CHAPTER I

CULTURAL AND HISTORICAL INFORMATION

TABLE OF CONTENTS

Page

1.0 INTRODUCTION CI-1

2.0 PROJECT AREA DESCRIPTION CI-2
- 2.1 Physical Environment CI-2
- 2.2 Climate CI-2
- 2.3 Fauna CI-2
- 2.4 Geologic History in Relation to Prehistory CI-3

3.0 CULTURAL HISTORY OF THE REGION CI-4
- 3.1 Prehistory CI-4
- 3.2 Cultural Chronology CI-5

4.0 FIELD SURVEY METHODS AND RESULTS CI-6

5.0 DISCUSSION AND CONCLUSIONS CI-7

6.0 REFERENCES CITED CI-7

7.0 RESPONSIBLE PARTY CI-9

1.0 INTRODUCTION

Usibelli Coal Mine, Inc. (UCM) is proceeding with plans to develop the Jumbo Dome coal mine project located north and east of Healy, in central Alaska. This proposed mine is an extension of the company's existing surface mining operation in the Hoseanna Creek valley and represents the next logical mining unit within their coal reserve area. The permit area for the proposed surface mining operation includes state coal leases (See Plate A-1).

The regulations most relevant to field investigations for cultural resources are the National Historic Preservation Act of 1966 (PL 89-665, as amended in 1976, 1980, and 1992) which authorizes the National Register of Historic Places, and 36 CFR 800, which executes Section 106 of the National Historic Preservation Act through the definition of the review procedures for any cultural resource affected by a project located wholly or in part on federal lands funded wholly or in part with federal money or licensed wholly or in part by a federal agency. Cultural or paleontological resources located wholly or in part on State of Alaska lands are protected by the Alaska State Historic Preservation Act of 1971 (A.S. 41.35.000). The Alaska Surface Coal Mining Control and Reclamation Act (A.S. 27.21.000) further requires mine developers to complete cultural resource surveys on areas associated with surface coal mining operations.

A fairly large portion of the permit area for UCM's Jumbo Dome mine had been previously subjected to systematic cultural resource surveys. These surveys concluded that the study areas did not contain any significant cultural properties. In addition, it was also determined that the surrounding areas had poor potential for site preservation (Bacon 1987).

Site specific cultural resource surveys were conducted in 2002 and 2005 by Chris Campbell. These surveys concluded that the study areas did not contain any significant cultural properties.

.

2.0 PROJECT AREA DESCRIPTION

2.1 PHYSICAL ENVIRONMENT

The project area is contained within the subarctic physiographic province of the northern foothills of the Alaska Range. The Marguerite Creek, which flows northward into the California Creek which flows into the Totatlanika River which flows into the Tanana River, is the predominant drainage. The northern foothills are flat-topped east trending ridges ranging in elevation from 2,000 to 4,500 feet. They are separated by rolling lowlands 700 to 1,500 feet in altitude. The foothills are largely unglaciated, but some valleys were widened during the Pleistocene Epoch by glaciers from the Alaska Range. Badlands, such as those found in the UCM project area, are not uncommon (Warhaftig 1965).

2.2 CLIMATE

The climate in this vicinity is continental, with extreme seasonal temperatures fluctuating from a maximum of 93 degrees Fahrenheit in the summer months to a minimum of 63 degrees below zero Fahrenheit in the winter months. Winter temperatures are decreased even further by the wind chill factor. The region is relatively dry, with precipitation in the form of rain during the summer (predominantly in August) and in the form of snow during the winter. Snow cover lasts for little more than half of the year (Streten 1974).

2.3 FAUNA

Extinct megafauna are known to have occurred in this vicinity. They include steppe bison (Bison priscus), wapiti (Cervus canadensis), and mammoth (Mammuthus primigenius). These species have been dated from over 13,000 to c. 10,500 years old (Guthrie 1990; Powers et. al. 1983; Powers and Hoffecker 1985). Modern day fauna in the project area is discussed in Chapter CIX – Fish and Wildlife.

2.4 GEOLOGIC HISTORY IN RELATION TO PREHISTORY

The identification of archeological sites in a region is largely dependent upon a few major factors, the first being whether people had actually left behind traces of their use, such as tools, garbage, or camps which have been preserved. The second factor is dependent upon whether any such remains are actually identified in the field by the archeologist prior to ground disturbance. The third factor is dependent upon whether any such remains have since been destroyed by geomorphological processes, such as fluvial and colluvial dynamics.

There have been extensive studies conducted on the geologic history of the Hoseanna Creek drainage and these processes are applicable to the adjacent Marguerite Creek drainage as well. The Hoseanna Creek drainage is rapidly eroding to such an extent that it qualifies as badlands. All of the surface morphology in the Hoseanna Creek drainage dates to late Pleistocene Epoch or is of an even more recent derivation. Several important events have influenced the way that surface processes operate today. The first of these is associated with deglaciation. After the continental ice-sheets receded, the land base uplifted. The Alaska Range experienced isostatic rebound between 24,000 and 10,000 years ago. During this period, there was heavy downcutting as the Nenana River and its tributaries adjusted their gradients. Another contributing factor was late Quaternary tectonism which resulted in differential movement. Between 25,000 and 10,000 years ago, a major earthquake occurred along the Poker Flats fault. This dropped the local base level by c. 300 feet (100 m) at the confluence of Hoseanna Creek and the Nenana River (Wilbur 1995).

These glaciofluvial processes and tectonism caused headward incision along Hoseanna Creek and its tributaries. More recently, prior to 2,170 years ago, the Nenana River migrated eastward at the confluence with Hoseanna Creek. This shortened Hoseanna Creek, and it adjusted its gradient by cutting through the fan and into bedrock. The gradient at the mouth increased the carrying capacity of Hoseanna Creek and resulted in the creek migrating eastward, accelerating the downcutting into the upper part of the watershed (ibid.).

The rate at which Hoseanna Creek incised the land base was dependent upon the parent material: it rapidly eroded stream deposits, but the rate was slower through coal bearing deposits and even

more slow through metamorphic rock. As the downcutting continued toward the headwaters of Hoseanna Creek, the gradients of the tributary streams were increased too and they, in turn, incised headward. Headward incision intensified hillslope failure, landslide formation, increased erosion and sediment delivery to the mouths of the tributaries and the mouth of Hoseanna Creek (ibid.).

When the Hoseanna Creek fan first prograded westward, c. 1,000 to 2,000 years ago, the lower reaches of Hoseanna Creek adjusted by aggrading, which reduced the gradient of the main channel. The reduced gradient resulted in fans being built in the main channel at the mouths of the tributary creeks. The end result is that over five percent of the Hoseanna Creek watershed is covered by landslide deposits, and these highly accelerated erosional processes continue to this day (ibid.).

3.0 CULTURAL HISTORY OF THE REGION

3.1 PREHISTORY

In 1973, Dr. Charles Holmes discovered a deeply stratified archeological site at Dry Creek that appeared to hold much promise for answering questions about the peopling of the New World (Holmes 1974). Dry Creek was excavated under the supervision of Dr. Roger Powers under the auspices of the National Geographic Society with support from the National Parks Service. Simultaneously, archeological excavations were undertaken by graduate students David Plaskett and Peter Bowers at sites located near the Nenana River Gorge and Carlo Creek, respectively. Subsequently, field surveys in the Nenana River region were carried out by archeologists David Plaskett and Tim Smith, with support from geologist Robert Thorson. Their studies enabled a better understanding of local glaciations. They also found enough archeological sites to begin developing a predictive model (1979).

The potential significance of the Nenana River Valley seemed particularly promising due to a number of factors. First, it had remained largely unglaciated throughout the Pleistocene. During glacial peaks, when the Bering Land Bridge had been opened, the Nenana River Valley had been

vegetated grassland supporting ungulates and megafauna sought by early hunters in the New World. Second, the soils include pockets of deeply stratified loess located on prominences and overlooks where early hunters liked to wait for game, manufacturing tools as they whiled away time.

It appeared as though there was the potential for the archeological record to stretch back beyond 12,000 years. As a result, 1977 saw the formation of a study jointly sponsored by the National Geographic Society and the National Park Service, called "The North Alaska Range Project." Its mission was to search for Late Pleistocene sites in the Nenana River Valley. Subsequently, the National Geographic Society withdrew from the project because of the dearth of paleoenvironmental data. The project refocussed and expanded to include a series of valleys in the north Alaska Range. By 1980, after the discovery of only a small number of sites, the scope of the project was scaled down to include more recent cultural resources in the Nenana River Valley (Hoffecker 1985; Ten Brink 1983).

In the mid-1980's, UCM contracted with Alaska Heritage Research Group, Inc. to conduct archeological surveys and develop a cultural resources management plan for the Hoseanna Creek watershed. Two historic sites were identified along Hoseanna Creek. Overall, the remainder of the area was believed to be of low potential for locating archeological sites (Mobley 1985; Bacon 1987).

3.2 CULTURAL CHRONOLOGY

People have exploited the Nenana River Valley for nearly 12,000 years. Some of oldest, best documented archeological sites in the Americas are located in this region. The prehistory is documented nearly continuously from 12,000 years ago to the present.

The earliest component is the Nenana Complex, which dates back 12,000 years. People used tools with specific forms, such as the teardrop-shaped Chindadn points and triangular, bifacially flaked projectile points. The environment probably more closely resembled the steppes of the former Soviet Union, supporting herds of ungulates and megafauna, including bison, camels,

horse, and mammoth (Powers and Hoffacker 1985). The climate was warmer and dryer than it is presently.

The next complex is called the Denali Complex, and is typified by wedge-shaped microblade cores, microblades, macroblades, burins, scrapers, and leaf-shaped bifacial knives. It is a widespread tradition, with similar archeological components found to the northwest in Siberia (West 1981). Although this tradition is believed by some to have superseded the Nenana Complex, and to date from 10,690 to c. 7,000 years BP, this theory has yet to be proven. If true, this means that people who created these tools lived during the advent of the Holocene Epoch. Climatic changes resulted in the xeric steppe environment giving way to tundra-shrub vegetative communities.

The Northern Archaic tradition follows the Denali Complex, dating between 6,000 and 2,000 years BP. The most diagnostic tool in this tradition is the side-notched projectile point. The Northern Archaic tradition is believed to represent adaptation to spruce forests. Palynological data point to this era as being a time when boreal forests gained hold in the region (Ager 1975).

The last identified tradition found in this region is the Athapaskan tradition, dating from 2,000 years BP to the present. This tradition was well documented at the nearby Nenana Gorge Site, which had been occupied c. 1500 and 1685 A.D. The artifact assemblage discloses many items associated with Athapaskans at the time of contact, including copper tools as well as stone and bone tools (Plaskett 1977).

4.0 FIELD SURVEY METHODS AND RESULTS

The archeological survey was performed by Chris Campbell. Methodology included a literature review. Following this, consultation with the State Office of History and Archeology took place to identify any sites within or adjacent to the project area. Study and analysis of aerial photographs provided by UCM also occurred to identify areas of high potential based on the land forms of the region. Also noted were the many slides in the badlands. Concurrently,

topographic maps were examined to ascertain elevation and slope of the topography, and these findings were compared against the aerial photographs.

The next step was the site visit, which took place October 31, 2002. The aerial and pedestrian survey taken of the area failed to identify any trace of prehistoric or aboriginal land use. A further visit was conducted on May 17 and 18, 2005 by Campbell, accompanied by Margie Goatley. The area was overflown. Again, it was concluded that there was no likelihood of historic properties.

5.0 DISCUSSION AND CONCLUSIONS

The archeological survey for this project did not discover any new cultural resources. The area had previously been determined to be of low potential for discovering archeological sites. This opinion is reinforced by recent geological work demonstrating the instability of the area during the Pleistocene-Holocene interface and throughout the Holocene. Clearly, the land base supports abundant sign of game. However, the overlooks so preferred by prehistoric hunters, where they patiently awaited sign of game while manufacturing tools, would probably have been destroyed by erosion. However, the topography and vegetation is such that any artifacts would likely be isolated finds, like a single projectile point that missed its prey. Suitable overlooks were surveyed with negative results. The presence of an archeological site can never be ruled out. If a site is found during the course of project completion, work in the vicinity of the discovery should be suspended until consultation and mitigation procedures, as outlined in 36 CFR 800, are completed.

6.0 REFERENCES CITED

Ager, T.A. 1975 Late quaternary environmental history of the Tanana Valley, Alaska. Institute of Polar Studies No. 54, Ohio State University, Columbus.

Bacon, G. 1987 Cultural resources management plan for the Lignite (Hoseanna) Creek drainage. Alaska Heritage Research Group, Inc., Fairbanks Alaska.

Bowers, P.M. 1980 The Carlo Creek Site: Geology and archeology of an early Holocene site in the central Alaska range. Occasional Paper No. 27, Cooperative Parks Study Unit, University of Alaska.

Guthrie, R.D. 1990 Frozen fauna of the mammoth steppe: the story of Blue Babe. University of Chicago Press, Chicago.

Hoffecker, J.F. 1985 Archeological field research 1980. National Geographic Society Research Reports 19:48-59.

Holmes, C.E. 1974 New Evidence for a late Pleistocene culture in central Alaska: preliminary investigations at Dry Creek. Paper presented at the seventh annual meeting of the Canadian Archeological Association, Whitehorse, Yukon Territory, Canada.

Mobley, C. 1985 Cultural resources survey of the Hoseanna [sic] Creek haul road between Frances and Popovitch Creeks, Healy, Alaska. Alaska Heritage Research Group, Inc.

Plaskett, D. 1979 Final report: cultural resources in an area of the Nenana and Teklanika Rivers of central Alaska contract no. 02-76-00035-00. Submitted to the State of Alaska Department of Natural Resources, Division of Parks, Anchorage, Alaska.

Plaskett, D. 1977 The Nenana Gorge Site: a late prehistoric Athapaskan campsite in central Alaska. Unpublished M.A. thesis, Department of Anthropology, University of Alaska, Fairbanks.

Powers, W.R., R.D. Guthrie, and J.F. Hoffecker 1983 Dry Creek: archeology and paleoecology of a late Pleistocene Alaskan hunting camp. Report submitted to the National Parks Service, Washington.

Powers, W.R. and J. Hoffecker 1985 Nenana valley cultural resources survey, 1984. Report submitted to the Division of Parks, Anchorage.

Shaw, R. 1991 Letter to Usibelli coal mine, dated June 5, file no. 3130-2R DOM re Lignite Creek CRM plan. State of Alaska Department of Natural Resources, Division of Parks and Outdoor Recreation, Office of History and Archeology.

Streten, N.A. 1974 Some features of the summer climate of interior Alaska, Arctic 27(4):272-286.

Ten Brink, N.W. 1983 Glaciation of the Northern Alaska Range. In Glaciation in Alaska, ed. R.M, Thorson and T.D. Hamilton, pp. 82-91. Occasional Paper No. 2, Alaska Quaternary Center, Fairbanks.

U.S. Department of the Interior 1974 Final environmental impact statement for proposed Mt. McKinley National Park additions, Alaska. Government Printing Office, Washington.

Warhaftig, C.W. 1965 Physiographic regions of Alaska. U.S. Geological Survey Professional Paper 482.

Wilber, S.C. 1995 Fluvial and hillslope geomorphology of the Hoseanna Creek watershed, central Alaska, a thesis. Presented to the faculty of the University of Alaska in partial fulfillment of the requirement for the degree of a doctorate in philosophy. University of Alaska, Fairbanks.

7.0 RESPONSIBLE PARTY

The responsible party for this chapter is Chris R. Campbell, C.R.C. Cultural Resources Consultant, 1901 Bragaw, Suite 200, Anchorage, Alaska 99508-3440 601 Contact phone number is 907/729-3798.

CHAPTER II

GEOLOGY

TABLE OF CONTENTS

Page

1.0 INTRODUCTION CII-1
2.0. REGIONAL OVERVIEW OF THE GEOLOGY CII-1
3.0 STRATIGRAPHY AND STRUCTURE OF THE PERMIT AREA CII-5
4.0 GEOLOGY OF THE PROPOSED SURFACE MINING AREA CII-8
5.0 GEOLOGIC EXPLORATION AND DEVELOPMENT METHODS CII-9
6.0 REFERENCES CII-10
7.0 RESPONSIBLE PARTIES CII-10

LIST OF FIGURES

CII-1 Simplified Geologic Map of Jumbo Dome and Vicinity CII-3
CII-2 Stratigraphic Section of Coal Bearing Group CII-4
CII-3 Typical Mining Section of Suntrana Formation from Drill Holes 08JD02B & 08EXPL02 ..... CII-7

LIST OF PLATES

CII-1 Coal Structure for 3 Seam CII-11
CII-2 Coal Structure for 4 Seam CII-12
CII-3 Coal Structure for 5 Seam CII-13
CII-4 Coal Structure for 6 Seam CII-14
CII-5 Drill Hole Locations CII-15
CII-6 Geologic Cross-Sections CII-16
CII-7 Projected Outcrops CII-17

LIST OF APPENDICES

CII-1 DRILL HOLE LOGS CII-18

1.0 INTRODUCTION

This chapter discusses the geology of the Jumbo Dome permit area and immediate vicinity. The descriptions based herein are based on previous geologic field work as presented in various federal and state reports as listed at the end of this report, as well as exploration programs targeting the stratigraphy and coal structure. Maps depicting structure for the seams of interest, as well as Geologic Cross-Sections and a Drill Hole Location Map, are included with this report.

2.0 REGIONAL OVERVIEW OF THE GEOLOGY

The following description of the regional geology is a general overview to provide a geologic context for the geology of the Jumbo Dome mine area. For a more detailed description of the regional geology, please refer to USGS Bulletin 1274-D (Wahrhaftig, 1969).

The coal-bearing Usibelli Group of the Nenana Coal field subdivided into five formations, all of which are of Tertiary age. The oldest is the Healy Creek Formation, which ranges from the late Oligocene to early Miocene in age. Working up from this lies the Sanctuary Formation (early to middle Miocene), the Suntrana Formation (middle Miocene), the Lignite Creek Formation (middle Miocene), and the Grubstake Formation (late Miocene). Capping off the region are the Nenana Gravels (late Miocene).

Figure CII-1 shows the geology of the Marguerite Creek area and Figure CII-2 provides a copy of the lithologic log for the Usibelli Coal Group from USGS Bulletin 1274-D. The mineable coal seams targeted by the Jumbo Dome mine are contained in the Suntrana formation, as is the case with the Poker Flats and Two Bull Ridge mines. The coal bearing group continues from these mines up the Hoseanna Creek drainage; the Jumbo Dome mine lies just north of this drainage, at the base of the northwest slope of Jumbo Dome itself. Jumbo Dome is a massive hornblende and dacite intrusion of late Tertiary-to-early Quaternary age. The upheaval associated with the intrusion of Jumbo Dome greatly affected the structure of the overlying

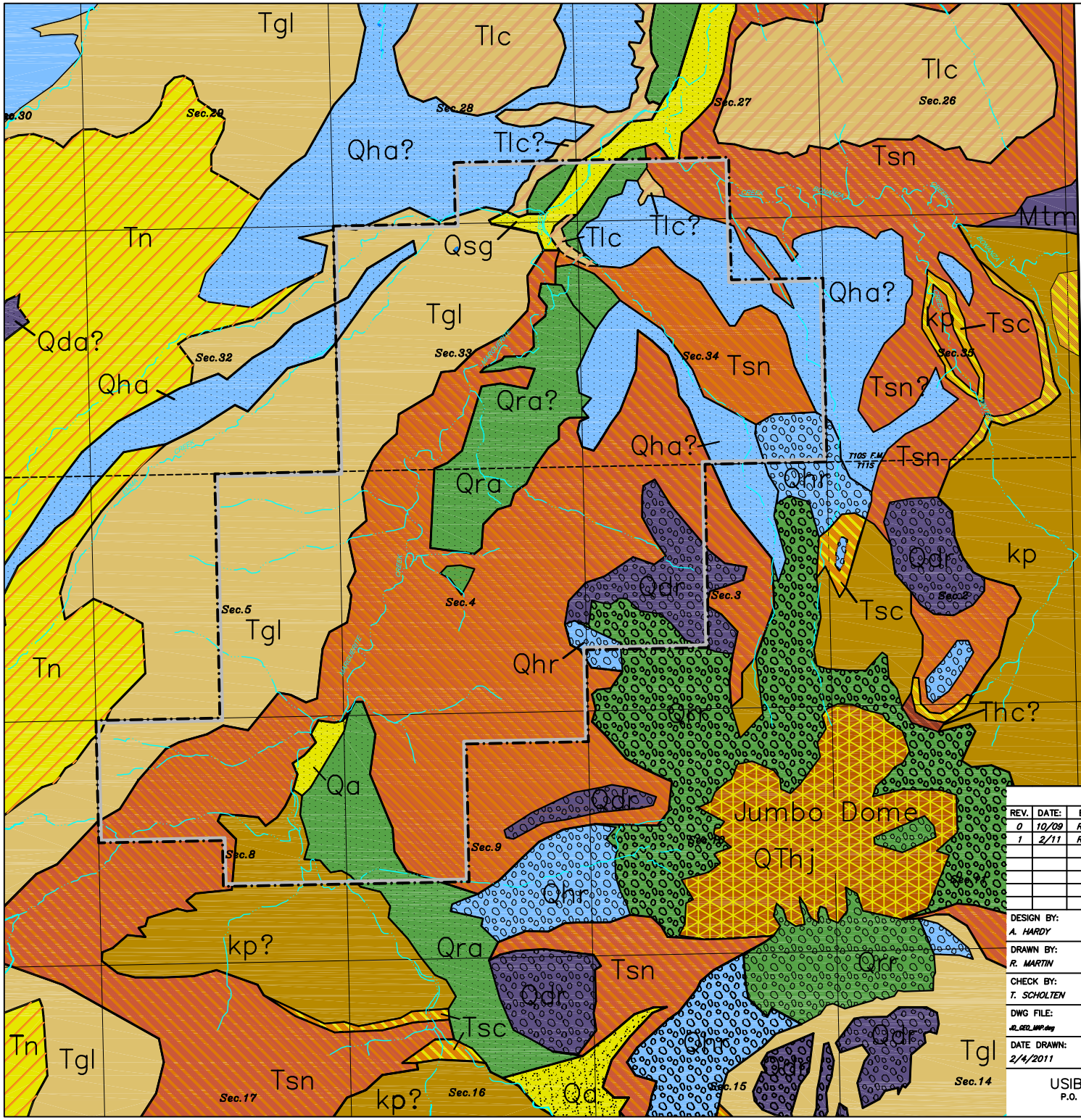
formations; this event is most responsible for the general structure of the immediate vicinity. The Suntrana formation in the mine area adjacent to Jumbo Dome is moderately dipping to the Northwest (away from the intrusion), with the steeper dips being found in closer proximity to the intrusion. Although significant structural alteration in the coal bearing strata occurred during the formation of Jumbo Dome, the intrusion does not appear to have chemically altered the coal, at least in the mine area. Chemical alterations would be more likely, and perhaps expected, in the zone where the Suntrana is in direct contact, or at least close proximity, with the Jumbo Dome intrusive. No drillholes in the mine area or immediate vicinity have intercepted the Jumbo dome intrusive material in a massive state (although associated rubble was encountered), suggesting that this zone is likely much further up the hill and away from the mine area; furthermore, results of quality testing of bulk and core samples has not suggested any chemical alteration of the coal.

The Hoseanna Creek basin is characterized by high erosion rates, resulting in numerous landslides and badlands topography (Wilbur, 1995). However, neither of these features is as prevalent in the Jumbo Dome area as they are in the Two Bull or Poker Flats mines; this is likely due to the fact that the Jumbo Dome mine is further away from Hoseanna creek than these mines.

FIGURE CII-1

SIMPLIFIED GEOLOGIC MAP OF

JUMBO DOME AND VICINITY



EXPLANATION

Holocene

- Qa — Alluvium
- Qsg — Stream gravel (Gravel of the Totatlanika River and its major tributaries)

Pleistocene

- Riley Creek Glaciation
  - Qra — Alluvium & pediment gravel
  - Qrr — Rubble of Jumbo Dome (Inactive rock glaciers and solifluction sheets)
- Healy Glaciation
  - Qha — Alluvium & pediment gravel
  - Qhr — Rubble of Jumbo Dome
- Dry Creek Glaciation
  - Qda — Alluvium and pediment gravel
  - Qdr — Rubble of Jumbo Dome

Pliocene or Pleistocene

- QThj — Hornblende dacite of Jumbo Dome

UNCONFORMITY

Pliocene(?)

- Tn — Nenana Gravel

Miocene / Oliocene and Miocene — Coal-bearing group

- Tlc — Lignite Creek Formation
- Tgl — Grubstake and Lignite Creek Formations, undivided
- Tsn — Suntrana Formation
- Tsc — Sanctuary Formation
- Thc — Healy Creek Formation

Totatlanika Schist

- Mtm — Moose Creek Member
- kp — Keevy Peak Formation

NATURAL DRAINAGE

PERMIT BOUNDARY

SCALE: 1"=3000'

1500' 0 1500' 3000'

SUBJECT REVISIONS

REV.	DATE:	BY:	DESCRIPTION
0	10/09	RLM	ORIGINAL SUBMITTAL
1	2/11	RLM	REVISION 1

DESIGN BY: A. HARDY

DRAWN BY: R. MARTIN

CHECK BY: T. SCHOLTEN

DWG FILE: JD_GEO_MAP.dwg

DATE DRAWN: 2/4/2011

JUMBO DOME MINE

USIBELLI COAL MINE, INC. UCM

PERMIT NUMBER

SIMPLIFIED GEOLOGIC MAP OF JUMBO DOME AND VICINITY

JUMBO DOME MINE

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743
(907) 683-2226

Figure No. CII-1

SHEET No. 1 OF 1

REV. 1

FIGURE CII-2

STRATIGRAPHIC SECTION OF COAL BEARING GROUP

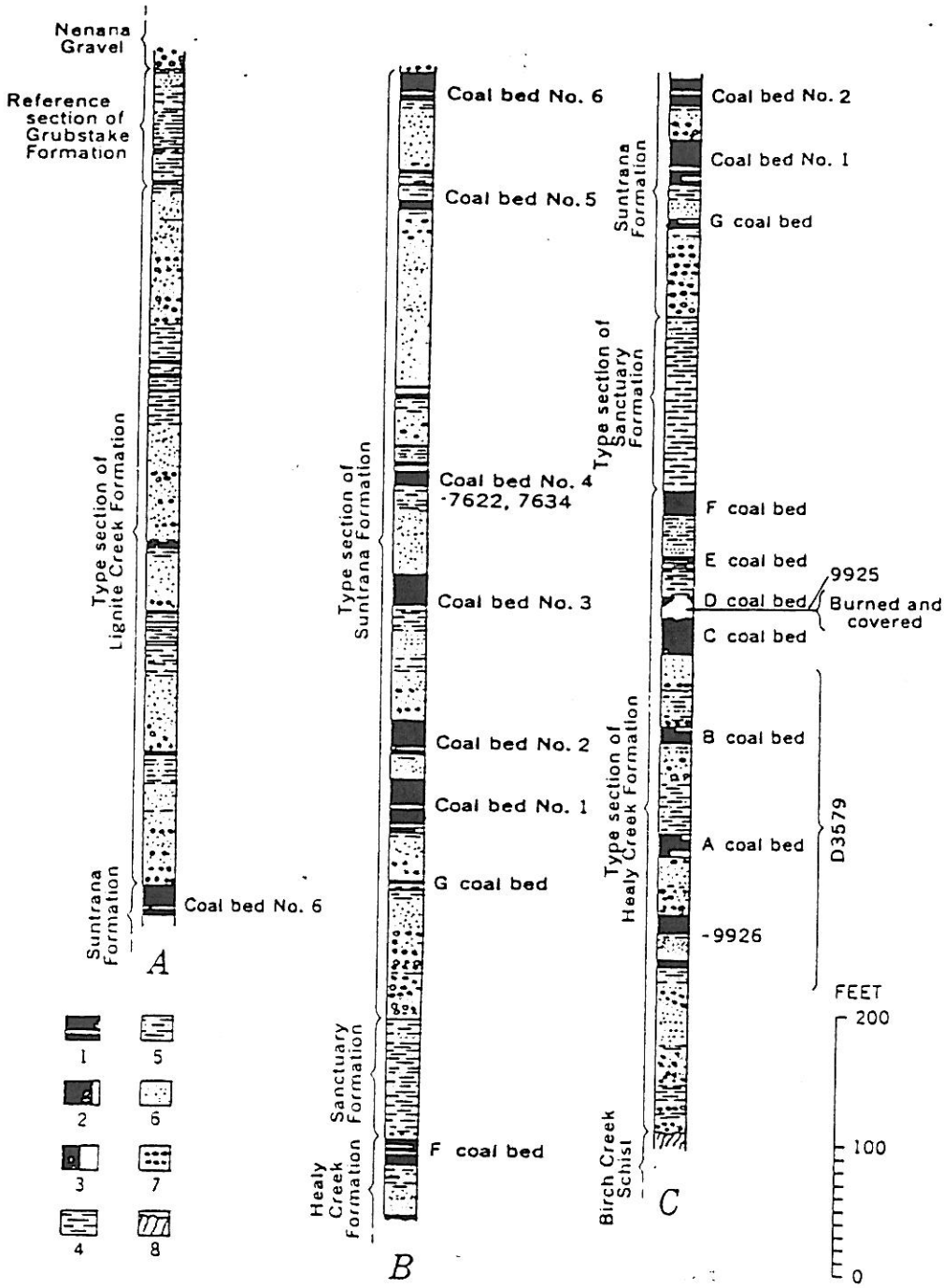


FIGURE 3.—Stratigraphic column of the type sections of the formations of the coal-bearing group at Suntrana, showing locations of plant megafossil localities and microfossil localities. Section *A*, measured along Suntrana Creek from coal bed No. 6 to the base of the Nenana Gravel; section *B*, measured along Suntrana Creek from near the railroad bridge to coal bed No. 6; section *C*, measured on the north bank of Healy Creek from the Usibelli tipple to top of the badland exposure east of the Suntrana mine. 1, coal (showing bone or clay parting); 2, bony coal; 3, bone; 4, claystone and shale; 5, siltstone; 6, sandstone, in part crossbedded; 7, pebbles and conglomerate; 8, schist (unconformity at top).

FIGURE CII-2

STRATIGRAPHIC SECTION OF COAL BEARING GROUP

3.0 STRATIGRAPHY AND STRUCTURE OF THE PERMIT AREA

As previously stated, the Jumbo Dome mine will be targeting coal seams contained in the Suntrana formation. There are four seams of primary interest in the Jumbo Dome mining area; 3, 4, 5, and 6 Seam (See Part D, Plate D2-2, Mine Plan Layout). The majority of the 3, 4, 5, and 6 Seams are structurally dipping to the northwest at an average dip angle of 5-10 degrees (with a few isolated areas with dips as high as 15-25 degrees) and striking northeast-southwest as shown on plate CII-1, CII-2,CII-3 and CII-4. A typical lithologic log for the Jumbo Dome mining section is shown in Figure CII-3. A published typical section of the Suntrana Formation is provided as Figure 2.3-2 in Wilbur (1995).

The lowest minable seam encountered in exploration drillholes in the Jumbo Dome mine area is the 3 Seam, which is between 15 and 40 feet thick. The interburden between 3 and 4 Seam is typically 30 feet thick and 4 Seam is 10 to 50 feet thick.

Above 4 Seam, there is up to 150 feet of interburden to the footwall of 6 Seam. 5 seam is contained within this interval**;** of the four target seams it is the most variable, and while not as consistent as 3, 4, and 6 seams, it will be mined where encountered and appropriate. The 6 Seam coal thickness is 5 to 25 feet; while this seam is high enough in the sequence that a relatively small portion of the current Jumbo Dome reserve is contained in this seam, it too will be mined where encountered and appropriate. The overburden above 6 Seam varies from minimal cover at the outcrop to over 200 feet in the east-central area of the proposed mine. The interburden material is typical of the Suntrana Formation, and consists of pebbly sandstone near the bottom of the interburden interval, grading up through fine sandstone to a clay bed immediately below a coal seam cap.

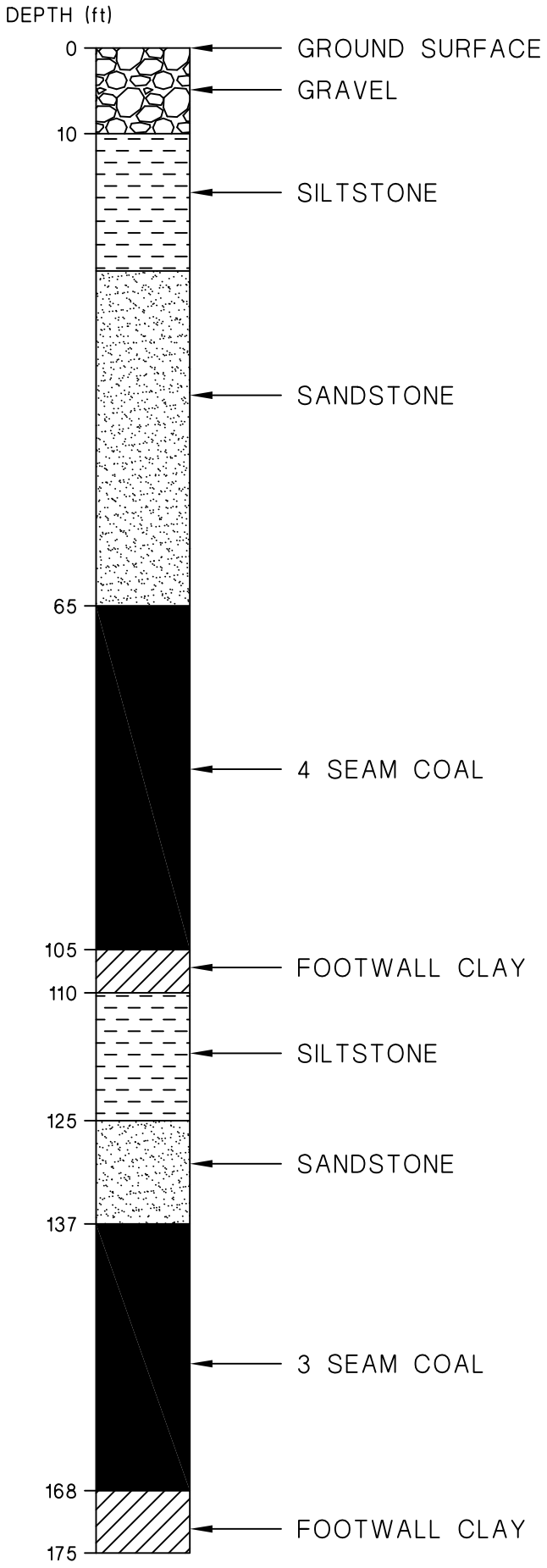
This footwall clay bed varies in thickness from seam to seam. Analysis of drill data indicates that, for those logs that verify the presence of footwall clays, the average thickness is 5, 8, 6 and 3 feet for the 6, 5, 4, and 3 seams, respectively. The actual thicknesses appear to be highly variable (ranging from 0 to 19 feet thick) with no definitive trend or depositional basin. Where

no clay is present or indicated, a siltstone, or at times Jumbo Dome talus, is generally present. Footwall clays are 30 to 50 percent montmorillonite, 30 to 50 percent kaolinite-chlorite, and 10 to 30 percent illite.

The overburden above 6 Seam is part of the Lignite Formation, which is very similar to the Suntrana Formation and is characterized by a gray to olive-green cross-bedded sandstone.
In some places, the overburden consists of rubble and tallus associated with erosion of the Jumbo Dome intrusion, as well as surficial gravel deposits.

FIGURE CII-3

TYPICAL MINING SECTION OF SUNTRANA FORMATION
FROM DRILL HOLES 08JD02B & 08EXPL02



LEGEND

- CLAY
- SILTSTONE
- SANDSTONE
- GRAVEL
- COAL

SUBJECT REVISIONS

REV.	DATE:	BY:	DESCRIPTION
0	10/09	AV	ORIGINAL SUBMITTAL

DESIGN BY: A. VENECHUK
DRAWN BY: A. VENECHUK
CHECK BY: F. WALLIS
DWG FILE: JD_FIGURES.DWG
DATE DRAWN: 10/05/2009

JUMBO DOME MINE

USIBELLI COAL MINE INC. UCM

PERMIT NUMBER

TYPICAL MINING SECTION OF SUNTRANA FORMATION FROM DRILL HOLES 08JD02B & 08EXPL02

JUMBO DOME MINE

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743
(907) 683-2226

FIGURE No. CII-3
SHEET No. 1 OF 1
REV. 0

4.0 GEOLOGY OF THE PROPOSED SURFACE MINING AREA

Plates CII-1, CII-2, CII-3 and CII-4 show the geologic interpretation of the hanging wall of each coal seam based on data gathered from all the drill holes shown on Plate CII-5. Plate CII-6 shows cross-sections showing the 3, 4, 5, and 6 Seam in the Jumbo Dome mining area.

The mineable coal seams, and in particular 3 Seam and 4 Seam, are projected to outcrop towards the south end of Marguerite Creek (see Plates CII-1 and CII-2, respectively) and gently dip to the northwest. The strike of the coal seams is generally northeast-southwest.

Aerial photo interpretation and modeling of coal seam structure suggest the possibility of two faults in the mine area which are shown on Plate CII-7. There are currently no drillhole intercepts of any faults in the mine area, and interpretation of drillhole intercepts from one drillhole to the next suggests that the magnitude of the displacement of any potential faults would be relatively small. The first of these faults appears to propagate off the Northern slope of Jumbo Dome to the southwest and may pass through the very southern part of the mine area; an apparent offset of Marguerite Creek southwest of the mine area may lend credence to the fault's inferred location. The second fault follows a southeast-northwest alignment and appears to create a drainage feeding into Marguerite Creek from the east. These faults are only a hypothesis at this time; additional exploration drilling targeting the possible location of these faults would be needed to confirm their existence, orientation, and displacement.

Structural competence of the spoil materials in the Suntrana Formation is presumed to be quite good and highwall slopes approaching 0.25H:1V (15 degrees to the vertical) have been cut and remain stable, except for surface erosion. The angle of repose for dry, loose spoil is observed to be approximately 1.6H:1V (32 degrees). Highwall and spoil angle configurations will be designed to standards established during mining of the same formation in the Two Bull Ridge and Poker Flats mines.

5.0 GEOLOGIC EXPLORATION AND DEVELOPMENT METHODS

Plate CII-5 shows the drillhole locations which have been drilled since 1974, with the latest exploration drilling program finishing in the fall of 2010. As can be seen from the drill hole location map, a substantial amount of drilling has taken place during the mid 1970s and in the last 4 years thus the coal structure is reasonably defined. In some cases, drillholes were "twinned" for one of several reasons, including obtaining core samples, confirming older exploration data, or to install monitoring wells in multiple seams at a given location. Groundwater was encountered in some of the exploration drill holes. The groundwater tends to be perched in and above each coal seam and is further discussed in Part C, chapter IV, Hydrogeology.

6.0 REFERENCES

Wahrhaftig, Wolfe, Leopold, and Lanphere, 1969. The Coal Bearing Group in the Nenana Coal Field, Alaska: U.S. Geological Survey Bulletin 1274-D.

Wahrhaftig, 1970. Geologic Map of the Fairbanks A-4 Quadrangle: U.S. Geological Survey, 1970.

Wahrhaftig, 1970. Geologic Map of the Healy D-4 Quadrangle: U.S. Geological Survey, 1970.

Rao and Wolfe, 1979-1982. Mineral Industry Research Laboratory, Fairbanks, Alaska, Characterization and Evaluation of Washability of Alaskan Coals: U.S. Department of Energy Report Doe/ET/13350-T1, T2, and T3.

Triplehorn, 1976. Clay Mineralogy and Petrology of the Coal-Bearing Group near Healy, Alaska:

Alaska Division of Geological and Geophysical Survey Geologic Report 52.

Mitchell and Mitchell, 1981. Mine Soil Characterization and Amendment Research: University of

Alaska Agricultural Station, Palmer, Alaska.

Denton, 1980. Geology and Coal Resources of the Lower Lignite Creek Area: Proceedings from

Focus on Alaska′s Coal.

Wilbur, Stephen C., 1995, Fluvial and Hillside Geomorphology of Hoseanna Creek Watershed, Central Alaska Master Thesis University of Alaska, Fairbanks, December.

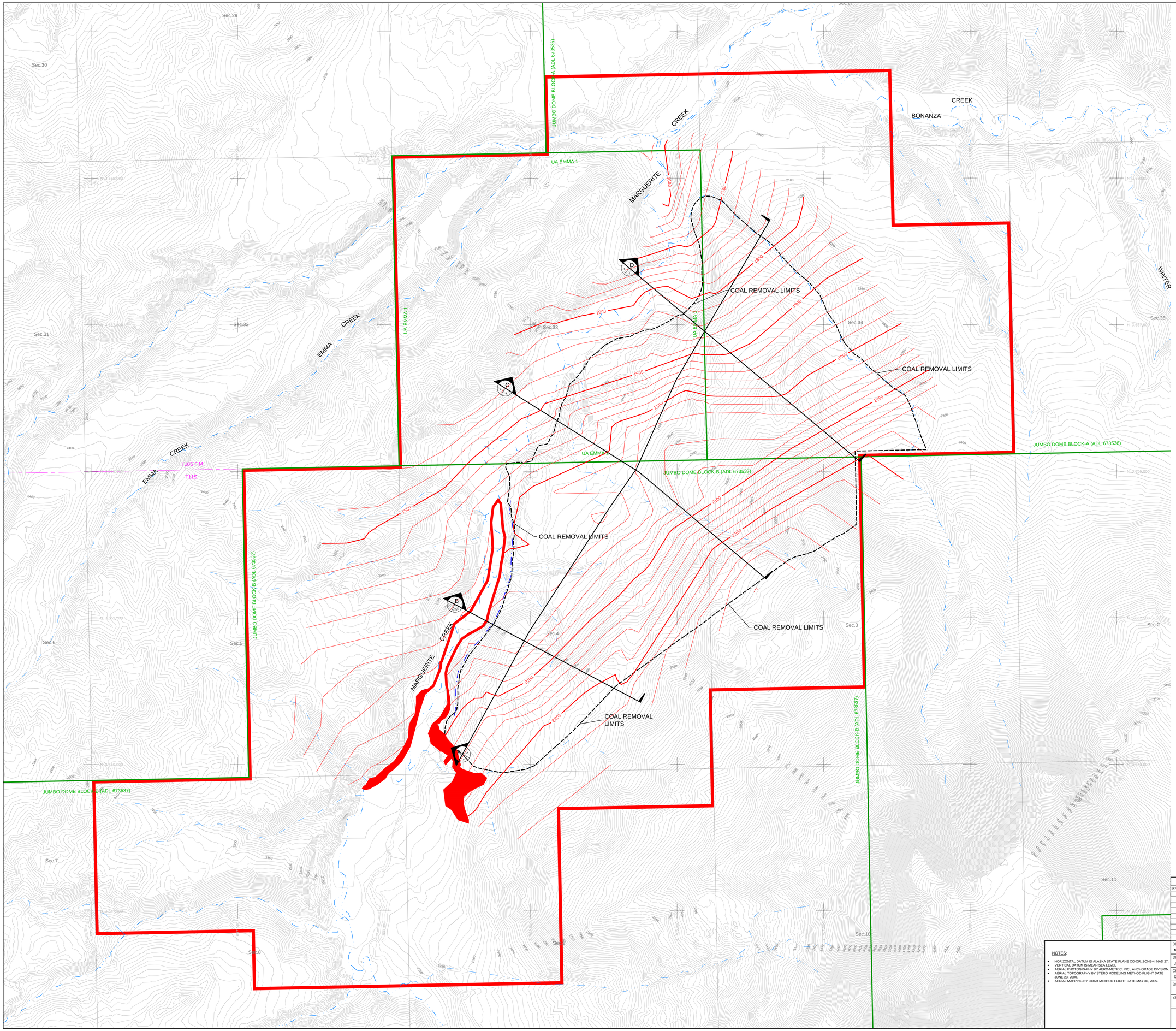
R.D. Merritt, 1985. Coal Atlas of Nenana Basin, Alaska, Alaska Division of Geological and Geophysical Surveys

7.0 RESPONSIBLE PARTIES

This section was prepared by Usibelli Coal Mine, Inc.

PLATE CII-1

COAL STRUCTURE FOR 3 SEAM



LEGEND

- PROPOSED PERMIT BOUNDARY
- COAL LEASE BOUNDARY
- SECTION LINE
- TOWNSHIP/RANGE LINE
- APPROXIMATE EXISTING CONTOUR AND ELEVATION, FT
- EXISTING STREAM/DRAINAGE
- PROPOSED MINING BOUNDARY
- COAL SEAM STRUCTURE BOTTOM OF SEAM
- 3 SEAM PROJECTED OUTCROP

SCALE

500' 0 500' 1000'

SUBJECT REVISIONS

REV.	DATE:	BY:	DESCRIPTION

NOTES:

- HORIZONTAL DATUM IS ALASKA STATE PLANE CO-OR. ZONE-4, NAD 27.
- VERTICAL DATUM IS MEAN SEA LEVEL.
- AERIAL PHOTOGRAPHY BY AERO-METRIC, INC., ANCHORAGE DIVISION.
- AERIAL TOPOGRAPHY BY STERO MODELING METHOD FLIGHT DATE JUNE 23, 2000.
- AERIAL MAPPING BY LIDAR METHOD FLIGHT DATE MAY 30, 2005.

DESIGN BY: MWH

DRAWN BY: JMB

CHECK BY: TEL

DWG FILE:

XREF DWG FILE:

COAL STRUCTURE FOR SEAM 3

JUMBO DOME MINE

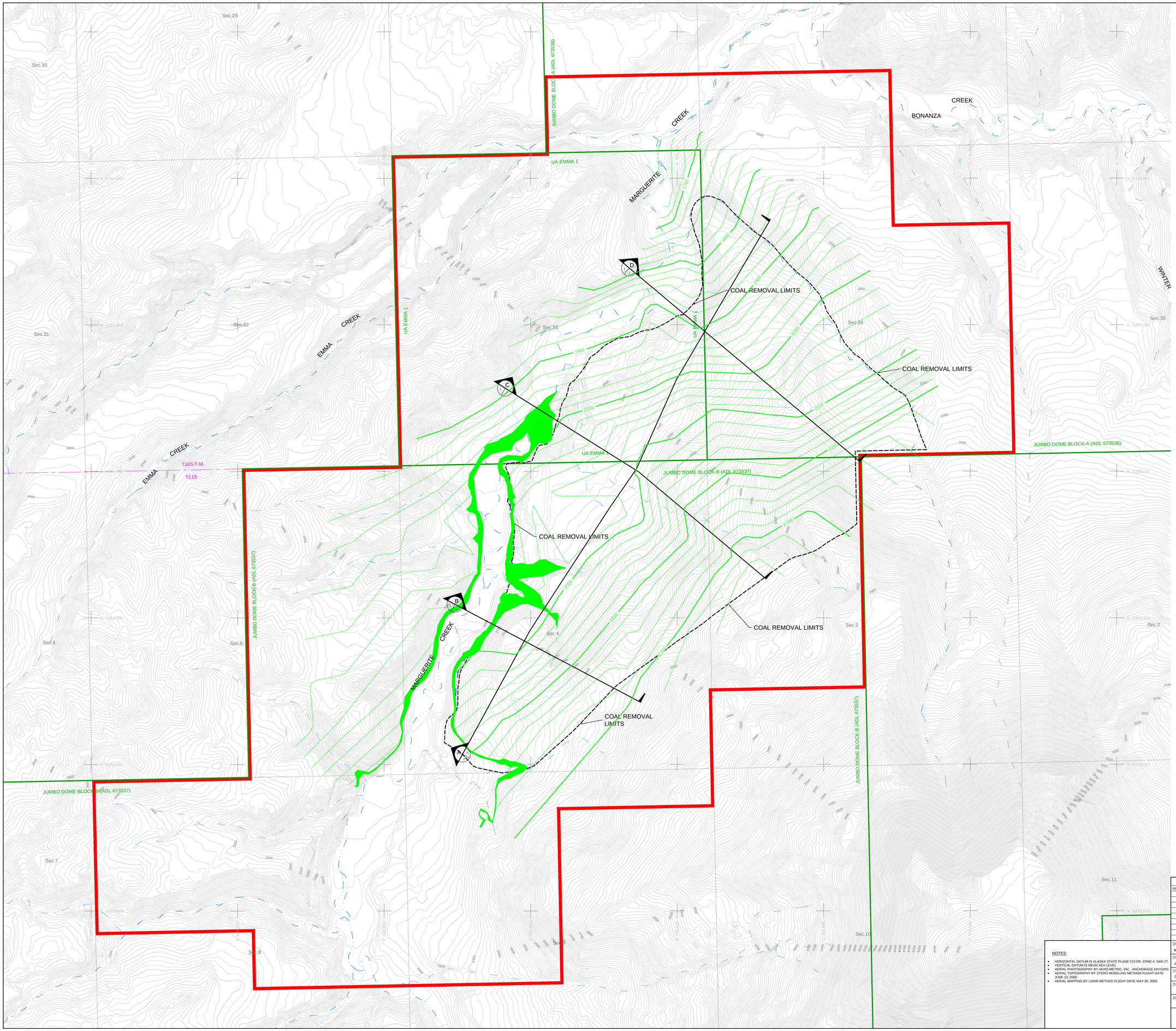
USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743

PLATE No. CII-1

REV. A

PLATE CII-2

COAL STRUCTURE FOR 4 SEAM



LEGEND

- PROPOSED PERMIT BOUNDARY
- COAL LEASE BOUNDARY
- SECTION LINE
- TOWNSHIP/RANGE LINE
- APPROXIMATE EXISTING CONTOUR AND ELEVATION, FT
- EXISTING STREAM/DRAINAGE
- PROPOSED MINING BOUNDARY
- COAL SEAM STRUCTURE BOTTOM OF SEAM
- 4 SEAM PROJECTED OUTCROP

SCALE

500' 0 500' 1000'

NOTES:

- HORIZONTAL DATUM IS ALASKA STATE PLANE CO-OR. ZONE-4, NAD 27.
- VERTICAL DATUM IS MEAN SEA LEVEL
- AERIAL PHOTOGRAPHY BY AERO-METRIC, INC., ANCHORAGE DIVISION.
- AERIAL TOPOGRAPHY BY STERO MODELING METHOD FLIGHT DATE JUNE 25, 2000.
- AERIAL MAPPING BY LIDAR METHOD FLIGHT DATE MAY 30, 2005.

SUBJECT REVISIONS

REV.	DATE:	BY:	DESCRIPTION

DESIGN BY: MRH

DRAWN BY: JMD

CHECK BY: TEL

DWG FILE:

XREF DWG FILE:

USIBELLI COAL MINE INC

COAL STRUCTURE FOR SEAM 4

JUMBO DOME MINE

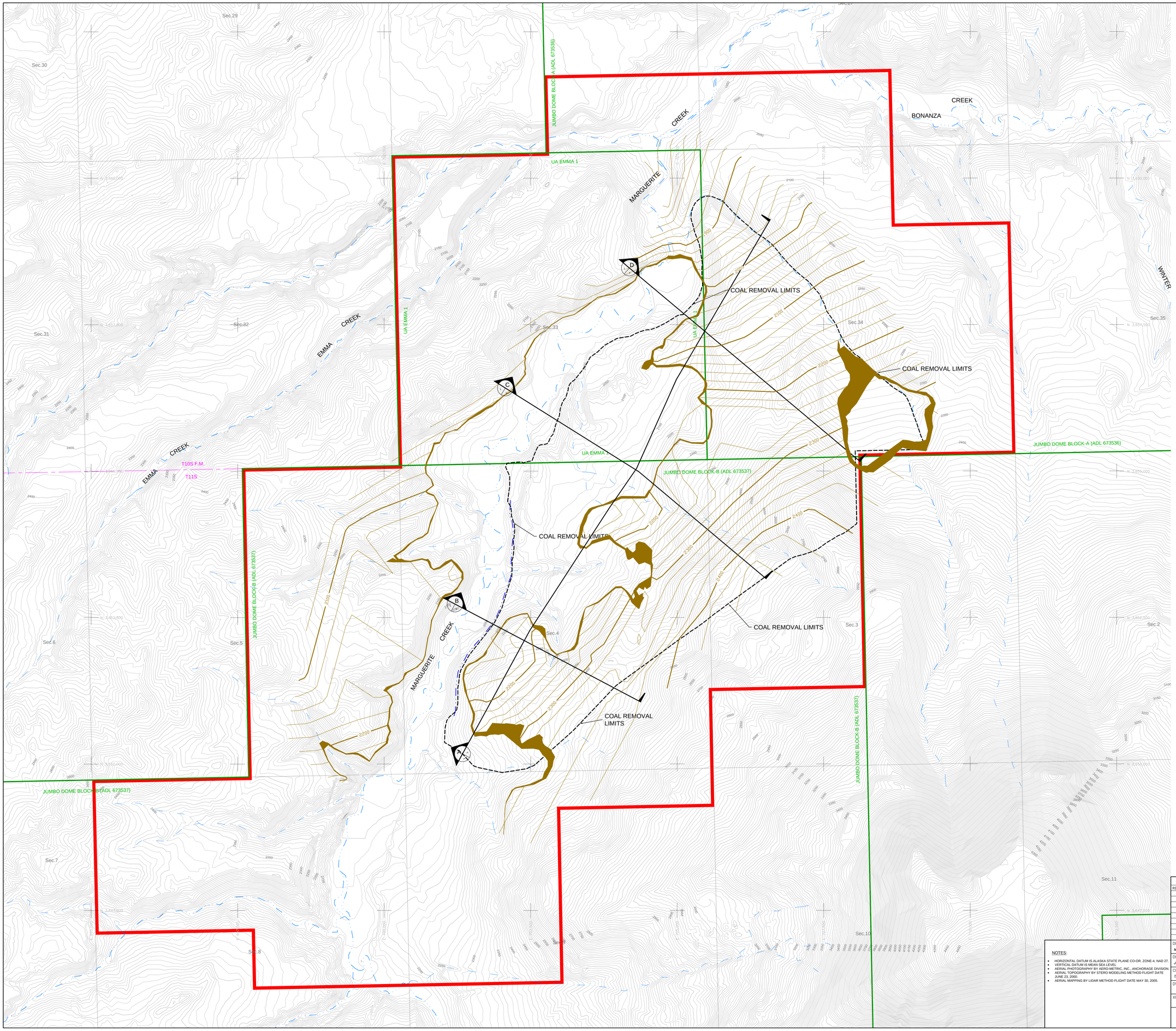
USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743

PLATE No. CII-2

REV. A

PLATE CII-3

COAL STRUCTURE FOR 5 SEAM



LEGEND

- PROPOSED PERMIT BOUNDARY
- COAL LEASE BOUNDARY
- SECTION LINE
- TOWNSHIP/RANGE LINE
- APPROXIMATE EXISTING CONTOUR AND ELEVATION, FT
- EXISTING STREAM/DRAINAGE
- PROPOSED MINING BOUNDARY
- COAL SEAM STRUCTURE BOTTOM OF SEAM
- 5 SEAM PROJECTED OUTCROP

SCALE

500' 0 500' 1000'

NOTES:

- HORIZONTAL DATUM IS ALASKA STATE PLANE CO-OR. ZONE-4, NAD 27.
- VERTICAL DATUM IS MEAN SEA LEVEL
- AERIAL PHOTOGRAPHY BY AERO-METRIC, INC., ANCHORAGE DIVISION.
- AERIAL TOPOGRAPHY BY STERO MODELING METHOD FLIGHT DATE JUNE 23, 2000.
- AERIAL MAPPING BY LIDAR METHOD FLIGHT DATE MAY 30, 2005.

SUBJECT REVISIONS

REV.	DATE:	BY:	DESCRIPTION

DESIGN BY: MWH

DRAWN BY: JMB

CHECK BY: TEL

DWG FILE:

XREF DWG FILE:

COAL STRUCTURE FOR SEAM 5

JUMBO DOME MINE

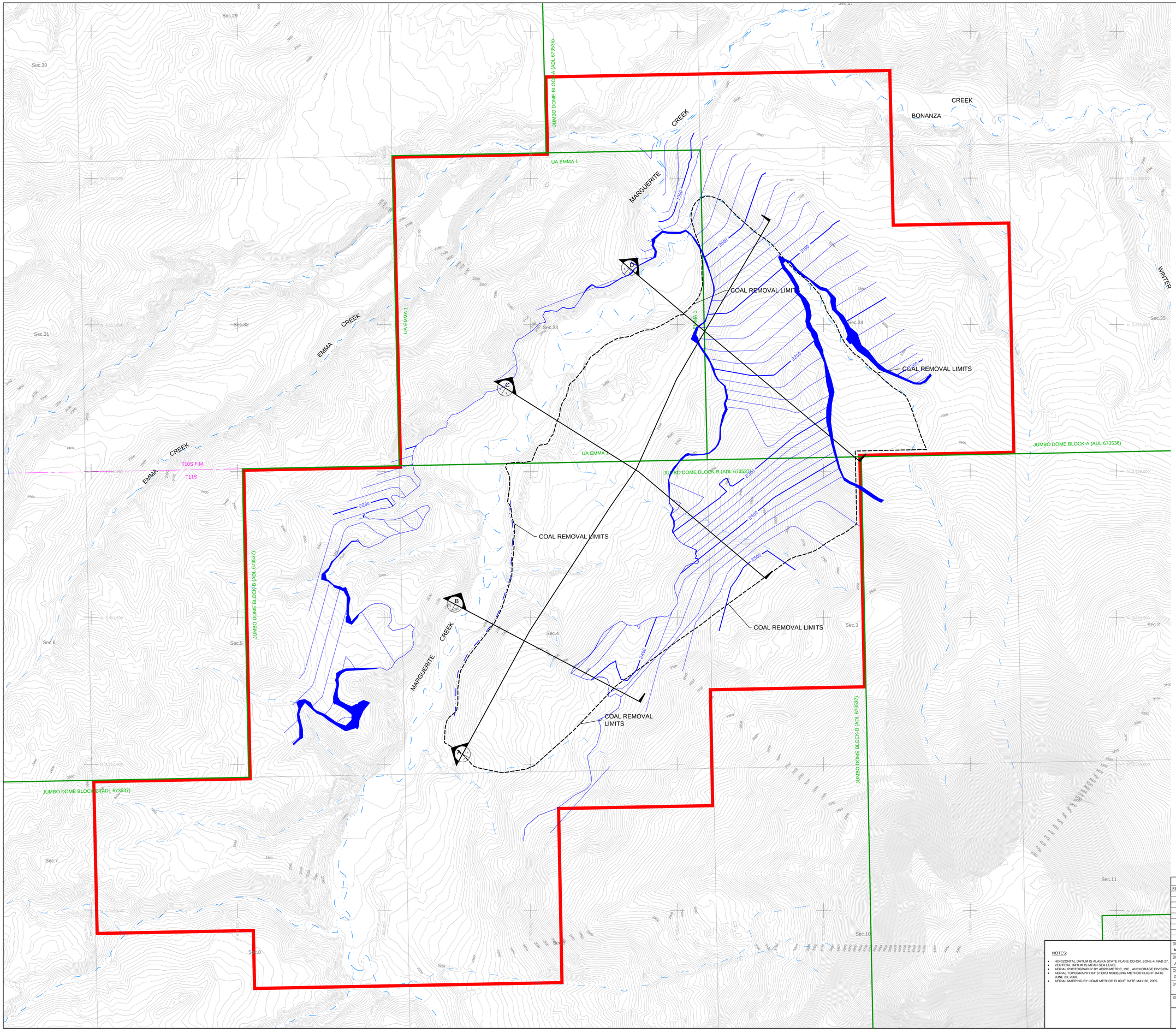
USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743

PLATE No. CII-3

REV. A

PLATE CII-4

COAL STRUCTURE FOR 6 SEAM



LEGEND

- PROPOSED PERMIT BOUNDARY
- COAL LEASE BOUNDARY
- SECTION LINE
- TOWNSHIP/RANGE LINE
- APPROXIMATE EXISTING CONTOUR AND ELEVATION, FT
- EXISTING STREAM/DRAINAGE
- PROPOSED MINING BOUNDARY
- COAL SEAM STRUCTURE BOTTOM OF SEAM
- 6 SEAM PROJECTED OUTCROP

SCALE

500' 0 500' 1000'

NOTES:

- HORIZONTAL DATUM IS ALASKA STATE PLANE CO-OR. ZONE-4, NAD 27.
- VERTICAL DATUM IS MEAN SEA LEVEL
- AERIAL PHOTOGRAPHY BY AERO-METRIC, INC., ANCHORAGE DIVISION.
- AERIAL TOPOGRAPHY BY STERO MODELING METHOD FLIGHT DATE JUNE 23, 2000.
- AERIAL MAPPING BY LIDAR METHOD FLIGHT DATE MAY 30, 2005.

SUBJECT REVISIONS

REV.	DATE:	BY:	DESCRIPTION

DESIGN BY: MWH

DRAWN BY: JMB

CHECK BY: TEL

DWG FILE:

XREF DWG FILE:

COAL STRUCTURE FOR SEAM 6

JUMBO DOME MINE

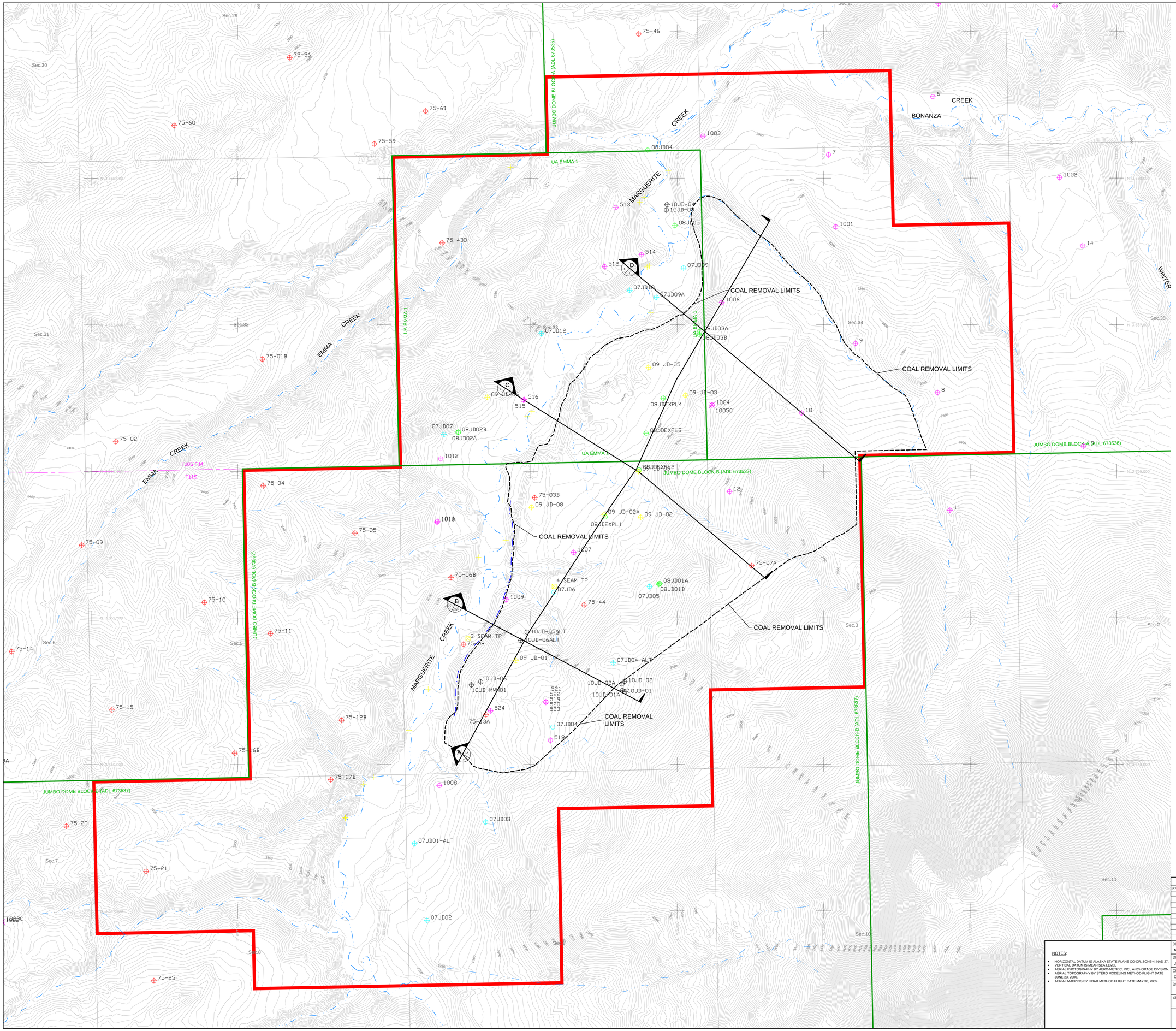
USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743

PLATE No. CII-4

REV. A

PLATE CII-5

DRILL HOLE LOCATIONS



LEGEND

	PROPOSED PERMIT BOUNDARY
	COAL LEASE BOUNDARY
	SECTION LINE
	TOWNSHIP/RANGE LINE
2000	APPROXIMATE EXISTING CONTOUR AND ELEVATION, FT
	EXISTING STREAM/DRAINAGE
	PROPOSED MINING BOUNDARY
2000	COAL SEAM STRUCTURE BOTTOM OF SEAM
8	AMEX 1974 DRILLHOLE RC
1005C	AMEX 1974 DRILLHOLE C
75-12B	AMEX 1975 DRILLHOLE RC
07JD09A	UCM 2007 DRILLHOLE
08JD03A	UCM 2008 DRILLHOLE
09 JD-08	UCM 2009 DRILLHOLE
3 SEAM TP	UCM 2009 TEST PIT
10JD-06	UCM 2010 DRILLHOLE
	UCM SURVEYED OUTCROP

SCALE

500' 0 500' 1000'

SUBJECT REVISIONS

REV.	DATE:	BY:	DESCRIPTION

NOTES:

- HORIZONTAL DATUM IS ALASKA STATE PLANE CO-OR. ZONE-4, NAD 27.
- VERTICAL DATUM IS MEAN SEA LEVEL.
- AERIAL PHOTOGRAPHY BY AERO-METRIC, INC., ANCHORAGE DIVISION.
- AERIAL TOPOGRAPHY BY STERO MODELING METHOD FLIGHT DATE JUNE 23, 2000.
- AERIAL MAPPING BY LIDAR METHOD FLIGHT DATE MAY 30, 2005.

DESIGN BY: MWY

DRAWN BY: JMB

CHECK BY: TEL

DWG FILE:

XREF DWG FILE:

USIBELLI COAL MINE INC

DRILLHOLE LOCATIONS

JUMBO DOME MINE

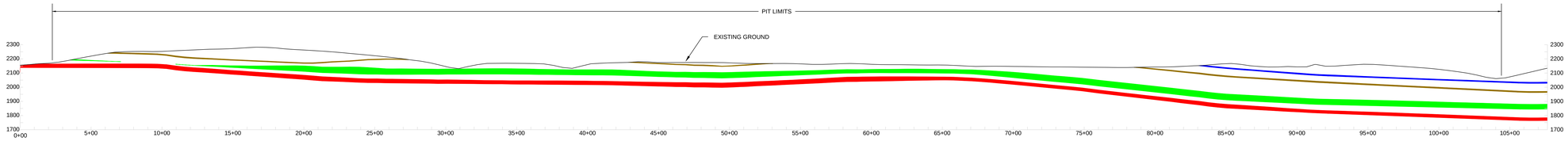
USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743

PLATE No. CII-5

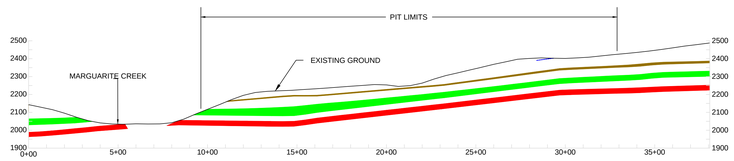
REV. A

PLATE CII-6

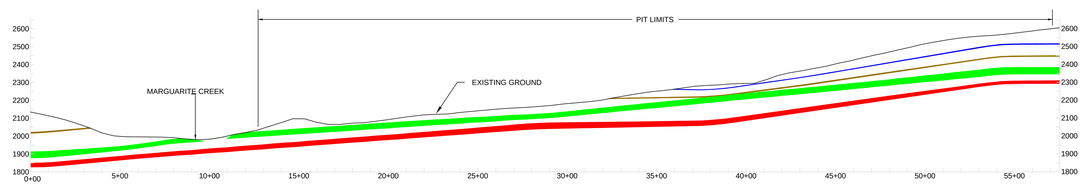
GEOLOGIC CROSS-SECTION



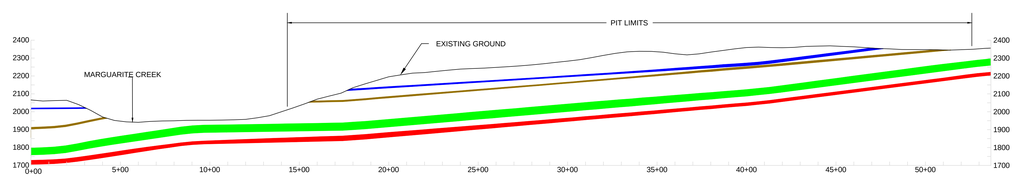
A CROSS-SECTION A



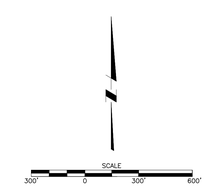
B CROSS-SECTION B



C CROSS-SECTION C



D CROSS-SECTION D



LEGEND

- 6 SEAM
- 5 SEAM
- 4 SEAM
- 3 SEAM

NOTES:

- HORIZONTAL DATUM IS ALASKA STATE PLANE CO-OR. ZONE-4, NAD 27.
- VERTICAL DATUM IS MEAN SEA LEVEL.
- AERIAL PHOTOGRAPHY BY AERO-METRIC, INC., ANCHORAGE DIVISION.
- AERIAL TOPOGRAPHY BY STERO MODELING METHOD FLIGHT DATE JUNE 23, 2000.
- AERIAL MAPPING BY LIDAR METHOD FLIGHT DATE MAY 30, 2005.

SUBJECT REVISIONS

REV.	DATE:	BY:	DESCRIPTION

DESIGN BY: MRH

DRAWN BY: JMB

CHECK BY: TEL

DWG FILE:

XREF DWG FILE:

GEOLOGIC CROSS-SECTION

JUMBO DOME MINE

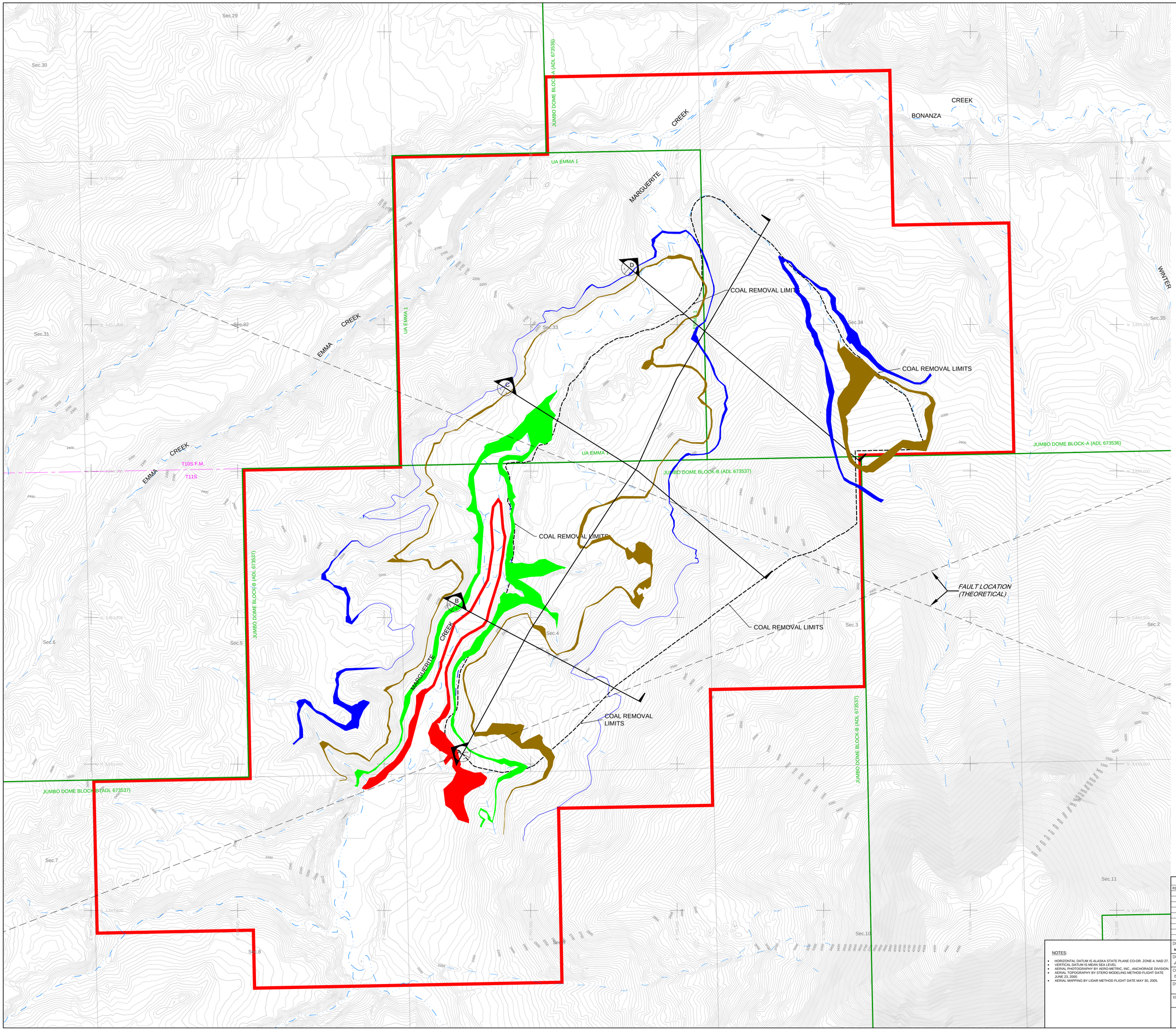
USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743

PLATE No. CII-6

REV. A

PLATE CII-7

PROJECTED OUTCROPS



LEGEND

- PROPOSED PERMIT BOUNDARY
- COAL LEASE BOUNDARY
- SECTION LINE
- TOWNSHIP/RANGE LINE
- APPROXIMATE EXISTING CONTOUR AND ELEVATION, FT
- EXISTING STREAM/DRAINAGE
- PROPOSED MINING BOUNDARY
- 3 SEAM PROJECTED OUTCROP
- 4 SEAM PROJECTED OUTCROP
- 5 SEAM PROJECTED OUTCROP
- 6 SEAM PROJECTED OUTCROP

SCALE
500' 0 500' 1000'

NOTES:

- HORIZONTAL DATUM IS ALASKA STATE PLANE CO-OR. ZONE-4, NAD 27.
- VERTICAL DATUM IS MEAN SEA LEVEL
- AERIAL PHOTOGRAPHY BY AERO-METRIC, INC., ANCHORAGE DIVISION.
- AERIAL TOPOGRAPHY BY STERO MODELING METHOD FLIGHT DATE JUNE 23, 2000.
- AERIAL MAPPING BY LIDAR METHOD FLIGHT DATE MAY 30, 2005.

SUBJECT REVISIONS

REV.	DATE:	BY:	DESCRIPTION

DESIGN BY: MWH
DRAWN BY: JMB
CHECK BY: TEL
DWG FILE:
XREF DWG FILE:

PROJECTED OUTCROPS

JUMBO DOME MINE

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743

PLATE No. CII-7

REV. A

APPENDIX CII-1

DRILL HOLE LOGS

DRILL LOG DATA
USIBELLI COAL MINE, INC.

Hole Number: 08 EXPL #2	Location:
Date: 7/6/08	Northing:
Geologist: Alec M. Venechuk	Easting:
Drill Crew: Tester Drilling	Elevation:

Footage	Lith.	Description	Footage	Lith.	Description
		Organics and Silty mud			
		Frozen Silty Sand			
20			200		
40		38'-40' Heavy Coarse Gravels	220		
		40'-64' Coal			
		4 Seam			
60			240		
		Clayey Silt			
80			260		
		Sandy Silt			
100			280		
		94'-125' Coal			
		3 Seam			
120			300		
		TD @ 130'			
140			320		
160			340		
180			360		

Notes:

DRILL LOG DATA
USIBELLI COAL MINE, INC.

Hole Number:	08JD02B	Location:	Jumbo Dome, Usibelli Coal Mine
Date:	6/30/08	Northing:	
Geologist:	Alex M. Venechuk	Easting:	
Drill Crew:	Tester Drilling	Elevation:	

Footage	Lith.	Description	Footage	Lith.	Description
					End of Coal @ 193'
		Clay layer			
20			200		TD@ 196'
40			220		
		Silty sandstone			
60			240		
80			260		
100			280		
		Coal 92'-128'			
120			300		
		128'-142'			
140		Clay (Fining upward Package)	320		
		Silt			
160		Sand	340		
		Coal 162'-193'			
180			360		

Notes: When cutting casing with a torch, the drillers melted a plastic bag covering the top of the well and it fell down the well. Not sure if that will change the chemical analysis of this well.

DRILL LOG DATA
USIBELLI COAL MINE, INC.

Hole Number: 08JD02 B	Location:
Date: 6/30/08	Northing:
Geologist: Alec Venechuk	Easting:
Drill Crew:	Elevation:

Footage	Lith.	Description	Footage	Lith.	Description
		Well Construction			
		4ft Bentonite plug			Well starts at 194'. Original drill depth was at 196'
20			200		
40			220		
60		Back-fill	240		
80			260		
100			280		
120			300		
140			320		
160		Bentonite 165'-169'	340		
		Sand Stops @ 169'			
		Screen Stops @ 174'			
180			360		

Notes:

CHAPTER III

OVERBURDEN AND INTERBURDEN ASSESSMENT

TABLE OF CONTENTS

Page

1.0 INTRODUCTION CIII-1
1.1 Purpose.....CIII-1
1.2 Scope of Work CIII-1
2.0 METHODOLOGY CIII-2
2.1 Sample Collection.....CIII-2
2.2 Laboratory Analyses CIII-2
3.0 ANALYSIS RESULTS CIII-3
4.0 CONCLUSIONS.....CIII-3
5.0 REFERENCES CIII-4
6.0 RESPONSIBLE PARTIES.....CIII-4

LIST OF TABLES

CIII-1 Overburden And Interburden Sample Summary CIII-6
CIII-2 Overburden And Interburden Analytical Parameters CIII-7
CIII-3 Coal Quality.....CIII-8
CIII-4 Chemical And Physical Characteristics Of
Overburden And Interburden.....CIII-9
CIII-5 Guidelines For Evaluating Overburden And Interburden Suitability.....CIII-10

LIST OF PLATES

CIII-1 Location Of Boreholes Used For Overburden And Interburden Sampling.....CIII-11

LIST OF APPENDICES

CIII-1 Overburden And Interburden Lab Analytical Results CIII-12
CIII-2 Coal Quality Lab Analytical Results CIII-13

1.0 INTRODUCTION

1.1 PURPOSE

The proposed surface coal mining activities, including both excavation and placement of spoil materials as backfill or in permanent out-of-pit spoil piles, will result in exposure of overburden and interburden materials to potential weathering, erosion, and leaching. Overburden and interburden materials within the Jumbo Dome Mine area have been sampled and analyzed in order to assess the potential for surface or ground water degradation due to weathering and leaching of these materials and to determine their suitability relative to mine reclamation and revegetation objectives. Coal seams have been sampled and analyzed to determine acid-forming and toxic-forming materials, including an analysis of the total sulfur content.

1.2 SCOPE OF WORK

Regulatory requirements for overburden and interburden assessment under 11 AAC 90.045 are:

- Physical properties such as texture, swell, and erodibility (11 AAC 90.045 (b)(3)).
- Chemical analyses to identify horizons which may contain potentially acid-forming, toxic-forming, or alkalinity-producing materials (11 AAC 90.045 (b)(4)).
- Coal seam analyses including but not limited to total sulfur content (11 AAC 90.045 (b)(5)).

These requirements are addressed in the following sections, with physical and chemical analysis of overburden and interburden and proximate analysis of coal seams addressed in Sections 2.0, 3.0, and 4.0 and the associated summary tables. In order to evaluate the potential for surface or ground water degradation and reclamation suitability, representative overburden and interburden samples have been collected, analyzed, and the analysis results compared with applicable suitability criteria to identify and assess any potential concerns.

2.0 METHODOLOGY

2.1 SAMPLE COLLECTION

In order to adequately characterize overburden and interburden units within the proposed Jumbo Dome Mine area, samples have been obtained from a total of 8 boreholes that were drilled up to 300 feet in depth. The boreholes covered the entire area of proposed mining activities, as shown by Plate CIII-1, Location of Boreholes Used for Overburden and Interburden Sampling, and intercepted all strata to be disturbed by mining down to and including the strata immediately below 3 Seam, the lowermost coal seam to be mined in the Suntrana Formation. UCM currently has no plans to mine below 3 Seam, thus, no samples were analyzed from this formation. Boreholes were completed using both air-rotary and core drilling methods. Samples from the rotary drilling included cuttings which were collected for each 5-foot drilling interval and then composited for selected sampling intervals as indicated by Table CIII-1, Overburden and Interburden Sample Summary. Samples from the core drilling were collected at discrete intervals but were still composited for selected sampling intervals. The selected sampling intervals correspond to specific stratigraphic units and include all overburden and interburden members as well as the primary two clay units which underlie the 3 and 4 Seams. Coal sampling involved several sampling programs covering the coal seams with collection of core samples, air rotary grab samples, and bulk samples. Lithology and thickness of all overburden, interburden, and coal units have been previously discussed in Section 3.0 of Chapter II, Geology, and illustrated by Plate CII-6, Geologic Cross-Sections.

2.2 LABORATORY ANALYSES

Each composited overburden and interburden sample was analyzed for specific chemical and physical parameters as identified in Table CIII-2, Overburden and Interburden Analytical Parameters. This parameter list was developed in consultation with the Division of Mining and Water Management during similar UCM permitting projects and includes those parameters necessary to assess the potential for surface and ground water degradation as well as reclamation suitability. Representative core samples of the coal seams were analyzed. Proximate analysis for sulfur was completed for each 3 Seam, 4 Seam, and 6 Seam core sample.

Sulfur analysis is often required for the high sulfur coals in the humid climate settings where acid production may be an issue. To satisfy the regulatory requirement for toxic and acid forming potential, we have included the sulfur analysis.

3.0 ANALYSIS RESULTS

The results of chemical and physical analyses of overburden and interburden materials within the proposed mining area are summarized by Table CIII-4, Chemical and Physical Characteristics of Overburden and Interburden. The results of sulfur analyses of 3, 4, and 6 Seams are summarized by Table CIII-3, Coal Quality.

4.0 CONCLUSIONS

Overburden and interburden analysis results, as summarized by Table CIII-4, were compared with accepted suitability criteria as presented in Table CIII-5, Guidelines for Evaluating Overburden and Interburden Suitability. This comparison indicated that overburden and interburden materials within the proposed mine area are generally not potentially acid-forming, toxic-forming, or alkalinity-producing and therefore, do not represent a concern relative to potential surface or ground water contamination or reclamation suitability. Only one minor textural limitation and one minor molybdenum leachate limitation were noted for the 3 Seam footwall clays (Sample 09JD08 [85-86.5’] and Sample 09JD03 [167-168.5’], respectively), and one minor saturated paste pH limitation was noted for a 6/4 Seam interburden sample (Sample 08JD03B [62-67’]), all three instances of which will be addressed through normal inter/overburden mixing in the mining process. Topsoil is proposed for salvage and use at Jumbo Dome. However, in the absence of topsoil a mixed spoil is also a suitable growth medium.

The coal groups typically contain less than 0.2 percent sulfur with the highest average value for any seam of 0.17%. Fifteen samples of coal representing 7 drillhole cores (09JD-01, 09JD-02A, 09JD-03, 09JD-05, 09JD-06, 09JD-09, and 09JD-10) were submitted for chemical analysis for sulfur fraction. The results are presented in Table CIII-3 and demonstrate that pyritic sulfur is present in very low percentages (0.01%) compared to the organic sulfur fraction (0.11%). Therefore, acid production potential is extremely low. This is supported by the overburden geochemical data for

ABP (Table CIII-4). Therefore, acid production from coal materials is not anticipated within the Jumbo Dome Mine area.

5.0 REFERENCES

Applicable regulatory requirements for overburden and interburden assessment and coal analysis are as cited in Section 1.2 (11 AAC 90.045[b][3] through 11 AAC 90.045[b][5]). Suitability criteria as discussed in Section 4.0 were obtained from Guideline 1 - Topsoil and Overburden (Wyoming Department of Environmental Quality - Land Quality Division, November, 1984).

6.0 RESPONSIBLE PARTIES

This section, including the collection, analysis, and presentation of the information provided herein, was prepared by Usibelli Coal Mine, Inc.

TABLES

TABLE CIII-1

OVERBURDEN AND INTERBURDEN SAMPLE SUMMARY

Borehole Number[1]	Sample Interval[2] (in ft bgs)	Date of Sample Collection	Primary Lithology[3]	Geologic Unit[3]
07JDA	83-108	9/4-5/07	Sandstone	4/3 Seam Interburden
	108-118		Sandstone	4/3 Seam Interburden
07JD12	134.6-136	8/29/07	Clay	4 Seam Footwall
08JD02B	47-52	6/30/08	Sandstone	4 Seam Overburden
	67-72		Sandstone	4 Seam Overburden
	127-132		Clay	4 Seam Footwall
	132-137		Clay	4 Seam Footwall
08JD03B	22-27	7/2/08	Silt	6/4 Seam Interburden
	47-52		Sandy Silt	6/4 Seam Interburden
	62-67		Sand	6/4 Seam Interburden
	142-147		Clayey Sand	6/4 Seam Interburden
	247-252		Sandy Silt	4/3 Seam Interburden
	257-262		Sand	4/3 Seam Interburden
	296-298		Clay	3 Seam Footwall
09JD01	151-152.5	6/25/09	Clay	4 Seam Footwall
	170.5-172		Sandstone	4/3 Seam Interburden
	210-211.5		Clay	3 Seam Footwall
09JD02A	113-114.5	7/1/09	Clay	4 Seam Footwall
	128.5-130		Clayey Silt	4/3 Seam Interburden
	142.5-144		Silty Sand	4/3 Seam Interburden
	179-180.5		Clay	3 Seam Footwall
09JD08	85-86.5	6/26-27/09	Clay	3 Seam Footwall
09JD03	59-60	6/29/09	Clay/Silt/Sand	4Seam Overburden
	106-107.5		Sandstone	4/3 Seam Interburden
	127-128		Sandstone	4/3 Seam Interburden
	167-168.5		Clay	3 Seam Footwall

Notes:

1. Borehole locations are shown on Plate CIII-1.
2. Cuttings from air rotary drilling were collected every 5 feet and composited over the sample interval.

TABLE CIII-2

Overburden and Interburden Analytical Parameters

Parameter	Laboratory Method	Detection Limit[1]
Arsenic	ASA No. 9 3-5.2.3 (AB-DTPA Extraction) EPA 7060 (Extract Analysis by GFAA)	-- 0.05 mg/kg
Boron	ASA No. 9 80-3 (Hot Water Extraction) EPA 6010 (Extract Analysis by ICP)	-- 0.05 mg/kg
Cation Exchange Capacity (CEC)	USDA No. 60	0.03 meq/100g
Conductivity	USDA Handbook 66, M2 (Saturated Past Extraction) EPA 120.1 (Extract Analysis	-- 0.001 mmhos/cm
Molybdenum	ASA No. 9 3-5.2.3 (AB-DTPA Extraction) EPA 6010 (Extract Analysis by ICP)	-- 0.5 mg/kg
Neutralization Potential	EPA 600/2-78-054 3.2.3	0.1% (as $CaCO_3$)
Nitrogen	ASA No. 9 10-2.3.2 (Water extraction) EPA 353.2 (Extract Analysis)	-- 1 mg/kg
pH	USDA Handbook 66, M2 (Saturated Paste Extraction) USDA No. 60 (21A) (Extract Analysis)	-- 0.1 s.u.
Phosphorous	ASA No. 9 3-5.2.3 (AB-DTPA Extraction) EPA 365.1 (Extract Analysis)	-- 1 mg/kg
Potassium	USDA Handbook 66, M2 (Saturated Paste Extraction) SW-846 6010 (Extract Analysis by ICP)	-- 0.008 meq/L
Rock Fragments (>2 mm)	ASA No. 9 15-4.2.2	0.1%
Saturation Percentage	ASA No. 9 10-2.3.1	0.01%
Total Sulfur	ASTM D-4239-85C (Leco Furnace)	0.01%
Texture	ASTM D422 (hydrometer method)	1%

Note:

1. Detection limits typically reported in 2009 by Energy Laboratories, Inc., Helena, Montana who performed the inter/overburden analyses.

TABLE CIII-3 Coal Quality					
		Pyritic	**Sulfate**	**Organic**	**Total**
Seam 3	Mean	0.01	0.01	0.11	0.13
	Minimum	0.01	0.01	0.08	0.1
	Maximum	0.02	0.01	0.16	0.19
	Standard Deviation	0.004	0.00	0.03	0.034
Seam 4	Mean	0.01	0.01	0.08	0.1
	Minimum	0.01	0.01	0.07	0.09
	Maximum	0.02	0.01	0.01	0.04
	Standard Deviation	0.004	0.00	0.011	0.015
Seam 6	Mean	0.01	0.01	0.15	0.17
	Minimum	0.01	0.01	0.15	0.17
	Maximum	0.01	0.01	0.15	0.17
	Standard Deviation	0.00	0.00	0.00	0.00

TABLE CIII-4CHEMICAL AND PHYSICAL CHARACTERISTICS OF OVERBURDEN AND INTERBURDEN

Borehole Number and Sample Interval[1]	Acid-base Potential[3] (T/KT)	Arsenic-extractable (mg/kg)	Boron – extractable (mg/kg)	Cation Exchange Capacity (meq/100g)	Conductivity-saturated paste (mmhos/cm)	Molybdenum-extractable (mg/kg)	Nitrate-soluble (mg/kg as N)	pH-saturated paste[2] (s.u.)	Phosphorous-extractable (mg/kg as P)	Potassium-saturated paste (meq/l)	Rock Fragments (%>2mm)	Saturation (%)	Sulfur- total (%)	% Clay	% Sand	% Silt	Classification[2,4]
Analyte Reporting Limit	n/a	0.1	n/a	0.09	0.01	0.1	1	0.1	0.2	0.03	2	0.1	0.01	1	1	1	
07JDA @ 83-108'	3	0.6	<0.10	3.98	1.50	0.1	2	6.6	0.8	0.53	8	21.7	<0.01	8	76	16	SL/SCL
07JDA @ 108-118'	0	0.5	<0.10	3.56	1.80	<0.1	1	5.5	0.7	0.54	12	19.4	0.03	6	78	16	LS
07JD12 @ 134.6-136'	5	<0.1	0.16	24.00	0.46	<0.1	1	6.3	<0.2	0.14	< 2	44.5	<0.01	22	18	60	SiL
08JD02B @ 47-52'	0	<0.1	<0.10	3.87	0.67	<0.1	2	6.0	0.4	0.21	6	20.7	0.04	4	82	14	LS
08JD02B @ 67-72'	0	0.2	<0.10	2.26	0.66	0.2	<1	7.2	0.3	0.15	< 2	21.5	0.01	4	80	16	LS
08JD02B @ 127-132'	4	<0.1	0.13	26.60	0.34	<0.1	1	6.5	<0.2	0.10	< 2	50.8	0.06	24	20	56	SiL
08JD02B @ 132-137'	6	0.6	0.12	11.80	1.36	0.7	2	6.7	0.2	0.21	< 2	48.2	<0.01	6	37	57	SiL
08JD03B @ 22-27'	8	<0.10	<0.10	15.90	0.77	0.2	3	7.2	<0.2	0.15	4	47.6	0.05	24	28	48	L
08JD03B @ 47-52'	5	0.2	<0.10	9.00	2.16	0.4	1	5.9	0.3	0.31	< 2	35.7	<0.01	10	52	38	L
08JD03B @ 62-67'	4	<0.1	0.26	17.90	1.17	<0.1	1	5.2	1.0	0.36	< 2	25.5	0.01	24	76	<1	SCL
08JD03B @ 142-147'	17	<0.1	<0.10	9.00	1.68	<0.1	1	7.0	0.6	0.16	< 2	36.5	<0.01	8	70	22	SL
08JD03B @ 247-252'	10	0.6	<0.10	5.87	1.01	0.1	1	6.8	0.6	0.23	< 2	32.5	<0.01	10	66	24	SL
08JD03B @ 257-262'	4	0.6	<0.10	4.87	0.75	<0.1	1	6.5	0.4	0.24	21	20.4	<0.01	6	78	16	LS
08JD03B @ 296-298'	5	0.1	0.41	23.70	0.32	<0.1	1	6.5	0.4	0.09	< 2	56.0	<0.01	34	14	52	SiCL
09JD01 @ 151-152.5'	3	0.4	<0.10	10.80	0.39	0.2	1	7.0	0.5	0.09	< 2	41.4	<0.01	14	48	38	L
09JD01 @ 170.5-172'	2	0.4	<0.10	4.44	0.43	0.1	1	7.7	0.6	0.20	< 2	27.2	<0.01	6	74	20	SL
09JD01 @ 210-211.5'	4	1.4	0.27	15.80	0.39	0.8	1	7.1	0.5	0.21	< 2	67.5	<0.01	32	8	60	SiCL
09JD02A @ 113-114.5'	4	<0.1	<0.10	17.90	0.48	<0.1	1	7.0	0.3	0.16	< 2	44.7	<0.01	26	16	58	SiL
09JD02A @ 128.5-130'	3	0.9	<0.10	4.87	0.54	0.1	1	7.6	0.6	0.12	3	31.1	<0.01	6	74	20	SL
09JD02A @ 142.5-144'	2	0.8	<0.10	2.69	0.51	<0.1	1	7.5	0.6	0.15	9	20.1	<0.01	6	80	14	LS
09JD02A @ 179-180.5'	4	0.5	0.31	15.30	0.44	0.4	1	7.5	0.6	0.15	< 2	50.6	0.09	20	20	60	SiL
09JD08 @ 85-86.5'	6	<0.1	0.46	28.70	0.32	<0.1	1	6.7	0.3	0.10	< 2	53.9	<0.01	44	12	44	SiC
09JD03 @ 59-60'	5	<0.1	<0.10	7.05	0.45	<0.1	1	5.6	1.3	0.16	< 2	23.5	<0.01	6	78	16	LS
09JD03 @ 106-107.5'	3	0.6	<0.10	14.50	0.55	0.6	1	7.3	0.5	0.14	< 2	46.2	0.09	20	12	68	SiL
09JD03 @ 127-128'	3	1.1	<0.10	2.86	0.66	0.1	1	7.5	0.5	0.14	13	22.5	<0.01	6	80	14	LS
09JD03 @ 167-168.5'	4	1.9	0.30	15.20	1.25	1.3	1	6.9	0.5	0.42	< 2	55.2	0.12	20	22	58	SiL

Notes: 1. See Table CIII-1, Overburden and Interburden Sample Summary, for lithology and geologic units associated with overburden samples. Borehole locations are shown on Plate CIII-1, Location of Boreholes Used for Overburden and Interburden Sampling.
2. Shaded results indicate overburden interval may be marginal or unsuitable. Refer to Table CIII-5, Guidelines for Evaluation of Overburden and Interburden Suitability. 3. Acid-base potential calculated by subtracting total sulfur content (as T/KT) from the acid neutralization potential 4. Classification based on USDA Soil Textural Triangle (Si=Silt, S=Sand, C=Clay, L=Loam; Example SiL=Silty Loam). 5. n/a = no numeric value given.

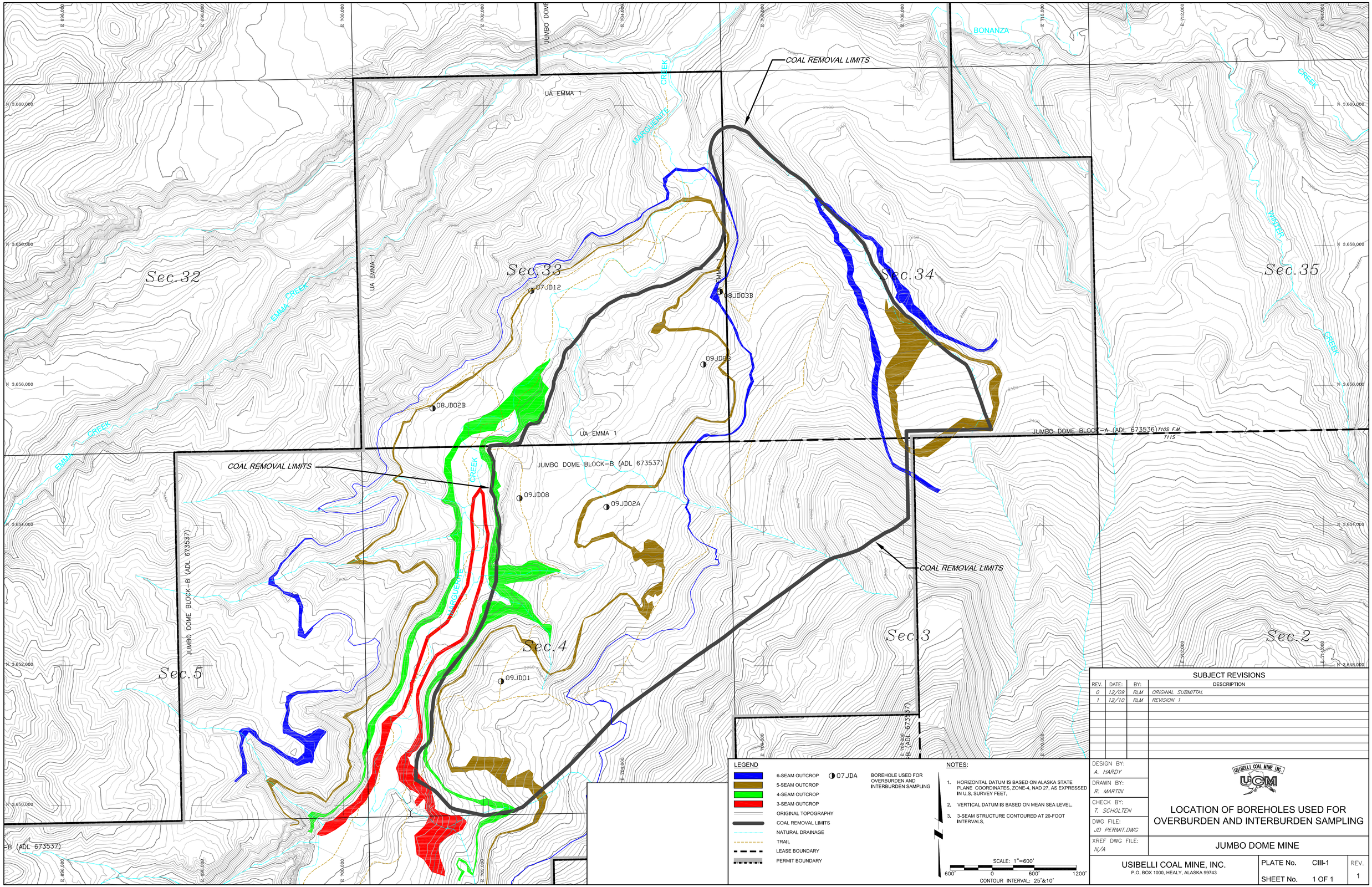
TABLE CIII-5

Guidelines for Evaluating Overburden and Interburden Suitability[1]

Parameter	Units	Criteria			
		Suitable	Marginal	Unsuitable	Unsuitable (Aquifer Restoration)
Acid/Base Potential	T/KT	> -5		< -5	< -5
Arsenic	mg/kg	<2.0	>2.0		Depends on pre-mining water quality and overburden quality
Boron	mg/kg	<5		>5	Depends on pre-mining water quality and overburden quality
Conductivity	mmhos/cm @ 25EC	0 to 8	8 to 12	>12	Depends on pre-mining water quality and overburden quality
Molybdenum	mg/kg	<1.0	>1.0		
Nitrate/Nitrogen	mg/kg as N				>50
pH	s.u.	5.5 - 8.5	5.0 - 5.5 8.5 - 9.0	< 5 > 9	Unsuitable as stated in the below referenced source.
Texture	Classification		c, sic, s		

[1] Source: Wyoming Department of Environmental Quality Land Quality Division, Guideline No. 1, Topsoil and Overburden, November 1984.

PLATE CIII-1
LOCATION OF BOREHOLES USED FOR
OVERBURDEN AND INTERBURDEN SAMPLING



SUBJECT REVISIONS			
REV.	DATE:	BY:	DESCRIPTION
0	12/09	RLM	ORIGINAL SUBMITTAL
1	12/10	RLM	REVISION 1

LEGEND

- 6-SEAM OUTCROP
- 5-SEAM OUTCROP
- 4-SEAM OUTCROP
- 3-SEAM OUTCROP
- ORIGINAL TOPOGRAPHY
- COAL REMOVAL LIMITS
- NATURAL DRAINAGE
- TRAIL
- LEASE BOUNDARY
- PERMIT BOUNDARY

07JDA BOREHOLE USED FOR OVERBURDEN AND INTERBURDEN SAMPLING

NOTES:

1. HORIZONTAL DATUM IS BASED ON ALASKA STATE PLANE COORDINATES, ZONE-4, NAD 27, AS EXPRESSED IN U.S. SURVEY FEET.
2. VERTICAL DATUM IS BASED ON MEAN SEA LEVEL.
3. 3-SEAM STRUCTURE CONTOURED AT 20-FOOT INTERVALS.

SCALE: 1"=600'

600' 0 600' 1200'

CONTOUR INTERVAL: 25'&10'

DESIGN BY: A. HARDY

DRAWN BY: R. MARTIN

CHECK BY: T. SCHOLTEN

DWG FILE: JD PERMIT.DWG

XREF DWG FILE: N/A

USIBELLI COAL MINE INC.

LOCATION OF BOREHOLES USED FOR OVERBURDEN AND INTERBURDEN SAMPLING

JUMBO DOME MINE

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743

PLATE No. CIII-1

SHEET No. 1 OF 1

REV. 1

APPENDIX CIII-1

OVERBURDEN AND INTERBURDEN

LAB ANALYTICAL RESULTS

ENERGY LABORATORIES, INC. * 3161 E Lyndale (59604) * PO Box 5688 * Helena, MT 59601
* 406.442.0711 * FAX 406.442.0712 * helena@energylab.com

LABORATORY ANALYTICAL REPORT

Revised Date: 09/29/09
Report Date: 09/16/09
Collection Date: 08/24/09 16:00
DateReceived: 09/02/09
Matrix: Soil

Client: AJAX Mountain Enterprises dba AJAX Ltd
Project: Jumbo Dome Mine Permit Project
Lab ID: H09090051-001
Client Sample ID: 07JDA@83-108'

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
SATURATED PASTE							
pH, sat. paste	6.6	s.u.		0.1		ASAM10-3.2	09/09/09 08:30 / wj
Conductivity, sat. paste	1.50	mmhos/cm		0.01		ASA10-3	09/10/09 11:47 / wj
Saturation	21.7	%		0.1		USDA27a	09/09/09 08:17 / wj
Potassium, sat. paste	0.53	meq/l		0.03		SW6010B	09/10/09 14:49 / sld
PHYSICAL CHARACTERISTICS							
Coarse Fragments	8	%		2		ASA15-5	09/04/09 11:27 / wj
Sand	76	%		1		ASA15-5	09/09/09 07:59 / sah
Silt	16	%		1		ASA15-5	09/09/09 07:59 / sah
Clay	8	%		1		ASA15-5	09/09/09 07:59 / sah
Texture	SL	unitless				ASA15-5	09/09/09 07:59 / sah
CHEMICAL CHARACTERISTICS							
Cation Exchange Capacity	3.98	meq/100g		0.09		SW6010B	09/09/09 16:51 / sld
Neutralization Potential	3	t/kt				Sobek Modifie	09/08/09 00:00 / wj
Acid Potential	0.11	t/kt	D	0.01		Sobek Modifie	09/10/09 00:00 / ejp
Acid/Base Potential	3	t/kt				Sobek Modifie	09/10/09 00:00 / ejp
Sulfur, Total	ND	%		0.01		Sobek Modifie	09/10/09 11:00 / ejp
Nitrate as N, KCL Extract	2	mg/kg		1		ASA33-8	09/08/09 16:56 / stp
METALS, ABDTPA EXTRACTABLE							
Arsenic	0.6	mg/kg		0.1		SW6010B	09/11/09 09:43 / sld
Molybdenum	0.1	mg/kg		0.1		SW6010B	09/11/09 09:43 / sld
Phosphorus	0.8	mg/kg		0.2		SW6010B	09/10/09 12:17 / sld
METALS, CACL2 EXTRACTABLE							
Boron	ND	mg/kg		0.10		SW6010B	09/08/09 16:52 / sld

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
D - RL increased due to sample matrix interference.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

ENERGY LABORATORIES, INC. * 3161 E Lyndale (59604) * PO Box 5688 * Helena, MT 59601
* 406.442.0711 * FAX 406.442.0712 * helena@energylab.com

LABORATORY ANALYTICAL REPORT

Revised Date: 09/29/09
Report Date: 09/16/09
Collection Date: 08/24/09 17:00
DateReceived: 09/02/09
Matrix: Soil

Client: AJAX Mountain Enterprises dba AJAX Ltd
Project: Jumbo Dome Mine Permit Project
Lab ID: H09090051-002
Client Sample ID: 07JDA @ 108-118'

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
SATURATED PASTE							
pH, sat. paste	5.5	s.u.		0.1		ASAM10-3.2	09/09/09 08:30 / wj
Conductivity, sat. paste	1.80	mmhos/cm		0.01		ASA10-3	09/10/09 11:47 / wj
Saturation	19.4	%		0.1		USDA27a	09/09/09 08:17 / wj
Potassium, sat. paste	0.54	meq/l		0.03		SW6010B	09/10/09 14:51 / sld
PHYSICAL CHARACTERISTICS							
Coarse Fragments	12	%		2		ASA15-5	09/04/09 11:27 / wj
Sand	78	%		1		ASA15-5	09/09/09 07:59 / sah
Silt	16	%		1		ASA15-5	09/09/09 07:59 / sah
Clay	6	%		1		ASA15-5	09/09/09 07:59 / sah
Texture	LS	unitless				ASA15-5	09/09/09 07:59 / sah
CHEMICAL CHARACTERISTICS							
Cation Exchange Capacity	3.56	meq/100g		0.09		SW6010B	09/09/09 16:53 / sld
Neutralization Potential	2	t/kt				Sobek Modifie	09/08/09 00:00 / wj
Acid Potential	0.78	t/kt	D	0.01		Sobek Modifie	09/10/09 00:00 / ejp
Acid/Base Potential	0	t/kt				Sobek Modifie	09/10/09 00:00 / ejp
Sulfur, Total	0.03	%		0.01		Sobek Modifie	09/10/09 11:03 / ejp
Nitrate as N, KCL Extract	1	mg/kg		1		ASA33-8	09/08/09 16:58 / stp
METALS, ABDTPA EXTRACTABLE							
Arsenic	0.5	mg/kg		0.1		SW6010B	09/11/09 09:46 / sld
Molybdenum	ND	mg/kg		0.1		SW6010B	09/11/09 09:46 / sld
Phosphorus	0.7	mg/kg		0.2		SW6010B	09/10/09 12:20 / sld
METALS, CACL2 EXTRACTABLE							
Boron	ND	mg/kg		0.10		SW6010B	09/08/09 16:54 / sld

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
D - RL increased due to sample matrix interference.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

ENERGY LABORATORIES, INC. * 3161 E Lyndale (59604) * PO Box 5688 * Helena, MT 59601
* 406.442.0711 * FAX 406.442.0712 * helena@energylab.com

LABORATORY ANALYTICAL REPORT

Revised Date: 09/29/09
Report Date: 09/16/09
Collection Date: 08/24/09 17:00
DateReceived: 09/02/09
Matrix: Soil

Client: AJAX Mountain Enterprises dba AJAX Ltd
Project: Jumbo Dome Mine Permit Project
Lab ID: H09090051-003
Client Sample ID: 07JD12 @ 134.6-136'

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
SATURATED PASTE							
pH, sat. paste	6.3	s.u.		0.1		ASAM10-3.2	09/09/09 08:31 / wj
Conductivity, sat. paste	0.46	mmhos/cm		0.01		ASA10-3	09/10/09 11:48 / wj
Saturation	44.5	%		0.1		USDA27a	09/09/09 08:17 / wj
Potassium, sat. paste	0.14	meq/l		0.03		SW6010B	09/10/09 14:54 / sld
PHYSICAL CHARACTERISTICS							
Coarse Fragments	ND	%		2		ASA15-5	09/16/09 08:19 / wj
Sand	18	%		1		ASA15-5	09/09/09 07:59 / sah
Silt	60	%		1		ASA15-5	09/09/09 07:59 / sah
Clay	22	%		1		ASA15-5	09/09/09 07:59 / sah
Texture	SiL	unitless				ASA15-5	09/09/09 07:59 / sah
CHEMICAL CHARACTERISTICS							
Cation Exchange Capacity	24.0	meq/100g		0.09		SW6010B	09/09/09 16:56 / sld
Neutralization Potential	5	t/kt				Sobek Modifie	09/08/09 00:00 / wj
Acid Potential	0.01	t/kt	D	0.01		Sobek Modifie	09/10/09 00:00 / ejp
Acid/Base Potential	5	t/kt				Sobek Modifie	09/10/09 00:00 / ejp
Sulfur, Total	ND	%		0.01		Sobek Modifie	09/10/09 11:05 / ejp
Nitrate as N, KCL Extract	1	mg/kg		1		ASA33-8	09/08/09 17:00 / stp
METALS, ABDTPA EXTRACTABLE							
Arsenic	ND	mg/kg		0.1		SW6010B	09/11/09 09:48 / sld
Molybdenum	ND	mg/kg		0.1		SW6010B	09/11/09 09:48 / sld
Phosphorus	ND	mg/kg		0.2		SW6010B	09/10/09 12:22 / sld
METALS, CACL2 EXTRACTABLE							
Boron	0.16	mg/kg		0.10		SW6010B	09/08/09 16:57 / sld

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
D - RL increased due to sample matrix interference.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

ENERGY LABORATORIES, INC. * 3161 E Lyndale (59604) * PO Box 5688 * Helena, MT 59601
* 406.442.0711 * FAX 406.442.0712 * helena@energylab.com

LABORATORY ANALYTICAL REPORT

Revised Date: 09/29/09
Report Date: 09/16/09
Collection Date: 08/24/09 17:00
DateReceived: 09/02/09
Matrix: Soil

Client: AJAX Mountain Enterprises dba AJAX Ltd
Project: Jumbo Dome Mine Permit Project
Lab ID: H09090051-004
Client Sample ID: 08JD02B @ 47-52'

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
SATURATED PASTE							
pH, sat. paste	6.0	s.u.		0.1		ASAM10-3.2	09/09/09 08:32 / wj
Conductivity, sat. paste	0.67	mmhos/cm		0.01		ASA10-3	09/10/09 11:48 / wj
Saturation	20.7	%		0.1		USDA27a	09/09/09 08:17 / wj
Potassium, sat. paste	0.21	meq/l		0.03		SW6010B	09/10/09 14:56 / sld
PHYSICAL CHARACTERISTICS							
Coarse Fragments	6	%		2		ASA15-5	09/04/09 11:27 / wj
Sand	82	%		1		ASA15-5	09/09/09 07:59 / sah
Silt	14	%		1		ASA15-5	09/09/09 07:59 / sah
Clay	4	%		1		ASA15-5	09/09/09 07:59 / sah
Texture	LS	unitless				ASA15-5	09/09/09 07:59 / sah
CHEMICAL CHARACTERISTICS							
Cation Exchange Capacity	3.87	meq/100g		0.09		SW6010B	09/09/09 16:58 / sld
Neutralization Potential	1	t/kt				Sobek Modifie	09/08/09 00:00 / wj
Acid Potential	1.1	t/kt	D	0.01		Sobek Modifie	09/10/09 00:00 / ejp
Acid/Base Potential	0	t/kt				Sobek Modifie	09/10/09 00:00 / ejp
Sulfur, Total	0.04	%		0.01		Sobek Modifie	09/10/09 11:07 / ejp
Nitrate as N, KCL Extract	2	mg/kg		1		ASA33-8	09/08/09 17:02 / stp
METALS, ABDTPA EXTRACTABLE							
Arsenic	ND	mg/kg		0.1		SW6010B	09/11/09 09:51 / sld
Molybdenum	ND	mg/kg		0.1		SW6010B	09/11/09 09:51 / sld
Phosphorus	0.4	mg/kg		0.2		SW6010B	09/10/09 12:25 / sld
METALS, CACL2 EXTRACTABLE							
Boron	ND	mg/kg		0.10		SW6010B	09/08/09 16:59 / sld

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
D - RL increased due to sample matrix interference.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

ENERGY LABORATORIES, INC. * 3161 E Lyndale (59604) * PO Box 5688 * Helena, MT 59601
* 406.442.0711 * FAX 406.442.0712 * helena@energylab.com

LABORATORY ANALYTICAL REPORT

Revised Date: 09/29/09
Report Date: 09/16/09
Collection Date: 08/24/09 17:00
DateReceived: 09/02/09
Matrix: Soil

Client: AJAX Mountain Enterprises dba AJAX Ltd
Project: Jumbo Dome Mine Permit Project
Lab ID: H09090051-005
Client Sample ID: 08JD02B @ 67-72'

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
SATURATED PASTE							
pH, sat. paste	7.2	s.u.		0.1		ASAM10-3.2	09/09/09 08:33 / wj
Conductivity, sat. paste	0.66	mmhos/cm		0.01		ASA10-3	09/10/09 11:49 / wj
Saturation	21.5	%		0.1		USDA27a	09/09/09 08:17 / wj
Potassium, sat. paste	0.15	meq/l		0.03		SW6010B	09/10/09 14:59 / sld
PHYSICAL CHARACTERISTICS							
Coarse Fragments	ND	%		2		ASA15-5	09/04/09 11:27 / wj
Sand	80	%		1		ASA15-5	09/09/09 07:59 / sah
Silt	16	%		1		ASA15-5	09/09/09 07:59 / sah
Clay	4	%		1		ASA15-5	09/09/09 07:59 / sah
Texture	LS	unitless				ASA15-5	09/09/09 07:59 / sah
CHEMICAL CHARACTERISTICS							
Cation Exchange Capacity	2.26	meq/100g		0.09		SW6010B	09/09/09 17:01 / sld
Neutralization Potential	1	t/kt				Sobek Modifie	09/08/09 00:00 / wj
Acid Potential	0.40	t/kt	D	0.01		Sobek Modifie	09/10/09 00:00 / ejp
Acid/Base Potential	0	t/kt				Sobek Modifie	09/10/09 00:00 / ejp
Sulfur, Total	0.01	%		0.01		Sobek Modifie	09/10/09 11:09 / ejp
Nitrate as N, KCL Extract	ND	mg/kg		1		ASA33-8	09/08/09 17:04 / stp
METALS, ABDTPA EXTRACTABLE							
Arsenic	0.2	mg/kg		0.1		SW6010B	09/11/09 09:54 / sld
Molybdenum	0.2	mg/kg		0.1		SW6010B	09/11/09 09:54 / sld
Phosphorus	0.3	mg/kg		0.2		SW6010B	09/10/09 12:27 / sld
METALS, CACL2 EXTRACTABLE							
Boron	ND	mg/kg		0.10		SW6010B	09/08/09 17:02 / sld

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
D - RL increased due to sample matrix interference.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

ENERGY LABORATORIES, INC. * 3161 E Lyndale (59604) * PO Box 5688 * Helena, MT 59601
* 406.442.0711 * FAX 406.442.0712 * helena@energylab.com

LABORATORY ANALYTICAL REPORT

Revised Date: 09/29/09
Report Date: 09/16/09
Collection Date: 08/24/09 17:00
DateReceived: 09/02/09
Matrix: Soil

Client: AJAX Mountain Enterprises dba AJAX Ltd
Project: Jumbo Dome Mine Permit Project
Lab ID: H09090051-006
Client Sample ID: 08JD02B @ 127-132'

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
SATURATED PASTE							
pH, sat. paste	6.5	s.u.		0.1		ASAM10-3.2	09/09/09 08:33 / wj
Conductivity, sat. paste	0.34	mmhos/cm		0.01		ASA10-3	09/10/09 11:49 / wj
Saturation	50.8	%		0.1		USDA27a	09/09/09 08:18 / wj
Potassium, sat. paste	0.10	meq/l		0.03		SW6010B	09/10/09 15:07 / sld
PHYSICAL CHARACTERISTICS							
Coarse Fragments	ND	%		2		ASA15-5	09/16/09 08:19 / wj
Sand	20	%		1		ASA15-5	09/09/09 07:59 / sah
Silt	56	%		1		ASA15-5	09/09/09 07:59 / sah
Clay	24	%		1		ASA15-5	09/09/09 07:59 / sah
Texture	SiL	unitless				ASA15-5	09/09/09 07:59 / sah
CHEMICAL CHARACTERISTICS							
Cation Exchange Capacity	26.6	meq/100g		0.09		SW6010B	09/09/09 17:04 / sld
Neutralization Potential	4	t/kt				Sobek Modifie	09/08/09 00:00 / wj
Acid Potential	ND	t/kt	D	0.01		Sobek Modifie	09/10/09 00:00 / ejp
Acid/Base Potential	4	t/kt				Sobek Modifie	09/10/09 00:00 / ejp
Sulfur, Total	ND	%		0.01		Sobek Modifie	09/10/09 11:12 / ejp
Nitrate as N, KCL Extract	1	mg/kg		1		ASA33-8	09/08/09 17:10 / stp
METALS, ABDTPA EXTRACTABLE							
Arsenic	ND	mg/kg		0.1		SW6010B	09/11/09 09:56 / sld
Molybdenum	ND	mg/kg		0.1		SW6010B	09/11/09 09:56 / sld
Phosphorus	ND	mg/kg		0.2		SW6010B	09/10/09 12:30 / sld
METALS, CACL2 EXTRACTABLE							
Boron	0.13	mg/kg		0.10		SW6010B	09/08/09 17:05 / sld

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
D - RL increased due to sample matrix interference.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

ENERGY LABORATORIES, INC. * 3161 E Lyndale (59604) * PO Box 5688 * Helena, MT 59601
* 406.442.0711 * FAX 406.442.0712 * helena@energylab.com

LABORATORY ANALYTICAL REPORT

Revised Date: 09/29/09
Report Date: 09/16/09
Collection Date: 08/24/09 17:00
DateReceived: 09/02/09
Matrix: Soil

Client: AJAX Mountain Enterprises dba AJAX Ltd
Project: Jumbo Dome Mine Permit Project
Lab ID: H09090051-007
Client Sample ID: 08JD02B @ 132-137'

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
SATURATED PASTE							
pH, sat. paste	6.7	s.u.		0.1		ASAM10-3.2	09/09/09 08:34 / wj
Conductivity, sat. paste	1.36	mmhos/cm		0.01		ASA10-3	09/10/09 11:50 / wj
Saturation	48.2	%		0.1		USDA27a	09/09/09 08:18 / wj
Potassium, sat. paste	0.21	meq/l		0.03		SW6010B	09/10/09 15:15 / sld
PHYSICAL CHARACTERISTICS							
Coarse Fragments	ND	%		2		ASA15-5	09/16/09 08:19 / wj
Sand	37	%		1		ASA15-5	09/09/09 07:59 / sah
Silt	57	%		1		ASA15-5	09/09/09 07:59 / sah
Clay	6	%		1		ASA15-5	09/09/09 07:59 / sah
Texture	SiL	unitless				ASA15-5	09/09/09 07:59 / sah
CHEMICAL CHARACTERISTICS							
Cation Exchange Capacity	11.8	meq/100g		0.09		SW6010B	09/09/09 17:11 / sld
Neutralization Potential	7	t/kt				Sobek Modifie	09/08/09 00:00 / wj
Acid Potential	1.8	t/kt	D	0.01		Sobek Modifie	09/10/09 00:00 / ejp
Acid/Base Potential	6	t/kt				Sobek Modifie	09/10/09 00:00 / ejp
Sulfur, Total	0.06	%		0.01		Sobek Modifie	09/10/09 11:14 / ejp
Nitrate as N, KCL Extract	2	mg/kg		1		ASA33-8	09/08/09 17:12 / stp
METALS, ABDTPA EXTRACTABLE							
Arsenic	0.6	mg/kg		0.1		SW6010B	09/11/09 10:09 / sld
Molybdenum	0.7	mg/kg		0.1		SW6010B	09/11/09 10:09 / sld
Phosphorus	0.2	mg/kg		0.2		SW6010B	09/10/09 12:43 / sld
METALS, CACL2 EXTRACTABLE							
Boron	0.12	mg/kg		0.10		SW6010B	09/08/09 17:17 / sld

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
D - RL increased due to sample matrix interference.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

ENERGY LABORATORIES, INC. * 3161 E Lyndale (59604) * PO Box 5688 * Helena, MT 59601
* 406.442.0711 * FAX 406.442.0712 * helena@energylab.com

LABORATORY ANALYTICAL REPORT

Revised Date: 09/29/09
Report Date: 09/16/09
Collection Date: 08/24/09 17:00
DateReceived: 09/02/09
Matrix: Soil

Client: AJAX Mountain Enterprises dba AJAX Ltd
Project: Jumbo Dome Mine Permit Project
Lab ID: H09090051-008
Client Sample ID: 08JD03B @ 22-27'

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
SATURATED PASTE							
pH, sat. paste	7.2	s.u.		0.1		ASAM10-3.2	09/09/09 08:34 / wj
Conductivity, sat. paste	0.77	mmhos/cm		0.01		ASA10-3	09/10/09 11:50 / wj
Saturation	47.6	%		0.1		USDA27a	09/09/09 08:18 / wj
Potassium, sat. paste	0.15	meq/l		0.03		SW6010B	09/10/09 15:17 / sld
PHYSICAL CHARACTERISTICS							
Coarse Fragments	4	%		2		ASA15-5	09/04/09 11:27 / wj
Sand	28	%		1		ASA15-5	09/09/09 07:59 / sah
Silt	48	%		1		ASA15-5	09/09/09 07:59 / sah
Clay	24	%		1		ASA15-5	09/09/09 07:59 / sah
Texture	L	unitless				ASA15-5	09/09/09 07:59 / sah
CHEMICAL CHARACTERISTICS							
Cation Exchange Capacity	15.9	meq/100g		0.09		SW6010B	09/09/09 17:19 / sld
Neutralization Potential	8	t/kt				Sobek Modifie	09/08/09 00:00 / wj
Acid Potential	ND	t/kt	D	0.01		Sobek Modifie	09/10/09 00:00 / ejp
Acid/Base Potential	8	t/kt				Sobek Modifie	09/10/09 00:00 / ejp
Sulfur, Total	ND	%		0.01		Sobek Modifie	09/10/09 11:17 / ejp
Nitrate as N, KCL Extract	3	mg/kg		1		ASA33-8	09/08/09 17:14 / stp
METALS, ABDTPA EXTRACTABLE							
Arsenic	ND	mg/kg		0.1		SW6010B	09/11/09 10:12 / sld
Molybdenum	0.2	mg/kg		0.1		SW6010B	09/11/09 10:12 / sld
Phosphorus	ND	mg/kg		0.2		SW6010B	09/10/09 12:45 / sld
METALS, CACL2 EXTRACTABLE							
Boron	ND	mg/kg		0.10		SW6010B	09/08/09 17:20 / sld

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
D - RL increased due to sample matrix interference.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

ENERGY LABORATORIES, INC. * 3161 E Lyndale (59604) * PO Box 5688 * Helena, MT 59601
* 406.442.0711 * FAX 406.442.0712 * helena@energylab.com

LABORATORY ANALYTICAL REPORT

Revised Date: 09/29/09
Report Date: 09/16/09
Collection Date: 08/24/09 17:00
DateReceived: 09/02/09
Matrix: Soil

Client: AJAX Mountain Enterprises dba AJAX Ltd
Project: Jumbo Dome Mine Permit Project
Lab ID: H09090051-009
Client Sample ID: 08JD03B @ 47-52'

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
SATURATED PASTE							
pH, sat. paste	5.9	s.u.		0.1		ASAM10-3.2	09/09/09 08:35 / wj
Conductivity, sat. paste	2.16	mmhos/cm		0.01		ASA10-3	09/10/09 11:51 / wj
Saturation	35.7	%		0.1		USDA27a	09/09/09 08:18 / wj
Potassium, sat. paste	0.31	meq/l		0.03		SW6010B	09/10/09 15:20 / sld
PHYSICAL CHARACTERISTICS							
Coarse Fragments	ND	%		2		ASA15-5	09/04/09 11:27 / wj
Sand	52	%		1		ASA15-5	09/09/09 07:59 / sah
Silt	38	%		1		ASA15-5	09/09/09 07:59 / sah
Clay	10	%		1		ASA15-5	09/09/09 07:59 / sah
Texture	L	unitless				ASA15-5	09/09/09 07:59 / sah
CHEMICAL CHARACTERISTICS							
Cation Exchange Capacity	9.00	meq/100g		0.09		SW6010B	09/09/09 17:22 / sld
Neutralization Potential	6	t/kt				Sobek Modifie	09/08/09 00:00 / wj
Acid Potential	1.6	t/kt	D	0.01		Sobek Modifie	09/10/09 00:00 / ejp
Acid/Base Potential	5	t/kt				Sobek Modifie	09/10/09 00:00 / ejp
Sulfur, Total	0.05	%		0.01		Sobek Modifie	09/10/09 11:19 / ejp
Nitrate as N, KCL Extract	1	mg/kg		1		ASA33-8	09/08/09 17:16 / stp
METALS, ABDTPA EXTRACTABLE							
Arsenic	0.2	mg/kg		0.1		SW6010B	09/11/09 10:14 / sld
Molybdenum	0.4	mg/kg		0.1		SW6010B	09/11/09 10:14 / sld
Phosphorus	0.3	mg/kg		0.2		SW6010B	09/10/09 12:48 / sld
METALS, CACL2 EXTRACTABLE							
Boron	ND	mg/kg		0.10		SW6010B	09/08/09 17:23 / sld

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
D - RL increased due to sample matrix interference.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

ENERGY LABORATORIES, INC. * 3161 E Lyndale (59604) * PO Box 5688 * Helena, MT 59601
* 406.442.0711 * FAX 406.442.0712 * helena@energylab.com

LABORATORY ANALYTICAL REPORT

Revised Date: 09/29/09
Report Date: 09/16/09
Collection Date: 08/24/09 17:00
DateReceived: 09/02/09
Matrix: Soil

Client: AJAX Mountain Enterprises dba AJAX Ltd
Project: Jumbo Dome Mine Permit Project
Lab ID: H09090051-010
Client Sample ID: 08JD03B @ 62-67'

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
SATURATED PASTE							
pH, sat. paste	5.2	s.u.		0.1		ASAM10-3.2	09/09/09 08:36 / wj
Conductivity, sat. paste	1.17	mmhos/cm		0.01		ASA10-3	09/10/09 11:51 / wj
Saturation	25.5	%		0.1		USDA27a	09/09/09 08:18 / wj
Potassium, sat. paste	0.36	meq/l		0.03		SW6010B	09/10/09 15:22 / sld
PHYSICAL CHARACTERISTICS							
Coarse Fragments	ND	%		2		ASA15-5	09/16/09 08:19 / wj
Sand	76	%		1		ASA15-5	09/09/09 07:59 / sah
Silt	ND	%		1		ASA15-5	09/09/09 07:59 / sah
Clay	24	%		1		ASA15-5	09/09/09 07:59 / sah
Texture	SCL	unitless				ASA15-5	09/09/09 07:59 / sah
CHEMICAL CHARACTERISTICS							
Cation Exchange Capacity	17.9	meq/100g		0.09		SW6010B	09/09/09 17:24 / sld
Neutralization Potential	5	t/kt				Sobek Modifie	09/08/09 00:00 / wj
Acid Potential	0.24	t/kt	D	0.01		Sobek Modifie	09/10/09 00:00 / ejp
Acid/Base Potential	4	t/kt				Sobek Modifie	09/10/09 00:00 / ejp
Sulfur, Total	ND	%		0.01		Sobek Modifie	09/10/09 12:28 / ejp
Nitrate as N, KCL Extract	1	mg/kg		1		ASA33-8	09/08/09 17:22 / stp
METALS, ABDTPA EXTRACTABLE							
Arsenic	ND	mg/kg		0.1		SW6010B	09/11/09 10:17 / sld
Molybdenum	ND	mg/kg		0.1		SW6010B	09/11/09 10:17 / sld
Phosphorus	1.0	mg/kg		0.2		SW6010B	09/10/09 12:51 / sld
METALS, CACL2 EXTRACTABLE							
Boron	0.26	mg/kg		0.10		SW6010B	09/08/09 17:25 / sld

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
D - RL increased due to sample matrix interference.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

ENERGY LABORATORIES, INC. * 3161 E Lyndale (59604) * PO Box 5688 * Helena, MT 59601
* 406.442.0711 * FAX 406.442.0712 * helena@energylab.com

LABORATORY ANALYTICAL REPORT

Revised Date: 09/29/09
Report Date: 09/16/09
Collection Date: 08/24/09 16:00
DateReceived: 09/02/09
Matrix: Soil

Client: AJAX Mountain Enterprises dba AJAX Ltd
Project: Jumbo Dome Mine Permit Project
Lab ID: H09090051-011
Client Sample ID: 08JD03B @ 142-147'

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
SATURATED PASTE							
pH, sat. paste	7.0	s.u.		0.1		ASAM10-3.2	09/09/09 08:37 / wj
Conductivity, sat. paste	1.68	mmhos/cm		0.01		ASA10-3	09/10/09 11:52 / wj
Saturation	36.5	%		0.1		USDA27a	09/09/09 08:18 / wj
Potassium, sat. paste	0.16	meq/l		0.03		SW6010B	09/10/09 15:27 / sld
PHYSICAL CHARACTERISTICS							
Coarse Fragments	ND	%		2		ASA15-5	09/04/09 11:27 / wj
Sand	70	%		1		ASA15-5	09/09/09 07:59 / sah
Silt	22	%		1		ASA15-5	09/09/09 07:59 / sah
Clay	8	%		1		ASA15-5	09/09/09 07:59 / sah
Texture	SL	unitless				ASA15-5	09/09/09 07:59 / sah
CHEMICAL CHARACTERISTICS							
Cation Exchange Capacity	9.00	meq/100g		0.09		SW6010B	09/09/09 17:29 / sld
Neutralization Potential	17	t/kt				Sobek Modifie	09/08/09 00:00 / wj
Acid Potential	0.36	t/kt	D	0.01		Sobek Modifie	09/10/09 00:00 / ejp
Acid/Base Potential	17	t/kt				Sobek Modifie	09/10/09 00:00 / ejp
Sulfur, Total	0.01	%		0.01		Sobek Modifie	09/10/09 11:33 / ejp
Nitrate as N, KCL Extract	1	mg/kg		1		ASA33-8	09/08/09 17:26 / stp
METALS, ABDTPA EXTRACTABLE							
Arsenic	ND	mg/kg		0.1		SW6010B	09/11/09 10:22 / sld
Molybdenum	ND	mg/kg		0.1		SW6010B	09/11/09 10:22 / sld
Phosphorus	0.6	mg/kg		0.2		SW6010B	09/10/09 12:56 / sld
METALS, CACL2 EXTRACTABLE							
Boron	ND	mg/kg		0.10		SW6010B	09/08/09 17:30 / sld

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
D - RL increased due to sample matrix interference.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

ENERGY LABORATORIES, INC. * 3161 E Lyndale (59604) * PO Box 5688 * Helena, MT 59601
* 406.442.0711 * FAX 406.442.0712 * helena@energylab.com

LABORATORY ANALYTICAL REPORT

Revised Date: 09/29/09
Report Date: 09/16/09
Collection Date: 08/24/09 16:00
DateReceived: 09/02/09
Matrix: Soil

Client: AJAX Mountain Enterprises dba AJAX Ltd
Project: Jumbo Dome Mine Permit Project
Lab ID: H09090051-012
Client Sample ID: 08JD03B @ 247-252'

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
SATURATED PASTE							
pH, sat. paste	6.8	s.u.		0.1		ASAM10-3.2	09/09/09 08:37 / wj
Conductivity, sat. paste	1.01	mmhos/cm		0.01		ASA10-3	09/10/09 11:52 / wj
Saturation	32.5	%		0.1		USDA27a	09/09/09 08:19 / wj
Potassium, sat. paste	0.23	meq/l		0.03		SW6010B	09/10/09 15:30 / sld
PHYSICAL CHARACTERISTICS							
Coarse Fragments	ND	%		2		ASA15-5	09/04/09 11:27 / wj
Sand	66	%		1		ASA15-5	09/09/09 07:59 / sah
Silt	24	%		1		ASA15-5	09/09/09 07:59 / sah
Clay	10	%		1		ASA15-5	09/09/09 07:59 / sah
Texture	SL	unitless				ASA15-5	09/09/09 07:59 / sah
CHEMICAL CHARACTERISTICS							
Cation Exchange Capacity	5.87	meq/100g		0.09		SW6010B	09/09/09 17:32 / sld
Neutralization Potential	10	t/kt				Sobek Modifie	09/08/09 00:00 / wj
Acid Potential	ND	t/kt	D	0.01		Sobek Modifie	09/10/09 00:00 / ejp
Acid/Base Potential	10	t/kt				Sobek Modifie	09/10/09 00:00 / ejp
Sulfur, Total	ND	%		0.01		Sobek Modifie	09/10/09 11:35 / ejp
Nitrate as N, KCL Extract	1	mg/kg		1		ASA33-8	09/08/09 17:32 / stp
METALS, ABDTPA EXTRACTABLE							
Arsenic	0.6	mg/kg		0.1		SW6010B	09/11/09 10:25 / sld
Molybdenum	0.1	mg/kg		0.1		SW6010B	09/11/09 10:25 / sld
Phosphorus	0.6	mg/kg		0.2		SW6010B	09/10/09 12:58 / sld
METALS, CACL2 EXTRACTABLE							
Boron	ND	mg/kg		0.10		SW6010B	09/08/09 17:33 / sld

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
D - RL increased due to sample matrix interference.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

ENERGY LABORATORIES, INC. * 3161 E Lyndale (59604) * PO Box 5688 * Helena, MT 59601
* 406.442.0711 * FAX 406.442.0712 * helena@energylab.com

LABORATORY ANALYTICAL REPORT

Revised Date: 09/29/09
Report Date: 09/16/09
Collection Date: 08/24/09 16:00
DateReceived: 09/02/09
Matrix: Soil

Client: AJAX Mountain Enterprises dba AJAX Ltd
Project: Jumbo Dome Mine Permit Project
Lab ID: H09090051-013
Client Sample ID: 08JD03B @ 257-262'

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
SATURATED PASTE							
pH, sat. paste	6.5	s.u.		0.1		ASAM10-3.2	09/09/09 08:38 / wj
Conductivity, sat. paste	0.75	mmhos/cm		0.01		ASA10-3	09/10/09 11:53 / wj
Saturation	20.4	%		0.1		USDA27a	09/09/09 08:19 / wj
Potassium, sat. paste	0.24	meq/l		0.03		SW6010B	09/10/09 15:33 / sld
PHYSICAL CHARACTERISTICS							
Coarse Fragments	21	%		2		ASA15-5	09/04/09 11:27 / wj
Sand	78	%		1		ASA15-5	09/09/09 07:59 / sah
Silt	16	%		1		ASA15-5	09/09/09 07:59 / sah
Clay	6	%		1		ASA15-5	09/09/09 07:59 / sah
Texture	LS	unitless				ASA15-5	09/09/09 07:59 / sah
CHEMICAL CHARACTERISTICS							
Cation Exchange Capacity	4.87	meq/100g		0.09		SW6010B	09/09/09 17:35 / sld
Neutralization Potential	4	t/kt				Sobek Modifie	09/08/09 00:00 / wj
Acid Potential	0.23	t/kt	D	0.01		Sobek Modifie	09/10/09 00:00 / ejp
Acid/Base Potential	4	t/kt				Sobek Modifie	09/10/09 00:00 / ejp
Sulfur, Total	ND	%		0.01		Sobek Modifie	09/10/09 11:37 / ejp
Nitrate as N, KCL Extract	1	mg/kg		1		ASA33-8	09/08/09 17:34 / stp
METALS, ABDTPA EXTRACTABLE							
Arsenic	0.6	mg/kg		0.1		SW6010B	09/11/09 10:27 / sld
Molybdenum	ND	mg/kg		0.1		SW6010B	09/11/09 10:27 / sld
Phosphorus	0.4	mg/kg		0.2		SW6010B	09/10/09 13:01 / sld
METALS, CACL2 EXTRACTABLE							
Boron	ND	mg/kg		0.10		SW6010B	09/08/09 17:36 / sld

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
D - RL increased due to sample matrix interference.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

ENERGY LABORATORIES, INC. * 3161 E Lyndale (59604) * PO Box 5688 * Helena, MT 59601
* 406.442.0711 * FAX 406.442.0712 * helena@energylab.com

LABORATORY ANALYTICAL REPORT

Revised Date: 09/29/09
Report Date: 09/16/09
Collection Date: 08/24/09 16:00
DateReceived: 09/02/09
Matrix: Soil

Client: AJAX Mountain Enterprises dba AJAX Ltd
Project: Jumbo Dome Mine Permit Project
Lab ID: H09090051-014
Client Sample ID: 08JD03B @ 296-298'

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
SATURATED PASTE							
pH, sat. paste	6.5	s.u.		0.1		ASAM10-3.2	09/09/09 08:38 / wj
Conductivity, sat. paste	0.32	mmhos/cm		0.01		ASA10-3	09/10/09 11:53 / wj
Saturation	56.0	%		0.1		USDA27a	09/09/09 08:19 / wj
Potassium, sat. paste	0.09	meq/l		0.03		SW6010B	09/10/09 15:35 / sld
PHYSICAL CHARACTERISTICS							
Coarse Fragments	ND	%		2		ASA15-5	09/16/09 08:19 / wj
Sand	14	%		1		ASA15-5	09/09/09 07:59 / sah
Silt	52	%		1		ASA15-5	09/09/09 07:59 / sah
Clay	34	%		1		ASA15-5	09/09/09 07:59 / sah
Texture	SiCL	unitless				ASA15-5	09/09/09 07:59 / sah
CHEMICAL CHARACTERISTICS							
Cation Exchange Capacity	23.7	meq/100g		0.09		SW6010B	09/09/09 17:37 / sld
Neutralization Potential	5	t/kt				Sobek Modifie	09/08/09 00:00 / wj
Acid Potential	ND	t/kt	D	0.01		Sobek Modifie	09/10/09 00:00 / ejp
Acid/Base Potential	5	t/kt				Sobek Modifie	09/10/09 00:00 / ejp
Sulfur, Total	ND	%		0.01		Sobek Modifie	09/10/09 11:40 / ejp
Nitrate as N, KCL Extract	1	mg/kg		1		ASA33-8	09/08/09 17:36 / stp
METALS, ABDTPA EXTRACTABLE							
Arsenic	0.1	mg/kg		0.1		SW6010B	09/11/09 10:30 / sld
Molybdenum	ND	mg/kg		0.1		SW6010B	09/11/09 10:30 / sld
Phosphorus	0.4	mg/kg		0.2		SW6010B	09/10/09 13:04 / sld
METALS, CACL2 EXTRACTABLE							
Boron	0.41	mg/kg		0.10		SW6010B	09/08/09 17:38 / sld

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
D - RL increased due to sample matrix interference.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

ENERGY LABORATORIES, INC. * 3161 E Lyndale (59604) * PO Box 5688 * Helena, MT 59601
* 406.442.0711 * FAX 406.442.0712 * helena@energylab.com

LABORATORY ANALYTICAL REPORT

Revised Date: 09/29/09
Report Date: 09/16/09
Collection Date: 08/24/09 16:00
DateReceived: 09/02/09
Matrix: Soil

Client: AJAX Mountain Enterprises dba AJAX Ltd
Project: Jumbo Dome Mine Permit Project
Lab ID: H09090051-015
Client Sample ID: 09JD01 @ 151-152.5'

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
SATURATED PASTE							
pH, sat. paste	7.0	s.u.		0.1		ASAM10-3.2	09/09/09 08:39 / wj
Conductivity, sat. paste	0.39	mmhos/cm		0.01		ASA10-3	09/10/09 11:54 / wj
Saturation	41.4	%		0.1		USDA27a	09/09/09 08:19 / wj
Potassium, sat. paste	0.09	meq/l		0.03		SW6010B	09/10/09 15:38 / sld
PHYSICAL CHARACTERISTICS							
Coarse Fragments	ND	%		2		ASA15-5	09/16/09 08:19 / wj
Sand	48	%		1		ASA15-5	09/09/09 07:59 / sah
Silt	38	%		1		ASA15-5	09/09/09 07:59 / sah
Clay	14	%		1		ASA15-5	09/09/09 07:59 / sah
Texture	L	unitless				ASA15-5	09/09/09 07:59 / sah
CHEMICAL CHARACTERISTICS							
Cation Exchange Capacity	10.8	meq/100g		0.09		SW6010B	09/09/09 17:40 / sld
Neutralization Potential	3	t/kt				Sobek Modifie	09/08/09 00:00 / wj
Acid Potential	ND	t/kt	D	0.01		Sobek Modifie	09/10/09 00:00 / ejp
Acid/Base Potential	3	t/kt				Sobek Modifie	09/10/09 00:00 / ejp
Sulfur, Total	ND	%		0.01		Sobek Modifie	09/10/09 11:42 / ejp
Nitrate as N, KCL Extract	1	mg/kg		1		ASA33-8	09/08/09 17:38 / stp
METALS, ABDTPA EXTRACTABLE							
Arsenic	0.4	mg/kg		0.1		SW6010B	09/11/09 10:37 / sld
Molybdenum	0.2	mg/kg		0.1		SW6010B	09/11/09 10:37 / sld
Phosphorus	0.5	mg/kg		0.2		SW6010B	09/10/09 13:11 / sld
METALS, CACL2 EXTRACTABLE							
Boron	ND	mg/kg		0.10		SW6010B	09/08/09 17:46 / sld

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
D - RL increased due to sample matrix interference.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

ENERGY LABORATORIES, INC. * 3161 E Lyndale (59604) * PO Box 5688 * Helena, MT 59601
* 406.442.0711 * FAX 406.442.0712 * helena@energylab.com

LABORATORY ANALYTICAL REPORT

Revised Date: 09/29/09
Report Date: 09/16/09
Collection Date: 08/24/09 16:00
DateReceived: 09/02/09
Matrix: Soil

Client: AJAX Mountain Enterprises dba AJAX Ltd
Project: Jumbo Dome Mine Permit Project
Lab ID: H09090051-016
Client Sample ID: 09JD01 @ 170.5-172'

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
SATURATED PASTE							
pH, sat. paste	7.7	s.u.		0.1		ASAM10-3.2	09/09/09 08:39 / wj
Conductivity, sat. paste	0.43	mmhos/cm		0.01		ASA10-3	09/10/09 11:54 / wj
Saturation	27.2	%		0.1		USDA27a	09/09/09 08:19 / wj
Potassium, sat. paste	0.20	meq/l		0.03		SW6010B	09/10/09 15:46 / sld
PHYSICAL CHARACTERISTICS							
Coarse Fragments	ND	%		2		ASA15-5	09/04/09 11:27 / wj
Sand	74	%		1		ASA15-5	09/09/09 07:59 / sah
Silt	20	%		1		ASA15-5	09/09/09 07:59 / sah
Clay	6	%		1		ASA15-5	09/09/09 07:59 / sah
Texture	SL	unitless				ASA15-5	09/09/09 07:59 / sah
CHEMICAL CHARACTERISTICS							
Cation Exchange Capacity	4.44	meq/100g		0.09		SW6010B	09/09/09 17:42 / sld
Neutralization Potential	2	t/kt				Sobek Modifie	09/08/09 00:00 / wj
Acid Potential	0.14	t/kt	D	0.01		Sobek Modifie	09/10/09 00:00 / ejp
Acid/Base Potential	2	t/kt				Sobek Modifie	09/10/09 00:00 / ejp
Sulfur, Total	ND	%		0.01		Sobek Modifie	09/10/09 11:44 / ejp
Nitrate as N, KCL Extract	1	mg/kg		1		ASA33-8	09/08/09 17:40 / stp
METALS, ABDTPA EXTRACTABLE							
Arsenic	0.4	mg/kg		0.1		SW6010B	09/11/09 10:40 / sld
Molybdenum	0.1	mg/kg		0.1		SW6010B	09/11/09 10:40 / sld
Phosphorus	0.6	mg/kg		0.2		SW6010B	09/10/09 13:14 / sld
METALS, CACL2 EXTRACTABLE							
Boron	ND	mg/kg		0.10		SW6010B	09/08/09 17:49 / sld

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
D - RL increased due to sample matrix interference.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

ENERGY LABORATORIES, INC. * 3161 E Lyndale (59604) * PO Box 5688 * Helena, MT 59601
* 406.442.0711 * FAX 406.442.0712 * helena@energylab.com

LABORATORY ANALYTICAL REPORT

Revised Date: 09/29/09
Report Date: 09/16/09
Collection Date: 08/24/09 16:00
DateReceived: 09/02/09
Matrix: Soil

Client: AJAX Mountain Enterprises dba AJAX Ltd
Project: Jumbo Dome Mine Permit Project
Lab ID: H09090051-017
Client Sample ID: 09JD01 @ 210-211.5'

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
SATURATED PASTE							
pH, sat. paste	7.1	s.u.		0.1		ASAM10-3.2	09/09/09 08:40 / wj
Conductivity, sat. paste	0.39	mmhos/cm		0.01		ASA10-3	09/10/09 11:55 / wj
Saturation	67.5	%		0.1		USDA27a	09/09/09 08:19 / wj
Potassium, sat. paste	0.21	meq/l		0.03		SW6010B	09/10/09 15:48 / sld
PHYSICAL CHARACTERISTICS							
Coarse Fragments	ND	%		2		ASA15-5	09/16/09 08:19 / wj
Sand	8	%		1		ASA15-5	09/09/09 07:59 / sah
Silt	60	%		1		ASA15-5	09/09/09 07:59 / sah
Clay	32	%		1		ASA15-5	09/09/09 07:59 / sah
Texture	SiCL	unitless				ASA15-5	09/09/09 07:59 / sah
CHEMICAL CHARACTERISTICS							
Cation Exchange Capacity	15.8	meq/100g		0.09		SW6010B	09/09/09 17:50 / sld
Neutralization Potential	4	t/kt				Sobek Modifie	09/08/09 00:00 / wj
Acid Potential	ND	t/kt	D	0.01		Sobek Modifie	09/10/09 00:00 / ejp
Acid/Base Potential	4	t/kt				Sobek Modifie	09/10/09 00:00 / ejp
Sulfur, Total	ND	%		0.01		Sobek Modifie	09/10/09 11:47 / ejp
Nitrate as N, KCL Extract	1	mg/kg		1		ASA33-8	09/08/09 17:42 / stp
METALS, ABDTPA EXTRACTABLE							
Arsenic	1.4	mg/kg		0.1		SW6010B	09/11/09 10:43 / sld
Molybdenum	0.8	mg/kg		0.1		SW6010B	09/11/09 10:43 / sld
Phosphorus	0.5	mg/kg		0.2		SW6010B	09/10/09 13:16 / sld
METALS, CACL2 EXTRACTABLE							
Boron	0.27	mg/kg		0.10		SW6010B	09/08/09 17:51 / sld

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
D - RL increased due to sample matrix interference.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

ENERGY LABORATORIES, INC. * 3161 E Lyndale (59604) * PO Box 5688 * Helena, MT 59601
* 406.442.0711 * FAX 406.442.0712 * helena@energylab.com

LABORATORY ANALYTICAL REPORT

Revised Date: 09/29/09
Report Date: 09/16/09
Collection Date: 08/24/09 16:00
DateReceived: 09/02/09
Matrix: Soil

Client: AJAX Mountain Enterprises dba AJAX Ltd
Project: Jumbo Dome Mine Permit Project
Lab ID: H09090051-018
Client Sample ID: 09JD02A @ 113-114.5'

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
SATURATED PASTE							
pH, sat. paste	7.0	s.u.		0.1		ASAM10-3.2	09/09/09 08:41 / wj
Conductivity, sat. paste	0.48	mmhos/cm		0.01		ASA10-3	09/10/09 11:55 / wj
Saturation	44.7	%		0.1		USDA27a	09/09/09 08:19 / wj
Potassium, sat. paste	0.16	meq/l		0.03		SW6010B	09/10/09 15:51 / sld
PHYSICAL CHARACTERISTICS							
Coarse Fragments	ND	%		2		ASA15-5	09/16/09 08:19 / wj
Sand	16	%		1		ASA15-5	09/09/09 07:59 / sah
Silt	58	%		1		ASA15-5	09/09/09 07:59 / sah
Clay	26	%		1		ASA15-5	09/09/09 07:59 / sah
Texture	SiL	unitless				ASA15-5	09/09/09 07:59 / sah
CHEMICAL CHARACTERISTICS							
Cation Exchange Capacity	17.9	meq/100g		0.09		SW6010B	09/09/09 17:53 / sld
Neutralization Potential	4	t/kt				Sobek Modifie	09/08/09 00:00 / wj
Acid Potential	ND	t/kt	D	0.01		Sobek Modifie	09/10/09 00:00 / ejp
Acid/Base Potential	4	t/kt				Sobek Modifie	09/10/09 00:00 / ejp
Sulfur, Total	ND	%		0.01		Sobek Modifie	09/10/09 11:49 / ejp
Nitrate as N, KCL Extract	1	mg/kg		1		ASA33-8	09/08/09 17:44 / stp
METALS, ABDTPA EXTRACTABLE							
Arsenic	ND	mg/kg		0.1		SW6010B	09/11/09 10:45 / sld
Molybdenum	ND	mg/kg		0.1		SW6010B	09/11/09 10:45 / sld
Phosphorus	0.3	mg/kg		0.2		SW6010B	09/10/09 13:19 / sld
METALS, CACL2 EXTRACTABLE							
Boron	ND	mg/kg		0.10		SW6010B	09/08/09 17:54 / sld

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
D - RL increased due to sample matrix interference.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

ENERGY LABORATORIES, INC. * 3161 E Lyndale (59604) * PO Box 5688 * Helena, MT 59601
* 406.442.0711 * FAX 406.442.0712 * helena@energylab.com

LABORATORY ANALYTICAL REPORT

Revised Date: 09/29/09
Report Date: 09/16/09
Collection Date: 08/24/09 16:00
DateReceived: 09/02/09
Matrix: Soil

Client: AJAX Mountain Enterprises dba AJAX Ltd
Project: Jumbo Dome Mine Permit Project
Lab ID: H09090051-019
Client Sample ID: 09JD02A @ 128.5-130'

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
SATURATED PASTE							
pH, sat. paste	7.6	s.u.		0.1		ASAM10-3.2	09/09/09 08:41 / wj
Conductivity, sat. paste	0.54	mmhos/cm		0.01		ASA10-3	09/10/09 11:55 / wj
Saturation	31.1	%		0.1		USDA27a	09/09/09 08:20 / wj
Potassium, sat. paste	0.12	meq/l		0.03		SW6010B	09/10/09 15:53 / sld
PHYSICAL CHARACTERISTICS							
Coarse Fragments	3	%		2		ASA15-5	09/04/09 11:27 / wj
Sand	74	%		1		ASA15-5	09/09/09 07:59 / sah
Silt	20	%		1		ASA15-5	09/09/09 07:59 / sah
Clay	6	%		1		ASA15-5	09/09/09 07:59 / sah
Texture	SL	unitless				ASA15-5	09/09/09 07:59 / sah
CHEMICAL CHARACTERISTICS							
Cation Exchange Capacity	4.87	meq/100g		0.09		SW6010B	09/09/09 17:55 / sld
Neutralization Potential	3	t/kt				Sobek Modifie	09/08/09 00:00 / wj
Acid Potential	0.03	t/kt	D	0.01		Sobek Modifie	09/10/09 00:00 / ejp
Acid/Base Potential	3	t/kt				Sobek Modifie	09/10/09 00:00 / ejp
Sulfur, Total	ND	%		0.01		Sobek Modifie	09/10/09 11:51 / ejp
Nitrate as N, KCL Extract	1	mg/kg		1		ASA33-8	09/08/09 17:46 / stp
METALS, ABDTPA EXTRACTABLE							
Arsenic	0.9	mg/kg		0.1		SW6010B	09/11/09 10:48 / sld
Molybdenum	0.1	mg/kg		0.1		SW6010B	09/11/09 10:48 / sld
Phosphorus	0.6	mg/kg		0.2		SW6010B	09/10/09 13:22 / sld
METALS, CACL2 EXTRACTABLE							
Boron	ND	mg/kg		0.10		SW6010B	09/08/09 17:56 / sld

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
D - RL increased due to sample matrix interference.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

ENERGY LABORATORIES, INC. * 3161 E Lyndale (59604) * PO Box 5688 * Helena, MT 59601
* 406.442.0711 * FAX 406.442.0712 * helena@energylab.com

LABORATORY ANALYTICAL REPORT

Revised Date: 09/29/09
Report Date: 09/16/09
Collection Date: 08/24/09 16:00
DateReceived: 09/02/09
Matrix: Soil

Client: AJAX Mountain Enterprises dba AJAX Ltd
Project: Jumbo Dome Mine Permit Project
Lab ID: H09090051-020
Client Sample ID: 09JD02A @ 142.5-144'

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
SATURATED PASTE							
pH, sat. paste	7.5	s.u.		0.1		ASAM10-3.2	09/09/09 08:42 / wj
Conductivity, sat. paste	0.51	mmhos/cm		0.01		ASA10-3	09/10/09 11:56 / wj
Saturation	20.1	%		0.1		USDA27a	09/09/09 08:20 / wj
Potassium, sat. paste	0.15	meq/l		0.03		SW6010B	09/10/09 15:56 / sld
PHYSICAL CHARACTERISTICS							
Coarse Fragments	9	%		2		ASA15-5	09/04/09 11:27 / wj
Sand	80	%		1		ASA15-5	09/09/09 07:59 / sah
Silt	14	%		1		ASA15-5	09/09/09 07:59 / sah
Clay	6	%		1		ASA15-5	09/09/09 07:59 / sah
Texture	LS	unitless				ASA15-5	09/09/09 07:59 / sah
CHEMICAL CHARACTERISTICS							
Cation Exchange Capacity	2.69	meq/100g		0.09		SW6010B	09/09/09 17:58 / sld
Neutralization Potential	2	t/kt				Sobek Modifie	09/08/09 00:00 / wj
Acid Potential	0.07	t/kt	D	0.01		Sobek Modifie	09/10/09 00:00 / ejp
Acid/Base Potential	2	t/kt				Sobek Modifie	09/10/09 00:00 / ejp
Sulfur, Total	ND	%		0.01		Sobek Modifie	09/10/09 15:28 / ejp
Nitrate as N, KCL Extract	1	mg/kg		1		ASA33-8	09/08/09 17:52 / stp
METALS, ABDTPA EXTRACTABLE							
Arsenic	0.8	mg/kg		0.1		SW6010B	09/11/09 10:50 / sld
Molybdenum	ND	mg/kg		0.1		SW6010B	09/11/09 10:50 / sld
Phosphorus	0.6	mg/kg		0.2		SW6010B	09/10/09 13:24 / sld
METALS, CACL2 EXTRACTABLE							
Boron	ND	mg/kg		0.10		SW6010B	09/08/09 17:59 / sld

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
D - RL increased due to sample matrix interference.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

ENERGY LABORATORIES, INC. * 3161 E Lyndale (59604) * PO Box 5688 * Helena, MT 59601
* 406.442.0711 * FAX 406.442.0712 * helena@energylab.com

LABORATORY ANALYTICAL REPORT

Revised Date: 09/29/09
Report Date: 09/16/09
Collection Date: 08/24/09 16:00
DateReceived: 09/02/09
Matrix: Soil

Client: AJAX Mountain Enterprises dba AJAX Ltd
Project: Jumbo Dome Mine Permit Project
Lab ID: H09090051-021
Client Sample ID: 09JD02A @ 179-180.5'

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
SATURATED PASTE							
pH, sat. paste	7.5	s.u.		0.1		ASAM10-3.2	09/09/09 08:43 / wj
Conductivity, sat. paste	0.44	mmhos/cm		0.01		ASA10-3	09/10/09 11:57 / wj
Saturation	50.6	%		0.1		USDA27a	09/09/09 08:20 / wj
Potassium, sat. paste	0.15	meq/l		0.03		SW6010B	09/10/09 16:01 / sld
PHYSICAL CHARACTERISTICS							
Coarse Fragments	ND	%		2		ASA15-5	09/16/09 08:19 / wj
Sand	20	%		1		ASA15-5	09/09/09 07:59 / sah
Silt	60	%		1		ASA15-5	09/09/09 07:59 / sah
Clay	20	%		1		ASA15-5	09/09/09 07:59 / sah
Texture	SiL	unitless				ASA15-5	09/09/09 07:59 / sah
CHEMICAL CHARACTERISTICS							
Cation Exchange Capacity	15.3	meq/100g		0.09		SW6010B	09/09/09 18:03 / sld
Neutralization Potential	7	t/kt				Sobek Modifie	09/08/09 00:00 / wj
Acid Potential	2.9	t/kt	D	0.01		Sobek Modifie	09/10/09 00:00 / ejp
Acid/Base Potential	4	t/kt				Sobek Modifie	09/10/09 00:00 / ejp
Sulfur, Total	0.09	%		0.01		Sobek Modifie	09/10/09 12:09 / ejp
Nitrate as N, KCL Extract	1	mg/kg		1		ASA33-8	09/08/09 17:56 / stp
METALS, ABDTPA EXTRACTABLE							
Arsenic	0.5	mg/kg		0.1		SW6010B	09/11/09 10:56 / sld
Molybdenum	0.4	mg/kg		0.1		SW6010B	09/11/09 10:56 / sld
Phosphorus	0.6	mg/kg		0.2		SW6010B	09/10/09 13:29 / sld
METALS, CACL2 EXTRACTABLE							
Boron	0.31	mg/kg		0.10		SW6010B	09/08/09 18:04 / sld

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
D - RL increased due to sample matrix interference.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

ENERGY LABORATORIES, INC. * 3161 E Lyndale (59604) * PO Box 5688 * Helena, MT 59601
* 406.442.0711 * FAX 406.442.0712 * helena@energylab.com

LABORATORY ANALYTICAL REPORT

Revised Date: 09/29/09
Report Date: 09/16/09
Collection Date: 08/24/09 16:00
DateReceived: 09/02/09
Matrix: Soil

Client: AJAX Mountain Enterprises dba AJAX Ltd
Project: Jumbo Dome Mine Permit Project
Lab ID: H09090051-022
Client Sample ID: 09JD08 @ 85-86.5'

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
SATURATED PASTE							
pH, sat. paste	6.7	s.u.		0.1		ASAM10-3.2	09/09/09 08:44 / wj
Conductivity, sat. paste	0.32	mmhos/cm		0.01		ASA10-3	09/10/09 11:58 / wj
Saturation	53.9	%		0.1		USDA27a	09/09/09 08:20 / wj
Potassium, sat. paste	0.10	meq/l		0.03		SW6010B	09/10/09 16:04 / sld
PHYSICAL CHARACTERISTICS							
Coarse Fragments	ND	%		2		ASA15-5	09/16/09 08:19 / wj
Sand	12	%		1		ASA15-5	09/09/09 07:59 / sah
Silt	44	%		1		ASA15-5	09/09/09 07:59 / sah
Clay	44	%		1		ASA15-5	09/09/09 07:59 / sah
Texture	SiC	unitless				ASA15-5	09/09/09 07:59 / sah
CHEMICAL CHARACTERISTICS							
Cation Exchange Capacity	28.7	meq/100g		0.09		SW6010B	09/09/09 18:06 / sld
Neutralization Potential	6	t/kt				Sobek Modifie	09/08/09 00:00 / wj
Acid Potential	ND	t/kt	D	0.01		Sobek Modifie	09/10/09 00:00 / ejp
Acid/Base Potential	6	t/kt				Sobek Modifie	09/10/09 00:00 / ejp
Sulfur, Total	ND	%		0.01		Sobek Modifie	09/10/09 12:11 / ejp
Nitrate as N, KCL Extract	1	mg/kg		1		ASA33-8	09/08/09 17:58 / stp
METALS, ABDTPA EXTRACTABLE							
Arsenic	ND	mg/kg		0.1		SW6010B	09/11/09 10:58 / sld
Molybdenum	ND	mg/kg		0.1		SW6010B	09/11/09 10:58 / sld
Phosphorus	0.3	mg/kg		0.2		SW6010B	09/10/09 13:32 / sld
METALS, CACL2 EXTRACTABLE							
Boron	0.46	mg/kg		0.10		SW6010B	09/08/09 18:07 / sld

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
D - RL increased due to sample matrix interference.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

ENERGY LABORATORIES, INC. * 3161 E Lyndale (59604) * PO Box 5688 * Helena, MT 59601
* 406.442.0711 * FAX 406.442.0712 * helena@energylab.com

LABORATORY ANALYTICAL REPORT

Revised Date: 09/29/09
Report Date: 09/16/09
Collection Date: 08/24/09 16:00
DateReceived: 09/02/09
Matrix: Soil

Client: AJAX Mountain Enterprises dba AJAX Ltd
Project: Jumbo Dome Mine Permit Project
Lab ID: H09090051-023
Client Sample ID: 09JD03 @ 59-60'

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
SATURATED PASTE							
pH, sat. paste	5.6	s.u.		0.1		ASAM10-3.2	09/09/09 08:44 / wj
Conductivity, sat. paste	0.45	mmhos/cm		0.01		ASA10-3	09/10/09 11:58 / wj
Saturation	23.5	%		0.1		USDA27a	09/09/09 08:20 / wj
Potassium, sat. paste	0.16	meq/l		0.03		SW6010B	09/10/09 16:06 / sld
PHYSICAL CHARACTERISTICS							
Coarse Fragments	ND	%		2		ASA15-5	09/16/09 08:19 / wj
Sand	78	%		1		ASA15-5	09/09/09 07:59 / sah
Silt	16	%		1		ASA15-5	09/09/09 07:59 / sah
Clay	6	%		1		ASA15-5	09/09/09 07:59 / sah
Texture	LS	unitless				ASA15-5	09/09/09 07:59 / sah
CHEMICAL CHARACTERISTICS							
Cation Exchange Capacity	7.05	meq/100g		0.09		SW6010B	09/09/09 18:08 / sld
Neutralization Potential	5	t/kt				Sobek Modifie	09/08/09 00:00 / wj
Acid Potential	0.12	t/kt	D	0.01		Sobek Modifie	09/10/09 00:00 / ejp
Acid/Base Potential	5	t/kt				Sobek Modifie	09/10/09 00:00 / ejp
Sulfur, Total	ND	%		0.01		Sobek Modifie	09/10/09 12:14 / ejp
Nitrate as N, KCL Extract	1	mg/kg		1		ASA33-8	09/08/09 18:04 / stp
METALS, ABDTPA EXTRACTABLE							
Arsenic	ND	mg/kg		0.1		SW6010B	09/11/09 11:01 / sld
Molybdenum	ND	mg/kg		0.1		SW6010B	09/11/09 11:01 / sld
Phosphorus	1.3	mg/kg		0.2		SW6010B	09/10/09 13:35 / sld
METALS, CACL2 EXTRACTABLE							
Boron	ND	mg/kg		0.10		SW6010B	09/08/09 18:09 / sld

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
D - RL increased due to sample matrix interference.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

ENERGY LABORATORIES, INC. * 3161 E Lyndale (59604) * PO Box 5688 * Helena, MT 59601
* 406.442.0711 * FAX 406.442.0712 * helena@energylab.com

LABORATORY ANALYTICAL REPORT

Revised Date: 09/29/09
Report Date: 09/16/09
Collection Date: 08/24/09 16:00
DateReceived: 09/02/09
Matrix: Soil

Client: AJAX Mountain Enterprises dba AJAX Ltd
Project: Jumbo Dome Mine Permit Project
Lab ID: H09090051-024
Client Sample ID: 09JD03 @ 106-107.5'

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
SATURATED PASTE							
pH, sat. paste	7.3	s.u.		0.1		ASAM10-3.2	09/09/09 08:45 / wj
Conductivity, sat. paste	0.55	mmhos/cm		0.01		ASA10-3	09/10/09 11:59 / wj
Saturation	46.2	%		0.1		USDA27a	09/09/09 08:20 / wj
Potassium, sat. paste	0.14	meq/l		0.03		SW6010B	09/10/09 16:09 / sld
PHYSICAL CHARACTERISTICS							
Coarse Fragments	ND	%		2		ASA15-5	09/16/09 08:19 / wj
Sand	12	%		1		ASA15-5	09/09/09 07:59 / sah
Silt	68	%		1		ASA15-5	09/09/09 07:59 / sah
Clay	20	%		1		ASA15-5	09/09/09 07:59 / sah
Texture	SiL	unitless				ASA15-5	09/09/09 07:59 / sah
CHEMICAL CHARACTERISTICS							
Cation Exchange Capacity	14.5	meq/100g		0.09		SW6010B	09/09/09 18:11 / sld
Neutralization Potential	6	t/kt				Sobek Modifie	09/08/09 00:00 / wj
Acid Potential	2.9	t/kt	D	0.01		Sobek Modifie	09/10/09 00:00 / ejp
Acid/Base Potential	3	t/kt				Sobek Modifie	09/10/09 00:00 / ejp
Sulfur, Total	0.09	%		0.01		Sobek Modifie	09/10/09 12:17 / ejp
Nitrate as N, KCL Extract	1	mg/kg		1		ASA33-8	09/08/09 18:06 / stp
METALS, ABDTPA EXTRACTABLE							
Arsenic	0.6	mg/kg		0.1		SW6010B	09/11/09 11:08 / sld
Molybdenum	0.6	mg/kg		0.1		SW6010B	09/11/09 11:08 / sld
Phosphorus	0.5	mg/kg		0.2		SW6010B	09/10/09 13:42 / sld
METALS, CACL2 EXTRACTABLE							
Boron	ND	mg/kg		0.10		SW6010B	09/08/09 18:17 / sld

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
D - RL increased due to sample matrix interference.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

ENERGY LABORATORIES, INC. * 3161 E Lyndale (59604) * PO Box 5688 * Helena, MT 59601
* 406.442.0711 * FAX 406.442.0712 * helena@energylab.com

LABORATORY ANALYTICAL REPORT

Revised Date: 09/29/09
Report Date: 09/16/09
Collection Date: 08/24/09 16:00
DateReceived: 09/02/09
Matrix: Soil

Client: AJAX Mountain Enterprises dba AJAX Ltd
Project: Jumbo Dome Mine Permit Project
Lab ID: H09090051-025
Client Sample ID: 09JD03 @ 127-128'

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
SATURATED PASTE							
pH, sat. paste	7.5	s.u.		0.1		ASAM10-3.2	09/09/09 08:46 / wj
Conductivity, sat. paste	0.66	mmhos/cm		0.01		ASA10-3	09/10/09 11:59 / wj
Saturation	22.5	%		0.1		USDA27a	09/09/09 08:20 / wj
Potassium, sat. paste	0.14	meq/l		0.03		SW6010B	09/10/09 16:17 / sld
PHYSICAL CHARACTERISTICS							
Coarse Fragments	13	%		2		ASA15-5	09/04/09 11:27 / wj
Sand	80	%		1		ASA15-5	09/09/09 07:59 / sah
Silt	14	%		1		ASA15-5	09/09/09 07:59 / sah
Clay	6	%		1		ASA15-5	09/09/09 07:59 / sah
Texture	LS	unitless				ASA15-5	09/09/09 07:59 / sah
CHEMICAL CHARACTERISTICS							
Cation Exchange Capacity	2.86	meq/100g		0.09		SW6010B	09/09/09 18:13 / sld
Neutralization Potential	3	t/kt				Sobek Modifie	09/08/09 00:00 / wj
Acid Potential	0.28	t/kt	D	0.01		Sobek Modifie	09/10/09 00:00 / ejp
Acid/Base Potential	3	t/kt				Sobek Modifie	09/10/09 00:00 / ejp
Sulfur, Total	ND	%		0.01		Sobek Modifie	09/10/09 12:19 / ejp
Nitrate as N, KCL Extract	1	mg/kg		1		ASA33-8	09/08/09 18:08 / stp
METALS, ABDTPA EXTRACTABLE							
Arsenic	1.1	mg/kg		0.1		SW6010B	09/11/09 11:11 / sld
Molybdenum	0.1	mg/kg		0.1		SW6010B	09/11/09 11:11 / sld
Phosphorus	0.5	mg/kg		0.2		SW6010B	09/10/09 13:45 / sld
METALS, CACL2 EXTRACTABLE							
Boron	ND	mg/kg		0.10		SW6010B	09/08/09 18:20 / sld

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
D - RL increased due to sample matrix interference.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

ENERGY LABORATORIES, INC. * 3161 E Lyndale (59604) * PO Box 5688 * Helena, MT 59601
* 406.442.0711 * FAX 406.442.0712 * helena@energylab.com

LABORATORY ANALYTICAL REPORT

Revised Date: 09/29/09
Report Date: 09/16/09
Collection Date: 08/24/09 16:00
DateReceived: 09/02/09
Matrix: Soil

Client: AJAX Mountain Enterprises dba AJAX Ltd
Project: Jumbo Dome Mine Permit Project
Lab ID: H09090051-026
Client Sample ID: 09JD03 @ 167-168.5'

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
SATURATED PASTE							
pH, sat. paste	6.9	s.u.		0.1		ASAM10-3.2	09/09/09 08:46 / wj
Conductivity, sat. paste	1.25	mmhos/cm		0.01		ASA10-3	09/10/09 12:00 / wj
Saturation	55.2	%		0.1		USDA27a	09/09/09 08:21 / wj
Potassium, sat. paste	0.42	meq/l		0.03		SW6010B	09/10/09 16:24 / sld
PHYSICAL CHARACTERISTICS							
Coarse Fragments	ND	%		2		ASA15-5	09/16/09 08:19 / wj
Sand	22	%		1		ASA15-5	09/09/09 07:59 / sah
Silt	58	%		1		ASA15-5	09/09/09 07:59 / sah
Clay	20	%		1		ASA15-5	09/09/09 07:59 / sah
Texture	SiL	unitless				ASA15-5	09/09/09 07:59 / sah
CHEMICAL CHARACTERISTICS							
Cation Exchange Capacity	15.2	meq/100g		0.09		SW6010B	09/09/09 18:21 / sld
Neutralization Potential	7	t/kt				Sobek Modifie	09/08/09 00:00 / wj
Acid Potential	3.7	t/kt	D	0.01		Sobek Modifie	09/10/09 00:00 / ejp
Acid/Base Potential	4	t/kt				Sobek Modifie	09/10/09 00:00 / ejp
Sulfur, Total	0.12	%		0.01		Sobek Modifie	09/10/09 12:23 / ejp
Nitrate as N, KCL Extract	1	mg/kg		1		ASA33-8	09/08/09 18:10 / stp
METALS, ABDTPA EXTRACTABLE							
Arsenic	1.9	mg/kg		0.1		SW6010B	09/11/09 11:14 / sld
Molybdenum	1.3	mg/kg		0.1		SW6010B	09/11/09 11:14 / sld
Phosphorus	0.5	mg/kg		0.2		SW6010B	09/10/09 13:47 / sld
METALS, CACL2 EXTRACTABLE							
Boron	0.30	mg/kg		0.10		SW6010B	09/08/09 18:22 / sld

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
D - RL increased due to sample matrix interference.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

APPENDIX CIII-2
COAL QUALITY
LAB ANALYTICAL RESULTS

SGS

October 26, 2009

Usibelli Coal Mine, Inc.
P.O. Box 1000
Healy, AK 99743
USA

Client Sample ID:	1	**Core Hole ID :**	09JD-01
Date Received:	10/07/2009	**Footage Begin :**	114
Matrix:	Coal	**Footage End :**	149
Net Sample Weight:	2442.20 g	**Sample Type :**	-2" Core
		Seam :	4

SGS Sample ID: 072-41800-001

		As Received	Dry	MAF
% Moisture, Total	[ASTM D 3302]	31.33		
% Ash	[ASTM D 3174/5142]	4.36	6.35	
% Volatile Matter	[ASTM D 5142]	34.06	49.60	52.97
% Fixed Carbon	[ASTM D 3172]	30.25	44.05	47.03
Gross Calorific Value (Btu/lb)	[ASTM D 5865]	7754	11292	12059
% Sulfur	[ASTM D 4239]	0.08	0.12	
% Carbon	[ASTM D 5373]	44.97	65.48	
% Hydrogen	[ASTM D 5373]	3.45	5.03	
% Nitrogen	[ASTM D 5373]	0.51	0.74	
% Oxygen (Calc)	[ASTM D 3176]	15.30	22.28	
% Sulfur, Pyritic - FOS	[ASTMD2492 Mod.]	0.01	0.02	
% Sulfur, Sulfate - FOS	[ASTMD2492 Mod.]	<0.01	<0.01	
% Sulfur, Organic - FOS	[ASTMD2492 Mod.]	0.07	0.10	

Analyte	Result	Method
Iodine, Dry	<20 ug/g	SGS Method
Pounds of Ash/mm Btu	5.63 lb	
Pounds of Sulfur/mm Btu	0.10 lb	
Pounds of SO2/mm Btu	0.21 lb	
Reducing - Initial Deformation	2355 °F	ASTM D 1857
Reducing - Softening	2383 °F	ASTM D 1857
Reducing - Hemispherical	2393 °F	ASTM D 1857
Reducing - Fluid	2444 °F	ASTM D 1857
Oxidizing - Initial Deformation	2447 °F	ASTM D 1857
Oxidizing - Softening	2454 °F	ASTM D 1857
Oxidizing - Hemispherical	2465 °F	ASTM D 1857
Oxidizing - Fluid	2493 °F	ASTM D 1857

Respectfully submitted,
SGS NORTH AMERICA INC.

Tony Stayko
Denver Laboratory

SGS North America Inc. | Minerals Services Division
4665 Paris Street, Suite B-200, Denver, CO 80239 t (303) 373-4772 f (303) 373-4791 www.us.sgs.com/minerals

F-465

Member of the SGS Group

GENERAL CONDITIONS OF SERVICE ON REVERSE

SGS

October 26, 2009

Usibelli Coal Mine, Inc.
P.O. Box 1000
Healy, AK 99743
USA

Client Sample ID:	2	**Core Hole ID :**	09JD-01
Date Received:	10/07/2009	**Footage Begin :**	178
Matrix:	Coal	**Footage End :**	207
Net Sample Weight:	2280.00 g	**Sample Type :**	-2" Core
		Seam :	3

SGS Sample ID: 072-41800-002

		As Received	Dry	MAF
% Moisture, Total	[ASTM D 3302]	30.98		
% Ash	[ASTM D 3174/5142]	5.46	7.91	
% Volatile Matter	[ASTM D 5142]	33.52	48.57	52.74
% Fixed Carbon	[ASTM D 3172]	30.04	43.52	47.26
Gross Calorific Value (Btu/lb)	[ASTM D 5865]	7772	11261	12227
% Sulfur	[ASTM D 4239]	0.13	0.19	
% Carbon	[ASTM D 5373]	44.94	65.11	
% Hydrogen	[ASTM D 5373]	3.43	4.97	
% Nitrogen	[ASTM D 5373]	0.49	0.70	
% Oxygen (Calc)	[ASTM D 3176]	14.57	21.12	
% Sulfur, Pyritic - FOS	[ASTMD2492 Mod.]	0.01	0.02	
% Sulfur, Sulfate - FOS	[ASTMD2492 Mod.]	<0.01	<0.01	
% Sulfur, Organic - FOS	[ASTMD2492 Mod.]	0.12	0.17	

Analyte	Result	Method
Iodine, Dry	<20 ug/g	SGS Method
Pounds of Ash/mm Btu	7.02 lb	
Pounds of Sulfur/mm Btu	0.17 lb	
Pounds of SO2/mm Btu	0.33 lb	
Reducing - Initial Deformation	2244 °F	ASTM D 1857
Reducing - Softening	2254 °F	ASTM D 1857
Reducing - Hemispherical	2275 °F	ASTM D 1857
Reducing - Fluid	2312 °F	ASTM D 1857
Oxidizing - Initial Deformation	2234 °F	ASTM D 1857
Oxidizing - Softening	2240 °F	ASTM D 1857
Oxidizing - Hemispherical	2260 °F	ASTM D 1857
Oxidizing - Fluid	2289 °F	ASTM D 1857

Respectfully submitted,
SGS NORTH AMERICA INC.

Tony Stoyko

Denver Laboratory

SGS North America Inc. | Minerals Services Division
4665 Paris Street, Suite B-200, Denver, CO 80239 t (303) 373-4772 f (303) 373-4791 www.us.sgs.com/minerals

F-465

Member of the SGS Group

GENERAL CONDITIONS OF SERVICE ON REVERSE

October 26, 2009

Usibelli Coal Mine, Inc.
P.O. Box 1000
Healy, AK 99743
USA

Client Sample ID:	3	**Core Hole ID :**	09JD-02A
Date Received:	10/07/2009	**Footage Begin :**	68
Matrix:	Coal	**Footage End :**	111
Net Sample Weight:	3024.30 g	**Sample Type :**	-2" Core
		Seam :	4

SGS Sample ID: 072-41800-003

		As Received	Dry	MAF
% Moisture, Total	[ASTM D 3302]	31.24		
% Ash	[ASTM D 3174/5142]	4.38	6.37	
% Volatile Matter	[ASTM D 5142]	34.02	49.48	52.85
% Fixed Carbon	[ASTM D 3172]	30.36	44.15	47.15
Gross Calorific Value (Btu/lb)	[ASTM D 5865]	7752	11275	12043
% Sulfur	[ASTM D 4239]	0.10	0.15	
% Carbon	[ASTM D 5373]	44.90	65.31	
% Hydrogen	[ASTM D 5373]	3.40	4.94	
% Nitrogen	[ASTM D 5373]	0.45	0.65	
% Oxygen (Calc)	[ASTM D 3176]	15.53	22.58	
% Sulfur, Pyritic - FOS	[ASTMD2492 Mod.]	0.01	0.02	
% Sulfur, Sulfate - FOS	[ASTMD2492 Mod.]	<0.01	<0.01	
% Sulfur, Organic - FOS	[ASTMD2492 Mod.]	0.09	0.13	

Analyte	Result	Method
Iodine, Dry	<20 ug/g	SGS Method
Pounds of Ash/mm Btu	5.65 lb	
Pounds of Sulfur/mm Btu	0.13 lb	
Pounds of SO2/mm Btu	0.27 lb	
Reducing - Initial Deformation	2374 °F	ASTM D 1857
Reducing - Softening	2389 °F	ASTM D 1857
Reducing - Hemispherical	2402 °F	ASTM D 1857
Reducing - Fluid	2445 °F	ASTM D 1857
Oxidizing - Initial Deformation	2434 °F	ASTM D 1857
Oxidizing - Softening	2441 °F	ASTM D 1857
Oxidizing - Hemispherical	2452 °F	ASTM D 1857
Oxidizing - Fluid	2478 °F	ASTM D 1857

Respectfully submitted,
SGS NORTH AMERICA INC.

Tony Stoyko
Denver Laboratory

SGS North America Inc. | Minerals Services Division
4665 Paris Street, Suite B-200, Denver, CO 80239 t (303) 373-4772 f (303) 373-4791 www.us.sgs.com/minerals

F-465

Member of the SGS Group

GENERAL CONDITIONS OF SERVICE ON REVERSE

October 26, 2009

Usibelli Coal Mine, Inc.
P.O. Box 1000
Healy, AK 99743
USA

Client Sample ID:	4	**Core Hole ID :**	09JD-02A
Date Received:	10/07/2009	**Footage Begin :**	146
Matrix:	Coal	**Footage End :**	150
Net Sample Weight:	1067.10 g	**Sample Type :**	-2" Core
		Seam :	3

SGS Sample ID: 072-41800-004

		As Received	Dry	MAF
% Moisture, Total	[ASTM D 3302]	25.85		
% Ash	[ASTM D 3174/5142]	19.10	25.76	
% Volatile Matter	[ASTM D 5142]	32.46	43.78	58.97
% Fixed Carbon	[ASTM D 3172]	22.59	30.46	41.03
Gross Calorific Value (Btu/lb)	[ASTM D 5865]	6715	9057	12199
% Sulfur	[ASTM D 4239]	0.18	0.24	
% Carbon	[ASTM D 5373]	38.44	51.84	
% Hydrogen	[ASTM D 5373]	3.33	4.49	
% Nitrogen	[ASTM D 5373]	0.46	0.61	
% Oxygen (Calc)	[ASTM D 3176]	12.64	17.06	
% Sulfur, Pyritic - FOS	[ASTMD2492 Mod.]	0.02	0.02	
% Sulfur, Sulfate - FOS	[ASTMD2492 Mod.]	<0.01	<0.01	
% Sulfur, Organic - FOS	[ASTMD2492 Mod.]	0.16	0.22	

Analyte	Result	Method
Iodine, Dry	<20 ug/g	SGS Method
Pounds of Ash/mm Btu	28.44 lb	
Pounds of Sulfur/mm Btu	0.26 lb	
Pounds of SO2/mm Btu	0.52 lb	
Reducing - Initial Deformation	2323 °F	ASTM D 1857
Reducing - Softening	2354 °F	ASTM D 1857
Reducing - Hemispherical	2420 °F	ASTM D 1857
Reducing - Fluid	2449 °F	ASTM D 1857
Oxidizing - Initial Deformation	2396 °F	ASTM D 1857
Oxidizing - Softening	2438 °F	ASTM D 1857
Oxidizing - Hemispherical	2531 °F	ASTM D 1857
Oxidizing - Fluid	2592 °F	ASTM D 1857

Respectfully submitted,
SGS NORTH AMERICA INC.

Tony Stojko

Denver Laboratory

SGS North America Inc. | Minerals Services Division
4665 Paris Street, Suite B-200, Denver, CO 80239 t (303) 373-4772 f (303) 373-4791 www.us.sgs.com/minerals

F-465

Member of the SGS Group

GENERAL CONDITIONS OF SERVICE ON REVERSE

SGS

October 26, 2009

Usibelli Coal Mine, Inc.
P.O. Box 1000
Healy, AK 99743
USA

Client Sample ID:	5	**Core Hole ID :**	09JD-02A
Date Received:	10/07/2009	**Footage Begin :**	150
Matrix:	Coal	**Footage End :**	174
Net Sample Weight:	2055.00 g	**Sample Type :**	-2" Core
		Seam :	3

SGS Sample ID: 072-41800-005

		As Received	Dry	MAF
% Moisture, Total	[ASTM D 3302]	30.32		
% Ash	[ASTM D 3174/5142]	6.00	8.61	
% Volatile Matter	[ASTM D 5142]	33.19	47.63	52.12
% Fixed Carbon	[ASTM D 3172]	30.49	43.76	47.88
Gross Calorific Value (Btu/lb)	[ASTM D 5865]	7625	10942	11973
% Sulfur	[ASTM D 4239]	0.09	0.13	
% Carbon	[ASTM D 5373]	43.96	63.08	
% Hydrogen	[ASTM D 5373]	3.27	4.69	
% Nitrogen	[ASTM D 5373]	0.53	0.76	
% Oxygen (Calc)	[ASTM D 3176]	15.83	22.73	
% Sulfur, Pyritic - FOS	[ASTMD2492 Mod.]	<0.01	<0.01	
% Sulfur, Sulfate - FOS	[ASTMD2492 Mod.]	<0.01	<0.01	
% Sulfur, Organic - FOS	[ASTMD2492 Mod.]	0.09	0.13	

Analyte	Result	Method
Iodine, Dry	<20 ug/g	SGS Method
Pounds of Ash/mm Btu	7.87 lb	
Pounds of Sulfur/mm Btu	0.12 lb	
Pounds of SO2/mm Btu	0.24 lb	
Reducing - Initial Deformation	2273 °F	ASTM D 1857
Reducing - Softening	2285 °F	ASTM D 1857
Reducing - Hemispherical	2304 °F	ASTM D 1857
Reducing - Fluid	2336 °F	ASTM D 1857
Oxidizing - Initial Deformation	2276 °F	ASTM D 1857
Oxidizing - Softening	2286 °F	ASTM D 1857
Oxidizing - Hemispherical	2306 °F	ASTM D 1857
Oxidizing - Fluid	2339 °F	ASTM D 1857

Respectfully submitted,
SGS NORTH AMERICA INC.

Tony Stoyko

Denver Laboratory

SGS North America Inc. | Minerals Services Division
4665 Paris Street, Suite B-200, Denver, CO 80239 t (303) 373-4772 f (303) 373-4791 www.us.sgs.com/minerals

F-465

Member of the SGS Group

GENERAL CONDITIONS OF SERVICE ON REVERSE

SGS

October 26, 2009

Usibelli Coal Mine, Inc.
P.O. Box 1000
Healy, AK 99743
USA

Client Sample ID:	6	**Core Hole ID :**	09JD-03
Date Received:	10/07/2009	**Footage Begin :**	60
Matrix:	Coal	**Footage End :**	103
Net Sample Weight:	3497.50 g	**Sample Type :**	-2" Core
		Seam :	4

SGS Sample ID: 072-41800-006

		As Received	Dry	MAF
% Moisture, Total	[ASTM D 3302]	31.13		
% Ash	[ASTM D 3174/5142]	5.00	7.26	
% Volatile Matter	[ASTM D 5142]	34.12	49.54	53.42
% Fixed Carbon	[ASTM D 3172]	29.75	43.20	46.58
Gross Calorific Value (Btu/lb)	[ASTM D 5865]	7672	11140	12012
% Sulfur	[ASTM D 4239]	0.08	0.12	
% Carbon	[ASTM D 5373]	44.44	64.53	
% Hydrogen	[ASTM D 5373]	3.38	4.91	
% Nitrogen	[ASTM D 5373]	0.45	0.65	
% Oxygen (Calc)	[ASTM D 3176]	15.52	22.53	
% Sulfur, Pyritic - FOS	[ASTMD2492 Mod.]	<0.01	<0.01	
% Sulfur, Sulfate - FOS	[ASTMD2492 Mod.]	<0.01	<0.01	
% Sulfur, Organic - FOS	[ASTMD2492 Mod.]	0.08	0.12	

Analyte	Result	Method
Iodine, Dry	<20 ug/g	SGS Method
Pounds of Ash/mm Btu	6.52 lb	
Pounds of Sulfur/mm Btu	0.11 lb	
Pounds of SO2/mm Btu	0.21 lb	
Reducing - Initial Deformation	2217 °F	ASTM D 1857
Reducing - Softening	2227 °F	ASTM D 1857
Reducing - Hemispherical	2232 °F	ASTM D 1857
Reducing - Fluid	2270 °F	ASTM D 1857
Oxidizing - Initial Deformation	2204 °F	ASTM D 1857
Oxidizing - Softening	2209 °F	ASTM D 1857
Oxidizing - Hemispherical	2216 °F	ASTM D 1857
Oxidizing - Fluid	2280 °F	ASTM D 1857

Respectfully submitted,
SGS NORTH AMERICA INC.

Tony Stryko

Denver Laboratory

SGS North America Inc. | Minerals Services Division
4665 Paris Street, Suite B-200, Denver, CO 80239 t (303) 373-4772 f (303) 373-4791 www.us.sgs.com/minerals

F-465

Member of the SGS Group

GENERAL CONDITIONS OF SERVICE ON REVERSE

October 26, 2009

Usibelli Coal Mine, Inc.
P.O. Box 1000
Healy, AK 99743
USA

Client Sample ID:	7	**Core Hole ID :**	09JD-05
Date Received:	10/07/2009	**Footage Begin :**	120
Matrix:	Coal	**Footage End :**	162
Net Sample Weight:	3318.20 g	**Sample Type :**	-2" Core
		Seam :	4

SGS Sample ID: 072-41800-007

		As Received	Dry	MAF
% Moisture, Total	[ASTM D 3302]	31.57		
% Ash	[ASTM D 3174/5142]	7.21	10.53	
% Volatile Matter	[ASTM D 5142]	32.88	48.04	53.69
% Fixed Carbon	[ASTM D 3172]	28.34	41.43	46.31
Gross Calorific Value (Btu/lb)	[ASTM D 5865]	7357	10750	12015
% Sulfur	[ASTM D 4239]	0.09	0.14	
% Carbon	[ASTM D 5373]	43.04	62.89	
% Hydrogen	[ASTM D 5373]	3.21	4.69	
% Nitrogen	[ASTM D 5373]	0.40	0.59	
% Oxygen (Calc)	[ASTM D 3176]	14.48	21.16	
% Sulfur, Pyritic - FOS	[ASTMD2492 Mod.]	0.02	0.03	
% Sulfur, Sulfate - FOS	[ASTMD2492 Mod.]	<0.01	<0.01	
% Sulfur, Organic - FOS	[ASTMD2492 Mod.]	0.07	0.11	

Analyte	Result	Method
Iodine, Dry	<20 ug/g	SGS Method
Pounds of Ash/mm Btu	9.80 lb	
Pounds of Sulfur/mm Btu	0.13 lb	
Pounds of SO2/mm Btu	0.25 lb	
Reducing - Initial Deformation	2100 °F	ASTM D 1857
Reducing - Softening	2108 °F	ASTM D 1857
Reducing - Hemispherical	2117 °F	ASTM D 1857
Reducing - Fluid	2140 °F	ASTM D 1857
Oxidizing - Initial Deformation	2237 °F	ASTM D 1857
Oxidizing - Softening	2244 °F	ASTM D 1857
Oxidizing - Hemispherical	2249 °F	ASTM D 1857
Oxidizing - Fluid	2259 °F	ASTM D 1857

Respectfully submitted,
SGS NORTH AMERICA INC.

Tony Stayko

Denver Laboratory

SGS North America Inc. | Minerals Services Division
4665 Paris Street, Suite B-200, Denver, CO 80239 t (303) 373-4772 f (303) 373-4791 www.us.sgs.com/minerals

F-465

Member of the SGS Group

GENERAL CONDITIONS OF SERVICE ON REVERSE

October 26, 2009

Usibelli Coal Mine, Inc.
P.O. Box 1000
Healy, AK 99743
USA

Client Sample ID:	8	**Core Hole ID :**	09JD-05
Date Received:	10/07/2009	**Footage Begin :**	184
Matrix:	Coal	**Footage End :**	216
Net Sample Weight:	2580.40 g	**Sample Type :**	-2" Core
		Seam :	3

SGS Sample ID: 072-41800-008

		As Received	Dry	MAF
% Moisture, Total	[ASTM D 3302]	31.87		
% Ash	[ASTM D 3174/5142]	5.90	8.66	
% Volatile Matter	[ASTM D 5142]	33.41	49.03	53.68
% Fixed Carbon	[ASTM D 3172]	28.82	42.31	46.32
Gross Calorific Value (Btu/lb)	[ASTM D 5865]	7592	11143	12199
% Sulfur	[ASTM D 4239]	0.10	0.14	
% Carbon	[ASTM D 5373]	43.82	64.32	
% Hydrogen	[ASTM D 5373]	3.39	4.98	
% Nitrogen	[ASTM D 5373]	0.47	0.70	
% Oxygen (Calc)	[ASTM D 3176]	14.45	21.20	
% Sulfur, Pyritic - FOS	[ASTMD2492 Mod.]	<0.01	0.01	
% Sulfur, Sulfate - FOS	[ASTMD2492 Mod.]	<0.01	<0.01	
% Sulfur, Organic - FOS	[ASTMD2492 Mod.]	0.10	0.13	

Analyte	Result	Method
Iodine, Dry	<20 ug/g	SGS Method
Pounds of Ash/mm Btu	7.77 lb	
Pounds of Sulfur/mm Btu	0.13 lb	
Pounds of SO2/mm Btu	0.25 lb	
Reducing - Initial Deformation	2242 °F	ASTM D 1857
Reducing - Softening	2280 °F	ASTM D 1857
Reducing - Hemispherical	2292 °F	ASTM D 1857
Reducing - Fluid	2346 °F	ASTM D 1857
Oxidizing - Initial Deformation	2237 °F	ASTM D 1857
Oxidizing - Softening	2260 °F	ASTM D 1857
Oxidizing - Hemispherical	2275 °F	ASTM D 1857
Oxidizing - Fluid	2320 °F	ASTM D 1857

Respectfully submitted,
SGS NORTH AMERICA INC.

Tony Stayko

Denver Laboratory

SGS North America Inc | Minerals Services Division
4665 Paris Street, Suite B-200, Denver, CO 80239 t (303) 373-4772 f (303) 373-4791 www.us.sgs.com/minerals

F-465

Member of the SGS Group

GENERAL CONDITIONS OF SERVICE ON REVERSE

October 26, 2009

Usibelli Coal Mine, Inc.
P.O. Box 1000
Healy, AK 99743
USA

Client Sample ID:	9	**Core Hole ID :**	09JD-06
Date Received:	10/07/2009	**Footage Begin :**	147
Matrix:	Coal	**Footage End :**	184
Net Sample Weight:	3333.40 g	**Sample Type :**	-2" Core
		Seam :	4

SGS Sample ID: 072-41800-009

		As Received	Dry	MAF
% Moisture, Total	[ASTM D 3302]	30.62		
% Ash	[ASTM D 3174/5142]	5.22	7.52	
% Volatile Matter	[ASTM D 5142]	34.30	49.43	53.45
% Fixed Carbon	[ASTM D 3172]	29.86	43.05	46.55
Gross Calorific Value (Btu/lb)	[ASTM D 5865]	7682	11072	11972
% Sulfur	[ASTM D 4239]	0.08	0.11	
% Carbon	[ASTM D 5373]	44.52	64.17	
% Hydrogen	[ASTM D 5373]	3.38	4.87	
% Nitrogen	[ASTM D 5373]	0.41	0.59	
% Oxygen (Calc)	[ASTM D 3176]	15.77	22.74	
% Sulfur, Pyritic - FOS	[ASTMD2492 Mod.]	<0.01	<0.01	
% Sulfur, Sulfate - FOS	[ASTMD2492 Mod.]	<0.01	<0.01	
% Sulfur, Organic - FOS	[ASTMD2492 Mod.]	0.08	0.11	

Analyte	Result	Method
Iodine, Dry	<20 ug/g	SGS Method
Pounds of Ash/mm Btu	6.79 lb	
Pounds of Sulfur/mm Btu	0.10 lb	
Pounds of SO2/mm Btu	0.21 lb	
Reducing - Initial Deformation	2218 °F	ASTM D 1857
Reducing - Softening	2230 °F	ASTM D 1857
Reducing - Hemispherical	2243 °F	ASTM D 1857
Reducing - Fluid	2275 °F	ASTM D 1857
Oxidizing - Initial Deformation	2213 °F	ASTM D 1857
Oxidizing - Softening	2216 °F	ASTM D 1857
Oxidizing - Hemispherical	2227 °F	ASTM D 1857
Oxidizing - Fluid	2252 °F	ASTM D 1857

Respectfully submitted,
SGS NORTH AMERICA INC.

Tony Stayler

Denver Laboratory

SGS North America Inc. | Minerals Services Division
4665 Paris Street, Suite B-200, Denver, CO 80239 t (303) 373-4772 f (303) 373-4791 www.us.sgs.com/minerals

F-465

Member of the SGS Group

GENERAL CONDITIONS OF SERVICE ON REVERSE

October 26, 2009

Usibelli Coal Mine, Inc.
P.O. Box 1000
Healy, AK 99743
USA

Client Sample ID:	10	**Core Hole ID :**	09JD-06
Date Received:	10/07/2009	**Footage Begin :**	219
Matrix:	Coal	**Footage End :**	231
Net Sample Weight:	1686.90 g	**Sample Type :**	-2" Core
		Seam :	3

SGS Sample ID: 072-41800-010

		As Received	Dry	MAF
% Moisture, Total	[ASTM D 3302]	27.48		
% Ash	[ASTM D 3174/5142]	21.82	30.09	
% Volatile Matter	[ASTM D 5142]	30.13	41.54	59.42
% Fixed Carbon	[ASTM D 3172]	20.57	28.37	40.58
Gross Calorific Value (Btu/lb)	[ASTM D 5865]	6002	8276	11838
% Sulfur	[ASTM D 4239]	0.11	0.15	
% Carbon	[ASTM D 5373]	34.93	48.16	
% Hydrogen	[ASTM D 5373]	2.97	4.10	
% Nitrogen	[ASTM D 5373]	0.40	0.55	
% Oxygen (Calc)	[ASTM D 3176]	12.29	16.95	
% Sulfur, Pyritic - FOS	[ASTMD2492 Mod.]	<0.01	<0.01	
% Sulfur, Sulfate - FOS	[ASTMD2492 Mod.]	<0.01	<0.01	
% Sulfur, Organic - FOS	[ASTMD2492 Mod.]	0.11	0.15	

Analyte	Result	Method
Iodine, Dry	<20 ug/g	SGS Method
Pounds of Ash/mm Btu	36.36 lb	
Pounds of Sulfur/mm Btu	0.18 lb	
Pounds of SO2/mm Btu	0.36 lb	
Reducing - Initial Deformation	2326 °F	ASTM D 1857
Reducing - Softening	2358 °F	ASTM D 1857
Reducing - Hemispherical	2431 °F	ASTM D 1857
Reducing - Fluid	2492 °F	ASTM D 1857
Oxidizing - Initial Deformation	2370 °F	ASTM D 1857
Oxidizing - Softening	2417 °F	ASTM D 1857
Oxidizing - Hemispherical	2527 °F	ASTM D 1857
Oxidizing - Fluid	2607 °F	ASTM D 1857

Respectfully submitted,
SGS NORTH AMERICA INC.

Tony Stopko

Denver Laboratory

SGS North America Inc. | Minerals Services Division
4665 Paris Street, Suite B-200, Denver, CO 80239 t (303) 373-4772 f (303) 373-4791 www.us.sgs.com/minerals

F-465

Member of the SGS Group

GENERAL CONDITIONS OF SERVICE ON REVERSE

October 26, 2009

Usibelli Coal Mine, Inc.
P.O. Box 1000
Healy, AK 99743
USA

Client Sample ID:	11	**Core Hole ID :**	09JD-06
Date Received:	10/07/2009	**Footage Begin :**	231
Matrix:	Coal	**Footage End :**	242
Net Sample Weight:	1850.60 g	**Sample Type :**	-2" Core
		Seam :	3

SGS Sample ID: 072-41800-011

		As Received	Dry	MAF
% Moisture, Total	[ASTM D 3302]	32.13		
% Ash	[ASTM D 3174/5142]	6.14	9.05	
% Volatile Matter	[ASTM D 5142]	33.11	48.78	53.63
% Fixed Carbon	[ASTM D 3172]	28.62	42.17	46.37
Gross Calorific Value (Btu/lb)	[ASTM D 5865]	7375	10866	11947
% Sulfur	[ASTM D 4239]	0.08	0.12	
% Carbon	[ASTM D 5373]	43.10	63.51	
% Hydrogen	[ASTM D 5373]	3.28	4.83	
% Nitrogen	[ASTM D 5373]	0.50	0.73	
% Oxygen (Calc)	[ASTM D 3176]	14.77	21.76	
% Sulfur, Pyritic - FOS	[ASTMD2492 Mod.]	<0.01	<0.01	
% Sulfur, Sulfate - FOS	[ASTMD2492 Mod.]	<0.01	<0.01	
% Sulfur, Organic - FOS	[ASTMD2492 Mod.]	0.08	0.12	

Analyte	Result	Method
Iodine, Dry	<20 ug/g	SGS Method
Pounds of Ash/mm Btu	8.33 lb	
Pounds of Sulfur/mm Btu	0.11 lb	
Pounds of SO2/mm Btu	0.21 lb	
Reducing - Initial Deformation	2395 °F	ASTM D 1857
Reducing - Softening	2412 °F	ASTM D 1857
Reducing - Hemispherical	2428 °F	ASTM D 1857
Reducing - Fluid	2460 °F	ASTM D 1857
Oxidizing - Initial Deformation	2414 °F	ASTM D 1857
Oxidizing - Softening	2417 °F	ASTM D 1857
Oxidizing - Hemispherical	2432 °F	ASTM D 1857
Oxidizing - Fluid	2465 °F	ASTM D 1857

Respectfully submitted,
SGS NORTH AMERICA INC.

Tony Stryker

Denver Laboratory

SGS North America Inc. | Minerals Services Division
4665 Paris Street, Suite B-200, Denver, CO 80239 t (303) 373-4772 f (303) 373-4791 www.us.sgs.com/minerals

F-465

Member of the SGS Group

GENERAL CONDITIONS OF SERVICE ON REVERSE

October 26, 2009

Usibelli Coal Mine, Inc.
P.O. Box 1000
Healy, AK 99743
USA

Client Sample ID:	12	**Core Hole ID :**	09JD-08
Date Received:	10/07/2009	**Footage Begin :**	60
Matrix:	Coal	**Footage End :**	85
Net Sample Weight:	2941.40 g	**Sample Type :**	-2" Core
		Seam :	3

SGS Sample ID: 072-41800-012

		As Received	Dry	MAF
% Moisture, Total	[ASTM D 3302]	31.08		
% Ash	[ASTM D 3174/5142]	8.06	11.70	
% Volatile Matter	[ASTM D 5142]	33.45	48.54	54.97
% Fixed Carbon	[ASTM D 3172]	27.41	39.76	45.03
Gross Calorific Value (Btu/lb)	[ASTM D 5865]	7344	10656	12068
% Sulfur	[ASTM D 4239]	0.10	0.15	
% Carbon	[ASTM D 5373]	42.44	61.58	
% Hydrogen	[ASTM D 5373]	3.31	4.80	
% Nitrogen	[ASTM D 5373]	0.46	0.67	
% Oxygen (Calc)	[ASTM D 3176]	14.55	21.10	
% Sulfur, Pyritic - FOS	[ASTMD2492 Mod.]	<0.01	<0.01	
% Sulfur, Sulfate - FOS	[ASTMD2492 Mod.]	<0.01	<0.01	
% Sulfur, Organic - FOS	[ASTMD2492 Mod.]	0.10	0.15	

Analyte	Result	Method
Iodine, Dry	<20 ug/g	SGS Method
Pounds of Ash/mm Btu	10.98 lb	
Pounds of Sulfur/mm Btu	0.14 lb	
Pounds of SO2/mm Btu	0.27 lb	
Reducing - Initial Deformation	2160 °F	ASTM D 1857
Reducing - Softening	2169 °F	ASTM D 1857
Reducing - Hemispherical	2194 °F	ASTM D 1857
Reducing - Fluid	2244 °F	ASTM D 1857
Oxidizing - Initial Deformation	2233 °F	ASTM D 1857
Oxidizing - Softening	2245 °F	ASTM D 1857
Oxidizing - Hemispherical	2262 °F	ASTM D 1857
Oxidizing - Fluid	2348 °F	ASTM D 1857

Respectfully submitted,
SGS NORTH AMERICA INC.

Tony Stoyko

Denver Laboratory

SGS North America Inc. | Minerals Services Division
4665 Paris Street, Suite B-200, Denver, CO 80239 t (303) 373-4772 f (303) 373-4791 www.us.sgs.com/minerals

F-465

Member of the SGS Group

GENERAL CONDITIONS OF SERVICE ON REVERSE

SGS

October 26, 2009

Usibelli Coal Mine, Inc.
P.O. Box 1000
Healy, AK 99743
USA

Client Sample ID:	13	**Core Hole ID :**	09JD-09
Date Received:	10/07/2009	**Footage Begin :**	45
Matrix:	Coal	**Footage End :**	65
Net Sample Weight:	2303.80 g	**Sample Type :**	-2" Core
		Seam :	4

SGS Sample ID: 072-41800-013

		As Received	Dry	MAF
% Moisture, Total	[ASTM D 3302]	35.10		
% Ash	[ASTM D 3174/5142]	3.05	4.71	
% Volatile Matter	[ASTM D 5142]	33.28	51.28	53.81
% Fixed Carbon	[ASTM D 3172]	28.57	44.01	46.19
Gross Calorific Value (Btu/lb)	[ASTM D 5865]	7187	11074	11621
% Sulfur	[ASTM D 4239]	0.10	0.15	
% Carbon	[ASTM D 5373]	42.46	65.42	
% Hydrogen	[ASTM D 5373]	3.14	4.83	
% Nitrogen	[ASTM D 5373]	0.42	0.65	
% Oxygen (Calc)	[ASTM D 3176]	15.73	24.24	
% Sulfur, Pyritic - FOS	[ASTMD2492 Mod.]	<0.01	<0.01	
% Sulfur, Sulfate - FOS	[ASTMD2492 Mod.]	<0.01	<0.01	
% Sulfur, Organic - FOS	[ASTMD2492 Mod.]	0.10	0.15	

Analyte	Result	Method
Iodine, Dry	<20 ug/g	SGS Method
Pounds of Ash/mm Btu	4.25 lb	
Pounds of Sulfur/mm Btu	0.14 lb	
Pounds of SO2/mm Btu	0.27 lb	
Reducing - Initial Deformation	2387 °F	ASTM D 1857
Reducing - Softening	2399 °F	ASTM D 1857
Reducing - Hemispherical	2411 °F	ASTM D 1857
Reducing - Fluid	2469 °F	ASTM D 1857
Oxidizing - Initial Deformation	2438 °F	ASTM D 1857
Oxidizing - Softening	2454 °F	ASTM D 1857
Oxidizing - Hemispherical	2463 °F	ASTM D 1857
Oxidizing - Fluid	2485 °F	ASTM D 1857

Respectfully submitted,
SGS NORTH AMERICA INC.

Tony Stayko

Denver Laboratory

SGS North America Inc. | Minerals Services Division
4665 Paris Street, Suite B-200, Denver, CO 80239 t (303) 373-4772 f (303) 373-4791 www.us.sgs.com/minerals

Member of the SGS Group

GENERAL CONDITIONS OF SERVICE ON REVERSE

SGS

October 26, 2009

Usibelli Coal Mine, Inc.
P.O. Box 1000
Healy, AK 99743
USA

Client Sample ID:	14	**Core Hole ID :**	09JD-09
Date Received:	10/07/2009	**Footage Begin :**	99
Matrix:	Coal	**Footage End :**	125
Net Sample Weight:	2790.20 g	**Sample Type :**	-2" Core
		Seam :	3

SGS Sample ID: 072-41800-014

		As Received	Dry	MAF
% Moisture, Total	[ASTM D 3302]	30.59		
% Ash	[ASTM D 3174/5142]	5.92	8.53	
% Volatile Matter	[ASTM D 5142]	34.44	49.62	54.25
% Fixed Carbon	[ASTM D 3172]	29.05	41.85	45.75
Gross Calorific Value (Btu/lb)	[ASTM D 5865]	7727	11132	12171
% Sulfur	[ASTM D 4239]	0.09	0.13	
% Carbon	[ASTM D 5373]	44.56	64.20	
% Hydrogen	[ASTM D 5373]	3.44	4.96	
% Nitrogen	[ASTM D 5373]	0.48	0.69	
% Oxygen (Calc)	[ASTM D 3176]	14.92	21.49	
% Sulfur, Pyritic - FOS	[ASTMD2492 Mod.]	0.01	0.01	
% Sulfur, Sulfate - FOS	[ASTMD2492 Mod.]	<0.01	<0.01	
% Sulfur, Organic - FOS	[ASTMD2492 Mod.]	0.08	0.12	

Analyte	Result	Method
Iodine, Dry	<20 ug/g	SGS Method
Pounds of Ash/mm Btu	7.67 lb	
Pounds of Sulfur/mm Btu	0.12 lb	
Pounds of SO2/mm Btu	0.23 lb	
Reducing - Initial Deformation	2313 °F	ASTM D 1857
Reducing - Softening	2317 °F	ASTM D 1857
Reducing - Hemispherical	2330 °F	ASTM D 1857
Reducing - Fluid	2365 °F	ASTM D 1857
Oxidizing - Initial Deformation	2322 °F	ASTM D 1857
Oxidizing - Softening	2335 °F	ASTM D 1857
Oxidizing - Hemispherical	2356 °F	ASTM D 1857
Oxidizing - Fluid	2395 °F	ASTM D 1857

Respectfully submitted,
SGS NORTH AMERICA INC.

Tony Stoyko

Denver Laboratory

SGS North America Inc. | Minerals Services Division
4665 Paris Street, Suite B-200, Denver, CO 80239 t (303) 373-4772 f (303) 373-4791 www.us.sgs.com/minerals

Member of the SGS Group

GENERAL CONDITIONS OF SERVICE ON REVERSE

SGS

October 26, 2009

Usibelli Coal Mine, Inc.
P.O. Box 1000
Healy, AK 99743
USA

Client Sample ID:	15	**Core Hole ID :**	09JD-10
Date Received:	10/07/2009	**Footage Begin :**	65
Matrix:	Coal	**Footage End :**	80
Net Sample Weight:	2301.10 g	**Sample Type :**	-2" Core
		Seam :	6

SGS Sample ID: 072-41800-015

		As Received	Dry	MAF
% Moisture, Total	[ASTM D 3302]	29.31		
% Ash	[ASTM D 3174/5142]	19.42	27.47	
% Volatile Matter	[ASTM D 5142]	30.21	42.73	58.91
% Fixed Carbon	[ASTM D 3172]	21.06	29.80	41.09
Gross Calorific Value (Btu/lb)	[ASTM D 5865]	6009	8500	11720
% Sulfur	[ASTM D 4239]	0.15	0.22	
% Carbon	[ASTM D 5373]	34.93	49.41	
% Hydrogen	[ASTM D 5373]	2.90	4.10	
% Nitrogen	[ASTM D 5373]	0.47	0.66	
% Oxygen (Calc)	[ASTM D 3176]	12.82	18.14	
% Sulfur, Pyritic - FOS	[ASTMD2492 Mod.]	<0.01	0.01	
% Sulfur, Sulfate - FOS	[ASTMD2492 Mod.]	<0.01	<0.01	
% Sulfur, Organic - FOS	[ASTMD2492 Mod.]	0.15	0.21	

Analyte	Result	Method
Iodine, Dry	<20 ug/g	SGS Method
Pounds of Ash/mm Btu	32.31 lb	
Pounds of Sulfur/mm Btu	0.25 lb	
Pounds of SO2/mm Btu	0.51 lb	
Reducing - Initial Deformation	2303 °F	ASTM D 1857
Reducing - Softening	2322 °F	ASTM D 1857
Reducing - Hemispherical	2410 °F	ASTM D 1857
Reducing - Fluid	2481 °F	ASTM D 1857
Oxidizing - Initial Deformation	2328 °F	ASTM D 1857
Oxidizing - Softening	2346 °F	ASTM D 1857
Oxidizing - Hemispherical	2430 °F	ASTM D 1857
Oxidizing - Fluid	2504 °F	ASTM D 1857

Respectfully submitted,
SGS NORTH AMERICA INC.

Tony Stayko

Denver Laboratory

SGS North America Inc | Minerals Services Division
4665 Paris Street, Suite B-200, Denver, CO 80239 t (303) 373-4772 f (303) 373-4791 www.us.sgs.com/minerals

Member of the SGS Group

GENERAL CONDITIONS OF SERVICE ON REVERSE

SGS

October 26, 2009

Usibelli Coal Mine, Inc.
P.O. Box 1000
Healy, AK 99743
USA

Client Sample ID:	16	**Core Hole ID :**	09SW-11C
Date Received:	10/07/2009	**Footage Begin :**	68
Matrix:	Coal	**Footage End :**	80
Net Sample Weight:	1971.50 g	**Sample Type :**	-2" Core
		Seam :	4

SGS Sample ID: 072-41800-016

		As Received	Dry	MAF
% Moisture, Total	[ASTM D 3302]	32.32		
% Ash	[ASTM D 3174/5142]	7.77	11.48	
% Volatile Matter	[ASTM D 5142]	32.77	48.42	54.71
% Fixed Carbon	[ASTM D 3172]	27.14	40.10	45.29
Gross Calorific Value (Btu/lb)	[ASTM D 5865]	7026	10382	11729
% Sulfur	[ASTM D 4239]	0.19	0.28	
% Carbon	[ASTM D 5373]	40.90	60.44	
% Hydrogen	[ASTM D 5373]	3.11	4.60	
% Nitrogen	[ASTM D 5373]	0.48	0.71	
% Oxygen (Calc)	[ASTM D 3176]	15.23	22.49	
% Sulfur, Pyritic - FOS	[ASTMD2492 Mod.]	<0.01	<0.01	
% Sulfur, Sulfate - FOS	[ASTMD2492 Mod.]	<0.01	<0.01	
% Sulfur, Organic - FOS	[ASTMD2492 Mod.]	0.19	0.28	

Analyte	Result	Method
Iodine, Dry	<20 ug/g	SGS Method
Pounds of Ash/mm Btu	11.06 lb	
Pounds of Sulfur/mm Btu	0.27 lb	
Pounds of SO2/mm Btu	0.54 lb	
Reducing - Initial Deformation	2123 °F	ASTM D 1857
Reducing - Softening	2136 °F	ASTM D 1857
Reducing - Hemispherical	2174 °F	ASTM D 1857
Reducing - Fluid	2230 °F	ASTM D 1857
Oxidizing - Initial Deformation	2252 °F	ASTM D 1857
Oxidizing - Softening	2263 °F	ASTM D 1857
Oxidizing - Hemispherical	2293 °F	ASTM D 1857
Oxidizing - Fluid	2348 °F	ASTM D 1857

Respectfully submitted,
SGS NORTH AMERICA INC.

Tony Stoyko

Denver Laboratory

SGS North America Inc. | Minerals Services Division
4665 Paris Street, Suite B-200, Denver, CO 80239 t (303) 373-4772 f (303) 373-4791 www.us.sgs.com/minerals

Member of the SGS Group

GENERAL CONDITIONS OF SERVICE ON REVERSE

SGS

October 26, 2009

Usibelli Coal Mine, Inc.
P.O. Box 1000
Healy, AK 99743
USA

Client Sample ID:	17	**Core Hole ID :**	09SW-11C
Date Received:	10/07/2009	**Footage Begin :**	110
Matrix:	Coal	**Footage End :**	118
Net Sample Weight:	1549.30 g	**Sample Type :**	-2" Core
		Seam :	3

SGS Sample ID: 072-41800-017

		As Received	Dry	MAF
% Moisture, Total	[ASTM D 3302]	30.63		
% Ash	[ASTM D 3174/5142]	8.31	11.97	
% Volatile Matter	[ASTM D 5142]	33.25	47.93	54.45
% Fixed Carbon	[ASTM D 3172]	27.81	40.10	45.55
Gross Calorific Value (Btu/lb)	[ASTM D 5865]	7183	10355	11763
% Sulfur	[ASTM D 4239]	0.09	0.13	
% Carbon	[ASTM D 5373]	41.82	60.29	
% Hydrogen	[ASTM D 5373]	3.22	4.64	
% Nitrogen	[ASTM D 5373]	0.51	0.74	
% Oxygen (Calc)	[ASTM D 3176]	15.42	22.23	
% Sulfur, Pyritic - FOS	[ASTMD2492 Mod.]	<0.01	<0.01	
% Sulfur, Sulfate - FOS	[ASTMD2492 Mod.]	<0.01	<0.01	
% Sulfur, Organic - FOS	[ASTMD2492 Mod.]	0.09	0.13	

Analyte	Result	Method
Iodine, Dry	<20 ug/g	SGS Method
Pounds of Ash/mm Btu	11.56 lb	
Pounds of Sulfur/mm Btu	0.13 lb	
Pounds of SO2/mm Btu	0.25 lb	
Reducing - Initial Deformation	2139 °F	ASTM D 1857
Reducing - Softening	2146 °F	ASTM D 1857
Reducing - Hemispherical	2163 °F	ASTM D 1857
Reducing - Fluid	2223 °F	ASTM D 1857
Oxidizing - Initial Deformation	2176 °F	ASTM D 1857
Oxidizing - Softening	2182 °F	ASTM D 1857
Oxidizing - Hemispherical	2196 °F	ASTM D 1857
Oxidizing - Fluid	2242 °F	ASTM D 1857

Respectfully submitted,
SGS NORTH AMERICA INC.

Tony Stayho

Denver Laboratory

SGS North America Inc. | Minerals Services Division
4665 Paris Street, Suite B-200, Denver, CO 80239 t (303) 373-4772 f (303) 373-4791 www.us.sgs.com/minerals

Member of the SGS Group

GENERAL CONDITIONS OF SERVICE ON REVERSE

October 26, 2009

Usibelli Coal Mine, Inc.
P.O. Box 1000
Healy, AK 99743
USA

Client Sample ID:	18	**Core Hole ID :**	09SW-12C
Date Received:	10/07/2009	**Footage Begin :**	23
Matrix:	Coal	**Footage End :**	42
Net Sample Weight:	2223.70 g	**Sample Type :**	-2" Core
		Seam :	4

SGS Sample ID: 072-41800-018

		As Received	Dry	MAF
% Moisture, Total	[ASTM D 3302]	31.01		
% Ash	[ASTM D 3174/5142]	6.58	9.54	
% Volatile Matter	[ASTM D 5142]	34.17	49.53	54.75
% Fixed Carbon	[ASTM D 3172]	28.24	40.93	45.25
Gross Calorific Value (Btu/lb)	[ASTM D 5865]	7414	10747	11880
% Sulfur	[ASTM D 4239]	0.19	0.28	
% Carbon	[ASTM D 5373]	43.21	62.63	
% Hydrogen	[ASTM D 5373]	3.29	4.77	
% Nitrogen	[ASTM D 5373]	0.48	0.70	
% Oxygen (Calc)	[ASTM D 3176]	15.24	22.08	
% Sulfur, Pyritic - FOS	[ASTMD2492 Mod.]	0.01	0.02	
% Sulfur, Sulfate - FOS	[ASTMD2492 Mod.]	<0.01	<0.01	
% Sulfur, Organic - FOS	[ASTMD2492 Mod.]	0.18	0.26	

Analyte	Result	Method
Iodine, Dry	<20 ug/g	SGS Method
Pounds of Ash/mm Btu	8.88 lb	
Pounds of Sulfur/mm Btu	0.26 lb	
Pounds of SO2/mm Btu	0.52 lb	
Reducing - Initial Deformation	2080 °F	ASTM D 1857
Reducing - Softening	2086 °F	ASTM D 1857
Reducing - Hemispherical	2108 °F	ASTM D 1857
Reducing - Fluid	2142 °F	ASTM D 1857
Oxidizing - Initial Deformation	2252 °F	ASTM D 1857
Oxidizing - Softening	2258 °F	ASTM D 1857
Oxidizing - Hemispherical	2268 °F	ASTM D 1857
Oxidizing - Fluid	2302 °F	ASTM D 1857

Respectfully submitted,
SGS NORTH AMERICA INC.

Tony Stayer

Denver Laboratory

SGS North America Inc. | Minerals Services Division
4665 Paris Street, Suite B-200, Denver, CO 80239 t (303) 373-4772 f (303) 373-4791 www.us.sgs.com/minerals

F-463

Member of the SGS Group

GENERAL CONDITIONS OF SERVICE ON REVERSE

SGS

October 26, 2009

Usibelli Coal Mine, Inc.
P.O. Box 1000
Healy, AK 99743
USA

Client Sample ID: 19
Date Received: 10/07/2009
Matrix: Coal
Net Sample Weight: 2479.00 g

Core Hole ID : 09SW-12C
Footage Begin : 110
Footage End : 134
Sample Type : -2" Core
Seam : 3

SGS Sample ID: 072-41800-019

		As Received	Dry	MAF
% Moisture, Total	[ASTM D 3302]	30.43		
% Ash	[ASTM D 3174/5142]	9.82	14.11	
% Volatile Matter	[ASTM D 5142]	33.13	47.62	55.44
% Fixed Carbon	[ASTM D 3172]	26.62	38.27	44.56
Gross Calorific Value (Btu/lb)	[ASTM D 5865]	7107	10215	11894
% Sulfur	[ASTM D 4239]	0.10	0.14	
% Carbon	[ASTM D 5373]	41.30	59.37	
% Hydrogen	[ASTM D 5373]	3.19	4.59	
% Nitrogen	[ASTM D 5373]	0.50	0.72	
% Oxygen (Calc)	[ASTM D 3176]	14.66	21.07	
% Sulfur, Pyritic - FOS	[ASTMD2492 Mod.]	<0.01	<0.01	
% Sulfur, Sulfate - FOS	[ASTMD2492 Mod.]	<0.01	<0.01	
% Sulfur, Organic - FOS	[ASTMD2492 Mod.]	0.10	0.14	

Analyte	Result	Method
Iodine, Dry	<20 ug/g	SGS Method
Pounds of Ash/mm Btu	13.81 lb	
Pounds of Sulfur/mm Btu	0.14 lb	
Pounds of SO2/mm Btu	0.28 lb	
Reducing - Initial Deformation	2241 °F	ASTM D 1857
Reducing - Softening	2282 °F	ASTM D 1857
Reducing - Hemispherical	2325 °F	ASTM D 1857
Reducing - Fluid	2396 °F	ASTM D 1857
Oxidizing - Initial Deformation	2328 °F	ASTM D 1857
Oxidizing - Softening	2334 °F	ASTM D 1857
Oxidizing - Hemispherical	2406 °F	ASTM D 1857
Oxidizing - Fluid	2450 °F	ASTM D 1857

Respectfully submitted,
SGS NORTH AMERICA INC.

Tony Stoyko
Denver Laboratory

SGS North America Inc. | Minerals Services Division
4665 Paris Street, Suite B-200, Denver, CO 80239 t (303) 373-4772 f (303) 373-4791 www.us.sgs.com/minerals

Member of the SGS Group

GENERAL CONDITIONS OF SERVICE ON REVERSE

CHAPTER IV

HYDROGEOLOGY

TABLE OF CONTENTS

1.0 INTRODUCTION CIV-1

2.0 METHODOLOGY CIV-1

2.1 APPROACH CIV-1

2.2 DATA SOURCES CIV-2

2.2.1 Previous Investigations and Studies CIV-2

2.2.2 Recent (2007-9) Investigations CIV-2

2.3 BASELINE DATA SUMMARY CIV-3

2.3.1 Seasonal Variation of Groundwater Levels CIV-7

2.3.2 Hydraulic Conductivity CIV-8

2.3.3 Discharge Rates CIV-13

2.3.4 Transmissivity CIV-13

2.3.5 Storage Coefficient CIV-14

2.3.6 Well Yields CIV-14

2.3.7 Ground Water Quality CIV-15

3.0 PROJECT AREA HYDROGEOLOGY CIV-23

3.1 HYDROGEOLOGIC UNITS CIV-23

3.2 DIRECTION AND GRADIENT OF GROUND WATER FLOW CIV-24

3.3 GROUND WATER RECHARGE, DISCHARGE AND CONTRIBUTION TO BASE FLOW CIV-24

4.0 GENERAL AREA HYDROGEOLOGY CIV-25

5.0 REFERENCES CIV-26

6.0 RESPONSIBLE PARTY CIV-26

LIST OF TABLES

CIV-1 Monitoring Well Completion Summary CIV-4
CIV-2 Ground Water Level Data Summary CIV-9
CIV-3 Hydraulic Conductivity Data Summary..... CIV-12
CIV-4 Summary of Aquifer Transmissivity Values CIV-14
CIV-5 Water Quality Parameters CIV-17
CIV-6 Summary of Ground Water Quality Monitoring..... CIV-20
CIV-7 Summary of Initial Baseline Ground Water Quality Data CIV-21
CIV-8 Summary of Additional Baseline Ground Water Quality Data……..CIV-22

LIST OF FIGURES

CIV-1 TYPICAL MONITORING WELL COMPLETION.....CIV-6

LIST OF PLATES

CIV-1 MONITORING WELL LOCATIONS.....CIV-27
CIV-2 POTENTIOMETRIC SURFACE MAP & CROSS-SECTION INDEX…….CIV-28
CIV-3 HYDROGEOLOGIC CROSS-SECTIONS.....CIV-29

LIST OF APPENDICES

CIV-1 HYDROGEOLOGICAL EVALUATION REPORT, JUMBO DOME MINE…....CIV-30

1.0 INTRODUCTION

Per Section 047 (Ground Water Information) of Article 4 (Environmental Resource Information Requirements) of 11 AAC 90, each permit application shall include *"a description of the ground water hydrology for the proposed mining area."* Therefore, Chapter CIV of the permit application describes groundwater flow and quality characteristics, ground water monitoring schedules, and general aquifer morphology within the Jumbo Dome Mine area which also applies to the regional hydrogeology.

2.0 METHODOLOGY

2.1 APPROACH

Specific components of the hydrogeologic evaluation required by 11 ACC 90 include:

- the depths, thickness and aerial distributions of water-bearing units within the mining area;
- stratigraphy of the aquifer matrices;
- ground water uses;
- ground water quality;
- ground water/surface water interactions; and,
- recharge, storage, and discharge characteristics of the aquifers.

In order to address the above concerns, UCM relied on past observations and studies from the general area (Hoseanna Creek Valley) to develop a conceptual model of the groundwater regime for existing mine areas and expanded it to the Jumbo Dome Mine area. This was based on the extension of the geologic formation as well as indications from previous exploration drilling and preliminary geotechnical and hydrological studies. UCM developed a detailed and thorough baseline program to confirm the regional conceptual model as it applies to the Jumbo Dome Mine area. This model can be applied regionally within these geologic formations. The basic points of the model are:

- The coal seams act as the primary water bearing unit. Coal seams generally have a higher permeability than the adjacent strata with groundwater storage and movement being predominantly fracture controlled.
- The overlying sandstone units act as aquitards, being of a lower permeability. The sandstones are hydrologically tied to the underlying coal seams, with the coal/sandstone forming one hydrostratigraphic unit.
- The underclays and/or siltstones act as efficient aquicludes.
- Fault systems generally act as hydrogeologic conduits and behave as recharge boundaries where they intersect coal seams.
- Groundwater systems generally contribute to stream surface flow where the drainage valleys intersect the coal outcrops.

2.2 DATA SOURCES

2.2.1 Previous Investigations and Studies

UCM's predecessors, including AMAX Coal Company (AMAX), conducted an extensive series of exploration drilling programs from 1972 through 1975 in the Jumbo Dome mining area to evaluate coal reserves and characterize site geology. Pertinent geologic logs generated from the AMAX drilling programs are available from the UCM mine offices in Healy.

2.2.2 Recent (2007-2010) Investigation

UCM has also conducted a comprehensive exploration drilling program from 2007 through 2010 to further evaluate the coal reserves, install monitoring wells, and characterize subsurface lithology and groundwater conditions, including aquifer testing. Geologic logs generated from the UCM drilling program are included in Appendix CII-1. UCM's logs also include information regarding the occurrence of ground water. As is the case regionally, indications were that the coal seams act as the primary water bearing units. Field aquifer tests performed during the 2009 and 2010 drilling programs in a selection of the monitoring wells provided

hydraulic conductivity, storativity, and transmissivity data in both the 3 and 4 seams specific to the Jumbo Dome mine area.

For the 19 monitoring wells installed by UCM from 2007 through 2010, water levels have been periodically measured between September 2007 and December 2010. The data also indicates that the coal seams are the primary water-bearing units within the Jumbo Dome project area. Three of the 19 existing monitoring wells, 07JDA, 07JD10, and 07JD12, were utilized by DNR-DMLW to complete the initial baseline monitoring program for the area. DNR-DMLW has requested additional baseline data for all seams above and below mining. The existing monitoring well locations are presented on Plate CIV-1, Monitoring Well Locations. Completion summaries for the monitoring wells are included in Table CIV-1, Monitoring Well Completion Summary and on the geologic and well construction logs provided in Appendix CII-1. A standard monitoring well schematic is shown on Figure CIV-1.

Monthly water levels were collected during September, October, and/or December of 2007 and January, February, March, and/or June of 2008 for the three 2007 monitoring wells. Monthly water levels were collected during July, September (early, late), November (early, late), and/or December of 2008 for 11 monitoring wells. Monthly water levels were collected during January, February, and April through December of 2009 for 11 monitoring wells. Monthly water levels were collected in 19 wells, including the 8 wells drilled in 2010 following completion in September 2010. Some mid-winter water levels were measured despite logistical problems with the well equipment in cold temperatures. Water quality samples were collected from the 3 monitoring wells listed previously for field and laboratory analyses during October 2007, May 2008, December 2009, and August 2010. Results from the groundwater program are discussed in further detail in Section 2.3 of this chapter.

2.3 BASELINE FIELD DATA SUMMARY

This subsection provides a discussion of the procedures and methods used to gather baseline ground water information and a summary of the baseline data. Completion summaries for the monitoring wells are provided in Table CIV-1.

TABLE CIV-1

MONITORING WELL COMPLETION SUMMARY

Monitoring Well/ Piezometer Number	Date Completed	Location		Surface Elevation (in feet)[2]	PVC Casing Stickup (in feet)[3]	Casing/Screen Diameter (in inches)	Effective Screen Zone[4] (in feet bgs)	Total Well Depth (in feet bgs)	Water-bearing Units Monitored[6]
		Northing (in feet)[1]	Easting (in feet)[1]						
07JDA	09/05/07	3652942.87	702894.51	2164.53	2.55	2	128-148	148	3 Seam
07JD10	08/29/07	3658098.89	704189.66	1971.49	4.20	2	168-197	197	3 Seam
07JD12	08/29/07	3657356.19	702681.73	2007.18	2.00	2	188-208	208	3 Seam
08JD01A	06/26/08	3653092.48	704701.97	2340.68	2.85	2	101-112	112	4 Seam
08JD01B	06/25/08	3653079.51	704687.30	2340.07	2.73	2	171-191	191	3 Seam
08JD02A	06/29/08	3655671.06	701259.57	2044.39	2.75	2	101-138	138	4 Seam
08JD02B	06/30/08	3655675.68	701271.68	2044.43	2.44	2	169-194	194	3 Seam
08JD03A	07/03/08	3657395.82	705385.64	2144.66	1.68	2	202-238	238	4 Seam
08JD03B	07/02/08	3657343.84	705376.35	2146.33	1.42	2	270-298	298	3 Seam
08JD04	07/05/08	3660487.10	704496.53	1921.57	3.85	2	64-90	90	6 Seam
10JD01	9/13/2010	3651249.1	704109.5	2436.2	3	4	194-204	230	3 Seam
10JD01A	9/1/2010	3651268.342	704064.034	2431.67	3	2	198-218	232	3 Seam
10JD02	9/6/2010	3651423.311	704102.016	2429.837	3	4	143-163	173	4 Seam
10JD02A	9/16/2010	3651379.8	704058	2427.1	3	2	124-154	170	4 Seam
10JD03	9/23/2010	3659464.4	704818.1	1934.8	3	4	300-320	364	3 Seam
10JD04	9/19/2010	3659554.8	704827.9	1932.9	3	4	129-139	156	5 Seam
10JD05 Alt	9/26/2010	3652263.4	702438.2	2210.2	2	2	159-179	193	4 Seam

TABLE CIV-1

MONITORING WELL COMPLETION SUMMARY

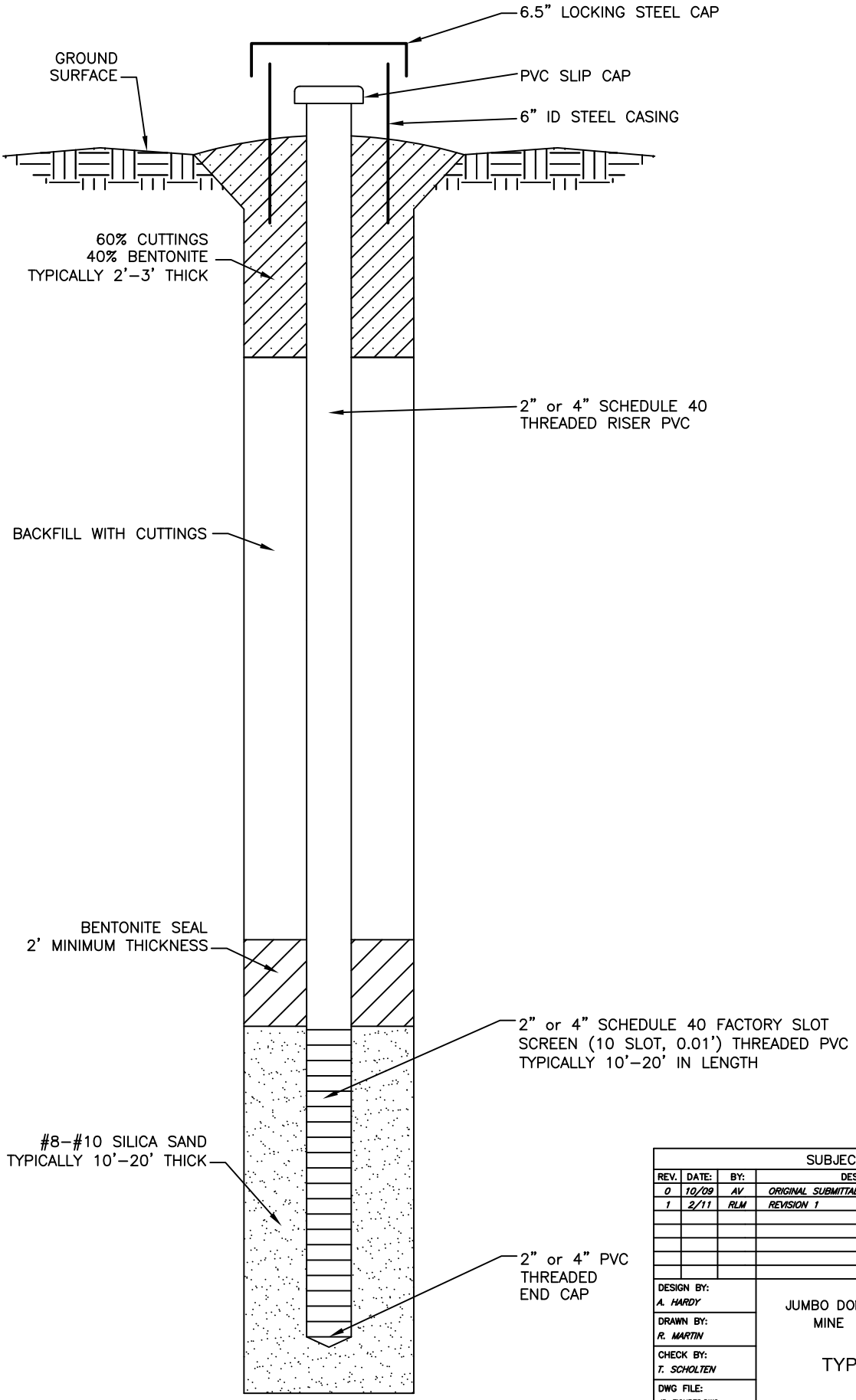
Monitoring Well/ Piezometer Number	Date Completed	Location		Surface Elevation (in feet)[2]	PVC Casing Stickup (in feet)[3]	Casing/Screen Diameter (in inches)	Effective Screen Zone[4] (in feet bgs)	Total Well Depth (in feet bgs)	Water-bearing Units Monitored[6]
		Northing (in feet)[1]	Easting (in feet)[1]						
10JD06 Alt	9/27/2010	3652121.6	702331.6	2222.3	2	2	123-143	157	3 Seam

Notes:

1. All coordinates directly surveyed by UCM.
2. All elevations directly surveyed by UCM.
3. Stickup measured by UCM.
4. Includes filter pack and any backfill zones below the bentonite seal and above the bottom of the borehole.
5. Copies of geologic and well completion logs are provided in Appendix CII-1.

FIGURE CIV-1

TYPICAL MONITORING WELL COMPLETION



NOTE: CONSTRUCTION OF SOME EXISTING PIEZOMETERS DIFFER FROM THE SPECIFICATIONS SHOWN IN THIS FIGURE.

SUBJECT REVISIONS

REV.	DATE:	BY:	DESCRIPTION
0	10/09	AV	ORIGINAL SUBMITTAL
1	2/11	RLM	REVISION 1

DESIGN BY: A. HARDY
DRAWN BY: R. MARTIN
CHECK BY: T. SCHOLTEN
DWG FILE: JD_FIGURES.DWG
DATE DRAWN: 1/31/2011

JUMBO DOME MINE

USIBELLI COAL MINE INC. UCM

PERMIT NUMBER

TYPICAL MONITORING WELL COMPLETION

JUMBO DOME MINE

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743
(907) 683–2226

FIGURE No. CIV–1
SHEET No. 1 OF 1
REV. 0

2.3.1 Seasonal Variation of Groundwater Levels

Sampling dates for ground water level data from the wells of the Jumbo Dome project area are summarized in Table CIV-2, Ground Water Level Data Summary. Measurement dates between September 2007 and December 2010 are listed in Section 2.2.2, the results of which vary according to year of well construction and climatic and groundwater conditions at the time of measurement. Water level fluctuations and temporal water-level trends within a specific water-bearing unit are noted below. For this discussion, level changes of less than 2 feet are considered "minor." Most of the wells had fluctuations near 1 foot or less.

- The 3 seam monitoring wells can be grouped into two types. The seven wells installed east of Marguerite Creek and 08JD02B installed above and west of Marguerite Creek have been fairly stable and show no significant seasonal changes in over a year (at least 10 measurements) of water level readings. The second set of 3 seam monitoring wells includes 07JD10, 07JD12 and 10JD03. These latter three wells are artesian. Wells 07JD10 and 07JD12 have recorded significant seasonal variations (both increasing and decreasing) with perhaps the most significant changes (increase of up to 6 feet followed by decrease of up to 12 feet) during the summer and fall of 2008. Water levels increased from approximately November 2007 through to spring 2008 and then dropped from mid to late summer 2008 through November 2008. This would signify a decrease in discharge (in proportion to recharge) into Marguerite Creek. One of the 3 seam wells is located just north of the mining boundary, 10JD03 will illustrate water quality in the 3 seam down gradient from mining.

- The 4 seam monitoring wells show minor seasonal variation. This close range shows a very stable aquifer with a steady discharge/recharge relationship. Five of the 4 seam wells are installed close to the 6 seam outcrop east of Marguerite Creek above the 2,000 ft. elevation. The other two 4 seam wells are installed closer to Marguerite Creek just outside the western limits of the proposed Jumbo Dome mining area. Water level readings in all four 4 seam monitoring wells imply confining conditions for the 4 seam aquifer.

- A 5 seam well was installed east of Marguerite Creek in the fall of 2010. 10JD04 is located just north of the mining boundary, was installed within the floodplain of Marguerite creek and is

artesian. As this well does not yet have significant data from which to discuss seasonal fluctuations in groundwater level, it is reasonable to assume it will behave similar to the 6 seam well located just down gradient.

- The 6 seam monitoring well is installed just west of the northern end of the proposed Jumbo Dome mining area and within the Marguerite Creek flood plain. Seasonal fluctuations in this well have been no more than 4 feet with expected patterns of change; that is, high water levels in winter and spring and decreasing throughout the summer and fall as recharge is less than discharge volumes once snowmelt and summer thunderstorms have finished.

2.3.2 Hydraulic Conductivity

Available hydraulic conductivity data are presented in Table CIV-3, Hydraulic Conductivity Data Summary. Aquifer tests from which the data were calculated include three slug tests conducted in 2009 from two 2008 monitoring wells and one 2007 monitoring well; and validated by aquifer tests performed in 2010, both drawdown (performed in 4 wells) and slug tests (performed in 2 wells). Data were collected from the 3 and 4 coal seams. Available data indicate that coal seams are moderately to relatively permeable units, having hydraulic conductivity values similar to fine uncemented sands or fractured rock. The 4 seam displays a range that is slightly lower than the 3 seam data ranges. Hydraulic conductivity values calculated from tests performed on the 3 coal seam is typically 1.7×10^{-3} ft/min. Hydraulic conductivity values calculated from tests performed on the 4 coal seam is typically 6.2×10^{-4} ft/min. Aquifer tests performed at other UCM mine properties indicate lower hydraulic conductivities for the sandstone interburden layers, typically around 1×10^{-5} to 1×10^{-6} ft/min. This agrees with observations made during drilling activities at Jumbo Dome (where sustained discharge of water is usually encountered from within the coal seams and not the overlying sandstones) and from surrounding mine areas and exposures along creeks (where sustained flow generally emanates from the coal seams and not from sandstone strata).

TABLE CIV-2

GROUND WATER LEVEL DATA SUMMARY

Page 1 of 3

Monitoring Well Number	Range of Ground Water Depth Measurements From Ground Surface (in feet)	Difference Between High and Low Ground Water Depths (in feet)	Top of PVC Casing Elevation (in feet)[1]	Measurement Dates[2]																Water-bearing Unit
				9/27/07	10/18/07	12/19/07	1/30/08	2/28/08	3/25/08	7/10/08	9/3/08	9/27/08	11/1/08	11/22/08	12/19/08	1/31/09	2/24/09	4/2/09	5/20/09	
07JDA	44.4-53.4	9.0	2167.08	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	3 Seam
07JD10	(-45.8)-(-62.0)	16.2	1975.69	✓	✓	F	F	✓	F	✓	F	✓	✓	F	F	F	F	F	F	3 Seam
07JD12	(-6.6)-(-18.2)	11.6	2009.18	✓	✓	F	✓	✓	F	✓	F	✓	F	F	F	F	F	F	F	3 Seam
08JD01A	97.2-99.5	2.3	2343.53	n/a	n/a	n/a	n/a	n/a	n/a	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	4 Seam
08JD01B	45.2-53.7	8.5	2342.80	n/a	n/a	n/a	n/a	n/a	n/a	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓[3]	3 Seam
08JD02A	35.5-37.2	1.7	2047.14	n/a	n/a	n/a	n/a	n/a	n/a	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	4 Seam
08JD02B	28.1-29.1	1.0	2046.87	n/a	n/a	n/a	n/a	n/a	n/a	✓	✓[3]	✓	✓	✓	✓	✓	✓	✓	✓	3 Seam
08JD03A	193.9-194.3	0.4	2146.34	n/a	n/a	n/a	n/a	n/a	n/a	✓	✓[3]	✓	✓	✓	✓	✓	✓	✓	✓	4 Seam
08JD03B	148.1-150.1	2.0	2147.75	n/a	n/a	n/a	n/a	n/a	n/a	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	3 Seam
08JD04	4.7-(-2.5)	7.2	1925.42	n/a	n/a	n/a	n/a	n/a	n/a	✓	✓	✓	✓	✓	✓	✓	✓	✓	n/a	6 Seam
08JD05	(-1.9)-(-2.4)	0.5	1947.86	n/a	n/a	n/a	n/a	n/a	n/a	✓	✓[3]	✓	✓	✓	✓	✓	✓	✓	✓	4 Seam

TABLE CIV-2

GROUND WATER LEVEL DATA SUMMARY

Page 2 of 3

Monitoring Well Number	Range of Ground Water Depth Measurements From Ground Surface (in feet)	Difference Between High and Low Ground Water Depths (in feet)	Top of PVC Casing Elevation (in feet)[1]	Measurement Dates[2]							Water-bearing Unit
				6/25/09	7/14/09	8/25/09	9/24/09	10/21/09	11/24/09	12/23/09	
07JDA	44.4-53.4	9.0	2167.08	✓	✓	✓	✓	✓	✓	✓	3 Seam
07JD10	(-45.8)-(-62.0)	16.2	1975.69	n/a	n/a	✓	✓	✓	n/a	n/a	3 Seam
07JD12	(-6.6)-(-18.2)	11.6	2009.18	n/a	n/a	✓	✓	✓	n/a	n/a	3 Seam
08JD01A	97.2-99.5	2.3	2343.53	✓	✓	✓	✓	✓	✓	✓	4 Seam
08JD01B	45.2-53.7	8.5	2342.80	✓	✓	✓	✓	✓	✓	✓	3 Seam
08JD02A	35.5-37.2	1.7	2047.14	✓	✓	✓	✓	✓	✓	✓	4 Seam
08JD02B	28.1-29.1	1.0	2046.87	✓	✓	✓	✓	✓	✓	✓	3 Seam
08JD03A	193.9-194.3	0.4	2146.34	✓	✓	✓	✓	✓	✓	✓	4 Seam
08JD03B	148.1-150.1	2.0	2147.75	✓	✓	✓	✓	✓	✓	✓	3 Seam
08JD04	4.7-(-2.5)	7.2	1925.42	✓	✓	✓	✓	✓	✓	✓	6 Seam
08JD05	(-1.9)-(-2.4)	0.5	1947.86	n/a	n/a	n/a	n/a	n/a	n/a	n/a	4 Seam

NOTES:

1. All elevations directly surveyed by UCM.
2. Measurements made within 1 week of well completion are not included. All measurements made by UCM personnel.
3. Measurements resulted in unusual and significant drop in water level possibly indicating false reading; data not included in this summary.

LEGEND: ✓= measurement was made.

F = measurement was attempted; well was frozen.

n/a = measurement not applicable or not possible due to adverse travel conditions.

TABLE CIV-2

GROUND WATER LEVEL DATA SUMMARY

Page 3 of 3

Monitoring Well Number	Range of Ground Water Depth Measurements From Ground Surface (in feet)	Difference Between High and Low Ground Water Depths (in feet)	Top of PVC Casing Elevation (in feet)[1]	Measurement Dates[2]										Water-bearing Unit
				2/01/10	2/24/10	3/31/10	4/29/10	6/12/10	7/7/10	8/10/10	9/25/10	10/27/10	11/19/10	
07JDA	44.4-53.4	9.0	2167.08	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	3 Seam
07JD10	(-45.8)-(-62.0)	16.2	1975.69	✓	✓	F	F	✓	F	✓	F	✓	✓	3 Seam
07JD12	(-6.6)-(-18.2)	11.6	2009.18	✓	✓	F	✓	✓	F	✓	F	✓	F	3 Seam
08JD01A	97.2-99.5	2.3	2343.53	n/a	n/a	n/a	n/a	n/a	n/a	✓	✓	✓	✓	4 Seam
08JD01B	45.2-53.7	8.5	2342.80	n/a	n/a	n/a	n/a	n/a	n/a	✓	✓	✓	✓	3 Seam
08JD02A	35.5-37.2	1.7	2047.14	n/a	n/a	n/a	n/a	n/a	n/a	✓	✓	✓	✓	4 Seam
08JD02B	28.1-29.1	1.0	2046.87	n/a	n/a	n/a	n/a	n/a	n/a	✓	✓[3]	✓	✓	3 Seam
08JD03A	193.9-194.3	0.4	2146.34	n/a	n/a	n/a	n/a	n/a	n/a	✓	✓[3]	✓	✓	4 Seam
08JD03B	148.1-150.1	2.0	2147.75	n/a	n/a	n/a	n/a	n/a	n/a	✓	✓	✓	✓	3 Seam
08JD04	4.7-(-2.5)	7.2	1925.42	n/a	n/a	n/a	n/a	n/a	n/a	✓	✓	✓	✓	6 Seam
08JD05	(-1.9)-(-2.4)	0.5	1947.86	n/a	n/a	n/a	n/a	n/a	n/a	✓	✓[3]	✓	✓	4 Seam
10JD01	117.3-117.5	0.2	2436.19	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	✓	✓	3 Seam
10JD01A	113.85-114.1	0.25	2431.67	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	✓	✓	3 Seam
10JD02	107.3-108.5	0.7	2429.84	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	✓	✓	4 Seam
10JD02A	104.7-105.3	0.6	2427.10	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	✓	✓	4 Seam
10JD03	n/a	n/a	1934.80	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	3 Seam

10JD04	n/a	n/a	1932.90	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	5 Seam
10JD05 Alt	95.7-96.0	0.3	2210.21	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	✓	✓	4 Seam
10JD06 Alt	109.25-109.7	0.45	2222.26	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	✓	✓	3 Seam

TABLE CIV-3

HYDRAULIC CONDUCTIVITY DATA SUMMARY

Water-bearing Unit	Well Number[1]	Test Interval (in ft bgs)	Test Date	Test Type[2]	Method of Analysis[2]	Hydraulic Conductivity (in ft/min)
3 Seam	07JDA	128-148	09/21/09	Slug	Bouwer and Rice	1.7×10^{-3}
	08JD03B	270-298	09/21/09	Slug	Bouwer and Rice	1.7×10^{-3}
4 Seam	08JD03A	202-238	09/21/09	Slug	Bouwer and Rice	6.2×10^{-4}

Notes:

1. All wells are located at Jumbo Dome.
2. A description of test types and methods of analysis is presented in Fetter (1988).
3. Copies of field data sheets and office calculations are available from the UCM project files.

2.3.3 Discharge Rates

Ground water contributions to surface flow in creek drainages can be estimated assuming all surface flow during the winter months results from ground water discharge. This is a rational assumption based on temporal/seasonal surface flow characteristics (see Chapter CV) and the average air temperatures during the colder months, which are below the freezing point of water and, therefore, act to freeze all sources of surface water flow except ground water contributions. Flow data collected during the colder months are limited to discharges measured in February 2007, March 2005, and March 2008 from monitoring stations in the lower reaches of Emma Creek, and in March 2005 in Lower Marguerite Creek and Middle Marguerite Creek (see Table CV-3).

The average high and low temperatures recorded for March in the general area are 27.6°F and 5.5°F, respectively. Therefore, surface runoff from snowmelt is expected to be limited during March in the project drainages. Discharges from the site creeks measured on the dates indicated above include:

- Lower Emma Creek – 2.82 cfs (1,266 gpm) to 56.3 cfs (25,269 gpm);
- Lower Marguerite Creek – 4.98 cfs (2,235 gpm); and,
- Middle Marguerite Creek – 3.96 cfs (1,777 gpm).

The surface flows shown above are thought to be primarily ground water contributions to site creeks.

2.3.4 Transmissivity

Aquifer transmissivity is a measure of the volume of water that can be transmitted horizontally by the full saturated thickness of the aquifer under a hydraulic gradient of 1. Using hydraulic conductivity values presented in Table CIV-3, a range of transmissivity values can be calculated for the 3 and 4 coal seams, based on the equation (Fetter, 1980):

$$T=KB$$

where: T = transmissivity (L^2/t);

K = hydraulic conductivity (L/t); and

B = saturated aquifer thickness (L).

The thickness assigned to each coal aquifer for the purpose of transmissivity calculations is based on the average thickness of each unit within the excavation boundary. Transmissivity values are summarized below:

TABLE CIV-4

SUMMARY OF AQUIFER TRANSMISSIVITY VALUES

Coal Seam	Hydraulic Conductivity (ft/min)	Aquifer Thickness (ft)	Transmissivity (ft^2/min)
3	1.7×10^{-3}	15-40	4.0×10^{-2} to 4.6×10^{-2}
4	6.2×10^{-4}	10-50	2.6×10^{-2}

2.3.5 Storage Coefficient

The storage coefficient of an aquifer, or storativity, is a dimensionless value representing the volume of water that the aquifer will absorb or expel from storage per unit surface area per unit change in head (Fetter, 1980). Storativity values determined from pump tests performed in the 3 and 4 coal seams of the Suntrana Formation in 1985 and 1991 ranged from 10^{-3} to 10^{-4} (Golder, 1985 and Golder, 1991). This storage is a combination of the fractures within the Suntrana coal seams (primary control) and drainage from the overlying Suntrana sandstone units (secondary).

2.3.6 Well Yields

Pump tests were performed in October of 2010 at 4 wells drilled and installed within the Jumbo Dome area in. There were two-well pairs used to perform the tests; a 4” diameter pumping well and a 2” diameter observation well approximately 50 feet away in each of the two well pairs.

One well pair is located in the 3 seam and the other in the 4 seam. Data from these wells confirmed the hydraulic conductivity values calculated during the aquifer tests performed in 2009.

2.3.7 Ground Water Quality

Field and laboratory parameters included in the current ground water monitoring program are summarized in Table CIV-5, Water Quality Parameters, and include field parameters, general laboratory parameters, major ions, nutrients and trace elements/metals. Analytical methods and current instrument detection limits are also listed in Table CIV-5. The current parameter list was developed in consultation with the State of Alaska, Division of Mining and Water Management and was an extended suite intended to be used only for the baseline data collection period. Wells included in the initial and additional baseline monitoring program are listed in Table CIV-6, Summary of Ground Water Quality Monitoring. As shown in Table CIV-6, the 3 monitoring wells for which samples have been obtained for initial baseline groundwater quality testing data were completed in 3 seam. Water quality data collected from these 3 monitoring wells are summarized in Table CIV-7, Summary of Initial Baseline Ground Water Quality Data.
Water Quality Data collected to date for the additional baseline monitoring program are summarized in Table CIV-8, Summary of Additional Baseline Ground Water Quality Data.

Field and General Chemistry Parameters

Available field data show that ground water at the site can be characterized as neutral to mildly acidic, with pH values ranging from 6.3 to 7.8. Ground water temperatures range from 3.4 to 8.2^{o}C. Total Dissolved Solids (TDS) concentrations indicate that ground water at the site varies from fresh to brackish. TDS concentrations in ground water from 3, 4, 5, and 6 seams varies from 156 to 481 mg/L.

Nutrients

No nutrients were detected in ground water samples from the site, with the exception of ammonia and phosphate, which were approximately 0.1-0.8 and 0.02-0.27 mg/L, respectively.

Metals, Nonmetals, and Metalloids

In general, most total and dissolved trace metals, nonmetals, and metalloids included in the initial baseline and additional baseline sampling suite were not elevated in ground water samples from the site wells. The Manganese concentrations above the Alaska Water Quality Effluent Limits (WQBEL's) were found above and below mining for seams 3 and 4. Iron and Manganese exceedences were found in seams 5 and 6 below mining and in seams 3 and 4 above mining but not below mining. Copper levels above WQBEL's were also found in seam 6 below mining and in seams 3 and 4 above mining but not below mining. Exceedences of zinc were very high and only found in the above mining well for seam 4. Levels have been dropping drastically with every sample effort. The drillers did use a product containing zinc that may have caused this excursion. UCM shall be monitoring this well and adjacent wells in the same seam to determine if this excursion in zinc was due to a drilling contaminant or is naturally occurring. Additional wells in the first 5 year mining term within the 3 and 4 seams will also be sampled to try to determine future characterize the groundwater quality for discharge permit requirements.

TABLE CIV-5, WATER QUALITY PARAMETERS *(Page 1 of 3)*		
Parameter	**Analytical Method[1]**	**Typical Reporting Limits[2]**
Field Parameters		
Conductivity	Field Meter	0.01 µmhos/cm
Dissolved Oxygen (DO)	Field Meter	0.01 mg/l
pH	Field Meter	0.01 s.u.
Temperature	Field Meter	0.1 °C
Turbidity	Field Meter	0.01 NTU
General and Physical Laboratory Parameters		
Alkalinity	Method SM2320B	1 mg/l (as $CaCO_3$)
Total Dissolved Solids (TDS)	Method SM2540C	20 mg/l
Total Suspended Solids (TSS)	Method SM2540D	1 mg/l
Major Cations		
Calcium	Method 6010B	0.009 mg/l
Magnesium	Method 6010B	0.011 mg/l
Potassium	Method 6010B	0.27 mg/l
Sodium	Method 6010B	0.12 mg/l
Major Anions		
Chloride	EPA Method 300.0	0.05 mg/l
Sulfate	EPA Method 300.0	0.2 mg/l
Nutrients		
Ammonia	EPA Method 350.1	1 mg/l (as NH_3-N)
Nitrate as Nitrogen	EPA Method 300.0	0.03 mg/l (as NO_3-N)

TABLE CIV-5, WATER QUALITY PARAMETERS *(Page 2 of 3)*		
Parameter	**Analytical Method[1]**	**Typical Reporting Limits[2]**
Nitrate+Nitrite as Nitrogen	EPA Method 353.2	0.03 mg/l (as NO_2-N)
Total Phosphate	EPA Method 365.3	0.04 mg/l (as PO_4-P)
Trace Elements/Metals		
Aluminum	EPA Method 200.8	2.0 ug/l
Ammonia	EPA Method 350.1	0.05 ug/l
Antimony	EPA Method 200.8	0.05 ug/l
Arsenic	EPA Method 200.8	0.5 ug/l
Barium	EPA Method 6010B	5 ug/l
Beryllium	EPA Method 200.8	0.02 ug/l
Boron	EPA Method 6010B	50 ug/l
Cadmium	EPA Method 200.8	0.02 ug/l
Chromium	EPA Method 200.8	0.2 ug/l
Cobalt	EPA Method 200.8	0.02 ug/l
Copper	EPA Method 200.8	0.1 ug/l
Iron	Method 6010B	20 ug/l
Lead	EPA Method 200.8	0.02 ug/l
Magnesium	EPA Method 6010B	20 ug/l
Manganese	EPA Method 6010B	5 ug/l
Mercury	EPA Method 7470A	0.2 ug/l
Molybdenum	EPA Method 200.8	0.05 ug/l
Nickel	EPA Method 200.8	0.2 ug/l
Selenium	EPA Method 200.8	1 ug/l
Silicon	EPA Method 6010B	400 ug/l
Silver	EPA Method 200.8	0.02 ug/l

TABLE CIV-5, WATER QUALITY PARAMETERS

(Page 3 of 3)

Parameter	Analytical Method[1]	Typical Reporting Limits[2]
Thallium	EPA Method 200.8	0.02 ug/l
Vanadium	EPA Method 200.8	0.2 ug/l
Zinc	EPA Method 200.8	0.5.ug/l

Notes:

1. The methods listed were used by Columbia Analytical Services (CAS), Kelso, WA to analyze samples collected by DNR-DMLW between 2007 and 2009.
2. The reporting limits are provided by CAS in accordance with the 2007-9 analytical testing program.

TABLE CIV-6

SUMMARY OF GROUND WATER QUALITY MONITORING [1]

WELL NO.[2]	HYDROLOGIC UNIT	DATE SAMPLED
07JDA	3 Seam	10/18/07
		05/29/08
		09/09/10
07JD10	3 Seam	10/18/07
		05/29/08
		12/02/09
		12/15/10
07JD12	3 Seam	10/18/07
		05/29/08
		08/24/10
		12/15/10
08JD04	6 Seam	08/24/10
08JD05	4 Seam	11/10/10
08JD01A		09/09/10
08JD02A		09/09/10
08JD02B	3 Seam	09/09/10
08JD03B		09/09/10
10JD01		12/15/10
10JD02	4 Seam	11/10/10
		12/15/10
10JD03	3 Seam	11/10/10
		12/15/10
10JD04	5 Seam	11/10/10
		12/15/10

Note:

1. Includes field and laboratory water quality analyses.
2. Wells 07 were the initial baseline data. Wells 08 and 10 were the additional requested baseline data.

Table CIV-7
SUMMARY OF BASELINE GROUND WATER QUALITY DATA (range values)

PARAMETER	3 seam		
	07JDA	07JD10	07JD12
FIELD PARAMETERS			
Conductivity(µS/cm)	438-499	367-413	686-755
Dissolved Oxygen (mg/L)	3.0	0.4-3.0	0.5-2.7
pH (s.u.)	6.48-6.87	6.96-7.05	7.04-7.45
Temperature (ºC)	3.42-3.9	6.98-7.19	7.7-8.2
Turbiditiy (NTU)	61.8-68.5	1.56-3.4	0.8-1.5
GENERAL PHYSICAL LABORATORY PROPERTIES			
Alkalinity (mg/L as $CaCO_3$)	5-264	90-100	336-344
Total Diss. Solids (mg/L)	264-307	165-293	333-397
MAJOR CATIONS			
Calcium (µg/L)	58600-59000	24500-25500	31700-35000
Magnesium (µg/L)	23000-23400	8270-9130	11100-12000
Potassium (µg/L)	3000-3320	2430-2540	4490-4660
Sodium (µg/L)	10400-11000	39500-44000	125000-131000
MAJOR ANIONS			
Chloride (mg/L)	0.9-1	47.5-49.7	29.5-35.1
Sulfate (mg/L)	1.0-1.2	21.5-23.2	18.4-19.0
NUTRIENTS			
Ammonia (mg/L)	0.76	0.36	0.52
Nitrate as N (mg/L)	<0.1	<0.1	<0.1
Nitrate+Nitrite as N (mg/L)	<0.5	<0.5	<0.5
Total Phosphate (mg/L)	0.06-0.08	0.04-0.15	0.02-0.03
TRACE METALS - TOTAL (T)/DISSOLVED (D) WHEN AVAILABLE			
Aluminum, T/D (µg/L)	1140-1190/3.3-<50	<2-<50/<2-<50	6.1-<50/2.8-<50
Antimony, T/D (µg/L)	0.2-0.2/0.05-0.12	<0.05-<0.1/<0.05-<0.1	<0.05-<0.1/<0.05-<0.1
Arsenic, T/D (µg/L)	1.2-2.4/<0.5-<1	<0.5-<1/<0.5-<1	0.5-<1/0.5-<1
Barium, T/D (µg/L)	735-854/666-723	367-380/365-411	215-216/215-227
Beryllium, T/D (µg/L)	0.06-0.08/<0.02-0.04	0.02-<0.04/0.02-<0.04	<0.02-<0.04/<0.02-<0.04
Boron T/D (µg/L)	<50-<50/<50-<50	<50-<50/<50-<50	173-200/170-194
Cadmium, T/D (µg/L)	0.12-0.16/0.04-0.05	<0.02-<0.04/<0.02-<0.04	<0.04-0.05/<0.04-0.05
Chromium, T/D (µg/L)	2.4-3.8/<0.4-0.6	0.3-0.4/0.3-0.4	<0.4-0.5/<0.4-0.7
Cobalt, T/D (µg/L)	1.07-2.79/0.98-1.06	0.06-<0.3/0.06-0.23	0.27-<0.3/0.24-<0.3
Copper, T/D (µg/L)	15.5-31.4/1.3-1.3	0.1-2.3/0.2-0.3	0.05-0.4/<0.02-0.3
Iron, T/D (µg/L)	3920-3980/1060-1110	618-765/628-735	261-344/240-290
Lead, T/D (µg/L)	4.2-4.83/0.22-0.32	<0.02-1.6/<0.02-<0.04	<0.04-0.1/<0.04-0.04
Magnesium, T/D (µg/L)	23000-23400/22200-22800	8270-9130/8310-9280	11100-12000/10900-11800
Manganese, T/D (µg/L)	243-260/225-232	97.5-103/92.5-103	44-49.1/48-48.2
Mercury, T/D (µg/L)	<0.2-<0.2/<0.2-0<0.2	<0.2-<0.2/<0.2-0<0.2	<0.2-<0.2/<0.2-0<0.2
Molybdenum, T/D (µg/L)	0.13-0.16/<0.05-<0.1	<0.05-<0.1/<0.05-<0.1	<0.5-<0.1/<0.05-<0.1
Nickel, T/D (µg/L)	3.8-7.8/1.5-1.9	0.4-0.8/0.4-0.7	0.7-1.2/0.6-1.2
Seleieum, T/D (µg/L)	<1-<2/<1-<2	<1-<2/<1-<2	<1-<2/<1-<2
Silicon, T/D (µg/L)	18800-19900/17600-17600	11700-11900/11900-12000	7880-7880/7800-7870
Silver, T/D (µg/L)	0.06-0.08/<0.02-0.04	<0.02-0.08/<0.02-0.04	<0.02-<0.04/<0.02-<0.04
Thallium, T/D (µg/L)	0.03-<0.04/<0.02/<0.04	<0.02-<0.04/<0.02-<0.04	<0.02-<0.04/<0.02-<0.04
Vandaium, T/D (µg/L)	3.1-4/<0.04-<0.2	<0.2-<0.4/<0.2-<0.4	<0.2-<0.4/<0.2-<0.4
Zinc, T/D (µg/L)	37.6-49.9/24.2-29.5	<0.5-19.7/3.2-19.9	16.6-16.6/3.4-14.1

Table CIV-8
SUMMARY OF ADDITIONAL BASELINE GROUND WATER QUALITY DATA

PARAMETER	3 SEAM						4 SEAM						5 SEAM			6 SEAM		
	10JD01 Above mining			10JD03 Below Mining			10JD02 Above Mining			08JD05 Below Mining			10JD04 Below Mining			08JD04 Below Mining		
	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
FIELD PARAMETERS																		
Conductivity(µS/cm)	644	694	669	350	418	377	627	677	650	279	387	332	361	422	389	332	453	392.5
Dissolved Oxygen (mg/L)	0.22	0.66	0.44	0.25	0.7	0.46	0.08	0.51	0.3	0.3	0.52	0.4	0.38	0.91	0.62	0.4	0.66	0.53
pH (s.u.)	5.96	6.05	6	6.95	7.07	7	6.04	6.15	6.09	6.94	6.98	6.96	6.43	6.48	6.45	6.41	6.45	6.43
Temperature (ºC)	0.05						0.18			2.38			1.34	1.79	1.5		2.81	
Turbiditiy (NTU)	0.42	0.71	0.565	0.41	0.69	0.567	1.26	2.54	1.87	0.4	1.28	0.93	0.32	0.58	0.43	0.9	0.9	0.9
GENERAL PHYSICAL PROPERTIES																		
Alkalinity (mg/L as $CaCO_3$)	203	203	203	111	116	113.5	233	238	235.5	114	114	114	123	131	127	135	151	143
Total Diss. Solids (mg/L)	481	481	481	181	197	189	456	460	458	156	156	156	199	214	206.5	180	185	182.5
MAJOR CATIONS																		
Calcium (µg/L)	75700	75700	75700	25000	25700	25350	74400	75700	75050	33600	33600	33600	34700	35200	34950	32200	35700	34875
Magnesium (µg/L)	35600	35600	35600	8070	8400	8235	33500	33600	33550	6150	6150	6150	12100	12500	12300	11300	12700	12000
Potassium (µg/L)	2970	2970	2970	2150	2250	2200	2970	3000	2985	1930	1930	1930	1390	1460	1425	823	926	874.5
Sodium (µg/L)	7020	7020	7020	25500	27800	26650	8860	9940	9400	21100	21100	21100	10500	11500	11000	5210	7130	6170
MAJOR ANIONS																		
Chloride (mg/L)	0.73	0.73	0.73	23.2	24.9	24	0.8	1.1	0.955	2.14	2.14	2.14	3.7	4.78	4.24	<0.40	0.55	0.475
Sulfate (mg/L)	135	135	135	7.49	7.81	7.29	92.3	98.1	95.2	10.1	10.1	10.1	24.8	25.1	24.95	9.96	10.1	10.03
NUTRIENTS																		
Ammonia (mg/L)	0.73	0.73	0.73	0.22	0.3	0.26	0.75	0.77	0.76	0.23	0.23	0.23	0.09	0.21	0.15	0.14	0.23	0.185
Nitrate as N (mg/L)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Nitrate+Nitrite as N (mg/L)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Total Phosphate (mg/L)	0.23	0.23	0.23	0.08	0.15	0.12	0.09	0.17	0.13	0.1	0.1	0.1	0.06	0.11	0.85	0.06	0.1	0.08
TRACE METALS - TOTAL (T)/DISSOLVED (D) WHEN AVAILABLE																		
Aluminum, T/D (µg/L)	7/3.3	7/3.3	7/3.3	<2.0/<2.0	11/<2.0	6.5/<2.0	15/6.1	21/6.3	18/6.2	14.3/5.1	14.3/5.1	14.3/5.1	3.8/<2.0	4.1/2.1	3.95/2.05	8.6/4.4	15.4/5.1	12/4.75
Antimony, T/D (µg/L)	<0.05/<0.05	<0.05/<0.05	<0.05/<0.05	<0.05/<0.05	<0.05/<0.05	<0.05/<0.05	<0.05/<0.05	<0.05/<0.05	<0.05/<0.05	<0.05/<0.05	<0.05/<0.05	<0.05/<0.05	<0.05/<0.05	<0.05/<0.05	<0.05/<0.05	<0.05/<0.05	<0.05/<0.05	<0.05/<0.05
Arsenic, T/D (µg/L)	1.8/1.8	1.8/1.8	1.8/1.8	<0.5/<0.5	<0.5/<0.5	<0.5/<0.5	0.5/<0.5	0.6/0.6	0.55/0.55	<0.5/<0.5	<0.5/<0.5	<0.5/<0.5	<0.5/<0.5	<0.5/<0.5	<0.5/<0.5	<0.5/<0.5	<0.5/<0.5	<0.5/<0.5
Barium, T/D (µg/L)	498/470	498/470	498/470	324/316	332/328	328/322	504/496	527/539	515.5/517.5	204/205	204/205	204/205	151/153	164/165	157.5/159	250/250	290/285	270/265.5
Beryllium, T/D (µg/L)	<0.02/0.02	<0.02/0.02	<0.02/0.02	<0.02/0.02	<0.02/0.02	<0.02/0.02	<0.02/0.02	<0.02/0.02	<0.02/0.02	<0.02/0.02	<0.02/0.02	<0.02/0.02	<0.02/0.02	<0.02/0.02	<0.02/0.02	<0.02/0.02	<0.02/0.02	<0.02/0.02
Boron T/D (µg/L)	<50/<50	<50/<50	<50/<50	<50/<50	<50/<50	<50/<50	<50/<50	<50/<50	<50/<50	<50/<50	<50/<50	<50/<50	<50/<50	<50/<50	<50/<50	<50/<50	<50/<50	<50/<50
Cadmium, T/D (µg/L)	<0.02/<0.02	<0.02/<0.02	<0.02/<0.02	<0.02/<0.02	<0.02/<0.02	<0.02/<0.02	<0.02/<0.02	<0.02/<0.02	<0.02/<0.02	<0.02/<0.02	<0.02/<0.02	<0.02/<0.02	<0.02/<0.02	<0.02/<0.02	<0.02/<0.02	<0.02/<0.02	<0.02/<0.02	<0.02/<0.02
Chromium, T/D (µg/L)	0.70/1.0	0.70/1.0	0.70/1.0	0.3/<0.2	0.4/0.3	0.35/0.25	1.4/0.9	1.5/1.1	1.45/1.0	0.3/0.2	0.3/0.2	0.3/0.2	0.6/0.4	0.7/0.5	0.65/0.45	0.5/0.6	0.6/0.6	0.55/0.6
Cobalt, T/D (µg/L)	0.24/0.31	0.24/0.31	0.24/0.31	0.1/0.15	0.17/0.27	0.14/0.21	0.33/0.48	0.39/0.59	0.36/0.54	0.09/0.10	0.09/0.10	0.09/0.10	0.07/0.14	0.07/0.33	0.07/0.235	0.06/0.36	0.09/0.43	0.075/0.575
Copper, T/D (µg/L)	0.4/0.5	0.4/0.5	0.4/0.5	0.1/0.1	0.2/0.2	0.15/0.15	0.5/0.3	0.6/0.5	0.55/0.4	0.3/0.2	0.3/0.2	0.3/0.2	0.1/0.1	0.1/0.2	0.1/0.15	0.4/0.2	0.7/0.2	0.55/0.2
Iron, T/D (µg/L)	7020/7100	7020/7100	7020/7100	442/410	501/506	471.5/458	4140/4180	4340/4240	4240/4200	977/950	977/950	977/950	1060/1060	1080/1070	1070/1065	4590/4520	5450/5680	5020/5100
Lead, T/D (µg/L)	0.05/<0.02	0.05/<0.02	0.05/<0.02	0.02/<0.02	0.39/<0.02	0.20/<0.02	0.3/0.14	0.57/0.27	0.44/0.21	0.07/<0.02	0.07/<0.02	0.07/<0.02	<0.02/<0.02	<0.02/<0.02	<0.02/<0.02	0.07/<0.02	0.37/0.08	0.22/0.06
Manganese, T/D (µg/L)	1040/1060	1040/1060	1040/1060	99.8/99.4	109/106	104.4/102.7	697/688	697/711	697/699.5	73/73.4	73/73.4	73/73.4	375/378	424/430	399.5/404	783/787	833/832	808/809.5
Mercury, T/D (µg/L)	<0.02/0.02	<0.02/0.02	<0.02/0.02	<0.02/0.02	<0.02/0.02	<0.02/0.02	<0.02/0.02	<0.02/0.02	<0.02/0.02	<0.02/0.02	<0.02/0.02	<0.02/0.02	<0.02/0.02	<0.02/0.02	<0.02/0.02	<0.02/0.02	<0.02/0.02	<0.02/0.02
Molybdenum, T/D (µg/L)	<0.05/<0.05	<0.05/<0.05	<0.05/<0.05	<0.05/<0.05	<0.05/<0.05	<0.05/<0.05	<0.05/<0.05	<0.05/<0.05	<0.05/<0.05	<0.05/<0.05	<0.05/<0.05	<0.05/<0.05	<0.05/<0.05	<0.05/<0.05	<0.05/<0.05	<0.05/<0.05	<0.05/<0.05	<0.05/<0.05
Nickel, T/D (µg/L)	0.8/0.8	0.8/0.8	0.8/0.8	0.2/0.4	0.7/0.7	0.45/0.55	0.4/0.5	2.2/2.2	1.3/1.4	1.6/1.4	1.6/1.4	1.6/1.4	<0.2/<0.2	1.0/0.9	0.6/0.55	0.5/0.6	0.6/0.7	0.55/0.65
Seleieum, T/D (µg/L)	<1.0/<1.0	<1.0/<1.0	<1.0/<1.0	<1.0/<1.0	<1.0/<1.0	<1.0/<1.0	<1.0/<1.0	<1.0/<1.0	<1.0/<1.0	<1.0/<1.0	<1.0/<1.0	<1.0/<1.0	<1.0/<1.0	<1.0/<1.0	<1.0/<1.0	<1.0/<1.0	<1.0/<1.0	<1.0/<1.0
Silicon, T/D (µg/L)	18700/19100	18700/19100	18700/19100	13200/12800	14900/14700	14050/13750	18800/18600	18900/19400	18850/19000	16400/16400	16400/16400	16400/16400	13100/13200	14000/14000	13550/13600	10600/10800	10600/10800	10600/10800
Silver, T/D (µg/L)	<0.02/<0.02	<0.02/<0.02	<0.02/<0.02	<0.02/<0.02	<0.02/<0.02	<0.02/<0.02	<0.02/<0.02	<0.02/<0.02	<0.02/<0.02	<0.02/<0.02	<0.02/<0.02	<0.02/<0.02	<0.02/<0.02	<0.02/<0.02	<0.02/<0.02	<0.02/<0.02	<0.02/<0.02	<0.02/<0.02
Thallium, T/D (µg/L)	<0.02/<0.02	<0.02/<0.02	<0.02/<0.02	<0.02/<0.02	<0.02/<0.02	<0.02/<0.02	<0.02/<0.02	<0.02/<0.02	<0.02/<0.02	<0.02/<0.02	<0.02/<0.02	<0.02/<0.02	<0.02/<0.02	<0.02/<0.02	<0.02/<0.02	<0.02/<0.02	<0.02/<0.02	<0.02/<0.02
Vandaium, T/D (µg/L)	<0.02/<0.02	<0.02/<0.02	<0.02/<0.02	<0.02/<0.02	<0.02/<0.02	<0.02/<0.02	0.3/0.2	0.4/0.3	0.35/0.25	<0.02/<0.02	<0.02/<0.02	<0.02/<0.02	<0.02/<0.02	<0.02/<0.02	<0.02/<0.02	<0.02/<0.02	<0.02/<0.02	<0.02/<0.02
Zinc, T/D (µg/L)	2.9/3.8	2.9/3.8	2.9/3.8	<0.5/<0.5	1.1/0.9	0.8/0.7	783/767	1680/1640	1232/1203	1.0/2.3	1.0/2.3	1.0/2.3	<0.5/<0.5	0.9/0.8	0.7/0.65	1.9/4.0	3.1/4.3	2.5/4.15

3.0 PROJECT AREA HYDROGEOLOGY

3.1 Hydrogeologic Units

As was discussed in Chapter CII, Geology, the coal reserves are contained in a repeated sequence of coarse sandstone grading upward to finer sandstone, with increasing amounts of silt and clay. Grading continues to a siltstone and clay layer upon which lies the coal seams. This stratigraphy controls the groundwater aquifers. Data from this program demonstrates that the clay and siltstone layers below each coal seam act as an effective aquiclude. Thus, as the coal deposit repeats itself, so is its ability to support individual aquifers. The coal seams are the most permeable layers in the formation. This permeability is controlled by fractures within the coal. This has been evidenced both by visual observations within active mining areas as well as in the variability of hydraulic conductivity of the coal in testing (see Table CIV-3, Hydraulic Conductivity Data Summary). The sandstones which overlay the coal act as an aquitard - it is able to transmit water, but at a much lower rate/higher resistance.

The model described above has been proven in several manners. Ice flows during winter within other UCM active pits clearly come from the coal seams. Summer water flows also are derived from the coal while the overlying sandstones show only evidence of moisture but no sustained flow. Nested sets of piezometers at UCM's Poker Flats mining area show (1) adjacent piezometers placed in different coal seams clearly display separate water levels, and (2) nested piezometers placed in the coal and in the directly overlying sandstone typically have the same water levels (Golder, 1985).

Surficial gravel deposits may contain significant volumes of water (1) despite their somewhat discontinuous nature and thickness within the project area, (2) they are typically truncated by valley erosion, and (3) they are underlain predominantly by sandstone (or schist), which as stated earlier does have some hydraulic conductivity and will transmit water, thus minimizing the chance of a perched aquifer in the gravel deposits. The alluvium deposits appear to be present in the Marguerite Creek valley proper, but they do not appear to be well established in the tributary

drainages. Tributary drainages appear to interact with the groundwater systems primarily at the coal crop crossings within the valley bottom.

Structural features also act as hydrogeologic conduits or barriers. Faults within the region generally appear to act as recharge boundaries, providing an avenue of supply to the primary aquifer units (the coal seams). Where faults intersect a series of coal seams and daylight into a valley or bluff, they may act as a discharge avenue for the aquifers. The only significant faults within the project area are located along the southern border of the proposed mining area trending approximately NE-SW and across the lower central portion of the proposed mining area trending approximately NW-SE. While seeps might be found near the faults as they daylight, any potential discharge volume would not appear to have a significant drawdown on the 3 or 4 seam aquifers (see plate CIV-2, Potentiometric Surface Map).

3.2 Direction and Gradient of Ground Water Flow

Water level data collected during 2008, 2009 and 2010 were used to generate a potentiometric surface map of the 3 and 4 coal seams in the project area, as presented on Plate CIV-2, Potentiometric Surface Map & Cross-Section Index. The potentiometric surface map indicates a predominantly northwest direction of ground water flow in the 3 and 4 coal seams. As expected, flow within the coal seams generally follows the dip of the beds. The lateral hydraulic gradient in the 3 coal seam ranges from approximately 0.04 to 0.12 ft/ft and the lateral hydraulic gradient in the 4 coal seam ranges from approximately 0.04 to 0.08 ft/ft, both decreasing downgradient across the site. Gradients are affected to the greatest degree where drainages intersect the coal formation and a discharge situation may occur.

3.3 Groundwater Recharge, Discharge, and Contribution to Baseflow

Coal seams of the Suntrana Formation within the project area are recharged primarily by infiltration from precipitation, including spring snowmelt. The limited extent of local outcrops in the mining area probably restricts the volume of local recharge to the seams. As shown on

Plate CIV-2, Potentiometric Surface Map & Cross-Section Index, the flow direction is out of the mining area, thus supporting the idea that the area is a recharge zone for the coal seam aquifers. This is further evidenced on Plate CIV-3, Hydrogeologic Cross-Sections. Water infiltrates near to, and to a lesser extent between, the outcrop areas and works its way west and north along the coal beds in an confined state. As the water continues north and as the coal seam(s) start to dip more to the north, the coal becomes fully saturated and begins to saturate the overlying sandstone. This could be viewed as a partially confined or semi-confined state. In other portions of the Hoseanna Creek valley, this saturation has been such that the coal and overlying sandstone is completely saturated and the upper clay layer again acts as an aquiclude, this time as a confining layer.

The coal seams discharge locally along creeks where exposed and otherwise maintain flow to the northwest across the site. Any slide areas above the Jumbo Dome mine area to the east will likely recharge the coal seams where exposed beneath the rubble layers and infiltrate contributing to aquifer volumes. Creek alluvium is likely recharged by coal seam discharge and some infiltration, which contributes to base flow in creeks and springs during low-flow months. It should be noted that on Plate CIV-2, Potentiometric Surface Map & Cross-section Index, the contours of the Potentiometric surface generally meet the ground surface at the coal outcrops in the Marguerite Creek drainage.

4.0 GENERAL AREA HYDROGEOLOGY

The groundwater model presented above can likely be applied throughout the Marguerite Creek Valley. Due to the stratigraphic and structural controls of the aquifer matrices, most coal-bearing sequences within the region have the ability to contain multi-layered aquifers. The coal seams act as the primary water-bearing unit with fracture-controlled flow being the primary mechanism of transfer. These are affected locally by folds and faulting as well as drainage systems. Faults have generally been viewed as recharge boundaries, supplying water into the adjacent coal formations. Flow within the coal can be locally controlled by folding, creating structural domes to impede flow, along with creating fractures to enhance flow and structural lows to collect

water. Drainages cutting through the coal formations can create discharge points, particularly where coal outcrops cross drainages.

The Hoseanna Creek Valley, under this model, has various areas that are primarily recharge zones, discharge zone, and some areas that have no significant aquifers established. Two Bull Ridge is an example of a recharge area, with coal crops traversing flat terrain where they have an enhanced exposure for infiltration. Poker Flats is an example of an area that is more of a discharge area - a major fault to the south provides a recharge boundary with a hydraulic gradient to the north towards the coal outcrops. Other regions, such as Jumbo Dome, have exposure for infiltration via outcrops on a steeply dipping terrain. Infiltration likely occurs vertically and through tallus and rubble areas at the lower slopes of Jumbo Dome itself. These areas are likely very active from a groundwater perspective. The basic principles defined in the Jumbo Dome baseline study can reasonably be applied to other areas throughout the region containing similar geology with only limited additional data required to support such an application and interpret local, site-specific factors affecting the hydrogeology.

5.0 REFERENCES

Golder Associates, Inc., 1991, Pump Test at Phase I, Poker Flats on September 10-13, 1991: Letter from David C. Lanning and Rupert G. Tart to Dan Graham, Usibelli Coal Mine, Inc., December 20, 1991.

Golder Associates, Inc., 1985, Hydrological Investigation at Poker Flats, Usibelli Coal Mine: Prepared for Usibelli Coal Mine, Inc., Healy, Alaska, January 1985.

Fetter, C.W., 1980, Applied Hydrogeology: Bell and Howell Company, Columbus, Ohio, 488p.

6.0 RESPONSIBLE PARTIES

Part C, Chapter IV, Hydrogeology, was prepared by Usibelli Coal Mine, Inc.

PLATE CIV-1

MONITORING WELL LOCATIONS

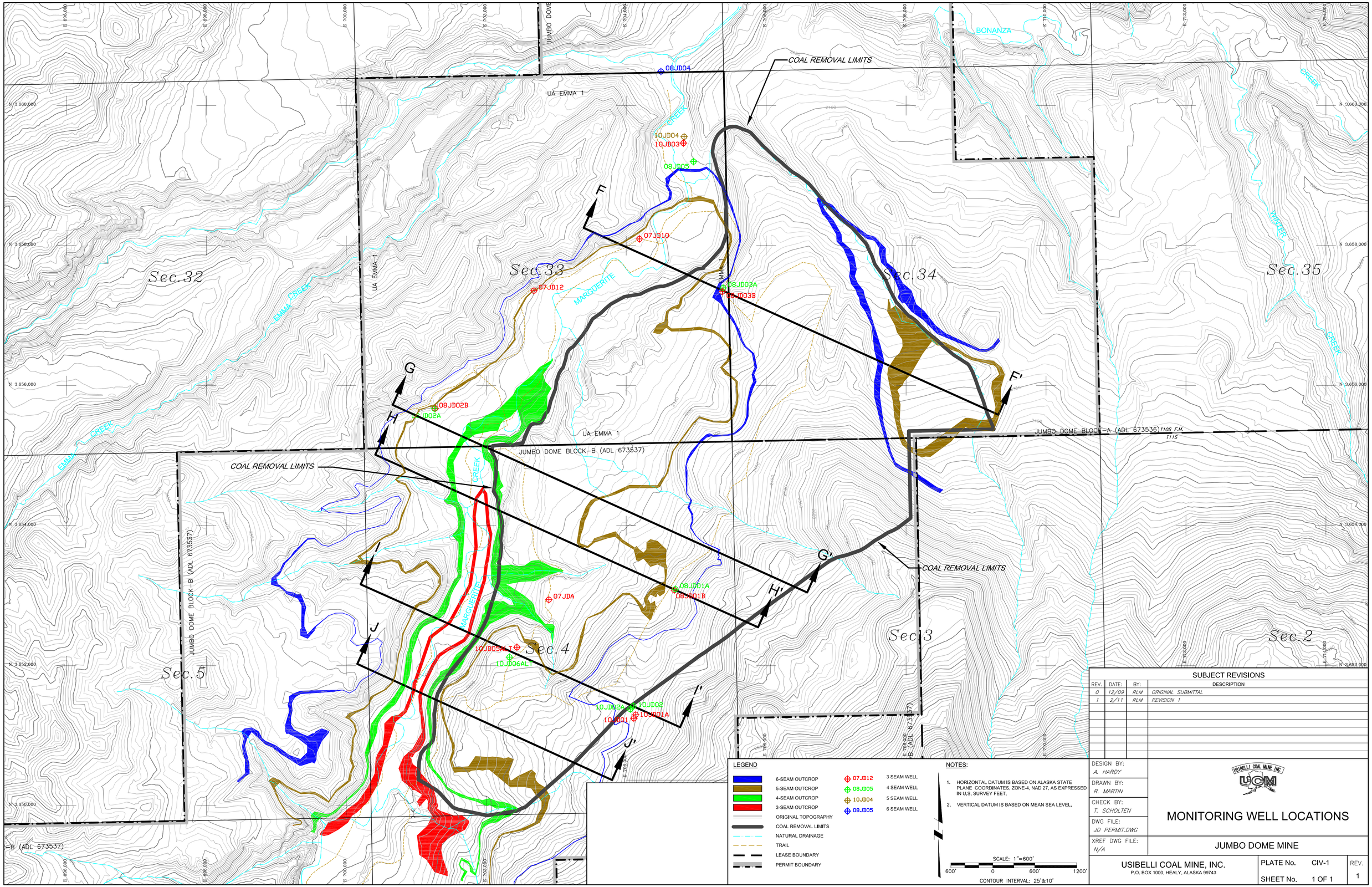
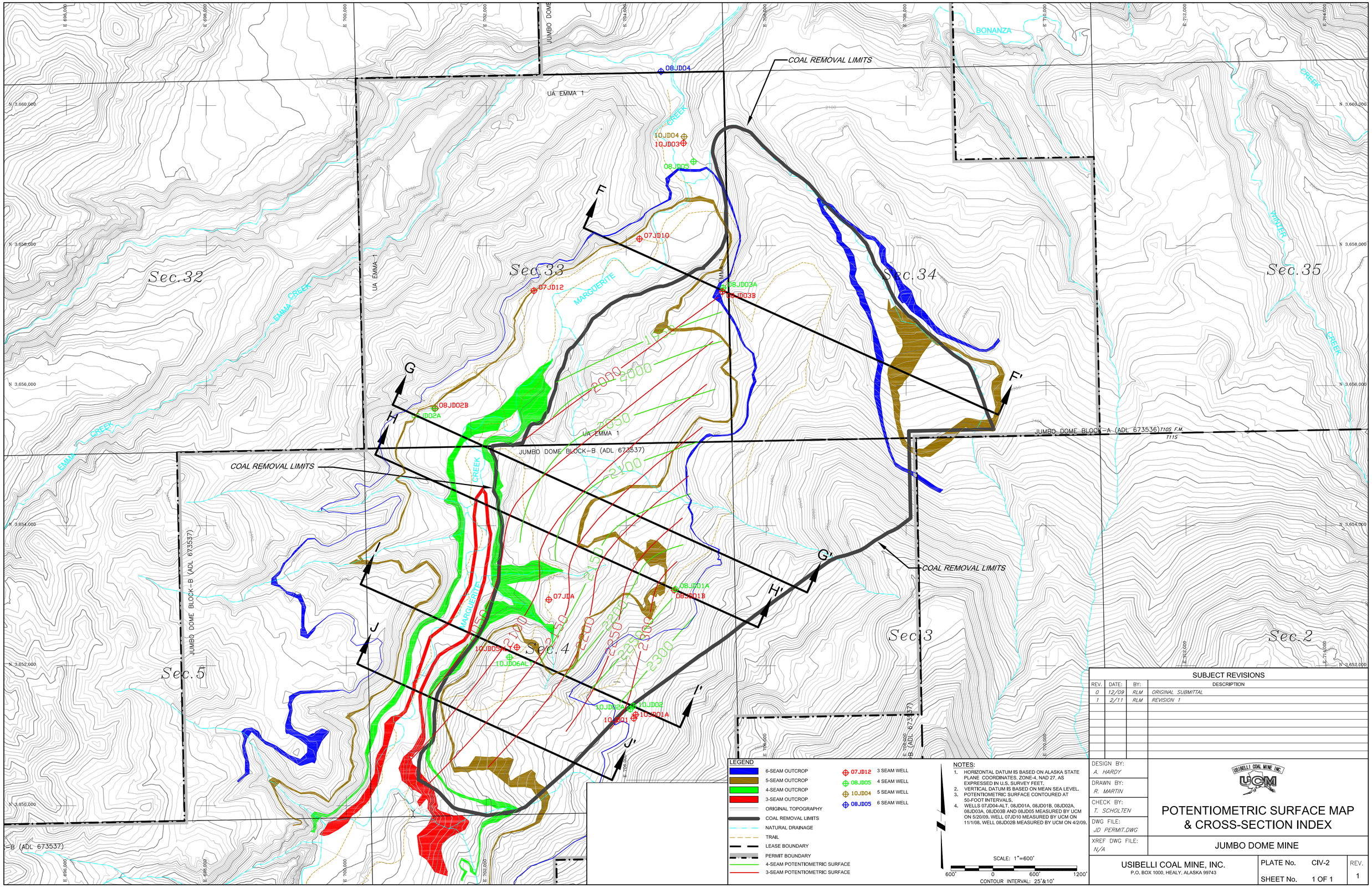

COAL REMOVAL LIMITS
COAL REMOVAL LIMITS
COAL REMOVAL LIMITS
JUMBO DOME BLOCK-B (ADL 673537)
JUMBO DOME BLOCK-A (ADL 673536)
UA EMMA 1
BONANZA
CREEK
WHITER
EMMA CREEK
MARGUERITE
Sec.32
Sec.33
Sec.34
Sec.35
Sec.5
Sec.4
Sec.3
Sec.2
08JD04
10JD04
10JD03
08JD05
07JD10
07JD12
08JD03A
08JD03B
08JD02B
10JD02A
08JD01A
08JD01B
07JDA
10JD05ALT
10JD06ALT
10JD02A
10JD02
10JD01
10JD01A
F
F'
G
G'
H
H'
I
I'
J
J'
LEGEND
6-SEAM OUTCROP
5-SEAM OUTCROP
4-SEAM OUTCROP
3-SEAM OUTCROP
ORIGINAL TOPOGRAPHY
COAL REMOVAL LIMITS
NATURAL DRAINAGE
TRAIL
LEASE BOUNDARY
PERMIT BOUNDARY
07JD12 3 SEAM WELL
08JD05 4 SEAM WELL
10JD04 5 SEAM WELL
08JD05 6 SEAM WELL
NOTES:
1. HORIZONTAL DATUM IS BASED ON ALASKA STATE PLANE COORDINATES, ZONE-4, NAD 27, AS EXPRESSED IN U.S. SURVEY FEET.
2. VERTICAL DATUM IS BASED ON MEAN SEA LEVEL.
SCALE: 1"=600'
600' 0 600' 1200'
CONTOUR INTERVAL: 25'&10'
SUBJECT REVISIONS
REV. DATE: BY: DESCRIPTION
0 12/09 RLM ORIGINAL SUBMITTAL
1 2/11 RLM REVISION 1
DESIGN BY: A. HARDY
DRAWN BY: R. MARTIN
CHECK BY: T. SCHOLTEN
DWG FILE: JD PERMIT.DWG
XREF DWG FILE: N/A
USIBELLI COAL MINE, INC.
MONITORING WELL LOCATIONS
JUMBO DOME MINE
USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743
PLATE No. CIV-1
SHEET No. 1 OF 1
REV. 1

PLATE CIV-2

POTENTIOMETRIC SURFACE MAP &

CROSS-SECTION INDEX



LEGEND

- 6-SEAM OUTCROP
- 5-SEAM OUTCROP
- 4-SEAM OUTCROP
- 3-SEAM OUTCROP
- ORIGINAL TOPOGRAPHY
- COAL REMOVAL LIMITS
- NATURAL DRAINAGE
- TRAIL
- LEASE BOUNDARY
- PERMIT BOUNDARY
- 4-SEAM POTENTIOMETRIC SURFACE
- 3-SEAM POTENTIOMETRIC SURFACE

- 07JD12 3 SEAM WELL
- 08JD05 4 SEAM WELL
- 10JD04 5 SEAM WELL
- 08JD05 6 SEAM WELL

NOTES:

1. HORIZONTAL DATUM IS BASED ON ALASKA STATE PLANE COORDINATES, ZONE-4, NAD 27, AS EXPRESSED IN U.S. SURVEY FEET.
2. VERTICAL DATUM IS BASED ON MEAN SEA LEVEL.
3. POTENTIOMETRIC SURFACE CONTOURED AT 50-FOOT INTERVALS.
4. WELLS 07JD04-ALT, 08JD01A, 08JD01B, 08JD02A, 08JD03A, 08JD03B AND 08JD05 MEASURED BY UCM ON 5/20/09. WELL 07JD10 MEASURED BY UCM ON 11/1/08. WELL 08JD02B MEASURED BY UCM ON 4/2/09.

SCALE: 1"=600'

600' 0 600' 1200'

CONTOUR INTERVAL: 25'&10'

SUBJECT REVISIONS

REV.	DATE:	BY:	DESCRIPTION
0	12/09	RLM	ORIGINAL SUBMITTAL
1	2/11	RLM	REVISION 1

DESIGN BY: A. HARDY

DRAWN BY: R. MARTIN

CHECK BY: T. SCHOLTEN

DWG FILE: JD PERMIT.DWG

XREF DWG FILE: N/A

USIBELLI COAL MINE INC.

POTENTIOMETRIC SURFACE MAP & CROSS-SECTION INDEX

JUMBO DOME MINE

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743

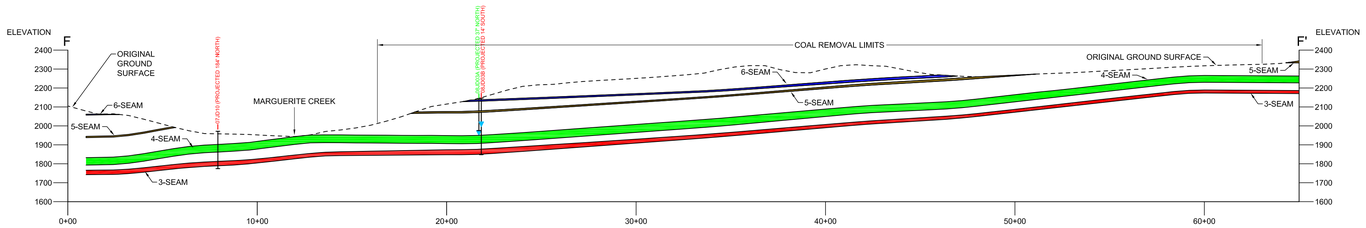
PLATE No. CIV-2

SHEET No. 1 OF 1

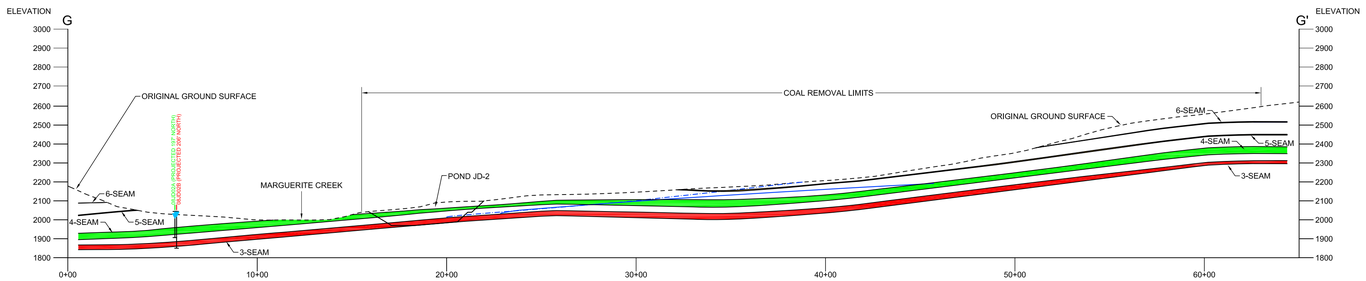
REV. 1

PLATE CIV-3

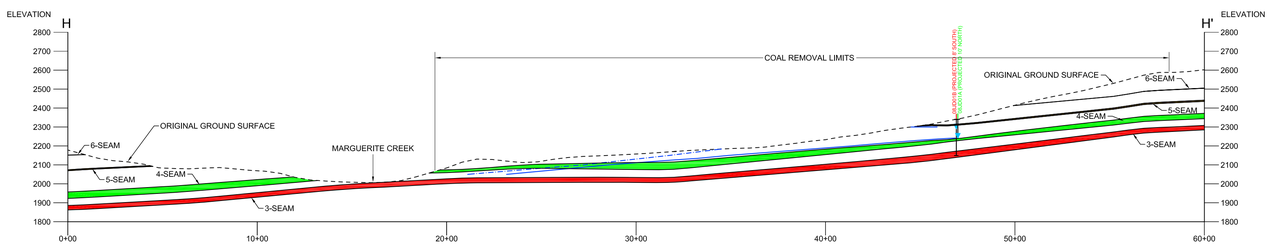
HYDROGEOLOICAL CROSS-SECTIONS



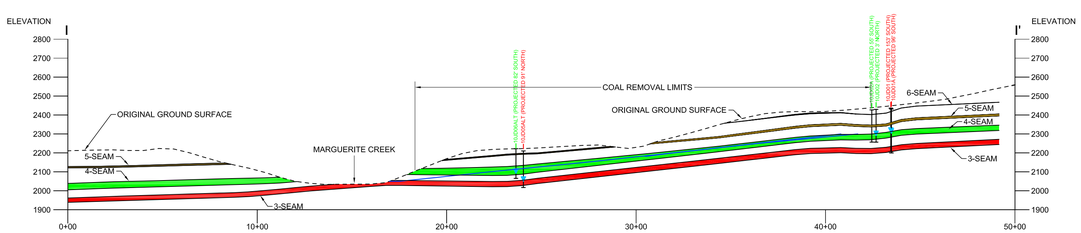
CROSS SECTION F-F'



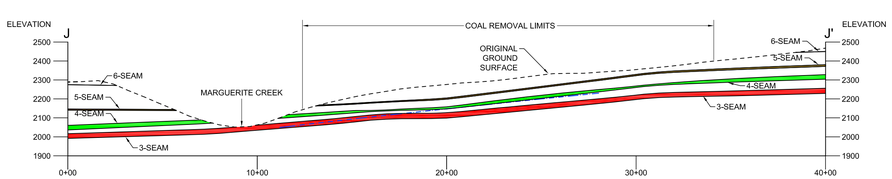
CROSS SECTION G-G'



CROSS SECTION H-H'



CROSS SECTION I-I'



CROSS SECTION J-J'

LEGEND

- 6-SEAM
- 5-SEAM
- 4-SEAM
- 3-SEAM
- ORIGINAL GROUND SURFACE
- 4-SEAM POTENTIOMETRIC SURFACE
- 3-SEAM POTENTIOMETRIC SURFACE
- MEASURED WATER LEVEL

NOTES:

1. FOR HYDROGEOLOGIC CROSS SECTION ORIENTATION REFER TO PLATES CIV-1 AND CIV-2.
2. HORIZONTAL DATUM IS BASED ON ALASKA STATE PLANE COORDINATES, ZONE-4, NAD 27, AS EXPRESSED IN U.S. SURVEY FEET.
3. VERTICAL DATUM IS BASED ON MEAN SEA LEVEL.

SCALE: 1"=400'

400' 0 400' 800'

SUBJECT REVISIONS

REV.	DATE:	BY:	DESCRIPTION
0	12/09	RLM	ORIGINAL SUBMITTAL
1	2/11	RLM	REVISION 1

DESIGN BY: A. HARDY

DRAWN BY: R. MARTIN

CHECK BY: T. SCHOLTEN

DWG FILE: JD PERMIT.DWG

XREF DWG FILE: N/A

USIBELLI COAL MINE, INC.

HYDROGEOLOGIC CROSS-SECTIONS

JUMBO DOME MINE

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743

PLATE No. CIV-3

SHEET No. 1 OF 1

REV. 1

APPENDIX CIV-1

HYDROGEOLOGICAL EVALUATION REPORT

JUMBO DOME MINE

Prepared for:

USIBELLI COAL MINE
P.O. Box 1000
Healy, Alaska 99743

HYDROGEOLOGICAL EVALUATION REPORT
JUMBO DOME MINE

Healy, Alaska

February 2011

Prepared by:

28828 Cedar Circle
Evergreen, CO 80439

TABLE OF CONTENTS

Section No. **Page No.**

1.0 INTRODUCTION 1

2.0 SITE SETTING 2

2.1 GEOLOGY 2
2.2 HYDROGEOLOGY 2

3.0 FIELD INVESTIGATIONS FROM 2007 THROUGH 2010 3

3.1 EXPLORATION RC DRILLING, CORING, AND AUGERING 3
3.2 WATER LEVEL MONITORING 4
3.2.1 Seasonal Variation of Groundwater Levels 4
3.2.2 Piezometric Surface Contouring 5

4.0 SCOPE OF WORK 8

4.1 WELL DRILLING 8
4.1.1 Well Completion and Construction 8
4.2 AQUIFER TESTING 8
4.2.1 Slug Tests 8
4.2.2 Drawdown Tests 9

5.0 AQUIFER TESTING AND GROUNDWATER MODELING 10

5.1 HYDRAULIC CONDUCTIVITY AND TRANSMISSIVITY ESTIMATES 12

6.0 SEDIMENTATION POND JD-2 SEEPAGE ESTIMATE 14

6.1 MODELING 14
6.2 RESULTS 14

7.0 CONCLUSIONS 15

8.0 REFRENCES 16

TABLES

Table No.	Title
1	Monitoring Well Completion Summary
2	Hydraulic Conductivity Data Summary
3	Summary of Aquifer Transmissivity Values

DRAWINGS

Drawing No.	Title
JD-HYDGEO-1	Monitoring Well Locations
JD-HYDGEO-2	Potentiometric Surface Map & Cross-Section Index
JD-HYDGEO-3	Hydrogeologic Cross-Sections
JD-HYDGEO-A	Typical Cross-Section Through Wells

APPENDICES

Appendix	Description
A	Drilling Logs
B	Well Construction Schematic
C	Water Level Measurements Table
D	Aquifer Testing Raw Data
E	Aquifer Test Results - Calculations

1.0 INTRODUCTION

Usibelli Coal Mine, Inc. (UCM) proposes to commence development of a new mining operation at the Jumbo Dome area of their Hoseanna Valley properties located near Healy, Alaska on the northern flanks of the Alaska Range. This new mining area is located northeast of the UCM Office and the Poker Flats and Two Bull Ridge Mining Areas and north of Hoseanna Creek and the Gold Run Pass Mining Area. It is anticipated that mining may utilize a combination of dragline and truck/shovel methods. Development of this new mining area will require permit approval in accordance with the requirements of the Alaska Surface Mining Control and Reclamation Act (ASMCRA).

The new mine plan includes an 83Mt open pit coal target with a strip ratio of approximately 2.4:1, designed with 250 feet wide pits mined at up to 3Mt per year. The average pit duration is approximately 6 months before the next pit to the north will be mined. Initially, during the first box cut and furthest pits to the south, spoils will be hauled to an out-of-pit spoil pile to be constructed over a predominantly schist exposure south of the proposed mine. A shop pad involving approximately 50K cy of earthwork will also be constructed south of the open pit. Sedimentation ponds, diversion channels, and other storm water controls will also be constructed and maintained at and inside the mining limits to control in-pit seepage and storm water runoff.

2.0 SITE SETTING

2.1 GEOLOGY

The coal bearing group in the Nenana Coal field is of Tertiary age, overlain in some areas by several thousand feet of Tertiary gravels (the Nenana Gravels). In areas mined by surface methods, the Nenana Gravels are eroded off, and up to one hundred feet of Quaternary outwash gravels overlay the coal bearing formations. The Usibelli Group is subdivided into five formations, all of which are of Tertiary age. The oldest is the Healy Creek Formation, which ranges from the late Oligocene to early Miocene in age. Working up from this lies the Sanctuary Formation (early to middle Miocene), the Suntrana Formation (middle Miocene), the Lignite Creek Formation (middle Miocene), and the Grubstake Formation (late Miocene). Capping off the region are the Nenana Gravels (late Miocene). For a more detailed description of each formation, refer to USGS Bulletin 1274-D (Wahrhaftig, 1969).

The Jumbo Dome mining area lies geologically within the Suntrana Formation. The Suntrana Formation consists of 6 coal seams numbered from 1 at the bottom to 6 at the top. There are two partings of clay and bone making 1 Seam unattractive for mining. The quality of 2 Seam is poor and it is not economical to mine at this time. The 5 and 6 seams are thin and are not currently considered economically minable at this time. Therefore, only two of the six seams are of interest in the Jumbo Dome mining area, 3 and 4 seams.

Generally, the coal seams are structurally dipping to the northwest at an angle of 5-10 degrees with a few isolated areas dipping as high as 15-25 degrees and striking northeast-southwest.

The base of each coal seam is generally underlain by a footwall clay. The thickness varies from seam to seam as well as beneath any given seam. Analysis of drill data indicates that, for those logs that verify the presence of footwall clays, the average thickness is 5, 6 and 3 feet for the 6, 4 and 3 Seams, respectively. The actual thicknesses appear to be highly variable (ranging from 0 to 19 feet thick) with no definitive trend or depositional basin. Where no clay is present or indicated, a siltstone, or at times Jumbo Dome tallus, is generally present. Footwall clays are 30 to 50 percent montmorillonite, 30 to 50 percent kaolinite-chlorite, and 10 to 30 percent illite.

The mineable coal seams, 3 Seam and 4 Seam, generally outcrop towards the south end of Marguerite Creek and gently dip to the northwest. The strike of the coal seams is generally northeast-southwest.

2.2 HYDROGEOLOGY

Within the Jumbo Dome area, the coal seams act as the primary water bearing unit. Coal seams generally have a higher permeability than the adjacent strata with groundwater storage and movement being predominantly structure controlled. Sandstone is commonly above (overburden) and between (interburden) the coal seams. The sandstone acts as an aquitard. The sandstone intervals are hydrologically tied to the underlying coal seams, with the coal/sandstone forming one hydrostratigraphic unit. The underclays (footwall clay) and/or siltstones act as efficient aquicludes.

Groundwater systems generally contribute to stream surface flow where the drainage valleys intersect the coal outcrops (see Drawing 3, Hydrogeologic Cross-Sections).

3.0 FIELD INVESTIGATIONS FROM 2007 THROUGH 2010

UCM conducted a comprehensive exploration drilling program from 2007 through 2010 to further evaluate the coal reserves, install monitoring wells, and characterize subsurface lithology and groundwater conditions. Logs generated from the UCM drilling program are also included in Appendix A, and a typical well construction log is included in Appendix B. The monitoring well locations are presented on Drawing JD-HYDGEO-1. Completion summaries for the monitoring wells are included below in Table 1. UCM's logs also include information regarding the occurrence of ground water. As is the case regionally, indications were that the coal seams act as the primary water bearing units. Field aquifer tests performed during the 2009 and 2010 drilling program in seven of the monitoring wells provided hydraulic conductivity data in both the 3 and 4 seams specific to the Jumbo Dome mine area to aid in UCM's extrapolation of its current hydrogeologic model from existing mine areas (particularly Poker Flats and Two Bull Ridge) to the Jumbo Dome mine area.

For the 19 monitoring wells installed by UCM in 2007, 2008 and 2010, water levels have been periodically measured between September 2007 and November 2010. Monthly water levels were collected during September, October, and/or December of 2007 and January, February, March, and/or June of 2008 for the three 2007 monitoring wells. Monthly water levels were collected during July, September (early, late), November (early, late), and/or December of 2008 for 11 monitoring wells. Monthly water levels were collected during January, February, and April through December of 2009 for 11 monitoring wells and October and November 2010 for 6 of the 8 new monitoring wells (two of the new wells were either artesian or frozen). Some mid-winter water levels were measured despite logistical problems with the well equipment in cold temperatures. The latest series of water level measurements were used to update the Potentiometric Surface Map (see Drawing JD-HYDGEO-2).

3.1 EXPLORATION RC DRILLING, CORING, AND AUGERING

All drilling has been performed by Tester Drilling Services, Inc. (Tester) of Anchorage, Alaska. Two drilling methods were utilized: reverse circulation (RC) and core drilling. The coring was completed with a track-mounted Mobile Nodwell B-61 drill rig. RC drilling was completed using an air rotary drill rig. The rotary drill rig had an inner drill stem and outer casing. Tricone bits were used for most of the drilling. Installation of the 2-inch diameter monitoring wells required drilling a 4-inch diameter borehole. Installation of the 4-inch diameter monitoring wells required drilling a 5.25-inch diameter borehole. To allow for detection of groundwater, the holes were drilled using air as the drilling fluid until groundwater was detected. Once groundwater was detected, the boreholes were advanced an additional 10 to 20 feet to allow for sufficient depth to install the well screen.

During drilling, samples of soil were collected every five to ten feet. The sample was typically taken by grabbing the cuttings produced by the circulation of air. The sampling method was dependent on the hardness of the formation. Samples were placed in plastic bags. All samples were logged in the field by an engineer or geologist, and sample descriptions were recorded on log forms.

Coring was completed with the auger using 3.25-inch inside diameter (I.D.) hollow stem augers that created a 6-inch diameter hole. This system extracted 2.25-inch diameter core samples. This system used a 5-ft long core barrel and was typically unable to retrieve core in the upper 10 to 15-ft of the drillhole. Continuous auger sampling was accomplished by advancing the augers into

the ground while a soil core rode up into the long split core barrel contained within the bottom hollow-stem auger flight. The core barrel was connected to the drill rods by a bearing assembly that rotated under torque from the drill head, thereby allowing the core barrel to remain stationary while the augers turned. The core barrel was typically retrieved after a 2 to 5 ft. hole advancement and split open lengthwise to reveal the recorded sample. The distance between the tip of the core barrel shoe and the drill bit was adjustable. Adjustments were made as needed to balance recovery with drilling efficiency.

3.2 WATER LEVEL MONITORING

The wells were used for measuring water levels during the field investigation and were not developed in the field during the drilling programs but after the 2009 and 2010 programs. Groundwater levels in the monitoring wells installed for this exploration program were measured several times between late summer 2007 and fall 2010. Although groundwater is generally artesian on the west side of Marguerite Creek and therefore difficult to measure and sample, the monitoring wells will continue to be monitored and sampled to evaluate the response of perched phreatic surfaces (above the coal seams) to climatic conditions.

The data indicates that the coal seams are the primary water-bearing units within the Jumbo Dome project area. The existing monitoring well locations are presented on Drawing JD-HYDGEO-1. Geologic and well construction logs are provided in Appendix A. A standard monitoring well schematic is provided in Appendix B.

3.2.1 Seasonal Variation of Groundwater Levels

Ground water level data from the wells of the Jumbo Dome project area are provided in Appendix C. Water level fluctuations and temporal water-level trends within a specific water-bearing unit are noted below. For this discussion, level changes of less than 2 feet are considered “minor.” Most of the wells had fluctuations regularly near 1 foot or less.

- The 3 seam monitoring wells can be grouped into two types. The seven wells installed east of Marguerite Creek and 08JD02B installed above and west of Marguerite Creek have been fairly stable and show no significant seasonal changes in over a year (at least 10 measurements) of water level readings. The second set of 3 seam monitoring wells includes 07JD10, 07JD12 and 10JD03. These latter three wells are artesian. Wells 07JD10 and 07JD12 have recorded significant seasonal variations (both increasing and decreasing) with perhaps the most significant changes (increase of up to 6 feet followed by decrease of up to 12 feet) during the summer and fall of 2008. Water levels increased from approximately November 2007 through to spring 2008 and then dropped from mid to late summer 2008 through November 2008. This would signify a decrease in discharge (in proportion to recharge) into Marguerite Creek. One of the 3 seam wells is located just north of the mining boundary, 10JD03 will illustrate water quality in the 3 seam down gradient from mining.

- The 4 seam monitoring wells show minor seasonal variation. This close range shows a very stable aquifer with a steady discharge/recharge relationship. Five of the 4 seam wells are installed close to the 6 seam outcrop east of Marguerite Creek above the 2,000 ft. elevation. The other two 4 seam wells are installed closer to Marguerite Creek just outside the western limits of the proposed Jumbo Dome mining area. Water level readings in all four 4 seam monitoring wells imply confining conditions for the 4 seam aquifer.

- A 5 seam well was installed east of Marguerite Creek in the fall of 2010. 10JD04 is located

just north of the mining boundary, was installed within the floodplain of Marguerite creek and is artesian. As this well does not yet have significant data from which to discuss seasonal fluctuations in groundwater level, it is reasonable to assume it will behave similar to the 6 seam well located just down gradient.

- The 6 seam monitoring well is installed just west of the northern end of the proposed Jumbo Dome mining area and within the Marguerite Creek flood plain. Seasonal fluctuations in this well have been no more than 4 feet with expected patterns of change; that is, high water levels in winter and spring and decreasing throughout the summer and fall as recharge is less than discharge volumes once snowmelt and summer thunderstorms have finished.

3.2.2 Piezometric Surface Contouring

The UCM field program included collecting water levels at the 19 wells across the site and mapping springs and seeps in the pit area, in order to plot conceptual groundwater elevation contours and for constructing hydrogeologic cross-sections in the vicinity of the proposed pit. Using the measured and stabilized groundwater levels provided in the permit application, it has been possible to prepare the 3 and 4 seam potentiometric surface maps required for the Jumbo Dome permit application. Utilizing the software program Surfer, and converting the contour lines into AutoCAD, Drawing JD-HYDGEO-2 provides the potentiometric surfaces of these two coal seams.

Groundwater elevations were used to construct the conceptual potentiometric surface map. The initial evaluation of the water elevation data was done with Surfer® contouring software. The resulting contours were transferred to an AutoCAD base map of the Jumbo Dome mine area. Groundwater elevations calculated from surveyed wells were also plotted on the base map. These data points were used to construct a triangulation network. The contours were checked for accuracy by comparing their location against the triangulated position of that contour interval within the network. Estimated groundwater elevations from mapped seeps were also considered when drawing the conceptual groundwater contours but the primary goal of checking and editing the contours was to ensure that groundwater elevations from surveyed wells were honored wherever possible. Contours were not extrapolated outside the limits of the monitoring well network. Some wells showed considerably different water levels than those in nearby wells. This may be due to the vertical component of groundwater flow being reflected in wells of different depths with different screened intervals.

Groundwater flow at the site generally follows topography. Groundwater in the vicinity of the proposed mine flows towards the northwest and Marguerite Creek. Coal seams of the Suntrana Formation within the project area are recharged primarily by infiltration from precipitation, including spring snowmelt. The limited extent of local outcrops in the mining area probably restricts the volume of local recharge to the seams. The flow direction is out of the mining area, thus supporting the idea that the area is a recharge zone for the coal seam aquifers. This is further evidenced on Drawing JD-HYDGEO-3. Water infiltrates near to, and to a lesser extent between, the outcrop areas and works its way west and north along the coal beds in an confined state. As the water continues north and as the coal seam(s) start to dip more to the north, the coal becomes fully saturated and likely begins to saturate the overlying sandstone. This could be viewed as a partially confined or semi-confined state. In other portions of the Marguerite Creek valley, this saturation has been such that the coal and overlying sandstone is completely saturated and the upper clay layer again acts as an aquiclude, this time as a confining layer.

The coal seams discharge locally along creeks where exposed, and otherwise maintain flow to the northwest across the site. Any riprap slide areas above the Jumbo Dome mine area to the east will likely recharge the coal seams where exposed beneath the rubble layers and infiltrate contributing to aquifer volumes. Creek alluvium is likely recharged by coal seam discharge and some infiltration, which contributes to base flow in creeks and springs during low-flow months. It should be noted that on Drawing JD-HYDGEO-2 of the permit application the contours of the Potentiometric surface generally meet the ground surface at the coal outcrops in the Marguerite Creek drainage.

TABLE 1

MONITORING WELL COMPLETION SUMMARY

Monitoring Well/ Piezometer Number	Date Completed	Location		Surface Elevation (in feet)[2]	PVC Casing Stickup (in feet)[3]	Casing/Screen Diameter (in inches)	Effective Screen Zone[4] (in feet bgs)	Total Well Depth (in feet bgs)	Water-bearing Units Monitored[6]
		Northing (in feet)[1]	Easting (in feet)[1]						
07JDA	09/05/07	3652942.87	702894.51	2164.53	2.55	2	128-148	148	3 Seam
07JD10	08/29/07	3658098.89	704189.66	1971.49	4.20	2	168-197	197	3 Seam
07JD12	08/29/07	3657356.19	702681.73	2007.18	2.00	2	188-208	208	3 Seam
08JD01A	06/26/08	3653092.48	704701.97	2340.68	2.85	2	101-112	112	4 Seam
08JD01B	06/25/08	3653079.51	704687.30	2340.07	2.73	2	171-191	191	3 Seam
08JD02A	06/29/08	3655671.06	701259.57	2044.39	2.75	2	101-138	138	4 Seam
08JD02B	06/30/08	3655675.68	701271.68	2044.43	2.44	2	169-194	194	3 Seam
08JD03A	07/03/08	3657395.82	705385.64	2144.66	1.68	2	202-238	238	4 Seam
08JD03B	07/02/08	3657343.84	705376.35	2146.33	1.42	2	270-298	298	3 Seam
08JD04	07/05/08	3660487.10	704496.53	1921.57	3.85	2	64-90	90	6 Seam
08JD05	07/05/08	3659199.90	704961.75	1945.89	1.97	2	192-237	237	4 Seam
10JD01	9/13/10	3651249.1	704109.5	2436.2	1.97	4	194-204	230	3 Seam
10JD01A	9/1/2010	3651268.342	704064.034	2431.670	3	2	198-218	232	3 seam
10JD02	9/6/2010	3651423.311	704102.016	2429.837	3	4	143-163	173	4 seam
10JD02A	9/16/2010	3651379.8	704058.0	2427.1	3	2	124-154	170	4 seam
10JD03	9/23/2010	3659464.4	704818.1	1934.8	3	4	300-320	364	3 seam
10JD04	9/19/2010	3659554.8	704827.9	1932.9	3	4	129-139	156	5 seam
10JD05 alt	9/26/2010	3652263.4	702438.2	2210.2	3	2	159-179	193	3 seam
10JD06 alt	9/27/2010	3652121.6	702331.6	2222.3	3	2	123-143	157	4 seam

Notes:
1. All coordinates directly surveyed by UCM.
2. All elevations directly surveyed by UCM.
4. Includes filter pack and any backfill zones below the bentonite seal and above the bottom of the borehole.
5. Copies of geologic and well completion logs are provided in Appendix A & B respectively

4.0 SCOPE OF WORK

4.1 WELL DRILLING

4.1.1 Well Completion and Construction

Once a targeted coal seam was intercepted, the hole was generally drilled ten feet beyond the bottom of the targeted seam. The well was then constructed with the intent to place the screened interval within the water-bearing unit (coal seam). The length of screened interval was designed for each well individually based on the amount of exposed coal seam.

The screened intervals were sealed both above and below with bentonite clay in order to isolate groundwater from the targeted coal seam. Well completion logs are provided in Appendix A. A typical well construction schematic is provided in Appendix B.

4.2 AQUIFER TESTING

Two types of aquifer tests were performed during the 2009 and 2010 investigations. Drawdown tests (or pumping tests) as well as slug tests were performed. A drawdown test involves a pumping well and at least one observation well screened in the same hydrostratigraphic unit. A slug test is performed within one well. Specific details regarding the methods employed for both types of tests is provided below.

4.2.1 Slug Tests

Slug tests are a type of aquifer test that is both performed and observed in one same well. A slug test can be performed in one of two ways; either introduce a physical slug that displaces water causing a rise in water level, or pump out a volume of water very quickly, so as to cause a rapid reduction of groundwater within the well. Once either method is employed, the recovery of groundwater within the well is monitored until it has returned to the pre-test elevation.

In 2009, slug tests were performed in three 2-inch wells; 07JDA, 08JD03A and 08JD03B. In these tests, a slug (1-inch galvanized pipe filled with sand and capped at both ends) was lowered into the well with the intent of instantaneous water displacement (rise in water level). Water levels were recorded using a pressure transducer to monitor recovery of groundwater in that well.

In 2010, slug tests were performed in three 4-inch wells; 10JD02A, 10JD05 alt and 10JD06 alt. In these slug tests, a pump was used to evacuate groundwater rapidly from the well. As soon as a predetermined volume of water was removed, the pump was de-energized. Recovery of the groundwater in each well was monitored using pressure transducers until the water levels reached the pre-test elevation.

Both 3 and 4 seams were targeted in the slug tests. All six tests between 2009 and 2010 verified hydraulic conductivities calculated from the drawdown tests in each seam. The benefit of performing these slug tests is that while the drawdown tests gave UCM comprehensive hydrologic data for one specific location within the Jumbo Dome area, these slug test data helped reduce data gaps within the overall hydrologic regime of the Jumbo Dome area.

4.2.2 Drawdown Tests

Drawdown tests were performed in two separate well pairs; one in the 4 seam and one in the 3 seam. Each well pair included a 4-inch pumping well and a 2-inch observation well approximately 50 feet away. Each well pair is screened in the same coal seam.

The procedure for the drawdown tests was to pump for 24 hours at a sustainable rate. At regular intervals water levels were measured in both the observation well and pumping well. Once 24 hours of pumping had occurred, observance of the subsequent 24 hours of recovery followed with regular interval measurements of water levels in both wells. Once 48 hours worth of raw data was collected (Appendix D), the raw data was used as input to the aquifer testing software Aqtesolv to calculate the transmissivity and storativity.

5.0 AQUIFER TESTING AND GROUNDWATER MODELING

Aquifer testing was conducted on wells drilled for this investigation. The results of this testing, as well as lithology, water level observations, and field aquifer testing, were used as inputs for groundwater modeling to estimate the groundwater inflow into the initial mine cut.

Aquifer Test Analysis

Pumping and observation wells were drilled in both the 3 and 4 seams. The data from these tests was evaluated using the aquifer test analysis software Aqtesolv. Both tests were evaluated using the Theis solution for confined aquifers.

The results of the 2010 aquifer testing were indeterminate, possibly due to pressure transducer failures. Although the data did show a general pattern approximating a drawdown curve, there was considerable noise in the data set. The aquifer testing program did confirm some of the observations made during the 2009 drilling and testing. Most notably the 4 seam test suggested that the seam may be unconfined in some areas. The calculated storativity value for the 4 seam is within the range of values typical of an unconfined aquifer. At the time of the test the potentiometric surface in the 4 seam pumping well was 32 feet above the top of the seam. The water level in the pumping well may have fallen below the top of the seam during the test. This is consistent with earlier observations that the flow into the pit from 4 seam may be considerably smaller than the flow from 3 seam and may be dry in portions of the mining area.

Groundwater Modeling

The volume of water to be removed from the initial mine cut was estimated using the Winflow groundwater modeling software. Winflow is an analytical element model that uses the solution to the Theis equation for drawdown from a well in a confined aquifer and the principal of superposition to simulate drawdown or recharge from well fields, line sinks, and ponds. Winflow is a two-dimensional model that assumes a flat aquifer of unlimited areal extent and constant thickness and hydraulic conductivity. It is not capable of simulating complex hydrology and geology. However, it is useful for initial estimates of groundwater flow.

Two dewatering scenarios were modeled. First, the use of dewatering wells along the initial cut only. For this simulation, the first mine cut was modeled as a line sink. Separate models were run for 3 and 4 seams and the flow was added for a total inflow estimate. Parameters such as aquifer thickness and hydraulic head were taken from the logs of new wells drilled in the east side of the initial mine cut.

The second scenario is the use of a series of dewatering wells along the mining boundary on the southeast side of the mine limit combined with in-pit water control by ditching or drains. The advantage of this scenario is that the wells are not destroyed by mining and assist with dewatering of subsequent mine cuts. Multiple modeling runs determined that the optimal number of wells might be ten. This effectively dewaters the east side of the mine cut with in-pit controls becoming necessary as you mine west towards Marguerite Creek.

Results

In the Winflow model the flux from the 3 seam pit line sink was calibrated to produce approximately 105 feet of drawdown (the difference between the bottom of the seam and the top

of the potentiometric surface) to simulate the amount of water that would have to be removed from the pit area to produce a dry pit bottom. Daily groundwater discharge from 3 Seam into the pit is approximately 128,000 gallons per day (GPD).

The flux from the 4 seam pit line sink was calibrated to produce approximately 60 feet of drawdown (the difference between the bottom of the seam and the top of the potentiometric surface) to simulate the amount of water that would have to be removed from the pit area to produce a dry pit bottom. Daily groundwater discharge from 4 seam into the pit is approximately 28,158 GPD. These results are summarized below.

Scenario 1 – Wells Running the Length of the Initial Cut:

Inflow from 3 Seam	128,428 gallons per day
Inflow from 4 Seam	28,158 gallons per day
Combined Inflow	156,586 gallons per day

In the second scenario the target dewatering elevations are the same but they are achieved with 10 wells and in-pit water control, as described above. The results for that scenario are shown below.

Scenario 2 – 10 Wells Along Mining Boundary with In-pit Water Control:

Total water pumped from wells	86,400 gallons per day
Inflow from 3 and 4 seams to in-pit controls	97,216 gallons per day

Well Spacing

Applying these inflow calculations with the Winflow model and assuming that the wells would have to remove the same volume of water; well spacing was taken into consideration for dewatering wells in 3 and 4 seams. Based on these data, an estimated optimal well spacing would be approximately 100 feet.

Each well could be screened across both seams, with a dedicated pump at the bottom. This would allow a single well to handle the inflow of both 3 and 4 seams. Using this construction, a single well could be placed every 100 feet to dewater both seams simultaneously.

Conclusions

Based on modeling two dewatering scenarios it is estimated that the total combined discharge into to be handled in the pit and/or from the wells from 3 and 4 seams was estimated at between 156,586 GPD and 183,616 GPD depending on the dewatering scenario. Most of this water comes from 3 Seam.

5.1 HYDRAULIC CONDUCTIVITY AND TRANSMISSIVITY ESTIMATES

Hydraulic Conductivity

Available hydraulic conductivity data are presented in Table 2 below. Aquifer tests from which the data were calculated include three slug tests conducted in 2009 from two 2008 monitoring wells and one 2007 monitoring well. Data were collected from the 3 and 4 coal seams. Available data indicate that coal seams are moderately to relatively permeable units, having hydraulic conductivity values similar to fine uncemented sands or fractured rock. 4 Seam displays a range that is slightly lower than 3 Seam data ranges. Hydraulic conductivity values calculated from tests performed on 3 Seam is typically $1.7x10^{-3}$ ft/min. Hydraulic conductivity values calculated from tests performed on 4 Seam is typically $6.2x10^{-4}$ ft/min. Aquifer tests performed at other UCM mine properties indicate lower hydraulic conductivities for the sandstone interburden layers, typically around $1x10^{-5}$ to $1x10^{-6}$ ft/min. This agrees with observations made during drilling activities at Jumbo Dome (where sustained discharge of water is usually encountered from within the coal seams and not the overlying sandstones) and from surrounding mine areas and exposures along creeks (where sustained flow generally emanates from the coal seams and not from sandstone strata).

TABLE 2
HYDRAULIC CONDUCTIVITY DATA SUMMARY

Water-bearing Unit	Well Number[1]	Test Interval (ft bgs)	Test Date	Test Type[2]	Method of Analysis[2]	Hydraulic Conductivity (ft/min)
3 Seam	07JDA	128-148	09/21/09	Slug	Bouwer and Rice	$1.7x10^{-3}$
	08JD03B	270-298	09/21/09	Slug	Bouwer and Rice	$1.7x10^{-3}$
4 Seam	08JD03A	202-238	09/21/09	Slug	Bouwer and Rice	$6.2x10^{-4}$

Notes:
1. All wells are located at Jumbo Dome.
2. A description of test types and methods of analysis is presented in Fetter (1988).
3. Copies of field data sheets and office calculations are available from the UCM project files.

Transmissivity

Aquifer transmissivity is a measure of the volume of water that can be transmitted horizontally by the full saturated thickness of the aquifer under a hydraulic gradient of 1. Using hydraulic conductivity values presented in Table 2 above, a range of transmissivity values can be calculated for the 3 and 4 coal seams, based on the equation (Fetter, 1980):

$$T = KB$$

where: T = transmissivity (L^2/t);
K = hydraulic conductivity (L/t); and
B = saturated aquifer thickness (L).

The thickness assigned to each coal aquifer for the purpose of transmissivity calculations is based on the average thickness of each unit within the excavation boundary. Calculated transmissivity values are summarized in Table 3 below.

TABLE 3
SUMMARY OF AQUIFER TRANSMISSIVITY VALUES

Coal Seam	Hydraulic Conductivity (ft/min)	Aquifer Thickness (ft)	Transmissivity (ft^2/min)
3	1.7×10^{-3}	15-40	4.0×10^{-2} to 4.6×10^{-2}
4	6.2×10^{-4}	10-50	2.6×10^{-2}

6.0 SEDIMENTATION POND JD-2 SEEPAGE ESTIMATE

The volume of water likely to be lost from sedimentation pond JD-2 was estimated using the Winflow groundwater modeling software. Winflow is a simple 2-dimensional analytical element model that uses the solution to the Theis equation for drawdown from a well in a confined aquifer and the principal of superposition to simulate drawdown or recharge from well fields, line sinks, and ponds.

Winflow is a two-dimensional model that assumes a flat aquifer of unlimited areal extent and constant thickness and hydraulic conductivity. It is not capable of simulating complex hydrology and geology. However, it is useful for initial estimates of flow.

6.1 MODELING

The results of the pit inflow model were used as a starting point for this model. 3 Seam has a higher potentiometric surface than 4 and was used to calculate to what depth these ponds might fill. The 3 Seam potentiometric surface in the area of JD-2 is at an approximate elevation of 2,025 feet. The drawdown analysis from the pit dewatering model shows that dewatering the first cut could lower the potentiometric surface of 3 seam an additional 30 feet to 1,995 feet. This is 37 feet below the proposed operating level of 2,032 feet. Pit seepage loss was modeled with the assumption that the pond would be held at the operating level. Therefore the head difference of 37 feet is the driving force for flow out of the pond. In this model, the head inside the pond was held 37 feet above the static level outside the pond and flow into 3 Seam was calculated. The model was run as a steady state model. The steady state model assumes that the flow system has reached equilibrium and there are no further changes in water levels.

Only 3 Seam was modeled. In examining the pond cross-sections, 4 Seam thins considerably in the area of the pond and most of its outcrop within the pond would be above the waterline when the pond is operated at its normal operating level. Parameters such as aquifer thickness, transmissivity, and storativity were taken from the flow model already developed for the pit inflow model.

6.2 RESULTS

The estimated daily discharge from the sedimentation pond into 3 Seam is approximately 19,300 gallons per day (GPD). This result should be viewed as conservative. It assumes that the pond is filled to its normal operating capacity and stays there for as long as it takes the system to reach a steady state condition. Also, the model does not allow for changes in the hydraulic conductivity of the exposed 3 Seam in the pond. It is common in infiltration ponds, designed to recharge water, for the recharge capacity to be reduced to one half or even one third of their original capacity over time. This occurs as the pore spaces in the bottom and walls of the pond become partially sealed by fine sediment.

7.0 CONCLUSIONS

Groundwater within the existing, unmined area appears to exist in the coal seams and is laterally continuous, related to the northwest-trending dip of the coal seam structure and the overlying topography. Relatively large quantities of groundwater may be encountered during mining, which may emanate from both the coal seams and from within and under the rubble and tallus layers that have been observed at the site. According to the dewatering well simulation modeling, it should be a relatively straight forward practice to plan and manage this volume of groundwater.

8.0 REFRENCES

Alaska Department of Natural Resources, Division of Mining, Land, and Water, 2009. *Alaska Surface Coal Mining Program, Regulations Governing Coal Mining in Alaska*, 11 AAC 90. Dated April 24.

Alaska Department of Natural Resources, Division of Mining, Land, and Water, 2006. *Permit to Conduct Surface Coal Mining Activities, Jumbo dome Mine Road Corridor, S-0605*, Surface Mining Permit Application, Final Findings of Fact and Decision – Usibelli Coal Mine, Inc., Healy, Alaska. Dated December 21.

Alaska Division of Geological and Geophysical Surveys, 2006. *Geologic Ground-Truth Inventory of Liberty Bell, Western Bonnifield Mining District Geophysical Survey Tract*, by Jennifer E. Athey, Fairbanks, Alaska. Vol. 9, No. 1, Alaska GeoSurvey News. Dated February.

Linnell, K.A. and Kaplar, C.W., 1966, *Description and Classification of Frozen Soils:* U.S. Army Cold Regions Res. Eng. Lab. Tech Rep. 150

Usibelli Coal Mine, Inc., 1999. *TBR-FR Permit Application 02-86-795, Permit Revision Application*, Healy, Alaska. Dated July.

Usibelli Coal Mine, Inc., 2002. *Hoseanna Creek and Emma Creek, Coal Exploration Permit 02-86-795, Permit Revision Application*, Healy, Alaska. Dated July.

Usibelli Coal Mine, Inc., unpublished and proprietary in-house data.

Wahrhaftig, C., 1970, *Geologic Map of the Healy D-4 Quadrangle, Alaska*: U.S.Geological Survey Map GQ-806, scale 1:63,360.

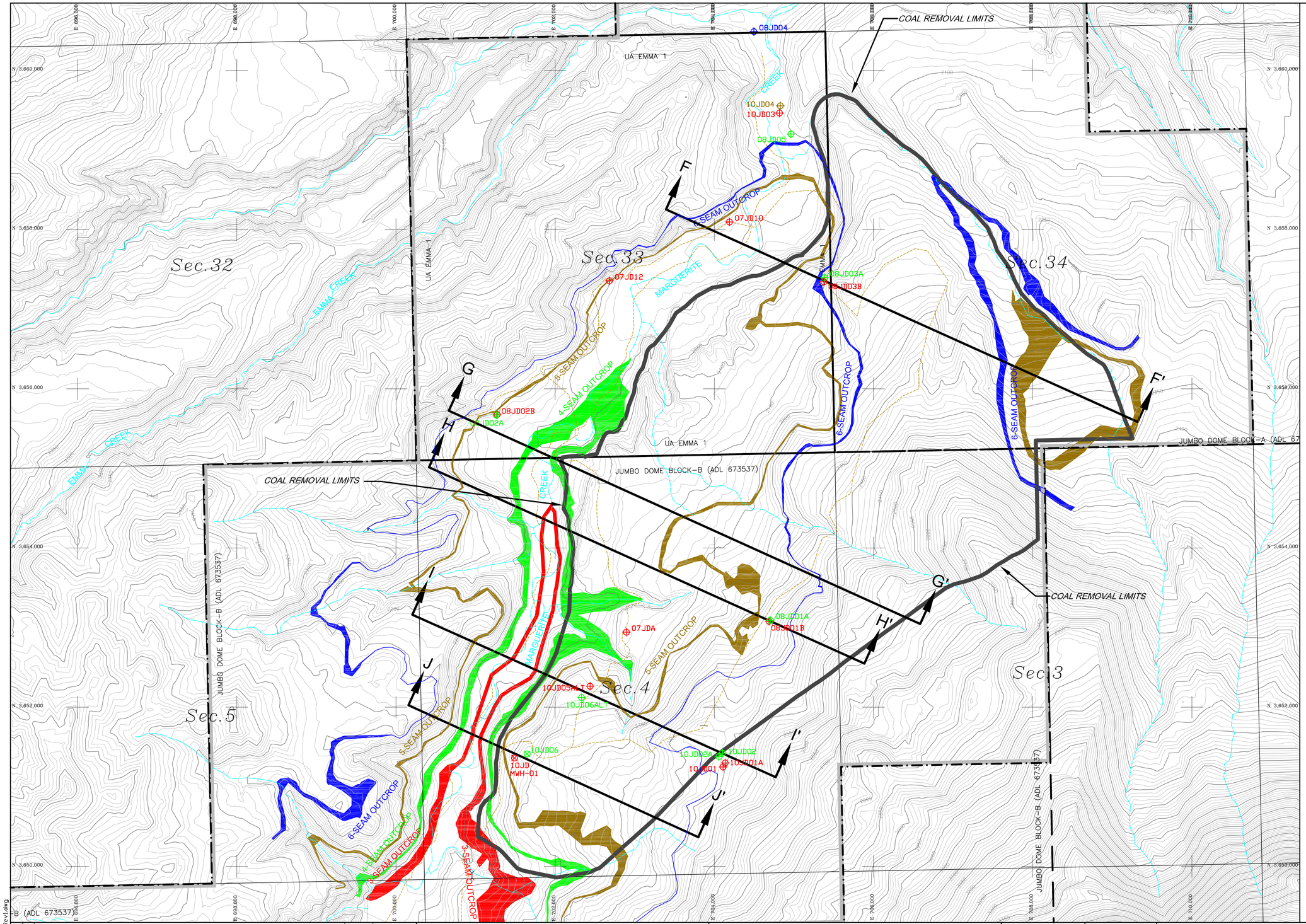
Wahrhaftig, C., and Birman, J.H., 1954, *Stripping Coal Deposits on Lower Lignite Creek, Nenana Coal Field, Alaska*: U.S.Geological Survey Circular 310, 11p.

Wilbur, S.C., 1995, *Fluvial and Hillside Geomorphology of Hoseanna Creek Watershed, Central Alaska*, a Thesis. University of Alaska, Fairbanks, Alaska. Dated December.

Limitations:

Professional judgments on subsurface conditions and engineering properties of geologic materials are presented in this report. They are based partially on the evaluation of the technical information gathered from this study, partially on our understanding of the characteristics of the site, and partially on our experience with subsurface conditions in the surrounding area. We do not guarantee the performance of the project in any respect; only that our engineering work and judgments rendered meet the standard of care for our profession. Variations from the conditions portrayed, which are not indicated by the test explorations or laboratory testing, may occur. Judgments made should consider this potential variability. If different conditions are encountered during future mining excavations, it is necessary that we be contacted so that our recommendations can be reviewed. We represent that our services are performed within the limits set forth by UCM, in a manner consistent with the level of care and skill ordinarily exercised by other professional consultants under similar circumstances. No other representation to UCM, expressed or implied, and no warranty or guarantee is included or intended.

DRAWINGS



LEGEND

- 6-SEAM OUTCROP
- 5-SEAM OUTCROP
- 4-SEAM OUTCROP
- 3-SEAM OUTCROP
- ORIGINAL TOPOGRAPHY
- COAL REMOVAL LIMITS
- NATURAL DRAINAGE
- TRAIL
- LEASE BOUNDARY
- PERMIT BOUNDARY
- 07JD12 3 SEAM WELL
- 08JD05 4 SEAM WELL
- 10JD04 5 SEAM WELL
- 08JD05 6 SEAM WELL

N

SCALE

600' 0 600' 1200'

CONTOUR INTERVAL: 10 FT

NOTES:

1. HORIZONTAL DATUM IS BASED ON ALASKA STATE PLANE COORDINATES, ZONE-4, NAD 27, AS EXPRESSED IN U.S. SURVEY FEET.
2. VERTICAL DATUM IS BASED ON MEAN SEA LEVEL.
3. WELLS 07JD04-ALT, 08JD01A, 08JD01B, 08JD02A, 08JD03A, 08JD03B AND 08JD05 MEASURED BY UCM ON 5/20/09, WELL 07JD10 MEASURED BY UCM ON 11/1/08, WELL 08JD02B MEASURED BY UCM ON 4/2/09.

REV	DESCRIPTION OF REVISION	BY	DATE
0	DRAFT	RLM	2/11

AutoCAD FILE: JD_Permit_Rev1.dwg

USIBELLI COAL MINE, INC.

AJAX
28828 CEDAR CIRCLE
EVERGREEN, CO 80439
(303) 241-2057

WARNING
0 0.5 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

DESIGNED	
DRAWN	RLM
CHECKED	AJH
REVIEWED	
CLIENT	
DATE	2/4/11

USIBELLI COAL MINE

JUMBO DOME MINE

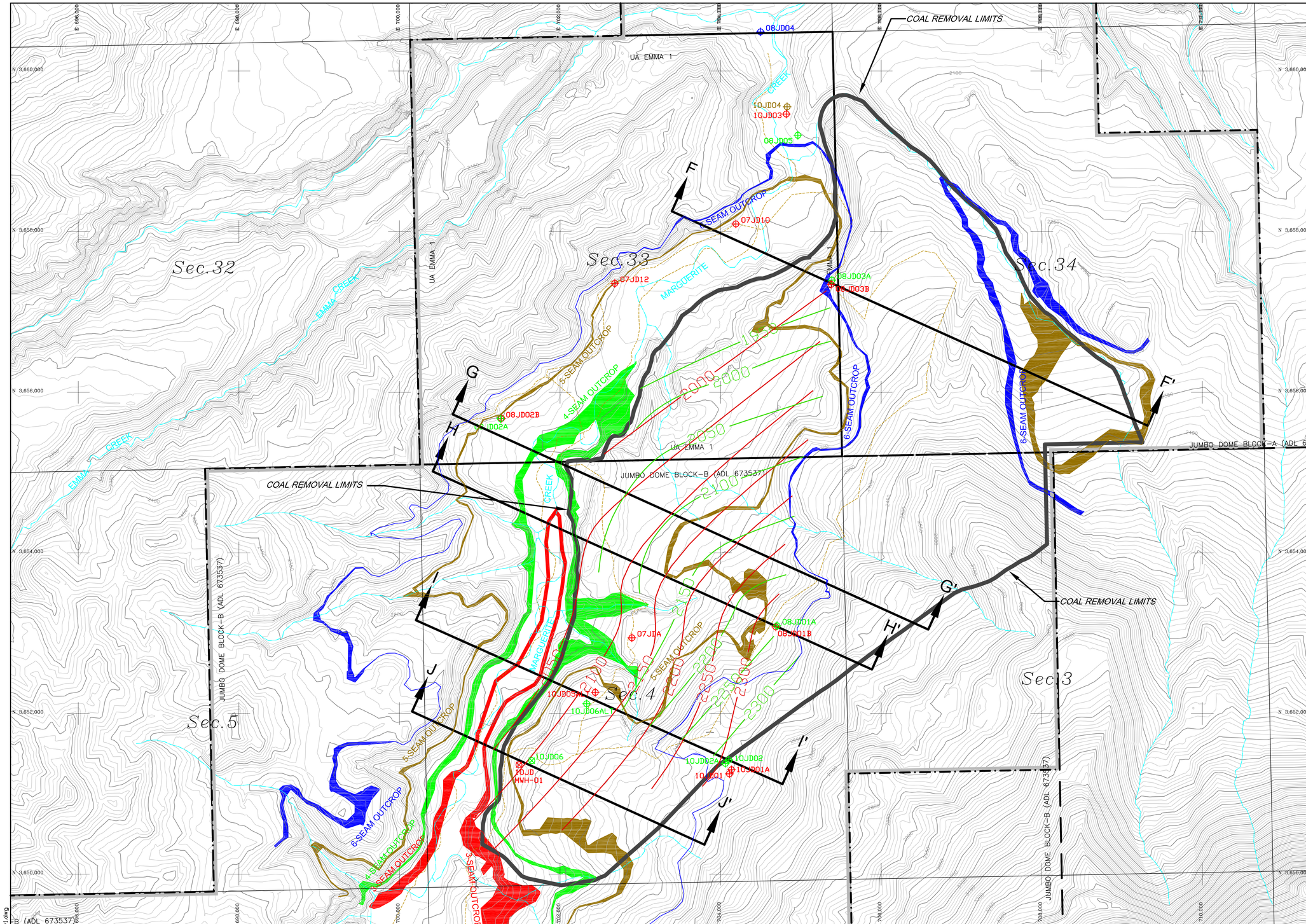
MONITORING WELL LOCATIONS

REVISION 0

PROJECT NO.

DRAWING JD-HYDGEO-1

SHEET 1 OF 1



LEGEND

- 6-SEAM OUTCROP
- 5-SEAM OUTCROP
- 4-SEAM OUTCROP
- 3-SEAM OUTCROP
- ORIGINAL TOPOGRAPHY
- COAL REMOVAL LIMITS
- NATURAL DRAINAGE
- TRAIL
- LEASE BOUNDARY
- PERMIT BOUNDARY
- 07JD12 3 SEAM WELL
- 08JD05 4 SEAM WELL
- 10JD04 5 SEAM WELL
- 08JD05 6 SEAM WELL
- 4 SEAM POTENTIOMETRIC SURFACE
- 3 SEAM POTENTIOMETRIC SURFACE

N

SCALE

600' 0 600' 1200'

CONTOUR INTERVAL: 10 FT

NOTES:

1. HORIZONTAL DATUM IS BASED ON ALASKA STATE PLANE COORDINATES, ZONE-4, NAD 27, AS EXPRESSED IN U.S. SURVEY FEET.
2. VERTICAL DATUM IS BASED ON MEAN SEA LEVEL.
3. POTENTIOMETRIC SURFACE CONTOURED AT 50-FOOT INTERVALS.
4. WELLS 07JD04-ALT, 08JD01A, 08JD01B, 08JD02A, 08JD03A, 08JD03B AND 08JD05 MEASURED BY UCM ON 5/20/09. WELL 07JD10 MEASURED BY UCM ON 11/1/08. WELL 08JD02B MEASURED BY UCM ON 4/2/09.

REV	DESCRIPTION OF REVISION	BY	DATE
0	DRAFT	RLM	2/11

AutoCAD FILE: JD_Permt_Revisdwg

USIBELLI COAL MINE, INC.

AJAX
28828 CEDAR CIRCLE
EVERGREEN, CO 80439
(303) 241-2057

WARNING
0 0.5 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

DESIGNED	
DRAWN	RLM
CHECKED	AJH
REVIEWED	
CLIENT	
DATE	2/4/11

USIBELLI COAL MINE

JUMBO DOME MINE

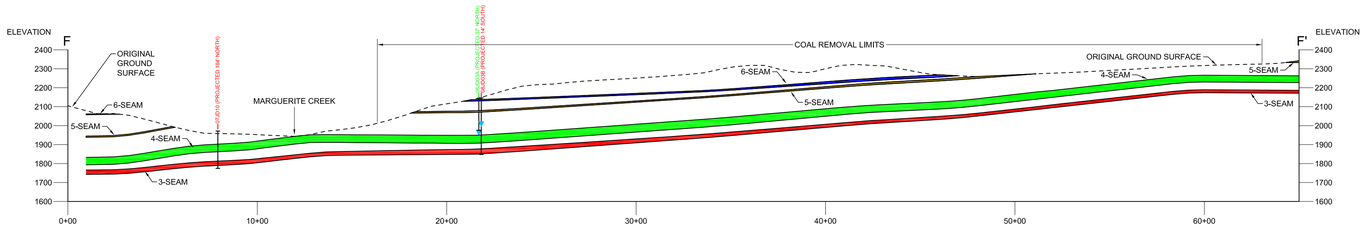
POTENTIOMETRIC SURFACE MAP & CROSS-SECTION INDEX

REVISION 0

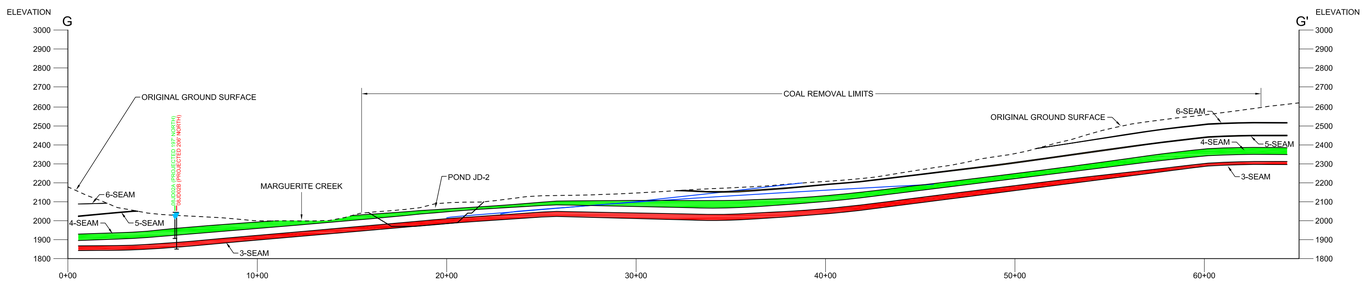
PROJECT NO.

DRAWING JD-HYDGEO-2

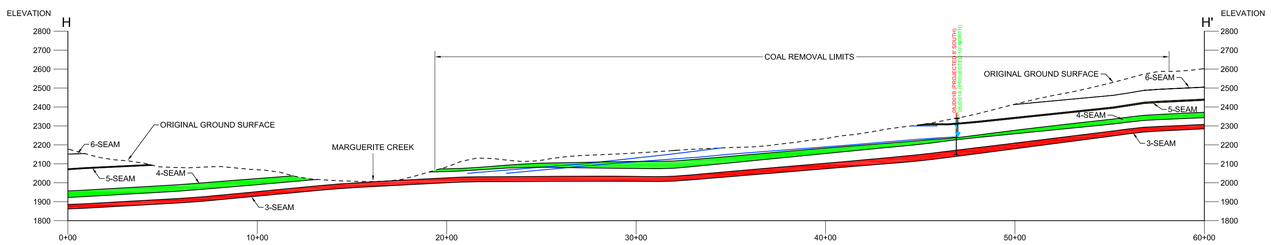
SHEET 1 OF 1



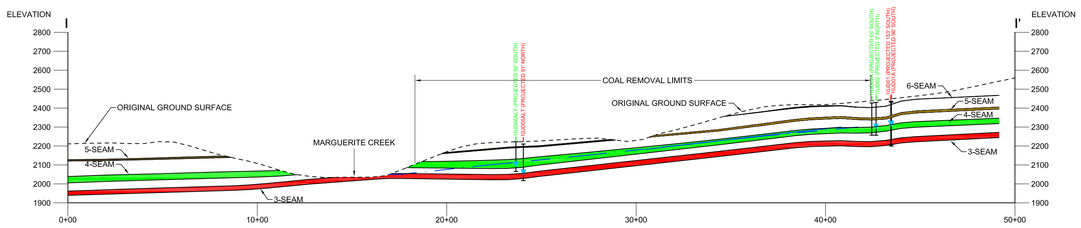
CROSS SECTION F-F'



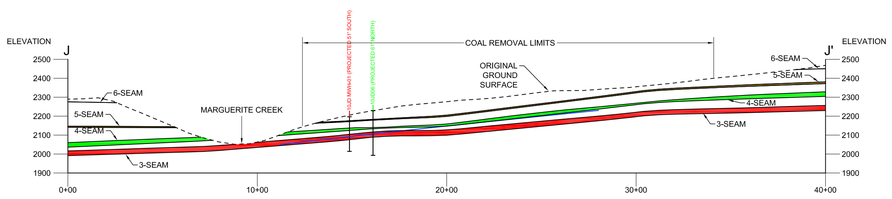
CROSS SECTION G-G'



CROSS SECTION H-H'



CROSS SECTION I-I'



CROSS SECTION J-J'

LEGEND

- 6-SEAM OUTCROP
- 5-SEAM OUTCROP
- 4-SEAM OUTCROP
- 3-SEAM OUTCROP
- ORIGINAL GROUND SURFACE
- 4-SEAM POTENTIOMETRIC SURFACE
- 3-SEAM POTENTIOMETRIC SURFACE
- MEASURED WATER LEVEL

SCALE

400' 0 400' 800'

CONTOUR INTERVAL: N/A

NOTES:

1. HORIZONTAL DATUM IS BASED ON ALASKA STATE PLANE COORDINATES, ZONE-4, NAD 27, AS EXPRESSED IN U.S. SURVEY FEET.
2. VERTICAL DATUM IS BASED ON MEAN SEA LEVEL.
3. WELLS 07JD04-ALT, 08JD01A, 08JD01B, 08JD02A, 08JD03A, 08JD03B AND 08JD05 MEASURED BY UCM ON 5/20/09. WELL 07JD10 MEASURED BY UCM ON 11/1/08. WELL 08JD02B MEASURED BY UCM ON 4/2/09.

REV	DESCRIPTION OF REVISION	BY	DATE
0	DRAFT	RLM	2/11

AutoCAD FILE: JD_Permt_Rev1.dwg

UCM USIBELLI COAL MINE, INC.

AJAX
28828 CEDAR CIRCLE
EVERGREEN, CO 80439
(303) 241-2057

WARNING
0 0.5 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

DESIGNED	
DRAWN	RLM
CHECKED	AJH
REVIEWED	
CLIENT	
DATE	2/4/11

USIBELLI COAL MINE

JUMBO DOME MINE

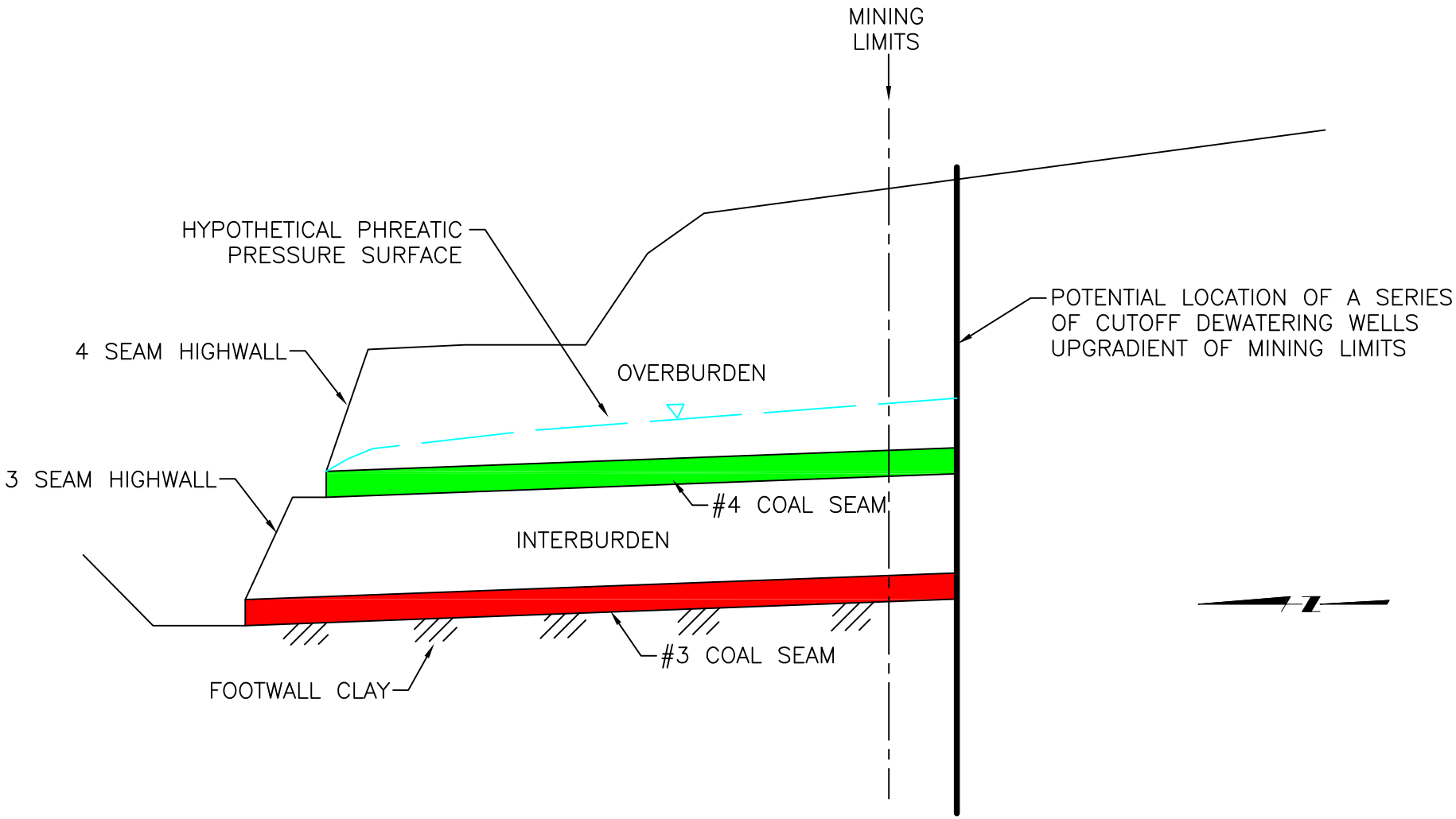
HYDROGEOLOGIC CROSS-SECTIONS

REVISION 0

PROJECT NO.

DRAWING JD-HYDGEO-3

SHEET 1 OF 1



REV	DESCRIPTION OF REVISION	BY	DATE
0	DRAFT	RLM	02/11

USIBELLI COAL MINE, INC.

AJAX
201 E. CEDAR STREET
GLOBE, AZ 85501
(928) 425-5005

WARNING
0 0.5 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

DESIGNED
DRAWN RLM
CHECKED
REVIEWED AJH
CONTACT
DATE 2-11-11

USIBELLI COAL MINE

TYPICAL CROSS SECTION THROUGH WELLS

REVISION 0
PROJECT NO.
DRAWING JD-HYDGEO-A
SHEET 1 OF 1

AutoCAD FILE: JD_FIGURES

APPENDIX A

DRLLING LOGS

Borehole: 07JDA

Date: 09/04/07 - 09/05/07

Geologist: E. Usibelli

Driller: Tester Drilling Services, Inc.

Project: Jumbo Dome

Location: UCM, Healy, AK

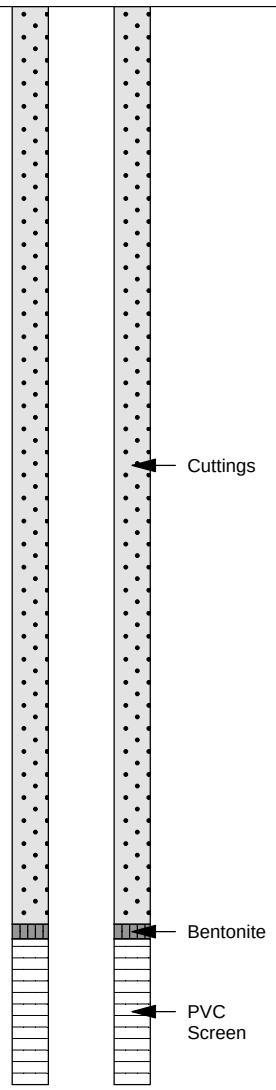
Northing: 3652943.00

Easting: 702894.50

Elevation: 2164.53

Depth	Log	Description	Comments
0		Silt	Mixed organic / tundra.
		Gravel	2-20 mixed gravels
20		Sandstone	Gray, pebbly, Suntrana sandstone. Fine to very fine-grained; moderate to well sorted, 80% quartz.
		Gravel	Angular pebbles.
40		Coal	4 Seam.
60			
		Clay	4 Seam footwall.
80		Sandstone	Gray, Suntrana sandstone; 80% quartz; fine to very fine-grained; moderate to well sorted; subround to round pebbly intervals at base of sequence above #3.
100			
120		Gravel	2 to 3' water standing in borehole 9/5/07.
		Coal	3 Seam.
140			
		Clay	3 Seam footwall.
		Sandstone	Suntrana sandstone.
160			
180			
200			

Well Detail



USIBELLI COAL MINE, INC.

Borehole: 07JD10

Date: 08/29/07

Geologist: E. Usibelli

Driller: Tester Drilling Services, Inc.

Project: Jumbo Dome

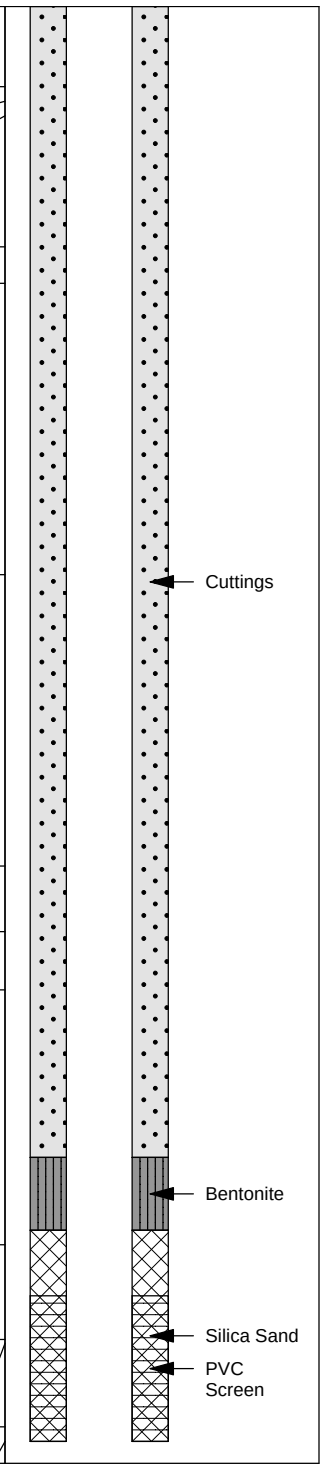
Location: UCM, Healy, AK

Northing: 3658095.90

Easting: 704189.70

Elevation: 1971.50

Depth	Log	Description	Comments
0		Gravel	Brown, cold permafrost, a little frozen.
		Sand Pebbles	
20		Sand	Cold, slurry of sand with 2 inches frozen permafrost chunks.
		Sand	
		Silty Sand	
40		Sand with Pebbles	
60			
80		Coal	4 Seam
100			
120		Clay	4 Seam footwall.
		Silt	
140		Sand	
160			
		Coal	3 Seam.
180			
		Clay	3 Seam parting.
		Coal	No samples taken.
		Clay	3 Seam footwall.
200			



USIBELLI COAL MINE, INC.

Borehole: 07JD12

Date: 08/29/07

Geologist: E. Usibelli

Driller: Tester Drilling Services, Inc.

Project: Jumbo Dome

Location: UCM, Healy, AK

Northing: 3657356.20

Easting: 702681.70

Elevation: 2007.20

Depth	Log	Description	Comments	Well Detail
0		Gravel with Sand	No returns. 2 inch gravel with brown sand at 10 - 25'.	
20		Sand		
		Clay		
40		Coal		
		Sand		
60				
80				
100		Coal	4 Seam. No sample, mixed with sandstone and quartz.	Silica Sand
120				
140				
		Clay	4 Seam footwall. Gray, chippy, hard.	
160		Sand		
		Coal	3 Seam.	
180				
		Clay	3 Seam footwall.	
200		Sand	Gray	PVC Screen

USIBELLI COAL MINE, INC.

Borehole: 07JD12

Date: 08/29/07

Geologist: E. Usibelli

Driller: Tester Drilling Services, Inc.

Project: Jumbo Dome

Location: UCM, Healy, AK

Northing: 3657356.20

Easting: 702681.70

Elevation: 2007.20

Depth	Log	Description	Comments	Well Detail
200				
220				
240				
260				
280				
300				
320				
340				
360				
380				

USIBELLI COAL MINE, INC.

Borehole: 08JD01A

Date: 06/26/08

Geologist: Alec M. Venechuk

Driller: Tester Drilling Services, Inc.

Project: Jumbo dome

Location: UCM, Healy, AK

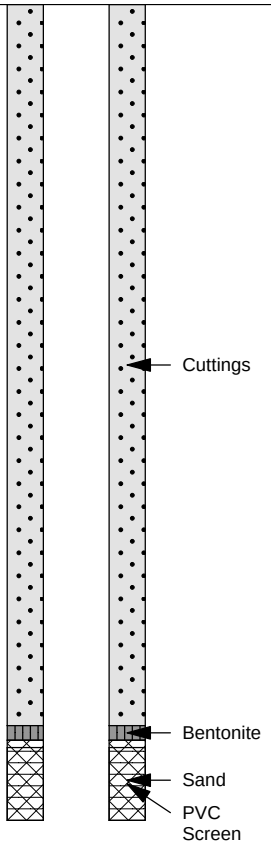
Northing: 3653092.00

Easting: 704702.00

Elevation: 2340.68

Depth	Log	Description	Comments
0		Gravel	Tallus and Organics
20		Gravel with Sand	Clay and Tallus at 8 - 27'.
40		Gravel	Jumbo Dome Tallus; some sand. Visible Ice at 63-90'. Water encountered at 92'.
60			
80			
100		Silty Sand	
		Coal	4 Seam
120			
140			
160			
180			
200			

Well Detail



USIBELLI COAL MINE, INC.

Borehole: 08JD01B

Date: 06/25/08

Geologist: Alec M. Venechuk

Driller: Tester Drilling Services, Inc.

Project: Jumbo Dome

Location: UCM, Healy, AK

Northing: 3653080.00

Easting: 704687.30

Elevation: 2340.07

Depth	Log	Description	Comments	Well Detail
0		Gravel	Odex drilling all the way to 3 seam (164'). Returns are poor but match up well with 08JD1B (abandoned).	
		Coal	Coal stringer at 14'.	
20		Gravel		
		Clayey Silt	Bits of coal.	
		Sandy Silt	Brown	
		Sand	Tallus	
40		Gravel		
		Silty Sand	Tallus Visible ice at 60' - 90'.	
60		Gravel		
80			Water at 92'.	Cuttings
100		Clayey Silt		
		Coal	4 Seam	
120		Gravel	JD Tallus	
		Clay and Silt	Thin clay and silt layer at 129'.	
		Coal	Coal stringer.	
140		Sandy Clay	Gray, some silt.	
		Clay		
160		Sandy Clay		
		Coal	3 Seam, hard coal. Water @ 167'.	Bentonite
180				PVC Screen with Silica Sand
200				

USIBELLI COAL MINE, INC.

Borehole: 08JD02A

Date: 06/29/08

Geologist: Keith Clark

Driller: Tester Drilling Services, Inc.

Project: Jumbo Dome

Location: UCM, Healy, AK

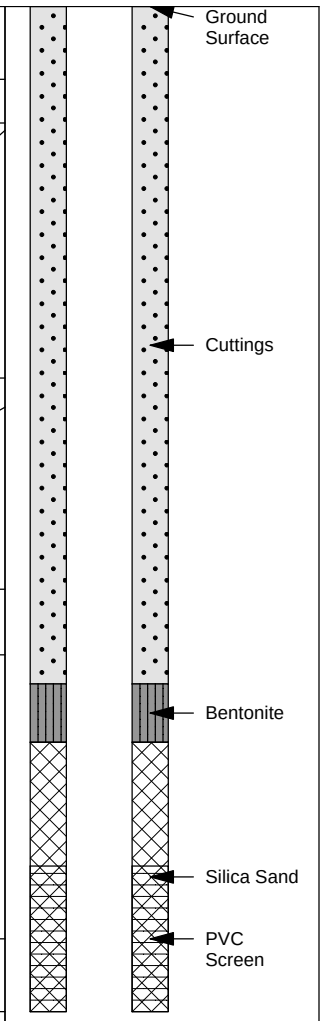
Northing: 3655676.00

Easting: 701271.70

Elevation: 2044.42

Depth	Log	Description	Comments
0		Sand	Sand with 10% gravel.
		Sandstone	Gray loose sandstone, some silt, gray clay layer.
20		Clay	
		Sandstone	Medium to fine gray, silty sandstone. At 30' to bottom of borehole; lots of water.
40			
		Gravel and Sand	Coarse sand, rounded pea gravel.
60		Sand and Silt	Sand with 40% silt.
80		Sand	5% gravel.
		Coal	4 Seam. Mixed coal/sand at 89'.
100			
120			
		Clay	4 Seam footwall.
140			
160			
180			
200			

Well Detail



USIBELLI COAL MINE, INC.

Borehole: 08JD02B

Date: 06/30/08

Geologist: Alec M. Venechuk

Driller: Tester Drilling Services, Inc.

Project: Jumbo Dome

Location: UCM, Healy, AK

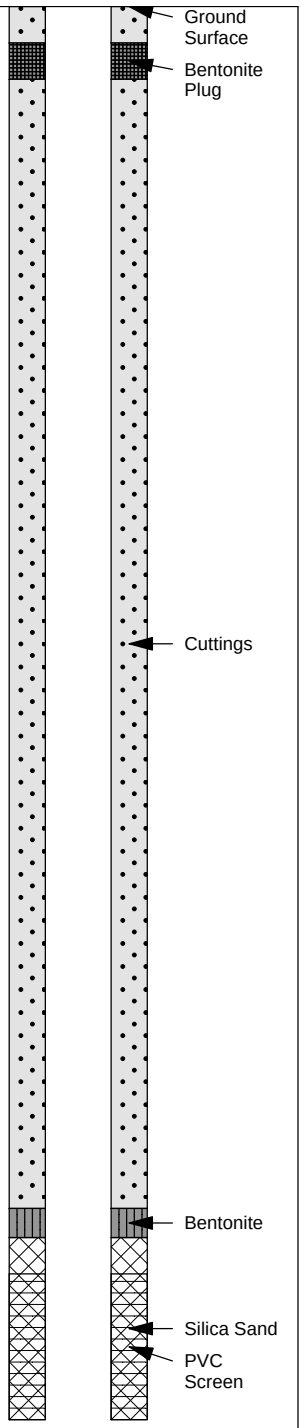
Northing: 3655671.00

Easting: 701259.60

Elevation: 2044.39

Depth	Log	Description	Comments
0		Gravelly Sand	
20		Clay	Silty.
		Sandstone	
40			
60			
80			
		Coal	4 Seam.
100			
120			
		Clay	4 Seam footwall.
140			
		Silt	
		Silty Sand	
160		Sand	
		Coal	3 Seam.
180			
		Clay	3 Seam footwall.
200			

Well Detail



USIBELLI COAL MINE, INC.

Borehole: 08JD03A

Date: 07/3/08

Geologist: Alec M Venechuck

Driller: Tester Drilling Services, Inc.

Project: Jumbo Dome

Location: UCM, Healy, AK

Northing: 3657396.00

Easting: 705385.60

Elevation: 2144.66

Depth	Log	Description	Comments	Well Detail
0		Blank	No returns, Odex drilling	
		Coal		
20		Clay		
		Silt		
40		Silty Sand		
		Sand		
60		Gravel		
		Coal		
80		Silty Sand		
100		Gravel		Cuttings
		Silty Sand		
120		Sand		
140		Gravelly Sand		
		Clayey Sand		
160		Coal		
		Silty Sand		
180		Gravel		
		Sand		
200				Bentonite

USIBELLI COAL MINE, INC.

Borehole: 08JD03A

Date: 07/3/08

Geologist: Alec M Venechuck

Driller: Tester Drilling Services, Inc.

Project: Jumbo Dome

Location: UCM, Healy, AK

Northing: 3657396.00

Easting: 705385.60

Elevation: 2144.66

Depth	Log	Description	Comments	Well Detail
200		Coal	4 Seam.	
220				Sand Screen
240				
260				
280				
300				
320				
340				
360				
380				

USIBELLI COAL MINE, INC.

Borehole: 08JD03B

Date: 07/02/08

Geologist: Alec M. Venechuk

Driller: Tester Drilling Services, Inc.

Project: Jumbo Dome

Location: UCM, Healy, AK

Northing: 3657344.00

Easting: 705376.40

Elevation: 2146.33

Depth	Log	Description	Comments	Well Detail
0		Sand	Brown sand & organics	
		Coal	6 Seam.	
		Clay		
20		Silt		
40				
		Sandy Silt		
		Fine Sand		
60				
		Sand		
		Coal	5 Seam.	
		Sandy Silt		
80				
100		Gravel	Gravel and quartz pebbles	
		Silt		
		Silty Sand		
120		Sand	Medium grained sand	
		Sand and Gravels	Coarse sand	Cuttings
140				
		Clayey Sand		
160		Coal	Coal stringer	
		Clayey Sand		
		Sand and Gravels		
180		Sand	Brown sand	
200		Coal	4 Seam.	

USIBELLI COAL MINE, INC.

Borehole: 08JD03B

Date: 07/02/08

Geologist: Alec M. Venechuk

Driller: Tester Drilling Services, Inc.

Project: Jumbo Dome

Location: UCM, Healy, AK

Northing: 3657344.00

Easting: 705376.40

Elevation: 2146.33

Depth	Log	Description	Comments	Well Detail
200				
220				
240		Clay	4 Seam footwall.	
		Sandy Silt		
260		Sand	Gray sand, medium grained, high silica content	
		Coal	3 Seam. Discharge 3 - 4 gpm.	Bentonite PVC Screen with silica sand
280				
300		Clay	3 Seam footwall.	
320				
340				
360				
380				

USIBELLI COAL MINE, INC.

Borehole: 08JD04

Date: 07/05/08

Geologist: Alec M. Venechuk

Driller: Tester Drilling Services, Inc.

Project: Jumbo Dome

Location: UCM, Healy, AK

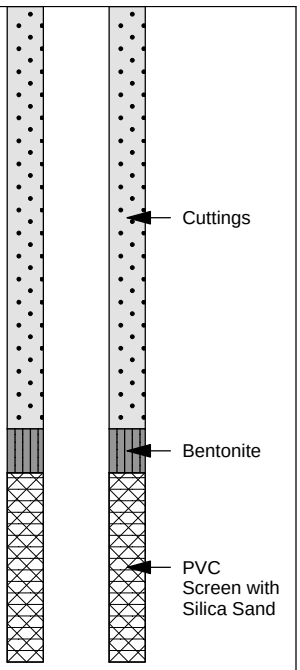
Northing: 3660487.00

Easting: 704496.50

Elevation: 1921.57

Depth	Log	Description	Comments
0		Gravel	Some organics
		Sandstone	
		Clayey Silt	
20		Silt	Gray
		Sandstone	Fine-grained Suntrana Sandstone.
40		Sand	Some organics; medium-grained.
60		Gravel	Water encountered at 57'.
		Coal	6 Seam.
80		Clay	6 Seam footwall.
100			
120			
140			
160			
180			
200			

Well Detail



USIBELLI COAL MINE, INC.

Borehole: 08JD05

Date: 07/05/08

Geologist: Alec M. Venechuk

Driller: Tester Drilling Services, Inc.

Project: Jumbo Dome

Location: UCM, Healy, AK

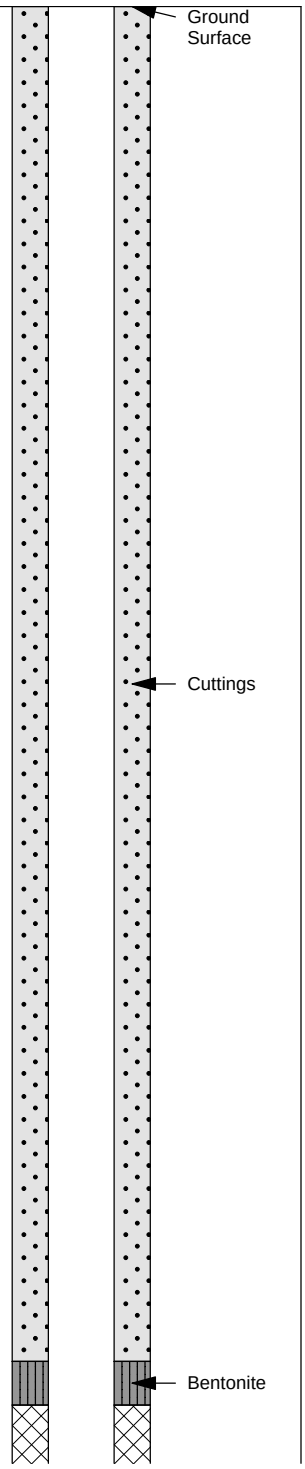
Northing: 3659200.00

Easting: 704961.80

Elevation: 1945.89

Depth	Description	Comments
0	Gravel	Fluvial gravels.
	Clay	
20	Coal	6 Seam; water encountered.
	Clay	
	Silty Clay	
40	Silt	
	Sand	At 47' coal stringer less than 1' thick; medium to fine grained sand
60	Silt	
	Silty Sand	Fining upwards package, grains of 80% silica
	Sandy Gravel	
80	Silty Sand	
	Coal	5 Seam; water at 40 gpm.
	Clay	
100	Clayey Silt	
	Sandy Silt	
120	Silty Sand	Medium grain sand, 80% silica
	Gravel	Fluvial gravels.
	Sand	Medium-grained.
140	Gravelly Sand	
160		
	Gravel	
180	Coal	4 Seam.
200		

Well Detail



USIBELLI COAL MINE, INC.

Borehole: 08JD05

Date: 07/05/08

Geologist: Alec M. Venechuk

Driller: Tester Drilling Services, Inc.

Project: Jumbo Dome

Location: UCM, Healy, AK

Northing: 3659200.00

Easting: 704961.80

Elevation: 1945.89

Depth	Log	Description	Comments	Well Detail
200				
220				Silica Sand PVC Screen
		Clay	4 Seam footwall.	
240				
260				
280				
300				
320				
340				
360				
380				

USIBELLI COAL MINE, INC.

Borehole: 10JD01

Date: 9-11-10

Location:

Geologist: Nicole Lindenlaub

Northing: 3651249.1

Driller: Tester

Easting: 704109.5

Project: Jumbo Dome drilling - Well Installation

Elevation: 2436.2

Depth	Log	Ground water	Description	Samples	Comments	Well Detail
0			Jumbo Rubble predominantly hornblende dacite, angular chips hornblende dacite, hornblende phenocrysts, dark reddish brown to black, up to 0.5 cm in length in a fine grained groundmass of plagioclase (andesine?) & quartz, pink dacite, grey dacite is dominante, TR magnetite in groundmass. large sandstone boulder, light reddish brown returns mud (drilling with water) dominant lithology continues as hornblende dacite, large boulders - driller fighting to advance @ 41' returns are sandsize particles of mixed lithologies, driller commented it was drilling like sandstone, dominant lith is pink dacite mixed lithologies continue but predominanlty sandstone with >2% other sedimentary lith chips, siltstone, mudstone, quartz, all sand size chips		surface material ripped by dozer are angular boulders of dacite drilling with water drilling still consistent advance although much slower than when in sandstone	
20						
40						

Borehole: 10JD01

Date: 9-11-10

Location:

Geologist: Nicole Lindenlaub

Northing: 3651249.1

Driller: Tester

Easting: 704109.5

Project: Jumbo Dome drilling - Well Installation

Elevation: 2436.2

Depth	Log	Ground water	Description	Samples	Comments	Well Detail
60			permafrost? slow, steady drilling, ~1 cup tanner fuel antifreeze poured down drillstring by 62' predominantly mudstone, brick orange red and dark greyish blue angular chips, +/- quartz (rounded) +/- small quantites >3% hornblende dacite chips, trace green argilite chips.			
80			coal? no returns to confirm, suspect black mud came up when blowing air while adding casing, driller confirmed my suspicion based on drill behavior coupled with smell of coal, but no returns to confirm		no returns	
100			Jumbo Rubble 86' first returns, mixed lithologies & clayey silt, drilling like we are in dacite returns alternate between angular chips, sand sized and gravel sized rounded chips mixed lithology - rounded quartz, mudstone, argilite, schist, angular to subangular sandsized chips	Mudstone/Siltstone 75% dacite 20% quartz 3% red orange sed >1% green argilite >1% schist >1%	minimal returns by 93' returns good, no more drilling water struggling to advance mixed lithologies Mudstone 75% quartz 20% dacite 2%	

Borehole: 10JD01

Date: 9-11-10

Location:

Geologist: Nicole Lindenlaub

Northing: 3651249.1

Driller: Tester

Easting: 704109.5

Project: Jumbo Dome drilling - Well Installation

Elevation: 2436.2

Depth	Log	Ground water	Description	Samples	Comments	Well Detail
100			angular sandsize chips of mixed lithology, mudstone, siltstone, argilite, quartz, dacite		siltstone 1% schist >1% argilite >1%	
			increase in clay content			
120			coal - 4 seam groundwater at 128'	no samples taken	144 -145 increase in groundwater	
140			footwall clay		147 - 149'	

Borehole: 10JD01

Date: 9-11-10

Location:

Geologist: Nicole Lindenlaub

Northing: 3651249.1

Driller: Tester

Easting: 704109.5

Project: Jumbo Dome drilling - Well Installation

Elevation: 2436.2

Depth	Log	Ground water	Description	Samples	Comments	Well Detail
			increasing volume of gravel & cobbles; increasing size of cobble		increase in groundwater	
160			Sandstone drilling with water		no water in sandstones	
180			Sandstone + cobbles and gravel			
200			coal - 3 seam groundwater at 198' driller commented on hardness of	no samples taken	small amount of groundwater, driller still has to use drilling water	

Borehole: 10JD01

Date: 9-11-10

Location:

Geologist: Nicole Lindenlaub

Northing: 3651249.1

Driller: Tester

Easting: 704109.5

Project: Jumbo Dome drilling - Well Installation

Elevation: 2436.2

Depth	Log	Ground water	Description	Samples	Comments	Well Detail
200			coal, slow drilling, bit trying to core through coal, large pieces coming out of cyclone all cyclone returns were full of sand with coal, but driller and drill helper think sand was coming down the hole and contaminating coal returns, first started with dacite and then sand		coal seam making plenty of water, filled 5 gallon bucket in 15 sec driller believes it is a solid coal seam, not bony as returns suggest	
220			footwall clay Sandstone with clay			

Borehole: 10JD01A

Date: Edit-Text

Location:

Geologist: Nicole Lindenlaub

Northing: 3651268.342

Driller: Tester

Easting: 704064.034

Project: Jumbo dome drilling - Well Installation

Elevation: 2431.67

Depth	Log	Ground water	Description	Samples	Comments	Well Detail
0			Jumbo Rubble less than 1 foot of top soil schist boulder? (color change of return mud from greyish brown to greenish grey (easier drilling, better advance rate)		boulder making drilling difficult and slow	
20						
40						

Borehole: 10JD01A

Date: Edit-Text

Location:

Geologist: Nicole Lindenlaub

Northing: 3651268.342

Driller: Tester

Easting: 704064.034

Project: Jumbo dome drilling - Well Installation

Elevation: 2431.67

Depth	Log	Ground water	Description	Samples	Comments	Well Detail
60			Coal - 5 seam changed out to RC in order to sample, then soon after drilled out of seam	no samples, still casing & using hammer, not RC so no recoverable return	no water	
80			Jumbo Rubble angular hornblende dacite 60% (pink dacite), angular dacite 35% (grey dacite?), rounded quartz & sedimentary lithology 5%			
100			Sandstone			

Borehole: 10JD01A

Date: Edit-Text

Location:

Geologist: Nicole Lindenlaub

Northing: 3651268.342

Driller: Tester

Easting: 704064.034

Project: Jumbo dome drilling - Well Installation

Elevation: 2431.67

Depth	Log	Ground water	Description	Samples	Comments	Well Detail
100			increasingly dirty and less well sorted by depth			
120			Coal - 4 seam bony - top 8' groundwater at 129'		placed a 5 gallon bucket under cyclone, filled in 20 seconds	
140						

Borehole: 10JD01A

Date: Edit-Text

Location:

Geologist: Nicole Lindenlaub

Northing: 3651268.342

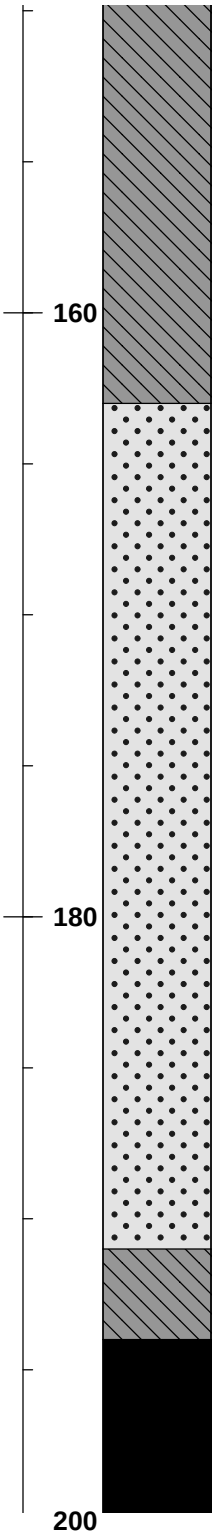
Driller: Tester

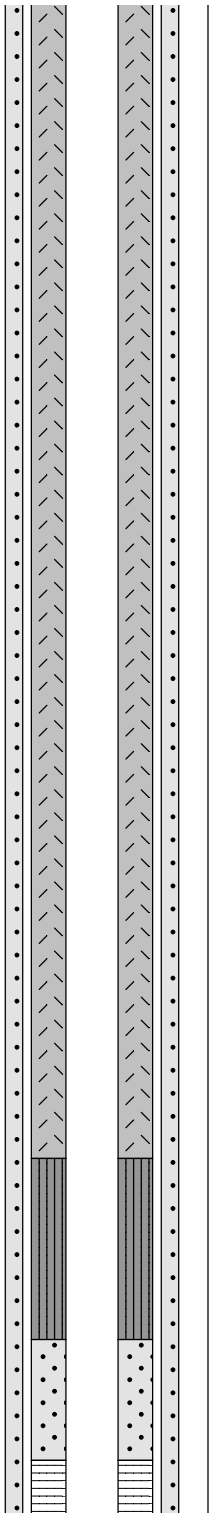
Easting: 704064.034

Project: Jumbo dome drilling - Well Installation

Elevation: 2431.67

Depth	Log	Ground water	Description	Samples	Comments	Well Detail
160			footwall clay groundwater, 15 gpm			
			Sandstone fairly clean		15 gpm	
180			clay with coal			
			coal- 3 Seam		15 gpm filled a 5 gallon bucket in 20 seconds	
200						





Borehole: 10JD01A

Date: Edit-Text

Location:

Geologist: Nicole Lindenlaub

Northing: 3651268.342

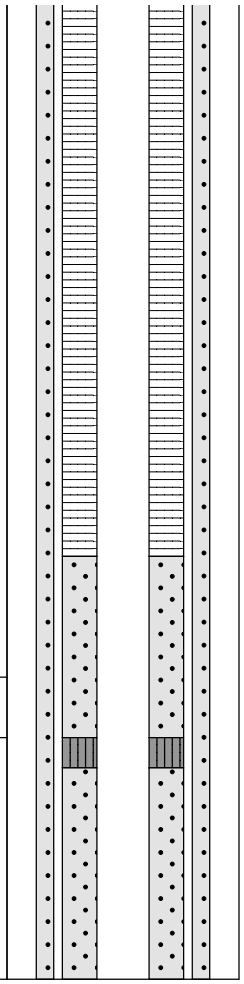
Driller: Tester

Easting: 704064.034

Project: Jumbo dome drilling - Well Installation

Elevation: 2431.67

Depth	Log	Ground water	Description	Samples	Comments	Well Detail
200						
220						
			footwall clay			
			Sandstone fairly clean, well sorted		15 gpm	



Borehole: 10JD02

Date: 9-3-10

Location:

Geologist: Nicole Lindenlaub

Northing: 3651423.311

Driller: Tester

Easting: 704102.016

Project: Jumbo Dome - Well Installation

Elevation: 2436.2

Depth	Log	Ground water	Description	Samples	Comments	Well Detail
0			Jumbo Rubble less than 1' top soil 39 - 42' big boulder, difficult drilling, slow advance 59 - 62' large boulder, difficult drilling, slow advance			
20						
40						

Borehole: 10JD02

Date: 9-3-10

Location:

Geologist: Nicole Lindenlaub

Northing: 3651423.311

Driller: Tester

Easting: 704102.016

Project: Jumbo Dome - Well Installation

Elevation: 2436.2

Depth	Log	Ground water	Description	Samples	Comments	Well Detail
60						
			Jumbo Dome Horneblende Dacite hornblende visible, pinkish red return mud, chip angular 80% pink, 20% gray			
80			Sandstone			
			clay			
			Sandstone			
100			coal - 5 seam minimal to no water	1.94'-100' 2.100'-106'	two 6' composite samples	

Borehole: 10JD02

Date: 9-3-10

Location:

Geologist: Nicole Lindenlaub

Northing: 3651423.311

Driller: Tester

Easting: 704102.016

Project: Jumbo Dome - Well Installation

Elevation: 2436.2

Depth	Log	Ground water	Description	Samples	Comments	Well Detail
100						
			footwall clay			
			Sandstone			
			dacite (sill?)			
			Sandstone			
			clay balls up to cobble size coming out of cyclone			
120			Sandstone dirty, poorly, sorted			
			Sandstone + gravels and cobbles			
140			coal - 4 seam @139' groundwater bony first 2'	1. 138 - 142' 2. 142 -144' 3. 144-146' 4. 146-148' 5. 148-150' 6. 150-152' 7. 152-154' 8. 154-156' 9. 156-158' 10. 158-160'	5 gallons in 30 sec=10 gpm	

Borehole: 10JD02

Date: 9-3-10

Location:

Geologist: Nicole Lindenlaub

Northing: 3651423.311

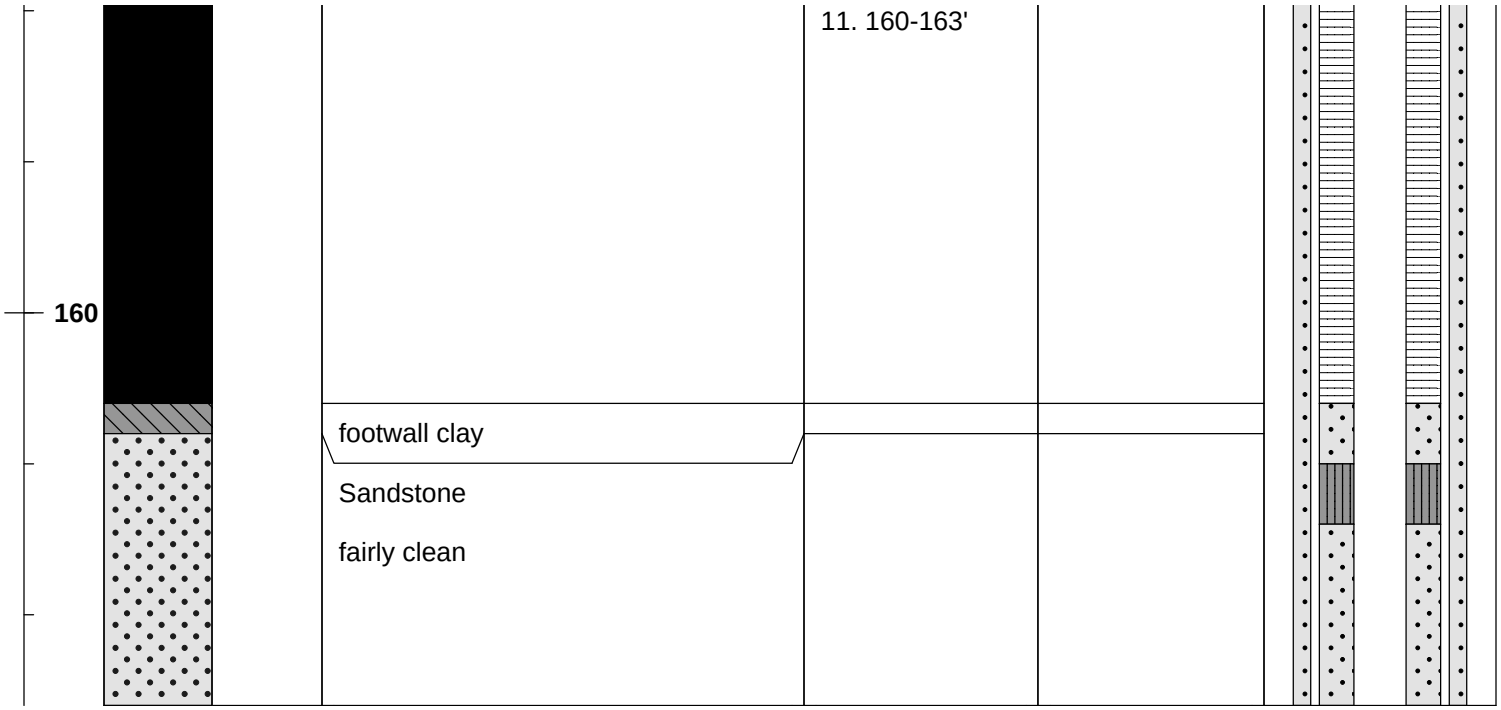
Driller: Tester

Easting: 704102.016

Project: Jumbo Dome - Well Installation

Elevation: 2436.2

Depth	Log	Ground water	Description	Samples	Comments	Well Detail
				11. 160-163'		
160						
			footwall clay			
			Sandstone fairly clean			



Borehole: 10JD02A

Date: 9-15-10

Location:

Geologist: Nicole Lindenlaub

Northing: 3651379.8

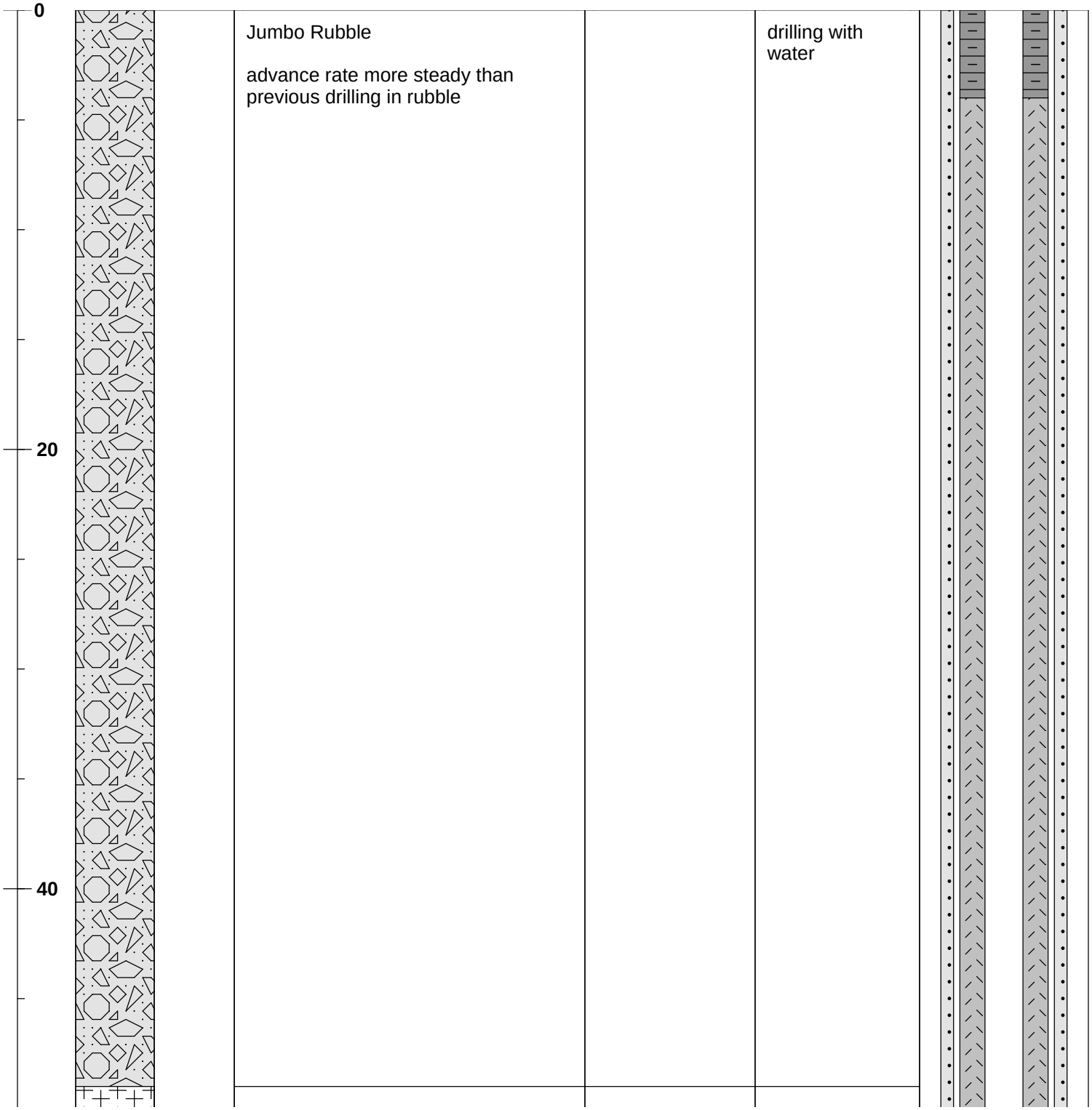
Driller: Tester

Easting: 704058

Project: Jumbo Dome drilling - Well Installation

Elevation: 2427.1

Depth	Log	Ground water	Description	Samples	Comments	Well Detail
0			Jumbo Rubble advance rate more steady than previous drilling in rubble		drilling with water	
20						
40						



Borehole: 10JD02A

Date: 9-15-10

Location:

Geologist: Nicole Lindenlaub

Northing: 3651379.8

Driller: Tester

Easting: 704058

Project: Jumbo Dome drilling - Well Installation

Elevation: 2427.1

Depth	Log	Ground water	Description	Samples	Comments	Well Detail
60			Jumbo Dacite 95% reddish brown dacite, 5% grey dacite		not drilling with water, enough residule moisture in rock	
			clay, dark grey			
80			Jumbo Rubble 85% angular, 25% rounded to subrounded drilling with water		Returns: dacite 80% qtz 19% mudstone 3% argilite >1% chert >1%	
			coal - 5 Seam			
			footwall clay			
100			Jumbo Rubble - coal mixed in 90% angular 10% rounded to subrounded increased clay content, decreased grain size		Returns: dacite 85% qtz 10% clay 3% mudstone >1% drilling with water by 103', easier drilling, pressure reduced	

Borehole: 10JD02A

Date: 9-15-10

Location:

Geologist: Nicole Lindenlaub

Northing: 3651379.8

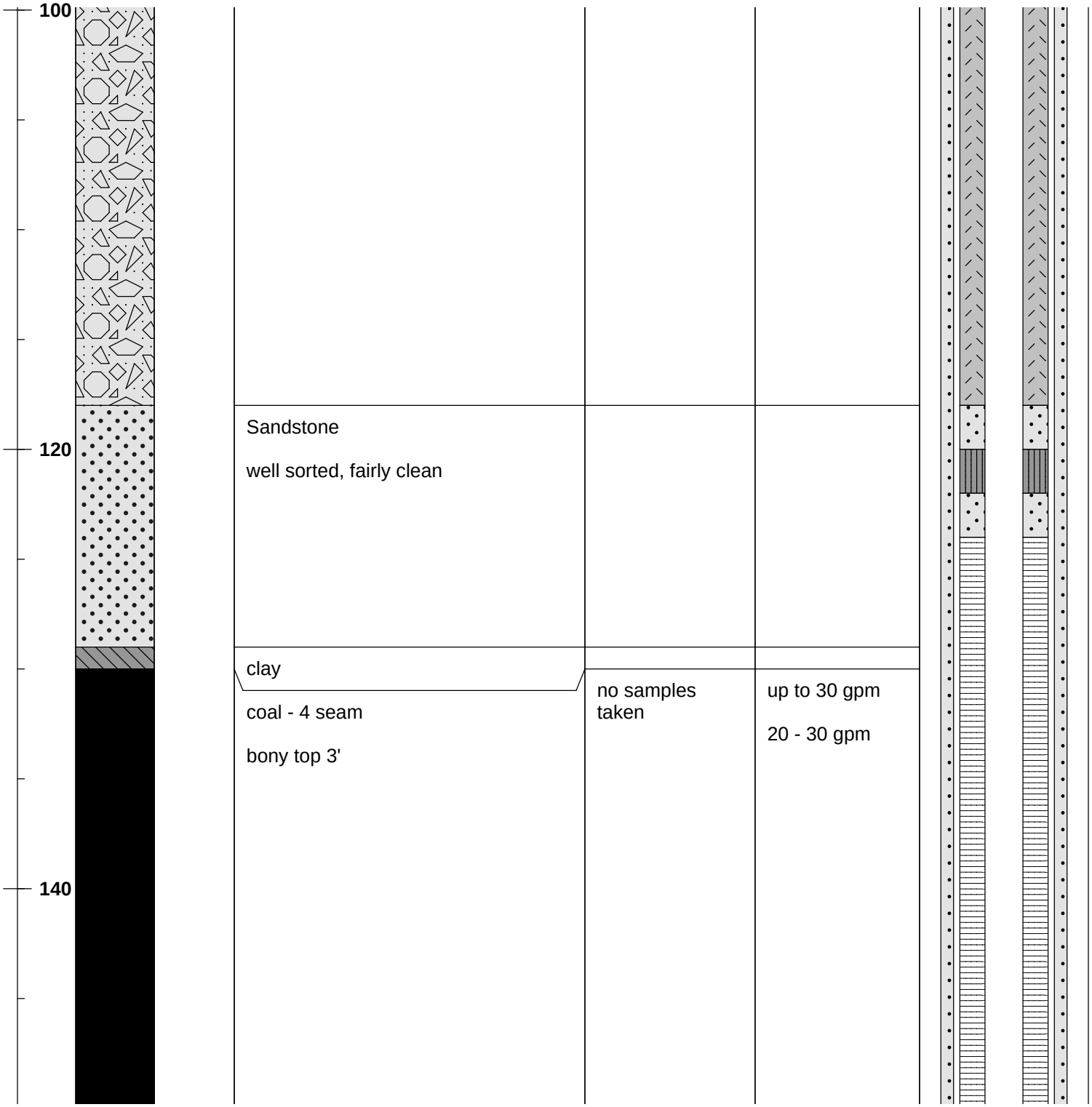
Driller: Tester

Easting: 704058

Project: Jumbo Dome drilling - Well Installation

Elevation: 2427.1

Depth	Log	Ground water	Description	Samples	Comments	Well Detail
100						
120			Sandstone well sorted, fairly clean			
			clay			
			coal - 4 seam bony top 3'	no samples taken	up to 30 gpm 20 - 30 gpm	
140						



Borehole: 10JD02A

Date: 9-15-10

Location:

Geologist: Nicole Lindenlaub

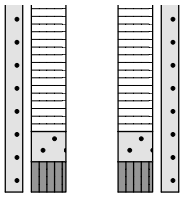
Northing: 3651379.8

Driller: Tester

Easting: 704058

Project: Jumbo Dome drilling - Well Installation

Elevation: 2427.1

Depth	Log	Ground water	Description	Samples	Comments	Well Detail
						
160			footwall clay			
			Sandstone (clayey)			

Borehole: 10JD03

Date: 9-20-10

Location:

Geologist: Nicole Lindenlaub

Northing: 3659464.4

Driller: Tester

Easting: 704818.1

Project: Jumbo Dome drilling - well installation

Elevation: 1934.8

Depth	Log	Ground water	Description	Samples	Comments	Well Detail
0			Alluvium - Marguerite Creek Qal by 9', moist (unsaturated)			
20			Sandstone moist (unsaturated)			
40						

Borehole: 10JD03

Date: 9-20-10

Location:

Geologist: Nicole Lindenlaub

Northing: 3659464.4

Driller: Tester

Easting: 704818.1

Project: Jumbo Dome drilling - well installation

Elevation: 1934.8

Depth	Log	Ground water	Description	Samples	Comments	Well Detail
			clay, no more moisture			
			Sandstone (unsaturated) increased clay content			
60						
			Coal cuttings mixed in with sand (~70% coal)			
80			Sandstone			
100						

Borehole: 10JD03

Date: 9-20-10

Location:

Geologist: Nicole Lindenlaub

Northing: 3659464.4

Driller: Tester

Easting: 704818.1

Project: Jumbo Dome drilling - well installation

Elevation: 1934.8

Depth	Log	Ground water	Description	Samples	Comments	Well Detail
100						
120						
			coal - 5 seam hard, slow advance	5 seam samples 1. 126-128' 2.128-130' 3. 130-131'		
			footwall clay			
			Sandstone dry fairly clean, well sorted		25 - 30 gpm	
140			207 - 209' coal in sandstone, up to 30% of returns are coal 209 - 243' coarse sandstone 238 - 239' coal in sandstone >50% returns are coal 240 - 243' coal in sandstone			

Borehole: 10JD03

Date: 9-20-10

Location:

Geologist: Nicole Lindenlaub

Northing: 3659464.4

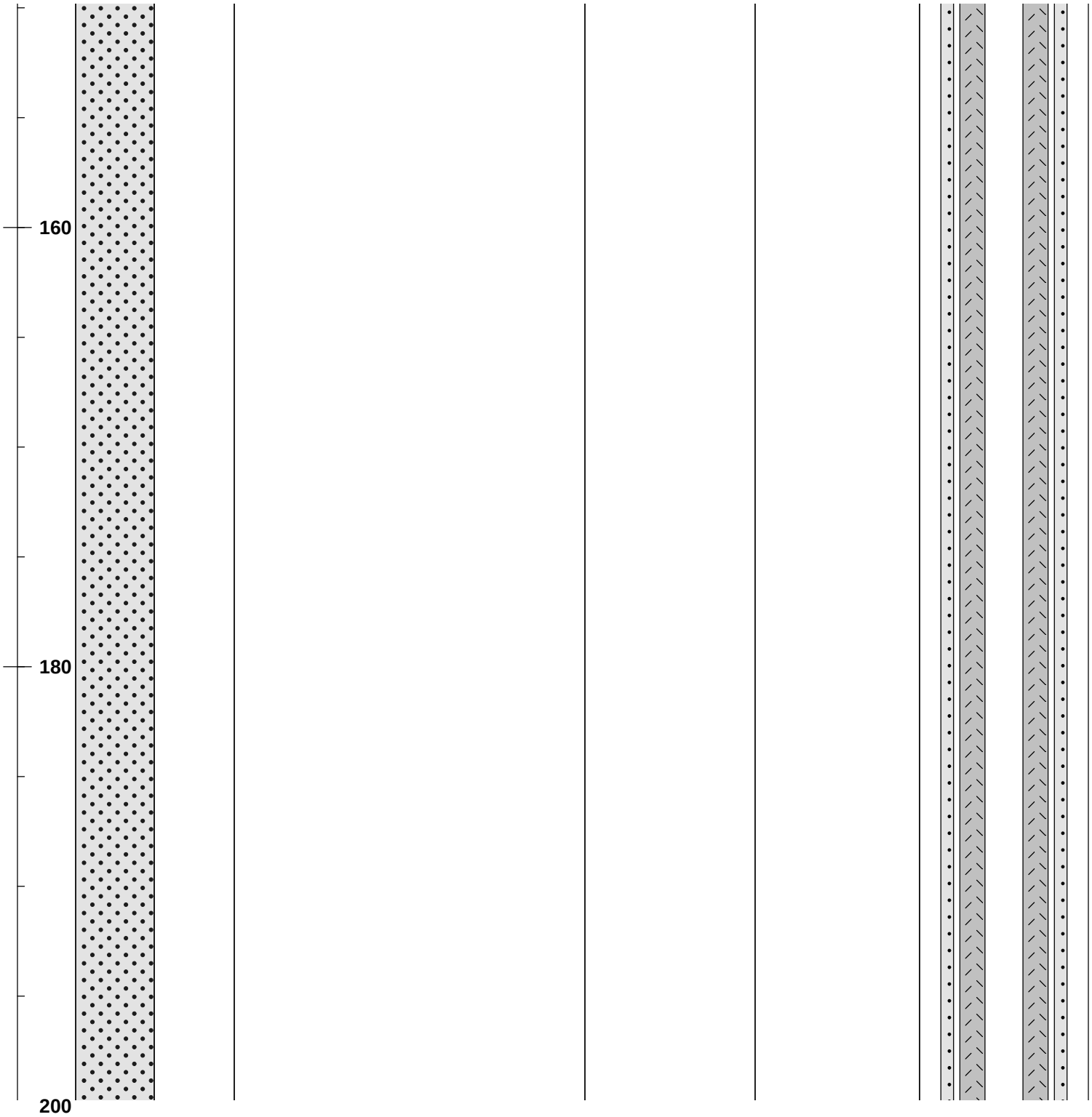
Driller: Tester

Easting: 704818.1

Project: Jumbo Dome drilling - well installation

Elevation: 1934.8

Depth	Log	Ground water	Description	Samples	Comments	Well Detail



Borehole: 10JD03

Date: 9-20-10

Location:

Geologist: Nicole Lindenlaub

Northing: 3659464.4

Driller: Tester

Easting: 704818.1

Project: Jumbo Dome drilling - well installation

Elevation: 1934.8

Depth	Log	Ground water	Description	Samples	Comments	Well Detail
200						
220						
240						
			coal - 4 seam		35-40 gpm	

Borehole: 10JD03

Date: 9-20-10

Location:

Geologist: Nicole Lindenlaub

Northing: 3659464.4

Driller: Tester

Easting: 704818.1

Project: Jumbo Dome drilling - well installation

Elevation: 1934.8

Depth	Log	Ground water	Description	Samples	Comments	Well Detail
260						
			clay layer within coal seam			
			footwall clay			
			Sandstone (clayey)			
280			reduced clay content. 292 - 299' coarse gravelty sands, up to 5% gravel			
300						

Borehole: 10JD03

Date: 9-20-10

Location:

Geologist: Nicole Lindenlaub

Northing: 3659464.4

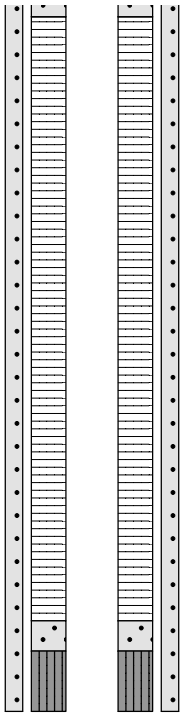
Driller: Tester

Easting: 704818.1

Project: Jumbo Dome drilling - well installation

Elevation: 1934.8

Depth	Log	Ground water	Description	Samples	Comments	Well Detail
300			coal - 3 seam		35-40 gpm	
			clay within coal seam			
320					35-40 gpm	
			footwall clay			
340			Sandstone (clayey) fine grained, well sorted increasing grain size, moderately clean to dirty, poorly sorted		35-40 gpm	



Borehole: 10JD03

Date: 9-20-10

Geologist: Nicole Lindenlaub

Driller: Tester

Project: Jumbo Dome drilling - well installation

Location:

Northing: 3659464.4

Easting: 704818.1

Elevation: 1934.8

Depth	Log	Ground water	Description	Samples	Comments	Well Detail
360						

Borehole: 10JD04

Date: 9-17-10

Location:

Geologist: Nicole Lindenlaub

Northing: 3659554.8

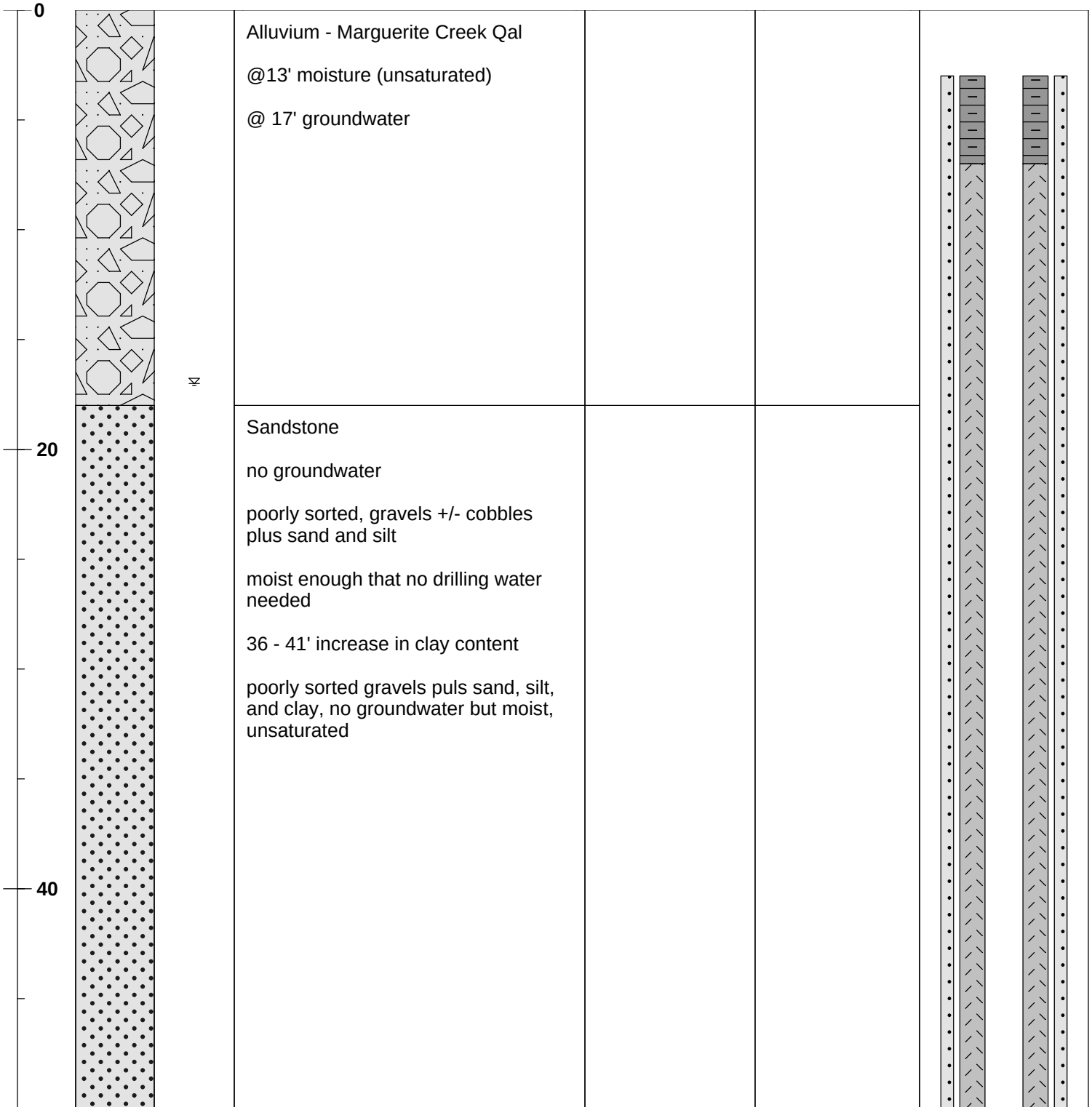
Driller: Tester

Easting: 704827.9

Project: Jumbo Dome drilling - Well Installation

Elevation: 1932.9

Depth	Log	Ground water	Description	Samples	Comments	Well Detail
0			Alluvium - Marguerite Creek Qal @13' moisture (unsaturated) @ 17' groundwater			
20			Sandstone no groundwater poorly sorted, gravels +/- cobbles plus sand and silt moist enough that no drilling water needed 36 - 41' increase in clay content poorly sorted gravels puls sand, silt, and clay, no groundwater but moist, unsaturated			
40						



Borehole: 10JD04

Date: 9-17-10

Location:

Geologist: Nicole Lindenlaub

Northing: 3659554.8

Driller: Tester

Easting: 704827.9

Project: Jumbo Dome drilling - Well Installation

Elevation: 1932.9

Depth	Log	Ground water	Description	Samples	Comments	Well Detail
60						
			coal - 6 seam			
			clay		drilling with water	
			Sandstone - clayey, fine grained, well sorted			
			clay			
			coal - 6 Seam continued.			
			footwall clay			
			clayey sand			
			coal		drilling with water	
80			Sandstone clayey, angular to subangular chips, moist but no groundwater, unsaturated @ 93' groundwater, saturated 115 - 120' increase in clay content 130 - 134' clayey		up to 40 gpm well is artesian	
100						

Borehole: 10JD04

Date: 9-17-10

Location:

Geologist: Nicole Lindenlaub

Northing: 3659554.8

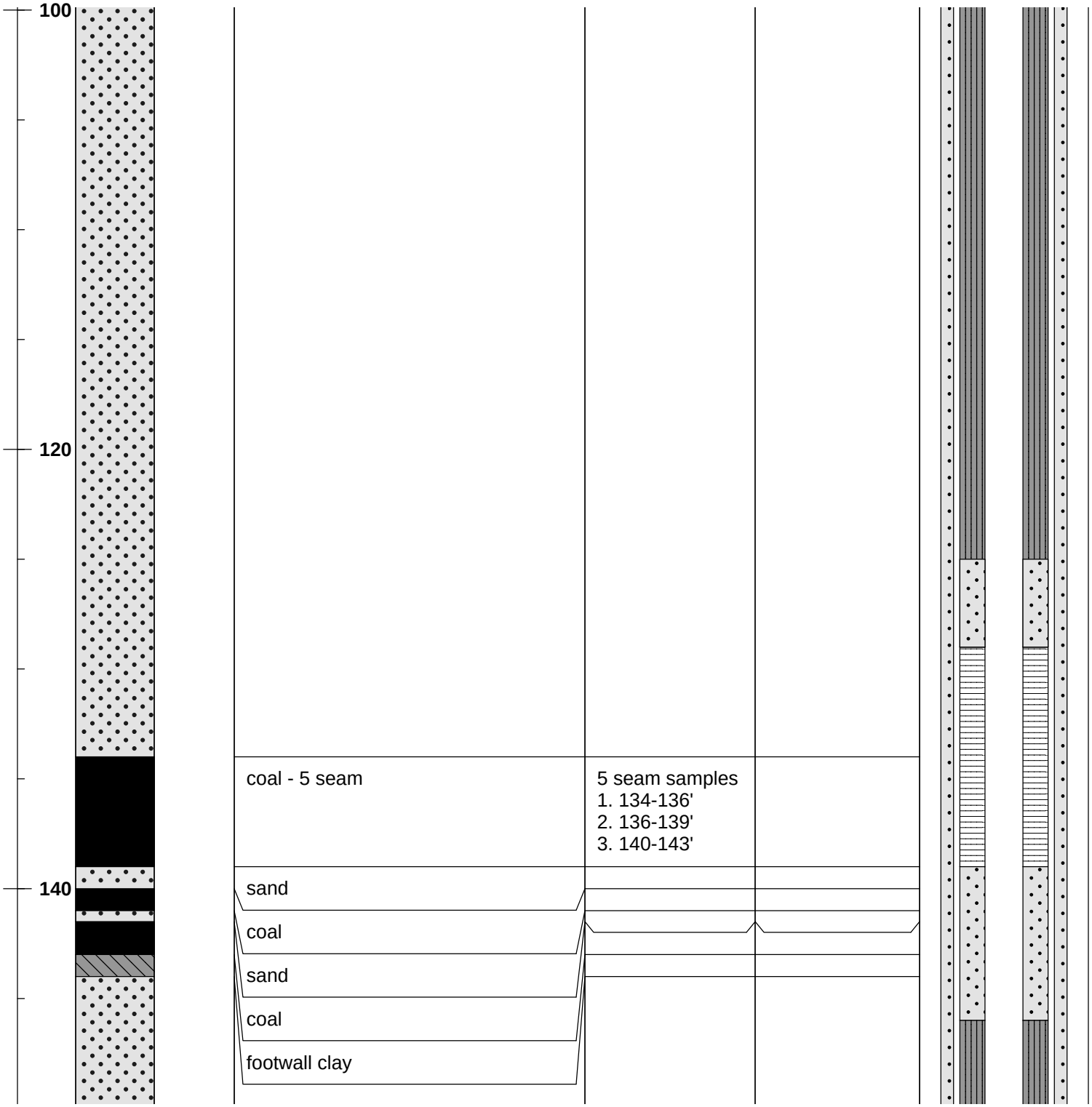
Driller: Tester

Easting: 704827.9

Project: Jumbo Dome drilling - Well Installation

Elevation: 1932.9

Depth	Log	Ground water	Description	Samples	Comments	Well Detail
100						
120						
			coal - 5 seam	5 seam samples 1. 134-136' 2. 136-139' 3. 140-143'		
140			sand			
			coal			
			sand			
			coal			
			footwall clay			



Borehole: 10JD04

Date: 9-17-10

Location:

Geologist: Nicole Lindenlaub

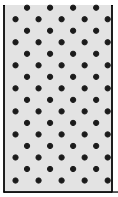
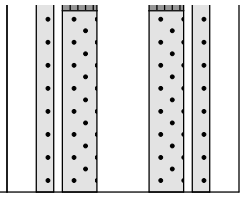
Northing: 3659554.8

Driller: Tester

Easting: 704827.9

Project: Jumbo Dome drilling - Well Installation

Elevation: 1932.9

Depth	Log	Ground water	Description	Samples	Comments	Well Detail
			Sandstone (clayey)			

Borehole: 10JD05alt

Date: 9-25-10

Location:

Geologist: Nicole Lindenlaub

Northing: 3652263.4

Driller: Tester

Easting: 702438.2

Project: Jumbo Dome drilling - Well Installation

Elevation: 2210.2

Depth	Log	Ground water	Description	Samples	Comments	Well Detail
0			Jumbo Rubble (moist) predominantly pinkish red Jumbo dacite			
20						
			Jumbo Dacite (sill?)		very slow advance driller commented that drilling was like in solid rock	
40						
			reddish brown clay			
			silty clay			
			Jumbo Rubble			

Borehole: 10JD05alt

Date: 9-25-10

Location:

Geologist: Nicole Lindenlaub

Northing: 3652263.4

Driller: Tester

Easting: 702438.2

Project: Jumbo Dome drilling - Well Installation

Elevation: 2210.2

Depth	Log	Ground water	Description	Samples	Comments	Well Detail
60			sandy clay, reddish brown, w/ silt fining downwards moist to dry			
80			Sandstone moist to dry			
			coal - 4 seam			
			clay			
100			coal - 4 seam dry water from 119 - 120', moist from 120 - 123'			

Borehole: 10JD05alt

Date: 9-25-10

Location:

Geologist: Nicole Lindenlaub

Northing: 3652263.4

Driller: Tester

Easting: 702438.2

Project: Jumbo Dome drilling - Well Installation

Elevation: 2210.2

Depth	Log	Ground water	Description	Samples	Comments	Well Detail
100						
120						
			footwall clay			
			Sandstone top 10' grade from sandy clay to clayey sand			
140						

Borehole: 10JD05alt

Date: 9-25-10

Location:

Geologist: Nicole Lindenlaub

Northing: 3652263.4

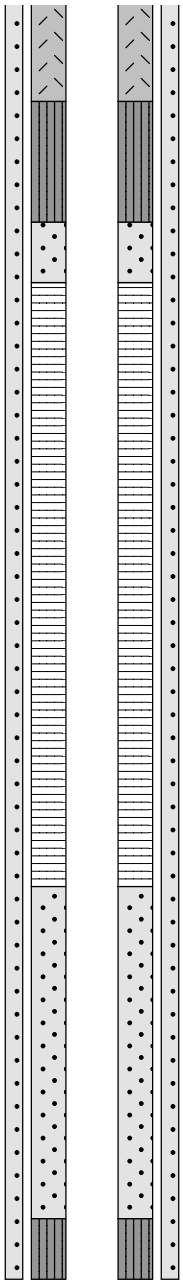
Driller: Tester

Easting: 702438.2

Project: Jumbo Dome drilling - Well Installation

Elevation: 2210.2

Depth	Log	Ground water	Description	Samples	Comments	Well Detail
160			coal - 3 seam @161' groundwater			
180						
			footwall clay			
			Sandstone - sandy clay			



Borehole: 10JD06alt

Date: 9-27-10

Location:

Geologist: Nicole Lindenlaub

Northing: 3652121.6

Driller: Tester

Easting: 702331.6

Project: Jumbo Dome drilling - Well Installation

Elevation: 2222.3

Depth	Log	Ground water	Description	Samples	Comments
0			Jumbo Rubble		frozen?
20			coal - 5 Seam		
			footwall clay, no returns once in clay, difficult to determine end		
			black clay		
			Jumbo Rubble		
40					
			Jumbo Dacite (sill?)		

Borehole: 10JD06alt

Date: 9-27-10

Location:

Geologist: Nicole Lindenlaub

Northing: 3652121.6

Driller: Tester

Easting: 702331.6

Project: Jumbo Dome drilling - Well Installation

Elevation: 2222.3

Depth	Log	Ground water	Description	Samples	Comments
60					
80			Slide material? in and out of sandstone, dacite, and clay, moist to wet		
100			coal - 4 Seam dry @128' moist @131' groundwater		

Borehole: 10JD06alt

Date: 9-27-10

Location:

Geologist: Nicole Lindenlaub

Northing: 3652121.6

Driller: Tester

Easting: 702331.6

Project: Jumbo Dome drilling - Well Installation

Elevation: 2222.3

Depth	Log	Ground water	Description	Samples	Comments
100					
120					
140					
			footwall clay		
			Sandstone 4' clayey		

Borehole: 10JD06alt

Date: 9-27-10

Location:

Geologist: Nicole Lindenlaub

Northing: 3652121.6

Driller: Tester

Easting: 702331.6

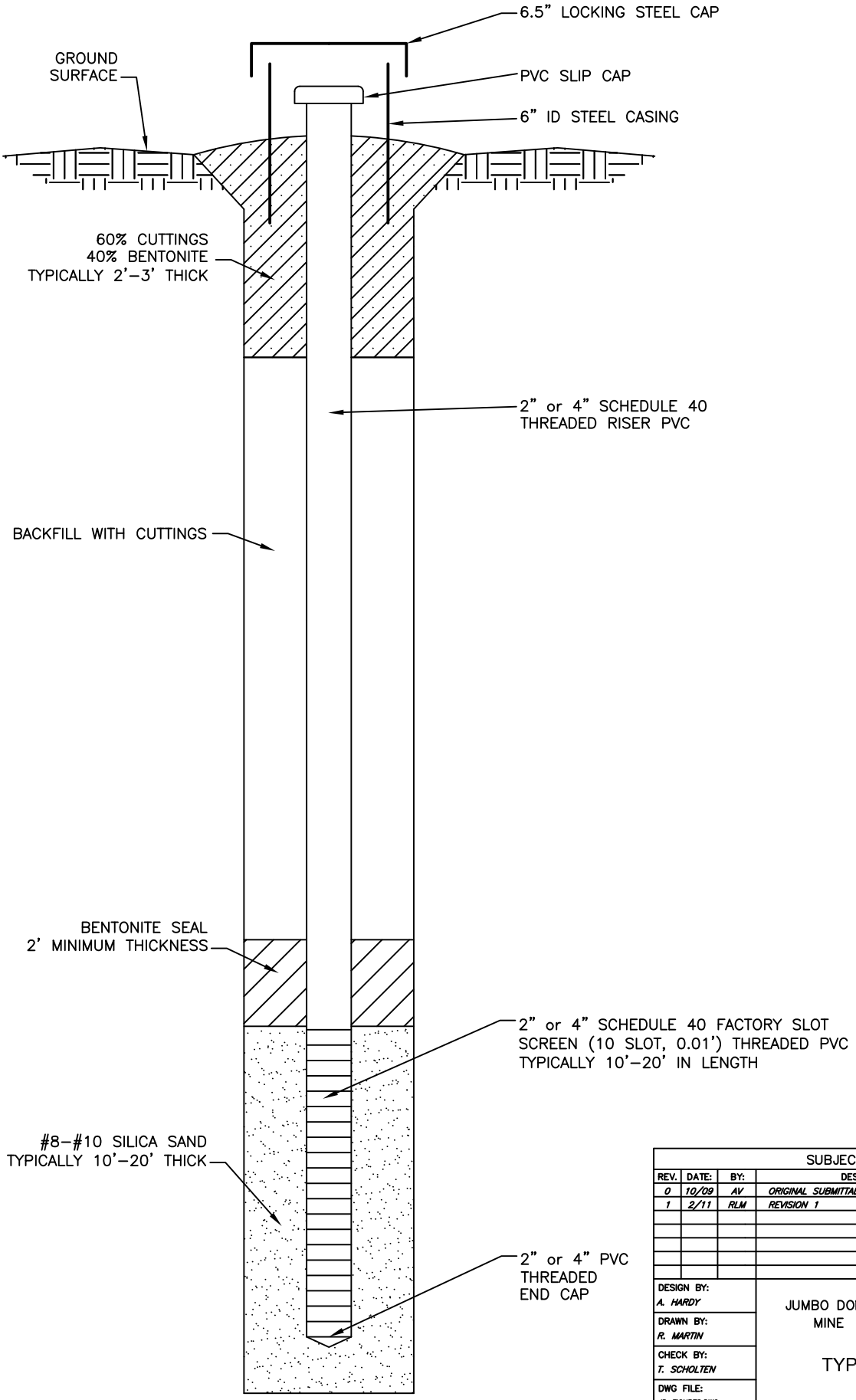
Project: Jumbo Dome drilling - Well Installation

Elevation: 2222.3

Depth	Log	Ground water	Description	Samples	Comments

APPENDIX B

WELL CONSTRUCTION SCHEMATIC



NOTE: CONSTRUCTION OF SOME EXISTING PIEZOMETERS DIFFER FROM THE SPECIFICATIONS SHOWN IN THIS FIGURE.

SUBJECT REVISIONS

REV.	DATE:	BY:	DESCRIPTION
0	10/09	AV	ORIGINAL SUBMITTAL
1	2/11	RLM	REVISION 1

DESIGN BY: A. HARDY
DRAWN BY: R. MARTIN
CHECK BY: T. SCHOLTEN
DWG FILE: JD_FIGURES.DWG
DATE DRAWN: 1/31/2011

JUMBO DOME MINE

USIBELLI COAL MINE INC. UCM

PERMIT NUMBER

TYPICAL MONITORING WELL COMPLETION

JUMBO DOME MINE

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743
(907) 683–2226

FIGURE No. CIV–1
SHEET No. 1 OF 1
REV. 0

APPENDIX C

WATER LEVEL MEASUREMENTS TABLE

MONITORING WELL WATER LEVEL READING LOG
Hole No. 07JD10

Hole No.	Date	Time	Reading	Surface Correction	Water Level (BGS)	Surface Elev	Water Level Elev	Difference w/ last mo.
07JD10	07/10/08	n/a	25.0 psi	4.2	-61.95	1971.5	2033.45	
07JD10	09/03/08	n/a	0.00 ft	4.2	n/a	1971.5	n/a	
07JD10	09/27/08	1:00 PM	23.0 psi	4.2	-57.33	1971.5	2028.83	
07JD10	11/01/08	n/a	18.0 psi	4.2	-45.78	1971.5	2017.28	-11.55
07JD10	11/22/08	1:15 PM	n/a	4.2		1971.5		
07JD10	12/19/08	n/a	n/a	4.2		1971.5		
07JD10	01/31/09	n/a	n/a	4.2		1971.5		
07JD10	02/24/09	n/a	n/a	4.2		1971.5		
07JD10	04/02/09	n/a	n/a	4.2		1971.5		
07JD10	05/20/09	n/a	n/a	4.2		1971.5		
07JD10	06/25/09	n/a	n/a	4.2		1971.5		
07JD10	07/14/09	n/a	n/a	4.2		1971.5		
07JD10	08/25/09	n/a	28.0 psi	4.2	-68.88	1971.5	2040.38	
07JD10	09/24/09	n/a	28.0 psi	4.2	-68.88	1971.5	2040.38	0
07JD10	10/21/09	n/a	28.0 psi	4.2	-68.88	1971.5	2040.38	0
07JD10	11/24/09	n/a		4.2	-68.88	1971.5		
07JD10	12/23/09			4.2	-68.88	1971.5		
07JD10	02/01/10			4.2	-68.88	1971.5		
07JD10	02/24/10			4.2	-68.88	1971.5		
07JD10	03/31/10		21 psi	4.2	-52.71	1971.5	2024.21	
07JD10	04/29/10		21 psi	4.2	-52.71	1971.5	2024.21	
07JD10	06/12/10			4.2		1971.5		
07JD10	07/07/10			4.2		1971.5		
07JD10	08/10/10							
07JD10	09/23/10		25 psi					

MONITORING WELL WATER LEVEL READING LOG
Hole No. 07JD12

Hole No.	Date	Time	Reading	Surface Correction	Water Level (BGS)	Surface Elev	Water Level Elev	Difference w/ last mo.
07JD12	07/10/08	n/a	7.0 psi	2	-18.17	2007.2	2025.37	
07JD12	09/03/08	n/a	0.00 ft	2	n/a	2007.2	n/a	
07JD12	09/27/08	12:45 PM	6.0 psi	2	-15.86	2007.2	2023.06	
07JD12	11/01/08	n/a	n/a	2		2007.2		
07JD12	11/22/08	1:15 PM	n/a	2		2007.2		
07JD12	12/19/08	n/a	n/a	2		2007.2		
07JD12	01/31/09	n/a	n/a	2		2007.2		
07JD12	02/24/09	n/a	n/a	2		2007.2		
07JD12	04/02/09	n/a	n/a	2		2007.2		
07JD12	05/20/09	n/a	n/a	2		2007.2		
07JD12	06/25/09	n/a	n/a	2		2007.2		
07JD12	07/14/09	n/a	n/a	2		2007.2		
07JD12	08/25/09	n/a	8.0 psi	2	-20.48	2007.2	2027.68	
07JD12	09/24/09	n/a	8.0 psi	2	-20.48	2007.2	2027.68	0
07JD12	10/21/09	n/a	8.0 psi	2	-20.48	2007.2	2027.68	0
07JD12	11/24/09	n/a		2	-20.48	2007.2		
07JD12	12/23/09			2	-20.48	2007.2		
07JD12	02/01/10			2	-20.48	2007.2		
07JD12	02/24/10			2	-20.48	2007.2		
07JD12	03/31/10			2	-20.48	2007.2		
07JD12	04/29/10			2	-20.48	2007.2		
07JD12	06/12/10			2	-20.48	2007.2		
07JD12	07/07/10			2	-20.48	2007.2		
07JD12	08/10/10							
07JD12	09/23/10		5 psi					

MONITORING WELL WATER LEVEL READING LOG
Hole No. 08JD04

Hole No.	Date	Time	Reading	Surface Correction	Water Level (BGS)	Surface Elev	Water Level Elev	Difference w/ last mo.
08JD04	07/10/08	n/a	5.82 ft	3.85	1.97	1921.565	1919.60	
08JD04	09/03/08	n/a	8.00 ft	3.85	4.15	1921.565	1917.42	-2.18
08JD04	09/27/08	1:50 PM	5.90 ft	3.85	2.05	1921.565	1919.52	2.10
08JD04	11/01/08	n/a	8.55 ft	3.85	4.70	1921.565	1916.87	-2.65
08JD04	11/22/08	1:30 PM	4.63 ft	3.85	0.78	1921.565	1920.79	3.92
08JD04	12/19/08	n/a	4.55 ft	3.85	0.70	1921.565	1920.87	0.08
08JD04	01/31/09	12:15 PM	3.17 ft	3.85	-0.68	1921.565	1922.25	1.38
08JD04	02/24/09	n/a	1.39 ft	3.85	-2.46	1921.565	1924.03	1.78
08JD04	04/02/09	n/a	2.04 ft	3.85	-1.81	1921.565	1923.38	-0.65
08JD04	05/20/09	n/a	n/a	3.85		1921.565		
08JD04	06/25/09	n/a	6.19 ft	3.85	2.34	1921.565	1919.23	1919.23
08JD04	07/14/09	n/a	6.67 ft	3.85	2.82	1921.565	1918.75	-0.48
08JD04	08/25/09	n/a	6.76	3.85	2.91	1921.565	1918.655	-0.09
08JD04	09/24/09	n/a	6.63	3.85	2.78	1921.565	1918.785	0.13
08JD04	10/21/09	n/a	6.45	3.85	2.6	1921.565	1918.965	0.18
08JD04	11/24/09	n/a	5.59	3.85	1.74	1921.565	1919.825	0.86
08JD04	12/23/09		4.35	3.85	0.5	1921.565	1921.065	1.24
08JD04	02/01/10		3.73	3.85	-0.12	1921.565	1921.685	0.62
08JD04	02/24/10		0	3.85	-3.85	1921.565	1925.415	3.73
08JD04	03/31/10		-0.29	3.85	-4.14	1921.565	1925.705	0.29
08JD04	04/29/10		1.65	3.85	-2.2	1921.565	1923.765	-1.94
08JD04	06/12/10		5.87	5.2	0.67	1921.565	1920.895	-2.87
08JD04	07/07/10		8.4	5.2	3.2	1921.565	1918.365	-2.53
08JD04	08/10/10	2:10 AM	6.7	5.2	1.5	1921.565	1920.065	1.7
08JD04	09/25/10		6.73	5.2	1.53	1922.565	1921.035	0.97
08JD04	09/28/10			5.2	-5.2	1921.565	1926.765	
08JD04	01/05/11	3:00 PM	2.65	5.2	-2.55	1921.565	1924.115	

MONITORING WELL WATER LEVEL READING LOG
Hole No. 08JD05

Hole No.	Date	Time	Reading	Surface Correction	Water Level (BGS)	Surface Elev	Water Level Elev	Difference w/ last mo.
08JD05	07/10/08	n/a	0.00 ft	1.97	-1.97	1945.894	1947.86	
08JD05	09/03/08	n/a	0.00 ft	2.35	-2.35	1945.894	1948.24	0.38
08JD05	09/27/08	2:00 PM	0.00 ft	1.97	-1.97	1945.894	1947.86	-0.38
08JD05	11/01/08	n/a	0.10 ft	1.97	-1.87	1945.894	1947.76	-0.10
08JD05	11/22/08	1:30 PM	0.00 ft	1.97	-1.97	1945.894	1947.86	0.10
08JD05	12/19/08	n/a	0.00 ft	1.97	-1.97	1945.894	1947.86	0.00
08JD05	01/31/09	12:45 PM	0.00 ft	1.97	-1.97	1945.894	1947.86	0.00
08JD05	02/24/09	n/a	0.00 ft	1.97	-1.97	1945.894	1947.86	0.00
08JD05	04/02/09	n/a	0.00 ft	1.97	-1.97	1945.894	1947.86	0.00
08JD05	05/20/09	n/a	0.00 ft	1.97	-1.97	1945.894	1947.86	0.00
08JD05	06/25/09	n/a	n/a	1.97		1945.894		
08JD05	07/14/09	n/a	n/a	1.97		1945.894		
08JD05	08/25/09	n/a	n/a	1.97		1945.894		
08JD05	09/24/09	n/a	n/a	1.97		1945.894		
08JD05	10/21/09	n/a	n/a	1.97		1945.894		
08JD05	11/24/09	n/a	n/a	1.97		1945.894		
08JD05	12/23/09		n/a	1.97		1945.894		
08JD05	02/01/10		n/a	1.97		1945.894		
08JD05	02/24/10		n/a	1.97		1945.894		
08JD05	03/31/10		n/a	1.97		1945.894		
08JD05	04/29/10		n/a	1.97		1945.894		
08JD05	06/12/10		n/a	1.97		1945.894		
08JD05	07/07/10		n/a	1.97		1945.894		
08JD05	08/10/10	1:50 PM	n/a					
08JD05	09/25/10							
08JD05	10/08/10		n/a					

MONITORING WELL WATER LEVEL READING LOG
Hole No. 08JD01A

Hole No.	Date	Time	Reading	Surface Correction	Water Level (BGS)	Surface Elev	Water Level Elev	Difference w/ last mo.
08JD01A	07/10/08	n/a	100.04	2.9	97.19	2340.68	2243.49	
08JD01A	09/03/08	n/a	102.50	3.1	99.44	2340.68	2241.24	-2.25
08JD01A	09/27/08	11:45 AM	100.92	2.9	98.07	2340.68	2242.61	1.37
08JD01A	11/01/08	n/a	101.01	2.9	98.16	2340.68	2242.52	-0.09
08JD01A	11/22/08	11:00 AM	100.61	2.9	97.76	2340.68	2242.92	0.40
08JD01A	12/19/08	n/a	101.57	2.9	98.72	2340.68	2241.96	-0.96
08JD01A	01/31/09	10:45 AM	101.35	2.9	98.50	2340.68	2242.18	0.22
08JD01A	02/24/09	n/a	101.82	2.9	98.97	2340.68	2241.71	-0.47
08JD01A	04/02/09	n/a	101.98	2.9	99.13	2340.68	2241.55	-0.16
08JD01A	05/20/09	n/a	102.39	2.9	99.54	2340.68	2241.14	-0.41
08JD01A	06/25/09	n/a	102.04	2.9	99.19	2340.68	2241.50	0.36
08JD01A	07/14/09	n/a	101.89	2.9	99.04	2340.68	2241.64	0.14
08JD01A	08/25/09	n/a	101.66	2.9	98.81	2340.68	2241.87	0.23
08JD01A	09/24/09	n/a	101.16	2.9	98.31	2340.68	2242.37	0.50
08JD01A	10/21/09	n/a	101.90	2.9	99.05	2340.68	2241.63	-0.74
08JD01A	11/24/09	n/a	100.85	2.9	98.00	2340.68	2242.68	1.05
08JD01A	12/23/09		101.10	2.9	98.25	2340.68	2242.43	-0.25
08JD01A	02/01/10		101.56	2.9	98.71	2340.68	2241.97	-0.46
08JD01A	02/24/10		101.24	2.9	98.39	2340.68	2242.29	0.32
08JD01A	03/31/10		101.32	2.9	98.47	2340.68	2242.21	-0.08
08JD01A	04/29/10		101.83	2.9	98.98	2340.68	2241.70	-0.51
08JD01A	06/12/10		101.85	2.9	99.00	2340.68	2241.68	-0.02
08JD01A	07/07/10		102.38	2.9	99.53	2340.68	2241.15	-0.53
08JD01A	08/10/10	3:00 PM	101.65	2.9	98.80	2340.68	2241.88	0.73
08JD01A	09/25/10		101.09	2.9	98.24	2340.68	2242.44	0.56
08JD01A	10/27/10	4:35 PM	101.10	2.9	98.25	2340.68	2242.43	-0.01
08JD01A	11/19/10	1:45 PM	101.80	2.9	98.95	2340.68	2241.73	-0.70
08JD01A	01/07/11	12:25 PM	101.82	2.9	98.97	2340.68	2241.71	-0.02
08JD01A	01/25/11	1:20 PM	100.55	2.9	97.70	2340.68	2242.98	-1.27

MONITORING WELL WATER LEVEL READING LOG
Hole No. 08JD01B

Hole No.	Date	Time	Reading	Surface Correction	Water Level (BGS)	Surface Elev	Water Level Elev	Difference w/ last mo.
08JD01B	07/10/08	n/a	56.43 ft	2.73	53.70	2340.07	2286.37	
08JD01B	09/03/08	n/a	51.00 ft	2.98	48.02	2340.07	2292.05	5.68
08JD01B	09/27/08	11:45 AM	49.17 ft	2.73	46.44	2340.07	2293.63	1.58
08JD01B	11/01/08	n/a	48.01 ft	2.73	45.28	2340.07	2294.79	1.16
08JD01B	11/22/08	11:10 AM	48.01 ft	2.73	45.28	2340.07	2294.79	0.00
08JD01B	12/19/08	n/a	47.99 ft	2.73	45.26	2340.07	2294.81	0.02
08JD01B	01/31/09	10:45 AM	47.92 ft	2.73	45.19	2340.07	2294.88	0.07
08JD01B	02/24/09	n/a	47.92 ft	2.73	45.19	2340.07	2294.88	0.00
08JD01B	04/02/09	n/a	47.92 ft	2.73	45.19	2340.07	2294.88	0.00
08JD01B	05/20/09	n/a	86.95 ft	2.73	84.22	2340.07	2255.85	-39.03
08JD01B	06/25/09	n/a	47.93 ft	2.73	45.20	2340.07	2294.87	39.02
08JD01B	07/14/09	n/a	47.92 ft	2.73	45.19	2340.07	2294.88	0.01
08JD01B	08/25/09	n/a	47.93	2.73	45.20	2340.07	2294.87	-0.01
08JD01B	09/24/09	n/a	48.01	2.73	45.28	2340.07	2294.79	-0.08
08JD01B	10/21/09	n/a	48.01	2.73	45.28	2340.07	2294.79	0
08JD01B	11/24/09	n/a	48.01	2.73	45.28	2340.07	2294.79	0
08JD01B	12/23/09		48.01	2.73	45.28	2340.07	2294.79	0
08JD01B	02/01/10		48.03	2.73	45.30	2340.07	2294.77	-0.02
08JD01B	02/24/10		48.01	2.73	45.28	2340.07	2294.79	0.02
08JD01B	03/31/10		48.01	2.73	45.28	2340.07	2294.79	0
08JD01B	04/29/10		48.01	2.73	45.28	2340.07	2294.79	0
08JD01B	06/12/10		48.01	2.73	45.28	2340.07	2294.79	0
08JD01B	07/07/10		48.04	2.73	45.31	2340.07	2294.76	-0.03
08JD01B	08/10/10	3:00 PM	48	2.73	45.27	2340.07	2294.8	0.04
08JD01B	09/25/10		8.5	2.73	5.77	2340.07	2334.3	39.5
08JD01B	10/27/10	4:32 PM	6	2.73	3.27	2340.07	2336.80	-2.50
08JD01B	11/19/10		6	2.73	3.27	2340.07	2336.80	0.00
08JD01B	01/25/11	1:25 PM	5.7	2.73	2.97	2340.07	2337.10	-0.30

MONITORING WELL WATER LEVEL READING LOG
Hole No. 08JD02A

Hole No.	Date	Time	Reading	Surface Correction	Water Level (BGS)	Surface Elev	Water Level Elev	Difference w/ last mo.
08JD02A	07/10/08	n/a	39.98 ft	2.75	37.23	2044.425	2007.20	
08JD02A	09/03/08	n/a	40.00 ft	3.19	36.81	2044.425	2007.62	0.42
08JD02A	09/27/08	12:10 PM	38.21 ft	2.75	35.46	2044.425	2008.97	1.35
08JD02A	11/01/08	n/a	38.64 ft	2.75	35.89	2044.425	2008.54	-0.43
08JD02A	11/22/08	12:40 PM	38.83 ft	2.75	36.08	2044.425	2008.35	-0.19
08JD02A	12/19/08	n/a	38.04 ft	2.75	35.29	2044.425	2009.14	0.79
08JD02A	01/31/09	11:05 AM	39.26 ft	2.75	36.51	2044.425	2007.92	-1.22
08JD02A	02/24/09	n/a	38.67 ft	2.75	35.92	2044.425	2008.51	0.59
08JD02A	04/02/09	n/a	38.36 ft	2.75	35.61	2044.425	2008.82	0.31
08JD02A	05/20/09	n/a	38.77 ft	2.75	36.02	2044.425	2008.41	-0.41
08JD02A	06/25/09	n/a	38.43 ft	2.75	35.68	2044.425	2008.75	0.34
08JD02A	07/14/09	n/a	38.43 ft	2.75	35.68	2044.425	2008.75	0.00
08JD02A	08/25/09	n/a	38.12	2.75	35.37	2044.425	2009.06	0.31
08JD02A	09/24/09	n/a	38.17	2.75	35.42	2044.425	2009.01	-0.05
08JD02A	10/21/09	n/a	38.1	2.75	35.35	2044.425	2009.08	0.07
08JD02A	11/24/09	n/a	38.5	2.75	35.75	2044.425	2008.68	-0.4
08JD02A	12/23/09		38.41	2.75	35.66	2044.425	2008.77	0.09
08JD02A	02/01/10		37.51	2.75	34.76	2044.425	2009.67	0.9
08JD02A	02/24/10		37.01	2.75	34.26	2044.425	2010.17	0.5
08JD02A	03/31/10		34.75	2.75	32	2044.425	2012.43	2.26
08JD02A	04/29/10		35.96	2.75	33.21	2044.425	2011.22	-1.21
08JD02A	06/12/10		38.15	2.75	35.4	2044.425	2009.03	-2.19
08JD02A	07/07/10		39.19	2.75	36.44	2044.425	2007.99	-1.04
08JD02A	08/10/10	1:30 PM	39.5	2.75	36.75	2044.425	2007.68	-0.31
08JD02A	09/25/10		38.71	2.75	35.96	2044.425	2008.47	0.79
08JD02A	10/28/10	2:45 PM	38.8	2.75	36.05	2044.425	2008.38	-0.09
08JD02A	11/19/10	2:05 PM	38.9	2.75	36.15	2044.425	2008.28	-0.1
08JD02A	12/28/10	3:00 PM	38.8	2.75	36.05	2044.425	2008.38	0.1
08JD02A	01/25/11	2:15 PM	38.27	2.75	35.52	2044.425	2008.91	-0.53

MONITORING WELL WATER LEVEL READING LOG
Hole No. 08JD02B

Hole No.	Date	Time	Reading	Surface Correction	Water Level (BGS)	Surface Elev	Water Level Elev	Difference w/ last mo.
08JD02B	07/10/08	n/a	31.58 ft	2.44	29.14	2044.386	2015.25	
08JD02B	09/03/08	n/a	25.50 ft	2.64	22.86	2044.386	2021.53	6.28
08JD02B	09/27/08	12:10 PM	31.01 ft	2.44	28.57	2044.386	2015.82	-5.71
08JD02B	11/01/08	n/a	31.00 ft	2.44	28.56	2044.386	2015.83	0.01
08JD02B	11/22/08	12:45 PM	31.06 ft	2.44	28.62	2044.386	2015.77	-0.06
08JD02B	12/19/08	n/a	31.04 ft	2.44	28.60	2044.386	2015.79	0.02
08JD02B	01/31/09	11:05 AM	31.22 ft	2.44	28.78	2044.386	2015.61	-0.18
08JD02B	02/24/09	n/a	30.93 ft	2.44	28.49	2044.386	2015.90	0.29
08JD02B	04/02/09	n/a	30.58 ft	2.44	28.14	2044.386	2016.25	0.35
08JD02B	05/20/09	n/a	31.18 ft	2.44	28.74	2044.386	2015.65	-0.60
08JD02B	06/25/09	n/a	31.33 ft	2.44	28.89	2044.386	2015.50	-0.15
08JD02B	07/14/09	n/a	31.45 ft	2.44	29.01	2044.386	2015.38	-0.12
08JD02B	08/25/09	n/a	31.13	2.44	28.69	2044.386	2015.696	0.32
08JD02B	09/24/09	n/a	31.19	2.44	28.75	2044.386	2015.636	-0.06
08JD02B	10/21/09	n/a	31.2	2.44	28.76	2044.386	2015.626	-0.01
08JD02B	11/24/09	n/a	31.25	2.44	28.81	2044.386	2015.576	-0.05
08JD02B	12/23/09		31.18	2.44	28.74	2044.386	2015.646	0.07
08JD02B	02/01/10		30.57	2.44	28.13	2044.386	2016.256	0.61
08JD02B	02/24/10		30.11	2.44	27.67	2044.386	2016.716	0.46
08JD02B	03/31/10		28.92	2.44	26.48	2044.386	2017.906	1.19
08JD02B	04/29/10		29.25	2.44	26.81	2044.386	2017.576	-0.33
08JD02B	06/12/10		30.77	2.44	28.33	2044.386	2016.056	-1.52
08JD02B	07/07/10		31.53	2.44	29.09	2044.386	2015.296	-0.76
08JD02B	08/10/10	1:30 PM	56.3	2.44	53.86	2044.386	1990.526	-24.77
08JD02B	08/12/10	11:05 AM	31.7	2.44	29.26	2044.386	2015.126	24.6
08JD02B	09/25/10		31.55	2.44	29.11	2044.386	2015.276	0.15
08JD02B	10/28/10	2:50 PM	30.9	2.44	28.46	2044.386	2015.926	0.65
08JD02B	11/19/10	2:10 PM	31.6	2.44	29.16	2044.386	2015.226	-0.7
08JD02B	12/28/10	3:05 PM	31.5	2.44	29.06	2044.386	2015.326	0.1
08JD02B	01/25/11	2:18 PM	31.3	2.44	28.86	2044.386	2015.53	-0.20

MONITORING WELL WATER LEVEL READING LOG
Hole No. 08JD03A

Hole No.	Date	Time	Reading	Surface Correction	Water Level (BGS)	Surface Elev	Water Level Elev	Difference w/ last mo.
08JD03A	07/10/08	n/a	196.00	1.68	194.32	2144.662	1950.34	
08JD03A	09/03/08	n/a	127.00	2.23	124.77	2144.662	2019.89	69
08JD03A	09/27/08	1:15 PM	195.68	1.68	194.00	2144.662	1950.66	-68.68
08JD03A	11/01/08	n/a	195.61	1.68	193.93	2144.662	1950.73	0.07
08JD03A	11/22/08	11:25 AM	195.69	1.68	194.01	2144.662	1950.65	-0.08
08JD03A	12/19/08	n/a	195.80	1.68	194.12	2144.662	1950.54	-0.11
08JD03A	01/31/09	11:30 AM	195.76	1.68	194.08	2144.662	1950.58	0.04
08JD03A	02/24/09	n/a	195.70	1.68	194.02	2144.662	1950.64	0.06
08JD03A	04/02/09	n/a	195.70	1.68	194.02	2144.662	1950.64	0
08JD03A	05/20/09	n/a	195.87	1.68	194.19	2144.662	1950.47	-0.17
08JD03A	06/25/09	n/a	195.67	1.68	193.99	2144.662	1950.67	0.2
08JD03A	07/14/09	n/a	195.91	1.68	194.23	2144.662	1950.43	-0.24
08JD03A	08/25/09	n/a	195.73	1.68	194.05	2144.662	1950.61	0.18
08JD03A	09/24/09	n/a	195.72	1.68	194.04	2144.662	1950.62	0.01
08JD03A	10/21/09	n/a	195.70	1.68	194.02	2144.662	1950.64	0.02
08JD03A	11/24/09	n/a	195.96	1.68	194.28	2144.662	1950.38	-0.26
08JD03A	12/23/09		195.78	1.68	194.10	2144.662	1950.56	0.18
08JD03A	02/01/10		195.72	1.68	194.04	2144.662	1950.62	0.06
08JD03A	02/24/10		196.05	1.68	194.37	2144.662	1950.29	-0.33
08JD03A	03/31/10		196.35	1.68	194.67	2144.662	1949.99	-0.3
08JD03A	04/29/10		196.10	1.68	194.42	2144.662	1950.24	0.25
08JD03A	06/12/10		195.52	1.68	193.84	2144.662	1950.82	0.58
08JD03A	07/07/10		195.88	1.68	194.20	2144.662	1950.46	-0.36
08JD03A	08/10/10	2:40 PM	196.00	1.68	194.32	2144.662	1950.34	-0.12
08JD03A	09/25/10		196.09	1.68	194.41	2144.662	1950.25	-0.09
08JD03A	10/27/10	4:20 PM	196.15	1.68	194.47	2144.662	1950.19	-0.06
08JD03A	11/19/10	11:27 AM	196.20	1.68	194.52	2144.662	1950.14	-0.05
08JD03A	12/28/10	2:30 PM	195.00	1.68	193.32	2144.662	1951.34	1.2
08JD03A	01/25/11	1:40 PM	195.98	1.68	194.30	2144.662	1950.36	0.98

MONITORING WELL WATER LEVEL READING LOG
Hole No. 08JD03B

Hole No.	Date	Time	Reading	Surface Correction	Water Level (BGS)	Surface Elev	Water Level Elev	Difference w/ last mo.
08JD03B	07/10/08	n/a	150.64 ft	1.42	149.22	2146.332	1997.11	
08JD03B	09/03/08	n/a	152.00 ft	1.98	150.02	2146.332	1996.31	-0.80
08JD03B	09/27/08	1:20 PM	149.47 ft	1.42	148.05	2146.332	1998.28	1.97
08JD03B	11/01/08	n/a	149.98 ft	1.42	148.56	2146.332	1997.77	-0.51
08JD03B	11/22/08	11:25 AM	150.34 ft	1.42	148.92	2146.332	1997.41	-0.36
08JD03B	12/19/08	n/a	150.52 ft	1.42	149.1	2146.332	1997.23	-0.18
08JD03B	01/31/09	11:30 AM	150.75 ft	1.42	149.33	2146.332	1997.00	-0.23
08JD03B	02/24/09	n/a	150.97 ft	1.42	149.55	2146.332	1996.78	-0.22
08JD03B	04/02/09	n/a	150.97 ft	1.42	149.55	2146.332	1996.78	0.00
08JD03B	05/20/09	n/a	151.55 ft	1.42	150.13	2146.332	1996.20	-0.58
08JD03B	06/25/09	n/a	152.05 ft	1.42	150.63	2146.332	1995.70	-0.50
08JD03B	07/14/09	n/a	152.06 ft	1.42	150.64	2146.332	1995.69	-0.01
08JD03B	08/25/09	n/a	152.84	1.42	151.42	2146.332	1994.912	-0.78
08JD03B	09/24/09	n/a	153.33	1.42	151.91	2146.332	1994.422	-0.49
08JD03B	10/21/09	n/a	150.9	1.42	149.48	2146.332	1996.852	2.43
08JD03B	11/24/09	n/a	150.53	1.42	149.11	2146.332	1997.222	0.37
08JD03B	12/23/09		150.47	1.42	149.05	2146.332	1997.282	0.06
08JD03B	02/01/10		150.28	1.42	148.86	2146.332	1997.472	0.19
08JD03B	02/24/10		150.61	1.42	149.19	2146.332	1997.142	-0.33
08JD03B	03/31/10		150.73	1.42	149.31	2146.332	1997.022	-0.12
08JD03B	04/29/10		150.85	1.42	149.43	2146.332	1996.902	-0.12
08JD03B	06/12/10		151.18	1.42	149.76	2146.332	1996.572	-0.33
08JD03B	07/07/10		151.2	1.42	149.78	2146.332	1996.552	-0.02
08JD03B	08/10/10	2:40 PM	151.1	1.42	149.68	2146.332	1996.652	0.1
08JD03B	09/25/10		152.06	1.42	150.64	2146.332	1995.692	-0.96
08JD03B	10/27/10	4:23 PM	152.15	1.42	150.73	2146.332	1995.602	-0.09
08JD03B	11/19/10	11:15 AM	152.1	1.42	150.68	2146.332	1995.652	0.05
08JD03B	12/28/10	2:35 PM	150.85	1.42	149.43	2146.332	1996.902	1.25
08JD03B	01/25/11	1:45 PM	150.2	1.42	148.78	2146.332	1997.55	-0.65

MONITORING WELL WATER LEVEL READING LOG
Hole No. 07JDA

Hole No.	Date	Time	Reading	Surface Correction	Water Level (BGS)	Surface Elev	Water Level Elev	Difference w/ last mo.
07JDA	07/10/08	n/a	51.82 ft	2.55	49.27	2164.5	2115.23	
07JDA	09/03/08	n/a	53.00 ft	2.9	50.10	2164.5	2114.40	-0.83
07JDA	09/27/08	12:00 PM	52.19 ft	2.55	49.64	2164.5	2114.86	0.46
07JDA	11/01/08	n/a	52.27 ft	2.55	49.72	2164.5	2114.78	-0.08
07JDA	11/22/08	12:25 PM	53.85 ft	2.55	51.30	2164.5	2113.20	-1.58
07JDA	12/19/08	n/a	54.21 ft	2.55	51.66	2164.5	2112.84	-0.36
07JDA	01/31/09	1:00 PM	54.56 ft	2.55	52.01	2164.5	2112.49	-0.35
07JDA	02/24/09	n/a	55.13 ft	2.55	52.58	2164.5	2111.92	-0.57
07JDA	04/02/09	n/a	55.45 ft	2.55	52.90	2164.5	2111.60	-0.32
07JDA	05/20/09	n/a	55.97 ft	2.55	53.42	2164.5	2111.08	-0.52
07JDA	06/25/09	n/a	55.42 ft	2.55	52.87	2164.5	2111.63	0.55
07JDA	07/14/09	n/a	55.97 ft	2.55	53.42	2164.5	2111.08	-0.55
07JDA	08/25/09	n/a	55.82	2.55	53.27	2164.5	2111.23	0.15
07JDA	09/24/09	n/a	55.92	2.55	53.37	2164.5	2111.13	-0.1
07JDA	10/21/09	n/a	55.86	2.55	53.31	2164.5	2111.19	0.06
07JDA	11/24/09	n/a	56.11	2.55	53.56	2164.5	2110.94	-0.25
07JDA	12/23/09		56.5	2.55	53.95	2164.5	2110.55	-0.39
07JDA	02/01/10		56.78	2.55	54.23	2164.5	2110.27	-0.28
07JDA	02/24/10		56.73	2.55	54.18	2164.5	2110.32	0.05
07JDA	03/31/10		56.53	2.55	53.98	2164.5	2110.52	0.2
07JDA	04/29/10		56.71	2.55	54.16	2164.5	2110.34	-0.18
07JDA	06/12/10		56.55	2.55	54.00	2164.5	2110.5	0.16
07JDA	07/07/10		56.62	2.55	54.07	2164.5	2110.43	-0.07
07JDA	08/10/10	1:00 PM	56.7	2.55	54.15	2164.5	2110.35	-0.08
07JDA	09/25/10		56.35	2.55	53.80	2164.5	2110.7	0.35
07JDA	10/27/10	5:10 PM	56.5	2.55	53.95	2164.5	2110.55	-0.15
07JDA	11/19/10	2:30 PM	56.8	2.55	54.25	2164.5	2110.25	-0.3
07JDA	01/07/11	1:25 PM	57.16	2.55	54.61	2164.5	2109.89	0.36
07JDA	01/25/11	2:30 PM	56.88	2.55	54.33	2164.5	2110.17	-0.28

MONITORING WELL WATER LEVEL READING LOG
Hole No. 10JD-01

Hole No.	Date	Time	Reading	Surface Correction	Water Level (BGS)	Surface Elev	Water Level Elev	Difference w/ last mo.
10JD-01	10/27/10	4:45 PM	120.30	3.0	117.30	2436.192	2318.89	
10JD-01	11/19/10	1:20 PM	120.50	3.0	117.50	2436.192	2318.69	-0.20
10JD-01	12/29/10	1:20 PM	119.20	3.0	116.20	2436.192	2319.99	1.30
10JD-01	01/25/11	12:00 AM	119.00	3.0	116.00	2436.192	2320.19	0.20

MONITORING WELL WATER LEVEL READING LOG
Hole No. 10JD-01A

Hole No.	Date	Time	Reading	Surface Correction	Water Level (BGS)	Surface Elev	Water Level Elev	Difference w/ last mo.
10JD-01A	10/27/10	4:48 PM	116.85	3.0	113.85	2431.67	2317.82	
10JD-01A	11/19/10	1:15 PM	117.10	3.0	114.10	2431.67	2317.57	0.25
10JD-01A	12/29/10	1:30 PM	115.75	3.0	112.75	2431.67	2318.92	-1.35
10JD-01A	01/25/11	12:45 PM	115.50	3.0	112.50	2431.67	2319.17	-0.25

MONITORING WELL WATER LEVEL READING LOG
Hole No. 10JD-02

Hole No.	Date	Time	Reading	Surface Correction	Water Level (BGS)	Surface Elev	Water Level Elev	Difference w/ last mo.
10JD-02	10/27/10	4:50 PM	110.30	3.0	107.30	2429.837	2322.54	
10JD-02	11/19/10	1:30 PM	111.00	3.0	108.00	2429.837	2321.84	0.70
10JD-02	12/29/10	2:45 PM	110.00	3.0	107.00	2429.837	2322.84	-1.00
10JD-02	01/25/11	12:55 PM	110.17	3.0	107.17	2429.837	2322.67	0.17

MONITORING WELL WATER LEVEL READING LOG
Hole No. 10JD-02A

Hole No.	Date	Time	Reading	Surface Correction	Water Level (BGS)	Surface Elev	Water Level Elev	Difference w/ last mo.
10JD-02A	10/27/10	4:50 PM	107.70	3.0	104.70	2427.097	2322.40	
10JD-02A	11/19/10	1:25 PM	108.30	3.0	105.30	2427.097	2321.80	0.60
10JD-02A	12/29/10	2:50 PM	107.50	3.0	104.50	2427.097	2322.60	-0.80
10JD-02A	01/25/11	12:50 PM	107.60	3.0	104.60	2427.097	2322.50	0.10

MONITORING WELL WATER LEVEL READING LOG
Hole No. 10JD-05alt

Hole No.	Date	Time	Reading	Surface Correction	Water Level (BGS)	Surface Elev	Water Level Elev	Difference w/ last mo.
10JD-05 alt	10/27/10	5:05 PM	98.70	3.0	95.70	2210.207	2114.51	
10JD-05 alt	11/19/10	3:30 PM	99.00	3.0	96.00	2210.207	2114.21	0.30
10JD-05 alt	01/07/11	1:10 PM	99.08	3.0	96.08	2210.207	2114.13	0.08
10JD-05 alt	01/25/11	2:40 PM	98.85	3.0	95.85	2210.207	2114.36	-0.23

MONITORING WELL WATER LEVEL READING LOG
Hole No. 10JD-06alt

Hole No.	Date	Time	Reading	Surface Correction	Water Level (BGS)	Surface Elev	Water Level Elev	Difference w/ last mo.
10JD-06 alt	10/27/10	5:15 PM	112.25	3.0	109.25	2222.258	2113.01	
10JD-06 alt	11/19/10	3:35 PM	112.70	3.0	109.70	2222.258	2112.56	0.45
10JD-06 alt	01/07/11	1:03 PM	113.55	3.0	110.55	2222.258	2111.71	0.85
10JD-06 alt	01/25/11	2:50 PM	113.67	3.0	110.67	2222.258	2111.59	0.12

CHAPTER V

SURFACE WATER HYDROLOGY

TABLE OF CONTENTS

1.0 INTRODUCTION CV-1

1.1 SCOPE OF WORK CV-1

1.2 DATA SOURCES CV-2

1.2.1 Previous Investigations and Studies CV-2

1.2.2 Ongoing Baseline Monitoring Program CV-2

2.0GENERAL AREA SURFACE WATER HYDROLOGY CV-2

3.0 PROJECT AREA HYDROLOGY CV-5

3.1 CLIMATIC CONDITIONS CV-5

3.2 DRAINAGES CV-5

3.3 SURFACE WATER BODIES CV-6

3.3.1 Creeks CV-6

3.3.2 Springs and Seeps CV-7

3.4 SURFACE WATER FLOWS CV-7

3.4.1 Creek Discharge CV-7

3.4.2 Spring Discharge CV-16

3.5 SURFACE WATER QUALITY CV-16

3.5.1 Field and General Chemistry Parameters CV-22

3.5.2 Nutrients CV-22

3.5.3 Metals, Nonmetals and Metalloids CV-22

3.5.4 Suspended Sediments CV-23

4.0 REFERENCES CV-26

5.0 RESPONSIBLE PARTY CV-26

LIST OF TABLES

CV-1 PROJECT AREA DRAINAGES.....CV-8

CV-2 SURFACE WATER BODIES.....CV-9

CV-3 SUMMARY OF HISTORIC POINT DISCHARGE MEASUREMENTS OF PROJECT AREA CREEKS CV-12

CV-4 SUMMARY OF HISTORIC CONTINUOUS DISCHARGE MONITORING OF PROJECT AREA CREEKS…….……CV-13

CV-5 RECENT POINT DISCHARGE MEASUREMENTS OF PROJECT AREA CREEKS CV-14

CV-6 SUMMARY OF SPRING AND SEEP DISCHARGE DATA CV-17

CV-7 SUMMARY OF SURFACE WATER QUALITY MONITORING.....CV-18

CV-8 SUMMARY OF BASELINE SURFACE WATER QUALITY DATA CV-21

CV-9 HISTORIC SUSPENDED SEDIMENT CONCENTRATION DATA CV-24

LIST OF FIGURES

CV-1 DRAINAGE AREAS…….....CV-4

CV-2 CREEK SAMPLE COLLECTION SITES……..CV-10

CV-3 2003-2008 STREAM FLOW HYDROGRAPH FOR MARGUERITE CREEK…….CV-15

LIST OF PLATES

CV-1 LOCATION OF SURFACE WATER BODIES…….…….. CV-25

1.0 INTRODUCTION

Per Section 049 (Surface Water Information) of Article 4 (Environmental Resource Information Requirements) of 11 AAC 90, each permit application shall include "*information about surface water, including the name of the watershed which will receive water discharges, the location of all surface water bodies, the location of any water discharge into any surface water bodies, and the descriptions of surface drainage systems sufficient to identify, in detail, the seasonal variations in water quantity and quality within the proposed permit area and adjacent area..*". Therefore, Chapter V of this permit application describes surface water flow and quality characteristics, surface water monitoring schedules, and general stream morphology within the proposed Jumbo Dome Mining area.

1.1 SCOPE OF WORK

Specific components of the hydrologic evaluation required by 11 AAC 90 include the following:

- Maximum, minimum, and mean discharge conditions of streams within the adjacent area affected by the proposed mining area.
- Quality of surface water sources flowing into the mining area and sources which will receive mine runoff, including the following parameters: total dissolved solids (mg/L), total suspended solids (mg/L), acidity, pH (standard units), total and dissolved iron (mg/L), and total manganese (mg/L).
- Other information required by the commissioner (e.g., 11 AAC 90.051 Alternative Water Supply Information).

1.2 DATA SOURCES

1.2.1 Previous Investigations and Studies

In 2002, the United States Geological Survey (USGS) in cooperation with UCM, initiated an extensive program to measure precipitation, stream flow, and surface water quality within the Marguerite Creek Basin. The six surface water stations of greatest relevance to the proposed mining area include one established (by USGS as a gage site) on the right bank of Marguerite Creek approximately 1,200 feet upstream of the mouth of Emma Creek; one below the USGS gage site on Lower Emma Creek approximately 330 feet upstream of the confluence with Marguerite Creek; one on Lower Marguerite Creek approximately 300 feet upstream of the confluence with Emma Creek; one at the bottom of Marguerite Creek below the confluence with Bonanza Creek; one on Lower Bonanza Creek approximately 330 feet upstream of the confluence with Marguerite Creek; and, one on Middle Marguerite Creek approximately 2,500 feet downstream of the road crossing. The USGS gage station has been monitored from 2003 to the present for stream flow, sediment load (suspended solids), and temperature. A more complete suite of stream flow and water quality analyses are, however, available for the 5 UCM stations listed above.

1.2.2 Baseline Monitoring Program

UCM performed a spring and seep survey along each site drainage during August 2009, including the collection of field water quality parameters and discharge measurements. UCM also completed up to 4 measurements of stream flows and field water quality parameters per year since 2002 at the 5 stations listed above, and collected samples for laboratory analyses.

2.0 GENERAL AREA SURFACE WATER HYDROLOGY

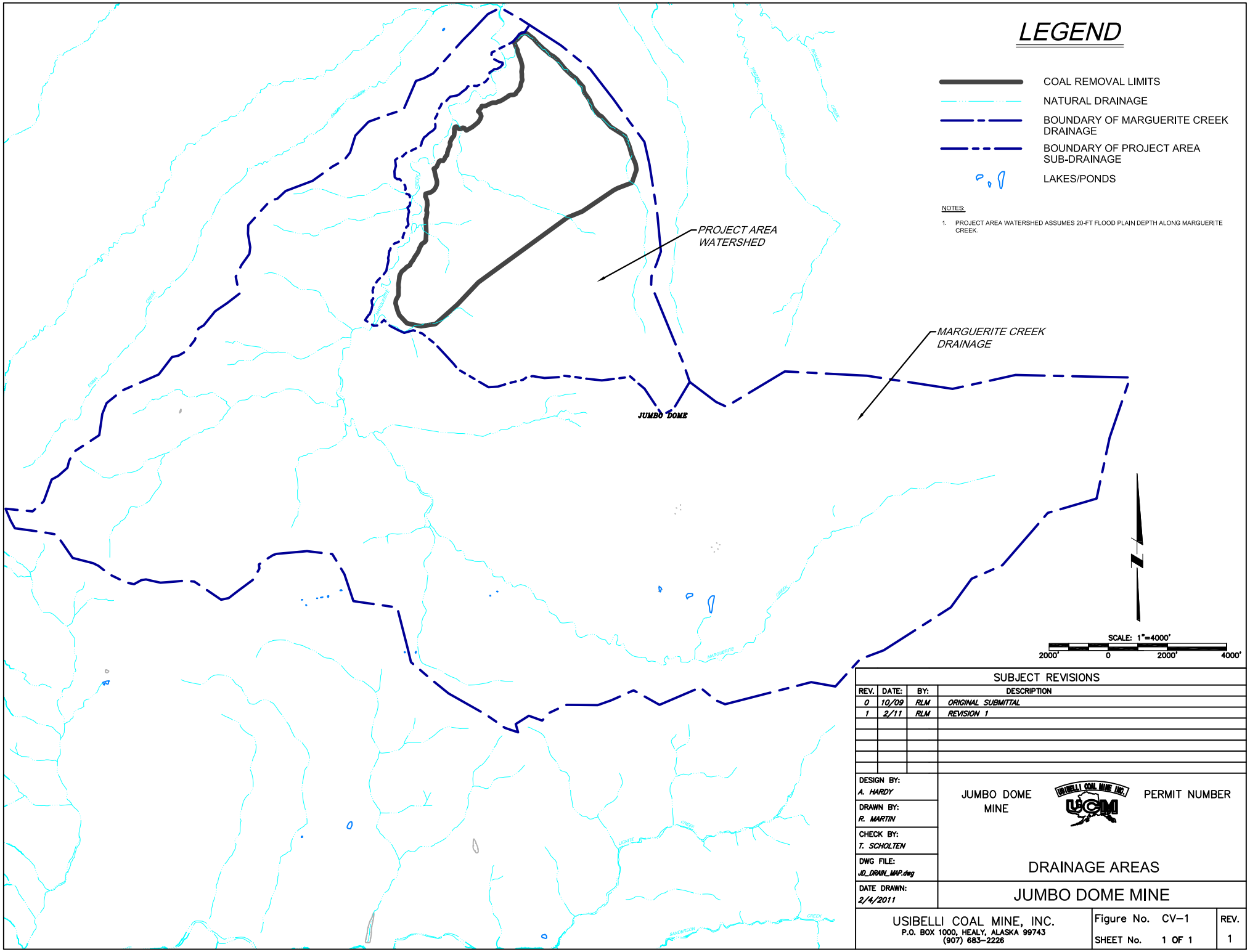
Marguerite Creek's tributaries are high gradient subarctic streams with the potential for high stream velocities and sediment transport. Marguerite Creek itself is a low gradient stream with an average gradient of approximately 1.5 percent. The Marguerite Creek watershed is comprised of 18 major basins and 14 minor basins, encompassing an area of approximately 15 square miles

(USGS, 2009) as shown on Figure CV-1, Drainage Areas. The watershed trends east-west and then south-north, and is tributary to the northward flowing California Creek then into the Totatlanika River which is a tributary to the Tanana River. The downstream end of Marguerite Creek at the north end of the proposed mining area is at an approximate elevation of 1,950 feet amsl. The approximate elevation of Marguerite Creek at the southern end of the proposed mining area about 10,000 feet away is 2,100 feet amsl.

North-facing high relief permafrost basins underlain by resistant schistose rocks have relatively high peak flows of short duration that decline during the summer to low base flows. In contrast, south-facing, non-permafrost low relief basins underlain by coal-bearing rocks have reduced peak flows due to higher interception and infiltration while base flows are relatively higher and sustained due to high volume aquifer storage in thick fractured coal seams.

FIGURE CV-1

DRAINAGE AREAS


LEGEND
COAL REMOVAL LIMITS
NATURAL DRAINAGE
BOUNDARY OF MARGUERITE CREEK DRAINAGE
BOUNDARY OF PROJECT AREA SUB-DRAINAGE
LAKES/PONDS
NOTES:
1. PROJECT AREA WATERSHED ASSUMES 20-FT FLOOD PLAIN DEPTH ALONG MARGUERITE CREEK.
PROJECT AREA WATERSHED
MARGUERITE CREEK DRAINAGE
JUMBO DOME
SCALE: 1"=4000'
2000' 0 2000' 4000'
SUBJECT REVISIONS
REV. DATE: BY: DESCRIPTION
0 10/09 RLM ORIGINAL SUBMITTAL
1 2/11 RLM REVISION 1
DESIGN BY: A. HARDY
DRAWN BY: R. MARTIN
CHECK BY: T. SCHOLTEN
DWG FILE: JD_DRAIN_MAP.dwg
DATE DRAWN: 2/4/2011
JUMBO DOME MINE
USIBELLI COAL MINE, INC.
UCM
PERMIT NUMBER
DRAINAGE AREAS
JUMBO DOME MINE
USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743
(907) 683-2226
Figure No. CV-1
SHEET No. 1 OF 1
REV. 1

3.0 PROJECT AREA HYDROLOGY

The general area for the Jumbo Dome Mine area includes one major drainage, Marguerite Creek. The location of Marguerite Creek and its neighboring creeks, Emma Creek to the west and Bonanza Creek to the east, are shown on Figure CV-1, Drainage Areas. The following subsections describe the climatic and hydrologic conditions associated with these drainages.

3.1 CLIMATIC CONDITIONS

The Marguerite Creek watershed has a typical interior Alaskan subarctic climatic regime, which includes short, warm summers with high intensity cyclonic storms and long, cold winters with low precipitation that provide for the maintenance of discontinuous permafrost terrain. In addition, because of the area's proximity to the Nenana River Gorge which transects the Alaska Range, warm, moist winds (chinooks) from coastal Alaska occasionally cross into the Nenana Valley area during wintertime. The chinooks alter the normal dormant winter patterns by producing warmer periods which may yield snowmelt and/or rain. Average annual rainfall ranges from 14 to 16.5 inches with most precipitation occurring during June, July, and August and average temperatures in the area range from 16.2 to 44 degrees Fahrenheit with a range of -6 to 69. Additional climatic information is presented in Chapter VII, Climatological Information.

3.2 DRAINAGES

As shown on Figure CV-1, Drainage Areas, Marguerite Creek first trends generally east-west and then turns northwest and north as it parallels the western limits of the proposed mining area. Most of the tributaries to Marguerite Creek come into the drainage from the southwest and west, with a few additional tributaries emanating from the western flanks of Jumbo Dome, draining into Marguerite Creek's eastern banks. The tributaries draining into Marguerite Creek's western bank generally flow from south to north and/or west to east. Before intersecting Marguerite Creek's eastern banks, tributaries generally flow from east to west and/or southeast to northwest. Table CV-1, Project

Area Drainages, provides details of the approximate vertical relief, watershed drainage area, and primary surface lithology of the Marguerite Creek drainage basin.

3.3 SURFACE WATER BODIES

Surface water bodies in the proposed mining area include creeks, springs, seeps, and seepage zones. A summary of surface water bodies is included in Table CV-2, Surface Water Bodies. The locations of major surface water bodies are shown on Plate CV-1, Locations of Surface Water Bodies. Both individual spring and seep stations and seepage zones mapped in the area are shown on Plate CV-1.

3.3.1 Creeks

The major creek within the project area includes Marguerite Creek. It covers an area of 15.2 square miles. The primary surface lithologies in this drainage include the Tertiary Suntrana Formation sandstones, the quart-sericite schist of the Precambrian or Paleozoic Keevy Peak Formation, the siltstones and claystones of the Tertiary Grubstake and Lignite Creek Formations, and Quaternary rubbles, alluvium, and pediment gravels of Jumbo Dome (see Table CV-1).

Surface water monitoring for Marguerite and neighboring creeks include one established (by USGS) on the right bank of Marguerite Creek approximately 1,200 feet upstream of the mouth of Emma Creek; one below the USGS gage site on Lower Emma Creek approximately 330 feet upstream of the confluence with Marguerite Creek; one on Lower Marguerite Creek approximately 300 feet upstream of the confluence with Emma Creek; one at the bottom of Marguerite Creek below the confluence with Bonanza Creek; one on Lower Bonanza Creek approximately 330 feet upstream of the confluence with Marguerite Creek; and, one on Middle Marguerite Creek approximately 2,500 feet downstream of the road crossing (see Figure CV-2 and Table CV-2). The middle and lower locations along Marguerite Creek assess surface water quality conditions within the project area. The other monitoring and sampling stations may be discontinued in the long term.

3.3.2 Springs and Seeps

Springs and seeps are defined as surface expressions of ground water discharge. Springs are delineated from seeps based on flow volume. Springs have measurable flow, whereas seeps have visible flow, but at volumes too small to accurately measure. Most springs and seeps identified at Jumbo Dome occur in the general vicinity of natural drainages, some of which appear as a result of ground water discharge from coal seams. A spring and seep survey was conducted by UCM in August 2009 for the Jumbo Dome mine area. Seepage zones and the location of springs and sampling locations for collection of field water quality parameters are shown on Plate CV-1. Based upon a review of the location of the coal seam outcrops and the seepage shading shown on Plate CV-1, it appears that 6 Seam likely contributes to a majority of the mapped seepage areas.

3.4 SURFACE WATER FLOWS

3.4.1 Creek Discharge

Historic point discharge monitoring and continuous discharge monitoring of site creeks are summarized in Tables CV-3 and CV-4 Summary of Historic Point/Continuous Discharge Measurements for Project Area Creeks, respectively. Data from Tables CV-3 and CV-4 show that the minimum and maximum discharge ranges for each area creek include the following: Marguerite Creek [0.55-227.00 cubic feet per second (cfs)]; Emma Creek (2.60-56.30 cfs); Bonanza Creek (4.58-18.30 cfs); and Jumbo Creek (0.70-1.01 cfs). These discharges are measured near the mouths of each tributary drainage. The upper reaches of the creeks are ephemeral, with visible flow resulting from localized precipitation events and/or spring runoff. Visible flow in the upper reaches of the creeks during the low-flow months is directly correlated to the location of ground water discharge from coal-seam outcrops.

TABLE CV-1

PROJECT AREA DRAINAGES[1]

Drainage Basin	Monitoring Station[2]	Drainage Area (in mi^2)[3]	Approximate Range in Drainage Elevation[3] (in feet)	Primary Surface Lithology[4,5]
Marguerite Creek	15515060	15.52	1,950 - 4,500	Qra, Qha, Qhr, Tgl, Tsn, kp

Notes:

1. Location of drainage basins shown on Figure CV-1, Drainage Areas.
2. Official USGS gage station (2009); location provided on USGS website.
3. Estimated from USGS and site topographic maps from drainage headwaters to monitoring station.
4. Qhr = Quaternary rubble of Jumbo Dome.
   Qra, Qha = Quaternary alluvium and pediment gravel.
   Tgl = Tertiary Grubstake and Lignite Creek Formation siltstones and claystones.
   Tsn = Tertiary Suntrana Formation sandstones.
   kp = Quartz-sericite schist of the Keevy Peak Formation.
5. Surface lithologies presented in Wahrhaftig (1970).

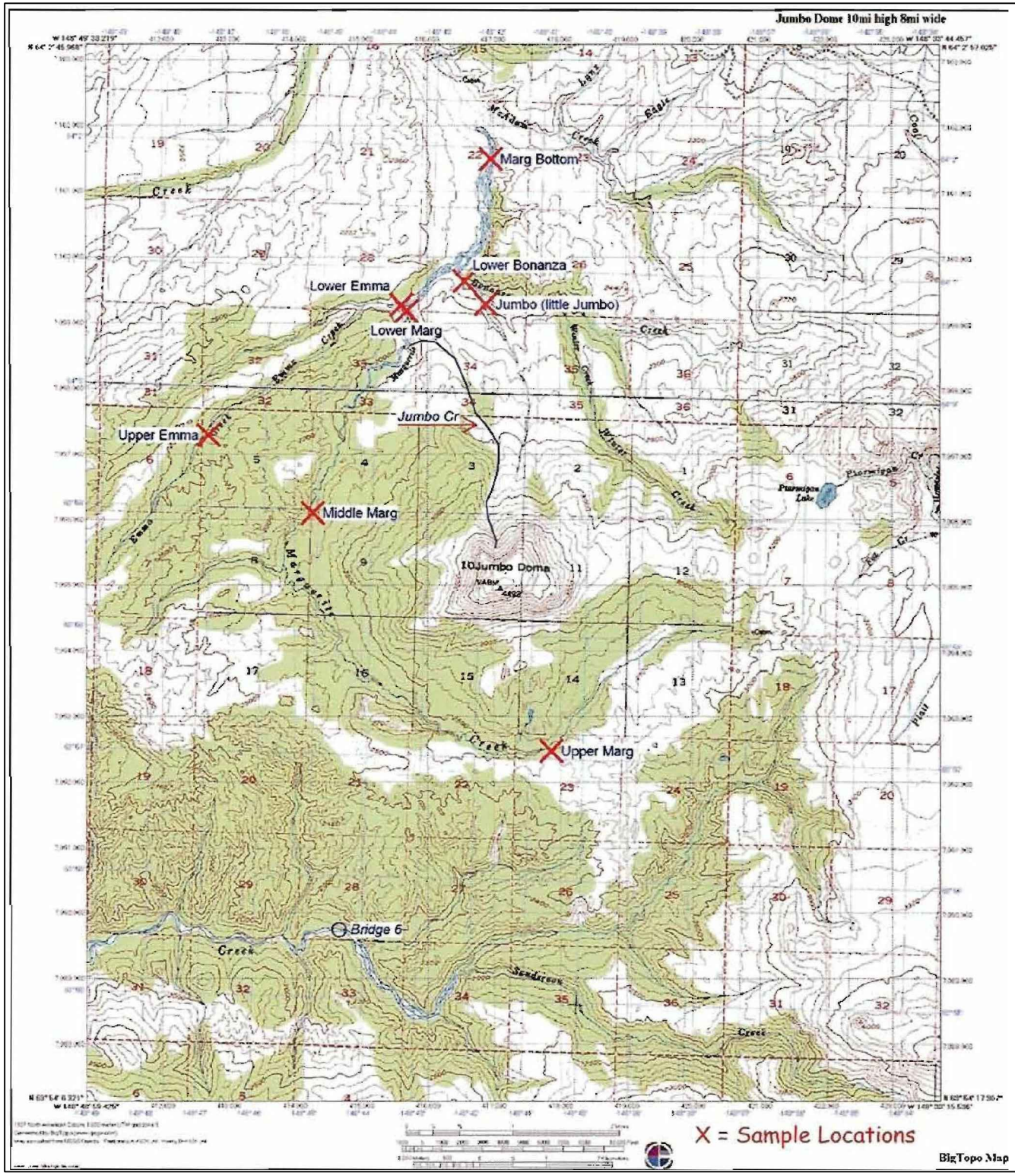
TABLE CV-2
SURFACE WATER BODIES[1]

Type	Drainage Basin	Site Designation[2]	Monitoring[3]	Comments
Creeks	Marguerite Creek above Emma Creek	15515060	Q, F	USGS Gage Site; 1,200' upstream of mouth of Emma Creek
	Lower Emma Creek	LE	Q, F, L	330' upstream of confluence with Marguerite Creek
	Lower Marguerite Creek	LM	Q, F, L	330' upstream of confluence with Emma Creek
	Bottom Marguerite Creek	BM	Q, F, L	Below confluence with Bonanza Creek
	Lower Bonanza Creek	LB	Q, F, L	330' upstream of confluence with Marguerite Creek
	Middle Marguerite Creek	MM	Q, F, L	2,500' downstream of road crossing
Springs and Seeps	Marguerite Creek Drainage Basin	JDS09-001	Q, F	Seep
		JDS09-002	Q, F	Seep
		JDS09-003	Q, F	Seep
		JDS09-004	Q, F	Seep
		JDS09-005	Q, F	Seep
		JDS09-006	Q, F	Seep
		JDS09-007	Q, F	Seep
		JDS09-008	Q, F	Seep
		JDS09-009	Q, F	Seep

Notes:

1. Site locations shown on Plate CV-1, Location of Surface Water Bodies and Figure CV-2, Creek Sample Collection Sites.
2. All sites identified by UCM with the exception of 15515060 which was identified in cooperation with USGS in 2002.
3. Q = flow measurement; F = field water quality measurements; L = laboratory water quality measurements.

FIGURE CV-2
CREEK SAMPLE COLLECTION SITES



SUBJECT REVISIONS			
REV.	DATE:	BY:	DESCRIPTION
0	12/09	RLM	ORIGINAL SUBMITTAL

DESIGN BY: A. HARDY

DRAWN BY: R. MARTIN

CHECK BY: F. WALLIS

DWG FILE: JD_DRAIN_MAP.dwg

DATE DRAWN: 12/14/2009

JUMBO DOME MINE

USIBELLI COAL MINE INC.

PERMIT NUMBER

CREEK SAMPLE COLLECTION SITES

JUMBO DOME MINE

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743
(907) 683-2226

Figure No. CV-2

SHEET No. 1 OF 1

REV. 0

Seasonal discharge variability within the site creeks is best characterized by the hydrograph shown on Figure CV-3, 2003-2008 Stream Flow Hydrograph for Marguerite Creek. Seasonal surface water flow variations, as seen during an average precipitation season (Figure CV-3), begin with peak flows from rainfall and snowmelt during May and early June. Discharge decreases then stabilizes from mid-June to mid-July as the snowpack is diminished. The hydrograph then shows a slight increasing discharge trend from summer precipitation. August and September mark the general decline in measured flow as the hydrographs approach baseflow conditions. The hydrograph on Figure CV-3 shows the impact of localized summer rain storms on surface flow in the creeks. The series of peaks on the hydrographs are the result of storm events, many of which result in short-term discharge equal to peak flows from spring runoff.

TABLE CV-3

SUMMARY OF HISTORIC POINT DISCHARGE MEASUREMENTS OF PROJECT AREA CREEKS

Creek	Monitoring Station[3]	Period of Record	Number of Measurements	Measurement Method[4]	Measured Discharge (in cfs)		Specific discharge (in cfs/mi^2)[5]	
					Minimum	Maximum	Minimum	Maximum
Marguerite[1]	15515060	2004-2008	Continuous Monitoring	CM	0.55 (3/13/07)	227.00 (7/31/08)	0.04	14.63
Emma[2]	LE	2002-2009	8	CM	2.60 (11/25/08)	56.30 (3/20/08)	1.37	29.63
Bonanza[2]	LB	2002-2007	6	CM	4.58 (8/16/06)	18.30 (5/20/05)	0.55	2.20
Jumbo[2]	J	2002-2003	2	CM	0.70 (7/29/03)	1.01 (8/20/02)	0.77	1.11

Notes:

1. Data collected by USGS.
2. Data collected by UCM.
3. Location of monitoring stations shown on Figure CV-2, Creek Sample Collection Sites.
4. CM = Current meter.
5. Specific discharge calculated by dividing measured discharge by drainage area.

TABLE CV-4
SUMMARY OF HISTORIC CONTINUOUS DISCHARGE MONITORING OF PROJECT AREA CREEKS

Creek	Monitoring Station[2]	Period of Record	Measurement Method[3]	Measured Discharge (in cfs)		Specific Discharge (in cfs/mi^2)[4]		SSC[5,7] (mg/l)		SSD[6,7] (tons/day)	
				Minimum	Maximum	Minimum	Maximum	Aug 2008	May 2008	Aug 2008	May 2008
Marguerite[1]	15515060	2004-2008	CM	0.55	227.00	0.04	4.90	11	71	0.49	2.80

Notes:

1. Data collected by USGS.
2. Location of monitoring station shown on USGS website.
3. CM = Current meter.
4. Specific discharge calculated by dividing measured discharge by drainage area.
5. SSC = Suspended Sediment Concentration.
6. SSD = Suspended Sediment Discharge.
7. "Water Year October 2007 to September 2008" (USGS, 2008).

TABLE CV-5

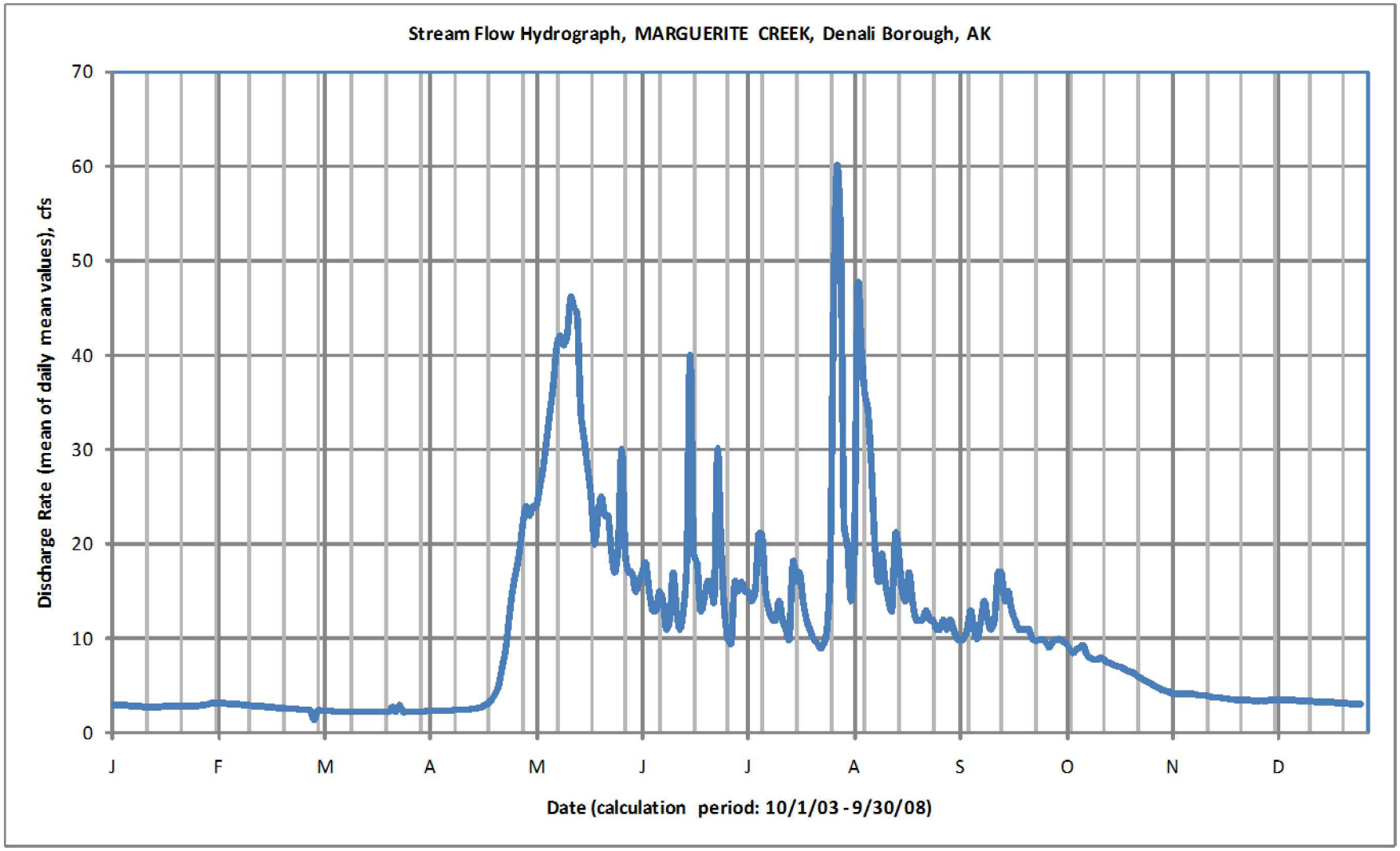
RECENT POINT DISCHARGE MEASUREMENTS OF PROJECT AREA CREEKS

Creek	Monitoring Station	Measurement Method[1]	Discharge (in cfs)	Date	Source[2]
Lower Emma Creek	LE	CM	9.20	8/20/02	UCM
		CM	7.10	7/29/03	UCM
		CM	4.56	6/21/04	UCM
		CM	2.82	3/28/05	UCM
		CM	4.54	5/20/05	UCM
		CM	3.66	2/6/07	UCM
		CM	56.30	3/20/08	UCM
		CM	2.60	11/25/08	UCM
Lower Marguerite Creek	LM	CM	43.20	8/20/02	UCM
		CM	25.20	7/29/03	UCM
		CM	10.50	6/21/04	UCM
		CM	4.98	3/28/05	UCM
		CM	13.90	5/20/05	UCM
		CM	16.60	8/28/08	UCM
		CM	5.80	11/25/08	UCM
Bottom Marguerite Creek	BM	CM	65.20	8/20/02	UCM
		CM	48.00	7/29/03	UCM
		CM	20.60	6/21/04	UCM
		CM	40.10	5/20/05	UCM
Lower Bonanza Creek	LB	CM	17.80	8/20/02	UCM
		CM	15.20	7/29/03	UCM
		CM	5.31	6/21/04	UCM
		CM	18.30	5/20/05	UCM
		CM	4.56	8/16/06	UCM
		CM	5.09	8/24/07	UCM
Middle Marguerite Creek	MM	CM	28.20	8/20/02	UCM
		CM	16.50	7/29/03	UCM
		CM	7.08	6/21/04	UCM
		CM	4.70	8/26/04	UCM
		CM	4.10	9/1/04	UCM
		CM	3.96	3/28/05	UCM
		CM	5.71	8/23/05	UCM
		CM	6.34	8/16/06	UCM
Upper Emma Creek	UE	CM	1.24	8/20/02	UCM
		CM	0.70	7/29/03	UCM
		CM	1.30	6/21/04	UCM
Upper Marguerite Creek	UM	CM	7.15	8/20/02	UCM
		CM	4.60	7/29/03	UCM
		CM	2.29	6/21/04	UCM
Jumbo Creek	J	CM	1.01	8/20/02	UCM
		CM	0.70	7/29/03	UCM

Notes:

1. CM = Current Meter.
2. UCM = Usibelli Coal Mine Project files.

FIGURE CV-3
2003-2008 STREAM FLOW HYDROGRAPH FOR
MARGUERITE CREEK



NOTES:

1. DATA PROVIDED BY USGS, http://waterdata.usgs.gov/ak/nwis/dvstat?&site_no=15515060&agency_cd=USGS&por_15515060_1=2205944,00060,1&referred_module=sw&format=html_table

2. CALCULATION PERIOD FROM 10/1/2003 to 9/30/2008.

SUBJECT REVISIONS

REV.	DATE:	BY:	DESCRIPTION
0	12/09	RLM	ORIGINAL SUBMITTAL

DESIGN BY: A. HARDY

DRAWN BY: R. MARTIN

CHECK BY: F. WALLIS

DWG FILE: JD_DRAIN_MAP.dwg

DATE DRAWN: 10/15/2009

JUMBO DOME MINE

USIBELLI COAL MINE INC. UCM

PERMIT NUMBER

2003-2008 STREAM FLOW HYDROGRAPH FOR MARGUERITE CREEK

JUMBO DOME MINE

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743
(907) 683-2226

Figure No. CV-3

SHEET No. 1 OF 1

REV. 0

3.4.2 Spring Discharge

Spring and seep discharge data are summarized in Table CV-6, Summary of Spring and Seep Discharge Data. As stated previously in Section 3.3.2, seeps are defined as surface expressions of ground water that have discharge volumes too small to accurately measure. Therefore, seep "discharges" referred to in Table CV-6 refer to field estimates of visible flow at seep locations during monitoring events. Recorded discharge from seeps in the Marguerite Creek drainage basin observed within the proposed mining area varies from less than 1 to over 80 gpm. Significant discharges were recorded for seep locations JDS09-003 (80-90 gpm), JDS09-004 (32 gpm), JDS09-007 (50 gpm), and JDS09-009 (80 gpm).

3.5 SURFACE WATER QUALITY

Surface water quality samples were originally collected from the creek monitoring stations in the late 2002. Historic sampling is summarized in Table CV-7, Summary of Surface Water Quality Monitoring. Historic surface water quality samples were analyzed using different parameter lists with changes over time as sampling and analysis techniques evolved. Current monitoring parameters and analytical methods are identical to those listed for ground water in Table CIV-5 of Chapter CIV Section 2.3.7. The current parameter list and analytical methods were developed in consultation with the State of Alaska, in conjunction with current regulatory guidelines.

Water quality data collected from creeks within the project area are summarized in Table CV-8, Summary of Baseline Surface Water Quality Data. Data collected as part of the baseline water quality program at the site include field parameters, general laboratory parameters, major ions, nutrients and trace elements/metals.

TABLE CV-6 SUMMARY OF SPRING AND SEEP DISCHARGE DATA[1]			
Drainage Basin	**Site Designation**	**Date**	**Estimated Discharge (gpm)**
Marguerite Creek	JDS09-001	8/20/09	Seep – no flow measurable
	JDS09-002	8/20/09	2
	JDS09-003	8/20/09	80-90
	JDS09-004	8/20/09	32
	JDS09-005	8/20/09	<1
	JDS09-006	8/20/09	Seep – no flow measurable
	JDS09-007	8/20/09	50
	JDS09-008	8/20/09	1
	JDS09-009	8/20/09	80

TABLE CV-7
SUMMARY OF SURFACE WATER QUALITY MONITORING[1]
(Page 1of 3)

Type	Drainage Basin	Site Designation[2]	Date Sampled	Field Parameters	Laboratory Parameters	Data Sources
Creeks	Lower Emma Creek	LE	8/20/02	✓	✓	UCM, DNR-DMLW
			7/29/03	✓	✓	UCM, DNR-DMLW
			6/21/04	✓	✓	UCM, DNR-DMLW
			3/28/05	✓	✓	UCM, DNR-DMLW
			5/20/05	✓	✓	UCM, DNR-DMLW
			3/27/06	✓	✓	UCM, DNR-DMLW
			8/16/06	✓	✓	UCM, DNR-DMLW
			2/6/07	✓	✓	UCM, DNR-DMLW
			3/27/07	✓	✓	UCM, DNR-DMLW
			5/16/07	✓	✓	UCM, DNR-DMLW
			8/24/07	✓	✓	UCM, DNR-DMLW
			3/20/08	✓	✓	UCM, DNR-DMLW
			5/21/08	✓	✓	UCM, DNR-DMLW
			8/28/08	✓	✓	UCM, DNR-DMLW
			11/25/08	✓	✓	UCM, DNR-DMLW
			3/21/09	✓	✓	UCM, DNR-DMLW
			6/30/09	✓	✓	UCM, DNR-DMLW
			10/5/09	✓	✓	UCM, DNR-DMLW
			3/31/10	✓	✓	UCM, DNR-DMLW
			6/8/10	✓	✓	UCM-DNR-DMLW
	Lower Marguerite Creek	LM	8/20/02	✓	✓	UCM, DNR-DMLW
			7/29/03	✓	✓	UCM, DNR-DMLW
			6/21/04	✓	✓	UCM, DNR-DMLW
			3/28/05	✓	✓	UCM, DNR-DMLW
			5/20/05	✓	✓	UCM, DNR-DMLW
			3/27/06	✓		UCM, DNR-DMLW
			8/16/06	✓	✓	UCM, DNR-DMLW
			3/27/07	✓	✓	UCM, DNR-DMLW
			5/16/07	✓	✓	UCM, DNR-DMLW
			8/24/07	✓	✓	UCM, DNR-DMLW
			3/20/08	✓	✓	UCM, DNR-DMLW
			5/21/08	✓	✓	UCM, DNR-DMLW
			8/28/08	✓	✓	UCM, DNR-DMLW
			11/25/08	✓	✓	UCM, DNR-DMLW
			6/30/09	✓	✓	UCM, DNR-DMLW
			10/5/09	✓	✓	UCM, DNR-DMLW
			6/8/10	✓	✓	UCM, DNR-DMLW
	Upper Emma Creek	UE	8/20/02	✓	✓	UCM, DNR-DMLW
			7/29/03	✓	✓	UCM, DNR-DMLW
			6/21/04	✓	✓	UCM, DNR-DMLW

TABLE CV-7
SUMMARY OF SURFACE WATER QUALITY MONITORING[1]
(Page 2 of 3)

Creeks	Upper Marguerite Creek	UM	8/20/02	✓	✓	UCM, DNR-DMLW
			7/29/03	✓	✓	UCM, DNR-DMLW
			6/21/04	✓	✓	UCM, DNR-DMLW
	Bottom Marguerite Creek	BM	8/20/02	✓	✓	UCM, DNR-DMLW
			7/29/03	✓	✓	UCM, DNR-DMLW
			6/21/04	✓	✓	UCM, DNR-DMLW
			3/28/05	✓	✓	UCM, DNR-DMLW
			5/20/05	✓	✓	UCM, DNR-DMLW
			8/16/06	✓	✓	UCM, DNR-DMLW
			3/27/07	✓	✓	UCM, DNR-DMLW
			8/24/07	✓	✓	UCM, DNR-DMLW
			8/28/08	✓	✓	UCM, DNR-DMLW
			11/25/08	✓	✓	UCM, DNR-DMLW
			3/21/09	✓	✓	UCM, DNR-DMLW
			6/30/09	✓	✓	UCM, DNR-DMLW
			10/5/09	✓	✓	UCM, DNR-DMLW
			6/8/10	✓	✓	UCM, DNR-DMLW
	Lower Bonanza Creek	LB	8/20/02	✓	✓	UCM, DNR-DMLW
			7/29/03	✓	✓	UCM, DNR-DMLW
			6/21/04	✓	✓	UCM, DNR-DMLW
			3/28/05	✓	✓	UCM, DNR-DMLW
			5/20/05	✓	✓	UCM, DNR-DMLW
			8/16/06	✓	✓	UCM, DNR-DMLW
			3/27/07	✓	✓	UCM, DNR-DMLW
			5/16/07	✓	✓	UCM, DNR-DMLW
			8/24/07	✓	✓	UCM, DNR-DMLW
			8/28/08	✓	✓	UCM, DNR-DMLW
			11/25/08	✓	✓	UCM, DNR-DMLW
			6/30/09	✓	✓	UCM, DNR-DMLW
			10/5/09	✓	✓	UCM, DNR-DMLW
			3/31/10	✓	✓	UCM, DNR-DMLW
			6/8/10	✓	✓	UCM, DNR-DMLW
	Jumbo Creek	J	8/20/02	✓	✓	UCM, DNR-DMLW
			7/29/03	✓	✓	UCM, DNR-DMLW

TABLE CV-7
SUMMARY OF SURFACE WATER QUALITY MONITORING[1]
(Page 3 of 3)

Type	Drainage Basin	Site Designation[2]	Date Sampled	Field Parameters	Laboratory Parameters	Data Sources
Creeks	Middle Marguerite Creek	MM	8/20/02	✓	✓	UCM, DNR-DMLW
			7/29/03	✓	✓	UCM, DNR-DMLW
			6/21/04	✓	✓	UCM, DNR-DMLW
			8/26/04	✓	✓	UCM, DNR-DMLW
			9/1/04	✓	✓	UCM, DNR-DMLW
			9/8/04	✓	✓	UCM, DNR-DMLW
			3/28/05	✓	✓	UCM, DNR-DMLW
			8/23/05	✓	✓	UCM, DNR-DMLW
			8/16/06	✓	✓	UCM, DNR-DMLW
			3/27/07	✓	✓	UCM, DNR-DMLW
			5/16/07	✓	✓	UCM, DNR-DMLW
			8/24/07	✓	✓	UCM, DNR-DMLW
			5/21/08	✓	✓	UCM, DNR-DMLW
			8/28/08	✓	✓	UCM, DNR-DMLW
			11/25/08	✓	✓	UCM, DNR-DMLW
			3/21/09	✓	✓	UCM, DNR-DMLW
			6/30/09	✓	✓	UCM, DNR-DMLW
			10/5/09	✓	✓	UCM, DNR-DMLW
			3/31/10	✓	✓	UCM, DNR-DMLW
			6/8/10	✓	✓	UCM, DNR-DMLW
Seeps	Marguerite	JDS09-001	8/20/09	✓		UCM
		JDS09-002	8/20/09	✓		UCM
		JDS09-003	8/20/09	✓		UCM
		JDS09-004	8/20/09	✓		UCM
		JDS09-005	8/20/09	✓		UCM
		JDS09-006	8/20/09	✓		UCM
		JDS09-007	8/20/09	✓		UCM
		JDS09-008	8/20/09	✓		UCM
		JDS09-009	8/20/09	✓		UCM

TABLE CV-8 SUMMARY OF BASELINE SURFACE WATER QUALITY DATA

Parameter	Lower Emma Creek					Lower Marguerite Creek					Bottom-Marguerite Creek					Middle Marguerite Creek					Bonanza				
FIELD PARAMETERS	Range of Results-Period of Record Low	High	Mean	Median	Standard Deviation	Range of Results-Period of Record Low	High	Mean	Median	Standard Deviation	Range of Results-Period of Record Low	High	Mean	Median	Standard Deviation	Range of Results-Period of Record Low	High	Mean	Median	Standard Deviation	Range of Results-Period of Record Low	High	Mean	Median	Standard Deviation
Conductivity (µmhos/cm) range value	108	242				58	246				194	331				88	220				328	1090			
Dissolved Oxygen (mg/l) range value	9.4	13.9				9	14.6				6.6	11.9				8	14.3				8	12.8			
pH (s.u.) range value	6.64	8.89				6.55	9.02				7.04	8.91				6.98	8.61				6.79	8.75			
Temperature (°C) range value	0.23	10.1				0.2	10.2				0.23	15.2				0.23	17.3				0.2	15.5			
GENERAL AND PHYSICAL LABORATORY PARAMETERS																									
Hardness (mg/L) range value	55.9	117	80.40	77.35	17.15	36.9	84.8	56.77	54.40	15.77	71.9	127	95.79	94.35	16.1	40.9	78.8	100.7	58.75	141.88	95	308	208.67	196	103.81
pH (units) range value	7.14	7.98	7.549	7.58	0.28	6.69	7.66	7.29	7.29	0.31	6.63	8.08	7.6	7.78	0.44	6.73	7.88	7.57	7.56	0.29	7.18	8.13	7.97	7.88	0.62
Color (PCU) range value	<5	120	22	15	25.26	10	140	43.33	32.5	36.58	10	45	27.67	25	20.52	5	140	33.91	30	27.43	10	200	60	27.50	62.85
Turbidity (NTU) range value	2.53	40	8.56	5.8	8.47	2	232	27.54	5.2	62.24	1.4	18.9	16.76	4.5	36.16	0.4	301	21.32	4.38	63.22	1.3	161	33.98	6.43	55.73
TSS (mg/L) range value	<5	154	28.62	19	38.84	<5	298	78.89	11	122.88	<5	36	48.17	15.5	79.67	<5	623	230.50	146.50	270.03	<5	390	148.67	56.50	184.66
SS (mg/L) range value	<.1	0.3	0.17	0.1	0.12	<0.1	0.5	0.33	0.4	0.21	<0.1	0.1	0.1	0.1	n/a	<0.1	0.8	0.4	0.2	0.35	<0.1	0.3	0.25	0.25	0.07
TDS (mg/L) range value	55	158	115.61	112	32.41	17	158	99.36	105.5	36.01	144	191	175.64	186	19.57	80	141	178.09	112	237.44	207	518	433.83	419.50	203.23
MAJOR CATIONS																									
Calcium (ug/L) range value	11600	25300	17004.35	16300	3745.36	7860	20900	13347.78	12650	4211.02	14600	29500	20080	19700	4082.23	8790	18200	22142.17	13800	30511.15	18200	69300	39518.75	36100	19071.45
Magnesium (ug/L) range value	6540	13000	9279.57	8950	1822.14	4200	7940	5691.11	5535	1274.15	8610	13800	11354	11400	1617.22	4470	8080	10668.26	6140	15228.64	12000	37000	28562.5	26600	14350.84
Potassium (ug/L) range value	562	793	654.13	627.5	80.26	771	919	853.25	861.5	61.56	<2000	2050	1331.29	1150	383.66	679	10000	3159.75	940	4201.55	<2000	12100	3642.73	2400	3134.57
Sodium (ug/L) range value	2000	4360	3180.87	3180	615.75	3930	12700	8340.56	8450	2819.28	8700	26200	18873.33	19200	5187.27	4600	100000	17044.78	9730	26230.76	24800	127000	62468.75	53800	32644.63
MAJOR ANIONS																									
Chloride (mg/L) range value	<.2	0.6	0.37	0.32	0.1	4.3	9.8	6.75	7.05	2.42	5.7	34.7	23.87	29.2	10.25	2.9	13.8	14.67	9.2	21.79	17.5	164	93.83	85.2	58.01
Fluoride (mg/L) range value	<.2	<.4	n/a	n/a	n/a	<0.2		n/a	n/a	n/a	<0.2		n/a	n/a	n/a	<0.2		n/a	n/a	n/a	<0.2		n/a	n/a	n/a
Sulfate (mg/L) range value	7.9	19.5	15.46	15.7	3.07	5.7	21.3	13.94	13.85	4.94	19.7	28	22.14	21.3	3.03	5.8	19.8	22.97	12	36.02	16.3	112	65.28	46.65	61.77
NUTRIENTS																									
Ammonia (mg/L) range value	<0.05	<1	n/a	n/a	n/a	<0.05	0.06	0.06	0.06	n/a	<0.05	0.07	0.07	0.07	n/a	<0.05		n/a	n/a	n/a	<0.05	<1	n/a	n/a	n/a
Nitrate (mg/L) range value	<.1	0.4	0.40	0.40	n/a	<0.01	0.1	0.08	0.1	0.03	<0.1	0.4	0.23	0.2	0.15	<0.1	0.4	0.29	0.2	0.2	<0.1	0.4	0.26	0.25	0.11
Nitrate + Nitrite (mg/L) range value	<0.05	0.08	0.07	0.07	0.01	<0.05	0.05	0.05	0.05	8.49837E-18	<0.05	<0.11	0.09	0.09	0.02	<0.05	0.22	0.29	0.172	0.25	<0.05	0.5	0.21	0.18	0.13
Phosphate (mg/L) range value	<0.01	0.04	0.02	0.01	0.02	<0.01	0.04	0.02	0.014	0.01	<0.01	0.03	0.02	0.02	0.01	<0.01	0.02	0.02	0.019	0.01	<0.01	0.04	0.02	0.02	0.01
TRACE ELEMENTS/TOTAL METALS																									
Aluminum (ug/L) range value	24.7	2750	323.20	75.80	579.35	8.6	3920	637.31	56.80	1340.8	10.2	1530	197.67	38.1	448.29	8.7	7730	474.32	21.2	1612.82	11	1960	374.53	31.85	686.84
Antimony (ug/L) range value	<0.05	0.17	0.08	0.07	0.03	<0.05	0.23	0.11	0.08	0.06	<0.05	0.25	0.12	0.11	0.06	<0.05	0.47	0.13	0.07	0.14	0.09	0.34	0.21	0.19	0.08
Arsenic (ug/L) range value	<0.5	1.5	0.74	0.60	0.43	<0.5	2.2	1.26	0.8	0.86	<0.5	1.6	0.83	0.7	0.36	<0.5	3.5	1.30	1	1.02	<0.5	2.3	1.35	1.15	0.6
Arsenic (diss) (ug/L) range value	<0.5		n/a	n/a	n/a	<0.5	0.6	0.6	n/a	n/a	<0.5	0.7	0.65	0.65	0.07	<0.5	1	0.90	1	0.17	<0.5	1.6	0.93	0.65	0.55
Barium (ug/L) range value	15.6	67.3	23.37	20.80	10.51	34.4	137	62.13	47.15	29.9	51.1	96.1	65.68	62.4	12.28	26.6	226	55.43	35.5	56.83	83.9	392	166.41	140.5	95.27
Beryllium (ug/L) range value	<0.02	0.16	0.05	0.04	0.04	<0.02	0.2	0.08	0.03	0.08	<0.02	0.09	0.05	0.04	0.03	<0.02	0.39	0.11	0.04	0.16	<0.02	0.14	0.06	0.04	0.04
Boron (ug/L) range value	<50		n/a	n/a	n/a	<50	50	50	50	n/a	<50	52.4	52.4	52.4	n/a	<50	63	62.50	62.5	0.71	<50	61	61	61	n/a
Cadmium (ug/L) range value	<0.02	0.14	0.04	0.03	0.03	<0.02	0.12	0.05	0.03	0.04	<0.02	0.06	0.03	0.03	0.02	<0.02	0.15	0.06	0.03	0.06	<0.02	0.11	0.06	0.05	0.03
Cadmium (diss) (ug/L) range value	<0.02	0.4	0.032	0.03	0.01	<0.02	0.04	0.03	0.03	0.01	<0.02	0.03	0.03	0.03	0.00	<0.02	0.14	0.05	0.03	0.05	<0.02	0.12	0.07	0.05	0.04
Chromium (ug/L) range value	<0.2	5.9	1.06	0.75	1.25	<0.2	6	1.14	0.4	1.81	<0.2	1.6	0.65	0.4	0.43	<0.2	11.1	1.18	0.30	2.61	<0.2	2.3	0.90	0.90	0.64
Colbalt (ug/L) range value	0.3	3.65	0.69	0.56	0.68	0.46	4.94	1.15	0.65	1.38	0.09	2.02	0.62	0.51	0.44	0.08	8.16	1.08	0.72	1.61	0.47	5.44	1.82	1.15	1.50
Copper (ug/L) range value	0.4	8.1	1.42	0.90	1.61	0.4	12.6	2.72	1.55	3.59	0.7	5.9	1.84	1.2	1.42	0.8	21.4	2.73	1.20	4.35	0.9	10.3	3.18	2.45	2.83
Copper (diss) (ug/L) range value	0.2	2	0.7	0.6	0.41	0.5	2.8	1.28	1.10	0.63	0.7	2.1	1.2	1.1	0.46	0.7	3.3	1.52	1.10	1.08	0.8	3.6	1.86	1.75	0.89
Iron (ug/L) range value	454	6360	1271.59	943	1225.74	488	10600	1982.83	829.50	3080.05	60	5140	1017.8	681	1245.21	30.1	19400	1745.27	656	3989.62	196	9320	1992.13	792.50	2790.75
Iron (diss) (ug/L) range value	<20	404	237.57	207.9	202	84.92	731	452.76	351	172.95	32	452	222.96	236	123.57	<20	1050	378.80	342	246.06	124	667	237.57	181.5	150.73
Lead (ug/L) range value	0.03	2.34	0.30	0.13	0.49	<0.02	7.94	1.28	0.18	2.66	0.03	3.77	0.53	0.12	0.98	<0.02	15.3	1	0.06	3.27	0.04	6.61	1.25	0.14	2.16
Lead (diss) (ug/L) range value	<0.02	0.05	0.04	0.04	0.01	<0.02	3.4	0.1	0.04	0.1	<0.02	0.21	0.08	0.07	0.06	<0.02	0.44	0.11	0.05	0.13	<0.02	0.38	0.13	0.09	0.11
Manganese (ug/L) range value	234	618	320.15	310	115.92	100	366	162.39	130.5	79.09	13.3	174	122.07	120	38.76	2.38	444	164.92	138	85.86	63.4	654	226.38	134	192.57
Manganese (diss) (ug/L) range value	190	425	266.91	269.5	89.48	82	198	136.69	127	34.20	14.4	164	107.38	111	40.96	1.7	192	148.46	136	63.23	58	577	209.05	130.5	198.57
Mercury (ug/L) range value	<0.2		n/a	n/a	n/a	<0.2		n/a	n/a	n/a	<0.2		n/a	n/a	n/a	<0.2		n/a	n/a	n/a	<0.2		n/a	n/a	n/a
Molybdenum (ug/L) range value	0.27	0.41	0.34	0.34	0.05	<0.05	0.12	0.1	0.1	0.01	0.09	0.2	0.14	0.14	0.03	0.06	1.04	0.22	0.14	0.25	0.07	0.29	0.14	0.13	0.05
Nickel (ug/L) range value	1.8	17.6	4.00	3.20	3.68	1.9	11.8	3.98	3.25	2.83	0.86	6.4	3.48	3.1	1.67	2.2	17.9	4.45	3.40	3.54	2.8	37.7	9.23	4.95	10.49
Nickel (diss) (ug/L) range value	0.7	4.6	2.56	2.30	0.91	1.8	4.7	3.01	2.5	0.87	0.96	4.5	2.9	2.6	0.99	2.1	9.1	3.88	3.00	2.05	2.7	36.7	8.89	4.60	11.35
Selenium (ug/L) range value	<1		n/a	n/a	n/a	<1		n/a	n/a	n/a	<1	1.4	1.4	1.4	n/a	<1	<2	n/a	n/a	n/a	<1	8.1	2.67	1.60	2.35
Silicon (ug/L) range value	7360	12100	9603.89	9300	1151.20	5580	11600	8486.25	7930	1788.14	5490	10500	7780.83	7045.00	1716.53	5640	12600	8456.11	8260	1763.21	3460	34400	7206.67	4260	8713.28
Silver (ug/L) range value	<0.02	0.08	0.04	0.03	0.03	<0.02	0.06	0.06	0.06	0	<0.02	0.03	0.03	0.03	n/a	<0.02	0.1	0.065	0.065	0.05	<0.02	0.14	0.05	0.04	0.04
Thallium (ug/L) range value	<0.02	0.04	0.04	0.04	n/a	<0.02	0.06	0.06	0.06	0	<0.02	0.02	0.02	0.02	n/a	<0.02	0.1	0.065	0.065	0.05	<0.02	0.05	0.05	0.05	0.01
Vanadium (ug/L) range value	<0.2	6.8	1.13	0.60	1.64	<0.2	8.5	2.28	1.05	2.87	<0.2	2.5	0.7	0.45	0.68	<0.2	15.2	3.01	2.20	3.38	<0.2	2.7	0.71	0.25	0.89
Zinc (ug/L) range value	0.8	19.7	4.51	3.80	3.98	1.3	31.4	7.31	3.90	8.76	1.6	12.4	4.11	3.80	2.75	2.2	51.5	8.13	4	10.79	1.1	19.8	8.53	7.45	5.73
Zinc (diss) (ug/L) range value	1.1	7	2.48	2.25	1.22	2	12.2	5.09	3.85	2.59	1.2	10.2	3.72	3.20	2.31	1.1	18.5	5.31	3.7	4.72	1	16.9	5.26	4.35	4.22

3.5.1 Field and General Chemistry Parameters

Field data show that Marguerite Creek water at the site can be characterized as neutral to mildly alkaline, with pH values ranging from 6.63 to 8.08. The pH range for seeps at the site varies from 5.69 to 7.19. Surface water temperatures in the creeks range from 0 to 17.3°C and are slightly lower in the seeps (0.8 to 5.99°C). Dissolved oxygen measurements range from 6.6 to 14.6 mg/L in the creeks and from 9.4 to 13.26 mg/L in the seeps. No variations in field parameters between creeks are evident from the available data. The concentration range for total dissolved solids (TDS) indicates that surface water at the site varies from fresh to slightly brackish. TDS concentrations in surface water samples from the creeks vary from 17 to 518 mg/L. TDS values from Bonanza Creek are significantly higher than the other creeks and also increase in Marguerite Creek in a downstream direction.

3.5.2 Nutrients

Nitrate and phosphate are the only nutrients that have been detected in surface water samples from the site. Nitrate concentrations from site creeks vary from <0.1 to 0.4 mg/L and total phosphate concentrations vary from <0.01 to 0.04 mg/L.

3.5.3 Metals, Nonmetals and Metalloids

In general, most dissolved trace metals, nonmetals and metalloids included in the baseline sampling suite were either not detected or near the detection limit in surface water samples from the site creeks. Total recoverable and, in some cases, dissolved metals detected at most creek stations and their respective concentrations are provided in Table CV-8. Seven metals had at least one sample that had concentrations higher than the Alaska Water Quality Based Effluent Limits. Those metals are Aluminum, Cadmium, Copper, Iron, Lead, Manganese, and Zinc.

No variations in metal concentrations between drainages are evident. However, in correlation with the downstream TDS increases previously discussed in Section 3.5.1, several metallic analyte concentrations decrease from the upstream to the downstream stations in Marguerite Creek. It is also notable that some metals concentrations are higher when Marguerite Creek flow is predominately base flow from groundwater or seeps

and some metals, primarily aluminum, concentrations are higher when Marguerite Creek has significant surface water flows from storm events.

3.5.4 Suspended Sediments

Suspended sediment concentrations at the creek sampling stations are also included as part of the surface water quality summary. Suspended sediment in the water column of a surface water body is directly related to the energy in the system and the geologic materials in the bedload and channel walls. A summary of historic suspended sediment concentrations for each drainage is included in Table CV-9, Historic Suspended Sediment Concentration Data.

TABLE CV-9

HISTORIC SUSPENDED SEDIMENT CONCENTRATION DATA

Creek	Monitoring Station[1]	Period of Record	Number of Samples	Sample Types[2]	Suspended Sediment Concentration (in mg/l)	
					Minimum	Maximum
Lower Emma	LE	2002-2009	18	Fg, Ug	<0.1	0.3
Lower Marguerite	LM	2002-2009	15	Fg, Ug	<0.1	0.5
Bottom Marguerite	BM	2002-2009	13	Fg, Ug	<0.1	0.1
Middle Marguerite	MM	2002-2009	18	Fg, Ug	<0.1	0.8
Bonanza	B	2002-2009	13	Fg, Ug	<0.1	0.3

Notes:

1. Location of monitoring stations shown in Plate CV-1, Location of Surface Water Bodies.
2. Fg = filtered grab sample; Ug = unfiltered grab sample.

Surface water in the Bottom of Marguerite Creek appears to have the smallest sediment concentrations, likely resulting from lower stream gradients and significantly higher flow volumes versus its steeper tributary drainages. Of the remaining creeks, Lower Emma Creek has the lowest concentration range, followed by Lower Marguerite and Bonanza Creeks.

PLATE CV-1

LOCATION OF SURFACE WATER BODIES

COAL REMOVAL LIMITS
UA EMMA 1
Sec.31
Sec.32
Sec.33
Sec.34
Sec.35
Sec.6
Sec.5
Sec.4
Sec.3
Sec.2
Sec.7
Sec.8
Sec.9
Sec.10
EMMA CREEK
MARGUERITE CREEK
JUNIPER CREEK
OBSERVED SEEP
FLOW MEASUREMENT N/A
SPRING AND SEEP STATION
JDS09-001
SPRING AND SEEP STATION
JDS09-002
SPRING AND SEEP STATION
JDS09-003
SPRING AND SEEP STATION
JDS09-004
SPRING AND SEEP STATION
JDS09-005
SPRING AND SEEP STATION
JDS09-006
SPRING AND SEEP STATION
JDS09-007
SPRING AND SEEP STATION
JDS09-008
SPRING AND SEEP STATION
JDS09-009
SEEP/SURFACE RUNOFF
DUE TO PERMAFROST
JUMBO DOME BLOCK-A (ADL 673536)
JUMBO DOME BLOCK-B (ADL 673537)
T105 F.M.
T115

LEGEND

- ORIGINAL TOPOGRAPHY
- COAL REMOVAL LIMITS
- NATURAL DRAINAGE
- TRAIL
- LEASE BOUNDARY
- PERMIT BOUNDARY
- SEEPAGE ZONE
- LAKE/POND
- SPRING & SEEP STATION

NOTES:

1. HORIZONTAL DATUM IS BASED ON ALASKA STATE PLANE COORDINATES, ZONE-4, NAD 27, AS EXPRESSED IN U.S. SURVEY FEET.
2. VERTICAL DATUM IS BASED ON MEAN SEA LEVEL.

SCALE: 1"=800'
800' 0 800' 1600'
CONTOUR INTERVAL: 25'&10'

SUBJECT REVISIONS

REV.	DATE:	BY:	DESCRIPTION
0	12/09	RLM	ORIGINAL SUBMITTAL
1	2/11	RLM	REVISION 1

DESIGN BY: A. HARDY
DRAWN BY: R. MARTIN
CHECK BY: T. SCHOLTEN
DWG FILE: JD PERMIT.DWG
XREF DWG FILE: N/A

USIBELLI COAL MINE INC.

LOCATION OF SURFACE WATER BODIES

JUMBO DOME MINE

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743

PLATE No. CV-1
SHEET No. 1 OF 1
REV. 1

4.0 REFERENCES

USGS, 2009. http://waterdata.usgs.gov/ak/nwis/uv?cb_00060=on&cb_00065=on&cb_00010=on&format=gif_default&period=7&site_no=15515060

Wahrhaftig, 1970. Geologic Map of the Healy D-4 Quadrangle: U.S. Geological Survey, 1970.

Wilbur, Stephen C., 1995, Fluvial and Hillside Geomorphology of Hoseanna Creek Watershed, Central Alaska: Masters Thesis, University of Alaska, Fairbanks, December, 1995.

5.0 RESPONSIBLE PARTY

This section was prepared by Usibelli Coal Mine, Inc.

CHAPTER VI

SURFACE AND GROUNDWATER RIGHTS AND USE

TABLE OF CONTENTS

Page

1.0 INTRODUCTION CVI-1

2.0 SURFACE WATER CVI-1

2.1 Surface Water Resources CVI-1

2.2 Water Rights CVI-1

2.3 Existing Water Supply Intakes CVI-2

3.0 GROUNDWATER CVI-2

3.1 Groundwater Resources CVI-2

3.2 Groundwater Rights CVI-2

4.0 RESPONSIBLE PARTIES CVI-2

LIST OF FIGURES

CVI-1 Water Rights Search Area CVI-3

LIST OF APPENDICES

CVI-1 Water Rights……..…….…….CVI-4

1.0 INTRODUCTION

This chapter presents information on surface and groundwater rights and uses within and adjacent to the proposed permit area of the Jumbo Dome coal project. The information is based on a search of permitted water rights that are maintained through the Department of Natural Resources' Land Administration System. For this evaluation, the search area encompassed approximately 15 square miles and is depicted on Figure CVI-1.

2.0 SURFACE WATER

2.1 SURFACE WATER RESOURCES

The proposed Jumbo Dome mine is located within the drainage of Marguerite Creek. Marguerite Creek flows from east to west and then south to north where it flows into California Creek. California Creek flows into the Totatlanika River which flows into the Tanana River. Marguerite Creek flows year-around and exhibits peak flows from early May to mid-May and during late July to early August. The flowing water is slightly basic in chemical character and typically has low to moderate levels of suspended solids. There are no major lakes or ponds within the water rights search area.

2.2 WATER RIGHTS

Only two surface water right applications, besides those that Usibelli Coal Mine, Inc has applied for exploratory drilling, were identified in the search area. One water right was for Section 21, Township 9 South, Range 6 West of the search area. This water right application (LAS 25921) was filed by David W. Jacobs for placer mining operations on California Creek (See Appendix CVI-1). One water right for Sections 7, 8, 13, 14, 18, 23, and 24 of Township 10 South, Range 6 West of the search area was found. This water right application (LAS 25506) was filed by David W. Jacobs for placer mining operations on Eva Creek (See Appendix CVI-1).

2.3 EXISITING WATER SUPPLY INTAKES

No known water supply intakes are located in the water rights search area.

3.0 GROUNDWATER

3.1 GROUNDWATER RESOURCES

Groundwater resources in and near the proposed permit area are limited. Throughout the Marguerite Creek basin the primary water-bearing tend to be the coal seams. The overlying glacial deposits are fairly discontinuous with only moderate to low quantities of water and do not represent an important aquifer.

3.2 GROUNDWATER RIGHTS

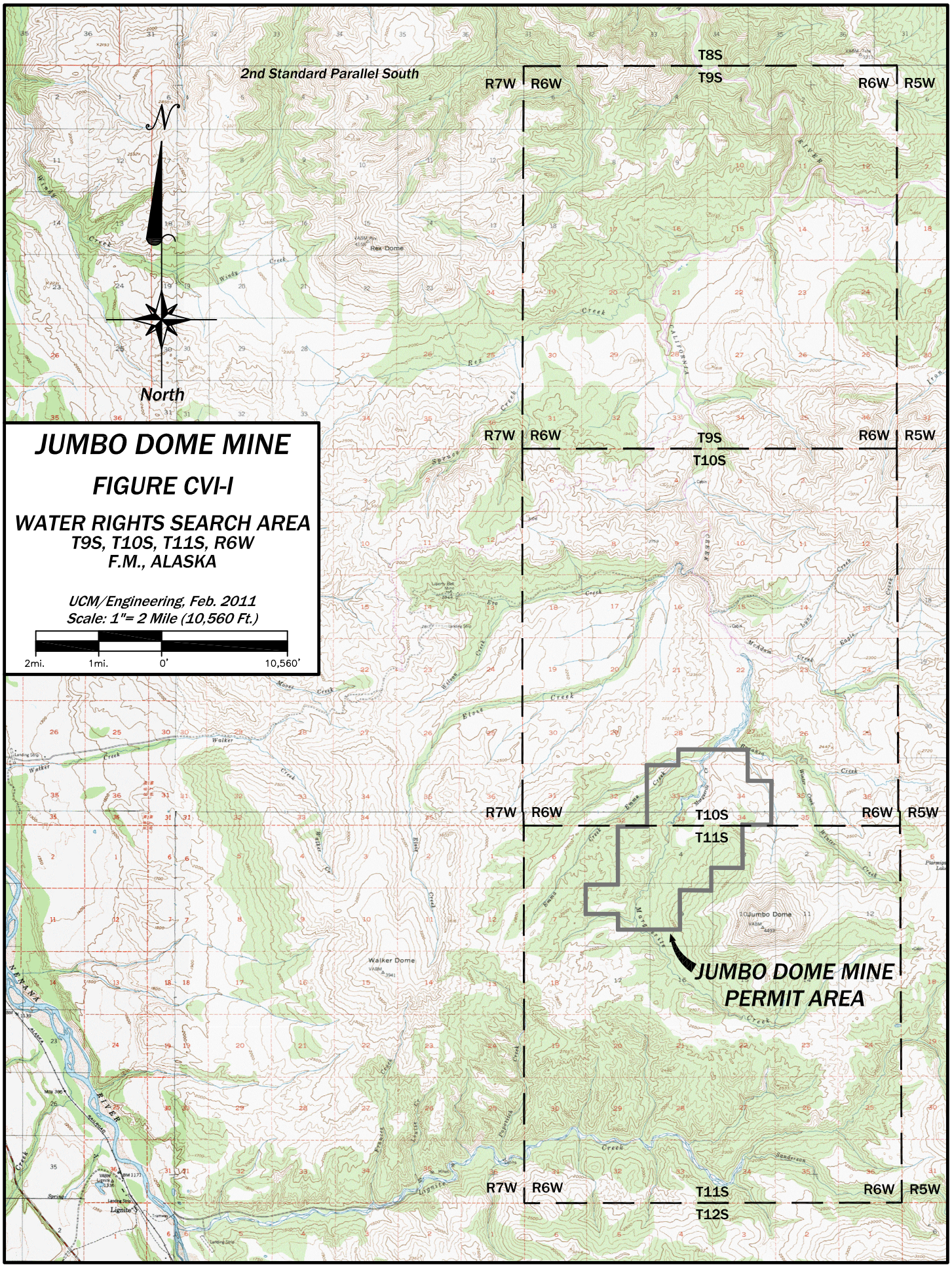
There were no groundwater right permit applications within the search area.

4.0 RESPONISBLE PARTIES

This chapter was prepared by Usibelli Coal Mine, Inc.

FIGURE CVI-1

WATER RIGHTS SEARCH AREA



JUMBO DOME MINE

FIGURE CVI-I

WATER RIGHTS SEARCH AREA
T9S, T10S, T11S, R6W
F.M., ALASKA

UCM/Engineering, Feb. 2011
Scale: 1"= 2 Mile (10,560 Ft.)

APPENDIX CVI-1

WATER RIGHT ABSTRACTS

Case Detail

File Type: **LAS** File Number: **25506**

See Township, Range, Section and Acreage? **Yes**

11/30/2010

Customer: 000029594 JACOBS, DAVID W
HC 1 BOX 3090
HEALY AK 99743

Case Type: 801 WATER RIGHTS DNR Unit: 800 WATER

File Location: WFBX WATER MGT-FAIRBANKS

Case Status: 09 APPLICATION RECEIVED Status Date: 06/30/1999

Total Acres: 0.000 Date Initiated: 06/30/1999

Office of Primary Responsibility: WFBX WATER MGT-FAIRBANKS

Last Transaction Date: 02/23/2009 Case Subtype: SUR SURFACE

Last Transaction: CHGSTCD CASE STATUS CODE CHANGED

Meridian: F	**Township:** 010S	**Range:** 006W	**Section:** 07	**Section Acres:** 0
Meridian: F	**Township:** 010S	**Range:** 006W	**Section:** 08	**Section Acres:** 0
Meridian: F	**Township:** 010S	**Range:** 006W	**Section:** 18	**Section Acres:** 0
Meridian: F	**Township:** 010S	**Range:** 007W	**Section:** 13	**Section Acres:** 0
Meridian: F	**Township:** 010S	**Range:** 007W	**Section:** 14	**Section Acres:** 0
Meridian: F	**Township:** 010S	**Range:** 007W	**Section:** 23	**Section Acres:** 0
Meridian: F	**Township:** 010S	**Range:** 007W	**Section:** 24	**Section Acres:** 0

Case Actions

Transaction: INITIATE INITIATE CASE

Transaction Date: 06-30-1999	Time: 83829	SubSystem ID: CAS
Input Date: 12-14-2005	User: NWRCLCA	Terminal: X2GE
STATUS DATE	06-30-1999	
LOCATION FROM	WFBX	WATER MGT-FAIRBANKS
LOCATION TO	WFBX	WATER MGT-FAIRBANKS
CASE STATUS	11	APLN/INITIAL STATUS
OFFICE PRI RESP	WFBX	WATER MGT-FAIRBANKS
SPECIAL CODE	SUR	SURFACE
CUSTOMER NUMBER	000029594	JACOBS,DAVID W
UNIT CODE	800	WATER
RELATIONSHIP CODE	10	OWNER

F 010S 006W 07
F 010S 006W 08
F 010S 006W 18
F 010S 007W 14
F 010S 007W 13
F 010S 007W 23
F 010S 007W 24

Transaction: APR APPLICATION RECEIVED

Transaction Date: 06-30-1999	Time: 84031	SubSystem ID: CAS
Input Date: 12-14-2005	User: NWRCLCA	Terminal: X2GE
STATUS 11	11	APLN/INITIAL STATUS

APMA F999607 RECEIVED FOR PLACER OPERATION ON EVA CREEK.

Transaction: CHGSTCD CASE STATUS CODE CHANGED

Transaction Date: 02-23-2009	Time: 183401	SubSystem ID: CAS
Input Date: 02-23-2009	User: BATCH	Terminal: X127

STATUS CODE: 09 APPLICATION RECEIVED

FIXED STATUS CODE THAT WAS CHANGED DURING STATUS CODE STANDARDIZED

Legal Description

No Legal Description Found

End of Case Detail

Case Summary

File Type: **LAS** File Number: **25506**

See Township, Range, Section and Acreage? **Yes**

11/30/2010

Customer: 000029594 JACOBS, DAVID W
HC 1 BOX 3090
HEALY AK 99743

Case Type: 801 WATER RIGHTS

DNR Unit: 800 WATER

File Location: WFBX WATER MGT-FAIRBANKS

Case Status: 09 APPLICATION RECEIVED

Status Date: 06/30/1999

Total Acres: 0.000

Date Initiated: 06/30/1999

Office of Primary Responsibility: WFBX WATER MGT-FAIRBANKS

Last Transaction Date: 02/23/2009

Case Subtype: SUR SURFACE

Last Transaction: CHGSTCD CASE STATUS CODE CHANGED

Meridian: F	**Township:** 010S	**Range:** 006W	**Section:** 07	**Section Acres:** 0
Meridian: F	**Township:** 010S	**Range:** 006W	**Section:** 08	**Section Acres:** 0
Meridian: F	**Township:** 010S	**Range:** 006W	**Section:** 18	**Section Acres:** 0
Meridian: F	**Township:** 010S	**Range:** 007W	**Section:** 13	**Section Acres:** 0
Meridian: F	**Township:** 010S	**Range:** 007W	**Section:** 14	**Section Acres:** 0
Meridian: F	**Township:** 010S	**Range:** 007W	**Section:** 23	**Section Acres:** 0
Meridian: F	**Township:** 010S	**Range:** 007W	**Section:** 24	**Section Acres:** 0

Legal Description

No Legal Description Found

End of Case Summary

Case Abstract

File Type: **LAS** File Number: **25506**

See Township, Range, Section and Acreage? **Yes**

11/30/2010

Customer: 000029594 JACOBS, DAVID W
HC 1 BOX 3090
HEALY AK 99743

Case Type: 801 WATER RIGHTS DNR Unit: 800 WATER

File Location: WFBX WATER MGT-FAIRBANKS

Case Status: 09 APPLICATION RECEIVED Status Date: 06/30/1999

Total Acres: 0.000 Date Initiated: 06/30/1999

Office of Primary Responsibility: WFBX WATER MGT-FAIRBANKS

Last Transaction Date: 02/23/2009 Case Subtype: SUR SURFACE

Last Transaction: CHGSTCD CASE STATUS CODE CHANGED

Meridian: F	**Township:** 010S	**Range:** 006W	**Section:** 07	**Section Acres:** 0
Meridian: F	**Township:** 010S	**Range:** 006W	**Section:** 08	**Section Acres:** 0
Meridian: F	**Township:** 010S	**Range:** 006W	**Section:** 18	**Section Acres:** 0
Meridian: F	**Township:** 010S	**Range:** 007W	**Section:** 13	**Section Acres:** 0
Meridian: F	**Township:** 010S	**Range:** 007W	**Section:** 14	**Section Acres:** 0
Meridian: F	**Township:** 010S	**Range:** 007W	**Section:** 23	**Section Acres:** 0
Meridian: F	**Township:** 010S	**Range:** 007W	**Section:** 24	**Section Acres:** 0

Case Actions

06-30-1999 APPLICATION RECEIVED
STATUS 11 11 APLN/INITIAL STATUS
APMA F999607 RECEIVED FOR PLACER OPERATION ON EVA CREEK.

02-23-2009 CASE STATUS CODE CHANGED
STATUS CODE: 09 APPLICATION RECEIVED
FIXED STATUS CODE THAT WAS CHANGED DURING STATUS CODE STANDARDIZED

Legal Description

No Legal Description Found

End of Case Abstract

Alaska DNR Land Abstract

Meridian: F **Township:** 010S **Range:** 006W **Section:** 07 **Acres:** 607.530 Search Plats
Search for Status Plat Updates

Case Type: or **Case Category:** 8 See Customer **Name and Address?** Yes No

New Search

LAS Menu

DNR Area	**NO**	NORTHERN REGION
Recording Dist.	**R414**	NENANA
Senate Dist.	**Q**	DISTRICT Q
House Dist.	**34Q**	DISTRICT 34
Regional Corp.	**95**	DOYON LTD.
State Info. Dist.	**BDE**	DENALI BOROUGH
Public Land Order		NONE
Area Plan Data		NONE
Coastal Zone		NO
USGS Map	**058 A4**	FAIRBANKS
	067 D4	HEALY

WATER

File: LAS 25506 *Case Type:* 801 WATER RIGHTS
Initiate Date: 06/30/1999 *Special Code:* SUR SURFACE
Status Date: 06/30/1999 *Case Status:* 09 APPLICATION RECEIVE
Section Acres: 0

All cases have been displayed

Last updated on 11/30/2010.

Not sure who to contact? Have a question about DNR? Visit the Public Information Center.
Report technical problems with this page to the Webmaster.

Site optimized for Netscape 7, IE 6 or above.
This site also requires that all COOKIES must be accepted.

State of Alaska Natural Resources LAS Home Copyright Privacy System Status

Case Abstract

File Type: **LAS** File Number: **25921**

See Township, Range, Section and Acreage? **Yes**

11/30/2010

Customer: 000029594 JACOBS, DAVID W
HC 1 BOX 3090
HEALY AK 99743

Case Type: 801 WATER RIGHTS DNR Unit: 800 WATER

File Location: WFBX WATER MGT-FAIRBANKS

Case Status: 09 APPLICATION RECEIVED Status Date: 04/14/2004

Total Acres: 0.000 Date Initiated: 04/14/2004

Office of Primary Responsibility: WFBX WATER MGT-FAIRBANKS

Last Transaction Date: 02/23/2009 Case Subtype: SUR SURFACE

Last Transaction: CHGSTCD CASE STATUS CODE CHANGED

Meridian: F **Township:** 009S **Range:** 006W **Section:** 21 **Section Acres:** 0

Case Actions

04-14-2004 APPLICATION RECEIVED
STATUS 11 11 APLN/INITIAL STATUS
APMA F20049779 RECEIVED FOR A PLACER OPERATION ON CALIFORNIA CREEK.

02-23-2009 CASE STATUS CODE CHANGED
STATUS CODE: 09 APPLICATION RECEIVED
FIXED STATUS CODE THAT WAS CHANGED DURING STATUS CODE STANDARDIZED

Legal Description

No Legal Description Found

End of Case Abstract

Case Summary

File Type: **LAS** File Number: **25921**

See Township, Range, Section and Acreage? **Yes**

11/30/2010

Customer: 000029594 JACOBS, DAVID W
HC 1 BOX 3090
HEALY AK 99743

Case Type: 801 WATER RIGHTS

DNR Unit: 800 WATER

File Location: WFBX WATER MGT-FAIRBANKS

Case Status: 09 APPLICATION RECEIVED

Status Date: 04/14/2004

Total Acres: 0.000

Date Initiated: 04/14/2004

Office of Primary Responsibility: WFBX WATER MGT-FAIRBANKS

Last Transaction Date: 02/23/2009

Case Subtype: SUR SURFACE

Last Transaction: CHGSTCD CASE STATUS CODE CHANGED

Meridian: F **Township:** 009S **Range:** 006W **Section:** 21 **Section Acres:** 0

Legal Description

No Legal Description Found

End of Case Summary

Case Detail

File Type: **LAS** File Number: **25921**

See Township, Range, Section and Acreage? **Yes**

11/30/2010

Customer: 000029594 JACOBS, DAVID W
HC 1 BOX 3090
HEALY AK 99743

Case Type: 801 WATER RIGHTS DNR Unit: 800 WATER

File Location: WFBX WATER MGT-FAIRBANKS

Case Status: 09 APPLICATION RECEIVED Status Date: 04/14/2004

Total Acres: 0.000 Date Initiated: 04/14/2004

Office of Primary Responsibility: WFBX WATER MGT-FAIRBANKS

Last Transaction Date: 02/23/2009 Case Subtype: SUR SURFACE

Last Transaction: CHGSTCD CASE STATUS CODE CHANGED

Meridian: F **Township:** 009S **Range:** 006W **Section:** 21 **Section Acres:** 0

Case Actions

Transaction: INITIATE INITIATE CASE

Transaction Date: 04-14-2004	Time: 95323	SubSystem ID: CAS
Input Date: 10-30-2006	User: NWRCLCA	Terminal: X2PG
STATUS DATE	04-14-2004	
LOCATION FROM	WFBX	WATER MGT-FAIRBANKS
LOCATION TO	WFBX	WATER MGT-FAIRBANKS
CASE STATUS	11	APLN/INITIAL STATUS
OFFICE PRI RESP	WFBX	WATER MGT-FAIRBANKS
SPECIAL CODE	SUR	SURFACE
CUSTOMER NUMBER	000029594	JACOBS,DAVID W
UNIT CODE	800	WATER
RELATIONSHIP CODE	10	OWNER
F 009S 006W 21		

Transaction: APR APPLICATION RECEIVED

Transaction Date: 04-14-2004	Time: 140250	SubSystem ID: CAS
Input Date: 10-25-2006	User: NWRCLCA	Terminal: X4NM
STATUS 11	11	APLN/INITIAL STATUS

APMA F20049779 RECEIVED FOR A PLACER OPERATION ON CALIFORNIA CREEK.

Transaction: CHGSTCD CASE STATUS CODE CHANGED

Transaction Date: 02-23-2009	Time: 190301	SubSystem ID: CAS
Input Date: 02-23-2009	User: BATCH	Terminal: X127
STATUS CODE:	09	APPLICATION RECEIVED

FIXED STATUS CODE THAT WAS CHANGED DURING STATUS CODE STANDARDIZED

Legal Description

No Legal Description Found

End of Case Detail

CHAPTER VII

CLIMATOLOGICAL INFORMATION

TABLE OF CONTENTS

Page

1.0 REGIONAL AND AREA OVERVIEW CVII-1

2.0 SITE CONDITIONS CVII-2

3.0 REFERENCES CVII-11

4.0 RESPONSIBLE PARTIES CVII-11

LIST OF TABLES

CVII-1 Comparison of Precipitation Data from Different Meteorological Stations During Wet, Dry, and Average Years ……...……CVII-3

CVII-2 Summary of Monthly Precipitation Data……..CVII-5

CVII-3 Summary of Annual Precipitation Data for Healy Station……...CVII-6

CVII-4 Summary of Annual Precipitation Data for Jumbo Dome……....CVII-7

CVII-5 Summary of Monthly Temperature Data……..CVII-8

CVII-6 Summary of Annual Average Temperature Data for Healy Station…….CVII-9

CVII-7 Summary of Annual Average Temperature Data for Jumbo Dome……...CVII-10

1.0 REGIONAL AND AREA OVERVIEW

Four climatic zones occur within the State of Alaska (USDOC 1968): 1) maritime, 2) continental, 3) transition between marine and continental influences, and 4) arctic. The region covering Fairbanks and Healy is located in the continental zone. This zone follows typical interior Alaskan patterns in which short warm summers, with high intensity cyclonic storms, follow long cold winters of moderate precipitation. An extreme range of temperatures coupled with low cloudiness and low humidity further characterize the continental climate of the region.

Annual variations in insolation (sunshine) in the Fairbanks/Healy region are large and result in marked seasonal changes. The sun is above the horizon 18 to 21 hours each day during summer and only 3 to 6 hours during winter. The mean percentage of possible sunshine experienced in the Fairbanks area on an annual basis is about 43 percent. Normally March receives the highest percentage of sunshine (61%) and October the lowest percentage (28%).

The lack of insolation during the winter results in very cold temperatures. A persistent snow cover contributes to the cold temperatures by reflecting solar energy and allowing thermal radiation to escape. Based on 37 years of record, monthly average temperatures in Fairbanks range from a low of -13°F in January to a high of 62°F in July. Temperature extremes identified include a high of 96°F recorded in June 1969 and a low of -62°F recorded in December 1961 (NOAA 1988). The mean annual number of days with freezing temperatures in Fairbanks is 233.

The average precipitation is classified as semi-arid for the region. Mean snowfall amounts at Fairbanks for January, February, and March are 10.4, 11.8, and 8.2 inches, respectively. The mean annual precipitation is approximately 12 inches.

2.0 SITE CONDITIONS

The general climate within the vicinity of the proposed Jumbo Dome mine varies somewhat from that of Fairbanks. The mine project is located at the foothills of the Alaska Range amid rugged terrain. Nearby hills and mountains surround the area, resulting in a narrow valley sloping and widening to the north. Because of its proximity to the Nenana River gorge, which transects the Alaskan Range, warm moist winds (Chinooks) from coastal Alaska occasionally complicate the climate pattern. Air masses separated by the high terrain frequently produce strong pressure gradients and, consequently, high wind episodes.

There are three (3) weather stations located in the vicinity of the proposed mine site. The Healy station is located approximately 10 miles from the project area and is a certified meteorological station operated by the NOAA. The Poker Flats and Gold Run Pass stations are operated by Usibelli Coal Mine, Inc. (UCM) and are located in the vicinity of the Jumbo Dome mine permit area. The elevation of each station is as follows: Healy, 1,495 feet above mean sea level (amsl); Poker Flats, 1,770 feet amsl; and Gold Run Pass, 2,540 amsl. There is one USGS temporary weather station located at the confluence of Marguerite Creek and Emma Creek in the Jumbo Dome mine permit area, 1850 feet amsl. This weather station was installed in 2005 and has limited non-certified data on precipitation (rain only) and temperature only. The elevation of the Jumbo Dome mine area ranges from 1,800 feet to 2,100 feet amsl.

Data from the Poker Flats and Gold Run Pass stations indicate that winds predominantly originate from the southeast, with a secondary direction of predominance from the northwest. This corresponds to the general orientation of the Nenana River valley, and indicates that winds are channeled up and down the valley the greatest majority of the time. During the winter months, high south-southeasterly winds frequently occur with gusts ranging from 40 to 55 mph. There is no wind data available from the Jumbo Dome station.

Monthly precipitation records at Healy, Poker Flats and Gold Run Pass stations for rainfall months (May - September) during dry, average, and wet years are shown in Table CVII-1, Comparison of Precipitation Data From Different Meteorological Stations During Wet, Dry, and Average Years. As shown in the table, precipitation data at the Healy station compare favorably to data from the other two stations. Monthly precipitation data for the Healy station collected from 1979 through August

TABLE CVII-1, COMPARISON OF PRECIPITATION DATA FROM DIFFERENT METEOROLOGICAL STATIONS DURING WET, DRY AND AVERAGE YEARS

Year[1]	Precipitation Station[2]	Monthly Precipitation[3] (in inches)					Total Season Precipitation (in inches)	Percentage of Healy Seasonal Total
		May	June	July	August	September		
1987 (Dry)	Healy	0.70	1.75	3.86	1.22	1.19	8.72	100%
	Gold Run Pass	0.12	1.08	2.52	3.24	4.32	11.28	129%
	Poker Flats	0.23	2.17	3.74	2.10	1.16	9.40	108%
1989 (average)	Healy	0.83	4.23	1.35	4.82	1.13	12.36	100%
	Gold Run Pass	0.96	6.20	1.32	4.92	0.84	14.24	115%
	Poker Flats	0.49	3.90	1.25	3.11	1.31	10.06	81%
1990 (Wet)	Healy	0.59	3.02	2.51	4.07	3.73	13.92	100%
	Gold Run Pass	0.96	0.96	4.44	4.92	4.08	15.36	110%
	Poker Flats	0.90	0.74	3.72	4.59	3.14	13.09.	94%

Notes:

1. Dry, average, and wet years represent lowest, near average, and highest annual precipitation measured at Healy station between 1979 and 1995.
2. The Healy station is located approximately 3 miles southwest of the project area boundary at an elevation of 1,496 feet.
   . The Gold Run Pass station is located approximately 3 miles east of the project area boundary at an elevation of 2,540 feet.
   . The Poker Flats station is located adjacent to the project area boundary at an elevation of 1770 feet.
3. Sources of precipitation data include Mack (1988), Ray (1990), Ray and others (1990), UCM site records, and Healy station records.

2004 and the Jumbo Dome station collected from 2005 to 2010 are presented in Table CVII-2, Summary of Monthly Precipitation Data. Data in Table CVII-2 show that the months during which the project area is expected to receive the greatest precipitation include June, July and August and that the project area is expected to have slightly higher precipitation than the Healy Station.

Annual precipitation totals for the Healy station from 1980 to 2004 are presented in Table CVII-3, Summary of Annual Precipitation Data for Healy Station (Certified data for Healy Station ended in 2004 so there are no years of overlap for direct comparisons). The table indicates that the average annual rainfall was 16.55 inches of rain. The table indicates that wet years near the project area are characterized by approximately 17 to 22 inches equivalent rainfall, dry years are characterized by approximately 12.5 to 15 inches equivalent rainfall, and average years by approximately 15.5 to 16.5 inches of equivalent rainfall. The annual precipitation totals for the Jumbo Dome station from 2005 to 2010 are presented in Table CVII-4, Summary of Annual Precipitation for Jumbo Dome Station and show that the average precipitation at Jumbo Dome of 15.52 which is within the average precipitation range for the Healy Station. There were data gaps in August of 2008 and in April and May of 2009.

As stated previously, the climate of the project area is typical of subarctic patterns in which short, warm summers are followed by long, cold winters. Monthly temperature data collected from 1980 to 2004 for the Healy station and for 2005 to 2010 for the Jumbo Dome station are shown in Table CVII-5, Summary of Monthly Temperature Data. Monthly table for Jumbo Dome was calculated by using the averaging the daily average temperatures. The monthly minimum and maximum temperatures were calculated averaging daily maximum and minimum temperatures. Table CVII-5 indicates that average winter temperatures in the project area (November-February) vary from approximately -3.5 to 2.3 $^{\circ}$F, average spring temperatures (March-May) vary from approximately -3.3 to 43.9 $^{\circ}$F, average summer temperatures (June-August) vary from approximately 49.6 to 56.1°F, and average autumn temperatures (September-October) vary from approximately 22.6 to 40.6 $^{\circ}$F. Table CVII-5 also shows that the average air temperature at the project area is less than the freezing point of water for approximately 7 months each year. Average monthly high and low temperatures from the Healy weather station were used to calculate average annual high and low temperatures from 1980 to 2004 (see Table CVII-6, Summary of Annual Average Temperature Data for Healy Station). Table CVII-7, Summary of Annual Average Temperature Data for Jumbo Dome Station was calculated using the average monthly values for the minimum, maximum, and average

TABLE CVII-2: SUMMARY OF MONTHLY PRECIPITATION DATA

	Healy Station[1] in inches of water[2]				Jumbo Dome[3] USGS Station in inches of water			
Month	Period of Record	Minimum	Maximum	Average	Period of Record	Minimum	Maximum	Average
January	1980-2004	0.10	1.43	0.55	2005-2010	0	2.05	0.43
February	1980-2004	0.07	2.53	0.54	2005-2010	0	0.07	0.02
March	1980-2004	0.00	1.12	0.34	2005-2010	0	0.06	0.01
April	1980-2004	0.00	2.18	0.58	2005-2010	0	0.8	0.36
May	1980-2004	0.00	2.01	0.86	2005-2010	0	0.84	1.58
June	1980-2004	0.53	3.82	2.18	2005-2010	1.94	4.92	3.01
July	1980-2004	0.00	5.54	2.83	2005-2010	0.06	5.43	3.13
August	1980-2004	0.15	4.22	2.56	2005-2010	0	5.12	2.49
September	1980-2004	0.46	3.41	1.61	2005-2010	0.78	3.04	1.6
October	1980-2004	0.12	2.09	1.12	2005-2010	0.05	2.53	0.63
November	1980-2004	0.00	2.86	0.74	2005-2010	0	0.61	0.14
December	1980-2004	0.00	2.83	0.81	2005-2010	0	0.05	0.01

Notes:

1. Precipitation measurements were taken at a certified meteorological station in Healy. Healy is located approximately 10 miles from the project boundary. No data after 2004.
2. Ten (10) inches of snow were assumed to be equivalent to 1 inch of water.
3. Precipitation measurements were taken at a USGS un-certified weather station located at the north end of the project. Jumbo Dome records rain only.

TABLE CVII-3, SUMMARY OF ANNUAL PRECIPITATION DATA FOR HEALY STATION		
Year	Annual Precipitation (in inches of water)[1-2]	Percentage of Average Annual Precipitation
1980	14.86	90
1981	15.96	96
1982	16.69	101
1983	16.23	98
1984	16.66	101
1985	13.73	83
1986	14.98	91
1987	11.92	72
1988	14.41	87
1989	14.68	89
1990	22.40	135
1991	12.49	75
1992	17.14	104
1993	13.37	81
1994	14.51	88
1995	15.35	93
1996	13.67	83
1997	15.02	91
1998	15.29	92
1999	13.27	80
2000	15.12	91
2001	12.40	75
2002	19.08	115
2003	14.96	90
2004	15.15	92
Minimum	11.92	
Maximum	22.40	
Average	16.55	100

NOTES:

1. Precipitation measurements were taken at a certified meteorological station in healy. The Healy station is located approximately 3 miles from the project area boundary. No data available after 2004.
2. Ten (10) inches of snow were assumed to be equivalent to 1 inch of water.

CVII-4 SUMMARY OF ANNUAL PRECIPITATION DATA FOR JUMBO DOME		
Year	Annual Precipitation (in inches of water)	Percentage of Average Annual Precipitation
2005	13.41	107%
2006	11.1	89%
2007	13.91	111%
2008	13.29	106%
2009	13.22	106%
2010	10.21	82%

TABLE CVII-5: SUMMARY OF MONTHLY TEMPERATURE DATA								
	Healy Station[1] in Fahrenheit				Jumbo Dome[2] USGS Station in Fahrenheit			
Month	Period of Record	Minimum	Maximum	Average	Period of Record	Minimum	Maximum	Average
January	1980-2004	-9.5	30.3	3.4	2005-2010	-9.0	9.3	-0.9
February	1980-2004	-7.1	20.7	10.5	2005-2010	-11.4	19.0	-3.5
March	1980-2004	5.9	29.8	16.9	2005-2010	-12.5	24.8	-3.3
April	1980-2004	18.2	38.9	32.6	2005-2010	13.8	45.1	29.8
May	1980-2004	37.8	51.5	44.5	2005-2010	28.2	59.0	43.9
June	1980-2004	53.2	62.6	59.1	2005-2010	37.2	67.5	52.5
July	1980-2004	57.3	64.1	57.4	2005-2010	41.4	68.5	56.1
August	1980-2004	40.7	61.5	53.9	2005-2010	36.3	64.6	49.6
September	1980-2004	26.9	52.5	44.8	2005-2010	36.7	55.0	40.6
October	1980-2004	13.9	37.1	23	2005-2010	12.2	35.1	22.6
November	1980-2004	-4.8	28.8	9.3	2005-2010	-8.0	16.2	2.3
December	1980-2004	-19.7	23	4.6	2005-2010	-9.9	13.3	1.9

Notes:
1. Temperature measurements were taken at a certified meteorological station in Healy. Healy is located approximately 10 miles from the project boundary. No data after 2005.
2. Temperature measurements were taken at a USGS un-certified weather station located at the north end of the project.

TABLE CVII-6, SUMMARY OF ANNUAL TEMPERATURE DATA FOR HEALY STATION[1]

Year	Low Temperature	High Temperature	Average Temperature
1980	-19.7	40.1	28.8
1981	8.1	53.5	22.5
1982	-9.6	59.0	22.1
1983	1.5	57.6	18.4
1984	-0.8	56.0	23.9
1985	18.2	60.7	29.1
1986	4.8	59.6	29.9
1987	5.1	60.0	31.8
1988	-5.4	61.4	29.2
1989	-4.8	60.8	30.3
1990	-7.9	61.6	29.8
1991	2.6	60.1	30.8
1992	-5.4	61.0	26.9
1993	4.5	62.2	34.1
1994	0.5	62.3	28.6
1995	0.1	59.4	30.0
1996	-9.5	59.6	26.3
1997	-1.8	61.0	30.6
1998	-8.2	59.4	30.2
1999	-7.1	59.4	25.9
2000	-2.3	58.9	31.9
2001	-3.1	58.1	30.8
2002	13.2	59.4	34.4
2003	1.9	59.4	31.7
2004	-9.4	62.6	32.2
Minimum	**-19.7**	**40.1**	**18.4**
Maximum	**18.2**	**62.6**	**34.4**
Average	**-1.4**	**58.9**	**28.8**

NOTES:

1. Temperature measurements were taken at a certified meteorological station in Healy. Healy is located approximately 3 miles from the project are boundary. No data after 2004.

TABLE CVII-7, SUMMARY OF ANNUAL TEMPERATURES AT JUMBO DOME			
YEAR	Annual Average Average Temperature	Annual Average High Temperature	Annual Average Low Temperature
2007	26.2	41.0	11.3
2008	23.0	37.0	-3.6
2010	29.8	42.3	16.0

Notes:
Temperatures were taken at a USGS non-certified weather station located on the northern end of the project. Only used years with complete data to compute annual temperatures.

temperatures for each month (Only 2007, 2008, and 2010 were used due to data gaps for the other years). Table CVII-7 shows that annual average high temperatures at the Jumbo Dome station range from 37.0 to 42.3 °F, the annual average low temperatures range from -3.6 to 16.0 °F, and the average annual temperature ranges from 23.0 to 29.8°F.

3.0 REFERENCES

NOAA (National Oceanic and Atmospheric Administration). 1988. Local Climatological and Data, Annual Summary with Comparative Data. Fairbanks, Alaska.

USDOC (United States Department of Commerce). 1968. Weather Atlas of the United States. Environmental Science Services. June.

4.0 RESPONSIBLE PARTIES

This chapter was prepared by Usibelli Coal Mine, Inc.

CHAPTER CVIII

VEGETATION

TABLE OF CONTENTS

1.0 INTRODUCTION……...CVIII-1
2.0 METHODS……..CVIII-1
2.1 2007 Field Survey……CVIII-1
2.2 2007 Post Field Data Review……..CVIII-1
2.3 2010 GIS-Based Mapping……...CVIII-2
2.4 2010 Fieldwork……CVIII-2
2.5 2010 Final Mapping…….CVIII-2
3.0 GENERAL DESCRIPTION OF THE LEASE AREA……...CVIII-2
3.1 Vegetation……CVIII-3
3.2 Soils…...……..CVIII-3
3.3 Hydrology……CVIII-4
4.0 SUMMARY OF VEGETATION COVER TYPES……CVIII-4
4.1 Herbaceous Cover Type...……...CVIII-5
4.2 Shrub Cover Type……CVIII-5
4.3 Forested Cover Type……...…CVIII-6
4.4 Unvegetated Cover Types……..CVIII-7
5.0 CONCLUSION……..CVIII-7
6.0 REFERENCES……...CVIII-7
7.0 RESPONSIBLE PARTIES…….CVIII-8

LIST OF TABLES

CVIII-1: Identified Vascular Species in the Lease Area…….CVIII-3
CVIII-2: Proposed Impact Area Vegetation Summary…….. CVIII-4

LIST OF PLATES

CVIII-1: 2010 Vegetation Mapping……CVIII-9

LIST OF APPENDICES

CVIII-1: Data Summary (WHPacific 2007)…….……CVIII-10
CVIII-2: Data Summary (HDR 2010)…….…….CVIII-16

1.0 INTRODUCTION

The Jumbo Dome Mine baseline study area encompasses 4,798 acres. The Jumbo Dome Mine lease area encompasses approximately 3,238 acres. Within that area, is a smaller area of 1,101.2 acres considered the "mining limits", referred to in this Chapter as the "proposed impact area". (Please note that there is an overlap in impact area between the "mine impact area" and the "road corridor impact area. This overlap is 10.4 acres. For the purpose of this chapter the overlap area has been removed from the impact area calculations so there is no double counting".) This is the area of the proposed pit, and associated staging areas and settling pond areas. Development of the area will be conducted in five separate phases, each approximately five years in length.

Within The baseline study area approximately 2,926 acres of that are forested habitats, 1,755 acres are shrub habitat, 74 acres are herbaceous habitat, and 40 acres are rock outcrops, with the remaining balance (3 acres) present as roads. Within the impact area out of the total proposed impact area of 1,101.2 acres, 718.5 acres are classified as a forested cover type; 419.5 acres are classified as a shrub cover type; 5.5 acres are classified as a herbaceous type cover; and 17.7 acres a classified as un-vegetated cover.

2.0 METHODS

Data and mapping from two separate wetland and vegetation studies, including one completed in 2007 by WHPacific, Inc. (WHPacific) and one completed in 2010 by HDR Alaska, Inc. (HDR) will be used to determine re-vegetation measures. UCM intends to reclaim the mine area to wildlife habitat as this is the primary current land use.

2.1 2007 Field Survey

In 2007, WHPacific conducted a field survey of wetland and vegetation cover types across the Jumbo Dome lease area. Vegetation data, including species and percent cover were recorded on wetland delineation forms prepared in accordance with the Interim Regional Supplement to the Corps of Engineers Wetland Delineation Manual, Alaska Region (USACE, 2006), and vegetation cover types were classified according to The Alaska Vegetation Classification (Viereck et al., 1992). Plant species within a 50-foot radius circular plot were recorded and absolute percent cover was assessed. WHPacific field staff used Viereck and Little's (1972) Alaska Trees and Shrubs and Collet's (2004) *Willows of Interior Alaska* to assist with the field identification of dominant plant species. When species could not be identified in the field, samples from the plant or plants were returned to field base camp or to the office for identification with the assistance of taxonomic keys found in *Flora of Alaska and Neighboring Territories: A Manual of the Vascular Plants* (Hulten, 1968). Vegetative cover data are presented in Appendix CVIII-2.

2.2 2007 Post-Field Data Review

Upon returning from the field, the National Wetland Inventory (NWI) classification system was used to evaluate the delineated wetland habitats (Cowardin et al., 1979), and the Alaska Vegetation Classification handbook (Viereck et al., 1992) was used to evaluate both wetland and non-wetland areas (Data sheets and photos for WHPacific's field efforts are available upon request). Acreage estimates of vegetation cover types were made using the field data, wetland field data, and soil survey mapping.

2.3 2010 GIS-Based Mapping

WHPacific collected vegetation field data in 2007; however vegetation mapping suitable for mine permitting was not produced. In May 2010, HDR was contracted by UCM to prepare GIS based wetland and vegetation mapping for the proposed impact area. HDR reviewed the field data collected by WHPacific in 2007, aerial photographs, existing mapping and documentation, and field photographs, to identify the vegetation cover types within the Jumbo Dome Mine Area. Field data and ground photographs collected by WHPacific were matched with photo signatures (color, texture) observed on aerial photography. GIS polygons were attributed with cover type classes from the Alaska Vegetation Classification handbook (Viereck et al., 1992).

2.4 2010 Fieldwork

HDR scientists conducted a reconnaissance-level field investigation for the proposed impact area over a 4 day period between September 17 and 20, 2010. Prior to fieldwork, locations of characteristic plant communities occurring at different landform positions, representative wetland or upland sites (based on aerial photography interpretation), as well as questionable areas were selected using GIS. These selected field sampling locations were uploaded into handheld GPS units. Once in the field, scientists used the waypoints in the GPS unit to navigate to areas needing investigation.

Locations visited in the field were studied using the USACE 1987 wetland delineation manual's three-parameter method of determining an area's wetland status and methods described in the Alaska Regional Supplement to the 1987 Wetland Delineation Manual (USACE 1987, 2007). This included collecting detailed information on plant community composition. Field mapping entailed visually estimating percent cover of dominant growth forms and species, then assigning uniform areas to Viereck vegetation classes. Vegetation characteristics used in determining cover type included plant growth form, percent canopy cover, plant height, site disturbance, and species composition. Viereck's classification system uses a hierarchical system with five levels of resolution. For the purpose of this study, vegetation communities were mapped to the third level of resolution. (Data sheets and photos for HDR's field efforts are available upon request.)

2.5 2010 Final Mapping

Final vegetation mapping was completed for the proposed impact area primarily by using aerial photography interpretation. Vegetation mapping derived from air photo interpretation was compared to field-collected vegetation data (from both the 2007 and 2010 field efforts). If the vegetation mapping differed from field-collected data, the mapping was revised to match actual, on the ground conditions. The data was incorporated into a GIS database by digitizing the vegetation type boundaries onto a digital, orthorectified aerial photograph.

3.0 GENERAL DESCRIPTION OF THE LEASE AREA

According to Land Resource Regions and Major Land Resource Areas of Alaska (Kautz and Taber, 2004), the lease area is within Major Land Resource Area (MLRA) 228, Interior Alaska Mountains. This region encompasses major interior mountain chains including the Alaska Range and its associated glaciated hills and plains where the lease area is located.

Brief summers and long, cold winters are characteristic of the area and region. Average annual temperatures and precipitation vary greatly in the MLRA, but precipitation typically ranges from 15-20 inches in the lower elevations and the frost-free period varies from 50 to 80 days.

3.1 Vegetation

Upland conditions support a mixture of white spruce forest, paper-birch-quaking aspen forest, and dry forb herbaceous communities. Wetland conditions in the lease area support sedge-cottongrass wet meadow, bluejoint meadow, willow shrub and alder-willow shrub communities, black spruce woodlands and forest, and ericaceous shrub tundra. Out of the total proposed impact area of 1,101 acres, the total acreage of uplands is approximately 941 acres, or 85.4percent of the area (see Jumbo Dome Wetland Chapter 2010). The total acreage of wetlands and other waters is approximately 160 acres, or 14.6 percent of the area. A map showing the distribution of mapped vegetation cover types is included in Appendix CVIII-A. See Table CVIII-1 for a summary of the most common vascular plant species in the lease area.

.

Table CVIII-1: Identified Vascular Species in the Lease Area

Scientific Name	Common Name		Scientific Name	Common Name
Achillea millefolium	Common yarrow		*Oxycoccus microcarpus*	Swamp cranberry
Alnus crispa	Green alder		*Petasites frigidus*	Coltsfoot
Alnus sinuata	Sitka alder		*Picea glauca*	White spruce
Andromeda polifolia	Bog rosemary		*Picea mariana*	Black spruce
Arctostaphylos uva-ursi	Kinnickinnick		*Polygonum alaskanum*	Wild rhubarb
Betula glandulosa	Bog birch		*Populus balsamifera*	Balsam poplar
Betula nana	Bog birch		*Populus tremuloides*	Quaking aspen
Betula papyrifera	Paper birch		*Potentilla fruticosa*	Shrubby cinquefoil
Boschniakia rossica	Poque		*Rosa acicularis*	Prickly rose
Calamagrostis canadensis	Bluejoint		*Rubus chamaemorus*	Cloudberry
Carex bigelowii	Bigelow sedge		*Salix alaxensis*	Felt-leaf willow
Cornus canadensis	Bunchberry dogwood		*Salix bebbiana*	Bebb willow
Cornus stolonifera	Red-osier dogwood		*Salix pulchra planifolia*	Diamondleaf willow
Epilobium angustifolium	Fireweed		*Spiraea beauverdiana*	Beauverd spiraea
Equisetum arvense	Meadow horsetail		*Vaccinium uliginosum*	Bog blueberry
Eriophorum angustifolium	Tall cottongrass		*Vaccinium vitis-idaea*	Low-bush cranberry
Eriophorum vaginatum	Tussock cottongrass		*Oxycoccus microcarpus*	Swamp cranberry
Geocaulon lividum	Sandalwood		*Petasites frigidus*	Coltsfoot
Ledum groenlandicum	Bog Labrador tea		*Picea glauca*	White spruce
Lupinus arcticus	Arctic lupine		*Picea mariana*	Black spruce
Mertensia paniculata	Tall bluebell		*Polygonum alaskanum*	Wild rhubarb

3.2 Soils

Soils in the lease area are described in detail in Chapter X – SOIL RESOURCES.

3.3 Hydrology

The lease area is drained by Marguerite Creek and its main tributaries, Emma Creek (to the east) and Bonanza Creek (to the north). Emma Creek divides into two roughly equal branches. Marguerite Creek has several smaller perennial and intermittent tributaries within the lease area. The floodplains of the main streams are frequently inundated during spring break up, and portions remained covered with snow and ice into mid-summer. The lowlands associated with the secondary drainages are typically saturated year-round and provide base flow to the tributaries. In addition, substantial higher elevation plateaus, gradually sloping areas and steeper north-facing slopes remain saturated during the summer. These areas have underlying frozen soils. The active layer is typically only a few inches deep, and these areas may remain permanently frozen as little as a foot below the surface. Water gradually drains from these areas toward the lower drainages through a variety of swales and ravines.

During the HDR field visit, numerous groundwater seeps were observed within the proposed impact area. The seeps appear to be the primary source of water for most of the sites where wetland hydrology was observed.

4.0 SUMMARY OF VEGETATION COVER TYPES

The Jumbo Dome Mine Lease area is 4,798 acres in size. In 2007, WHPacific estimated that approximately 2,926 acres of that are forested habitat, 1,755 acres are shrub habitat, 74 acres are herbaceous habitat, and 40 acres are rock outcrops, with the remaining balance (3 acres) present as roads. In 2010, HDR documented similar results within the 1,101.2-acre proposed impact area and identified the same general habitat types comprised of 10 mapped cover types. The mapped cover types include 8 terrestrial and 2 unvegetated types (Table CVIII-2). A map showing the mapped cover types in the proposed impact area is included in Appendix CVIII-A. Photographs representative of each cover type are included in Appendix CVIII-B. Descriptions of the major cover types are listed below.

Table CVIII-2: Proposed Impact Area Vegetation Mapping Summary

		Impacts by Mine Phase (acres)					
Mapping Code	**Description**	**Year 1-5**	**Year 6-10**	**Year 11-15**	**Year 16-20**	**Year 21-26**	**TOTAL**
IA2	Open Needleleaf Forest	132.8	21.5	66.0	10.5	69.3	**300.1**
IA3	Needleleaf Woodland	253.7	29.5	25.2	18.3	52.1	**378.8**
IIA3	Dwarf Tree Scrub Woodland	56.6	3.8	3.9	3.3	-	**67.6**
IIB1	Closed Tall Scrub	9.9	0.4	-	2.7	1.7	**14.7**
IIB2	Open Tall Scrub	1.3	17.0	20.8	17.3	2.1	**58.5**
IIC1	Closed Low Scrub	6.5	8.6	4.7	11.6	13.2	**44.6**
IIC2	Open Low Scrub	38.4	35.6	38.3	54.0	50.7	**217.0**
IIIA3	Wet Graminoid Herbaceous	1.3	2.9	-	1.3	-	**5.5**
BSV	Barren/Sparsely Vegetated	8.9	-	1.1	1.8	2.7	**14.5**
	Total Area (acres)*	**509.4**	**119.4**	**159.9**	**120.7**	**191.8**	**1,101.2**

*Acreage estimates have been rounded to the nearest tenth (0.1) of an acre. Table totals may not add exactly due to rounding.

4.1 Herbaceous Cover Type

Herbaceous habitats are those dominated by terrestrial or emergent non-woody vegetation. Tree cover is generally less than 10%, and shrub cover is generally less than 25%. Wet graminoid herbaceous habitats are dominated by non-woody vegetation and are found in the lease area in association with emergent wetland plant communities. Wet graminoid herbaceous communities are found throughout the entire lease area. Within the proposed impact area, wet graminoid herbaceous cover types occupy approximately 5.5 acres (Table CVIII-2). These communities are commonly found in topographically flat or slightly depressional portions of the lease area.

Wet graminoid herbaceous community types identified in the lease area are typically dominated by cottongrass species and sedges (Bigelow's sedge and water sedge), with smaller amounts of bluejoint. There is also up to 25% cover of low shrubs, including bog birch, Labrador tea and bog blueberry. There may be scattered, stunted black spruce and willows. Sedge-cottongrass communities are found typically in broad, shallow drainage ways and on plateaus. Representative communities can be found at Plots B4-8 and C2-17 as described in Appendix CVIII-2.

The dry forb herbaceous community is a dry tundra community found in small areas typically on ridge tops and south-facing slopes. Vegetative cover is often sparse. Typical species are alpine arnica, Arctic lupine, bluejoint, Arctic bluegrass, and tall bluebells. There are patches of low shrubs, such as kinnickinnick and bog birch. This community is often interspersed among open mixed forest and open needleleaf forest communities. This community was not sampled at any of the plots or mapped separately, as these areas are small.

4.2 Shrub Cover Type

Shrub habitats are dominated by woody, multi-stemmed vegetation that is short in stature. Shrub habitats were found throughout the lease area on slopes, flats, in drainages, and in floodplains, and included wetland and upland habitats. WHPacific identified six distinct shrub communities in the lease area, including open and closed tall scrub, open and closed low scrub, open dwarf tree scrub and dwarf tree scrub woodland. Each type identified in the lease area was also mapped in the proposed impact area except for open dwarf tree scrub. A total of 419.4 acres of shrub cover type were identified in the impact area (Table CVIII-2). Descriptions of the different shrub communities' area as follows:

Open and closed tall scrub communities are often found on dry sloping upland sites with south or western aspect. Dominant species include bog birch in its taller form, green alder, bog blueberry, Labrador tea and various willow species, especially diamondleaf willow (Plot C3-1, Appendix CVIII-2).

Open tall scrub communities can also be found in swales, and are dominated by bog birch and diamondleaf willow with a herbaceous layer dominated by bluejoint and cottongrass (Plot B3-10, Appendix CVIII-2).

Another common tall scrub community is dominated by willows, often three or four species together, including felt-leaf, diamondleaf, Bebb and Scouler willow. Common associates are green alder, Sitka alder, bog birch, bog blueberry, and Labrador tea, together with bluejoint,

Bigelow's sedge, and water sedge. This community is typically found along the low floodplain of Marguerite Creek (Plots B3-19 and C2-11, Appendix CVIII-2).

Low scrub communities tend to be wetter than tall scrub. They can be found in relatively flat drainages or on the main creek floodplains, and are typically dominated by willows with shrubby cinquefoil and bog blueberry, and with an herbaceous layer of bluejoint and water sedge (Plots B3-14, C2-1, and C2-12, Appendix CVIII-2).

Dwarf tree scrub is found typically on very wet sites in flat topography. Cover of dwarf trees (under 10 feet) is at least 10%. The tree species are black and white spruce, with dominant shrub species bog birch, bog blueberry, and Labrador tea. Sedges are the typical herbaceous dominant species (Plot A5-6, Appendix CVIII-2). This community is not exclusively found in wetlands (Plot B4-33, Appendix CVIII-2).

Lesser amounts of crowberry, low-bush cranberry, cloudberry, and swamp cranberry may be found in these communities in the herbaceous layer.

4.3 Forested Cover Type

According to the Viereck classification (Viereck et al, 1992), forested habitats are those dominated by single–stem terrestrial woody vegetation. Habitats with greater than 10 percent tree cover are generally considered a forested habitat. Forested habitats are further classified by the percent of canopy cover and species composition or dominance into needleleaf or mixed woodland (10-24% tree cover), open forest (25-59% tree cover) and closed forest (>60% tree cover).

Needleleaf forest is the most prevalent habitat type in the lease area, and is found in closed, open and woodland forms, depending on canopy cover. Closed needleleaf forest stands dominated by white spruce tend to be found in sheltered south-facing locations with deep soils. White spruce reaches its maximum development in these stands, up to 50 feet high and 12 inches or more dbh. Common associates are bog blueberry, crowberry, and bluejoint (Plot B2-3, Appendix CVIII-2). No closed canopy needleleaf forests were mapped in the proposed impact area.

Open needleleaf forest stands dominated by white spruce are found in a variety of sloping sites with different aspects, except that they tend not to be found on steep north-facing slopes. Typical associates are bog blueberry, bog birch, Labrador tea, and Bigelow's sedge (Plots A6-15 and A6-16). Approximately 322 acres of open needleleaf forest occur in the proposed impact area (Table CVIII-2).

Needleleaf woodland tends to be found on wetter sites, such as gradual north, north-west or north-east-facing slopes. Common associates of white spruce are black spruce, bog birch, bog blueberry, willows, crowberry, Labrador tea, and low-bush cranberry. Bigelow's sedge is the most prevalent species in the herbaceous layer. The wetter and more open the site; the more prevalent are black spruce and Labrador tea (see Plot A6-10 for a white spruce wetland site). Needleleaf woodland dominated by black spruce is typically found on north-facing slopes and flats. It is a forested wetland community. Typical associates are bog birch, bog cranberry, Labrador tea, willows, crowberry, low-bush cranberry, and cloudberry. Hydrophytic species in the herbaceous layer include Bigelow's sedge, water sedge, and coltsfoot (see Plot B3-1A,

Appendix CVIII-2). Approximately 397 acres of needleleaf woodland occur in the proposed impact area (Table CVIII-2).

Open mixed, closed mixed forest and mixed woodland habitats dominated by paper birch, white spruce and quaking aspen are typically found on south facing slopes where soils are gravelly, deeper, warmer, and drier (see Plots A3-7, B4-22A, and A4-9, Appendix CVIII-2). Balsam poplar and green alder are common associates. These mixed conifer-hardwood stands have the ubiquitous bog birch and bog blueberry as understory associates, as well as prickly rose. A variety of forbs and grasses are found in the herbaceous layer, including bluejoint, alpine arnica, tall bluebells, arctic lupine, and wild rhubarb. Smaller areas of broadleaf forest (closed or open) are also found in the lease area in similar landscape positions and are similar to mixed forest classes except for the near-absence of black or white spruce. No mixed or broadleaf forest types occur within the proposed impact area.

4.4 Unvegetated Cover Types

This cover type includes both barren or sparsely vegetated areas and inundated areas that are generally void of vegetation. Areas mapped as barren/sparsely vegetated include roads, excavated exploration pits, and all other cleared or developed areas. Barren/sparsely vegetated areas do not have an Alaska Vegetation Classification System code. These areas are labeled as "BSV" (barren/sparsely vegetated) on the vegetation map (Appendix CVIII-1). Approximately 17.7 acres of unvegetated areas were mapped in the proposed impact area (Table CVIII-2).

Open water areas also do not have an Alaska Vegetation Classification System code. These areas are labeled as "OW" (open water) on the vegetation map. Only 0.04 acre of open water was mapped in the proposed impact area (Table CVIII-2).

5.0 CONCLUSION

The vegetation in the proposed Jumbo Dome Mine area is represented outside the permit area in the region. No threatened or endangered plant species were found within the baseline study area.

6.0 REFERENCES

Collett, D.M. 2004. *Willows of Interior Alaska*. U.S. Fish and Wildlife Service, Region 7. Anchorage, AK.

Hulten, E. 1968. *Flora of Alaska and Neighboring Territories: A Manual of the Vascular Plants*. Standford University Press. Stanford, CA.

Kautz, D.R. and P. Taber. 2004. *Land Resource Regions and Major Land Resource Areas of Alaska*. U.S. Department of Agriculture, Natural Resources Conservation Service, Major Land Resource Region 17. Palmer, AK.

U.S. Army Corps of Engineers Environmental Laboratory (USACE). 2007. Regional Supplement to the Corps of Engineers Wetlands Delineation Manual: Alaska Region. Vicksburg, MS.

U.S. Army Corps of Engineers Environmental Laboratory (USACE). 1987. Corps of Engineers Wetlands Delineation Manual. Vicksburg, MS.

Viereck, L.A. and E.L. Little Jr. 1972. Alaska Trees and Shrubs. Agricultural Handbook 410. U.S. Department of Agriculture, Forest Service. Washington, D.C.

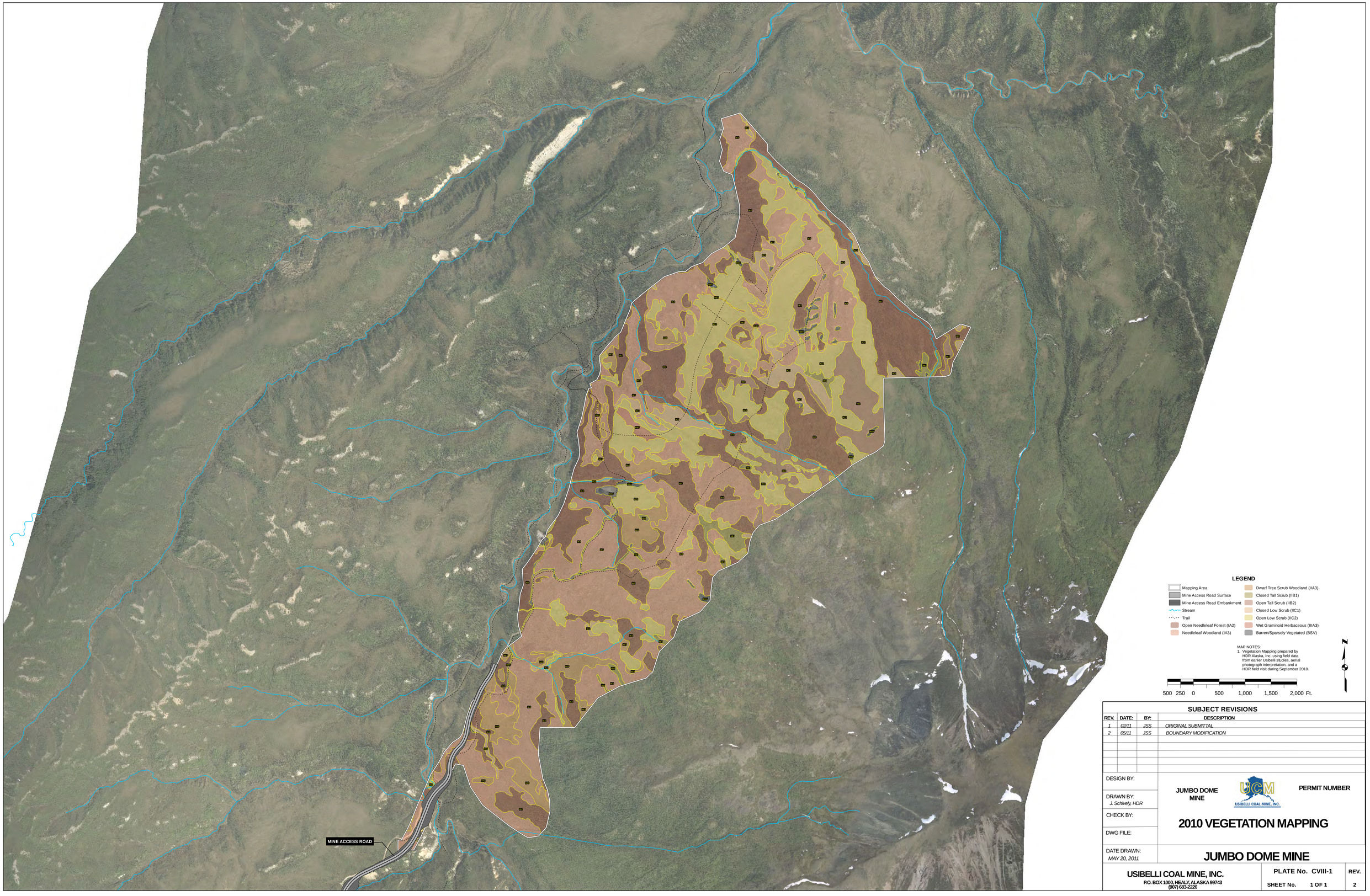
Viereck, L.A., C.T. Dyrness, A.R. Batten, and K.J. Wenzlick. 1992. The Alaska Vegetation Classification Gen. Tech. Rep. PNW-GTR-286. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. Portland, OR.

7.0 RESPONSIBLE PARTIES

Jeff Shively, Professional Wetland Scientist, for HDR, Alaska.

PLATE CVIII-1

2010 VEGETATION MAPPING



SUBJECT REVISIONS

REV.	DATE:	BY:	DESCRIPTION
1	02/11	JSS	ORIGINAL SUBMITTAL
2	05/11	JSS	BOUNDARY MODIFICATION

DESIGN BY:

DRAWN BY: J. Schively, HDR

CHECK BY:

DWG FILE:

DATE DRAWN: MAY 20, 2011

JUMBO DOME MINE

USIBELLI COAL MINE, INC.

PERMIT NUMBER

2010 VEGETATION MAPPING

JUMBO DOME MINE

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743
(907) 683-2226

PLATE No. CVIII-1

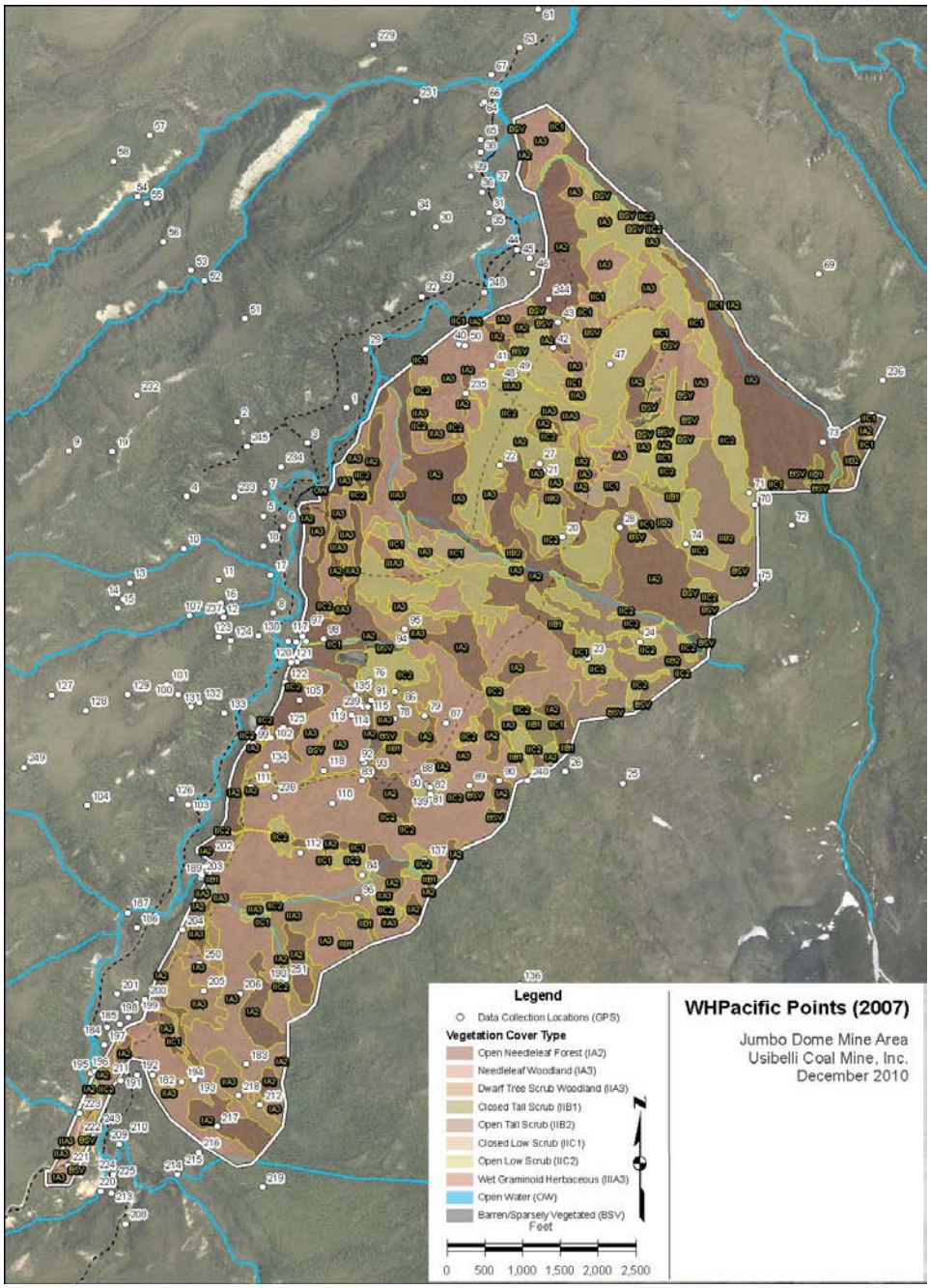
SHEET No. 1 OF 1

REV. 2

APPENDIX CVIII-1

DATA SUMMARY WHPACIFIC 2007

The following data was collected by WHPacific, Inc. in 2007. The inset map below shows the GPS locations of each site visited; a summary table of each point follows.



Point ID	Soil Unit	Wetland	Cowardin	Viereck
A3-1	22	No	NA	Needleleaf woodland
A3-2	65	No	NA	Needleleaf woodland
A3-3	65	No	NA	Needleleaf woodland
A3-4	40	Yes	PSS/PEM	Closed low scrub
A3-5	65	No	NA	Open needleleaf forest
A3-6	13	Yes	PSS/PEM	Needleleaf woodland
A3-7	23	No	NA	Open mixed forest
A3-8	13	Yes	PSS/PEM	Closed tall scrub
A4-1	65	No	NA	Open mixed forest
A4-2	22	No	NA	Closed tall scrub
A4-3	40	Yes	PSS/PEM	Closed low scrub
A4-4	22	No	NA	Closed low scrub
A4-5	65	No	NA	Open needleleaf forest
A4-6	40	Yes	PSS/PEM	Closed low scrub
A4-7	13	Yes	PSS/PEM	Dwarf tree scrub woodland
A4-8	41	No	NA	Needleleaf woodland
A4-9	65	No	NA	Mixed woodland
A4-10	41	Yes	PSS/PEM	Open low scrub
A4-11	65	Yes	PSS/PEM	Needleleaf woodland
A5-1	23	No	NA	Closed broadleaf forest
A5-2	13	Yes	PSS/PEM	Open low scrub
A5-3	65	No	NA	Open broadleaf forest
A5-4	23	No	NA	Closed broadleaf forest
A5-5	40	Yes	PSS/PEM	Closed low scrub
A5-6	21	No	NA	Dwarf tree scrub woodland
A5-7	13	Yes	PSS/PEM	Needleleaf woodland
A5-8	64	No	NA	Needleleaf woodland
A6-1	56	No	NA	Needleleaf woodland
A6-2	56	No	NA	Closed tall scrub
A6-3	41	Yes	PSS/PEM	Closed low scrub
A6-4	40	Yes	PSS/PEM	Closed low scrub
A6-5	40	Yes	PSS/PEM	Open low scrub
A6-6	56	No	NA	Closed low scrub
A6-7	56	No	NA	Needleleaf woodland
A6-8	57	No	NA	Needleleaf woodland
A6-9	22	No	NA	Needleleaf woodland
A6-10	41	Yes	PSS	Needleleaf woodland
A6-11	40	Yes	PSS/PEM	Closed low scrub
A6-12	13	Yes	PSS/PEM	Needleleaf woodland
A6-13	13	Yes	PSS/PEM	Closed low scrub
A6-14	23	No	NA	Open mixed forest
A6-15	21	No	NA	Open needleleaf forest
A6-16	23	No	NA	Open needleleaf forest
A6-17	40	Yes	PSS	Closed low scrub
A6-18	40	Yes	PSS	Closed low scrub
A6-19	23	No	NA	Open needleleaf forest
B1-1	40	Yes	PSS	Needleleaf woodland
B1-2	40	Yes	PFO/PSS	Open needleleaf forest
B1-3	40	No	NA	Open mixed forest
B1-4	64	No	NA	Open needleleaf forest
B2-1	57	No	NA	Open needleleaf forest
B2-2	23	No	NA	Closed tall scrub
B2-3	23	No	NA	Closed needleleaf forest
B2-4	23	No	NA	Needleleaf woodland
B2-5	21	No	NA	Needleleaf woodland
B2-6	11	No	NA	Closed broadleaf forest
B3-1	21	No	NA	Open needleleaf forest
B3-2	22	No	NA	Open mixed forest
B3-2A	23	No	NA	Open needleleaf forest
B3-3	65	No	NA	Open needleleaf forest
B3-4	43	Yes	PSS/PEM	Closed low scrub
B3-5	22	No	NA	Open needleleaf forest
B3-6	40	Yes	PSS/PEM	Closed low scrub

Point ID	Soil Unit	Wetland	Cowardin	Viereck
B3-7	22	No	NA	Open needleleaf forest
B3-8	13	Yes	PFO/PSS	Open needleleaf forest
B3-9	21	No	NA	Open needleleaf forest
B3-10	40	Yes	PSS/PEM	Open tall scrub
B3-11B	12	Yes	PSS/PEM	Open needleleaf forest
B3-12B	22	No	NA	Open needleleaf forest
B3-13B	64	No	NA	Open needleleaf forest
B3-14B	12	Yes	PSS/PEM	Closed low scrub
B3-15B	63	No	NA	Open needleleaf forest
B3-16B	64	No	NA	Open needleleaf forest
B3-17B	64	No	NA	Closed low scrub
B3-18	12	Yes	PSS/PEM	Needleleaf woodland
B3-19	11	Yes	PSS	Closed tall scrub
B3-20	63	No	NA	Closed needleleaf forest
B3-21	63	No	NA	Open needleleaf forest
B3-22	63	No	NA	Open needleleaf forest
B3-23	63	No	NA	Open needleleaf forest
B3-24	10	Yes	PSS/PEM	Needleleaf woodland
B4-1	66	No	NA	Needleleaf woodland
B4-2	60	No	NA	Needleleaf woodland
B4-3	60	No	NA	Needleleaf woodland
B4-4	50	Yes	PFO/PSS	Open needleleaf forest
B4-5	11	No	NA	Open needleleaf forest
B4-6	65	No	NA	Needleleaf woodland
B4-7	23	No	NA	Open needleleaf forest
B4-8	43	Yes	PEM	Wet graminoid herbaceous
B4-9	43	Yes	PSS/PEM	Closed low scrub
B4-10	64	No	NA	Needleleaf woodland
B4-11	64	No	NA	Open needleleaf forest
B4-12	21	No	NA	Open needleleaf forest
B4-13A	50	Yes	PSS/PEM	Open needleleaf forest
B4-13B	23	No	NA	Open needleleaf forest
B4-14	10	Yes	PSS	Closed tall scrub
B4-15	65	No	NA	Open needleleaf forest
B4-15A	50	Yes	PSS/PEM	Needleleaf woodland
B4-16	64	Yes	PSS/PEM	Needleleaf woodland
B4-16A	23	No	NA	Needleleaf woodland
B4-17	22	No	NA	Open mixed forest
B4-17A	23	No	NA	Needleleaf woodland
B4-18	23	No	NA	Closed tall scrub
B4-18A	23	No	NA	Needleleaf woodland
B4-19	64	No	NA	Open needleleaf forest
B4-19A	23	No	NA	Closed low scrub
B4-20	40	Yes	PSS	Closed low scrub
B4-20A	11	Yes	PSS/PEM	Closed low scrub
B4-21A	11	Yes	PSS	Closed low scrub
B4-22A	23	No	NA	Closed mixed forest
B4-23A	23	No	NA	Open needleleaf forest
B4-24A	60	No	NA	Needleleaf woodland
B4-26	66	No	NA	Needleleaf woodland
B4-27	56	No	NA	Needleleaf woodland
B4-28	10	No	NA	Needleleaf woodland
B4-29	60	Yes	PSS	Needleleaf woodland
B4-30	60	Yes	PSS/PEM	Closed tall scrub
B4-31	60	No	NA	Open needleleaf forest
B4-32	60	No	NA	Closed tall scrub
B4-33	57	No	NA	Open dwarf tree scrub
B5-1	12	Yes	PSS/PEM	Needleleaf woodland
B5-2	12	Yes	PFO/PSS	Open needleleaf forest
B5-3	58	No	NA	Closed tall scrub
B5-4	51	Yes	PSS/PEM	Closed low scrub
B5-5	13	Yes	PSS/PEM	Needleleaf woodland
B5-6	60	No	NA	Needleleaf woodland

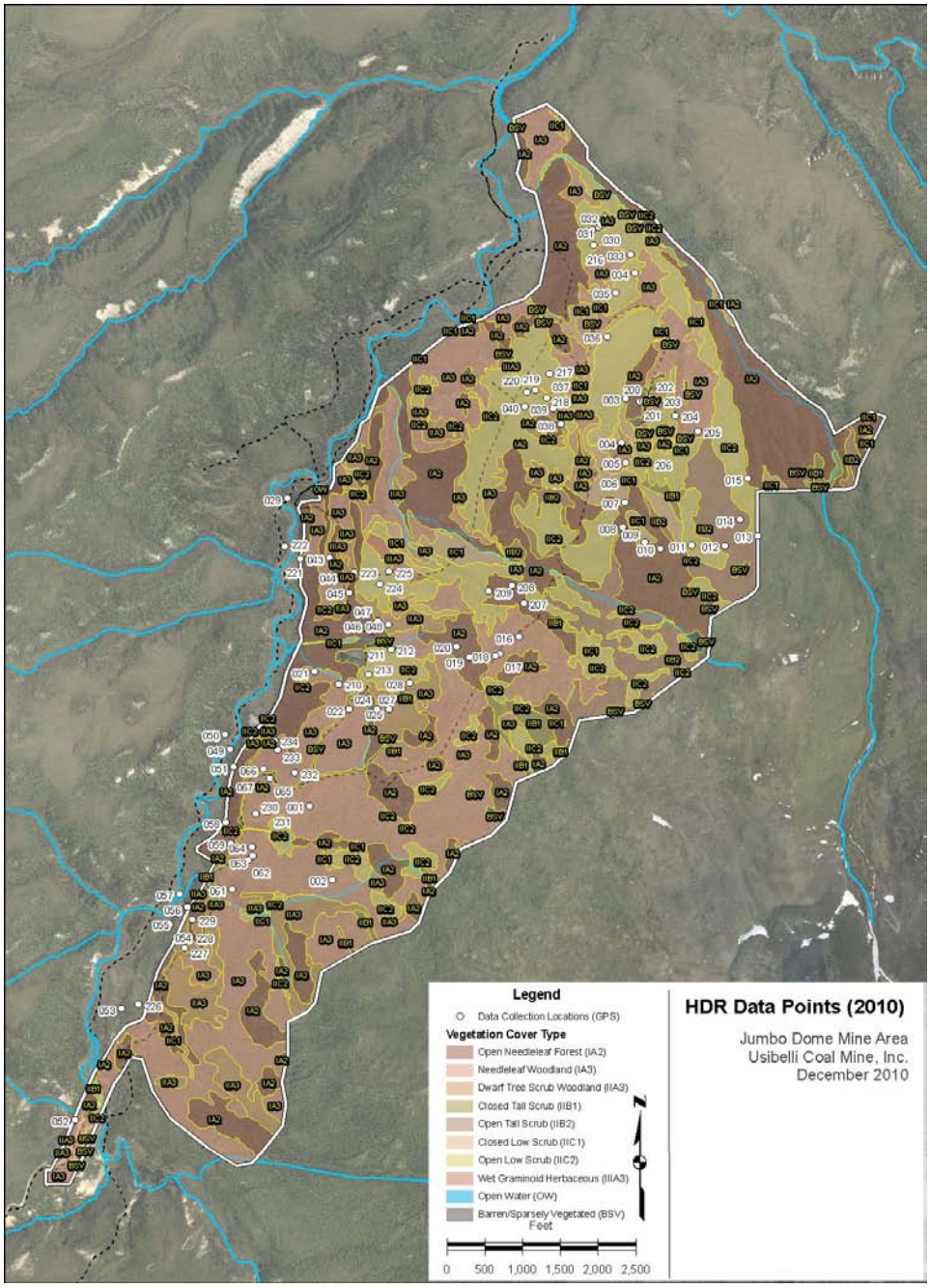
Point ID	Soil Unit	Wetland	Cowardin	Viereck
B5-7	3	Yes	PSS	Closed low scrub
B5-8	3	Yes	PSS/PEM	Open tall scrub
B5-9	12	Yes	PSS/PEM	Needleleaf woodland
B5-10	63	No	NA	Needleleaf woodland
B5-11	63	No	NA	Open needleleaf forest
B5-12	12	Yes	PSS	Open needleleaf forest
B5-13	12	Yes	PSS/PEM	Closed low scrub
B5-14	12	Yes	PSS/PEM	Closed low scrub
B5-15	12	Yes	PSS/PEM	Open low scrub
B5-17	65	No	NA	Needleleaf woodland
B5-18	3	No	NA	Closed tall scrub
B5-19	58	Yes	PFO/PSS	Open needleleaf forest
B5-20	58	No	NA	Needleleaf woodland
B5-21	10	Yes	PSS/PEM	Closed tall scrub
B5-22	57	No	NA	Dwarf tree scrub woodland
B5-23	12	Yes	PSS/PEM	Open low scrub
B5-25	57	No	NA	Needleleaf woodland
B5-26	51	Yes	PSS/PEM	Closed low scrub
B5-27	60	Yes	PSS	Needleleaf woodland
B5-28	60	No	NA	Open needleleaf forest
B5-29	60	No	NA	Open needleleaf forest
B6-1	13	Yes	PSS	Open needleleaf forest
B6-2	23	No	NA	Needleleaf woodland
B6-3	22	No	NA	Open needleleaf forest
B6-4	13	No	NA	Needleleaf woodland
B6-5	4	No	NA	Needleleaf woodland
B6-6	4	No	NA	Open low scrub
B6-7	23	Yes	PSS	Closed low scrub
B6-8	23	No	NA	Open needleleaf forest
B6-9	23	No	NA	Open needleleaf forest
B6-10	23	No	NA	Open needleleaf forest
B6-11	23	No	NA	Dwarf tree scrub woodland
B6-12	4	Yes	PSS	Needleleaf woodland
B6-13	3	Yes	PSS	Needleleaf woodland
B6-13B	12	Yes	PSS/PEM	Closed low scrub
B6-14	12	Yes	PSS/PEM	Needleleaf woodland
B6-15	10	No	NA	Open tall scrub
B6-16	10	No	NA	Open mixed forest
B6-17	51	No	NA	Needleleaf woodland
B6-18	63	No	NA	Open needleleaf forest
B6-19	51	No	NA	Needleleaf woodland
B6-20	51	Yes	PSS/PEM	Dwarf tree scrub woodland
B6-21	65	No	NA	Needleleaf woodland
C1-1	41	Yes	PSS/PEM	Needleleaf woodland
C1-2	41	Yes	PSS/PEM	Closed low scrub
C1-3	41	No	NA	Closed low scrub
C1-4	11	No	NA	Open mixed forest
C1-5	11	Yes	PSS/PEM	Open low scrub
C1-6	11	Yes	PSS/PEM	Dwarf tree scrub woodland
C1-7	41	Yes	PSS/PEM	Needleleaf woodland
C1-8	64	No	NA	Open needleleaf forest
C1-9	43	Yes	PSS/PEM	Closed low scrub
C1-10	23	No	NA	Open needleleaf forest
C2-1	11	Yes	PSS	Closed low scrub
C2-2	23	No	NA	Open needleleaf forest
C2-3	23	No	NA	Closed mixed forest
C2-4	41	Yes	PSS	Dwarf tree scrub woodland
C2-5	64	No	NA	Needleleaf woodland
C2-6	23	No	NA	Needleleaf woodland
C2-7	10	Yes	PSS/PEM	Closed low scrub
C2-8	23	No	NA	Open needleleaf forest
C2-9	3	No	NA	Open mixed forest
C2-10	23	No	NA	Open mixed forest

Point ID	Soil Unit	Wetland	Cowardin	Viereck
C2-11	23	No	NA	Closed tall scrub
C2-12	11	No	NA	Closed low scrub
C2-13	21	No	NA	Needleleaf woodland
C2-14	21	Yes	PFO/PSS	Open needleleaf forest
C2-15	22	No	NA	Needleleaf woodland
C2-16	44	Yes	PSS/PEM	Open low scrub
C2-17	44	Yes	PEM	Wet graminoid herbaceous
C2-18	71	No	NA	Needleleaf woodland
C2-19	44	Yes	PSS/PEM	Open low scrub
C2-20	23	No	NA	Needleleaf woodland
C2-21	22	No	NA	Open needleleaf forest
C2-22	10	Yes	PSS/PEM	Open low scrub
C2-23	10	Yes	PSS/PEM	Open low scrub
C2-24	10	Yes	PSS/PEM	Closed tall scrub
C3-1	66	N	NA	Closed tall scrub
C3-2	66	Yes	PSS/PEM	Closed low scrub
C3-3	22	No	NA	Needleleaf woodland
C3-4	44	Yes	PSS/PEM	Needleleaf woodland
C3-5	44	No	NA	Closed tall scrub
C3-6	44	Yes	PSS/PEM	Needleleaf woodland
C3-7	44	Yes	PSS/PEM	Open tall scrub
C3-8	66	No	NA	Open needleleaf forest
C3-9	40	Yes	PSS/PEM	Open low scrub
C3-10	40	Yes	PSS/PEM	Open low scrub
C4-1	40	Yes	PSS/PEM	Open low scrub
C4-2	41	Yes	PSS/PEM	Dwarf tree scrub woodland
C4-3	56	No	NA	Needleleaf woodland
C4-4	41	Yes	PSS/PEM	Closed low scrub
C4-5	56	No	NA	Needleleaf woodland
C4-6	56	Yes	PSS	Closed tall scrub
C4-7	56	No	NA	Closed tall scrub
C4-9	60	No	NA	Needleleaf woodland
C4-10	51	Yes	PSS/PEM	Closed low scrub
C4-11	51	Yes	PSS/PEM	Open low scrub
C4-12	51	Yes	PSS/PEM	Closed tall scrub
C4-13	60	No	NA	Needleleaf woodland
C4-14	56	No	NA	Closed tall scrub
C4-15	56	No	NA	Closed tall scrub
C4-16	41	No	NA	Needleleaf woodland
C4-17	66	No	NA	Needleleaf woodland
C4-18	56	No	NA	Open mixed forest
C4-19	51	Yes	PSS/PEM	Closed low scrub
C4-20	51	Yes	PSS/PEM	Open low scrub
C4-21	60	No	NA	Open needleleaf forest
C4-22	58	No	NA	Closed tall scrub
C4-23	53	No	NA	Needleleaf woodland
C5-1	58	Yes	PSS/PEM	Closed low scrub
C5-2	51	Yes	PSS/PEM	Closed low scrub
C5-3	51	Yes	PSS/PEM	Closed low scrub
C5-4	51	Yes	PSS/PEM	Open low scrub
C6-1	51	Yes	PSS/PEM	Closed low scrub
D2-1	44	Yes	PSS/PEM	Open low scrub
D2-2	44	Yes	PSS/PEM	Closed low scrub
D3-1	60	No	NA	Closed low scrub
D3-2	44	Yes	PSS/PEM	Open tall scrub
D3-3	44	Yes	PSS/PEM	Open tall scrub
D3-4	61	No	NA	Closed low scrub
D3-5	44	Yes	PSS/PEM	Open low scrub
D3-6	53	No	NA	Open needleleaf forest

APPENDIX CVIII-2

DATA SUMMARY HDR 2010

The following note summaries were collected by HDR Alaska, Inc. in September 2010 to field verify a desktop-level mapping study of mine area wetlands and vegetation communities. The primary source data used for the mapping was the much more extensive 2007 wetland field survey data collected by WHPacfic Inc. Information included here was used to supplement that dataset and verify the accuracy of boundaries delineated on project aerial photography in 2010. Standard USACE wetland data forms were used for note-taking and in many cases were not completely filled out; instead only limited data specific to a sites wetland status and vegetation community were collected. The inset map below shows the GPS locations of each site visited; a summary table of each point follows.



Site ID	Latitude	Longitude	Vegetation Mapping Code	Vegetation Type	Wetland Mapping Code	Wetland Type
001	63.98582163	-148.7411318	IA3	Needleleaf Woodland	U	Upland (non-wetland)
002	63.98314177	-148.7394066	IIC2	Open Low Scrub	PSS1/EM1C	Seasonally Flooded Broadleaf Scrub-Shrub/Emergent Wetland
003	64.00028989	-148.7144882	IA3	Needleleaf Woodland	U	Upland (non-wetland)
004	63.99869774	-148.7149127	IIC1	Closed Low Scrub	U	Upland (non-wetland)
005	63.99798243	-148.7146139	IIIA3	Wet Graminoid Herbaceous	PEM1F	Semi-Permanently Flooded Emergent Wetland
006	63.99727567	-148.7147722	IIC2	Open Low Scrub	PSSI/EM1B	Saturated Broadleaf Scrub-Shrub/Emergent Wetland
007	63.99654158	-148.7147283	IIB1	Closed Tall Scrub	U	Upland (non-wetland)
008	63.99564304	-148.7149778	IIB2	Open Tall Scrub	U	Upland (non-wetland)
009	63.99508196	-148.7131702	IIC1	Closed Low Scrub	U	Upland (non-wetland)
010	63.99485372	-148.7119019	IIC2	Open Low Scrub	U	Upland (non-wetland)
011	63.99494181	-148.7092998	IIB2	Open Tall Scrub	U	Upland (non-wetland)
012	63.99490401	-148.7066024	IIC1	Closed Low Scrub	U	Upland (non-wetland)
013	63.99524407	-148.7038447	IIC1	Closed Low Scrub	U	Upland (non-wetland)
014	63.99582912	-148.7053314	IIC2	Open Low Scrub	U	Upland (non-wetland)
015	63.99730735	-148.704583	IA2	Open Needleleaf Forest	U	Upland (non-wetland)
016	63.99175904	-148.7236698	IIB1	Closed Tall Scrub	U	Upland (non-wetland)
017	63.99116769	-148.7252447	IIC1	Closed Low Scrub	PSS1/3B	Saturated Broadleaf/Broadleaf Evergreen Scrub-Shrub Wetland
018	63.99109645	-148.7256343	IIC1	Closed Low Scrub	PSS1/3B	Saturated Broadleaf/Broadleaf Evergreen Scrub-Shrub Wetland
019	63.99105554	-148.7278044	IA3	Needleleaf Woodland	U	Upland (non-wetland)
020	63.99146274	-148.7287885	IA3	Needleleaf Woodland	U	Upland (non-wetland)
021	63.99065481	-148.7405007	BSV	Barren/Sparsely Vegetated	U	Upland (non-wetland)
022	63.98927674	-148.737737	IA2	Open Needleleaf Forest	PSS1/4B	Saturated Broadleaf/Needleleaf Scrub-Shrub Wetland
023	63.98957832	-148.7370115	IIC2	Open Low Scrub	PSS1/EM1C	Seasonally Flooded Broadleaf Scrub-Shrub/Emergent Wetland
024	63.98926919	-148.73545	IIB1	Closed Tall Scrub	U	Upland (non-wetland)
025	63.98925352	-148.7344824	IIC2	Open Low Scrub	PSS1/3B	Saturated Broadleaf/Broadleaf Evergreen Scrub-Shrub Wetland
026	63.98954085	-148.7341397	IIC2	Open Low Scrub	PSS1/3B	Saturated Broadleaf/Broadleaf Evergreen Scrub-Shrub Wetland
027	63.98997604	-148.7333894	IIC2	Open Low Scrub	PSS1/3B	Saturated Broadleaf/Broadleaf Evergreen Scrub-Shrub Wetland
028	63.99017486	-148.7327503	IA3	Needleleaf Woodland	U	Upland (non-wetland)
029	63.99693277	-148.7424948	OW	Open Water	R3UBH	Open Water (Stream)
030	64.00648227	-148.7164678	IIC2	Open Low Scrub	U	Upland (non-wetland)
031	64.0065883	-148.71629	IIB2/BSV	Open Tall Scrub/Barren-Sparsely Vegetated	U	Upland (non-wetland)
032	64.00684043	-148.7159724	IA2	Open Needleleaf Forest	U	Upland (non-wetland)
033	64.00546873	-148.7138869	IIB2/BSV	Open Tall Scrub/Barren-Sparsely Vegetated	U	Upland (non-wetland)
034	64.0048048	-148.7135523	IIC1	Closed Low Scrub	PSS1/EM1B	Saturated Broadleaf Scrub-Shrub/Emergent Wetland
035	64.00410902	-148.7151529	IA3	Needleleaf Woodland	U	Upland (non-wetland)
036	64.00252568	-148.715943	IIC2	Open Low Scrub	PSS1/EM1B	Saturated Broadleaf Scrub-Shrub/Emergent Wetland
037	64.00079439	-148.7185878	IIC2	Open Low Scrub	PSS1/EM1B	Saturated Broadleaf Scrub-Shrub/Emergent Wetland

Site ID	Latitude	Longitude	Vegetation Mapping Code	Vegetation Type	Wetland Mapping Code	Wetland Type
038	63.99940258	-148.7198719	IIC2	Open Low Scrub	PSS1/EM1B	Saturated Broadleaf Scrub-Shrub/Emergent Wetland
039	63.99998412	-148.7204839	IIA3	Dwarf Tree Scrub Woodland	U	Upland (non-wetland)
040	64.00006601	-148.7227863	IIIA3	Wet Graminoid Herbaceous	PEM1F	Semi-Permanently Flooded Emergent Wetland
041	63.99467669	-148.7406389	IIIA3	Wet Graminoid Herbaceous	PEM1A	Temporarily Flooded Emergent Wetland
042	63.99470167	-148.7397942	IIA3	Dwarf Tree Scrub Woodland	U	Upland (non-wetland)
043	63.99474702	-148.7391165	IA2	Open Needleleaf Forest	U	Upland (non-wetland)
044	63.99405434	-148.7381012	IIC2	Open Low Scrub	PSS1/EM1B	Saturated Broadleaf Scrub-Shrub/Emergent Wetland
045	63.99349292	-148.7375385	IIC2	Open Low Scrub	PSS1/EM1C	Seasonally Flooded Broadleaf Scrub-Shrub/Emergent Wetland
046	63.992644	-148.7360993	IA3	Needleleaf Woodland	U	Upland (non-wetland)
047	63.99242615	-148.7352749	IA3	Needleleaf Woodland	U	Upland (non-wetland)
048	63.99228852	-148.7343576	IIA3	Dwarf Tree Scrub Woodland	PSS1/4B	Saturated Broadleaf/Needleleaf Scrub-Shrub Wetland
049	63.98792842	-148.7475852	BSV	Barren/Sparsely Vegetated	U	Upland (non-wetland)
050	63.9884704	-148.747988	BSV	Barren/Sparsely Vegetated	U	Upland (non-wetland)
051	63.98727011	-148.7473126	IA2	Open Needleleaf Forest	PSS3/4B	Saturated Broadleaf/Needleleaf Evergreen Scrub-Shrub Wetland
052	63.9746597	-148.7609435	IIC2	Open Low Scrub	PSS1/EM1B	Saturated Broadleaf Scrub-Shrub/Emergent Wetland
053	63.97863817	-148.7569243	IIC1	Closed Low Scrub	PSS1C	Seasonally Flooded Broadleaf Scrub-Shrub Wetland
054	63.98163454	-148.7528252	IA2	Open Needleleaf Forest	U	Upland (non-wetland)
055	63.9820543	-148.7523324	IIA3	Dwarf Tree Scrub Woodland	U	Upland (non-wetland)
056	63.9822579	-148.7513742	IIC1	Closed Low Scrub	PSS1C	Seasonally Flooded Broadleaf Scrub-Shrub Wetland
057	63.98274229	-148.751988	IA3	Needleleaf Woodland	U	Upland (non-wetland)
058	63.98528938	-148.7480485	IA3	Needleleaf Woodland	U	Upland (non-wetland)
059	63.98452437	-148.7477005	IIC2	Open Low Scrub	PSS1/EM1C	Seasonally Flooded Broadleaf Scrub-Shrub/Emergent Wetland
060	63.98387183	-148.7474151	IA3	Needleleaf Woodland	U	Upland (non-wetland)
061	63.98286249	-148.7476379	IA3	Needleleaf Woodland	U	Upland (non-wetland)
062	63.98391693	-148.746289	IIA3	Dwarf Tree Scrub Woodland	PSS4/EM1B	Saturated Needleleaf Scrub-Shrub/Emergent Wetland
063	63.98406688	-148.7458808	IIC2	Open Low Scrub	PSS1/EM1C	Seasonally Flooded Broadleaf Scrub-Shrub/Emergent Wetland
064	63.98438263	-148.7459733	IIC2	Open Low Scrub	PSS1/EM1C	Seasonally Flooded Broadleaf Scrub-Shrub/Emergent Wetland
065	63.98683769	-148.7443711	IA2	Open Needleleaf Forest	U	Upland (non-wetland)
066	63.98717246	-148.7449135	IA3	Needleleaf Woodland	U	Upland (non-wetland)
067	63.98659361	-148.7452712	IA3	Needleleaf Woodland	U	Upland (non-wetland)
200	64.00017698	-148.713362	IIC2	Open Low Scrub	U	Upland (non-wetland)
201	64.00017883	-148.7130643	IIC2	Open Low Scrub	U	Upland (non-wetland)
202	64.00028712	-148.7124462	IA2	Open Needleleaf Forest	U	Upland (non-wetland)
203	64.0000712	-148.7118459	BSV	Barren/Sparsely Vegetated	U	Upland (non-wetland)
204	63.99963241	-148.7104187	IA3	Needleleaf Woodland	U	Upland (non-wetland)

Site ID	Latitude	Longitude	Vegetation Mapping Code	Vegetation Type	Wetland Mapping Code	Wetland Type
205	63.99905222	-148.7086253	IIC2	Open Low Scrub	PSS1/EM1B	Saturated Broadleaf Scrub-Shrub/Emergent Wetland
206	63.99792912	-148.71269	IIC2	Open Low Scrub	PSS1/EM1B	Saturated Broadleaf Scrub-Shrub/Emergent Wetland
207	63.99297928	-148.7232174	IIC1	Closed Low Scrub	U	Upland (non-wetland)
208	63.99361085	-148.7241863	IIB1	Closed Tall Scrub	U	Upland (non-wetland)
209	63.99342855	-148.7260678	IIC2	Open Low Scrub	PSS1B	Saturated Broadleaf Scrub-Shrub Wetland
210	63.99017435	-148.7385452	IIC2	Open Low Scrub	PSS1/EM1C	Seasonally Flooded Broadleaf Scrub-Shrub/Emergent Wetland
211	63.9914624	-148.7341075	IA3	Needleleaf Woodland	U	Upland (non-wetland)
212	63.99140239	-148.7342149	IA3	Needleleaf Woodland	U	Upland (non-wetland)
213	63.9905279	-148.7360958	IIC2	Open Low Scrub	PSS1/EM1C	Seasonally Flooded Broadleaf Scrub-Shrub/Emergent Wetland
214	64.00640641	-148.7169902	IIC2	Open Low Scrub	PSS1/EM1B	Saturated Broadleaf Scrub-Shrub/Emergent Wetland
215	64.00637297	-148.7177924	IA3	Needleleaf Woodland	U	Upland (non-wetland)
216	64.00583284	-148.7168601	IIC2	Open Low Scrub	U	Upland (non-wetland)
217	64.00124425	-148.7207055	IA3	Needleleaf Woodland	U	Upland (non-wetland)
218	64.00036155	-148.7209981	IIC2	Open Low Scrub	U	Upland (non-wetland)
219	64.00064151	-148.7219098	IIC2	Open Low Scrub	PSS1/EM1B	Saturated Broadleaf Scrub-Shrub/Emergent Wetland
220	64.00059298	-148.7226048	IIC2	Open Low Scrub	PSS1/EM1B	Saturated Broadleaf Scrub-Shrub/Emergent Wetland
221	63.99475448	-148.7415014	IA3	Needleleaf Woodland	U	Upland (non-wetland)
222	63.99519042	-148.7427534	IA3	Needleleaf Woodland	U	Upland (non-wetland)
223	63.99423103	-148.7371154	IIIA3	Wet Graminoid Herbaceous	PSS1/EM1C	Seasonally Flooded Broadleaf Scrub-Shrub/Emergent Wetland
224	63.99376231	-148.735022	IIIA3	Wet Graminoid Herbaceous	PSS1/EM1C	Seasonally Flooded Broadleaf Scrub-Shrub/Emergent Wetland
225	63.9942208	-148.7342146	IA3	Needleleaf Woodland	U	Upland (non-wetland)
226	63.97878293	-148.7555239	IA2	Open Needleleaf Forest	U	Upland (non-wetland)
227	63.98077548	-148.7516311	IIA3	Dwarf Tree Scrub Woodland	U	Upland (non-wetland)
228	63.98116867	-148.7511592	IA2	Open Needleleaf Forest	U	Upland (non-wetland)
229	63.98180922	-148.7509586	IA2	Open Needleleaf Forest	U	Upland (non-wetland)
230	63.98558317	-148.7456151	IA3	Needleleaf Woodland	U	Upland (non-wetland)
231	63.98565182	-148.7445869	IA3	Needleleaf Woodland	U	Upland (non-wetland)
232	63.98702963	-148.742303	BSV	Barren/Sparsely Vegetated	U	Upland (non-wetland)
233	63.98786087	-148.7437123	IA2	Open Needleleaf Forest	U	Upland (non-wetland)
234	63.9882041	-148.7439096	IA2	Open Needleleaf Forest	U	Upland (non-wetland)

CHAPTER IX

FISH AND WILDLIFE INFORMATION

TABLE OF CONTENTS

Page

1.0 INTRODUCTION CIX-1

2.0 METHODOLOGY CIX-2

2.1 Field Survey CIX-2

2.2 Fish and Wildlife Habitat Evaluation CIX-2

3.0 FISH AND WILDLIFE SPECIES IN PROJECT AREA CIX-4

3.1 Common Wildlife Species in the Project Area CIX-4

3.1.1 Birds CIX-4

3.1.2 Mammals CIX-7

3.1.3 Amphibians CIX-7

3.1.4 Fish CIX-7

4.0 HABITAT TYPES OBSERVED IN THE PROJECT AREA CIX-10

4.1 Streams CIX-10

4.2 Terrestrial Habitats CIX-10

4.2.1 Herbaceous Habitats CIX-11

4.2.2 Shrub Habitats CIX-12

4.2.3 Forested Habitats CIX-12

5.0 THREATENED AND ENDANGERED SPECIES CIX-14

6.0 BALD AND GOLDEN EAGLES CIX-14

7.0 REFERENCES CIX-15

8.0 RESPONSIBLE PARTY CIX-16

LIST OF TABLES

Page

Table CIX-1 Common Bird Species of the Denali Park and Reserve Potentially Found in the Project Area……...…CIX-5

Table CIX-2 Mammal Species of the Denali National Park and Reserve Area Potentially Found in the Project Area……CIX-8

Table CIX-3 Summary of Terrestrial Habitats……...CIX-13

LIST OF EXHIBITS

Exhibit CIX-1 WHPacific's Jumbo Dome Habitat and Vegetation Maps…….....CIX-20

LIST OF APPENDICES

Appendix CIX-1 Fish and Wildlife Habitat Evaluation for Jumbo Dome Mine by WHPacific…….CIX-17

Appendix CIX-2 Fish Assessment for Marguerite Creek by WHPacfic……CIX-18

Appendix CIX – 3 Stream Morphology Report , Marguerite Creek, Jumbo Dome Area by WHPacific……..CIX-19

1.0 INTRODUCTION

Fish and wildlife resources within the Hoseanna Creek basin have been inventoried and assessed in two separate previous studies. These studies were designed to evaluate the effects of development activities in the local area and are directly applicable to the proposed Jumbo Mine Road Corridor Project. They are entitled "Biological Studies of a Proposed Power Plant Site Near Healy, Alaska" and "Wildlife Food Habits and Habitat Use on Revegetated Stripmine Land in Alaska." The first study was completed in February, 1979 by Woodward-Clyde Consultants for the Golden Valley Electric Association. The second study is a thesis that was prepared and published by Chuck Elliott in 1984. Copies of these studies are included in Usibelli Coal Mine, Inc.'s surface coal mining permit application for the Poker Flats mine which is on file with the Division of Mining and Water Management in Anchorage.

The field survey work for the studies included aquatic sampling of Hoseanna Creek which adjoins the permit area for the Jumbo Dome Mine permit area. Study results indicated that there are low numbers of small mammals, furbearers, and large mammals and low to moderate numbers of songbirds, waterfowl, and raptors within the area.

To support environmental permitting for development of the Jumbo Dome Mine, WHPacific, Inc. (formerly ASCG) conducted a wetland, vegetation, and fish and wildlife habitat survey of the Jumbo Dome Mine project area in the summer of 2007. The field investigation for wetlands, vegetation, and wildlife habitat was conducted between June 5 and July 15, 2007. Fishery studies were conducted May and July of 2008. Stream morphology field studies were conducted July, August and September of 2008 by WHPacific. These reports were used to develop this chapter. The reports may be found in the appendices of this chapter. All appendices, raw data, and photos associated with these reports not referenced in this chapter are available upon request.

2.0 METHODOLOGY

2.1 FIELD SURVEY

During the course of the wetland investigation, notes were compiled on the wetland delineation data forms on evidence of wildlife use in the project area. Notes documented wildlife evidence including direct observations, vegetation browse indicators, tracks, scats, trails, and similar wildlife sign. The data forms, including wildlife habitat notes, and site photos can be provided upon request.

Fish sampling efforts were undertaken to determine the distribution and diversity of fish populations in the project area. Sampling efforts were timed to determine potential for spawning and residential fish populations. Sampling efforts included the use of beach seines, minnow traps, angling, and electro-shocking.

Stream morphology study was conducted on Marguerite Creek beginning at the confluence with Emma Creek and extending 13,100 feet through the Jumbo Dome Mine project area to the upper reaches of Marguerite Creek. WHPacific conducted a Rosgen Level II survey to characterize the stream channel types and typical habitats and provide a baseline understanding of the general function and character of the stream.

2.2 FISH AND WILDLIFE HABITAT EVALUATION

Habitat types were evaluated using the National Wetland Inventory (NWI) classifications of the delineated wetland habitats (Cowardin et al., 1979), the Alaska vegetation classifications (Viereck et al., 1992) for both wetland and non-wetland areas, and general landscape properties that affect wildlife use and distribution such as habitat quality, land use, and other site characteristics.

Habitat types were derived from a combination of the above resources, the derived habitat classes, and habitat characteristics from Alaska's Comprehensive Wildlife Strategy (ADF&G 2006). Habitat maps were prepared using AutoCAD software, using soil mapping units associated with Viereck plant community classes as the basis (see below for a discussion of methodology). See the attached set of Habitat Maps.

Common wildlife species present in the area were determined using species lists for the Denali National Park (NPS 2008), the Alaska Department of Natural Resources (DNR) Preliminary Best Interest Finding for the Healy Basin (2005), site observations (see Field Sheets), and the Alaska Department of Fish and Game (ADF&G) Wildlife Notebook Series (2004). Characteristic uses of habitat(s) by species were derived from information on the NatureServe Explorer website (NatureServe, 2008) and the ADF&G Wildlife Notebook Series (ADF&G, 2004).

Sampling locations were chosen to determine the extent of fish populations that may be fragmented upstream and downstream by mining activities, potential populations within the proposed mining limits, and to determine overall diversity of fish communities in the project area and adjacent areas. Fish species were identified, measured, counted, and checked for ripeness.

Representative reaches of Marguerite Creek were established within the 13,100 foot study area in an effort to characterize representative stream channel types and to capture variations throughout the valley. Within these reaches a longitudinal profile was obtained, representative cross sections were established, and pebble counts were made to characterize substrate.

3.0 FISH AND WILDLIFE SPECIES IN PROJECT AREA

3.1 COMMON WILDLIFE SPECIES IN THE PROJECT AREA

According to the National Park Service (NPS) website for Denali National Park 165 species of birds, 38 species of mammals, and 1 amphibian species have been identified inside the Park and Reserve. According to the Healy Basin Best Interest Finding, 139 species of birds have been identified in the Healy basin and nine (9) species of fish. The common species of fish and wildlife found in proximity to the project area are listed in the subheadings below.

3.1.1 Birds

Bird species at least fairly common during some time of the year for the Denali National Park and Reserve are shown in Table CIX-1 below. Many of the shorebirds and waterfowl listed below have a low probability of being found on site, as appropriate habitat is not present.

TABLE CIX-1 COMMON BIRD SPECIES OF THE DENALI PARK AND RESERVE POTENTIALLY FOUND IN THE PROJECT AREA	
Scientific Name	**Common Name**
Actitis macularia	Spotted Sandpiper
Anas acuta	Northern Pintail
Anas Americana	American Widgeon
Anas clypeata	Northern Shoveler
Anas crecca	Green-winged Teal
Anas platyrhynchos	Mallard
Anser albifrons	Greater White-fronted Goose
Aquila chrysaetos	Golden Eagle
Aytha marila	Greater Scaup
Bubo virginianus	Great-horned Owl
Bucephala albeola	Bufflehead
Bucephala islandica	Barrow's Goldeneye
Calcarius lapponicus	Lapland Longspur
Calidris minutilla	Least Sandpiper
Carduelis flammea	Common Redpoll
Catharus minimus	Gray-cheeked Thrush
Catharus ustulatus	Swainson's Thrush
Charadrius semipalmatus	Semipalmated Plover
Circus cyaneus	Northern Harrier
Colaptes auratus	Northern Flicker
Cygnus buccinators	Lesser Scaup
Cygnus buccinators	Trumpeter Swan
Dendroica petechia	Yellow Warbler
Eremophila alpstris	Horned Lark
Falcipennis Canadensis	Spruce Grouse
Falco columbarius	Merlin

TABLE CIX-1 COMMON BIRD SPECIES OF THE DENALI PARK AND RESERVE POTENTIALLY FOUND IN THE PROJECT AREA	
Scientific Name	**Common Name**
Falco sparverius	American Kestrel
Gallinago gallinago	Common Snipe
Histionicus histrionicus	Harlequin Duck
Ixoreus naevius	Varied Thrush
Lagopus mutus	Rock Ptarmigan
Melospiza lincolnii	Lincoln's Sparrow
Oenanthe oenanthe	Northern Wheatear
Passerculus sandwichensis	Savannah Sparrow
Passerella iliaca	Fox Sparrow
Petrochelidon pyrrhonota	Cliff Swallow
Phalaropus lobatus	Red-necked Phalarope
Phylloscopus borealis	Arctic Warbler
Pica hudsonia	Black-billed Magpie
Plectrophenax nivalis	Snow bunting
Podiceps auritus	Horned Grebe
Poecile atricapilla	Black-capped Chickadee
Poecile hudsonica	Boreal chickadee
Regulus calendula	Ruby-crowned Kinglet
Riparia riparia	Bank Swallow
Sayornis saya	Say's Phoebe
Sterna pardisaea	Arctic Tern
Tachycineta thalassina	Violet-green Swallow
Tringa flavipes	Lesser Yellowlegs
Vermivora celata	Orange-crowned Warbler
Wilsonia pusilla	Wilson's Warbler

3.1.2 Mammals

Common mammals identified in the Denali Park and Reserve and potentially found in the project area are included in Table CIX-2.

3.1.3 Amphibians

The wood frog (*Rana sylvatica*) is the only known amphibian species potentially in the project area.

3.1.4 Fish

Fish species identified by Alaska DNR (James Durst, ADNR, 2007) as potentially residing in Marguerite and Emma Creeks include: Arctic grayling (*Thymallus arcticus*), round whitefish (*Prosopium cylindraceum*), Dolly Varden (*Salvelinus malma*), and slimy sculpin (*Cottus cognatus*).

Fish sampling efforts yielded a low diversity of species but an extensive distribution of the two most common species, arctic grayling and slimy sculpin. Sampling efforts yielded one round white fish and no Dolly Varden.

TABLE CIX-2 MAMMAL SPECIES OF THE DENALI NATIONAL PARK AND RESERVE AREA POTENTIALLY FOUND IN THE PROJECT AREA	
Scientific Name	**Common Name**
Alces alces	moose
Canis latrans	coyote
Canis lupis	wolf
Castor canadenisis	beaver
Clethrionomys rutilus	northern red-backed vole
Erethizon dorsatum	porcupine
Glaucomys sabrinus	northern flying squirrel
Gulo gulo	wolverine
Lemmus trimucronatus	brown lemming
Lepus americanus	snowshoe hare
Lontra Canadensis	northern river otter
Lynx Canadensis	Canada lynx
Marmota caligata	hoary marmot
Martes Americana	American marten
Microtus spp.	voles
Mustela ermine	ermine
Scientific Name	Common Name
Mustela nivalis	least weasel
Mustela vison	mink
Myotis lucifugus	little brown bat
Ochotona collaris	collared pika
Ondatra zibethicus	muskrat
Ovis dalli	Dall's sheep
Rangifer tarandus	caribou
Sorex spp.	shrews
Spermophilus parryii	arctic ground squirrel

TABLE CIX-2 MAMMAL SPECIES OF THE DENALI NATIONAL PARK AND RESERVE AREA POTENTIALLY FOUND IN THE PROJECT AREA	
Scientific Name	**Common Name**
Synaptomys borealis	northern bog lemming
Tamiasciurus hudsonicus	red squirrel
Ursus americanus	black bear
Ursus arctos	brown bear
Vulpes vulpes	red fox
Zapus hudsonius	meadow jumping mouse
Mustela nivalis	least weasel

4.0 HABITAT TYPES OBSERVED IN THE PROJECT AREA

Terrestrial habitats including uplands and wetlands and riverine habitats were identified in the project area. Habitat types, typically associated fish and wildlife species, and potential project impacts are discussed in the following sections.

4.1 STREAMS

Streams (Marguerite Creek, Emma Creek, and their major tributaries) are a significant project area feature. These streams contain resident slimy sculpin and a seasonal spawning run as well as resident arctic grayling. The majority of the stream reaches are contained within well developed floodplains. Slopes are gentle throughout the study area (approximately 0.05-1.5%) and point bars are common. Attributes that lead to high enrichment ratios (and low degrees of entrenchment), including relatively narrow bankfull widths relative to floodprone widths, were observed throughout the study area. All of study area was highly sinuous, with large meanders coursing through the well developed floodplain. Also consistent throughout the study area were the presence of hard points associated with coal seams and bedrock outcrops. Based upon the results of the surveyed reaches and these observations it is estimated that most of the stream segments can be classified as C3 or C4 stream types.

4.2 TERRESTRIAL HABITATS

The project baseline study area is 4,798 acres in size. Approximately 2,926 acres of the project baseline area is forested habitat, 1,755 acres is shrub habitat, and 74 acres is herbaceous habitat, and 40 acres are rock outcrops, with the balance (3 acres) being roads. Out of the total impact area of 909 acres, the respective impacts to various habitats include 34 acres of herbaceous habitat, 310 acres of shrub habitat, 561 acres of forest habitat, 3 acres of roadways, and 1 acre of rock outcrops (See Table CIX-3). Note that these totals include areas in the Riverine (Cowardin) classification along the major streams, which typically fall into the shrub or herbaceous habitat types under the Viereck classification.

Distribution of these habitats is depicted in the attached set of Habitat Maps (Exhibit CIX-1). Habitat types, including descriptions of associated fish and wildlife species, are included in the following sections. Project impacts were calculated by overlaying the proposed mine footprint over the wetland and vegetation mapping in AutoCAD.

Many of the mammal species listed in Table CIX-2 and some of the more cosmopolitan bird species will be found across all of the terrestrial habitat types and communities. Moose, caribou, wolf, black and brown bear, least weasel, wolverine, voles, shrews, lemmings, red fox, mice, ermine, hare, and little brown bat may use all of the terrestrial habitat for a combination of feeding, breeding, and cover.

4.2.1 Herbaceous Habitats

Herbaceous habitats are those dominated by terrestrial or emergent non-woody vegetation. Tree cover is generally less than 10%, and shrub cover is generally less than 25%. Wet graminoid herbaceous habitats are dominated by non-woody vegetation and are found in the project area in association with emergent wetland plant communities. Wet graminoid herbaceous communities are found throughout the project area with several over ten acres in size. These communities are commonly found in topographically flat or slightly depressional portions of the project area.

Ducks and geese may forage in wet and dry meadows, although they are less common in habitat distant from open water. Herbaceous communities on flats, in broad shallow drainages, and adjacent to Marguerite Creek and its tributaries may provide nesting and feeding habitat for ducks and geese, grebes, and snipe. Ptarmigan, birds of prey, swallows, sparrows, and magpies are expected to feed in herbaceous areas in the project area.

Mammals including mice, voles, lemmings, pika, ground squirrel, and mink utilize herbaceous habitats for feeding, cover, and breeding. Beaver, mink, muskrat, and river otter are expected to be found in herbaceous habitats adjacent to Marguerite Creek and its tributaries.

4.2.2 Shrub Habitats

Shrub habitats are dominated by woody, multi-stemmed vegetation that is short in stature. Under the Viereck classification, shrub habitat is less than 10 percent and shrub cover is 25 percent or greater. Shrub habitats were found throughout the project area on slopes, flats, in drainages, and in floodplains, and included wetland and upland habitats. Shrub habitats are utilized by many songbirds, ptarmigan, and grouse for feeding, nesting, and cover. Hare, porcupine, and mink are expected to use shrub habitats for feeding, breeding, and cover. Lemmings and other small mammals utilize shrub habitats for feeding and breeding. Moose regularly utilize willow shrub communities for browse, and river otter, beaver, and muskrat will utilize the habitat when adjacent to Marguerite Creek and its tributaries.

4.2.3 Forested Habitats

According to the Viereck classification (Viereck et al, 1992), forested habitats are those dominated by single–stem terrestrial woody vegetation. Habitats with greater than 10 percent tree cover are generally considered a forested habitat. Forested habitats are further classified by the percent of canopy cover and species composition or dominance into needleleaf or mixed woodland (10-24% tree cover), open forest (25-59% tree cover) and closed forest (>60% tree cover). All of these communities are represented in the project area.

Many large and small mammals utilize forested habitat. Caribou, coyote, wolverine, lynx, snowshoe hare, marten, porcupine, red and northern flying squirrels most commonly utilize forest habitats for feeding, cover, and breeding. In addition, many birds of prey, grouse, and songbirds utilized these habitats for nesting and feeding.

TABLE CIX-3 SUMMARY OF TERRESTRIAL HABITATS		
Viereck Classification	**Project Area (Acres)**	**Project Impacts (Acres)**
Herbaceous Habitats (<10% tree cover, <25% shrub cover)		
Wet Graminoid Herbaceous	74	34
Total Herbaceous Habitat	**74**	**34**
Shrub Habitats (<10% tree cover, >25% shrub cover)		
Open Tall Scrub	106	11
Closed Tall Scrub	467	126
Open Low Scrub	248	42
Closed Low Scrub	921	119
Open Dwarf Tree Scrub	13	12
Total Shrub Habitat	**1,755**	**310**
Forested Habitats (>10% tree cover)		
Closed Canopy Forests (>60% tree cover)		
Closed Needleleaf Forest	24	5
Closed Mixed Forest	35	17
Closed Broadleaf Forest	44	-
Closed Canopy Subtotal	**103**	**22**
Open Canopy Forest (25-59% tree cover)		
Open Needleleaf Forest	1,110	226
Open Mixed Forest	197	44
Open Broadleaf Forest	30	0
Open Canopy Subtotal	**1,337**	**270**
Woodlands (10-24% tree cover)		
Needleleaf Woodland	1,345	250
Mixed Woodland	30	0
Dwarf Tree Scrub Woodland	111	19
Woodlands Subtotal	**1,486**	**269**
Total Forested Habitat	**2,926**	**561**
Disturbed Areas (Roads etc.)	**3**	**3**
Rock Outcrops	**40**	**1**
TOTAL AREA	**4,798**	**909**

5.0 THREATENED AND ENDANGERED SPECIES

Plant and animal species listed under the Endangered Species Act are not expected in the project area. In addition, planned development of the Jumbo Dome Mine is not expected to impact listed species or critical habitat in or outside of the project area. Many of the species listed in Alaska are marine mammals and coastal or marine birds and are removed from the influence of development activities.

6.0 BALD AND GOLDEN EAGLES

Ground surveys of the project area have not identified bald or golden eagle nests in the project area. Typical nesting and foraging habitat for bald eagles is limited or absent on site and the species is not expected to occur here. Golden eagles have the potential to occur in the project area, but nearby nest sites (rocky cliffs and large trees) are not immediately available for the species on site.

7.0 REFERENCES

ADF&G. 1994. *ADF&G Wildlife Notebook Series*. Juneau, AK. March 13-16, 2008 http://www.adfg.state.ak.us/pubs/notebook/notehome.php

ADF&G. 2006. *Our Wealth Maintained: A Strategy for Conserving Alaska's Diverse Wildlife and Fish Resources*. April 2006. Juneau, AK. March 13-16, 2008 http://www.sf.adfg.state.ak.us/statewide/ngplan/ng_outline.cfm

Alaska DNR. 2005. Proposed Healy Basin Exploration License: Preliminary Finding of the Director. August, 2005. Juneau, AK. March 13-16, 2008. http://www.dog.dnr.state.ak.us/oil/products/publications/healy/healy_toc.htm

Kautz, D.R. and P. Taber. 2004. *Land Resource Regions and Major Land Resource Areas of Alaska*. U.S. Department of Agriculture, Natural Resources Conservation Service, Major Land Resource Region 17. Palmer, AK.

National Park Service. 2008. Animals of Denali National Park. NPS. U.S. Department of the Interior. Washington, D.C.. March 13-16, 2008 http://www.nps.gov/dena/naturescience/animals.htm.

NatureServe. 2007. NatureServe Explorer: An Online Encyclopedia of Life [web application]. Version 6.2. NatureServe. Arlington, VA. March 13-16, 2008 http://www.natureserve.org/explorer.

Viereck, L.A., C.T. Dyrness, A.R. Batten, and K.J. Wenzlick. 1992. The Alaska Vegetation Classification Gen. Tech. Rep. PNW-GTR-286. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. Portland, OR.

8.0 RESPONSIBLE PARTY

This section prepared by WHPacific, Inc.

APPENDIX CIX-1

FISH & WILDLIFE HABITAT EVALUATION

Fish and Wildlife Habitat Evaluation for:

Jumbo Dome Mine, Healy, Alaska

Prepared for

Usibelli Coal Mine

May 27, 2008

Prepared by

WHPacific, Inc.
515 7th Avenue, Suite 310
Fairbanks, Alaska 99701

WHPacific

Prepared for: Bartly Coiley, Environmental Affairs Manager
Usibelli Coal Mine
100 Cushman Street, Suite 210
Fairbanks, AK 99701

Title: Fish and Wildlife Habitat Evaluation

Project: Jumbo Dome Mine
Healy, Alaska

Prepared by: WHPacific, Inc.
515 7th Avenue, Suite 310
Fairbanks, Alaska 99701

Contact: Philip J. Quarterman, PWS
Sr. Wetland Scientist
WHPacific, Inc., Portland OR.
(503) 372-3562
pquarterman@whpacific.com

TABLE OF CONTENTS

1.0 INTRODUCTION 3
1.1 LOCATION 3
1.2 PROJECT DESCRIPTION 3
2.0 METHODOLOGY 3
2.1 FIELD SURVEY 3
2.2 FISH AND WILDLIFE HABITAT EVALUATION 4
3.0 GENERAL DESCRIPTION OF PROJECT AREA 4
3.1 VEGETATION 4
3.2 SOILS 5
3.3 HYDROLOGY 5
4.0 FISH AND WILDLIFE SPECIES IN PROJECT AREA 5
4.1 COMMON WILDLIFE SPECIES IN THE PROJECT AREA 5
4.1.1 BIRDS 5
4.1.2 MAMMALS 6
4.1.3 AMPHIBIANS 6
4.1.4 FISH 7
5.0 HABITAT TYPES OBSERVED IN THE PROJECT AREA 7
5.1 STREAMS 7
5.2 TERRESTRIAL HABITATS 7
5.2.1 HERBACEOUS HABITATS 8
5.2.2 SHRUB HABITATS 8
5.2.3 FORESTED HABITATS 9
6.0 THREATENED AND ENDANGERED SPECIES 10
7.0 BALD AND GOLDEN EAGLES 10
8.0 LITERATURE AND OTHER DATA SOURCES 11

LIST OF TABLES

Table 1 Common Bird Species of the Denali Park and Reserve Potentially Found in the Project Area
Table 2 Mammal Species of the Denali National Park and Reserve Area Potentially Found in the Project Area
Table 3 Summary of Terrestrial Habitats and Estimated Impacts

LIST OF APPENDICES

Appendix A: Background Data
Appendix A.1 Amphibians
Appendix A.2 Birds

Appendix A.3 Fish
Appendix A.4 Mammals
Appendix B: Data Sheets and Site Photographs

ACRONYMS AND ABBREVIATIONS

ADNR	Alaska Department of Natural Resources
ADL	Alaska Division of Land
ATV	All Terrain Vehicle
CEP	Certified Environmental Professional
CFR	Code of Federal Regulations
FAC	Facultative Species
FACU	Facultative Upland Species
FACW	Facultative Wetland Species
HGM	Hydrogeomorphic
NAD 83	North American Datum 1983
NI	Non-indicator species
NRCS	Natural Resources Conservation Service
NWI	National Wetland Inventory
NWR	National Wildlife Refuge
OBL	Obligate Wetland Species
OHMP	Office of Habitat Management and Permitting
OHW	Ordinary High Water
PWD	Preliminary Wetland Delineation
Section 404	Section 404 of the Clean Water Act
UCM	Usibelli Coal Mine, Inc.
UPL	Upland Species
USACE	U.S. Army Corps of Engineers
USC	United States Code
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

1.0 INTRODUCTION

Usibelli Coal Mine, Inc. (UCM) is planning to develop the Jumbo Dome Mine to extract coal resources in the leased area following results of preliminary resource exploration in 2007.

To support environmental permitting for development of the Jumbo Dome Mine WHPacific, Inc. (formerly ASCG) conducted a wetland, vegetation, and fish and wildlife habitat survey of the project area in the summer of 2007. The field investigation was conducted between June 5 and July 15, 2007.

1.1 Location

The project area near Healy, Alaska (approximately 10 miles northeast) is approximately 4,800 acres in size and is located to the west and northwest of the geologic feature of Jumbo Dome. The Jumbo Dome Mine is located in Townships 10 and 11 South, Range 6 West, Fairbanks Meridian.

The project area lies in the northern foothills of the central Alaska Range. The terrain is hilly with the valleys of Marguerite and Emma Creeks and the northwest slopes of Jumbo Dome dominating the landscape forms.

1.2 Project Description

UCM has coal lease holdings in the project area. UCM has conducted exploratory studies of the coal reserves and intends to develop the mine site for the extraction of coal resources. Coal resources will be removed by surface mining following procedures typical to other UCM mines. Mined lands will be reclaimed as the mining activity moves through the project area.

A pre-mining soil inventory will be completed prior to mining activities and soils will be saved for use in reclaiming the site. A vegetation survey in the project area was completed in the summer of 2007. Data from this survey will be used to determine revegetation measures. UCM intends to reclaim the mine area to wildlife habitat as this is the primary current land use.

With the proposed mine development, Marguerite Creek will be rerouted during active mining, but will be restored to an approximation of its existing course and structure at the conclusion of mining activities. A hydrogeomorphic study of the creek in the project area will be completed during the summer of 2008 to determine the nature of the system and to aid in the reclamation of Marguerite Creek.

2.0 METHODOLOGY

2.1 Field Survey

During the course of the wetland investigation, notes were compiled on the wetland delineation data forms on evidence of wildlife use in the project area. Notes documented wildlife evidence including direct observations, vegetation browse indicators, tracks, scats, trails, and similar

wildlife sign. The data forms, including wildlife habitat notes, and site photos are presented in Appendix B.

2.2 Fish and Wildlife Habitat Evaluation

Habitat types were evaluated using the National Wetland Inventory (NWI) classifications of the delineated wetland habitats (Cowardin et al., 1979), the Alaska vegetation classifications (Viereck et al., 1992) for both wetland and non-wetland areas, and general landscape properties that affect wildlife use and distribution such as habitat quality, land use, and other site characteristics.

Habitat types were derived from a combination of the above resources, the derived habitat classes, and habitat characteristics from Alaska's Comprehensive Wildlife Strategy (ADF&G 2006). Habitat maps were prepared using AutoCAD software, using soil mapping units associated with Viereck plant community classes as the basis (see below for a discussion of methodology). See the attached set of Habitat Maps.

Common wildlife species present in the area were determined using species lists for the Denali National Park (NPS 2008), the Alaska Department of Natural Resources (DNR) Preliminary Best Interest Finding for the Healy Basin (2005), site observations (see Field Sheets), and the Alaska Department of Fish and Game (ADF&G) Wildlife Notebook Series (2004), . Characteristic uses of habitat(s) by species were derived from information on the NatureServe Explorer website (NatureServe, 2008) and the ADF&G Wildlife Notebook Series (ADF&G, 2004). Excerpts for habitat of commonly-occurring species in the project area from the above resources are presented in Appendix A.

3.0 GENERAL DESCRIPTION OF PROJECT AREA

According to Land Resource Regions and Major Land Resource Areas of Alaska (Kautz and Taber, 2004), the project area is within Major Land Resource Area (MLRA) 228, Interior Alaska Mountains. This region encompasses major interior mountain chains including the Alaska Range and its associated glaciated hills and plains where the project area is located.

Brief summers and long, cold winters are characteristic of the area and region. Average annual temperatures and precipitation varying greatly in the MLRA, but are typically 15-20 inches in the lower elevations and the frost-free period varies from 50 to 80 days.

3.1 Vegetation

Upland conditions support a mixture of white spruce forest, paper-birch-quaking aspen forest, and dry forb herbaceous communities. Wetland conditions in the project area support sedge-cottongrass wet meadow, bluejoint meadow, willow shrub and alder-willow shrub communities, and black spruce woodlands and forest, and ericaceous shrub tundra. Out of the total project area of 4,798 acres, the total acreage of uplands in the project area is approximately 3,371 acres. Total acreage of wetlands and other waters is 1,427 acres (see wetland delineation report).

3.2 Soils

Soils in the project area are described in detail in the accompanying report Soil Resources of Jumbo Dome Area (WHPacific, May 1, 2008), prepared by Dr. Chien-Lu Ping, CPSS. The report describes the results of an on-site soil survey, and includes detailed soil unit mapping.

3.3 Hydrology

Wetlands in the project area include riparian wetlands and wetlands that are precipitation driven. Spring runoff from snowmelt and summer rains drains into area wetlands and lead to the Marguerite and Emma Creeks in the project area. These creeks lead to California Creek, a tributary of the Totatlanika River, a tributary of the Tanana River in the Yukon River system. No lakes were identified in the project area.

4.0 FISH AND WILDLIFE SPECIES IN PROJECT AREA

4.1 Common Wildlife Species in the Project Area

According to the National Park Service (NPS) website for Denali National Park 165 species of birds, 38 species of mammals, and 1 amphibian species have been identified inside the Park and Reserve. According to the Healy Basin Best Interest Finding, 139 species of birds have been identified in the Healy basin and nine (9) species of fish. The common species of fish and wildlife found in proximity to the project area are listed in the subheadings below.

4.1.1 Birds

Bird species at least fairly common during some time of the year for the Denali National Park and Reserve are shown in Table 2 below. Many of the shorebirds and waterfowl listed below have a low probability of being found on site, as appropriate habitat is not present.

Table 1: Common Bird Species of the Denali Park and Reserve Potentially Found in the Project Area

Scientific Name	Common Name		Scientific Name	Common Name
Actitis macularia	Spotted Sandpiper		*Gallinago gallinago*	Common Snipe
Anas acuta	Northern Pintail		*Histionicus histrionicus*	Harlequin Duck
Anas Americana	American Widgeon		*Ixoreus naevius*	Varied Thrush
Anas clypeata	Northern Shoveler		*Lagopus mutus*	Rock Ptarmigan
Anas crecca	Green-winged Teal		*Melospiza lincolnii*	Lincoln's Sparrow
Anas platyrhynchos	Mallard		*Oenanthe oenanthe*	Northern Wheatear
Anser albifrons	Greater White-fronted Goose		*Passerculus sandwichensis*	Savannah Sparrow
Aquila chrysaetos	Golden Eagle		*Passerella iliaca*	Fox Sparrow
Aytha marila	Greater Scaup		*Petrochelidon pyrrhonota*	Cliff Swallow
Bubo virginianus	Great-horned Owl		*Phalaropus lobatus*	Red-necked Phalarope
Bucephala albeola	Bufflehead		*Phylloscopus borealis*	Arctic Warbler
Bucephala islandica	Barrow's Goldeneye		*Pica hudsonia*	Black-billed Magpie
Calcarius lapponicus	Lapland Longspur		*Plectrophenax nivalis*	Snow bunting
Calidris minutilla	Least Sandpiper		*Podiceps auritus*	Horned Grebe

Scientific Name	Common Name		Scientific Name	Common Name
Carduelis flammea	Common Redpoll		*Poecile atricapilla*	Black-capped Chickadee
Catharus minimus	Gray-cheeked Thrush		*Poecile hudsonica*	Boreal chickadee
Catharus ustulatus	Swainson's Thrush		*Regulus calendula*	Ruby-crowned Kinglet
Charadrius semipalmatus	Semipalmated Plover		*Riparia riparia*	Bank Swallow
Circus cyaneus	Northern Harrier		*Sayornis saya*	Say's Phoebe
Colaptes auratus	Northern Flicker		*Sterna pardisaea*	Arctic Tern
Cygnus buccinators	Lesser Scaup		*Tachycineta thalassina*	Violet-green Swallow
Cygnus buccinators	Trumpeter Swan		*Tringa flavipes*	Lesser Yellowlegs
Dendroica petechia	Yellow Warbler		*Vermivora celata*	Orange-crowned Warbler
Eremophila alpstris	Horned Lark		*Wilsonia pusilla*	Wilson's Warbler
Falcipennis Canadensis	Spruce Grouse			
Falco columbarius	Merlin			
Falco sparverius	American Kestrel			

4.1.2 Mammals

Common mammals identified in the Denali Park and Reserve and potentially found in the project area are included in Table 3 below.

Table 2: Mammal Species of the Denali National Park and Reserve Area Potentially Found in the Project Area

Scientific Name	Common Name		Scientific Name	Common Name
Alces alces	moose		*Mustela nivalis*	least weasel
Canis latrans	coyote		*Mustela vison*	mink
Canis lupis	wolf		*Myotis lucifugus*	little brown bat
Castor canadenisis	beaver		*Ochotona collaris*	collared pika
Clethrionomys rutilus	northern red-backed vole		*Ondatra zibethicus*	muskrat
Erethizon dorsatum	porcupine		*Ovis dalli*	Dall's sheep
Glaucomys sabrinus	northern flying squirrel		*Rangifer tarandus*	caribou
Gulo gulo	wolverine		*Sorex spp.*	shrews
Lemmus trimucronatus	brown lemming		*Spermophilus parryii*	arctic ground squirrel
Lepus americanus	snowshoe hare		*Synaptomys borealis*	northern bog lemming
Lontra canadensis	northern river otter		*Tamiasciurus hudsonicus*	red squirrel
Lynx Canadensis	Canada lynx		*Ursus americanus*	black bear
Marmota caligata	hoary marmot		*Ursus arctos*	brown bear
Martes americana	American marten		*Vulpes vulpes*	red fox
Microtus spp.	voles		*Zapus hudsonius*	meadow jumping mouse
Mustela ermine	ermine		*Mustela nivalis*	least weasel

4.1.3 Amphibians

The wood frog (*Rana sylvatica*) is the only known amphibian species potentially in the project area.

4.1.4 Fish

Fish species identified by Alaska DNR (James Durst, ADNR, 2007) as potentially residing in Marguerite and Emma Creeks include: Arctic grayling (*Thymallus arcticus*), round whitefish (*Prosopium cylindraceum*), Dolly Varden (*Salvelinus malma*), and slimy sculpin (*Cottus cognatus*). Other fish species that are potentially found in the project area (although unlikely) include: Coho salmon (*Oncorhynchus kisutch*), chum salmon (*Oncorhynchus keta*), Chinook salmon (*Oncorhynchus tshawytscha*), burbot (*Lota lota*), and northern pike (*Esox lucius*).

5.0 HABITAT TYPES OBSERVED IN THE PROJECT AREA

Terrestrial habitats including uplands and wetlands and riverine habitats were identified in the project area. Habitat types, typically associated fish and wildlife species, and potential project impacts are discussed in the following sections.

5.1 Streams

Streams (Marguerite Creek, Emma Creek, and their major tributaries) are a significant project area feature. These streams are expected to contain resident slimy sculpin, Dolly Varden, and round whitefish and are also expected to receive a seasonal spawning run of Arctic grayling (James Durst, ADNR, 2007). The total area of streams in the project area is approximately 43 acres, based on the mapped area of Riverine habitat using the Cowardin classification (see wetland delineation report, p. 9)

Development of the Jumbo Dome Mine is expected to occur under and along the present stream course of Marguerite Creek. Marguerite Creek will be relocated during development and extraction of coal resources in the area. At the conclusion of mining operations in the vicinity of the existing channel, Marguerite Creek will be relocated to an approximation of its original course. Approximately 21 acres of Riverine habitat will be impacted by the project.

A 404 removal/fill permit will be obtained from the Corps of Engineers (USACE) for work expected to occur within the existing waterways on site. In addition, an analysis of fisheries resources and stream geomorphology is expected to begin in May of 2008 to document existing biological and physical resources associated with Marguerite Creek in the project area. A Fish Habitat Permit will also be required from Alaska Department of Fish and Game if fish are found to be present in the streams.

5.2 Terrestrial Habitats

The project area is 4,798 acres in size. Approximately 2,926 acres of the project area is forested habitat, 1,755 acres is shrub habitat, and 74 acres is herbaceous habitat, and 40 acres are rock outcrops, with the balance (3 acres) being roads. Out of the total impact area of 909 acres, the respective impacts to various habitats include 34 acres of herbaceous habitat, 310 acres of shrub habitat, 561 acres of forest habitat, 3 acres of roadways, and 1 acre of rock outcrops. Note that these totals include areas in the Riverine (Cowardin) classification along the major streams, which typically fall into the shrub or herbaceous habitat types under the Viereck classification.

Distribution of these habitats is depicted in the attached set of Habitat Maps. Habitat types, including descriptions of associated fish and wildlife species, are included in the following sections. Project impacts were calculated by overlaying the proposed mine footprint over the wetland and vegetation mapping in AutoCAD.

Many of the mammal species listed in Table 2 and some of the more cosmopolitan bird species will be found across all of the terrestrial habitat types and communities. Moose, caribou, wolf, black and brown bear, least weasel, wolverine, voles, shrews, lemmings, red fox, mice, ermine, hare, and little brown bat may use all of the terrestrial habitat for a combination of feeding, breeding, and cover.

5.2.1 Herbaceous Habitats

Herbaceous habitats are those dominated by terrestrial or emergent non-woody vegetation. Tree cover is generally less than 10%, and shrub cover is generally less than 25%. Wet graminoid herbaceous habitats are dominated by non-woody vegetation and are found in the project area in association with emergent wetland plant communities. Wet graminoid herbaceous communities are found throughout the project area with several over ten acres in size. These communities are commonly found in topographically flat or slightly depressional portions of the project area.

Ducks and geese may forage in wet and dry meadows, although they are less common in habitat distant from open water. Herbaceous communities on flats, in broad shallow drainages, and adjacent to Marguerite Creek and its tributaries may provide nesting and feeding habitat for ducks and geese, grebes, and snipe. Ptarmigan, birds of prey, swallows, sparrows, and magpies are expected to feed in herbaceous areas in the project area.

Mammals including mice, voles, lemmings, pika, ground squirrel, and mink utilize herbaceous habitats for feeding, cover, and breeding. Beaver, mink, muskrat, and river otter are expected to be found in herbaceous habitats adjacent to Marguerite Creek and its tributaries.

5.2.2 Shrub Habitats

Shrub habitats are dominated by woody, multi-stemmed vegetation that is short in stature. Under the Viereck classification, shrub habitat is less than 10 percent and shrub cover is 25 percent or greater. Shrub habitats were found throughout the project area on slopes, flats, in drainages, and in floodplains, and included wetland and upland habitats. Shrub habitats are utilized by many songbirds, ptarmigan, and grouse for feeding, nesting, and cover. Hare, porcupine, and mink are expected to use shrub habitats for feeding, breeding, and cover. Lemmings and other small mammals utilize shrub habitats for feeding and breeding. Moose regularly utilize willow shrub communities for browse, and river otter, beaver, and muskrat will utilize the habitat when adjacent to Marguerite Creek and its tributaries.

Table 4: Summary of Terrestrial Habitats

Viereck Classification	Project Area (Acres)	Project Impacts (Acres)
Herbaceous Habitats (<10% tree cover, <25% shrub cover)		
Wet Graminoid Herbaceous	74	34
Total Herbaceous Habitat	**74**	**34**
Shrub Habitats (<10% tree cover, >25% shrub cover)		
Open Tall Scrub	106	11
Closed Tall Scrub	467	126
Open Low Scrub	248	42
Closed Low Scrub	921	119
Open Dwarf Tree Scrub	13	12
Total Shrub Habitat	**1,755**	**310**
Forested Habitats (>10% tree cover)		
Closed Canopy Forests (>60% tree cover)		
Closed Needleleaf Forest	24	5
Closed Mixed Forest	35	17
Closed Broadleaf Forest	44	-
Closed Canopy Subtotal	**103**	**22**
Open Canopy Forest (25-59% tree cover)		
Open Needleleaf Forest	1,110	226
Open Mixed Forest	197	44
Open Broadleaf Forest	30	0
Open Canopy Subtotal	**1,337**	**270**
Woodlands (10-24% tree cover)		
Needleleaf Woodland	1,345	250
Mixed Woodland	30	0
Dwarf Tree Scrub Woodland	111	19
Woodlands Subtotal	**1,486**	**269**
Total Forested Habitat	**2,926**	**561**
Disturbed Areas (Roads etc.)	**3**	**3**
Rock Outcrops	**40**	**1**
TOTAL AREA	4,798	909

5.2.3 Forested Habitats

According to the Viereck classification (Viereck et al, 1992), forested habitats are those dominated by single–stem terrestrial woody vegetation. Habitats with greater than 10 percent tree cover are generally considered a forested habitat. Forested habitats are further classified by

the percent of canopy cover and species composition or dominance into needleleaf or mixed woodland (10-24% tree cover), open forest (25-59% tree cover) and closed forest (>60% tree cover). All of these communities are represented in the project area.

Many large and small mammals utilize forested habitat. Caribou, coyote, wolverine, lynx, snowshoe hare, marten, porcupine, red and northern flying squirrels most commonly utilize forest habitats for feeding, cover, and breeding. In addition, many birds of prey, grouse, and songbirds utilized these habitats for nesting and feeding.

6.0 THREATENED AND ENDANGERED SPECIES

Plant and animal species listed under the Endangered Species Act are not expected in the project area. In addition, planned development of the Jumbo Dome Mine is not expected to impact listed species or critical habitat in or outside of the project area. Many of the species listed in Alaska are marine mammals and coastal or marine birds and are removed from the influence of development activities.

7.0 BALD AND GOLDEN EAGLES

Ground surveys of the project area have not identified bald or golden eagle nests in the project area. Typical nesting and foraging habitat for bald eagles is limited or absent on site and the species is not expected to occur here. Golden eagles have the potential to occur in the project area, but nearby nest sites (rocky cliffs and large trees) are not immediately available for the species on site.

8.0 LITERATURE AND OTHER DATA SOURCES

ADF&G. 1994. *ADF&G Wildlife Notebook Series*. Juneau, AK. March 13-16, 2008 http://www.adfg.state.ak.us/pubs/notebook/notehome.php

ADF&G. 2006. *Our Wealth Maintained: A Strategy for Conserving Alaska's Diverse Wildlife and Fish Resources*. April 2006. Juneau, AK. March 13-16, 2008 http://www.sf.adfg.state.ak.us/statewide/ngplan/ng_outline.cfm

Alaska DNR. 2005. Proposed Healy Basin Exploration License: Preliminary Finding of the Director. August, 2005. Juneau, AK. March 13-16, 2008. http://www.dog.dnr.state.ak.us/oil/products/publications/healy/healy_toc.htm

Kautz, D.R. and P. Taber. 2004. *Land Resource Regions and Major Land Resource Areas of Alaska*. U.S. Department of Agriculture, Natural Resources Conservation Service, Major Land Resource Region 17. Palmer, AK.

National Park Service. 2008. Animals of Denali National Park. NPS. U.S. Department of the Interior. Washington, D.C.. March 13-16, 2008 http://www.nps.gov/dena/naturescience/animals.htm.

NatureServe. 2007. NatureServe Explorer: An Online Encyclopedia of Life [web application]. Version 6.2. NatureServe. Arlington, VA. March 13-16, 2008 http://www.natureserve.org/explorer.

Viereck, L.A., C.T. Dyrness, A.R. Batten, and K.J. Wenzlick. 1992. The Alaska Vegetation Classification Gen. Tech. Rep. PNW-GTR-286. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. Portland, OR.

APPENDIX CIX-2

FISHERIES ASSESSMENT FOR MARGUERITE CREEK

Fisheries Assessment for:

Marguerite Creek

Prepared for

Usibelli Coal Mine

January 16, 2008

Prepared by

WHPacific
9755 S.W. Barnes Road
Portland, Oregon 97225

WHPacific

Table of Contents

1.0 Introduction 2
1.1 Location and Site Conditions 2
2.0 Project Description 2
3.0 Methods 3
4.0 Results 4
5.0 Discussion 7
6.0 References 9

Appendix A: Maps

Figure 1: Vicinity Map and Sample Stations
– Sheet 1 Spring Effort
– Sheet 2 Summer Effort

Appendix B: Sample Data

Appendix C: Photographs

1.0 Introduction

This report presents the results of fisheries sampling conducted during the spring and summer of 2008 on Marguerite Creek and associated tributaries in the Jumbo Dome mining area. Sampling was conducted on the behalf of Usibelli Coal Mine, Inc. to determine the extent of fisheries resources as they pertain to areas associated with potential mining impact. Cursory investigations by Alaska DNR staff and expectations by state biologists had indicated the potential for important fisheries resources in the project area.

1.1 Location and Site Conditions

The project area is located approximately 10 air miles east of Healy, Alaska in the Denali Borough. Access is obtained from the Parks Highway (Highway 3), then Healy Road to the Usibelli Mine Headquarters and then on to the current primary haul road along Lignite Creek and finally to new and previously existing portions of the Popovich Trail road. The project area consists of an estimated impact area and portions of Marguerite and Emma Creek upstream and downstream of the potential impact area. The most upstream portion of the study area is upstream of the first trail/road ford of the Popovich trail over Marguerite Creek approximately 200-250 meters downstream of a large fork in the drainage (Figure 1 – Sheets 1 and 2). The most downstream extent of the study area is located at the confluence of Marguerite Creek and Mr. Adam Creek.

Marguerite Creek and Mr. Adam Creek meet downstream of the proposed central mining area to form California Creek, a major tributary to the Totatlanika River in the Tanana River-Yukon River basin. At the northernmost and most downstream portion of the proposed mining area, Emma Creek joins Marguerite Creek from the west.

The headwaters of Marguerite Creek drain from the western and southern slope of Jumbo Dome and Emma Creek enters from the west and drains the eastern slope of Walker Dome. Other smaller tributaries, including Bonanza Creek and unnamed drainages enter Marguerite Creek within the study area and generally do not exceed more than a mile in total length.

2.0 Project Description

The fisheries sampling project was undertaken by WHPacific to determine the distribution and diversity of fish populations in the project area. Two primary sampling efforts were completed to capture potential seasonal changes in fish population structure and to also document potential spawning or seasonal migrations by Arctic grayling (*Thymallus arcticus*) and Dolly Varden (*Salvelinus malma*).

The first fisheries sampling effort was conducted during the last week of May 2008. The primary objective of this sampling effort was to determine whether grayling were entering Marguerite Creek as part of a spawning migration and to document other potential resident fish populations in Marguerite Creek. The first sampling effort was timed to sample Marguerite

Creek soon after spring break-up, a time indicated when grayling have the highest likelihood of spawning. Grayling often enter spawning streams, spawn during narrow temperature windows, and then migrate downstream to larger streams for summer feeding (ADF&G 1994 and James Durst, AKDNR ,Pers. Comm., 2008). The spring sampling effort was also directed at the collection of resident fish that may have utilized springs and seeps during winter freeze-up to survive in upstream locales.

The second sampling effort was conducted at the end of July 2008 and was made in an attempt to document whether grayling and other fish utilize the project area beyond the spring spawning period. Warmer water temperatures during this time period were expected to make fish more active and to provide potential seasonal habitat to fish from downstream areas within the greater California Creek – Totatlanika River system.

3.0 Methods

Sample locations were chosen to determine the extent of fish populations that may be fragmented upstream to downstream by mining activities, potential populations within the proposed mining limits, and to determine overall diversity of fish communities in the project area and adjacent areas.

Sampling was conducted within Marguerite Creek, upstream of the upstream mining area limits, downstream of the mining area limits, and within the proposed mining area. Sampling was also conducted at the mouth of tributaries, and within tributaries themselves. Additional sampling was conducted on Emma Creek, from the creek's confluence with Marguerite Creek and within the mining area limits, to a major split in the Emma Creek drainage, well upstream from the mining area. A description of collection points is provided in Table 1 below and a map of sample reaches is located in Appendix A, Figure 1.

Sampling methods planned for the project include the use of beach seines, minnow traps, snorkeling, angling, fyke nets, and electro-shocking. Due to weather and water conditions, fyke nets and snorkeling were not employed during the sample efforts. High water events and ice break-up prevented deployment of nets, and turbidity through much of the sampling eliminated water clarity sufficient for snorkel observations. Electro-fishing, seine hauling, and angling were the most commonly utilized methods for fish collection. Seine hauling proved to be the most efficient method for collecting fish, particularly during time when turbidity limited the ability to dip net fish affected by shocking. In most instances, all fish collected were measured to standard length and their lengths were recorded. In several instances, lengths were estimated due to fish being lost from the net and during one instance when a measuring board was lost downstream. A small collection of voucher specimens was retained and several voucher photos were taken (Appendix C).

Anecdotal observations of fish distribution and habitat utilization were also made during stream survey activities conducted in late August and early September, 2008. During this time period, precipitation and accompanying turbidity were not encountered and fish, particularly grayling, were commonly observed throughout portions of the study area.

4.0 Results

Sampling during spring and summer efforts yielded an expected low diversity of species, but an extensive distribution, of the two most common species, grayling and slimy sculpin (*Cottus cognatus*). These two species were collected at all stations during at least one of the collection efforts, except Emma Creek, where sculpins were not collected. Sampling yielded one additional species, round whitefish (*Prosopium cylindraceum*) just downstream of the proposed mining limits and near the confluence of Emma and Marguerite Creeks during the summer collection effort.

A total of 105 grayling were collected during the course of fisheries sampling, with an additional 30-50 grayling observed during sample efforts. Sizes of grayling ranged between 64 and 220 mm standard length. The largest collection of grayling collected during sample efforts was made during the summer effort within Reach 4. Twenty grayling were collected within this reach with the spring effort yielding ten (10) grayling and observations of 20-30 additional grayling made within the same reach. General observations conducted in August and September found grayling to be common to abundant throughout the approximately 13,000 foot long mining area surveyed. Most pools and run habitat contained at least one, or more commonly 2-4 grayling feeding and resting in this habitat.

Seine hauling was far and away the most effective method for collecting grayling during the sampling effort. Efficiency with this method can most likely be attributed to the difficult spotting and netting conditions found within most reaches during both sample efforts. Seine hauling often captured 2 or more fish per haul, particularly when employed in eddy and backwater habitat, where fish could be trapped by current and bank obstructions. Several grayling were collected by angling, but this method was generally not as effective as others, due in part to the low feeding activity of grayling during the spring effort. Angling was not employed during the summer effort, due to extremely high turbidity.

Grayling were not collected within Emma Creek during the spring sampling effort, at a time when a spawning run from Marguerite Creek would be expected. However, grayling were found to be common within Emma Creek during the summer collection effort. During this effort, rain events had elevated the turbidity of Marguerite Creek substantially, while Emma Creek remained clear, suggesting that Emma Creek serves as a high water refuge for grayling and provides an area for foraging and rest.

Grayling over approximately 150 mm standard length collected during the spring sample effort (24 total) were checked for spawning condition. Gentle pressure was applied to the sides of these fish in an attempt to determine ripeness. Three males were running milt on May 31, 2008 and were 165 mm (2) and 170 mm in length and collected in a single seine haul. These were the only grayling collected that were positively identified as being in spawning condition.

Slimy sculpins were collected in all reaches except those in Emma Creek. A total of 57 sculpins were collected during the entirety of the sampling effort, with approximately 25 individuals observed, but not collected. Sculpins were most commonly collected in riffles and runs and were most frequently collected using a backpack electro-fisher and dip net. Kick-set seining without the aid of an electro-fisher also yielded sculpins. Sculpins were observed during the subsequent

stream survey efforts, but were not as readily noted as grayling, owing to the different habitat preferences of the species.

A single round whitefish was collected in proximity to the Emma and Marguerite Creek confluence by seine hauling a swift run below the confluence. Whitefish were not observed during other collection efforts or during survey observations.

Table 1 below provides a summary of collection results and stream reach sample locations for both collection efforts. Detailed sample results are found in Appendix B.

Table 1. Sample Locations, Dates, and Fish Collected by Site

Field Number	Location	Date	*Thymallus articus*	*Prosopium cylindraceum*	*Cottus cognatus*
CMS 08-01 Spring Reach 1	Marguerite Creek at ford upstream of action area	May 28, 2008	1	-	15
CMS 08-02 Spring Reach 2	Marguerite Creek downstream of Emma Creek confluence	May 29, 2008	7	-	2
CMS 08-03 Spring Reach 3	Emma Creek upstream from Marguerite Creek confluence	May 29, 2008	-	-	-
CMS 08-04 Spring Reach 4	Marguerite Creek approx. 350 meters upstream from Emma Creek Confluence	May 29, 2008	10	-	3
CMS 08-05 Spring Reach 5	Marguerite Creek at upstream end of mining area	May 30, 2008	5	-	13
CMS 08-06 Spring Reach 6	Marguerite Creek from Mr. Adam Creek confluence upstream approx. 500 meters	May 31, 2008	8	-	6
CMS 08-07 Spring Reach 4(B)	Marguerite Creek (same as CMS 08-04)	May 31, 2008	18	-	-
CMS 08-08 Summer Reach 1	Marguerite Creek at ford upstream of action area	July 28, 2008	18	-	2
CMS 08-09 Summer Reach 2	Marguerite Creek downstream (and up to) Emma Creek confluence	July 29, 2008	6	1	8

Table 1 continued. Sample Locations, Dates, and Fish Collected by Site					
CMS 08-10 Summer Reach 3	Emma Creek from confluence upstream to fork.	July 29, 2008	12	-	-
CMS 08-11 Summer Reach 4	Marguerite Creek at third road ford	July 29, 2008	20	-	8

The following table (Table 2) describes the level of effort and total reach habitat sampled. Most habitat was spot sampled, in an effort to cover significant habitat and to increase the potential diversity of species collected.

Table 2. Sample Effort, Reach Length, and Methods Employed				
Field Number	**Location**	**Reach Length**	**Sample Methods**	**Level of Effort**
CMS 08-01 Spring Reach 1	Marguerite Creek at ford upstream of action area	Approximately 250 meters	BPEF-all habitat, baited minnow traps	955 shocking seconds 2 traps deployed for 24 hours
CMS 08-02 Spring Reach 2	Marguerite Creek downstream of Emma Creek confluence	525 meters	BPEF – spot sampling	973 shocking seconds
CMS 08-03 Spring Reach 3	Emma Creek upstream from Marguerite Creek confluence	150 meters	BPEF – spot sampling	345 shocking seconds
CMS 08-04 Spring Reach 4	Marguerite Creek approx. 350 meters upstream from Emma Creek Confluence	500 meters	BPEF – spot sampling, angling	1391 shocking seconds 0.75 hours angling
CMS 08-05 Spring Reach 5	Marguerite Creek at upstream end of mining area	570 meters	BPEF – 150 meters all habitat 320 meters spot sampling	1479 shocking seconds
CMS 08-06 Spring Reach 6	Marguerite Creek from Mr. Adam confluence upstream approx. 850 meters	850 meters	BPEF – spot sampling, seine hauling/sets, angling	911 shocking seconds, 10 + hauls and sets, 1.25 hours angling
CMS 08-07 Spring Reach 4(B)	Marguerite Creek (same as CMS 08-04) plus additional 30 meters	530 meters	Seine hauls	Approximately 10 hauls in pool and run habitat

Table 2 continued. Sample Effort, Reach Length, and Methods Employed				
CMS 08-08 Summer Reach 1	Marguerite Creek at ford upstream of action area and including lower 50 meters of unnamed tributary	Approximately 250 meters	Seine hauls – all pool and run habitat. Seine kick-sets, riffle habitat	Hauls and sets through all appropriate habitat (~20 hauls and sets)
CMS 08-09 Summer Reach 2	Marguerite Creek downstream (and up to) Emma Creek confluence	530 meters	Seine hauls and sets	Approximately 15 hauls and sets
CMS 08-10 Summer Reach 3	Emma Creek from confluence upstream to fork.	365 meters	Seine hauls and sets	Approximately 20 hauls and sets combined
CMS 08-11 Summer Reach 4	Marguerite Creek at third road ford	300 meters	Seine hauls – limited by high water event	Approximately 10 hauls in accessible habitat

Photographs of typical habitat and sample reaches are included in Appendix C.

5.0 Discussion

Fisheries collections indicate an extensive and likely resident population of slimy sculpin and Arctic grayling throughout the Marguerite Creek system, including habitat upstream of the proposed mining area and including Emma Creek. Initial expectations of fish distributions within the study area were that grayling likely entered the study area from larger waters downstream of the project area for spawning alone, and returned to these large water areas to feed. However, the prevalence of grayling in the most upstream sample reach (Reach 1) soon after break-up, the continued presence of grayling in these and other stream reaches sampled, and the small size of sexually mature fish observed, indicate a likely resident dynamic in the grayling population here. Grayling were collected in proximity to the mouth of Bonanza Creek during the spring and summer efforts and at the mouth of an unnamed tributary near Reach 1 (downstream of the ford/road crossing) during the summer effort. Observations along the lower portion of Bonanza Creek did not reveal grayling or sculpins, and sampling of the unnamed tributary near the upstream ford did not yield grayling in the spring or summer collection effort. However, small tributaries within the study area and the proposed mining area, including Bonanza Creek and other unnamed tributaries, are expected to contain grayling during spawning runs at some capacity.

Additionally, sculpins were found throughout the sample area during both seasonal sampling efforts. Sculpins are likely present, at least seasonally in Emma Creek, despite their absence from collections and may be found seasonally in smaller tributaries not sampled, but within the project area.

Only a single round whitefish was collected during all sampling efforts. However, it is possible that this species occurs in higher frequency as stream temperatures rise through the summer. The

deepest pool habitat within the project area could not be effectively sampled during any of the collection efforts. Such habitat is suitable for the species. Observations during survey activities did not identify round whitefish in shallower pools or runs. The species is not a common resident within of the project area.

Dolly Varden were expected to be collected within the study area, but were not collected or observed during site work. Sampling of Marguerite Creek well downstream of the project area near the confluence of Mr. Adam Creek and upstream to Emma Creek was completed in an effort to potentially capture fish associated with larger stream habitats and/or those species and individuals moving from downstream habitats for seasonal feeding and spawning. The target species in this reach were primarily large grayling, whitefish, and Dolly Varden. Results of this sampling produced an abundance of grayling, sculpins, and the single round whitefish. Dolly Varden may occur in this and other stream reaches, including the project area, but are likely rare if they occur.

Reconnaissance level fisheries sampling indicates that Marguerite Creek contains a resident population of grayling and slimy sculpins. These species are found within the proposed mining area, as well as habitat upstream and downstream of this area. In addition, grayling were common seasonally within Emma Creek. Seasonal and temporary occupation by grayling and sculpins of area tributaries within the proposed mining area were not observed, but are expected at some level.

6.0 References

Alaska Department of Fish and Game. 1994. Wildlife Notebook Series: Arctic Grayling. Accessed at: http://www.adfg.state.ak.us/pubs/notebook/fish/grayling.php

Durst, J. May 2008. Personal Communication in a telephone call with Casey Storey (WHPacific). Alaska DNR.

Appendix B – Collection Data

Spring Reach 1 : Marguerite Creek at ford upstream of proposed mining area.

Sampled Date: 5/28/2008

Reach Length: Approximately 250 meters

Shock Seconds 955

Catch Data

Genus	Species	SL	Preserved/Released
Thymallus	*arcticus*	140	Released
Cottus	*cognatus*	84	Released
Cottus	*cognatus*	68	Released
Cottus	*cognatus*	84	Released
Cottus	*cognatus*	55	Released
Cottus	*cognatus*	89	Released
Cottus	*cognatus*	67	Released
Cottus	*cognatus*	68	Released
Cottus	*cognatus*	56	Released
Cottus	*cognatus*	62	Released
Cottus	*cognatus*	62	Released
Cottus	*cognatus*	77	Released
Cottus	*cognatus*	78	Released
Cottus	*cognatus*	58	Released
Cottus	*cognatus*	50	Released
Cottus	*cognatus*	56	Released

Observation Data

Genus	Species	Total Number Observed Not Collected
Thymallus	*arcticus*	2

Spring Reach 2 : Marguerite Creek downstream of Emma Creek confluence

Sampled Date: 5/29/2008

Reach Length: 525 Meters

Shock Seconds 973

Catch Data

Genus	Species	SL	Preserved/Released
Thymallus	***arcticus***	**195**	Released
Thymallus	***arcticus***	215	Released
Thymallus	***arcticus***	210	Released
Thymallus	***arcticus***	220	Released
Thymallus	***arcticus***	105	Released
Thymallus	***arcticus***	190	Released
Thymallus	***arcticus***	164	Released
Cottus	***cognatus***	72	Released
Cottus	***cognatus***	65	Released

Observation Data

Genus	Species	Total Number Observed Not Collected
Thymallus	*arcticus*	***5***
Cottus	***cognatus***	***5***

Spring Reach 3 : Emma Creek upstream of confluence with Marguerite Creek and USGS gauging station (Emma Creek)

Sampled Date: 5/29/2008

Reach Length: 150 Meters

Shock Seconds 345

Catch Data

Genus	Species	SL	Preserved/Released
No Fish Collected			

Observation Data

Genus	Species	Total Number Observed Not Collected
		None observed

Spring Reach 4 : Marguerite Creek approximately 350 meters upstream from Emma Creek Confluence

Sampled Date: 5/29/2008

Reach Length: 500 Meters

Shock Seconds 1391

Angling Effort 0.75 hours

Catch Data

Genus	Species	SL	Preserved/Released
Thymallus	*arcticus*	106	Released
Thymallus	*arcticus*	142	Released
Thymallus	*arcticus*	96	Released
Thymallus	*arcticus*	130	Released
Thymallus	*arcticus*	185	Released
Thymallus	*arcticus*	185	Released
Thymallus	*arcticus*	140	Released
Thymallus	*arcticus*	145	Released
Thymallus	*arcticus*	130	Released
Thymallus	*arcticus*	94	Released
Cottus	*cognatus*	56	Released
Cottus	*cognatus*	63	Released
Cottus	*cognatus*	40	Released

Observation Data

Genus	Species	Total Number Observed Not Collected
Thymallus	*arcticus*	*20-30*

Spring Reach 5 : Marguerite Creek at upper end of mining area

Sampled Date: 5/30/2008

Reach Length: 570 meters

Shock Seconds 1479

Catch Data

Genus	Species	SL	Preserved/Released
Thymallus	*arcticus*	200	Released
Thymallus	*arcticus*	172	Released
Thymallus	*arcticus*	109	Released
Thymallus	*arcticus*	82	Released
Thymallus	*arcticus*	88	Released
Cottus	*cognatus*	58	Released
Cottus	*cognatus*	64	Released
Cottus	*cognatus*	78	Released
Cottus	*cognatus*	71	Released
Cottus	*cognatus*	73	Released
Cottus	*cognatus*	63	Released
Cottus	*cognatus*	65	Released
Cottus	*cognatus*	63	Released
Cottus	*cognatus*	59	Released
Cottus	*cognatus*	63	Released
Cottus	*cognatus*	82	Released
Cottus	*cognatus*	73	**Retained**
Cottus	*cognatus*	61	**Retained**

Observation Data

Genus	Species	Total Number Observed Not Collected
Cottus	*cognatus*	15-20

Spring Reach 6 : Marguerite Creek from Mr. Adam Creek confluence upstream 850 meters

Sampled Date: 5/31/2008

Reach Length: 850 meters

Shock Seconds 911

Seine Hauling 10+ hauls

Angling 1.25 hours

Catch Data

Genus	Species	SL	Preserved/Released
Thymallus	*arcticus*	151	Released
Thymallus	*arcticus*	130	Released
Thymallus	*arcticus*	83	Released
Thymallus	*arcticus*	105	Released
Thymallus	*arcticus*	64	**Retained**
Thymallus	*arcticus*	114	Released
Thymallus	*arcticus*	90	Released
Thymallus	*arcticus*	160	Released
Cottus	*cognatus*	58	Released
Cottus	*cognatus*	33	Released
Cottus	*cognatus*	70	Released
Cottus	*cognatus*	63	Released
Cottus	*cognatus*	66	Released

Observation Data

Genus	Species	Total Number Observed Not Collected

Spring Reach 4B : Reach 4 plus an additional 30 meters upstream

Sampled Date: 5/31/2008

Reach Length: 530 meters

Shock Seconds not used

Seine Hauls 20+ hauls/sets

Catch Data

Genus	Species	SL	Preserved/Released
Thymallus	*arcticus*	165*	Released
Thymallus	*arcticus*	170*	Released
Thymallus	*arcticus*	165*	Released
Thymallus	*arcticus*	~160-170mm	Released
Thymallus	*arcticus*	~160-170mm	Released
Thymallus	*arcticus*	~160-170mm	Released
Thymallus	*arcticus*	~160-170mm	Released
Thymallus	*arcticus*	~160-170mm	Released
Thymallus	*arcticus*	~160-170mm	Released
Thymallus	*arcticus*	~160-170mm	Released
Thymallus	*arcticus*	~160-170mm	Released
Thymallus	*arcticus*	~120-160mm	Released
Thymallus	*arcticus*	~120-160mm	Released
Thymallus	*arcticus*	~120-160mm	Released
Thymallus	*arcticus*	~120-160mm	Released
Thymallus	*arcticus*	~120-160mm	Released
Thymallus	*arcticus*	~120-160mm	Released
Thymallus	*arcticus*	~120-160mm	Released

Observation Data

Genus	Species	Total Number Observed Not Collected

*** - Running milt**

Summer Reach 1 : Marguerite Creek at ford upstream of proposed mining area.

Sampled Date: 7/28/2008

Reach Length: Approximately 250 meters

Seine Hauls 20 hauls/sets

Catch Data

Genus	Species	SL	Preserved/Released
Thymallus	*arcticus*	152	Released
Thymallus	*arcticus*	190	Released
Thymallus	*arcticus*	198	Released
Thymallus	*arcticus*	193	Released
Thymallus	*arcticus*	136	Released
Thymallus	*arcticus*	148	Released
Thymallus	*arcticus*	166	Released
Thymallus	*arcticus*	165	Released
Thymallus	*arcticus*	167	Released
Thymallus	*arcticus*	150	Released
Thymallus	*arcticus*	123	Released
Thymallus	*arcticus*	124	Released
Thymallus	*arcticus*	164	Released
Thymallus	*arcticus*	166	Released
Thymallus	*arcticus*	143	Released
Thymallus	*arcticus*	124	Released
Thymallus	*arcticus*	121	Released
Thymallus	*arcticus*	120	Released
Cottus	*cognatus*	55	Released
Cottus	*cognatus*	60	Released

Observation Data

Genus	Species	Total Number Observed Not Collected

Summer Reach 2 : Marguerite Creek - downstream and up to Emma Creek confluence

Sampled Date: 7/29/2008

Reach Length: 530 meters

Seine Hauls 15 hauls/sets

Catch Data

Genus	Species	SL	Preserved/Released
Thymallus	*arcticus*	175	Released
Thymallus	*arcticus*	210	Released
Thymallus	*arcticus*	193	Released
Thymallus	*arcticus*	135	Released
Thymallus	*arcticus*	102	Released
Thymallus	*arcticus*	114	Released
Cottus	*cognatus*	55	Released
Cottus	*cognatus*	68	Released
Cottus	*cognatus*	53	Released
Cottus	*cognatus*	50	Released
Cottus	*cognatus*	76	Released
Cottus	*cognatus*	65	Released
Cottus	*cognatus*	55	Released
Cottus	*cognatus*	49	Released
Prosopium	*cylindraceum*	163	Released

Observation Data

Genus	Species	Total Number Observed Not Collected

Summer Reach 3 : Emma Creek from confluence to first main fork

Sampled Date: 7/29/2008

Reach Length: 365 meters

Seine Hauls 20 hauls/sets

Catch Data

Genus	Species	SL	Preserved/Released
Thymallus	*arcticus*	192	Released
Thymallus	*arcticus*	215	Released
Thymallus	*arcticus*	166	Released
Thymallus	*arcticus*	220	Released
Thymallus	*arcticus*	167	Released
Thymallus	*arcticus*	200	Released
Thymallus	*arcticus*	195	Released
Thymallus	*arcticus*	171	Released
Thymallus	*arcticus*	174	Released
Thymallus	*arcticus*	100	Released
Thymallus	*arcticus*	135	Released
Thymallus	*arcticus*	215	Released

Observation Data

Genus	Species	Total Number Observed Not Collected

Summer Reach 4 : Marguerite Creek at third road ford (downstream)

Sampled Date: 7/29/2008

Reach Length: 300 meters

Seine Hauls 10 hauls/sets

Catch Data

Genus	Species	SL	Preserved/Released	Genus	Species	SL	Preserved/Released
Thymallus	*arcticus*	200	Released	*Cottus*	*cognatus*	80	Released
Thymallus	*arcticus*	188	Released	*Cottus*	*cognatus*	68	Released
Thymallus	*arcticus*	210	Released	*Cottus*	*cognatus*	52	Released
Thymallus	*arcticus*	135	Released	*Cottus*	*cognatus*	24	Released
Thymallus	*arcticus*	205	Released	*Cottus*	*cognatus*	22	Released
Thymallus	*arcticus*	120	Released				
Thymallus	*arcticus*	155	Released				
Thymallus	*arcticus*	172	Released				
Thymallus	*arcticus*	168	Released				
Thymallus	*arcticus*	165	Released				
Thymallus	*arcticus*	112	Released				
Thymallus	*arcticus*	152	Released				
Thymallus	*arcticus*	205	Released				
Thymallus	*arcticus*	140	Released				
Thymallus	*arcticus*	160	Released				
Thymallus	*arcticus*	86	Released				
Thymallus	*arcticus*	182	Released				
Thymallus	*arcticus*	130	Released				
Thymallus	*arcticus*	112	Released				
Thymallus	*arcticus*	121	Released				
Cottus	*cognatus*	75	Released				
Cottus	*cognatus*	70	Released				
Cottus	*cognatus*	61	Released				

Appendix C – Photographs

Photo 1: Reach 1 (spring and summer effort) at Marguerite Creek stream ford, looking downstream July 2008

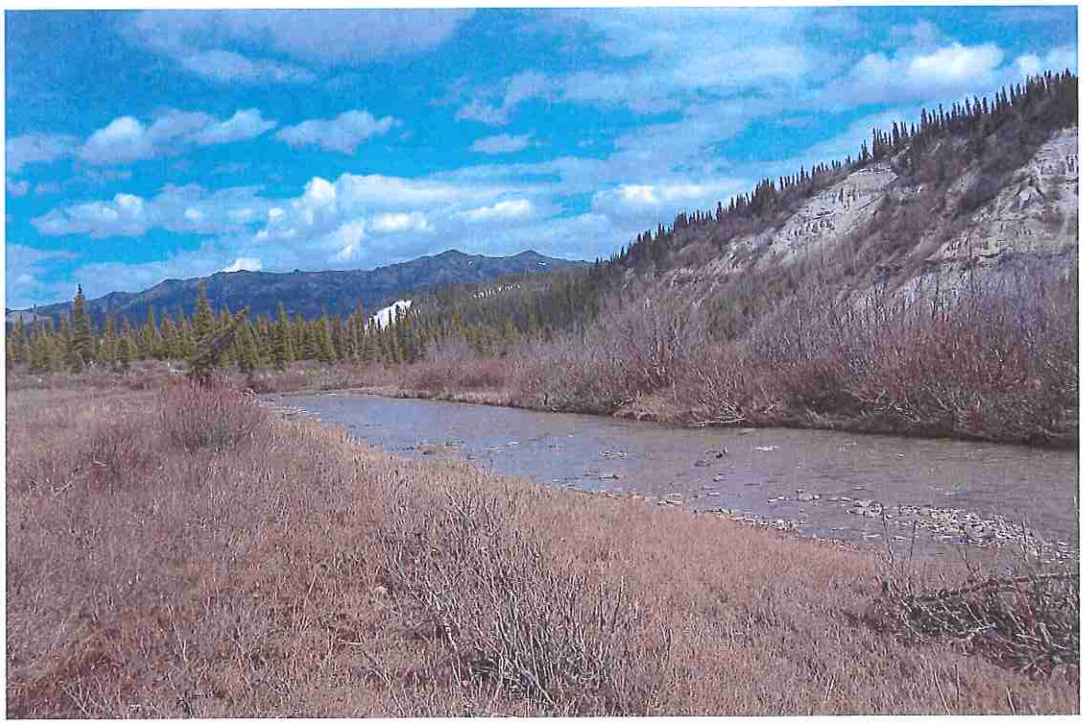


Photo 2: Typical habitat in proximity to Reach 2 (spring and summer effort) and Reach 6 (summer). Looking downstream. May 2008.

Photo 3: Downstream end of Reach 2 (spring and summer) – looking upstream. May 2008.

Photo 4: Mid-point of reach 4 (4B) – spring and summer – looking upstream. May 2008.

Photo 5: Downstream end of Reach 5 – spring effort, looking downstream at ice bridge.

Photo 6: Downstream end of Reach 5 – spring effort, looking upstream.

Photo 7: Emma Creek Reach 3 (spring and summer). July 2008

Photo 8: High water event – Marguerite Creek at mouth of Emma Creek, looking downstream. July 2008.

Photo 9: Slimy sculpin (*Cottus cognatus*)

Photo 10: Round whitefish (*Prosopium cylindraceum*).

Photo 11: Arctic grayling (*Thymallus arcticus*)

APPENDIX CIX-3

STREAM MORPHOLOGY REPORT
MARGUERITE CREEK, JUMBO DOME AREA

Technical Report

Stream Morphology Report
Marguerite Creek
Jumbo Dome Area

Prepared for

Usibelli Coal Mine, Inc.

January 11, 2008

Prepared by

WHPacific, Inc.
9755 S.W. Barnes Road
Portland, Oregon 97225

WHPacific

Prepared for: Bartly K. Coiley,
Manager Environmental Affairs
100 Cushman Street, Suite 210
Fairbanks, Alaska 99701
(907) 452-2625
E-mail address: bcoiley@usibelli.com

Title: Marguerite Creek Stream Morphology Report

Project: Jumbo Dome Area

Prepared by: WHPacific, Inc.
9755 SW Barnes Road, Suite 300
Portland, Oregon 97225

Contact: Casey M. Storey,
Environmental Project Coordinator
(503) 372-3648
FAX: (503) 526-0775
E-mail cstorey@whpacific.com

Phil Quarterman
Senior Wetland Scientist and Environmental Project Manager
(503) 372-3562
E-mail address: pquarterman@whpacific.com

TABLE OF CONTENTS

1.0 INTRODUCTION 4

2.0 METHODS 4

3.0 RESULTS 6

3.1 LONGITUDINAL PROFILE 6
3.2 CROSS SECTIONS 7
3.3 SUBSTRATE 8
3.4 SINUOSITY 8
3.5 SUMMARY AND STREAM TYPE DETERMINATION 9

4.0 DISCUSSION 10

5.0 REFERENCES 12

TABLE

Table 1: Survey Summary

APPENDICES

Appendix A: Site Maps
Appendix B: Survey Figures
Appendix C: Site Photographs

1.0 Introduction

The following report presents stream morphology data gathered during a field effort in August and September, 2008 by WHPacific. Marguerite Creek, within the Jumbo Dome mining area was the focus of the survey

Marguerite Creek is a large tributary to California Creek in the Totatlanika River system of the greater Tanana - Yukon River system. The Marguerite Creek study area is approximately 10 airmiles northeast of the town of Healy, Alaska. The objective of the Rosgen Level II survey conducted on Marguerite Creek was to characterize the entirety of the stream, utilizing reference reaches that represent stream channel types and typical habitats noted during field investigations. Such data can be utilized to quantify fish habitat, to serve as baseline data for restoration efforts at the conclusion of mining operations, and to provide an understanding of the general function and character of the stream. The survey analysis of Marguerite Creek followed and ran concurrently to fisheries sampling efforts conducted by WHPacific on Marguerite Creek, Emma Creek, and tributaries.

2.0 Methods

To efficiently characterize Marguerite Creek, representative survey reaches were determined at the conclusion of fisheries sampling conducted in May, June, and July 2008. The overall study area was determined to begin at the confluence of Marguerite and Emma Creek and extended upstream to the approximate upstream extent of proposed mining limits. At the conclusion of fisheries sampling in July, station staking of the study area began at the mouth of Emma Creek and progressed upstream. Station establishment placed stakes at 100 foot intervals on the right bank (facing downstream). During this time (July 29th – August 1) a significant storm event occurred and raised the stream stage to a level that prevented staking beyond station 20+00. Staking resumed in late August, 2008, with stations established upstream to Station 131+00 (13,000 feet). While staking, visual observations of stream character were made, including general substrate composition, valley form, stream channel slope, and meander characteristics. From multiple field observations, reference reaches were established within the 13,000 foot study area in an effort to characterize representative stream channel types and to capture variations throughout the valley. Within these reaches a longitudinal profile was obtained, representative cross sections were established, and pebble counts were made to characterize substrate.

Three representative reaches were chosen within the study area. These are referred to as the lower, middle, and upper reaches and are depicted in Figures 1 and 2 (Appendix A). The lower reach represents a segment of Marguerite Creek that widens into a larger valley and joins with the valley of Emma Creek. The lower reference reach reflects similar habitat and stream and valley form found downstream of the Emma Creek

confluence. The lower reference reach extends from the confluence with Emma Creek (Station 1+00) to a point 625 feet upstream (Station 7+25).

The middle reach is located in a narrower valley than that of the lower reach and is confined by bluffs and steep valley slopes. The middle reach begins approximately 3,300 feet (Station 34+23) upstream of the Emma Creek confluence. The starting point is located at an ATV trail crossing and approximately 100 feet downstream of the last major downstream access road crossing. The middle reach includes major meanders, gravel islands, and a large coal seam bluff. The end point of the middle reach is at Station 46+70. The total reach length is 1,247 feet.

Finally, the upper reach begins at the first road crossing upstream of the end of the middle reach. The starting station of the upper reach is Station 84+75. The upper reach occupies a similar valley form to that of the middle reach, but is characterized by slightly deeper entrenchment, several steep segments of streambank at sharp meanders, and no major bluffs or hard points. The end point of the upper reach is Station 95+00.

The results of each survey component (longitudinal profile, cross sections, substrate, and sinuosity) help place the channel types into a category of stream types and provides a reference for existing channel conditions pending in-stream impacts to stream reaches.

Longitudinal Profile Methods
Following survey techniques established by Dave Rosgen (Rosgen, 1996), longitudinal profiles for three representative reaches were made. The channel distance was measured along the right bank (facing downstream) at 100 foot intervals from Emma Creek to the approximate upstream limits of the mining project area (Station 131+00). The thalweg or deepest and/or primary flow channel and water surface elevations were measured with the use of a surveyor's rod and hand level. These measurements were taken at intervals that captured individual habitat types (pool, riffles, and runs or glides) and at a frequency that helped to depict the general longitudinal channel form. The elevation for each longitudinal profile was approximated based on elevations obtained by GPS reading.

After the survey of the three reference reaches, a basic survey of habitat types was conducted on all stream segments within the study area not covered by the reference reaches. This survey included the length measurement of habitat (riffle, pool, and run) in the stream segment between the lower and middle reach (7+25 to 34+25), the middle and upper reach (46+69 to 84+75), and between the end of the upper reach (95+33) and the end of the study area (131+00). A percent of each habitat type and number of habitat features was produced for each measured stream segment.

Cross Section Methods
Following Rosgen methods (Rosgen, 1996) a total of 11 cross sections were made on Marguerite Creek. Three cross sections were taken within the lower reach, four cross sections were taken on the middle reach, and four cross sections were taken on the upper reach. Cross sections were taken of representative habitat features and at least one within

each reach was placed in order to effectively obtain flood-prone width and bankfull width measurements. A measuring tape was stretched perpendicular across each cross section from estimated bankfull indicators on each bank. In most instances, bankfull indicators included scour lines, breaks in vegetation, or water stains on substrate. Elevations of the bank and channel bed were taken in generally even frequencies along the tape to provide a bed profile. The edge of water and water surface elevation were also taken at each cross section. Floodprone widths were determined following the equation below:

Max Channel Depth Elevation – Bankfull Stage Elevation = Max Depth Value

Max Depth Value x 2 = Floodprone Elevation

Distance between Floodprone Elevations on each bank = Floodprone Width

Obtaining the floodprone width allows the determination of the entrenchment ratio within the reference reach and provides additional information for the classification of the stream type. The entrenchment ratio is determined by dividing the flood-prone width by the bankfull width.

Bed Sediment Survey (Pebble Count) Methods
A modified Wolman pebble count (Wolman 1954, Rosgen 1993) was used to conduct a substrate analysis within each study reach. Following this method, transects were evenly spaced across the surveyed reach to represent a relatively even proportion of each habitat type. Particles were randomly selected along each transect at a frequency to result in the measurement of 100 particles within each representative reach.

Sinuosity Methods
A basic calculation is used to extrapolate sinuosity. Using stream distance as measured in the field and dividing this by the valley distance as measured from aerial photographs, a sinuosity ratio is calculated.

3.0 Results

The following lists results for each survey component from each reference reach.

3.1 Longitudinal Profile

Lower Reach
The lower reach was measured at 625 feet along the right bank. The profile began at Station 1+00 and extended upstream to 7+25. The average water surface slope for the reach was 1.08%. The dominant habitat types within the lower reach are riffles and pools, with some run habitat identified. Riffles comprise 63% of the reach, followed by

pools at 22%, and runs occupying the remaining 15%. See Appendix B for a longitudinal profile of each reach.

Middle Reach
The middle reach was measured at 1,244 feet along the right bank from station 34+25 to 46+69. The water surface slope for the reach was 0.7 %. The most common habitat type identified was riffle (67%), followed by pool (25%), and run (8%).

Upper Reach
The upper reach was measured at 1,058 feet along the left bank of the surveyed stream segment. The profile began at 84+75 and extended upstream to 95+33. Riffles were the most common habitat type (69%) and pools were the only other habitat type (31%).

Habitat Measurements
Habitat survey measurements for the stream segment between the lower and middle reference reaches resulted in 80% riffle, 16% pool, and 4% run. A total of 8 riffles were measured, 7 pools, and 1 run. Survey measurements for the stream segment between the middle and upper reference reaches resulted in 62% riffle, 27% pool, and 11% run. A total of 19 riffles were measured, followed by 15 pools, and 2 runs. Finally, for the stream segment between the upstream end of the reference reach and the end of the study area, habitat was partitioned at 65% riffle, 33% pool, and 2% run. A total of 22 riffles, 21 pools, and 1 run were identified in the stream segment.

3.2 Cross Sections

Lower Reach
Three cross sections were established within the lower reach. One cross section was placed within a riffle at station 2+54, one was placed within a run at 3+00, and another cross section was placed in a riffle at 3+85. At each cross section a general profile, bankfull width, and wetted width were obtained. At station 3+85 the floodprone width was measured. The bankfull width at station 23+00 was 29.0 feet, at 3+00 it was 47.0 feet, and 31.50 feet at station 3+85. The flood-prone width determined at station 3+85 was 118.00 feet. The calculated width depth ratio (bankfull width/average channel depth) was 23.33 and the entrenchment ratio was 3.75. Cross sections are presented in Appendix B.

Middle Reach
Four cross sections were established within the middle reference reach. Two cross sections were taken in riffles (stations 36+22 and 3+42+17), one station (39+00) was taken in a pool, and one station (44+48) was taken in a run. Bankfull widths were determined at all four stations and the floodprone elevation and width/depth ratio was determined at station 44+48. Bankfull widths were 25.50, 25.00, 34.00, and 31.00 feet at these four stations (progressing upstream). The flood-prone width was calculated at

75.00 feet and the width/depth ratio at 23.35. The calculated entrenchment ratio was 2.41.

Upper Reach
Four cross sections were established within the uppermost reference reach. A cross section was placed at station 85+42 (pool), 87+30 (riffle), 92+33 (riffle), and 93+29 (pool). Bankfull estimates were made at all cross sections and a flood-prone width was determined at station 92+33. Bankfull widths were 27.50, 31.00, 16.50, and 17.50 feet at each station. The flood-prone width was calculated at 84.00 feet, the width/depth ratio at 10.38, and an entrenchment ratio of 5.09.

3.3 Substrate

Lower Reach
Particle types in the lower reach are nearly evenly split between sand (< 2 mm), gravel (2 – 64 mm), and cobble (64-256 mm). A logarithmic plot of pebble count size distributions is located in Appendix B. Stream banks adjacent to the study area were composed of a large percentage of sand, with larger particles evident in some bank slumps.

Middle Reach
As in the lower reach, particle types in the middle reach are nearly evenly split between sand (< 2 mm), gravel (2 – 64 mm), and cobble (64-256 mm). See Appendix B for the logarithmic plot of particles for the middle reach. Stream bank substrate is dominated by sand and fines, with cobble and gravel found in lesser amounts. This study reach included a coal seam segment within the wetted channel and adjacent bank (see Appendix C, Photographs).

Upper Reach
The dominant particle size class from the upper reach was gravel (approximately 50%), followed by cobble (approximately 33%), and sand (approximately 17%). See Appendix B for a logarithmic distribution. Adjacent stream bank materials were dominated by sand and some grave, with several bank cuts exhibited cobble deposition.

3.4 Sinuosity

A measure of sinuosity was established for each reach. Aerial photographs were utilized to measure stream valley distance and station distances within the reach were used to determine the channel length within the valley segment.

Lower Reach
The sinuosity of the stream reach including reach is approximately 1.15.

Middle Reach
The sinuosity of the middle reach of Marguerite Creek is 1.88.

Upper Reach
The sinuosity of the upper reach is nearly identical to that of the middle reach at 1.89.

3.5 Summary and Stream Type Determination

The following table summarizes the survey results from each representative reach. Each component (except landform) was calculated following methods outlined by Rosgen (1996). A suite of these results is used to place the reference reach into one of eight major stream types and numerous subtypes as outlined by Rosgen (1994, 1996).

Table 1: Survey Summary

Reach	Surrounding Landform	Percent Slope	Width/Depth Ratio	Dominant Substrate	Entrenchment Ratio	Sinuosity
Lower Reach	Broad Valley	1.08%	23.3	Sand, Gravel, and Cobble Evenly Distributed	3.74	1.15
Middle Reach	Broad Valley	0.70%	23.35	Sand, Gravel, and Cobble Evenly Distributed	2.41	1.88
Upper Reach	Broad Valley	0.90%	10.38	Gravel	5.09	1.89

Stream Types
The following describes the determined stream types as based on the survey results.

Lower Reach
The lower representative reach can best be described as a **C3 stream type**. Streams of this type form in low-slope glacial valleys and in alluvial valleys. Cobble is the typical dominant bed material type and the typical slope is < 2%. Entrenchment ratios are typically greater than 2.2, sinuosity is > 1.2, and width depth ratios are greater than 12 (Rosgen 1996).

The lower stream reach channel type was not determined to be dominated by cobble size bed material, but was more evenly distributed between the substrate types. In addition, the meander ratio of 1.15 is slightly below the typical low value (1.2) for C stream types.

All other channel type parameters, as depicted in Table 1 fall within the general conditions specified for C3 channel types.

Several cobble and gravel islands are located within the reference reach and a single bedrock/coal hard point is located near the end of the reach.

The lower reach is located at the head of a widening valley segment. Emma Creek enters on the left bank of the stream reach near the downstream end (start) of the reach. Downstream of the lower reference reach and the Emma Creek confluence, an extensive wetland is located on the bench above Marguerite Creek on the left bank.

Middle Reach
The middle representative reach can also be classified as a **C3 stream type**. The slope of the middle reference reach was less than 1% (0.70%), the width/depth ratio was above 12, sinuosity significantly exceeds 1.2, and the entrenchment ratio is above 2.2 (2.4). The composition of substrate is similar to that found in the lower reference reach.
The middle reach is characterized by small point bars, willow and birch shrub communities, and a single coal seam hard point in the lower half of the reach.

Upper Reach
The upper reach is best classified as **C4 stream type**, although the width/depth ratio falls below the minimum ratio typical for this stream type. A C4 stream type shares attributes of the C3 stream type, but is typically dominated by gravel channel materials, more prevalent point bars and depositional features, and increased sinuosity. Width/depth ratios are typically above 12. The width/depth ratio within the upper reach is approximately 10.40 and is below the standard for the classification type. However, the bankfull width of the cross section from which this ratio was calculated was narrower than that of all other cross sections taken in this reference reach. It is expected that the width/depth ratio within the reference reach would likely meet the standard of 12 if taken within a less confined channel segment.

Characteristics of the upper reach include substantial point bars and bank depositions, several segments of undercut banks, bank slumps, and minor hard points (bedrock outcrops). Stream bank vegetation is mixed spruce forest in the lower half of the reach and a willow-dominated shrub community in the upper half of the reach.

4.0 Discussion

The reference reaches characterized above help depict pre-development channel form and habitat characteristics in the study area. These reaches can be used to make inferences about the stream segments that were not surveyed at the same fine detail. After multiple observations of all stream segments during staking, surveying, and fish collections, non-surveyed stream reach types can be estimated. Based upon the results of the surveyed reaches and these observations it is estimated that most or all of the stream segments can be classified as **C3 or C4 stream types**.

The majority of the study area stream reaches are contained within well developed floodplains. Slopes are gentle throughout the study area (approximately 0.50-1.5%) and point bars are common. Attributes that lead to high entrenchment ratios (and low degrees of entrenchment), including relatively narrow bankfull widths relative to floodprone widths, were observed throughout the study area. Some habitats observed upstream of the upper reference reach were noted as having slightly higher entrenchment (and likely a lower entrenchment ratio), but are likely still above 2.2 (the general cutoff) for "C" stream types. Bankfull widths and average channel depths were relatively similar throughout most stream segments. Finally, all of the study area was highly sinuous, with large meanders coursing through the well developed floodplain.

Also consistent throughout the study area were the presence of hard points associated with coal seams and bedrock outcrops. Marguerite Creek is generally confined between these bluffs and points along the valley slope. The most significant deep water habitat (pools) found in the study area were associated with these hard points and the scouring resulting from them.

For site photos depicting stream channel conditions and general habitat, see Appendix C.

5.0 References

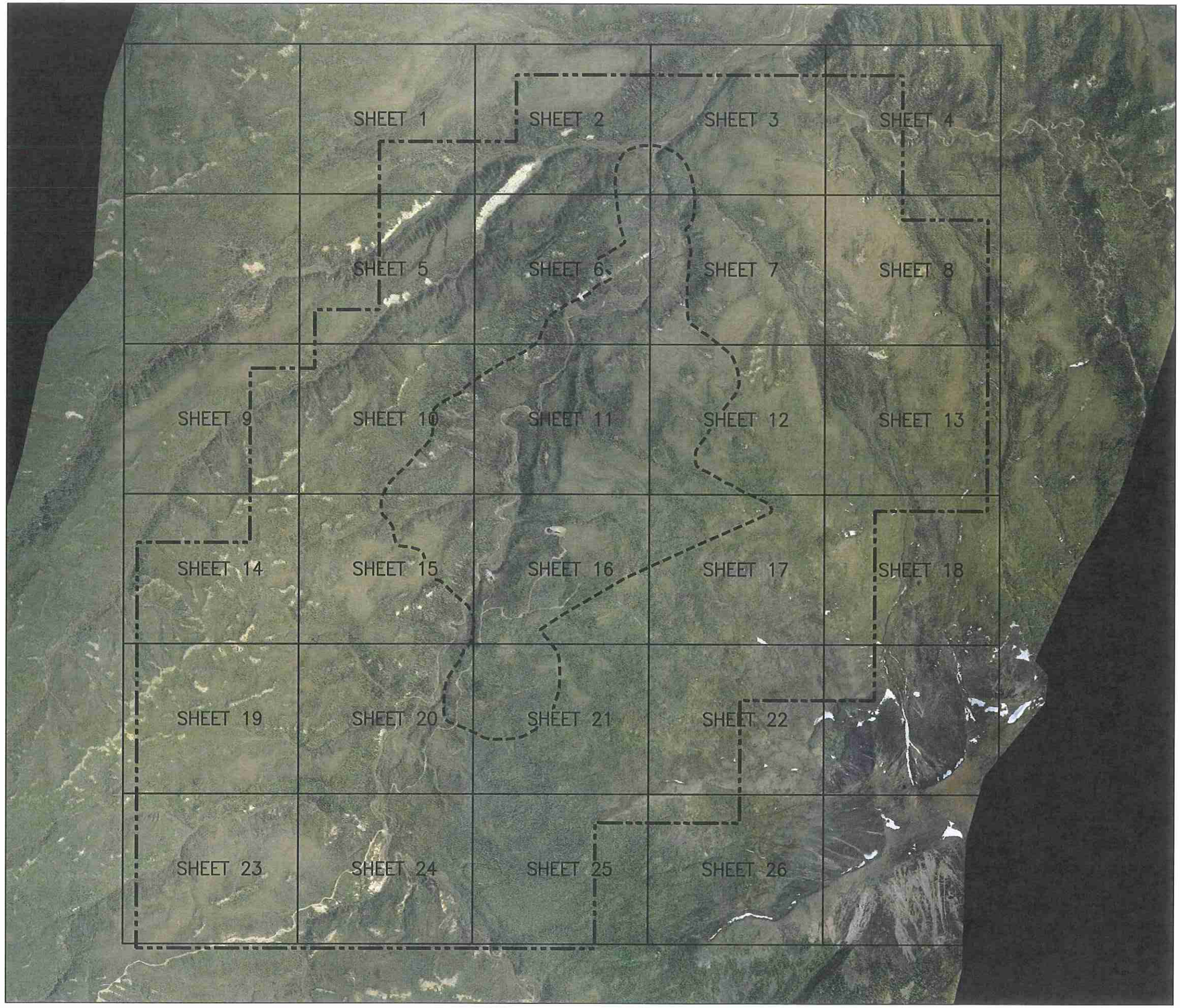
Rosgen, D., 1994. A Classification of Natural Rivers. Catena, Vol 22: 169-199. Elsevier Science, B.V. Amsterdam

Rosgen, D., 1996. Applied River Morphology. Wildland Hydrology, Pagosa Springs, Colorado.

Wolman, M.G., 1954. A Method of Sampling Coarse River-Bed Material. Transactions of American Geophysical Union 35: 951-956

EXHIBIT CIX-1

WHPACIFIC'S JUMBO DONE HABITAT AND VEGETATION MAPS



LEGEND

- STUDY AREA BOUNDARY
- PROPOSED IMPACT AREA

0 500' 1000' 2000' NORTH

WHPacific
519 7th Avenue, Suite 310
Fairbanks, AK 99701
907-456-2142 Fax 907-456-2143
www.whpacific.com

FAIRBANKS OFFICE
100 CUSHMAN STREET, SUITE 210
FAIRBANKS, AK 99701-2253

MINE OFFICE
P.O. BOX 1000
HEALY, AK 99743

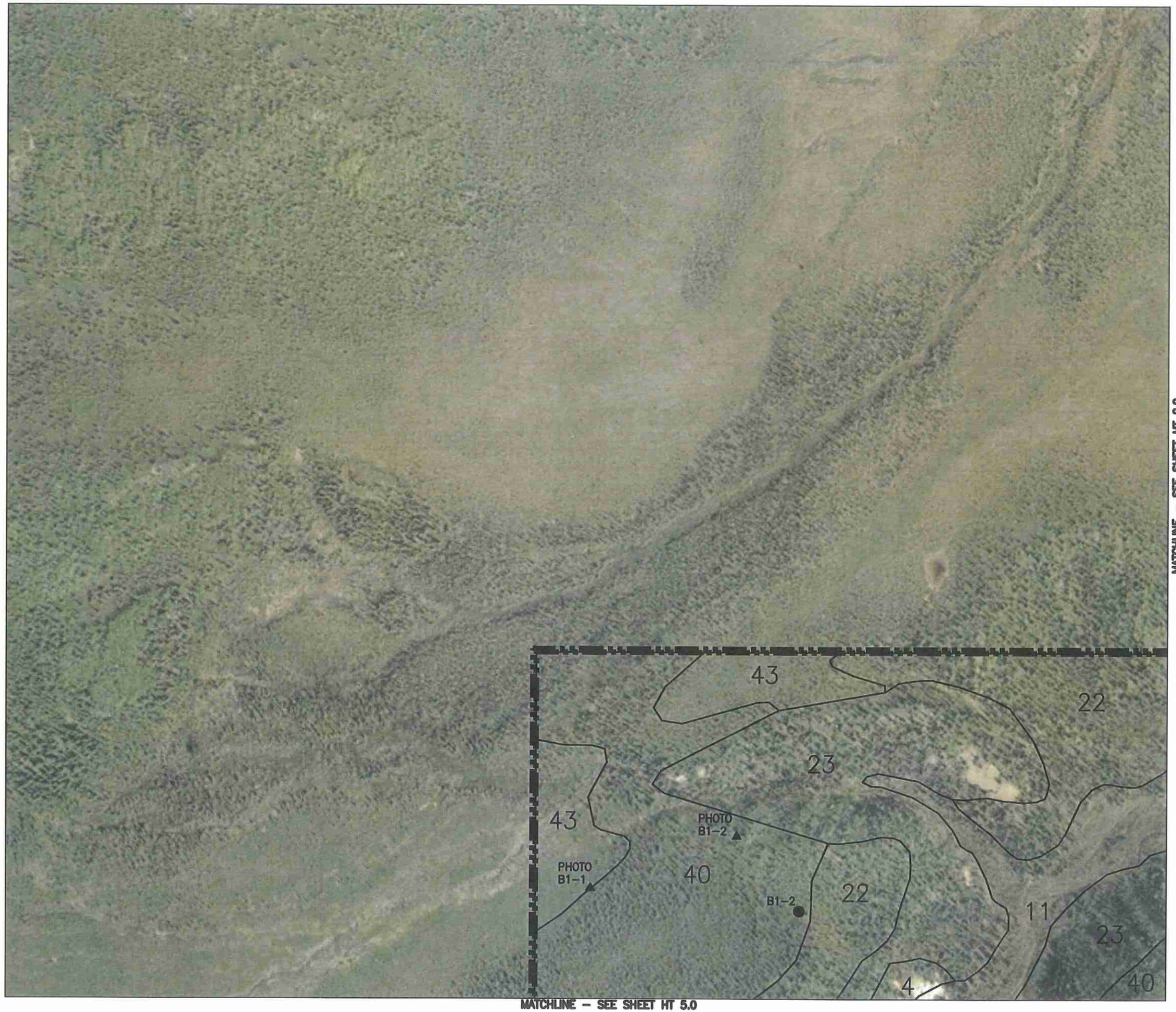
USIBELLI COAL MINE
JUMBO DOME MINE

HABITAT AND VEGETATION MAP

REVISIONS

NUMBER:	DATE:

JOB NO.:	5159
DATE:	JUNE 2008
DRAWN BY:	LJT
CHECKED BY:	PJQ
DRAWING NO.:	INDEX SHEET



MATCHLINE – SEE SHEET HT 5.0

MATCHLINE – SEE SHEET HT 2.0

LEGEND

- STUDY AREA BOUNDARY
- PROPOSED IMPACT AREA
- B1–2 ● WETLAND PLOT
- B1–3 ■ NON–WETLAND PLOT
- PHOTO B1–2/843 ▲ PHOTO POINT

MAP UNITS	VIERECK CLASSES (ABBREVIATION)
3	OMF, NW, CTS, CLS, OTS
4	NW, OLS
5	N/A
10	OMF, NW, CTS, CLS, OTS, OLS
11	CBF, ONF, OMF, DTSW, CTS, CLS, OLS
12	ONF, NW, CLS, OLS
13	ONF, NW, DTSW, CTS, CLS, OLS
20	ONF, NW, CTS
21	ONF, NW, DTSW
22	ONF, OMF, NW, CTS, CLS
23	CBF, CNF, ONF, CMF, OMF, NW, DTSW, CTS, CLS
40	ONF, OMF, NW, CLS, OTS, OLS
41	NW, DTSW, CLS, OLS
43	CLS, WGH
44	NW, CTS, CLS, OTS, OLS, WGH
50	ONF, NW
51	NW, DTSW, CTS, CLS, OLS
53	ONF, NW
56	OMF, NW, CTS, CLS
57	ONF, NW, DTSW, DTS
58	ONF, NW, CTS, CLS
60	ONF, NW, CTS, CLS
61	CLS, ONF
63	CNF, ONF, NW
64	ONF, NW, CLS
65	OBF, ONF, OMF, MW, NW
66	ONF, NW, CTS, CLS
71	NW

VIERECK CLASSIFICATION/ ABBREVIATION

HERBACEOUS HABITATS
<10% TREE COVER, <25% SHRUB COVER

WET GRAMINOID HERBACEOUS – WGH

SHRUB HABITATS
<10% TREE COVER, >25% SHRUB COVER

OPEN TALL SCRUB – OTS
CLOSED TALL SCRUB – CTS
OPEN LOW SCRUB – OLS
CLOSED LOW SCRUB – CLS
OPEN DWARF TREE SCRUB – ODTS
DWARF TREE SCRUB WOODLAND – DTSW

CLOSED CANOPY FOREST
>60% TREE COVER

CLOSED NEEDLELEAF FOREST – CNF
CLOSED BROADLEAF FOREST – CBF

OPEN CANOPY FOREST
25–59% TREE COVER

OPEN NEEDLELEAF FOREST – ONF
OPEN MIXED FOREST – OMF
OPEN BROADLEAF FOREST – OBF

WOODLANDS
10–24% TREE COVER

NEEDLELEAF WOODLAND – NW
MIXED WOODLAND – MW

WHPacific
516 7th Avenue, Suite 310
Fairbanks, AK 99701
907-456-2142 Fax 907-456-2143
www.whpacific.com

FAIRBANKS OFFICE
100 CUSHMAN STREET, SUITE 210
FAIRBANKS, AK 99701-2253

MINE OFFICE
P.O. BOX 1000
HEALY, AK 99743

USIBELLI COAL MINE
JUMBO DOME MINE

HABITAT AND VEGETATION MAP

REVISIONS

NUMBER:	DATE:

JOB NO.:	5159
DATE:	JUNE 2008
DRAWN BY:	LJT
CHECKED BY:	PJQ
DRAWING NO.:	HT 1.0
SHEET	

LEGEND

- STUDY AREA BOUNDARY
- PROPOSED IMPACT AREA
- B1-2 WETLAND PLOT
- B1-3 NON-WETLAND PLOT
- PHOTO B1-2/843 PHOTO POINT

MAP UNITS	VIERECK CLASSES (ABBREVIATION)
3	OMF, NW, CTS, CLS, OTS
4	NW, OLS
5	N/A
10	OMF, NW, CTS, CLS, OTS, OLS
11	CBF, ONF, OMF, DTSW, CTS, CLS, OLS
12	ONF, NW, CLS, OLS
13	ONF, NW, DTSW, CTS, CLS, OLS
20	ONF, NW, CTS
21	ONF, NW, DTSW
22	ONF, OMF, NW, CTS, CLS
23	CBF, CNF, ONF, CMF, OMF, NW, DTSW, CTS, CLS
40	ONF, OMF, NW, CLS, OTS, OLS
41	NW, DTSW, CLS, OLS
43	CLS, WGH
44	NW, CTS, CLS, OTS, OLS, WGH
50	ONF, NW
51	NW, DTSW, CTS, CLS, OLS
53	ONF, NW
56	OMF, NW, CTS, CLS
57	ONF, NW, DTSW, DTS
58	ONF, NW, CTS, CLS
60	ONF, NW, CTS, CLS
61	CLS, ONF
63	CNF, ONF, NW
64	ONF, NW, CLS
65	OBF, ONF, OMF, MW, NW
66	ONF, NW, CTS, CLS
71	NW

VIERECK CLASSIFICATION/ ABBREVIATION

HERBACEOUS HABITATS
<10% TREE COVER, <25% SHRUB COVER

WET GRAMINOID HERBACEOUS – WGH

SHRUB HABITATS
<10% TREE COVER, >25% SHRUB COVER

OPEN TALL SCRUB – OTS
CLOSED TALL SCRUB – CTS
OPEN LOW SCRUB – OLS
CLOSED LOW SCRUB – CLS
OPEN DWARF TREE SCRUB – ODTS
DWARF TREE SCRUB WOODLAND – DTSW

CLOSED CANOPY FOREST
>60% TREE COVER

CLOSED NEEDLELEAF FOREST – CNF
CLOSED BROADLEAF FOREST – CBF

OPEN CANOPY FOREST
25–59% TREE COVER

OPEN NEEDLELEAF FOREST – ONF
OPEN MIXED FOREST – OMF
OPEN BROADLEAF FOREST – OBF

WOODLANDS
10–24% TREE COVER

NEEDLELEAF WOODLAND – NW
MIXED WOODLAND – MW

WHPacific
515 7th Avenue, Suite 310
Fairbanks, AK 99701
907-459-3142 Fax 907-458-2143
www.whpacific.com

FAIRBANKS OFFICE
100 CUSHMAN STREET, SUITE 210
FAIRBANKS, AK 99701-2253

MINE OFFICE
P.O. BOX 1000
HEALY, AK 99743

USIBELLI COAL MINE
JUMBO DOME MINE

HABITAT AND VEGETATION MAP

REVISIONS

NUMBER:	DATE:

JOB NO.:	5159
DATE:	JUNE 2008
DRAWN BY:	LJT
CHECKED BY:	PJQ
DRAWING NO.:	HT 2.0
SHEET	

LEGEND

- STUDY AREA BOUNDARY
- PROPOSED IMPACT AREA
- B1-2 ● WETLAND PLOT
- B1-3 ■ NON-WETLAND PLOT
- PHOTO B1-2/843 ▲ PHOTO POINT

MAP UNITS	VIERECK CLASSES (ABBREVIATION)
3	OMF, NW, CTS, CLS, OTS
4	NW, OLS
5	N/A
10	OMF, NW, CTS, CLS, OTS, OLS
11	CBF, ONF, OMF, DTSW, CTS, CLS, OLS
12	ONF, NW, CLS, OLS
13	ONF, NW, DTSW, CTS, CLS, OLS
20	ONF, NW, CTS
21	ONF, NW, DTSW
22	ONF, OMF, NW, CTS, CLS
23	CBF, CNF, ONF, CMF, OMF, NW, DTSW, CTS, CLS
40	ONF, OMF, NW, CLS, OTS, OLS
41	NW, DTSW, CLS, OLS
43	CLS, WGH
44	NW, CTS, CLS, OTS, OLS, WGH
50	ONF, NW
51	NW, DTSW, CTS, CLS, OLS
53	ONF, NW
56	OMF, NW, CTS, CLS
57	ONF, NW, DTSW, DTS
58	ONF, NW, CTS, CLS
60	ONF, NW, CTS, CLS
61	CLS, ONF
63	CNF, ONF, NW
64	ONF, NW, CLS
65	OBF, ONF, OMF, MW, NW
66	ONF, NW, CTS, CLS
71	NW

VIERECK CLASSIFICATION/ ABBREVIATION

HERBACEOUS HABITATS
<10% TREE COVER, <25% SHRUB COVER

WET GRAMINOID HERBACEOUS – WGH

SHRUB HABITATS
<10% TREE COVER, >25% SHRUB COVER

OPEN TALL SCRUB – OTS
CLOSED TALL SCRUB – CTS
OPEN LOW SCRUB – OLS
CLOSED LOW SCRUB – CLS
OPEN DWARF TREE SCRUB – ODTS
DWARF TREE SCRUB WOODLAND – DTSW

CLOSED CANOPY FOREST
>60% TREE COVER

CLOSED NEEDLELEAF FOREST – CNF
CLOSED BROADLEAF FOREST – CBF

OPEN CANOPY FOREST
25–59% TREE COVER

OPEN NEEDLELEAF FOREST – ONF
OPEN MIXED FOREST – OMF
OPEN BROADLEAF FOREST – OBF

WOODLANDS
10–24% TREE COVER

NEEDLELEAF WOODLAND – NW
MIXED WOODLAND – MW

WHPacific
515 7th Avenue, Suite 310
Fairbanks, Alaska 99701
907-458-3142 Fax 907-458-3143
www.whpacific.com

FAIRBANKS OFFICE
100 CUSHMAN STREET, SUITE 210
FAIRBANKS, AK 99701-2253

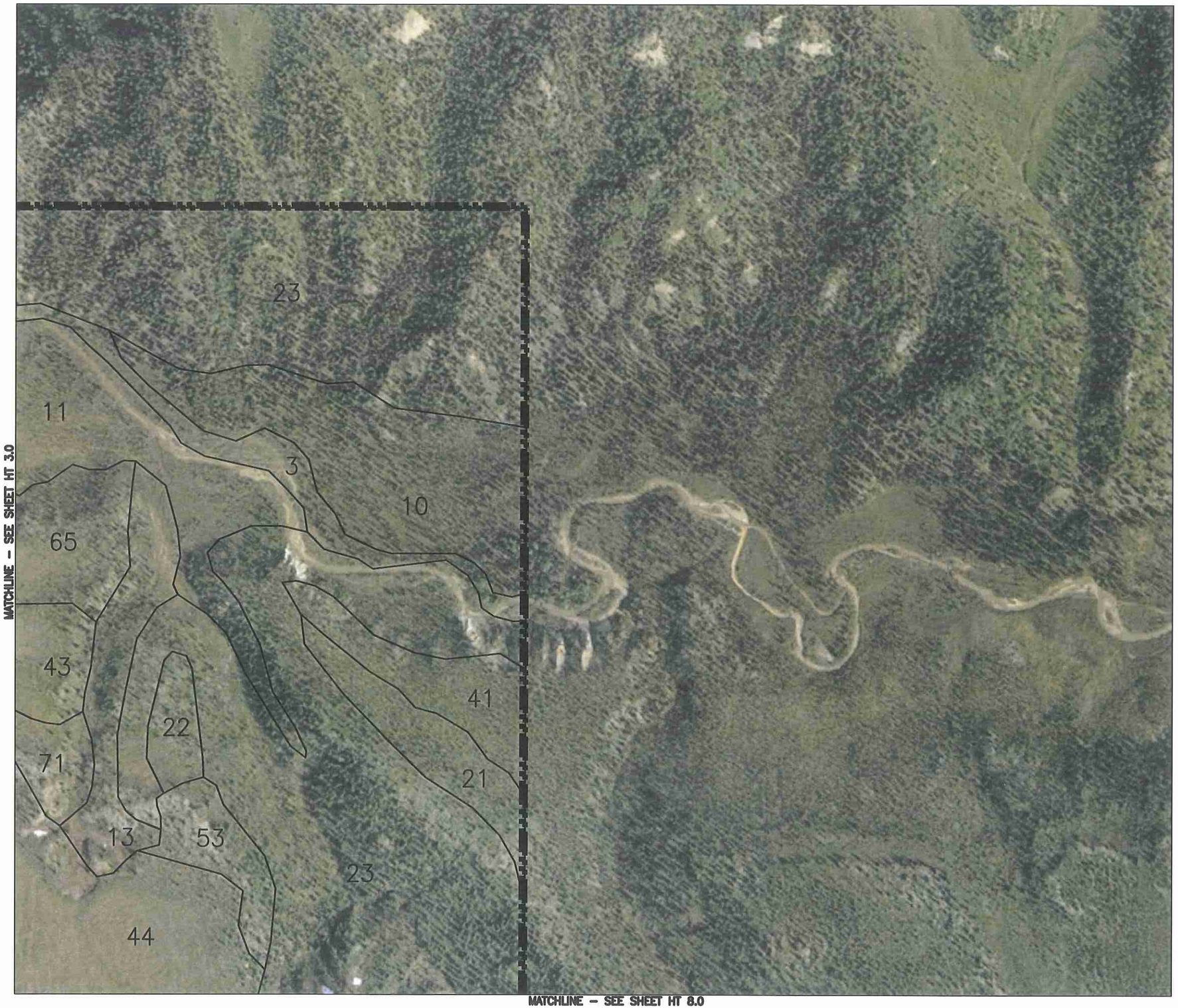
MINE OFFICE
P.O. BOX 1000
HEALY, AK 99743

USIBELLI COAL MINE
JUMBO DOME MINE
HABITAT AND VEGETATION MAP

REVISIONS

NUMBER:	DATE:

JOB NO.:	5159
DATE:	JUNE 2008
DRAWN BY:	LJT
CHECKED BY:	PJQ
DRAWING NO.:	HT 3.0
SHEET	



LEGEND

- STUDY AREA BOUNDARY
- PROPOSED IMPACT AREA
- B1–2 ● WETLAND PLOT
- B1–3 ■ NON–WETLAND PLOT
- PHOTO B1–2/843 ▲ PHOTO POINT

MAP UNITS	VIERECK CLASSES (ABBREVIATION)
3	OMF, NW, CTS, CLS, OTS
4	NW, OLS
5	N/A
10	OMF, NW, CTS, CLS, OTS, OLS
11	CBF, ONF, OMF, DTSW, CTS, CLS, OLS
12	ONF, NW, CLS, OLS
13	ONF, NW, DTSW, CTS, CLS, OLS
20	ONF, NW, CTS
21	ONF, NW, DTSW
22	ONF, OMF, NW, CTS, CLS
23	CBF, CNF, ONF, CMF, OMF, NW, DTSW, CTS, CLS
40	ONF, OMF, NW, CLS, OTS, OLS
41	NW, DTSW, CLS, OLS
43	CLS, WGH
44	NW, CTS, CLS, OTS, OLS, WGH
50	ONF, NW
51	NW, DTSW, CTS, CLS, OLS
53	ONF, NW
56	OMF, NW, CTS, CLS
57	ONF, NW, DTSW, DTS
58	ONF, NW, CTS, CLS
60	ONF, NW, CTS, CLS
61	CLS, ONF
63	CNF, ONF, NW
64	ONF, NW, CLS
65	OBF, ONF, OMF, MW, NW
66	ONF, NW, CTS, CLS
71	NW

VIERECK CLASSIFICATION/ ABBREVIATION

HERBACEOUS HABITATS
<10% TREE COVER, <25% SHRUB COVER

WET GRAMINOID HERBACEOUS – WGH

SHRUB HABITATS
<10% TREE COVER, >25% SHRUB COVER

OPEN TALL SCRUB – OTS
CLOSED TALL SCRUB – CTS
OPEN LOW SCRUB – OLS
CLOSED LOW SCRUB – CLS
OPEN DWARF TREE SCRUB – ODTS
DWARF TREE SCRUB WOODLAND – DTSW

CLOSED CANOPY FOREST
>60% TREE COVER

CLOSED NEEDLELEAF FOREST – CNF
CLOSED BROADLEAF FOREST – CBF

OPEN CANOPY FOREST
25–59% TREE COVER

OPEN NEEDLELEAF FOREST – ONF
OPEN MIXED FOREST – OMF
OPEN BROADLEAF FOREST – OBF

WOODLANDS
10–24% TREE COVER

NEEDLELEAF WOODLAND – NW
MIXED WOODLAND – MW

WHPacific
5157 7th Avenue, Suite 310
Fairbanks, AK 99701
907-458-3142 Fax 907-458-2143
www.whpacific.com

FAIRBANKS OFFICE
100 CUSHMAN STREET, SUITE 210
FAIRBANKS, AK 99701-2253

MINE OFFICE
P.O. BOX 1000
HEALY, AK 99743

USIBELLI COAL MINE
JUMBO DOME MINE

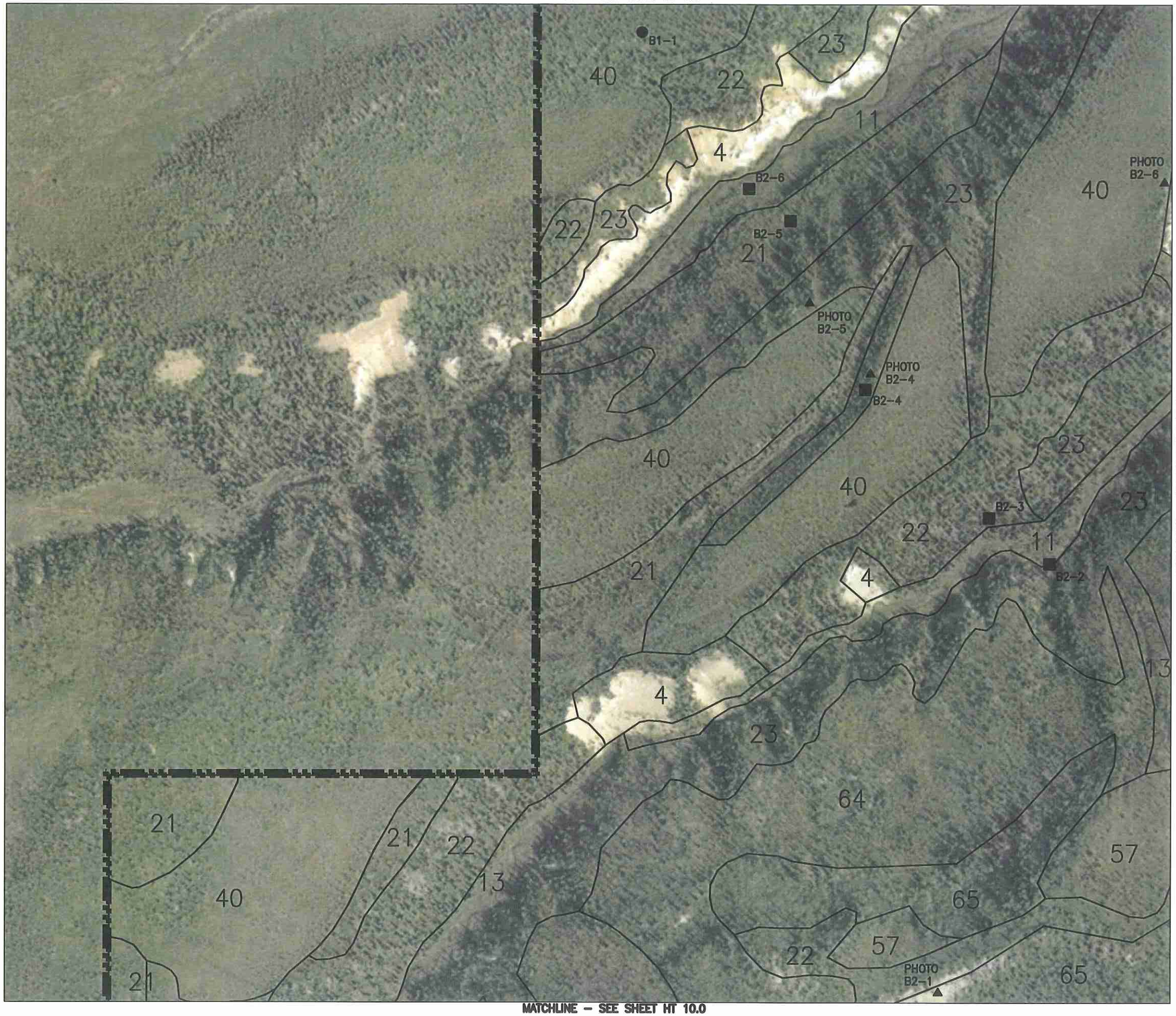
HABITAT AND VEGETATION MAP

REVISIONS

NUMBER:	DATE:

JOB NO.:	5159
DATE:	JUNE 2008
DRAWN BY:	LJT
CHECKED BY:	PJQ
DRAWING NO.:	HT 4.0
SHEET	

MATCHLINE – SEE SHEET HT 1.0



MATCHLINE – SEE SHEET HT 10.0

MATCHLINE – SEE SHEET HT 6.0

LEGEND

- STUDY AREA BOUNDARY
- PROPOSED IMPACT AREA
- B1–2 WETLAND PLOT
- B1–3 NON–WETLAND PLOT
- PHOTO B1–2/843 PHOTO POINT

MAP UNITS	VIERECK CLASSES (ABBREVIATION)
3	OMF, NW, CTS, CLS, OTS
4	NW, OLS
5	N/A
10	OMF, NW, CTS, CLS, OTS, OLS
11	CBF, ONF, OMF, DTSW, CTS, CLS, OLS
12	ONF, NW, CLS, OLS
13	ONF, NW, DTSW, CTS, CLS, OLS
20	ONF, NW, CTS
21	ONF, NW, DTSW
22	ONF, OMF, NW, CTS, CLS
23	CBF, CNF, ONF, CMF, OMF, NW, DTSW, CTS, CLS
40	ONF, OMF, NW, CLS, OTS, OLS
41	NW, DTSW, CLS, OLS
43	CLS, WGH
44	NW, CTS, CLS, OTS, OLS, WGH
50	ONF, NW
51	NW, DTSW, CTS, CLS, OLS
53	ONF, NW
56	OMF, NW, CTS, CLS
57	ONF, NW, DTSW, DTS
58	ONF, NW, CTS, CLS
60	ONF, NW, CTS, CLS
61	CLS, ONF
63	CNF, ONF, NW
64	ONF, NW, CLS
65	OBF, ONF, OMF, MW, NW
66	ONF, NW, CTS, CLS
71	NW

VIERECK CLASSIFICATION/ ABBREVIATION

HERBACEOUS HABITATS
<10% TREE COVER, <25% SHRUB COVER

WET GRAMINOID HERBACEOUS – WGH

SHRUB HABITATS
<10% TREE COVER, >25% SHRUB COVER

OPEN TALL SCRUB – OTS
CLOSED TALL SCRUB – CTS
OPEN LOW SCRUB – OLS
CLOSED LOW SCRUB – CLS
OPEN DWARF TREE SCRUB – ODTS
DWARF TREE SCRUB WOODLAND – DTSW

CLOSED CANOPY FOREST
>60% TREE COVER

CLOSED NEEDLELEAF FOREST – CNF
CLOSED BROADLEAF FOREST – CBF

OPEN CANOPY FOREST
25–59% TREE COVER

OPEN NEEDLELEAF FOREST – ONF
OPEN MIXED FOREST – OMF
OPEN BROADLEAF FOREST – OBF

WOODLANDS
10–24% TREE COVER

NEEDLELEAF WOODLAND – NW
MIXED WOODLAND – MW

WHPacific
515 7th Avenue, Suite 310
Fairbanks, AK 99701
907-458-2142 Fax 907-458-2143
www.whpacific.com

FAIRBANKS OFFICE
100 CUSHMAN STREET, SUITE 210
FAIRBANKS, AK 99701-2253

MINE OFFICE
P.O. BOX 1000
HEALY, AK 99743

USIBELLI COAL MINE
JUMBO DOME MINE

HABITAT AND VEGETATION MAP

REVISIONS

NUMBER:	DATE:

JOB NO.:	5159
DATE:	JUNE 2008
DRAWN BY:	LJT
CHECKED BY:	PJQ
DRAWING NO.:	HT 5.0
SHEET	

MATCHLINE – SEE SHEET HT 2.0

MATCHLINE – SEE SHEET HT 5.0

MATCHLINE – SEE SHEET HT 7.0

MATCHLINE – SEE SHEET HT 11.0

LEGEND

- STUDY AREA BOUNDARY
- PROPOSED IMPACT AREA
- B1–2 WETLAND PLOT
- B1–3 NON–WETLAND PLOT
- PHOTO B1–2/843 PHOTO POINT

MAP UNITS	VIERECK CLASSES (ABBREVIATION)
3	OMF, NW, CTS, CLS, OTS
4	NW, OLS
5	N/A
10	OMF, NW, CTS, CLS, OTS, OLS
11	CBF, ONF, OMF, DTSW, CTS, CLS, OLS
12	ONF, NW, CLS, OLS
13	ONF, NW, DTSW, CTS, CLS, OLS
20	ONF, NW, CTS
21	ONF, NW, DTSW
22	ONF, OMF, NW, CTS, CLS
23	CBF, CNF, ONF, CMF, OMF, NW, DTSW, CTS, CLS
40	ONF, OMF, NW, CLS, OTS, OLS
41	NW, DTSW, CLS, OLS
43	CLS, WGH
44	NW, CTS, CLS, OTS, OLS, WGH
50	ONF, NW
51	NW, DTSW, CTS, CLS, OLS
53	ONF, NW
56	OMF, NW, CTS, CLS
57	ONF, NW, DTSW, DTS
58	ONF, NW, CTS, CLS
60	ONF, NW, CTS, CLS
61	CLS, ONF
63	CNF, ONF, NW
64	ONF, NW, CLS
65	OBF, ONF, OMF, MW, NW
66	ONF, NW, CTS, CLS
71	NW

VIERECK CLASSIFICATION/ ABBREVIATION

HERBACEOUS HABITATS
<10% TREE COVER, <25% SHRUB COVER

WET GRAMINOID HERBACEOUS – WGH

SHRUB HABITATS
<10% TREE COVER, >25% SHRUB COVER

OPEN TALL SCRUB – OTS
CLOSED TALL SCRUB – CTS
OPEN LOW SCRUB – OLS
CLOSED LOW SCRUB – CLS
OPEN DWARF TREE SCRUB – ODTS
DWARF TREE SCRUB WOODLAND – DTSW

CLOSED CANOPY FOREST
>60% TREE COVER

CLOSED NEEDLELEAF FOREST – CNF
CLOSED BROADLEAF FOREST – CBF

OPEN CANOPY FOREST
25–59% TREE COVER

OPEN NEEDLELEAF FOREST – ONF
OPEN MIXED FOREST – OMF
OPEN BROADLEAF FOREST – OBF

WOODLANDS
10–24% TREE COVER

NEEDLELEAF WOODLAND – NW
MIXED WOODLAND – MW

WHPacific
515 7th Avenue, Suite 310
Fairbanks, AK 99701
907-458-2142 Fax 907-458-2143
www.whpacific.com

FAIRBANKS OFFICE
100 CUSHMAN STREET, SUITE 210
FAIRBANKS, AK 99701-2253

MINE OFFICE
P.O. BOX 1000
HEALY, AK 99743

USIBELLI COAL MINE
JUMBO DOME MINE

HABITAT AND VEGETATION MAP

REVISIONS

NUMBER:	DATE:

JOB NO.:	5159
DATE:	JUNE 2008
DRAWN BY:	LJT
CHECKED BY:	PJQ
DRAWING NO.:	HT 6.0
SHEET	

MATCHLINE – SEE SHEET HT 3.0

MATCHLINE – SEE SHEET HT 6.0

MATCHLINE – SEE SHEET HT 8.0

MATCHLINE – SEE SHEET HT 12.0

LEGEND

- STUDY AREA BOUNDARY
- PROPOSED IMPACT AREA
- B1–2 WETLAND PLOT
- B1–3 NON–WETLAND PLOT
- PHOTO B1–2/843 PHOTO POINT

MAP UNITS	VIERECK CLASSES (ABBREVIATION)
3	OMF, NW, CTS, CLS, OTS
4	NW, OLS
5	N/A
10	OMF, NW, CTS, CLS, OTS, OLS
11	CBF, ONF, OMF, DTSW, CTS, CLS, OLS
12	ONF, NW, CLS, OLS
13	ONF, NW, DTSW, CTS, CLS, OLS
20	ONF, NW, CTS
21	ONF, NW, DTSW
22	ONF, OMF, NW, CTS, CLS
23	CBF, CNF, ONF, CMF, OMF, NW, DTSW, CTS, CLS
40	ONF, OMF, NW, CLS, OTS, OLS
41	NW, DTSW, CLS, OLS
43	CLS, WGH
44	NW, CTS, CLS, OTS, OLS, WGH
50	ONF, NW
51	NW, DTSW, CTS, CLS, OLS
53	ONF, NW
56	OMF, NW, CTS, CLS
57	ONF, NW, DTSW, DTS
58	ONF, NW, CTS, CLS
60	ONF, NW, CTS, CLS
61	CLS, ONF
63	CNF, ONF, NW
64	ONF, NW, CLS
65	OBF, ONF, OMF, MW, NW
66	ONF, NW, CTS, CLS
71	NW

VIERECK CLASSIFICATION/ ABBREVIATION

HERBACEOUS HABITATS
<10% TREE COVER, <25% SHRUB COVER

WET GRAMINOID HERBACEOUS – WGH

SHRUB HABITATS
<10% TREE COVER, >25% SHRUB COVER

OPEN TALL SCRUB – OTS
CLOSED TALL SCRUB – CTS
OPEN LOW SCRUB – OLS
CLOSED LOW SCRUB – CLS
OPEN DWARF TREE SCRUB – ODTS
DWARF TREE SCRUB WOODLAND – DTSW

CLOSED CANOPY FOREST
>60% TREE COVER

CLOSED NEEDLELEAF FOREST – CNF
CLOSED BROADLEAF FOREST – CBF

OPEN CANOPY FOREST
25–59% TREE COVER

OPEN NEEDLELEAF FOREST – ONF
OPEN MIXED FOREST – OMF
OPEN BROADLEAF FOREST – OBF

WOODLANDS
10–24% TREE COVER

NEEDLELEAF WOODLAND – NW
MIXED WOODLAND – MW

WHPacific
515 7th Avenue, Suite 310
Fairbanks, Alaska 99701
907-458-2142 Fax 907-458-2143
www.whpacific.com

FAIRBANKS OFFICE
100 CUSHMAN STREET, SUITE 210
FAIRBANKS, AK 99701-2253

MINE OFFICE
P.O. BOX 1000
HEALY, AK 99743

USIBELLI COAL MINE
JUMBO DOME MINE

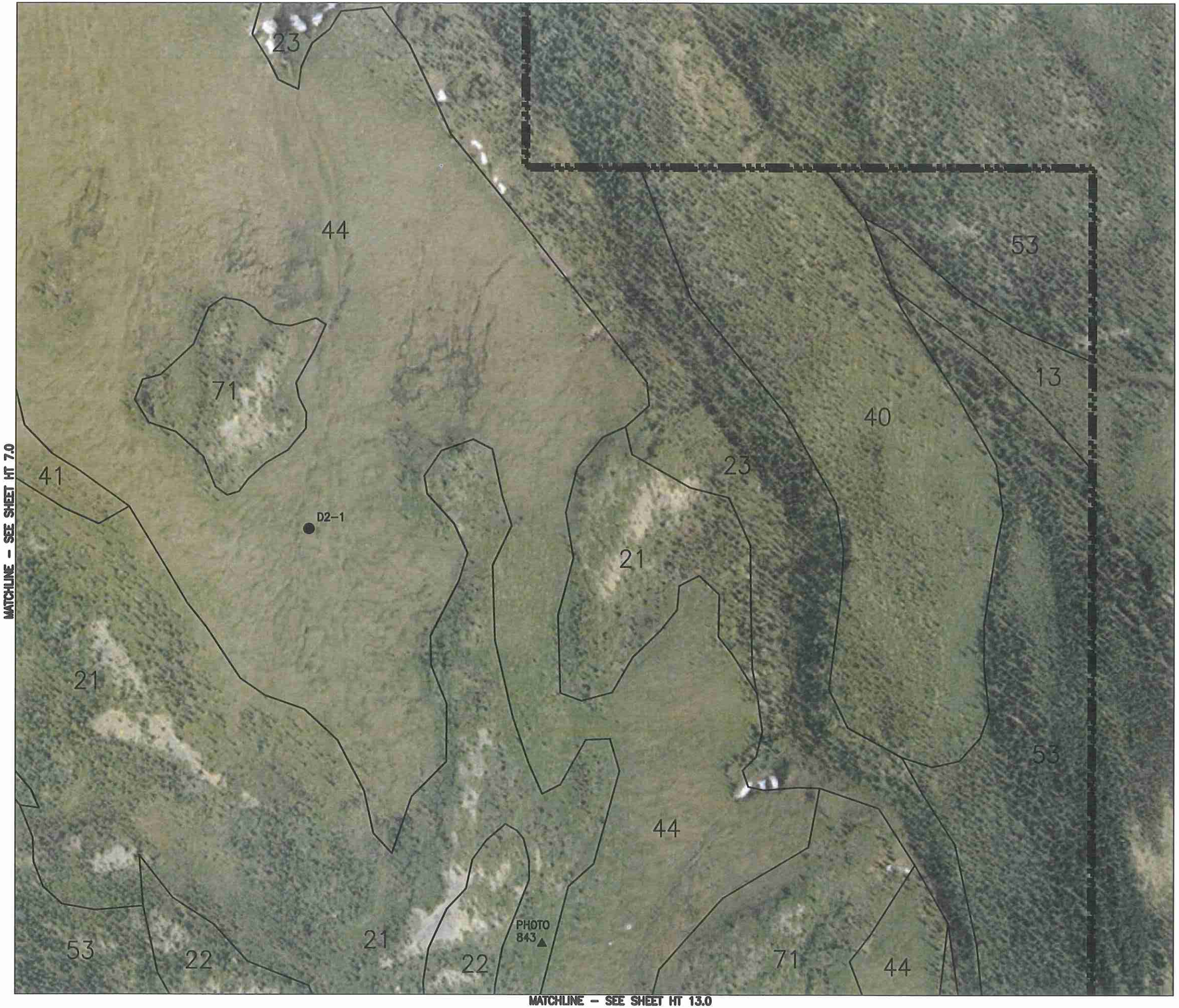
HABITAT AND VEGETATION MAP

REVISIONS

NUMBER:	DATE:

JOB NO.:	5159
DATE:	JUNE 2008
DRAWN BY:	LJT
CHECKED BY:	PJQ
DRAWING NO.:	HT 7.0
SHEET	

MATCHLINE – SEE SHEET HT 4.0



MATCHLINE – SEE SHEET HT 7.0

MATCHLINE – SEE SHEET HT 13.0

LEGEND

- STUDY AREA BOUNDARY
- PROPOSED IMPACT AREA
- B1–2 ● WETLAND PLOT
- B1–3 ■ NON–WETLAND PLOT
- PHOTO B1–2/843 ▲ PHOTO POINT

MAP UNITS	VIERECK CLASSES (ABBREVIATION)
3	OMF, NW, CTS, CLS, OTS
4	NW, OLS
5	N/A
10	OMF, NW, CTS, CLS, OTS, OLS
11	CBF, ONF, OMF, DTSW, CTS, CLS, OLS
12	ONF, NW, CLS, OLS
13	ONF, NW, DTSW, CTS, CLS, OLS
20	ONF, NW, CTS
21	ONF, NW, DTSW
22	ONF, OMF, NW, CTS, CLS
23	CBF, CNF, ONF, CMF, OMF, NW, DTSW, CTS, CLS
40	ONF, OMF, NW, CLS, OTS, OLS
41	NW, DTSW, CLS, OLS
43	CLS, WGH
44	NW, CTS, CLS, OTS, OLS, WGH
50	ONF, NW
51	NW, DTSW, CTS, CLS, OLS
53	ONF, NW
56	OMF, NW, CTS, CLS
57	ONF, NW, DTSW, DTS
58	ONF, NW, CTS, CLS
60	ONF, NW, CTS, CLS
61	CLS, ONF
63	CNF, ONF, NW
64	ONF, NW, CLS
65	OBF, ONF, OMF, MW, NW
66	ONF, NW, CTS, CLS
71	NW

VIERECK CLASSIFICATION/ ABBREVIATION

HERBACEOUS HABITATS
<10% TREE COVER, <25% SHRUB COVER

WET GRAMINOID HERBACEOUS – WGH

SHRUB HABITATS
<10% TREE COVER, >25% SHRUB COVER

OPEN TALL SCRUB – OTS
CLOSED TALL SCRUB – CTS
OPEN LOW SCRUB – OLS
CLOSED LOW SCRUB – CLS
OPEN DWARF TREE SCRUB – ODTS
DWARF TREE SCRUB WOODLAND – DTSW

CLOSED CANOPY FOREST
>60% TREE COVER

CLOSED NEEDLELEAF FOREST – CNF
CLOSED BROADLEAF FOREST – CBF

OPEN CANOPY FOREST
25–59% TREE COVER

OPEN NEEDLELEAF FOREST – ONF
OPEN MIXED FOREST – OMF
OPEN BROADLEAF FOREST – OBF

WOODLANDS
10–24% TREE COVER

NEEDLELEAF WOODLAND – NW
MIXED WOODLAND – MW

WHPacific
515 7th Avenue, Suite 310
Fairbanks, AK 99701
907-458-2142 Fax 907-458-2143
www.whpacific.com

FAIRBANKS OFFICE
100 CUSHMAN STREET, SUITE 210
FAIRBANKS, AK 99701-2253

MINE OFFICE
P.O. BOX 1000
HEALY, AK 99743

USIBELLI COAL MINE
JUMBO DOME MINE

HABITAT AND VEGETATION MAP

REVISIONS

NUMBER:	DATE:

JOB NO.:	5159
DATE:	JUNE 2008
DRAWN BY:	LJT
CHECKED BY:	PJQ
DRAWING NO.:	HT 8.0
SHEET	

LEGEND

- STUDY AREA BOUNDARY
- PROPOSED IMPACT AREA
- B1–2 WETLAND PLOT
- B1–3 NON–WETLAND PLOT
- PHOTO B1–2/843 PHOTO POINT

MAP UNITS	VIERECK CLASSES (ABBREVIATION)
3	OMF, NW, CTS, CLS, OTS
4	NW, OLS
5	N/A
10	OMF, NW, CTS, CLS, OTS, OLS
11	CBF, ONF, OMF, DTSW, CTS, CLS, OLS
12	ONF, NW, CLS, OLS
13	ONF, NW, DTSW, CTS, CLS, OLS
20	ONF, NW, CTS
21	ONF, NW, DTSW
22	ONF, OMF, NW, CTS, CLS
23	CBF, CNF, ONF, CMF, OMF, NW, DTSW, CTS, CLS
40	ONF, OMF, NW, CLS, OTS, OLS
41	NW, DTSW, CLS, OLS
43	CLS, WGH
44	NW, CTS, CLS, OTS, OLS, WGH
50	ONF, NW
51	NW, DTSW, CTS, CLS, OLS
53	ONF, NW
56	OMF, NW, CTS, CLS
57	ONF, NW, DTSW, DTS
58	ONF, NW, CTS, CLS
60	ONF, NW, CTS, CLS
61	CLS, ONF
63	CNF, ONF, NW
64	ONF, NW, CLS
65	OBF, ONF, OMF, MW, NW
66	ONF, NW, CTS, CLS
71	NW

VIERECK CLASSIFICATION/ ABBREVIATION

HERBACEOUS HABITATS
<10% TREE COVER, <25% SHRUB COVER

WET GRAMINOID HERBACEOUS – WGH

SHRUB HABITATS
<10% TREE COVER, >25% SHRUB COVER

OPEN TALL SCRUB – OTS
CLOSED TALL SCRUB – CTS
OPEN LOW SCRUB – OLS
CLOSED LOW SCRUB – CLS
OPEN DWARF TREE SCRUB – ODTS
DWARF TREE SCRUB WOODLAND – DTSW

CLOSED CANOPY FOREST
>60% TREE COVER

CLOSED NEEDLELEAF FOREST – CNF
CLOSED BROADLEAF FOREST – CBF

OPEN CANOPY FOREST
25–59% TREE COVER

OPEN NEEDLELEAF FOREST – ONF
OPEN MIXED FOREST – OMF
OPEN BROADLEAF FOREST – OBF

WOODLANDS
10–24% TREE COVER

NEEDLELEAF WOODLAND – NW
MIXED WOODLAND – MW

0 75' 150' 300' NORTH

WHPacific
515 7th Avenue, Suite 310
Fairbanks, AK 99701
907-458-2142 Fax 907-458-2143
www.whpacific.com

FAIRBANKS OFFICE
100 CUSHMAN STREET, SUITE 210
FAIRBANKS, AK 99701-2253

MINE OFFICE
P.O. BOX 1000
HEALY, AK 99743

USIBELLI COAL MINE
JUMBO DOME MINE

HABITAT AND VEGETATION MAP

REVISIONS

NUMBER:	DATE:

JOB NO.:	5159
DATE:	JUNE 2008
DRAWN BY:	LJT
CHECKED BY:	PJQ
DRAWING NO.:	HT 9.0
SHEET	

MATCHLINE – SEE SHEET HT 5.0

MATCHLINE – SEE SHEET HT 9.0

MATCHLINE – SEE SHEET HT 11.0

MATCHLINE – SEE SHEET HT 15.0

LEGEND

- STUDY AREA BOUNDARY
- PROPOSED IMPACT AREA
- B1–2 ● WETLAND PLOT
- B1–3 ■ NON–WETLAND PLOT
- PHOTO B1–2/843 ▲ PHOTO POINT

MAP UNITS	VIERECK CLASSES (ABBREVIATION)
3	OMF, NW, CTS, CLS, OTS
4	NW, OLS
5	N/A
10	OMF, NW, CTS, CLS, OTS, OLS
11	CBF, ONF, OMF, DTSW, CTS, CLS, OLS
12	ONF, NW, CLS, OLS
13	ONF, NW, DTSW, CTS, CLS, OLS
20	ONF, NW, CTS
21	ONF, NW, DTSW
22	ONF, OMF, NW, CTS, CLS
23	CBF, CNF, ONF, CMF, OMF, NW, DTSW, CTS, CLS
40	ONF, OMF, NW, CLS, OTS, OLS
41	NW, DTSW, CLS, OLS
43	CLS, WGH
44	NW, CTS, CLS, OTS, OLS, WGH
50	ONF, NW
51	NW, DTSW, CTS, CLS, OLS
53	ONF, NW
56	OMF, NW, CTS, CLS
57	ONF, NW, DTSW, DTS
58	ONF, NW, CTS, CLS
60	ONF, NW, CTS, CLS
61	CLS, ONF
63	CNF, ONF, NW
64	ONF, NW, CLS
65	OBF, ONF, OMF, MW, NW
66	ONF, NW, CTS, CLS
71	NW

VIERECK CLASSIFICATION/ ABBREVIATION

HERBACEOUS HABITATS
<10% TREE COVER, <25% SHRUB COVER

WET GRAMINOID HERBACEOUS – WGH

SHRUB HABITATS
<10% TREE COVER, >25% SHRUB COVER

OPEN TALL SCRUB – OTS
CLOSED TALL SCRUB – CTS
OPEN LOW SCRUB – OLS
CLOSED LOW SCRUB – CLS
OPEN DWARF TREE SCRUB – ODTS
DWARF TREE SCRUB WOODLAND – DTSW

CLOSED CANOPY FOREST
>60% TREE COVER

CLOSED NEEDLELEAF FOREST – CNF
CLOSED BROADLEAF FOREST – CBF

OPEN CANOPY FOREST
25–59% TREE COVER

OPEN NEEDLELEAF FOREST – ONF
OPEN MIXED FOREST – OMF
OPEN BROADLEAF FOREST – OBF

WOODLANDS
10–24% TREE COVER

NEEDLELEAF WOODLAND – NW
MIXED WOODLAND – MW

0 75' 150' 300' NORTH

WHPacific
515 7th Avenue, Suite 310
Fairbanks, AK 99701
Phone: 907-452-5128 Fax: 907-456-2143
www.whpacific.com

FAIRBANKS OFFICE
100 CUSHMAN STREET, SUITE 210
FAIRBANKS, AK 99701-2253

MINE OFFICE
P.O. BOX 1000
HEALY, AK 99743

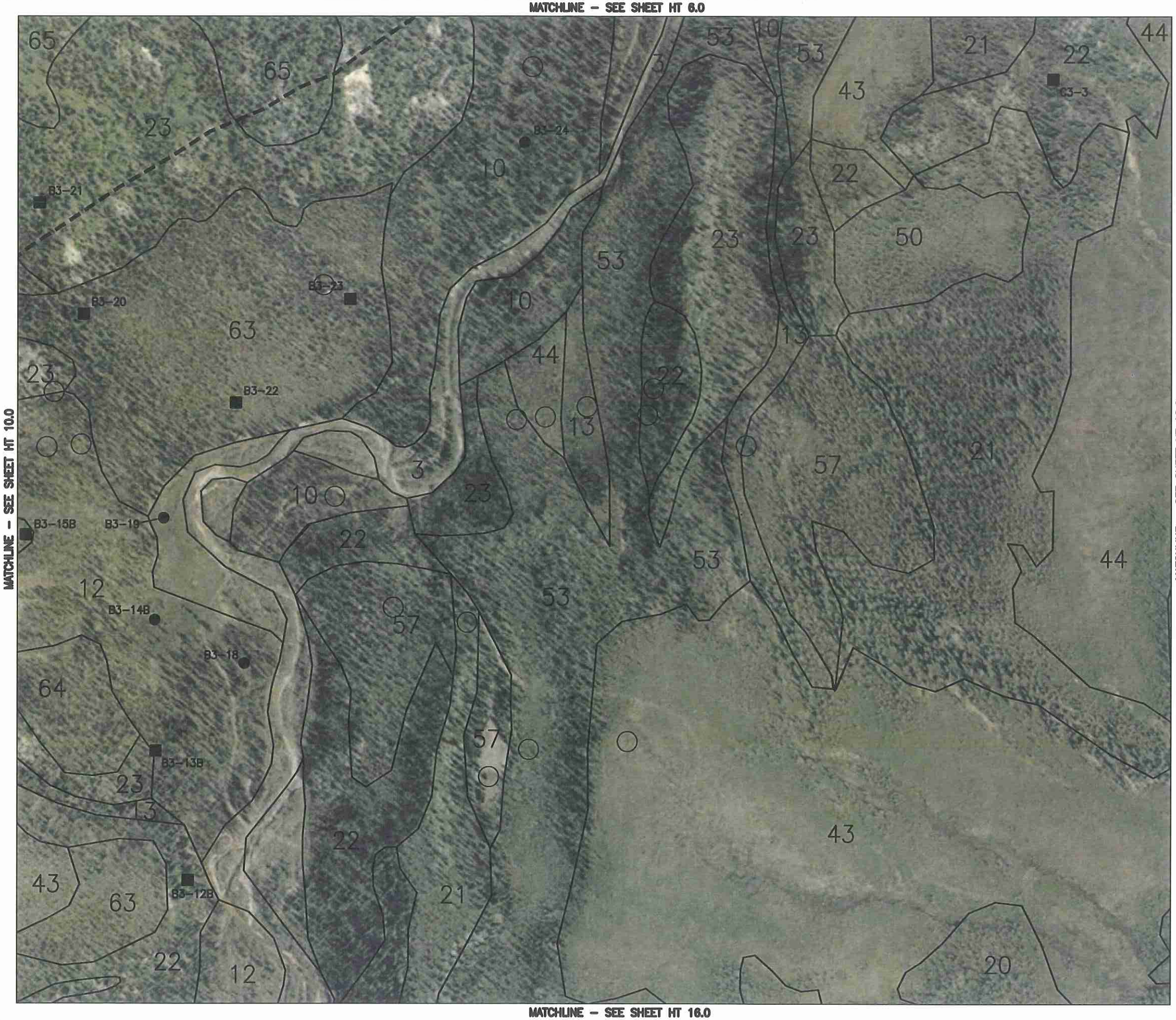
USIBELLI COAL MINE
JUMBO DOME MINE

HABITAT AND VEGETATION MAP

REVISIONS	
NUMBER:	DATE:

JOB NO.:	5159
DATE:	JUNE 2008
DRAWN BY:	LJT
CHECKED BY:	PJQ
DRAWING NO.:	HT 10.0
SHEET	

MATCHLINE – SEE SHEET HT 6.0



MATCHLINE – SEE SHEET HT 10.0

MATCHLINE – SEE SHEET HT 12.0

MATCHLINE – SEE SHEET HT 16.0

LEGEND

- STUDY AREA BOUNDARY
- PROPOSED IMPACT AREA
- B1–2 WETLAND PLOT
- B1–3 NON–WETLAND PLOT
- PHOTO B1–2/843 PHOTO POINT

MAP UNITS	VIERECK CLASSES (ABBREVIATION)
3	OMF, NW, CTS, CLS, OTS
4	NW, OLS
5	N/A
10	OMF, NW, CTS, CLS, OTS, OLS
11	CBF, ONF, OMF, DTSW, CTS, CLS, OLS
12	ONF, NW, CLS, OLS
13	ONF, NW, DTSW, CTS, CLS, OLS
20	ONF, NW, CTS
21	ONF, NW, DTSW
22	ONF, OMF, NW, CTS, CLS
23	CBF, CNF, ONF, CMF, OMF, NW, DTSW, CTS, CLS
40	ONF, OMF, NW, CLS, OTS, OLS
41	NW, DTSW, CLS, OLS
43	CLS, WGH
44	NW, CTS, CLS, OTS, OLS, WGH
50	ONF, NW
51	NW, DTSW, CTS, CLS, OLS
53	ONF, NW
56	OMF, NW, CTS, CLS
57	ONF, NW, DTSW, DTS
58	ONF, NW, CTS, CLS
60	ONF, NW, CTS, CLS
61	CLS, ONF
63	CNF, ONF, NW
64	ONF, NW, CLS
65	OBF, ONF, OMF, MW, NW
66	ONF, NW, CTS, CLS
71	NW

VIERECK CLASSIFICATION/ ABBREVIATION

HERBACEOUS HABITATS
<10% TREE COVER, <25% SHRUB COVER

WET GRAMINOID HERBACEOUS – WGH

SHRUB HABITATS
<10% TREE COVER, >25% SHRUB COVER

OPEN TALL SCRUB – OTS
CLOSED TALL SCRUB – CTS
OPEN LOW SCRUB – OLS
CLOSED LOW SCRUB – CLS
OPEN DWARF TREE SCRUB – ODTS
DWARF TREE SCRUB WOODLAND – DTSW

CLOSED CANOPY FOREST
>60% TREE COVER

CLOSED NEEDLELEAF FOREST – CNF
CLOSED BROADLEAF FOREST – CBF

OPEN CANOPY FOREST
25–59% TREE COVER

OPEN NEEDLELEAF FOREST – ONF
OPEN MIXED FOREST – OMF
OPEN BROADLEAF FOREST – OBF

WOODLANDS
10–24% TREE COVER

NEEDLELEAF WOODLAND – NW
MIXED WOODLAND – MW

0 75' 150' 300' NORTH

WHPacific
515 7th Avenue, Suite 310
Fairbanks, AK 99701
907-458-2142 Fax 907-458-2143
www.whpacific.com

FAIRBANKS OFFICE
100 CUSHMAN STREET, SUITE 210
FAIRBANKS, AK 99701-2253

MINE OFFICE
P.O. BOX 1000
HEALY, AK 99743

USIBELLI COAL MINE
JUMBO DOME MINE

HABITAT AND VEGETATION MAP

REVISIONS

NUMBER:	DATE:

JOB NO.:	5159
DATE:	JUNE 2008
DRAWN BY:	LJT
CHECKED BY:	PJQ
DRAWING NO.:	HT 11.0
SHEET	

MATCHLINE – SEE SHEET HT 7.0

MATCHLINE – SEE SHEET HT 11.0

MATCHLINE – SEE SHEET HT 13.0

MATCHLINE – SEE SHEET HT 17.0

LEGEND

- STUDY AREA BOUNDARY
- PROPOSED IMPACT AREA
- B1-2 ● WETLAND PLOT
- B1-3 ■ NON-WETLAND PLOT
- PHOTO B1-2/843 ▲ PHOTO POINT

MAP UNITS	VIERECK CLASSES (ABBREVIATION)
3	OMF, NW, CTS, CLS, OTS
4	NW, OLS
5	N/A
10	OMF, NW, CTS, CLS, OTS, OLS
11	CBF, ONF, OMF, DTSW, CTS, CLS, OLS
12	ONF, NW, CLS, OLS
13	ONF, NW, DTSW, CTS, CLS, OLS
20	ONF, NW, CTS
21	ONF, NW, DTSW
22	ONF, OMF, NW, CTS, CLS
23	CBF, CNF, ONF, CMF, OMF, NW, DTSW, CTS, CLS
40	ONF, OMF, NW, CLS, OTS, OLS
41	NW, DTSW, CLS, OLS
43	CLS, WGH
44	NW, CTS, CLS, OTS, OLS, WGH
50	ONF, NW
51	NW, DTSW, CTS, CLS, OLS
53	ONF, NW
56	OMF, NW, CTS, CLS
57	ONF, NW, DTSW, DTS
58	ONF, NW, CTS, CLS
60	ONF, NW, CTS, CLS
61	CLS, ONF
63	CNF, ONF, NW
64	ONF, NW, CLS
65	OBF, ONF, OMF, MW, NW
66	ONF, NW, CTS, CLS
71	NW

VIERECK CLASSIFICATION/ ABBREVIATION

HERBACEOUS HABITATS
<10% TREE COVER, <25% SHRUB COVER

WET GRAMINOID HERBACEOUS – WGH

SHRUB HABITATS
<10% TREE COVER, >25% SHRUB COVER

OPEN TALL SCRUB – OTS
CLOSED TALL SCRUB – CTS
OPEN LOW SCRUB – OLS
CLOSED LOW SCRUB – CLS
OPEN DWARF TREE SCRUB – ODTS
DWARF TREE SCRUB WOODLAND – DTSW

CLOSED CANOPY FOREST
>60% TREE COVER

CLOSED NEEDLELEAF FOREST – CNF
CLOSED BROADLEAF FOREST – CBF

OPEN CANOPY FOREST
25–59% TREE COVER

OPEN NEEDLELEAF FOREST – ONF
OPEN MIXED FOREST – OMF
OPEN BROADLEAF FOREST – OBF

WOODLANDS
10–24% TREE COVER

NEEDLELEAF WOODLAND – NW
MIXED WOODLAND – MW

0 75' 150' 300' NORTH

WHPacific
515 7th Avenue, Suite 310
Fairbanks, AK 99701
907-458-2142 Fax 907-458-2143
www.whpacific.com

FAIRBANKS OFFICE
100 CUSHMAN STREET, SUITE 210
FAIRBANKS, AK 99701-2253

MINE OFFICE
P.O. BOX 1000
HEALY, AK 99743

USIBELLI COAL MINE
JUMBO DOME MINE
HABITAT AND VEGETATION MAP

REVISIONS

NUMBER:	DATE:

JOB NO.:	5159
DATE:	JUNE 2008
DRAWN BY:	LJT
CHECKED BY:	PJQ
DRAWING NO.:	HT 12.0
SHEET	

MATCHLINE – SEE SHEET HT 8.0

MATCHLINE – SEE SHEET HT 12.0

MATCHLINE – SEE SHEET HT 18.0

LEGEND

- STUDY AREA BOUNDARY
- PROPOSED IMPACT AREA
- B1–2 ● WETLAND PLOT
- B1–3 ■ NON–WETLAND PLOT
- PHOTO B1–2/843 ▲ PHOTO POINT

MAP UNITS	VIERECK CLASSES (ABBREVIATION)
3	OMF, NW, CTS, CLS, OTS
4	NW, OLS
5	N/A
10	OMF, NW, CTS, CLS, OTS, OLS
11	CBF, ONF, OMF, DTSW, CTS, CLS, OLS
12	ONF, NW, CLS, OLS
13	ONF, NW, DTSW, CTS, CLS, OLS
20	ONF, NW, CTS
21	ONF, NW, DTSW
22	ONF, OMF, NW, CTS, CLS
23	CBF, CNF, ONF, CMF, OMF, NW, DTSW, CTS, CLS
40	ONF, OMF, NW, CLS, OTS, OLS
41	NW, DTSW, CLS, OLS
43	CLS, WGH
44	NW, CTS, CLS, OTS, OLS, WGH
50	ONF, NW
51	NW, DTSW, CTS, CLS, OLS
53	ONF, NW
56	OMF, NW, CTS, CLS
57	ONF, NW, DTSW, DTS
58	ONF, NW, CTS, CLS
60	ONF, NW, CTS, CLS
61	CLS, ONF
63	CNF, ONF, NW
64	ONF, NW, CLS
65	OBF, ONF, OMF, MW, NW
66	ONF, NW, CTS, CLS
71	NW

VIERECK CLASSIFICATION/ ABBREVIATION

HERBACEOUS HABITATS
<10% TREE COVER, <25% SHRUB COVER

WET GRAMINOID HERBACEOUS – WGH

SHRUB HABITATS
<10% TREE COVER, >25% SHRUB COVER

OPEN TALL SCRUB – OTS
CLOSED TALL SCRUB – CTS
OPEN LOW SCRUB – OLS
CLOSED LOW SCRUB – CLS
OPEN DWARF TREE SCRUB – ODTS
DWARF TREE SCRUB WOODLAND – DTSW

CLOSED CANOPY FOREST
>60% TREE COVER

CLOSED NEEDLELEAF FOREST – CNF
CLOSED BROADLEAF FOREST – CBF

OPEN CANOPY FOREST
25–59% TREE COVER

OPEN NEEDLELEAF FOREST – ONF
OPEN MIXED FOREST – OMF
OPEN BROADLEAF FOREST – OBF

WOODLANDS
10–24% TREE COVER

NEEDLELEAF WOODLAND – NW
MIXED WOODLAND – MW

0 75' 150' 300' NORTH

WHPacific
515 7th Avenue, Suite 310
Fairbanks, AK 99701
907-459-2142 Fax 907-459-2143
www.whpacific.com

FAIRBANKS OFFICE
100 CUSHMAN STREET, SUITE 210
FAIRBANKS, AK 99701-2253

MINE OFFICE
P.O. BOX 1000
HEALY, AK 99743

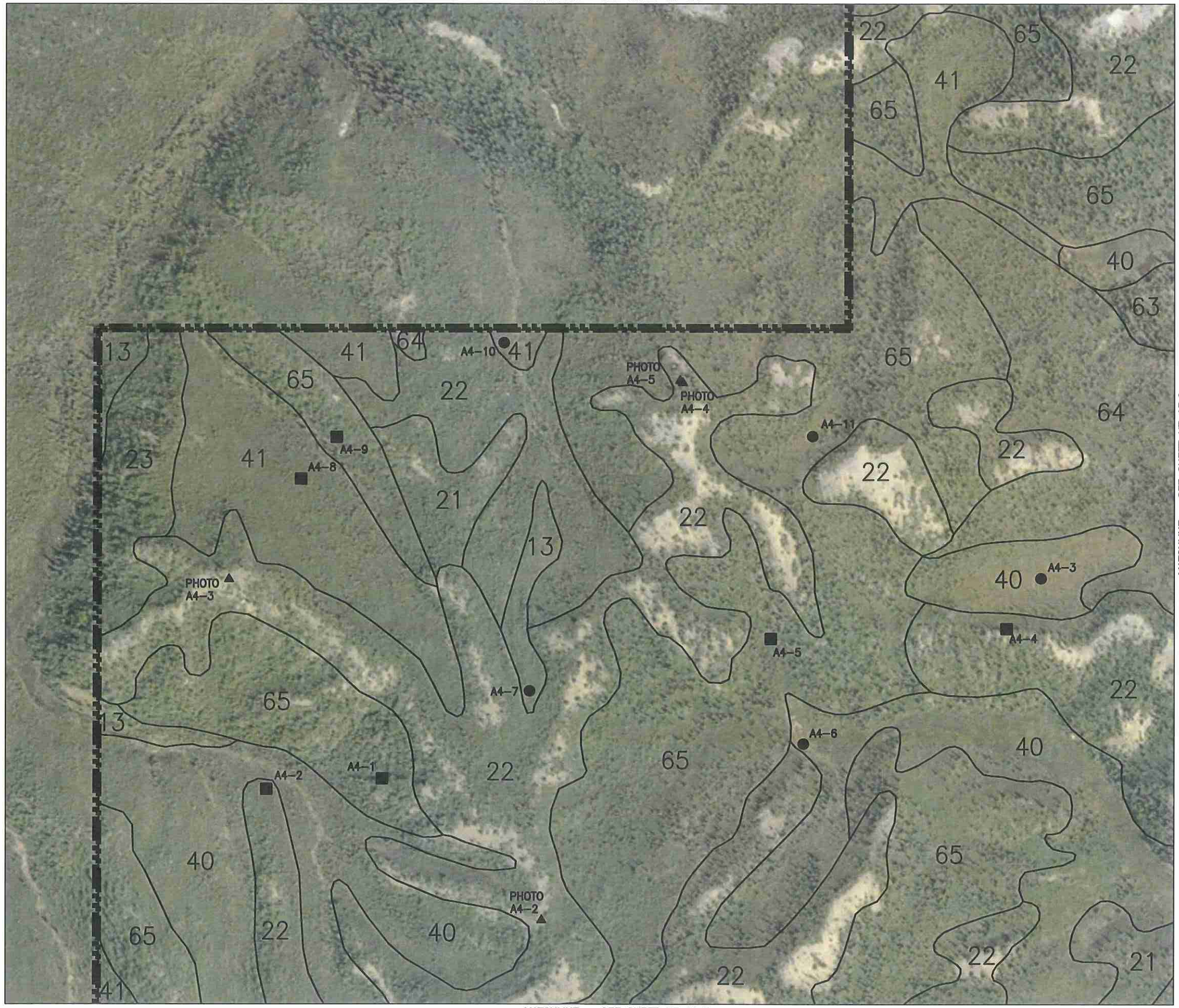
USIBELLI COAL MINE
JUMBO DOME MINE

HABITAT AND VEGETATION MAP

REVISIONS	
NUMBER:	DATE:

JOB NO.:	5159
DATE:	JUNE 2008
DRAWN BY:	LJT
CHECKED BY:	PJQ
DRAWING NO.:	HT 13.0
SHEET	

MATCHLINE – SEE SHEET HT 9.0



MATCHLINE – SEE SHEET HT 19.0

MATCHLINE – SEE SHEET HT 15.0

LEGEND

- STUDY AREA BOUNDARY
- PROPOSED IMPACT AREA
- B1–2 ● WETLAND PLOT
- B1–3 ■ NON–WETLAND PLOT
- PHOTO B1–2/843 ▲ PHOTO POINT

MAP UNITS	VIERECK CLASSES (ABBREVIATION)
3	OMF, NW, CTS, CLS, OTS
4	NW, OLS
5	N/A
10	OMF, NW, CTS, CLS, OTS, OLS
11	CBF, ONF, OMF, DTSW, CTS, CLS, OLS
12	ONF, NW, CLS, OLS
13	ONF, NW, DTSW, CTS, CLS, OLS
20	ONF, NW, CTS
21	ONF, NW, DTSW
22	ONF, OMF, NW, CTS, CLS
23	CBF, CNF, ONF, CMF, OMF, NW, DTSW, CTS, CLS
40	ONF, OMF, NW, CLS, OTS, OLS
41	NW, DTSW, CLS, OLS
43	CLS, WGH
44	NW, CTS, CLS, OTS, OLS, WGH
50	ONF, NW
51	NW, DTSW, CTS, CLS, OLS
53	ONF, NW
56	OMF, NW, CTS, CLS
57	ONF, NW, DTSW, DTS
58	ONF, NW, CTS, CLS
60	ONF, NW, CTS, CLS
61	CLS, ONF
63	CNF, ONF, NW
64	ONF, NW, CLS
65	OBF, ONF, OMF, MW, NW
66	ONF, NW, CTS, CLS
71	NW

VIERECK CLASSIFICATION/ ABBREVIATION

HERBACEOUS HABITATS
<10% TREE COVER, <25% SHRUB COVER

WET GRAMINOID HERBACEOUS – WGH

SHRUB HABITATS
<10% TREE COVER, >25% SHRUB COVER

OPEN TALL SCRUB – OTS
CLOSED TALL SCRUB – CTS
OPEN LOW SCRUB – OLS
CLOSED LOW SCRUB – CLS
OPEN DWARF TREE SCRUB – ODTS
DWARF TREE SCRUB WOODLAND – DTSW

CLOSED CANOPY FOREST
>60% TREE COVER

CLOSED NEEDLELEAF FOREST – CNF
CLOSED BROADLEAF FOREST – CBF

OPEN CANOPY FOREST
25–59% TREE COVER

OPEN NEEDLELEAF FOREST – ONF
OPEN MIXED FOREST – OMF
OPEN BROADLEAF FOREST – OBF

WOODLANDS
10–24% TREE COVER

NEEDLELEAF WOODLAND – NW
MIXED WOODLAND – MW

0 75' 150' 300' NORTH

WHPacific
515 7th Avenue, Suite 310
Fairbanks, AK 99701
907-459-2142 Fax: 907-459-2143
www.whpacific.com

FAIRBANKS OFFICE
100 CUSHMAN STREET, SUITE 210
FAIRBANKS, AK 99701-2253

MINE OFFICE
P.O. BOX 1000
HEALY, AK 99743

USIBELLI COAL MINE
JUMBO DOME MINE

HABITAT AND VEGETATION MAP

REVISIONS

NUMBER:	DATE:

JOB NO.:	5159
DATE:	JUNE 2008
DRAWN BY:	LJT
CHECKED BY:	PJQ
DRAWING NO.:	HT 14.0
SHEET	

MATCHLINE – SEE SHEET HT 10.0

MATCHLINE – SEE SHEET HT 14.0

MATCHLINE – SEE SHEET HT 16.0

MATCHLINE – SEE SHEET HT 20.0

LEGEND

- STUDY AREA BOUNDARY
- PROPOSED IMPACT AREA
- B1–2 WETLAND PLOT
- B1–3 NON–WETLAND PLOT
- PHOTO B1–2/843 PHOTO POINT

MAP UNITS	VIERECK CLASSES (ABBREVIATION)
3	OMF, NW, CTS, CLS, OTS
4	NW, OLS
5	N/A
10	OMF, NW, CTS, CLS, OTS, OLS
11	CBF, ONF, OMF, DTSW, CTS, CLS, OLS
12	ONF, NW, CLS, OLS
13	ONF, NW, DTSW, CTS, CLS, OLS
20	ONF, NW, CTS
21	ONF, NW, DTSW
22	ONF, OMF, NW, CTS, CLS
23	CBF, CNF, ONF, CMF, OMF, NW, DTSW, CTS, CLS
40	ONF, OMF, NW, CLS, OTS, OLS
41	NW, DTSW, CLS, OLS
43	CLS, WGH
44	NW, CTS, CLS, OTS, OLS, WGH
50	ONF, NW
51	NW, DTSW, CTS, CLS, OLS
53	ONF, NW
56	OMF, NW, CTS, CLS
57	ONF, NW, DTSW, DTS
58	ONF, NW, CTS, CLS
60	ONF, NW, CTS, CLS
61	CLS, ONF
63	CNF, ONF, NW
64	ONF, NW, CLS
65	OBF, ONF, OMF, MW, NW
66	ONF, NW, CTS, CLS
71	NW

VIERECK CLASSIFICATION/ ABBREVIATION

HERBACEOUS HABITATS
<10% TREE COVER, <25% SHRUB COVER

WET GRAMINOID HERBACEOUS – WGH

SHRUB HABITATS
<10% TREE COVER, >25% SHRUB COVER

OPEN TALL SCRUB – OTS
CLOSED TALL SCRUB – CTS
OPEN LOW SCRUB – OLS
CLOSED LOW SCRUB – CLS
OPEN DWARF TREE SCRUB – ODTS
DWARF TREE SCRUB WOODLAND – DTSW

CLOSED CANOPY FOREST
>60% TREE COVER

CLOSED NEEDLELEAF FOREST – CNF
CLOSED BROADLEAF FOREST – CBF

OPEN CANOPY FOREST
25–59% TREE COVER

OPEN NEEDLELEAF FOREST – ONF
OPEN MIXED FOREST – OMF
OPEN BROADLEAF FOREST – OBF

WOODLANDS
10–24% TREE COVER

NEEDLELEAF WOODLAND – NW
MIXED WOODLAND – MW

0 75' 150' 300' NORTH

WHPacific
515 7th Avenue, Suite 310
Fairbanks, AK 99701
907-458-2142 Fax 907-458-2143
www.whpacific.com

FAIRBANKS OFFICE
100 CUSHMAN STREET, SUITE 210
FAIRBANKS, AK 99701-2253

MINE OFFICE
P.O. BOX 1000
HEALY, AK 99743

USIBELLI COAL MINE
JUMBO DOME MINE
HABITAT AND VEGETATION MAP

REVISIONS

NUMBER:	DATE:

JOB NO.:	5159
DATE:	JUNE 2008
DRAWN BY:	LJT
CHECKED BY:	PJQ
DRAWING NO.:	HT 15.0
SHEET	

MATCHLINE – SEE SHEET HT 11.0

MATCHLINE – SEE SHEET HT 21.0

LEGEND

- STUDY AREA BOUNDARY
- PROPOSED IMPACT AREA
- B1–2 ● WETLAND PLOT
- B1–3 ■ NON–WETLAND PLOT
- PHOTO B1–2/843 ▲ PHOTO POINT

MAP UNITS	VIERECK CLASSES (ABBREVIATION)
3	OMF, NW, CTS, CLS, OTS
4	NW, OLS
5	N/A
10	OMF, NW, CTS, CLS, OTS, OLS
11	CBF, ONF, OMF, DTSW, CTS, CLS, OLS
12	ONF, NW, CLS, OLS
13	ONF, NW, DTSW, CTS, CLS, OLS
20	ONF, NW, CTS
21	ONF, NW, DTSW
22	ONF, OMF, NW, CTS, CLS
23	CBF, CNF, ONF, CMF, OMF, NW, DTSW, CTS, CLS
40	ONF, OMF, NW, CLS, OTS, OLS
41	NW, DTSW, CLS, OLS
43	CLS, WGH
44	NW, CTS, CLS, OTS, OLS, WGH
50	ONF, NW
51	NW, DTSW, CTS, CLS, OLS
53	ONF, NW
56	OMF, NW, CTS, CLS
57	ONF, NW, DTSW, DTS
58	ONF, NW, CTS, CLS
60	ONF, NW, CTS, CLS
61	CLS, ONF
63	CNF, ONF, NW
64	ONF, NW, CLS
65	OBF, ONF, OMF, MW, NW
66	ONF, NW, CTS, CLS
71	NW

VIERECK CLASSIFICATION/ ABBREVIATION

HERBACEOUS HABITATS
<10% TREE COVER, <25% SHRUB COVER

WET GRAMINOID HERBACEOUS – WGH

SHRUB HABITATS
<10% TREE COVER, >25% SHRUB COVER

OPEN TALL SCRUB – OTS
CLOSED TALL SCRUB – CTS
OPEN LOW SCRUB – OLS
CLOSED LOW SCRUB – CLS
OPEN DWARF TREE SCRUB – ODTS
DWARF TREE SCRUB WOODLAND – DTSW

CLOSED CANOPY FOREST
>60% TREE COVER

CLOSED NEEDLELEAF FOREST – CNF
CLOSED BROADLEAF FOREST – CBF

OPEN CANOPY FOREST
25–59% TREE COVER

OPEN NEEDLELEAF FOREST – ONF
OPEN MIXED FOREST – OMF
OPEN BROADLEAF FOREST – OBF

WOODLANDS
10–24% TREE COVER

NEEDLELEAF WOODLAND – NW
MIXED WOODLAND – MW

0 75' 150' 300' NORTH

WHPacific
515 7th Avenue, Suite 310
Fairbanks, Alaska 99701
907-458-2142 Fax 907-458-2143
www.whpacific.com

FAIRBANKS OFFICE
100 CUSHMAN STREET, SUITE 210
FAIRBANKS, AK 99701-2253

MINE OFFICE
P.O. BOX 1000
HEALY, AK 99743

USIBELLI COAL MINE
JUMBO DOME MINE

HABITAT AND VEGETATION MAP

REVISIONS

NUMBER:	DATE:

JOB NO.:	5159
DATE:	JUNE 2008
DRAWN BY:	LJT
CHECKED BY:	PJQ
DRAWING NO.:	HT 16.0
SHEET	

MATCHLINE – SEE SHEET HT 12.0

MATCHLINE – SEE SHEET HT 16.0

MATCHLINE – SEE SHEET HT 18.0

MATCHLINE – SEE SHEET HT 22.0

LEGEND

- STUDY AREA BOUNDARY
- PROPOSED IMPACT AREA
- B1–2 WETLAND PLOT
- B1–3 NON–WETLAND PLOT
- PHOTO B1–2/843 PHOTO POINT

MAP UNITS	VIERECK CLASSES (ABBREVIATION)
3	OMF, NW, CTS, CLS, OTS
4	NW, OLS
5	N/A
10	OMF, NW, CTS, CLS, OTS, OLS
11	CBF, ONF, OMF, DTSW, CTS, CLS, OLS
12	ONF, NW, CLS, OLS
13	ONF, NW, DTSW, CTS, CLS, OLS
20	ONF, NW, CTS
21	ONF, NW, DTSW
22	ONF, OMF, NW, CTS, CLS
23	CBF, CNF, ONF, CMF, OMF, NW, DTSW, CTS, CLS
40	ONF, OMF, NW, CLS, OTS, OLS
41	NW, DTSW, CLS, OLS
43	CLS, WGH
44	NW, CTS, CLS, OTS, OLS, WGH
50	ONF, NW
51	NW, DTSW, CTS, CLS, OLS
53	ONF, NW
56	OMF, NW, CTS, CLS
57	ONF, NW, DTSW, DTS
58	ONF, NW, CTS, CLS
60	ONF, NW, CTS, CLS
61	CLS, ONF
63	CNF, ONF, NW
64	ONF, NW, CLS
65	OBF, ONF, OMF, MW, NW
66	ONF, NW, CTS, CLS
71	NW

VIERECK CLASSIFICATION/ ABBREVIATION

HERBACEOUS HABITATS
<10% TREE COVER, <25% SHRUB COVER

WET GRAMINOID HERBACEOUS – WGH

SHRUB HABITATS
<10% TREE COVER, >25% SHRUB COVER

OPEN TALL SCRUB – OTS
CLOSED TALL SCRUB – CTS
OPEN LOW SCRUB – OLS
CLOSED LOW SCRUB – CLS
OPEN DWARF TREE SCRUB – ODTS
DWARF TREE SCRUB WOODLAND – DTSW

CLOSED CANOPY FOREST
>60% TREE COVER

CLOSED NEEDLELEAF FOREST – CNF
CLOSED BROADLEAF FOREST – CBF

OPEN CANOPY FOREST
25–59% TREE COVER

OPEN NEEDLELEAF FOREST – ONF
OPEN MIXED FOREST – OMF
OPEN BROADLEAF FOREST – OBF

WOODLANDS
10–24% TREE COVER

NEEDLELEAF WOODLAND – NW
MIXED WOODLAND – MW

0 75' 150' 300' NORTH

WHPacific
515 7th Avenue, Suite 310
Fairbanks, Alaska 99701
907-458-2142 Fax 907-458-2143
www.whpacific.com

FAIRBANKS OFFICE
100 CUSHMAN STREET, SUITE 210
FAIRBANKS, AK 99701-2253

MINE OFFICE
P.O. BOX 1000
HEALY, AK 99743

USIBELLI COAL MINE
JUMBO DOME MINE

HABITAT AND VEGETATION MAP

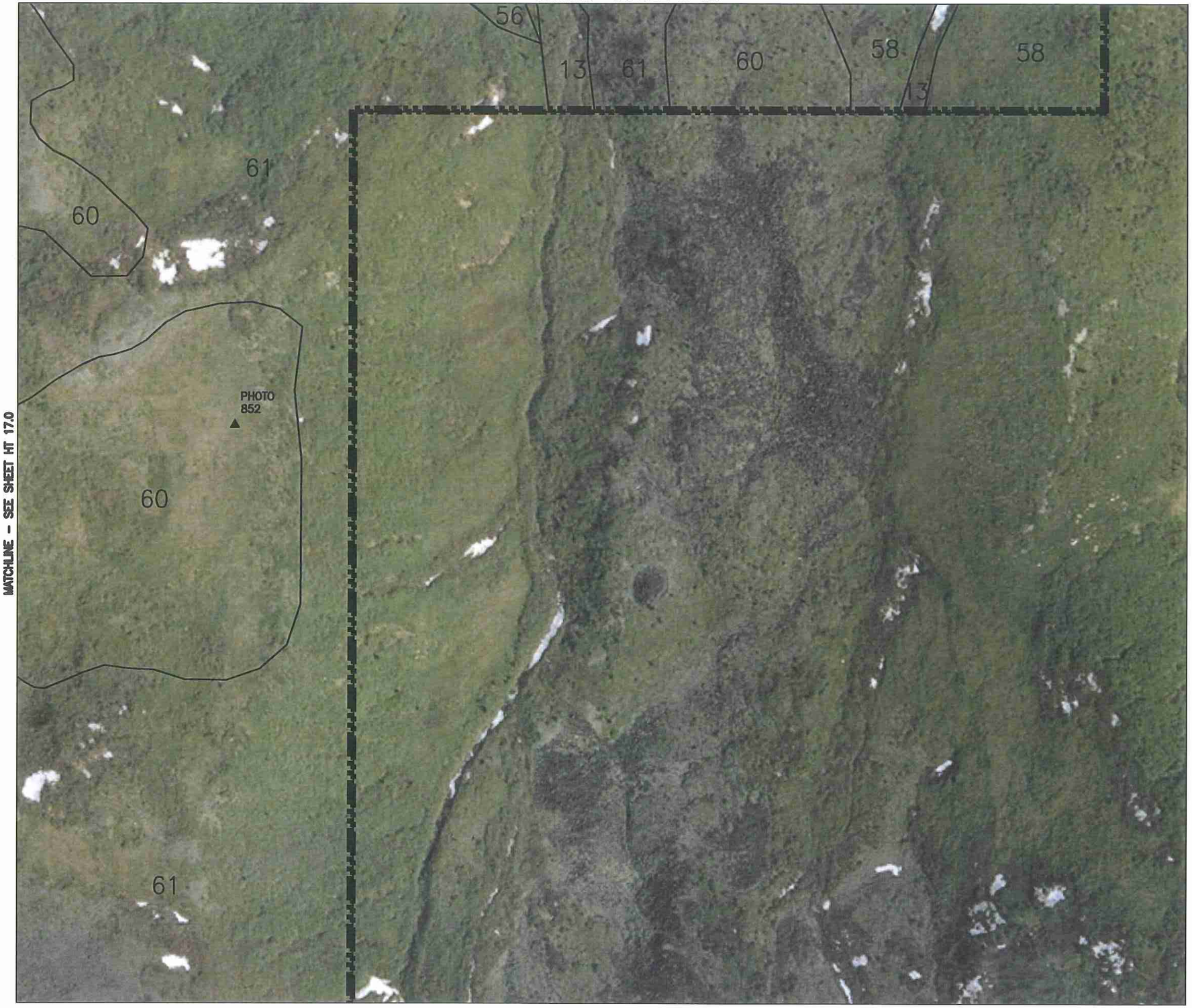
REVISIONS

NUMBER:	DATE:

JOB NO.:	5159
DATE:	JUNE 2008
DRAWN BY:	LJT
CHECKED BY:	PJQ
DRAWING NO.:	HT 17.0
SHEET	

MATCHLINE – SEE SHEET HT 13.0

MATCHLINE – SEE SHEET HT 17.0



LEGEND

- STUDY AREA BOUNDARY
- PROPOSED IMPACT AREA
- B1–2 ● WETLAND PLOT
- B1–3 ■ NON–WETLAND PLOT
- PHOTO B1–2/843 ▲ PHOTO POINT

MAP UNITS	VIERECK CLASSES (ABBREVIATION)
3	OMF, NW, CTS, CLS, OTS
4	NW, OLS
5	N/A
10	OMF, NW, CTS, CLS, OTS, OLS
11	CBF, ONF, OMF, DTSW, CTS, CLS, OLS
12	ONF, NW, CLS, OLS
13	ONF, NW, DTSW, CTS, CLS, OLS
20	ONF, NW, CTS
21	ONF, NW, DTSW
22	ONF, OMF, NW, CTS, CLS
23	CBF, CNF, ONF, CMF, OMF, NW, DTSW, CTS, CLS
40	ONF, OMF, NW, CLS, OTS, OLS
41	NW, DTSW, CLS, OLS
43	CLS, WGH
44	NW, CTS, CLS, OTS, OLS, WGH
50	ONF, NW
51	NW, DTSW, CTS, CLS, OLS
53	ONF, NW
56	OMF, NW, CTS, CLS
57	ONF, NW, DTSW, DTS
58	ONF, NW, CTS, CLS
60	ONF, NW, CTS, CLS
61	CLS, ONF
63	CNF, ONF, NW
64	ONF, NW, CLS
65	OBF, ONF, OMF, MW, NW
66	ONF, NW, CTS, CLS
71	NW

VIERECK CLASSIFICATION/ ABBREVIATION

HERBACEOUS HABITATS
<10% TREE COVER, <25% SHRUB COVER

WET GRAMINOID HERBACEOUS – WGH

SHRUB HABITATS
<10% TREE COVER, >25% SHRUB COVER

OPEN TALL SCRUB – OTS
CLOSED TALL SCRUB – CTS
OPEN LOW SCRUB – OLS
CLOSED LOW SCRUB – CLS
OPEN DWARF TREE SCRUB – ODTS
DWARF TREE SCRUB WOODLAND – DTSW

CLOSED CANOPY FOREST
>60% TREE COVER

CLOSED NEEDLELEAF FOREST – CNF
CLOSED BROADLEAF FOREST – CBF

OPEN CANOPY FOREST
25–59% TREE COVER

OPEN NEEDLELEAF FOREST – ONF
OPEN MIXED FOREST – OMF
OPEN BROADLEAF FOREST – OBF

WOODLANDS
10–24% TREE COVER

NEEDLELEAF WOODLAND – NW
MIXED WOODLAND – MW

0 75' 150' 300' NORTH

WHPacific
515 7th Avenue, Suite 310
Fairbanks, AK 99701
907-459-2142 Fax 907-459-2143
www.whpacific.com

FAIRBANKS OFFICE
100 CUSHMAN STREET, SUITE 210
FAIRBANKS, AK 99701-2253

MINE OFFICE
P.O. BOX 1000
HEALY, AK 99743

USIBELLI COAL MINE
JUMBO DOME MINE
HABITAT AND VEGETATION MAP

REVISIONS	
NUMBER:	DATE:

JOB NO.:	5159
DATE:	JUNE 2008
DRAWN BY:	LJT
CHECKED BY:	PJQ
DRAWING NO.:	HT 18.0
SHEET	

MATCHLINE – SEE SHEET HT 14.0

MATCHLINE – SEE SHEET HT 20.0

MATCHLINE – SEE SHEET HT 23.0

LEGEND

- STUDY AREA BOUNDARY
- PROPOSED IMPACT AREA
- B1–2 WETLAND PLOT
- B1–3 NON–WETLAND PLOT
- PHOTO B1–2/843 PHOTO POINT

MAP UNITS	VIERECK CLASSES (ABBREVIATION)
3	OMF, NW, CTS, CLS, OTS
4	NW, OLS
5	N/A
10	OMF, NW, CTS, CLS, OTS, OLS
11	CBF, ONF, OMF, DTSW, CTS, CLS, OLS
12	ONF, NW, CLS, OLS
13	ONF, NW, DTSW, CTS, CLS, OLS
20	ONF, NW, CTS
21	ONF, NW, DTSW
22	ONF, OMF, NW, CTS, CLS
23	CBF, CNF, ONF, CMF, OMF, NW, DTSW, CTS, CLS
40	ONF, OMF, NW, CLS, OTS, OLS
41	NW, DTSW, CLS, OLS
43	CLS, WGH
44	NW, CTS, CLS, OTS, OLS, WGH
50	ONF, NW
51	NW, DTSW, CTS, CLS, OLS
53	ONF, NW
56	OMF, NW, CTS, CLS
57	ONF, NW, DTSW, DTS
58	ONF, NW, CTS, CLS
60	ONF, NW, CTS, CLS
61	CLS, ONF
63	CNF, ONF, NW
64	ONF, NW, CLS
65	OBF, ONF, OMF, MW, NW
66	ONF, NW, CTS, CLS
71	NW

VIERECK CLASSIFICATION/ ABBREVIATION

HERBACEOUS HABITATS
<10% TREE COVER, <25% SHRUB COVER

WET GRAMINOID HERBACEOUS – WGH

SHRUB HABITATS
<10% TREE COVER, >25% SHRUB COVER

OPEN TALL SCRUB – OTS
CLOSED TALL SCRUB – CTS
OPEN LOW SCRUB – OLS
CLOSED LOW SCRUB – CLS
OPEN DWARF TREE SCRUB – ODTS
DWARF TREE SCRUB WOODLAND – DTSW

CLOSED CANOPY FOREST
>60% TREE COVER

CLOSED NEEDLELEAF FOREST – CNF
CLOSED BROADLEAF FOREST – CBF

OPEN CANOPY FOREST
25–59% TREE COVER

OPEN NEEDLELEAF FOREST – ONF
OPEN MIXED FOREST – OMF
OPEN BROADLEAF FOREST – OBF

WOODLANDS
10–24% TREE COVER

NEEDLELEAF WOODLAND – NW
MIXED WOODLAND – MW

0 75' 150' 300' NORTH

WHPacific
515 7th Avenue, Suite 310
Fairbanks, Alaska 99701
907-458-2142 Fax 907-458-2143
www.whpacific.com

FAIRBANKS OFFICE
100 CUSHMAN STREET, SUITE 210
FAIRBANKS, AK 99701-2253

MINE OFFICE
P.O. BOX 1000
HEALY, AK 99743

USIBELLI COAL MINE
JUMBO DOME MINE
HABITAT AND VEGETATION MAP

REVISIONS

NUMBER:	DATE:

JOB NO.:	5159
DATE:	JUNE 2008
DRAWN BY:	LJT
CHECKED BY:	PJQ
DRAWING NO.:	HT 19.0
SHEET	

MATCHLINE – SEE SHEET HT 15.0

MATCHLINE – SEE SHEET HT 19.0

MATCHLINE – SEE SHEET HT 21.0

MATCHLINE – SEE SHEET HT 24

LEGEND

- STUDY AREA BOUNDARY
- PROPOSED IMPACT AREA
- B1–2 WETLAND PLOT
- B1–3 NON–WETLAND PLOT
- PHOTO B1–2/843 PHOTO POINT

MAP UNITS	VIERECK CLASSES (ABBREVIATION)
3	OMF, NW, CTS, CLS, OTS
4	NW, OLS
5	N/A
10	OMF, NW, CTS, CLS, OTS, OLS
11	CBF, ONF, OMF, DTSW, CTS, CLS, OLS
12	ONF, NW, CLS, OLS
13	ONF, NW, DTSW, CTS, CLS, OLS
20	ONF, NW, CTS
21	ONF, NW, DTSW
22	ONF, OMF, NW, CTS, CLS
23	CBF, CNF, ONF, CMF, OMF, NW, DTSW, CTS, CLS
40	ONF, OMF, NW, CLS, OTS, OLS
41	NW, DTSW, CLS, OLS
43	CLS, WGH
44	NW, CTS, CLS, OTS, OLS, WGH
50	ONF, NW
51	NW, DTSW, CTS, CLS, OLS
53	ONF, NW
56	OMF, NW, CTS, CLS
57	ONF, NW, DTSW, DTS
58	ONF, NW, CTS, CLS
60	ONF, NW, CTS, CLS
61	CLS, ONF
63	CNF, ONF, NW
64	ONF, NW, CLS
65	OBF, ONF, OMF, MW, NW
66	ONF, NW, CTS, CLS
71	NW

VIERECK CLASSIFICATION/ ABBREVIATION

HERBACEOUS HABITATS
<10% TREE COVER, <25% SHRUB COVER

WET GRAMINOID HERBACEOUS – WGH

SHRUB HABITATS
<10% TREE COVER, >25% SHRUB COVER

OPEN TALL SCRUB – OTS
CLOSED TALL SCRUB – CTS
OPEN LOW SCRUB – OLS
CLOSED LOW SCRUB – CLS
OPEN DWARF TREE SCRUB – ODTS
DWARF TREE SCRUB WOODLAND – DTSW

CLOSED CANOPY FOREST
>60% TREE COVER

CLOSED NEEDLELEAF FOREST – CNF
CLOSED BROADLEAF FOREST – CBF

OPEN CANOPY FOREST
25–59% TREE COVER

OPEN NEEDLELEAF FOREST – ONF
OPEN MIXED FOREST – OMF
OPEN BROADLEAF FOREST – OBF

WOODLANDS
10–24% TREE COVER

NEEDLELEAF WOODLAND – NW
MIXED WOODLAND – MW

0 75' 150' 300' NORTH

WHPacific
515 7th Avenue, Suite 310
Fairbanks, AK 99701
907-458-2142 Fax 907-458-2143
www.whpacific.com

FAIRBANKS OFFICE
100 CUSHMAN STREET, SUITE 210
FAIRBANKS, AK 99701-2253

MINE OFFICE
P.O. BOX 1000
HEALY, AK 99743

USIBELLI COAL MINE
JUMBO DOME MINE

HABITAT AND VEGETATION MAP

REVISIONS

NUMBER:	DATE:

JOB NO.:	5159
DATE:	JUNE 2008
DRAWN BY:	LJT
CHECKED BY:	PJQ
DRAWING NO.:	HT 20.0
SHEET	

MATCHLINE – SEE SHEET HT 16.0

MATCHLINE – SEE SHEET HT 20.0

MATCHLINE – SEE SHEET HT 22.0

MATCHLINE – SEE SHEET HT 25.0

LEGEND

- STUDY AREA BOUNDARY
- PROPOSED IMPACT AREA
- B1–2 WETLAND PLOT
- B1–3 NON–WETLAND PLOT
- PHOTO B1–2/843 PHOTO POINT

MAP UNITS	VIERECK CLASSES (ABBREVIATION)
3	OMF, NW, CTS, CLS, OTS
4	NW, OLS
5	N/A
10	OMF, NW, CTS, CLS, OTS, OLS
11	CBF, ONF, OMF, DTSW, CTS, CLS, OLS
12	ONF, NW, CLS, OLS
13	ONF, NW, DTSW, CTS, CLS, OLS
20	ONF, NW, CTS
21	ONF, NW, DTSW
22	ONF, OMF, NW, CTS, CLS
23	CBF, CNF, ONF, CMF, OMF, NW, DTSW, CTS, CLS
40	ONF, OMF, NW, CLS, OTS, OLS
41	NW, DTSW, CLS, OLS
43	CLS, WGH
44	NW, CTS, CLS, OTS, OLS, WGH
50	ONF, NW
51	NW, DTSW, CTS, CLS, OLS
53	ONF, NW
56	OMF, NW, CTS, CLS
57	ONF, NW, DTSW, DTS
58	ONF, NW, CTS, CLS
60	ONF, NW, CTS, CLS
61	CLS, ONF
63	CNF, ONF, NW
64	ONF, NW, CLS
65	OBF, ONF, OMF, MW, NW
66	ONF, NW, CTS, CLS
71	NW

VIERECK CLASSIFICATION/ ABBREVIATION

HERBACEOUS HABITATS
<10% TREE COVER, <25% SHRUB COVER

WET GRAMINOID HERBACEOUS – WGH

SHRUB HABITATS
<10% TREE COVER, >25% SHRUB COVER

OPEN TALL SCRUB – OTS
CLOSED TALL SCRUB – CTS
OPEN LOW SCRUB – OLS
CLOSED LOW SCRUB – CLS
OPEN DWARF TREE SCRUB – ODTS
DWARF TREE SCRUB WOODLAND – DTSW

CLOSED CANOPY FOREST
>60% TREE COVER

CLOSED NEEDLELEAF FOREST – CNF
CLOSED BROADLEAF FOREST – CBF

OPEN CANOPY FOREST
25–59% TREE COVER

OPEN NEEDLELEAF FOREST – ONF
OPEN MIXED FOREST – OMF
OPEN BROADLEAF FOREST – OBF

WOODLANDS
10–24% TREE COVER

NEEDLELEAF WOODLAND – NW
MIXED WOODLAND – MW

0 75' 150' 300' NORTH

WHPacific
515 7th Avenue, Suite 310
Fairbanks, AK 99701
907-458-2142 Fax 907-458-2143
www.whpacific.com

FAIRBANKS OFFICE
100 CUSHMAN STREET, SUITE 210
FAIRBANKS, AK 99701-2253

MINE OFFICE
P.O. BOX 1000
HEALY, AK 99743

USIBELLI COAL MINE
JUMBO DOME MINE

HABITAT AND VEGETATION MAP

REVISIONS

NUMBER:	DATE:

JOB NO.:	5159
DATE:	JUNE 2008
DRAWN BY:	LJT
CHECKED BY:	PJQ
DRAWING NO.:	HT 21.0
SHEET	

MATCHLINE – SEE SHEET HT 17.0

MATCHLINE – SEE SHEET HT 21.0

MATCHLINE – SEE SHEET HT 26.0

LEGEND

- STUDY AREA BOUNDARY
- PROPOSED IMPACT AREA
- B1–2 WETLAND PLOT
- B1–3 NON–WETLAND PLOT
- PHOTO B1–2/843 PHOTO POINT

MAP UNITS	VIERECK CLASSES (ABBREVIATION)
3	OMF, NW, CTS, CLS, OTS
4	NW, OLS
5	N/A
10	OMF, NW, CTS, CLS, OTS, OLS
11	CBF, ONF, OMF, DTSW, CTS, CLS, OLS
12	ONF, NW, CLS, OLS
13	ONF, NW, DTSW, CTS, CLS, OLS
20	ONF, NW, CTS
21	ONF, NW, DTSW
22	ONF, OMF, NW, CTS, CLS
23	CBF, CNF, ONF, CMF, OMF, NW, DTSW, CTS, CLS
40	ONF, OMF, NW, CLS, OTS, OLS
41	NW, DTSW, CLS, OLS
43	CLS, WGH
44	NW, CTS, CLS, OTS, OLS, WGH
50	ONF, NW
51	NW, DTSW, CTS, CLS, OLS
53	ONF, NW
56	OMF, NW, CTS, CLS
57	ONF, NW, DTSW, DTS
58	ONF, NW, CTS, CLS
60	ONF, NW, CTS, CLS
61	CLS, ONF
63	CNF, ONF, NW
64	ONF, NW, CLS
65	OBF, ONF, OMF, MW, NW
66	ONF, NW, CTS, CLS
71	NW

VIERECK CLASSIFICATION/ ABBREVIATION

HERBACEOUS HABITATS
<10% TREE COVER, <25% SHRUB COVER

WET GRAMINOID HERBACEOUS – WGH

SHRUB HABITATS
<10% TREE COVER, >25% SHRUB COVER

OPEN TALL SCRUB – OTS
CLOSED TALL SCRUB – CTS
OPEN LOW SCRUB – OLS
CLOSED LOW SCRUB – CLS
OPEN DWARF TREE SCRUB – ODTS
DWARF TREE SCRUB WOODLAND – DTSW

CLOSED CANOPY FOREST
>60% TREE COVER

CLOSED NEEDLELEAF FOREST – CNF
CLOSED BROADLEAF FOREST – CBF

OPEN CANOPY FOREST
25–59% TREE COVER

OPEN NEEDLELEAF FOREST – ONF
OPEN MIXED FOREST – OMF
OPEN BROADLEAF FOREST – OBF

WOODLANDS
10–24% TREE COVER

NEEDLELEAF WOODLAND – NW
MIXED WOODLAND – MW

0 75' 150' 300' NORTH

WHPacific
515 7th Avenue, Suite 310
Fairbanks, Alaska 99701
907-458-3142 Fax 907-458-3143
www.whpacific.com

FAIRBANKS OFFICE
100 CUSHMAN STREET, SUITE 210
FAIRBANKS, AK 99701-2253

MINE OFFICE
P.O. BOX 1000
HEALY, AK 99743

USIBELLI COAL MINE
JUMBO DOME MINE

HABITAT AND VEGETATION MAP

REVISIONS

NUMBER:	DATE:

JOB NO.:	5159
DATE:	JUNE 2008
DRAWN BY:	LJT
CHECKED BY:	PJQ
DRAWING NO.:	HT 22.0
SHEET	

MATCHLINE – SEE SHEET HT 19.0

MATCHLINE – SEE SHEET HT 24.0

LEGEND

- STUDY AREA BOUNDARY
- PROPOSED IMPACT AREA
- B1–2 ● WETLAND PLOT
- B1–3 ■ NON–WETLAND PLOT
- PHOTO B1–2/843 ▲ PHOTO POINT

MAP UNITS	VIERECK CLASSES (ABBREVIATION)
3	OMF, NW, CTS, CLS, OTS
4	NW, OLS
5	N/A
10	OMF, NW, CTS, CLS, OTS, OLS
11	CBF, ONF, OMF, DTSW, CTS, CLS, OLS
12	ONF, NW, CLS, OLS
13	ONF, NW, DTSW, CTS, CLS, OLS
20	ONF, NW, CTS
21	ONF, NW, DTSW
22	ONF, OMF, NW, CTS, CLS
23	CBF, CNF, ONF, CMF, OMF, NW, DTSW, CTS, CLS
40	ONF, OMF, NW, CLS, OTS, OLS
41	NW, DTSW, CLS, OLS
43	CLS, WGH
44	NW, CTS, CLS, OTS, OLS, WGH
50	ONF, NW
51	NW, DTSW, CTS, CLS, OLS
53	ONF, NW
56	OMF, NW, CTS, CLS
57	ONF, NW, DTSW, DTS
58	ONF, NW, CTS, CLS
60	ONF, NW, CTS, CLS
61	CLS, ONF
63	CNF, ONF, NW
64	ONF, NW, CLS
65	OBF, ONF, OMF, MW, NW
66	ONF, NW, CTS, CLS
71	NW

VIERECK CLASSIFICATION/ ABBREVIATION

HERBACEOUS HABITATS
<10% TREE COVER, <25% SHRUB COVER

WET GRAMINOID HERBACEOUS – WGH

SHRUB HABITATS
<10% TREE COVER, >25% SHRUB COVER

OPEN TALL SCRUB – OTS
CLOSED TALL SCRUB – CTS
OPEN LOW SCRUB – OLS
CLOSED LOW SCRUB – CLS
OPEN DWARF TREE SCRUB – ODTS
DWARF TREE SCRUB WOODLAND – DTSW

CLOSED CANOPY FOREST
>60% TREE COVER

CLOSED NEEDLELEAF FOREST – CNF
CLOSED BROADLEAF FOREST – CBF

OPEN CANOPY FOREST
25–59% TREE COVER

OPEN NEEDLELEAF FOREST – ONF
OPEN MIXED FOREST – OMF
OPEN BROADLEAF FOREST – OBF

WOODLANDS
10–24% TREE COVER

NEEDLELEAF WOODLAND – NW
MIXED WOODLAND – MW

0 75' 150' 300' NORTH

WHPacific
515 7th Avenue, Suite 310
Fairbanks, AK 99701
907-458-2142 Fax 907-458-2143
www.whpacific.com

FAIRBANKS OFFICE
100 CUSHMAN STREET, SUITE 210
FAIRBANKS, AK 99701-2253

MINE OFFICE
P.O. BOX 1000
HEALY, AK 99743

USIBELLI COAL MINE
JUMBO DOME MINE

HABITAT AND VEGETATION MAP

REVISIONS

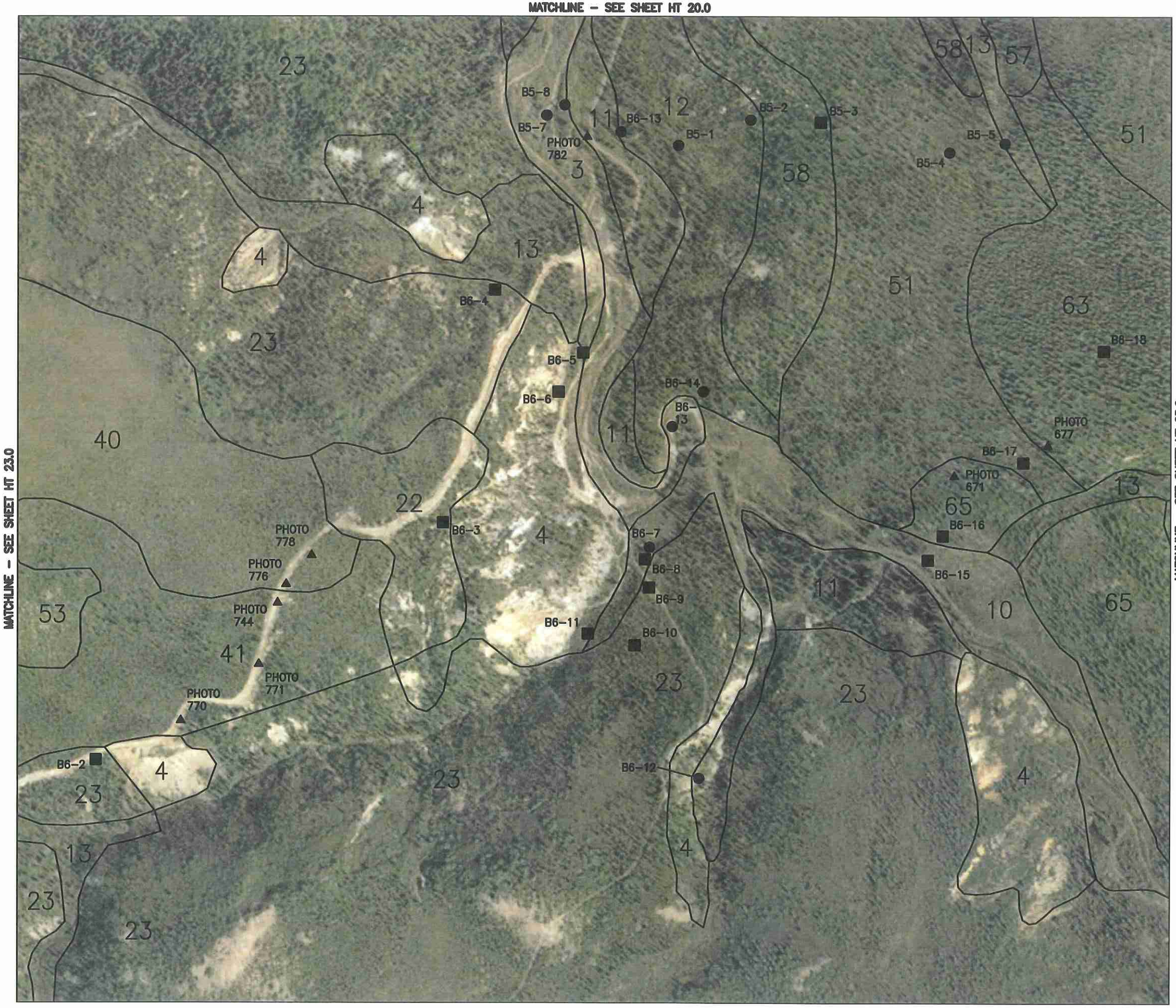
NUMBER:	DATE:

JOB NO.:	5159
DATE:	JUNE 2008
DRAWN BY:	LJT
CHECKED BY:	PJQ
DRAWING NO.:	HT 23.0
SHEET	

MATCHLINE – SEE SHEET HT 20.0

MATCHLINE – SEE SHEET HT 23.0

MATCHLINE – SEE SHEET HT 25.0



LEGEND

- STUDY AREA BOUNDARY
- PROPOSED IMPACT AREA
- B1–2 ● WETLAND PLOT
- B1–3 ■ NON–WETLAND PLOT
- PHOTO B1–2/843 ▲ PHOTO POINT

MAP UNITS	VIERECK CLASSES (ABBREVIATION)
3	OMF, NW, CTS, CLS, OTS
4	NW, OLS
5	N/A
10	OMF, NW, CTS, CLS, OTS, OLS
11	CBF, ONF, OMF, DTSW, CTS, CLS, OLS
12	ONF, NW, CLS, OLS
13	ONF, NW, DTSW, CTS, CLS, OLS
20	ONF, NW, CTS
21	ONF, NW, DTSW
22	ONF, OMF, NW, CTS, CLS
23	CBF, CNF, ONF, CMF, OMF, NW, DTSW, CTS, CLS
40	ONF, OMF, NW, CLS, OTS, OLS
41	NW, DTSW, CLS, OLS
43	CLS, WGH
44	NW, CTS, CLS, OTS, OLS, WGH
50	ONF, NW
51	NW, DTSW, CTS, CLS, OLS
53	ONF, NW
56	OMF, NW, CTS, CLS
57	ONF, NW, DTSW, DTS
58	ONF, NW, CTS, CLS
60	ONF, NW, CTS, CLS
61	CLS, ONF
63	CNF, ONF, NW
64	ONF, NW, CLS
65	OBF, ONF, OMF, MW, NW
66	ONF, NW, CTS, CLS
71	NW

VIERECK CLASSIFICATION/ ABBREVIATION

HERBACEOUS HABITATS
<10% TREE COVER, <25% SHRUB COVER

WET GRAMINOID HERBACEOUS – WGH

SHRUB HABITATS
<10% TREE COVER, >25% SHRUB COVER

OPEN TALL SCRUB – OTS
CLOSED TALL SCRUB – CTS
OPEN LOW SCRUB – OLS
CLOSED LOW SCRUB – CLS
OPEN DWARF TREE SCRUB – ODTS
DWARF TREE SCRUB WOODLAND – DTSW

CLOSED CANOPY FOREST
>60% TREE COVER

CLOSED NEEDLELEAF FOREST – CNF
CLOSED BROADLEAF FOREST – CBF

OPEN CANOPY FOREST
25–59% TREE COVER

OPEN NEEDLELEAF FOREST – ONF
OPEN MIXED FOREST – OMF
OPEN BROADLEAF FOREST – OBF

WOODLANDS
10–24% TREE COVER

NEEDLELEAF WOODLAND – NW
MIXED WOODLAND – MW

0 75' 150' 300' NORTH

WHPacific
515 7th Avenue, Suite 310
Fairbanks, Alaska 99701
907-459-2142 Fax 907-458-2143
www.whpacific.com

FAIRBANKS OFFICE
100 CUSHMAN STREET, SUITE 210
FAIRBANKS, AK 99701-2253

MINE OFFICE
P.O. BOX 1000
HEALY, AK 99743

USIBELLI COAL MINE
JUMBO DOME MINE

HABITAT AND VEGETATION MAP

REVISIONS	
NUMBER:	DATE:

JOB NO.:	5159
DATE:	JUNE 2008
DRAWN BY:	LJT
CHECKED BY:	PJQ
DRAWING NO.:	HT 24.0
SHEET	

MATCHLINE – SEE SHEET HT 21.0

MATCHLINE – SEE SHEET HT 24.0

MATCHLINE – SEE SHEET HT 26.0

LEGEND

- STUDY AREA BOUNDARY
- PROPOSED IMPACT AREA
- B1–2 ● WETLAND PLOT
- B1–3 ■ NON–WETLAND PLOT
- PHOTO B1–2/843 ▲ PHOTO POINT

MAP UNITS	VIERECK CLASSES (ABBREVIATION)
3	OMF, NW, CTS, CLS, OTS
4	NW, OLS
5	N/A
10	OMF, NW, CTS, CLS, OTS, OLS
11	CBF, ONF, OMF, DTSW, CTS, CLS, OLS
12	ONF, NW, CLS, OLS
13	ONF, NW, DTSW, CTS, CLS, OLS
20	ONF, NW, CTS
21	ONF, NW, DTSW
22	ONF, OMF, NW, CTS, CLS
23	CBF, CNF, ONF, CMF, OMF, NW, DTSW, CTS, CLS
40	ONF, OMF, NW, CLS, OTS, OLS
41	NW, DTSW, CLS, OLS
43	CLS, WGH
44	NW, CTS, CLS, OTS, OLS, WGH
50	ONF, NW
51	NW, DTSW, CTS, CLS, OLS
53	ONF, NW
56	OMF, NW, CTS, CLS
57	ONF, NW, DTSW, DTS
58	ONF, NW, CTS, CLS
60	ONF, NW, CTS, CLS
61	CLS, ONF
63	CNF, ONF, NW
64	ONF, NW, CLS
65	OBF, ONF, OMF, MW, NW
66	ONF, NW, CTS, CLS
71	NW

VIERECK CLASSIFICATION/ ABBREVIATION

HERBACEOUS HABITATS
<10% TREE COVER, <25% SHRUB COVER

WET GRAMINOID HERBACEOUS – WGH

SHRUB HABITATS
<10% TREE COVER, >25% SHRUB COVER

OPEN TALL SCRUB – OTS
CLOSED TALL SCRUB – CTS
OPEN LOW SCRUB – OLS
CLOSED LOW SCRUB – CLS
OPEN DWARF TREE SCRUB – ODTS
DWARF TREE SCRUB WOODLAND – DTSW

CLOSED CANOPY FOREST
>60% TREE COVER

CLOSED NEEDLELEAF FOREST – CNF
CLOSED BROADLEAF FOREST – CBF

OPEN CANOPY FOREST
25–59% TREE COVER

OPEN NEEDLELEAF FOREST – ONF
OPEN MIXED FOREST – OMF
OPEN BROADLEAF FOREST – OBF

WOODLANDS
10–24% TREE COVER

NEEDLELEAF WOODLAND – NW
MIXED WOODLAND – MW

0 75' 150' 300' NORTH

WHPacific
515 7th Avenue, Suite 310
Fairbanks, AK 99701
907-458-2142 Fax 907-458-2143
www.whpacific.com

FAIRBANKS OFFICE
100 CUSHMAN STREET, SUITE 210
FAIRBANKS, AK 99701-2253

MINE OFFICE
P.O. BOX 1000
HEALY, AK 99743

USIBELLI COAL MINE
JUMBO DOME MINE

HABITAT AND VEGETATION MAP

REVISIONS

NUMBER:	DATE:

JOB NO.:	5159
DATE:	JUNE 2008
DRAWN BY:	LJT
CHECKED BY:	PJQ
DRAWING NO.:	HT 25.0
SHEET	

MATCHLINE – SEE SHEET HT 22.0

MATCHLINE – SEE SHEET HT 25.0

LEGEND

- STUDY AREA BOUNDARY
- PROPOSED IMPACT AREA
- B1–2 ● WETLAND PLOT
- B1–3 ■ NON–WETLAND PLOT
- PHOTO B1–2/843 ▲ PHOTO POINT

MAP UNITS	VIERECK CLASSES (ABBREVIATION)
3	OMF, NW, CTS, CLS, OTS
4	NW, OLS
5	N/A
10	OMF, NW, CTS, CLS, OTS, OLS
11	CBF, ONF, OMF, DTSW, CTS, CLS, OLS
12	ONF, NW, CLS, OLS
13	ONF, NW, DTSW, CTS, CLS, OLS
20	ONF, NW, CTS
21	ONF, NW, DTSW
22	ONF, OMF, NW, CTS, CLS
23	CBF, CNF, ONF, CMF, OMF, NW, DTSW, CTS, CLS
40	ONF, OMF, NW, CLS, OTS, OLS
41	NW, DTSW, CLS, OLS
43	CLS, WGH
44	NW, CTS, CLS, OTS, OLS, WGH
50	ONF, NW
51	NW, DTSW, CTS, CLS, OLS
53	ONF, NW
56	OMF, NW, CTS, CLS
57	ONF, NW, DTSW, DTS
58	ONF, NW, CTS, CLS
60	ONF, NW, CTS, CLS
61	CLS, ONF
63	CNF, ONF, NW
64	ONF, NW, CLS
65	OBF, ONF, OMF, MW, NW
66	ONF, NW, CTS, CLS
71	NW

VIERECK CLASSIFICATION/ ABBREVIATION

HERBACEOUS HABITATS
<10% TREE COVER, <25% SHRUB COVER

WET GRAMINOID HERBACEOUS – WGH

SHRUB HABITATS
<10% TREE COVER, >25% SHRUB COVER

OPEN TALL SCRUB – OTS
CLOSED TALL SCRUB – CTS
OPEN LOW SCRUB – OLS
CLOSED LOW SCRUB – CLS
OPEN DWARF TREE SCRUB – ODTS
DWARF TREE SCRUB WOODLAND – DTSW

CLOSED CANOPY FOREST
>60% TREE COVER

CLOSED NEEDLELEAF FOREST – CNF
CLOSED BROADLEAF FOREST – CBF

OPEN CANOPY FOREST
25–59% TREE COVER

OPEN NEEDLELEAF FOREST – ONF
OPEN MIXED FOREST – OMF
OPEN BROADLEAF FOREST – OBF

WOODLANDS
10–24% TREE COVER

NEEDLELEAF WOODLAND – NW
MIXED WOODLAND – MW

0 75' 150' 300' NORTH

WHPacific
515 7th Avenue, Suite 310
Fairbanks, AK 99701
907-458-2142 Fax 907-458-2143
www.whpacific.com

FAIRBANKS OFFICE
100 CUSHMAN STREET, SUITE 210
FAIRBANKS, AK 99701-2253

MINE OFFICE
P.O. BOX 1000
HEALY, AK 99743

USIBELLI COAL MINE
JUMBO DOME MINE

HABITAT AND VEGETATION MAP

REVISIONS	
NUMBER:	DATE:

JOB NO.:	5159
DATE:	JUNE 2008
DRAWN BY:	LJT
CHECKED BY:	PJQ
DRAWING NO.:	HT 26.0
SHEET	

CHAPTER X

SOIL RESOURCES

TABLE OF CONTENTS

Page

1.0 INTRODUCTION CX-1

2.0 METHODOLOGY CX-1

2.1 Soil Survey CX-1

2.2 Soil Mapping CX-2

3.0 RESULTS AND DISCUSSION CX-2

3.1 Soil Morphological Properties and Classification CX-2

3.2 Soil Map Unit Description CX-2

3.3 Soil Properties CX-11

3.4 Criteria for Suitability CX-13

3.5 Salvage Depth CX-15

4.0 WETLAND DELINEATION CX-15

5.0 REFERENCES CX-16

6.0 RESPONSIBLE PARTY CX-17

LIST OF TABLES

CX-1. Soil Map Units of the Jumbo Dome Mine Area CX-18

CX-2. Field Measurements of Soil Temperature, pH and Redox Potentials of Selected sites in the Jumbo Dome Mine area CX-19

CX-3. Chemical Properties for Selected Soils from the Jumbo Dome Mine area CX-20

CX-4. Criteria to Establish Suitability of Topsoil CX-21

CX-5. Maximum Potential Salvage Depth and Limitations of Topsoils in the Jumbo Dome Mine Area CX-22

CX-6. Wetland Determination for the Map Units in the Jumbo Dome Mine Area CX-23

LIST OF EXHIBITS

CX-1 Soil Survey Map CX-26

LIST OF APPENDICES

CX-1 Soil Profile Descriptions of Excavated Pits, Jumbo Dome Mine Area CX-24
CX-2 Summary of Soil Pits Excavated in the Jumbo Dome Mine Area.....CX 25

1.0 INTRODUCTION

The soil resources of the Jumbo Dome coal mine lease area were surveyed from August 8 to 11, then August 11 to September 1, 2007 for topsoil availability, assessment of soil resources for post-mining reclamation, hydric soils distribution and general planning purposes. The soil survey area is within the baseline study area boundary located on both sides of the Marguerite Creek, west of Jumbo Dome. It covers SE and NE corner Sec. 33 and Sec. 34 of T10S, R6W, and the W1/2 Sec. 3, E1/2 Sec. 5, Sec 4, W1/2 Sec. 8, and W1/2 Sec. 9, T11S, R6W, F.M. The area of disturbance proposed for the Jumbo Dome Mine Project has changed from that shown on Soil Survey Map in Appendix CX-3, the information in this chapter is baseline data and therefore the mine disturbance boundary has not been change on the Soil Survey Map.

2.0 METHODOLOGY

2.1 SOIL SURVEY

The ground truthing was completed by studying the morphological properties of the soils and their relationships to vegetation communities and landforms along elevation transects on both sides of the creek. The soil morphological properties were studied according to USDA National Soil Survey Center standards (Schoeneberger et al., 2002). In the field the soils were described according to genetic horizons with thickness and arrangement of each horizon recorded. The parameters used to define each soil horizon included Munsell color, presence and abundance of redoximorphic features, including Fe concentration and depletion and mottles, field texture, structure, moist and wet consistency, root distribution, water table at the time of description, and other associated landscape features such as % slope, slope shape, parent materials, landscape position, drainage, vegetation communities, coarse fragment and surface stones. Soil samples were taken from selected sites to verify the organic matter contents. Soil characterization analysis was conducted at the University of Alaska Fairbanks Palmer Research Center Plant Tissue and Soils Analytical Laboratory. Soil, pH redox potential and temperature were measured in selected soil pits by a field gauge. The locations of the pits are marked on the soil map (see Appendix CX-3). Each pit was assigned to an appropriate map unit (Table CX-1) and the map units are described in the following section. Detailed soil profile descriptions are listed in Appendix CX-1 and relevant soil properties are presented in Table CX-2.

2.2 SOIL MAPPING

Soil map units were established based on soils, vegetation and landforms according to Soil Survey Manual (Soil Survey Division Staff, 1994). Consociation map units are those map units with only one taxonomic unit. This kind of map unit contains less than 15% of soils of contrasting nature but may contain up to 40% of soils with similar nature which have the same land use interpretations. The complex map units are those units containing soils of contrasting nature of more than 15%. Soil boundaries were established by identifying representative soil profiles in the landform unit and then correlating the landform with vegetation communities, drainage and other surface features. Soil pits were classified according to Keys to Soil Taxonomy (Soil Survey Staff, 2006) and used to define the map unit. The map (Appendix CX-3) was compiled by plotting soil boundaries on 1:400 aerial photo maps with the aid of a topographic map and paired color aerial photographs. Ground checking was used to verify the boundaries. Soils of each map unit are described in the following section and the soil profile descriptions are listed in Appendix CX-1.

3.0 RESULTS AND DISCUSSION

3.1 SOIL MORPHOLOGICAL PROPERTIES AND CLASSIFICATION

During the 8 days of field work, a total of 60 soil pits were excavated and described. The soil profile descriptions are presented as Appendix CX-1. Soil physical environment, including GPS position, landform, slope, land cover types and soil classification of each pit are summarized in Table CX-1. Soil morphological properties are summarized in Appendix CX-2.

3.2 SOIL MAP UNIT DESCRIPTION

The mapping units are based on ground truthing excavated pits. Map unit symbols are expressed in numbers as marked on the Soil Map in Appendix CX-3. Map Unit Legend is presented in

Table CX-1. All soil pits were classified to the family level according to Keys to Soil Taxonomy (Soil Survey Staff, 2006) and are presented in Appendix CX-1.

3.2.1 Miscellaneous Land Types

MU 3. River channels and sand bars

MU 4. Escarpments

This unit includes landslides with precipitous slopes and without vegetation cover, coal seam exposures, and escarpments along terrace breaks and steep hill slopes.

MU 5. Roads or Disturbed Area

This unit is limited to the road corridor, drilling pads and test pits.

3.2.2 Poorly Drained Bottomland Soils (Entisols)

Entisols are soils formed recently with minimum horizon development.

MU 10. Gelaquents – Gelqauepts – Gelifluvents complex, loamy, 0-3% slopes

These soils are cold Entisols having mean annual soil temperature at 20 inches from the mineral soil surface less than 32 degrees F (0°C) but no permafrost within 6 feet. They occur in valley floors, stream terraces, and toe slopes adjacent to streams or drainageways along the Marguerite Creek and its tributaries. This map unit consists of 45% Typic Gelaquents, 35% Typic Gelaquepts and 20% Aquic Gelifluvents. These soils are poorly to very poorly drained.

The Typic Gelaquents formed in alluvial deposit over extremely gravelly river wash on flood plain. They are represented by Pit 34. The soil has hummocky surface organic mounds over 4 inches of peaty and mucky organic layer. The subsurface horizon (Bg1)

consists of 12 inches of stratified gleyed silt loam and rusty red sand over 10 inches of another horizon (Bg2) with stratified gray sandy loam and grayish brown loamy sand. The substratum (2C) below 26 inches is extremely sandy. The typical vegetation community consists of tundra with scattered stunted black spruce.

The Typic Gelaquepts formed in alluvial deposits over extremely cobbly riverbed on flood plains and are represented by Pit 32. The soil has a thin (<2 inches) organic horizon over 3 inches of brown sandy loam with some mottles. Below there is a 3 inch thick gray sandy layer containing organic debris of fluvial origin. Further down there is an 18 inch layer of highly mottled silt loam over very cobbly sandy loam. The vegetation consists of shrubs and scattered black spruce. The water table was 24 inches below the mineral surface at the time of description.

The Aquic Gelifluvents are deep, poorly drained soils occuring on nearly level to gently sloping alluvial fans and toe slopes. They formed in stratified medium-coarse-textured alluvial material over buried surface horizons (A) with distinct mottling near the surface. Vegetation includes black and white spruce, shrubs and moss. In a representative profile, (Pit 30), 2 inches of peat overlies 6 inches of dark gray silt loam with distinct mottles. The stratified substratum consists of sand (C), dark silt loam (A), banded brown and gray silt loam (C) and gleyed silt loam (Cg) over frozen substratum (Cg) at 44 inches.

MU 11 Typic Gelaquents, sandy, 0-3% slopes

The Typic Gelaquents occur in similar landforms to that of MU 10, i.e., on flood plains except these soils formed in sandy alluvial deposits along the Marguerite Creek and its tributaries. In representative pit (#7), there is a 4-inch thick organic layer (Oe) over a 8 inch-thick gleyed subsurface horizon (Bg) with silt loam texture, over a compact, variegated very gravelly sand substratum (C) which perches water. These soils are very poorly drained.

MU 12 Typic Cryaquents, loamy, 3-8% slopes

This map unit occurs in alluvial fans with tundra vegetation dominated by sedge and some stunted black spruce. In a representative pit (#26), there are 4 inches of newly

added sandy layer (C) over 4 inches of buried organic layer (Oi) over 20 inches of gleyed loam (Bg). The soils are poorly drained.

MU 13 Typic Gelaquents, 8-25% slopes

This poorly drained soil formed in drainage channels on the west facing slopes east of Marguerite Creek. In a representative pit (#23), the surface is characterized by large hummocks consists of organic matter rich surface horizons (A) over 16 inches of gleyed subsurface horizon (Bg) over frozen, gleyed substratum. In the inter-hummock areas there is no A horizon. The drainage channels are dominated by willow shrubs. Some of this map unit has stones under the organic or surface horizons.

3.2.3 Well Drained Upland Sandy Soils (Entisols)

MU 20 Gelorthents, sandy, 15-35% slopes

These deep, well-drained soils formed in colluvium from parent materials mainly of the Suntrana Formation on high alluvial and colluvial slopes. In a representative pit (#42), it has a thin (<4 in) organic horizon over a pale brown gravelly sand to grayish brown sand substratum over a buried black and dark brown Organic and A horizon at 36-40 in. over stratified sand and sandy loam to over 56 in. deep. The vegetation consists of black spruce and ericaceous shrubs and mosses.

MU 21 Typic Cryorthents, sandy, 8– 25 % slopes

These deep, excessively to well drained soils occur on backslopes. Vegetation on the Cryorthents is dominantly scattered white spruce, birch and thin shrubs. The Typic Cryorthents are represented by Pit 25. It generally has a very thin (less than 4 inch) organic mat over 3 inches of dark gray organic rich surface layer over 23 inches of grayish brown to yellowish brown sandy layer. The substratum at 30 to 44 inches has 18% of gravel, cobble and stones.

MU 22 Typic Cryorthents – Entic Haplocryods complex, sandy, 25 – 45 % slopes

The Typic Cryorthents are deep, well-drained soils formed in residuum and colluvium of sandstone material on terrace breaks, dissected foot slopes and toe slopes. The slopes range from plane to complex and have a flat to undulating topography. The vegetation is characterized by black spruce with scattered dense tall shrub understory. In a representative profile of Typical Cryorthents (Pit 37), 4 inches of peat overlies 8 inches dark grayish brown sandy loam A horizon. The substratum consists of stratified gravelly sand and very gravelly sand and sandy loam to 38 inches with seasonal frost below. This map unit may contain up to 35% of Entic Haplocryods that are deep, well drained sandy soils. In a representative profile (Pit 56), there is a 3 inch organic horizon over 3 inches of mixed dark brown and gray sandy loam. The subsurface B horizon consists of 7 inches of dark brown loamy sand. The substratum is olive brown gravelly sand extending to over 40 inches deep.

MU 23 Cryorthents – Cryopsamments complex, sandy, 45-90% slopes

The well to excessively-drained Typic Cryothents formed in residuum and colluvium of sandstone material on ridge tops, shoulder slopes, back slopes and dissected foot slopes. The slopes range from plane to complex and have a flat to undulating topography. The vegetation is characterized by white spruce with scattered paper birch, patches of alder, shrub and grass understory. In a representative profile of sandy Typical Cryorthents (Pit 36), 4 inches of peat overlies 10 inches dark brown to dark grayish brown gravelly sand A horizon. The substratum consists of very gravelly to very cobbly sand to more than 56 inches. This map unit includes 35 % Cryopsamments that formed on colluvium of sandstone parent material on back slopes. In a representative pt (#14), there is a 1/3 inch of peat over 5 inches of a dark brown sandy A horizon. The substratum consists of sand to more than 40 inches deep.

3.2.4 Organic and Poorly Drained Mineral Soils

MU40 Ruptic Historthels, permafrost substratum, 0-8% slopes

These shallow, poorly drained soils occur on terraces overlying permafrost. They form in medium-textured alluvium and colluvium. The slopes are plane and have a slightly undulating relief. Vegetation includes stunted black spruce, dwarf birch, blueberry,

sedges, willow, mosses (including sphagnum) and lichens. In a representative profile (Pit 16), a thick organic layer, about 11 inches, overlies a dark gray, frozen, silt loam mineral horizon that has strong alpha alpha reaction.

MU 41 Historthels, permafrost substratum, 8 – 12% slopes

This poorly drained soils formed in forest tundra on nearly level to slightly concave colluvium and alluvial slopes with permafrost within 3 feet to the surface. The vegetation is characterized by stunted black spruce with ericaceous shrubs and mosses. In a representative pit (#19), there are 11 inches of peat over a gleyed sandy loam B horizon to 27 inches before it encounters frost table. The gleyed B horizon has strong alpha alpha reaction and contains more than 30% cobble stone.

MU 43 Cryohemists, 0-3 % slopes

These poorly to very poorly drained organic soils formed on terraces. The land cover type is tussock tundra. In a representative pit (#53), the soil consists of deep (>2 feet) peaty muck with lenses of stratified mineral material due to fluvial deposits.

MU 44 Cryosaprists, 0-15% slopes

These poorly drained soils formed in highly decomposed organic matter on gently sloping terraces and alluvial slopes. In a representative pit (#47), there are 16 inches of muck over 5 inches of buried A horizon. The substratum consists of gleyed sandy loam to over 48 inches deep.

MU 50 Typic Gelaquepts, 18 – 30% slopes

These poorly drained mineral soils formed in alluvial deposits on moderately sloping backslopes. The vegetation is characterized by white spruce with tall shrub understory and mosses and lichens. In a representative profile (Pit 45), 4 inches of peat and muck overlies 19 inches brown to olive brown, gravelly sand subsurface horizon. The substratum consists of stratified very cobbly and very gravelly sand to more than 48 inches. This map unit also includes about 10% well drained Gelorthents.

MU 51 Histic Cryaquepts-Typic Cryaquepts complex, 0-8 % slopes

These deep, somewhat poorly drained soils occur on terraces in the open meadow with tussock tundra land cover type. They form in medium-textured residual material from schist rocks. The slopes are plane and have a slightly undulating relief. Vegetation includes dwarf white spruce, dwarf birch, blueberry, sedges, willow, mosses (including sphagnum) and lichens. In a representative profile (Pedon 1), a dusky red mat of peat and mucky peat, about 9 inches, overlies a dark gray extremely channery silt loam subsurface horizon, about 7 inches thick. The mottled lower subsurface horizon consists of stratified sand and silt loam of 14 inches over a very gravelly silt loam to a depth of more than 40 inches deep. This map unit contains about 30% Typic Cryaquepts that form in colluvial slopes with cobbly or gravelly sandy loam texture. These soils have organic horizon, usually less than 6 inches and have a mottled B horizons. The substratum may be sand or stratified layers.

3.2.5 Well Drained Upland Loamy Soils (Inceptisols)

MU 53 Typic Dystrogelepts, 3-18% slopes

These deep, well-drained soils occur on terraces and shaded backslopes with mean annual soil temperature at 20 inches at or below 32F but without permafrost within 4 feet. The vegetation is dominated by white spruce, dwarf birch blueberry, mosses and lichens. In a representative profile (Pit 52), a mucky sandy loam surface horizon of 7 inches overlies 18 inches of dark brown sandy loam subsurface horizon. The substratum consists of very gravelly loamy sand to a depth of more than 40 inches.

MU 56 Lithic Humicryepts – Dystrogelepts complex, very stony, 25-45% slopes

This map unit describes the soils formed on the colluvial shoulder slopes and backslopes on the footslopes of Jumbo Dome. The soils are generally shallow and have over 65% stones and boulders. In a representative profile (Pit 18), there is a 4 inch thick organic horizon over 3 inches of black A horizon with a silt loam texture. The subsurface horizon consists of 5 inches of brown silt loam over bedrock. This map unit also includes 30%

MU 53 that are deep but may contain up to 40% of cobbles and stones. There are more than 10% stones exposed on the surface.

MU 57 Aquic Humicryepts – Dystrocryepts complex, stony, 0 -15% slopes

These deep, moderately well to well-drained soils form in colluvium on footslopes and back slopes on the east side of Marguerite Creek. The slopes are complex and have a slightly undulating relief. Vegetation includes white spruce, dwarf birch, blueberry, Labrador tea, mosses and lichens. In a representative profile (Pit 24), a dark brown A horizon about 10 inches thick overlies a mottled brown sandy loam B horizon, about 18 inches thick over stones and boulders.. This map unit also includes up to 40% MU 53 that are deep but may contain up to 45% of cobbles and stones originated from the colluvial action of Jumbo Dome. There are about 5 % of stones on the surface.

MU 58 Humicryepts – Dystrogelepts complex, very bouldery, 15 -35% slopes

These deep, very well to well-drained soils form in colluvium on footslopes and back slopes on the east side of the creek. The slopes are complex and have a slightly undulating relief. Vegetation includes white spruce, dwarf birch, blueberry, Labrador tea, mosses and lichens. In a representative profile (Pit 22), a 3 inch peat layer over a dark brown A horizon about 6 inches thick overlies a dark gray and dark brown, extremely stony sandy loam B horizon, extending to varying depths from 40 to 50 inches to boulders and stones. This map unit also includes up to 40% MU 53 that is deep but lacks the dark A horizon and may contain up to 45% of cobbles and stones originated from the colluvial action of Jumbo Dome. There are about 5 % boulders on the surface.

MU 60 Lithic Dystrocryepts, fragmental, 3-25% slopes

These shallow, well drained soils occur in association with stone circles (sorted circles) on footslopes and high terraces on the east side of Marguerite Creek. The slopes are slightly undulating. Vegetation includes scattered white spruce, dwarf birch, blueberry, Labrador tea, mosses and lichens. In a representative profile (Pit 4), there is a 2 inch peat

layer over a dark brown silt loam A horizon about 4 inches thick, The subsurface horizon is 10 inch thick extremely stony sandy loam that rests on fractured bedrock. These soils contains up to 80% of rock fragments in the profile. This map unit also includes up to 10% MU 53 that are deep but lack the dark A horizon and may contain up to 65% of cobbles and stones originating from the colluvial action of Jumbo Dome. There are about 15 % stones on the surface but in places the stones are covered with vegetation mat.

MU 61 Lithic-Paralithic Dystrocryepts-Rubblelands, 25-65% slopes

This map unit describes the exposed ridge tops and convex shoulder and back slopes on the eastern side of Jumbo Dome. The shallow, well drained soils formed in colluvium over fractured bedrock. In a representative profile (Pit 11), there is a 3-inch peat layer over 6 inches dark brown silt loam A horizon. The subsurface B horizon has a silt loam texture about 6 inches over fractured sandstone. This map unit may contain up to 20 % of MU 56 (Pit 3) that has deep well drained soils. Rubbleland consists of about 35% of the map unit.

MU 63 Fluvaquentic Dystrocryepts, 3-15% slopes

These deep, moderately well-drained soils formed in alluvial fans. The vegetation consists of black spruce and ericaceous shrubs. In a representative profile (Pit 28), there is a mucky peat horizon about 8 inches thick over 9 inches dark grayish brown A horizon. Below there are several layers of stratified charcoal layer, brownish sandy layers and black muck layers down to 40 inches deep. This map unit may contain up to 5 % of MU 50, Gelaquepts.

MU 64 Typic Dystrocryepts, sandy, 0-20% slopes

These deep, well drained soils occur mainly on terraces in the western part of the valley. They formed in sandstone material. The vegetation includes mixed spruce, dwarf birch, blueberry, Labrador tea, mosses, and lichens. In a representative profile (Pit 12), a 4- inch peat layer overlies a thin (3 inches) surface horizon (A). The subsurface horizon consists of 16 inches of dark brown sandy loam and loamy sand. The substratum is a massive loamy sand layer

extending to more than of 40 inches deep. This map unit includes 15% of MU 21 that lacks the subsurface B horizons.

MU65 Typic Dystrocryepts, loamy, 20-45% slopes

These deep, well drained soils form on exposed summit, shoulder slopes and terrace breaks. The vegetation community is dominantly mixed spruce forest with ericaceous understory. In a representative profile (Pit 13), a thin organic mat, about 3 inches thick, overlies a 6 in inch dark brown silt loam A horizon. The subsurface B horizon consists of stratified brownish fine sandy loam. The sandy substratum extends from 20 to more than 50 inches deep. This map unit includes up to 20% of MU 22 that lacks the A horizons.

MU 71 – Entic Haplocryods, 3-18 % slopes

These soils formed in sandy material on gentle sloping terraces. Vegetation includes scattered white spruce, dwarf birch, blueberry, and a thick lichen cover. In a representative profile (Pit 46), a thin mat of peat, about 1.5 inches thick, overlies a 6 inch brownish subsurface B horizon. Underneath, there is a one inch buried light brown sandy loam over a yellowish brown very cobbly loamy fine sandy layer about 5 inches thick. The stratified sandy substratum (C) extends to more than 52 inches deep. This map unit may include up to 20% of MU64 that lacks the yellowish brown layers.

3.3 SOIL PROPERTIES

3.3.1 Morphological Properties

Morphological properties are summarized in Appendix CX-1, soil profile description.

3.3.2 Soil Temperature Regime

Soil temperatures were measured at selected sites to verify the soil temperature regime (Table CX-2). Most mine soils south of the Jumbo Dome area have cryic soil temperature regime; they have mean annual soil temperature at 20 inches from 0-8C (32-48.4F). However, the Jumbo Dome soils are at a higher elevation and have thicker vegetation cover. Thus the soils are cooler. For those sites measured (Table CX-2), most soils temperatures at or projected to 20 inches have a summer temperature less than 3C (37.4F). Considering that soil temperature is at its highest at the end of summer (end of August to early September), and the winter temperature is estimated below 5C (23F) then the average mean annual soil temperature should be less than 0C (32F). For those soils that have a mean annual soil temperature less than 0F but without permafrost within one meter (3.3 feet), the soil temperature regime is subgelic and these soils are keyed out in the gelic great group according to Soil Taxonomy.

3.3.3 Soil Chemical Properties

The chemical property of selected pits is shown in Table CX-3. The parent material in the survey area is mainly sandstone that has very little buffering capacity due to its coarse texture. The area is generally higher than previously surveyed mine areas (Ping, 1992) and with cooler temperatures (Table CX-3) and potentially higher rainfall, there is expected to be a high rate of leaching under the spruce forest and the tundra vegetation. Thus all the soils have very strongly to strongly acidic reaction. The organic horizons are especially acidic with pH values ranging from 3.5 to 4.5. The mineral horizons have pH values ranging from 3.7 to 5.3. Thus most of the mineral soils are classified in the Dystro- great group reflecting the low base status. Soil fertility properties can be inferred from organic carbon content. The organic horizons have high carbon content as expected. The organic content of the mineral horizons varies according to drainage and parent material. Soils formed in sandstone material are poor in nutrients, such as Pits 31 and 42, in which the carbon contents in the B horizons are generally less than 1%. However, those soils formed on the colluvial slopes on the east side of the main drainage (Pits 1, 33 and 56) have loamy texture with better water holding capacity and thicker surface organic

horizons. The carbon contents in the subsurface B horizons are generally higher (1-2.5%).

3.3.4. Soil Physical Properties

The common soil structure in the surveyed area is platy due to the action of seasonal frost. In some pits, weak medium subangular blocky structures were observed in the B horizons. Soil textures ranges from silt loam to extremely gravelly or cobbly sandy loam to sand. On terraces and floodplains, stratification of different textures was observed.

3.4 CRITERIA FOR SUITABILITY

The suitability of the soils for topsoil in the permitting area has been assessed by reviewing their morphological, physical and chemical properties. Soils in the western, central and northeastern parts of the mine area generally formed in sandstone parent materials which have sandy to loamy sand texture. Soils in the southeastern part of the mine area formed in colluvium on the footslopes of the Jumbo Dome. These soils generally have loamy texture but contain appreciable amount of gravel, cobble, stone and boulders. These materials are not highly weathered and do not have properties adversary to plant growth (Ping and Kajia, 1989; Ping, 1992). Based on test plots conducted at the nearby Two Bull area that shares similar lithology, Helm (1996) has proved that the native soils in the area are suitable for revegetation. The criteria used to establish the suitability of the topsoil are summarized in Table CX-3. The criteria for suitability are selected based on suitability for plant growing medium.

(1). pH: pH value is an index of soil acidity. Throughout the permitting area, pH values for most soil horizons range from 4.1 to 5.7. The lower values are found mostly in the organic horizons. But considering the fact that the bulk density of the organic horizon is only one fifth of the mineral horizons, (0.3 vs. 1.5 g/cm3, respectively), after stockpiling, the pH values of the mixed soils horizons will be more than 4.1. Thus, pH is not a limiting factor of suitability in the permitting area.

(2). Soil texture: Medium to fine textured soil materials are suitable because they have better water and nutrients holding capacity for plant growth. The texture classes are considered suitable including sandy loam, fine sandy loam, silt, silt loam, loam, silty clay loam, muck sandy loam, mucky silt loam, mucky loam, peat, muck peat, peaty muck, and muck. Soils in the permitting area are dominantly coarse textured in the western part due to the sandstone bedrock and medium textured in the eastern part due to mixed alluvial and colluvial materials from the igneous bedrock from Jumbo Dome. The wind blown materials were eroded and redeposited by water in lowlands and along the streams. No finer-textured soils such as clay loam, or clay are found in the permit areas, and silty clay loam was found in a small area at the southern end of the permitting area north of the stream crossing but this unit is not within the projected mine boundary. Generally, regardless of texture, the soil is suitable for topsoil when the A and B horizons are mixed with organic layers. But some of the substratum, the C or 2C horizons are derived from river outwash or flush flood which contains varying amount of rock fragments. When gravel exceeds 35% by volume, the materials are not suitable for stockpiling. The soils formed in colluvium from Jumbo Dome are too high in rock fragment thus not suitable for stockpiling.

(3). Coarse fragments: "Coarse fragments" is defined as mineral fragments larger than 2 mm in diameter, and it serves as a texture modifier. Excessive coarse fragments will decrease the water and nutrient holding capacities. Thus for suitable soil materials the content of rock fragments is best limited to 35% by volume or 50% by weight. In the USDA soil texture class, rock fragments over 35% by volume is designated as very gravelly, very cobbly, very stony or very bouldery depending on the size of coarse fragments. If the rock fragment content is over 65% then it becomes extremely gravelly, cobbly, stony or bouldery.

(4). Slope: Slope is not a soil property but a map unit property. In the permitting area, the natural topographic break ranges from 40 to 45% slope depending on the map units. Generally, when the slope is too steep, it inhibits the ability of equipment to maneuver especially

under wet or frozen conditions. In addition, these soils are generally shallow with topsoil mixed with substratum materials, mostly sandstone materials or outwash gravel on the eastern and northwestern parts of the mine area, and those on the southeastern part have varying depth but the rock fragment content is too high.

3.5 SALVAGE DEPTH

The salvage depth is defined as the depth at which the soil material reaches a contrasting layer such as sand or very gravelly layers, or to bedrock or the coal seam. The maximum salvage depth of each map unit is summarized in Table CX-4.

4.0 WETLAND DELINEATION

The wetlands in the survey area were delineated according to the three parameters of wetlands: hydric soils, wetland hydrology and hydrophytic vegetation. In this report, hydric soils delineation is based on map unit properties but the wetland calls are based on consolidation of soils, hydrology and vegetation data from the wetland inventory performed by the team led by Steve Becker, WHPacific, Inc. (formerly ASCG Incorporated of Alaska) and subsequently adjusted by Jeff Schively of HDR Alaska. Hydric soils, hydrophytic vegetation, and hydrology were determined according to the Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Alaska Supplement (U.S. Army Corps of Engineers, 2007) and with reference to the 1997 Wetland Manual (U.S. Army Corps of Engineers, 1987) and Soil Taxonomy (Soil Survey Staff, 2006). Soil classification of the major soils in each map unit is presented in Table CX-5.

5.0 REFERENCES

Helm, D.J. 1996. Two Bull Revegetation Trails 1995 Progress Report. Submitted to Usibelli Coal Mine. Agricultural and Forestry Experiment Station, School of Agriculture and Land Resources Management. University of Alaska Fairbanks, Palmer Research Center.

Ping, C.L. 1992. Soil Resource Baseline Study in the Hoseanna/Lignite Valley Area. Contract report submitted to Usibelli Coal Mine, Inc. Agricultural and Forestry Experiment Station, School of Agriculture and Land Resources Management, University of Alaska Fairbanks.

Ping, C.L., and K.J. Kaija. 1987. Characteristics and Fertility Status of Soils and Minesoils in Selected Areas of Usibelli Coal Mine, Healy, Alaska. Bulletin 66. Agricultural and Forestry Experiment Station, School of Agriculture and Land Resources Management, University of Alaska Fairbanks.

Schoeneberger, P.J., D.A. Wysocki, E.C. Benham, W.D. Broderson. 2002. Field Book for Describing and Sampling Soils, Version 2.0. USDA Natural Resources Conservation Service, National Soil Survey Center, Lincoln, NE

Soil Survey Division Staff. 1994. Soil Survey Manual. U.S. Department of Agriculture, Soil Conservation Service, Washington D.C.

Soil Survey Staff. 2006. Keys to Soil Taxonomy, Tenth Edition. U.S. Department of Agriculture, Natural Resource Conservation Service. Washington, D.C.

U.S. Army of Corps of Engineers. 1987. Corps of Engineers Wetland Delineation Manual. Environmental Laboratory Wetland Research Program U.S. Army Corps of Engineers Waterways Experiment Station Technical Report Y-87-1. Vicksburg, MS.

U.S. Army of Corps of Engineers. 2007. Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Alaska Region (Version 2.0). U.S. Army Corps of Engineers. Washington, D.C.

6.0 RESPONSIBLE PARTY

This report was prepared by Chien-Lu Ping, Ph.D., Arctic Soils, LLC, Certified Professional Soil Scientist of the American Registry of Certified Professional Agronomy, Crops and Soil Scientists, P.O. Box 2885, Palmer, Alaska, 99645

TABLE CX-1. SOIL MAP UNITS OF THE JUMBO DOME MINE AREA

Hydric Soil Map Units Outlined in Yellow

Map Unit	Map Unit Name	Pit #
3	River channels and sand/gravel bar	n/a
4	Escarpments, rock outcrops	n/a
5	Roads and disturbed area	n/a
10	Typic Gelaquents-Gelaquepts-Gelifluvents complex, 0-3% slopes Alluvial fan, river terrace, PIMA, spruce tundra, mostly 0-3%	28, 30, 32, 34, 35, 41,
11	Typic Cryaquents, sandy, 0-3% slope Floodplain, bottomland	7, 8, 9, 10
12	Typic Cryaquents, 3-8% alluvial fan, tundra Below pmf w. of river	26, 27
13	Typic Gelaquents, 8-25% slope, high channels	23, 59
20	Gelorthent, 15-35% slopes, sandy, well-drained High alluvium/colluvium (E)	42
21	Typic Cryorthents, sandy, 8– 25 % slopes	25
22, 72	Typic Cryorthents- Entic Haplocryods complex, sandy, 25 – 45 % slopes (Suntrana)	37, 56, 58
23	Cryorthents – Cryopsamments complex, sandy, 45-90% slopes	14, 29, 36, 40, 60
40	Ruptic Historthels, 0 – 8 slopes, alluvium, tundra	16
41	Historthels- Histoturbels complex 8 – 25% slopes Forest tundra, colluvium, PIMA, (E)	19, 20, 39, 43, 44
43	Cryohemists, 0-3% slopes	53
44	Cryosaprists, 0-15% slopes	45, 47, 55
50	Typic Gelaquepts, 18-30% stony Tundra, colluvium, concave slope (E)	15
51	Histic Cryaquepts-Typic Cryaquepts complex, 0-8% slopes open meadow, tussock tundra (E)	21, 49, 50
53	Typic Dystrogelepts, 3-18% slopes	38, 52, 54
56	Lithic Humicryepts-Dystrogelepts complex, 25-45% slopes, very stony	18
57	Aquic Humicryepts –Dystrogelepts complex 0-15% slopes, stony	24, 33, 51, 57
58	Humicryepts-Dystrogelepts, 15-35% slopes, bouldery (E)	1, 6, 22, 17, 48
60	Lithic Dystrocryepts, 3-25% slopes, fragmental, stone circles (JB)	2, 4, 5
61, 66	Lithic-Paralithic-Typic Dystrocryepts, complex 25-65% slopes, rubbleland (JB)	3
63	Fluvaquentic Dystrocryepts, 3-15% slopes Well-drained alluvial fan	31
64	Typic Dystrocryepts, sandy, 0-20% slopes, (Suntrana)	12
65	Typic Dystrocryepts, loamy, 20-45% slopes, (Suntrana)	11, 13
71	Entic Haplocryods, 3-18% slopes (E)	46

Rev: 5/1/08

TABLE CX-2. FIELD MEASUREMENTS OF SOIL TEMPERATURE, PH AND REDOX POTENTIALS OF SELECTED SITES IN THE JUMBO DOME MINE AREA.

Pit #	Soil Great group	Soil T ^{o}C	Measured Depth, cm (mineral)	Thickness O horizon, cm	pH / depth, cm	Redox potential., mv
10	Typic Cryaquept	n.a.			6.47/0	
15	Typic Gelaquept	0	67	8		
19	Typic Historthel	0	33	27		
20	Typic Historthel	0	40	27		
23	Typic Gelaquent	0	40/70			
26	Typic Cryaquent	n.a.			5.60/10	81
28	Dystrogelepts	0	80	20		
30	Typic Gelaquept	0	106	4		
33	Aquic Humicryepts	3.7	50	10		
34	Typic Gelaquent	2.7 1.9	50 60	10 10	5.60/65	84
35	Typic Gelaquent	4.6	30	12	6.20/2	65
39	Typic Historthel	0.8	40	23	5.40/20	96
41	Histic Gelaquept	1.6	62	12	4.4/22	156
43	Typic Historthel	0	50	24		
44	Typic Historthel	0	40	20		
52	Typic Dystrogelept	3.2	50	3		
53	Terric Cryohemist	2.9	35	5	4.9/25	121
54	Typic Dystrogelept	0.9	33	17	3.8//50	189
55	Terric Cryosaprist	0.7	30	20	4.7/50	199

TABLE CX-3. CHEMICAL PROPERTIES FOR SELECTED SOILS FROM THE JUMBO DOME AREA.

Soil Pit Horizon	Depth cm	pH 1:1	Field Texture	Bulk density g/cm^3	% Rock fragment >2mm	Total C %	Total N %
Pit 1.							
O&A	0-11	3.78	MK/SIL		7.0	8.17	0.34
Bw	11-30	4.27	GSL		11.8	1.49	0.09
Ab	30-55	5.34	VGSL		23.1	1.21	0.04
Bg	55-90	5.31	SICL		5.3	2.94	0.08
Pit 31							
Oi/Oe	0-14	3.49	MkPT		<0.1	44.53	1.12
E/A	14-18	4.10	SIL		<0.1	6.95	0.22
Bs	18-36	4.72	SL		<0.1	0.88	0.04
BC	36-68	4.80	LS		2.7	0.26	<0.01
C1	68-71	5.26	S		3.9	0.33	<0.01
Pit 33							
OA	3-13	3.93	MKSL		<0.1	9.72	0.39
A	13-31	4.50	GLS		2.4	2.57	0.10
Bg	31-47	4.86	SL		4.1	2.46	0.08
Bw	47-74	4.75	SL		1.1	1.62	0.05
BC	74-90	4.95	SL		4.3	1.28	0.05
Pit 42							
Oe/Oa	0-12	3.97	PTMK		<0.1	13.30	0.46
Bw	12-20	4.91	LS		8.2	1.07	0.02
BC	20-40	5.07	GS		16.5	0.30	<0.01
C1	40-75	4.71	S		<0.1	0.23	0.01
C2	75-89	4.59	L		0.8	0.24	0.01
Oab	89-95	4.78	MK		15.5	3.81	0.12
Ab	95-100	5.73	S		9.4	0.27	0.01
Pit 44							
Oa	2-21	4.32	MKSL		<0.1	15.08	0.57
A	21-38	4.57	SL		2.0	3.65	0.14
Bg	38-75	4.65	FSL		2.0	0.95	0.06
BC	75-95	5.38	GSL		1.5	0.89	0.04
Pit 47							
Oi	0-6	3.91	PT		<0.1	28.48	1.11
A	6-18	4.21	MK		7.1	8.15	0.31
Oa	18-40	4.70	MK		2.9	6.51	0.25
Ab	40-52	4.70	MKSL		15.3	4.75	0.17
Pit 56							
Oi/Oe	0-8	3.74	PTMK		<0.1	21.94	0.69
A/E	8-16	3.72	MKSL		16.8	1.19	0.04
Bs	16-24	4.13	LS		24.5	1.36	0.05
BC	24-34	4.33	LS		22.1	0.78	0.01

TABLE CX-4. CRITERIA TO ESTABLISH SUITABILITY OF TOPSOIL

Parameter	**Unsuitable Level**
Ph	<4.0
Texture	sand, clay
Coarse fragments	
Gravel and cobble (2mm-10 inch)	>35% by volume
Stone and boulder	>35% by volume
Slope	>35%

TABLE CX-5. MAXIMUM POTENTIAL SALVAGE DEPTH AND LIMITATIONS OF TOPSOILS IN JUMBO DOME

Mine Area

Map Unit Symbol	Salvage Depth (inch)	% Slope	Limiting Factors
3	N/A	0	wetness
4	N/A	>100	no topsoil
5	N/A	N/A	utility corridor
10	40	0-3	wetness
11	40	0-3	high water table
12	40	0-8	wetness
13	40	8-25	wetness, stone
20	40	15-35	sand
21	40	8-25	sand
22	40	25-45	sand, moderate slope
23	20	45-90	steep slope, sand
40	40	0-8	peat, wetness, frozen subsoils
41	40	8-25	peat, wetness, frozen subsoils
43	40	0-3	bog, water table
44	40	0-8	bog, mucky surface, wetness
50	30	8-25	wetness, stone
51	40	0-8	wetness, peat surface
53	30	0-18	gravelly substratum
56	10	25-45	very stony, bouldery, slope
57	30	0-15	very stony
58	30	15-35	very bouldery
60	10	3-25	extremely stony
61	10	25-65	bedrock and steep slope
63	40	3-15	
64	40	0-20	sand
65	40	20-45	moderate slope
71	40	3-18	sand

TABLE CX-6. WETLAND DETERMINATION FOR THE MAP UNITS IN THE JUMBO DOME MINE AREA

Soil Map Unit	Hydric soil indicator		Hydrology indicator		Wetland/ Upland
	2007 Regional Supplement	1987 Manual	2007 Regional Supplement	1987 Manual	
3	N/A		A1		Waters
4	N/A		N/A		Rocks
5	N/A		N/A		Roads
10	A13		A2		Wetland
11	A13, A14		A3		Wetland
12	A13		A3, B2		Wetland
13	A12		A2		Wetland
20	N/A		N/A		Upland
21	N/A		N/A		Upland
22	N/A		N/A		Upland
23	N/A		N/A		Upland
40	A2		A2		Wetland
41	A2		A3		Wetland
43	A1		A2		Wetland
44	A1		A3		Wetland
50	A14		D2		Wetland
51	A2		A3		Wetland
53	N/A		N/A		Upland
56	N/A		N/A		Upland
57	N/A		N/A		Upland
58	N/A		N/A		Upland
60	N/A		N/A		Upland
61	N/A		N/A		Upland
64	N/A		N/A		Upland
65	N/A		N/A		Upland
71	N/A		N/A		Upland

APPENDIX CX-1

SOIL PROFILE DESCRIPTIONS OF EXCAVATED PITS, JUMBO DOME MINE AREA

Soil Pit #: 1
Date Sampled: 08/09/2007
USDA-NRCS Soil Survey Area:

Soil Series:

Latitude: 63°59.096'N Longitude: 148°44.943'W
Elevation: 2189ft asl

Slope Characteristic Information
Slope: up 30% down 42 % Aspect: 245 degrees
Horizontal Shape: convex Vertical Shape: convex

Physiography:
Major: glaciated uplands Local: outwash plain
Geomorphic Position: adjacent mountain extremely bouldery
Surface stones: Stoney Silt loam
Parent material: loess/fluvial/lucustrine/outwash
Drainage:
Water table at time of description:

Runoff: Type of Erosion: Degree of Erosion:
Slope slump, creeping trees leaning upslope with bases bent.
Landcover type:
Plant Names: Betula Glandulosa, White spruce, Black spruce, LzAz, Equisetum, grasses, salix, Cladina, Cladonia, Soapberry

Classification: Aquic Dystrocryept

Described and sampled by: C.L. Ping, Gary Michaelson

Oe: 0 - 6 cm; very dark grey (7.5YR3/1) many very fine, fine, medium and few coarse roots; abrupt smooth boundary.

A: 6 – 11 cm; very dark gray (10YR3/1) silt loam; weak medium subangular blocky structure, friable, slightly sticky and slightly plastic; many very fine, fine, medium and few coarse roots; abrupt smooth boundary.

Bw1: 11 – 28 cm; dark yellowish brown (10YR4/4) sandy loam with 30% gravel; weak medium subangular bocky structure; friable, nonsticky and slightly plastic; common fine and medium roots; clear smooth boundary, pH 5.88.

Ab1: 11 – 43 cm; very dark greyish brown (10YR3/2) very cobbly sandy loam; weak medium subangular blocky structure; very friable, common fine and many medium roots; abrupt smooth boundary.

Ab2: 43 – 55 cm; very dark greyish brown (10YR3/2) very gravelly sandy loam with mixed sand pockets; moderate medium subangular blocky structure; slightly sticky and slightly plastic; few fine and medium roots; abrupt smooth boundary.

Bw2: 55 – 65 cm; brown; olive brown (10YR4/3; 2.5Y4/3) sandy loam; massive structure; few very and fine roots; abrupt smooth boundary.

Bg2: 65 – 93cm; dark grey (2.5Y4/1matrix); strong brown; dark brown (7.5YR4/6 pore linings-30%; 10YR3/3 in mass-20%) silty clay loam; massive structure; coarse and very fine root remains, abrupt smooth boundary.

C: 93 – 130 cm; dark grayish brown (10YR4/3) very gravelly sandy loam.
Sampled 0-28, 28-55, and 55-90 27% slope (convex-convex), aspect 219°. same vegetation

Soil Pit #: 2
Date Sampled: 08/09/2007
USDA-NRCS Soil Survey Area:

Soil Series:

Latitude: 63°59.148'N Longitude: 148°44.6603'W Elevation: 2307ft asl

Slope Characteristic Information
Slope: up 4 % Aspect: 264 degrees
Horizontal Shape: Vertical Shape:

Physiography:
Major: glaciated uplands Local: slightly undulating high terrace
Geomorphic Position:
Surface stones:
Parent material: fluvial deposit over coal seam
Drainage: well
Water table at time of description:

Runoff: Type of Erosion: Degree of Erosion:

Landcover type:
Plant Names: Picea Glauca, Betula Glandulosa, salix, vaccinium Uliginosum, ledum decumbens, Cladonia.

Classification:

Described and sampled by: C.L. Ping, Gary Michaelson

Oe: 0 - 3 cm; very dark grey (7.5YR3/1) common very fine, fine, and few medium roots; abrupt smooth boundary.

A: 3 – 19 cm; black (10YR2/1) silt loam; weak fine subangular blocky structure, slightly sticky and slightly plastic; many very fine, fine, and common medium roots; abrupt smooth boundary; charcoal present.

A&B: 19 – 58 cm; dark brown (A-10YR3/3-55%; 10YR3/2-sand); dark yellowish brown (B-10YR3/2); sand; streaks of <1cm weak red (2.5YR4/2) silt loam; weak medium subangular blocky structure; friable, slightly sticky and slightly plastic; few very fine and fine roots; abrupt wavy boundary.

Ab: 58 – 80 cm; very dark brown (10YR2/2); 40% cobbles, 10% gravel; very cobbly sand; weak medium subangular blocky structure; very friable, few very fine and fine roots; abrupt smooth boundary.

2C: 80+ cm; coal seam.

Soil Pit #: 3
Date Sampled: 08/09/2007
USDA-NRCS Soil Survey Area:

Soil Series:

Latitude: 63°59.176'N Longitude: 148°44.279'W Elevation: 2335ft asl

Slope Characteristic Information
Slope: up 38% Aspect: 214 degrees
Horizontal Shape: convex Vertical Shape: convex

Physiography:
Major: glaciated uplands Local:
Geomorphic Position: knob, backslope
Surface stones: andesitic boulders
Parent material:
Drainage: well
Water table at time of description:

Runoff: Type of Erosion: Degree of Erosion:
Landcover type:
Plant Names: Picea Glauca, Vaccinium Vitis-idaea, Geoculum, Vaccinium glandulosum, lichens, Alnus, Betula Glandulosa, Arctostaphylus Rubra

Classification:

Described and sampled by: C.L. Ping, Gary Michaelson

Oe: 0 - 3 cm; very dark brown (10YR2/2) mucky peat; many very fine, fine, and common medium and coarse roots; abrupt smooth boundary.

A: 3 – 9 cm; dark yellowish brown (10YR3/4) very gravelly sandy loam; medium grangular structure, non sticky and non plastic; many very fine, fine, few medium and coarse roots; clear smooth boundary.

Bw1: 9 – 20 cm; dark yellowish brown (10YR3/4) sandy loam; weak fine subangular bocky structure; nonsticky and slightly plastic; many very fine, fine and common medium roots; abrupt smooth boundary.

A'b: 20 – 23 cm; very dark brown and dark brown (10YR2/2;3/3) silt loam; weak fine subangular blocky structure; slightly sticky slightly plastic; common very fine, fine and few medium roots; abrupt smooth boundary.

Bw': 23 – 40 cm; dark yellowish brown (10YR3/4) very gravelly sandy loam; fine moderate subangular blocky structure; non sticky and non plastic; common very fine, fine and few medium roots; clear wavy boundary.

BC: 40 – 110 cm; brown (10YR4/3) extra stony loamy sand; few very fine and fine roots; nonsticky non plastic; clear smooth boundary.

2C: 110 – 150cm; brown (10YR4/3); extra stony silt loam.

Soil Pit #: 4
Date Sampled: 08/09/2007
USDA-NRCS Soil Survey Area:

Soil Series:

Latitude: 63°59.156'N Longitude: 148°44.239'W Elevation: 2396ft asl

Slope Characteristic Information
Slope: 15 % Aspect: 270 degrees
Horizontal Shape: linear Vertical Shape: linear

Physiography:
Major: glaciated uplands Local:
Geomorphic Position: toeslope
Surface stones:
Parent material:
Drainage: moderately well, 90% stone cobbles, undercoating contains OM-Fe
Water table at time of description:

Runoff: Type of Erosion: Degree of Erosion:

Landcover type:
Plant Names: Picea Glauca; Betula Glandulosa, Vaccinium Uliginosum, Ledum Decumbens, Ledum Groenlandicum, OMNI, Polytricum, pleurosem shrubs, lichens, Alnus, Hylocomium sp.

Classification: Lithic Cryumbrept; Dystrocryept.

Described and sampled by: C.L. Ping, Gary Michaelson

Oi: 0 - 5 cm; peat.

A: 5 – 15 cm; very dark gray (7.5YR3/2) silt loam; fine moderate granular structure, friable, slightly sticky and slightly plastic; many very fine, fine, few medium roots; abrupt wavy boundary.

Bw: 15 – 40 cm; extra stony sandy loam with 90% cobbles; fine moderate subangular bocky structure; friable, slightly sticky and slightly plastic; few fine roots; irregular wavy boundary.

R: 40+ cm; fractured bedrock, sorted circles, no cutains.

Soil Pit #: 5
Date Sampled: 08/09/2007
USDA-NRCS Soil Survey Area:

Soil Series:

Latitude: 63°59.180'N Longitude: 148°44.349'W Elevation: 2302ft asl

Slope Characteristic Information
Slope: 8 % Aspect: 27 degrees
Horizontal Shape: Vertical Shape:

Physiography: undulating, generally plane
Major: glaciated uplands Local: outwash plain
Geomorphic Position: center of sorted circle
Surface stones:
Parent material:
Drainage: water around circle centers
Water table at time of description: around mound center 0-60 cm.

Runoff: Type of Erosion: Degree of Erosion:
Slope slump, creeping trees leaning upslope with bases bent.
Landcover type:
Plant Names: Picea Mariana; salix, Betula Glandulosa, carex, sphagnum, Vaccinium Uliginosum.

Classification: Aquic Dystrocryept

Described and sampled by: C.L. Ping, Gary Michaelson

Oi: 2 - 0 cm; sedge roots.

A: 0 – 85 cm; very dark grayish brown (10YR3/2) sandy loam; weak moderate subangular blocky structure, friable, slightly sticky and slightly plastic; many very fine, fine, and few medium roots.

85+ cm; paralithic

Soil Pit #: 6
Date Sampled: 08/10/2007
USDA-NRCS Soil Survey Area:

Soil Series:

Latitude: 63°59.239'N Longitude: 148°44.856'W Elevation: 2155ft asl

Slope Characteristic Information
Slope: up 31% Aspect: 311 degrees
Horizontal Shape: convex Vertical Shape: convex

Physiography:
Major: Local:
Geomorphic Position: lower backslope
Surface stones:
Parent material: colluvium over coal seam
Drainage: poorly
Water table at time of description:

Runoff: Type of Erosion: Degree of Erosion:
Landcover type:
Plant Names: Picea Mariana, salix, Betula Glandulosa, Vaccinium Uliginosum, Ledum Groenlandicum, Ledum Decumbens, carex, Sphagnum, GMNI,

Classification: Typic Humicryept

Described and sampled by: C.L. Ping, Gary Michaelson

Oi: 0 - 12 cm; brown (7.5YR4/4) peat; sphagnum roots; many very fine, fine and common medium roots; abrupt smooth boundary; not saturated.

A1: 12 – 35 cm; very dark brown (10YR2/2) silt loam; weak fine subangular blocky structure; slightly sticky and slightly plastic; many very fine, fine, and few medium roots; many dead root remains; clear smooth boundary.

A2: 35 – 73 cm; very dark brown (10YR2/2) sandy; slightly sticky and slightly plastic; few very fine, fine and medium roots; abrupt smooth boundary, saturated.

C1: 73 – 90 cm; black (10YR2/1) coal seam, few very fine and fine roots; abrupt smooth boundary.

C2: 90 – 120 cm; extra cobbly very gravelly sandy loam.

Notes: No alpha, alpha reaction
In A2 pockets of light grey 10YR3/3 sandstone
Water perched over clay

Soil Pit #: 7
Date Sampled: 08/10/2007
USDA-NRCS Soil Survey Area:

Soil Series:

Latitude: 63°59.328'N Longitude: 148°44.831'W Elevation: 2120ft asl

Slope Characteristic Information
Slope: up Aspect:
Horizontal Shape: Vertical Shape:

Physiography:
Major: Local:
Geomorphic Position: floodplain
Surface stones:
Parent material:
Drainage: poorly
Water table at time of description:

Runoff: Type of Erosion: Degree of Erosion:
Landcover type:
Plant Names: Alnus, salix, Vaccinium Uliginosum, Potentilla, Calamagrostis Canadensis, carex,

Classification: Typic Cryaquept

Described and sampled by: C.L. Ping, Gary Michaelson

Oe: 0 - 10 cm; very dark grayish brown (10YR3/2) peaty muck; many very fine, fine and medium roots; discontinuous on old river channel; abrupt smooth boundary.

Bg: 10 – 30 cm; dark grey (5Y4/1-matrix) silt loam; brown (7.5YR4/4-pockets of gravelly sand) sand; massive structure; sticky and plastic; many very fine, fine, and few medium roots; abrupt smooth boundary.

C: 30+ cm; variegated very gravelly sand; compact; perches water.

Soil Pit #: 8
Date Sampled: 08/10/2007
USDA-NRCS Soil Survey Area:

Soil Series:

Latitude: 63°59.340'N Longitude: 148°44.900'W Elevation: 2060ft asl

Slope Characteristic Information
Slope: up 0-1% Aspect:
Horizontal Shape: Vertical Shape:

Physiography:
Major: Local:
Geomorphic Position: outwash terrace old floodplain
Surface stones:
Parent material: fluvial sediments
Drainage: well
Water table at time of description:

Runoff: Type of Erosion: Degree of Erosion:
Landcover type:
Plant Names: Picea Glauca, Alnus, salix, Calamagrostis Canadensis, Vaccinium Uliginosum, moss.

Classification: Fluvaquentic Cryaquept

Described and sampled by: C.L. Ping, Gary Michaelson

A: 0 - 11 cm; light olive brown (2.5Y5/3) loamy sand; yellowish brown (10YR5/4-30%); common very fine, fine and medium roots; abrupt smooth boundary.

Bw/AC: 11 – 25 cm; dark grey (2.5Y4/1) sand; dark yellowish brown (10YR4/6) sand; very dark greyish brown (10YR3/2-30%) sandy loam; few very fine, fine, and medium roots; abrupt wavy boundary.

Cg: 25 – 57 cm; brown (10YR5/3); dark grayish brown (10YR4/2); dark grey (2.5Y4/1-root pores); olive brown (2.5Y4/6-mass and pore linings) sand; few very fine, fine and medium roots; abrupt smooth boundary.

2C: 57+ cm; extra cobbly sand.

Control section: sand

Soil Pit #: 9
Date Sampled: 08/10/2007
USDA-NRCS Soil Survey Area:

Soil Series:

Latitude: 63°59.346'N Longitude: 148°44.987'W Elevation: 2078ft asl

Slope Characteristic Information
Slope: up Aspect:
Horizontal Shape: Vertical Shape:

Physiography:
Major: Local:
Geomorphic Position: alluvial terrace
Surface stones:
Parent material:
Drainage:
Water table at time of description:

Runoff: Type of Erosion: Degree of Erosion:
Landcover type: dense old spruce stand
Plant Names: Picea Glauca, Alnus, salix, Vaccinium Uliginosum, moss. Potentilla sp, GMNI, Hylocomium Splendens, Ledum Groenlandicum.

Classification: Fluvaquentic Cryaquept

Described and sampled by: C.L. Ping, Gary Michaelson

Oe: 0 - 7 cm; black (10YR2/1) mucky peat; common very fine, fine, medium and coarse roots; abrupt smooth boundary.

Bw: 7 – 20 cm; dark yellowish brown (10YR4/6-matrix) sand; dark grey (2.5Y4/1-20% in pore linings and mass) loamy sand; very dark greyish brown (10YR3/1-10% thin platy) silt loam; dark grey (7.5YR4/1-pore linings, very fine); clear wavy boundary.

2C: 20+ cm; extremely cobbly sand.

Soil Pit #: 10
Date Sampled: 08/10/2007
USDA-NRCS Soil Survey Area:

Soil Series:

Latitude: 63°59.346'N Longitude: 148°44.988'W Elevation: 2081ft asl

Slope Characteristic Information
Slope: up Aspect:
Horizontal Shape: Vertical Shape:

Physiography:
Major: Local:
Geomorphic Position: seepage below topo break
Surface stones:
Parent material:
Drainage: poor
Water table at time of description:

Runoff: Type of Erosion: Degree of Erosion:
Landcover type:

Classification: Typic Cryaquent (inclusion)

Described and sampled by: C.L. Ping, Gary Michaelson

Rusty red and strong brown 7.5YR5/8;
Outside channel: black (10YR2/1) mucky sand over dark grey (2.5Y4/1) sand; pH 6.47.

Soil Pit #: 11
Date Sampled: 08/10/2007
USDA-NRCS Soil Survey Area:

Soil Series:

Latitude: 63°59.405'N Longitude: 148°45.061'W Elevation: 2081ft asl

Slope Characteristic Information
Slope: 18-23% Aspect:
Horizontal Shape: concave Vertical Shape: linear, undulating

Physiography:
Major: Local:
Geomorphic Position: slope
Surface stones:
Parent material: colluvium over paralithic red sandstone
Drainage: well
Water table at time of description:

Runoff: Type of Erosion: Degree of Erosion:
Landcover type:
Plant Names: Picea Glauca, Alnus, Vaccinium Uliginosum, Vaccinium Vitis-idaea, Ledum Decumbens, Cladonia, coltsfoot.

Classification: Lithic Dystrocryept

Described and sampled by: C.L. Ping, Gary Michaelson

Oe: 0-8 cm; very dark brown (10YR2/2) mucky peat; common very fine, fine and few medium and coarse roots; abrupt wavy boundary.

A: 8-22 cm; very dark brown (7.5YR2.5/2) silt loam; pockets of charcoal, black (10YR2/1); weak moderate subangular blocky structure; slightly sticky slightly plastic; friable; many very fine, fine and common medium and few coarse roots; abrupt smooth boundary.

Bw: 22-37 cm; very dark grayish brown (10YR3/2) sandy loam; weak moderate subangular blocky structure; slightly sticky slightly plastic; very friable; common very fine, fine and medium roots; abrupt wavy boundary.

BCr 37+ cm; fractured red sandstone; common very fine, fine and few medium roots.

Soil Pit #: 12
Date Sampled: 08/10/2007
USDA-NRCS Soil Survey Area:

Soil Series:

Latitude: 63°59.442'N Longitude: 148°46.103'W Elevation: 2242ft asl

Slope Characteristic Information
Slope: 3% (downslope: 25%) Aspect: 63 degrees
Horizontal Shape: convex Vertical Shape: convex

Physiography:
Major: Local:
Geomorphic Position: summit
Surface stones:
Parent material:
Drainage: well
Water table at time of description:

Runoff: Type of Erosion: Degree of Erosion:
Landcover type: old growth black spruce
Plant Names: Picea Mariana, Betula Glandulosum, Vaccinium Uliginosum, Vaccinium Vitis-idaea, Ledum Groenlandicum, Hyloconium sp, Equisetum.

Classification: Typic Dystrcryept

Described and sampled by: C.L. Ping, Gary Michaelson

Oe: 0-9 cm; very dark brown (10YR2/2) mucky peat; many very fine, fine and few medium and coarse roots; abrupt smooth boundary.

A: 9-16 cm; very dark brown (7.5YR2.5/2) fine sandy loam; weak coarse granular and weak fine subangular blocky structure; slightly sticky slightly plastic; friable; many very fine, fine and common medium and few coarse roots; abrupt wavy boundary.

Bw1: 16-31 cm; very dark yellowish brown (10YR4/4) fine sandy loam; ash band 1 cm charcoal (10YR2/2) and strong brown (7.5YR5/8); weak moderate subangular blocky structure; slightly sticky slightly plastic; very friable; common very fine, fine and few medium roots; abrupt smooth boundary, pH 4.68.

Bw2: 31-42; very dark brown (10YR2/2-30%), yellowish brown (10YR5/4-60%), yellowish brown (10YR5/6-10%) stratified loamy sand; non sticky non plastic; common very fine, fine and few medium roots, clear smooth boundary.

BC: 42-60; dark brown (10YR3/3) loamy sand; clear smooth boundary.

C 60+ cm; very dark grayish brown (10YR3/2) loamy sand; massive structure.

Soil Pit #: 13
Date Sampled: 08/10/2007
USDA-NRCS Soil Survey Area:

Soil Series:

Latitude: 63°59.411'N Longitude: 148°45.094'W Elevation: 2214ft asl

Slope Characteristic Information
Slope: 43% (downslope: 54%) Aspect: 110 degrees
Horizontal Shape: convex Vertical Shape: convex

Physiography:
Major: Local:
Geomorphic Position: summit
Surface stones:
Parent material:
Drainage: well
Water table at time of description:

Runoff: Type of Erosion: Degree of Erosion:
Landcover type: dense growth black spruce
Plant Names: Picea Mariana, Vaccinium Uliginosum, Ledum Groenlandicum, clubmoss, Hyloconium sp, Carex, lichens.

Classification: Typic Dystrcryept

Described and sampled by: C.L. Ping, Gary Michaelson

Oe: 0-8 cm; very dark brown (10YR2/2) mucky peat; weak moderate granular structure; many very fine, fine, medium and few coarse roots; abrupt smooth boundary.

A: 8-22 cm; dark brown (10YR3/3) silt loam; weak moderate subangular blocky structure; slightly sticky slightly plastic; friable; many very fine, fine and few medium roots; abrupt smooth boundary.

Bw: 22-50 cm; dark yellowish brown (10YR4/6), dark yellowish brown (10YR4/4), yellowish brown (10YR5/6), dark yellowish brown (10YR3/6) stratified fine sandy loam; slightly sticky slightly plastic; common very fine, fine and few medium roots; abrupt smooth boundary.

C: 50-125; very dark brown (10YR4/4) sand; non sticky non plastic.

Soil Pit #: 14
Date Sampled: 08/10/2007
USDA-NRCS Soil Survey Area:

Soil Series:

Latitude: 63°59.384'N Longitude: 148°44.962'W Elevation: 2132ft asl

Slope Characteristic Information
Slope: 63% Aspect: 180 degrees
Horizontal Shape: complex Vertical Shape: convex

Physiography:
Major: Local:
Geomorphic Position: backslope
Surface stones:
Parent material: colluvium
Drainage: well
Water table at time of description:

Runoff: Type of Erosion: Degree of Erosion:
Landcover type: spruce forest
Plant Names: Picea Glauca, Betula Papyrifera, Vaccinium Uliginosum, Vaccinium Vitis-idaea, Alnus, lichens. Geocaulon.

Classification: Typic Cryopsamment

Described and sampled by: C.L. Ping, Gary Michaelson

Oi: 0-1 cm; very dark brown (7.5YR2.5/2) peat (spruce needles); abrupt smooth boundary.

A: 1-14 cm; dark brown (10YR4/3) sand; many medium and few very fine and fine roots; clear smooth boundary.

C1: 14-40 cm; light olive brown (2.5Y5/3), light olive brown (2.5Y5/4), sand; few very fine and fine and many medium roots; diffuse smooth boundary.

C2: 40-100; light olive brown (2.5Y5/3) sand.

Soil Pit #: 15
Date Sampled: 08/10/2007
USDA-NRCS Soil Survey Area:

Soil Series:

Latitude: 63°59.305'N Longitude: 148°44.775'W Elevation: 2109ft asl

Slope Characteristic Information
Slope: 18% Aspect: 304 degrees
Horizontal Shape: linear Vertical Shape: convex

Physiography:
Major: Local:
Geomorphic Position: slope
Surface stones:
Parent material: colluvium
Drainage:
Water table at time of description: water flowing at 65 cm

Runoff: Type of Erosion: Degree of Erosion:
Landcover type: spruce forest
Plant Names: Picea Mariana, Betula Glandulosa, Carex, Ledum Decumbens, Vaccinium Uliginosum, Hyloconium.

Classification: Typic Cryaquept

Described and sampled by: C.L. Ping, Gary Michaelson

Oi: 0-8 cm; dark reddish brown (5YR2.5/2) peat; many very fine, fine and common medium roots; abrupt smooth boundary.

A: 8-30 cm; very dark greyish brown (10YR3/2); stratified with dark grayish brown (2.5Y4/2-20%) sandy loam; common very fine, fine and few medium roots; slightly sticky slightly plastic; no redox features; charcoal particles; clear smooth boundary.

ACBg: 30-52 cm; very dark greyish brown (10YR3/2), dark yellowish brown (10YR4/4-10% in mass and pore linings) sandy loam; weak coarse angular blocky structure; slightly sticky slightly plastic; few very fine roots; clear smooth boundary.

C: 52-75; very dark greyish brown (10YR3/2) sandy loam; slightly sticky slightly plastic; many fine root remains; frozen above Cr; abrupt smooth boundary.

Cr: 75+ cm; dark yellowish brown (10YR4/4-10-15% mass); now alpha alpha reaction.

Soil Pit #: 16
Date Sampled: 08/10/2007
USDA-NRCS Soil Survey Area:

Soil Series:

Latitude: 63°59.390'N Longitude: 148°44.297'W Elevation: 2148ft asl

Slope Characteristic Information
Slope: Aspect:
Horizontal Shape Vertical Shape:

Physiography:
Major: Local:
Geomorphic Position: Terrace
Surface stones:
Parent material: colluvium
Drainage: well
Water table at time of description:

Runoff: Type of Erosion: Degree of Erosion:
Landcover type: spruce forest
Plant Names: Picea Mariana (small), Betula Nana, Vaccinium Uliginosum, Ledum Decumbens, Carex, lichens. Sphagnum, Rubus Camaemorus.

Classification: South of pit Ruptic Historthel

Described and sampled by: C.L. Ping, Gary Michaelson

Oi: 0-10 cm; peat; many very fine, fine and medium roots; abrupt smooth boundary.

Oa: 10-28 cm; very dark brown (10YR2/2) muck; many very fine and fine roots; abrupt smooth boundary.

Cgf: 28-35 cm; very dark grey (2.5Y3/1) silt loam; strong platy structure; slightly sticky slightly plastic; ice lenses; strong alpha alpha reaction.

Soil Pit #: 17
Date Sampled: 08/11/2007
USDA-NRCS Soil Survey Area:

Soil Series:

Latitude: 63°59.228'N Longitude: 148°43.922'W Elevation: 2429ft asl

Slope Characteristic Information
Slope:18% Aspect: 304
Horizontal Shape undulating Vertical Shape: undulating

Physiography:
Major: Local:
Geomorphic Position: shoulder slope-upper backslope
Surface stones: very stoney surface covered by vegetation mat
Parent material: colluvium
Drainage: well
Water table at time of description:

Runoff: Type of Erosion: Degree of Erosion:
Landcover type:
Plant Names: Picea Mariana, Betula Glandulosa, Arctostapholus Rubra, Vaccinium Uliginosum, Empetrum Nigrum, Vaccinium vitis-idaea, Carex, lichens. Ledum Decumbins, Cladonia, Hyloconium Splendens, Salix.

Classification: Typic Dystrocryept

Described and sampled by: C.L. Ping, Gary Michaelson

Oi: 0-7 cm; dark reddish brown (5YR3/3) peat; many very fine, fine, common medium and few coarse roots; abrupt smooth boundary.

A&E: 7-12 cm; very dark greyish brown (10YR3/2) silt loam; dark grayish brown (10YR4/2) silt loam; few sand pockets; weak fine granular structure; and weak fine subangular blocky structure; slightly sticky slightly plastic; friable; many very fine, fine, common medium and few coarse roots; abrupt smooth boundary.

Bw: 12-42 cm; dark yellowish brown (10YR4/4) sandy loam; weak medium subangular blocky structure; non sticky non plastic; very friable; few fine and medium roots; abrupt smooth boundary.

Oab1: 42-59 cm; very dark grey (10YR3/1) 30-40% cobbles, mucky silt loam; weak fine to medium subangular blocky structure; non sticky non plastic; friable; few fine roots; abundant charcoal; abrupt smooth boundary.

Bwb1: 59-70 cm; dark yellowish brown (10YR4/4) stratified sand; discontinuous bands of brown (7.5YR4/3) sandy loam; clear smooth boundary.

BCb: 70-87 cm; brown (10YR4/3) and dark yellowish brown (10YR4/4) sand; abrupt smooth boundary.

Oab2: 87-92 cm; black (10YR2/1); abrupt smooth boundary.

2C: 92+ cm; very cobbly sand; >40% cobbles.

Soil Pit #: 18
Date Sampled: 08/11/2007
USDA-NRCS Soil Survey Area:

Soil Series:

Latitude: 63°59.319'N Longitude: 148°43.923'W Elevation: 2425ft asl

Slope Characteristic Information
Slope: 33-36% Aspect:
Horizontal Shape undulating Vertical Shape: undulating

Physiography:
Major: Local:
Geomorphic Position: shoulderslope-upper backslope
Surface stones: very stoney surface covered by vegetation mat
Parent material: colluvium
Drainage: well
Water table at time of description:

Runoff: Type of Erosion: Degree of Erosion:
Landcover type: open forest
Plant Names: Picea Mariana, Betula Glandulosa, Vaccinium Uliginosum, Empetrum Nigrum, lichens. Ledum Decumbins, Lycopodium, Calamagrostis Canadensis.

Classification: fragmental phase (70% boulders and stones in profile), Lithic Humicryept

Described and sampled by: C.L. Ping, Gary Michaelson

Oi/Oe: 0-10 cm;

A: 10-18 cm; black (10YR2/1) silt loam.

Bw: 18-30 cm; dark yellowish brown (10YR4/4) silt loam.

R: 30+ cm;

Soil Pit #: 19
Date Sampled: 08/11/2007
USDA-NRCS Soil Survey Area:

Soil Series:

Latitude: 63°59.359'N Longitude: 148°44.030'W Elevation: 2293ft asl

Slope Characteristic Information
Slope: 25% Aspect: 294 degrees
Horizontal Shape undulating Vertical Shape: slightly concave

Physiography:
Major: Local:
Geomorphic Position: lower backslope
Surface stones:
Parent material: colluvium
Drainage:
Water table at time of description:

Runoff: Type of Erosion: Degree of Erosion:
Landcover type: hummocky scatted black spruce
Plant Names: Picea Mariana, Betula Glandulosa, Betula Nana, Alnus, Salix, Carex, Vaccinium Uliginosum, Empetrum Nigrum, Ledum Decumbins, Hyloconium, Sphagnum.

Classification: Typic Historthel, Ruptic (frozen at 60cm) Histic Cryaquept

Described and sampled by: C.L. Ping, Gary Michaelson

Oi: 0-11 cm; very dark brown (7.5YR2.5/2) peat; many very fine, fine and common medium roots; abrupt smooth boundary.

Oa: 11-27 cm; very dark grayish brown (10YR3/2) muck; many very fine and fine roots; abrupt smooth boundary.

Bg1: 27-45 cm; dark greyish brown (2.5Y4/2), dark brown and brown (7.5YR3/4-30%; 7.5YR4/4-30%) sandy loam; weak medium subangular blocky structure; nonsticky and slightly plastic; friable; common very fine and fine roots; saturated; strong alpha alpha reaction; abrupt smooth boundary.

Bg2: 45-60+ cm; dark brown (10YR3/3) very cobbly sandy loam; slightly sticky slightly plastic; frozen; strong alpha alpha reaction;

Soil Pit #: 20
Date Sampled: 08/11/2007
USDA-NRCS Soil Survey Area:

Soil Series:

Latitude: 63°59.326'N Longitude: 148°44.137'W Elevation: 2284ft asl

Slope Characteristic Information
Slope: 19% Aspect: 304 degrees
Horizontal Shape undulating Vertical Shape: slightly concave

Physiography:
Major: Local:
Geomorphic Position: lower backslope
Surface stones:
Parent material: colluvium
Drainage:
Water table at time of description:

Runoff: Type of Erosion: Degree of Erosion:
Landcover type: hummocky scatted black spruce
Plant Names: Picea Mariana, Betula Glandulosa, Betula Nana, Alnus, Salix, Carex, Vaccinium Uliginosum, Empetrum Nigrum, Ledum Decumbins, Hyloconium, Sphagnum.

Classification: Typic Historthel, Ruptic (frozen at 67cm) Histic Cryaquept

Described and sampled by: C.L. Ping, Gary Michaelson

Oi: 0-11 cm; very dark brown (7.5YR2.5/2) peat; many very fine, fine and common medium roots; abrupt smooth boundary.

Oa: 11-27 cm; very dark grayish brown (10YR3/2) muck; many very fine and fine roots; abrupt smooth boundary.

Bg1: 27-45 cm; dark greyish brown (2.5Y4/2), dark brown and brown (7.5YR3/4-30%; 7.5YR4/4-30%) sandy loam; weak medium subangular blocky structure; nonsticky and slightly plastic; friable; common very fine and fine roots; saturated; strong alpha alpha reaction; abrupt smooth boundary.

Bg2: 45-60+ cm; dark brown (10YR3/3) very cobbly sandy loam; slightly sticky slightly plastic; frozen; strong alpha alpha reaction;

Soil Pit #: 21
Date Sampled: 08/11/2007
USDA-NRCS Soil Survey Area:

Soil Series:

Latitude: 63°59.142'N Longitude: 148°44.059'W Elevation: 2417ft asl

Slope Characteristic Information
Slope: 8% Aspect: 265 degrees
Horizontal Shape undulating Vertical Shape: slightly concave

Physiography:
Major: Local:
Geomorphic Position: basin
Surface stones:
Parent material:
Drainage:
Water table at time of description:

Runoff: Type of Erosion: Degree of Erosion:
Landcover type: open medow
Plant Names: Picea Mariana (dwarfed), Betula Nana, Salix, Eriophorum Vaginatum, Vaccinium Uliginosum, Ledum Decumbins, Sphagnum.

Classification: Histic Cryaquept

Described and sampled by: C.L. Ping, Gary Michaelson

Under tussock:
Oi1: 0-15 cm; straw; abrupt irregular boundary.

Oi2: 15-25 cm; black (7.5YR2.5/1) dead roots of Eriophorum; many fine and medium roots; abrupt smooth boundary.

Oa1: 25-30 cm; very dusky red (2.5Y2.5/2) muck; many very fine, fine and few medium roots; abrupt smooth boundary.

Oa2: 25-47 cm; black (7.5YR2.5/1) muck; many very fine, fine and few medium roots; strong alpha alpha reaction; pH 5.74; abrupt smooth boundary.

Cg: 47-60+ cm; very dark grayish brown (10YR3/2) fine sandy loam; weak medium to coarse subangular blocky structure; slightly sticky slightly plastic; friable; strong apha alpha reaction; pH 5.74.

Intertussock
Oi: 0-5 cm;
Oa: 5-25 cm;
Cg: 25-60 cm;

Soil Pit #: 22
Date Sampled: 08/11/2007
USDA-NRCS Soil Survey Area:

Soil Series:

Latitude: 63°59.069'N Longitude: 148°43.930'W Elevation: 2476ft asl

Slope Characteristic Information
Slope: 24% Aspect: 314 degrees
Horizontal Shape convex Vertical Shape: undulating

Physiography:
Major: Local: hummocky due to frost heave of boulders
Geomorphic Position: slope
Surface stones: extremely bouldery phase rocks exposed and covered by vegetation mat
Parent material: colluvium (cutans on bottom of gravel and stones)
Drainage:
Water table at time of description:

Runoff: Type of Erosion: Degree of Erosion:
Landcover type:
Plant Names: Picea Glauca, Betula Glandulosa, Alnus, Vaccinium Uliginosum, Vaccinium Vitis-idaea, Empetrum Nigrum, Ledum Decumbins, Hyloconium, lichens.

Classification: Typic Humicryept

Described and sampled by: C.L. Ping, Gary Michaelson

Oi: 0-7 cm; very dark brown (7.5YR2.5/3) peat; many very fine, and fine roots; abrupt smooth boundary.

A: 7-20 cm; very dark brown (7.5YR2.5/2) sandy loam; weak medium subangular blocky and weak medium granular structure; non sticky non plastic; very friable; many very fine, fine and few medium roots; many charcoal particles; abrupt wavy boundary.

Bw: 20-55 cm; black (7.5Y2.5/1), very dark gray (10YR3/1 50% stones) extra stony sandy loam; weak medium subangular blocky structure; nonsticky and slightly plastic; very friable; common very fine, fine and few medium roots; abrupt irregular boundary.

BC: 55-90 cm; very dark brown (7.5YR2.5/2); black (7.7YR2.5/1) extra cobbly sandy loam; non sticky non plastic; abrupt irregular boundary.

Soil Pit #: 23
Date Sampled: 08/11/2007
USDA-NRCS Soil Survey Area:

Soil Series:

Latitude: 63°59.088'N Longitude: 148°43.947'W Elevation: 2466ft asl

Slope Characteristic Information
Slope: 8% Aspect: 243 degrees
Horizontal Shape convex Vertical Shape: undulating

Physiography:
Major: Local: mounds in waterway
Geomorphic Position: waterway
Surface stones:
Parent material:
Drainage: poor
Water table at time of description:

Runoff: Type of Erosion: Degree of Erosion:
Landcover type:
Plant Names: Vaccinium Uliginosum (on mounds), Carex (in waterways).

Classification: Fluvaquentic Cryaquept

Described and sampled by: C.L. Ping, Gary Michaelson

A1: 0-30 cm; black (7.5YR2.5/1) mucky sandy loam;weak medium subangular blocky and weak medium granular structure; non sticky non plastic; many very fine, fine and common medium roots; clear smooth boundary.

Bg: 30-70 cm; black (2.5Y2.5/2) mucky sandy loam; common very fine, fine and few medium roots; many buried twigs; strong alpha alpha reaction.

Bgf: 70+ cm; seasonally frozen.

Soil Pit #: 24
Date Sampled: 08/11/2007
USDA-NRCS Soil Survey Area:

Soil Series:

Latitude: 63°59.108'N Longitude: 148°43.940'W Elevation: 2476ft asl

Slope Characteristic Information
Slope: 8-10% Aspect: 261 degrees
Horizontal Shape convex (hummocky) Vertical Shape: convex

Physiography:
Major: Local: hummocky
Geomorphic Position: slope
Surface stones:
Parent material: colluvium
Drainage:
Water table at time of description:

Runoff: Type of Erosion: Degree of Erosion:
Landcover type: partially open forest
Plant Names: Picea Glauca, Betula Glandulosa (tall), Alnus, Vaccinium Uliginosum, Vaccinium Vitis-idaea, Ledum Decumbins, Ledum Groenlandicum, Carex, Hyloconium, lichens.

Classification: Aquic Humicryept

Described and sampled by: C.L. Ping, Gary Michaelson

A1: 0-10 cm; very dark brown (7.5YR2.5/2) sandy loam; many very fine, fine and few coarse roots; clear smooth boundary.

A2: 10-25 cm; very dark grayish brown (10YR3/2) sandy loam; many very fine, fine and common medium roots; clear smooth boundary.

Bw1: 25-45 cm; brown (10YR4/3), dark grayish brown (2.5Y4/2-in pore linings 5%) sandy loam; slightly sticky slightly plastic; common very fine, fine and few medium roots; clear smooth boundary.

Bw2: 45-70 cm; very dark gray (7.5YR3/1), strong brown (7.5YR4/6-in pore linings with sand), reddish brown (5YR4/4) fine sandy loam; weak coarse platy structure; slightly sticky and slightly plastic; friable; common very fine, fine and few medium roots; many very fine and fine dead roots.

R: 70+ cm;

Soil Pit #: 25
Date Sampled: 08/29/2007
USDA-NRCS Soil Survey Area:

Soil Series:

Latitude: 63°59.749'N Longitude: 148°44.462'W Elevation: 2124ft asl

Slope Characteristic Information
Slope: 12% Aspect: 270 degrees
Horizontal Shape Vertical Shape:

Physiography:
Major:
Geomorphic Position: backslope of knob
Surface stones:
Parent material: glaciofluvial/ Birch Creek schist
Drainage:
Water table at time of description:

Runoff: Type of Erosion: Degree of Erosion:
Landcover type: forest
Plant Names: Picea Mariana, Picea Glauca, Betula Glandulosa, Vaccinium Uliginosum, Ledum Decumbins, Ledum Groenlandicum, Carex sp, lichens.

Classification: Sandy mixed Cryic

Described and sampled by: C.L. Ping, Gary Michaelson

Oi: 0-9 cm; very dark brown (7.5YR2.5/2) peat; many very fine, fine, medium and few coarse roots; abrupt smooth boundary.

AO: 9-17 cm; very dark gray (7.5YR3/1) mucky sandy loam; many very fine, fine and common medium roots; stratified charcoal layers, abrupt smooth boundary.

E: 17-21 cm; grayish brown (10YR5/2), sandy loam; slightly sticky slightly plastic; many very fine, fine and few medium roots; abrupt smooth boundary.

Bs: 21-45 cm; dark yellowish brown (10YR3/4), sand with 5% rounded gravel; single-grained loose structure; common very fine, fine and few medium roots; clear smooth structure.

BC: 45-75 cm; yellowish brown (10YR5/4) sand; single-grained loose structure; few very fine and fine roots; clear smooth boundary.

C: 75-110 cm; light yellowish brown (10YR6/4), gravelly sand (10% gravel cobbles and stones, 8% fine pebbles).

Soil Pit #: 26
Date Sampled: 08/29/2007
USDA-NRCS Soil Survey Area:

Soil Series:

Latitude: 63°59.839'N Longitude: 148°44.927'W Elevation: 2040ft asl

Slope Characteristic Information
Slope: 5-6% Aspect: 126 degrees
Horizontal Shape concave Vertical Shape: concave

Physiography:
Major: Local: hummocky
Geomorphic Position: headwater drainage
Surface stones:
Parent material: fluvial
Drainage:
Water table at time of description:

Runoff: Type of Erosion: Degree of Erosion:
Landcover type:
Plant Names: Picea Mariana (stunted), Carex sp, salix, Calamagrostis Canadensis.

Classification: Typic Cryaquent / Cryaquept

Described and sampled by: C.L. Ping, Gary Michaelson

C1: 0-11 cm; dark gray (10YR4/1) sand; many very fine, fine and medium roots; pH 5.6 at 10 cm; MV 81.7; clear smooth boundary.

Oi: 11-22 cm; very dark grayish brown (10YR3/2), dark gray (10YR4/1) peaty sandy loam; many very fine, fine and medium roots; clear smooth boundary.

Bg1: 22-70 cm; dark gray (5YR4/1) loam; slightly sticky slightly plastic; few very fine, and fine roots; saturated; abrupt smooth boundary.

Soil Pit #: 27
Date Sampled: 08/29/2007
USDA-NRCS Soil Survey Area:

Soil Series:

Latitude: 63°59.840'N Longitude: 148°44.889'W Elevation: 2043ft asl

Slope Characteristic Information
Slope: 4% Aspect: 166 degrees
Horizontal Shape slightly convex Vertical Shape: slightly convex

Physiography:
Major: Local:
Geomorphic Position: alluvial fan
Surface stones:
Parent material: colluvium
Drainage:
Water table at time of description: 80 cm

Runoff: Type of Erosion: Degree of Erosion:
Landcover type:
Plant Names: Picea Glauca, Salix sp, Salix Reticulata, Vaccinium Uliginosum, Ledum Decumbins, Empitrum Nigum, Sedge, Hyloconium, Arctostapholus Rubra, sphagnum, Rubus Chamaemorus.

Classification:

Described and sampled by: C.L. Ping, Gary Michaelson

Oi: 0-10 cm; dark brown (10YR3/3) peat; many very fine, fine and common medium roots; abrupt wavy boundary.

Oa: 10-12 cm; black (7.5YR2.5/1) muck; many very fine, fine and common medium roots; abrupt wavy boundary.

Bw1: 12-27 cm; olive brown (2.5Y4/3-50%), dark grayish brown (2.5Y4/2) sand; common very fine and fine roots; abrupt smooth boundary.

Bw2: 27-32 cm; dark yellowish brown (10YR3/4-60%), dark grey (2.5Y4/1sand; common very fine and fine roots; abrupt smooth boundary.

Bg1: 32-50 cm; dark gray (5Y4/1) stratified sand, very dark brown (10YR2/2-organic matter bands 15%, lenses of fine pebbles) loamy fine sand to sand; saturated; clear smooth boundary.

Bg2: 50-110 cm; black (5Y2.5/2) pockets of organic matter, sand; saturated.

Soil Pit #: 28
Date Sampled: 08/29/2007
USDA-NRCS Soil Survey Area:

Soil Series:

Latitude: 63°59.849'N Longitude: 148°45.036'W Elevation: 2074ft asl

Slope Characteristic Information
Slope: 8% Aspect: 138 degrees
Horizontal Shape slightly Vertical Shape:

Physiography:
Major: Local:
Geomorphic Position: alluvial fan
Surface stones:
Parent material: alluvium (Suntrana formation)
Drainage:
Water table at time of description:

Runoff: Type of Erosion: Degree of Erosion:
Landcover type:
Plant Names: Picea Mariana, Vaccinium Uliginosum, Ledum Groenlandicum, Empitrum Nigum, lichens.

Classification: Haplorthel

Described and sampled by: C.L. Ping, Gary Michaelson

Oi: 0-11 cm; very dark brown (10YR2/2) peat; common very fine, fine, many medium and few coarse roots; abrupt smooth boundary.

Oe: 11-20 cm; black (10YR2/2) mucky peat; many very fine, fine, medium and common coarse roots; abrupt smooth boundary.

A: 20-42 cm; dark grayish brown (10YR4/2), sandy loam; common very fine, fine and few medium roots; abrupt smooth boundary.

41-42 cm; very dark brown (10YR2/2) band of charcoal, fine muck.

Bw: 42-50 cm; yellowish brown (10YR5/4) loamy sand, common very fine and fine roots; clear smooth boundary.

BC: 50-93 cm; gray (10YR5/1) loamy sand, pockets of black (10YR2/1) muck; wet; few very fine and fine roots; abrupt smooth boundary.

Oab: 93-98 cm; black (10YR2/1) muck; abrupt smooth boundary.

Cg: 98-100 cm; grayish brown (2.5Y5/2) sandy loam; saturated above 100 cm.

Cf: 100+ cm; grayish brown (2.5Y5/2) sandy loam.

Organic layer dry

Soil Pit #: 29
Date Sampled: 08/29/2007
USDA-NRCS Soil Survey Area:

Soil Series:

Latitude: 63°59.866'N Longitude: 148°44.918'W Elevation: 2081ft asl

Slope Characteristic Information
Slope: 20-35% Aspect: 144 degrees
Horizontal Shape slightly convex Vertical Shape: convex

Physiography:
Major: Local:
Geomorphic Position: convex knob
Surface stones:
Parent material: colluvium
Drainage:
Water table at time of description:

Runoff: Type of Erosion: Degree of Erosion:
Landcover type:
Plant Names: Picea Glauca, Vaccinium Uliginosum, Vaccinium Vitis-idaea, bearberry, lichens.

Classification:

Described and sampled by: C.L. Ping, Gary Michaelson

Oi: 0-15 cm; dark brown (7.5YR3/3) peat.

A: 15-24 cm; dark yellowish brown (10YR4/4) sandy loam.

Bw1: 24-43 cm; yellowish brown (10YR5/6) sand.

Bw2: 43-60 cm; yellowish brown (10YR5/4), grayish brown (10YR5/2-mottling 20%) loamy sand.

BC: 60-75 cm; yellowish brown (10YR5/4), grayish brown (2.5Y5/2-20%), strong brown (7.5YR5/6-10%) sandy loam.

2C1: 75-120 cm; grayish brown (2.5YR5/2) stratified 1-7% gravel, gravely sand.

3C2: 12-180 cm; brown (10YR4/3) fine sandy loam, black (10YR2/1-charcoal bands stratified with sand: 50/50), strong brown (7.5YR5/8-mottles) stratified silt loam.

Soil Pit #: 30
Date Sampled: 08/29/2007
USDA-NRCS Soil Survey Area:

Soil Series:

Latitude: 63°00.021'N Longitude: 148°44.387'W Elevation: 2010ft asl

Slope Characteristic Information
Slope: 2% Aspect: 147 degrees
Horizontal Shape Vertical Shape:

Physiography:
Major: Local:
Geomorphic Position: alluvial fan
Surface stones:
Parent material: micaecous alluvium
Drainage:
Water table at time of description: frost at 110 cm

Runoff: Type of Erosion: Degree of Erosion:
Landcover type:
Plant Names: Picea Glauca, Picea Mariana, Ledum Groenlandicum, Betula Nana, Vaccinium Uliginosum, Vaccinium Vitis-idaea, Hyoconium, carex, coltsfoot, lichens.

Classification: Aquic Cryaquept

Described and sampled by: C.L. Ping, Gary Michaelson

Oi: 0-4 cm; very dark brown (10YR2/2) peat; many very fine, fine and few medium roots; abrupt irregular boundary.

Ag: 4-18 cm; dark grayish brown (10YR4/2), grayish brown (2.5Y5/2-40% iron depletions), strong brown (7.5YR4/6-in mass and pore linings) silt loam; common very fine and fine and few medium roots; slightly sticky slightly plastic; abrupt irregular boundary.

C: 18-36 cm; yellowish brown (10YR5/6-iron concentrations), variegated coarse sand with pebbles and coal particles; few very fine and fine roots; abrupt irregular boundary.

Ab: 36-41 cm; very dark gray (10YR3/1),sandy loam; some coarse, few very fine and fine roots.

Bg: 41-80 cm; dark yellowish brown (10YR4/4), gray (10YR4/1-stratified in bands) silt loam; wet.

Cg: 80-110 cm; strong brown (7.5YR5/6-30% in mass) silt loam, dark brown (7.5YR3/4) and gray (10YR5/1-matrix) gravely sandy loam; massive; slightly sticky slightly plastic.

Cf: 110+ cm;

Soil Pit #: 31
Date Sampled: 08/29/2007
USDA-NRCS Soil Survey Area:

Soil Series:

Latitude: 63°59.916'N Longitude: 148°44.615'W Elevation: 2043ft asl

Slope Characteristic Information
Slope: 8% Aspect: 145 degrees
Horizontal Shape Vertical Shape:

Physiography:
Major: Local:
Geomorphic Position: alluvial fan
Surface stones:
Parent material: Suntrana formation, alluvium
Drainage:
Water table at time of description:

Runoff: Type of Erosion: Degree of Erosion:
Landcover type:
Plant Names: Picea Mariana, Ledum Groenlandicum, Vaccinium Uliginosum, Vaccinium Vitis-idaea, Hyoconium, Carex sp, lichens.

Classification:

Described and sampled by: C.L. Ping, Gary Michaelson

Oi: 0-11 cm; very dark brown (7.5YR2.5/3) peat; many very fine, fine and common medium roots; abrupt smooth boundary.

Oe: 11-14 cm; very dark brown (10YR2/2), peaty muck; weak coarse granular structure; very friable; many very fine, fine and few medium roots; abrupt smooth boundary.

E/A: 14-18 cm; very dark gray (7.5YR3/1-A), dark grayish brown (10YR4/2-E) silt loam; few very fine, fine and few medium roots; abrupt smooth boundary.

Bs: 18-36 cm; dark brown (7.5YR3/4), strong brown (7.5YR5/8) sandy loam; weak fine subangular blocky structure; friable; slightly sticky slightly plastic; common very fine, fine and few medium roots; clear smooth boundary.

BC: 36-68 cm; dark yellowish brown (10YR4/6), yellowish brown (10YR5/6), dark grayish brown (10YR4/2-stratified in bands) loamy sand; common very fine and fine roots; abrupt smooth boundary.

C1: 68-71 cm; grayish brown (2.5YR5/2) sand, few very fine and fine roots; abrupt smooth boundary.

Bwb: 71-79 cm; dark brown (7.5YR3/4-pebbles coated) sand; few very fine and fine roots; clear smooth boundary.

BC: 79-91 cm; yellowish brown (10YR5/6) loamy sand; few very fine and fine roots; clear smooth boundary.

C2: 91-110 cm; gray (2.5Y5/1) and grayish brown (2.5Y5/2) sandy loam.

Soil Pit #: 32
Date Sampled: 08/29/2007
USDA-NRCS Soil Survey Area:

Soil Series:

Latitude: 63°59.812'N Longitude: 148°44.607'W Elevation: 2012ft asl

Slope Characteristic Information
Slope: Aspect: degrees
Horizontal Shape Vertical Shape:

Physiography:
Major: Local:
Geomorphic Position: flood plain
Surface stones:
Parent material: alluvium
Drainage:
Water table at time of description: frost at 65 cm

Runoff: Type of Erosion: Degree of Erosion:
Landcover type:
Plant NamesPicea Mariana, Alnus, Salix (dense), Ledum Groenlandicum, Vaccinium Uliginosum, Calamagrostis Canadensis, Potentilla sp.

Classification: Gelaquept

Described and sampled by: C.L. Ping, Gary Michaelson

Oi: 0-4 cm; black (10YR2/1) peat; abrupt smooth boundary.

Bw/A: 4-12 cm; yellowish brown (10YR5/6), gray (10YR5/1- oxidation) iron masses in pore linings, sandy loam; many medium and few coarse roots.

C: 12-19 cm; dark gray (2.5Y4/1) sand with organic matter layer at the bottom; common very fine, fine and few medium roots.

Bw/Bg: 19-65 cm; strong brown (7.5YR4/6-60%), dark grayish brown (10YR4/2-40%) silt loam; common very fine, fine and few medium roots; iron concentrations in mass and pore linings; burned organic matter.

2C: 65+ cm; very cobbly sand; riverbed.

Soil Pit #: 33
Date Sampled: 08/30/2007
USDA-NRCS Soil Survey Area:

Soil Series:

Latitude: 63°59.757'N Longitude: 148°44.544'W Elevation: 2092ft asl

Slope Characteristic Information
Slope: 1% Aspect: 194 degrees
Horizontal Shape Vertical Shape:

Physiography:
Major: Local: moss mound
Geomorphic Position: terrace
Surface stones:
Parent material: alluvium
Drainage:
Water table at time of description:
Temperature at 5 cm to mineral surface: 3.7 C
Runoff: Type of Erosion: Degree of Erosion:
Landcover type:
Plant Names: Picea Glauca, Picea Mariana, Betula Glandulosa, Alnus, Salix, Vaccinium Uliginosum, Vaccinium Vitis-idaea, Empetrum Nigrum, Hyloconium splendens, Cladonia, Sphagnum.

Classification: Cryoumbrept, Geleumbrept

Described and sampled by: C.L. Ping, Gary Michaelson

Oi: 0-3 cm; dusky red (2.5YR3/2) peat; many very fine, fine and few medium roots; abrupt irregular boundary (2-6 cm).

O/A: 3-13 cm; reddish black (2.5YR2.5/1), muck; weak medium subangular blocky structure; non sticky non plastic; many very fine, fine, medium and few coarse roots; abrupt irregular boundary (0-11cm), 40% of pedon channers.

A: 13-31 cm; dark brown (7.5YR3/3) gravely loamy sand; weak medium subangular blocky structure; non sticky non plastic; very friable; common very fine, fine and medium roots; abrupt smooth boundary; 20% gravel.

Bg: 31-47 cm; brown (10YR4/3-40%), olive brown (2.5Y4/3-40%) dark brown (7.5YR3/2-in mass), 10% gravel sandy loam; moderate fine lenticular structure; slightly sticky slightly plastic; friable; common very fine, fine and few medium roots; abrupt smooth boundary.

Bw: 47-74 cm; dark grayish brown (10YR4/2) dark yellowish brown (10YR4/6-20%) sandy loam; (top baved 10YR4/4 disantieds 1/3 pretlueds 10% gravel)?

BC: 74-90 cm; dark gray (10YR4/1-matrix), dark yellowish brown (10YR4/6- in pore linings and mass 30%) sandy loam; weak moderate subangular blocky structure; slightly sticky slightly plastic; friable; few very fine roots; abrupt smooth boundary.

2C: 90-110 cm; brown (10YR4/3), dark grayish brown (10YR4/2), 50% cobbles and gravel with clean surfaces, very cobbly sandy loam; massive structure; slightly sticky slightly plastic.

Soil Pit #: 34
Date Sampled: 08/30/2007
USDA-NRCS Soil Survey Area:

Soil Series:

Latitude: 63°00.266'N Longitude: 148°43.596'W Elevation: 1974 ft asl

Slope Characteristic Information
Slope: 0% Aspect: degrees
Horizontal Shape Vertical Shape:

Physiography:
Major: Local: Hummocky
Geomorphic Position: flood plain
Surface stones:
Parent material: alluvium over river-wash gravel
Drainage:
Water table at time of description: 65 cm

Runoff: Type of Erosion: Degree of Erosion:
Landcover type:
Plant Names: Picea Mariana, Vaccinium Vitis-idaea, lichens, Hyloconium, Pleurosum, Pelfegra, Carex, Sphagnum.

Classification: Gelaquept

Described and sampled by: C.L. Ping, Gary Michaelson

Oi: 0-5 cm; dark brown (7.5YR3/2) peat; many very fine, fine, and common medium roots; abrupt smooth boundary.

Oa: 5-10 cm; very dark brown (7.5YR2.5/2), muck; many very fine, fine, and common medium roots; abrupt smooth boundary.

Bg1: 10-40 cm; olive gray (Y4/1.5-40%) stratified silt loam, strong brown (7.5YR5/6-30%), fine sand and sand, olive brown (2.5Y4/3-30%) loamy sand; massive structure; slightly sticky slightly plastic; friable; common very fine, fine and few medium roots; clear smooth boundary, alpha alpha positive.

Bg2: 40-65 cm; dark gray (2.5YR4/1-matrix-40%) sandy loam, olive brown (2.5Y4/3-40%) loamy sand, dark brown (7.5YR4/3- pore linings-20%) loamy sand (stratified); few very fine and fine roots; abrupt smooth boundary.

2C: 65-100+ cm; strong brown (7.5YR5/6) extremely gravely sand; few very fine roots.

Soil Pit #: 35
Date Sampled: 08/30/2007
USDA-NRCS Soil Survey Area:

Soil Series:

Latitude: 63°00.291'N Longitude: 148°43.505'W Elevation: 1958 ft asl

Slope Characteristic Information
Slope: 0% Aspect: degrees
Horizontal Shape Vertical Shape:

Physiography:
Major: Local: moss mounds
Geomorphic Position: waterway
Surface stones:
Parent material: alluvium over river-wash gravel
Drainage: very poorly, with ppt iron, sheen
Water table at time of description: 0 cm

Runoff: Type of Erosion: Degree of Erosion:
Landcover type:
Plant Names: Picea Mariana (scattered dead), salix, Calamagrostic Canadensis, sedge tussocks, Aloconium, Betula Glandulosa, Sphagnum.

Classification: Ruptic Histic Gelaquept

Described and sampled by: C.L. Ping, Gary Michaelson

Oe: 0-12 cm; very dusky red (2.5YR2.5/2) peat.

Bg: 12-65 cm; dark gray (4/N) sandy loam; pH 6.2, 65mv at 20 cm, T=4.6C at 30 cm.

Soil Pit #: 36
Date Sampled: 08/30/2007
USDA-NRCS Soil Survey Area:

Soil Series:

Latitude: 63°00.270'N Longitude: 148°43.266'W Elevation: 2056 ft asl

Slope Characteristic Information
Slope: 35-70% (55% hub,36% saddle) Aspect: 331 degrees
Horizontal Shape Vertical Shape:

Physiography:
Major: Local:
Geomorphic Position: complex ravine
Surface stones:
Parent material: alluvium over river-wash gravel
Drainage:
Water table at time of description:

Runoff: Type of Erosion: Degree of Erosion:
Landcover type:
Plant Names: Picea Mariana, Betula Glandulosa, Plurosum, Vaccinium Goenlandicum, Vaccinium Vitis-idaea, salix, Spirea, sphagnum, coltsfoot, sedge.

Classification: Typic Cryorthent (deep)

Described and sampled by: C.L. Ping, Gary Michaelson

Oi: 0-10 cm; very dark brown (10YR2/2) peat; many very fine, fine, medium and coarse roots; abrupt smooth boundary.

A: 10-20 cm; dark brown (10YR3/3) loamy sand; many very fine, fine, medium and few coarse roots; abrupt smooth boundary.

AC: 20-35 cm; dark grayish brown (10YR2/2) very gravely sand; 38% fine pebbles and gravel with clean surfaces; many very fine and fine roots; clear smooth boundary.

C1: 35-100 cm; brown (10YR4/3) very gravely sand; 40% gravel; common very fine and fine roots; clear smooth boundary.

C2: 100-140 cm; very dark grayish brown (10YR3/2) very cobbly sand; few very fine roots.

Shallow soil over Suntrana formation or clay bed over coal.

Soil Pit #: 37
Date Sampled: 08/30/2007
USDA-NRCS Soil Survey Area:

Soil Series:

Latitude: 63°00.310'N Longitude: 148°43.339'W Elevation: 2055 ft asl

Slope Characteristic Information
Slope: 28-34% (25-35% break) Aspect: 190 degrees
Horizontal Shape Vertical Shape:

Physiography:
Major: Local:
Geomorphic Position: toeslope
Surface stones:
Parent material: colluvium
Drainage: well , active layer 95 cm
Water table at time of description:

Runoff: Type of Erosion: Degree of Erosion:
Landcover type:
Plant Names: : Picea Mariana, Betula Glandulosa, Plurosum, Vaccinium Goenlandicum, Vaccinium Vitis-idaea, salix, Spirea, sphagnum, coltsfoot, sedge.

Classification: Gelorthent

Described and sampled by: C.L. Ping, Gary Michaelson

Oi: 0-10 cm; very dark brown (10YR3/3) peat; many very fine, fine, common medium and few coarse roots; abrupt smooth boundary; 10 cm live sphagnum then dead moss.

A: 13-30 cm; dark grayish brown (10YR4/2) 10% pebbles, sandy loam; weak medium subangular blocky structure, slightly sticky slightly plastic, friable, many very fine, fine, medium and few coarse roots; abrupt wavy boundary.

C1: 30-55 cm; brown (10YR4/3) very gravely sand; few very fine and fine roots; abrupt smooth boundary.

C2: 55-60 cm; 45% gravel and pebbles with clean surfaces; abrupt smooth boundary.

C3: 60-70 cm; dark yellowish brown (10YR3/4) gravely loamy sand, dark grayish brown (10YR4/20) 30% pebbles, sandy loam; abrupt smooth boundary.

C4: 70-95 cm; dark gray (10YR4/1) sandy loam; abrupt smooth boundary.

Cf: 95+ cm; dark gray (10YR4/1) sandy loam.

Soil Pit #: 38 (similar to #31)
Date Sampled: 08/30/2007
USDA-NRCS Soil Survey Area:

Soil Series:

Latitude: 63°00.314'N Longitude: 148°43.429'W Elevation: 1984 ft asl

Slope Characteristic Information
Slope: 6% Aspect: 170 degrees
Horizontal Shape Vertical Shape:

Physiography:
Major: Local:
Geomorphic Position: toeslope
Surface stones:
Parent material:
Drainage:
Water table at time of description:

Runoff: Type of Erosion: Degree of Erosion:
Landcover type: open old mature black spruce forest with lichen patches
Plant Names: : Picea Mariana, Betula Glandulosa, Vaccinium Goenlandicum, Vaccinium Vitis-idaea, salix, carex lichen, coltsfoot.

Classification: Aquic Gelcryept

Control Section sandy, on 2 cm sandy loam A.

Soil Pit #: 39
Date Sampled: 08/30/2007
USDA-NRCS Soil Survey Area:

Soil Series:

Latitude: 63°00.326'N Longitude: 148°43.888'W Elevation: 2092 ft asl

Slope Characteristic Information
Slope: 18% Aspect: 50 degrees
Horizontal Shape: concave Vertical Shape: concave

Physiography:
Major: Local:
Geomorphic Position: upland saddle (chute)
Surface stones:
Parent material:
Drainage:
Water table at time of description: 38 cm, profile saturated at 20 cm

Runoff: Type of Erosion: Degree of Erosion:
Landcover type:
Plant Names: : Picea Mariana (stunted), Betula Glandulosa, Empitrum Nigrum, moss, Vaccinium Goenlandicum, Vaccinium Vitis-idaea, Ledum Decumbens, sphagnum, coltsfoot, carex.

Classification:

Described and sampled by: C.L. Ping, Gary Michaelson

Oi: 0-18 cm; very dark brown (10YR2/2) moss-sedge peat; many very fine, fine and common medium roots; clear smooth boundary.

Oe: 18-33 cm; black (10YR2/1) mucky peat; many very fine and fine roots; pH at 20 cm 5.4, mv 96; T=0.8 C; abrupt smooth boundary.

Bg: 33-38 cm; dark gray (10YR4/1) sand; many very fine and fine roots; abrupt smooth boundary.

Ob: 38-40 cm; few very fine roots.

Soil Pit #: 40
Date Sampled: 08/30/2007
USDA-NRCS Soil Survey Area:

Soil Series:

Latitude: 63°00.268'N Longitude: 148°43.844'W Elevation: 2065 ft asl

Slope Characteristic Information
Slope: 34% Aspect: 137 degrees
Horizontal Shape:undulating/complex Vertical Shape:

Physiography:
Major: Local:
Geomorphic Position: backslope
Surface stones:
Parent material: colluvium
Drainage: pit moist with dry organic matter
Water table at time of description: 38 cm, profile saturated at 20 cm

Runoff: Type of Erosion: Degree of Erosion:
Landcover type:
Plant Names: : Picea Glauca (tall), open Betula Glandulosa, Empitrum Nigrum, moss, Vaccinium Goenlandicum, Vaccinium Vitis-idaea, Cladonia.

Classification:

Described and sampled by: C.L. Ping, Gary Michaelson

Oe: 0-8 cm; dark brown (7.5YR3/2) peaty muck; many very fine, fine and medium roots; abrupt smooth boundary.

A: 8-14 cm; dark grayish brown (10YR4/2) mucky loamy sand; many very fine, fine and medium roots; abrupt smooth boundary.

Bw: 14-28 cm; dark yellowish brown (10YR4/6) 50% gravel, very gravely sand; common very fine and fine roots; clear smooth boundary.

BC: 28-40 cm; yellowish brown (10YR5/6) sand; clear smooth boundary.

C1: 40-65 cm; yellowish brown (10YR5/4) 10% gravel and fine pebbles, sand; clear smooth boundary.

C2 65-110 cm; light olive brown (2.5Y5/3) sand; clear smooth boundary.

Soil Pit #: 41
Date Sampled: 08/30/2007
USDA-NRCS Soil Survey Area:

Soil Series:

Latitude: 63°00.233'N Longitude: 148°43.823'W Elevation: 1997 ft asl

Slope Characteristic Information
Slope: 0-1% Aspect: 135 degrees
Horizontal Shape:undulating/complex Vertical Shape:

Physiography:
Major: Local: low tussocks moss mounds and hummocks
Geomorphic Position: alluvial terrace
Surface stones:
Parent material: alluvium
Drainage:
Water table at time of description: 70 cm, profile saturated at 20 cm

Runoff: Type of Erosion: Degree of Erosion:
Landcover type:
Plant Names: : Picea Mariana (dwarf and stunted), Betula Glandulosa, salix, Ledum decumbens, Sphagum moss, Vaccinium Goenlandicum, Vaccinium Vitis-idaea, Carex Aquatalis.

Classification: Humic Gelaquept

Described and sampled by: C.L. Ping, Gary Michaelson

Oe: 0-6 cm; black (10YR2/1) mucky peat; many very fine, fine and common medium roots; abrupt smooth boundary.

Oa: 6-12 cm; black (10YR2/2) muck; saturated; many very fine, fine and few medium roots; abrupt smooth boundary.

Bg1: 12-22 cm; dark yellowish brown (10YR4/4-matrix), dark gray (10YR4/1), reddish yellow (7.5YR6/8-5%) pore linings and ped faces, sandy loam; weak medium subangular blocky structure; slightly sticky slightly plastic; few very fine and fine roots; clear smooth boundary.

Bg2: 22-30 cm; dark gray (10YR4/1), dark yellowish gray (10YR4/6), gray and gray (2.5Y5/1, and 2.5Y4/1), iron concretions and depletions in pore linings and mass, silt loam; weak fine platy structure; slightly sticky slightly plastic; abrupt smooth boundary.

C: 30-90 cm; dark gray (10YR4/1), yellowish brown (10YR5/6) sand.

2C 90+ cm; gravel.

Soil Pit #: 42
Date Sampled: 08/31/2007
USDA-NRCS Soil Survey Area:

Soil Series:

Latitude: 63°59.588'N Longitude: 148°43.423'W Elevation: 2375 ft asl

Slope Characteristic Information
Slope: 28% Aspect: 197 degrees
Horizontal Shape: convex Vertical Shape: convex

Physiography:
Major: Local: low tussocks moss mounds and hummocks
Geomorphic Position: upper backslope
Surface stones:
Parent material: colluvium (Suntrana formation)
Drainage: well drained
Water table at time of description:

Runoff: Type of Erosion: Degree of Erosion:
Landcover type: open forest shrubland
Plant Names: Picea Mariana, Betula Glandulosa, Betula Papyrifera, Ledum decumbens, lichen and moss,

Classification:

Described and sampled by: C.L. Ping, Gary Michaelson

Oe: 0-6 cm; black (7.5YR2.5/1) mucky peat; many very fine, fine and common medium roots; abrupt smooth boundary.

Oa: 6-12 cm; black (10YR2/2) mucky sand; weak medium granular structure; nonsticky nonplastic; friable; many very fine, fine and medium roots; heavy cutans under 2" rock in lower horizon; abrupt smooth boundary.

Bw: 12-20 cm; brown (7.5YR4/4) 10% gravel, loamy sand; many very fine, fine and common medium roots; clear wavy boundary.

BC: 20-40 cm; olive brown (2.5Y4/3) 25% gravel, gravely sand; few very fine and fine roots; clear smooth boundary.

C1: 40-75 cm; grayish brown (2.5Y5/2) sand; clear smooth boundary.

C2: 75-89 cm; yellowish brown (10YR5/6), dark grayish brown (2.5Y4//2-40%), grayish brown (2.5Y5/2)stratified, loam, strong fine subangular blocky structure; abrupt smooth boundary.

Oab: 89-95 cm; black (10YR2/1) muck (coal-like); abrupt smooth boundary.

Ab: 95-100 cm; dark grayish brown (10YR4/2) sand; clear smooth boundary.

C3 100-140+ cm; brown (10YR4/3) stratified sand; grayish brown (10YR5//2-20%) sandy loam.

Soil Pit #: 43
Date Sampled: 08/30/2007
USDA-NRCS Soil Survey Area:

Soil Series:

Latitude: 63°59.553'N Longitude: 148°43.438'W Elevation: 2370 ft asl

Slope Characteristic Information
Slope: 17% Aspect: 192 degrees
Horizontal Shape: concave Vertical Shape: linear

Physiography:
Major: Local:
Geomorphic Position: slope
Surface stones:
Parent material:
Drainage:
Water table at time of description:

Runoff: Type of Erosion: Degree of Erosion:
Landcover type:
Plant Names: Picea Mariana, Betula Glandulosa, Vaccinium Uliganosum, Ledum Decumbens, Carex, Plurosan Sch., and Empitrum Nigrum,

Classification: Typic Hisorthel

Described and sampled by: C.L. Ping, Gary Michaelson

Oi: 0-12 cm; dark brown (7.5YR3/2) peat; many very fine, fine and medium roots; abrupt smooth boundary.

Oa: 12-24 cm; black (7.5YR2.5/1) muck; many very fine, fine and medium roots; abrupt smooth boundary.

Bg: 24-50 cm; dark gray (5Y4/1), dark yellowish brown (10YR4/6-10% iron concretions in pores); massive; saturated; slightly sticky slightly plastic; many very fine and fine roots; abrupt smooth boundary.

Bgf: 50+ cm; dark gray (5Y4/1) loam.

Soil Pit #: 44
Date Sampled: 08/30/2007
USDA-NRCS Soil Survey Area:

Soil Series:

Latitude: $63^{59.669}$'N Longitude: 148°43.337'W Elevation: 2368 ft asl

Slope Characteristic Information
Slope: 10% Aspect: 223 degrees
Horizontal Shape: flat Vertical Shape: planer

Physiography:
Major: Local:
Geomorphic Position: saddle slope
Surface stones:
Parent material:
Drainage:
Water table at time of description:

Runoff: Type of Erosion: Degree of Erosion:
Landcover type:
Plant Names: : Picea Mariana (dwarf), Betula Nana, moss, Vaccinium Uliganosum, Carex.

Classification: Typic Historthel

Described and sampled by: C.L. Ping, Gary Michaelson

Oe: 0-2 cm; black (7.5YR2.5/1) 10% cobbles, peaty muck; many very fine, fine, medium and few coarse roots; abrupt smooth boundary.

Oa: 2-21 cm; black (7.5YR2.5/1) 10% cobbles, mucky silt loam; many very fine, fine and few medium roots; abrupt wavy boundary.

A: 21-38 cm; dark brown (10YR3/3) sandy loam; non sticky non plastic; many very fine, fine and few medium roots; abrupt smooth boundary.

Bg: 38-75 cm; dark gray (2.5Y4/1), yellowish brown (10YR5/6-10%) fine sandy loam; wet; slightly sticky slightly plastic; common very fine and few fine roots; clear smooth boundary.

BC: 75-95 cm; dark grayish brown (10YR4/2), dark yellowish brown (10YR4/6-25%), dark gray (4/N-30%) gravely sandy loam; slightly sticky slightly plastic; moist; few very fine and fine roots; clear smooth boundary.

C 95-130+ cm; dark gray (10YR4/1), dark yellowish brown (10YR4/6-iron masses 20%) very gravely sandy loam; moist; few very fine and fine roots.

Soil Pit #: 45
Date Sampled: 08/30/2007
USDA-NRCS Soil Survey Area:

Soil Series:

Latitude: 63°59.781'N Longitude: 148°43.206'W Elevation: 2458 ft asl

Slope Characteristic Information
Slope: 26% Aspect: 161 degrees
Horizontal Shape: concave Vertical Shape: con cave

Physiography:
Major: Local: low tussocks moss mounds and hummocks
Geomorphic Position: upper backslope
Surface stones:
Parent material: colluvium (Suntrana formation)
Drainage: moist
Water table at time of description:

Runoff: Type of Erosion: Degree of Erosion:
Landcover type:
Plant Names: Picea Glauca, Betula Glandulosa, Betula Glandulosa, Ledum Decumbens, Vaccinium Uliganosum, Vaccinium Vitis-idaea, Hylocomium,, Sphagnum, sedge, lichen and moss,

Classification: Aquic Gelecryept, lower slope Historthels

Described and sampled by: C.L. Ping, Gary Michaelson

Oi: 0-5 cm; black (7.5YR2.5/1) mucky peat; many very fine, fine and common medium roots; abrupt smooth boundary.

Oa: 5-11 cm; black (10YR2/2) mucky sand; weak medium granular structure; nonsticky nonplastic; friable; many very fine, fine and medium roots; heavy cutans under 2" rock in lower horizon; abrupt smooth boundary.

Bw/A: 11-25 cm; brown (7.5YR4/4) 10% gravel, loamy sand; many very fine, fine and common medium roots; clear wavy boundary.

Bg/Bw: 25-57 cm; olive brown (2.5Y4/3) 25% gravel, gravely sand; few very fine and fine roots; clear smooth boundary.

Bg: 57-73 cm;

C1: 73-95 cm;

C2: 95- lost in xerox copy

Soil Pit #: 46
Date Sampled: 08/31/2007
USDA-NRCS Soil Survey Area:

Soil Series:

Latitude: 63°59.749'N Longitude: 148°43.226'W Elevation: 2398 ft asl

Slope Characteristic Information
Slope: 12% Aspect: 237 degrees
Horizontal Shape: convex Vertical Shape: convex

Physiography:
Major: Local:
Geomorphic Position: ridge
Surface stones:
Parent material:
Drainage:
Water table at time of description:

Runoff: Type of Erosion: Degree of Erosion:
Landcover type: open forest shrubland
Plant Names: Picea Glauca, Betula Glandulosa, Vaccinium Vitis-idaea, Empitrum Nigrum, Bearberry.

Classification: Gelochrept

Described and sampled by: C.L. Ping, Gary Michaelson

Oi: 0-4 cm; dark brown (7.5YR3/3) peat; many very fine, fine, medium and few coarse roots; abrupt smooth boundary.

A: 4-10 cm; brown (7.5YR4/2) sand; many very fine, fine, common medium and few coarse roots; abrupt smooth boundary.

Bw: 10-18 cm; dark yellowish brown (10YR4/6) sandy loam; non sticky non plastic; many very fine, fine and few medium roots; abrupt wavy boundary.

Eb: 18-20 cm; brown (10YR5/3) sandy loam; non sticky non plastic; many very fine and fine roots; abrupt irregular boundary.

Bwb: 20-32 cm; dark yellowish brown (10YR4/6) 20% cobbles, loamy fine sand; common very fine and fine roots; abrupt wavy boundary.

Ab: 32-52 cm; dark grayish brown (10YR4/2) sand; few very fine and fine roots; abrupt irregular boundary.

ACb: 52-75 cm; grayish brown (10YR5/2-A-30%), grayish brown (2.5Y5/2-70%) stratified sand; few fine roots; clear smooth boundary.

C: 75-130 cm; grayish brown (2.5Y5/2) sand.

Soil Pit #: 47
Date Sampled: 08/30/2007
USDA-NRCS Soil Survey Area:

Soil Series:

Latitude: 63°00.177'N Longitude: 148°42.973'W Elevation: 2260 ft asl

Slope Characteristic Information
Slope: 1% Aspect: 194 degrees
Horizontal Shape: convex Vertical Shape: convex

Physiography:
Major: Local:
Geomorphic Position: high terrace bench
Surface stones:
Parent material:
Drainage:
Water table at time of description:

Runoff: Type of Erosion: Degree of Erosion:
Landcover type: tundra
Plant Names: Picea Glauca (sparse), Betula Nana, Salix, Vaccinium Uliganosum, lichens and moss.

Classification: Cryosaprist

Described and sampled by: C.L. Ping, Gary Michaelson

Oi: 0-6 cm; black (7.5YR2.5/1) peat; many very fine and fine roots; abrupt wavy boundary.

O/A: 6-18 cm; black (7.5YR2.5/1) muck, dark brown (7.5YR3/2-40%) sandy loam; many very fine and fine roots; abrupt wavy boundary.

Oa: 18-40 cm; very dusky red (2.5YR2.5/2) muck; many very fine and fine roots; abrupt wavy boundary.

Ab: 40-52 cm; dark brown (7.5YR.3/2) mucky sandy loam; non sticky non plastic; common very fine and fine roots; abrupt smooth boundary.

Cg: 52-120 cm; light brownish gray (2.5Y6/2) sandy loam, yellowish brown (10YR5/4-20% in pores), dark gray (5Y4/1-pore linings-20%) 10% gravel, sand.

Soil Pit #: 48
Date Sampled: 08/30/2007
USDA-NRCS Soil Survey Area:

Soil Series:

Latitude: 63°00.177'N Longitude: 148°42.973'W Elevation: 2260 ft asl

Slope Characteristic Information
Slope: 32% Aspect: 176 degrees
Horizontal Shape: Vertical Shape:

Physiography:
Major: Local:
Geomorphic Position: slope
Surface stones: Andisitic Boulders
Parent material:
Drainage: well
Water table at time of description:

Runoff: Type of Erosion: Degree of Erosion:
Landcover type: stone circles
Plant Names: Picea Glauca, Betula Glandulosa, Alnus, Vaccinium Uliganosum, Ledum Decumbens.

Classification:

Described and sampled by: C.L. Ping, Gary Michaelson

Oi: 0-12 cm; 2-20 cm range thickness; many very fine, fine and medium roots; abrupt wavy boundary.

Bw1: 12-30 cm; dark yellowish brown (10YR4/4) extremely cobbly and stony sandy loam, many very fine and fine roots.

BC: 30-55 cm; very dusky red (10YR4/2) extremely stony sandy loam.

C: 55-100 cm; dark grayish brown (2.5Y4/2) extremely stony sandy loam.

Soil Pit #: 49
Date Sampled: 08/30/2007
USDA-NRCS Soil Survey Area:

Soil Series:

Latitude: 63°59.180'N Longitude: 148°44.561'W Elevation: 2301 ft asl

Slope Characteristic Information
Slope: 6% Aspect: 328 degrees
Horizontal Shape: convex Vertical Shape: convex

Physiography:
Major: Local:
Geomorphic Position:
Surface stones:
Parent material:
Drainage:
Water table at time of description:

Runoff: Type of Erosion: Degree of Erosion:
Landcover type: tundra
Plant Names: Picea Glauca, Picea Mariana, Betula Glandulosa, Salix, Vaccinium Uliganosum, Ledum Decumbens, Empetrum Nigrum, lichens and moss.

Classification: Histic Cryaquept

Described and sampled by: C.L. Ping, Gary Michaelson

Oe: 0-16 cm; very dark brown (7.5YR2.5/2) peaty muck; many very fine, fine and common medium roots.

Oa: 16-32 cm; very dark grayish brown (10YR3/2) muck, many very fine, fine and common medium roots.

Cg1: 32-40 cm; olive gray (5Y4/2) mucky sand; saturated many very fine and fine roots.

Cg2: 40-60 cm; dark gray (4/N) mucky sand; few very fine roots.

Cg3: 60-85 cm; dark gray (4/N) mucky sand.

Coal seam 85+ cm.

Soil Pit #: 50
Date Sampled: 09/01/2007
USDA-NRCS Soil Survey Area:

Soil Series:

Latitude: 63°58.567'N Longitude: 148°45.428'W Elevation: 2206 ft asl

Slope Characteristic Information
Slope: Aspect: 197 degrees
Horizontal Shape: convex Vertical Shape: convex

Physiography:
Major: Local:
Geomorphic Position: terrace
Surface stones:
Parent material:
Drainage:
Water table at time of description: 105 cm

Runoff: Type of Erosion: Degree of Erosion:
Landcover type: open black spruce forest
Plant Names: Picea Mariana, Betula Glandulosa, Salix, Vaccinium Uliganosum, Vaccinium Vitis-idaea, Ledum Decumbens, Cladonia (black lichen), Plureusium S.

Classification: Cryaquept

Described and sampled by: C.L. Ping, Gary Michaelson

Oi: 0-10 cm; very dark brown (7.5YR2.5/2) peat; many very fine, fine and medium roots; abrupt wavy boundary.

Oa: 10-22 cm; very dark brown (10YR2/2) mucky sandy loam, many very fine, fine and medium roots; 2-15 cm thickness range; charcoal abundant; abrupt irregular boundary.

A: 22-30 cm; dark grayish brown (10YR4/2) 30% cobbles and 10% stones, very cobbly sandy loam; non sticky non plastic; many very fine, fine and few medium roots; 0-10 cm thickness range; abrupt irregular boundary.

Bw: 30-42 cm; dark gray (10YR4/1), very dark grayish brown (10YR3/2) very cobbly sandy loam; common very fine and fine roots; abrupt smooth boundary.

Bg: 42-80 cm; gray (10YR5/1) 30% cobbles, 10% stones, very cobbly loam; slightly sticky slightly plastic,; friable.

C: 42-80 cm; dark yellowish brown (10YR4/4) sand 6%, brown (10YR5/3) sand mixed with silty clay loam-40%.

Soil Pit #: 51
Date Sampled: 09/01/2007
USDA-NRCS Soil Survey Area:

Soil Series:

Latitude: 63°58.567'N Longitude: 148°45.428'W Elevation: 2206 ft asl

Slope Characteristic Information
Slope: 3% Aspect: 150 degrees
Horizontal Shape: linear Vertical Shape: slightly convex

Physiography:
Major: Local:
Geomorphic Position: alluvial fan (interfluv)
Surface stones:
Parent material:
Drainage: well
Water table at time of description:

Runoff: Type of Erosion: Degree of Erosion:
Landcover type: bluejoint meadow
Plant Names: Calamagrostis Canadensis, moss.

Classification: Cryaquept

Described and sampled by: C.L. Ping, Gary Michaelson

Oi: 0-2 cm; peat; straw; abrupt smooth boundary.

A: 2-26 cm; very dark brown (10YR2/2) mucky fine sandy loam, weak medium granular structure; many very fine and fine roots; clear smooth boundary.

Bw: 26-41 cm; dark grayish brown (10YR4/2) yellowish brown (10YR5/6-35%, pore linings and mass) sandy loam; medium fine subangular blocky structure; friable; many very fine and fine roots; clear smooth boundary.

BC: 41-50 cm; dark grayish brown (10YR4/2), dark yellowish brown (10YR4/6-mass, iron concentrations) sandy loam; weak medium subangular blocky structure; slightly sticky slightly plastic; common very fine and fine roots; clear smooth boundary.

C: 50-100 cm; dark grayish brown (10YR4/2), brown (10YR4/3) 30% gravel, gravelly sandy loam or loam; slightly sticky slightly plastic; few very fine roots; moist no water table Aquic.

Soil Pit #: 52
Date Sampled: 09/01/2007
USDA-NRCS Soil Survey Area:

Soil Series:

Latitude: 63°59.686'N Longitude: 148°44.396'W Elevation: 2132 ft asl

Slope Characteristic Information
Slope: 6-8% Aspect: 201 degrees
Horizontal Shape: linear Vertical Shape: slightly convex

Physiography:
Major: Local:
Geomorphic Position: terrace break
Surface stones:
Parent material:
Drainage: moderately well
Water table at time of description:

Runoff: Type of Erosion: Degree of Erosion:
Landcover type:
Plant Names: Picea Glauca, Betula Glandulosa, Vaccinium Uliganosum, Vaccinium Vitis-idaea, Carex, lichens and moss.
Severely burned in the past
Classification:

Described and sampled by: C.L. Ping, Gary Michaelson

Oi: 0-3 cm; peat; many very fine and fine roots; abrupt smooth boundary.

Oa/A: 3-17 cm; black (10YR2/1), very dark brown (10YR2/2) mucky sandy loam; common very fine, fine and few medium roots; Oa charcoal rich; gravel 2 inch diameter at bottom contact that has iron-OM coatings; abrupt smooth boundary.

Bw1: 17-27 cm; dark grayish brown (10YR4/2) brown (10YR4/3-iron concretions in mass) sandy loam; non sticky non plastic; very friable; common very fine and fine roots; abrupt smooth boundary.

Bw2: 27-32 cm; dark brown (7.5YR3/4), loamy fine sand; massive structure; non sticky non plastic; very friable; common very fine and fine roots; abrupt wavy boundary.

Bw3: 32-50 cm; dark grayish brown (10YR4/2), fine sandy loam; weak coarse subangular blocky structure; non sticky non plastic; very friable; common very fine and few fine and medium roots; temperature at 50 cm = 3.2C; clear smooth boundary.

BC: 50-63 cm; dark grayish brown (10YR4/2) sandy loam, grayish brown (10YR5/2) sand, dark yellowish brown (10YR4/6-5%-root channels); few very fine and fine roots; clear smooth boundary.

2C: 63-100+ cm; grayish brown (10YR5/2); very gravelly loamy sand.

Soil Pit #: 53
Date Sampled: 09/01/2007
USDA-NRCS Soil Survey Area:

Soil Series:

Latitude: 63°59.689'N Longitude: 148°44.286'W Elevation: 2173 ft asl

Slope Characteristic Information
Slope: Aspect: degrees
Horizontal Shape: Vertical Shape:

Physiography:
Major: Local:
Geomorphic Position: terrace break
Surface stones:
Parent material:
Drainage:
Water table at time of description:

Runoff: Type of Erosion: Degree of Erosion:
Landcover type: tussock meadow – open pond complex
Plant Names: Sedge tussocks, Betula Nana, Vaccinium Uliganosum, salix.

Classification: Terric Cryohemist

Described and sampled by: C.L. Ping, Gary Michaelson

Tussocks:
Oi: 0-40 cm; peat; abrupt irregular boundary.

Intertussocks:
Oi: 0-5 cm;

5-8 cm; sand; varigated.

8-11 cm; dark gray (2.5Y4/1), silt loam.

Oe1: 11-40 cm; very dark brown (10YR2/2), peaty muck; at 25 cm pH=4.9, mv=121, Temperature at 40cm=2.9C.

Oe2: 40-60 cm; very dark brown (7.5YR2.5/2) peaty muck with lenses of sand.

Soil Pit #: 54
Date Sampled: 09/01/2007
USDA-NRCS Soil Survey Area:

Soil Series:

Latitude: 63°59.848'N Longitude: 148°44.403'W Elevation: 2068 ft asl

Slope Characteristic Information
Slope: 12-18% Aspect: 350 degrees
Horizontal Shape: convex Vertical Shape: convex

Physiography:
Major: Local:
Geomorphic Position: midslope of knob backslope
Surface stones:
Parent material:
Drainage: well
Water table at time of description:

Runoff: Type of Erosion: Degree of Erosion:
Landcover type: open forest
Plant Names: Picea Mariana, Betula Glandulosa, Vaccinium Uliganosum, Vaccinium Vitis-idaea, Ledum Decumbens, Hylocomium, Carex, lichens and Sphagnum in chunks moss-mounds.

Classification: Sandy Aquic Dystro Gelept

Described and sampled by: C.L. Ping, Gary Michaelson

Oe: 0-12 cm; very dark brown (10YR2/2) peaty muck; many very fine, fine and medium roots; abrupt smooth boundary.

Oa: 12-17 cm; black (10YR2/1), mucky sand; many very fine, fine and few medium roots; abrupt smooth boundary.

E: 17-20 cm; grayish brown (10YR5/2) sand; common very fine and fine roots; abrupt smooth boundary.

Bw: 20-36 cm; dark brown (10YR3/3), sand; common very fine and fine roots; abrupt smooth boundary.

Oab: 36-38 cm; black (10YR2/1), muck; common coarse and medium roots; abrupt irregular boundary.

Bwb: 38-42 cm; brown (7.5YR4/4) sand; massive single grained; non sticky non plastic; few fine roots; wet; abrupt smooth boundary.

BC: 42-50 cm; black (10YR2/1) and very dark brown (10YR2/2) stratified 2 cm, muck, grayish brown (2.5Y5/2-matrix-80%) sand, light olive brown (2.5Y5/3-iron concentrations-10%); wet; clear smooth boundary.

C: 50-85 cm; grayish brown (2.5Y5/2-lenses of dark bands) sand; few fine roots; abrupt smooth boundary.

2C: 85+ cm; coal; pH=3.8; mv=189; wet.

Soil Pit #: 55
Date Sampled: 09/01/2007
USDA-NRCS Soil Survey Area:

Soil Series:

Latitude: 63°59.849'N Longitude: 148°44.371'W Elevation: 2050 ft asl

Slope Characteristic Information
Slope: 12%(0-15%) Aspect: 102 degrees
Horizontal Shape: Vertical Shape:

Physiography:
Major: Local:
Geomorphic Position: slope
Surface stones:
Parent material:
Drainage:
Water table at time of description:

Runoff: Type of Erosion: Degree of Erosion:
Landcover type: willowpatches in open forest
Plant Names: Salix, Picea Mariana, Picea Glauca, Betula Glandulosa, Vaccinium Uliganosum, Calamagrostis Canadensis, and Sphagnum and other mosses.

Classification: Terric Cryosaprist

Described and sampled by: C.L. Ping, Gary Michaelson

Oe: 0-16 cm; very dark brown (7.5YR2.5/2); abrupt smooth boundary.

Oa: 16-20 cm; black (7.5YR2.5/1); abrupt smooth boundary.

Bg/Oa: 20-23 cm; grayish brown (10YR5/2) sand and organic matter; abrupt smooth boundary.

Oab1: 23-39 cm; black (10YR2/1); abrupt smooth boundary.

Bg2: 39-41 cm; dark gray (2.5Y4/1) silt loam; abrupt smooth boundary.

Oab2: 41-70 cm; strong brown (7.5YR4/6) muck; reddish fiber; abrupt smooth boundary.

Cf: 70+ cm;

Soil Pit #: 56
Date Sampled: 09/01/2007
USDA-NRCS Soil Survey Area:

Soil Series:

Latitude: 63°59.849'N Longitude: 148°44.257'W Elevation: 2088 ft asl

Slope Characteristic Information
Slope: 37% Aspect: 154 degrees
Horizontal Shape: linear Vertical Shape: linear

Physiography:
Major: Local:
Geomorphic Position: terrace break midslope
Surface stones:
Parent material: colluvium
Drainage: well
Water table at time of description:

Runoff: Type of Erosion: Degree of Erosion:
Landcover type: open forest
Plant Names: Picea Mariana, Betula Glandulosa, Vaccinium Uliganosum, Vaccinium Vitis-idaea, Ledum Decumbens, lichen.

Classification: Entic Haplocryod or Gelod? (seepage over moss mounds Aquent on toeslope below)

Described and sampled by: C.L. Ping, Gary Michaelson

Oe: 0-5 cm; very dark brown (10YR2/2) peat; many very fine, fine, medium and few coarse roots; abrupt smooth boundary.

Oa: 5-8 cm; very dark brown (10YR2/2), muck; moderate medium granular structure; many very fine, fine, medium and few coarse roots; abrupt smooth boundary.

A/E: 8-16 cm; black (10YR2/1), very dark brown (10YR2/2) mucky sandy loam; gray (10YR5/1), dark yellowish brown (10YR4/6) 5% gravel, sandy loam; weak medium granular and subangular blocky structure; common very fine and fine roots; abrupt smooth boundary.

Bs: 16-24 cm; dark brown (7.5YR3/4), 8% gravel, cobbles present, loamy sand; weak fine subangular blocky structure; non sticky non plastic; very friable; common very fine and fine roots; clear smooth boundary.

BC: 24-34 cm; dark brown (10YR3/3) 10% gravel, loamy sand; few fine roots; clear smooth boundary.

C: 34-100+ cm; olive brown (2.5Y4/3) gravelly sand; single grained; non sticky non plastic; no roots.
Cobbles and gravels are undercoated with iron-organic matter

Soil Pit #: 57
Date Sampled: 09/01/2007
USDA-NRCS Soil Survey Area:

Soil Series:

Latitude: 63°59.833'N Longitude: 148°44.148'W Elevation: 2122 ft asl

Slope Characteristic Information
Slope: 7-16% Aspect: 336 degrees
Horizontal Shape: convex Vertical Shape: convex

Physiography:
Major: Local:
Geomorphic Position: midslope
Surface stones:
Parent material: colluvium
Drainage: well
Water table at time of description:

Runoff: Type of Erosion: Degree of Erosion:
Landcover type: open forest
Plant Names: Picea Glauca, Picea Mariana, Betula Nana, Vaccinium Uliganosum, Vaccinium Vitis-idaea, Ledum Decumbens, Hylocomium, lichens, mosses.

Classification: Aquic Dystrochrept

Described and sampled by: C.L. Ping, Gary Michaelson

Oi: 0-9 cm; very dark brown (10YR2/2) peat; many very fine, fine and medium roots; abrupt smooth boundary.

Oe: 9-14 cm; very dark brown (10YR2/2), peaty muck; many very fine, fine, medium and few coarse roots; abrupt smooth boundary.

A: 14-25 cm; black (10YR2/1), very dark brown (10YR2/2), very dark grayish brown (10YR3/2) very cobbly sandy loam; non sticky non plastic; many very fine and fine roots; abrupt smooth boundary.

Bg/Bw: 25-41 cm; gray (10YR5/1), dark gray (10YR4/1), dark yellowish brown (10YR4/6-10%) sandy loam; moderate fine and medium platy structure; non sticky non plastic; common very fine, fine and few medium roots; abrupt smooth boundary.

BC: 41-60 cm; dark grayish brown (10YR4/2) 65% angular and subangular cobbles and gravel, extremely cobbly loamy sand; common coarse and medium roots; clear smooth boundary.

C: 60-100+ cm; dark grayish brown (10YR4/2) 60% angular and subrounded gravels and cobbles, extremely cobbly loamy sand.

Soil Pit #: 58
Date Sampled: 09/01/2007
USDA-NRCS Soil Survey Area:

Soil Series:

Latitude: 63°59.862'N Longitude: 148°44.250'W Elevation: 2089 ft asl

Slope Characteristic Information
Slope: 33% Aspect: 199 degrees
Horizontal Shape: concave Vertical Shape: concave

Physiography:
Major: Local:
Geomorphic Position: midslope
Surface stones:
Parent material:
Drainage: well
Water table at time of description:

Runoff: Type of Erosion: Degree of Erosion:
Landcover type:
Plant Names: moss-mounds.

Classification: Typic Cryochrept and 25-45% Gelorthent

Described and sampled by: C.L. Ping, Gary Michaelson

Oe1: 0-10 cm;

Oe2: 10-13 cm;

A: 13-15 cm; Cobbles have iron staining on undersides, extremely cobbly loamy sand.

Bw: 15-20 cm; sand.

Soil Pit #: 59
Date Sampled: 09/01/2007
USDA-NRCS Soil Survey Area:

Soil Series:

Latitude: 63°59.854'N Longitude: 148°44.312'W Elevation: 2068 ft asl

Slope Characteristic Information
Slope: 17% Aspect: 223 degrees
Horizontal Shape: convex Vertical Shape: convex

Physiography:
Major: Local:
Geomorphic Position: midslope
Surface stones:
Parent material:
Drainage: well
Water table at time of description:

Runoff: Type of Erosion: Degree of Erosion:
Landcover type: hummocky, moss-mounds
Plant Names: Salix, mosses, Betula Glandulosa, Vaccinium Uliganosum, sedge.

Classification: Histic Cryaquent, Typic Gelaquent

Described and sampled by: C.L. Ping, Gary Michaelson

0-4 cm; very dark brown (7.5YR2.5/2) peaty sand.

4-10 cm; dark brown (7.5YR3/2), mucky sand.

10+ cm; dark gray (4/N) very gravely sand.

Soil Pit #: 60
Date Sampled: 09/01/2007
USDA-NRCS Soil Survey Area:

Soil Series:

Latitude: 63°59.846'N Longitude: 148°44.276'W Elevation: 2137 ft asl

Slope Characteristic Information
Slope: 53% Aspect: 172 degrees
Horizontal Shape: Vertical Shape:

Physiography:
Major: Local:
Geomorphic Position: backslope
Surface stones:
Parent material: Suntrana formation residuum
Drainage: well
Water table at time of description:

Runoff: Type of Erosion: Degree of Erosion:
Landcover type: forest
Plant Names: Picea Glauca, Betula Glandulosa, Vaccinium Uliganosum, Vaccinium Vitis-idaea, Empitrum Nigrum, rose, lichens and moss.

Classification: Typic Cryorthent (45-70%)

Described and sampled by: C.L. Ping, Gary Michaelson

Oi: 0-1 cm; peat; needle litter; abrupt smooth boundary.

Oe: 1-8 cm; very dark brown (10YR2/2), peaty muck; common very fine, fine, medium and many coarse roots; abrupt smooth boundary.

Bw1: 8-21 cm; dark yellowish brown (10YR4/4) sandy loam; weak medium subangular blocky structure; slightly sticky slightly plastic; many very fine, fine and few medium roots; clear smooth boundary.

Bw2: 21-31 cm; dark yellowish brown (10YR4/6), sand; many very fine and fine roots; clear smooth boundary.

BC: 31-50 cm; light olive brown (2.5Y5/4), sand; few fine and medium roots; clear smooth boundary.

C1: 50-75 cm; grayish brown (2.5Y5/2), light olive brown (2.5Y5/3) sand; few fine and medium roots; clear smooth boundary.

C2: 75-86 cm; light olive brown (2.5Y5/3) sand; abrupt smooth boundary.

86-90 cm; iron band; yellowish brown (10YR5/4) loamy sand.

C3: 86-150+ cm; gray (2.5Y5/1), grayish brown (2.5Y5/2), grayish brown (10YR5/2) sand.

C2: Thin iron band, brown (10YR5/3), four bands at 0.5-0.8 cm thickness.

APPENDIX CX-2

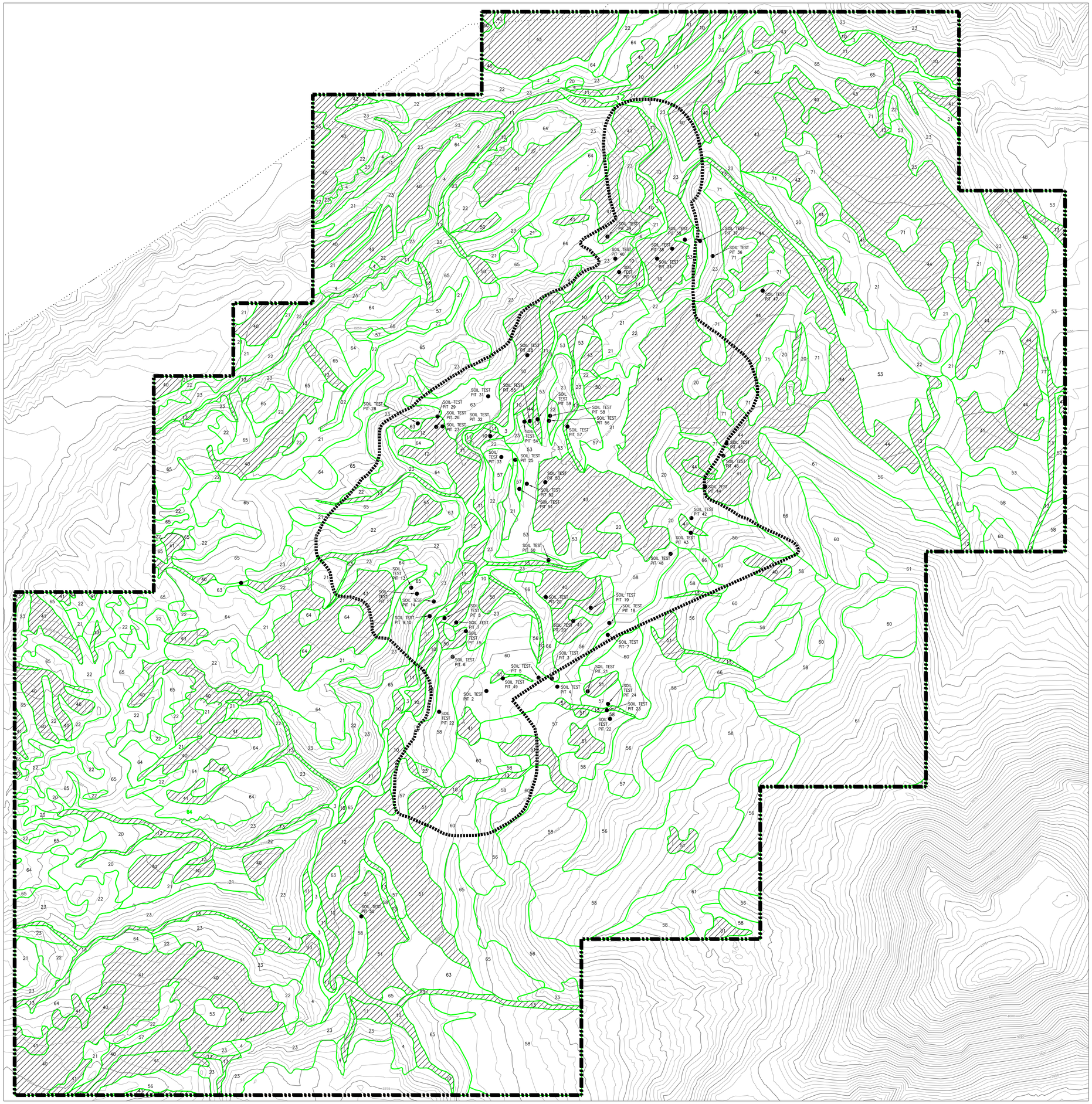
SUMMARY OF SOIL PITS EXCAVATED IN THE JUMBO DOME MINE AREA

Site #	Lat. N	Long. W	Subgroup	Great Group, family	% slope	Aspect °	landform	parent material	plant community	Map Unit	elev. ft	limiting layer	Hydric
1	63°59.096	148°44.943	Aquic	Dystrocryept, loamy-skeletal, mixed, frigid	30	219	footslope	colluvium	mixed forest	58	2189	stones	
2	63°59.148'	148°44.660'	Lithic	Gelumbrept, sandy, mixed, subgelic	4	264	terrace	alluvium	white spruce	60	2307	Coal 80cm	
3	63°59.176'	148°44.279'	Typic	Dystrocryept, loamy-skeletal, mixed, frigid	38	214	shoulder	colluvium	white spruce	66	2335	stones	
4	63°59.156'	148°44.239'	Lithic	Dystrocryept, loamy-skeletal, mixed, frigid	15	270	saddle	colluvium	white spruce	60	2396	boulders	
5	63°59.180'	148°44.349'	Aquic	Humicryept, coarse-loamy, mixed, frigid	8	27	toeslope	stone circle	black spruce	60	2302	boulders	
6	63°59.239'	148°44.856'	Aquic	Humicryept, coarse-loamy, mixed, frigid	31	311	backslope	loess/outwash	black spruce	58	2155	90 cm grv.	
7	63°59.328'	148°44.831'	Typic	Cryaquent, sandy or sandy-skeletal, mixed, frigid	0	na	Floodplain	alluvium	willow	11	2120	wetness	Y
8	63°59.340'	148°44.900'	Typic	Cryaquent, sandy or sandy-skeletal, mixed, frigid	0	na	floodplain	alluvium	mixed forest	11	2060	cobblestone	Y
9	63°59.346'	148°44.987'	Typic	Cryaquent, sandy or sandy-skeletal, mixed, frigid	0	na	terrace	alluvium	alder	11	2078	cobblestone	Y
10	63°59.346'	148°44.988'	Typic	Cryaquent, sandy, mixed, frigid			toeslope	coluvium	alder	11	2081	wetness	Y
11	63°59.405'	148°45.061'	Lithic	Dystrocryept, coarse-loamy, mixed, frigid	21		toeslope	colluvium	mixed forest	65	2181	37cm bedrock	
12	63°59.442'	148°46.103'	Typic	Dystrocryept, coarse-loamy over sandy, mixed, frigid	3	63	summit	loess/outwash	mixed forest	64	2242	17" to sand	
13	63°59.421'	148°45.094'	Typic	Dystrocryept, coarse-loamy over sandy, mixed, frigid	43	110	backslope	loess/sand	black spruce	65	2214	20" to sand	
14	63°59.384'	148°44.962'	Typic	Cryopsamment, sandy, mixed, frigid	63	180	backslope	sand	mixed forest	23	2134	sand	
15	63°59.305'	148°44.775'	Typic	Gelaquept, coarse-loamy, mixed, frigid	18	304	terrace	colluvium	black spruce	50	2109	wetness	Y
16	63°59.390'	148°44.297'	Ruptic	Historthel, coarse-loamy, mixed, frigid	0		terrace	aluvium	tundra	40	2148	permafrost	Y
17	63°59.288'	148°43.933'	Typic	Dystrocryept, coarse-loamy over sandy or sandy-skeletal, mixed, frigid	18	304	shoulder	colluvium	black spruce	58	2429	stones	
18	63°59.319'	148°43.923'	Lithic	Humicryod, coarse-silty, mixed, frigid	34		backslope	colluvium	black spruce	56	2425	boulders	
19	63°59.359'	148°44.030'	Typic	Historthel, coarse-loamy, mixed, subgelic	25	294	backslope		tundra	41	2293	permafrost	Y
20	63°59.326'	148°44.137'	Typic	Historthel, coarse-loamy, mixed, subgelic	19	304				41	2284	permafrost	Y
21	63°59.142'	148°44.059'	Histic	Cryaquept, coarse-loamy, mixed, frigid	8	265	basin	org/alluvium	meadow	51	2417	wetness	Y
22	63°59.069'	148°43.930'	Typic	Humicryept, coarse-loamy, mixed, frigid	24	314	backslope	colluvium	shrubland	58	2476	90cm R	
23	63°59.088'	148°43.947'	Typic	Gelaquent, coarse-loamy, mixed, frigid	8	243	basin	colluvium	willow	13	2466	wetness	Y
24	63°59.108'	148°43.940'	Aquic	Humicryept, coarse-loamy, mixed, frigid	9	261		colluvium	mixed forest	57	2476		
25	63°59.749'	148°44.462'	Typic	Cryorthent, sandy, mixed, frigid	12	270	backslope	glaciofluvial	mixed forest	21	2124		
26	63°59.839'	148°44.927'	Typic	Cryaquent, coarse-loamy, mixed, frigid	5	126	basin	toeslope	meadow	12	2040	wetness	Y
27	63°59.840'	148°44.889'	Typic	Cryaquent, sandy, mixed, frigid	4	166	fan	alluvium	mixed forest	12	2043		Y
28	63°59.849'	148°45.036'	Aquic	Gelifluvent, coarse-loamy, mixed, subgelic	8	138	fan	alluvium	bog	10	2074		
29	63°59.866'	148°44.918'	Spodic	Dystrocryept, sandy, mixed, frigid	30	144	knob	colluvium	white sspruce	23	2237		
30	64°00.021'	148°44.378'	Typic	Gelaquent, coarse-silty, mixed, subgelic	27	147	fan	alluvium	mixed forest	10	2010		
31	63°59.916'	148°44.615'	Fluvaquen	Dystrocryept, sandy, mixed, frigid	8	145	fan	alluvium	black spruce	63	2043		
32	63°59.812'	148°44.607'	Fluvaquen	Gelaquept, coarse loamy over sandy or sandy-skeletal, mixed, subgelic	0	n/a	fan	alluvium	black spruce	10	2012	65cm gr.	Y
33	63°59.757'	148°44.544'	Aquic	Dystrogelept, coarse-loamy over sandy or sandy-skeletal, mixed, subgelic	1		terrace	alluvium	mixed forest	53	2092	90cm, gr	
34	64°00.266'	148°43.596'	Typic	Gelaquept, coarse-loamy over sandy or sandy-skeletal, mixed, subgelic	0	n/a	floodplain	alluvium	shrubland	10	1974		Y
35	64°00.291'	148°43.505'	Typic	Gelaquent, coarse-loamy over sandy or sandy-skeletal, mixed, subgelic	0	n/a	drainage	alluvium	shrubland	10	1958	surface water	Y
36	64°00.270'	148°43.266'	Typic	Cryorthent, sandy-skeletal, mixed, frigid	55	331	backslope	outwash	white spruce	23	2056	10 cm sand	
37	64°00.310'	148°43.339'	Typic	Cryorthent, sandy-skeletal, mixed, frigid	31	190	toeslope	colluvium	black spruce	22	2055		
38	64°00.314'	148°43.429'	Aquic	Cryofluvent, sandy, mixed, frigid	6	170	toeslope		open forest	63	1984		
39	64°00.326'	148°43.888'	Typic	Historthel, sandy, mixed, frigid	18	50	saddle			41	2092		Y
40	64°00.268'	148°43.844	Typic	Cryorthent, sandy, mixed, frigid	34	137		colluvium	white spruce	23	2065	sand	
41	64°00.233'	148°43.823'	Histic	Gelaquept, coarse-loamy, mixed, subgelic	1	SE	terrace	alluvium	tundra	10	1997		Y
42	63°59.588'	148°43.423'	Typic	Gelorthent, coarse-loamy, mixed, frigid	28	197	backslope	colluvium		20	2375		
43	63°59.553'	148°43.438'	Typic	Historthel, coarse-loamy, mixed, subgelic	17	192	backslope	colluvium	tundra	41	2370	permafrost	Y

44	63°59.669'	148°43.337'	Typic	Historthel, coarse-loamy, mixed, subgelic	10	223	saddle	alluvium	tundra	41	2368	permafrost	Y
45	63°59.781'	148°43.206'	Typic	Gelaquepts, coarse loamy over sandy or sandy-skeletal, mixed, subgelic	25	161	toeslope	colluvium	tundra	44	2458	cobblestone	
46	63°59.749'	148°43.226'	Entic	Haplocryod, sandy, mixed, frigid	12	237	summit	outwash	white spruce	71	2398		
47	64°00.177'	148°42.973'	Terric	Cryosaprist, euic, frigid	1	194	terrace	alluvium	tundra	44	2260		Y
48	63°59.496'	148°43.551'	Lithic	Dystrogelept, loamy-skeletal, mixed, subgelic	32	176	backslope	colluvium	white spruce	54	2343	Stone circle	
49	63°59.180'	148°44.561'	Histic	Gelaquept, sandy, mixed, subgelic	6	328		alluvium	tundra	51	2310	wetness	Y
50	63°58.567'	148°45.428'	Histic	Cryaquept, loamy-skeletal, mixed, frigid		147	terrace		tundra	51	2204	wetness	Y
51	63°59.673'	148°44.441'	Aquic	Humicryept, coarse-loamy, mixed, frigid	3	150	alluvial fan	alluvium	grass	57	2124		
52	63°59.686'	148°44.396'	Humic	Dystrogelept, coarse-loamy over sandy or sandy-skeletal, mixed, subgelic	6	201	terrace brk	alluvium	white spruce	53	2132	gr 63cm	
53	63°59.689'	148°44.286'	Terric	Cryohemist, euic, frigid	0	n/a	terrace	organics	tussock	43	2173	water table	Y
54	63°59.848'	148°44.403'	Aquic	Gelifluvent, sandy, mixed, frigid	16	350	knob slopesand		open forest	53	2068		
55	63°59.849'	148°44.371'	Terric	Cryosaprist, euic, frigid	12	102	river channel	Alluvium	willow	44	2050	organics	Y
56	63°59.849'	148°44.257'	Entic	Haplocryod, sandy-skeletal, mixed, frigid	37	154	terrace break outwash	colluvium	black spruce	22	2088	sand	
57	63°59.833'	148°44.148'	Aquic	Dystrocryept, coarse-loamy over sandy or sandy-skeletal, mixed, frigid	10	336	terrace	colluvium	mixed forest	57	2122	cobblestone	
58	63°59.862'	148°44.250'	Typic	Gelorthent, sandy-skeletal, mixed, subgelic	33	199	backslope	colluvium	open forest	22	2089		
59	63°59.854'	148°44.312'	Typic	Gelaquent, sandy-skeletal, mixed, subgelic	17	223	toeslope	alluvium	meadow	13	2081	wetness	Y
60	63°59.486'	148°44.276'	Typic	Cryorthent, sandy, mixed, frigid	53	172	backslope	residuum	open forest	23	2137	sand	

EXHIBIT CX-1

SOIL SURVEY MAP



LEGEND

- STUDY AREA BOUNDARY
- PROPOSED IMPACT AREA
- SOIL TEST PIT 35 — SOIL TEST PIT
- HYDRIC SOIL MAP UNITS

SOIL MAP UNITS

3 – RIVER CHANNELS AND SAND/GRAVEL BAR

4 – ESCARPMENT, ROCK OUTCROPS

5 – ROADS AND DISTURBED AREA

10 – TYPIC GELAQUENTS–GELAQUEPTS–GELIFLUVENTS COMPLEX

11 – TYPIC CRYAQUENTS, SANDY, 0–3% SLOPE

12 – TYPIC CRYAQUENTS, 3–8% SLOPE

13 – TYPIC GELAQUENTS

20 – GELORTHENT

21 – TYPIC CRYORTHENTS, SANDY, 8–25% SLOPE

22 – TYPIC CRYORTHENTS, SANDY, 25–45% SLOPE

23 – CRYORTHENTS–CRYOPSAMMENTS COMPLEX

40 – RUPTIC HISTORTHELS

41 – HISTORTHELS–HISTOTURBELS COMPLEX

43 – CRYOHEMISTS

44 – CRYOSAPRISTS

50 – TYPIC GELAQUEPTS

51 – HISTIC CRYAQUEPTS–TYPIC CRYAQUEPTS COMPLEX

53 – TYPIC DYSTROGELEPTS

56 – LITHIC HUMICRYEPTS–DYSTROGELEPTS COMPLEX

57– AQUIC HUMICRYEPTS–DYSTROGELEPTS COMPLEX

58 – HUMICRYEPTS–DYSTROGELEPTS

60 – LITHIC DYSTROCRYEPTS

61 – LITHIC–PARALITHIC DYSTROCRYEPTS

63 – FLUVAQUENTIC DYSTROCRYEPTS

64 – TYPIC DYSTROCRYEPTS, SANDY

65 – TYPIC DYSTROCRYEPTS, LOAMY

66 – TYPIC DYSTROGELEPTS

71 – ENTIC HAPLOCRYODS, 3–18% SLOPE

72 – ENTIC HAPLOCRYODS, 18–45% SLOPE

0 250' 500' 1000' NORTH

SUBJECT REVISIONS

REV.	DATE:	BY:	DESCRIPTION

DESIGN BY: LJT

DRAWN BY: LJT

CHECK BY: PJO

DWG FILE: ENVR–SO–SITE.DWG

DATE DRAWN: JUNE 2008

JUMBO DOME MINE

USIBELLI COAL MINE INC. UCM

PERMIT NUMBER

SOIL SURVEY MAP

JUMBO DOME MINE

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743
(907) 683–2226

DRAW. No. SITE

SHEET No. 1 OF 1

REV.

CHAPTER XI

WETLANDS

TABLE OF CONTENTS

Page

1.0 INTRODUCTION……..……...CXI-1

2.0 REGULATORY REQUIREMENTS…….…….…..CXI-1

3.0 METHODS……...…CXI-2

3.1 2007 Preliminary Data Gathering and Analysis...……...…….CXI-2

3.2 2007 Field Investigation……..…….CXI-3

3.3 2007 Post-Field Data Review……...CXI-4

3.4 2010 GIS-Based Mapping……...……..CXI-4

3.5 2010 Fieldwork……..…...CXI-5

3.6 2010 Final Mapping……..CXI-5

4.0 PROJECT AREA…….……..…..CXI-6

4.1 Vegetation……...…..CXI-6

4.2 Soils……..…CXI-8

4.3 Hydrology……...…..CXI-8

5.0 WETLAND CLASSES OBSERVED IN PROJECT AREA…….……..CXI-9

5.1 Emergent Persistend (PEM1) Wetlands…….……....CXI-10

5.2 Shrub-Scrub Deciduous/Persistent Emergent (PSS1/EM1) Wetlands……...CXI-10

5.3 Scrub-Shrub Deciduous (PSS1) Wetlands……...…...CXI-10

5.4 Scrub-Shrub Needle-Leaved Evergreen (PSS4) Wetlands……...…..CXI-11

5.5 Uplands……...…CXI-11

5.6 Non-Navigable Tributary Waters of the United States……...…CXI-12

6.0 PRELIMINARY JURISDICTIONAL DETERMINATION……..……CXI-12

7.0 RESPONSIBLE PARTIES……..CXI-12

LIST OF TABLES

CXI-1 Wetland Indicator Status of Most Common Identified Vascular Species……...CXI-7
CXI-2 Soil Series Described in the Project Area……....CXI-8
CXI-3 Wetland and Upland Mapping Summary….…….……..CXI-9

LIST OF PLATES

CXI-1 2010 Wetland Mapping…….CXI-15

LIST OF APPENDICES

CXI-1 Data Summary (WHPacific 2007)……CXI-13
CXI-2 Data Summary (HDR 2010)…….….CXI-14

1.0 INTRODUCTION

The Jumbo Dome Mine baseline study is 4,798 acres in area. The Jumbo Dome lease area is 3237.7 acres. Within that area, is a smaller area of 1,101.2 acres considered the "mining limits", referred to in this report as the "proposed impact area". There is an overlap of impact area in the southwest portion of the with the ASMCRA permit for Jumbo Dome Road Corridor Permit No. S-0605. (Please note that there is an overlap in impact area between the "mine impact area" and the "road corridor impact area. This overlap is 10.4 acres. For the purpose of this chapter the overlap area has been removed from the impact area calculations so there is no double counting".) This overlap of wetland areas have been deducted from the mine wetland impact. The impact area is the area of the proposed pit, and associated staging areas and settling pond areas. Development of the area will be conducted in five separate phases, each approximately five years in length. Approximately 160.4 acres (14.6 percent) of the 1,101.2 acre impact area have been identified as wetlands or other waters. The remaining 940.8 acres (85.4%) of the impact area have been identified as uplands. Wetland classes found within the proposed impact area, and approximate total acreages of each Cowardin classification are listed below in Table XI-3.

2.0 REGULATORY REQUIREMENTS

Section 404 of the Clean Water Act, United States Code Title 33, Section 1344 (33 USC 1344), authorizes the Secretary of the Army, acting through the Chief of Engineers, to issue permits for the discharge of dredged or fill material into the waters of the United States, including wetlands. Wetlands are defined by the US Army Corps of Engineers (USACE) as: "areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances, do support, a prevalence of vegetation typically adapted for life in saturated soil conditions" (USACE, 1987).

A consideration for siting and selection of new mining facilities is the presence of wetlands and other regulated waters. This report describes locations within the five proposed development phases (Plate CXI-1) that are preliminarily determined to be wetlands. Wetlands are subject to the jurisdiction of the USACE under authority of Section 404 of the Clean Water Act. By federal law (Clean Water Act) and associated policy, it is necessary to avoid project impacts to wetlands wherever practicable, minimize impact where impact is not avoidable, and in some cases compensate for the impact.

3.0 METHODS

3.1 2007 Preliminary Data Gathering and Analysis

In 2007, WHPacfic, Inc. used the following data sources, identified in Part IV, Section B of the USACE 1987 Manual, to determine the presence of wetlands in the project area. Excerpts from the data sources below are located in Appendix CXI-1. Data sources from the USACE 1987 Manual not listed below either do not exist or were not identified during background research.

- US Geological Survey (USGS Quadrangle Map, Healy D-4 (1: 63,360): A review of the USGS Quadrangle map for the project area shows two streams, Marguerite Creek and Emma Creek, and two of their primary tributaries. No other wetlands or other waters are indicated.
- US Fish and Wildlife Service (USFWS) National Wetland Inventory (NWI) Map, Healy D-4: A review of the NWI data for the project area shows the two streams and their tributaries.
- Soil Surveys: No soil survey data were available. A detailed on-site soil survey was performed during summer of 2007, after this site investigation (see Soil Resources of Jumbo Dome Area, May 1, 2008)
- Remote Sensing: High resolution color aerial photographs. A review of recent aerial photography confirmed the presence of the streams and indicated the likely presence of areas of shrub-scrub type bogs and linear shrub-scrub wetlands along the stream corridors. The field investigation confirmed the presence of these wetlands.
- Topographic Mapping: Topographic mapping developed from aerial photography showed areas of relatively level topography, which typically support bog wetlands, and north facing slopes, which typically support forested wetlands dominated by black spruce. The field investigation confirmed that areas of this wetland type were present.
- State of Alaska Department of Fish and Game Preliminary Best Interest Finding, Healy Basin, Chapter 3, Habitat, Fish and Wildlife: This study documents plant communities and wetlands within the Healy Basin license area, which includes the project area. The study documents the presence of the following habitat types which are typically wetlands: open black spruce forest, ericaceous shrub tundra, and bluejoint meadow. Other identified habitat types such as alder shrubland, paper birch forest, and aspen forest, may also be wetlands. Specifically, the study noted that a small portion of the lease (not in the project area) had already been delineated. The most common type of wetland delineated was a scrub-shrub lowland typically found in depressions on hilltops, on gentle slopes, in valley bottoms, and flatlands. The field investigation confirmed that this wetland type was widespread in the project area in these locations.

3.2 2007 Field Investigation

WHPacific, Inc. conducted a field investigation between June 5 and July 15 2007. A 6-person team mobilized into the project area and set up a base camp. The team consisted of Steve Becker, CEP, Sr. Environmental Professional and Project Manager, Travis Hines, Megan Boldenow, Biologist, Sarah Runck, Biologist, Phil Quarterman, PWS, Sr. Wetland Scientist, and Lamont Turcotte, Wetland Biologist.

The first two days were spent familiarizing the team with the plant communities, and soil and hydrologic conditions, and using the Alaska Regional Supplement data sheets. After that, the latter four members completed the field investigation, working as two 2-person teams.

The site aerial photograph was divided into a grid and printed in separate sections with an index map, for ease of use in the field. The teams also carried a copy of the site topographic map with 5 foot contour intervals. Each team carried a Garmin hand-held GPS unit, and standard wetland delineation tools: a shovel, Munsell soil-color chart, tape measure, colored tape, marking pen, camera, alpha-alpha dipyridyl reagent to test for reducing conditions, and data sheets.

Access to the project area was on foot, except where rough trails allowed the use of 4-wheeler vehicles. The teams navigated partly by following the topographic map and aerial photographs, and partly by GPS way-points, to identify and locate discrete plant communities or habitat types using color and texture signatures on the aerial photos.

The teams established a total of 249 sample plots in representative locations in each habitat type within the 4,798 acre project area, covering each square of the project area grid. In some places, photographs only were taken to document habitat types that had plots in other locations.

The field investigation followed the methods outlined in Part IV, Section D, Subsection 2 of the USACE 1987 Manual. Vegetation, soils and hydrology were assessed at each sample plot in accordance with the protocols in the Alaska Regional Supplement. Plant species within 50 feet radius of the plot were recorded, and absolute percent cover was measured. The teams used Viereck and Little's (1972) Alaska Trees and Shrubs and Collet's (2004) Willows of Interior Alaska to assist with the field identification of plant species. When a dominant plant species could not be identified in the field, a sample was collected for later identification in the field office, using the taxonomic keys in Hulten's (1968) Flora of Alaska and Neighboring Territories: A Manual of the Vascular Plants. The indicator status of each dominant plant species was determined using the National List of Plant Species That Occur in Wetlands: Alaska (Region A) (Reed, 1988), and the presence of hydrophytic vegetation was determined using the 50/20 dominance test and the prevalence index.

At each sampling point a soil pit was dug to a depth of 24 inches below the soil surface, or to an impervious layer (e.g. a frozen layer or rock), and the soil profile was described in accordance with the Field Book for Describing and Sampling Soils (Schoeneberger et al., 2002). Field indicators of hydric soil were noted in accordance with Field Indicators of Hydric Soils in Alaska

(Moore, 2005). Indicators of wetland hydrology were also noted. Data sheets and associated photographs are available upon request.

3.3 2007 Post-Field Data Review

At the end of the field investigation, WHPacific staff reviewed data sheets for completeness and accuracy, identified the collected plant samples, reviewed photographs and preliminarily mapped wetland boundaries. Edited data sheets were transcribed to electronic format. A plot correlation table showing all the sample plots, and associated soil map units, a wetland determination, and Cowardin class is included in Appendix CXI-1.

3.4 2010 GIS-Based Mapping

WHPacific collected field data in 2007; however wetland mapping suitable for Section 404 permitting was not produced. In May 2010, HDR Alaska, Inc. (HDR) was contracted by UCM to prepare GIS based wetland mapping for the proposed impact area. HDR reviewed the field data collected by WHPacific in 2007, aerial photographs, existing mapping and documentation, and field photographs, to determine the presence or absence of wetlands and non-wetland "waters of the U.S." within the Jumbo Dome Mine Area. Color aerial imagery was analyzed in a GIS database to identify probable wetlands occurring within the lease area. Wetland determination data forms and ground photographs collected by WHPacific were used to identify apparent wetland areas and wherever possible, those photo locations were located on the aerial photography. Photo signatures (color, texture) observed on aerial photography were matched with the on-the-ground photographs, and were then extrapolated to similar locations throughout the lease area and wetland/upland boundaries were digitized into the GIS database. Delineating wetlands from aerial photography includes using the following methods:

Vegetation clues: On aerial photography and site photography, scientists look for saturation-adapted vegetation communities, low plant height, and presence of hydrophytic plant species.

Evidence of soil saturation: Visible evidence of wetland hydrology is sought, including surface water and darker areas of photos indicating surface saturation. A site's proximity to streams, open water habitat, and marshes can be indicative of shallow subsurface water.

Topography: Evidence of topographic high points and sloped surfaces that would allow soils to drain is used to support classifying those areas as upland. Topographic depressions, toes of slopes, and flat topography serve as indicators of potentially poor soil drainage.

GIS polygons were attributed with NWI mapping codes based on the U.S. Fish and Wildlife Service Classification of Wetlands and Waterbodies (Cowardin et al., 1979).

3.5 2010 Fieldwork

During September 2010, HDR wetland scientists Jeff Schively (Professional Wetland Scientist #1813) and Doug Jewell conducted a reconnaissance-level site visit to the Jumbo Dome area to verify the presence or absence of wetlands and "other Waters of the U.S." The primary activities of the trip were to field verify the office-based preliminary delineation and adjust pre-mapped boundaries to actual on-the-ground conditions. Soil conditions, hydrology, and plant communities were studied using methods described in the 1987 USACE Wetland Delineation Manual and in the Alaska Regional Supplement to the 1987 Wetland Delineation Manual (USACE 1987, 2007). Prior to fieldwork, pre-determined waypoints representative of wetland or upland sites (based on pre-mapping) as well as locations of questionable areas were loaded into a handheld GPS unit.

Once in the field, wetland scientists used the predetermined waypoints in the GPS unit to navigate to areas needing investigation. Upon arrival at a waypoint scientists took detailed notes related to vegetation, hydrology, and soils. Where wetland sites were similar to areas already visited, scientists recorded mapping classifications and took photographs. Geographic coordinates were logged at all data collection locations. In addition to the pre-determined waypoints, many other representative locations based on vegetation community and landform position that were not pre-determined were also investigated. A summary of data collected by HDR is included in Appendix CXI-2.

3.6 2010 Final Mapping

Upon returning from the field, HDR amended the office-delineated wetland boundaries. The wetland types were classified based on a review of WHPacific data, field notes, data forms, and site photographs. GPS locations of field-visited sites were overlain on the aerial photography, and data forms and photographs completed at each site were reviewed to identify and classify the different wetland types present within the project area.

4.0 PROJECT AREA

According to *Land Resource Regions and Major Land Resource Areas of Alaska* (Kautz and Taber, 2004), the project area is within Major Land Resource Area (MLRA) 228, Interior Alaska Mountains, which includes this broad expanse of low glaciated hills associated with the Alaska Range. The climate in this MLRA is characterized by brief, cool summers and long, cold winters. The predominant vegetation in the subalpine zone in which the project area lies is low and medium scrub dominated by shrub birch and ericaceous shrubs that grade into white spruce woodlands. Major mammal species include brown bear, black bear, Dall sheep, caribou, moose, wolf, coyote, fox and snowshoe hare. Remote wildland recreation is the principal land use, though Kautz and Taber note mining (including the Usibelli Coal Mine) as a historic use in the Healy area (ibid. p. 30). The Interior Alaska Lowlands (MLRA 229) extend to the north of the project area.

The vegetation, hydrology, and soil conditions described below are based on the 2007 fieldwork conducted by WHPacific. Similar conditions were observed by HDR in 2010.

4.1 Vegetation

Productive well-drained upland soils, predominantly on south-facing slopes, are capable of supporting white spruce forests and mixed white spruce-paper birch-quaking aspen-Sitka alder forests.

High floodplains and low stream terraces support mixed white spruce-hardwood forests. Low floodplains support mixed willow, alder and balsam poplar shrub communities.

Cold, poorly-drained soils, predominantly on north, north-east or northwest facing slopes, generally support less productive forests, consisting of stunted black spruce and white spruce, or shrub communities consisting of bog birch and Labrador tea with other ericaceous species.

Flats and shallow depressions in broad drainages typically support herbaceous communities dominated by Bigelow's sedge and other sedges, cottongrass species, and bluejoint.

Open, gravelly south-facing slopes and ridge tops typically support a sparse tundra community with herbaceous species and stunted trees and shrubs.

A list of the most common plants observed in the project area during the field investigation and their respective wetland indicator status is provided in Table XI-1.

Table XI-1. Wetland Indicator Status of Most Common Identified Vascular Species

Scientific Name	Common Name	Wetland Indicator Status	Scientific Name	Common Name	Wetland Indicator Status
Achillea millefolium	Common yarrow	FACU	*Lupinus arcticus*	Arctic lupine	NI
Alnus crispa	Green alder	FAC	*Mertensia paniculata*	Tall bluebell	FACU
Alnus sinuata	Sitka alder	FAC	*Oxycoccus microcarpus*	Swamp cranberry	OBL
Andromeda polifolia	Bog rosemary	OBL	*Petasites frigidus*	Coltsfoot	FACW
Arctostaphylos uva-ursi	Kinnickinnick	UPL	*Picea glauca*	White spruce	FACU
Betula glandulosa	Bog birch	FAC	*Picea mariana*	Black spruce	FACW
Betula nana	Bog birch	FAC	*Poa arctica*	Arctic bluegrass	FAC
Betula papyrifera	Paper birch	FACU	*Polygonum alaskanum*	Wild rhubarb	FAC
Boschniakia rossica	Poque	FACU	*Populus balsamifera*	Balsam poplar	FACU
Calamagrostis canadensis	Bluejoint reedgrass	FAC	*Populus tremuloides*	Quaking aspen	FACU
Carex spp.	Sedges	FAC-OBL	*Potentilla fruticosa*	Shrubby cinquefoil	FAC
Carex aquatilis	Water sedge	OBL	*Rosa acicularis*	Prickly rose	FACU
Carex bigelowii	Bigelow sedge	FAC	*Rubus chamaemorus*	Cloudberry	FACW
Cornus canadensis	Bunchberry dogwood	FACU	*Salix spp.*	Willows	FAC-FACW
Cornus stolonifera	Red-osier dogwood	FAC	*Salix alaxensis*	Felt-leaf willow	FAC
Empetrum nigrum	Crowberry	FAC	*Salix bebbiana*	Bebb willow	FAC
Epilobium angustifolium	Fireweed	FACU	*Salix hastata*	Halberd willow	FAC
Equisetum arvense	Meadow horsetail	FACU	*Salix planifolia pulchra*	Diamondleaf willow	FACW
Eriophorum angustifolium	Tall cottongrass	OBL	*Salix reticulata*	Net-leaved willow	FAC
Eriophorum vaginatum	Tussock cottongrass	OBL	*Salix scouleriana*	Scouler willow	FAC
Geocaulon lividum	Sandalwood	FACU	*Spiraea beauverdiana*	Beauverd spiraea	FAC
Ledum decumbens	Bog Labrador tea	FACW	*Vaccinium uliginosum*	Bog blueberry	FAC
Ledum groenlandicum	Bog Labrador tea	FACW	*Vaccinium vitis-idaea*	Low-bush cranberry	FAC

Wetland Indicator Status (Reed, 1988)
FAC: Facultative: species equally likely to occur in wetlands and non-wetlands
FACU: Facultative Upland: species usually occurs in non-wetlands
FACW: Facultative Wetland: species usually occurs in wetlands
OBL: species almost always occurs under natural conditions in wetlands
NI: Non indicator or species not listed in the *National List of Plant Species that Occur in Wetlands: Alaska (Region A)*
UPL: Upland: species occur almost always in non-wetlands under natural conditions

4.2 Soils

There are 24 identified soil series and three non-soil map units in the project area. Non-soil map units consist of stream channels and sand/gravel bars (Unit 3), escarpments and rock outcrops (Unit 4), and roads and other disturbed areas (Unit 5). A general description of each soil series is provided below in Table XI-2. These soils generally match what was observed in the field. See Chapter CX Soil Resources.

Table XI-2: Soil Series Described in the Project Area

Soil Series	General Description	Hydric Status (Y/N)
10	Typic Gelaquents-Gelaquepts-Gelifluvents complex, 0-3% slopes. Alluvial fan, river terrace, PIMA, spruce tundra, mostly 0-3%	Y
11	Typic Cryaquents, sandy, 0-3% slope. Floodplain, bottomland	Y
12	Typic Cryaquents, 3-8% alluvial fan, tundra. West of Marguerite Creek	Y
13	Typic Gelaquents, 8-25% slope, high channels	Y
20	Gelorthent, 15-35% slopes, sandy, well-drained. High alluvium/colluvium (E)	N
21	Typic Cryorthents, sandy, 8– 25 % slopes	N
22, 72	Typic Cryorthents – Entic Haplocryods complex, sandy, 25 – 45 % slopes (Suntrana)	N
23	Cryorthents – Cryopsamments complex, sandy, 45-90% slopes	N
40	Ruptic Historthels, 0 – 8 slopes, alluvium, tundra	Y
41	Historthels- Histoturbels complex 8 – 25% slopes. Forest tundra, colluvium, PIMA, (E)	Y
43	Cryohemists, 0-3% slopes	Y
44	Cryosaprists, 0-15% slopes	Y
50	Typic Gelaquepts, 18-30% stony. Tundra, colluvium, concave slope (E)	Y
51	Histic Cryaquepts-Typic Cryaquepts complex, 0-8% slopes open meadow, tussock tundra (E)	Y
53	Typic Dystrogelepts, 3-18% slopes	N
56	Lithic Humicryepts-Dystrogelepts complex, 25-45% slopes, very stony	N
57	Aquic Humicryepts –Dystrogelepts complex 0-15% slopes, stony	N
58	Humicryepts-Dystrogelepts, 15-35% slopes, bouldery (E)	N
60	Lithic Dystrocryepts, 3-25% slopes, fragmental, stone circles (JB)	N
61, 66	Lithic-Paralithic - Typic Dystrocryepts complex, 25-65% slopes, rubbleland (JB)	N
63	Fluvaquentic Dystrocryepts, 3-15% slopes Well-drained alluvial fan	N
64	Typic Dystrocryepts, sandy, 0-20% slopes, (Suntrana)	N
65	Typic Dystrocryepts, loamy, 20-45% slopes, (Suntrana)	N
71	Entic Haplocryods, 3-18% slopes (E)	N

4.3 Hydrology

The project area is drained by Marguerite Creek and its main tributaries, Emma Creek (to the east) and Bonanza Creek (to the north). Emma Creek divides into two roughly equal branches. Marguerite Creek has several smaller perennial and intermittent tributaries within the project area. The floodplains of the main streams are frequently inundated during spring break up, and portions remained covered with snow and ice into mid-summer. The lowlands associated with the secondary drainages are typically saturated year-round and provide base flow to the tributaries.

In addition, substantial higher elevation plateaus, gradually sloping areas and steeper north-facing slopes remain saturated during the summer. These areas have underlying frozen soils. The active layer is typically only a few inches deep, and these areas may remain permanently frozen as little as a foot below the surface. Water gradually drains from these areas toward the lower drainages through a variety of swales and ravines.

During the HDR field visit, numerous groundwater seeps were observed within the proposed impact area. The seeps appear to be the primary source of water for most of the sites where wetland hydrology was observed.

5.0 WETLAND CLASSES OBSERVED IN PROJECT AREA

Wetlands were identified where WHPacific field data indicated wetlands, and at additional areas where HDR scientists observed indicators of hydrophytic vegetation, wetland hydrology, and hydric soils. Areas that appear on aerial photographs to be similar to wetlands identified in the field were also identified as wetland. Approximately 160.4 acres (14.6 percent) of the 1,101.2-acre impact area have been identified as wetlands or other waters. The remaining 940.8 acres (85.4%) of the impact area have been identified as uplands. Wetland classes found within the proposed impact area, and approximate total acreages of each Cowardin classification are listed below in Table XI-3.

Table XI-3: Wetland and Upland Mapping Summary

		Impacts by Mine Phase (acres)				
Mapping Code	**Description**	**Year 1-5**	**Year 6-10**	**Year 11-15**	**Year 16-20**	**Year 21-26**
PEM1A	Temporarily Flooded Emergent Wetland	0.5	-	-	-	-
PEM1C	Semi-Permanently Flooded Emergent Wetland	0.8	2.9	-	-	-
PEM1F	Semi-Permanently Flooded Emergent Wetland	-	-	-	1.3	-
PSS1/EM1B	Saturated Broadleaf Scrub-Shrub/Emergent Wetland	18.6	10.6	11.8	41.4	38.7
PSS1/EM1C	Seasonally Flooded Broadleaf Scrub-Shrub/Emergent Wetland	9.8	5.0	-	-	-
PSS1A	Temporarily Flooded Broadleaf Scrub-Shrub Wetland	0.3	-	-	-	-
PSS1B	Saturated Broadleaf Scrub-Shrub Wetland	0.3	4.3	-	-	-
PSS1C	Seasonally Flooded Broadleaf Scrub-Shrub Wetland	1.7	-	-	-	-
PSS1/4B	Saturated Broadleaf/Needleleaf Scrub-Shrub Wetland	-	1.9	-	-	-
PSS3/4B	Saturated Broadleaf/Needleleaf Evergreen Scrub-Shrub Wetland	1.6	-	-	-	-
PSS4/EM1B	Saturated Needleleaf Scrub-Shrub/Emergent Wetland	6.4	0.3	2.2	-	-
	Total Wetlands and other Waters (acres)	**39.9**	**25.0**	**14.1**	**42.7**	**38.7**
U	Upland	469.5	94.4	145.8	78.0	153.1
	Total Area (acres)	**509.4**	**119.4**	**159.9**	**120.7**	**191.8**

5.1 Emergent Persistent (PEM1) Wetlands

Wetlands dominated by persistent emergent vegetation are predominantly found on flats and in shallow depressions in drainages (Inset 2). The communities are generally dominated either by Bigelow's sedge, water sedge and other sedges, and cottongrass, or by bluejoint reedgrass. The soils in these communities were typically histosols. These communities have saturated soil conditions throughout the growing season, with pockets of seasonal inundation.

Pure sedge-cottongrass wet meadow is a relatively uncommon vegetation type on flats or areas with a slight north slope. This wetland type was dominated by tall cottongrass or tussock cottongrass with lesser cover of Bigelow's sedge (see Plots C2-17 and B4-8). Small amounts of bog birch, bog blueberry and Labrador tea, and scattered dwarfed black spruce were found. Usually these low shrubs are found in amounts sufficient to place the communities in the shrub-scrub class. Soils are generally organic and poorly drained.

5.2 Shrub-Scrub Deciduous/Persistent Emergent (PSS1/EM1) Wetlands

This community is very widespread in the project area. It is a variant of cottongrass or sedge meadows with a larger component of shrub-scrub, and is similarly found on flats and areas with gentle north-facing slopes (Inset 3). This community is dominated by bog birch, Labrador tea, bog blueberry, and willows in the shrub layer, and Bigelow's sedge and water sedge in the herbaceous layer (see Plots C2-16, C2-24 and C3-6 for examples). The soils in this community are typically histosols or have a histic epipedon. This community has saturated soil conditions throughout the growing season.

5.3 Scrub-Shrub Deciduous (PSS1) Wetlands

Wetlands dominated by deciduous scrub-shrub vegetation are found on flats and gradual slopes,

Inset 1. Typical Emergent Persistent (PEM1) Wetland

Inset 2. Typical Scrub-scrub/Emergent (PSS1/EM1) Wetland

Inset 3. Typical Scrub-shrub Deciduous (PSS1) Wetland

Inset 4. Typical Scrub-shrub Needle-leaved (PSS4) Wetland

typically with north, north-west or north-east facing aspect. This community is also found on floodplains (Inset 4). Soils on flats and gradual slopes typically have a histic epipedon. Soils on floodplains are sandy or gravelly loam. These communities have saturated soil conditions for much of the growing season.

These communities have dense closed shrub canopies with sparse herbaceous layer cover. Dominant species on flats and gradual slopes are bog birch, both low and tall growth-forms, bog blueberry, and Labrador tea (see Plot B4-32). Soils are typically highly organic over a sandy or gravelly loam. Dominant species on floodplains are willow, alder and bog blueberry. Soils are a sandy loam (see Plot B4-14).

5.4 Scrub-Shrub Needle-Leaved Evergreen (PSS4) Wetlands

Wetlands dominated by evergreen scrub-shrub are found predominantly on north-facing slopes varying from gently to steeply-sloped (Inset 5). These wetlands are dominated by black spruce in the shrub layer with lesser amounts of Labrador tea, bog birch, bog blueberry, and lesser amounts of crowberry, cloudberry, and low-bush cranberry in the shrub layer (see Plots B1-2, B3-8, and B4-4). The herbaceous layer is relatively sparse. The typical dominant is Bigelow's sedge. Soils are typically organic in the surface layer, and sandy or gravelly loam beneath. These wetlands typically remain saturated throughout the growing season, with a frozen layer within less than 12 inches of the surface.

5.5 Uplands

Uplands in the project area consist primarily of the following communities: white spruce forest, mixed white spruce-hardwood forest, hardwood forest, and dry tundra.

White spruce forest is found extensively on predominantly level to sloping sites with south, southwest, or southeast aspect. It is associated with bog birch in the shrub layer. A variety of forbs and grasses are dominant in the herbaceous layer. Soils are typically a gravelly or sandy loam. Saturation is temporary after melting of the frost layer.

Mixed white spruce-hardwood forest is a variant of this community, which primarily occupies steeper south facing slopes. Hardwood forest occupies the steepest, south facing slopes. Dominant hardwood species in these two communities are paper birch, quaking aspen, and balsam poplar. The shrub layer is dominated by bog birch, primarily the tall growth form, and green alder. A variety of forbs and grasses are dominant in the herbaceous layer. Soils are a deep, well-drained gravelly or sandy loam. Saturation and a frost layer close to the surface are typically absent, as these soil warm up quickly in the growing season.

Dry tundra communities occupy ridge-tops and adjacent steep slopes. Plant cover is typically low, and consists of stunted trees and shrubs such as balsam poplar, quaking aspen, green alder, white spruce, and bog birch, together with characteristic species such as kinnickinnick.

5.6 Non-Navigable Tributary Waters of the United States

Marguerite Creek borders the western side of the proposed impact area. Several small, ephemeral tributaries of Marguerite Creek occur within the mapped area. Marguerite Creek is a headwater tributary of California Creek, which flows north to become the Totatlanika River. The latter stream has its confluence with the Tanana River, which is designated as a "traditional navigable water" (ibid.), several miles upstream from the town of Nenana.

6.0 PRELIMINARY JURISDICTIONAL DETERMINATION

This wetland delineation was prepared in compliance with the U.S. Army Corps of Engineers Wetlands Delineation Manual (USACE 1987) and the Regional Supplement to the Corps of Engineers Wetland Delineation Manual, Alaska Region (USACE 2007). The area of this determination is located east of Healy within the Denali Borough of the State of Alaska. The delineation area begins at approximately Latitude 63.92 degrees North, Longitude 148.78 degrees West, and ends at approximately Latitude 64.02 degrees North, Longitude 148.70 degrees West (NAD 83), and is 1,101.2 acres in size.

The on-site determination conducted by WHPacific during June 5-July 15, 2007, and by HDR during September 17-20, 2010 indicates that of the total of 1,101.2 acres in the proposed impact area, there are approximately 160.4 acres of potentially jurisdictional wetlands.

Based on the most recent Corps of Engineers guidance on jurisdiction (ibid.), the wetlands are adjacent to or abutting Marguerite Creek, non-navigable tributaries of the Tanana River, a navigable water of the U.S., and are subject to the jurisdiction of the USACE under Section 404 of the Clean Water Act. This assumes there are no "isolated" wetlands, and that "adjacent" rather than "abutting" wetlands have a "significant nexus" to navigable waters. Marguerite Creek, located along the western edge of mapped area, and it's relatively-permanently flowing tributaries would also be subject to the jurisdiction of the USACE under Section 404 of the Clean Water Act.

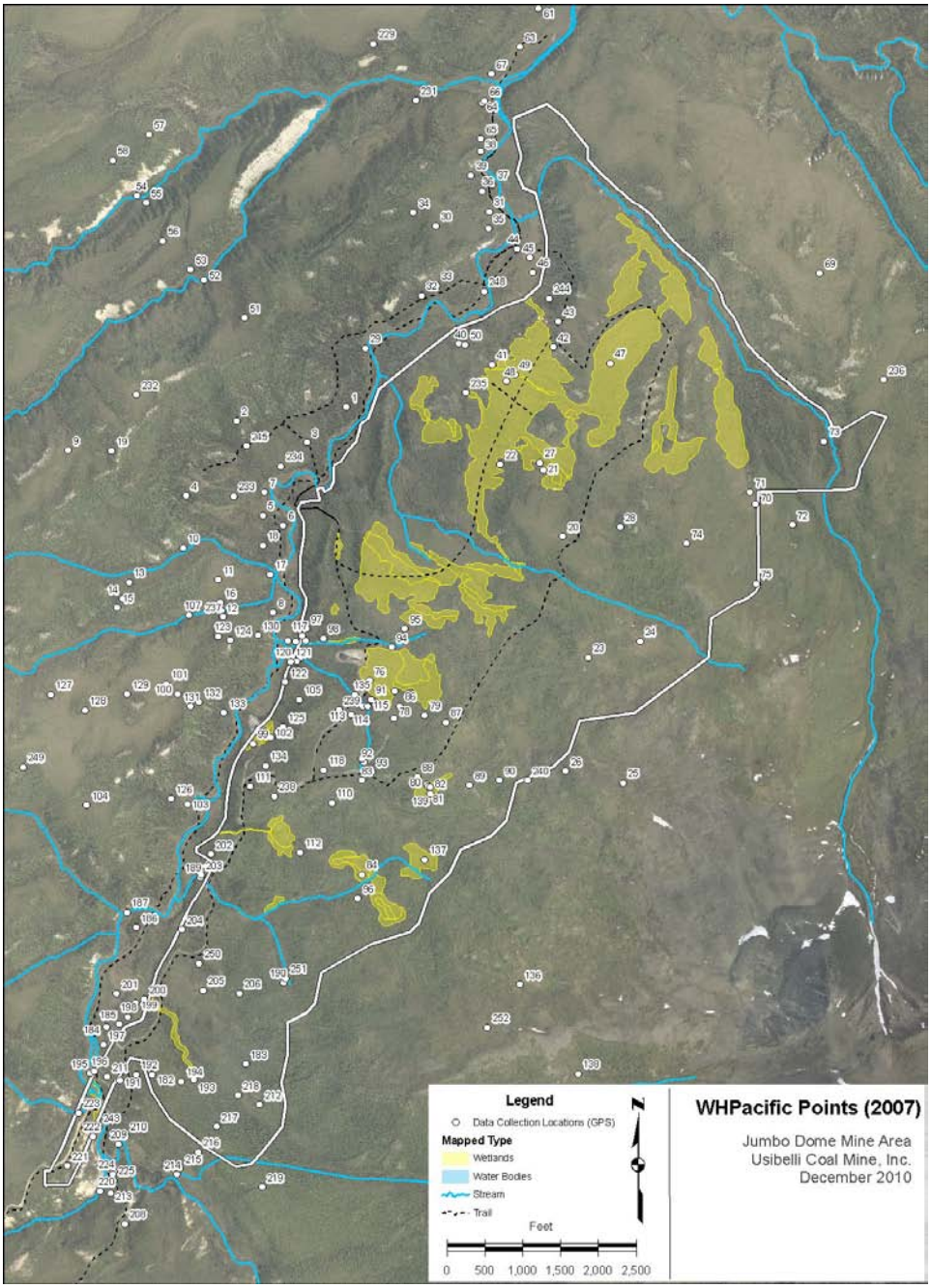
7.0 RESPONISBLE PARTIES

Jeff Shively, Professional Wetland Scientist, for HDR, Alaska.

APPENDIX CXI-1

DATA SUMMARY (WHPacific 2007)

The following data was collected by WHPacific, Inc. in 2007. The inset map below shows the GPS locations of each site visited; a summary table of each point and the raw data and photographs follow.



Point ID	Soil Unit	Wetland	Cowardin	Viereck
A3-1	22	No	NA	Needleleaf woodland
A3-2	65	No	NA	Needleleaf woodland
A3-3	65	No	NA	Needleleaf woodland
A3-4	40	Yes	PSS/PEM	Closed low scrub
A3-5	65	No	NA	Open needleleaf forest
A3-6	13	Yes	PSS/PEM	Needleleaf woodland
A3-7	23	No	NA	Open mixed forest
A3-8	13	Yes	PSS/PEM	Closed tall scrub
A4-1	65	No	NA	Open mixed forest
A4-2	22	No	NA	Closed tall scrub
A4-3	40	Yes	PSS/PEM	Closed low scrub
A4-4	22	No	NA	Closed low scrub
A4-5	65	No	NA	Open needleleaf forest
A4-6	40	Yes	PSS/PEM	Closed low scrub
A4-7	13	Yes	PSS/PEM	Dwarf tree scrub woodland
A4-8	41	No	NA	Needleleaf woodland
A4-9	65	No	NA	Mixed woodland
A4-10	41	Yes	PSS/PEM	Open low scrub
A4-11	65	Yes	PSS/PEM	Needleleaf woodland
A5-1	23	No	NA	Closed broadleaf forest
A5-2	13	Yes	PSS/PEM	Open low scrub
A5-3	65	No	NA	Open broadleaf forest
A5-4	23	No	NA	Closed broadleaf forest
A5-5	40	Yes	PSS/PEM	Closed low scrub
A5-6	21	No	NA	Dwarf tree scrub woodland
A5-7	13	Yes	PSS/PEM	Needleleaf woodland
A5-8	64	No	NA	Needleleaf woodland
A6-1	56	No	NA	Needleleaf woodland
A6-2	56	No	NA	Closed tall scrub
A6-3	41	Yes	PSS/PEM	Closed low scrub
A6-4	40	Yes	PSS/PEM	Closed low scrub
A6-5	40	Yes	PSS/PEM	Open low scrub
A6-6	56	No	NA	Closed low scrub
A6-7	56	No	NA	Needleleaf woodland
A6-8	57	No	NA	Needleleaf woodland
A6-9	22	No	NA	Needleleaf woodland
A6-10	41	Yes	PSS	Needleleaf woodland
A6-11	40	Yes	PSS/PEM	Closed low scrub
A6-12	13	Yes	PSS/PEM	Needleleaf woodland
A6-13	13	Yes	PSS/PEM	Closed low scrub
A6-14	23	No	NA	Open mixed forest
A6-15	21	No	NA	Open needleleaf forest
A6-16	23	No	NA	Open needleleaf forest
A6-17	40	Yes	PSS	Closed low scrub
A6-18	40	Yes	PSS	Closed low scrub
A6-19	23	No	NA	Open needleleaf forest
B1-1	40	Yes	PSS	Needleleaf woodland
B1-2	40	Yes	PFO/PSS	Open needleleaf forest
B1-3	40	No	NA	Open mixed forest
B1-4	64	No	NA	Open needleleaf forest
B2-1	57	No	NA	Open needleleaf forest
B2-2	23	No	NA	Closed tall scrub
B2-3	23	No	NA	Closed needleleaf forest
B2-4	23	No	NA	Needleleaf woodland
B2-5	21	No	NA	Needleleaf woodland
B2-6	11	No	NA	Closed broadleaf forest
B3-1	21	No	NA	Open needleleaf forest
B3-2	22	No	NA	Open mixed forest
B3-2A	23	No	NA	Open needleleaf forest
B3-3	65	No	NA	Open needleleaf forest
B3-4	43	Yes	PSS/PEM	Closed low scrub

Point ID	Soil Unit	Wetland	Cowardin	Viereck
B3-5	22	No	NA	Open needleleaf forest
B3-6	40	Yes	PSS/PEM	Closed low scrub
B3-7	22	No	NA	Open needleleaf forest
B3-8	13	Yes	PFO/PSS	Open needleleaf forest
B3-9	21	No	NA	Open needleleaf forest
B3-10	40	Yes	PSS/PEM	Open tall scrub
B3-11B	12	Yes	PSS/PEM	Open needleleaf forest
B3-12B	22	No	NA	Open needleleaf forest
B3-13B	64	No	NA	Open needleleaf forest
B3-14B	12	Yes	PSS/PEM	Closed low scrub
B3-15B	63	No	NA	Open needleleaf forest
B3-16B	64	No	NA	Open needleleaf forest
B3-17B	64	No	NA	Closed low scrub
B3-18	12	Yes	PSS/PEM	Needleleaf woodland
B3-19	11	Yes	PSS	Closed tall scrub
B3-20	63	No	NA	Closed needleleaf forest
B3-21	63	No	NA	Open needleleaf forest
B3-22	63	No	NA	Open needleleaf forest
B3-23	63	No	NA	Open needleleaf forest
B3-24	10	Yes	PSS/PEM	Needleleaf woodland
B4-1	66	No	NA	Needleleaf woodland
B4-2	60	No	NA	Needleleaf woodland
B4-3	60	No	NA	Needleleaf woodland
B4-4	50	Yes	PFO/PSS	Open needleleaf forest
B4-5	11	No	NA	Open needleleaf forest
B4-6	65	No	NA	Needleleaf woodland
B4-7	23	No	NA	Open needleleaf forest
B4-8	43	Yes	PEM	Wet graminoid herbaceous
B4-9	43	Yes	PSS/PEM	Closed low scrub
B4-10	64	No	NA	Needleleaf woodland
B4-11	64	No	NA	Open needleleaf forest
B4-12	21	No	NA	Open needleleaf forest
B4-13A	50	Yes	PSS/PEM	Open needleleaf forest
B4-13B	23	No	NA	Open needleleaf forest
B4-14	10	Yes	PSS	Closed tall scrub
B4-15	65	No	NA	Open needleleaf forest
B4-15A	50	Yes	PSS/PEM	Needleleaf woodland
B4-16	64	Yes	PSS/PEM	Needleleaf woodland
B4-16A	23	No	NA	Needleleaf woodland
B4-17	22	No	NA	Open mixed forest
B4-17A	23	No	NA	Needleleaf woodland
B4-18	23	No	NA	Closed tall scrub
B4-18A	23	No	NA	Needleleaf woodland
B4-19	64	No	NA	Open needleleaf forest
B4-19A	23	No	NA	Closed low scrub
B4-20	40	Yes	PSS	Closed low scrub
B4-20A	11	Yes	PSS/PEM	Closed low scrub
B4-21A	11	Yes	PSS	Closed low scrub
B4-22A	23	No	NA	Closed mixed forest
B4-23A	23	No	NA	Open needleleaf forest
B4-24A	60	No	NA	Needleleaf woodland
B4-26	66	No	NA	Needleleaf woodland
B4-27	56	No	NA	Needleleaf woodland
B4-28	10	No	NA	Needleleaf woodland
B4-29	60	Yes	PSS	Needleleaf woodland
B4-30	60	Yes	PSS/PEM	Closed tall scrub
B4-31	60	No	NA	Open needleleaf forest
B4-32	60	No	NA	Closed tall scrub
B4-33	57	No	NA	Open dwarf tree scrub
B5-1	12	Yes	PSS/PEM	Needleleaf woodland
B5-2	12	Yes	PFO/PSS	Open needleleaf forest
B5-3	58	No	NA	Closed tall scrub
B5-4	51	Yes	PSS/PEM	Closed low scrub

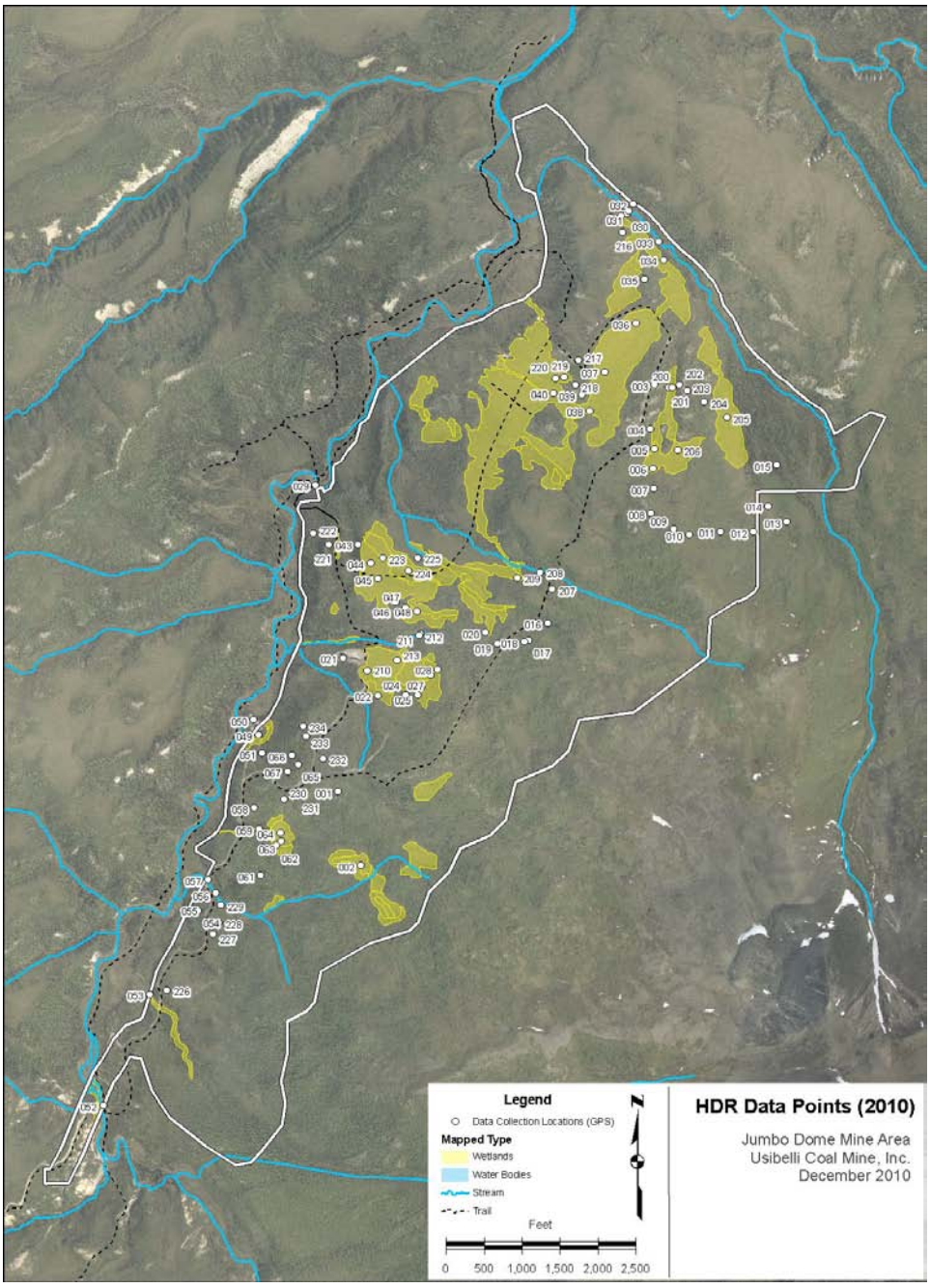
Point ID	Soil Unit	Wetland	Cowardin	Viereck
B5-5	13	Yes	PSS/PEM	Needleleaf woodland
B5-6	60	No	NA	Needleleaf woodland
B5-7	3	Yes	PSS	Closed low scrub
B5-8	3	Yes	PSS/PEM	Open tall scrub
B5-9	12	Yes	PSS/PEM	Needleleaf woodland
B5-10	63	No	NA	Needleleaf woodland
B5-11	63	No	NA	Open needleleaf forest
B5-12	12	Yes	PSS	Open needleleaf forest
B5-13	12	Yes	PSS/PEM	Closed low scrub
B5-14	12	Yes	PSS/PEM	Closed low scrub
B5-15	12	Yes	PSS/PEM	Open low scrub
B5-17	65	No	NA	Needleleaf woodland
B5-18	3	No	NA	Closed tall scrub
B5-19	58	Yes	PFO/PSS	Open needleleaf forest
B5-20	58	No	NA	Needleleaf woodland
B5-21	10	Yes	PSS/PEM	Closed tall scrub
B5-22	57	No	NA	Dwarf tree scrub woodland
B5-23	12	Yes	PSS/PEM	Open low scrub
B5-25	57	No	NA	Needleleaf woodland
B5-26	51	Yes	PSS/PEM	Closed low scrub
B5-27	60	Yes	PSS	Needleleaf woodland
B5-28	60	No	NA	Open needleleaf forest
B5-29	60	No	NA	Open needleleaf forest
B6-1	13	Yes	PSS	Open needleleaf forest
B6-2	23	No	NA	Needleleaf woodland
B6-3	22	No	NA	Open needleleaf forest
B6-4	13	No	NA	Needleleaf woodland
B6-5	4	No	NA	Needleleaf woodland
B6-6	4	No	NA	Open low scrub
B6-7	23	Yes	PSS	Closed low scrub
B6-8	23	No	NA	Open needleleaf forest
B6-9	23	No	NA	Open needleleaf forest
B6-10	23	No	NA	Open needleleaf forest
B6-11	23	No	NA	Dwarf tree scrub woodland
B6-12	4	Yes	PSS	Needleleaf woodland
B6-13	3	Yes	PSS	Needleleaf woodland
B6-13B	12	Yes	PSS/PEM	Closed low scrub
B6-14	12	Yes	PSS/PEM	Needleleaf woodland
B6-15	10	No	NA	Open tall scrub
B6-16	10	No	NA	Open mixed forest
B6-17	51	No	NA	Needleleaf woodland
B6-18	63	No	NA	Open needleleaf forest
B6-19	51	No	NA	Needleleaf woodland
B6-20	51	Yes	PSS/PEM	Dwarf tree scrub woodland
B6-21	65	No	NA	Needleleaf woodland
C1-1	41	Yes	PSS/PEM	Needleleaf woodland
C1-2	41	Yes	PSS/PEM	Closed low scrub
C1-3	41	No	NA	Closed low scrub
C1-4	11	No	NA	Open mixed forest
C1-5	11	Yes	PSS/PEM	Open low scrub
C1-6	11	Yes	PSS/PEM	Dwarf tree scrub woodland
C1-7	41	Yes	PSS/PEM	Needleleaf woodland
C1-8	64	No	NA	Open needleleaf forest
C1-9	43	Yes	PSS/PEM	Closed low scrub
C1-10	23	No	NA	Open needleleaf forest
C2-1	11	Yes	PSS	Closed low scrub
C2-2	23	No	NA	Open needleleaf forest
C2-3	23	No	NA	Closed mixed forest
C2-4	41	Yes	PSS	Dwarf tree scrub woodland
C2-5	64	No	NA	Needleleaf woodland
C2-6	23	No	NA	Needleleaf woodland
C2-7	10	Yes	PSS/PEM	Closed low scrub
C2-8	23	No	NA	Open needleleaf forest

Point ID	Soil Unit	Wetland	Cowardin	Viereck
C2-9	3	No	NA	Open mixed forest
C2-10	23	No	NA	Open mixed forest
C2-11	23	No	NA	Closed tall scrub
C2-12	11	No	NA	Closed low scrub
C2-13	21	No	NA	Needleleaf woodland
C2-14	21	Yes	PFO/PSS	Open needleleaf forest
C2-15	22	No	NA	Needleleaf woodland
C2-16	44	Yes	PSS/PEM	Open low scrub
C2-17	44	Yes	PEM	Wet graminoid herbaceous
C2-18	71	No	NA	Needleleaf woodland
C2-19	44	Yes	PSS/PEM	Open low scrub
C2-20	23	No	NA	Needleleaf woodland
C2-21	22	No	NA	Open needleleaf forest
C2-22	10	Yes	PSS/PEM	Open low scrub
C2-23	10	Yes	PSS/PEM	Open low scrub
C2-24	10	Yes	PSS/PEM	Closed tall scrub
C3-1	66	N	NA	Closed tall scrub
C3-2	66	Yes	PSS/PEM	Closed low scrub
C3-3	22	No	NA	Needleleaf woodland
C3-4	44	Yes	PSS/PEM	Needleleaf woodland
C3-5	44	No	NA	Closed tall scrub
C3-6	44	Yes	PSS/PEM	Needleleaf woodland
C3-7	44	Yes	PSS/PEM	Open tall scrub
C3-8	66	No	NA	Open needleleaf forest
C3-9	40	Yes	PSS/PEM	Open low scrub
C3-10	40	Yes	PSS/PEM	Open low scrub
C4-1	40	Yes	PSS/PEM	Open low scrub
C4-2	41	Yes	PSS/PEM	Dwarf tree scrub woodland
C4-3	56	No	NA	Needleleaf woodland
C4-4	41	Yes	PSS/PEM	Closed low scrub
C4-5	56	No	NA	Needleleaf woodland
C4-6	56	Yes	PSS	Closed tall scrub
C4-7	56	No	NA	Closed tall scrub
C4-9	60	No	NA	Needleleaf woodland
C4-10	51	Yes	PSS/PEM	Closed low scrub
C4-11	51	Yes	PSS/PEM	Open low scrub
C4-12	51	Yes	PSS/PEM	Closed tall scrub
C4-13	60	No	NA	Needleleaf woodland
C4-14	56	No	NA	Closed tall scrub
C4-15	56	No	NA	Closed tall scrub
C4-16	41	No	NA	Needleleaf woodland
C4-17	66	No	NA	Needleleaf woodland
C4-18	56	No	NA	Open mixed forest
C4-19	51	Yes	PSS/PEM	Closed low scrub
C4-20	51	Yes	PSS/PEM	Open low scrub
C4-21	60	No	NA	Open needleleaf forest
C4-22	58	No	NA	Closed tall scrub
C4-23	53	No	NA	Needleleaf woodland
C5-1	58	Yes	PSS/PEM	Closed low scrub
C5-2	51	Yes	PSS/PEM	Closed low scrub
C5-3	51	Yes	PSS/PEM	Closed low scrub
C5-4	51	Yes	PSS/PEM	Open low scrub
C6-1	51	Yes	PSS/PEM	Closed low scrub
D2-1	44	Yes	PSS/PEM	Open low scrub
D2-2	44	Yes	PSS/PEM	Closed low scrub
D3-1	60	No	NA	Closed low scrub
D3-2	44	Yes	PSS/PEM	Open tall scrub
D3-3	44	Yes	PSS/PEM	Open tall scrub
D3-4	61	No	NA	Closed low scrub
D3-5	44	Yes	PSS/PEM	Open low scrub
D3-6	53	No	NA	Open needleleaf forest

APPENDIX CXI-2

DATA SUMMARY (HDR 2010)

The following notes and photographs were collected by HDR Alaska, Inc. in September 2010 to field verify a desktop-level mapping study of mine area wetlands and vegetation communities. The primary source data used for the mapping was the much more extensive 2007 wetland field survey data collected by WHPacfic Inc. Information included here was used to supplement that dataset and verify the accuracy of boundaries delineated on project aerial photography in 2010. Standard USACE wetland data forms were used for note-taking and in many cases were not completely filled out; instead only limited data specific to a sites wetland status and vegetation community were collected. The inset map below shows the GPS locations of each site visited; a summary table of each point and the raw data and photographs follow.



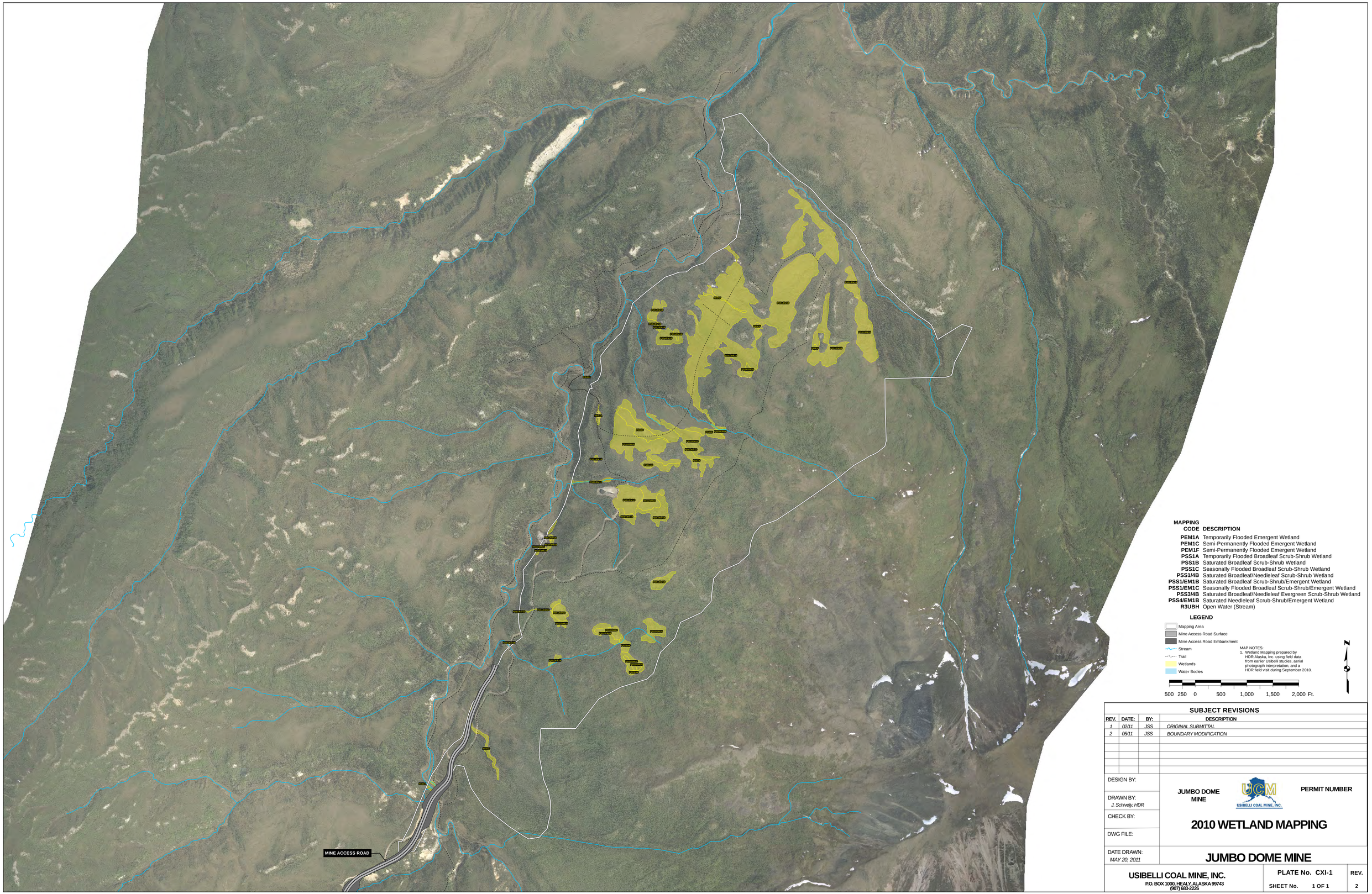
Site ID	Latitude	Longitude	Vegetation Mapping Code	Vegetation Type	Wetland Mapping Code	Wetland Type
001	63.98582163	-148.7411318	IA3	Needleleaf Woodland	U	Upland (non-wetland)
002	63.98314177	-148.7394066	IIC2	Open Low Scrub	PSS1/EM1C	Seasonally Flooded Broadleaf Scrub-Shrub/Emergent Wetland
003	64.00028989	-148.7144882	IA3	Needleleaf Woodland	U	Upland (non-wetland)
004	63.99869774	-148.7149127	IIC1	Closed Low Scrub	U	Upland (non-wetland)
005	63.99798243	-148.7146139	IIIA3	Wet Graminoid Herbaceous	PEM1F	Semi-Permanently Flooded Emergent Wetland
006	63.99727567	-148.7147722	IIC2	Open Low Scrub	PSSI/EM1B	Saturated Broadleaf Scrub-Shrub/Emergent Wetland
007	63.99654158	-148.7147283	IIB1	Closed Tall Scrub	U	Upland (non-wetland)
008	63.99564304	-148.7149778	IIB2	Open Tall Scrub	U	Upland (non-wetland)
009	63.99508196	-148.7131702	IIC1	Closed Low Scrub	U	Upland (non-wetland)
010	63.99485372	-148.7119019	IIC2	Open Low Scrub	U	Upland (non-wetland)
011	63.99494181	-148.7092998	IIB2	Open Tall Scrub	U	Upland (non-wetland)
012	63.99490401	-148.7066024	IIC1	Closed Low Scrub	U	Upland (non-wetland)
013	63.99524407	-148.7038447	IIC1	Closed Low Scrub	U	Upland (non-wetland)
014	63.99582912	-148.7053314	IIC2	Open Low Scrub	U	Upland (non-wetland)
015	63.99730735	-148.704583	IA2	Open Needleleaf Forest	U	Upland (non-wetland)
016	63.99175904	-148.7236698	IIB1	Closed Tall Scrub	U	Upland (non-wetland)
017	63.99116769	-148.7252447	IIC1	Closed Low Scrub	PSS1/3B	Saturated Broadleaf/Broadleaf Evergreen Scrub-Shrub Wetland
018	63.99109645	-148.7256343	IIC1	Closed Low Scrub	PSS1/3B	Saturated Broadleaf/Broadleaf Evergreen Scrub-Shrub Wetland
019	63.99105554	-148.7278044	IA3	Needleleaf Woodland	U	Upland (non-wetland)
020	63.99146274	-148.7287885	IA3	Needleleaf Woodland	U	Upland (non-wetland)
021	63.99065481	-148.7405007	BSV	Barren/Sparsely Vegetated	U	Upland (non-wetland)
022	63.98927674	-148.737737	IA2	Open Needleleaf Forest	PSS1/4B	Saturated Broadleaf/Needleleaf Scrub-Shrub Wetland
023	63.98957832	-148.7370115	IIC2	Open Low Scrub	PSS1/EM1C	Seasonally Flooded Broadleaf Scrub-Shrub/Emergent Wetland
024	63.98926919	-148.73545	IIB1	Closed Tall Scrub	U	Upland (non-wetland)
025	63.98925352	-148.7344824	IIC2	Open Low Scrub	PSS1/3B	Saturated Broadleaf/Broadleaf Evergreen Scrub-Shrub Wetland
026	63.98954085	-148.7341397	IIC2	Open Low Scrub	PSS1/3B	Saturated Broadleaf/Broadleaf Evergreen Scrub-Shrub Wetland
027	63.98997604	-148.7333894	IIC2	Open Low Scrub	PSS1/3B	Saturated Broadleaf/Broadleaf Evergreen Scrub-Shrub Wetland
028	63.99017486	-148.7327503	IA3	Needleleaf Woodland	U	Upland (non-wetland)
029	63.99693277	-148.7424948	OW	Open Water	R3UBH	Open Water (Stream)
030	64.00648227	-148.7164678	IIC2	Open Low Scrub	U	Upland (non-wetland)
031	64.0065883	-148.71629	IIB2/BSV	Open Tall Scrub/Barren-Sparsely Vegetated	U	Upland (non-wetland)
032	64.00684043	-148.7159724	IA2	Open Needleleaf Forest	U	Upland (non-wetland)
033	64.00546873	-148.7138869	IIB2/BSV	Open Tall Scrub/Barren-Sparsely Vegetated	U	Upland (non-wetland)
034	64.0048048	-148.7135523	IIC1	Closed Low Scrub	PSS1/EM1B	Saturated Broadleaf Scrub-Shrub/Emergent Wetland
035	64.00410902	-148.7151529	IA3	Needleleaf Woodland	U	Upland (non-wetland)
036	64.00252568	-148.715943	IIC2	Open Low Scrub	PSS1/EM1B	Saturated Broadleaf Scrub-Shrub/Emergent Wetland
037	64.00079439	-148.7185878	IIC2	Open Low Scrub	PSS1/EM1B	Saturated Broadleaf Scrub-Shrub/Emergent Wetland

Site ID	Latitude	Longitude	Vegetation Mapping Code	Vegetation Type	Wetland Mapping Code	Wetland Type
038	63.99940258	-148.7198719	IIC2	Open Low Scrub	PSS1/EM1B	Saturated Broadleaf Scrub-Shrub/Emergent Wetland
039	63.99998412	-148.7204839	IIA3	Dwarf Tree Scrub Woodland	U	Upland (non-wetland)
040	64.00006601	-148.7227863	IIIA3	Wet Graminoid Herbaceous	PEM1F	Semi-Permanently Flooded Emergent Wetland
041	63.99467669	-148.7406389	IIIA3	Wet Graminoid Herbaceous	PEM1A	Temporarily Flooded Emergent Wetland
042	63.99470167	-148.7397942	IIA3	Dwarf Tree Scrub Woodland	U	Upland (non-wetland)
043	63.99474702	-148.7391165	IA2	Open Needleleaf Forest	U	Upland (non-wetland)
044	63.99405434	-148.7381012	IIC2	Open Low Scrub	PSS1/EM1B	Saturated Broadleaf Scrub-Shrub/Emergent Wetland
045	63.99349292	-148.7375385	IIC2	Open Low Scrub	PSS1/EM1C	Seasonally Flooded Broadleaf Scrub-Shrub/Emergent Wetland
046	63.992644	-148.7360993	IA3	Needleleaf Woodland	U	Upland (non-wetland)
047	63.99242615	-148.7352749	IA3	Needleleaf Woodland	U	Upland (non-wetland)
048	63.99228852	-148.7343576	IIA3	Dwarf Tree Scrub Woodland	PSS1/4B	Saturated Broadleaf/Needleleaf Scrub-Shrub Wetland
049	63.98792842	-148.7475852	BSV	Barren/Sparsely Vegetated	U	Upland (non-wetland)
050	63.9884704	-148.747988	BSV	Barren/Sparsely Vegetated	U	Upland (non-wetland)
051	63.98727011	-148.7473126	IA2	Open Needleleaf Forest	PSS3/4B	Saturated Broadleaf/Needleleaf Evergreen Scrub-Shrub Wetland
052	63.9746597	-148.7609435	IIC2	Open Low Scrub	PSS1/EM1B	Saturated Broadleaf Scrub-Shrub/Emergent Wetland
053	63.97863817	-148.7569243	IIC1	Closed Low Scrub	PSS1C	Seasonally Flooded Broadleaf Scrub-Shrub Wetland
054	63.98163454	-148.7528252	IA2	Open Needleleaf Forest	U	Upland (non-wetland)
055	63.9820543	-148.7523324	IIA3	Dwarf Tree Scrub Woodland	U	Upland (non-wetland)
056	63.9822579	-148.7513742	IIC1	Closed Low Scrub	PSS1C	Seasonally Flooded Broadleaf Scrub-Shrub Wetland
057	63.98274229	-148.751988	IA3	Needleleaf Woodland	U	Upland (non-wetland)
058	63.98528938	-148.7480485	IA3	Needleleaf Woodland	U	Upland (non-wetland)
059	63.98452437	-148.7477005	IIC2	Open Low Scrub	PSS1/EM1C	Seasonally Flooded Broadleaf Scrub-Shrub/Emergent Wetland
060	63.98387183	-148.7474151	IA3	Needleleaf Woodland	U	Upland (non-wetland)
061	63.98286249	-148.7476379	IA3	Needleleaf Woodland	U	Upland (non-wetland)
062	63.98391693	-148.746289	IIA3	Dwarf Tree Scrub Woodland	PSS4/EM1B	Saturated Needleleaf Scrub-Shrub/Emergent Wetland
063	63.98406688	-148.7458808	IIC2	Open Low Scrub	PSS1/EM1C	Seasonally Flooded Broadleaf Scrub-Shrub/Emergent Wetland
064	63.98438263	-148.7459733	IIC2	Open Low Scrub	PSS1/EM1C	Seasonally Flooded Broadleaf Scrub-Shrub/Emergent Wetland
065	63.98683769	-148.7443711	IA2	Open Needleleaf Forest	U	Upland (non-wetland)
066	63.98717246	-148.7449135	IA3	Needleleaf Woodland	U	Upland (non-wetland)
067	63.98659361	-148.7452712	IA3	Needleleaf Woodland	U	Upland (non-wetland)
200	64.00017698	-148.713362	IIC2	Open Low Scrub	U	Upland (non-wetland)
201	64.00017883	-148.7130643	IIC2	Open Low Scrub	U	Upland (non-wetland)
202	64.00028712	-148.7124462	IA2	Open Needleleaf Forest	U	Upland (non-wetland)
203	64.0000712	-148.7118459	BSV	Barren/Sparsely Vegetated	U	Upland (non-wetland)
204	63.99963241	-148.7104187	IA3	Needleleaf Woodland	U	Upland (non-wetland)

Site ID	Latitude	Longitude	Vegetation Mapping Code	Vegetation Type	Wetland Mapping Code	Wetland Type
205	63.99905222	-148.7086253	IIC2	Open Low Scrub	PSS1/EM1B	Saturated Broadleaf Scrub-Shrub/Emergent Wetland
206	63.99792912	-148.71269	IIC2	Open Low Scrub	PSS1/EM1B	Saturated Broadleaf Scrub-Shrub/Emergent Wetland
207	63.99297928	-148.7232174	IIC1	Closed Low Scrub	U	Upland (non-wetland)
208	63.99361085	-148.7241863	IIB1	Closed Tall Scrub	U	Upland (non-wetland)
209	63.99342855	-148.7260678	IIC2	Open Low Scrub	PSS1B	Saturated Broadleaf Scrub-Shrub Wetland
210	63.99017435	-148.7385452	IIC2	Open Low Scrub	PSS1/EM1C	Seasonally Flooded Broadleaf Scrub-Shrub/Emergent Wetland
211	63.9914624	-148.7341075	IA3	Needleleaf Woodland	U	Upland (non-wetland)
212	63.99140239	-148.7342149	IA3	Needleleaf Woodland	U	Upland (non-wetland)
213	63.9905279	-148.7360958	IIC2	Open Low Scrub	PSS1/EM1C	Seasonally Flooded Broadleaf Scrub-Shrub/Emergent Wetland
214	64.00640641	-148.7169902	IIC2	Open Low Scrub	PSS1/EM1B	Saturated Broadleaf Scrub-Shrub/Emergent Wetland
215	64.00637297	-148.7177924	IA3	Needleleaf Woodland	U	Upland (non-wetland)
216	64.00583284	-148.7168601	IIC2	Open Low Scrub	U	Upland (non-wetland)
217	64.00124425	-148.7207055	IA3	Needleleaf Woodland	U	Upland (non-wetland)
218	64.00036155	-148.7209981	IIC2	Open Low Scrub	U	Upland (non-wetland)
219	64.00064151	-148.7219098	IIC2	Open Low Scrub	PSS1/EM1B	Saturated Broadleaf Scrub-Shrub/Emergent Wetland
220	64.00059298	-148.7226048	IIC2	Open Low Scrub	PSS1/EM1B	Saturated Broadleaf Scrub-Shrub/Emergent Wetland
221	63.99475448	-148.7415014	IA3	Needleleaf Woodland	U	Upland (non-wetland)
222	63.99519042	-148.7427534	IA3	Needleleaf Woodland	U	Upland (non-wetland)
223	63.99423103	-148.7371154	IIIA3	Wet Graminoid Herbaceous	PSS1/EM1C	Seasonally Flooded Broadleaf Scrub-Shrub/Emergent Wetland
224	63.99376231	-148.735022	IIIA3	Wet Graminoid Herbaceous	PSS1/EM1C	Seasonally Flooded Broadleaf Scrub-Shrub/Emergent Wetland
225	63.9942208	-148.7342146	IA3	Needleleaf Woodland	U	Upland (non-wetland)
226	63.97878293	-148.7555239	IA2	Open Needleleaf Forest	U	Upland (non-wetland)
227	63.98077548	-148.7516311	IIA3	Dwarf Tree Scrub Woodland	U	Upland (non-wetland)
228	63.98116867	-148.7511592	IA2	Open Needleleaf Forest	U	Upland (non-wetland)
229	63.98180922	-148.7509586	IA2	Open Needleleaf Forest	U	Upland (non-wetland)
230	63.98558317	-148.7456151	IA3	Needleleaf Woodland	U	Upland (non-wetland)
231	63.98565182	-148.7445869	IA3	Needleleaf Woodland	U	Upland (non-wetland)
232	63.98702963	-148.742303	BSV	Barren/Sparsely Vegetated	U	Upland (non-wetland)
233	63.98786087	-148.7437123	IA2	Open Needleleaf Forest	U	Upland (non-wetland)
234	63.9882041	-148.7439096	IA2	Open Needleleaf Forest	U	Upland (non-wetland)

PLATE CXI-1

2010 WETLAND MAPPING


MINE ACCESS ROAD
MAPPING CODE DESCRIPTION
PEM1A Temporarily Flooded Emergent Wetland
PEM1C Semi-Permanently Flooded Emergent Wetland
PEM1F Semi-Permanently Flooded Emergent Wetland
PSS1A Temporarily Flooded Broadleaf Scrub-Shrub Wetland
PSS1B Saturated Broadleaf Scrub-Shrub Wetland
PSS1C Seasonally Flooded Broadleaf Scrub-Shrub Wetland
PSS1/4B Saturated Broadleaf/Needleleaf Scrub-Shrub Wetland
PSS1/EM1B Saturated Broadleaf Scrub-Shrub/Emergent Wetland
PSS1/EM1C Seasonally Flooded Broadleaf Scrub-Shrub/Emergent Wetland
PSS3/4B Saturated Broadleaf/Needleleaf Evergreen Scrub-Shrub Wetland
PSS4/EM1B Saturated Needleleaf Scrub-Shrub/Emergent Wetland
R3UBH Open Water (Stream)
LEGEND
Mapping Area
Mine Access Road Surface
Mine Access Road Embankment
Stream
Trail
Wetlands
Water Bodies
MAP NOTES:
1. Wetland Mapping prepared by HDR Alaska, Inc. using field data from earlier Usibelli studies, aerial photograph interpretation, and a HDR field visit during September 2010.
500 250 0 500 1,000 1,500 2,000 Ft.
N
SUBJECT REVISIONS
REV. DATE: BY: DESCRIPTION
1 02/11 JSS ORIGINAL SUBMITTAL
2 05/11 JSS BOUNDARY MODIFICATION
DESIGN BY:
DRAWN BY: J. Schively, HDR
CHECK BY:
DWG FILE:
DATE DRAWN: MAY 20, 2011
JUMBO DOME MINE
UCM USIBELLI COAL MINE, INC.
PERMIT NUMBER
2010 WETLAND MAPPING
JUMBO DOME MINE
USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743
(907) 683-2226
PLATE No. CXI-1
SHEET No. 1 OF 1
REV. 2

CHAPTER XII
LAND USE INFORMATION

TABLE OF CONTENTS

Page

1.0 EXISTING AND HISTORIC LAND USES CXII-1

1.1 Past Use CXII-1

1.2 Present Use CXII-1

2.0 COMMUNITY CHARACTERISTICS CXII-2

3.0 LAND MANAGEMENT PLANS CXII-2

4.0 LAND CONDITION AND CAPABILITY CXII-3

5.0 RESPONSIBLE PARTIES CXII-4

1.0 EXISTING AND HISTORIC LAND USES

1.1 PAST USE

The patterns of settlement in the area and associated land uses that occurred are largely related to coal development activities that took place starting about the turn of the century. In 1915 the General Land Office subdivided the Nenana Coal Field into sections and townships and in 1916 the Geological Survey divided the field into leasing units and began issuing coal leases. Coal mining subsequently began around Healy, a station along the Alaska Railroad, in 1918. Five years later the Alaska Engineering Commission built a railroad spur line to developing coal mines near Suntrana. In 1943, Emil Usibelli started a small surface coal mining operation east of Suntrana and later bought several other underground coal properties in the area. As marketing opportunities evolved, Usibelli's operations grew and eventually expanded into the Hoseanna Creek valley in 1972. Exploration drilling was conducted by Amax as early as 1971 in the Jumbo Dome Mine project Area. Today the company produces approximately 2.0 million tons of coal per year and continues to expand the traditional coal mining land use within the resource area.

Besides coal mining, gold claims and mines were also established in the surrounding areas in the early 1900's. Although exploration and mining activities have been major uses since the turn of the century, no disturbances other than trails are evident in the proposed permit area. This area, as well as the surrounding areas not associated with mineral resource development has been used primarily as wildlife habitat and for hunting.

1.2 PRESENT USE

Current land uses for the proposed permit area include coal mining, wildlife habitat, hunting and to a limited extent, timber harvesting. UCM has been active in the immediate vicinity of the proposed mining area since 1976 when haul road construction and pre-stripping operations were initiated for the Poker Flats coal mine.

Some farming and haying has been done on previously mined and reclaimed areas to support feed requirements for local livestock owners. In the past, a small timber processing mill was utilized to provide a local supply source for building materials.

Access into recreational and other mineral areas has been established and maintained by virtue of the existing mine haul road system. UCM restricts access on the mine haul roads for safety and operational concerns to persons whom obtain access passes into the mine area. UCM will continue this procedure for the Jumbo Dome Mine Area. Sport hunting of large game and fur trapping continue to be primary uses. Other recreational activities in the general area include trail rides and pack trips into remote areas. Access to the Jumbo Dome area is available to the public from the Ferry Trail.

2.0 COMMUNITY CHARACTERISTICS

The proposed permit area lies within the newly established Denali Borough. The population of the Borough is estimated at approximately 2,077 residents. The unincorporated Healy area (Healy, Suntrana, and Usibelli) has a population of approximately 700 residents. The mainstay of the local economy is the Usibelli Coal Mine with additional employment provided by Golden Valley Electric Association, the Borough School District, Denali National Park, and tourism.

Clear Air Force Station is the largest employer in the Borough and employs over 300 people. UCM is another major employer, employing approximately 130 people. Denali National Park is another major employer in the Borough, employing approximately 120 full time and 220 seasonal employees. Other opportunities for year-round employment are somewhat limited by the seasonal nature of the area's tourist industry and a lack of commercial and industrial development.

3.0 LAND MANAGEMENT PLANS

The Alaska Department of Natural Resources develops land use management plans at three levels: statewide, areawide, and within specific management units. These plans provide land use guidance with emphasis on state lands within the area of jurisdiction. The Tanana Basin Area Plan for State

Lands addresses a broad area including the Jumbo Dome mine project and provides general recommendations for land use. It identifies the primary and secondary surface and subsurface uses planned for state lands in the Tanana Basin area. The area is divided into eight subregions and each subregion is divided into management units. The Plan establishes guidelines to allow for multiple uses of state land while minimizing conflicts.

The Jumbo Dome mine project falls within subunit D-4 of the Parks Highway/West Alaska Range subregion. One of the primary management goals for subsurface resources within the subregion is to contribute to Alaska's economy by making subsurface resources available for development. Within the D-4 subregion the Jumbo Dome Mine area is within three subunits. Subunit 4D4 has primary designation for minerals, and fish and wildlife habitat and harvest, and secondary designations for forestry and public use. Subunits 4M1 and 4P1 have primary designations for minerals, and fish and wildlife habitat and harvest, and secondary designation for public recreation.

4.0 LAND CONDITION AND CAPABILITY

The proposed permit area for the Jumbo Dome Mine coal project is in a relatively undisturbed natural condition. Other than access trails for mineral exploration, no other disturbances are evident. The pre-mining landuse, including surface and subsurface manmade features, is shown on Plate CV-1, Location of Surface Water Bodies. As previously discussed in Chapters IV, V, and X, soil and hydrologic conditions do not limit the capability of the area.

A study by the Soil Conservation Service (SCS) identified land use capabilities in a publication entitled Exploratory Soil Survey of Alaska. The proposed permit area for the Jumbo Dome mine is located within the area identified by the study as IQ25 (Section 173 Alaska Range). The major land resource areas were rated in two categories. The first category assessed suitability of the land for use as cropland; as rangeland for cattle, sheep, and reindeer; and for commercial forestry. In each of these categories, the proposed mine area was determined to be unsuitable with the exception of rangeland for reindeer. The second category defined limitations on land use in relation to road location, buildings, recreation, and off-road traffic. The SCS noted that all land areas were in the severe to very severe limitation categories.

The permit area is within Game Management Unit 20A. GMU 20A has been designated by the Board and Game for intensive management of moose under the Intensive Management Act. This designation mandates that GMU 20A manage moose and caribou populations for adequate and sustained harvests.

During the life of the mine precautions such as erosion protection and aggressive re-vegetation will help to encourage adequate wildlife productivity.

5.0 RESPONSIBLE PARTIES

This chapter was prepared by Usibelli Coal Mine, Inc.