PTP/MWMA Aquatics Project

2013/2014 Work Plan

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1.0) Introduction:

This document details the Work Plan for the Pacific Trails Pipeline (PTP) Morice Water Management Area (MWMA) Aquatics Project for the 2013 / 2014 program. This is year 2 of the project. The PTP / MWMA Aquatics Project is a data collection and analysis project designed to meet the Environmental Assessment follow up requirements of EA Certificate #E08-01. The main components of the project include the following;

- Water Quality sampling and analysis along the proposed PTP Pipeline Corridor,
- High Value Fish Habitat and Assessments and Fisheries Sensitive Areas Mapping along the proposed PTP Pipeline corridor,
- Benthic Invertebrate and sediment quality sampling,
- Reporting and analysis of the year 1 data.

This proposal covers project activities for the period November 2013 to November 2014 since the project year is from November to November. Costs for year 2 analysis and reporting will be included in a subsequent proposal prepared in the fall of 2014.

2.0) Scope of Work:

2.1) Water Quality Program;

The Water Quality program has two main components; 1) Monthly Spot Sampling and 2) Continuous Water Quality sampling. Water Quality spot sampling will continue through the winter to obtain a second year of baseline data. The sites to be sampled are listed in Table 1 below. Continuous water quality stations have been established to measure at-a-station turbidity, conductivity and temperature at the Owen Creek, Lamprey Creek and Thautil / Gosnell stations. The continuous water quality stations will be demobilized in November and redeployed in early April 2014. Additional water temperature monitoring stations will be installed at key locations for upstream / downstream comparison using "tidbit" temperature loggers.

Quality Control:

Quality control is an integral component of any water quality sampling program since the objective of sampling is to obtain data of known and consistent quality. The quality control program for this study involves adherence to approved field sampling procedures (MWLAP, 2003), analytical laboratory quality control protocols and post analysis data review. Specific quality control procedures being employed are as follows;

Field Sampling;

- Field sampling methods adhere to the document "*British Columbia Field Sampling Manual for Continuous Monitoring and the Collection of Air, Air Emission, Water, Wastewater, Soil, Sediment, and Biological Samples" (MWALP, 2003).* The document describes appropriate methods to avoid sample contamination, maintain chain of custody

from the field to the lab and prescribes field duplicates and field blank sampling procedures. Sampling QA/QC includes 10% Field Replicate and Field blank samples.

- Field parameters are measured with a YSI 650 water quality sonde. The sonde is calibrated every 3 months to assure consistent results. Unless otherwise stated all field parameters are measured at the mid-point in the water column.

Analytical Laboratory QA/QC:

- All samples are being analyzed at the MAXXAM Analytical laboratory in Burnaby BC. MAXXAM is a fully certified analytical laboratory with a comprehensive QA/QC program including Matrix spikes, Spike blanks and Method blanks and associated QC limits. MAXXAM verifies hold times and temperature at arrival for all samples.

Table 1: Active Water Quality Spot Sampling Locations

	Name	Coordinates	BC MOE EMS #	Elevation	Frequency
1	Cedric	9 U 618086 6005759	E292092	719 m	Monthly
2	Fenton	9 U 637569 6007888	E228741	732 m	Monthly
3	Floodplain	9 U 615260 6006099	E292089	690m	Monthly
4	Lamprey	9 U 624942 6005790	E256980	861 m	Monthly
5	Lower Parrot Creek	9 U 653262 6005602	E292090	853 m	Monthly
6	Morice 1	9 U 606830 6005942	E272549	762 m	Monthly
7	Owen Creek Lower	9 U 639679 6008044	E256979	671 m	Monthly
8	Owen Lake Trib.	9 U 647968 5995053	E290235	759 m	Monthly
9	Pimpernel Mt	9 U 629409 6007007	E292091	705 m	Monthly
10	Morice 2	9 U 615226 6006083	E292592	669 m	Monthly
11	Owen Wetland	9 U 639957 6008756	E292589	670 m	Monthly
12	WQ E1 (Goosly Lk Trib. Parrot FSR km 41.5)	9 U 672897 6005382	E294170	939 m	Monthly
13	WQ E2 (Parrot FSR km 43.5)	9 U 675370 6004488	E294171	936 m	Monthly
14	WQ E3 (Goosly N. FSR km 0.1)	9 U 675470 6004479	E294172	924 m	Monthly
15	WQ E4 (Parrot FSR km 47.5)	9 U 678404 6002822	E294173	992 m	Monthly
16	WQ E5 (Allen Creek FSR)	9 U 685711 6002083	E294174	1020	Monthly
17	WQ E6 (Maxan Creek)	9 U 694317 6004506	EMS #tbd	874 m	Monthly

Post Analysis Data Review:

All analytical results are reviewed by Hydrologic Inc for errors, using the BC Provincial EMS QA/QC protocol to ensure that hold times are met, laboratory QA/QC results are within limits, and chain of custody criteria are met and visually inspected for outliers. The protocol also

ensures that all of the data has migrated to the EMS database. Data reporting will include plots of the data and descriptive statistics to provide a more detailed review of the data quality.

2.2) High Value Fish Habitat Assessments and Fisheries Sensitive Areas Mapping:

The 2013 High Value Fish Habitat Program involved habitat mapping and assessments at a priority subset of proposed pipeline crossing sites as determined by reconnaissance and the Fisheries Sensitive Areas Mapping. The selected sites were streams and habitats crossed by the proposed pipeline alignment. These are sites that are directly proximal to the pipeline footprint and would be the initial receiving sites for any potential adverse effects from construction such as sediment releases or longer term habitat changes due to hydrologic effects. The 2014 program aims to follow up on these assessments with downstream habitat assessments at the far field receiving environments to assess habitat values (spawning areal estimates, rearing potential and pre-spawning holding value) and Gee trapping at the high value habitats to define habitat use (upstream extent of anadromous use and seasonal rearing). Further details on these components are detailed below.2

Habitat Assessments:

The habitat assessments proposed are based on an impact assessment methodology that defines the potential effects of linear corridor effects based on the contaminant pathway approach. Using this approach each high value site is assigned a point source impact site (the proposed pipeline crossing), a transport zone and a deposition / initial dilution zone similar to the "Sediment Transfer Hazard Classification System" described by Hogan and Wilford (1990). This approach assumes fluvial geomorphic processes are the primary driver of potential contaminant pathways.

In the context of the pipeline footprint the point source impact sites are the proposed crossings, the transport zones are the tributary stream channels between the impact site and the main stem Morice River and the deposition / initial dilution zones are the main stem Morice floodplain habitats receiving flows from the tributary transport zones. Using this approach a comprehensive evaluation of each potential contaminant pathway is achieved and the habitat values along the path are identified. The sites are also selected based on the output from the Fisheries Sensitive Areas mapping and ground reconnaissance / photo interpretation.

The Fisheries Sensitive Areas mapping, based on flow accumulation modeling identifies crossing sites with high sediment delivery potential. Ground reconnaissance and photo interpretation was used to identify sites which are likely to deliver sediment to the main-stem Morice high value habitats based on proximity to the Morice River and tributary channel grade. The site selection process creates a subset of sites that includes the larger tributaries proposed to be crossed with high sediment delivery potential and proximity to the main stem Morice, and Francois Lake. Minor tributaries with low sediment delivery potential, not directly proximal to main stem / high value habitats are assumed to be lower risk and adequately managed by Best Management Practices and careful construction techniques should the project proceed. This information then informs a risk based management framework for construction and operations that identifies the values at risk, identifies in-stream work windows and identifies Best Management monitoring options.

Sites:

Following up on the 2013 program, the proposed sites for 2014 include the following;

Table 2: Fish Habitat Assessment Sites for the 2013/2014 project year

Site #	Site Name	Coordinates	Site Objectives
1	**Allen Creek**	**9 U 685711 6002083**	**Fraser watershed site tributary to Francois Lk. Habitat mapping and Gee trapping to define PCP and habitat use.**
2	**Owen Creek**	**9 U 639679 6008044**	**Main stem Morice Habitat survey to define PCP receiving environment. Gee trapping in Owen Creek to assess anadromous habitat extent / barriers.**
3	**Fenton Creek**	**9 U 637569 6007888**	**Habitat surveys in the "Fenton side-channel", Gee trapping to assess anadromous extent.**
4	**Lamprey**	**9 U 624942 6005790**	**Habitat surveys in main stem Morice receiving zones, Gee trapping in Lamprey to determine rearing habitat use.**
5	**Morice River**	**9 U 606830 6005942**	**Habitat Mapping at the pipeline crossing above the km 66 bridge.**
6	**Thautil / Gosnell**	**9 U 608019 6007706**	**Habitat surveys in the Main stem Morice and Gosnell receiving / initial dilution zone.**
7	**327.59/326.76**	**9U 610514 6007267**	**Habitat surveys in Main stem Morice Receiving area below crossings 326 and 327**

2.3) Benthic Invertebrate Sampling:

Prior to commissioning, pipelines need to be tested for structural integrity by undergoing "hydrostatic testing". This is the process where the pipeline is charged with water in successive sections to check for leaks and weld strengths etc. After the test is complete the test water is discharged from the pipe back to some form of passive or active treatment system and then released to the environment in a metered manner. The discharge water usually has some remnant chemicals associated with it from flushing the inside of the pipe and may have thermal differences to the receiving environment. The Benthic Invertebrate and Sediment Quality Sampling proposed here are monitoring techniques designed to detect ecological effects arising from hydrostatic testing effluent releases to the environment.

At the current time there are two hydrostatic testing locations proposed, one at the km 66 bridge location near the proposed main stem Morice pipeline crossing and one at the crossing of the Clore River. Due to difficult logistics of working in the Clore in the fall pilot testing and training for the benthics and sediment program will be conducted in the main stem Morice only in the fall 2013 program. The Clore component will be added for the summer 2014 program.

Benthic invertebrates (BI) are bottom-dwelling organisms, the majority of which are insects, living on substrates such as rocks, sediment, logs, algae, and macrophytes in freshwater habitats for at least a portion of their life cycle (Rosenberg and Resh 1993). Benthic invertebrates are used extensively in monitoring and evaluating the effects of many and varied impacts to stream ecology worldwide (Rosenberg et al. 2008). Rosenberg and Resh (1993) summarized the reasons for the widespread use of BIs in aquatic biomonitoring programs: (1) they are present in most freshwater habitats; (2) the large number of species present show a range of responses to environmental stresses; (3) the primarily sessile

or sedentary nature of BIs allows more effective determination of the spatial extent of the environmental stresses; and (4) the long life cycles of BIs (relative to many other aquatic organisms) allows more effective determination of the temporal extent of the environmental stresses.

Benthic invertebrate sampling is often combined with sediment quality sampling to provide a "Multiple levels of Evidence" approach that minimizes the potential for false positive or false negative monitoring results (Simpson et al, 2005). By combining the semi quantitative results of benthic invertebrate community monitoring and the quantitative sediment quality data in a matrix approach a more robust effects monitoring protocol is achieved.

Benthic Invertebrate Sampling Objectives:

Seven objectives were identified for the benthic invertebrate and sediment quality sampling program:

1) Obtain benthic invertebrate baseline and post-discharge data to support the development and use of a monitoring tool to assess the effects of hydrostatic testing return flows on the aquatic ecology of the Morice and Clore rivers in the vicinity of the proposed discharge locations.

2) Obtain baseline and post-discharge sediment quality (metals and hydrocarbons) data for the potential effects radius of the hydrostatic testing discharge locations.

3) Conduct pilot BI sampling on the Morice River (fall 2013) to identify suitable control and impact sampling sites (i.e., sites upstream and downstream of proposed hydrostatic testing return discharge location). Results of the pilot sampling will inform subsequent baseline and post-discharge sampling following hydrostatic testing and will allow the investigators to assess the BI community variability between sampling sites selected during the pilot sampling phase to better inform the baseline and post-discharge sampling programs.

4) Summarize baseline benthic invertebrate data with respect to taxonomic diversity and abundance to support the design of an Effects Monitoring protocol.

5) Analyze the sediment toxicology data with respect to dissolved and total metals and hydrocarbons in a Before-After-Control-Impact (BACI) experimental design with sediment quality as the primary impact indicator.

6) Provide recommendations for future benthic invertebrate and sediment quality monitoring in consultation with the Office of the Wet'Suwet'en, BC Ministry of Environment, PTP, and Hydrologic Inc.

7) Provide training for Wet'Suwet'en Fisheries staff in sediment and benthic invertebrate sampling and quality control.

Similar to the parent monitoring program, the sampling plan for the benthic invertebrate and sediment quality components of the PTP/MWMA Aquatics Program must be adaptive due to the variability inherent in aquatic systems and benthic invertebrate communities; variability notwithstanding, this proposal provides a study plan and budget for a sampling and reporting program that is based on accepted, standard methodologies that will endeavor to meet project objectives in a safe manner, yet remain flexible enough to allow for adaptations as required by watershed conditions in a given sampling year.

A study plan and cost estimate for a sampling program that would be conducted following hydrostatic pressure testing of the proposed pipeline is beyond the scope of the present document and will be prepared as requested.

Approach and Work Plan:

The benthic invertebrate and sediment quality sampling components outlined in this proposal will be conducted in two phases:

- Phase 1 -2013-2014
  Phase 1 will include benthic invertebrate sample site selection; training Wet'Suwet'en Fisheries staff in benthic invertebrate and sediment sampling procedures; pilot sampling; and preparation of a pilot sampling report, literature review, and a detailed benthic invertebrate baseline sampling plan.

- Phase 2- 2014-2015
  Phase 2 will include baseline benthic invertebrate and sediment sampling; and reporting the results of the baseline sampling program.

A detailed work schedule showing the proposed timeline for each project deliverable discussed in the proposal is presented in the project task sheet attached as Appendix 1.

2.4) Benthic Invertebrate Methods

Literature Review

A brief literature review will be conducted of existing data and published or 'gray' literature (e.g., government reports) related to the existing benthic invertebrate community within the Morice and Clore rivers. This information will aid in defining the regional baseline conditions of the benthic communities within the Morice and Clore River watersheds.

Site Selection

A pilot sampling program was conducted on the Morice River in October / November 2013 to select suitable sampling sites exhibiting upstream and downstream (the Control and Impact sites, respectively) of the proposed pipeline crossing, which, are understood to be the sites where hydrostatic testing discharge will enter the river. Repeat sampling of these sites will allow comparisons of BI data collected during baseline sampling in 2014 with post-hydrostatic testing of the proposed pipeline in a future year. The establishment of Control and Impact sample sites will allow use of a before-after/control-impact (BACI) study design (see Section 3.7 for more details). Clore River sites will be selected during the pre-field Clore site visit in summer 2014.

To minimize natural variability of benthic invertebrate communities among sample sites, the sites will be established in erosional (riffle habitat) with cobble/gravel substrate of similar size, water depth and current velocity and at depositional sites paired with the sediment quality sampling. Sites selected are described in the following table.

Table 3: Benthic Invertebrate sampling locations for 2014			
Site #	Coordinates	Sample type	Comment
HT 1	606469E 6004851N	Erosional and depositional	Hydrostatic testing upstream control site.
HT 2	607922E 6007506N	Erosional and depositional	Hydrostatic testing downstream impact site
HT 3	576218E 6001959N	Erosional and depositional	Downstream Clore hydrostatic testing site
HT 4	TBD	Erosional and depositional	Upstream Clore hydrostatic testing site, precise location TBD

Timing of Sampling

Benthic invertebrate sampling will be conducted in the fall period during the 2013 pilot program and 2014 baseline program. A fall sampling program is the optimal period for maximum biomass and BI community diversity (Beatty et al. 2006), typically coincides with the descending limb of the hydrograph in interior BC streams, making sample collection during this time period safer and easier. The Clore sampling will be conducted first given the early onset of winter weather there and access issues.

Benthic Invertebrate (BI) Sampling Methodology

The objective of the PTP/MWMA BI baseline program is to characterize study area benthic invertebrate communities in terms of abundance and diversity. These variables can be used to assess the health of a stream and identify the presence of environmental stressors such as contamination and induced turbidity. The pilot and baseline sampling methods will employ conventional quantitative benthic invertebrate sampling methods to collect samples from natural substrates in erosional and depositional habitats.

A series of habitat measurements will be recorded as supporting information for each sample site and will include:

- site location using Global Positioning System;
- current velocity and water depth;
- Substrate description;
- Stream gradient;
- field water quality measurements (pH, conductivity, dissolved oxygen and water temperature, using a field-calibrated water quality meter);
- bank full and wetted channel widths; and
- aquatic macrophyte cover and species composition (visual assessment);

Further details of sampling methodology, supporting habitat measurements, and sample preservation techniques will be provided in the baseline sampling plan and Specific Work Instructions (SWI) document, both of which will be included in the overall report from the fall 2013 pilot sampling program. The SWI will serve as a ‘learning legacy’ document allowing repeatable and consistent sampling.

Laboratory Analysis

Benthic invertebrate samples will be shipped to a certified aquatic invertebrate taxonomist in BC for sorting and identification to the lowest practical taxonomic level. Benthic invertebrate samples will be sorted and identified following standard methods based on recommendations of Gibbons et al. (1993) and Environment Canada (2002).

Data Analysis and Reporting

As recommended by Environment Canada (2002) for environmental effects monitoring (EEM) at metal mines, benthic invertebrate data will be summarized using the following endpoints:

- Total density reported as number of organisms per square metre (no./m^2) for samples collected from erosional and depositional sites;
- Total richness as number of taxa per site (taxa/site) and mean number of taxa (± Standard Error) at a site;
- Simpson's Diversity Index (SDI), which takes into account both the density and taxonomic richness of benthic invertebrates at a sampling site. Simpson's Diversity Index is expressed as a number between one and zero, with one representing high diversity and zero representing low diversity.
- Evenness, which is a measure of how evenly the benthic invertebrate density at a sampling site is distributed among the taxa present at the site. Evenness is also expressed as a value between one and zero, with one representing high evenness and zero representing low evenness; and
- Relative density and community composition of each major taxon (i.e., taxa representing >1% of the total community) expressed as mean percent composition of the benthic community at each sample site.

These variables provide information about the productivity of the benthic invertebrate community, provide a measure of 'ecosystem health', and can be used to aid in assessing the effects of environmental stressors in aquatic systems.

The establishment of Control and Impact sampling sites in the Morice River will facilitate a Before-After/Control-Impact (BACI) sampling program (Stewart-Oaten et al. 1986), which is based on the concept of testing whether the difference between benthic invertebrate abundances at a Control site and an Impact site change once a specified impact has occurred. Consideration may be given to performing additional statistical analyses on the benthic invertebrate data following consultation with a statistics specialist.

The report summarizing the results from the fall 2013 pilot sampling program will also include the literature review, baseline sampling plan, and the Specific Work Instructions document described above in the Benthic Invertebrate Sampling Methodology section. A report detailing 2014 results will summarize the benthic invertebrate results from the Baseline Sampling program once the sampling and analysis has been completed.

Quality Assurance and Quality Control for Benthic Invertebrate Monitoring:

Field Sampling QA/QC

Field sampling will generally follow the sampling methodology outlined in the document "Guidelines for Sampling Benthic Invertebrates in British Columbia Streams" (Beatty et al. 2006). Benthic invertebrate samples will be collected by the same experienced person to minimize differences in sample composition that may occur as a result of slight differences in individual sampling techniques. Detailed field notes and

standard data collection sheets will be maintained to document the field sampling program. Chain-of-Custody for benthic invertebrate taxonomy samples will be maintained from the field to the lab.

Analytical Laboratory QA/QC

Sorting recovery checks will be conducted on 10% of the benthic invertebrate samples collected in a given study year. The samples will be randomly selected by the consulting taxonomist and resorted to verify sorting efficiency of benthic invertebrate sample processing. The data quality objective for benthic invertebrate sample sorting requires a minimum sorting efficiency of 90% removal of the organisms from each sample (Environment Canada 2002). In the event that this level of sorting efficiency is not achieved, the samples must be re-sorted until the 90% level is reached.

As conditions allow, the same certified taxonomist will be employed in each year of the sampling program to reduce the possibility of introduced error due to sample processing by different taxonomists.

Benthic Invertebrate Data Review and Reporting

Benthic invertebrate taxonomy and enumeration data received from the consulting taxonomist will be checked for errors prior to data analysis. The report will be peer reviewed prior to submission.

3.0 Sediment Quality Sampling:

Baseline sediment quality sampling was initially proposed as part of the water quality baseline program to assess baseline sediment concentrations of dissolved metals and hydrocarbons at selected hot spots in the study area. Further sediment sampling has been proposed in concert with the benthic invertebrate sampling program intended to monitor for ecosystem effects following hydrostatic testing. To maximize efficiencies the sediment and benthics sampling will be done simultaneously where possible. Benthic sites have been paired with sediment sites to provide a more robust monitoring protocol by allowing for comparison of observed benthic community effects and sediment contaminant levels. In the case that benthic ecological effects are detected after a contamination event simultaneous pre and post sediment quality analysis can provide a valuable record of instream dissolved loads, and changes to those loads, and can therefore be used to verify if detected ecological effects are due to water column chemistry or some other causative agent.

Sediment sampling is a monitoring technique often coupled with benthic invertebrate monitoring. Deposition zone sediments are the finest gradation of stream sediment since they are the product of water column settling in quiescent hydraulic environments where wash load silts and clays are allowed to settle out of suspension. Fine grained sediments have a high affinity to adsorb dissolved contaminants owing to their high surface area to mass ratio. Each fine particle has many exposed surfaces and edges that enhance the sorption of dissolved chemicals in contrast to larger particle sizes where much of the mass is “hidden” within the particles. Fine grained sediments with a range of particle types (different rock types, organic particles, etc.) are therefore excellent monitoring tools since they store chemical contaminants from the water column (USGS, 1994).

The following sections provide an overview of the sampling plan for the 2014 sampling season. The plan includes sampling associated with the benthic invertebrate sampling sites and hot spots sites in the Owen Lake watershed. The objective of the Owen watershed sampling is to examine baseline sediment contamination levels associated with multiple land uses occurring there.

Overall Sampling Strategy and Rationale:

The sampling strategy for sediment quality is a targeted approach. Targeted sampling differs from random sampling in that sampling locations are driven by previous knowledge of contaminant hot spots (i.e. the Owen Watershed) or sites strategically selected as part of a monitoring program (i.e. the benthic paired sites) rather than any attempt to spatially map the levels of contaminants over a larger area. In the current program the objectives are two-fold; 1) to characterize contaminant levels at sites with known or suspected contamination issues in order to most efficiently determine baseline conditions (Owen sites) and 2) to establish baseline sites for the assessment of hydrostatic testing effects (the benthic paired sites). Targeted sampling is a useful pilot sampling technique since a small number of samples can generate useful data on specific sites of interest without the need for extensive and costly spatial, random sampling. At this stage a small number of sites are being targeted to gather information that can be used to refine future sampling efforts.

Parameters:

Parameters selected for the proposed program are listed below. The generalized analytic strategy is to provide data on sediment levels of trace metals, Total Organic Carbon (TOC), Polycyclic Aromatic Hydrocarbons (PAHs) and Extractable Petroleum Hydrocarbons (EPH). Particle size analysis is included to describe the samples

Total Organic Carbon (TOC):

TOC is included as an analyte because organic carbon in sediments is often involved in the binding of hydrocarbons and other contaminants in sediment and is therefore a key intermediary in contaminant pathway analysis.

Particle Size:

Particle size analysis is a used to determine the textural composition of a sample. Particle fractions from gravels to clay sizes are determined by sieving and hydrometer and described on a percent weight basis. The particle size analysis is used to characterize the samples to ensure the samples are representative of similar environments and are used to explain differences between the analytical results.

Polycyclic Aromatic Hydrocarbons (PAH):

PAHs are a class of hydrocarbon species consisting of two or more fused aromatic rings. They are present in the environment as a result of both anthropogenic and natural processes. Anthropogenic sources are byproducts from the low temperature / low oxygen combustion of hydrocarbons typical in industrial processes, crude oils and vehicle emissions. Most PAHs with more than 2 fused rings are essentially non-volatile and do not appreciably evaporate making them a relatively conservative environmental quality indicator. The rate of decay in source areas is largely driven by biodegradation.

Total Metals:

Samples are analyzed for a wide range of metal ions to determine the levels of trace metals in a sample. The analysis is used to assess the level of trace metals in a sample and can be compared to known toxicity values and regulatory triggers.

Extractable Petroleum Hydrocarbons (EPH):

Samples are analyzed for hydrocarbons between ten and 32 carbon links in length. This is a relatively wide spectrum hydrocarbon test used to speciate hydrocarbons in sediment and the water column.

Simultaneously Extracted Metals / Acid Volatile Sulfide (SEM/AVS):

SEM/AVS analysis is a trace metals analysis used to estimate the bioavailability of trace metals in the pore water of sediments. Acid volatile sulphide forms stable compounds with divalent metals and thus reduces their toxicity. The effective toxicity of trace metals in sediment is estimated by this test which is a measure of the degree of environmental effect that can be expected to occur in ecosystems exposed to the test sediments (Patton and Crecelius, 2001).

Sample sites:

Benthic -paired sites were selected based on the BACI experimental design program for the benthic invertebrate sampling detailed above. The resulting sites are located upstream (control site) of the proposed pipeline crossing of the Morice River and below the crossing Hydrostatic return flow location further downstream (impact site). These sites will be initially sampled in fall 2013 and then again in fall 2014. A second set of benthic control and impact field sites will be sampled at the Clore River pipeline crossing in the summer of 2014. Baseline sediment sampling will be sampled from five locations in the Owen watershed. The following table is a summary of the proposed sampling sites for the overall 2013 /2014 program.

Table 4: Sediment sampling locations

Site #	Coordinates	Sample type	Comment
OW 1	647963E 5994818N	Stream sediment	Sediment samples from below the Owen Trib. WQ site.
OW 2	647524E 5994158N	Lake sediment	Owen Lake below Owen Trib. WQ site.
OW 3	646439E 5998172N	Lake sediment	Outlet of Owen lake
OW 4	639679E 6008044N	Stream Sediment	Below the proposed pipeline crossing of Owen Creek
OW 5	639984E 6008460N	Stream sediment	Near Owen Wetland WQ site
HT 1	606469E 6004851N	Stream Sediment	Hydrostatic testing upstream control site.
HT 2	607922E 6007506N	Stream sediment	Hydrostatic testing downstream impact site
HT 3	576218E 6001959N	Stream sediment	Downstream Clore hydrostatic testing site
HT 4	TBD	Stream Sediment	Upstream Clore hydrostatic testing site, precise location TBD

Quality Control

Field Sampling;

- Field sampling methods adhere to the document "*British Columbia Field Sampling Manual for Continuous Monitoring and the Collection of Air, Air Emission, Water, Wastewater, Soil, Sediment, and Biological Samples" (MWALP, 2003).* The document describes appropriate methods to avoid sample contamination, maintain chain of custody from the field to the lab and prescribes field duplicates and field blank sampling procedures. Sampling QA/QC includes 10% Field Replicate and Field blank samples.

- Hydrologic has established office and field protocols for quality assurance including field data forms, chain of custody requisitions and field sampling methods that minimize the potential for sample contamination.

- All project data is entered into the BC Ministry of Environment EMS system which has its own internal quality assurance protocols.

Analytical Laboratory QA/QC:

- All samples are being analyzed at the MAXXAM Analytical laboratory in Burnaby BC. MAXXAM is a fully certified analytical laboratory with a comprehensive QA/QC program including Matrix spikes, Spike blanks and Method blanks and associated QC limits. MAXXAM verifies hold times and temperature at arrival for all samples.

5.0) Reporting and Analysis of Year 1 data:

Year one of the PTP / MWMA Aquatics project has generated a great deal of data and assessments that need to be summarized, analyzed and put in a format suitable for presentation to the working group. The following sections will outline the scope of that work and detail the deliverables to be produced.

5.1) Water Quality Data Summarization and Analysis:

All of the spot water quality data collected to date has been housed in the BC Provincial EMS data management system. Continuous water quality time series data will not be entered in to the EMS system and will be analyzed and summarized separately. To put the data into useable and presentable formats the following tasks are proposed;

- Data compilation into a master worksheet.
- Graphing of site level plots for reporting.
- Graphing of specific parameters for cross-site comparison and reporting.
- Cross referencing data to Provincial and Federal criteria.
- Descriptive statistical analysis of parameter data and summary plots.
- Specific analysis, discussion of water quality trends and nutrient status.
- Compilation of continuous monitoring data, analysis and discussion of trends.

5.2) GIS and Mapping:

GIS and mapping are key tools for analyzing and presenting spatial data. The GIS products required for year 1 reporting are as follows;

- Data entry of point data into GIS system.
- Key maps of project footprint and sample sites.
- Site maps for Fish Habitat program.
- Flow Accumulation model finalization and plots.
- Sediment quality and Benthic Invertebrate site maps.
- Water quality site maps.

5.3) Data Analysis and Reporting, Fish Habitat Program:

Reporting out on the Fish Habitat Program involves the following scope items;

- Produce site summaries and overall program summary.
- Summarize and analyze field data and plot specific parameters for reporting.
- Create a photo index of field photo-documentation.
- Analysis of field data, discussion of trends in habitat data and key watershed features.
- Discussion / planning of summer 2014 program.

5.4) Benthic Invertebrate Pilot Sampling Report & Baseline Sampling Plan:

Reporting for the fall 2013 benthic invertebrate pilot sampling event will include several components:

- Summary and discussion of benthic invertebrate data collected in fall 2013.
- Literature review of historical benthic invertebrate data for Morice River.
- Preparation of a detailed 2014 Baseline Benthic Sampling Plan for Morice River Control and Impact sites (aided by results from 2013 pilot sampling event).
- Preparation of Specific Work Instructions document detailing benthic sampling protocols for field personnel.

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