Percent of Max GVW		107.54
Loader Cycle Time (Min)		0.25
First Bucket Dump (Min)		0.05
Hauler Exchange Time (Min)		0.70
HAULER CYCLE TIMES		
Load with Exchange		1.75
Haul		1.59
Dump and Maneuver		0.60
Return		1.81
Potential Cycle Time		5.75
Wait on Slow Hauler		0.00
Wait TMPH		0.00
Wait to Load, Bunching AVG		1.78
Total Cycle Time		7.53
POTENTIAL PRODUCTION		
BCY per Hour	782.58	953.04
Avg mph		12.26

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Fleet Production and Cost Analysis

Phase 2 Subsoil | **Subsoil Haul** | **FLEET1**

Alton Coal Development, LLC | **Coal Hollow Mine** | **10-8-09**

Fleet Composition

	Qty
Loader	
385C LME	1
Haulers	
769C	4

Potential Production

	Model	BCY per Hour	Avg mph
1	385C LME	783	
2	769C	953	12.3

Fleet Availability (%)	76.50
BCY per Scheduled hour	542.45
Total BCY	153,026.00
Scheduled Hours Required	282.10
Total $	150,770.48
$ per BCY	0.99
BCY per Year	3,384,884.30
Years Required	0.05

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Fleet Production and Cost Analysis

Phase 2 Subsoil | **Subsoil Haul** | **FLEET1**

Alton Coal Development, LLC | **Coal Hollow Mine** | **10-8-09**

153,026 BCY

	Qty	Model	Machine Code	Hourly Cost Each Unit	Operating Hours	$ Total	$ per BCY
Loaders:	1	385C LME		149.56	254	37,972	0.248
Haulers:	4	769C	C202	72.49	959	69,529	0.454
Totals	4				959	69,529	0.454
Support:	1	14 Grader		87.04	56	4,911	0.032
	1	Water Truck		64.14	113	7,238	0.047
	1	D7 Dozer		110.32	282	31,121	0.203
Totals	3				451	43,270	0.283
Fleet Totals	8				1,664	150,770	0.985

Note: TMPH limits have been exceeded on the following Fleet/Course Combinations:

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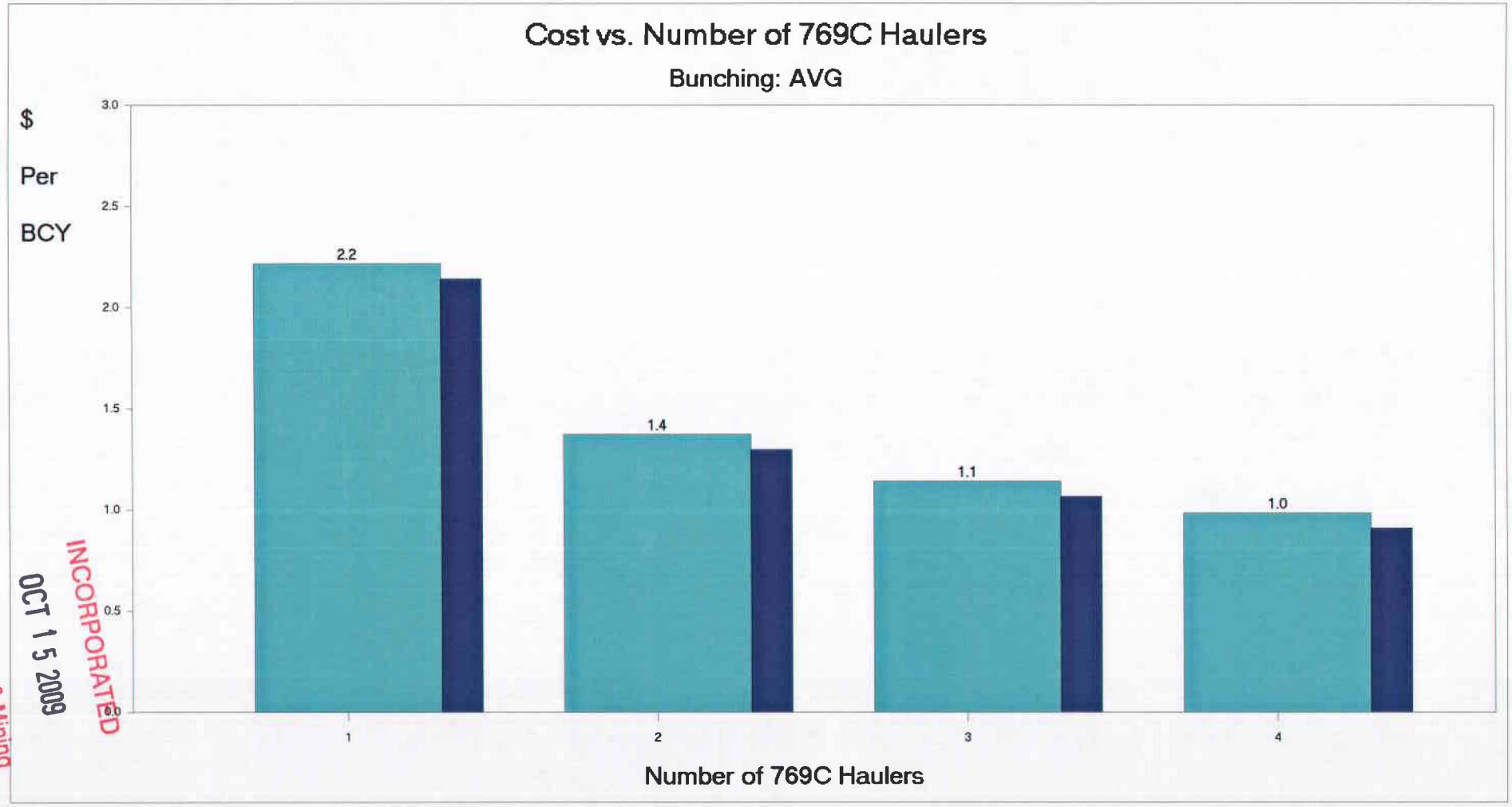
Fleet Production and Cost Analysis

Phase 2 Subsoil | **Subsoil Haul** | **FLEET1**

Alton Coal Development, LLC | **Coal Hollow Mine** | **10-8-09**

Loader:	1 385C LME	Availability: 90%		86 % Operator Efficiency
Haulers:	4 769C	Availability: 85%		6240 Sched Hours per Year
				AVG Bunching



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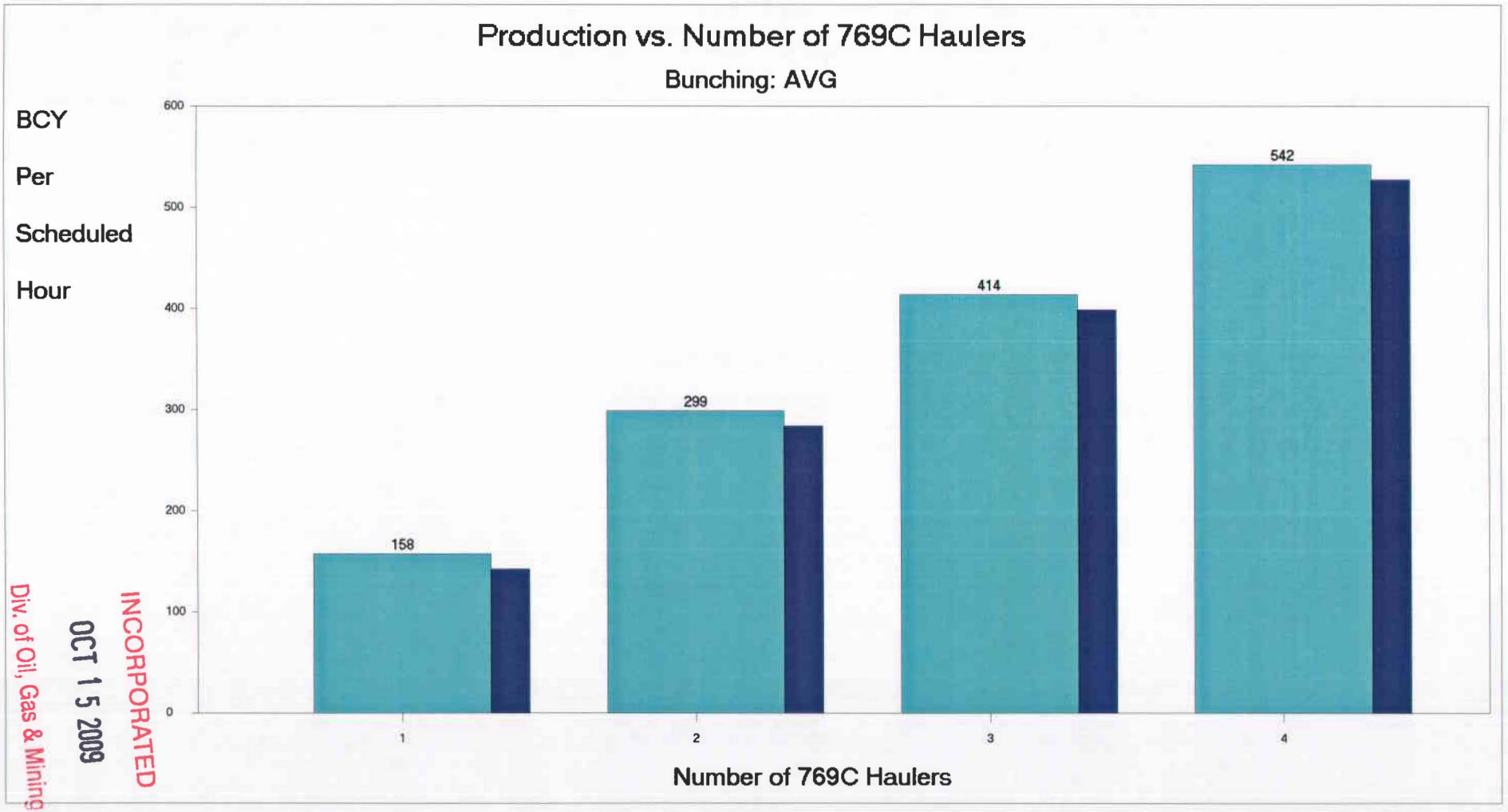
Fleet Production and Cost Analysis

Phase 2 Subsoil | **Subsoil Haul** | **FLEET1**

Alton Coal Development, LLC | **Coal Hollow Mine** | **10-8-09**

Loader:	1 385C LME	Availability: 90%	86 % Operator Efficiency
Haulers:	4 769C	Availability: 85%	6240 Sched Hours per Year
			AVG Bunching



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Phase 2 - Reclamation Estimate

Topsoil
Fleet Production and Cost Analysis

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Fleet Production and Cost Analysis

Phase 2 Topsoil
Alton Coal Development, LLC **Coal Hollow Mine** **10-8-09**

Topsoil Haul

Description:	Topsoil Pile to Phase 2 Reclamation
Material Qty (BCY)	124,827
lbs per BCY	2,596
lbs per LCY	2,107

3250 feet

Distance feet	Rolling Resistance %	Grade %	Haul mph Limit	Return mph Limit	Description
100	4.00	0.00	15.00	15.00	Leaving Excavator
1,550	4.00	-6.00	25.00	25.00	Segment 1
1,600	4.00	-1.50	25.00	25.00	Segment 2

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Fleet Production and Cost Analysis

Phase 2 Topsoil | **Topsoil Haul** | **FLEET1**

Alton Coal Development, LLC | **Coal Hollow Mine** | **10-8-09**

Operating Schedule

Operator Efficiency (%)	86.50
Sched Hrs per Year	6,240.00

Fleet Estimates

Fleet Availability (%)	86.17
BCY per Sched Hr	540.99
Total BCY	124,827.00
Sched Hrs Required	230.74
Total $	123,318.62
$ per BCY	0.99
BCY per Year	3,375,785.14
Years Required	0.04

	1 385C LME	4 769C
Loader Fill Factor % (7.25 CY)		90.00
Tons/Pass (2107 lbs/LCY):		6.87
System Passes per Hauler:		4.31
Hauler Payload in Tons		29.63
Percent of Max GVW		107.54
Loader Cycle Time (Min)		0.25
First Bucket Dump (Min)		0.05
Hauler Exchange Time (Min)		0.70
HAULER CYCLE TIMES		
Load with Exchange		1.75
Haul		1.64
Dump and Maneuver		0.60
Return		1.83
Potential Cycle Time		5.83
Wait on Slow Hauler		0.00
Wait TMPH		0.00
Wait to Load, Bunching AVG		1.72
Total Cycle Time		7.55
POTENTIAL PRODUCTION		
BCY per Hour	782.58	940.28
Avg mph		12.68

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Fleet Production and Cost Analysis

Phase 2 Topsoil | **Topsoil Haul** | **FLEET1**

Alton Coal Development, LLC | **Coal Hollow Mine** | **10-8-09**

Fleet Composition

	Qty
Loader	
385C LME	1
Haulers	
769C	4

Potential Production

	Model	BCY per Hour	Avg mph
1	385C LME	783	
2	769C	940	12.7

Fleet Availability (%)	76.50
BCY per Scheduled hour	540.99
Total BCY	124,827.00
Scheduled Hours Required	230.74
Total $	123,318.62
$ per BCY	0.99
BCY per Year	3,375,785.14
Years Required	0.04

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Fleet Production and Cost Analysis

Phase 2 Topsoil | **Topsoil Haul** | **FLEET1**

Alton Coal Development, LLC | **Coal Hollow Mine** | **10-8-09**

124,827 BCY

	Qty	Model	Machine Code	Hourly Cost Each Unit	Operating Hours	$ Total	$ per BCY
Loaders:	1	385C LME		149.56	208	31,058	0.249
Haulers:	4	769C	C202	72.49	785	56,869	0.456
Totals	4				785	56,869	0.456
Support:	1	14 Grader		87.04	46	4,017	0.032
	1	Water Truck		64.14	92	5,920	0.047
	1	D7 Dozer		110.32	231	25,455	0.204
Totals	3				369	35,391	0.284
Fleet Totals	8				1,361	123,319	0.988

Note: TMPH limits have been exceeded on the following Fleet/Course Combinations:

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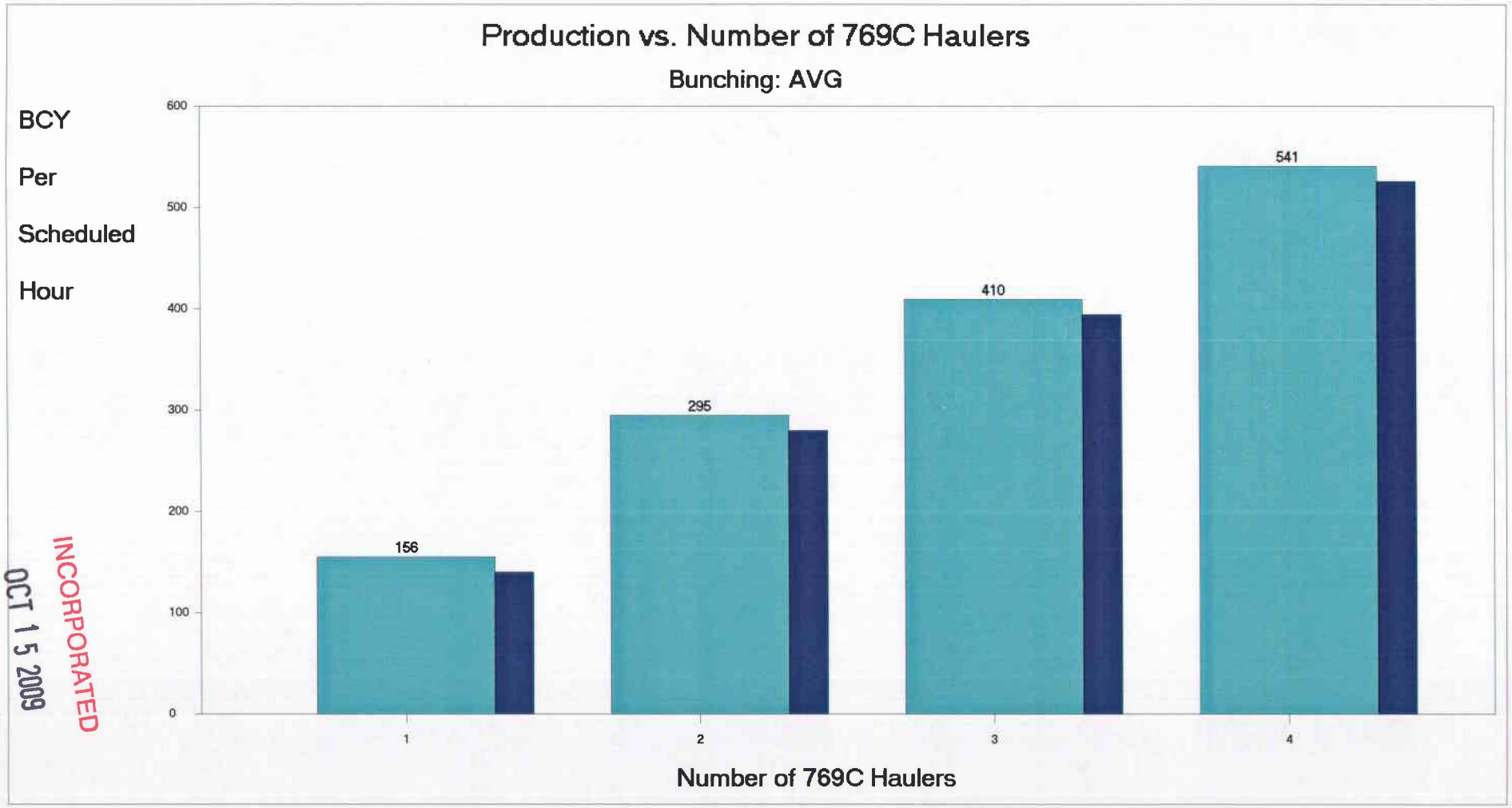
Fleet Production and Cost Analysis

Phase 2 Topsoil | **Topsoil Haul** | **FLEET1**

Alton Coal Development, LLC | **Coal Hollow Mine** | **10-8-09**

Loader:	1 385C LME	Availability: 90%	86 % Operator Efficiency
Haulers:	4 769C	Availability: 85%	6240 Sched Hours per Year
			AVG Bunching



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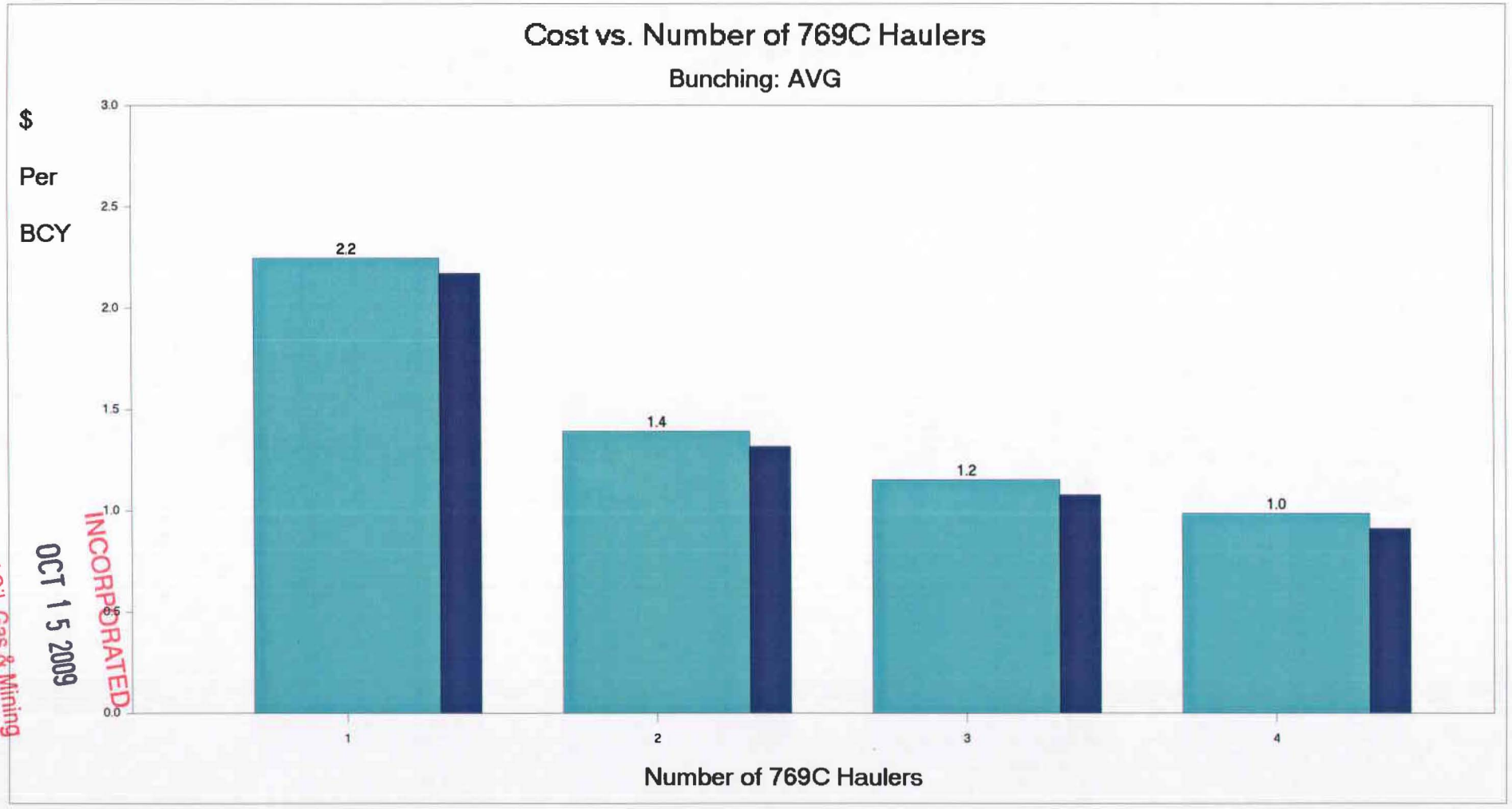
Fleet Production and Cost Analysis

Phase 2 Topsoil | **Topsoil Haul** | **FLEET1**

Alton Coal Development, LLC | **Coal Hollow Mine** | **10-8-09**

Loader:	1 385C LME	Availability: 90%	86 % Operator Efficiency
Haulers:	4 769C	Availability: 85%	6240 Sched Hours per Year
			AVG Bunching



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Phase 3 - Reclamation Estimate

Estimate Details

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Phase 3 Mine Reclamation Cost Estimate

Phase 3 Specialized Reclamation Areas

Item	*Unit	Quantity	Unit Cost ($)	Cost	**Cost Data Reference
Pond 2 backfill from embankment	yd^3	160	$1.88	$301	RSMeans Heavy Constr., 31 23 23.17 0020
Pond 2 backfill from excess spoil	yd^3	7,122	$5.87	$41,806	RSMeans Heavy Constr., 31 23 23.20 3014 & 31 23 16.42 1300 & 31 23 23.17 0020
Pond 2 topsoil	yd^3	860	$5.87	$5,048	RSMeans Heavy Constr., 31 23 23.20 3014 & 31 23 16.42 1300 & 31 23 23.17 0020
Pond 2 seeding	M.S.F	35	$39.00	$1,365	RS Means Heavy Constr., 32 92 19.14 3700
Pond 2 mulching	M.S.F	35	$60.00	$2,100	RS Means Heavy Constr., 32 91 13.16 0350
Pond 2 Subtotal				**$50,620**	
Pond 3 backfill from embankment	yd^3	4,767	$1.88	$8,962	RSMeans Heavy Constr., 31 23 23.17 0020
Pond 3 backfill from excess spoil pile	yd^3	6,107	$5.87	$35,848	RSMeans Heavy Constr., 31 23 23.20 3014 & 31 23 16.42 1300 & 31 23 23.17 0020
Pond 3 topsoil	yd^3	3,011	$5.87	$17,675	RSMeans Heavy Constr., 31 23 23.20 3014 & 31 23 16.42 1300 & 31 23 23.17 0020
Pond 3 seeding	M.S.F	122	$39.00	$4,758	RS Means Heavy Constr., 32 92 19.14 3700
Pond 3 mulching	M.S.F	122	$60.00	$7,320	RS Means Heavy Constr., 32 91 13.16 0350
Pond 3 Subtotal				**$74,563**	
Pond 4 backfill from embankment	yd^3	1,410	$1.88	$2,651	RSMeans Heavy Constr., 31 23 23.17 0020
Pond 4 backfill from excess spoil pile	yd^3	14,692	$5.87	$86,242	RSMeans Heavy Constr., 31 23 23.20 3014 & 31 23 16.42 1300 & 31 23 23.17 0020
Pond 4 topsoil	yd^3	2,055	$5.87	$12,065	RSMeans Heavy Constr., 31 23 23.20 3014 & 31 23 16.42 1300 & 31 23 23.17 0020
Pond 4 seeding	M.S.F	188	$39.00	$7,332	RS Means Heavy Constr., 32 92 19.14 3700
Pond 4 mulching	M.S.F	142	$60.00	$8,520	RS Means Heavy Constr., 32 91 13.16 0350
Pond 4 Subtotal				**$116,810**	
Phase 3 Specialized Reclamation Areas Total				**$191,381**	

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Phase 3 Mine Reclamation Cost Estimate

Phase 3 Pit Backfill and Land Reclamation

Item	*Unit	Quantity	Unit Cost ($)	Cost	**Cost Data Reference
Pit Backfill Rehandle Excess Spoil Pile - Excavator	yd^3 (Loose)	6,591,123	$0.97	$6,392,894	Production from Fleet Production and Cost Analysis Software, Cost data from CostMine Coal Cost Guide 2009
Topsoil	yd^3 (Loose)	160,415	$0.94	$151,040	Production from Fleet Production and Cost Analysis Software, Cost data from CostMine Coal Cost Guide 2009
Subsoil	yd^3 (Loose)	396,483	$0.95	$376,530	Production from Fleet Production and Cost Analysis Software, Cost data from CostMine Coal Cost Guide 2009
Seeding	M.S.F	5,271	$39.00	$205,560	RS Means Heavy Constr., 32 92 19.14 3700
Mulching	M.S.F	5,271	$60.00	$316,246	RS Means Heavy Constr., 32 91 13.16 0350
Subtotal				**$7,442,270**	
Mobilization/Demobolization (5%)				$372,113	
Project Management/Engineering (5%)				$372,113	
Contractor Profit/Overhead (15%)				$1,116,340	
Phase 3 Mine Reclamation Total				**$9,302,837**	

Phase 3 Reclamation Bond Summary

Facilities Reclamation	$1,395,235
Specialized Areas Reclamation	$191,381
Mine Reclamation	$9,302,837
Phase 3 Overall Bond Total	**$10,889,453**

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Phase 3 Mine Reclamation Material Handling Summary

Equipment Description	Production Rate (BCY)	Production Rate (LCY)	Cost/BCY	Cost/LCY	Total Volume (BCY)	Total Volume (LCY)	Total Cost
Rehandle with Truck/Shovel	670.1	891.2	$1.29	$0.97	4,955,732	6,591,123	$6,392,894
Topsoil	724.9	893.1	$1.16	$0.94	130,207	160,415	$151,040
Subsoil	719.6	886.6	$1.17	$0.95	322,344	396,483	$376,530
Total Phase 3 Material Handling							$6,920,464

Rehandle with Truck/Shovel Quantity	6,591,123	Loose Cubic Yards
Total Rehandle Quantity	6,591,123	Loose Cubic Yards
Software Overburden Swell Factor	33%	
Software Topsoil Swell Factor	23%	
Software Subsoil Swell Factor	23%	
Topsoil Area	121	acres
Subsoil Area (Open Pit)	60	acres

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Equipment Cost Data (Cost Mine 2009 Coal Cost Guide/2008 Mine and Mill Equipment Costs)

Equipment Description	$/hr
7 yd. Excavator	$116.40
25 Ton Haul Truck	$40.03
5,000 Gal. Water Truck	$31.25
14 Grader	$54.15
D10 Dozer	$140.17
D7 Dozer	$79.19
13 yd. Excavator	$264.49
40 Ton Haul Truck	$97.73

Manpower Type	$/hr (46% burden)
Excavator Operator	$32.31
Truck Drivers	$32.46
Heavy Equipment Operators	$31.33
Utility Operators	$32.89

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Phase 3 - Reclamation Estimate

Pit Backfill - Truck and Shovel
Fleet Production and Cost Analysis (FPC)

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Fleet Production and Cost Analysis

Phase 3 Truck-Shovel
Alton Coal Development, LLC **Coal Hollow Mine** **10-8-09**

Pit Backfill Haul

Description:	Haul from excess pile to pit
Material Qty (BCY)	4,955,732
lbs per BCY	2,798
lbs per LCY	2,107

5300 feet

Distance feet	Rolling Resistance %	Grade %	Haul mph Limit	Return mph Limit	Description
100	4.00	0.00	15.00	15.00	Leaving excavator location
1,000	4.00	2.00	25.00	25.00	Segment 1
4,200	4.00	-1.30	25.00	25.00	Segment 2

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Fleet Production and Cost Analysis

Phase 3 Truck-Shovel | **Pit Backfill Haul** | **FLEET1**

Alton Coal Development, LLC | **Coal Hollow Mine** | **10-8-09**

Operating Schedule

Operator Efficiency (%)	95.00
Sched Hrs per Year	6,240.00

Fleet Estimates

Fleet Availability (%)	85.35
BCY per Sched Hr	670.13
Total BCY	4,955,732.00
Sched Hrs Required	7,395.20
Total $	6,405,603.02
$ per BCY	1.29
BCY per Year	4,181,598.08
Years Required	1.19

	1 5130 FS	5 772
Loader Fill Factor % (13.75 CY)		90.00
Tons/Pass (2107 lbs/LCY):		13.04
System Passes per Hauler:		3.48
Hauler Payload in Tons		45.36
Percent of Max GVW		94.43
Loader Cycle Time (Min)		0.50
First Bucket Dump (Min)		0.05
Hauler Exchange Time (Min)		0.70
HAULER CYCLE TIMES		
Load with Exchange		2.25
Haul		2.90
Dump and Maneuver		0.70
Return		2.61
Potential Cycle Time		8.47
Wait on Slow Hauler		0.00
Wait TMPH		0.00
Wait to Load, Bunching AVG		3.30
Total Cycle Time		11.77
POTENTIAL PRODUCTION		
BCY per Hour	864.56	1,148.78
Avg mph		14.23

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Fleet Production and Cost Analysis

Phase 3 Truck-Shovel | **Pit Backfill Haul** | **FLEET1**

Alton Coal Development, LLC | **Coal Hollow Mine** | **10-8-09**

Fleet Composition

	Qty
Loader	
5130 FS	1
Haulers	
772	5

Potential Production

	Model	BCY per Hour	Avg mph
1	5130 FS	865	
2	772	1,149	14.2

Fleet Availability (%)	76.50
BCY per Scheduled hour	670.13
Total BCY	4,955,732.00
Scheduled Hours Required	7,395.20
Total $	6,405,603.02
$ per BCY	1.29
BCY per Year	4,181,598.08
Years Required	1.19

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Fleet Production and Cost Analysis

Phase 3 Truck-Shovel | **Pit Backfill Haul** | **FLEET1**

Alton Coal Development, LLC | **Coal Hollow Mine** | **10-8-09**

4,955,732 BCY

	Qty	Model	Machine Code	Hourly Cost Each Unit	Operating Hours	$ Total	$ per BCY
Loaders:	1	5130 FS		264.49	6,656	1,760,362	0.355
Haulers:	5	772	C314	97.73	31,430	3,071,616	0.620
Totals	5				31,430	3,071,616	0.620
Support:	1	14 Grader		87.04	3,698	321,839	0.065
	1	Water Truck		64.14	3,698	237,164	0.048
	1	D10 Dozer		171.50	5,916	1,014,622	0.205
Totals	3				13,311	1,573,625	0.318
Fleet Totals	9				51,397	6,405,603	1.293

Note: TMPH limits have been exceeded on the following Fleet/Course Combinations:

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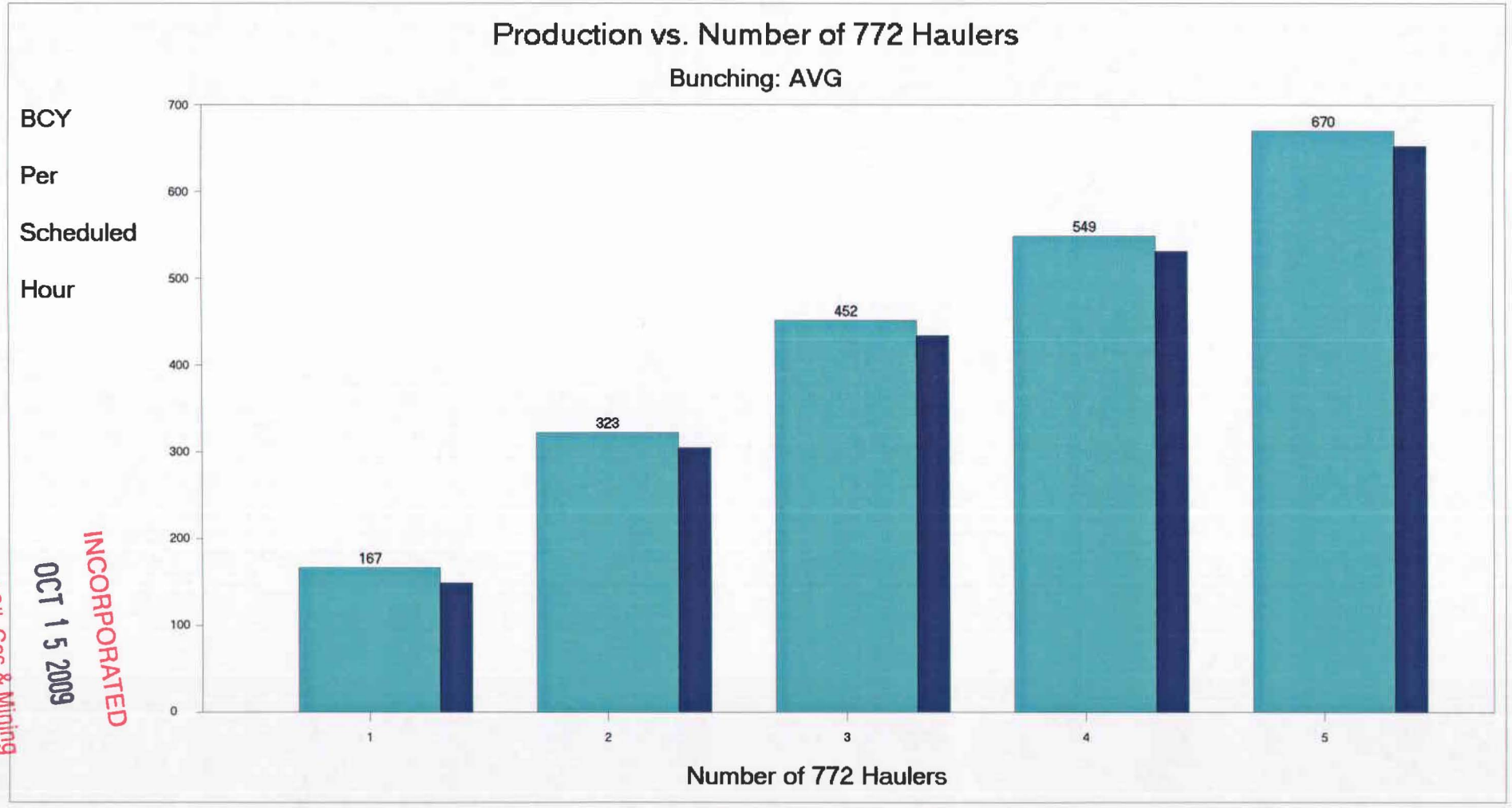
Fleet Production and Cost Analysis

Phase 3 Truck-Shovel | **Pit Backfill Haul** | **FLEET1**

Alton Coal Development, LLC | **Coal Hollow Mine** | **10-8-09**

Loader:	1 5130 FS	Availability: 90%	95 % Operator Efficiency
Haulers:	5 772	Availability: 85%	6240 Sched Hours per Year
			AVG Bunching



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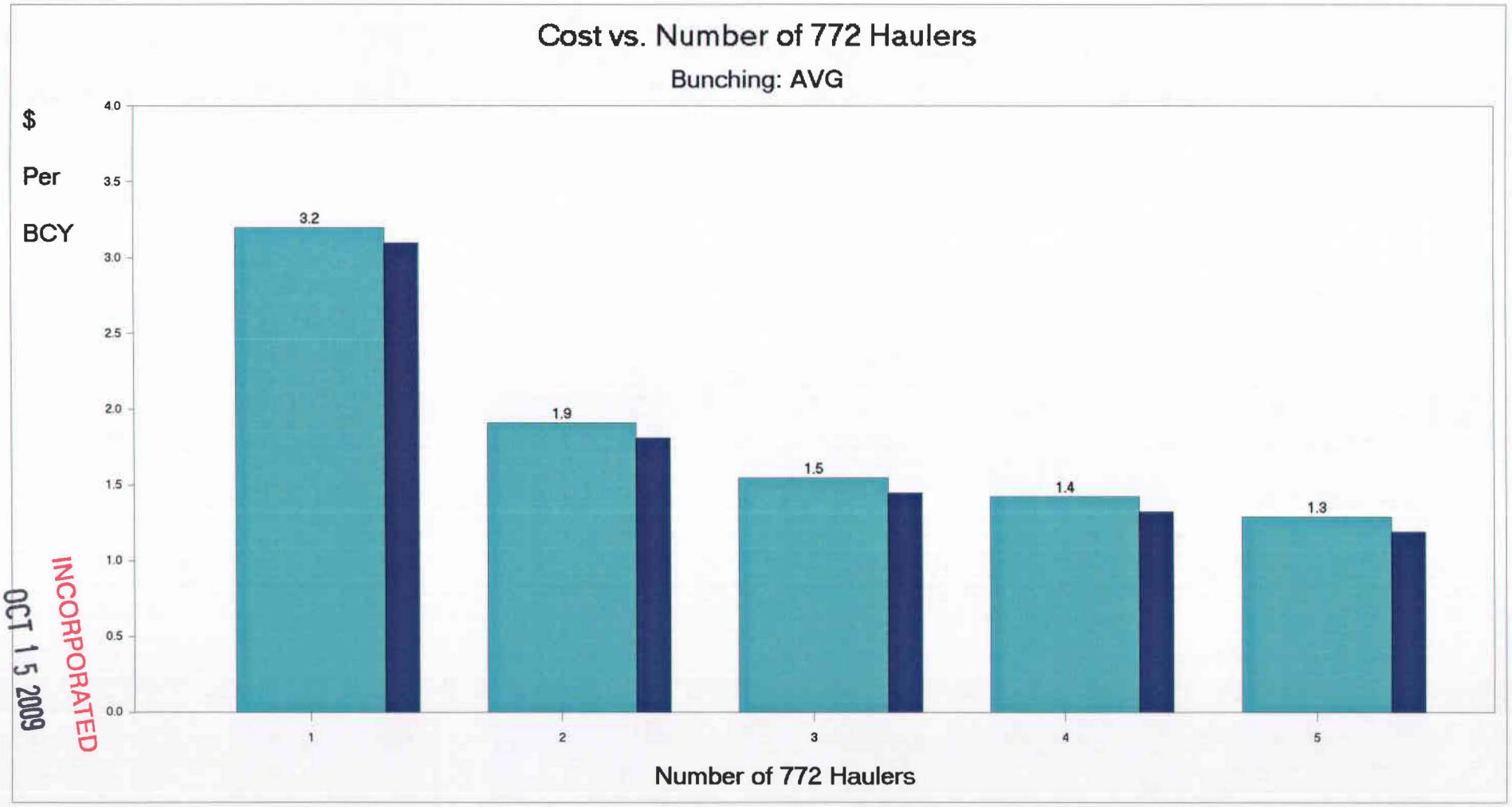
Fleet Productio and Cost Analysis

Phase 3 Truck-Shovel | **Pit Backfill Haul** | **FLEET1**

Alton Coal Development, LLC | **Coal Hollow Mine** | **10-8-09**

Loader:	1 5130 FS	Availability: 90%	95 % Operator Efficiency
Haulers:	5 772	Availability: 85%	6240 Sched Hours per Year
			AVG Bunching



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Phase 3 - Reclamation Estimate

Subsoil
Fleet Production and Cost Analysis

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Fleet Production and Cost Analysis

Phase 3 Subsoil
Alton Coal Development, LLC **Coal Hollow Mine** **10-8-09**

Subsoil Haul

Description:	Subsoil Pile to Phase 3 Reclamation
Material Qty (BCY)	322,344
lbs per BCY	2,596
lbs per LCY	2,107

5950 feet

Distance feet	Rolling Resistance %	Grade %	Haul mph Limit	Return mph Limit	Description
100	4.00	0.00	15.00	15.00	Leaving Excavator
250	4.00	-1.00	25.00	25.00	Segment 1
5,600	4.00	-2.00	25.00	25.00	Segment 2

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Fleet Production and Cost Analysis

Phase 3 Subsoil | **Subsoil Haul** | **FLEET1**

Alton Coal Development, LLC | **Coal Hollow Mine** | **10-8-09**

Operating Schedule

Operator Efficiency (%)	95.00
Sched Hrs per Year	6,240.00

Fleet Estimates

Fleet Availability (%)	85.35
BCY per Sched Hr	719.63
Total BCY	322,344.00
Sched Hrs Required	447.93
Total $	376,205.95
$ per BCY	1.17
BCY per Year	4,490,476.23
Years Required	0.07

	1 5130 FS	5 772
Loader Fill Factor % (13.75 CY)		90.00
Tons/Pass (2107 lbs/LCY):		13.04
System Passes per Hauler:		3.48
Hauler Payload in Tons		45.36
Percent of Max GVW		94.43
Loader Cycle Time (Min)		0.50
First Bucket Dump (Min)		0.05
Hauler Exchange Time (Min)		0.70
HAULER CYCLE TIMES		
Load with Exchange		2.25
Haul		2.94
Dump and Maneuver		0.50
Return		2.92
Potential Cycle Time		8.61
Wait on Slow Hauler		0.00
Wait TMPH		0.00
Wait to Load, Bunching AVG		3.21
Total Cycle Time		11.81
POTENTIAL PRODUCTION		
BCY per Hour	931.83	1,218.13
Avg mph		15.71

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Fleet Production and Cost Analysis

Phase 3 Subsoil | **Subsoil Haul** | **FLEET1**

Alton Coal Development, LLC | **Coal Hollow Mine** | **10-8-09**

Fleet Composition

	Qty
Loader	
5130 FS	1
Haulers	
772	5

Potential Production

	Model	BCY per Hour	Avg mph
1	5130 FS	932	
2	772	1,218	15.7

Fleet Availability (%)	76.50
BCY per Scheduled hour	719.63
Total BCY	322,344.00
Scheduled Hours Required	447.93
Total $	376,205.95
$ per BCY	1.17
BCY per Year	4,490,476.23
Years Required	0.07

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Fleet Production and Cost Analysis

Phase 3 Subsoil | **Subsoil Haul** | **FLEET1**

Alton Coal Development, LLC | **Coal Hollow Mine** | **10-8-09**

322,344 BCY

	Qty	Model	Machine Code	Hourly Cost Each Unit	Operating Hours	$ Total	$ per BCY
Loaders:	1	5130 FS		264.49	403	106,626	0.331
Haulers:	5	772	C314	97.73	1,904	186,050	0.577
Totals	5				1,904	186,050	0.577
Support:	1	14 Grader		87.04	90	7,798	0.024
	1	Water Truck		64.14	179	11,492	0.036
	1	D7 Dozer		110.32	582	64,241	0.199
Totals	3				851	83,530	0.259
Fleet Totals	9				3,158	376,206	1.167

Note: TMPH limits have been exceeded on the following Fleet/Course Combinations:

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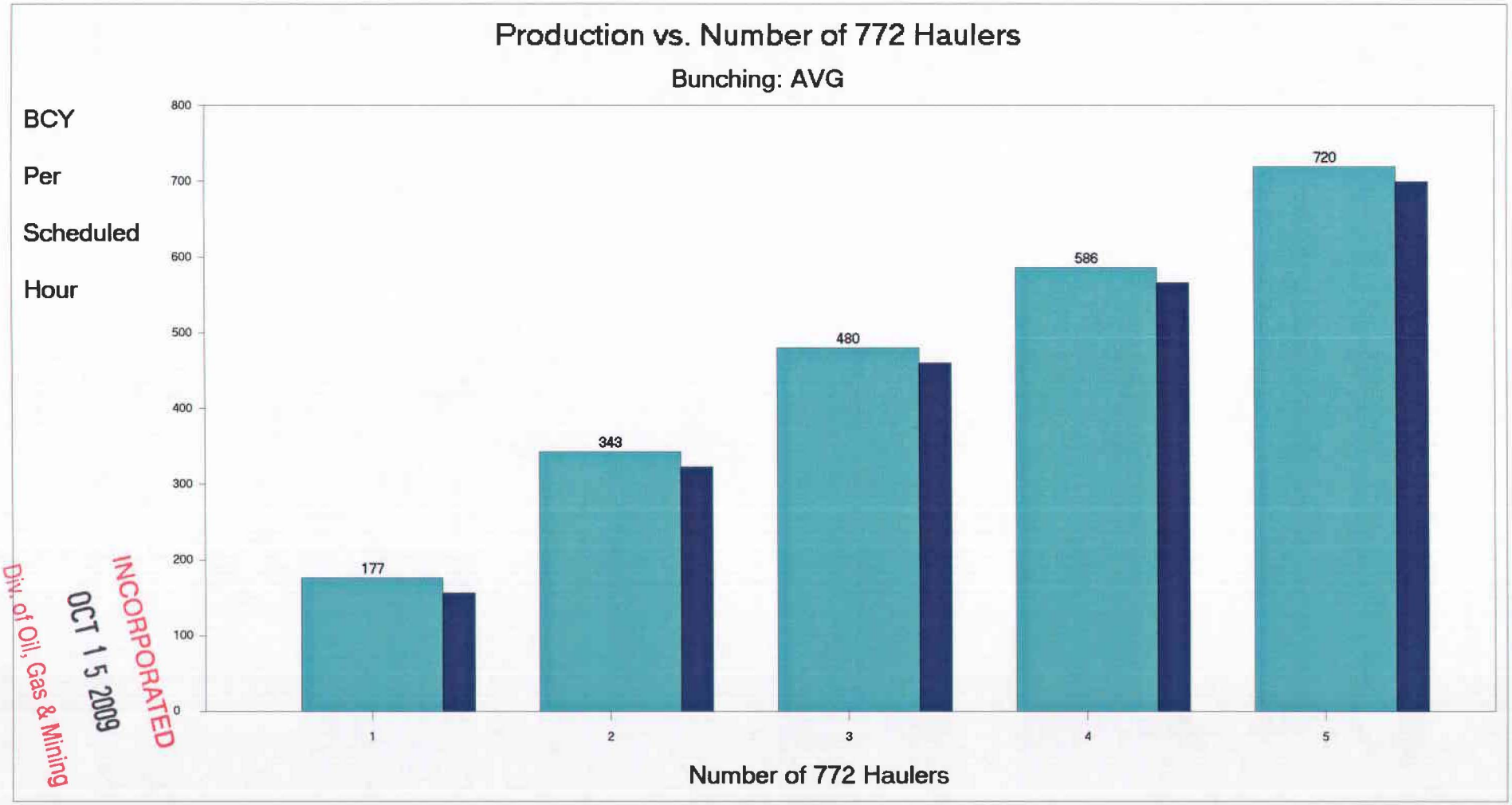
Fleet Production and Cost Analysis

Phase 3 Subsoil | **Subsoil Haul** | **FLEET1**

Alton Coal Development, LLC | **Coal Hollow Mine** | **10-8-09**

Loader:	1 5130 FS	Availability: 90%	95 % Operator Efficiency
Haulers:	5 772	Availability: 85%	6240 Sched Hours per Year
			AVG Bunching



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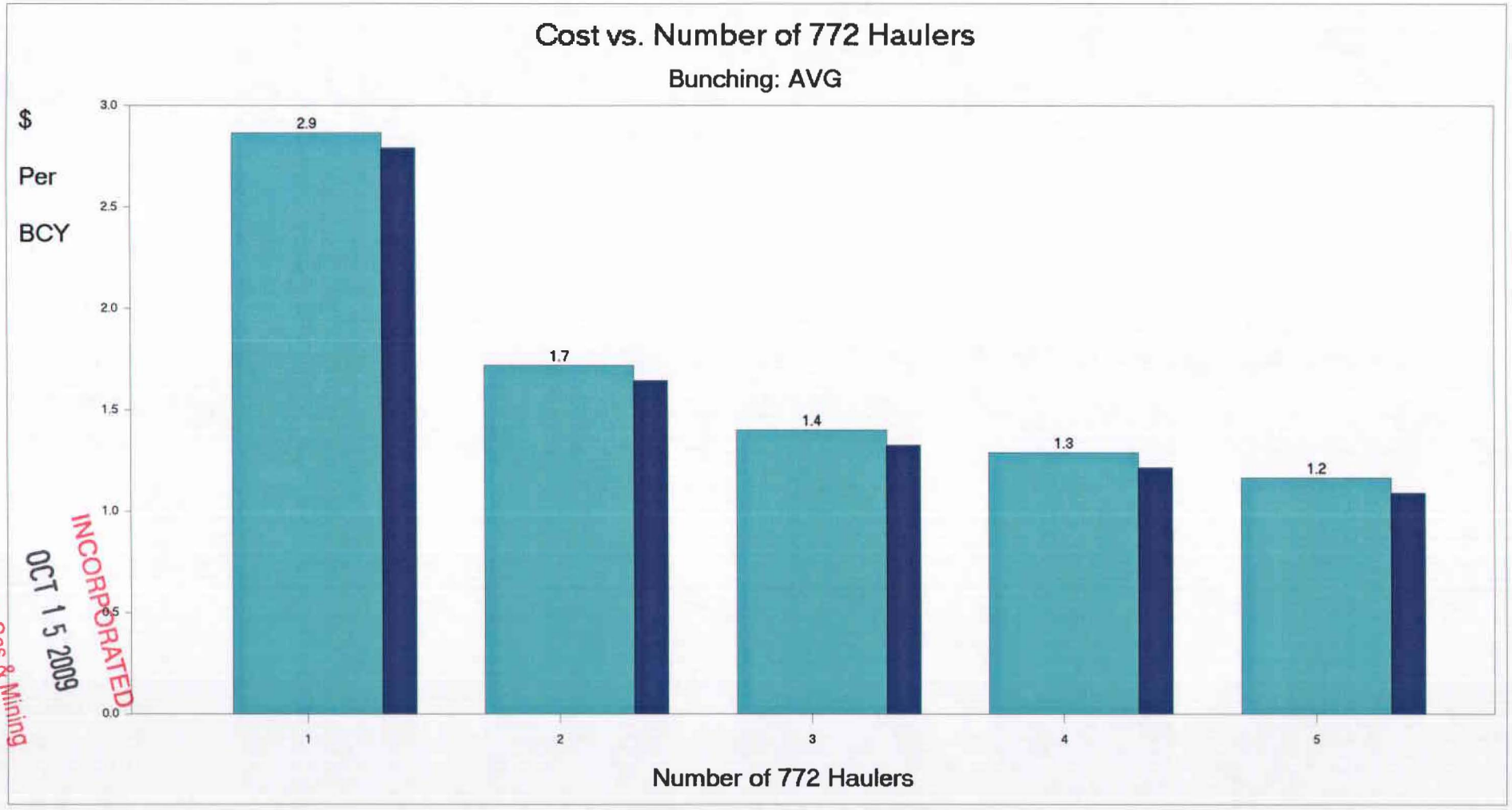
Fleet Production and Cost Analysis

Phase 3 Subsoil | **Subsoil Haul** | **FLEET1**

Alton Coal Development, LLC | **Coal Hollow Mine** | **10-8-09**

Loader:	1 5130 FS	Availability: 90%	95 % Operator Efficiency
Haulers:	5 772	Availability: 85%	6240 Sched Hours per Year
			AVG Bunching



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Phase 3 - Reclamation Estimate

Topsoil
Fleet Production and Cost Analysis

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Fleet Production and Cost Analysis

Phase 3 Topsoil
Alton Coal Development, LLC **Coal Hollow Mine** **10-8-09**

Topsoil Haul

Description:	Topsoil Pile to Phase 3 Reclamation
Material Qty (BCY)	130,207
lbs per BCY	2,596
lbs per LCY	2,107

5700 feet

Distance feet	Rolling Resistance %	Grade %	Haul mph Limit	Return mph Limit	Description
100	4.00	0.00	15.00	15.00	Leaving Excavator
5,600	4.00	-2.00	25.00	25.00	Segment 1

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Fleet Production and Cost Analysis

Phase 3 Topsoil | **Topsoil Haul** | **FLEET1**

Alton Coal Development, LLC | **Coal Hollow Mine** | **10-8-09**

Operating Schedule

Operator Efficiency (%)	95.00
Sched Hrs per Year	6,240.00

Fleet Estimates

Fleet Availability (%)	85.35	
BCY per Sched Hr	724.92	
Total BCY	130,207.00	
Sched Hrs Required	179.62	
Total $	150,855.24	
$ per BCY	1.16	
BCY per Year	4,523,477.11	
Years Required	0.03	
	1 5130 FS	5 772
Loader Fill Factor % (13.75 CY)		90.00
Tons/Pass (2107 lbs/LCY):		13.04
System Passes per Hauler:		3.48
Hauler Payload in Tons		45.36
Percent of Max GVW		94.43
Loader Cycle Time (Min)		0.50
First Bucket Dump (Min)		0.05
Hauler Exchange Time (Min)		0.70
HAULER CYCLE TIMES		
Load with Exchange		2.25
Haul		2.81
Dump and Maneuver		0.50
Return		2.80
Potential Cycle Time		8.36
Wait on Slow Hauler		0.00
Wait TMPH		0.00
Wait to Load, Bunching AVG		3.36
Total Cycle Time		11.72
POTENTIAL PRODUCTION		
BCY per Hour	931.83	1,253.51
Avg mph		15.49

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Fleet Production and Cost Analysis

Phase 3 Topsoil | **Topsoil Haul** | **FLEET1**

Alton Coal Development, LLC | **Coal Hollow Mine** | **10-8-09**

Fleet Composition

	Qty
Loader	
5130 FS	1
Haulers	
772	5

Potential Production

	Model	BCY per Hour	Avg mph
1	5130 FS	932	
2	772	1,254	15.5

Fleet Availability (%)	76.50
BCY per Scheduled hour	724.92
Total BCY	130,207.00
Scheduled Hours Required	179.62
Total $	150,855.24
$ per BCY	1.16
BCY per Year	4,523,477.11
Years Required	0.03

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Fleet Production and Cost Analysis

Phase 3 Topsoil | **Topsoil Haul** | **FLEET1**

Alton Coal Development, LLC | **Coal Hollow Mine** | **10-8-09**

130,207 BCY

	Qty	Model	Machine Code	Hourly Cost Each Unit	Operating Hours	$ Total	$ per BCY
Loaders:	1	5130 FS		264.49	162	42,756	0.328
Haulers:	5	772	C314	97.73	763	74,604	0.573
Totals	5				763	74,604	0.573
Support:	1	14 Grader		87.04	36	3,127	0.024
	1	Water Truck		64.14	72	4,608	0.035
	1	D7 Dozer		110.32	234	25,760	0.198
Totals	3				341	33,495	0.257
Fleet Totals	9				1,266	150,855	1.159

Note: TMPH limits have been exceeded on the following Fleet/Course Combinations:

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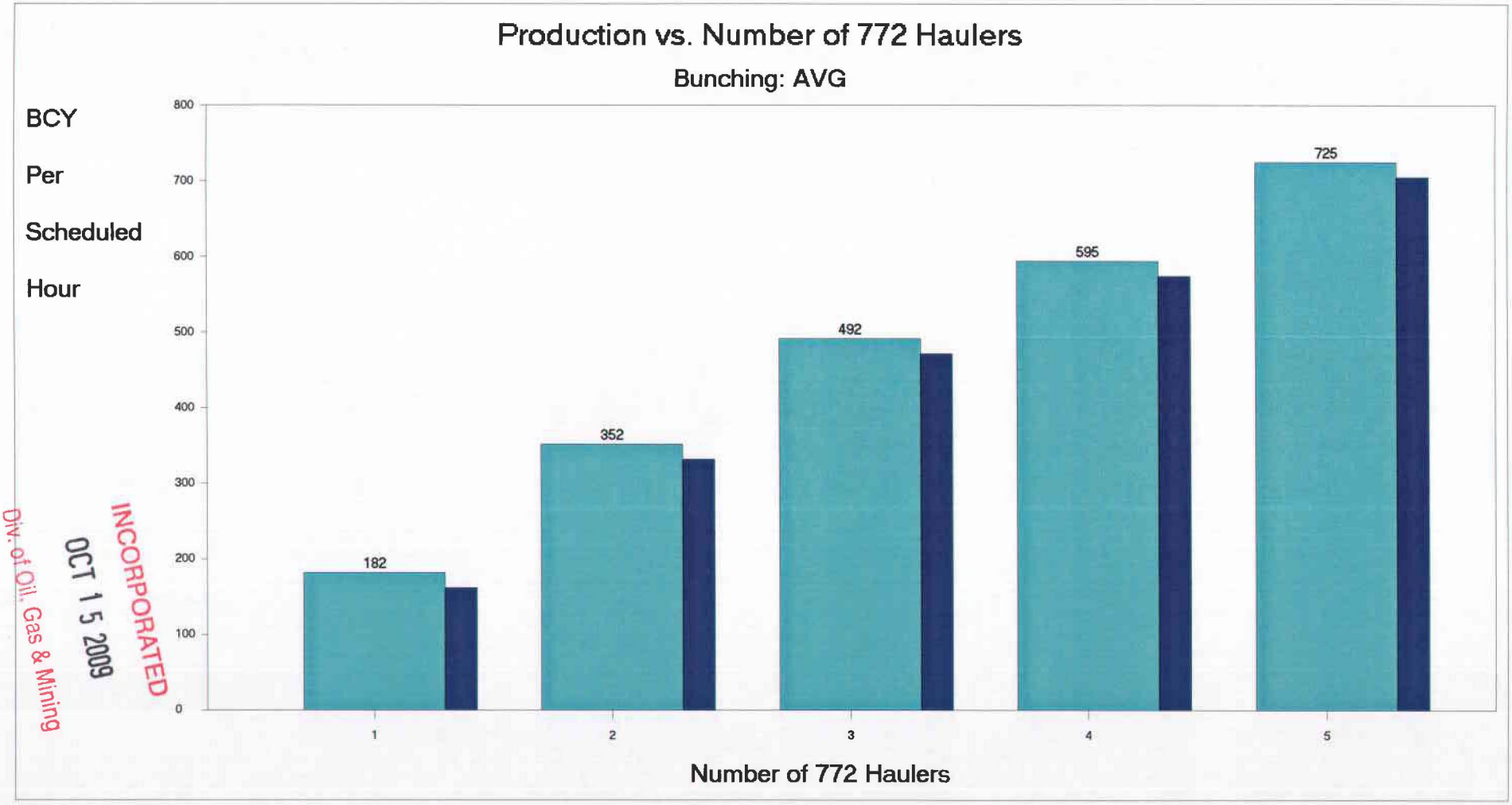
Fleet Production and Cost Analysis

Phase 3 Topsoil | **Topsoil Haul** | **FLEET1**

Alton Coal Development, LLC | **Coal Hollow Mine** | **10-8-09**

Loader:	1 5130 FS	Availability: 90%	95 % Operator Efficiency
Haulers:	5 772	Availability: 85%	6240 Sched Hours per Year
			AVG Bunching



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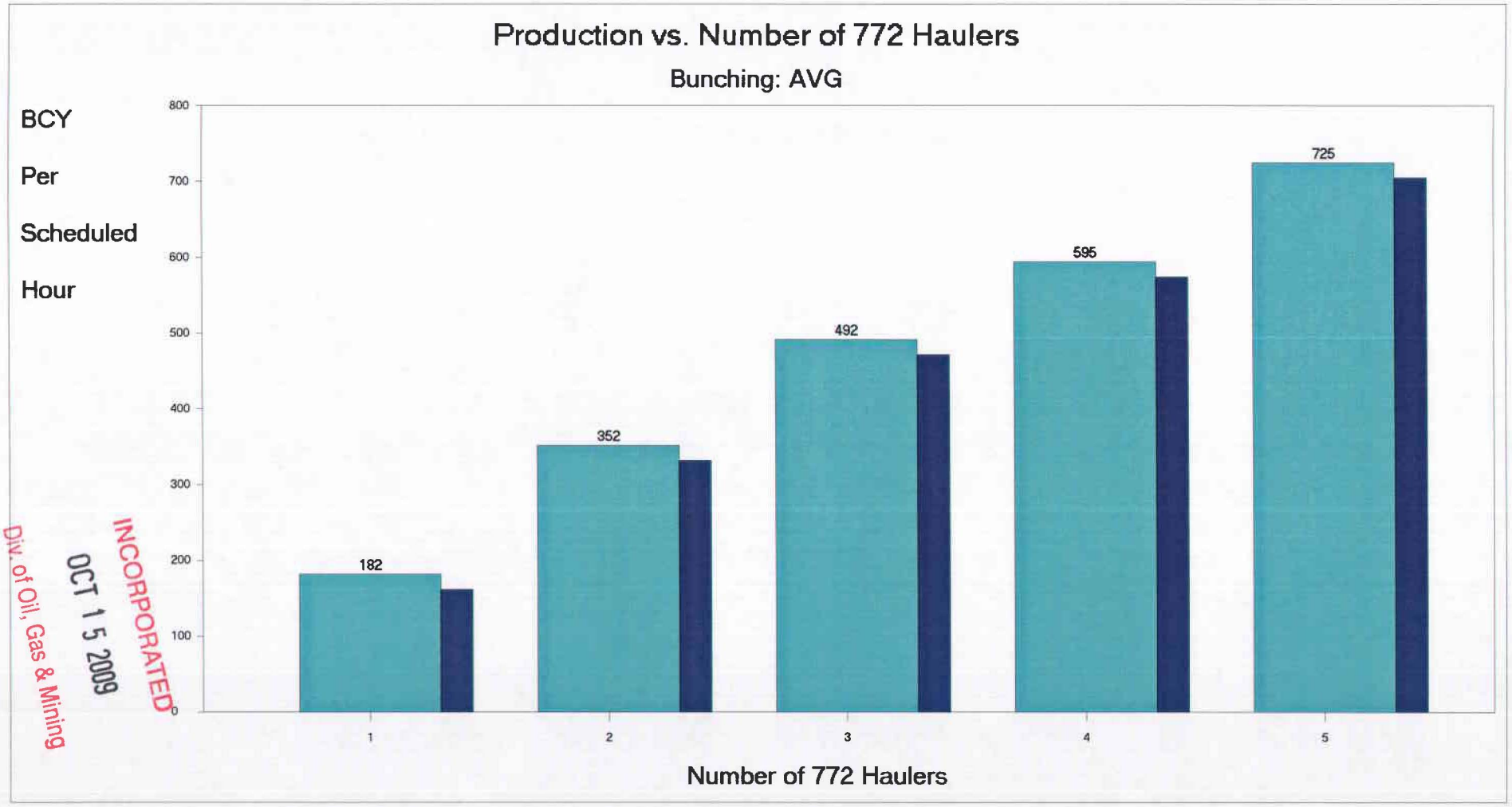
Fleet Production and Cost Analysis

Phase 3 Topsoil | **Topsoil Haul** | **FLEET1**

Alton Coal Development, LLC | **Coal Hollow Mine** | **10-8-09**

Loader:	1 5130 FS	Availability: 90%	95 % Operator Efficiency
Haulers:	5 772	Availability: 85%	6240 Sched Hours per Year
			AVG Bunching



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