Investigation of the Aquatic Communities of the Salmon Trout River, Yellow Dog River, and Cedar Creek in Marquette County, Michigan, 2012.

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List of Abbreviations, Acronyms, and Symbols

AEM	Advanced Ecological Management LLC
$\bar{x}$	Average
CC	Cedar Creek
CAS No.	Chemical abstract service number
°C	Degrees Celcius
EQL	Estimated quantification limit
ft	Feet
e.g.	For example
gpm	Gallons per minute
GLEAS	Great Lakes and Environmental Assessment Section
KEMC	Kennecott Eagle Minerals Company
KME	King & MacGregor Environmental
pH	Measure of acidity or alkalinity of a solution
MDEQ	Michigan Department of Environmental Quality
MNFI	Michigan Natural Features Inventory
µS/cm	MicroSiemens per centimeter
mg O_2/L	Milligrams of oxygen per liter of water
mg/kg	Milligrams per kilogram
ml	Milliliters
MDL	Minimum detection limit
N	North
n.a.	Not applicable
n.m.	Not measured
n.s.	Not sampled
P-51	Procedure Number 51
R	Range
n	Sample size
Sec	Section
s	Standard deviation
STRE	Salmon Trout River East Branch
STRM	Salmon Trout River Main Branch
T	Township
W	West
WCR	Wetland and Coastal Resources
YDR	Yellow Dog River

1.0 EXECUTIVE SUMMARY

Advanced Ecological Management (AEM) conducted aquatic surveys during 2012 at the Eagle Project site for use by Rio Tinto, and to maintain compliance with mine permit requirements. The Eagle Project is located in northern Marquette County, Michigan as shown on Figure 1-1. Rio Tinto is currently developing mining facilities at the site. Previous aquatic surveys have been conducted in the area, some within several of the same stations as these surveys. These surveys are similar in scope to the 2006 Aquatic survey (AEM, 2007) and are consistent with most of the stations sampled in the 2008 aquatic surveys (AEM, 2009). Where applicable, aquatic surveys at each station included fish, macroinvertebrate, and habitat community ratings according to the metrics outlined in the Great Lakes and Environmental Assessment Section (GLEAS) Procedure Number 51 (P-51), a survey protocol for wadable streams and rivers.

Fish were collected from ten locations including stations within the Salmon Trout River, tributaries in the East Branch of the Salmon Trout River, the Yellow Dog River, and Cedar Creek. Station locations are shown on Figure 1-2. Although all ten stations were sampled in the summer of 2008, high water due to beaver dams prohibited sampling of Station 4 in Cedar Creek and Station 8 in a tributary to the East Branch of the Salmon Trout River in their historic locations during the 2012 aquatic survey. However, 2012 sample locations for Station 4 and Station 8 remained consistent with 2011 locations.

The aquatic systems that were investigated for these surveys are predominantly functioning as coldwater trout streams. Because most of the fish communities of the Salmon Trout River and its tributaries and the Yellow Dog River were comprised of trout greater than 1% of the fish community composition, the P-51 fish community scores were determined from the macroinvertebrate community ratings for those streams. The macroinvertebrate communities within the Salmon Trout River have been scored by AEM as excellent or acceptable communities. In most stations, the macroinvertebrate community rating was consistent with previous sampling efforts conducted by AEM, Wetland and Coastal Resources (WCR), and the Michigan Department of Environmental Quality (MDEQ; AEM, 2012; AEM, 2009; AEM, 2008a; AEM, 2007; WCR, 2005; MDEQ/Premo et al., 2005, 2006).

The aquatic habitat was rated as excellent or good by AEM. The 2012 aquatic habitat scores were consistent with previous evaluations that were conducted by AEM (AEM,

2012; AEM, 2009; AEM, 2008a and b). A summary of P-51 macroinvertebrate and aquatic habitat scores appears on Table 1-1.

2.0 INTRODUCTION

In December 2007, Kennecott Eagle Minerals Company (KEMC) was granted a set of permits from the Michigan Department of Environmental Quality (MDEQ) to mine ore from an ore body located on the Yellow Dog Plains near the Main Branch of the Salmon Trout River (Figure 1-2). As part of a pre-mining environmental baseline, aquatic community investigations have been conducted within the Salmon Trout River and its tributaries, the Yellow Dog River, and Cedar Creek. These studies have been completed by Wetland and Coastal Resources (WCR, 2005), King & MacGregor Environmental (KME, 2005), the Michigan Department of Environmental Quality (MDEQ/Premo et al., 2005, 2006), and Advanced Ecological Management (AEM, 2012; AEM, 2009, 2008a and b; AEM, 2007). This 2012 aquatic community survey represents the second annual aquatic survey that has been conducted by AEM on behalf of KEMC since 2008. This 2012 aquatic survey is intended to satisfy mine permit requirements (Permit Condition L-40).

3.0 STUDY AREA

The principle area investigated for this study included portions of the Salmon Trout River and its tributaries, the Yellow Dog River, and Cedar Creek (Figure 1-2). These systems are all coldwater streams that flow through relatively undeveloped watersheds that are predominantly forested. The ore body and mine site are located near the headwaters of the Salmon Trout River Main Branch, which flows in a northeastern direction (Figure 1-2). The Salmon Trout River is characterized by a variety of habitat types in the vicinity of the stream segments investigated and includes slow-flowing segments with a silt substrate that have been heavily influenced by beaver activity (e.g., Stations 6 and 7), and high-gradient segments flowing through forested and hilly terrain with beaver dams intermittent (e.g., Stations 1 and 8).

The Yellow Dog River flows to the west along the southern boundary of the Yellow Dog Plains (Figure 1-2). Cedar Creek flows to the north and is not located within the same watershed as the Eagle mining project. Cedar Creek serves as a reference stream for the Eagle Project.

4.0 METHODS

The 2012 aquatic survey was conducted according to the MDEQ's Surface Water Quality Division *Procedure #51 Survey Protocols for Wadable Rivers* (P-51; MDEQ, 2002). Ten stream segments (stations) were sampled in the summer of 2012 using the P-51 survey protocol (Figure 1-2).

These sample stations are situated in the same sample locations, or close to the sample locations that were surveyed by AEM in 2011 and 2008. The 2012 aquatic survey follows protocol established in the Wetland and Coastal Resources survey of 2004, (WCR, 2005) in that fish collection data are summarized and P-51 scores are provided for macroinvertebrates and habitat quality.

4.1 Fish Collection

Survey stations were blocked at the upstream and downstream extents using seines that measured 4 feet by 50 feet, with a 0.19-inch mesh size. When adequate habitat conditions permitted, a multi-pass removal technique was used to evaluate fish abundance throughout each station (Van Deventer and Platts, 1983). A backpack electroshocker was used in narrow (approximately ≤10 feet), or difficult-to-access stations (e.g., areas with abundant woody debris). A barge-mounted electroshocker was used to sample stations that were deep (approximately 2 to 3 feet), wide (approximately >10 feet), and where woody debris was sparse enough to permit the passage of the barge unit. Three consecutive passes were conducted, each in an upstream direction. The duration of electroshocking was recorded for each pass and stunned fish were placed in a live-well for identification and enumeration. Following the third pass and subsequent fish identification, fish were released within the station.

As part of the enumeration process, the number of each species present was recorded. One representative of each species that was not identifiable in the field was placed in a voucher jar containing 10% formalin for later identification. Each voucher jar was labeled according to the sample location and date. Fish were identified to species using various taxonomic references (Bailey et al., 2003; Coon, 2001; Becker, 1983). The Michigan County Element List (MNFI, 2012) was also reviewed to determine if any threatened, endangered, or special concern aquatic species occurred within the Salmon Trout River and its tributaries, the Yellow Dog River, or Cedar Creek.

4.2 Macroinvertebrates

Sampling of aquatic macroinvertebrates, including mussels and crayfish (Decapoda), was conducted according to the P-51 protocol. Upon completion of fish sampling, macroinvertebrates were collected within each station using D-framed kick-nets (Merritt et al., 1996). Stations were sampled for 45 minutes using two kick-nets (total sample time = 1.5 hours) and samples were collected in all habitat types within each station to characterize the macroinvertebrate community. Collected specimens were stored in 250 ml plastic wide-mouth jars containing 70% ethanol, and were identified using various taxonomic references (Merritt et al., 2008; Bright, 2011; McCafferty, 1998; Cummings and Mayer, 1992; Peckarsky et al., 1990; Pennak, 1990).

The macroinvertebrate data were analyzed according to nine metrics identified in the P-51 methodology. The sum of the macroinvertebrate scores can range from –9 to +9; and are graded as excellent, acceptable, or poor according to the summation of the metric scores.

4.3 Stream Habitat Evaluation

Riparian and in-stream habitats were qualitatively described for each station during the aquatic survey. A description of stream morphology included run/riffle/pool/shallow pool configurations, substrate, substrate embeddedness, in-stream cover, vegetation, flow stability, and bank stability. Stream habitat was rated as excellent, good, marginal, or poor based on P-51 scores interpreted from 10 habitat metrics. Habitat was rated according to the following P-51 habitat scores (MDEQ, 2008):

Habitat characterization	Total Point Score
1. Excellent	> 154
2. Good	105 – 154
3. Marginal	56 – 104
4. Poor	< 56

Habitat conditions, water quality, and stream dimensions were documented during the aquatic survey. Photographs were taken at each station to illustrate the conditions during the sampling period (Exhibit C). Water temperature, dissolved oxygen, pH, and conductivity were measured as part of the stream habitat evaluation. These water quality parameters were measured using a Yellow Springs Instrument Professional Plus water quality meter.

Wetted stream width was measured at the lower, middle, and upper extent of each sample station. Depth was measured in the center, and at 20% and 80% of each stream width cross section. Stream flow was measured with a Marsh-McBirney Flo-Mate 2000®.

5.0 RESULTS

A total of ten stations were surveyed during summer 2012, including one station in the Yellow Dog River, one station in Cedar Creek, five stations in the Main Branch of the Salmon Trout River, and three stations in tributaries of the East Branch of the Salmon Trout River (Table 5-1 and Figure 1-2). Aquatic community sampling was conducted for all ten stations from 12 June 2012 through 15 June 2012. Station 5 in the Yellow Dog River and Station 6 in the Salmon Trout River were sampled on 12 June 2012, Stations 2, 3, 9, and 10 in the Salmon Trout River were sampled on 13 June 2012, Stations 1, 7, and 8 in the Salmon Trout River were sampled on 14 June 2012, and Station 4 in Cedar Creek was sampled on 15 June 2012.

5.1 Fish

A total of 359 fish were collected from all stations with 57% of the total being captured in Station 6 (Table 5-2). Among all stations, a total of nine species of fish were observed during the aquatic survey (Table 5-2). Northern redbelly dace (*Phoxinus eos*), brook trout (*Salvelinus fontinalis*), and blacknose dace (*Rhinichthys obtusus*) were the most frequently collected species.

No Michigan Natural Features Inventory (MNFI) listed threatened or endangered fish species were identified in the stations investigated in the Salmon Trout River and its tributaries, Yellow Dog River, or Cedar Creek in Marquette County, Michigan (MNFI, 2012).

5.1.1 Salmon Trout River Tributaries: Stations 1, 2, 3, 6, 7, 8, 9 and 10

Northern redbelly dace, brook trout, and brook stickleback (*Culaea inconstans*) were the most frequently observed species among all eight stations within the Salmon Trout River system (Table 5-2). Brook trout were the only species collected in Stations 1, 3, 8, 9, and 10 during June 2012.

In Station 6, a total of 203 fish were collected in June 2012 and northern redbelly dace was the most abundant species. The 2012 total catch from Station 6 was slightly greater than the 2011 total catch of 184 fish, and the relative abundance of each species was consistent between 2011 and 2012. Except for two brook trout that were 9.1 and 10.2 inches in length, most of the fish collected from Station 6 were approximately three inches or less in length.

A total of 25 fish, including eight brook trout, 16 northern redbelly dace, and one pearl dace (*Margariscus margarita*) were collected from Stations 2 and 3. Fish data from Stations 2 and 3 were consistent with surveys prior to 2011, which were conducted during bank full conditions following a substantial rain event.

Consistent with previous surveys, habitat conditions from beaver activity in Station 7 made it difficult to adequately block the station. Therefore, only a single-pass removal was conducted within this station. The fish community of Station 7 remained consistent with previous surveys, and was predominantly comprised of northern redbelly dace and a few brook sticklebacks (Table 5-2).

5.1.2 Yellow Dog River: Station 5

Station 5 is located in the Yellow Dog River and a total of 54 fish were collected during June 2012. The Station 5 fish community was comprised of six species, including blacknose dace, creek chubs, brook trout, rainbow trout (*Oncorhynchus mykiss*), northern redbelly dace, and a white sucker (*Catostomus commersonii*, Table 5-2).

5.1.3 Cedar Creek: Station 4

Station 4 is located in Cedar Creek outside of the project area drainage basin. Consistent with the 2011 aquatic survey, a beaver dam was located immediately upstream of the Northwestern Road crossing (Photograph C-1). Because of high water conditions caused by beaver activity, the 2012 aquatic survey was conducted north (downstream) of Northwestern Road. In addition, because of a channel braiding that occurred throughout much of the station, adequate blocking with nets was not possible. Therefore, a single pass removal was conducted in Station 4. A total of 10 brook trout were collected from Station 4 in 2012 (Table 5-2) compared to a total of 44 that were collected in 2011. The fewer numbers of brook trout that were collected in 2012 were believed to be related to a malfunctioning of the electroshocking gear. Cedar Creek

brook trout in 2012 ranged in length from 1.8 inches to 7.4 inches, with an average length of 4.6 inches (standard deviation *s* = 1.8 inches; sample size *n* = 10).

5.2 Macroinvertebrates

A total of 1,669 macroinvertebrates were collected from all ten stations that were investigated in 2012. Because of beaver dams in the vicinity of Station 6 and Station 7, the P-51 macroinvertebrate metrics evaluation protocol was not applied in these locations.

5.2.1 Salmon Trout River: Stations 1, 2, 3, 6, 7, 8, 9 and 10

A total of 1,322 macroinvertebrates representing 51 taxa identified to the Family level were observed collectively from Stations 1, 2, 3, 6, 7, 8, 9 and 10 in the Salmon Trout River and its tributaries during 2012. The greatest numbers of macroinvertebrates were collected from Station 8 and the fewest number of macroinvertebrates were collected from Station 7 (Table 5-3).

A total of 203 macroinvertebrates were collected in Station 1. Ephemeropterans (mayflies), trichopterans (caddisflies), and Dipterans (flies) were the most frequently collected macroinvertebrates in Station 1 (Table 5-3).

A total of 144 macroinvertebrates were collected from Station 2 with caddisflies and Dipterans (flies) being the most frequently collected macroinvertebrates in this station. A total of 169 macroinvertebrates were collected from Station 3 with caddisflies, and flies being the most frequently collected macroinvertebrates (Table 5-3).

A total of 210 macroinvertebrates were collected from Station 6, where amphipods (scuds), Odonates (dragonflies and damselflies), and Hemipterans were the most frequently collected macroinvertebrates (Table 5-3). A total of 105 macroinvertebrates were collected from Station 7 in 2012. Similar to Station 6, scuds were the most frequently collected organisms in Station 7, followed by snails and clams, and flies (Table 5-3).

A total of 242 macroinvertebrates were collected from Station 8, 118 macroinvertebrates were collected from Station 9, and 131 macroinvertebrates were collected from Station

10 (Table 5-3). Among Stations 8, 9, and 10 caddisflies, mayflies, and flies were frequently collected. Dragonflies and damselflies were also abundant within Station 10.

Where possible, macroinvertebrate collection data have been evaluated in accordance with the metrics outlined in P-51. Table 5-4 summarizes the values and scores for the nine metrics for each station. Stations 1, 9, and 10 were rated as "Excellent", and Stations 2, 3, and 8 were rated as "Acceptable" in 2012.

5.2.2 Yellow Dog River: Station 5

A total of 100 macroinvertebrates representing 24 taxa identified to the Family level were collected in Station 5 from the Yellow Dog River (Table 5-3). Dragonflies and damselflies, caddisflies, and mayflies were the most frequently collected macroinvertebrates. The macroinvertebrate community of Station 5 was rated as "Acceptable" in 2012 (Table 5-4).

5.2.3 Cedar Creek: Station 4

A total of 247 macroinvertebrates representing 25 taxa identified to the Family level were collected from Cedar Creek in Station 4 during 2012 (Table 5-3). Caddisflies, flies, and mayflies were the most frequently collected macroinvertebrates. The macroinvertebrate community of Station 4 was rated as "Excellent" in 2012 (Table 5-4).

5.3 Stream Habitat

Stream habitat during 2011 was evaluated for the KEMC Eagle project for the first time since 2008. Although beaver activity affected several stations and required relocating two stations to conduct the survey, habitat conditions in most stations remained consistent with conditions observed by AEM during 2008. The habitat conditions for all stations surveyed are described below.

5.3.1 Salmon Trout River: Stations 1, 2, 3, 6, 7, 8, 9 and 10

Station 1 is located in a narrow valley with relatively steep slopes rising more than 100 feet to the Yellow Dog Plains. Station 1 was 120 feet in length with an average width of 7.4 feet (s = 1.9 feet, n = 3), and average depth of 0.4 feet (s = 0.1 feet, n = 9, Table 5-5). Stream flow was measured at the downstream extent of Station 1 and discharge was estimated at 1,176 gallons per minute (gpm, Table 5-5).

The streambanks of Station 1 appeared consistent with conditions observed in previous surveys, and were vegetated with herbaceous and woody vegetation (Photographs C-2 and C-3). The streambed was characterized by a relatively steep gradient and the substrate was comprised of a variety of particles including sand, gravel, cobble, and boulders (Photographs C-2 and C-3). Woody debris was frequently observed throughout the station and an additional large tree had fallen into the river approximately at the midpoint of Station 1 since the previous 2011 site visit and was functioning as additional woody debris (Photograph C-4).

Station 2 is located south of Triple A Road and Station 3 is located north of Triple A Road (Figure 1-2 and Table 5-1). Station 2 was 100 feet in length and Station 3 was 200 feet in length. Average width of Station 2 was 5.6 feet (n = 3; s = 1.3 feet), and average width of Station 3 was 7.1 feet (n = 3; s = 1.1 feet, Table 5-5). Average depth in Station 2 was 0.8 feet (n = 9; s = 0.2 feet), and average depth in Station 3 was 0.4 feet (n = 9; s = 0.1 feet). Stream flow for Stations 2 and 3 was measured at the downstream extent of Station 3, and discharge was estimated at 536 gpm in 2012 (Table 5-5).

Station 2 was surrounded by an abundance of speckled alder (*Alnus rugosa*) and bluejoint grass (*Calamogrostis canadensis*, Photographs C-5 to C-6). Habitat conditions of Station 2 were consistent with 2011 observations. Evidence of beaver activity was present with the upstream extent of Station 2 and two partially constructed dams were present within the stream channel. Silt and organic matter appeared to be more abundant within the upstream extent of Station 2.

The streambank vegetation within Station 3 appeared similar to conditions observed in 2011. The vegetation within Station 3 was predominantly speckled alder with an understory of bluejoint grass and sedge (*Carex* sp., Photographs C-7 to C-8). Watercress (*Nasturtium* sp.) was present within portions of the stream channel of Station 3.

Station 6 is located in the vicinity of the ore body (Figure 1-2). Station 6 is 300 feet in length and was influenced by beaver dams that were located downstream of the station. The average width of Station 6 was 17.5 feet (n = 3; s = 3.2 feet) and the average depth was 2.4 feet (n = 9; s = 0.2 feet, Table 5-5), which was 0.2 feet deeper than the average

depth in 2011. The 2012 average stream was determined from the approximation of the stream channel/wetland vegetation boundary and was likely underestimated because of the difficulty determining the shore/water interface in the vicinity of floating vegetation and high water from beaver activity. Stream flow was measured at the middle extent of Station 6 and discharge was estimated at 290 gpm in the (Table 5-5).

The streambanks in Station 6 appeared similar to conditions observed in 2011, and were characterized by tussock sedge (*Carex stricta*), iris (*Iris* sp.), rush (*Juncus* sp.), willows (*Salix* sp.) and speckled alder (Photographs C-9 to C-10). Much of the aquatic vegetation seen during the summer sampling event was growing on organic matter that appeared to function as a floating mat of vegetation. The substrate of Station 6 was predominantly comprised of organic matter and fine sediments, such as silt and clay. Woody debris was present throughout the stream channel.

Station 7 is located near the headwaters of the Salmon Trout River and is influenced by beaver dams throughout the vicinity. Station 7 is 100 feet in length and a beaver dam is located at the upstream extent of this station. The average width of Station 7 was 6.1 feet (n = 3; s = 0.8 feet) and the average depth was 1.1 feet (n = 9; s = 0.3 feet, Table 5-5). Stream flow was not measured in Station 7 because of channel braiding due to beaver activity.

The streambanks of Station 7 were vegetated with speckled alder, tussock sedge, rush, and iris (Photographs C-11 and C-12), and appeared similar to conditions observed in 2011. The substrate was comprised of organic matter and silt. Woody debris was abundant throughout this station.

Because of high water from a beaver dam that was constructed in 2008, Station 8 was relocated in 2011 from approximately 50 feet southwest of Northwestern Road to approximately 75 feet northeast of Northwestern Road, and extending downstream (northeast) for 135 feet (Figure 1-2, Table 5-1). The average width of Station 8 was 8.7 feet (n = 3; s = 0.2 feet) and the average depth was 0.7 feet (n = 9; s = 0.3 feet, Table 5-5). Stream flow was measured at the middle extent of Station 8 and discharge was estimated at 1,456 gpm (Table 5-5).

The stream channel of Station 8 was largely shaded by a dense canopy of speckled alder with an abundance of sedge growing along the streambank (Photograph C-13). Small woody debris and undercut banks were present throughout the station, and the stream substrate was predominantly comprised of sand and small gravel. A green-metal fence post was observed in the substrate of the stream channel at the upstream extent of Station 8 during the 2012 aquatic survey. The fence post appeared to be indicative of other ongoing aquatic surveys that may be taking place within the Station 8 vicinity.

Station 9 is located immediately southwest of Northwestern Road and is approximately 85 feet in length (Figure 1-2). The average width of Station 9 was 6.9 feet (n = 3; s = 0.6 feet) and average depth was 0.6 feet (n = 9; s = 0.2 feet, Table 5-5). Stream flow was measured at the downstream extent of Station 9 and discharge was estimated at 1,084 gpm (Table 5-5).

Habitat conditions within Station 9 generally appeared similar to conditions observed in 2011 except for the downstream extent of the station where a green-metal fence post was observed in the substrate of the stream channel, and at the upstream extent of the station where numerous speckled alders had been removed. The understory of Station 9 was predominately sedge, while speckled alder covered much of the stream channel and contributed to in-stream cover (Photographs C-14 to C-15). The substrate was predominantly comprised of sand and silt.

Station 10 is located immediately southwest of Northwestern Road and is approximately 100 feet in length (Figure 1-2). Average width of Station 10 was 4.4 feet (n = 3; s = 0.8 feet) and average depth was 0.4 feet (n = 9; s = 0.3 feet, Table 5-5). Stream flow was measured at the downstream extent of Station 10 and discharge was estimated at 183 gpm (Table 5-5).

The streambanks within Station 10 were vegetated with large deciduous trees, speckled alder, and other herbaceous vegetation (Photographs C-16 and C-17), and appeared similar to conditions observed in 2011. Woody debris and undercut banks provided in-stream cover throughout this station. The substrate was predominantly comprised of sand, silt and some gravel; although cobble and large boulders were also present (Photographs C-16 and C-17). A green-metal fence post was observed in the substrate

of the stream channel and at the downstream extent of the station and was not observed in the 2011 aquatic survey.

5.3.2 Yellow Dog River: Station 5

Station 5 is located immediately west of an unnamed road that crosses the Yellow Dog River in a north-south orientation and links to Triple A Road approximately 1.5 miles north of the river (Figure 1-2). The station is 300 feet in length, with an average width of 21.4 feet (*n* = 3; *s* = 1.5 feet) and average depth of 1.9 feet (*n* = 9; *s* = 1.1 feet, Table 5-5). Stream flow was measured at the downstream extent of Station 5 and discharge was estimated at 5,030 gpm (Table 5-5).

Streambanks appeared consistent with the 2011 survey and were vegetated with a dense covering of speckled alder, which contributed to in-stream cover and woody debris within the channel (Photographs C-18 to C-19). The substrate was predominantly comprised of sand and silt.

5.3.3 Cedar Creek: Station 4

The downstream extent of Station 4 was relocated from approximately 117 feet upstream (south) of Northwestern Road to approximately 300 feet downstream (north) of Northwestern Road in 2011 because of high water from beaver dams (Figure 1-2). Station 4 was 300 feet in length, with an average width of 24.0 feet (*n* = 3; *s* = 2.0 feet) and average depth of 1.0 feet (*n* = 9; *s* = 0.4 feet, Table 5-5). Stream flow was measured at the upstream extent of Station 4 and discharge was estimated at 5,642 gpm (Table 5-5).

The riparian vegetation throughout much of the relocated Station 4 was mature northern white cedars (*Thuja occidentalis*), and white pines (*Pinus strobus*). Speckled alder was also present along the stream channel in the upstream and downstream extents of the station (Photographs C-20 and C-21). The river channel was braided throughout the middle portion of the station, with frequent undercut banks, large woody debris and variety of substrate, including sand, gravel, cobble and boulders contributing to habitat complexity.

5.3.4 P-51 Habitat Scores

Stations sampled during 2012 were rated as “Good” or “Excellent” habitat quality (Table 5-6). The 2012 P-51 habitat ratings for Stations 1 through 10 were generally consistent with previous surveys conducted by AEM (AEM, 2012; AEM, 2008a; AEM, 2007).

5.4 Water Quality

Water temperature ranged from 11.5°C in Station 3 to 18.9°C in Station 5 during 2012 (Table 5-7). Dissolved oxygen ranged from 5.6 mg/L in Station 7 to 10.5 mg/L in Station 9. Dissolved oxygen in Station 6 was the second lowest value at 6.3 mg/L, and remained lower than values observed in 2008 (average dissolved oxygen = 8.3 mg/L). Average pH ranged from 6.8 in Station 7 to 8.3 in Station 9. Conductivity was low in all stations, ranging from 47 microSiemens per cm (µS/cm) in Station 7 to 154 µS/cm in Station 4 (Table 5-7).

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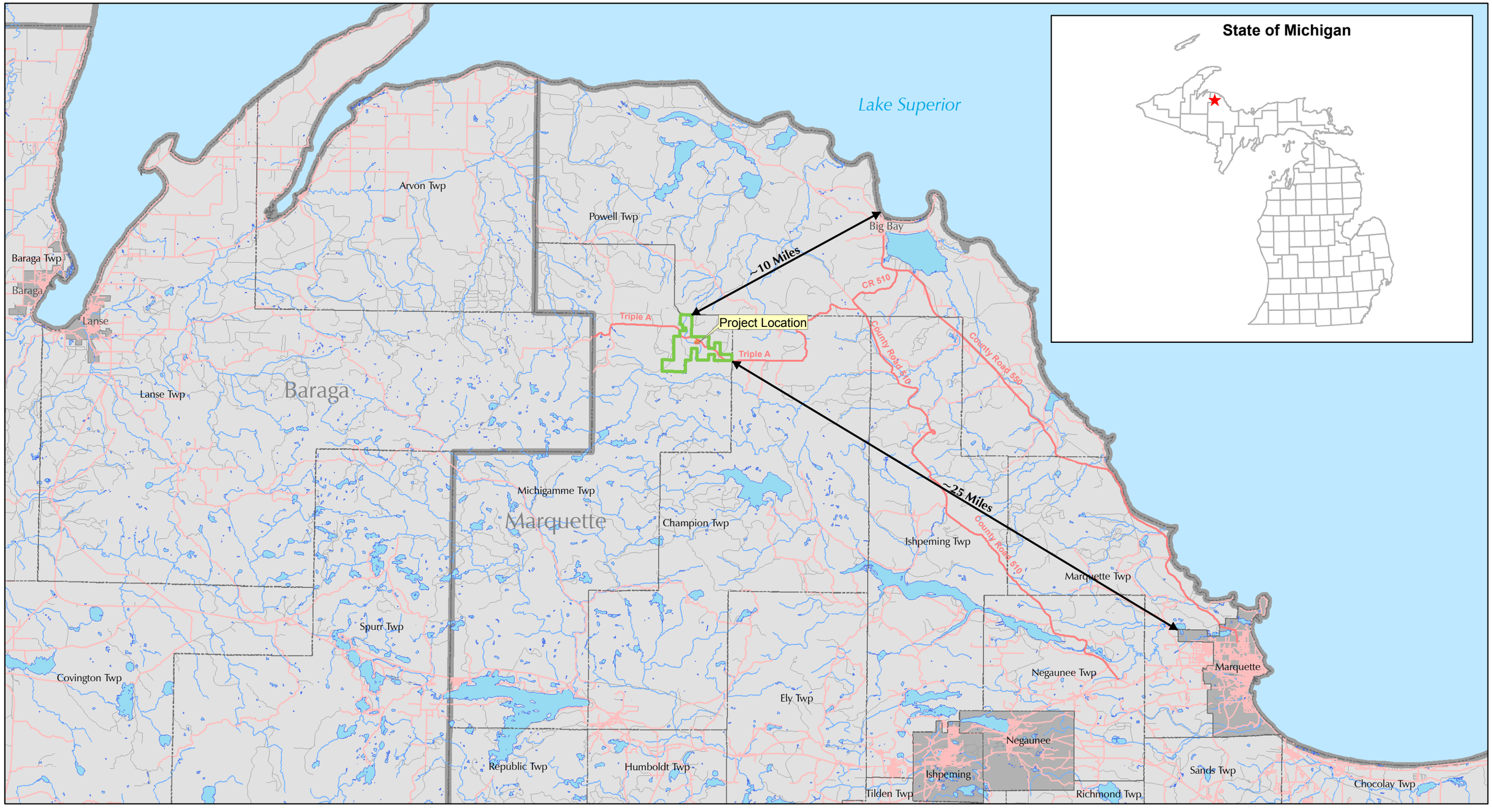
EXHIBIT A

REPORT FIGURES



NOTES

1. Surface property boundary as of November 18, 2004 supplied by Kennecott via Golder & Associates Inc., August, 2005.
2. Horizontal datum based on NAD 83/94. Horizontal coordinates based on UTM Zone 16.
3. All base information downloaded from Michigan Center of Geographic Information (http://www.michigan.gov/cgi).
4. Site Location - Project Site within Sections 11 &12, T50N, R29W, Town of Michigamme, Marquette County, Michigan.

LEGEND

- Counties
- Minor Civil Divisions
- Kennecott Surface Ownership
- Lakes and Rivers
- Highways
- Major Roads
- Minor Roads

N

ADVANCED ECOLOGICAL MANAGEMENT

Foth Infrastructure & Environment, LLC

Foth Infrastructure & Environment, LLC

REVISED	DATE	BY	DESCRIPTION

CHECKED BY:	DM	DATE: NOV. '08
APPROVED BY:	RDW	DATE: NOV. '08
APPROVED BY:		DATE:

Kennecott Eagle Minerals

FIGURE 1-1
PROJECT LOCATION

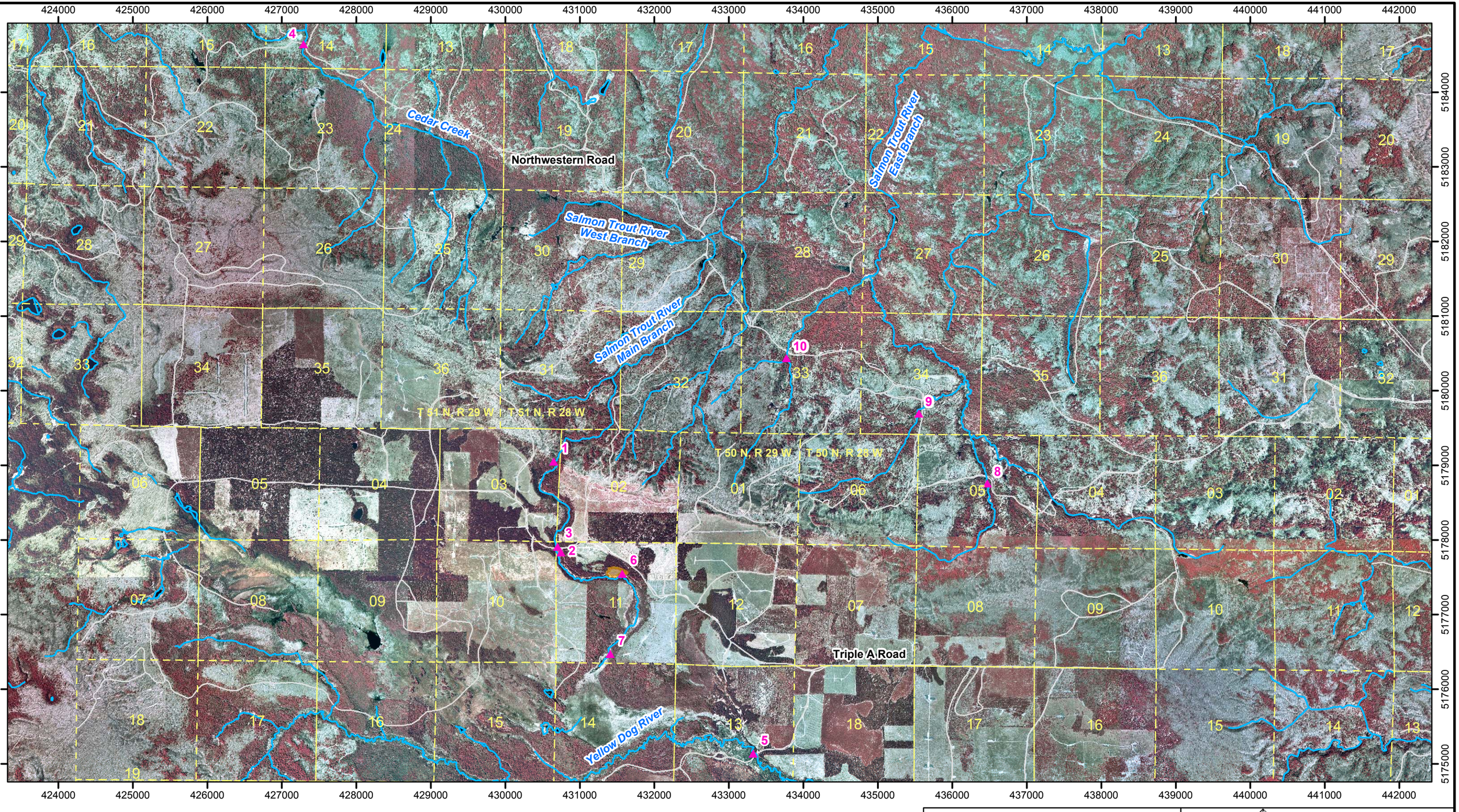
Scale: 0 2 4 Miles

Date: NOVEMBER 2008

Prepared by: DAT

Scope: 04W018

M:\kmceagle\mxd\AEM\2007\Report\projectlocation1_11x17.mxd March 28, 2008



NOTES

1. Surface Property Boundary, Ore Body, and Orthophotography supplied by Kennecott via Golder Associates Inc., August, 2005.
2. Horizontal datum based on NAD 83/94. Horizontal coordinates based on UTM Zone 16.
3. Site Location - Project Site within Sections 11 &12, T50N, R29W, Town of Michigamme, Marquette County, Michigan.

LEGEND

- 6 ▲ Aquatic Sampling Location and Number
- River
- Ore Body

N

ADVANCED ECOLOGICAL MANAGEMENT

Foth Infrastructure & Environment, LLC

REVISED	DATE	BY	DESCRIPTION

CHECKED BY:	DM	DATE: NOV. '08
APPROVED BY:	RDW	DATE: NOV. '08
APPROVED BY:		DATE:

Foth Infrastructure & Environment, LLC

Kennecott Eagle Minerals

FIGURE 1-2

KENNECOTT EAGLE PROJECT

2012 AQUATIC SAMPLING LOCATIONS

Scale: 0 600 1,200 Meters

Date: NOVEMBER 2008

Prepared by: DAT

Scope: 04W018

M:\kmceagle\mxd\AEM\2007\Report\samplinglocations1_11x17.mxd March 28, 2008

EXHIBIT B

REPORT TABLES

Table 1-1. Summary of the Procedure 51 Macroinvertebrate and Aquatic Habitat Scores for All Stations, 2012.

System Station Number	STRM 1	STRM 2	STRM 3	CC 4	YDR 5	STRM 6	STRM 7	STRE 8	STRE 9	STRE 10
Fish Score	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Macroinvertebrate Score	Excellent	Acceptable	Acceptable	Excellent	Acceptable	n.a.	n.a.	Acceptable	Excellent	Excellent
Stream Habitat Score	Excellent	Good	Excellent	Excellent	Good	n.a.	n.a.	Excellent	Excellent	Excellent

STRM – Salmon Trout River Main Branch
STRE – Salmon Trout River East Branch
CC – Cedar Creek
YDR – Yellow Dog River
n.a. – Not applicable

Table 5-1. Sample Station Location Description.

Station Number	Stream Name	Latitude/Longitude NAD 1983	Township/Range/ Section	Location Description
1	Salmon Trout River Main Branch	N 46.76130 W 87.90807	Michigamme Twp. T50N, R29W, Sec 3	Approximately 5,220 feet S of AAA Road and continuing S 120 feet.
2	Salmon Trout River Main Branch	N 46.75059 W 87.90720	Michigamme Twp. T50N, R29W, Sec. 11	Upstream extent located immediately S of AAA Road and continuing upstream 100 feet.
3	Salmon Trout River Main Branch	N 46.75148 W 87.90736	Michigamme Twp. T50N, R29W, Sec. 11	Downstream extent located immediately N of AAA Road and continuing downstream 200 feet.
4	Cedar Creek	N 46.81066 W 87.95323	Powell Twp. T51N, R29W, Sec. 14	Downstream extent located 300 feet N of Northwestern Road and continuing upstream to road crossing.
5	Yellow Dog River	N 46.72694 W 87.87268	Michigamme Twp. T50N, R29W, Sec. 13	Downstream extent located immediately upstream of unnamed road and continuing upstream 300 feet.
6	Salmon Trout River Main Branch	N 46.74793 W 89.89584	Michigamme Twp. T50N, R29W, Sec. 11	Downstream extent located approximately 4,600 feet upstream of AAA Road and continuing upstream 300 feet.
7	Salmon Trout River Main Branch	N 46.73808 W 87.89810	Michigamme Twp. T50N, R29W, Sec. 11	Near headwaters and N 100 feet.
8	Tributary to the East Branch of the Salmon Trout River	N 46.760113 W 87.83224	Champion Twp. T50N, R28W, Sec. 5	Upstream extent located 75 feet NE of Northwestern Road and continuing NE for 135 feet.
9	Tributary to the East Branch of the Salmon Trout River	N 46.76862 W 87.84377	Powell Twp. T51N, R28W, Sec. 34	Downstream extent located immediately SW of Northwestern Road and continuing SW for 85 feet.
10	Tributary to the East Branch of the Salmon Trout River	N 46.77471 W 87.86767	Powell Twp. T51N, R29W, Sec. 33	Downstream extent located immediately SW of Northwestern Road and continuing SW for 100 feet.

Table 5-2. 2012 Summer Fish Collection Data – Stations 1-10.

		Station Number									
Scientific Name	**Common Name**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Summer Data											
Catostomus commersonii	White sucker					1					
Culaea inconstans	Brook stickleback						13	3			
Margariscus margarita	Pearl dace		1				10				
Oncorhynchus mykiss	Rainbow trout					2					
Phoxinus eos	Northern redbelly dace		16			1	171	25			
Phoxinus neogaeus	Finescale dace						7				
Rhinichthys obtusus	Blacknose dace					26					
Salvelinus fontinalis	Brook trout	13	2	6	10	5	2		13	10	3
Semotilus atromaculatus	Creek chub					19					
	Total Number	**13**	**19**	**6**	**10***	**54**	**203**	**28**	**13**	**10**	**3**

Stations 1, 2, 3, 6, 7 - Salmon Trout River Main Branch
Stations 8, 9 and 10 - Salmon Trout River East Branch
Station 4 - Cedar Creek
Station 5 - Yellow Dog River
*** - Backpack shocker malfunctioned during survey of Station 4**

Table 5-3. 2012 Macroinvertebrate Community – Stations 1-10.

TAXA	1	2	3	4	5	6	7	8	9	10
ANNELIDA (segmented worms)										
Hirudinea (leeches)				9	3	3		2		
Oligochaeta (worms)	1			4				1	2	
ARTHROPODA										
Amphipoda (scuds)	1	3		10	1	99	39			
Arachnoidea										
Hyrdacarina							1	1		
Insecta										
Ephemeroptera (mayflies)										
Baetiscidae					1					
Baetidae	53	10	8	45	6			78	23	
Caenidae						7	7			
Ephemerellidae	56	1	3	17		2			5	9
Ephemeridae					8					1
Heptageniidae	3	1	2	1	2			3		1
Leptophlebiidae				6				32		1
Odonata										
Anisoptera (dragonflies)										
Aeshnidae		1			2	5	5		1	3
Cordulegastridae	9		2	1	3			1	2	19
Corduliidae						1	2			
Gomphidae					14					
Libellulidae						27	3			1
Zygoptera (damselflies)										
Calopterygidae		2			1					2
Coenagrionidae						9	1			
Plecoptera (stoneflies)										
Leuctridae									5	1
Nemouridae	2		1	1				6	3	
Perlodidae	5			1					1	
Pteronarcyidae	4									
Hemiptera (true bugs)										
Belostomatidae							1			
Corixidae	1					36	3			
Gerridae	3	2	6		1	1	3	1	3	18
Nepidae					1					
Notonectidae						5				
Megaloptera										
Corydalidae (dobson flies)		1	2							
Sialidae (alder flies)					3				2	2

Stations 1, 2, 3, 6, 7 - Salmon Trout River Main Branch
Stations 8, 9, 10 - Salmon Trout River East Branch
Station 4 - Cedar Creek
Station 5 - Yellow Dog River

Table 5-3 (Continued). 2012 Macroinvertebrate Community – Stations 1-10.

TAXA	1	2	3	4	5	6	7	8	9	10
Trichoptera (caddisflies)										
Brachycentridae	5		1	1						
Glossosomatidae	4			6						4
Hydropsychidae	1	33	60	6				64	6	11
Lepidostomatidae	14			34	9			12	3	16
Limnephilidae	2			4	15	2	1	1	1	2
Molannidae					1					
Philopotamidae	15	45	28	5				7		24
Phryganaeidae						2				
Polycentropodidae									2	
Rhyacophilidae	5			3					7	3
Uenoidae	4		26	3	1				31	3
Coleoptera (beetles)										
Haliplidae (adults)					5	5	3			
Hydrophilidae (total)	1	1								
Elmidae	2		1	2	2				5	1
Gyrindae (larvae)		1			1					
Diptera (flies)										
Athericidae	2			15				1	1	
Ceratopogonidae				3						
Chironomidae	4	11	7	51	8	4	15	10	10	5
Dixidae										1
Simuliidae	5	30	21	16				17	5	
Tabanidae					3	1		2		1
Tipulidae	1			2	1			2		2
MOLLUSCA										
Gastropoda (snails)										
Physidae		2	1							
Planorbidae					8		12			
Pisidiidae							2			
Sphaeriidae (clams)				1		1	7	1		
Total	**203**	**144**	**169**	**247**	**100**	**210**	**105**	**242**	**118**	**131**

Stations 1, 2, 3, 6, 7 - Salmon Trout River Main Branch
Stations 8, 9, 10 - Salmon Trout River East Branch
Station 4 - Cedar Creek
Station 5 - Yellow Dog River

Table 5-4. 2012 Macroinvertebrate Scores and Community Ratings – Stations 1-10.

	1		2		3		4		5	
Metric	**Value**	**Score**	**Value**	**Score**	**Value**	**Score**	**Value**	**Score**	**Value**	**Score**
Total Number of Taxa	25	1	14	0	15	0	25	0	23	0
Number of Mayfly Taxa	3	1	3	1	3	1	4	0	4	0
Number of Caddisfly Taxa	8	1	2	-1	4	0	8	1	4	0
Number of Stonefly Taxa	3	1	0	-1	1	0	2	1	0	-1
Percent Mayfly Comp.	55.17	1	8.33	0	7.69	0	27.94	1	17.00	0
Percent Caddisfly Comp.	24.63	0	54.17	1	68.05	1	25.10	0	26.00	0
Percent Dominant Taxon	27.59	-1	31.25	-1	35.50	-1	20.65	0	15.00	1
Percent Isopod, Snail, Leech	0.00	1	1.39	1	0.59	1	3.64	1	11.00	0
Percent Surf. Air Breathers	2.46	1	2.08	1	3.55	1	0.00	1	7.00	0
Total Score		6		1		3		5		0
Community Rating		**Excellent**		**Acceptable**		**Acceptable**		**Excellent**		**Acceptable**

	6		7		8		9		10	
Metric	**Value**	**Score**	**Value**	**Score**	**Value**	**Score**	**Value**	**Score**	**Value**	**Score**
Total Number of Taxa	17	0	16	0	19	0	20	1	23	1
Number of Mayfly Taxa	2	-1	1	-1	3	0	2	0	4	1
Number of Caddisfly Taxa	2	-1	1	-1	4	0	6	1	7	1
Number of Stonefly Taxa	0	-1	0	-1	1	0	3	1	1	1
Percent Mayfly Comp.	4.29	0	6.67	0	46.69	1	23.73	1	9.16	0
Percent Caddisfly Comp.	1.90	0	0.95	-1	34.71	1	42.37	1	48.09	1
Percent Dominant Taxon	47.14	-1	37.14	-1	32.23	-1	26.27	0	18.32	0
Percent Isopod, Snail, Leech	1.43	1	11.43	0	0.83	1	0.00	1	0.00	1
Percent Surf. Air Breathers	22.38	-1	9.52	0	0.41	1	2.54	1	13.74	-1
Total Score		-4		-5		3		7		5
Community Rating		**n.a.**		**n.a.**		**Acceptable**		**Excellent**		**Excellent**

Stations 1, 2, 3, 6, 7 - Salmon Trout River Main Branch
Stations 8, 9, 10 - Salmon Trout River East Branch
Station 4 - Cedar Creek
Station 5 - Yellow Dog River
n.a. – Not applicable

Table 5-5. 2012 Summer Physical Stream Dimensions – Stations 1-10.

Station	Length (ft)	Wetted width (ft)		Depth (ft)		Discharge (gpm)
		Average*	*s*	Average	*s*	
1	120	7.4 (3)	1.9	0.4 (9)	0.1	1,176
2	100	5.6 (3)	1.3	0.8 (9)	0.2	536
3	200	7.1 (3)	1.1	0.4 (9)	0.1	536
4	300	24.0 (3)	2.0	1.0 (9)	0.4	5,642
5	300	21.4 (3)	1.5	1.9 (9)	1.1	5,030
6	300	17.5 (3)	3.2	2.4 (9)	0.2	290
7	100	6.1 (3)	0.8	1.1 (9)	0.3	n.m.
8	135	8.7 (3)	0.2	0.7 (9)	0.3	1,456
9	85	6.9 (3)	0.6	0.6 (9)	0.2	1,084
10	100	4.4 (3)	0.8	0.4 (9)	0.3	183

Stations 1, 2, 3, 6, 7 - Salmon Trout River Main Branch
Stations 8, 9, 10 - Salmon Trout River East Branch
Station 4 - Cedar Creek
Station 5 - Yellow Dog River
***sample size is indicated within ()**
***s* = standard deviation**
gpm = Gallons per minute
n.m. = Not measured

Table 5-6. 2012 Procedure 51 Habitat Evaluation Scores – Stations 1-10.

	Sample Station									
	1	2	3	4	5	6	7	8	9	10
Habitat Metric	riffle/run	glide/pool	riffle/run	riffle/run	glide/pool	n.a.	n.a.	riffle/run	glide/pool	riffle/run
Substrate and In-stream Cover										
Epifaunal Substrate/Avail. Cover	19	13	18	18	10	-	-	15	12	18
Embeddedness	19		14	14		-	-	18		15
Pool Substrate Characterization		13			10	-	-		11	
Velocity Depth Regime	15		14	14		-	-	15		10
Pool Variability		10			14	-	-		13	
Sediment Deposition	15	12	15	13	14	-	-	17	14	17
Channel Morphology										
Maintained Flow Volume	9	9	9	9	9	-	-	9	10	7
Flashiness	9	7	8	9	7	-	-	9	8	7
Channel Alteration	20	16	18	19	20	-	-	20	15	15
Frequency of Riffles/Bends	19		15	15		-	-	12		17
Channel Sinuosity		12			14	-	-		14	
Riparian and Bank Structure										
Bank Stability (L)	9	9	9	9	7	-	-	9	10	10
Bank Stability (R)	9	9	9	9	7	-	-	9	10	10
Vegetative Protection (L)	10	10	10	10	10	-	-	10	10	10
Vegetative Protection (R)	10	10	10	10	10	-	-	10	10	10
Riparian Veg. Zone Width (L)	10	10	10	10	10	-	-	10	10	10
Riparian Veg. Zone Width (R)	10	10	10	10	10	-	-	10	10	10
Total Score	**183**	**150**	**169**	**169**	**152**	**n.a.**	**n.a.**	**173**	**157**	**166**
Habitat Rating	**Excellent**	**Good**	**Excellent**	**Excellent**	**Good**	**n.a.**	**n.a.**	**Excellent**	**Excellent**	**Excellent**

Stations 1, 2, 3, 6, 7 - Salmon Trout River Main Branch
Stations 8, 9, 10 - Salmon Trout River East Branch
Station 4 - Cedar Creek
Station 5 - Yellow Dog River
n.a. – Not applicable

Table 5-7. 2012 Average Water Quality Parameters – Stations 1-10.

Station Number	Date	Time	Water Temperature (°C)	Dissolved Oxygen (mg/L)	Percent Dissolved Oxygen	pH	Conductivity (µS/cm)
1	6/14/2012	14:44	13.3 (0.0)	9.6 (0.2)	91.0 (1.6)	7.8 (0.0)	70 (0.1)
2	6/13/2012	10:10	12.5 (0.3)	8.2 (0.4)	77.1 (3.6)	7.5 (0.1)	63 (1.5)
3	6/13/2012	9:08	11.5 (0.0)	9.1 (0.2)	83.6 (2.0)	7.6 (0.2)	60 (0.4)
4	6/15/2012	14:40	13.6 (0.1)	9.7 (0.1)	93.1 (0.6)	7.8 (0.1)	154 (1.0)
5	6/12/2012	17:03	18.9 (0.1)	7.9 (0.1)	84.9 (1.0)	7.3 (0.1)	75 (0.1)
6	6/12/2012	13:49	16.6 (0.3)	6.3 (0.2)	61.0 (5.4)	7.0 (0.3)	71 (2.2)
7	6/14/2012	16:27	16.2 (0.1)	5.6 (0.6)	57.0 (5.7)	6.8 (0.2)	47 (0.5)
8	6/14/2012	9:56	11.6 (0.0)	9.5 (0.1)	87.5 (1.3)	7.9 (0.0)	101 (0.8)
9	6/13/2012	16:15	11.6 (0.1)	10.5 (0.2)	95.9 (0.7)	8.3 (0.1)	102 (0.5)
10	6/13/2012	13:13	14.2 (0.1)	8.6 (0.7)	84.4 (6.4)	8.1 (0.1)	124 (2.5)

Stations 1, 2, 3, 6, 7 - Salmon Trout River Main Branch
Stations 8, 9, 10 - Salmon Trout River East Branch
Station 4 - Cedar Creek
Station 5 - Yellow Dog River
°C = Degrees Celsius
mg/L = Milligrams per liter
µS/cm = Microsiemens per centimeter
standard deviation is indicated within ()

EXHIBIT C

STATION PHOTOGRAPHS

Photograph C-1. Cedar Creek and beaver dam upstream of Northwestern Road. South View, June, 2012.

Photograph C-2. Station 1 – Upstream Extent North View, June, 2012.

Photograph C-3. Station 1 - Downstream Extent View South, June, 2012.

Photograph C-4. Station 1 – Woody debris mid-reach extent View South, June, 2012.

Photograph C-5. Station 2 – Upstream Extent View North, June, 2012.

Photograph C-6. Station 2 – Downstream Extent View South, June, 2012.

Photograph C-7. Station 3 – Upstream Extent View North, June, 2012.

Photograph C-8. Station 3 –Downstream Extent View South, June, 2012.

Photograph C-9. Station 6 – Upstream Extent View Southwest, June, 2012.

Photograph C-10. Station 6 – Downstream Extent View Southwest, June, 2012.

Photograph C-11. Station 7 – Downstream Extent View Southwest, June, 2012.

Photograph C-12. Station 7 – Upstream Extent View North, June, 2012.

Photograph C-13. Station 8 – Downstream Extent View South, June, 2012.

Photograph C-14. Station 9 – Downstream Extent View Southwest, June, 2012.

Photograph C-15. Station 9 – Upstream Extent View Northeast, June, 2012.

Photograph C-16. Station 10 – Downstream Extent View Southwest, June, 2012.

Photograph C-17. Station 10 – Upstream Extent View Northeast, June, 2012.

Photograph C-18. Station 5 – Downstream Extent View West, June, 2012.

Photograph C-19. Station 5 – Upstream Extent View East, June, 2012.

Photograph C-20. Station 4 – Downstream Extent View South, June, 2012.

Photograph C-21. Station 4 – Upstream Extent View North, June, 2012.