



PEBBLE PROJECT

DRAFT ENVIRONMENTAL BASELINE STUDIES PROPOSED 2008 STUDY PLANS

CHAPTER 4. SURFACE WATER HYDROLOGY

DRAFT



Prepared For:
State of Alaska Large Mine Permitting Team
Department of Natural Resources

Prepared By:
 THE
pebble
PARTNERSHIP

3201 C Street, Suite 604
Anchorage, AK 99503
(907) 339-2600

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4. SURFACE WATER HYDROLOGY

The surface hydrology program includes surface water hydrology, fluvial geomorphology, and snow-course surveys. HDR Alaska, Inc. (HDR) will lead the surface hydrology field work for the mine study area. ABR, Inc. (ABR) will lead the snow-course surveys. The fluvial geomorphology study will be managed by R2 Resource Consultants.

In addition to the studies noted above, the Alaska Peninsula Corporation (APC), together with the Pebble Partnership, will continue additional surface hydrology baseline studies in the lower reaches of Upper Talarik Creek and Newhalen River.

No data collection for the surface hydrology study is planned for 2008 in the transportation corridor.

4.1 Surface Hydrology Program—Mine Study Area

The objectives and study area of the 2008 baseline surface hydrology program are consistent with the 2007 Study Plan. Figure 4.1-1 shows the mine study area drainages.

A summary of tasks for the surface hydrology study for 2004 through 2008 is provided in Table 4.1-1. The methods are described in detail in the 2008 Field Sampling Plan.

The following three key tasks describe the 2008 surface hydrology program for the mine study area.

4.1.1 Monthly Hydrologic Baseline Data Collection Program

Consistent with previous years, the 2008 hydrologic data-collection program will consist of a combination of instantaneously measured and continuously gauged stations. In 2007, the number of stations increased from 32 to 35, when the responsibility for UT100A was transferred to the Alaska Peninsula Corporation (APC).

Table 4.1-2 summarizes the sampling at each of the surface hydrology and surface water stream stations in the mine study area during the period of record, including changes for 2008. Station locations are illustrated on Figure 2.1-2. Monthly field events in 2008 will be conducted in similar fashion as those in 2005 through 2007. However, there have been changes to the number of stations that will be included in the 2008 program, as summarized below:

- In August 2007 APCS added three new continuously gaged sites in the lower reaches of Upper Talarik Creek (UT100APC3, UT100APC2, and UT100APC1). UT100APC1 is located approximately one-quarter mile downstream of, and replaces, the former UT100A. Another new station (NH100APC1) was initiated on Alaska Peninsula Corporation land on the Newhalen River. NH100APC1 is not a continuously gaged station, but instantaneous discharge is measured coincident with the collection of water-quality samples. APCS plans to operate these four stations in 2008 using the same data-collection methods described herein.

- Four continuously gaged stations (SK100A, SK100B1, SK100F, and SK100G) have been removed from the surface hydrology program in 2008 because the period-of-record is now adequate to confidently predict discharge at these four locations (if required) using the continued data collection from other nearby continuous gages. No continuous gages will be installed at these four sites in 2008. However, instantaneous measurements will be collected from three of these sites along with water-quality samples. SK100B1 will have instantaneous measurements with water-quality samples collected through the May 2008 event and then be removed.
- Seventeen stations will not be sampled for water quality after May 2008. In addition, water-quality samples are no longer collected at UT100A because APCS has replaced UT100A with UT100APC1.

These changes to the surface water program are reflected in Table 4.1-2. The resulting 2008 program includes the following:

- Monthly collection of water-quality samples and instantaneous discharge measurements at 39 stations from January through breakup (expected) in May.
- Monthly collection of water-quality samples and instantaneous discharge measurements at 22 of the same stations from June through the remainder of 2008.
- Operation of 22 continuously-gaged (discharge) stations during the ice-free months. Monthly measurements of instantaneous discharge also will be collected at these gaging stations 12 months per year for the purpose of improving the reliability of the rating curves and to estimate the winter hydrograph.

4.1.2 Baseflow (Low Flow) Data Collection

The objective of baseflow measurements is to characterize surface water stream flows generated by groundwater expressions in the stream channel. Baseflow conditions typically occur during low-flow conditions. These data will provide information about gaining and losing aspects of the study area drainages, which will be used in the development of hydrogeologic models.

To measure baseflow conditions, a series of stream low-flow profiles will be completed in late March or early April 2008. The low-flow profiles will involve measuring instantaneous discharge at multiple stations each in the north and south forks of the Kaktuli River and in Upper Talarik Creek, identified in Figure 4.1-2. Specific measurement locations will be determined from data collected in previous years from existing baseflow stations and based on current site conditions. Discharge measurements will be collected with the same methods described above for the monthly instantaneous discharge measurements described in the 2008 Field Sampling Plan.

4.1.3 Fluvial Geomorphology and Spawning Gravel Assessment

Sediment size fractioning of bulk surface and subsurface sediment samples provides information on the size relationship between subsurface and surface sediments. This type of sediment data is important for understanding the relationships between stream flows and bed dynamics, the quality of substrate available for fish spawning and use by other aquatic organisms. It is also important for understanding the

incubation environment in the period between bed mobilization due to fall rains and emergence prior to break-up.

Sampling in 2007 included the collection of 32 dual bulk samples from 16 riffles throughout the three major watersheds near the Pebble Project (North Fork Koktuli, South Fork Koktuli, and Upper Talarik Creek). These riffles represented deposits in the alluvial (“al”) surficial geology subunit adjacent to glacial terraces (t-series), drift (d-series), outwash (o-series) and colluvium. Alluvial deposits bordered by terraces, drift and outwash make up the majority of surface geology boundary material composing or adjacent to the bed and banks of each river. However, not all the mapped surface geology boundary material encountered within the map area is represented by the sampling conducted to date. Certain prominent surficial soil sub-units, not sampled in 2007, appear to have different grain size patterns that may react differently to high flow events. In addition, it is important to understand how the particle size distribution in known salmon spawning locations is affected by fall high flow events and subsequent resorting of bed materials.

The sampling in 2008 will generally follow the same protocols established in 2007. Results of the proposed 2008 sampling will provide particle size distribution data associated with those surficial soil sub-units not sampled in 2007 and will document the conditions incubating salmon embryos will experience throughout the winter period. The work conducted under this Study Plan will be the determination of sample site locations, the collection of sediment bulk samples, and the sieve analysis of these samples and reporting of results to PLP.

The following tasks will be performed during the 2008 study period.

1. Obtain nine (9) dual bulk samples from channel areas associated with surficial geology sub-units that include eroding lake deposits, glacial outwashes, landslide occurrences and locations where sand particle appear to dominate.
2. Obtain six (6) dual bulk samples from within gravels used by salmon for spawning (but before spawning occurs) that will supplement 2007 bulk sample data, from nine (9) transects, three (3) from each of the Upper Talarik Creek, South Fork Koktuli River and North Fork Koktuli River.
3. Obtain a single dual bulk sample from each of the nine transects sample before spawning occurred (see 2 above).
4. Analyze all sample collected to determine particle size distribution.

4.2 Snow Surveys and Snow-distribution Mapping

The study areas for the snow surveys are depicted on Figure 4.2-1. The approach used in 2008 will be the same as those described in the 2007 Study Plan.

Spring snow surveys will be continued in 2008 to complement concurrent surface hydrology studies by characterizing the distribution, snow/water equivalent (SWE), and ablation rates of late-season (pre-breakup) snow across the landscape in the vicinity of the mine. Table 4.2-1 is a summary of tasks for the snow surveys in 2004 through 2008.

The 2008 plan for the snow surveys includes the following four components:

- Snow-distribution survey in the study area will be continued from 2004, 2005, 2006, and 2007 in the mine study area, described in the 2006 Study Plan and continued from 2007 in the extended study area. New plots will be established opportunistically to collect data to support snow distribution modeling. This task will also support calibration and validation of the lidar snow depth estimates across the study area. In the extended study area, long transects (one or two per crew per day) will be sampled in 2008.
- Acquire airborne lidar to measure the elevation at the top of the snowpack across the study area. This will provide estimates of drift volume and snow water equivalent in the largest snow accumulations. These are areas that may be unsafe to traverse and too deep to sample in the field.
- Ablation surveys will take place biweekly for three site visits in late April and May to provided measures of snow during breakup.
- Statistical and physical snow-distribution and ablation modeling in 2008 will add to existing models from 2004 through 2007. These efforts will support predictions of snow distribution under various development scenarios.

TABLES

TABLE 4.1-1
Pebble Project Environmental Studies
Studies Summary for Surface Water Hydrology, 2004-2008
Consultant: HDR Alaska

| Discipline | 2004 Study Tasks | 2005 Study Tasks | 2006 Study Tasks | 2007 Study Tasks | 2008 Study Tasks |
|--------------------------------|--|--|---|---|---|
| Surface Water Hydrology | Mine Studies Area | | | | |
| | Surface Hydrology Data Collection (7 Events) | Surface Hydrology Data Collection (8 Events) | Surface Hydrology Data Collection (10 Events) | Surface Hydrology Data Collection (12 Events) | Surface Hydrology Data Collection (12 Events) |
| | | Baseflow Measurements (1 Event) | Baseflow Measurements (1 Event) | Baseflow Measurements (1 Event) | Baseflow Measurements (1 Event) |
| | | Upper Hyporheic Temperature Monitoring | | Fluvial Geomorphology (2 Events) | |
| | | Flow Exchange Measurements During Low Flow | | | |
| | | Aerial Survey of Hydrography for Potential Temporary Road Corridor | | | |

TABLE 4.1-2.
 Surface Hydrology and Water Quality Period-of-Record Index
 Mine Study Area

| Sample Location | Year ¹ | Period-of-Record By Discipline | | | | | | | | | | | | | | | | | | | | | | | | Comment | | | | | | | | | | | | | | | |
|------------------|-------------------|--------------------------------|---|---|---|---|---|---|---|---|---|---|---|-----------------------|---|---|---|---|---|---|---|---|---|----------|---|---------|---|---|---|---|---|---|---|---|---|---|---|---|---|--|--|
| | | Surface Hydrology ² | | | | | | | | | | | | Surface Water Quality | | | | | | | | | | Sediment | | | | | | | | | | | | | | | | | |
| | | Month | J | F | M | A | M | J | J | A | S | O | N | D | J | F | M | A | M | J | J | A | S | O | N | | D | J | F | M | A | M | J | J | A | S | O | N | D | | |
| KC100A (HDR) | 2004 | | | | | I | I | I | C | C | C | | | | | | | | Q | Q | Q | Q | Q | Q | | | | | | | | | | F | F | | F | | | | |
| | 2005 | I | | I | C | C | C | C | C | C | C | | | | Q | Q | Q | Q | Q | Q | Q | Q | Q | | | | | | | | | | F | F | | | | | | | |
| | 2006 | | I | I | C | C | C | C | C | C | C | | | | Q | Q | Q | Q | Q | Q | Q | Q | Q | | | | | | | | | | | | | | | | | | |
| | 2007 | | I | I | I | C | C | C | C | C | C | I | I | | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | | | | | | | | | | | | | | | | |
| | 2008 | I | I | I | C | C | C | C | C | C | C | I | I | | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | | | | | | | | | | | | | | | | |
| KR100A (HDR) | 2004 | | | | I | | I | I | I | I | | | | | | Q | Q | Q | Q | Q | Q | Q | Q | | | | | | | | | | | F | F | | | | | | |
| | 2005 | | | I | | | I | I | I | I | | | | | | Q | | | Q | Q | Q | Q | Q | Q | | | | | | | | | | | | | | | | | |
| | 2006 | | | I | | | I | I | | | I | | | | | Q | | | Q | Q | | | Q | Q | | | | | | | | | | | | | | | | | |
| | 2007 | | I | I | I | I | I | I | I | I | I | I | | | | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | | | | | | | | | | | | | | | |
| | 2008 | I | I | I | I | I | I | I | I | I | I | I | | | | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | | | | | | | | | | | | | | | |
| NH100APC1 (APCS) | 2004 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 2005 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 2006 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 2007 | | | | | | | | | | I | I | I | I | | | | | | | | Q | Q | Q | Q | Q | Q | | | | | | | | | | | | | | |
| | 2008 | I | I | I | I | I | I | I | I | I | I | I | | | | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | | | | | | | | | | | | | | | |
| NK100A (USGS) | 2004 | | | | | I | I | I | C | C | C | | | | | | | | Q | Q | Q | Q | Q | Q | Q | | | | | | | | | F | F | | F | | | | |
| | 2005 | I | | I | C | C | C | C | C | C | C | | | | | Q | Q | | Q | Q | Q | Q | Q | Q | | | | | | | | | | F | F | | | | | | |
| | 2006 | | | I | C | C | C | C | C | C | C | | | | | Q | Q | | Q | Q | Q | Q | Q | Q | Q | | | | | | | | | F | | | | | | | |
| | 2007 | | | | C | C | C | C | C | C | C | I | I | | | | | | | Q | Q | Q | Q | Q | Q | Q | Q | | | | | | | | F | | | | | | |
| | 2008 | I | I | I | C | C | C | C | C | C | C | I | I | | | | | | | Q | Q | Q | Q | Q | Q | Q | Q | | | | | | | | | | | | | | |
| NK100A1 (HDR) | 2004 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 2005 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 2006 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 2007 | | I | I | I | C | C | C | C | C | C | I | I | | | | | | | Q | Q | Q | Q | Q | Q | Q | Q | | | | | | | | | | | | | | |
| | 2008 | I | I | I | C | C | C | C | C | C | C | I | I | | | | | | | Q | Q | Q | Q | Q | Q | Q | Q | | | | | | | | | | | | | | |
| NK100B (HDR) | 2004 | | | | | | | | | I | I | I | | | | | | | | | | | | | | | | | | | | | | | | F | F | | | | |
| | 2005 | I | | I | | | I | I | I | I | I | | | | | Q | Q | | Q | Q | Q | Q | Q | Q | | | | | | | | | | F | F | | F | | | | |
| | 2006 | | I | I | I | I | I | I | I | I | I | | | | | Q | Q | | Q | Q | Q | Q | Q | Q | Q | | | | | | | | | F | | | | | | | |
| | 2007 | | I | I | I | C | C | C | C | C | C | I | I | | | | | | | Q | Q | Q | Q | Q | Q | Q | Q | | | | | | | | F | | | | | | |
| | 2008 | I | I | I | C | C | C | C | C | C | C | I | I | | | | | | | Q | Q | Q | Q | Q | Q | Q | Q | | | | | | | | | | | | | | |
| NK100C (HDR) | 2004 | | | | | I | | I | C | C | C | | | | | | | | | | | Q | Q | Q | Q | Q | | | | | | | | | F | F | | F | | | |
| | 2005 | I | | I | C | C | C | C | C | C | | | | | | Q | Q | | Q | Q | Q | Q | Q | Q | | | | | | | | | | | F | F | | F | | | |
| | 2006 | | I | I | I | C | C | C | C | C | C | I | | | | | | | | Q | Q | Q | Q | Q | Q | Q | | | | | | | | | F | | | | | | |
| | 2007 | | I | I | I | C | C | C | C | C | C | I | I | | | | | | | Q | Q | Q | Q | Q | Q | Q | Q | | | | | | | | | F | | | | | |
| | 2008 | I | I | I | C | C | C | C | C | C | C | I | I | | | | | | | Q | Q | Q | Q | Q | Q | Q | Q | | | | | | | | | | | | | | |
| NK119A (HDR) | 2004 | | | | | | I | I | C | C | C | | | | | | | | | | | Q | Q | Q | Q | Q | | | | | | | | | F | F | | F | | | |
| | 2005 | I | | I | C | C | C | C | C | C | | | | | | Q | Q | | Q | Q | Q | Q | Q | Q | | | | | | | | | | | F | F | | | | | |
| | 2006 | I | I | I | C | C | C | C | C | C | C | I | | | | | | | | Q | Q | Q | Q | Q | Q | Q | | | | | | | | | | | | | | | |
| | 2007 | | I | I | C | C | C | C | C | C | C | I | I | | | | | | | | Q | Q | Q | Q | Q | Q | Q | Q | | | | | | | | | F | | | | |
| | 2008 | I | I | I | C | C | C | C | C | C | C | I | I | | | | | | | Q | Q | Q | Q | Q | Q | Q | Q | | | | | | | | | | | | | | |
| NK119B (HDR) | 2004 | | | | | I | I | I | I | I | I | | | | | | | | | | | Q | Q | Q | Q | Q | | | | | | | | | | | | | | | |
| | 2005 | I | | I | | I | I | I | I | I | | | | | | Q | Q | | Q | Q | Q | Q | Q | Q | | | | | | | | | | | | | | | | | |
| | 2006 | | I | I | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 2007 | | I | I | I | I | C | C | C | C | C | I | I | | | | | | | | Q | Q | Q | | | Q | Q | Q | | | | | | | | | | | | | |
| | 2008 | I | I | I | C | C | C | C | C | C | C | I | I | | | | | | | Q | Q | Q | Q | Q | Q | Q | Q | | | | | | | | | | | | | | |

| Sample Location | Year¹ | Period-of-Record By Discipline | | | | | | | | | | | | | | | | | | | | | | | | Comment | | | | | | | | | | | | |
|-----------------|-------|--------------------------------|---|---|---|---|---|---|---|---|---|---|---|-----------------------|---|---|---|---|---|---|---|---|---|---|---|---------|----------|---|---|---|---|---|---|---|---|--|---|---|
| | | Surface Hydrology² | | | | | | | | | | | | Surface Water Quality | | | | | | | | | | | | | Sediment | | | | | | | | | | | |
| | | Month | J | F | M | A | M | J | J | A | S | O | N | D | J | F | M | A | M | J | J | A | S | O | N | | D | J | F | M | A | M | J | J | A | S | O | N |
| SK100A (HDR) | 2004 | | | | I | | I | I | C | C | C | | | | | Q | Q | Q | Q | Q | Q | Q | | | | | | | F | | | | | | | | Continuous gage discontinued in 2008. IQ discharge measurements only. | |
| | 2005 | I | I | I | C | C | C | C | C | C | I | | | | Q | Q | Q | Q | Q | Q | Q | Q | | | | | | F | F | | | | | | | No sediment sampling in 2008. | | |
| | 2006 | | I | I | I | C | C | C | C | C | C | | | | I | Q | Q | Q | Q | Q | Q | Q | Q | Q | | | | F | | | | | | | | Water quality maintained through 2008. | | |
| | 2007 | I | I | I | C | C | C | C | C | C | C | | | | I | Q | Q | Q | Q | Q | Q | | Q | Q | Q | Q | | | F | | | | | | | | | |
| | 2008 | I | I | I | I | I | I | I | I | I | I | | | | I | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | | | | | | | | | | | | |
| SK100B (USGS) | 2004 | | | | | | | | I | I | C | C | C | | | | | Q | Q | Q | Q | Q | Q | | | | | F | F | | F | | | | | No sediment sampling in 2008. | | |
| | 2005 | | | I | C | C | C | C | C | C | C | | | | Q | Q | Q | Q | Q | Q | Q | Q | Q | | | | | F | F | | | | | | | USGS maintains continuous gage. | | |
| | 2006 | | I | I | C | C | C | C | C | C | C | | | | I | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | | | F | | | | | | | | | | |
| | 2007 | I | I | | C | C | C | C | C | C | C | I | I | | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | | | F | | | | | | | | | |
| SK100B1 (HDR) | 2004 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 2005 | | | | | | | | | | I | I | C | C | | | | | | | Q | Q | | | | | | | | | | | | | | | No water quality or hydrology after May 2008. | |
| | 2006 | C | C | C | C | C | C | C | C | C | C | I | | | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | | | | | | | | | | | No continuous gage installed in 2008. | | |
| | 2007 | I | I | I | C | C | C | C | C | C | C | I | I | | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | | | | | | | | | | | | |
| SK100B2 (HDR) | 2004 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 2005 | | | | | | | | I | I | I | I | I | I | | | | | Q | Q | Q | Q | Q | Q | | | | | | | | | | | | | No change in status. | |
| | 2006 | | I | I | | | I | I | I | I | I | I | I | | I | Q | | | Q | Q | Q | Q | Q | Q | Q | Q | | | | | | | | | | | | |
| | 2007 | I | I | I | I | I | I | I | I | I | I | I | I | | Q | Q | | | Q | Q | Q | Q | Q | Q | Q | Q | Q | | | | | | | | | | | |
| SK100C (HDR) | 2004 | | | | | | | | I | I | C | C | C | | | | | | Q | Q | Q | Q | Q | Q | | | | | F | F | | F | | | | | Water quality measurements discontinued after May 2008. | |
| | 2005 | I | | | | C | C | C | C | C | C | | | | Q | | | | Q | Q | Q | Q | Q | Q | | | | F | F | | | | | | | No sediment sampling in 2008. | | |
| | 2006 | | | I | I | | C | C | C | C | C | I | | | | | | | Q | Q | Q | Q | Q | Q | Q | Q | | | F | | | | | | | | Continuous gage maintained through 2008. | |
| | 2007 | | I | I | I | C | C | C | C | C | C | I | I | | | | | | Q | Q | Q | Q | Q | Q | Q | Q | | | F | | | | | | | | | |
| SK100D (HDR) | 2004 | | | | | | | | I | I | I | I | I | | | | | | Q | Q | Q | Q | Q | Q | | | | | | | | | | | F | | | |
| | 2005 | I | | | | | | | I | I | I | I | I | | | Q | Q | | | Q | Q | Q | Q | Q | Q | | | | | | | | | | | | No water quality or hydrology after May 2008. | |
| | 2006 | | | I | I | I | | | I | I | I | I | I | | | | | | | Q | Q | Q | Q | Q | Q | Q | Q | | | | | | | | | | No continuous gage installed in 2008. | |
| | 2007 | I | I | I | I | I | I | I | I | I | I | I | I | | Q | Q | | | Q | Q | Q | Q | Q | Q | Q | Q | Q | | | | | | | | | | | |
| SK100F (HDR) | 2004 | | | | | | | | I | I | I | C | C | C | | | | | | Q | Q | Q | Q | Q | Q | | | | | F | F | | F | | | | Continuous gage discontinued in 2008. IQ discharge measurements only. | |
| | 2005 | I | | | | C | C | C | C | C | C | | | | Q | Q | Q | | | Q | Q | Q | Q | Q | Q | Q | | | F | | | | | | | | No sediment sampling in 2008. | |
| | 2006 | I | I | I | I | C | C | C | C | C | C | I | | | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | | | F | | | | | | | | Water quality maintained through 2008. | |
| | 2007 | I | I | I | I | C | C | C | C | C | C | I | I | | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | | | | | | | | | | | |
| SK100G (HDR) | 2004 | | | | | | | | I | I | I | C | C | C | | | | | | Q | Q | Q | Q | Q | Q | | | | | F | F | | F | | | | Continuous gage discontinued in 2008. IQ discharge measurements only. | |
| | 2005 | I | | | | C | C | C | C | C | C | | | | Q | Q | Q | | | Q | Q | Q | Q | Q | Q | | | | F | F | | | | | | | No sediment sampling in 2008. | |
| | 2006 | I | I | I | | C | C | C | C | C | C | I | | | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | | | F | | | | | | | | Water quality maintained through 2008. | |
| | 2007 | I | I | I | I | C | C | C | C | C | C | I | I | | Q | Q | | | Q | Q | Q | Q | Q | Q | Q | Q | Q | | | | | | | | | | | |
| SK119A (HDR) | 2004 | | | | | | | | I | I | I | C | C | C | | | | | | Q | Q | Q | Q | Q | Q | | | | | F | F | | F | | | | Water quality measurements discontinued after May 2008. | |
| | 2005 | I | | | | C | C | C | C | C | C | | | | Q | Q | | | | Q | Q | Q | Q | Q | Q | | | | F | | | | | | | | Continuous gage maintained through 2008. | |
| | 2006 | | I | I | | | C | C | C | C | C | C | I | | | Q | Q | | | Q | Q | Q | Q | Q | Q | Q | Q | | | F | | | | | | | | |
| | 2007 | | I | | | C | C | C | C | C | C | I | I | | Q | Q | | | Q | Q | Q | Q | Q | Q | Q | Q | Q | | | | | | | | | | | |
| SK124A (HDR) | 2004 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 2005 | I | | | | | | | I | C | C | C | C | C | | | | | | Q | Q | Q | Q | Q | Q | Q | | | | | | | | | | | | Water quality measurements discontinued after May 2008. |
| | 2006 | I | I | I | | | | | C | C | C | C | C | I | | Q | Q | Q | | | Q | Q | Q | Q | Q | Q | Q | | | | | | | | | | | Continuous gage maintained through 2008. |
| | 2007 | I | I | I | | C | C | C | C | C | C | I | I | | Q | Q | | | | Q | Q | Q | Q | Q | Q | Q | Q | | | | | | | | | | | |
| SK124A (HDR) | 2008 | I | I | I | I | C | C | C | C | C | C | I | I | | Q | Q | Q | Q | | | | | | | | | | | | | | | | | | | | |

| Sample Location | Year ¹ | Period-of-Record By Discipline | | | | | | | | | | | | | | | | | | | | | | | | Comment | | | | | | | | | | | | |
|------------------|-------------------|--------------------------------|---|---|---|---|---|---|---|---|---|---|---|-----------------------|---|---|---|---|---|---|---|---|---|---|---|---------|----------|---|---|---|---|---|---|---|---|--|--|---|
| | | Surface Hydrology ² | | | | | | | | | | | | Surface Water Quality | | | | | | | | | | | | | Sediment | | | | | | | | | | | |
| | | Month | J | F | M | A | M | J | J | A | S | O | N | D | J | F | M | A | M | J | J | A | S | O | N | | D | J | F | M | A | M | J | J | A | S | O | N |
| SK131A (HDR) | 2004 | | | | I | I | I | I | I | I | I | I | | | | | Q | Q | Q | Q | Q | Q | Q | | | | | | | | | | F | F | | | No water quality or hydrology after May 2008. No continuous gage installed in 2008. | |
| | 2005 | I | I | I | I | I | I | I | I | I | I | I | | Q | Q | | Q | Q | Q | Q | Q | Q | Q | | | | | | | | | | | | | | | |
| | 2006 | I | I | I | I | I | I | I | I | I | I | I | | Q | Q | | Q | Q | Q | Q | Q | Q | Q | Q | | | | | | | | | | | | | | |
| | 2007 | I | I | I | I | I | I | I | I | I | I | I | | Q | Q | | Q | Q | Q | Q | Q | Q | Q | Q | Q | | | | | | | | | | | | | |
| | 2008 | I | I | I | I | I | | | | | | | | Q | Q | Q | Q | Q | | | | | | | | | | | | | | | | | | | | |
| SK133A (HDR) | 2004 | | | | I | I | I | I | I | I | I | I | | | | | Q | Q | Q | Q | Q | Q | Q | | | | | | | | | | | | | | No water quality or hydrology after May 2008. No continuous gage installed in 2008. | |
| | 2005 | | | I | I | I | I | I | I | I | I | I | | | | | Q | Q | Q | Q | Q | Q | Q | | | | | | | | | | | | | | | |
| | 2006 | | I | I | I | I | I | I | I | I | I | I | | Q | Q | | Q | Q | Q | Q | Q | Q | Q | Q | | | | | | | | | | | | | | |
| | 2007 | | I | I | I | I | I | I | I | I | I | I | | Q | Q | | Q | Q | Q | Q | Q | Q | Q | Q | Q | | | | | | | | | | | | | |
| | 2008 | I | I | I | I | I | | | | | | | | Q | Q | Q | Q | Q | | | | | | | | | | | | | | | | | | | | |
| SK134A (HDR) | 2004 | | | | I | I | I | I | I | I | I | I | | | | | Q | Q | Q | Q | Q | Q | Q | | | | | | | | | | | | | | No change in status. | |
| | 2005 | I | I | I | I | I | I | I | I | I | I | I | | Q | Q | | Q | Q | Q | Q | Q | Q | Q | | | | | | | | | | | | | | | |
| | 2006 | I | I | I | I | I | I | I | I | I | I | I | | Q | Q | | Q | Q | Q | Q | Q | Q | Q | Q | | | | | | | | | | | | | | |
| | 2007 | | I | I | I | I | I | I | I | I | I | I | | Q | Q | | Q | Q | Q | Q | Q | Q | Q | Q | Q | | | | | | | | | | | | | |
| | 2008 | I | I | I | I | I | I | I | I | I | I | I | | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | | | | | | | | | | | | | |
| SK136A (HDR) | 2004 | | | | I | I | I | I | I | I | I | I | | | | | Q | Q | Q | Q | Q | Q | Q | | | | | | | | | | | | | | No water quality or hydrology after May 2008. No continuous gage installed in 2008. | |
| | 2005 | I | | | I | I | I | I | I | I | I | I | | Q | Q | | Q | Q | Q | Q | Q | Q | Q | | | | | | | | | | | | | | | |
| | 2006 | I | I | I | I | I | I | I | I | I | I | I | | Q | Q | | Q | Q | Q | Q | Q | Q | Q | Q | | | | | | | | | | | | | | |
| | 2007 | | I | I | I | I | I | I | I | I | I | I | | Q | Q | | Q | Q | Q | Q | Q | Q | Q | Q | Q | | | | | | | | | | | | | |
| | 2008 | I | I | I | I | I | | | | | | | | Q | Q | Q | Q | Q | | | | | | | | | | | | | | | | | | | | |
| SK136B (HDR) | 2004 | | | | I | I | I | I | I | I | I | I | | | | | Q | Q | Q | Q | Q | Q | Q | | | | | | | | | | | | | | No water quality or hydrology after May 2008. No continuous gage installed in 2008. | |
| | 2005 | I | | | I | I | I | I | I | I | I | I | | Q | Q | | Q | Q | Q | Q | Q | Q | Q | | | | | | | | | | | | | | | |
| | 2006 | | I | I | I | I | I | I | I | I | I | I | | Q | Q | | Q | Q | Q | Q | Q | Q | Q | Q | | | | | | | | | | | | | | |
| | 2007 | | I | I | I | I | I | I | I | I | I | I | | Q | Q | | Q | Q | Q | Q | Q | Q | Q | Q | Q | | | | | | | | | | | | | |
| | 2008 | I | I | I | I | I | | | | | | | | Q | Q | Q | Q | Q | | | | | | | | | | | | | | | | | | | | |
| UT100A (HDR) | 2004 | | | | I | | | I | I | I | | | | | | Q | Q | | | Q | Q | Q | | | | | | | | | | | F | | | Station physically moved to UT100APC1 in August 2007. No HDR program in 2008. UT100APC1 under APCS control. | | |
| | 2005 | I | | | I | I | I | I | I | I | I | | Q | Q | | Q | Q | Q | | Q | Q | Q | Q | | | | | | | | | | | | | | | |
| | 2006 | | | I | | | I | I | I | I | | | | | | Q | Q | Q | Q | Q | Q | Q | Q | Q | | | | | | | | | | | | | | |
| | 2007 | | | I | | | I | I | I | I | | | Q | Q | | Q | Q | Q | Q | Q | Q | Q | Q | Q | | | | | | | | | | | | | | |
| | 2008 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| UT100APC1 (APC) | 2004 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | APCS initiated site in August 2007. Program managed by APCS. | |
| | 2005 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 2006 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 2007 | | | | | | | | I | I | I | I | I | | | | | | | | Q | Q | Q | Q | Q | | | | | | | | | | | | | |
| | 2008 | I | I | I | C | C | C | C | C | C | C | C | I | I | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | | | | | | | | | | | | |
| UT100APC2 (APCS) | 2004 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | APCS initiated site in August 2007. Program managed by APCS. | |
| | 2005 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 2006 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 2007 | | | | | | | | I | I | I | I | I | | | | | | | | Q | Q | Q | Q | Q | | | | | | | | | | | | | |
| | 2008 | I | I | I | C | C | C | C | C | C | C | C | I | I | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | | | | | | | | | | | | |
| UT100APC3 (APCS) | 2004 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | APCS initiated site in August 2007. Program managed by APCS. | |
| | 2005 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 2006 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 2007 | | | | | | | | I | I | I | I | I | | | | | | | | Q | Q | Q | Q | Q | | | | | | | | | | | | | |
| | 2008 | I | I | I | C | C | C | C | C | C | C | C | I | I | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | | | | | | | | | | | | |
| UT100B (USGS) | 2004 | | | | | I | I | I | C | C | C | | | | | Q | Q | Q | Q | Q | Q | Q | Q | | | | | | | | | | F | F | F | F | No sediment sampling in 2008. USGS maintains continuous gage. | |
| | 2005 | I | | | I | C | C | C | C | C | C | | Q | Q | | Q | Q | Q | Q | Q | Q | Q | Q | | | | | | | | | | F | F | | | | |
| | 2006 | | I | I | C | C | C | C | C | C | C | | | | | Q | Q | Q | Q | Q | Q | Q | Q | Q | | | | | | | | | F | | | | | |
| | 2007 | I | I | I | C | C | C | C | C | C | C | I | I | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | | | | | | | | | F | | | | |
| | 2008 | I | I | I | C | C | C | C | C | C | C | I | I | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | | | | | | | | | | | | | |

| Sample Location | Year ¹ | Period-of-Record By Discipline | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | Comment | | | | | |
|-----------------|-------------------|--------------------------------|---|---|---|---|---|---|---|---|---|---|---|-----------------------|---|---|---|---|---|---|---|---|---|---|---|----------|---|---|---|---|---|---|---|---|---|---|---|---------|---|----------------------|--|--|--|
| | | Surface Hydrology ² | | | | | | | | | | | | Surface Water Quality | | | | | | | | | | | | Sediment | | | | | | | | | | | | | | | | | |
| | | Month | J | F | M | A | M | J | J | A | S | O | N | D | J | F | M | A | M | J | J | A | S | O | N | D | J | F | M | A | M | J | J | A | S | O | N | | D | | | | |
| UT146A (HDR) | 2004 | | | | I | I | I | I | I | I | I | | | | | | Q | Q | Q | Q | Q | Q | Q | Q | | | | | | | | | F | | F | | | | | No change in status. | | | |
| | 2005 | I | | I | | | I | I | I | I | I | I | | Q | | Q | | | Q | Q | Q | Q | Q | Q | | | | | | | | | | | | | | | | | | | |
| | 2006 | | I | | | | I | I | I | I | I | I | I | | Q | | | | Q | Q | Q | Q | Q | Q | | Q | | | | | | | | | | | | | | | | | |
| | 2007 | I | I | I | I | I | I | I | I | I | I | I | I | Q | Q | | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | | | | | | | | | | | | | | | | | |
| | 2008 | I | I | I | I | I | I | I | I | I | I | I | I | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | | | | | | | | | | | | | | | | | |

KEY:

Shaded cells indicate a change for 2008. Details are provided in the comments column.

- C Continuous stage/discharge hydrometric data collected in streams (gaged stations with dataloggers).
- F Sediment samples collected. Seep sediment samples show number of seeps sampled through 2007. Sediment symbol not shown on associated map.
- I Instantaneous stream discharge measurements taken each month coincident with water-quality sampling (ungaged stations without dataloggers).
- Q Surface water-quality samples collected for field and laboratory analyses.

NOTES:

- 1 Work for 2008 is shown as planned, but has not yet been completed.
- 2 At stations where continuous hydrometric data are collected, continuous hydrographs will be estimated throughout winter months using standard hydrometric methods. Stream gages are reinstalled each spring as early as breakup conditions allow.

TABLE 4.2-1
Pebble Project Environmental Studies
Study Summary for Snow Surveys, 2004-2008
Consultant: ABR, Inc.

| Discipline | 2004 Data Collected or Tasks | 2005 Data Collected or Tasks | 2006 Data Collected or Tasks | 2007 Data Collected or Tasks | 2008 Tasks to be Completed |
|---------------------|---|---|---|---|---|
| Snow Surveys | Mine Studies Area* | | | | |
| | Information Gathering / Literature Search | Information Gathering / Literature Search & Review | Information Gathering / Literature Search & Review | Information Gathering / Literature Search & Review | Information Gathering / Literature Search & Review |
| | Scope, Schedule, Field Sampling Plan | Scope, Schedule, Field Sampling Plan | Scope, Schedule, Field Sampling Plan | Scope, Schedule, Field Sampling Plan | Scope, Schedule, Field Sampling Plan |
| | 2004 Study Plan | 2005 Study Plan | 2006 Study Plan Summary | 2007 Study Plan | |
| | Snow Distribution Surveys (April) | Snow Distribution Surveys (April) | Snow Distribution Surveys (April) | Snow Distribution Surveys (April) | Snow Distribution Surveys (April) |
| | Snow Ablation Surveys (May) | Snow Ablation Surveys (May) | Snow Ablation Surveys (May) | Snow Ablation Surveys (April and May) | Snow Ablation Surveys (April and May) |
| | Data Entry and Analysis | Data Entry and Analysis | Data Entry and Analysis | Data Entry and Analysis | Data Entry and Analysis |
| | Communication and Data Management | Communication and Data Management | Communication and Data Management | Communication and Data Management | Communication and Data Management |
| | Coordination with NDM, Agency Meetings | Coordination with NDM, Agency Meetings, and Monthly Reporting | Coordination with NDM, Agency Meetings, and Monthly Reporting | Coordination with NDM, Agency Meetings, and Monthly Reporting | Coordination with PLP, Agency Meetings, and Monthly Reporting |
| | | 2004 Progress Report | Preliminary Environmental Baseline Document | Environmental Baseline Document | Comprehensive Environmental Baseline Document |

* In 2007, the study area was extended to include the full extent of the north and south Fork Kaktuli and Upper Talarik basins.

FIGURES

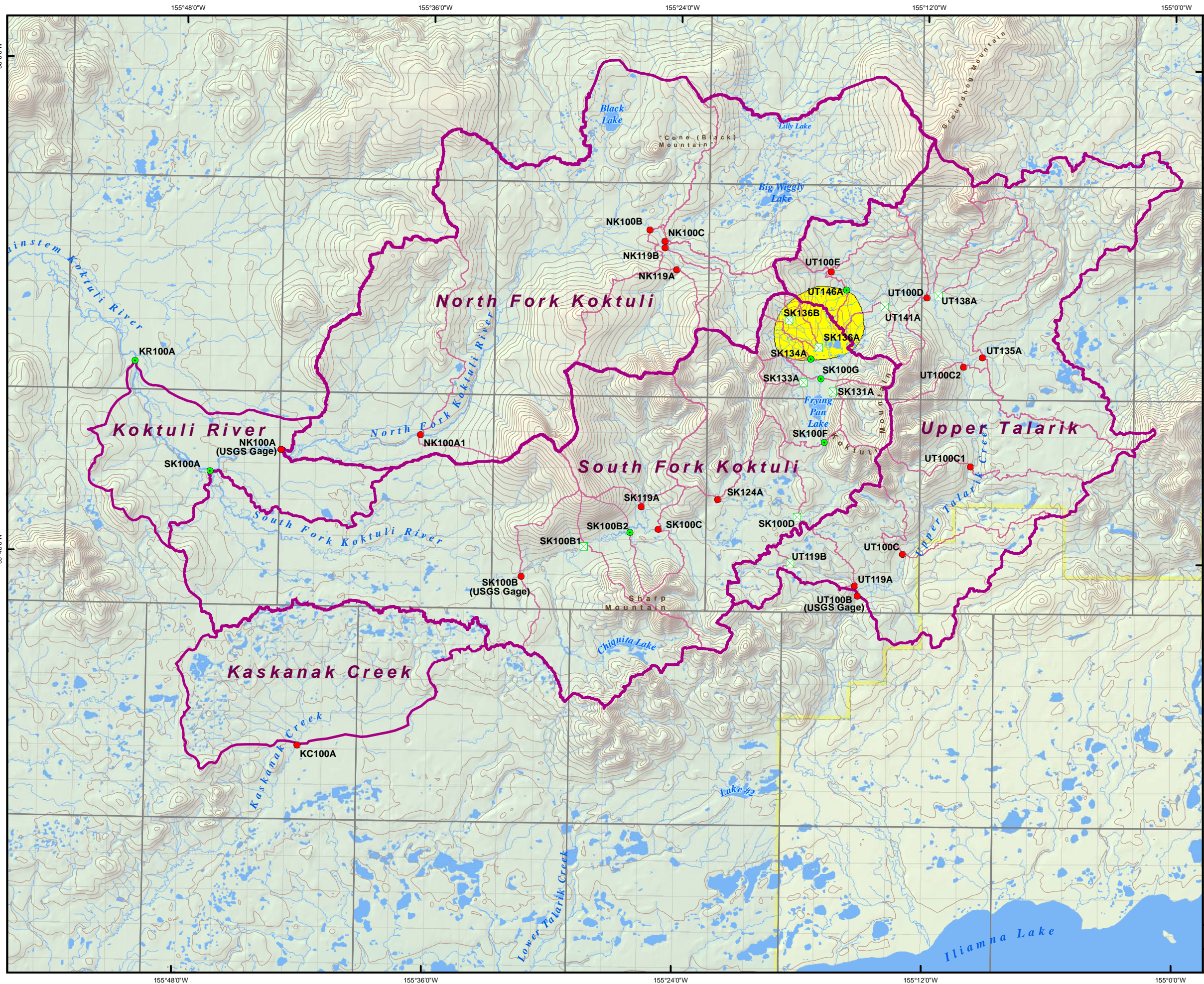
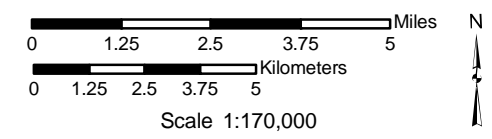


Figure 4.1-1
2008 Study Plan
Surface Water Hydrology
Mine Study Area Drainages and
Hydrologic Stations

DRAFT

- Legend**
- Major Drainage Boundary
 - Sub-drainage Boundary
 - Baseline Hydrologic Stations**
 - Measured throughout 2008**
 - Continuous
 - Instantaneous
 - Measured January-May 2008**
 - Instantaneous
 - Stream
 - Water Feature
 - Village Corporation Boundary
 - General Deposit Location



Alaska State Plane Zone 5 (units feet)
1983 North American Datum

| | |
|---|-------------------|
| File: HDR_Fig4.1-1_StudyAreaDrainages.mxd | Date: 20 May 2008 |
| Version: 1 | Author: HDR - MC |

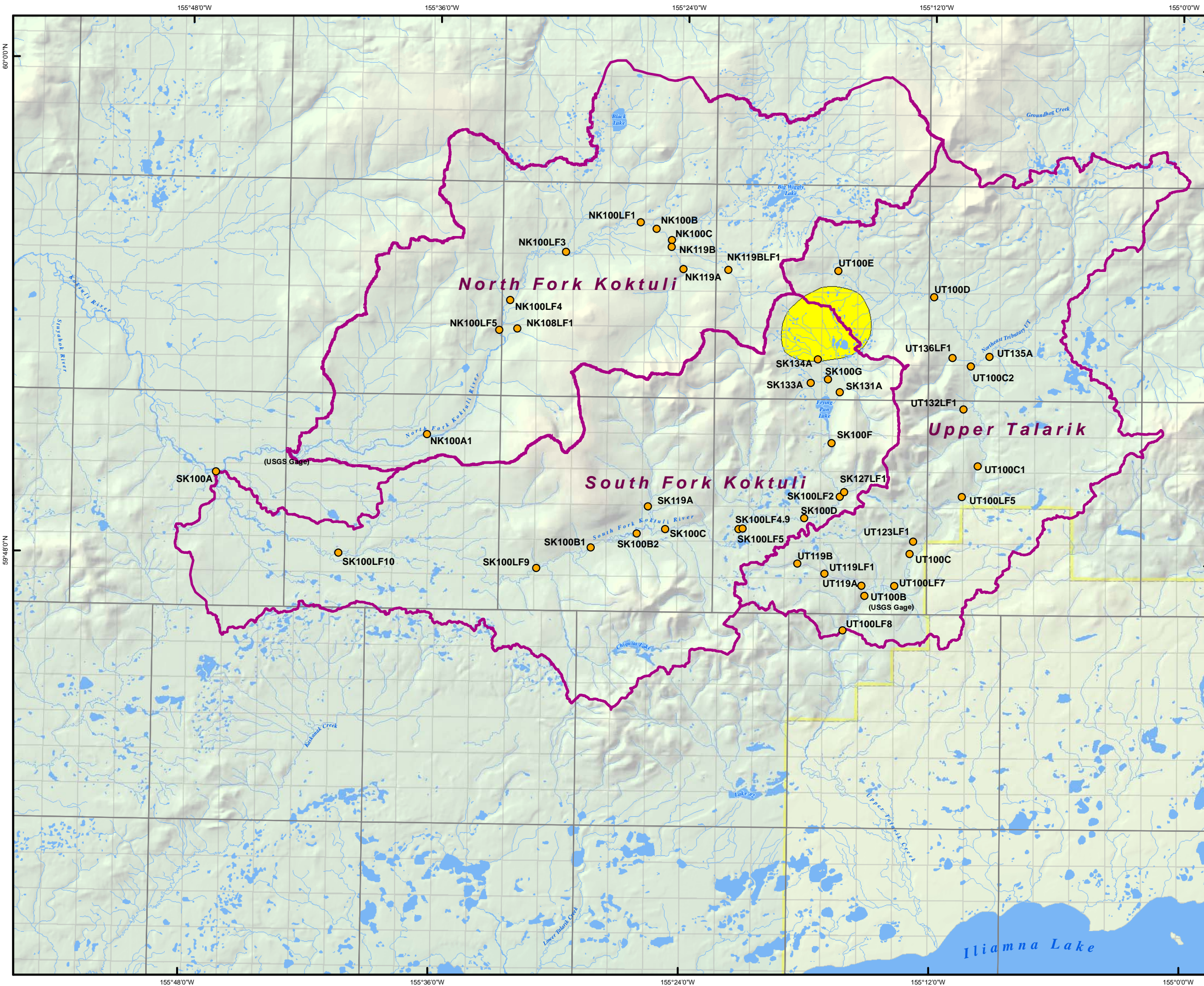






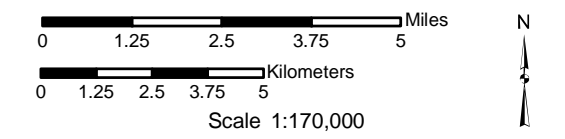


Figure 4.1-2
2008 Study Plan
Surface Water Hydrology
Baseflow Stations, Mine Study Area

DRAFT

Legend

-  Baseflow Station
-  Drainage Boundary
-  Stream
-  Water Feature
-  General Deposit Location
-  Village Corporation Boundary



Alaska State Plane Zone 5 (units feet)
1983 North American Datum

File: HDR_Fig4.1-2_BaseFlowStatn.mxd

Date: 20 May 2007

Version: 1









Author: HDR - MC

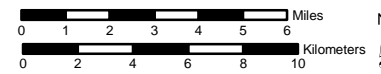


Figure 4.2-1. 2008 Study Plan, Snow Survey Study Areas and Field Sampling

DRAFT

Legend

-  Field Survey Transect
-  Lidar Acquisition Area
-  Extended Mine Study Area
-  Basin Boundary
-  Monitored Sub-basin Boundary
-  100-foot Contour
-  General Deposit Location
-  Possible Road Alignment



Scale 1:275,000
Alaska State Plane Zone 5 (units feet)
1983 North American Datum

File: SnowSurvey_StudyPlan_2008_v01.mxd

Date: May 20, 2008

Version: 1

Author: ABR-AZC

