

Appendix G

Aquatic Study

G-1

Baseline Aquatic Study

Aquatic Assessment

Kennecott Minerals Company
Eagle Project
Marquette County, Michigan

Prepared for:

Golder Associates, Inc.

Prepared by:



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SUMMARY

Wetland and Coastal Resources, Inc. (WCR) was contracted by Golder Associates, Inc. (Golder) to perform fisheries, aquatic biota, and aquatic habitat assessments for the Salmon Trout and Yellow Dog Rivers. The assessments are part of a baseline environmental study within a 1600-acre project study area located northwest of Marquette, Michigan. Wetland and Coastal Resources, Inc. conducted field baseline studies during August of 2004.

The Salmon Trout River is a first order coldwater stream classified by the state as a designated trout stream. The biotic communities and habitats associated with the Salmon Trout River include valued aquatic resources with significant habitats for both cold and cool water fish. The river is known to support populations of naturally reproducing brook trout including a self-sustaining population of migratory, or “coaster”, brook trout. However, based on site reviews and conversations with management biologists at the Michigan Department of Natural Resources, there are a number of impassable dams and falls downstream of the project study area that prevent upstream movement of fish.

Habitat, fish and macroinvertebrate communities were sampled at three stations on the Salmon Trout River using Great Lakes and Environmental Assessment Section (GLEAS) Procedure #51, *Qualitative Biological and Habitat Survey Protocols for Wadable Streams and Rivers* (1997), with 2002 revisions (Procedure 51). Habitat surveys resulted in ratings of excellent at all three stations, although excess sediment was found at each. Based on site surveys and literature reviews, the gravel road infrastructure and clear-cutting activities within the watershed are likely primary sources of sediment.

Macroinvertebrate sampling on the Salmon Trout River resulted in ratings of excellent at Stations 1 and 3 and acceptable at Station 2. Although all three stations had habitat ratings of excellent, differences in macroinvertebrate scores are believed to be a reflection of habitat variation between stations. Stations 1 and 3 are part of downstream reaches within the study area where higher gradients and hard substrates are present. Station 2 is located within an

upstream reach where low gradients and finer substrates (sands) are dominant. Beaver ponds are also present immediately upstream of Station 2.

Fish surveys resulted in collection of 65 fish at the three stations with 76.9 % of the catch consisting of brook trout. Only one trout caught (Station 2) was above the legal harvestable size limit of 17.8 cm (7 inches). All three stations met the state coldwater stream designation under Procedure 51.

Cedar Creek (Station 4) was established as a control site outside the influence of the project area. Procedure 51 was used to sample one station northwest of the study area, upstream of Northwestern Road. Habitat and macroinvertebrate sampling resulted in scores of good and acceptable, respectively. Aquatic insects requiring good water quality dominated the sample. However, because Cedar Creek is wider than the Salmon Trout, more aquatic habitat is available and Procedure 51 metrics are scored more critically. Based upon the Procedure 51 habitat rating, sediment appears to be the major cause of degradation at this station.

Fish surveys on Cedar Creek resulted in collection of 13 fish. All fish collected were brook trout, with two individuals exceeding the legal size limit for harvest. These results are similar to those found at Stations 1 and 3. However, fish densities were much lower in Cedar Creek, which is likely the result of habitat differences between stations.

One station (Station 5) was sampled on the Yellow Dog River at closest road crossing to the study area. Habitat and macroinvertebrate sampling resulted in scores of good and acceptable, respectively, indicating that the river contains quality macroinvertebrate communities and habitats. However, both scores are one level below the highest rating under Procedure 51, reflecting lower scores for substrate, in-stream cover, sediment deposition, and channel sinuosity.

Sampling for fish on the Yellow Dog River did not result in collection of any trout species. The lack of trout in the catch does not allow for coldwater designation under Procedure 51. However, the MDNR considers the river a coldwater trout stream and observations at road

crossings downstream of the sample station show the river to contain a variety of habitats desirable to trout and other coldwater organisms.

Results of these surveys and review of available literature indicate that the Salmon Trout and Yellow Dog Rivers are both high quality coldwater trout streams with a variety of in-stream habitats and adjacent bank cover. Protection of the headwaters of these streams and adjacent habitats is important to protect and maintain the quality of the streams and downstream receiving waters.

1.0 INTRODUCTION

In July of 2002, Kennecott Minerals Company (Kennecott) discovered a high-grade nickel and copper deposit approximately 45 kilometers northwest of Marquette in Michigan's Upper Peninsula. The discovery is known as the Eagle Project. Since this discovery, economic and environmental evaluations were initiated to determine the potential for developing an operating mine.

The purpose of this evaluation is to collect baseline environmental data and document existing biological conditions. Furthermore, the purpose of collecting these data is to provide sufficient information to support future mine facility alternative analysis and design, environmental permitting, and potential project impact analysis.

Golder Associates, Inc. (Golder) was chosen as the prime consultant to manage the baseline environmental study programs. On February 6, 2004, Golder authorized Wetland and Coastal Resources, Inc. (WCR) to perform baseline environmental studies including assessments for wetlands, wildlife, aquatic organisms and habitats, and threatened and endangered species. This report presents the findings of WCR's assessments for aquatic organisms and aquatic habitats. Results of wildlife, wetlands, and threatened and endangered species reviews are presented in separate reports.

The work conducted on this site and the content of this report represent the opinions of WCR. The aquatic assessments presented are based on one-time surveys designed to characterize representative conditions of the watercourses sampled.

1.1 Project Area

Kennecott currently controls more than 1600 acres of mineral and surface rights in the project area. The project area is located in Sections 2, 3, 10, 11, 12, 14, 15, T50N, R29W of Michigamme Township, Marquette County, Michigan within the Yellow Dog Plains at the headwaters of the Salmon Trout River. **Figure 1.1 (Appendix A)** shows the boundaries of the project area and **Figure 1.2 (Appendix A)** identifies the five stations sampled. Three stations were sampled within the project area on the Salmon Trout River and two stations (Cedar Creek and Yellow Dog River) were sampled outside of the project area.

1.2 Project Purpose

The purpose of conducting the aquatic assessments was to (1) characterize the physical characteristics and quality of the streams at the locations sampled, (2) identify the macroinvertebrate and fish communities that inhabit the streams and (3) document baseline conditions for potential use in monitoring. This report is being presented to Golder to utilize as part of environmental assessment to assist in developing and assessing project alternatives.

2.0 METHODS

The methods used to assess the biological integrity of the streams at each sampling location are those set forth in Great Lakes and Environmental Assessment Section (GLEAS) Procedure #51, *Qualitative Biological and Habitat Survey Protocols for Wadable Streams and Rivers* (1997), with 2002 revisions (Procedure 51). Procedure 51 is accepted by both federal and state agencies as an accurate, consistent and repeatable sampling and analytical protocol for Michigan streams.

The survey protocols detail evaluation of the macroinvertebrate community, the fish community, and habitat quality. The results are used as indicators of water quality and biological integrity. Analysis is made according to a set of selected metrics (measurements) that are made in the field. Under protocols for Procedure 51, biological integrity of a stream is based on the results of the fish and macroinvertebrate community sampling. However, fish community scores are not calculated for coldwater streams. Instead, sampling is used to evaluate whether a stream meets coldwater designation. To meet this designation, the proportion of salmonids to the total number of fish must exceed 1%. Therefore, the biological integrity at each station is based upon the scores for macroinvertebrates only.

2.1 Literature Review

Prior to field sampling, a literature search was conducted and contact was made with representatives of the Michigan Department of Environmental Quality (MDEQ), Michigan Department of Natural Resources (MDNR) and the United States Fish and Wildlife Service (USFWS). The search was focused on obtaining existing information related to the aquatic resources of the Salmon Trout River, Yellow Dog River, Cedar Creek, or any of their tributaries.

2.2 Station Selection

Sampling stations on the Salmon Trout River were selected based on the pre-stated purposes of this assessment and to represent all accessible stream habitats within the project area. Stations located at a road crossing were sampled upstream of the crossing as recommended in Procedure 51, with the exception of Station 3. This station was sampled downstream of the road to include habitats within the center of the project area that are not otherwise present upstream, and to provide baseline information immediately downstream of Triple A Road. When possible, stations were selected that are easily accessible, unmodified, and are not included in current or anticipated MDEQ sampling schedules. In selection of all stations, an extended length of stream was observed prior to station selection to find the best location for sampling.

Station 1 is located on the Salmon Trout River at the downstream end of the project area. **(Figure 2.1, Appendix A)**. This station is a 125 feet (ft) (38 meters (m)) reach with difficult access. However, this station was chosen to provide baseline information downstream of potential project activities and for comparison with potential operation and closure monitoring.

Stations 2 and 3 are located near the center of the project area on the Salmon Trout River and have easy access from Triple A Road **(Figure 2.1, Appendix A)**. Station 2 begins at the road crossing and continues upstream 100 ft (30 m) and Station 3 is 200 ft (61 m) in length and begins approximately 50 ft (15 m) downstream of the road crossing. The entire reach of river upstream of the road crossing was observed prior to station selection and beaver dams were found to be prevalent beginning approximately 100 ft (30 m) upstream of Triple A Road. Procedure 51 recommends sampling begin at an appropriate distance away from a road crossing to avoid influence of the crossing. However, sampling at Station 2 began at the road to include a minimum of 100 ft (30 m) of stream length for sampling.

Station 4 is located on Cedar Creek beginning 100 ft (30 m) upstream of Northwestern Road **(Figure 2.2, Appendix A)**. This station is 300 ft (91 m) in length and includes all habitat

types identified in Cedar Creek during initial investigation. Cedar Creek is outside the influence of the project area and the station was chosen to serve as a control site for potential future analyses.

Station 5 is 250 ft (76 m) in length located on the Yellow Dog River, beginning 100 ft (30 m) upstream of a gravel road crossing (**Figure 2.3, Appendix A**). This station is located south of the study area and within a different drainage area than the project area. The station was chosen based on availability of access and proximity to the project area.

2.3 Macroinvertebrates

Hand held dip nets with 1 mm mesh were used to sample aquatic macroinvertebrates. Sampling was conducted in an upstream direction and each station was sampled until no new taxa were found (30 minutes at Stations 1, 3 and 4; 35 minutes at Stations 2 and 5). All available habitats were sampled including fast and slow moving water areas, hard substrates, soft substrates, vegetated areas, and undercut banks. Kick sampling was used in most areas, except in slower moving water, where dip-netting methods were used. Larger stones and logs were sampled by hand. All organisms collected were identified, counted, and recorded. Merritt and Cummings (1996) reference was used to aide in identification of the aquatic insects.

The GLEAS Procedure # 51 program was used to calculate a score for each station based on the following nine metrics:

- *Total number of taxa.* Taxa richness and species diversity are standard indicators of healthy and stable biological communities. This metric evaluates the total number of taxa found and rates diverse systems higher than monotypic communities.
- *Number of mayfly taxa.* The total number of mayfly taxa is used as an overall indicator of stream quality. Mayflies are, as a group, considered to be intolerant to pollution. Their presence, in abundance is therefore rated high in this metric.
- *Number of caddisfly taxa.* Like mayflies, caddisflies are pollution intolerant. Areas containing high numbers of caddisflies are given higher metric values. However, several species can tolerate varying degrees of habitat degradation.

- *Number of stonefly taxa.* Stoneflies are the most sensitive to, and intolerant of poor water quality. Their presence is often an indicator of excellent water quality.
- *Percent mayfly composition.* This metric weights the presence of mayflies in relation to the total number of species found. As with the total number of mayfly taxa, the percent composition of mayflies can drastically decline with stream quality degradation.
- *Percent caddisfly composition.* This metric weights the number of caddisflies found in relation to the total number of species found within the sample area.
- *Percent contribution of dominant taxa.* This metric calculates the ratio of the number of dominant taxa found to the total number of organisms collected. The results provide an indication of community structure and balance. Those areas dominated by few species, or composed of several taxa but strongly dominated by one, indicate lower quality systems.
- *Percent isopods, snails, and leeches.* Taxa from these three groups are tolerant to a wide variety and range of environmental conditions. High percent abundance of these animals is a good indicator of degraded stream habitats and low water quality.
- *Percent surface air breathers.* Surface dependent taxa refers to invertebrates that obtain oxygen through direct atmospheric exchange, usually at the air/water interface. High abundance of these animals is an indication of diurnal oxygen changes or other biological or chemical oxygen use. These taxa are also found in streams with higher temperatures and lower, erratic flows that typically have low or fluctuating dissolved oxygen concentrations.

2.4 Habitat

Habitat assessments were completed by first determining whether the stream was characterized by riffles and runs or pools and glides. Riffle/run streams, as defined by Procedure 51, typically demonstrate a regular riffle/run sequence, have substrates composed primarily of coarse sediment and tend to have moderate to high gradients. Glide/pool streams exhibit a pool/glide sequence, have a dominance of finer substrates and low to moderate gradients. Upon determination of stream type, the physical characteristics of the stream and stream bank habitats were recorded for each sampling station based upon the metrics associated with each stream type. Both the riffle/run and glide/pool streams are scored using 10 metrics (**Table 1, Appendix B**), which are separated into three general

categories as identified below. The designation * refers to riffle/run only and the designation ** refers to glide/pool only.

Substrate and In-Stream Cover

- *Epifaunal Substrate/Available Cover*. This metric includes the relative quantity and diversity of natural structures in the stream, such as gravel, large rocks, woody debris, and undercut banks, available as habitat for aquatic organisms.
- *Embeddedness**. Embeddedness refers to the degree to which hard substrates such as gravel, cobble, boulders and logs are sunken into, or covered by, finer sediments. As hard substrates become more embedded, the fewer habitats are available to aquatic organisms.
- *Velocity/Depth Regime**. Patterns of depth and velocity are important features of habitat diversity. Streams with higher diversity have slow-deep water, slow-shallow water, fast-deep water and fast-shallow water.
- *Pool Substrate Characterization***. This metric evaluates the type and condition of substrate found in pools. Firm substrates and vegetation support a greater diversity of organisms.
- *Pool Variability***. This metric rates the overall variability of pool types according to size and depth. A larger variety of pool types supports a larger diversity of organisms.

Channel Morphology

- *Sediment Deposition*. This parameter measures the ratio of stream bottom affected by deposition of larger particles (sediment, clays, and loose sand) to the total area of the stream bottom. Areas that contain less depositional material are rated higher and show a more stable habitat for biotic organisms.
- *Channel Flow Status*. Adequate and stable water is a prime requisite for most aquatic organisms found in streams. Flow stability assesses the regularity, permanence, and stability of flows within the stream. Streams with stable flows and natural water supplies (groundwater dominant) receive higher ratings. Conversely, streams with “flashy”, unstable flows receive lower ratings.
- *Channel Alteration*. This is a measure of the large-scale change in stream morphology. Evidence of alteration may include dredging, artificial embankments or straightening. Higher scores are given to stream channels that offer natural habitats to aquatic organisms.

- *Frequency of Riffles (or Bends)**. This metric measures the heterogeneity of a stream. Riffles are a source of high quality habitat and harbor diverse fauna; therefore, an increased frequency is considered beneficial to a stream.
- *Channel Sinuosity***. This metric evaluates the degree of meandering to the stream. A large value indicates a higher degree of meandering and supports a larger diversity of organisms.

Riparian and Bank Structure

- *Bank Stability*. Bank stability is a measure of bank erosion, based on adjacent side slopes and the potential for extreme, high flow flooding conditions. Higher erosion potential (such as steep slopes) receives lower scores.
- *Bank Vegetative Protection*. This parameter is a measure of the density of bank vegetation and other erosion control structures (boulders, rocks, etc.). Streamside vegetation provides increased protection from bank erosion and subsequent sedimentation. Therefore, areas exhibiting higher densities receive higher scores.
- *Riparian Vegetation Zone Width*. This metric measures the width of vegetation along the banks. The riparian zone provides habitat, filters pollutants and sediment, and provides thermal protection to the stream channel.

Scoring for each metric was based on visual observation and best professional judgment. This procedure rates the habitat parameter most important to the biological community composition higher and provides a final qualitative habitat rating.

2.5 Fish

Although fish sampling is considered to be optional in Procedure 51 and a limited set of metrics is available for evaluation of coldwater streams, fisheries assessments were conducted to supplement data and ensure a thorough evaluation. To avoid disturbing fish prior to sampling, fish were sampled before macroinvertebrate sampling and habitat evaluations. Fish were sampled using a Smith-Root LR-24 backpack electrofisher and two passes in an upstream direction were conducted at each of the five sampling stations. Stations 1-5 were sampled for 1260 seconds (sec), 1484 sec, 1355 sec, 1600 sec, and 1550 sec, respectively. Data was compiled in accordance with the coldwater designated stream criteria of Procedure 51. Scott and Crossman (1979) and Becker (1983) were used as aides

for fish identification and to review habitat requirements and life histories of sampled species.

3.0 RESULTS

3.1 Literature Review

In July 2001, the GLEAS of the MDEQ conducted a biological survey of selected Lake Superior tributaries, including the Salmon Trout and Yellow Dog Rivers, to obtain baseline data on biological communities and habitat (MDEQ, 2002). Procedure 51 was conducted at 27 stations including one on the Salmon Trout River at Northwestern Road and one on the Yellow Dog River at County Road 510. Results of the assessment showed the habitat and macroinvertebrate community at both of these locations to be excellent. The macroinvertebrate community was found to be diverse at both stations with 31 and 19 taxa present at the Salmon Trout and Yellow Dog River stations, respectively. Since the sampling occurred prior to 2002, the procedures for habitat assessments followed by MDEQ did not include the 2002 protocol revisions of Procedure 51; however, methodologies are similar and results comparable. The two stations were not sampled for fish as part of this survey.

In August and September of 1998, the MDNR and USFWS conducted a comprehensive survey of the Salmon Trout River system (Madison 1998). One of their survey sites is located within the Eagle Project study area (Survey Site 7) on the Salmon Trout River, immediately downstream of Triple A Road. Another site (survey Site 8) is located on the Salmon Trout River, approximately 1 mile downstream of the Eagle Project study area. Data collection at sample stations included single-pass electrofishing, physical habitat measurements and macroinvertebrate collection.

Results of surveys at Site 7 showed the stream to be heavily shaded by tag alder (*Alnus rugosa*) with substrates composed of sand, gravel and woody debris. One hour of electrofishing produced a total of 24 fish, all of which were brook trout (*Salvelinus fontinalis*). Macroinvertebrate sampling produced 8 taxa with the number of individuals strongly dominated by caddisflies. This site coincides with a portion of Station 3 sampled by WCR.

Results of surveys at Site 8 showed the stream to have good cover and in-stream habitat for fish. A fair amount of spawning substrate for brook trout was present. Electrofishing produced a total of 35 brook trout in 0.75 hours of shocking effort. Macroinvertebrate sampling produced 9 taxa with the number of individuals strongly dominated by caddisflies. This site is located approximately 1 mile downstream of Station 1 sampled by WCR.

3.2 Salmon Trout River

Stations 1, 2 and 3 are located on the Salmon Trout River. Stations 1 and 2 were sampled August 5, 2004 and Station 3 was sampled on August 6. Weather conditions at the time of sampling were clear and sunny and air temperature ranged from 70-75° F (21-24°C).

3.2.1 Station 1

Station 1 is located at the downstream end of the study area within a remote part of the river valley. The river averages approximately 6 ft (1.8 m) in width and 3.5 inches (9 cm) in depth. On the date of sampling, Station 1 had an estimated surface velocity of 2.6 ft/second (0.8 m/sec) and a water temperature of 52°F (11°C). The sampling station is 125 ft (38 m) in length and covers approximately 755 ft² (70 m²).

Macroinvertebrate sampling resulted in the capture of 277 organisms representing 17 taxa (**Table 2, Appendix B**). The sample was dominated by Diptera, though caddisflies made up over 33% of the sample. Glossosomatids and Brachycentridae, which are two of the most sensitive families to water pollution, dominated the caddisflies sampled. Mayflies and stoneflies were also present. The presence of caddisflies, mayflies and stoneflies, combined with the absence of pollution tolerant organisms, results in a macroinvertebrate community rating of excellent.

The habitat evaluation for Station 1 also resulted in an excellent rating (**Table 3, Appendix B**). The station was considered to be a riffle/run stream and received a total score of 179 out of a possible score of 200. The reach is high gradient with substrates dominated by gravel, sand, and a wide variety of cover and habitat types are present. Eel grass (*Vallisneria*

Americana), watercress (*Nasturtium officinale*) and some attached algae are present in the stream. Bank vegetation is very healthy and stable and includes tag alder, swamp thistle (*Cirsium muticum*), bluejoint grass (*Calamagrostis canadensis*), sedge (*Carex gynandra*), balsam fir (*Abies balsamea*) and northern white cedar (*Thuja occidentalis*).

A total of 21 fish were captured during the electrofishing survey, all of which were brook trout (**Table 4, Appendix B**). The trout ranged from 1 to 6 inches (2.5 to 15.3 cm) in length and fish density was estimated to be .027 fish/ft² (0.30 fish/m²). An additional three brook trout were caught incidentally during macroinvertebrate sampling. Because the proportion of salmonids to the total number of fish collected exceeds 1%, the stream meets the State coldwater designation.

3.2.2 Station 2

Station 2 is located approximately 65 ft (20 m) upstream of Triple A Road. The river averages approximately 3 ft (1 m) in width and 1 ft (0.3 m) in depth and, on the date of sampling, had an estimated surface velocity of 0.65 ft/sec (0.20 m/sec) and a water temperature of 60°F (15.5°C). The sampling station is 100 ft (30 m) in length and covers approximately 345 ft² (32 m²). Beaver dams and ponds are prevalent immediately upstream of Station 2 to the southern end of the study area.

The macroinvertebrate community was rated as acceptable with 16 taxa present (**Table 2, Appendix B**). A total of 223 organisms were collected. While mayflies and caddisflies were found at this station, no stoneflies were collected and over 44% of the sample consisted of the damselfly, *Calopterygidae*. There are fewer taxa of mayflies and caddisflies at Station 2 than there are at Station 1, and the percent caddisfly composition is much lower at Station 2.

Approximately 10% of the macroinvertebrate sample consisted of air breathers, which are used as an indicator of potential diurnal dissolved oxygen shifts or other biological or chemical demanding constraints. A disproportionately high percentage of surface dependent macroinvertebrates are also commonly found in streams with elevated temperatures and low

or erratic flows. Station 2 does not exhibit these flow and temperature characteristics and is not likely to experience large shifts in dissolved oxygen levels. The relatively higher percentage of surface dependent species at this location is suspected to be a reflection of in-stream habitat differences between stations.

The habitat score was 161 on the glide/pool rating system, giving Station 2 an excellent rating (**Table 3, Appendix B**). The station is lower gradient than Station 1 and substrate is dominated by sand and other fine materials. Eel grass, watercress and attached algae were observed growing within the stream, and the banks are covered by sedge meadow and scrub-shrub vegetation. Sedge meadow is dominated by bluejoint grass, while the scrub-shrub is dominated by tag alder.

A total of 20 fish were captured by electrofishing including 5 brook trout, 2 northern redbelly dace (*Phoxinus eos*), 11 finescale dace (*Phoxinus neogaeus*) and two pearl dace (*Margariscus margarita*) (**Table 4, Appendix B**). The trout ranged from 3 to 7 inches (7.6 to 17.7 cm) in length and fish density was estimated to be 0.05 fish/ft² (0.60 fish/m²). An additional three brook sticklebacks (*Culaea inconstans*) were captured in dip nets during macroinvertebrate sampling. Station 2 meets the State coldwater designation based upon the percentage of salmonids in the sample.

3.2.3 Station 3

Station 3 is located approximately 50 ft (15 m) downstream of Triple A Road. The river averages approximately 6 ft (1.8 m) in width and 3.5 in (9 cm) in depth and, on the date of sampling, had an estimated surface velocity of 1.3 ft/sec (0.4 m/sec) and a water temperature of 60°F (15.5°C). The sampling station is 200 ft (61 m) in length and covers approximately 1195 ft² (111 m²).

The macroinvertebrate rating associated with Station 3 is excellent and the score was the highest of the five stations sampled (**Table 2, Appendix B**). A total of 23 taxa and 122 individual organisms were collected, over 51% of which were caddisflies. Seven families of caddisfly were collected, including Glossosomatidae and Branchycentidae, which are

extremely sensitive to water quality degradation. Three mayfly taxa and two stonefly taxa were also collected.

Habitat was also rated as excellent at Station 3, scoring 165 (**Table 3, Appendix B**). The station is characterized as a riffle/run system and has moderate gradient with sand and coarse substrate. Similar to the previous two stations, eel grass, watercress and attached algae were found growing with the channel. Riparian vegetation is dominated by tag alder, providing a very dense cover and root masses within the stream.

A total of 24 fish were collected at this station, all of which were brook trout (**Table 4, Appendix B**). The trout ranged from 1 to 6 inches (2.5 to 15.3 cm) in length and fish density was estimated to be 0.02 brook trout/ft² (0.22 brook trout/m²). Station 3 meets the State criteria for a coldwater designation.

3.3 Cedar Creek

3.3.1 Station 4

Station 4 is located on Cedar Creek upstream of Northwestern Road, north of the study area and outside of the project area drainage basin. Cedar Creek is approximately 12 ft (3.6 m) wide, with an average depth of approximately 1.25 ft (0.37 m) at this location. The stream was sampled on August 6, 2004 and the weather was clear and sunny, with an air temperature of 73°F (23°C). Water temperature was 55°F (13°C) and velocity was estimated to be 1 ft/sec (0.3 m/sec). The station is 300 ft (91 m) in length and covers approximately 3594 ft² (334 m²).

A total of 69 macroinvertebrates were collected at this station (**Table 2, Appendix B**). Although 20 taxa were found, including pollution intolerant species of stoneflies, caddisflies and mayflies, the station only received an acceptable rating. Because Cedar Creek is wider than the Salmon Trout River in the sampling location, it is scored more critically.

Station 4 exhibits characteristics of both a riffle/run and glide/pool type of stream. Several hundred meters of stream were visually surveyed upstream, but it was still unclear as to which type was more dominant. Therefore, as recommended in Procedure 51, the station was scored using both forms. The riffle/run segment had a total score of 148 (good). The glide/pool segment had a total score of 163 (excellent). Since the results were similar, they were averaged to give the station a total score of 155 and a borderline excellent rating (**Table 3, Appendix B**).

Sediment deposition is present within this reach and appears to be the most significant cause of impairment, as evidenced by the low scores for embeddedness and sediment deposition. The stream has a moderate gradient; however, fine sand and silt substrates are dominant. Eel grass, star duckweed (*Lemna trisulca*), slender naiad (*najas flexicalis*) and filamentous algae were observed in the sampling station. Riparian cover is dense and dominated by tag alder.

Fish sampling resulted in the capture of 13 brook trout and fish density was estimated to be 0.003 fish/ft² (0.04 fish/m²) (**Table 4, Appendix B**). Trout ranged from 1 to 8 inches (2.5 to 20.3 cm) in length. Station 4 meets State criteria for a coldwater designation.

3.4 Yellow Dog River

3.4.1 Station 5

Station 5 is located on the Yellow Dog River, south of the project area and upstream of a gravel road crossing. The sample reach was 250 ft (76 m) in length and the sampling area was approximately 4907 ft² (456 m²). The station was sampled on August 6, 2004 and weather was clear and sunny with an air temperature of 64°F (18°C). This is the largest stream section sampled, averaging 20 ft (6 m) in width and 1.5 ft (0.46 m) in depth. Water temperature was 52°F (16°C) and surface velocity was estimated to be 1 ft/sec 0.3 m/sec.

A total of only 52 macroinvertebrates were collected, representing 14 taxa (**Table 2, Appendix B**). Caddisflies and mayflies made up 21% and 13.5% of the sample,

respectively, though only four families of mayflies and one family of caddisflies were identified. No stoneflies were collected. Over 11% of the sample consisted of surface breathers, which is likely the result of habitat availability rather than water quality or flow constraints. Station 5 received an acceptable score based on the results of the survey.

Station 5 was determined to be a glide/pool type stream and had a total habitat score of 152, which is on the high end of good (slightly impaired) (**Table 3, Appendix B**). Though apparently unaltered, the stream at this location lacks sinuosity and diversity of pool habitats. Gradient is low to moderate and fine sands and silt dominant the substrate; however, some gravel and boulders are also present. Eel grass, *najas sp.*, *potamogeton sp.* and filamentous algae are present in stream. The banks are heavily vegetated with tag alder.

Ten longnose dace (*Rhinichthys cataractae*) and 2 mottled sculpins (*Cottus bairdii*) were captured at this station (**Table 4, Appendix B**). Fish density is estimated to be 0.003 fish/ft² 0.03 fish/m². Because no salmonids were captured, the Yellow Dog River does not meet the State coldwater designation criteria at this location.

4.0 DISCUSSION

4.1 Salmon Trout River

The Salmon Trout River flows south to north through the center of the study area. North of Triple A Road, the river is narrow and flows through a steep valley with high gradients and substrates dominated by sand and coarse material. These substrates are suitable spawning habitat for brook trout. Numerous groundwater seeps are present on the valley slopes and vegetation adjacent to the channel is dominated by dense woody plants, which provide shade and cover.

The character of the river upstream of Triple A Road is significantly different than downstream reaches. These are the upper headwaters where adjacent wetland complexes provide expansive floodplain areas that function to stabilize flow and filter sediment. This area of the river has been significantly impacted by beaver dams, which have created impoundments over 5 ft (1.5 m) in depth and greater than 30 ft (9 m) wide. Stream substrates consist of fine materials and flow velocities are low.

Habitat assessments associated with the stream resulted in a rating of excellent at all three stations sampled. Flows appear to be very stable and the stream banks are well vegetated with little evidence of erosion, despite the presence of clear-cut logging operations within the watershed. Water temperature was conducive to survival of coldwater organisms, including trout, during August sampling. In-stream habitat is diverse, with an abundance of hard substrates and woody debris.

Even though the stations on the Salmon Trout River received high scores for habitat, excessive deposition of sediment was found at all three stations. Causes of sedimentation were not investigated; however, likely sources include local roads and logging operations within the watershed.

Habitat surveys previously conducted by the MDEQ and MDNR on the Salmon Trout River resulted in similar findings (MDEQ 2002, Madison 1998). Assessments by the MDEQ

downstream of the project study area resulted in a habitat score of excellent using Procedure 51. Habitat assessments by Madison 1998 were limited to general observations and measurements of stream morphology at two sites on the river (MDNR Survey Sites 7 and 8), one which coincides with Station 3 sampled by WCR. Their observations found similar conditions including the presence of spawning substrates, dense bank cover, and impacts from sand deposition. Logging activities and the road infrastructure within the watershed were identified as primary sources of sedimentation.

The Salmon Trout River is designated by the MDNR as a coldwater stream supporting populations of naturally reproducing brook trout. Fish surveys at the three stations on the Salmon Trout River support this designation within the study area. A total of 65 fish were collected, with the majority of the catch consisting of brook trout (76.9%). Water temperatures at sample locations were 60°F (15.5°C) or lower during sampling in August 2004. A self-sustaining population of migratory, or “coaster”, brook trout is also known to exist in the lower reaches of the Salmon Trout River; however, there are a number of impassable dams and waterfalls that prevent movement upstream to the project area (**Figure 4.1, Appendix A**) (MDNR, personal communication). Therefore, all trout collected as part of this study are assumed to be non-migratory.

Fish sampling was conducted by the MDNR, immediately upstream of Triple A Road (MDNR Survey Site 7) in 1998 (Madison 1998). Results were similar to those found at Station 3 during the current study. Brook trout was the only species collected at both sites. However, the number of fish per square meter at Survey Site 7 was half that found by WCR at Station 3. Variation in fish densities between 1998 and 2004 could be the result of population fluctuations, fish migration, habitat recovery from a sedimentation event or differences in length of stream sampled.

The legal harvestable size limit for brook trout on the Salmon Trout River is 7 inches (17.8 cm) with one exception. Downstream sections at and near Lake Superior are part of a MDNR research area associated with coaster brook trout where the size limit is 18 inches (45.7 cm). One brook trout of harvestable size was collected at Station 2 during sampling.

The remaining 49 trout were below the legal size limit of 7 inches (17.8 cm). Similarly, all fish collected by MDNR at Sample Site 7 (Triple A Road) were below legal harvestable size (Madison 1998).

Results of macroinvertebrate sampling showed scores of excellent at Stations 1 and 3, while Station 2 was rated as acceptable. Based on the site assessment, habitat conditions observed downstream of Triple A Road (Stations 1 and 3) differ from conditions upstream (Station 2), which is likely a result of significant beaver activity upstream and relatively low gradient. Despite the lower macroinvertebrate score, organisms highly intolerant of pollution from the families Gomphidae and Brachycentridae were collected in limited numbers at Station 2, suggesting good water quality is present.

Macroinvertebrate sampling conducted by the MDEQ upstream of the project area also resulted in a score of excellent (MDEQ 2002). Compared with Station 1, the station sampled by MDEQ had a higher diversity of taxa (31). It also received the highest overall macroinvertebrate score (6) possible under Procedure 51. These results show that the Salmon Trout River has excellent water quality and contains quality stream habitats upstream of the project area. The MDNR also collected macroinvertebrates upstream of the project area between Station 1 sampled by WCR and MDEQ's sample site. Caddisfly families indicative of excellent water quality dominated the catch. Mayflies and stoneflies were also present (Madison 1998).

4.2 Cedar Creek

Cedar Creek, upstream of Northwestern Road, resembles the Yellow Dog River at Station 5 in its size and physical attributes, while areas downstream of Northwestern Road more closely match the Salmon Trout River at Station 3. Cedar Creek was established as a control site outside the influence of the project area. Future monitoring of this station could serve to separate changes resulting from potential project activities from those caused by other factors occurring throughout the region. Monitoring sites established by other agencies/firms should also be investigated for use as additional control sites.

Habitat at Station 4 was rated as good when combining both glide-pool and riffle-run scores. Although sediment covers many areas of the stream bed, dense bank cover, stable banks, and natural riparian zones account for the higher scores. Road grading activities, steep road slopes, and clear-cutting within the watershed are likely the primary sources of sediment.

Fish surveys on Cedar Creek resulted in collection of only 13 fish, in spite of extending the length of the sample reach to 300 ft (91 m). All fish collected were brook trout and two individuals exceeded legal size limits for harvest. These results are similar to those found at Stations 1 and 3. However, fish densities were much lower in Cedar Creek, which is likely the result of habitat differences between stations.

Macroinvertebrate sampling in Cedar Creek resulted in a rating of acceptable. Pollution intolerant species and a diversity of taxa were collected. However, wider stream reaches are expected to have a greater amount and diversity of habitat and are scored more critically. The score at this station is likely a result of a lesser amount of preferred habitat (substrates) due to sedimentation.

4.3 Yellow Dog River

The Yellow Dog River is located south and east of the study area. It flows east and discharges into Lake Independence. Much of the river south of the site is surrounded by a large, high quality wetland system (WCR Wetland Delineation and Functional Assessment Report, 2004). Observations at road crossings downstream of Station 5 show the river to consist of a variety of habitats desirable for trout and other coldwater organisms.

Assessment of habitat in the Yellow Dog River resulted in a good, or slightly impaired, rating. Like the Salmon Trout River and Cedar Creek, sediment appears to be having a negative impact on the Yellow Dog River. Sources of sediment were not investigated; however, road grading activities, steep road slopes, and clear-cutting are expected to be primary sources of sediment.

Although Station 5 received an acceptable macroinvertebrate score, it had the lowest number of macroinvertebrates collected and the lowest overall score (-1) of the five stations sampled. Results likely reflect the presence of sediment and resulting loss of preferred habitat. However, many of the macroinvertebrates associated with Station 5 have a low to moderate tolerance to pollution, indicating good water quality and that some existing habitats are suitable for colonization.

Macroinvertebrate sampling conducted by MDEQ in 2002 showed conflicting results downstream of Station 5, at County Road 510 (MDEQ 2002). Both habitat and the macroinvertebrate community were rated as excellent by MDEQ. These results reflect habitat differences between stations and are consistent with observations of downstream areas by WCR, where higher quality in-stream habitat was observed.

Sampling for fish at Station 5 did not result in collection of any trout species; however, two species of fish were collected that are both indicators of good water quality. The lack of trout in the catch does not allow for coldwater designation under Procedure 51. Still, trout populations are known to be prevalent in the Yellow Dog River and water temperatures are conducive to year-round survival; therefore, the Yellow Dog River is designated as a coldwater trout stream by the MDNR.

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6.0 LIST OF PREPARERS

Tom Bennett, Geomorphologist
Wetland and Coastal Resources, Inc.
5801 W. Michigan Ave.
Lansing, Michigan 48917
(517) 327-0970

Hal Harrington, Aquatic Biologist
Wetland and Coastal Resources, Inc.
5801 W. Michigan Avenue
Lansing, Michigan 48917

Stu Kogge, PWS, Wetland/Aquatic Biologist
Wetland and Coastal Resources, Inc.
5801 W. Michigan Avenue
Lansing, Michigan 48917

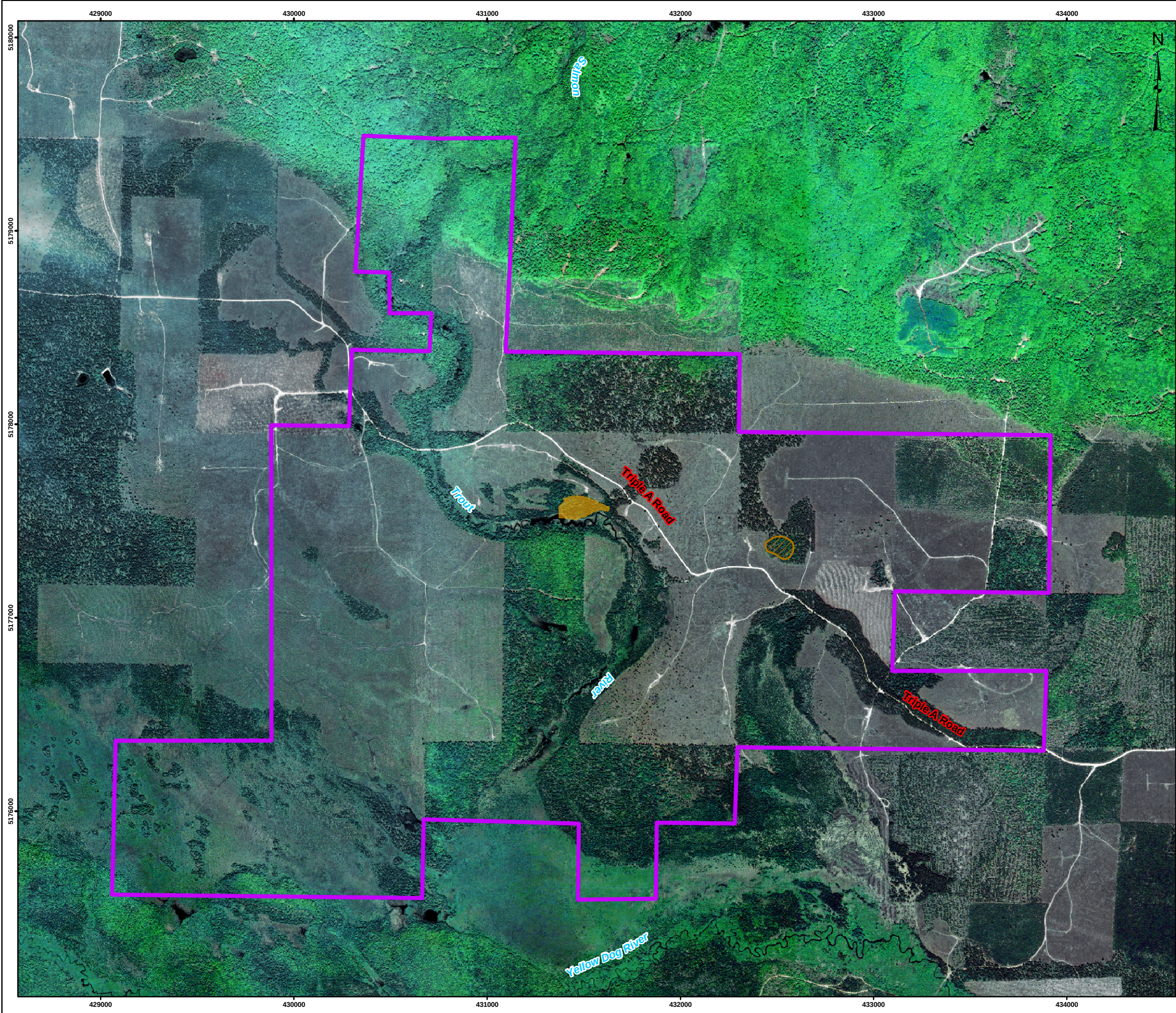
Mike Nurse, PWS, Wetland/Aquatic Biologist
Wetland and Coastal Resources, Inc.
5801 W. Michigan Avenue
Lansing, Michigan 48917

Aaron Snell, Fisheries Biologist
Wetland and Coastal Resources, Inc.
5801 W. Michigan Avenue
Lansing, Michigan 48917

APPENDIX A

Figures

I:/2003/033-2156/mapping/MXD/Wetland_Coastal/Aquatics/FIG1.1_85x11.mxd



LEGEND

	ORE BODY
	OUTCROP
	KMC/MDNR PROPERTY

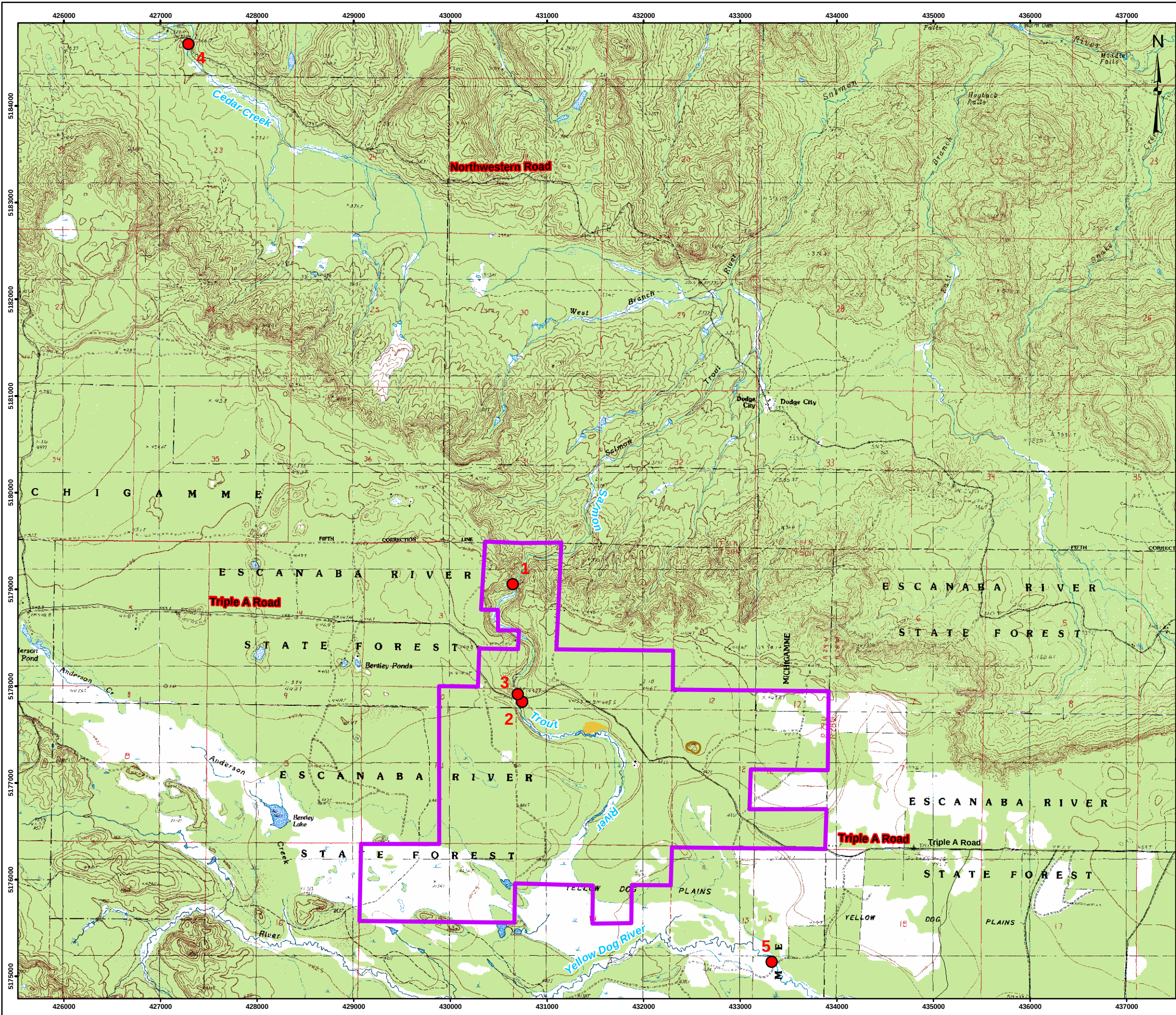
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TITLE				PROJECT AREA	
		PROJECT No. 033-2156C		SCALE AS SHOWN	REV. 0
DESIGN	SM	8 Apr. 2005	FIGURE 1.1		
GIS	TN	8 Apr. 2005			
CHECK	JM	8 Apr. 2005			
REVIEW					

I:/2003/033-2156/mapping/MXD/Wetland_Coastal/Aquatics/FIG1.2_11x17.mxd



LEGEND

- AQUATIC SAMPLING STATION
- ORE BODY
- OUTCROP
- KMC/MDNR PROPERTY

REFERENCE

DRG provided by Michigan DNR. Aquatic sampling stations provided by Wetland and Coastal Resources, Inc.
Datum: NAD 83 Projection: Transverse Mercator Coordinate System: UTM Zone 16

SCALE: 1: 40,000 FEET

PROJECT

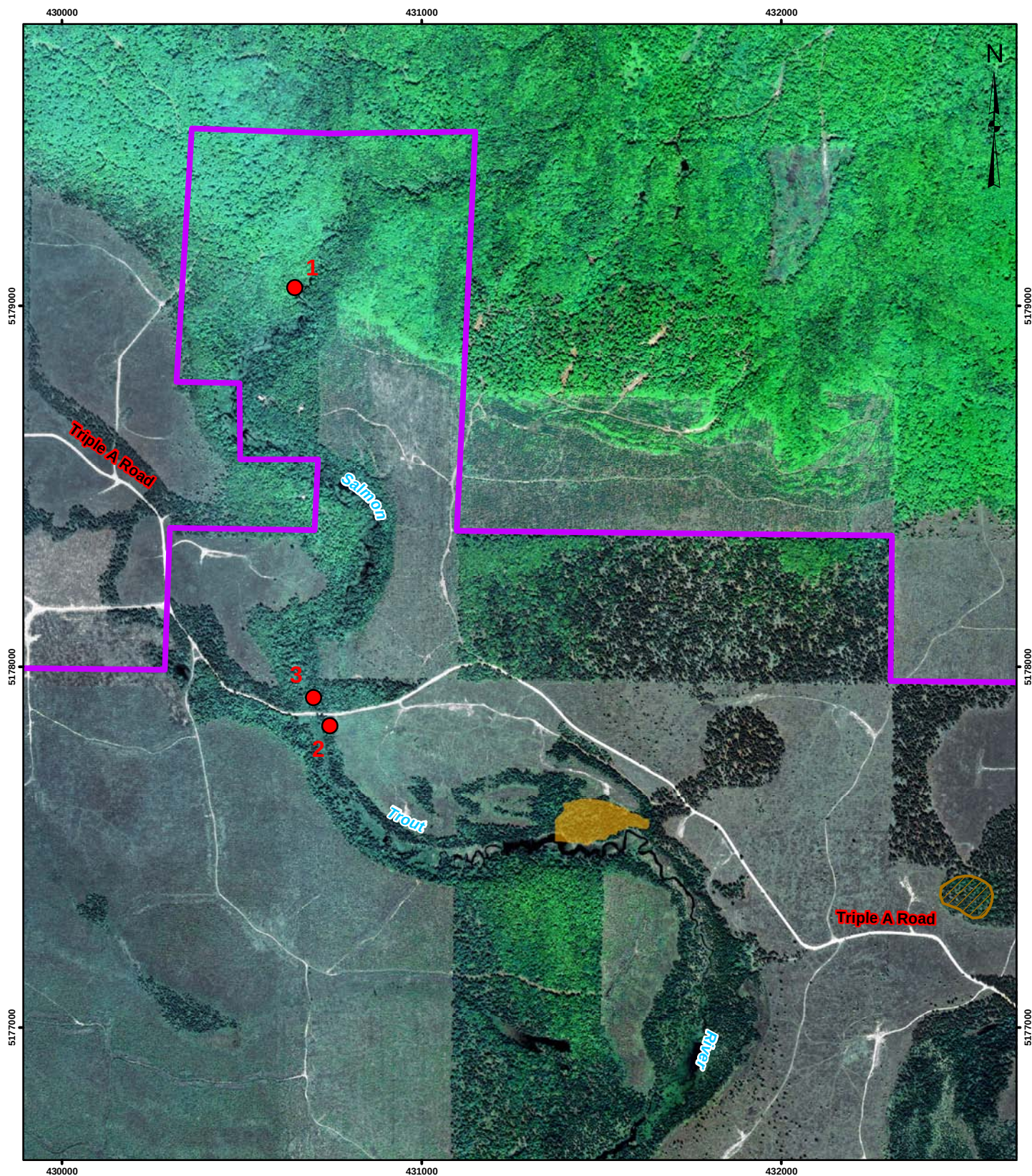
EAGLE PROJECT
BASELINE ENVIRONMENTAL STUDY
KENNECOTT MINERALS COMPANY

TITLE

LOCATION OF SAMPLE STATIONS

PROJECT No.	033-2156C		SCALE AS SHOWN	REV. 0
DESIGN	SM	8 Apr. 2005	FIGURE 1.2	
GIS	TN	8 Apr. 2005		
CHECK	JM	8 Apr. 2005		
REVIEW				

I:\2003\033-2156\mapping\MXD\Wetland_Coastal\Aquatics\FIG2.1_85x11.mxd



LEGEND

- ORE BODY
- OUTCROP
- KMC/MDNR PROPERTY
- AQUATIC SAMPLING STATION

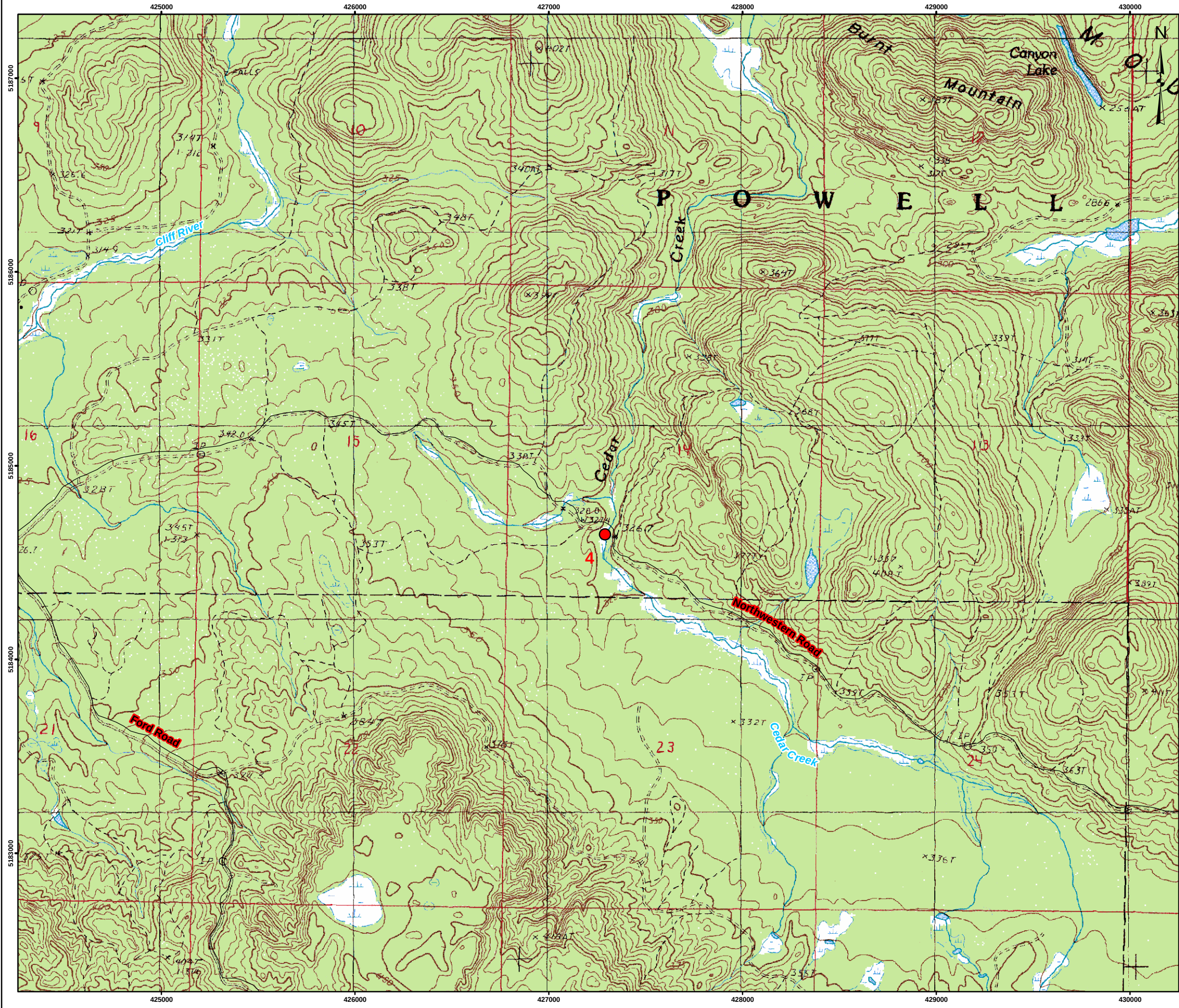
REFERENCE

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PROJECT 		EAGLE PROJECT	
TITLE 		BASELINE ENVIRONMENTAL STUDY	
		KENNECOTT MINERALS COMPANY	
		SAMPLE STATIONS FOR	
		SALMON TROUT RIVER	
		FIGURE 2.1	
		PROJECT No. 033-2156c	
		SCALE AS SHOWN	
		REV. 0	
DESIGN	SM	8 Apr. 2005	
GIS	TN	8 Apr. 2005	
CHECK	JM	8 Apr. 2005	
REVIEW			

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 AQUATIC SAMPLING STATION

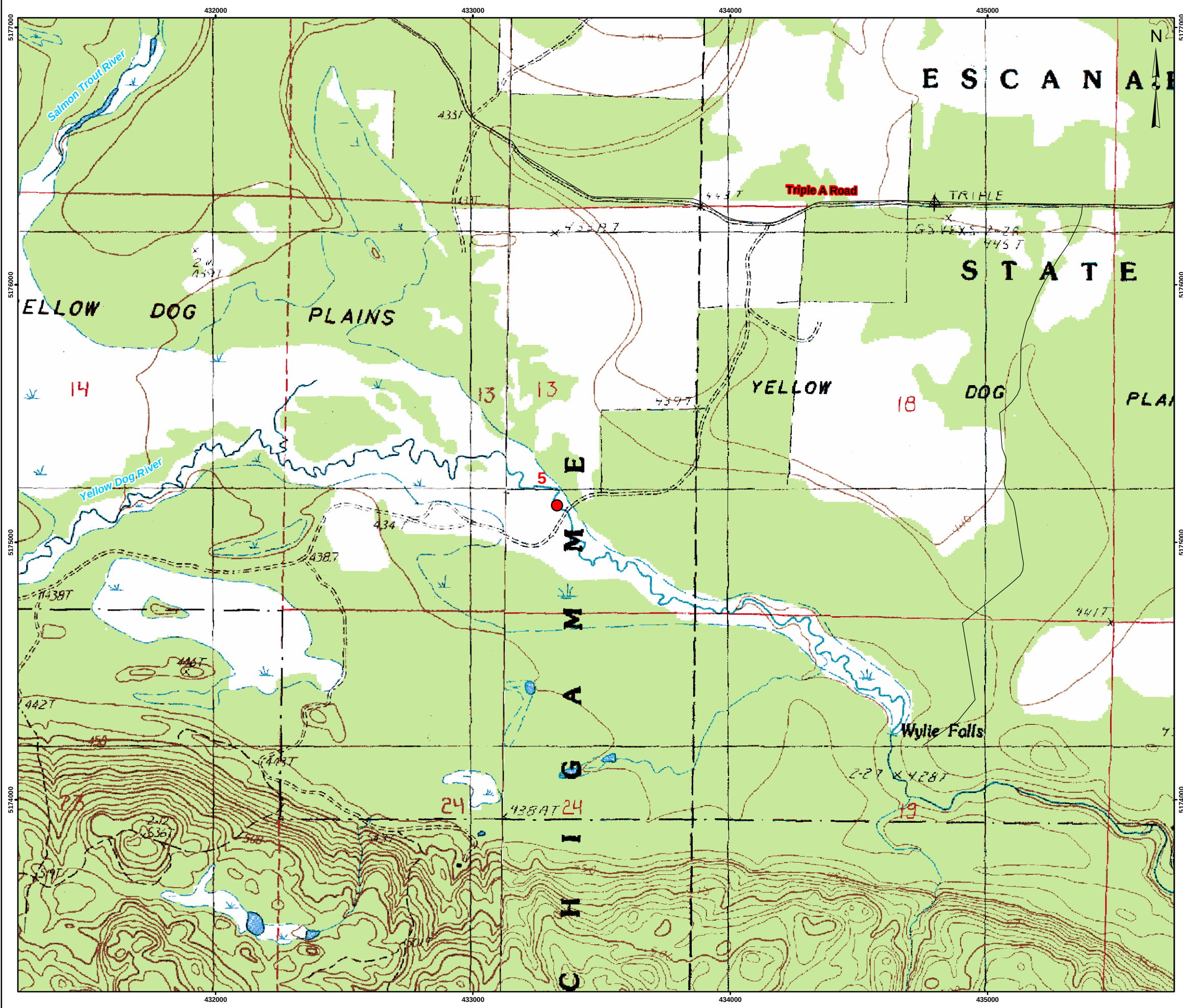
REFERENCE

DRG provided by Michigan DNR. Aquatic sampling station provided by Wetland and Coastal Resources, Inc.
Datum: NAD 83 Projection: Transverse Mercator Coordinate System: UTM Zone 16

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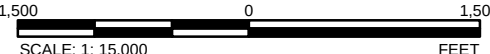
PROJECT 	EAGLE PROJECT BASELINE ENVIRONMENTAL STUDY KENNECOTT MINERALS COMPANY			
	TITLE  SAMPLE STATIONS FOR CEDAR CREEK			
	PROJECT No. 033-2156C		SCALE AS SHOWN	REV. 0
	DESIGN	SM	8 Apr. 2005	FIGURE 2.2
	GIS	TN	8 Apr. 2005	
	CHECK	JM	8 Apr. 2005	
	REVIEW			

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LEGEND
 AQUATIC SAMPLING STATION

REFERENCE
DRG provided by Michigan DNR. Aquatic sampling stations provided by Wetland and Coastal Resources, Inc.
Datum: NAD 83 Projection: Transverse Mercator Coordinate System: UTM Zone 16

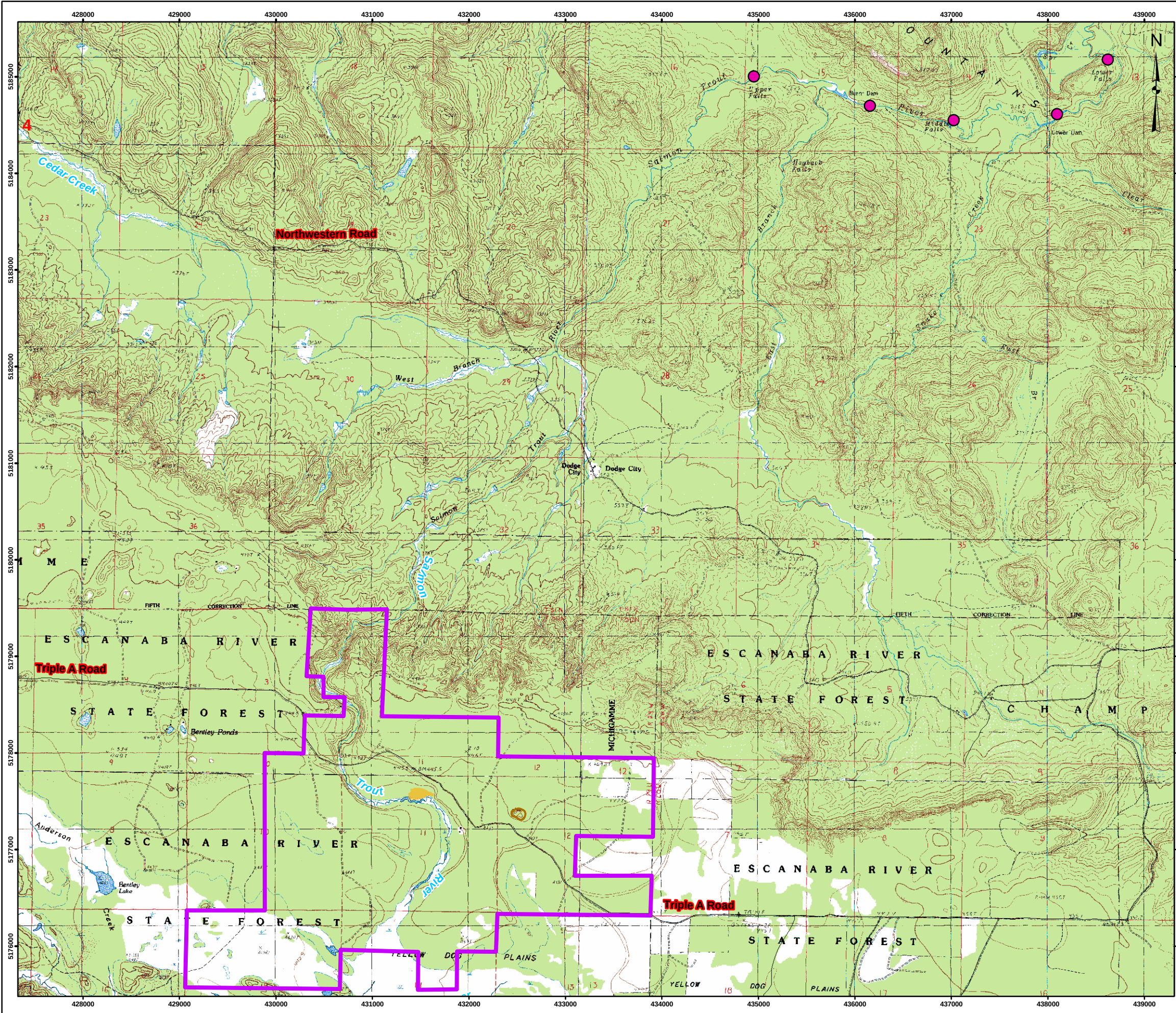

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PROJECT 	EAGLE PROJECT		
	BASELINE ENVIRONMENTAL STUDY		
KENNECOTT MINERALS COMPANY			

	TITLE		
	SAMPLE STATIONS FOR		
	YELLOW DOG RIVER		

	PROJECT No. 033-2156C			SCALE AS SHOWN	REV. 0
	DESIGN	SM	8 Apr. 2005	FIGURE 2.3	
	GIS	TN	8 Apr. 2005		
	CHECK	JM	8 Apr. 2005		
	REVIEW				

I:\2003\033-2156\mapping\MXD\Wetland_Coastal\Aquatics\FIG1.2_11x17.mxd



- LEGEND**
- IMPASSABLE DAM OR WATERFALL
 - ORE BODY
 - OUTCROP
 - STUDY AREA

REFERENCE

DRG provided by Michigan DNR. Dam and waterfall data provided by Wetland and Coastal Resources, Inc.
Datum: NAD 83 Projection: Transverse Mercator Coordinate System: UTM Zone 16

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PROJECT		EAGLE PROJECT BASELINE ENVIRONMENTAL STUDY KENNECOTT MINERALS COMPANY	
TITLE		LOCATIONS OF IMPASSABLE WATERFALLS AND DAMS	
		PROJECT No. 033-2156C DESIGN SM 8 Apr. 2005 GIS TN 18 Apr. 2005 CHECK JM 18 Apr. 2005 REVIEW	SCALE AS SHOWN REV. 0 FIGURE 4.1

APPENDIX B

Tables

Table 1. GLEAS Procedure 51 Habitat Rating Scale.

METRIC (RIFFLE/RUN)	SCORING RANGE/RATING			
	Excellent	Good	Marginal	Poor
<i>Substrate and Instream Cover</i>				
1. Epifaunal Substrate/Available Cover	20 - 16	15 - 11	10 - 6	5 - 0
2. Embeddedness	20 - 16	15 - 11	10 - 6	5 - 0
3. Velocity/Depth Regime	20 - 16	15 - 11	10 - 6	5 - 0
<i>Channel Morphology</i>				
4. Sediment Deposition	20 - 16	15 - 11	10 - 6	5 - 0
5a. Flow Status - Maintained Flow Volume	10 - 9	8 - 6	5 - 3	2 - 0
5b. Flow Status - Flashiness	10 - 9	8 - 6	5 - 3	2 - 0
6. Channel Alteration	20 - 16	15 - 11	10 - 6	5 - 0
7. Frequency of Riffles (or Bends)	20 - 16	15 - 11	10 - 6	5 - 0
<i>Riparian and Bank Structure</i>				
8. Bank Stability	10 - 9	8 - 6	5 - 3	2 - 0
9. Vegetative Protection	10 - 9	8 - 6	5 - 3	2 - 0
10. Riparian Vegetative Zone Width	10 - 9	8 - 6	5 - 3	2 - 0
METRIC (GLIDE/POOL)	SCORING RANGE/RATING			
	Excellent	Good	Marginal	Poor
<i>Substrate and Instream Cover</i>				
1. Epifaunal Substrate/Available Cover	20 - 16	15 - 11	10 - 6	5 - 0
2. Pool Substrate Characterization	20 - 16	15 - 11	10 - 6	5 - 0
3. Pool Variability	20 - 16	15 - 11	10 - 6	5 - 0
<i>Channel Morphology</i>				
4. Sediment Deposition	20 - 16	15 - 11	10 - 6	5 - 0
5a. Flow Status - Maintained Flow Volume	10 - 9	8 - 6	5 - 3	2 - 0
5b. Flow Status - Flashiness	10 - 9	8 - 6	5 - 3	2 - 0
6. Channel Alteration	20 - 16	15 - 11	10 - 6	5 - 0
7. Channel Sinuosity	20 - 16	15 - 11	10 - 6	5 - 0
<i>Riparian and Bank Structure</i>				
8. Bank Stability	10 - 9	8 - 6	5 - 3	2 - 0
9. Vegetative Protection	10 - 9	8 - 6	5 - 3	2 - 0
10. Riparian Vegetative Zone Width	10 - 9	8 - 6	5 - 3	2 - 0
HABITAT CHARACTERIZATION	TOTAL POINT SCORE (METRICS 1-10)			
Excellent	> 154			
Good	105 - 154			
Marginal	56 - 104			
Poor	< 56			

Table 2. Macroinvertebrate Sampling Results

TAXA	STATION 1	STATION 2	STATION 3	STATION 4	STATION 5
Arthropoda					
Crustacea					
Amphipoda (scuds)				4	
Insecta					
Ephemeroptera (mayflies)					
Baetidae			2	10	
Baetiscidae					1
Ephemerellidae	8		1		
Ephemeridae	7	12		4	3
Heptageniidae	1				2
Leptophlebiidae		5	4		
Siphonuridae					1
Odonata					
Anisoptera (dragonflies)					
Aeshnidae		12	5	2	3
Cordulegastridae	4	8	2		
Gomphidae		3			12
Libellulidae	19		14	3	3
Zygoptera (damselflies)					
Calopterygidae		104	13		
Plecoptera (stoneflies)					
Nemouridae			1		
Perlodidae	10		1	1	
Hemiptera (true bugs)					
Gerridae		23	3	5	5
Megaloptera					
Corydalidae (dobson flies)	1				
Trichoptera (caddisflies)					
Brachycentridae	29	4	15	4	
Glossosomatidae	31		3	3	
Hydropsychidae	1		17	6	
Leptoceridae	17	3	1	1	
Limnephilidae	5	4	4	15	11
Molannidae	2				
Philopotamidae	1		22		
Phryganeidae		1		1	
Rhyacophilidae	6		1		
Coleoptera (beetles)					
Elmidae					1
Dytiscidae (total)				1	
Diptera (flies)					
Athericidae	12		3	1	
Chironomidae		1	3	1	6
Culicidae				1	
Simuliidae	123	8	3		2

TAXA	STATION 1	STATION 2	STATION 3	STATION 4	STATION 5
Stratiomyidae				2	1
Tabanidae			2		1
Tipulidae		1		1	
MOLLUSCA					
Gastropoda (snails)					
Physidae		3	1	3	
Pelecypoda (bivalves)					
Sphaeriidae (clams)		31	1		
TOTAL INDIVIDUALS	277	223	122	69	52

Table 2. Macroinvertebrate Sampling Results cont.

	STATION 1		STATION 2		STATION 3		STATION 4		STATION 5	
METRIC	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score
TOTAL NUMBER OF TAXA	17	1	16	1	23	1	20	0	14	0
NUMBER OF MAYFLY TAXA	3	1	2	1	3	1	2	-1	4	0
NUMBER OF CADDISFLY TAXA	8	1	4	0	7	1	6	1	1	-1
NUMBER OF STONEFLY TAXA	1	1	0	-1	2	1	1	0	0	-1
PERCENT MAYFLY COMP.	5.78	0	7.62	0	5.74	0	20.29	0	13.46	0
PERCENT CADDISFLY COMP.	33.21	1	5.38	0	51.64	1	43.48	1	21.15	0
PERCENT DOMINANT TAXON	44.40	-1	46.64	-1	18.03	0	21.74	0	23.08	0
PERCENT ISOPOD, SNAIL, LEECH	0.00	1	1.35	1	0.82	1	4.35	0	0.00	1
PERCENT SURF. AIR BREATHERS	0.00	1	10.31	0	2.46	1	13.04	0	11.54	0
TOTAL SCORE		6		1		7		1		-1
COMMUNITY RATING	EXCELLENT		ACCEPT.		EXCELLENT		ACCEPT.		ACCEPT.	

Table 3. Habitat Assessment	STATION 1	STATION 2	STATION 3	STATION 4 RR	STATION 4 GP	STATION 5
HABITAT METRIC						
Substrate and Instream Cover						
Epifaunal Substrate/ Avail Cover	18	12	17	15	15	16
Embeddedness*	19		11	4		
Velocity/Depth Regime*	15		14	18		
Pool Substrate Characterization**		15			16	18
Pool Variability**		15			16	13
Channel Morphology						
Sediment Deposition	13	11	8	7	7	14
Flow Status - Maint. Flow Volume	9	9	9	9	9	8
Flow Status - Flashiness	9	9	10	10	10	6
Channel Alteration	20	19	20	19	19	17
Frequency of Riffles/Bends*	18		16	8		
Channel Sinuosity**		13			13	8
Riparian and Bank Structure						
Bank Stability (L)	9	9	10	9	9	7
Bank Stability (R)	9	9	10	9	9	7
Vegetative Protection (L)	10	10	10	10	10	9
Vegetative Protection (R)	10	10	10	10	10	9
Riparian Veg. Zone Width (L)	10	10	10	10	10	10
Riparian Veg. Zone Width (R)	10	10	10	10	10	10
TOTAL SCORE (200):	179	161	165	148	163	152
HABITAT RATING:	EXCELLENT	EXCELLENT	EXCELLENT	GOOD	EXCELLENT	GOOD
	(NON-	(NON-	(NON-	(SLIGHTLY	(NON-	(SLIGHTLY
	IMPAIRED)	IMPAIRED)	IMPAIRED)	IMPAIRED)	IMPAIRED)	IMPAIRED)
Date:	Aug 5, 2004	Aug 5, 2004	Aug 6, 2004	Aug 6, 2004	Aug 6, 2004	Aug 6, 2004
Weather:	Clear	Clear	Clear	Clear	Clear	Clear
Air Temperature °F (°C):	76 (24)	72 (22)	74 (23)	74 (23)	74 (23)	64 (18)
Water Temperature °F (°C):	52 (11)	60 (15.5)	60 (15.5)	56 (13)	56 (13)	61 (16)
Avg. Stream Width ft (m):	6 (1.8)	3.6 (1.1)	6 (1.8)	12 (3.7)	12 (3.7)	20 (6.1)
Avg. Stream Depth ft (m):	0.3 (0.09)	1 (0.3)	0.3 (0.09)	1.25 (0.37)	1.25 (0.37)	1.5 (0.46)
Surface Velocity ft/sec (m/sec):	2.5 (0.76)	0.8 (0.24)	1.25 (0.38)	1 (0.31)	1 (0.31)	1.1 (0.34)
Estimated Flow cfs (cms):	4.5 (0.13)	2.8 (0.08)	2.1 (0.06)	14.5 (0.41)	14.5 (0.41)	32.8 (0.93)

Table 4. Fish Sampling Results

TAXA	STATION 1	STATION 2	STATION 3	STATION 4	STATION 5
<i>Salvelinus fontinalis</i> (brook trout)	21	5	24	13	
<i>Phoxinus eos</i> (N. redbelly dace)		2			
<i>Phoxinus neogaeus</i> (finescale dace)		11			
<i>Margariscus margarita</i> (pearl dace)		2			
<i>Rhinichthys cataractae</i> (longnose d.)					10
<i>Cottus bairdii</i> (mottled sculpin)					2
TOTAL INDIVIDUALS	21	20	24	13	12
Percent salmonids	100	25	100	100	0
Reach sampled ft (m)	125 (38)	100 (30)	200 (61)	300 (91)	250 (76)
Area sampled sq ft (sq m)	755 (70)	345 (32)	1195 (111)	3593 (334)	4907 (456)
Density # fish/sq ft (# fish/sq m)	0.027 (0.30)	0.05 (0.61)	0.02 (0.22)	0.04 (0.04)	0.003 (0.03)
Gear	bps	bps	bps	bps	bps

APPENDIX C

Photographs

Station 1 – Salmon Trout River



Station 2 – Salmon Trout River



Station 3 – Salmon Trout River
Downstream End



Station 3 – Salmon Trout River
Upstream End



Station 4 – Cedar Creek
Downstream End



Station 4 – Cedar Creek
Upstream End



Station 5 – Yellow Dog River
Upstream End



Station 5 – Yellow Dog River
Downstream End

