UPPER COLUMBIA RIVER

Work Plan for the Remedial Investigation and Feasibility Study

Volume II of II

Modified by

U.S. Environmental Protection Agency

Based on Draft Work Plan Provided By:

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December 2008

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APPENDIX A

TECHNICAL MEMORANDUM NO. 1, PRELIMINARY ECOLOGICAL RISK MANAGEMENT-BASED ACTION OBJECTIVES (RMAOS)–FINAL DRAFT

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TECHNICAL MEMORANDUM NO.1, PRELIMINARY ECOLOGICAL RISK MANAGEMENT-BASED ACTION OBJECTIVES (RMAOS) – FINAL DRAFT

teckcominco

March 11, 2007

Mr. Kevin Rochlin
Superfund Project Manager
U.S. Environmental Protection Agency, Region 10
1200 6th Avenue, ECL-112
Seattle, WA 98101

Subject: Technical Memorandum No. 1 - *Preliminary Ecological Risk Management Based Action Objectives* – Final Draft

Dear Kevin:

Further to your letter dated February 15, 2007 (received on February 20, 2007) and pursuant to Paragraph 13 of the June 2, 2006 Settlement Agreement, please find attached for your review and information the final draft of Technical Memorandum No. 1 – Preliminary Ecological Risk Management-Based Action Objectives.

Should you have any questions or require any additional information, please do not hesitate to contact the undersigned.

Sincerely,
Teck Cominco American Incorporated

Marko E. Adzic, P.E.
Manager, Environmental Engineering

Attachment (1)

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TECHNICAL MEMORANDUM NO. 1
PRELIMINARY ECOLOGICAL RISK MANAGEMENT-BASED ACTION OBJECTIVES

This technical memorandum presents preliminary ecological risk management-based action objectives (RMAOs)[1] for the remedial investigation and feasibility study (RI/FS) of the Upper Columbia River site (Site). Preliminary RMAOs developed for protection of human health will be developed by the U.S. Environmental Protection Agency (EPA) and are not included in this memorandum.

A critical objective of the RI/FS process for the Site is to delineate areas of the Site that may pose an unacceptable risk to ecological receptors (e.g., benthic invertebrates, fish, shellfish, plants, birds, and mammals, including those listed under the Endangered Species Act). Prior investigations conducted by state and federal agencies have identified contaminants of interest (COIs) at the Site, which include cadmium, copper, lead, mercury, zinc, and other metals and metalloids, as well as organic compounds such as dioxins, furans, and polychlorinated biphenyls (USEPA 2004). The RI/FS process will supplement information collected in prior studies to further delineate the nature and extent of contaminants present at the Site, including a comprehensive characterization of COIs; provide an understanding of the sources, fate, and transport of contaminants to and within the Site; and support an ecological risk assessment (ERA).

Preliminary ecological RMAOs for the Site will be defined consistent with the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) and EPA Guidance documents, in assessing potential ecological risks to better define risk management alternatives that will result in healthy and sustainable ecological populations within the Site ecosystem. At this early stage of the process, preliminary RMAOs for the protection of ecological receptors serve as a framework for the overall site assessment and ERA.

The preliminary ecological RMAOs presented in this memorandum will be refined in later stages of the RI/FS process as potential ecological risks are understood. Together with EPA's preliminary RMAOs for the protection of human health, these preliminary ecological RMAOs will ground the assessment in the overarching goal for the Site: to protect human health and the environment.

[1] As stated in the June 2, 2006, Settlement Agreement (USEPA 2006) between Teck Cominco American Incorporated and EPA, RMAOs developed for this site "shall have the same meaning as remedial action objectives in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) and their development shall be consistent with the NCP."

APPROACH USED TO DEVELOP PRELIMINARY ECOLOGICAL RMAOS FOR THE SITE

Table 1 summarizes preliminary ecological RMAOs developed for the Site. These preliminary ecological RMAOs are intended to provide a framework for Site-specific management decisions regarding ecological resources. These preliminary ecological RMAOs will evolve during the RI/FS and may be further refined as the conceptual site model (CSM), problem formulation, and ecological risk assessment proceed[2]. Development of these preliminary RMAOs is central to coordinating and communicating with other participating parties and the public.

Table 1. Preliminary Ecological RMAOs.

Medium	Preliminary Risk Management-Based Action Objective[a]
Soils	Reduce to acceptable levels the risks to plant communities that may be exposed to contaminants of concern (COCs) in soil
	Reduce to acceptable levels the risks to populations[b] of soil invertebrates that may be exposed to COCs in soil
	Reduce to acceptable levels the risks to populations of birds and mammals that feed on plants and/or soil invertebrates containing COCs, or that may directly ingest soils containing COCs
Sediments[c]	Reduce to acceptable levels the risks to populations of fish that may be exposed to sediment-bound COCs
	Reduce to acceptable levels the risks to populations of birds and mammals that feed on aquatic resources
	Reduce to acceptable levels the toxicity to benthic infauna that live in and on surface sediments
	Mitigate or prevent dispersion of sediment COCs through aerial transport to uncontaminated locations where unacceptable resource exposure may occur
Surface water	Reduce to acceptable levels the exposures of ecological receptors to COCs at water concentrations that exceed potential applicable or relevant and appropriate requirements (ARARs) for surface water quality
	Reduce to acceptable levels the risks to populations of birds and mammals that feed on aquatic resources or ingest surface water with elevated levels of COCs
	Reduce to acceptable levels the risks to populations of fish that may be exposed to COCs in surface water

a. The list of medium and relevant pathways to be evaluated during the RI/FS process (e.g., problem formulation) will not be constrained by the preliminary RMAOs presented and discussed herein.
b. "Populations" refer to local groups of individuals common to the Site. Individual level analyses may need to be considered in the ERA.
c. Sediments are broadly defined as particles deposited by wind or water that are transported by water and accumulate in or immediately adjacent to surface water bodies. For this Site, sediment is defined to include particles at the bottom and sides of the Upper Columbia River channels and reservoir, including beaches.

[2] Pursuant to Paragraph 13. f. i. of the June 2, 2006 Settlement Agreement, upon completion of the Baseline Ecological Risk Assessment, the preliminary RMAOs developed and presented herein will be further refined.

EPA guidance (USEPA 1988) specifies that Remedial Action Objectives (RAOs), here termed RMAOs, for protecting environmental receptors typically seek to preserve or restore a resource (e.g., fish) and are thus expressed in terms of a contaminant of concern (COC), medium of interest, and an acceptable contaminant level or range of levels. At this early stage in the RI/FS process, delineation of Site-specific COCs and acceptable contaminant levels have not been completed. When these preliminary RMAOs are refined, in the screening of remedial action alternatives, they will reflect up-to-date Site-specific information on COCs and acceptable contaminant levels or ranges based on the results of the baseline ecological risk assessment. However, for the purposes of this memorandum, COCs referred to in Table 1 and throughout the remainder of this memorandum are used interchangeably with COIs.

The overall goal of the preliminary ecological RMAOs for the Site is to manage ecological risks to levels that will result in the recovery and maintenance of healthy local populations and communities of biota. Accordingly, the phrase "reduce to acceptable levels the risks" used in the preliminary ecological RMAOs summarized in Table 1 refers to decreasing the unacceptable risks associated with the presence of COCs at the Site by means that are appropriate to the circumstances present, and may include but not necessarily be limited to lowering/mitigating their concentrations, mobility, bioavailability, toxicity, and/or exposure to receptors. Similarly, "acceptable levels" refers to risks posed by COCs that are less than unacceptable adverse risk or harm to identified ecological receptors at the Site. Thus, reference to acceptable contaminant levels presented in this memorandum does not reflect Site-specific numeric guidelines or standards (i.e., preliminary remediation goals), which will be developed after the ERA is completed.

In their preliminary form, these ecological RMAOs broadly encompass the primary exposure pathways and receptors of concern at the Site. These preliminary ecological RMAOs will be refined throughout the assessment process, as problem formulation and the conceptual exposure model for the ERA are further developed (e.g., chemicals, receptors, and exposure media may be screened out or screened in as new data become available), as applicable or relevant and appropriate requirements (ARARs) are identified, and as information about the Site is assembled and synthesized.

DEVELOPMENT OF POTENTIAL GENERAL RESPONSE ACTIONS ASSOCIATED WITH PRELIMINARY ECOLOGICAL RMAOS

As described in EPA RI/FS guidance (USEPA 1988), actions that will be used to satisfy the RMAOs are referred to as "general response actions." Initially defined during RI/FS scoping, general response actions are "refined throughout the RI/FS process as a better understanding of site conditions is gained and action-specific ARARs are identified." General response actions may include *in situ* capping, treatment, containment, excavation, dredging, disposal, institutional controls, monitored natural recovery, or some

combination of these actions (USEPA 1988). General response actions, like the RMAOs, are medium-specific.

Potential sediment remedies are provided in EPA's contaminated sediment remediation guidance (USEPA 2005). Based on this guidance, a list of remedial technologies that will be considered in the development of remedial alternatives for areas with unacceptable ecological risks at the Site include:

- No action
- Institutional controls
- Monitored natural recovery (MNR)
- *In situ* containment (e.g., capping)
- *In situ* treatment
- Removal and disposal (e.g., aquatic, nearshore, or upland confined disposal)
- Removal and treatment.

The current condition of the UCR ecosystem reflects the influence of multiple environmental stressors. In view of the multiple environmental stressors in the watershed, it is critical to consider the effects of the full range of chemical, physical and biological factors influencing the biota and habitats. These factors will be important to identifying and assessing effective remedial action alternatives.

As required by the Settlement Agreement (USEPA 2006), during the feasibility study, Teck Cominco American Incorporated will provide EPA with a technical memorandum on refined ecological RMAOs (Agreement Task 6: Development and Screening of Remedial Alternatives). The refined RMAOs will provide more specific objectives for reducing to acceptable levels the risks to ecological receptors based on the results of the baseline ERA and the remedial investigation, and will include more detailed identification and evaluation of potential remedial action alternatives and associated technologies.

REFERENCES

USEPA. 1988. Guidance for conducting remedial investigations and feasibility studies under CERCLA. Interim Final. EPA/540/G-89/004. OSWER Directive 9355.3-01. U.S. Environmental Protection Agency, Washington, DC.

USEPA. 2004. Draft Upper Columbia River Site RI/FS scoping plan. Prepared by CH2M Hill and Ecology and Environment, Inc. (Contract No. 68-S7-04-01). EPA/630/P-04/068B. August 2004. U.S. Environmental Protection Agency, Region 10, Seattle, WA.

USEPA. 2005. Contaminated sediment remediation guidance for hazardous waste sites. EPA-540-R-05-012. OSWER Directive 9355.0-85. December 2005. U.S. Environmental Protection Agency, Washington, DC.

USEPA. 2006. Settlement agreement for implementation of remedial investigation and feasibility study at the Upper Columbia River Site. June 2006. U.S. Environmental Protection Agency, Washington, DC.

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APPENDIX B

DATA MANAGEMENT PLAN

APPENDIX B

DATA MANAGEMENT PLAN FOR THE UPPER COLUMBIA RIVER RI/FS

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ACRONYMS AND ABBREVIATIONS

DMP	data management plan
EDD	electronic data deliverables
EPA	U.S. Environmental Protection Agency
GIS	geographic information system
QAPP	quality assurance project plan
RI/FS	remedial investigation and feasibility study
TCAI	Teck Cominco American Inc.
UCR	Upper Columbia River

1 INTRODUCTION

This data management plan (DMP) establishes standard procedures for the management of all non-privileged documents and environmental data (field and laboratory) generated during the Upper Columbia River (UCR) remedial investigation and feasibility study (RI/FS). This DMP describes data management procedures relating to the creation, acquisition, handling, storage, and distribution of project related data. The principal data types addressed in this document include:

- Physical and chemical measurements in various media collected from the study area (e.g., analytical chemistry, toxicity, current meter, and sediment profile imaging data)
- Spatial data (e.g., bathymetric, side-scan, and resource data)
- Project documents (e.g., finalized reports and laboratory documents).

The data management systems and procedures described below are intended to establish and maintain an efficient organization of large volumes of complex environmental information for a diverse combination of data types. To accomplish this task, four management systems will be used to provide organized and efficient data management and retrieval:

- Project database—Stores environmental sampling and analysis data, information pertaining to GIS files, and citations of documents related to collection, analysis, or interpretation of environmental data that are stored in the database.
- Geographic information system (GIS)—Stores spatial data and enables the cartographic presentation of data trends and patterns
- Hard copy files—Maintains a record and archive of documents from field investigations, contractual agreements, and resulting reports. Documents that are privileged (e.g., attorney work product or attorney-client privileged) will be maintained separately and are not addressed under this DMP or by the following procedures. TCAI and its consultants will use various document and reference management software to organize hard copy documents.
- Web site—Documents, electronic data, and other project information will be available via the secure project website. Users with appropriate privileges will be able to download electronic data, documents, and spatial files.

The relationship between data types and systems for handling them is portrayed in Figure B-1. This structure enables environmental data and documents from historical, current, and future investigations, including field data and ancillary technical information, to be effectively stored so that specific data queries can be rapidly addressed

and the results accessible to data users. Furthermore, quality assurance information and procedures can be systematically applied to the data and their results tracked.

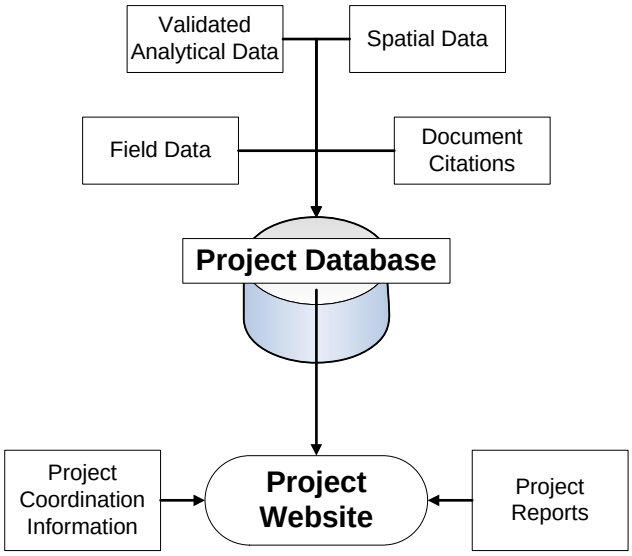

Figure B-1. Flowchart for UCR Data Management Systems.

2 DATA MANAGEMENT SYSTEMS

The major data management systems to be used for the UCR RI/FS are described in the following sections.

2.1 DATABASE

A relational database will be used to organize, analyze, and store project information and data, and guarantee data integrity. Both current and historical data will be stored in the project database.

Relational databases store data in different types of well-defined tables that are linked to each other via common fields. Each table represents a particular class of information, such as the information describing a sampling location, a sample, or an analytical result. The links between tables typically represent one-to-many relationships, such as the relationship between a single sampling location and the many samples that might be collected at the location. This linkage enables the efficient storage, updating, and retrieval of data, and the straightforward implementation of quality assurance procedures. Microsoft® Access, or a comparable relational database program, will be used specifically to:

- Provide a single authoritative repository for environmental data (including sediment, soil, and tissue chemistry, benthic macroinvertebrate abundance, and bioassay data)
- Maintain an inventory of GIS data layers and track successive versions of spatial data sets
- Carry out calculations and data summarization, such as total organic carbon (TOC) and lipid standardization, comparison to sediment and tissue guidelines, and summation of analytes
- Execute queries that summarize data completeness, quality assurance status, and final assessments of data quality levels, to support data quality assurance audits
- Store citations of documents containing project data, and link documents to data as appropriate

2.2 GIS

Many of the UCR RI/FS activities will use spatial data sets and analyses for planning, data interpretation, decision support, and data presentation. All GIS data will be stored in ESRI-compatible file formats. An inventory of spatial data sets will be maintained in the project database. Links between data in the project database and GIS files will be established via common identifiers for sampling locations and other geographic features. Spatial data analyses and maps will be carried out or prepared using ESRI (or compatible) software.

2.3 BACKUP AND MAINTENANCE OF GIS AND DATABASE FILES

The project database and all GIS files will be stored on both a networked server and the project web site (Section 2.5 addresses backup and maintenance of the project website). As data are added or changes are made, revisions to working versions of the database and GIS files will be made to files on the networked server. Once these changes are completed, the final files will be uploaded to the project web site. A log of database updates will be maintained on the web site. Previous database versions will be maintained on the networked server.

All data on the networked server will be stored on redundant, mirrored hard drives to protect against data loss due to hard drive failure. These drives will be mounted in a custom Linux fileserver protected by an uninterruptible power supply. The data from these drives, as well as any other data stored elsewhere on the network, will be backed up daily after work hours to a separate, corporate backup server to protect against data loss due to user error. This backup enables access to the most recently changed versions of all files. In addition, the on-site server will be regularly replicated to an off site server. Overall, maintenance of components that make up the data infrastructure (systems that store, backup, archive, etc.) and network systems will be monitored on a weekly basis to ensure that ongoing data storage and access needs are efficiently managed. Data will be protected from system failure, accidental damage, catastrophic failures, and intrusion.

2.4 HARD COPY FILES

Hard copy files will be generated for all project plans, activities, and data results for the UCR RI/FS. Draft and final documents will be distributed as hard copies to EPA and participating parties as listed in the Settlement Agreement (USEPA 2006). Critical documents, such as chain of custody forms, will be stored in locked file cabinets. Documents will also be scanned and stored on the network server as appropriate.

2.5 PROJECT WEB SITE

The UCR project web site will contain both information that is accessible to the general public and information that is password-protected and accessible only to authorized individuals. The password-protected component of the website will provide EPA, the participating parties, and TCAI and its consultants with access to electronic data compiled as part of the RI/FS. Users with appropriate privileges will be able to interactively query and download data from the project database, including spatial (GIS) data. The web site will also provide access to electronic copies of all documents produced during the investigation, and will provide citations for all documents linked to data in the database. A history of revisions to project data will also be available on the website so that users can identify when data of interest have changed. The public component of the project web site will provide project documents to the general public as they are approved by EPA. In addition, if EPA were to decide to share validated data with the public, TCAI will provide the validated data on the public portal of the web site, consistent with the procedures outlined in the Settlement Agreement (USEPA 2006).

3 DATA MANAGEMENT PROCEDURES

3.1 FIELD SAMPLING DATA

Effective management of data resulting from field operations is essential to providing consistent, accurate, and defensible documentation of data quality as well as straightforward access to data for analysis and interpretation. Field sampling data can be highly complex as a result of factors such as multiple sampling locations, dates, and depths; subsamples, splits, and different levels of sample replication; multiple analytical methods, data quality objectives and actual data quality and precision; and interpretation methods that may require a variety of methods of data summarization, standardization, or transformation. This section provides guidance for the management of field records and laboratory deliverables and the subsequent population of the project database with the qualitative and quantitative results of field investigations.

3.1.1 Field Records

Field records will include identifying information and descriptive and geographical information associated with sediment, soil, water, and biota sample collection. Daily field records (a combination of field logbooks and field data sheets) and navigational records will make up the main documentation for field activities. Field records will be stored both electronically and in hard copy and data contained within the field records will be entered into the project database, as appropriate. Further detail will be provided in individual quality assurance project plans (QAPPs) as they are developed

3.1.2 Data Storage and Archiving

All incoming field data, both hard copy and electronic, will be tracked in the project database. The sample numbers and date received will be noted and will be retained in the project database. Data entry, validation, and global positioning downloads also will be tracked in the same manner. Electronic copies of the original data will be retained. A complete record of data changes and updates made subsequent to data receipt from the laboratory will be stored either electronically or as hard copies, as appropriate.

3.1.3 Laboratory Deliverables

Laboratory deliverables will include electronic data deliverables (EDDs) and data packages in hard copy and portable document format (PDF) files. The EDDs will be in a format that can be directly imported into the project database. EDDs will include sample identification information, analyte concentrations in field and quality control samples,

units, and other related information. Data packages will include data summaries with all instrument printouts and raw data needed to complete full validation of the data.

After a laboratory deliverable is received, data management staff will carry out the following procedures to support data validation and ensure that the data are ready to be used for interpretation and analysis:

- EDDs will be loaded into the database and 10 percent of the imported data will be verified against the accompanying hard copy data package
- Data summaries will be produced and provided to the data validator
- The hard copy data package will be photocopied; one copy will be filed in the project file, and the other copy will be provided to the data validator with the data summaries
- Upon receipt of validation results from the data validator, data managers will update the database appropriately, perform an independent verification of the resulting data against the validator's notes, file the validator's notes in the project file, and update the quality assurance level flags in the database for all of the relevant results.
- Tables summarizing field and laboratory QC data will be produced and included in the data validation report.

3.1.4 Populating the Database

Most data will be loaded into the project database through the use of spreadsheet templates. Data received in spreadsheets will be compared to hard copy laboratory data packages prior to being loaded into the database as a quality assurance check. When necessary, data may also be manually entered. Manually entered data will be printed, verified against the original source documents, and corrected if necessary. The hard copies will be initialed as the electronic versions are verified against the original source documents. Once data have been loaded into the database, a series of quality assurance procedures will be used to review the data for completeness and to ensure correct formatting.

Following data validation, the data manager may need to modify the raw data in the database or associated qualifiers. Any changes to data values or qualifiers resulting from data validation will be 100 percent verified prior to disseminating the data.

3.1.5 Inclusion of Data with Unknown Quality

The project may include data with unknown quality or that will not be subject to verification. This may include spatial data, facility operations data, modeling results, data

provided by interested parties, and historical site conditions data. Data that are stored in the project database that have not been fully validated will be annotated to indicate the extent and type of data validation that has been applied, if any.

3.1.6 Database Records for Superseded Data

During the course of the project, specific data records may be agreed upon as being unsuitable for inclusion in certain analyses. Reanalyses of samples, for example, may produce more accurate results that supersede the original analysis. All records will be retained in the database; however, the records that are not selected for use through the data validation process will be flagged and not used in subsequent evaluations.

3.2 SPATIAL DATA

Spatial data includes study-specific data and information such as study investigation areas, sampling stations, locations of resources (e.g., mussel beds, riparian habitat, and vegetation), river and tributary boundaries, facilities, and remediation areas. Many of the UCR RI/FS activities will use GIS for decision support, analysis, and display. A common spatial reference framework and standardized attribute schematic will be developed to facilitate use by the various stakeholders. ArcView system's standards, protocols, and formats will be used to automate, store, update, manipulate, analyze, and display geographically referenced information. Furthermore, during the course of acquisition and analysis of spatial data, temporary working versions or subsets of the data are often created. Therefore, a major component of data management for spatial data is the documentation and tracking of authoritative versions of spatial data sets.

Spatial data will be accessible via the project web site.

3.2.1 Acquisition

Spatial data will be obtained from various sources, including field studies, Teck Cominco, participating parties, and geospatial data warehouses. Spatial data layers will also be developed from new and existing data. The original source of every spatial data layer will be recorded in the project database.

3.2.2 Data Storage

The project database will be used to store an inventory of all authoritative or finalized spatial data sets. Every spatial data set that is used in a deliverable map or data analysis will also be included in the GIS inventory. Each data set description will include notes regarding any update or revisions made to the data set. The database will be used to

record the name, originator, coordinate system, and other descriptive information for spatial data sets, including the details and rationale for changes made. Dates of changes and distribution to EPA and participating parties will also be recorded.

To facilitate use by the various parties, a common spatial reference framework and standardized attribute schematic will be applied to spatial data. The following standards will be applied:

- Horizontal Datum: North American Datum of 1983 (NAD83)
- Projection: State Plane Coordinate System, Washington North
- Units: U.S. feet
- Columbia River Datum: Hydrographic surveys.

3.2.3 Quality Assurance

Quality assurance measures will be applied to spatial data collected as part of this study. These measures will include field procedures for ensuring that data are recorded and preserved accurately and verification of check plots by field personnel. Data from other sources that have to be re-projected into the project coordinate system will also be verified to be of an acceptable level of accuracy. The GIS inventory will contain an estimate of the spatial accuracy of each data set, and will document the source of each spatial data set, any changes that have been made to it, and the quality assurance checks that have been applied.

3.3 DOCUMENT MANAGEMENT

All document files will be inventoried and archived in accordance with the UCR team consultants' standard operating procedure for maintaining project files. Copies of all documents will be stored by TCAI. As required by the Settlement Agreement (USEPA 2006), all records will be maintained for a minimum of 10 years after issuance of the final ROD for the site. EPA will be notified 90 days before the documents are scheduled to be destroyed.

Document management applies only to documents that relate directly to the RI/FS, and does not address management of all of the records referred to in the Settlement Agreement (USEPA 2006). Documents to be managed may include project plans, field records, laboratory records, relevant scientific literature, records of discussions and agreements between the parties, and reports produced during the projects. Records such as e-mails, contact reports, meeting agendas and other materials related to the overall

progress and status of the project will not be managed in the same way except insofar as they contain information important to the analysis or interpretation of RI/FS data.

The project database will be used to record the name, authors, date, and other descriptive information for documents that pertain to data with in the project database. This information will be stored in a manner consistent with efficient export to other citation management programs. Date of distribution of project deliverables to EPA and participating parties will also be recorded in the database. Project deliverables will be assigned a unique identifier, and that number will be used as a key to the citation in the database. Electronic copies of project documents will be stored in an uneditable form (PDF or other, as appropriate), and the document's identifier will be used as part of the filename. Paper copies of project documents will be filed by the document identifier.

4 DATA SHARING

4.1 DISTRIBUTION OF HARD COPY REPORTS

Finalized documents will be distributed to the EPA and participating parties, as required by the Settlement Agreement (USEPA 2006). The documents will also be available on the project web site (discussed further below). A list of recipients for all finalized documents will be maintained by the TCAI Project Coordinator.

4.2 PROJECT WEB SITE

A project web site will be established to provide a portal for authorized users to access project documents, schedules, and data. The web site will allow public access to all finalized documents. Draft documents and data will be available to members of the project team and to EPA and participating parties via secure (password-protected) access. The following information and data to be produced during the RI/FS will be distributed via the project web site (other information not directly related to RI/FS activities may also be included on the website):

- Finalized documents (public access)
- Project status and schedules (public access)
- Validated data files, if requested by EPA (public access)
- GIS files (secure access).
- Project database (secure access)
- Draft documents (secure access).

Members of the project team, EPA and participating parties will be notified via e-mail when updates have been made to the project database, project coordination information, or when new documents have been posted.

4.2.1 Document Repository

Reports, management plans, and other documents that are submitted to EPA in final form will be available to the public via the UCR RI/FS project web site. The web site will allow users to browse lists of these documents arranged by category and then interactively view and download those documents.

Users with appropriate privileges (i.e., project team members and participating parties) will be able to view and download a more extensive group of documents. Users will be able to access these documents either via a set of categorized lists (as for the public documents) or via a search tool.

4.2.2 Interactive Database Access

The project web site will facilitate the interactive query of data contained within the project database. A simple user interface will enable users to specify attributes of the data they are interested in retrieving. For example, a user could choose to view only sediment metals data from a particular location and range of dates. The result of each such query will be presented in tabular format on a web page; this table will contain links to related information, such as sampling location descriptions. Users will also be able to download query results in a format compatible with Microsoft® Excel. In addition, the entire project database will be available for download in a format compatible with Microsoft® Access.

The data available on the UCR RI/FS project website will be updated frequently, on a schedule to be dictated by project activities. As stipulated in the SOW, preliminary data and quality assurance information will be available to EPA and its government partners within 6 weeks of TCAI's receipt of the data. This data and quality assurance information will be made available on the web site (the information will also be available in hard copy). More frequent updates to the web site database will be made as necessary or appropriate. The date of the latest database update will be displayed as part of the status information available on the website.

4.2.3 Project Coordination Information

The project website will contain detailed information on project status and schedules. In addition, contact information for key team members, meeting agendas, and meeting summaries will be posted to the project website.

5 REFERENCES

CH2M HILL. 2005. Assessment of the Quality and Usability of Analytical Electronic Data – Upper Columbia River Site RI/FS, CH2M HILL, January 2005.

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APPENDIX C

PRELIMINARY HYDRODYNAMIC AND SEDIMENT TRANSPORT ANALYSES FOR THE UPPER COLUMBIA RIVER

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PRELIMINARY HYDRODYNAMIC AND SEDIMENT TRANSPORT ANALYSES FOR THE UPPER COLUMBIA RIVER

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1 INTRODUCTION

The transport and fate of constituents associated with granulated slag released from the Trail facility and other constituent sources is an important component of remedial investigation and feasibility study (RI/FS) efforts for the Upper Columbia River (UCR). Computer models are one tool that can be used to examine the transport and fate of constituents of interest (COIs) in support of RI/FS efforts by:

- Providing a systematic basis for data analysis as needed to characterize the nature and extent of contamination
- Allowing improved understanding of sediment, granulated slag, and COI transport and accumulation patterns
- Evaluating the extent to which transport patterns vary depending on pool level management in Lake Roosevelt
- Estimating current and future exposure concentrations for ecological and human receptors.

To support our current level of understanding of the UCR, bathymetric data for the UCR system were analyzed and used to perform preliminary 1-dimensional (1-D) hydraulic and 3-dimensional (3-D) hydrodynamic analysis for the UCR. The preliminary hydraulic analysis covers the area from the U.S.-Canadian border (USGS RM 745) to Grand Coulee Dam (USGS RM 596), while previous hydrodynamic analysis covers the area from the U.S.-Canadian border (USGS RM 745) to the downstream limit of Marcus Flats (USGS RM 702). Additional high resolution hydrodynamic simulations were also conducted for the area around Black Sand Beach (USGS RM 743). Results of bathymetric analyses and preliminary analyses are presented in the following sections of this appendix. These results highlight the hydrodynamic characteristics of the system that affect the transport and redistribution of sediment and granulated slag in the UCR and also help identify additional data needed to develop more detailed, hydrodynamic, sediment transport, and/or chemical transport and fate models for the site if required for the RI/FS. As detailed in the Settlement Agreement (USEPA 2006b), TCAI will submit a technical memorandum to the U.S. Environmental Protection Agency (EPA) describing proposed approaches where TCAI proposes that site characterization modeling is appropriate.

2 BATHYMETRIC DATA GEOSTATISTICAL ANALYSES

Bathymetric soundings for the UCR were analyzed in conjunction with Digital Elevation Model (DEM) data for the surrounding upland area and river shoreline data to determine the nature of spatial relationships between bed elevations and position along the river channel. Bathymetric data used for this analysis were collected in 1947–1949 and obtained from the U.S. Coastal and Geodetic Survey. The full data set contains 121,919 soundings (water depth measurements) for the area from the U.S.-Canadian border to Grand Coulee Dam. Within the delineated bounds of the Lake Roosevelt impoundment (USGS RM 736 to USGS RM 596), the USCGS reference datum (1288.6 ft mean sea level)[1] was used to convert the soundings to bed surface elevations. For the riverine section of the site near the border (USGS RM 745 to USGS RM 736), the soundings data were converted to bed surface elevations using the USCGS reference elevation and the average river slope. The soundings data are very detailed. The average distance between soundings is less than 30 m (100 ft) and the maximum distance is approximately 420 m (1,400 ft).

A range of geostatistical methods were explored, including inverse distance weighting (IDW) with difference weighting exponents and kriging with a common semi-variogram. Cross validation (jackknife) analyses were performed to determine the accuracy with which each method could interpolate and reproduce measured UCR bed elevations. All explorations were conducted using Surfer 8 (Golden Software 2004). As part of the initial analysis, each of the geostatistical methods was applied to three 1,000-point subsets of soundings and the full (121,919-point) data set. The 1,000-point subsets were selected from three different regions of the UCR system (Northport, Marcus Flats, Inchelium) to reflect differences in channel conditions across the Site. Predictive errors (mean deviation, root mean square error), standard deviations, and rank correlation coefficients for each method based on the full data set are presented in Figure C1. Error results summarized in Figure C1 are representative values; specific detail regarding estimated bed surface elevation errors is provided in subsequent text.

Of all the methods explored, IDW and kriging produced the lowest root mean square error and highest rank correlation values. With respect to the IDW and kriging methods, kriging was judged to be the better ("optimal") interpolator because it can 1) more easily account for the directional anisotropy of the sounding data; and 2) is less prone to producing "bullseyes" around each observation point.[2]

[1] The USCGS reference elevation of 1288.6 ft above mean sea level corresponds to the U.S. Bureau of Reclamation independent datum of 1290 ft for the Lake Roosevelt pool.

[2] Brief descriptions of the bullseye effect and other characteristics and limitations of geostatistical interpolation methods are presented in the Surfer manual (Golden Software 2004).

Kriging was then used to generate a continuous elevation surface. All kriging calculations and associated geographic information system (GIS) operations were conducted using ArcMap 9.2 with the Spatial Analyst and Geostatistical Analyst Extensions (ESRI 2005). Data used to develop the continuous surface were the USCGS soundings data, a DEM for the surrounding upland areas obtained from the U.S. Geological Survey (USGS), and river shoreline data obtained from the National Park Service (NPS). The approximate date of the DEM data from the USGS is 1972. The river shoreline data identify the location of the 393 m (1,290 ft) "full pool" elevation of the Lake Roosevelt impoundment and was obtained as a GIS coverage from the NPS in 2007. In the riverine section of the UCR, the 396–402 m (1,300–1,320 ft) contours were progressively followed to extend the delineated shoreline from the upstream limit of the impoundment to the border. A semi-variogram for the full set of soundings data was constructed using a lag distance of 90 m (~300 ft) and 25 lag intervals (2,250 m) (~7,400 ft). The anisotropy direction and extent of the soundings data were globally determined from the full data set. A spherical model was selected to approximate the empirical semi-variogram of the soundings. A summary of semi-variogram parameters is presented in Table C1. Kriging results are not particularly sensitive to the choice of model used to approximate the empirical semi-variogram, because most points within the local neighborhood for kriging calculations are within the sill distance of the semi-variogram. Specifically, most points in the local neighborhood for kriging calculations are located relatively close to each other and contribute to the steeply rising portion of the semi-variogram before the sill (i.e., the range). Within this range, all semi-variogram models explored have a similar (and approximately linear) shape.

For speed of calculation, kriging calculations for the area within the river shoreline were completed in 12 passes. Each pass used approximately 7,400 to 18,000 observations. There was a small area of overlap for each pass. The semi-variogram and kriging parameters for each pass were identical and equal to the global values summarized in Table C1. These results were then mosaiced together to form a single, continuous elevation surface for the riverbed within the UCR shoreline. The passes for the Spokane River and the adjoining section of Lake Roosevelt were mosaiced first using the main stem Lake Roosevelt results preferentially over the results for the Spokane River to eliminate edge differences near the river junction. The results of this first step mosaicing process were then joined with the kriging results from the rest of the passes. During the remaining mosaic steps, overlap areas for each pass were blended to minimize the impact of edge differences. The area of the DEM within the UCR shoreline was then removed and replaced by the kriging results for riverbed and mosaiced into a single, continuous raster surface with a 30 m by 30 m (100 ft by 100 ft) cell size. A display of the final bathymetric surface and surrounding upland elevations for the entire UCR site is presented in Figure C2. Close-up displays of the final bathymetric surface in the areas near Northport and Marcus Flats are presented in Figures C3 and C4, respectively.

For consistency between passes, semi-variogram and kriging parameters were optimized globally. Corresponding root mean square (RMS) error for estimated bed elevations is ±3.1 m (10.3 ft) as determined from cross validation performed using the Geostatistical Analyst in ArcGIS.

For future analyses and field investigations, it is worth noting that the treatment of islands and seasonally emergent rocks in the bathymetric analysis is problematic. Ship-borne sounding equipment does not capture the locations of islands or outcroppings because the survey boat cannot traverse those areas. Such areas that the survey boat cannot traverse do no have reported soundings values. When soundings data in the area of an island are used to develop a bathymetric surface, unreported areas within the river shoreline will be treated as if they are subject to the same interpolation as all other points in the region. The method used for bathymetric analysis (kriging, TINs, IDW, etc.) does not matter because all methods share this problem. If establishing the exact location and areal extent of small islands becomes important, it may be necessary to roughly survey the position and approximate height of the major islands/rock outcroppings. Although this would not necessarily require the same high level of accuracy as typically used for standard land surveys, the accuracy of interpolations could be improved by roughly surveying the elevations (and coordinates) of a few points on each major island or outcropping in the study area.

Again, notably, the final bathymetric surface is based on the USCGS soundings. It is possible that bed surface elevations may have changed over time in response to changing flow and sediment input conditions or other factors, introducing an element of uncertainty into the results. If bed elevations have occurred over time, the areas most prone to change are areas of low shear stress (e.g., the flooded lobes of Marcus Flats) where sediments (and granulated slag) are most likely to accumulate given pool management practices at Grand Coulee Dam and upstream flow controls. The bed in areas of high shear stress (e.g., the riverine reach near Northport) may have also experienced changes over time as a consequence of reductions in upstream sediment inputs. However, the potential for bed elevation decreases in high shear stress areas is lower than the potential for bed elevation increases in low shear stress areas as a consequence of upstream flow regulation over time. New bed elevation data would be useful to confirm (or refute) this aspect of river behavior. If new bed elevation data are collected, careful attention should be paid to establishing a reliable reference data so that elevations for different years can be accurately compared to determine the magnitude and extent of any elevations differences that may have occurred over time.

3 1-D HYDRAULIC ANALYSIS

A preliminary 1-D hydraulic analysis for the UCR system from the U.S.-Canadian border (USGS RM 745) to Grand Coulee Dam (USGS RM 596) was completed using the U.S. Army Corps of Engineers (USACE) HEC-RAS 4.0 (Hydraulic Engineering Center-River Analysis System) computer model (USACE 2006). HEC-RAS simulates 1-D hydrodynamics and sediment transport potential for non-cohesive materials. HEC-RAS solves is the standard tool endorsed by the USACE for river hydraulic analyses. A complete description of model equations and numerical methods is presented in the model reference manual and applications guide (USACE 2006).

3.1 DEVELOPMENT OF RIVER CROSS-SECTIONS FOR HEC-RAS

The final elevation surface from ArcGIS (combining bathymetry and upland data) was used to construct a series of cross-sections to parameterize HEC-RAS. Cross-sections for HEC-RAS were developed using the HEC-GeoRAS 4.0 (USACE 2005) extension to ArcGIS. Use of HEC-GeoRAS also requires the Spatial Analyst and 3D Analyst extensions in ArcGIS. A total of 409 cross sections with a typical spacing of 500 to 750 m (1,600 to 2,500 ft) were exported from ArcGIS using HEC-GeoRAS and read into the geometry editor in HEC-RAS. An overview of UCR cross-section locations as displayed in the HEC-RAS geometry editor is presented in Figure C5. Close-up displays typical cross sections in the areas near Northport and Marcus Flats as displayed in the HEC-RAS geometry editor are presented in Figures C6 and C7, respectively. F

3.2 PRELIMINARY HEC-RAS MODEL APPLICATION RESULTS

Preliminary (uncalibrated) HEC-RAS simulations were conducted for upstream flows ranging from 2,000 to 14,000 cubic meters per second (cms) (m^3/s) (71,000 to 495,000 cfs)[3] and downstream water depths of 368 m (1,210 ft) (low pool) and 393 m (1,290 ft) (high pool). For these simulations, a Manning *n* (flow resistance coefficient) of 0.040 was used. Model results (water surface elevations, and flow velocity and cross-section areas) for low pool conditions are presented in Figures C8 and C9. Similarly, results for high pool conditions are presented in Figures C10 and C11. Example results for a cross section near Black Sand Beach (XS 241022.2) (near RM 743) with simulated water surfaces for low pool and high pool conditions are in Figure C12 and C13, respectively. Similarly, example results for a cross section near Marcus Flats (XS 181116.3) (near RM 708) with simulated

[3] This range of flows includes all typical and extreme conditions that occurred since construction of the Grand Coulee Dam began (1938). Since upstream flow regulation began (around 1973), flows in the UCR have not exceeded approximately 8,500 cms (~300,000 cfs). Flows larger than 8,500 cms are representative of historical conditions.

water surfaces for low pool and high pool conditions are in Figures C14 and C15, respectively.

Again, it is notable that these preliminary results are for an uncalibrated model. Flow velocities and cross-section areas at any point in the river will be affected by uncertainties in underlying bed elevation estimates and Manning *n* values in particular. The sensitivity analyses to describe the variation of model results to differences in Manning *n* have been completed. For these sensitivity analyses, Manning *n* values were varied from a low of 0.020 (representing smooth bed, high depth conditions) to high of 0.080 (representing rough bed, low depth conditions) and suggest that computed water depths and flow velocities in most locations are not highly sensitive to small variations of roughness.

4 3-D HYDRODYNAMIC ANALYSIS

A preliminary large-scale, 3-D hydrodynamic analysis for the UCR from the U.S.-Canadian border (USGS RM 745) to the downstream limit of Marcus Flats (USGS RM 702) was completed using the ECOMSED model framework (HydroQual 2004). A preliminary fine-scale, 3-D hydrodynamic analysis for the UCR near Black Sand Beach (USGS RM 743) was also completed using ECOMSED. An overview of the ECOMSED framework and details of preliminary analysis follow.

4.1 OVERVIEW OF THE ECOMSED MODEL FRAMEWORK

ECOM (Estuarine, Coastal, and Ocean Model) is the hydrodynamic module and SED is the integrated sediment transport module. The predictive capability of the model has been assessed through extensive comparisons with data. A high degree of confidence has been established, demonstrating that the model represents the predominant physics of different water bodies in a realistic manner. The model solves coupled 3-D advection-diffusion equations for water mass, momentum, heat, and salinity and employs a two-equation turbulent-closure scheme (Blumberg and Mellor 1987; Galerpin et al. 1988; Mellor and Yamada 1982) to provide realistic representation of vertical mixing processes. ECOMSED can be used as a stand-alone hydrodynamic model or in conjunction with the integrated sediment-transport model to simulate the erosion, deposition, and transport of multiple size classes for both cohesive and non-cohesive particles. The model can also be coupled to other (external) chemical transport and fate models such as the USEPA WASP/IPX series of model frameworks (Ambrose et al. 1993; Velleux et al. 2001).

ECOMSED uses a conformal curvilinear coordinate system with variable grid resolution, which allows the model to effectively simulate the spatially variable geometry of the system. Fine spatial (horizontal) resolution can be achieved by using a smaller model grid size in areas of special interest or concern. In the vertical direction, the model uses a transformed sigma (σ)-coordinate system, which allows it to follow changes in bottom topography and surface elevation and to resolve associated vertical currents. A complete description of ECOMSED is presented by HydroQual (2004). Only the hydrodynamic module was used for these preliminary simulations demonstrating conditions in the UCR.

4.1.1 Hydrodynamic Transport

Water in a river channel moves (flows) by the action of gravity. In the UCR, the flow of water through the river channel can transport and redistribute bed sediment and associated metal contaminants. As water flows, it is subject to frictional resistance (drag) along the boundaries (surfaces) of all material it passes. The balance between gravity and drag forces along the flow path determines the velocity and depth of the flow. The force that is exerted by the flowing water on the riverbed and banks is described in terms of the

shear stress. The hydrodynamic module in ECOMSED is used to simulate flow, depth, velocity, and shear stress.

The governing equations for hydrodynamics are:

Conservation of Mass (Continuity)

$$\frac{\partial U}{\partial x} + \frac{\partial V}{\partial y} + \frac{\partial W}{\partial z} = 0$$

Conservation of Momentum

$$\frac{\partial U}{\partial t} + U\frac{\partial U}{\partial x} + V\frac{\partial U}{\partial y} + W\frac{\partial U}{\partial z} - fV = -\frac{1}{\rho_0}\frac{\partial P}{\partial x} + \frac{\partial}{\partial z}\left(K_M \frac{\partial U}{\partial z}\right) + F_x$$

$$\frac{\partial V}{\partial t} + U\frac{\partial V}{\partial x} + V\frac{\partial V}{\partial y} + W\frac{\partial V}{\partial z} + fU = -\frac{1}{\rho_0}\frac{\partial P}{\partial y} + \frac{\partial}{\partial z}\left(K_M \frac{\partial V}{\partial z}\right) + F_y$$

$$\rho g = -\frac{\partial P}{\partial z}$$

Where:

U, V, W	=	mean (Reynolds-average) velocities in the x, y, and z directions, respectively [L/T]
ρ_0	=	reference density of water [M/L^3]
ρ	=	local density of water [M/L^3]
g	=	gravitational acceleration [L/T^2]
f	=	Coriolis parameter [1/T]
P	=	pressure [M/L/T^2]
K_M	=	turbulent mixing coefficient (eddy viscosity) [L^2/T]
F_x, F_y	=	horizontal diffusion in the x- and y-directions, respectively [L^2/T].

The horizontal diffusion terms represent small (sub-grid) scale processes not directly resolved by the model grid and are expressed in a form analogous to molecular diffusion:

$$F_X = \frac{\partial}{\partial X}\left(2A_M \frac{\partial U}{\partial X}\right) + \frac{\partial}{\partial Y}\left[A_M\left(\frac{\partial U}{\partial Y} + \frac{\partial V}{\partial X}\right)\right]$$

$$F_Y = \frac{\partial}{\partial Y}\left(2A_M \frac{\partial V}{\partial Y}\right) + \frac{\partial}{\partial X}\left[A_M\left(\frac{\partial U}{\partial Y} + \frac{\partial V}{\partial X}\right)\right]$$

Where:

A_M = horizontal diffusivity [L^2/T].

These equations are transformed for use in a curvilinear, orthogonal, σ-level coordinate system as described by HydroQual (2004).

In developing these equations, two simplifying assumptions were made: 1) the weight of the fluid identically balances the pressure (hydrostatic pressure assumption); and 2) density differences are negligible unless the differences are multiplied by the gravitational acceleration (Boussinesq approximation).

The governing equations contain Reynolds stress and flux terms that account for the turbulent diffusion of momentum and are expressed by the eddy viscosity. The turbulence closure approach of Mellor and Yamada (1982) is used to solve these equations. Through the turbulence closure scheme and boundary conditions for water (free) surface and friction at the sediment bed, the main model calibration parameter for hydrodynamics is the bottom roughness height, z_0. The principal outputs of the hydrodynamic model are water velocities in the x, y, and z directions, depths (stage), and shear stresses at the sediment–water interface.

4.1.2 Linkage to Sediment Transport

In the water column, particles are transported by advection and can be exchanged between the bed and the water column by erosion and deposition. Particles may be transported as suspended load (fully entrained in the flow) or bedload (in contact with the bed). The shear stress at the sediment–water interface generated by water flowing over the bed surface is a primary determinant of the extent to which materials settling out of the water column are deposited on the bed, are eroded from it, and whether particles in motion are transported as suspended load or bedload. Within a thin layer near the bed

(i.e., the boundary layer), the water velocity decreases and typically diminishes to zero at the bed interface. This vertical velocity gradient generates a shear stress that acts on the bed. Close to the bed, particularly when bedload transport occurs, at a scale that ranges from a few particle diameters to the length of bed forms (e.g., ripples and dunes), the total bed shear stress can be separated into two components: 1) form drag; and 2) skin friction (surface drag). The relationship between the total shear stress and its components is:

$$\tau_b = \tau_f + \tau_g$$

Where:

τ_b	=	total bed shear stress [M/L/T^2]
τ_f	=	form drag shear stress [M/L/T^2]
τ_g	=	surface drag (grain-related) shear stress [M/L/T^2].

Surface drag acts to initiate the movement of particles off the bed surface, through the boundary layer, and into the main body of the flow. The surface drag component of the total bed shear stress is termed the grain-related shear stress.

For this preliminary presentation of model results, the total shear stress was decomposed into bed-form and grain-related components by matching logarithmic velocity profiles using the "Law of the Wall" assuming that the total bed roughness height (z_0) was 5 cm and that the grain-related roughness height was equal to one-half the diameter of the particles typically present on the bed surface.

Recent upgrades to ECOMSED significantly enhance the sediment transport capabilities of the model. In particular, ECOMSED now uses SEDZLJ (Jones and Lick 2001) to compute erosion for bed of mixed composition (cohesive and non-cohesive) and differing grain sizes as a function of measured erosion rates. The enhanced model also simulates suspended and bedload transport of any number of particle classes.

4.1.3 Linkage to Chemical Transport and Fate

Metals associated with granulated slag are chemicals of interest for UCR RI/FS efforts. In the aquatic environment, metals may exist in different chemical phases: 1) freely dissolved, 2) complexed to dissolved organic material or other ligands; and 3) particulate. In the UCR, the flow of water through the river channel can transport and redistribute metals in all phases. Particulate-phase metals are typically associated with particles and will move between the sediment bed and the water column as those particles are eroded

or deposited. The hydrodynamic and sediment transport modules in ECOMSED are used to simulate flow, depth, velocity, shear stress, and particle erosion and deposition fluxes. These results could be used to drive subsequent metals transport and fate computations. A separate chemical transport model such as the USEPA WASP/IPX water quality models or the Row Column AESOP (RCA) model could be used in conjunction with ECOMSED to simulate metals transport and fate.

4.2 APPLICATION TO THE UPPER COLUMBIA RIVER

In the UCR, fluid transport is expected to control the distribution of granulated slag-related solids and particulate metals as well as the distribution of dissolved or bound (complexed) metals. Frictional interaction of the moving fluid with the riverbed creates a drag force or boundary shear stress that can erode the bed if the force per unit area of bed is sufficiently large. The boundary shear stress is proportional to depth-averaged velocity squared, so a doubling of current speed corresponds to a quadrupling of boundary shear stress. When the shear stress exceeds the critical shear stress for erosion (i.e., the incipient motion threshold), particles can move as bedload (sliding, rolling or saltating along the bed surface) or as suspended load (fully entrained in the water column). Turbulence generated at the bed can mix eroded particles higher into the water column so particles moving as bedload can move as suspended load as conditions change. For a particular particle size and density, the interaction of the forces acting on a particle will determine the future position of the particle over time. Gravity moves particles downward toward the bed. Mixing by turbulence can move particles upward. Advection (the downstream movement of water) moves particles and dissolved constituents downstream.

In general, particles of a given size and density transported by flowing water will move vertically to a height above the sediment bed where downward motion due to gravity is balanced by upward mixing due to turbulence. Smaller, less dense particles will be mixed well away from the bed and move as suspended load. In contrast, larger, denser particles will remain very near the bed and move as bedload. Because flow velocities generally increase with distance above the bed, the vertical distribution of particles in the water column regulates their rate of movement downstream. Particles large and dense enough to overcome both vertical turbulent mixing and local boundary shear stress will deposit to the bed and cease downstream movement altogether. Although this is a very simplified presentation (other forces and fluid, particle, and bed characteristics can play important roles), it describes the essential features of sediment transport.

A large-scale 3-D hydrodynamic preliminary analysis was performed to estimate flow velocities, bed shear stresses, and grain-related (skin friction) shear stresses in the UCR between the U.S.-Canadian border (USGS RM 745) and the downstream limit of Marcus Flats (USGS RM 702). Discrete soundings from the 1947–1949 survey conducted by the USCGS were used to generate a continuous bed elevation (bathymetric) surface in order

to assign model depth to each model grid cell. To represent the river between the border and the end of Marcus Flats, the grid for the large-scale model has 165 columns in the downstream direction and 17 rows across the channel with a total of 933 total active cells (segments). The number of active cells across the channel upstream of Marcus Flats ranges from 3 to 8. Through Marcus Flats, there is a maximum of 12 cells across the grid. In all cells, there are 10 vertical layers. The model grid is presented in Figure C16.

A more detailed, fine-scale (high resolution) 3-D hydrodynamic preliminary analysis was performed to simulate boundary shear stress and depositional characteristics in the vicinity of Black Sand Beach, a known deposit of granulated slag near RM 743. The high-resolution grid covered a 1.9 km (1.2-mile) region of the UCR centered on Black Sand Beach. The grid and bathymetry contours for the fine-scale model are shown in Figure C17. The grid segmentation for the fine-scale model was 81 columns by 24 rows by 10 vertical layers. The average cell size near Black Sand Beach was approximately 15 m by 15 m (49 ft by 49 ft), with cell size gradually increasing in the upstream and downstream directions.

Preliminary analyses were completed for flows from 2,000 to 14,000 m^3/s (71,000 to 495,000 cfs). This range of flows covers the entire range reported at the USGS international border gage for flow regime that has existed since 1938. Annual peak flow (flood) frequency distributions for the UCR are presented in Figure C18. Flood frequency estimates for three time frames are also presented: 1938–2005, 1938–1972, and 1973–2005. These estimates show the significant impact and shift in flood regime that has occurred in the UCR system since upstream flow control began.

In the absence of calibration data, river stage (i.e., depth or elevation) was allowed to adjust naturally based on bed roughness height. Riverbed roughness (i.e., bed roughness height) was scaled to represent cobble-sized (~ 4 to 5 in.) roughness elements and bed forms for smaller particle sizes. Water temperature was assumed to be constant at 59°F and salinity was set to 0 parts per thousand (ppt).

4.3 PRELIMINARY 3-D HYDRODYNAMIC PRELIMINARY ANALYSIS

Preliminary (uncalibrated) 3-D hydrodynamic analysis was conducted based on simple estimates of bed roughness. Large-scale model depth-averaged velocities and grain-related shear stress results are for flows that range from 2,000 to 14,000 m^3/s. The regions for which results are presented correspond to the reaches defined in the UCR RI/FS work plan: Reach 1–2 (Figures C19 and C20) and Reach 2–3 (Figures C21 and C22). The color scale used for the grain-related shear stress results indicates the size of particle (or smaller) particle that could be transported for each given flow condition. The terms "granule" and "pebble" are classifications for gravel-sized particles using the Wentworth scale.

Collectively, these results suggest that the upstream portions of the UCR nearest to the U.S.-Canadian border are largely transport zones for most particle types. In most areas of the river, velocities and shear stresses are large enough to transport all size classes of sediment. The reported difficulty in obtaining bed sediment samples in this section of the UCR (USEPA 2006a) qualitatively confirms this result. In Reaches 1 and 2, only a few hydrodynamically sheltered areas of lower shear stress exist. In these low shear stress areas, particles may deposit over time and may remain in place and be stable if historically deposited under high flow regimes. Depending on the degree of sheltering that exists, some deposited particles may be in transient storage and could be eroded and transported downstream during extreme events. However, in the most sheltered areas, deposited sediments may not be remobilized even during extreme events. Black Sand Beach is an example of an isolated area where sand-sized particles can accumulate over time.

These results further suggest that other areas of the UCR through Marcus Flats (and likely further downstream) are largely deposition zones. Even at flows as large as 8,000 m^3/s (an estimated 1-in-50 year flood based on flows from 1973 to 2005), much of the Marcus Flats area is depositional. However, at 8,000 m^3/s shear stresses and corresponding sediment transport capacities in small areas near the river thalweg are expected be larger. This suggests that particles that deposit in mid-channel areas during lower flow conditions are in transient storage and could be eroded during subsequent large floods.

Velocity and shear stress patterns near Blank Sand Beach were examined using a fine-scale (high resolution), 3-D hydrodynamic analysis. Granulated slag particles are a large fraction of the total particles mass comprising beach sediments at Black Sand Beach. Despite the generally high shear stresses (and high sediment transport potentials) that occur in this river reach, Black Sand Beach exists in a hydrodynamically sheltered area and has been a long-standing and persistent feature of the river. To evaluate the transport potential of particles in this area of the river, results are presented for a flow of 8,000 m^3/s (283,000 cfs). This flow corresponds to the typical magnitude of annual floods that occurred before 1973 and is only slightly less than the maximum peak flood of 8,550 m^3/s (302,000 cfs) that occurred between 1973 and 2005.

Simulated depth-averaged velocities for the area around Black Sand Beach are presented in Figure C23. The maximum depth-averaged velocity was approximately 4 m/s (13 ft/s.) The main flow path shown in Figure C23 crosses from the river from north to south toward the outside of the river bend, as the flow follows deeper areas of the river thalweg. However, the rocky promontory protruding from the south bank just upstream of Black Sand Beach forces the main flow back across the river channel toward the north bank. This interaction between flow and bathymetry produces a small eddy in the area of Black Sand Beach as presented in Figure C24. Simulated velocities also decrease in the area

immediately upstream of the rock outcropping that protects Black Sand Beach. This small area is predicted to be a depositional zone. For these example calculations, the rock outcropping at the upstream edge of Black Sand Beach was represented in the model by suppressing transport between the upstream edges of model grid cells at the location of the outcropping (denoted as a solid line in the vicinity of Black Sand Beach).

The fine-scale preliminary analysis provides further insight into the transport characteristics of the UCR near Black Sand Beach. The total shear stress simulated is presented in Figures C25 and C26. In Figure C25 the color scale is adjusted to highlight the differences in the largest simulated total bed shear stresses and in Figure C26 the color scale is adjusted to highlight differences in the lowest shear stresses. The preliminary analysis suggests that total shear stresses exceed 80 dyne/cm^2 for much of the channel, with some isolated areas that exceed 625 dyne/cm^2. For comparative purposes, estimated critical shear stresses needed to initiate erosion for different size classes of unconsolidated granulated slag are shown in Table C2. These estimates assume that granulated slag particles have a density of 3.50 g/cm^3 and have rounded shapes similar to natural quartz particles. The estimated critical shear stress for erosion of the largest slag particles is 50 dyne/cm^2. These results suggest that even the largest granulated slag particle that occur would be transported along the main channel (outside the eddy) under high flow conditions. This is consistent with field observations that indicate the riverbed in this region largely comprises cobbles (USEPA 2006b). The results also indicate that shear stresses within the eddy are much lower and would allow particles to deposit and accumulate. This is also consistent with the observed occurrence and character (color, grain size) of the particles that comprise Black Sand Beach. As an additional qualitative check of performance, it is noted that the locations of simulated eddies and deposition zones correspond to the locations of observed depositional zones as seen in aerial photographs of the site (Figure C27). It is also noted that the model successfully simulated the occurrence of the depositional area on the north bank of the river as shown in Figure C26.

5 SUMMARY OF POTENTIAL DATA NEEDS

The physics of fluid motion (e.g., Batchelor 1967; Blevins 1984; Chen et al. 1996; Nezu and Nakagawa 1993) and the transport of non-cohesive sediment (e.g., Middleton 1984; Soulsby 1997; van Rijn 1996; Whitehouse et al. 2000) are reasonably well understood and can be described mathematically. Additional information regarding the flow characteristics of the UCR, as well as detailed information regarding the particles of interest (native sediment and granulated slag), will help improve the ability to accurately simulate where contaminated particles are likely to accumulate and their long-term stability and fate.

However, it is important to recognize that the preliminary results presented in this appendix were developed using relatively simple analytical and semi-empirical solutions to describe the expected large-scale distributional pattern of granulated slag along the axis of the UCR. Although large-scale simulations are useful, development of fine-scale, high-resolution simulations require more highly resolved data to assess the complexity of the UCR channel morphometry, flow characteristics, and sediment transport potentials. Should such analysis be required, the data needed to support development of fine-scale hydrodynamic, sediment transport, and metals transport and fate models include the following:

- Updated, detailed bathymetry (with an accurately defined reference datum) in targeted areas of the river
- Current velocity measurements
- Water surface elevations
- Improved sediment bed characterization for sediments and metals
- Measurements to estimate inflow and loads for solids and metals

Sediment deposition and burial rates and metals concentration trends.

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FIGURES

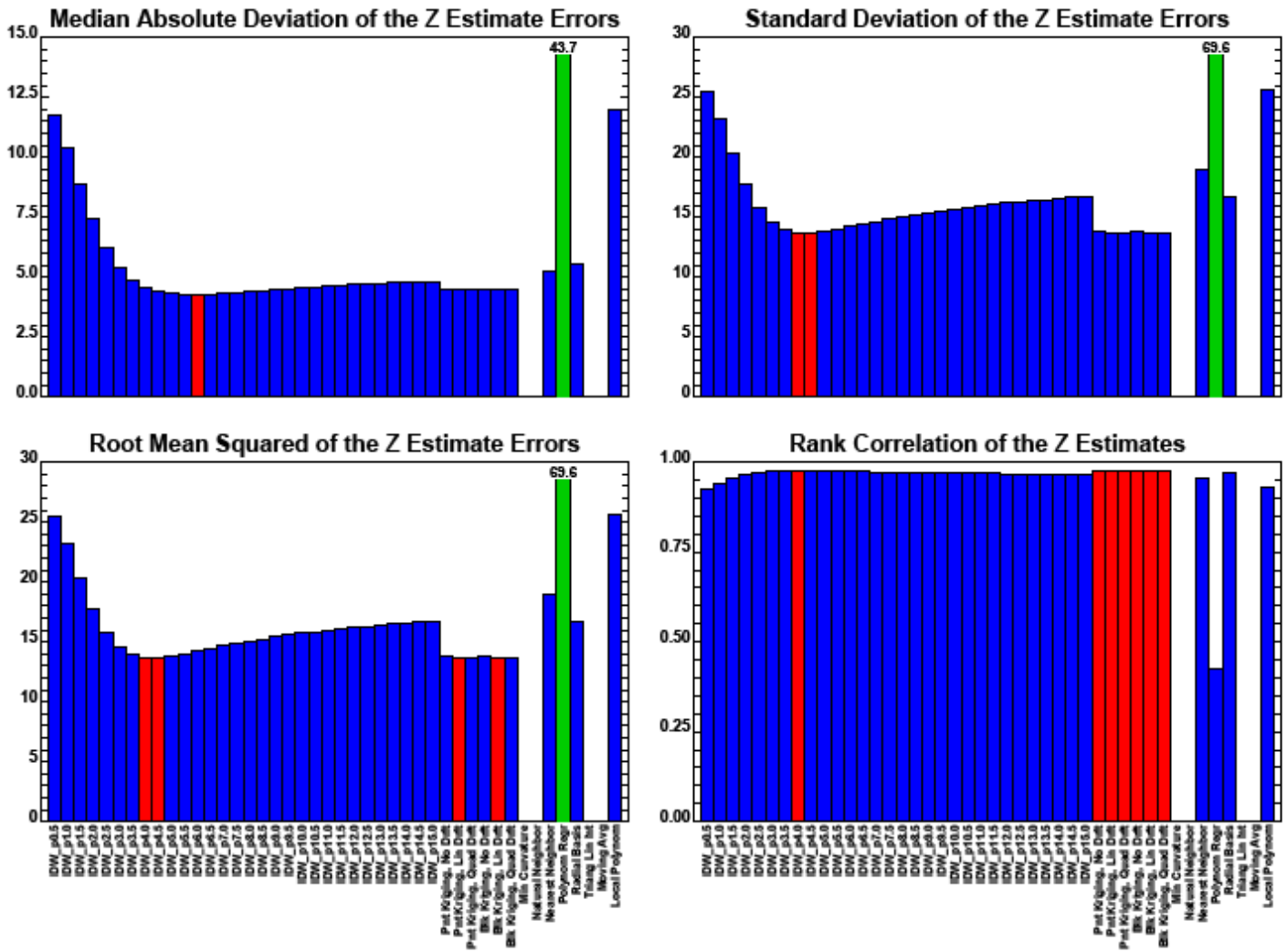

Figure C1. Geostatistical method evaluation predictive errors (ft), standard deviations (ft), and rank correlations using all 121,919 soundings

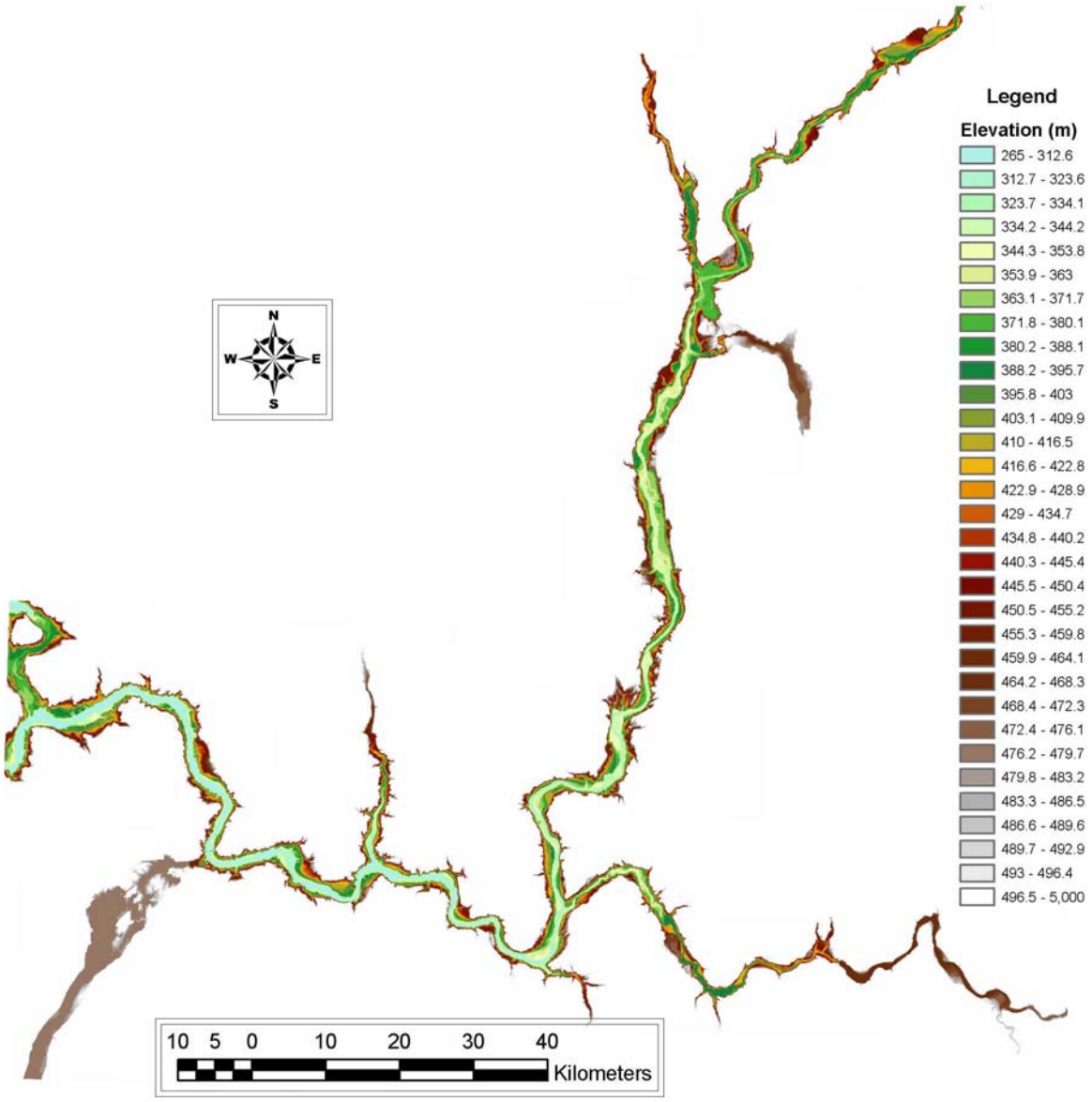

Figure C2. Mosaiced elevation surface (with surrounding upland elevations) for the UCR system from the border (USGS RM 745) to Grand Coulee Dam (USGS RM 596).

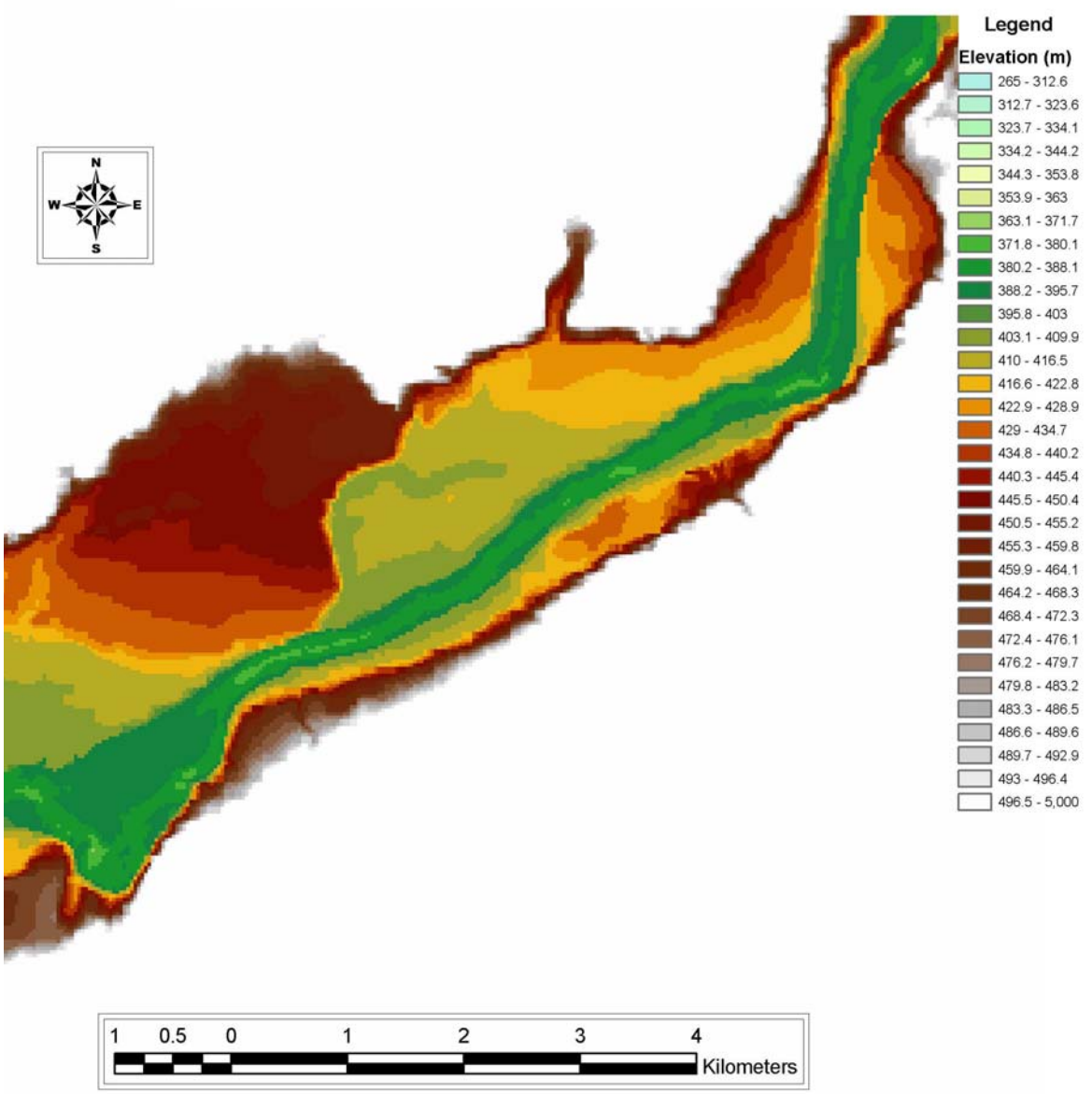

Figure C3. Close-up of mosaiced elevation surface (with surrounding upland elevations) for the UCR system from the U.S.-Canadian border to Northport.

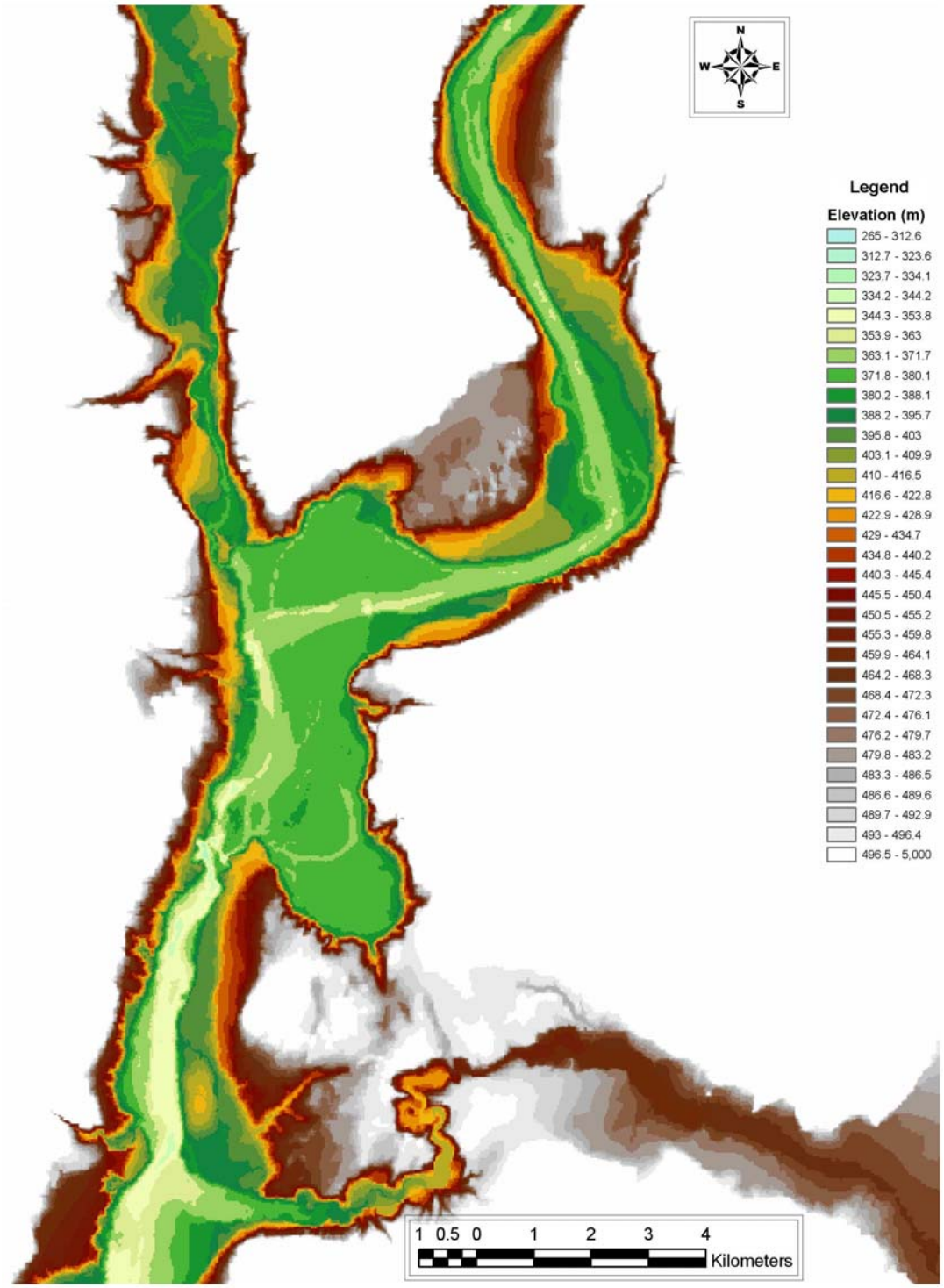

Figure C4. Close-up of mosaiced elevation surface (with surrounding upland elevations) for the UCR system near Marcus Flats

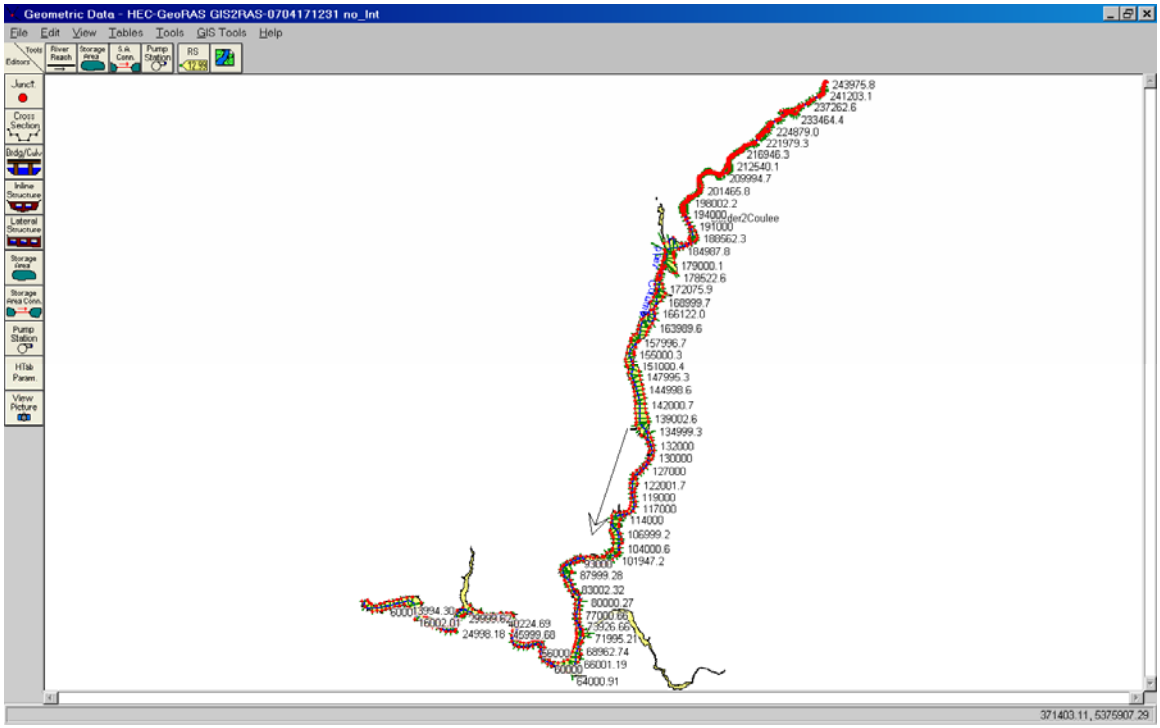

Figure C5. Overview of UCR cross-section locations as displayed in the HEC-RAS geometry editor

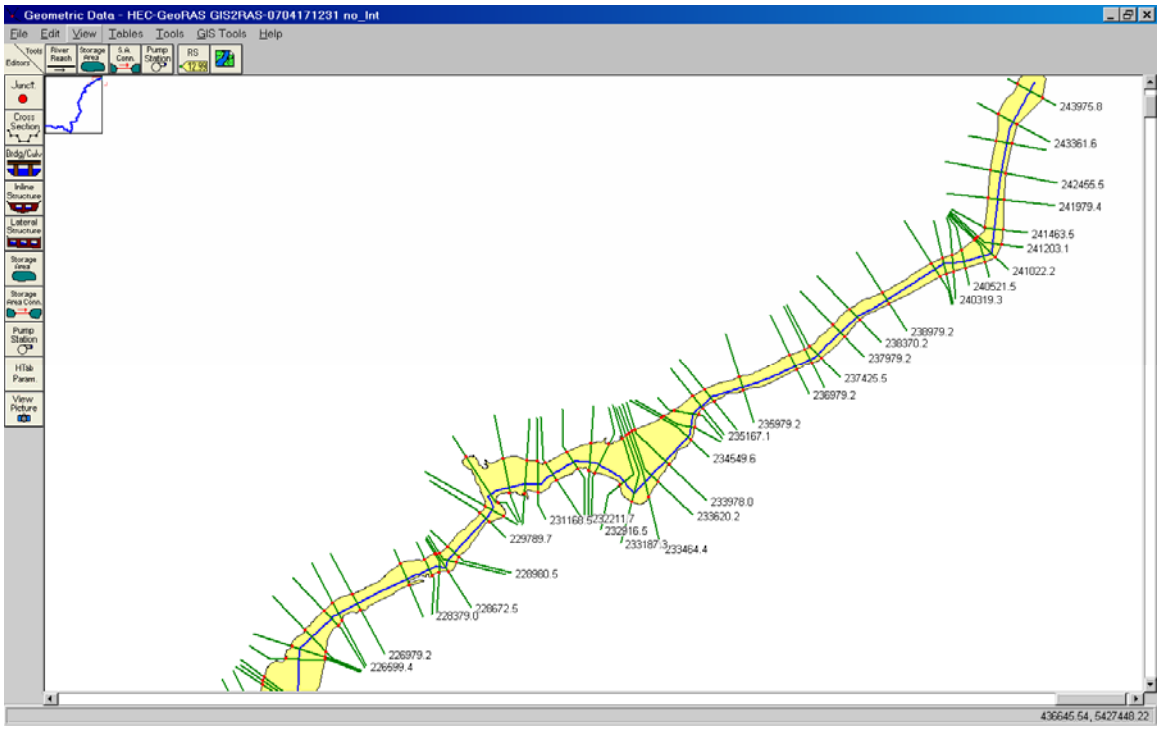

Figure C6. Close-up of UCR cross-section locations between the U.S.-Canadian border and Northport as displayed in the HEC-RAS geometry editor

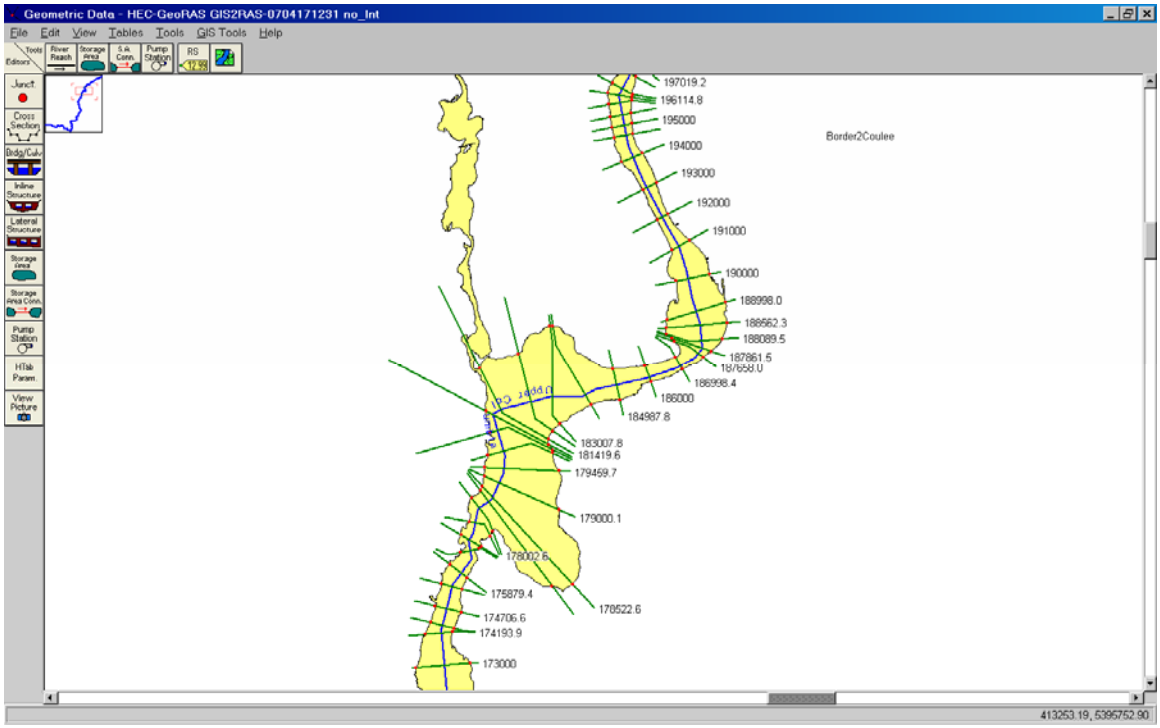

Figure C7. Close-up of UCR cross-section locations near Marcus Flats as displayed in the HEC-RAS geometry editor

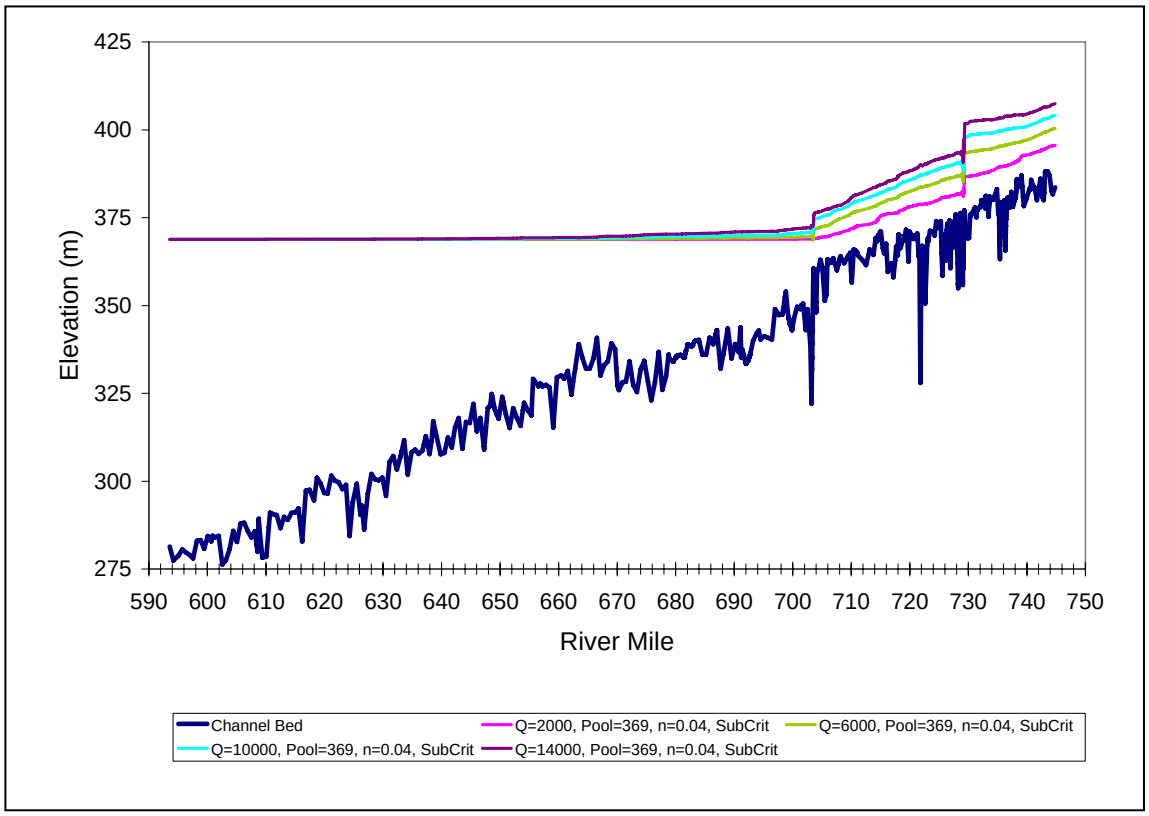

Figure C8. HEC-RAS water surface profiles for low pool (369 m) conditions with flows ranging from 2,000 to 14,000 cms and an assumed Manning *n* value of 0.040

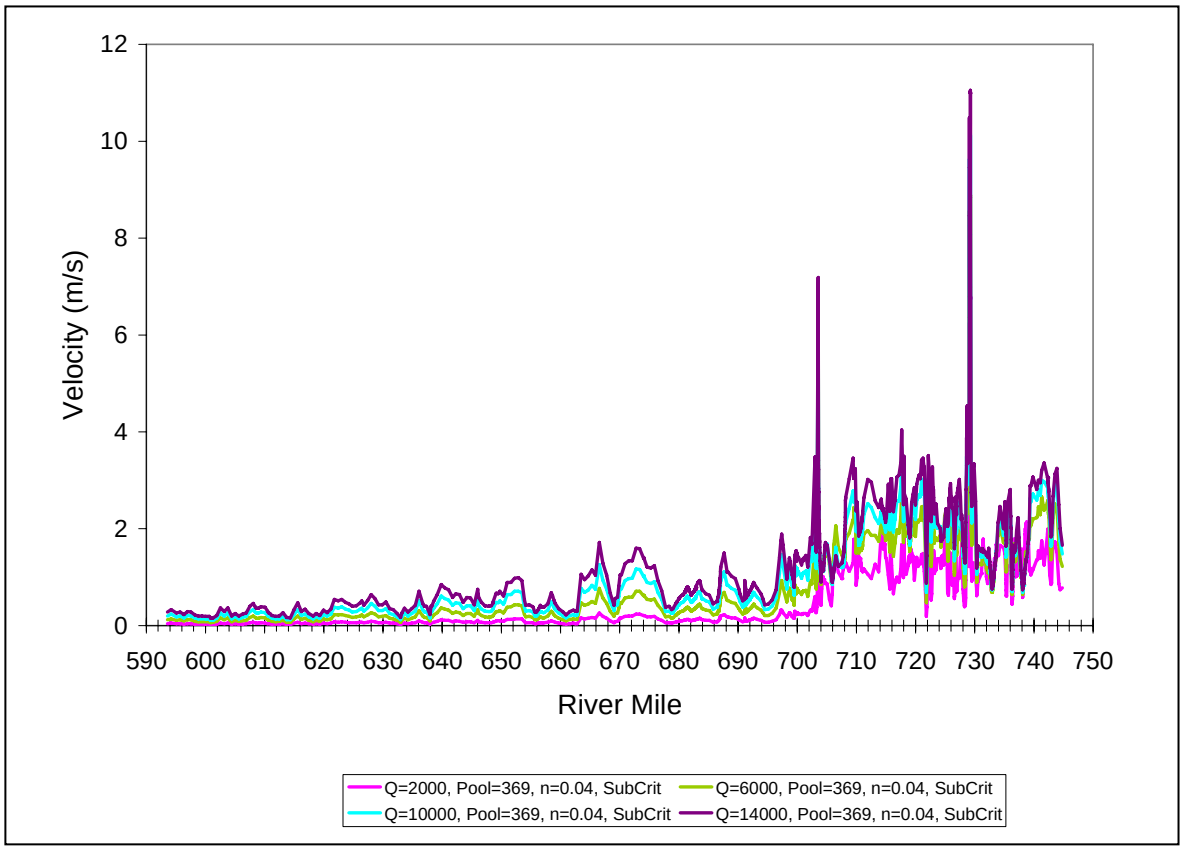

Figure C9. HEC-RAS flow velocities for low pool (369 m) conditions with flows ranging from 2,000 to 14,000 cms and an assumed Manning *n* value of 0.040

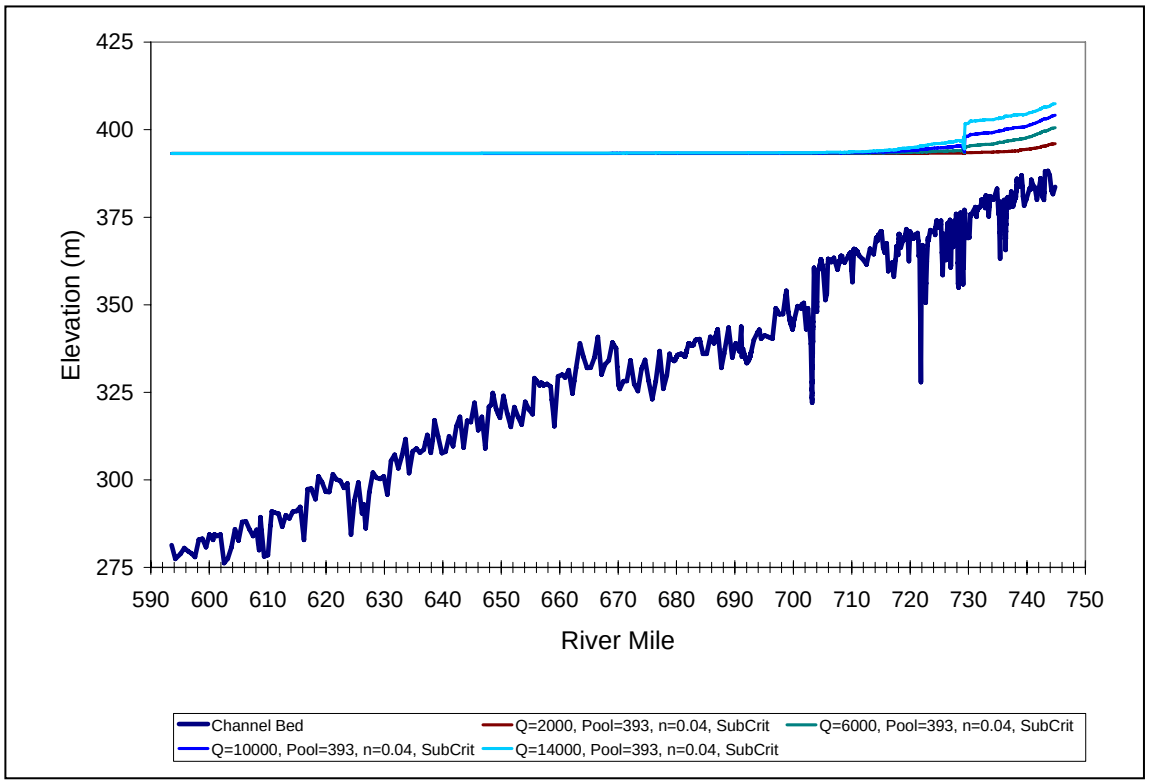

Figure C10. HEC-RAS water surface profiles for high pool (393 m) conditions with flows ranging from 2,000 to 14,000 cms and an assumed Manning *n* value of 0.040

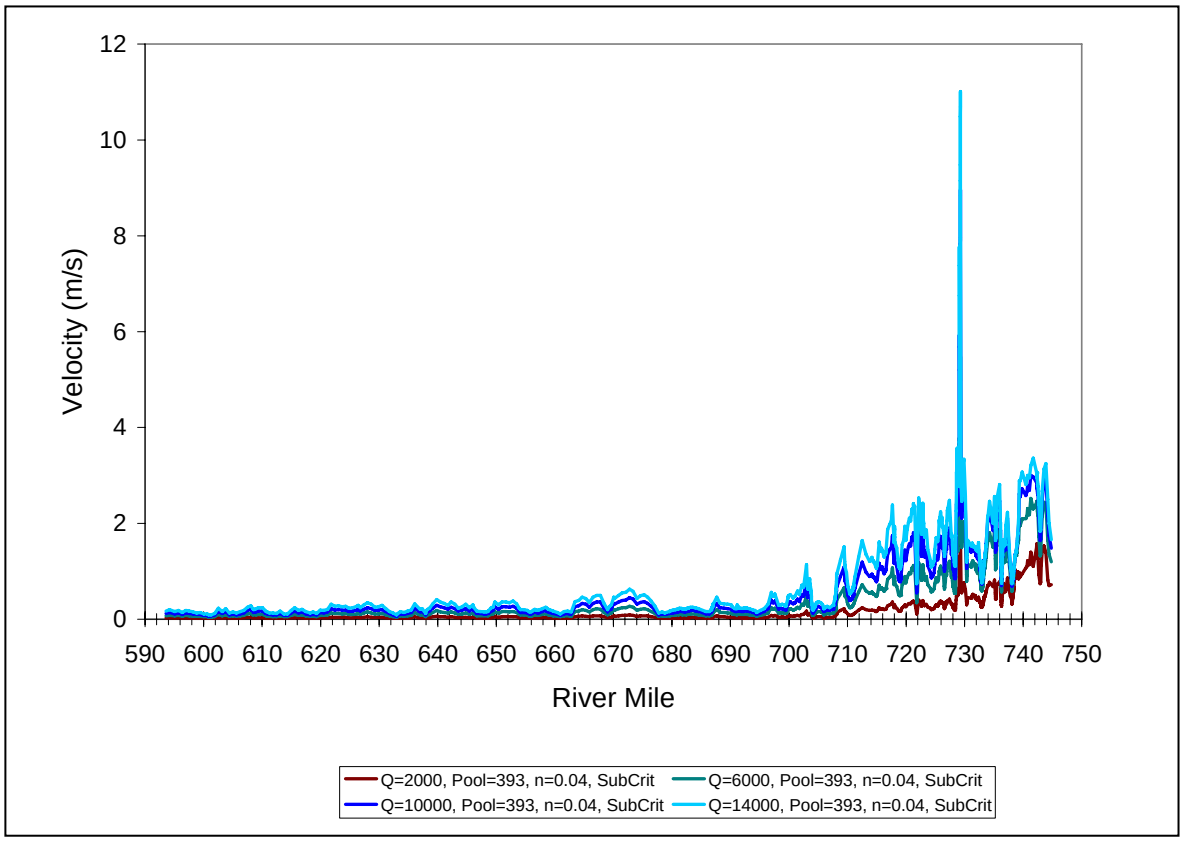

Figure C11. HEC-RAS flow velocities for high pool (393 m) conditions with flows ranging from 2,000 to 14,000 cms and an assumed Manning *n* value of 0.040

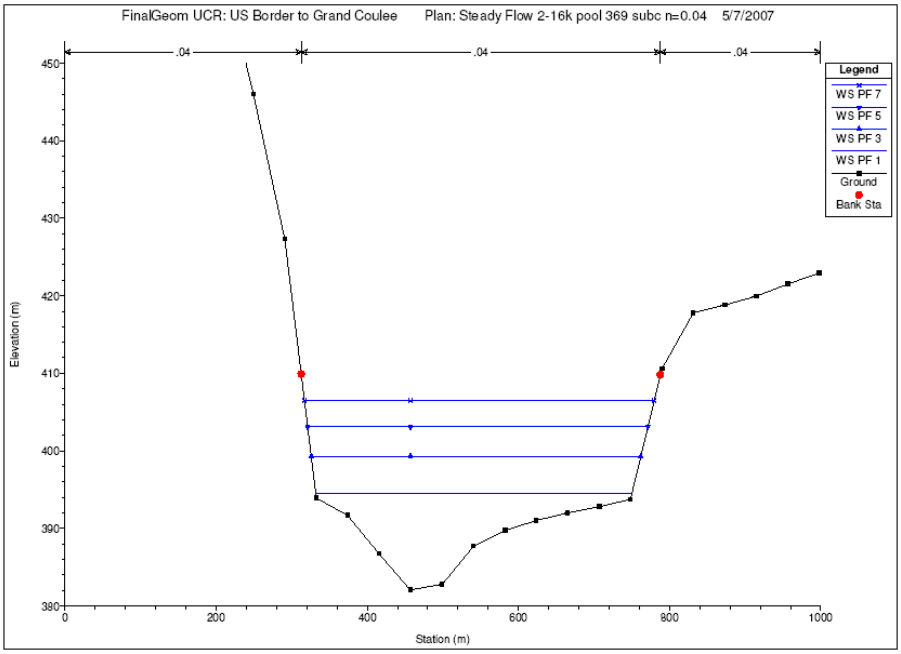

Figure C12. HEC-RAS flow velocities and cross-section areas at XS 241022.2 (Blank Sand Beach) for low pool (369 m) conditions with flows ranging from 2,000 to 14,000 cms and an assumed Manning *n* value of 0.040

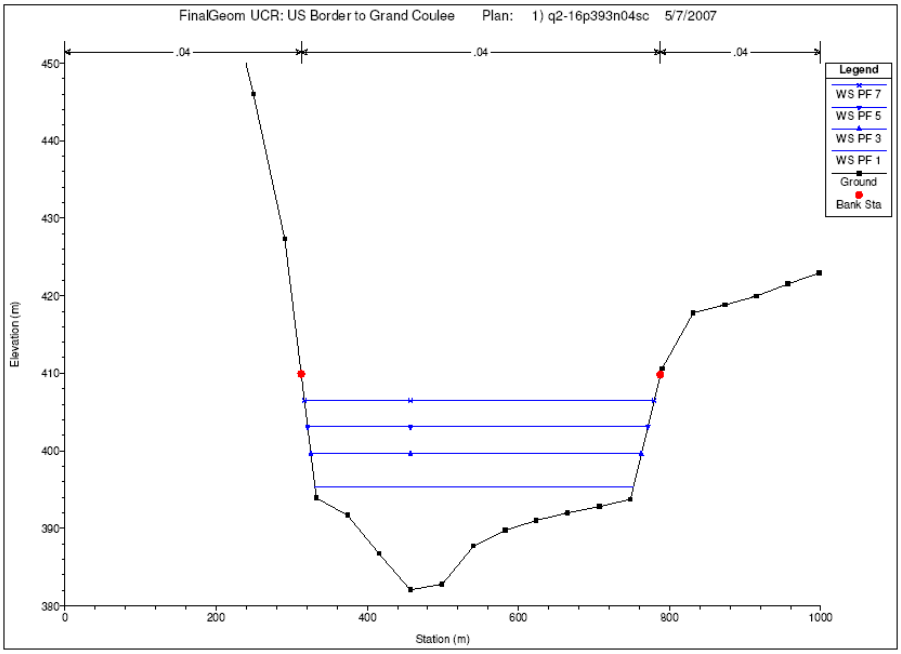

Figure C13. HEC-RAS flow velocities and cross-section areas at XS 241022.2 (Blank Sand Beach) for high pool (393 m) conditions with flows ranging from 2,000 to 14,000 cms and an assumed Manning *n* value of 0.040

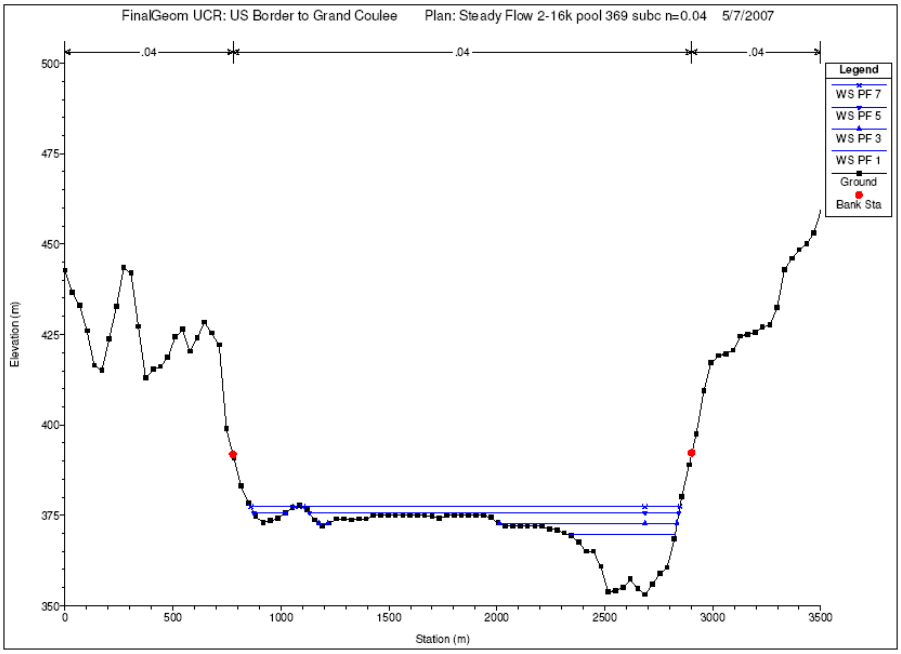

Figure C14. HEC-RAS flow velocities and cross-section areas at XS 181116.3 (Marcus Flats) for low pool (368 m) conditions with flows ranging from 2,000 to 14,000 cms and an assumed Manning *n* value of 0.040

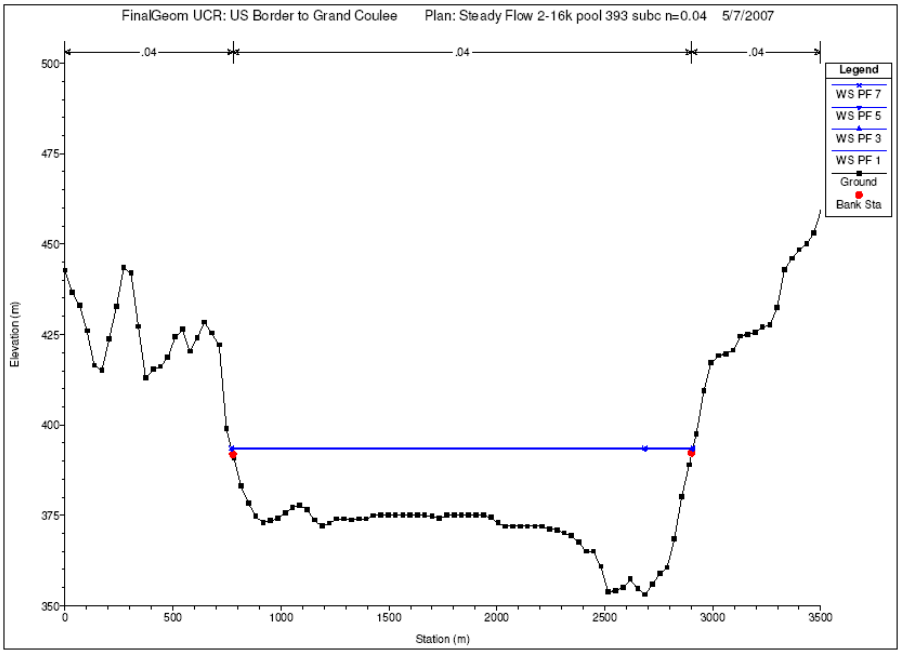

Figure C15. HEC-RAS flow velocities and cross-section areas at XS 181116.3 (Marcus Flats) for high pool (393 m) conditions with flows ranging from 2,000 to 14,000 cms and an assumed Manning *n* value of 0.040

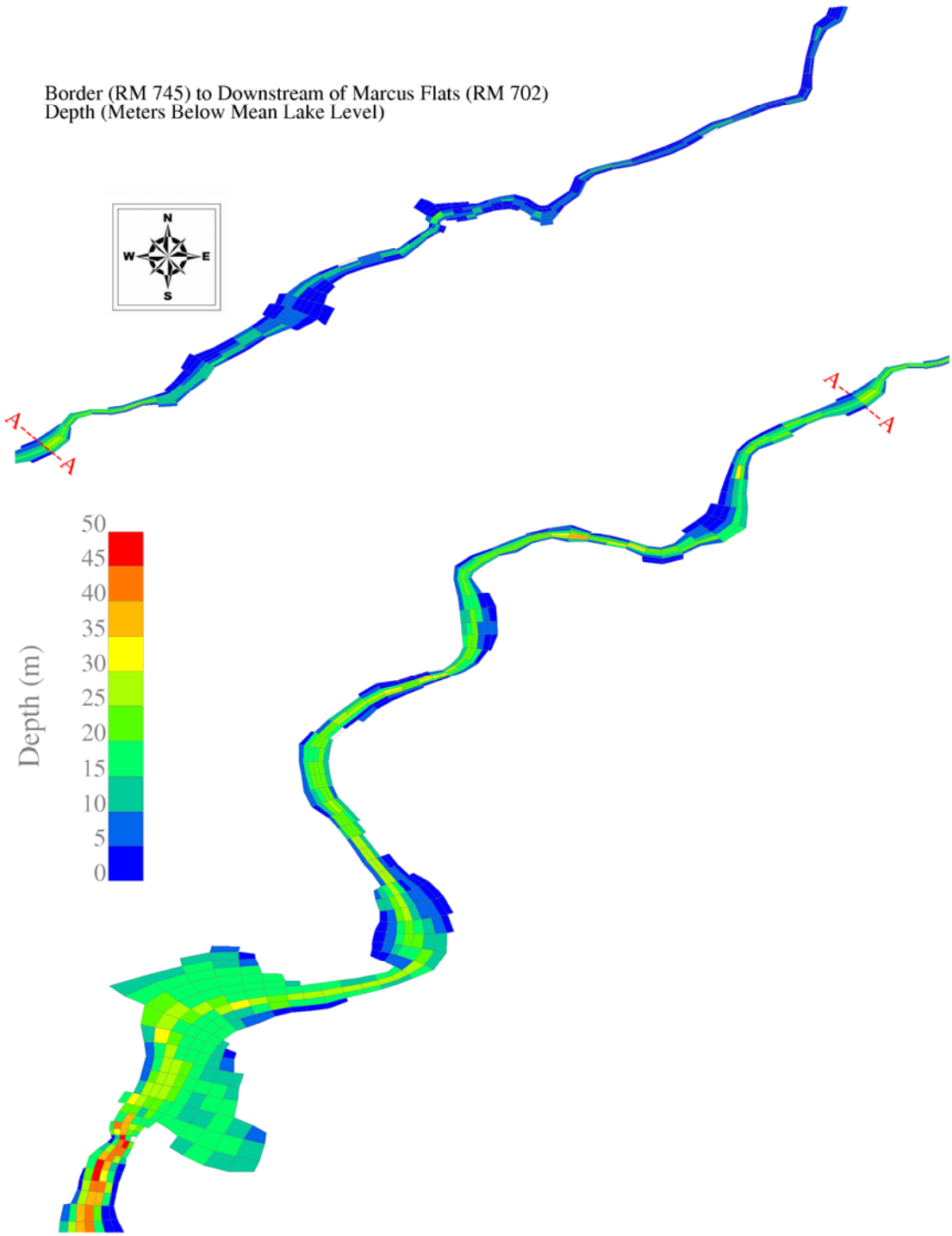

Figure C16. ECOMSED model grid for the large-scale 3-D hydrodynamic model application to the Upper Columbia River from the U.S.-Canadian border (USGS RM 745) to the downstream limit of Marcus Flats (USGS RM 702). Values presented are water depths below the USCGS mean lake level datum (near full pool: 1288.6 ft)

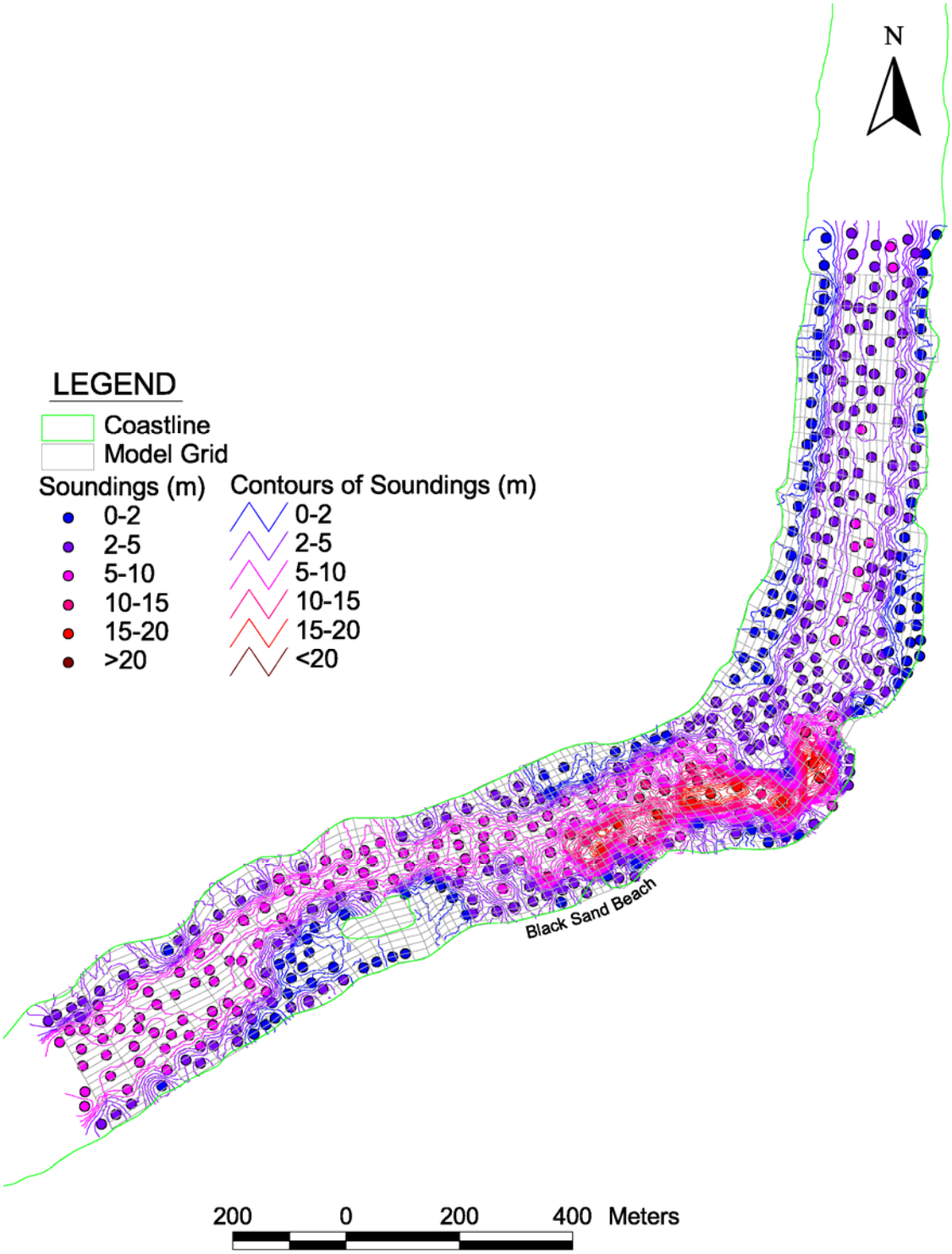

Figure C17. ECOMSED model grid for the fine-scale 3-D hydrodynamic preliminary analysis to the Upper Columbia River near Blank Sand Beach (USGS RM 743)

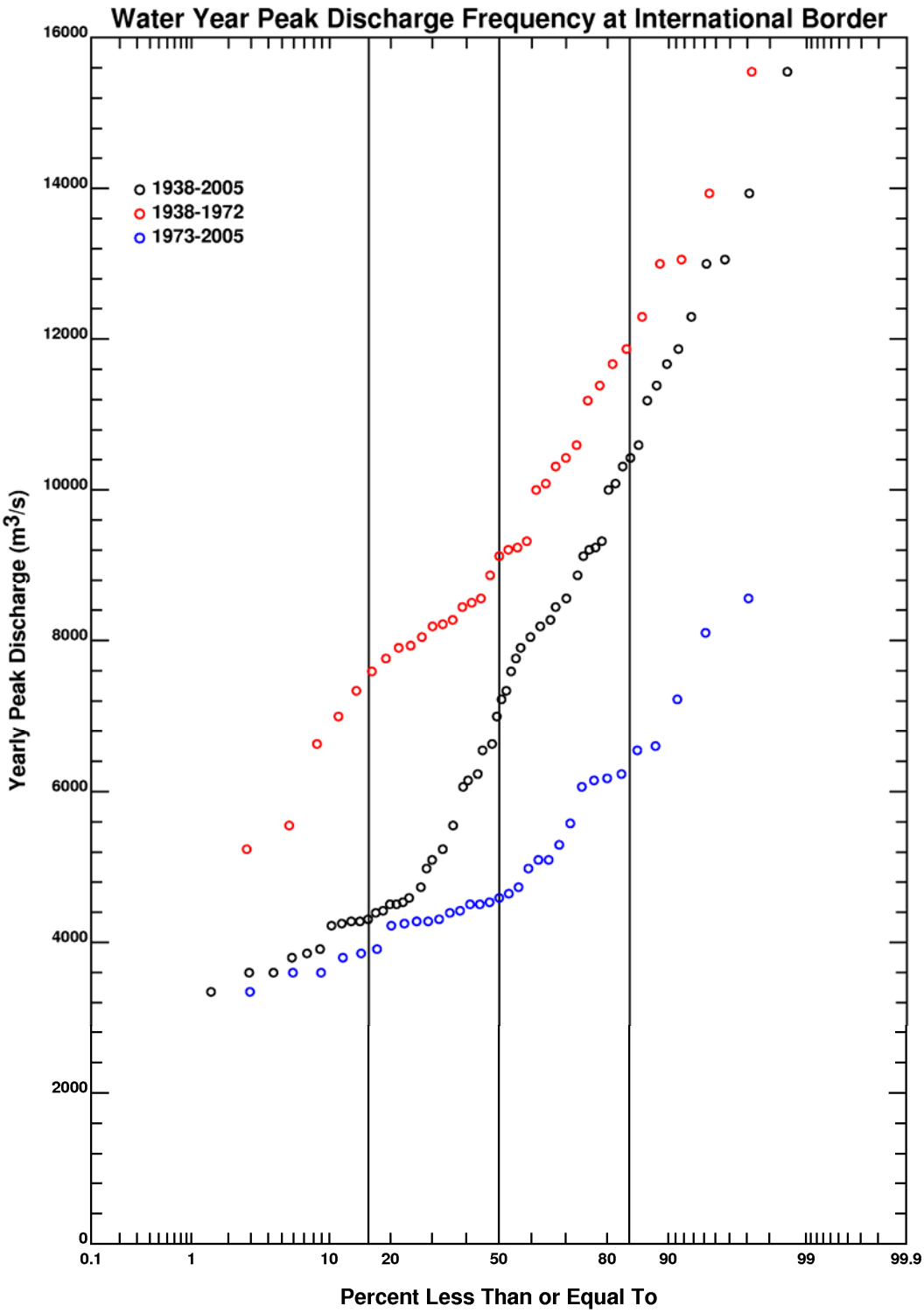

Figure C18. Upper Columbia River annual flood frequency at the U.S.-Canadian border: 1938–2005, 1938–1972, and 1973–2005

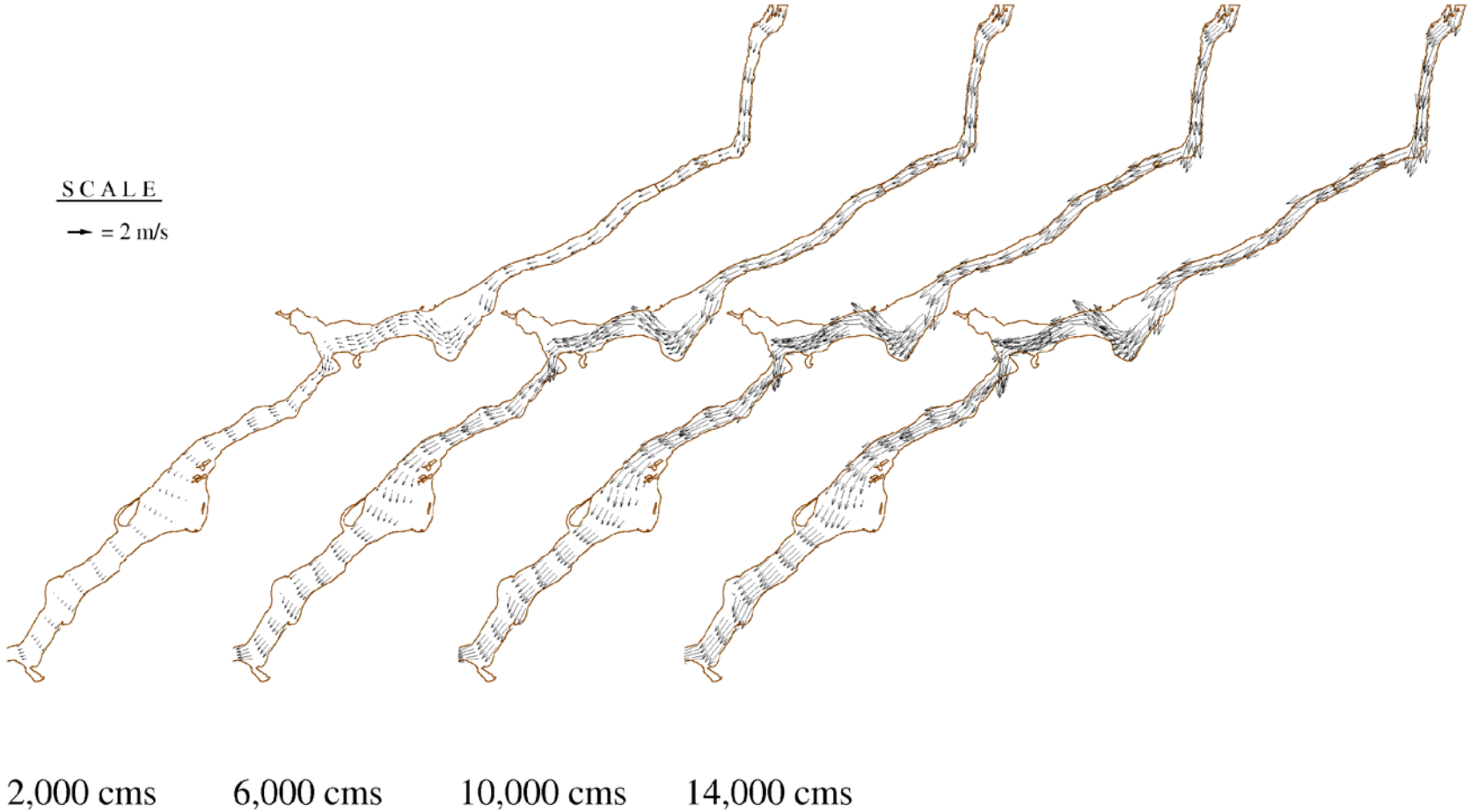

Figure C19. Preliminary 3-D hydrodynamic analysis results for the Upper Columbia River Reaches 1–2: velocities for flows from 2,000 to 14,000 cms

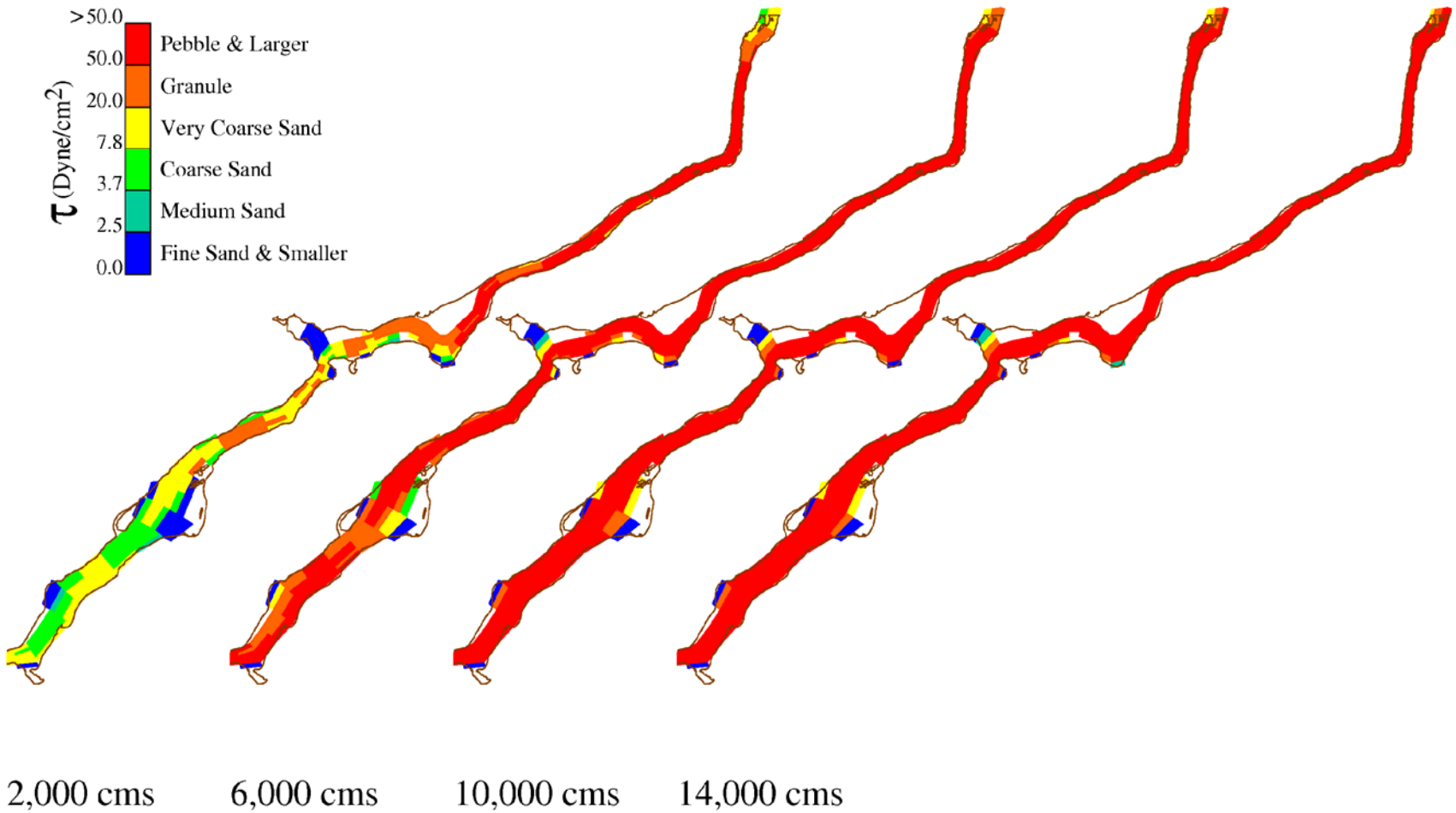

Figure C20. Preliminary 3-D hydrodynamic analysis results for the Upper Columbia River Reaches 1–2: grain-related shear stresses for flows from 2,000 to 14,000 cms

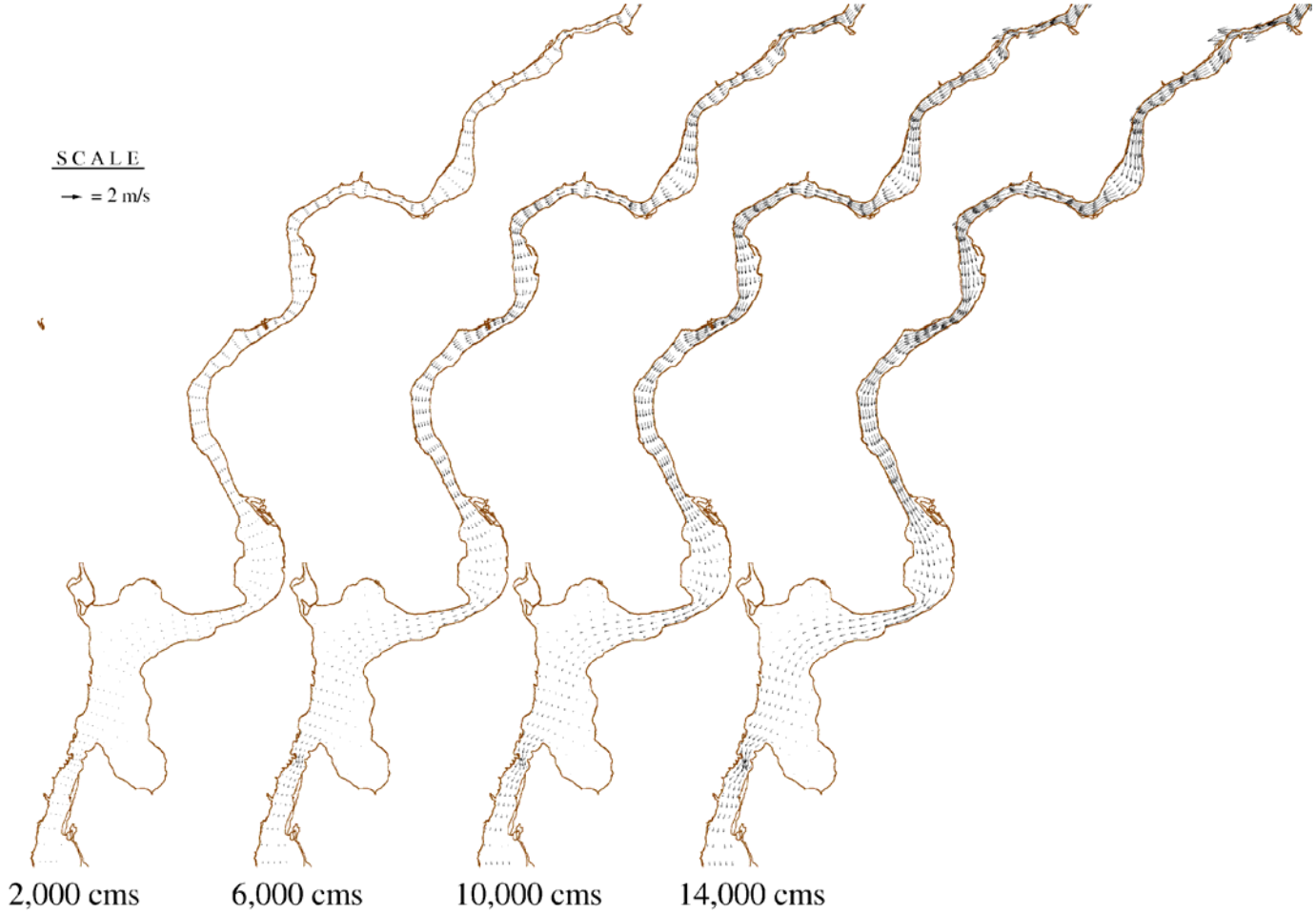

Figure C21. Preliminary 3-D hydrodynamic analysis results for the Upper Columbia River Reaches 2–3: velocities for flows from 2,000 to 14,000 cms

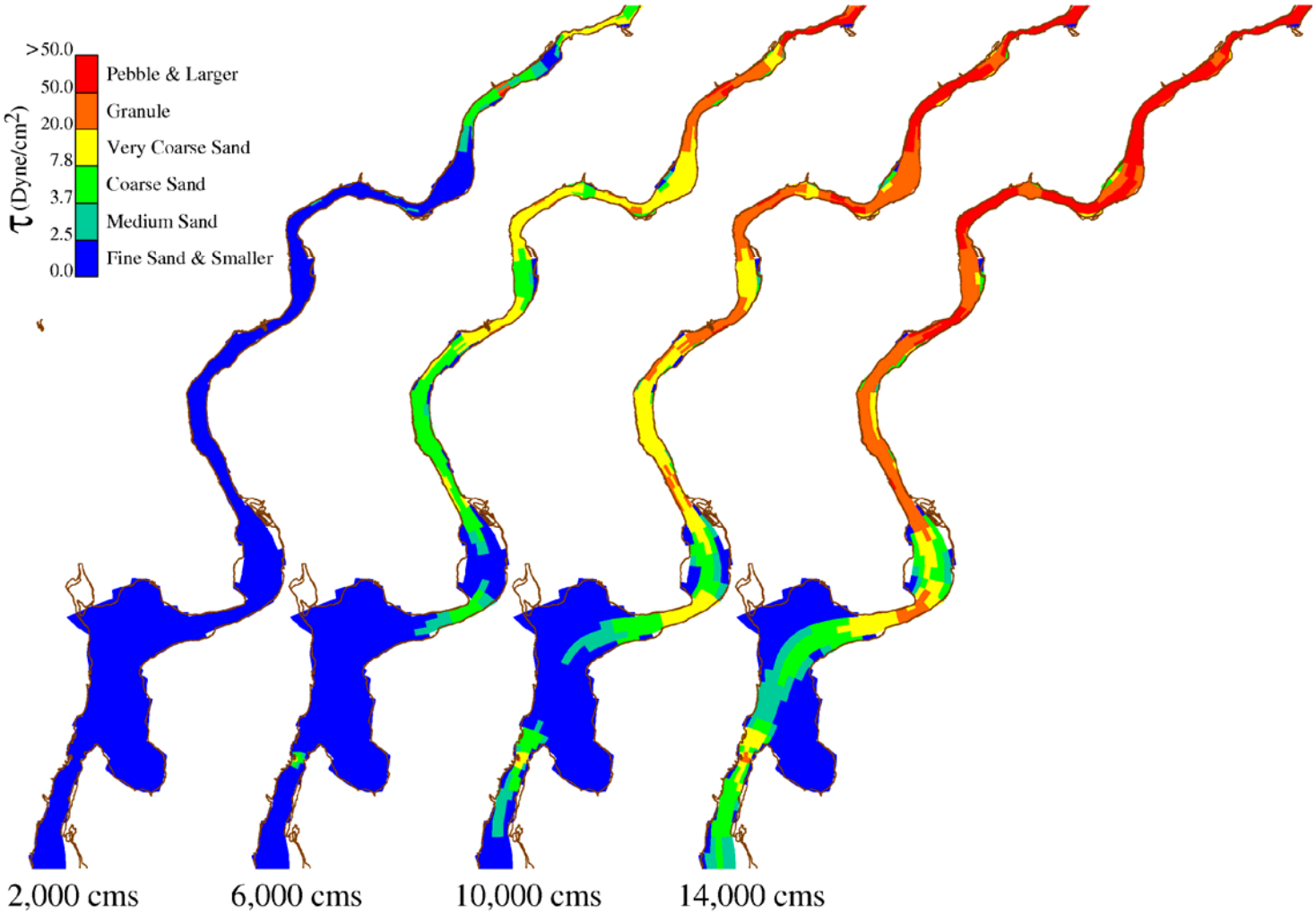

Figure C22. Preliminary 3-D hydrodynamic analysis results for the Upper Columbia River Reaches 2–3: grain-related shear stresses for flows from 2,000 to 14,000 cms

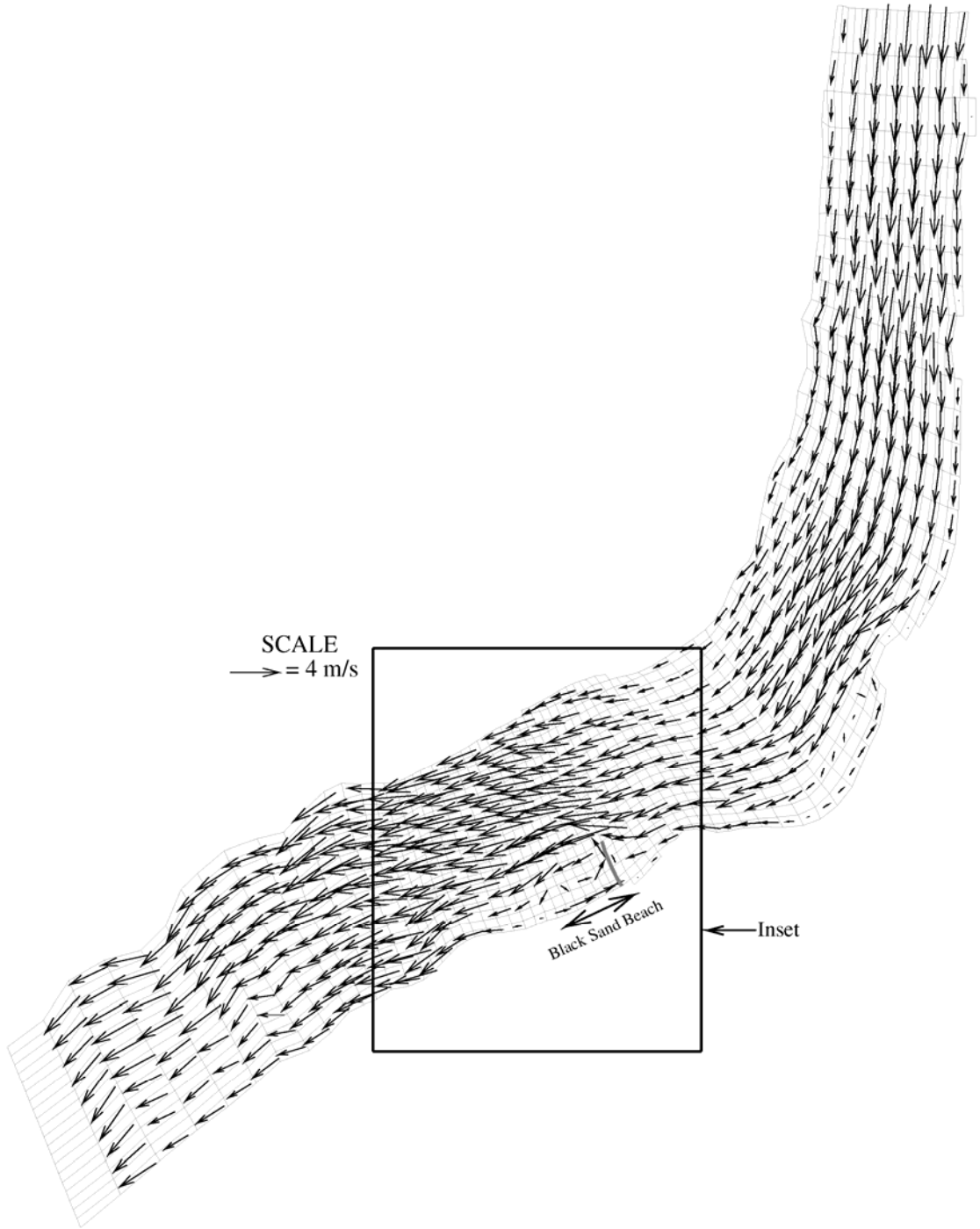

Figure C23. Depth-averaged velocities simulated using the fine-scale (high-resolution), 3-D hydrodynamic model. Note the eddy that occurs along the south bank within the rectangle overlay. The double arrow marks the approximate position and extent of Black Sand Beach

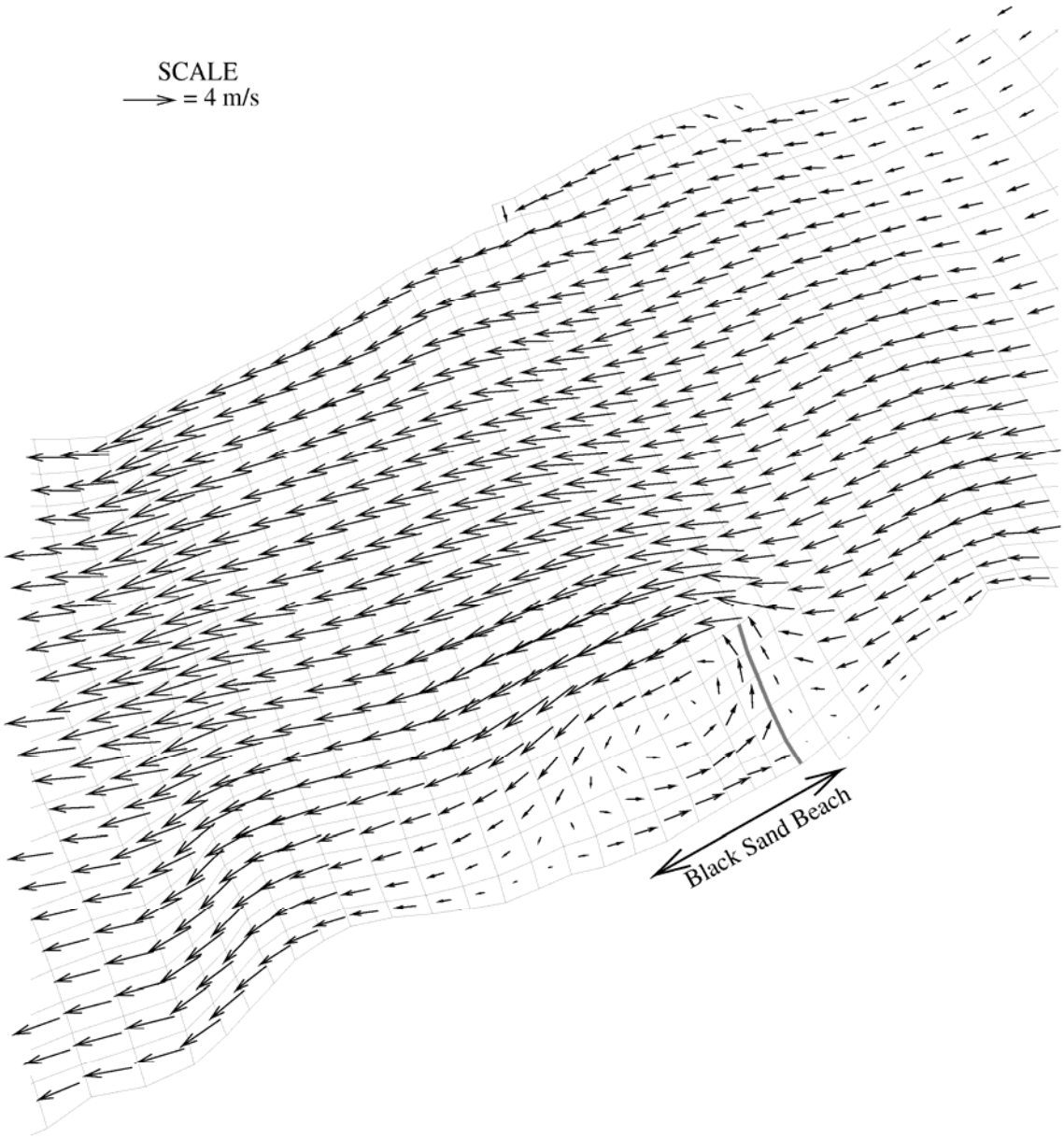

Figure C24. Details of the simulated eddy at Black Sand Beach. The double arrow marks the approximate position and extent of the beach. The rock outcropping that occurs at the upstream edge of the beach is represented by the solid line that extends into the flow

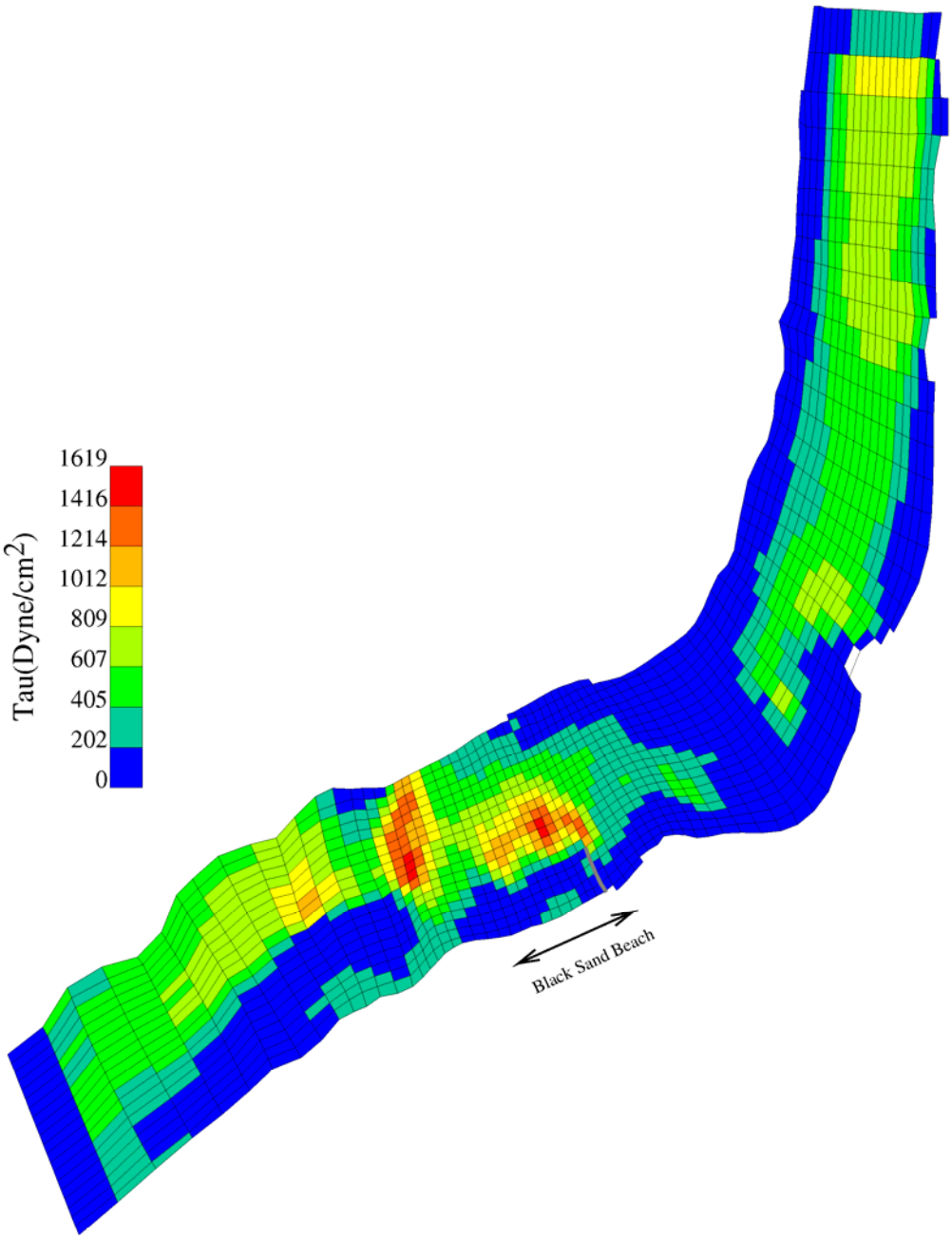

Figure C25. Modeled total shear stress in the region near Black Sand Beach. The color scale for shear stress values is adjusted to best represent the highest values simulated. The double arrow marks the approximate position and extent of Black Sand Beach

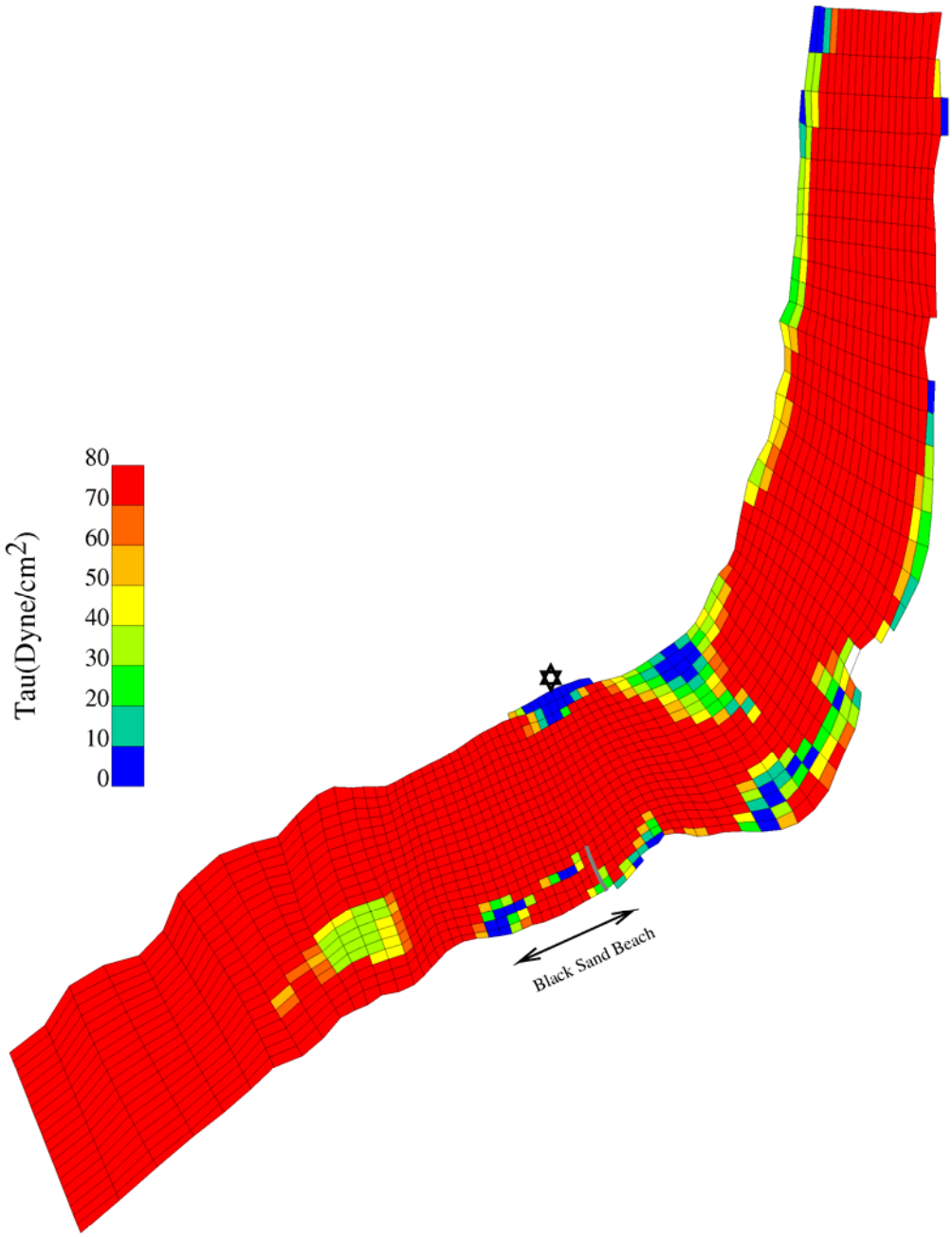

Figure C26. Modeled total shear stress in the region near Black Sand Beach. The color scale for shear stress values is adjusted to best represent the lowest values simulated. The double arrow marks the approximate position and extent of Black Sand Beach. The black star on the north bank marks a second model-predicted depositional zone

Figure C27. Aerial photograph of the region simulation using the fine-scale (high-resolution) 3-D hydrodynamic analysis. The yellow star on the south bank indicates the location of Black Sand Beach. The yellow star on the north bank marks a second model-predicted depositional zone

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Table C1. Kriging Semi-Variogram Parameters

Model Parameter	Value
Number of Lags	25
Lag Size	90
Nugget	0
Model	Spherical with Anisotropy
Major Range	882.016
Minor Range	770.116
Direction	57.828
Sill	559.727

Table C2. Estimated Critical Boundary Shear Stress To Initiate Erosion for Various Size Fractions of Granulated Slag

Particle Diameter (mm)	Wentworth Size Class	Critical Boundary Shear Stress (dyne/cm^2)	Percentage of Granulated Slag by Mass
4		50	
	granule		10%
2		20	
	very coarse sand		30%
1		7.8	
	coarse sand		30%
0.5		3.7	
	medium sand		25%
0.25		2.5	
	fine sand		5%
< 0.25	& smaller	< 2.5	

Note: Values assume a granulated slag density of 3.50 g/cm^3 and that particles have rounded shapes similar to natural quartz particles.

APPENDIX D

TRAIL FACILITY OPERATIONS

APPENDIX D1

TRAIL FACILITY OPERATIONS

Modified December 9, 2008

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ACRONYMS AND ABBREVIATIONS

B.C. MoE	British Columbia Ministry of Environment
CCME	Canadian Council of Ministers of the Environment
ETP	effluent treatment plant
IDZ	initial dilution zone
igpm	imperial gallons per minute
Migpd	million imperial gallons per day
pcf	pounds per cubic foot
RI/FS	remedial investigation and feasibility study
SO_2	sulfur dioxide
UCR	Upper Columbia River

1. INTRODUCTION

This appendix provides detailed information regarding the Trail facility, including present-day operations, permitted discharges, and monitoring programs.

2. PRESENT ZINC OPERATIONS

As indicated in Figure D1-1, six major metallurgical plants, one fertilizer plant, and two specialty metal plants are included under zinc operations. Principal feedstock into zinc operations are zinc concentrates delivered to a central receiving station by either rail or truck, which are then blended and conveyed to plant feed bins. A simplified process flow diagram of on-site zinc operations is presented in Figure D1-2.

Two Lurgi Fluo-solid roasters treat approximately 77 percent of the zinc concentrates, and the remaining 23 percent is treated by the pressure leaching plant. Zinc calcine (ZnO), produced by burning sulfide-bearing concentrates with oxygen-enriched air, is the soluble zinc form that ultimately becomes the primary feed for the sulfide leaching plant. Process gas generated from the roasters, at 930 degrees Celsius (°C) and containing approximately 8 percent SO_2, is passed through heat recovery boilers, generating approximately 600 pounds per square inch of steam for on-site process heating operations. Following the boilers, the gas is further cooled and cleaned on its path towards the sulfuric acid plants. At the pressure leaching plant, reground zinc concentrates are pumped into an autoclave with sulfuric acid and oxygen, and agitated at a constant pressure and temperature of 1,400 kilopascals and 150°C, respectively, to produce zinc sulfate solution and a sulfur/plumbo-jarosite solid phase. Elemental sulfur is separated from the plumbo-jarosite concentrate in a series of flotation cells and ultimately shipped to markets via rail tank cars. The remaining zinc sulfate solution and leach residues are pumped to the sulfide leaching plant for further processing.

Zinc calcine from the roasters and leach solutions from the pressure leaching plant are combined at the sulfide leaching plant and are further leached using sulfuric acid. The resulting acid leach slurry is separated into a zinc sulfate solution, which is further refined through a purification circuit, and a leach residue, which is washed and pumped to the lead smelter circuit for further processing and metal recovery.

Trace elements such as cadmium, cobalt, copper, thallium, and antimony are removed from the zinc sulfate solution using two stages of purification. The first stage removes copper, cadmium, and thallium at a temperature of 60°C; the second stage is heated to 85°C and removes cobalt and nickel. The purified zinc solution is then conveyed to the electrolytic plant, electrotwinned, and plated onto aluminum cathodes. The pure zinc is stripped from the cathodes, melted, alloyed as required per customer specifications, and cast for off-site shipment.

All on-site process gas containing SO_2 is treated by three single contact Monsanto Plants. These plants convert 95 percent of the contained SO_2 in the process gas to a marketable 93 percent sulfuric and battery acid. The remaining gas is recovered in an ammonia scrubbing process generating an ammonium bisulfate solution, which is subsequently acidified with sulfuric acid producing a pure SO_2 gas and ammonium sulfate solution.

The SO_2 gas is dried, compressed, and condensed to a liquid, while the ammonium sulfate solution is pumped to the fertilizer plant.

At the fertilizer plant, commercial grade ammonium sulfate fertilizer—crystalline and granular—is produced. Crystalline ammonium sulfate fertilizer is produced by evaporatively crystallizing the solution from SO_2 production. To produce granular ammonium sulfate, sulfuric acid and stripped zinc electrolyte from metallurgical operations are combined with anhydrous ammonia to produce a hot ammonium sulfate slurry.

3. PRESENT LEAD OPERATIONS

Seven major plants producing lead, silver, gold, bismuth, copper, and arsenic products are associated with on-site lead operations (Figure D1-1). The lead smelter is essential to both the production of lead and the processing of by-product residues from on-site zinc operations. In 1997, the facility underwent a major change in lead processing technology from the traditional sintering, blast furnace approach to the state-of-the-art KIVCET flash smelting process. One of the most significant differences between the traditional sintering blast furnace approach and the KIVCET furnace is the reduction of point source and fugitive atmospheric emissions (i.e., the KIVCET is completely self-contained). Feed mixture for lead operations consists of silica and limestone for fluxing; lead concentrate and precious metals; zinc operation residues rich in iron, zinc and lead; recycled battery scrap; fine, dry coal for fuel; and moderately coarse coke which is an important part of process chemistry. A simplified process flow diagram of on-site lead operations is presented in Figure D1-3.

Dry feed (i.e., pure coal) is injected at the top of the reaction shaft of the KIVCET furnace along with oxygen. Here, sulfur contained within the lead concentrate and fine coal instantly ignite to form a hot, concentrated SO_2 gas, while the lead, zinc, iron, and other metals form metal oxides. Fluxing agents and metal oxides combine to form molten smelt that falls to the bottom of the first compartment within the furnace along with the coarse coke. The coke collects as a surface layer, commonly referred to as a "coke checker," floating on top of the molten slag. When the metal oxides percolate through this layer of burning coke, they are reduced and the lead is converted to metal called bullion.

The bullion continues to settle through the molten slag layer beneath the coke checker. Together with the molten zinc-bearing iron slag, the molten bullion passes under a partition wall into a second compartment—the electric furnace. Given that the aforementioned partition wall extends into the molten slag, it forces hot SO_2 gas to pass through a waste heat boiler and on to an electrostatic precipitator as opposed to the electric furnace. The second compartment serves as a primary settling chamber where heat from large graphite electrodes maintains the bullion-slag bath in a molten state. Ultimately, gravity is used to separate the lighter molten slag from the lead bullion enabling them to be tapped as separate phases.

To recover zinc from the molten slag, which contains all the residual iron and zinc, it is transferred to a slag-fuming furnace where fine coal and air are injected. This injection generates more heat and more reducing conditions, causing the zinc and other metals such as indium and arsenic to vaporize eventually forming zinc oxide fume containing residual levels of lead, silver, cadmium, indium, and germanium. The zinc oxide fume is further transferred to on-site zinc operations for treatment and processing (i.e., recovery of the aforementioned metals). The molten slag is contained within the slag fuming furnace until the practical limit of approximately 2 percent zinc is reached. At that point, the slag is poured into a stream of water, solidified into black sand-like granulated slag

and sold to various cement manufacturers (i.e., as ferrous granules). Prior to 1995, however, ferrous granules were discharged into the Columbia River.

Lead bullion produced at this stage of the process contains residual silver, gold, bismuth, and copper, which must be further removed prior to off-site distribution. Residual copper is removed in the drossing plant, where the lead bullion is cooled from approximately 900°C to 400°C. This cooling step forces copper matte to form and float to the surface where it is removed for further processing within the copper products plant. The remaining lead bullion is subjected to a softening stage that employs oxygen to partially remove arsenic and antimony, which are further recovered and incorporated into saleable products (Figure D1-1). At this stage, the lead bullion is transferred to the refinery where the Betts electrolytic process is applied. As previously mentioned, lead is dissolved from the anode and plated onto the cathode, which is then melted, alloyed, and cast into final products. Slimes containing silver, gold, and bismuth are retained on the anode and are further processed to recover each metal, respectively.

As indicated by the above descriptions, on-site metallurgical operations at the facility are complex and intimately intertwined. The close integration of the zinc and lead plants allows for improved recoveries of elements contained in the feed to the facility compared with other smelters.

4. FACILITY EFFLUENT DISCHARGES

Operations at the Trail facility result in the generation of wastewater streams that following treatment, are ultimately discharged to the Columbia River through a series of facility outfalls (historically referred to as sewers). Wastewater generated from the facility can be grouped into the two following primary categories.

- Non-contact water: Water that does not contact or enter into either hydrometallurgical (i.e., zinc operations) or pyrometallurgical (i.e., lead operations) processes and is solely used for cooling purposes and is of similar water quality as the Columbia River.
- Process water: Water that comes into contact with process materials and ultimately contains heavy metals/metalloids, such as zinc, lead, cadmium, and arsenic.

In general, the bulk of facility wastewater is non-contact water derived from cooling process equipment. Non-contact water currently makes up approximately 95 to 98 percent of the wastewater discharged from the facility, with the remaining 2 to 5 percent derived from the manufacturing processes (Figure D1-4). In addition to the above mentioned categories, a small percentage (i.e., much less than 1 percent) of domestic sewage is also generated at the facility that is piped to the Regional Sewage Water Treatment Plant located within the City of Trail. Currently, all effluent discharges are under the authority and limits of Permit No. PE-02753 provided in Attachment D1-2 of this appendix. The following paragraphs are intended to provide a brief history of effluent permits issued to the Trail facility.

4.1. LIQUID EFFLUENT PERMITTING HISTORY

The facility first applied for and was granted a permit to discharge liquid effluent into the Columbia River under the Pollution Control Act in October 23, 1970. Since then, the permit has been amended and renewed on five separate occasions.. Dates on which the permit was amended are November 29, 1978, February 12, 1991, November 29, 1996, June 4, 1997, and June 8, 2006. Copies of the aforementioned permit and associated amendments are provided in Attachment D1-1.

In 1970, when the facility was first registered with the B.C. MoE, 10 individual discharge points were recognized and governed by the Department of Lands, Forests, and Water Resources. They included:

- Sewer T-1: Registered on October 23, 1970, to discharge non-contact cooling water, floor washings and coal drier impinger wastewater at a maximum rate of 3,500 imperial gallons per minute (igpm)

- Sewer T-2: Registered on October 23, 1970, to discharge non-contact cooling water and ferrous granules at a maximum rate of 4,100 igpm
- Sewer T-4: Registered on December 15, 1970, to discharge non-contact cooling water at a maximum rate of 2,500 igpm
- Sewer T-5: Registered on December 15, 1970, to discharge treated (i.e., settling tanks and filters) industrial wastewater at a maximum rate of 3,500 igpm
- Sewer T-6: Registered on December 15, 1970, to discharge treated (i.e., settling tanks and filters) industrial wastewater at a maximum rate of 8,000 igpm
- Sewer T-7: Registered on December 15, 1970, to discharge industrial waste at a maximum rate of 6,000 igpm
- Sewer T-8: Registered on December 15, 1970, to discharge treated (i.e., settling tanks and filters) industrial wastewater at a maximum rate of 8,700 igpm
- Sewer T-9: Registered on December 15, 1970, to discharge non-contact cooling water and wastewater from on-site analytical laboratories at a maximum rate of 150 igpm
- Sewer T-10: Registered on December 15, 1970, to discharge treated (i.e., settling tanks and filters) industrial wastewater at a maximum rate of 1,000 igpm
- Sewer T-14: Registered on December 15, 1970, to temporarily discharge domestic sewage at a maximum rate of 20 igpm until diversion into the Town of Trail sewage treatment plant was completed.

A detailed summary of corresponding discharge limits as specified within the 1970 permit are presented in Table D1-1. As indicated by the above-mentioned outfall/sewer descriptions, on-site treatment of effluents in the early 1970s was limited to primary treatment techniques (i.e., separation and settling), and chemicals/analytes of concern included total suspended solids, pH, temperature, ammonia, nitrate, arsenic, antimony, cadmium, fluoride, lead, sulfur, sulfate, and zinc.

On November 29, 1978, the B.C. MoE, Pollution Control Branch issued new effluent discharge permits to the facility for on-site metallurgical operations (i.e., Permit No. PE-02753 and PE-05309) (Attachment D1-1). Permit No. PE-02753 authorized the discharge of effluent from three discharge points (i.e., Metallurgical Plant Sewers I, II, and III) into the Columbia River, and PE-05309 authorized discharge from Warfield (i.e., fertilizer) Operations via Metallurgical Sewer IV. As outlined within Permit No. PE-02753, Metallurgical Plant Sewer I replaced Sewers T-1 and T-2 and was designated to handle effluents generated from the lead furnaces, fuming furnaces, drossing plant, and zinc tank rooms with a maximum discharge rate of 22 million imperial gallons per day (Migpd). Metallurgical Plant Sewer II was permitted to convey effluents from the lead fuming furnaces, sinter plant, zinc plant, and the smelter absorption plant at a maximum rate of 30 Migpd, and it replaced Sewers T-3, T-4, T-5, T-6 and T-7. Metallurgical Plant Sewer III replaced Sewers T-8 (a and b), T-9, and T-10, and it was permitted to handle effluents

from the lead and silver refinery, acid plants, zinc plant, and assay office at a maximum rate of 19 Migpd. By this time, domestic sewage (i.e., Sewer T-14) was piped and treated by the Town of Trail. Chemicals/analytes of concern associated with the aforementioned effluent permits included total suspended solids, pH, temperature, ammonia, phosphate, arsenic, cadmium, fluoride, lead, mercury, and zinc.

Permit No. PE-02753 was amended on February 12, 1991, and, as in previous years, authorized the discharge of effluent into the Columbia River through Metallurgical Plant Sewers I, II, and III. The 1991 permit also authorized and permitted effluent discharges from the lead smelter absorption plant through Sewer T-7 (formerly grouped within Metallurgical Plant Sewer II). In addition, the 1991 permit encompassed a number of projects undertaken by Teck Cominco Metals Ltd. during that time. These included but were not necessarily limited to the development of an overall site effluent management plan, submission of vehicle decontamination plans, and an assessment of environmental impacts of continued discharge of granulated slag into the Columbia River. At this time, the facility was also required to obtain monthly 24-hour composite samples from the Columbia River at an upstream (i.e., Stoney Creek – BCE Site 0200557) and downstream (i.e., Waneta – BCE Site 0200559) location. Surface water samples have been collected routinely at the above-referenced Columbia River monitoring stations since the late 1960s early 1970s, but this was the first time that such monitoring was specified within the permit. As such, 24-hour monthly composite samples were to be analyzed for the following analytes or as otherwise directed through the voluntary participation in the Columbia River Integrated Environmental Monitoring Program: total suspended solids, pH, total and dissolved zinc, total and dissolved arsenic, total and dissolved cadmium, total and dissolved lead, total and dissolved copper, total mercury, hardness, total and orthophosphate, dissolved ammonia, and dissolved sulfate. A copy of the 1991 permit is provided in Attachment D1-1. A detailed summary of the aforementioned discharge points and corresponding 1978 and 1991 regulatory limits is presented in Table D1-2.

PE-02753 was amended in 1996 and 1997 at which time Permit No. 05309 was once again reinstated. As in previous years, PE-05309 authorized discharges from the Warfield fertilizer plant, steam plant, analytical laboratory, and pure metals processing operation via Metallurgical Sewer/Outfall IV. Copies of both permits (i.e., PE-02753 and PE-05309) are provided in Attachment D1-1 with a summary of maximum discharge limits presented in Table D1-3. As with previous permits, chemicals/analytes of concern regulated by the B.C. MoE included total suspended solids, pH, ammonia, phosphate, arsenic, cadmium, copper, lead, mercury, thallium, and zinc. In addition to tighter permit limits (i.e., lower maximum discharge rates), a comprehensive monitoring program including biological toxicity testing on rainbow trout was required at each discharge/monitoring point within the amended permits.

Currently, effluent discharges into the Columbia River are limited to three permitted points (i.e., Metallurgical Plant Outfalls II, III, and IV) and are specified and defined within Permit No. PE-02753 (as amended on June 8, 2006) (Attachment D1-1). Non-

contact cooling water is directly discharged into the Columbia River via Metallurgical Plant Outfalls II, III, and IV, and process wastewater is conveyed to the effluent ETP and treated using lime precipitation. Treated wastewater is then discharged into the Columbia River via Metallurgical Plant Outfall III, and the solid residue (i.e., sludge) is recycled into on-site operations to recover heavy metals. A schematic illustrating on-site water/effluent flow processes is presented in Figure D1-4.

As indicated by the above information, the discharge of granulated slag was regulated from "sewer T-2" (October 23, 1970), which was later combined and referred to as Metallurgical Sewer I (since November 29, 1978) until 1995. The following paragraphs provide additional detail on this historical practice.

5. RIVER WATER QUALITY MONITORING

Since the late 1960s and as part of the facility's environmental monitoring program, surface water samples have been routinely collected downstream of the facility from the Columbia River (i.e., Waneta – BCE Site 0200559; located upstream of the confluence of the Pend Oreille River). Historical data show that, with the exception of zinc, trace metal concentrations for both total and dissolved fractions are frequently below analytical detection limits at Waneta. Although measurable differences in surface water zinc concentrations have historically been recorded at Waneta, concentrations were protective of human uses and freshwater aquatic life (Figures D1-5 and D1-6).

In addition to surface water monitoring at Waneta, and as previously noted within this appendix, a number of stations including end-of-pipe discharges from Metallurgical Sewers II, III, and IV; and upstream sites are continuously or routinely monitored as specified within Permit No. PE-02753. Furthermore, this permit establishes the initial dilution zone (IDZ) for the facility and is defined as extending from Metallurgical Plant Outfall IV to the Old Bridge (Figure D1-7). The IDZ is designed with due regard to water uses, aquatic life (including migratory fish), and other discharges. Water quality objectives as defined by the Provincial Government are not applicable within an IDZ (i.e., water quality within IDZs may exceed criteria for various water uses). A number of water quality monitoring programs conducted from the U.S.-Canadian border to the facility have demonstrated that effects of site effluent discharges (e.g., increases in metals concentrations) are localized within the IDZ. For example, data collected as part of a 1976 (i.e., prior to the installation of the ETP) region-wide study performed by the Canadian Federal Government demonstrated that surface water trace metal concentrations were locally elevated (within the IDZ), whereas measurable increases recorded at Waneta were always below drinking water standards and typically protective of freshwater aquatic life (B.C. MoE 1977, 1979). Similar findings were reported by Aquametrix (1994), MESL (1997), Cominco (1999), and G3 Consulting (2001), whereas concentrations of arsenic, cadmium, chromium, copper, and nickel recorded at Waneta were not elevated above upstream conditions (i.e., Birchbank). This is further illustrated based on data collected by Environment Canada (www.waterquality.ec.gc.ca) since the early 1980s (Figures D1-8 through D1-12).

As indicated by the data collected to date, there has been a general decline of analyte concentrations at both Birchbank (upstream of the facility) and Waneta as a function of time. As a result, it is anticipated that this decline is a reflection of improved analytical techniques and lower analytical detection limits as opposed to true differences (i.e., changes) in concentration. As indicated by the overlapping data ranges between Birchbank and Waneta, there does not appear to be a significant difference in surface water quality from the upstream to downstream locations. A detailed investigation on trace metal concentrations between Birchbank and Waneta was completed by Environment Canada (Ryan 2005) between March 1996 and April 1997. Based on these

findings, it was concluded that although trace metal concentrations were statistically higher at Waneta than at Birchbank, the concentrations satisfied Provincial water quality objectives and were always below the Canadian Council of Ministers of the Environment (CCME) guidelines for the protection of aquatic life. The only exception to this was cadmium, where concentrations had slightly exceeded water quality objectives at Waneta. Provincial water quality objectives for cadmium within this segment of the Columbia River have been set at a long-term 30-day mean of 0.03 μg/L, and a short-term 30-day mean of 0.05 μg/L, whereas the CCME interim guideline for the protection of aquatic life is 0.017 μg/L.

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FIGURES

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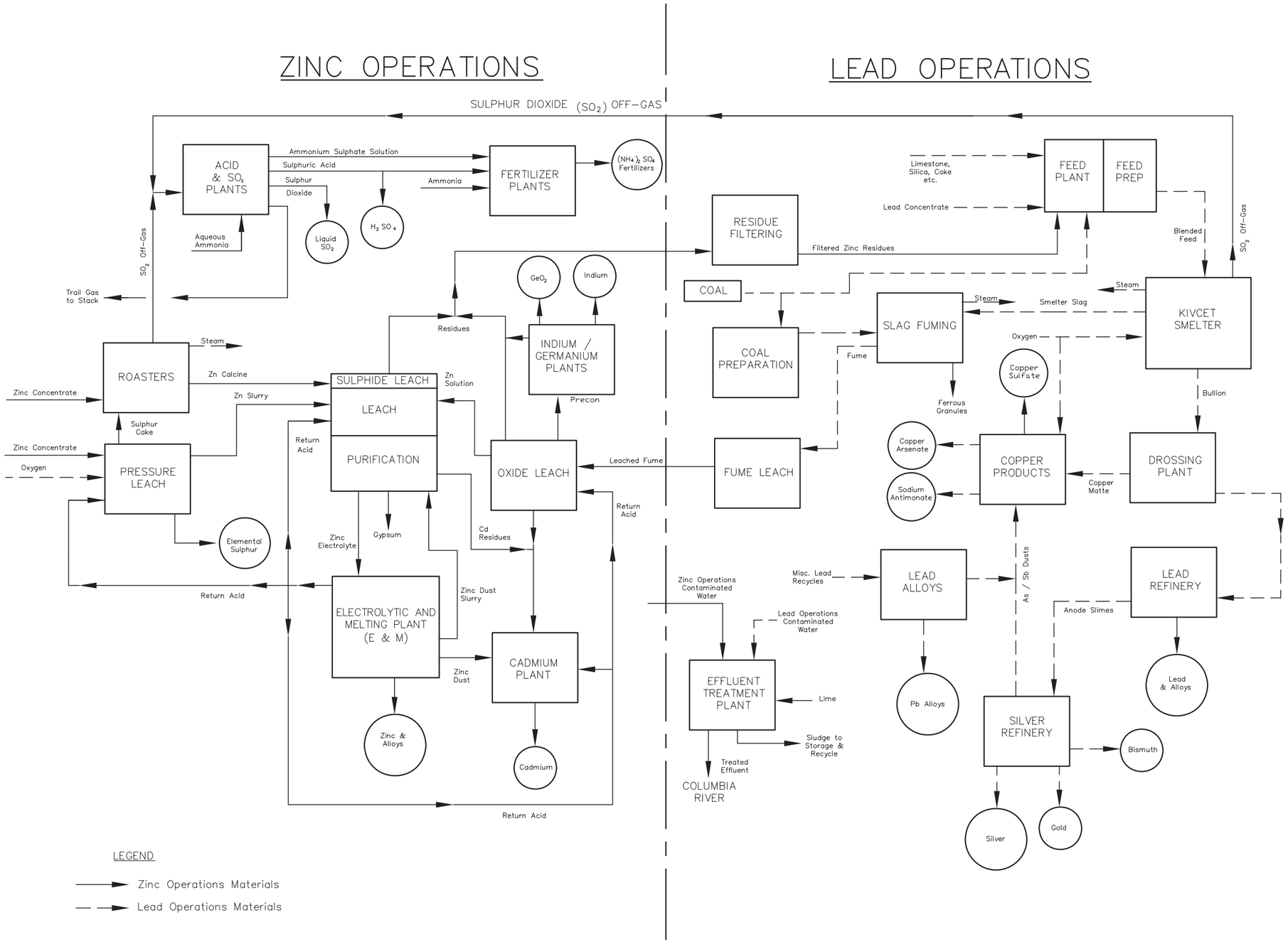

Integral Parametrix	**Not to a set scale**	**Figure: D1-1** **Trail Facility - Process Flow Diagram of Existing Zinc and Lead Operations Upper Columbia River, WA**

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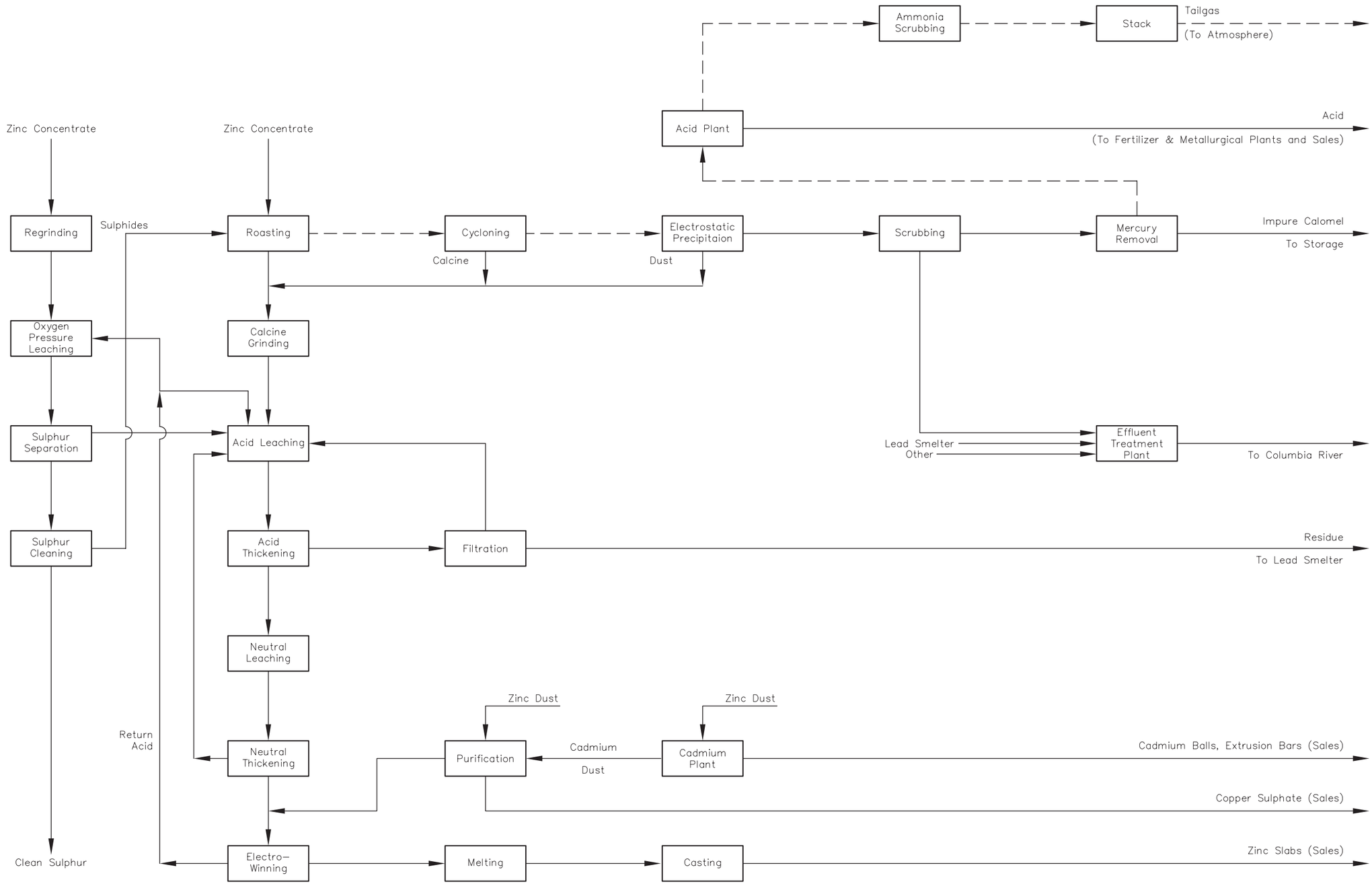

Integral Parametrix	**Not to a set scale**	**Figure: D1-2** **Simplified Process Flow Diagram of Existing On-Site Zinc Operations Upper Columbia River, WA**

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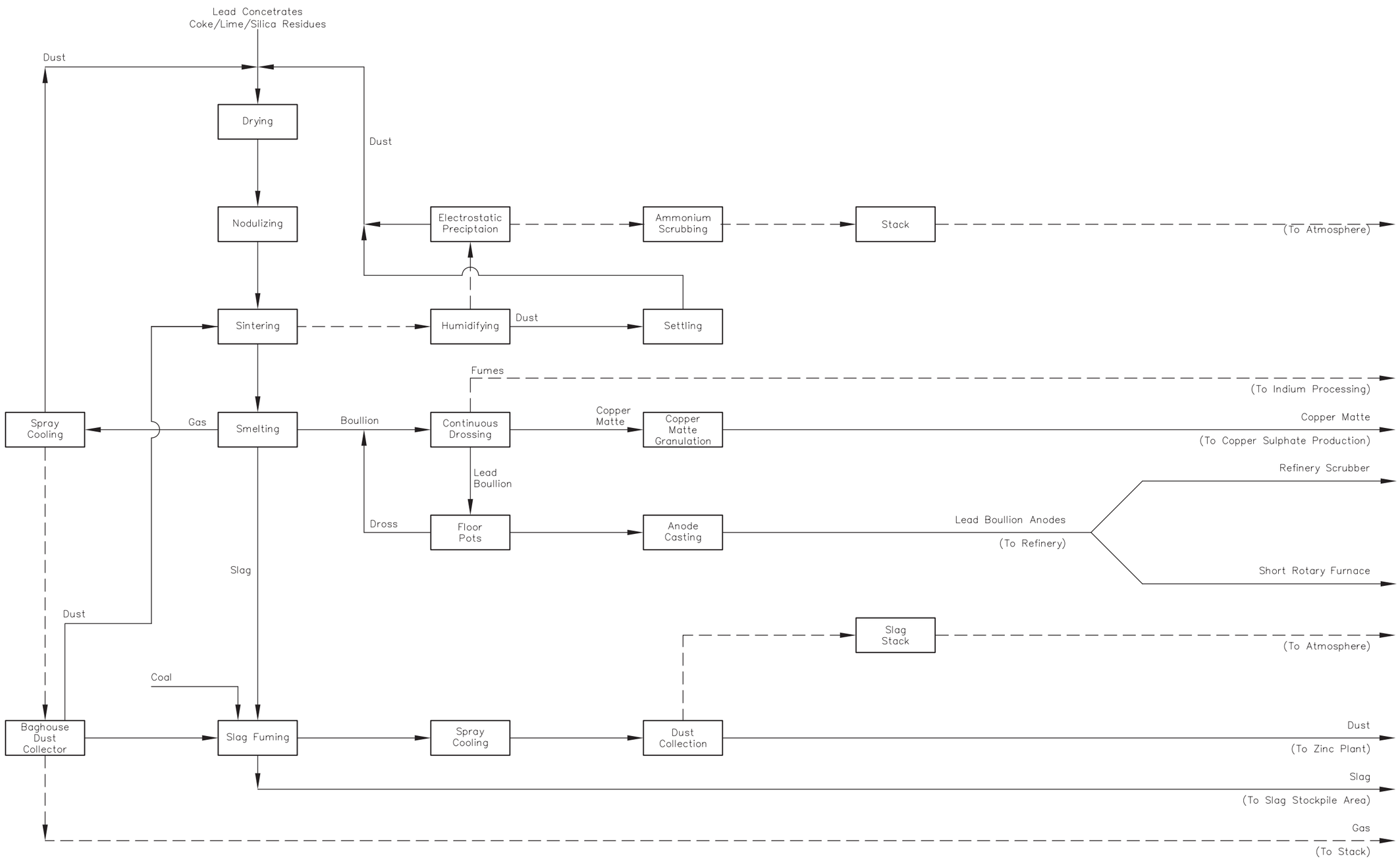

Integral Parametrix	**Not to a set scale**	**Figure: D1-3** **Simplified Process Flow Diagram of Existing On-Site Lead Operations Upper Columbia River, WA**

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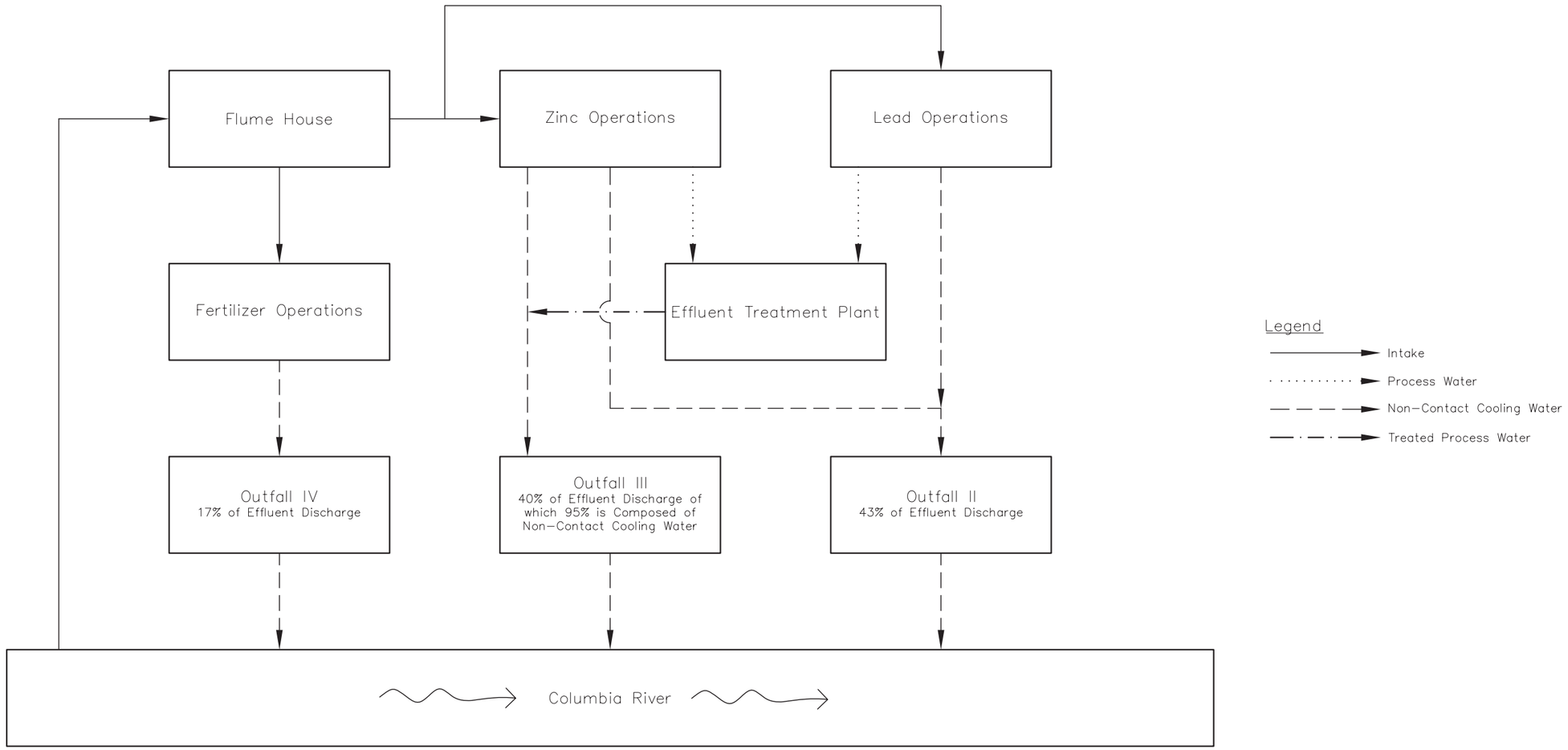

Integral Parametrix	Not to a set scale	Figure. D1-4 Remedial Investigation/Feasibility Study Water and Effluent Process Flows at the Trail Facility Upper Columbia River, WA

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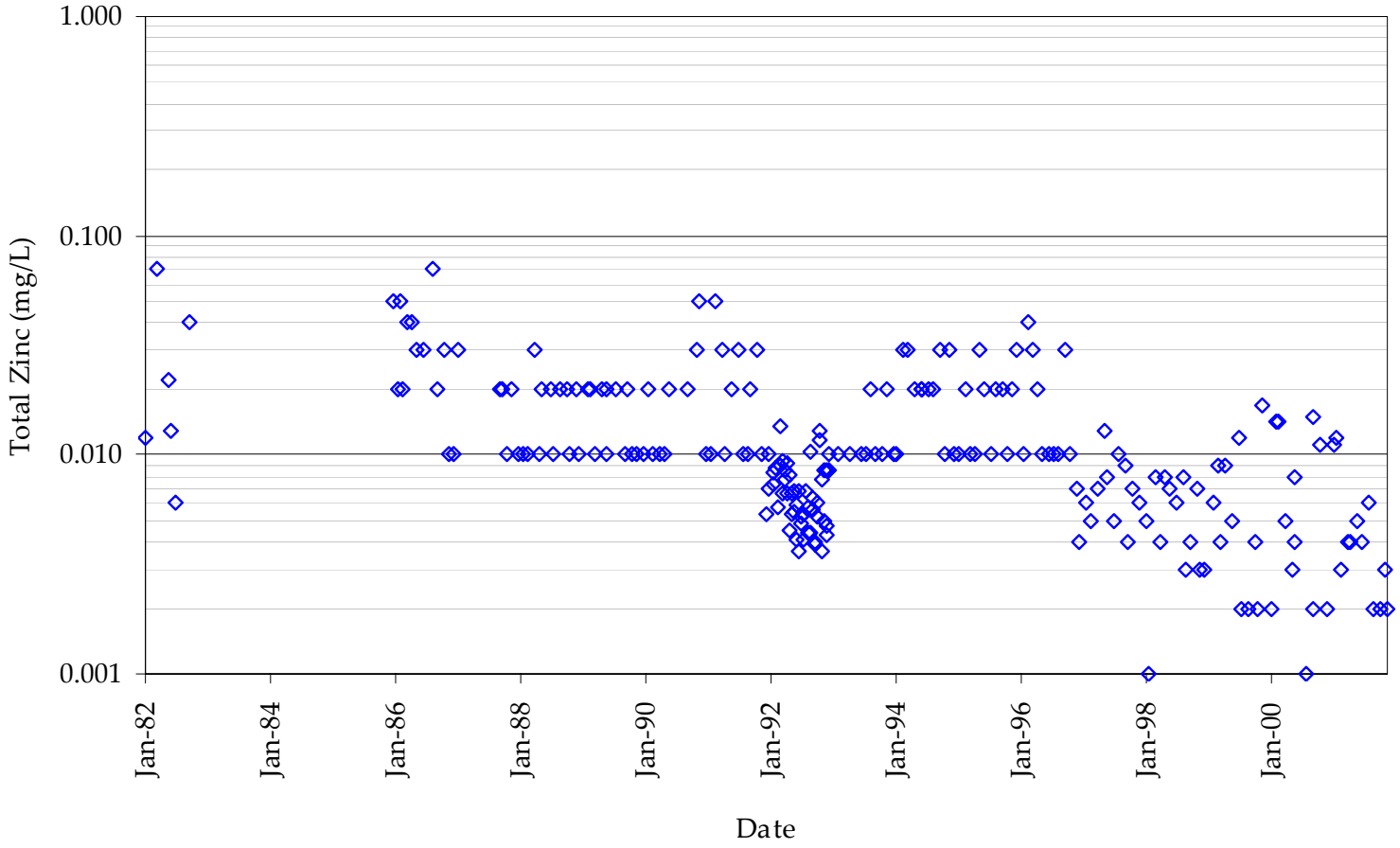


Figure D1-5. Total Zinc Surface Water Concentrations at Waneta as a Function of Time

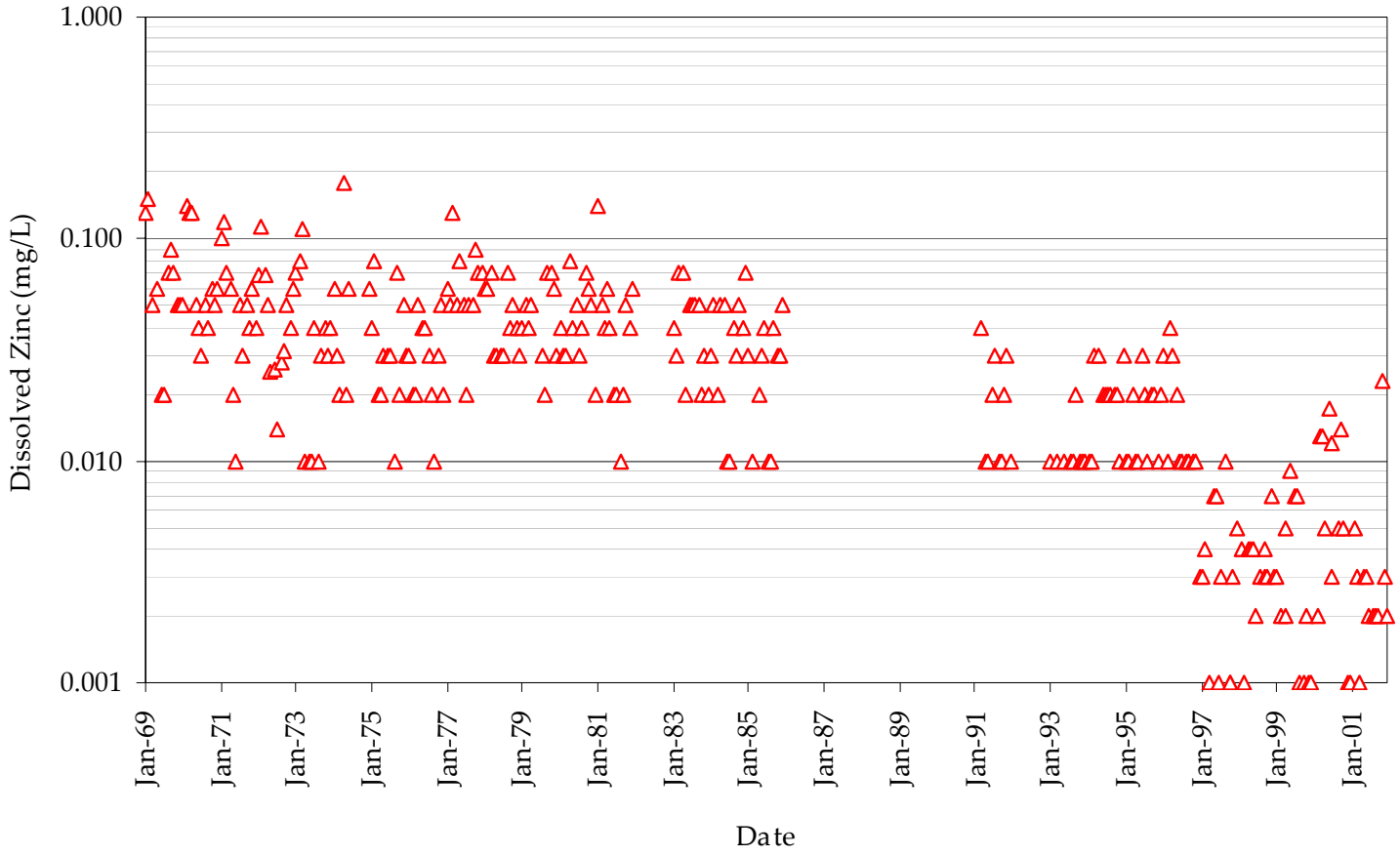
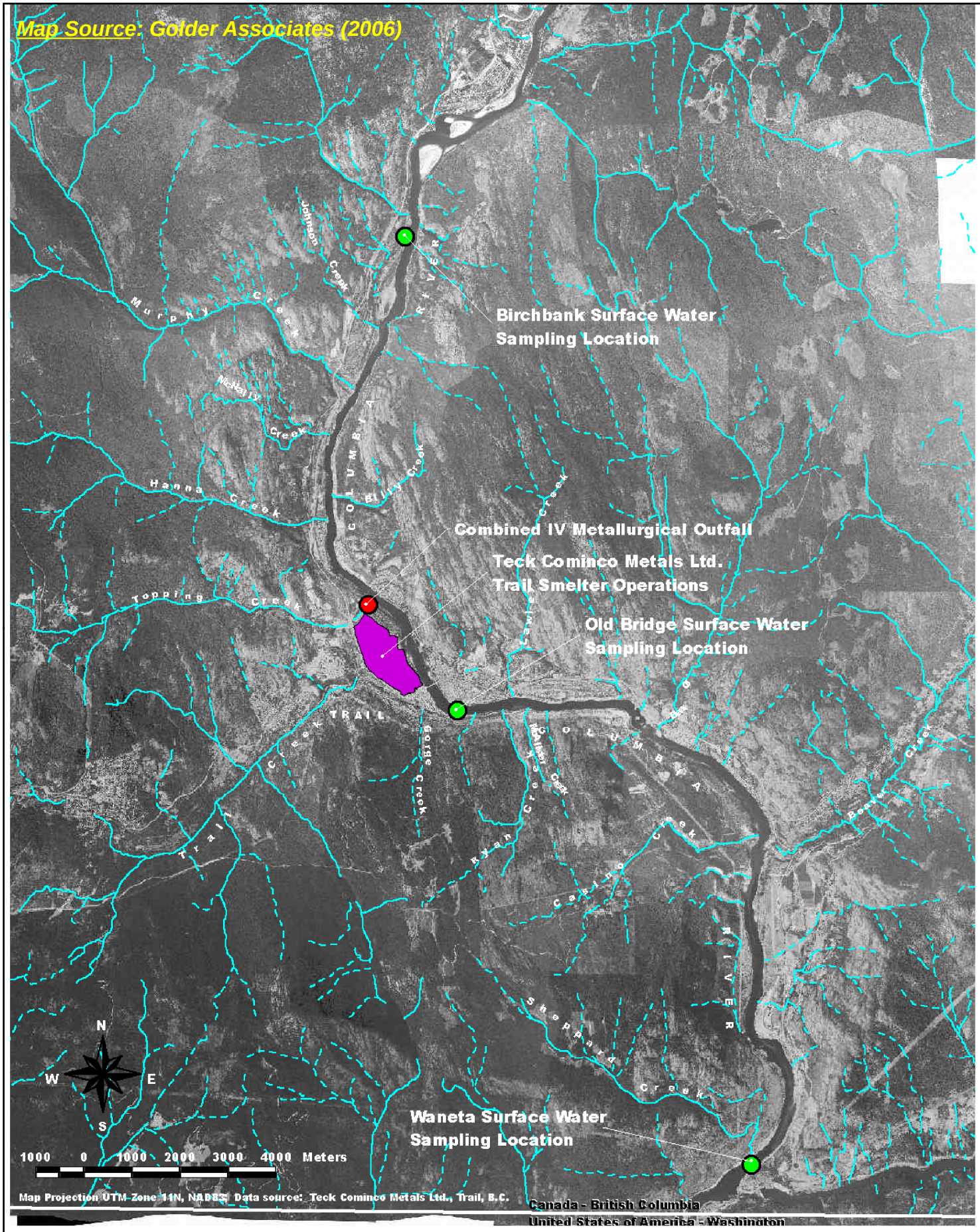


Figure D1-6. Dissolved Zinc Surface Water Concentrations at Waneta as a Function of Time. As indicated by the data, dissolved zinc concentrations recorded at Waneta are observed to decline as a function of time. It is important to note however that this decline may be a reflection of improved (i.e., lower) analytical detection limits as opposed to actual changes in concentration



Integral Parametrix	NOT TO A SET SCALE	Figure D1-7 **Surface Water Sampling Locations** Upper Columbia River, Trail, B.C.

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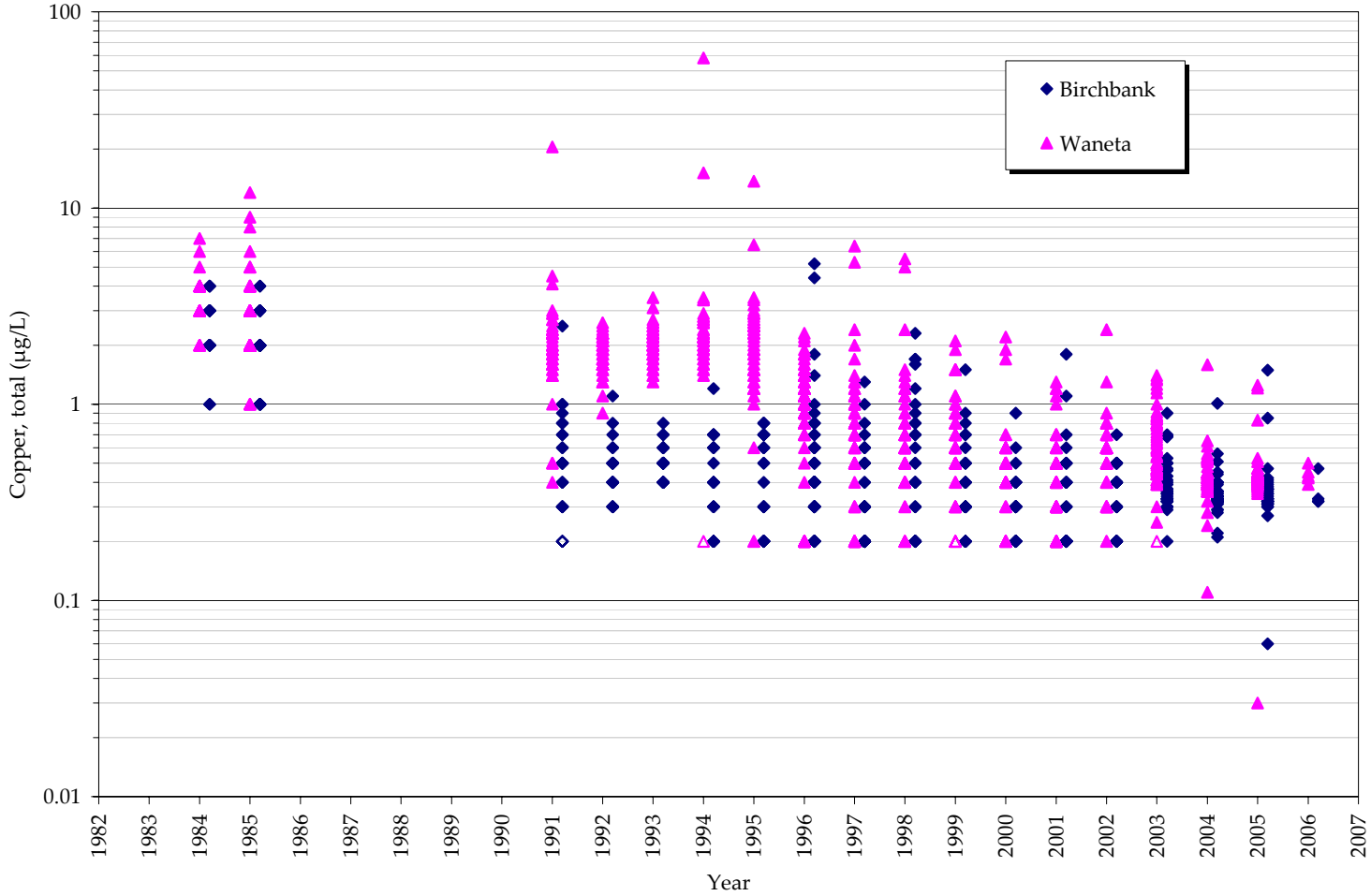


Figure D1-8. Comparison of Total Copper Surface Water Concentrations at Birchbank and Waneta as a Function of Time. Filled symbols reflect detected concentrations, while open symbols reflect detection limits for non-detected concentrations. Notice the significant degree of overlap between sampling data points within corresponding years.
Source: Environment Canada (www.waterquality.ec.gc.ca)

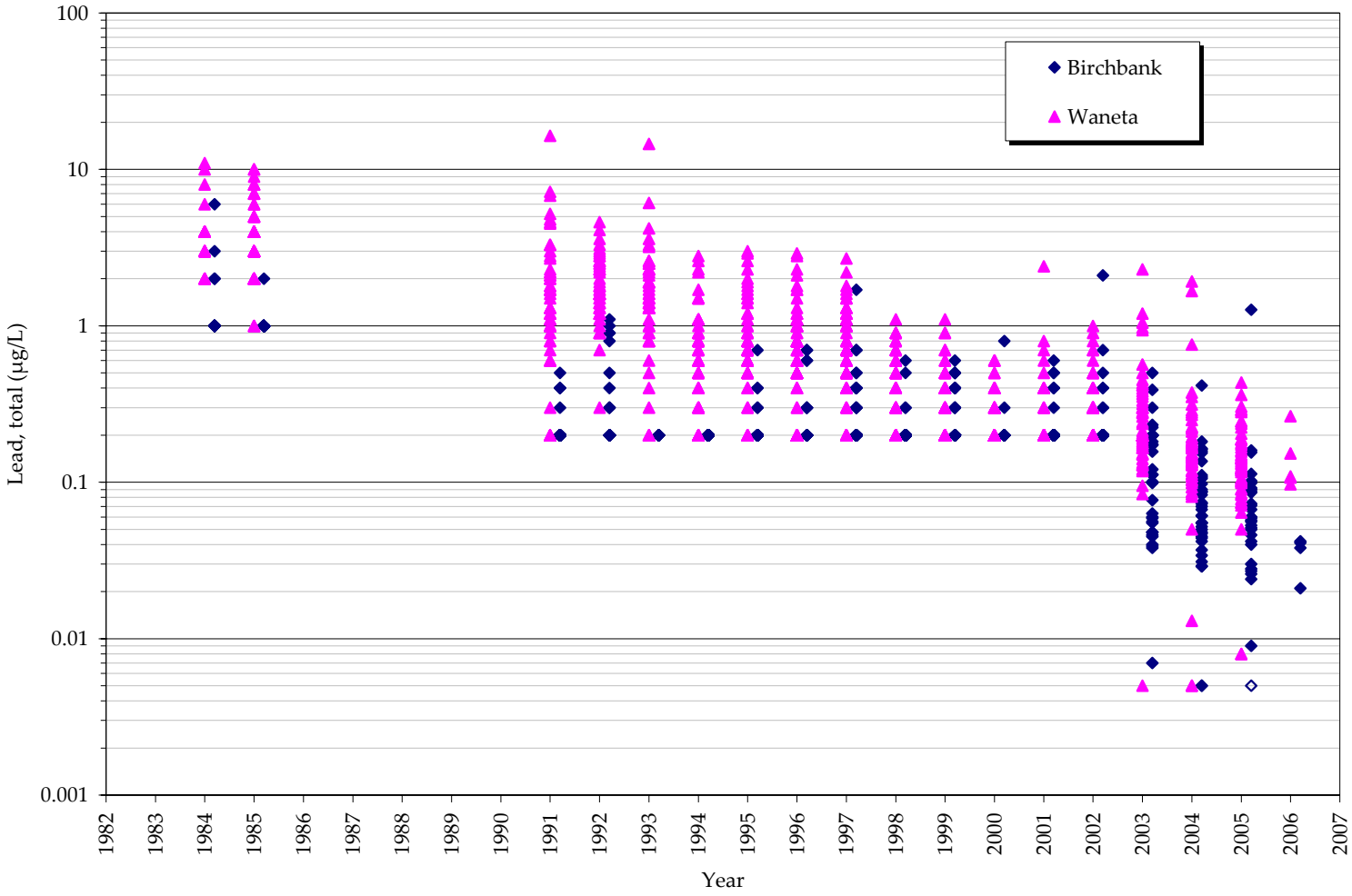


Figure D1-9. Comparison of Total Lead Surface Water Concentrations at Birchbank and Waneta as a Function of Time. Filled symbols reflect detected concentrations, while open symbols reflect detection limits for non-detected concentrations. Notice the significant degree of overlap between sampling data points within corresponding years
Source: Environment Canada (www.waterquality.ec.gc.ca)

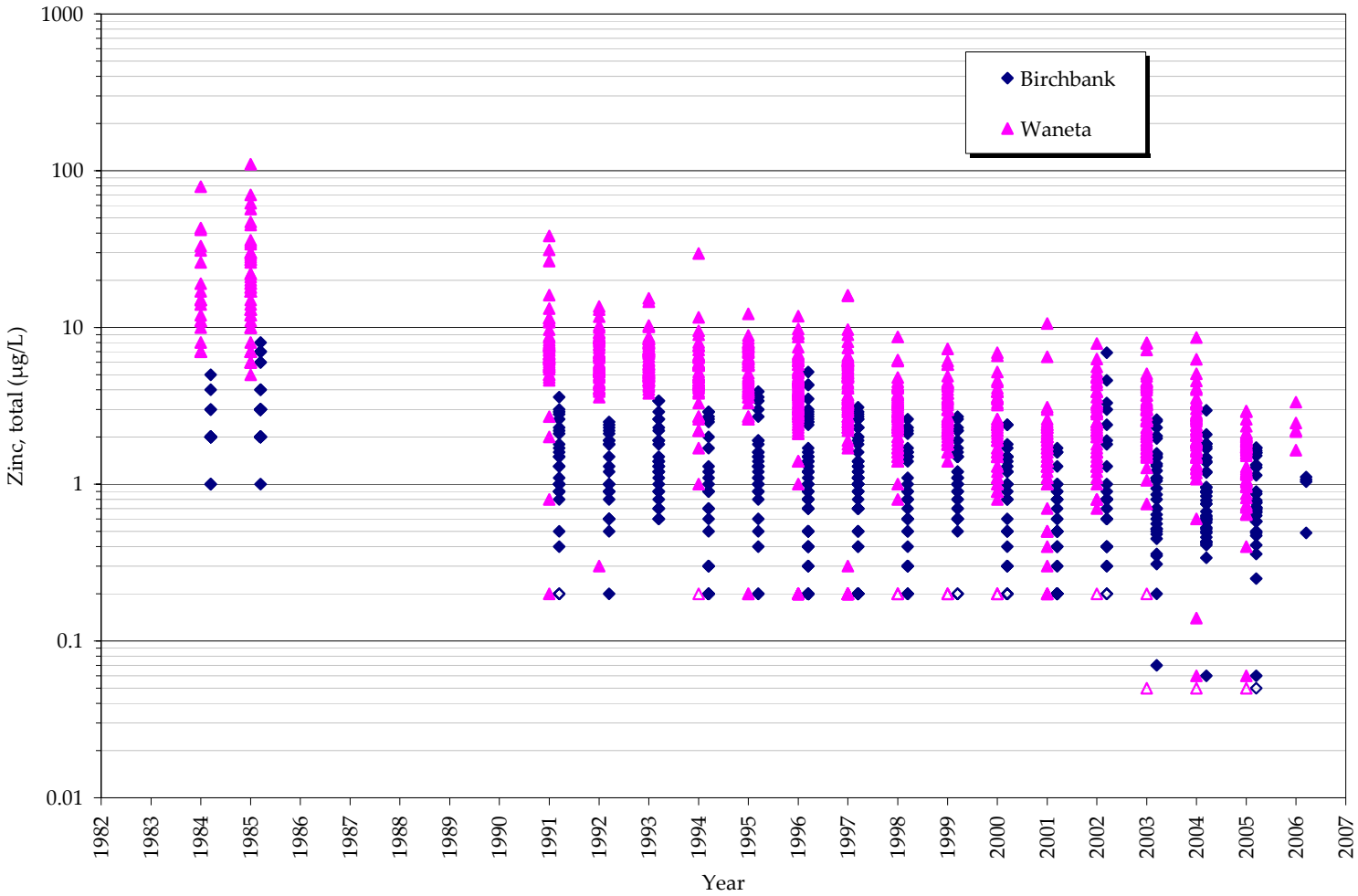


Figure D1-10. Comparison of Total Zinc Surface Water Concentrations at Birchbank and Waneta as a Function of Time. Filled symbols reflect detected concentrations, while open symbols reflect detection limits for non-detected concentrations. Notice the significant degree of overlap between sampling data points within corresponding years
Source: Environment Canada (www.waterquality.ec.gc.ca)

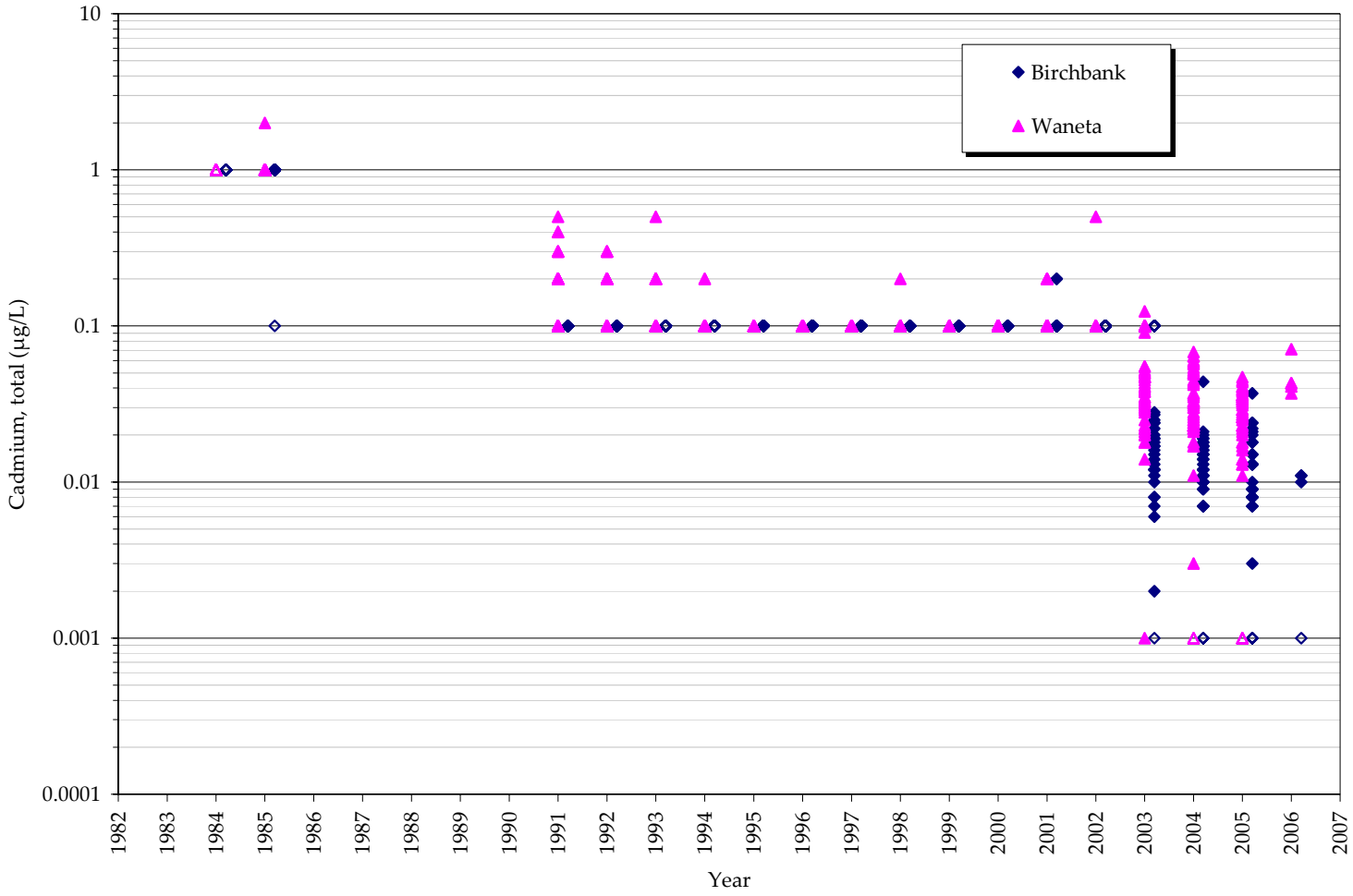


Figure D1-11. Comparison of Total Cadmium Surface Water Concentrations at Birchbank and Waneta as a Function of Time. Filled symbols reflect detected concentrations, while open symbols reflect detection limits for non-detected concentrations. Notice the significant degree of overlap between sampling data points within corresponding years
Source: Environment Canada (www.waterquality.ec.gc.ca).

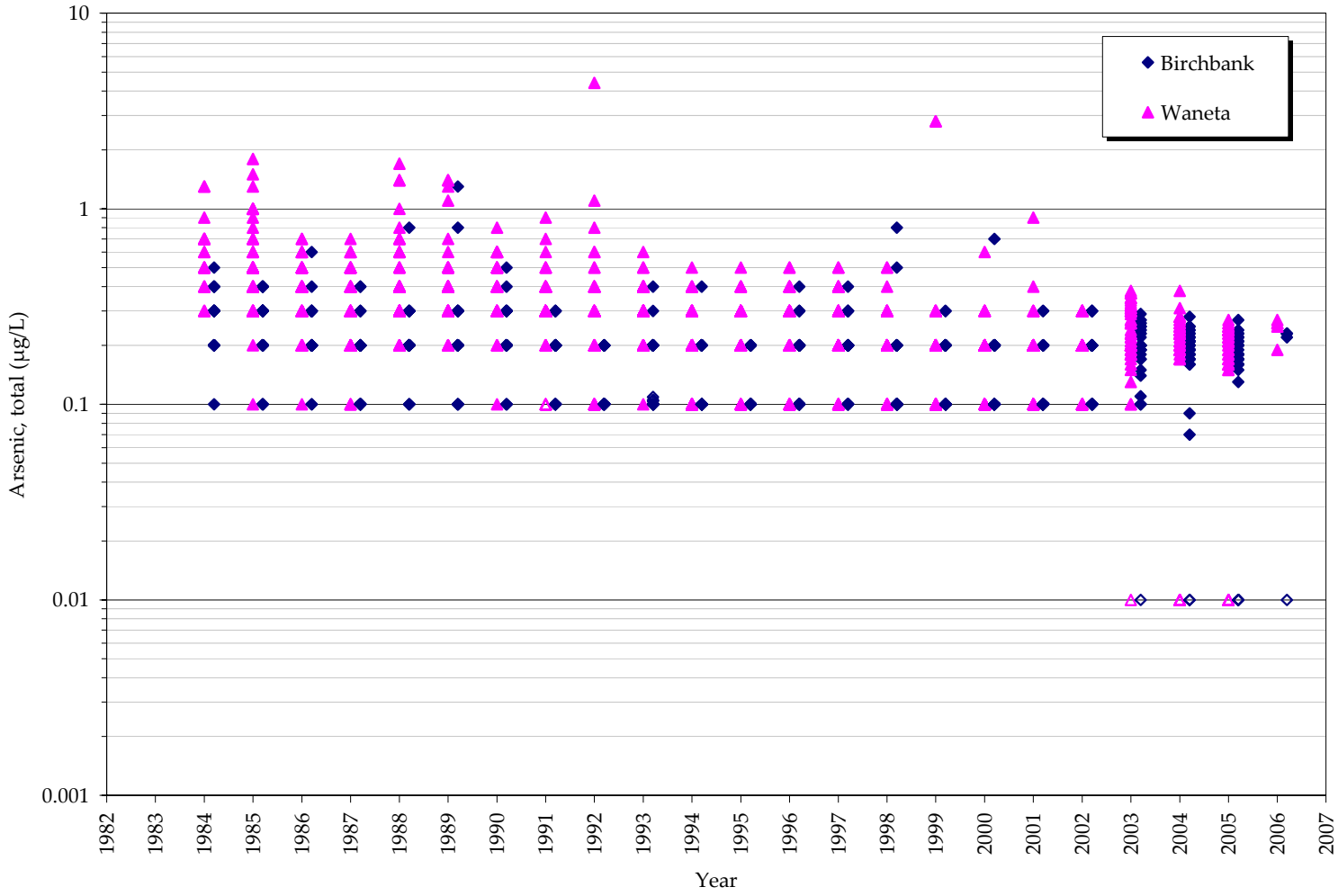


Figure D1-12. Comparison of Total Arsenic Surface Water Concentrations at Birchbank and Waneta as a Function of Time. Filled symbols reflect detected concentrations, while open symbols reflect detection limits for non-detected concentrations. Notice the significant degree of overlap between sampling data points within corresponding years
Source: Environment Canada (www.waterquality.ec.gc.ca).

TABLES

Table D1-1. Summary of Registered and Permitted Discharges from the Trail Facility Under the Pollution Control Act, 1967 with the Province of British Columbia Effective in October and December 1970

Parameter	Sewer/Outfall Descriptor									
	T-1 [a]	T-2 [b]	T-4 [c]	T-5 [d]	T-6 [d]	T-7 [d]	T-8 [d]	T-9 [e]	T-10 [d]	T-14 [f]
Discharge										
Permitted Rate (igpm) [g] =	3,500	4,100	2,500	3,500	8,000	6,000	8,700	150	1,000	20
(m^3/day) =	22,912	26,840	16,366	22,912	52,371	39,278	56,953	982	6,546	131
Suspended Solids (mg/L) [h] =	25	21,620 (slag)	3	22	12	30	23	8	34	-
Total Solids (mg/L) =	150	21,750	87	188	175	1,580	2,319	206	300	-
pH (s.u.) [i] =	6.8 - 8.0	6.9 - 8.0	6.8 - 7.7	6.5 - 7.5	6.5 - 7.5	1.5 - 3.5	1.5 - 3.0	6.5 - 7.5	8.0 - 9.3	-
Temperature (°F) =	60 - 72	55 - 83	55 - 65	55 - 68	65 - 70	77 - 90	65 - 75	55 - 68	50 - 68	-
Lead (mg/L)										
Total Fraction =	0.3	-	1	4.5	0.3	13.2	13.2	2.6	5	-
Dissolved Fraction =	<0.1	-	0.2	0.6	0.1	0.3	4.3	0.4	0.3	-
Zinc (mg/L)										
Total Fraction =	0.35	-	0.5	9.4	17	0.2	105	2.8	1.7	-
Dissolved Fraction =	0.3	-	0.4	3.4	16	0.2	105	2.3	0.1	-
Cadmium (mg/L)										
Total Fraction =	<0.1	-	0.1	0.14	0.1	0.74	0.38	0.12	<0.1	-
Dissolved Fraction =	<0.1	-	0.1	0.1	0.1	0.1	0.36	0.12	<0.1	-
Arsenic (mg/L)										
Total Fraction =	0.02	-	0.04	0.03	0.02	0.07	0.12	0.1	0.8	-
Dissolved Fraction =	0.02	-	0.02	0.01	0.02	0.02	0.08	0.04	0.2	-
Antimony (mg/L)										
Total Fraction =	-	-	-	-	-	-	-	-	0.69	-
Dissolved Fraction =	-	-	-	-	-	-	-	-	0.4	-
Fluoride (mg/L)										
Total Fraction =	-	-	-	-	-	-	-	-	3.5	-
Dissolved Fraction =	-	-	-	-	-	-	-	-	3.4	-
Sulfur (mg/L)										
Total Fraction =	7	-	3	28	22	810	650	7	-	-
Dissolved Fraction =	7	-	3	28	22	810	650	7	-	-
Sulfate (mg/L)										
Total Fraction =	7	-	3	28	22	320	650	7	-	-
Dissolved Fraction =	7	-	3	25	22	170	630	7	-	-
Ammonia (mg/L)										
Total Fraction =	-	-	-	-	-	-	110	-	-	-
Dissolved Fraction =	-	-	-	-	-	-	110	-	-	-
Nitrate (mg/L)										
Total Fraction =	-	-	-	-	-	-	2.4	-	-	-
Dissolved Fraction =	-	-	-	-	-	-	2.4	-	-	-

Notes: "-" denotes that the constituent was not regulated nor monitored for the given discharge.

[a] Registered on October 23, 1970 for the discharge of cooling water, some floor washings and coal drier impinger waste water.

[b] Registered on October 23, 1970 for the discharge of cooling water and granulated slag.

[c] Registered on December 15, 1970 for the discharge of cooling water.

[d] Registered on December 15, 1970 treated using settling tanks and filters prior to discharge.

[e] Registered on December 15, 1970 for the discharge of cooling water and waste water from analytical labs.

[f] Registered on December 15, 1970 for the discharge of domestic sewage.

[g] Discharge units are in imperial gallons per minute (igpm).

[h] Unless otherwise noted concentrations are reported in milligrams per liter (mg/L).

[i] Hydrogen ion activity (pH) is expressed in standard units (s.u.).

Table D1-2. Summary of November 29, 1978, and February 12, 1991, Maximum Authorized Effluent Discharge Rates and Concentrations into the Columbia River, PE-02753 and PE-05309

Parameter	Sewer/Outfall Descriptor				
	Sewer I	Sewer II	Sewer III	Sewer T-7	Sewer IV [a]
Permitted Maximum Discharge (m^3/day)					
November 29, 1978 [b]	100,000	136,000	86,000	na [c]	97,000
February 12, 1991 [d]	70,000	55,000	110,000	30,000	-
pH Range (s.u.) [e]					
November 29, 1978	6.5 - 8.5	6.5 - 9.5	6.5 - 9.5	-	2.5 - 7.5
February 12, 1991	6.5 - 8.5	6.5 - 8.5	6.5 - 9.5	2.0 - 8.5	-
Total Suspended Solids (mg/L)					
November 29, 1978	9,000	50	50	-	-
February 12, 1991	10,000	35	25	25	-
Zinc, Dissolved Fraction (mg/L)					
November 29, 1978	5.0	5.0	5.0	-	5.0
February 12, 1991	1.0	5.0	5.0	1.0	-
Arsenic, Dissolved Fraction (mg/L)					
November 29, 1978	0.05	0.05	0.05	-	-
February 12, 1991	0.05	0.05	0.05	0.25	-
Lead, Dissolved Fraction (mg/L)					
November 29, 1978	0.2	0.1	0.1	-	-
February 12, 1991	0.25	0.5	0.3	1.0	-
Cadmium, Dissolved Fraction (mg/L)					
November 29, 1978	0.05	0.05	0.05	-	-
February 12, 1991	0.05	0.07	0.05	0.5	-
Phosphate, Total Fraction (mg/L)					
November 29, 1978	-	-	-	-	115
February 12, 1991	-	-	-	-	-
Ammonia, Dissolved Fraction (mg/L)					
November 29, 1978	-	-	-	-	25
February 12, 1991	-	-	-	-	-
Fluoride, Dissolved Fraction (mg/L)					
November 29, 1978	-	-	-	-	100
February 12, 1991	-	-	-	-	-
Mercury, Total Fraction (mg/L)					
November 29, 1978	0.003	0.003	0.003	na	0.01
February 12, 1991	0.001	0.005	0.005	0.035	-

Notes: "-" denotes that the constituent was not regulated nor monitored for the given discharge.

[a] Discharges from Sewer IV were from Warfield (i.e., fertilizer) Operations and are regulated under Permit No. PE-05309.

[b] Metallurgical plant sewer descriptions/consolidations in 1978 were as follows:

- Metallurgical plant sewer I replaced sewers T-1 and T-2, under the 1970 permit/registration.
- Metallurgical plant sewer II replaced sewers T-3, T-4, T-5, T-6 and T-7, under the 1970 permit/registration.
- Metallurgical plant sewer III replaced sewers T-8, T-9 and T-10, under the 1970 permit/registration.

[d] Under the 1978 Permit No. PE-02753, Sewer T-7 was incorporated with discharge location Sewer II.

[e] Metallurgical plant sewer descriptions/consolidations in 1991 were as follows:

- Metallurgical plant sewer I replaces sewer T-2 and the Blast Furnace Pond Overflow.
- Metallurgical plant sewer II replaces sewers T-1, T-3, T-4, T-5, and T-6.
- Metallurgical plant sewer III replaces sewers T-8, T-9, T-10 and T-13.
- Metallurgical plant sewer T-7 (lead smelter absorption plant) was separated from Sewer II (1978 permit).

[f] Hydrogen ion activity (pH) is expressed in standard units (s.u.).

Table D1-3. Summary of Maximum Authorized Effluent Discharge Rates and Concentrations, PE-02753 and PE-05309

Effluent permits PE-02753 and PE-05309 were issued by BC Environment under the provisions of the Waste Management Act, authorizing the discharge of effluent from the Trail Facility into the Columbia River in 1996, 1997, and 2006.

Parameter	Sewer/Outfall Descriptor								
	SCPO [a]	SCPU [b]	SFFCWL [c]	Sewer II		Sewer III		Sewer IV [h]	Sewer 07 [i]
				Phase 1 [d]	Phase 2 [e]	Phase 1 [f]	Phase 2 [g]		
Permitted Maximum Discharge (m^3/day)									
1996	30,000	15,000	35,000	150,000	125,000	140,000	140,000	- [10]	60,000
1997	-	-	-	-	-	-	-	60,000	-
2006	-	-	-	150,000	-	140,000	-	60,000	-
pH Range (s.u.) [j]									
1996	-	-		6.5 - 8.5	6.5 - 8.5	6.5 - 9.5	6.5 - 9.5	-	-
1997	-	-	-	-	-	-	-	6.0 - 8.0	-
2006	-	-	-	6.5 - 8.5	-	6.5 - 9.5	-	6.2 - 8.5	-
Total Suspended Solids (kg/day)									
1996	*10,000*	*50*	*700*	*1,925*	*1,925*	*2,000*	*2,000*	-	-
1997	-	-	-	-	-	-	-	-	-
2006	-	-	-	-	-	*1,250*	-	-	-
Zinc, Dissolved Fraction (kg/day)									
1996	*40.0*	*4.0*	*20.0*	*100.0*	*75.0*	*90.0*	*90.0*	-	-
1997	-	-	-	-	-	-	-	*50.0*	-
2006	-	-	-	**175** [k]	-	**125.0**	-	**50.0**	-
Arsenic, Dissolved Fraction (kg/day)									
1996	*0.5*	*0.25*	*0.25*	**5**	**5**	**15**	**15**	-	-
1997	-	-	-	-	-	-	-	-	-
2006	-	-	-	-	-	**12**	-	-	-
Lead, Dissolved Fraction (kg/day)									
1996	*15*	*2*	*2*	**150**	**100**	**125**	**100**	-	-
1997	-	-	-	-	-	-	-	-	-
2006	-	-	-	**40**	-	**60**	-	-	-
Cadmium, Dissolved Fraction (kg/day)									
1996	*1*	*0.3*	*1*	*2.75*	*2.75*	*3*	*3*	-	-
1997	-	-	-	-	-	-	-	-	-
2006	-	-	-	**1**	-	**4**	-	-	-
Copper, Dissolved Fraction (kg/day)									
1996	*1*	*0.5*	*0.5*	**8**	**6**	**11**	**8**	-	-
1997	-	-	-	-	-	-	-	-	-
2006	-	-	-	**3**	-	**6**	-	-	-
Mercury, Total Fraction (kg/day)									
1996	*0.015*	*0.005*	*0.05*	*0.15*	*0.15*	*0.55*	*0.55*	-	-
1997	-	-	-	-	-	-	-	*0.097*	-
2006	-	-	-	*0.100*	-	*0.400*	-	*0.050*	-
Thallium, Total Fraction (kg/day)									
1996	-	-	-	-	-	-	-	-	-
1997	-	-	-	-	-	-	-	-	-
2006	-	-	-	-	-	**30**	-	-	-
Ammonia, as N (kg/day)									
1996	-	-	-	-	-	-	-	-	-
1997	-	-	-	-	-	-	-	*1,500*	-
2006	-	-	-	-	-	-	-	*1,000*	-

Notes: "-" denotes that the constituent was not regulated nor monitored for the given discharge.

[a] SCPO = Slag Collection Pond Overflow, formerly regulated under metallurgical outfall (sewer) I.

[b] SCPU = Slag Collection Pond Underflow formerly regulated under metallurgical outfall (sewer) I.

[c] SFFCWL = Slag Fuming Furnace Cooling Water Launder formerly regulated under metallurgical outfall (sewer) I.

[d] Phase 1 as defined for Sewer II was the period between November 29, 1996 and commencement of Phase 2. During this period, the smelting operation consists of a sinter plant, blast furnaces and existing slag fuming furnace, Kivcet Furnace and a new fuming furnace.

[e] Phase 2 for Sewer II was defined as the period after the Kivcet furnace has reached 90% of the normal feed rate of 1,500 tonnes/day expressed as a 30-day average and is operating on a continuous basis with a new slag fuming furnace and new drossing plant.

[f] Phase 1 as defined for Sewer III was the period between November 29, 1996 and commencement of Phase 2.

[g] Phase 2 for Sewer III was defined as the period when the Copper Products Filtrate Treatment Plant achieved 95% of capacity based on normal flows of 4.8 m^3/day.

[h] Sewer IV was first recognized as an individual discharge point and was issued a separate effluent permit (PE-05309).

[i] Discharge from Sewer 07 (also referred to as Sewer T-7) was discontinued in 1997.

[j] Hydrogen ion activity (pH) is expressed in standard units (s.u.).

[k] Discharge limits in bold typeface are for total as opposed to dissolved loading rates which are *italicized*.

Table D1-4. Chronological Summary of Historical Spills/Releases of Metals/Metalloids into the Columbia River from the Trail Facility

Spill/release information collected from records maintained by the B.C. Ministry of the Environment.

Date	Quantity Released	Permit Limit	Permit Variance [a]
Zinc			
23-Apr-81	9,500 kg/d	9,070 kg/d	430 kg/d
17-Sep-91	8.5 mg/L	5 mg/L	3.5 mg/L
1-Oct-91	8.2 mg/L	5 mg/L	3.2 mg/L
5-Nov-91	5.8 mg/L	5 mg/L	0.8 mg/L
3-Dec-91	7.3 mg/L	5 mg/L	2.3 mg/L
23-May-92	214.1 kg/d	63.7 kg/d	150.4 kg/d
13-Jun-95	960 kg/d	150 kg/d	810 kg/d
	0.005 mg/L	5 mg/L	-5.0 mg/L
13-Jun-95	1,321 kg/d	550 kg/d	770.5 kg/d
25-Jun-95	407.6 kg/d	150 kg/d	257.6 kg/d
17-Jan-96	2,074 kg/d	150 kg/d	1,924 kg/d
22-Jan-96	39.7 kg/d	20 kg/d	19.7 kg/d
9-Feb-96	31.5 kg/d	20 kg/d	11.5 kg/d
21-Feb-96	25 kg/d	20 kg/d	5.0 kg/d
21-Feb-96	16.2 kg/d	5 kg/d	11.2 kg/d
27-Feb-96	35 kg/d	20 kg/d	15.0 kg/d
26-Dec-98	177 kg/d	90 kg/d	87 kg/d
	2.2 mg/L	0.9 mg/L	1.3 mg/L
4-Oct-99	165 kg/d	75 kg/d	90 kg/d
	1.9 mg/L	1.4 mg/L	0.5 mg/L
7-Oct-99	106 kg/d	90 kg/d	16 kg/d
18-Feb-00	350 kg/d	75 kg/d	275 kg/d
	4 mg/L	1.4 mg/L	2.6 mg/L
31-Mar-00	693 µg/L	900 µg/L	-207 µg/L
4-Apr-00	1,810 µg/L	900 µg/L	910 µg/L
31-Jan-01	529.7 kg/d	75 kg/d	454.7 kg/d
	6.6 mg/L	1.4 mg/L	5.2 mg/L
26-Nov-01	NA	90 kg/d	NA
8-Jan-03	99.5 kg/d	75 kg/d	24.5 kg/d
Cadmium			
5-Nov-91	0.07 mg/L	0.05 mg/L	0.02 mg/L
27-Feb-95	NA	3.9 kg/d	NA
10-Mar-95	102 kg/d	60 kg/d	42.0 kg/d
	0.001 mg/L	0.05 mg/L	-0.049 mg/L
25-Jun-95	4.2 kg/d	4 kg/d	0.2 kg/d
10-Jan-96	0.87 kg/d	0.5 kg/d	0.37 kg/d
22-Jan-96	0.14 kg/d	0.1 kg/d	0.04 kg/d
22-Jan-96	0.82 kg/d	0.5 kg/d	0.32 kg/d
27-Feb-96	3.75 kg/d	2.75 kg/d	1.0 kg/d
13-Mar-97	40 kg/d	3 kg/d	37 kg/d
25-Mar-97	22 kg/d	3 kg/d	19 kg/d
3-May-98	15 kg/d	2.75 kg/d	12 kg/d
	0.0002 mg/L	0.022 mg/L	-0.022 mg/L
26-Dec-98	6.5 kg/d	3 kg/d	3.5 kg/d
	0.08 mg/L	0.03 mg/L	0.05 mg/L
24-Mar-99	3.53 kg/d	3 kg/d	0.53 kg/d

Table D1-4. Chronological Summary of Historical Spills/Releases of Metals/Metalloids into the Columbia River from the Trail Facility

Spill/release information collected from records maintained by the B.C. Ministry of the Environment.

Date	Quantity Released	Permit Limit	Permit Variance [a]
24-Mar-99	0.04 mg/L	0.03 mg/L	0.01 mg/L
25-Mar-99	4.01 kg/d	3 kg/d	1.01 kg/d
	0.045 mg/L	0.03 mg/L	0.02 mg/L
27-Mar-99	3.32 kg/d	3 kg/d	0.32 kg/d
	0.04 mg/L	0.03 mg/L	0.01 mg/L
22-Sep-99	6.04 kg/d	2.75 kg/d	3.29 kg/d
	0.073 mg/L	0.06 mg/L	0.013 mg/L
24-Sep-99	5.8 kg/d	3 kg/d	2.8 kg/d
	0.06 mg/L	0.03 mg/L	0.03 mg/L
7-Oct-99	3.48 kg/d	2.75 kg/d	0.73 kg/d
11-Oct-99	2.86 kg/d	2.75 kg/d	0.11 kg/d
9-Feb-00	3.7 kg/d	2.75 kg/d	0.95 kg/d
18-Feb-00	10.5 kg/d	2.75 kg/d	7.75 kg/d
	0.12 mg/L	0.06 mg/L	0.06 mg/L
Thallium [b]			
21-Jul-98	129 kg/d	NA	NA
12-Oct-98	100 kg/d	NA	NA
17-Apr-99	67.2 kg/d	NA	NA
	0.7 mg/L	NA	NA
18-Apr-99	196 kg/d	NA	NA
	2.1 mg/L	NA	NA
19-Apr-99	201 kg/d	NA	NA
	2.1 mg/L	NA	NA
20-Apr-99	136 kg/d	NA	NA
	1.5 mg/L	NA	NA
21-Apr-99	72.7 kg/d	NA	NA
	0.8 mg/L	NA	NA
22-Apr-99	56 kg/d	NA	NA
	0.6 mg/L	NA	NA
23-Apr-99	39 kg/d	NA	NA
	0.4 mg/L	NA	NA
8-Oct-00	43 kg/d	NA	NA
10-Oct-00	34 kg/d	NA	NA
11-Oct-00	31 kg/d	NA	NA
Arsenic			
9-Feb-94	21 kg/d [c]	NA	NA
	2.1 kg/d	5.5 kg/d	-3.4 kg/d
	0.02 mg/L	0.05 mg/L	-0.03 mg/L
10-Mar-94	NA	5.5 kg/d	NA
25-Jun-95	12.5 kg/d	11 kg/d	1.5 kg/d
22-Jan-96	0.32 kg/d	0.1 kg/d	0.22 kg/d
28-Jan-96	0.18 kg/d	0.1 kg/d	0.08 kg/d
4-Feb-96	0.14 kg/d	0.1 kg/d	0.04 kg/d
6-Mar-98	23 kg/d	15 kg/d	8 kg/d
7-Mar-98	23 kg/d	15 kg/d	8 kg/d
2-Jun-98	20.36 kg/d	15 kg/d	5 kg/d
Lead			

Table D1-4. Chronological Summary of Historical Spills/Releases of Metals/Metalloids into the Columbia River from the Trail Facility

Spill/release information collected from records maintained by the B.C. Ministry of the Environment.

Date	Quantity Released	Permit Limit	Permit Variance [a]
14-Aug-91	1.7 mg/L	1 mg/L	0.7 mg/L
25-Jun-95	63.8 kg/d	27.5 kg/d	36.3 kg/d
13-Mar-97	1,450 kg/d	17.13 kg/d	1,433 kg/d
Copper			
25-Jun-95	11.5 kg/d	5.5 kg/d	6.0 kg/d
30-Jul-98	15 kg/d	8 kg/d	7 kg/d
Mercury			
19-Mar-80	7,000 kg/d	0.258 kg/d	7,000 kg/d
18-Jul-91	0.014 mg/L	0.01 mg/L	0.004 mg/L
24-Jun-92	6.8-10 kg/d	1.05 kg/d	5.75 - 8.95 kg/d
30-Sep-92	60 kg/d	0.55 kg/d	59.45 kg/d
1-Oct-92	60 kg/d	0.55 kg/d	59.45 kg/d
2-Dec-92	0.014 mg/L	0.005 mg/L	0.009 mg/L
16-Dec-92	0.21 mg/L	0.005 mg/L	0.205 mg/L
6-Jan-93	0.13 mg/L	0.005 mg/L	0.125 mg/L
8-Jan-93	0.013 mg/L	0.005 mg/L	0.008 mg/L
12-Jan-93	0.014 mg/L	0.005 mg/L	0.009 mg/L
25-Apr-93	0.028 mg/L	0.005 mg/L	0.023 mg/L
1-May-93	0.012 mg/L	0.005 mg/L	0.007 mg/L
4-Jun-93	0.018 mg/L	0.005 mg/L	0.013 mg/L
10-Jun-93	0.3 mg/L	0.005 mg/L	0.295 mg/L
14-Jun-93	0.014 mg/L	0.005 mg/L	0.009 mg/L
15-Jun-93	0.032 mg/L	0.005 mg/L	0.027 mg/L
16-Jun-93	0.014 mg/L	0.005 mg/L	0.009 mg/L
20-Jun-93	0.014 mg/L	0.005 mg/L	0.009 mg/L
21-Jun-93	0.01 mg/L	0.005 mg/L	0.005 mg/L
23-Jun-93	0.027 mg/L	0.005 mg/L	0.022 mg/L
28-Jun-93	0.011 mg/L	0.005 mg/L	0.006 mg/L
6-Jul-93	0.011 mg/L	0.005 mg/L	0.006 mg/L
11-Aug-93	0.011 mg/L	0.005 mg/L	0.006 mg/L
21-Aug-93	0.023 mg/L	0.005 mg/L	0.018 mg/L
4-Jul-94	< 1 kg/d	0.56 kg/d	< 0.44 kg/d
14-Aug-94	0.014 mg/L	0.01 mg/L	0.004 mg/L
5-Feb-95	0.34 kg/d	0.15 kg/d	0.19 kg/d
	2.8E-06 mg/L	0.005 mg/L	-0.005 mg/L
26-Feb-95	0.18 kg/d	0.15 kg/d	0.03 kg/d
	1.7E-06 mg/L	0.005 mg/L	-0.005 mg/L
9-Mar-95	0.24 kg/d	0.15 kg/d	0.09 kg/d
	2.2E-06 mg/L	0.005 mg/L	-0.005 mg/L
26-Mar-95	0.68 kg/d	0.55 kg/d	0.13 kg/d
	6.0E-06 mg/L	0.005 mg/L	-0.005 mg/L
27-Mar-95	0.77 kg/d	0.55 kg/d	0.22 kg/d
	7.0E-06 mg/L	0.005 mg/L	-0.005 mg/L
3-Apr-95	0.70 kg/d	0.55 kg/d	0.15 kg/d
	8.0E-06 mg/L	0.005 mg/L	-0.005 mg/L

Table D1-4. Chronological Summary of Historical Spills/Releases of Metals/Metalloids into the Columbia River from the Trail Facility

Spill/release information collected from records maintained by the B.C. Ministry of the Environment.

Date	Quantity Released	Permit Limit	Permit Variance [a]
4-Apr-95	0.96 kg/d	0.55 kg/d	0.41 kg/d
	1.1E-05 mg/L	0.005 mg/L	-0.005 mg/L
5-Apr-95	0.66 kg/d	0.55 kg/d	0.11 kg/d
	7.8E-06 mg/L	0.005 mg/L	-0.005 mg/L
6-May-95	0.35 kg/d	0.15 kg/d	0.20 kg/d
7-May-95	0.44 kg/d	0.15 kg/d	0.29 kg/d
	3.7E-06 mg/L	0.005 mg/L	-0.005 mg/L
15-May-95	0.83 kg/d	0.55 kg/d	0.28 kg/d
	6.4E-06 mg/L	0.005 mg/L	-0.005 mg/L
16-May-95	0.77 kg/d	0.55 kg/d	0.22 kg/d
	5.5E-06 mg/L	0.005 mg/L	-0.005 mg/L
22-May-95	1.04 kg/d	0.55 kg/d	0.49 kg/d
	7.0E-06 mg/L	0.005 mg/L	-0.005 mg/L
31-May-95	0.23 kg/d	0.15 kg/d	0.08 kg/d
	1.3E-06 mg/L	0.005 mg/L	-0.005 mg/L
26-Jan-96	0.01 kg/d	0.009 kg/d	0.003 kg/d
26-Feb-96	0.020 kg/d	0.009 kg/d	0.01 kg/d
13-Mar-97	8.9 kg/d	0.55 kg/d	8.35 kg/d
8-May-01	1.42 kg/d	0.55 kg/d	0.87 kg/d

Notes: NA = Not available

[a] Permit variance was calculated as the difference between "Quantity Released" and the "Permit Limit".

[b] Under Permit No. PE-02753 thallium is not a regulated analyte.

[c] Based on spill records, 90 percent of the release occurred on land with only 10 percent being released into the Columbia River.

Table D1-5. Chronological Summary of Historical Spills/Releases of Nutrients, Acids, Organic Compuonds, and Total Suspended Solids into the Columbia River from the Trail Facility

Spill/release information collected from records maintained by the B.C. Ministry of the Environment.

Date	Chemical Name/Description	Quantity Released
Acids & Nutrients		
13-Jul-80	NH_3HSO_3	500 gallons
1-Nov-80	93% H_2SO_4	30 tonnes
4-Nov-80	P_2O_5	24 tonnes
4-May-81	93% H_2SO_4	25-30 tonnes
13-May-81	NH_3HSO_3	4,000 gallons
4-Aug-81	93% H_2SO_4	53 tonnes
6-Oct-81	93% H_2SO_4	40 tonnes
14-Aug-91	NH_3 - N	45 mg/L
17-Sep-91	NH_3 - N	40 mg/L
5-Nov-91	NH_3 - N	40 mg/L
8-Jan-92	93% H_2SO_4	100 - 150 L
6-Feb-92	H_2SO_4	400 L
22-Feb-92	H_2SO_4	250 gallons
1-Mar-92	Phosphoric acid	NA
3-Mar-92	93% H_2SO_4	NA
7-Mar-92	93% H_2SO_4	1 gallon
14-Mar-92	Phosphoric acid	NA
19-Mar-92	93% H_2SO_4	20 gallons
9-Apr-92	NH_3SO_4	150 gallons
14-Apr-92	93% H_2SO_4	30 gallons
18-Apr-92	93% H_2SO_4	100 gallons
20-Apr-92	Phosphoric acid	NA
8-May-92	27 % Phosphoric acid	NA
15-May-92	SO_3	40 gallons
25-May-92	21 % Phosphoric acid	5 tonnes
4-Jun-92	Ammonium Bisulphite	15 gallons
8-Jun-92	93.5% H_2SO_4	20 liters
26-Jun-92	Phosphoric acid	1.5 tonnes
1-Jul-92	Return Acid, Calcine	20 gallons
10-Jul-92	H_3PO_4	NA
14-Jul-92	H_2SO_4	20 liters
4-Aug-92	93% H_2SO_4	5-10 gallons
10-Aug-92	Phosphoric acid	1,500 L
4-Sep-92	Phosphoric acid	NA
5-Sep-92	98% H_2SO_4	10-15 gallons
14-Sep-92	Ammonium Bisulphite	30-40 gallons
2-Oct-92	SO_4	50-100 gallons

Table D1-5. Chronological Summary of Historical Spills/Releases of Nutrients, Acids, Organic Compuonds, and Total Suspended Solids into the Columbia River from the Trail Facility

Spill/release information collected from records maintained by the B.C. Ministry of the Environment.

Date	Chemical Name/Description	Quantity Released	
2-Oct-92	H_2SO_4	20-50	gallons
3-Nov-92	93% H_2SO_4	450	kg
4-Dec-92	H_2SO_4	10-15	gallons
8-Dec-92	Ammonium Sulfate	12	tonnes
16-Dec-92	93% H_2SO_4	2.5	tonnes
20-Dec-92	Ammonium Bisulphite	15-20	gallons
22-Dec-92	Ammonium Bisulphite	400	liters
25-Jun-95	Sulfuric Acid	3,000 - 5,000	L
9-Feb-96	NH_3 - N	30	mg/L
20-May-97	Sulfuric Acid	600	kg/d
28-Mar-00	NH_3 - N	1.9	tonnes
18-Apr-00	Low pH Alarm	NA	
Organics			
28-Jul-92	ESSO Teresso 68 Oil	25 - 30	L
17-Dec-92	Transformer Oil Voltesso 35	200	L
27-May-01	Oil	22	L
Total Suspended Solids			
17-Sep-91	Suspended Solids	39	mg/L
1-Oct-91	Suspended Solids	12,475	mg/L
5-Nov-91	Suspended Solids	10,989	mg/L
3-Dec-91	Suspended Solids	18,670	mg/L
7-Dec-95	Slag	75	tonnes
10-May-96	Slurry	35	tonnes
8-Nov-96	Barren Slag	35	tonnes
9-Jan-98	Slurry	1 to 3	m^3
7-Apr-98	Barren Slag	1	tonnes
20-Aug-98	Slag	1.9	m^3
24-Oct-98	Granulated Slag	15	min

Table D1-6. Summary of Permits Issued to the Trail Facility by the B.C. Government Authorizing On-Site Activities and/or Discharges

Permit No.	Applicable Facility Operations	General Description
Air		
PA-02691	Lead Operations	Governs atmospheric emissions from the smelter furnaces and the lead refinery.
PA-02692	Zinc Operations	Governs atmospheric emissions from roasters, acid plants leaching circuit, and electrolytic/melting plants.
PA-02690	Fertilizer Operations	Governs atmospheric emissions from fertilizer operations and other operations located in the Warfield Complex.
Water		
PE-02753	Metallurgical Liquid Effluents	Governs effluent discharges from all on-site operations through Metallurgical Plant Combined Outfalls II, III, and IV.
PE-02407	Waneta Dam Effluent	Governs and permits discharge from a septic system into septic tile fields.
License No. 11790	Water Rights	License to divert water from the Columbia River to Trail Operations (industrial and domestic uses).
Material Management Permits		
PR-11898	Slag Disposal	Permit to store barren slag at the Duncan Flats storage site. Although this permit is active, the storage facility has never been established given that ferrous granules are now sold to the cement industry.
PS-08310	Arsenic Storage	Permit to store arsenic containing materials at Duncan Flats. All wastes are contained in a lined facility (top and bottom), equipped with water collection system.
PS-11532	Thallium and Calomel Storage	Permit to operate an indoor storage facility for mercury and thallium containing materials resulting from on-site metallurgical operations.
AS-16033	Tellurium	Approval to discharge tellurium containing slag from the lead refinery but is now classified as a product (i.e., ferrous granules) and is sold to the cement industry. Therefore no longer applicable.
Landfill Permits		
PR-05175	Warfield Landfill	Permit to operate a non-hazardous waste landfill situated adjacent to the Warfield Operations.
PR-03423	Haley Gully	Permit to operate a non-hazardous waste landfill situated adjacent to the Warfield Operations. This landfill is no longer in use.
Hazardous and Special Waste Management		
PS-08672	Waste Solvent Storage	Permit to operate a waste solvent facility for the collection and safe temporary storage of such materials generated in the Tadanac/Warfield Operations. All materials are appropriately disposed off-site at licensed facilities as required.
PS-08443	Polychlorinated Biphenyl Storage	Permit to operate a storage facility for the temporary storage of PCB-containing materials (e.g., transformers) being phased out of all on-site operations.

Table D1-7. Summary of Annual Loadings into the Columbia River as Determined from All On-Site Discharges

Data listed below represent a compilation of on-site historical records (1980 - 1993) and National Records (1994 - 2005) as maintained by the Canadian Government.

Year	Total Annual Loading into the Columbia River (kg/day)							
	Antimony	Arsenic	Cadmium	Copper	Lead	Manganese	Mercury	Zinc
1980	-	25	47	-	887	-	7.3	17,785
1981	-	19	38	-	691	-	4.4	12,644
1982	-	20	87	-	708	-	6.4	9,969
1983	-	20	56	-	456	-	5.2	5,217
1984	-	26	26	-	278	-	1.9	4,486
1985	-	26	39	-	283	-	1.6	2,934
1986	-	25	39	-	339	-	2.2	3,958
1987	-	10	30	-	248	-	1.4	3,975
1988	-	13	39	-	252	-	3.2	2,653
1989	-	7	31	-	256	-	5.7	1,719
1990	-	9	12	-	148	-	1.7	523
1991	-	7	13	-	159	-	1.4	656
1992	-	9	13	-	235	-	1.6	358
1993	-	10	10	-	214	-	1.5	361
1994	9.0	114	16	2,460	408	3.8	0.4	12,175
1995	21.7	32	6	887	154	46.4	0.2	5,032
1996	13.7	8	5	43	101	32.4	0.1	375
1997	10.7	5	4	10	69	0.0	0.3	263
1998	11.9	2.5	1.5	1.9	20	1.2	0.2	149
1999	11.9	1.9	1.1	1.9	13	1.1	0.1	110
2000	6.2	1.4	0.8	1.3	7.6	1.1	0.1	85
2001	8.6	1.5	0.5	1.0	4.8	1.1	0.1	50
2002	12.7	1.8	0.6	0.8	5.3	1.5	0.03	67
2003	19.7	2.1	0.4	1.3	4.2	1.0	0.03	73
2004	16.6	1.5	0.4	1.4	5.6	1.2	0.03	67
2005	9.9	1.4	0.4	1.3	4.8	0.8	0.05	19

Notes: Data from 1980 to 1994 was taken from records maintained at the Trail Facility.
Data from 1994 to 2005 was taken from the National Pollutant Release Inventory, as of September 22, 2006.
"-" = no data was collected for the specific analyte in a given year.

This document is formatted for double-sided printing (print in duplex mode)

ATTACHMENT D1-1

TRAIL EFFLUENT DISCHARGE PERMITS AND ASSOCIATED AMENDMENTS

MINISTRY OF THE ENVIRONMENT

POLLUTION CONTROL BRANCH

PERMIT

Under the Provisions of the Pollution Control Act, 1967

Cominco Ltd. - Cominco Ltee.

200 Granville Square, Vancouver, British Columbia, V6C 2K2

is hereby authorized to discharge effluent

from a lead smelter, a zinc smelter, and associated plants

located at Trail, British Columbia

to the Columbia River

This permit has been issued under the terms and conditions prescribed in the attached appendices

01, 02, 03 and A

Assistant Director of Pollution Control

Date issued NOV 29 1978, 19

Amendments dated, 19

, 19

, 19

Permit No. PE-2753

PCB 11— ●

039 1101

MINISTRY OF THE ENVIRONMENT

POLLUTION CONTROL BRANCH

APPENDIX No. 01

to Pollution Control Permit No. PE-2753

(a) The discharge of effluent applicable to this appendix is from Metallurgical Plant Sewer I (which replaces Sewers T-1 and T-2 (effluents from lead furnaces, fuming furnaces, drossing plant, zinc tank room, etc.)) to the Columbia River (Source of operation) as shown on attached Appendix A

(b) The quantity of effluent which may be discharged is a maximum of 22.0 x 10^6 gallons per day (1.00 x 10^5 m^3/d)

(c) The characteristics of the effluent shall be equivalent to or better than

pH range	- 6.5 to 8.5	The effluent characteristics specified in this section shall be complied with by January 1, 1982 and thereafter.
total suspended solids	- 9000 mg/L	
dissolved zinc	- 5.0 mg/L	
" arsenic	- 0.05 mg/L	
" lead	- 0.20 mg/L	
" cadmium	- 0.05 mg/L	
total mercury	- 0.003 mg/L	

(d) The works authorized are a proposed combined sewer, outfall, and related appurtenances

~~approximately as shown on the attached Appendix~~

(e) The land from which the effluent originates and to which this appendix is appurtenant is Lot 1 and 2, Plan 4926 K.D.

(f) Those works authorized and proposed must be completed and in operation by January 1, 1982 and thereafter.

(g) The authority to discharge is contingent upon the authorized works having been constructed as per ~~final construction~~ plans approved in accordance with the *Pollution Control Act*, ~~1967~~.

Date issued NOV 29 1978, 19

Date amended, 19

, 19

Assistant Director of Pollution Control

PCB 13—0

039 1102

MINISTRY OF THE ENVIRONMENT

POLLUTION CONTROL BRANCH

APPENDIX No. 02

to Pollution Control Permit No. PE-2753

(*a*) The discharge of effluent applicable to this appendix is from Metallurgical Plant Sewer II (which replaces Sewers T-3, T-4, T-5, T-6, and T-7 (effluents from lead fuming furnaces, sinter plant, zinc plant, smelter absorption plant, etc.)) to the Columbia River (Source of operation) as shown on attached Appendix A

(*b*) The quantity of effluent which may be discharged is a maximum of 30.0 x 10^6 gallons per day (1.36 x 10^5 m^3/d)

(*c*) The characteristics of the effluent shall be equivalent to or better than*

pH range	- 6.5 to 9.5	The effluent characteristics specified in this section shall be complied with by January 1, 1983 and thereafter.
total suspended solids	- 50 mg/L	
dissolved zinc	- 5.0 mg/L	
" arsenic	- 0.05 mg/L	
" lead	- 0.10 mg/L	
" cadmium	- 0.05 mg/L	
total mercury	- 0.003 mg/L	

*A weighted average of the effluents from Sewers II and III shall meet these characteristics.

(*d*) The works authorized are a proposed combined sewer, submerged outfall, and related appurtenances; and treatment facilities as required to meet the effluent characteristics specified in (c) above

(*e*) The land from which the effluent originates and to which this appendix is appurtenant is Lot 1, 2, 3, and 4; Plan 4926 K.D.

(*f*) Those works authorized and proposed must be completed and in operation by December 31, 1979 and thereafter except that all treatment facilities required must be completed and in operation by January 1, 1983.

(*g*) The authority to discharge is contingent upon the authorized works having been constructed as per plans approved in accordance with the *Pollution Control Act*,

Date issued NOV 29 1978, 19

Date amended, 19

, 19

Assistant Director of Pollution Control

PCB 13—0

039 1103

MINISTRY OF THE ENVIRONMENT

POLLUTION CONTROL BRANCH

APPENDIX No. 03

to Pollution Control Permit No. PE-2753

(*a*) The discharge of effluent applicable to this appendix is from Metallurgical Plant Sewer III (which replaces Sewers T-8a, T-8b, T-9 and T-10 (effluents from lead and silver refinery, acid plants, zinc plant, assay office, etc.)) to the Columbia River (Source of operation) as shown on attached Appendix A.

(*b*) The quantity of effluent which may be discharged is a maximum of 19.0 x 10^6 gallons per day (0.86 x 10^5 m^3/d)

(*c*) The characteristics* of the effluent shall be equivalent to or better than

pH range	- 6.5 to 9.5	The effluent characteristics
total suspended solids	- 50 mg/L	specified in this section shall
dissolved zinc	- 5.0 mg/L	be complied with by January 1,
" arsenic	- 0.05 mg/L	1983 and thereafter.
" lead	- 0.10 mg/L	
" cadmium	- 0.05 mg/L	
total mercury	- 0.003 mg/L	

*A weighted average of the effluents from Sewers II and III shall meet these characteristics.

(*d*) The works authorized are a proposed combined sewer, submerged outfall, and related appurtenances; and treatment facilities as required to meet the effluent characteristics specified in (c) above ~~approximately as shown on the attached Appendix~~

(*e*) The land from which the effluent originates and to which this appendix is appurtenant is Lot 1, 2, 3, and 4, Plan 4926 K.D.

(*f*) Those works authorized and proposed must be completed and in operation by December 31, 1979 and thereafter except that all treatment facilities required must be completed and in operation by January 1, 1983.

(*g*) The authority to discharge is contingent upon the authorized works having been constructed as per ~~final~~ ~~construction~~ plans approved in accordance with the *Pollution Control Act*, ~~1967~~

Date issued NOV 29 1978, 19

Date amended, 19

, 19

Assistant Director of Pollution Control

PCB 13—0

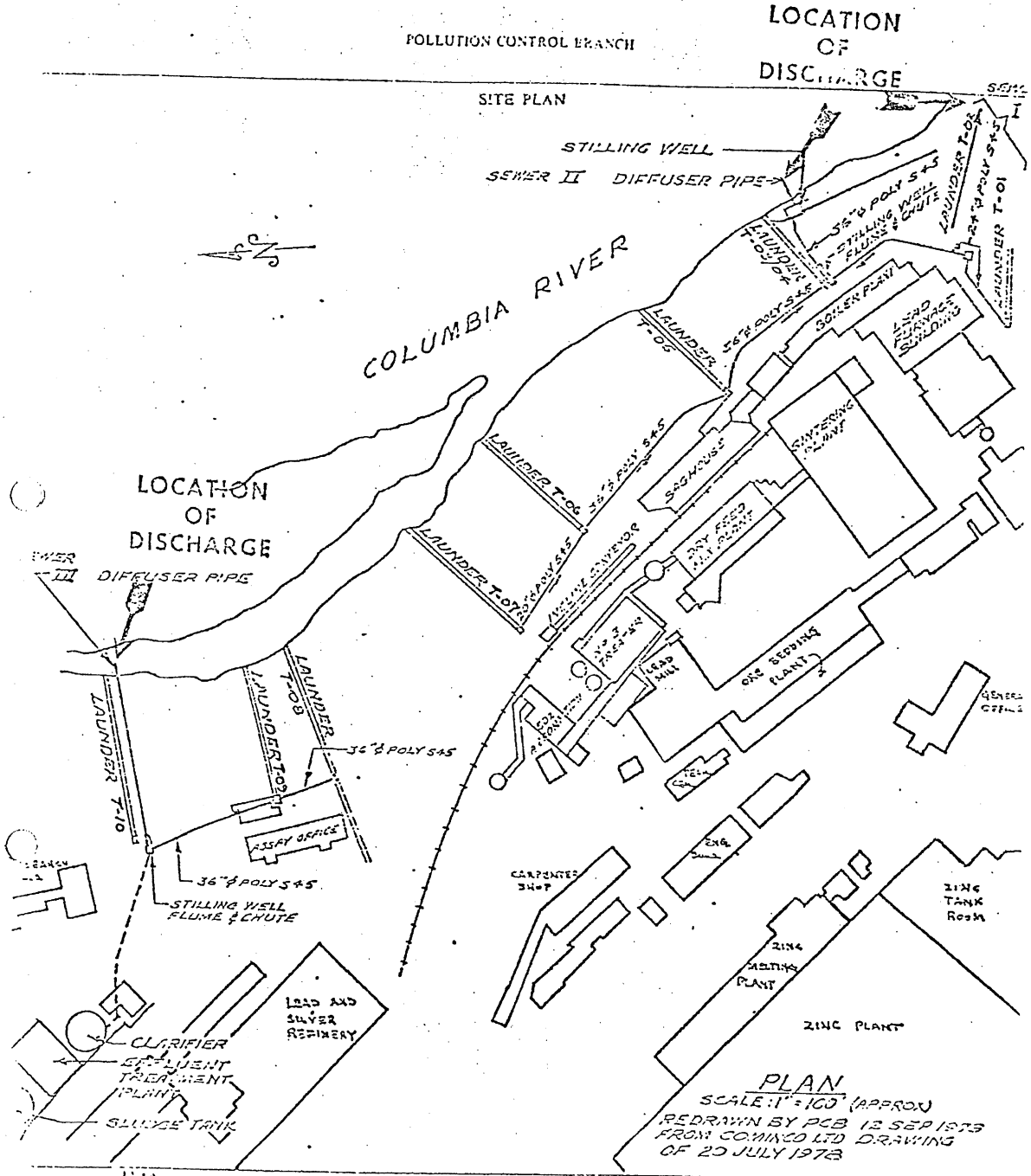
039 1104

Province of British Columbia

Ministry of the Environment

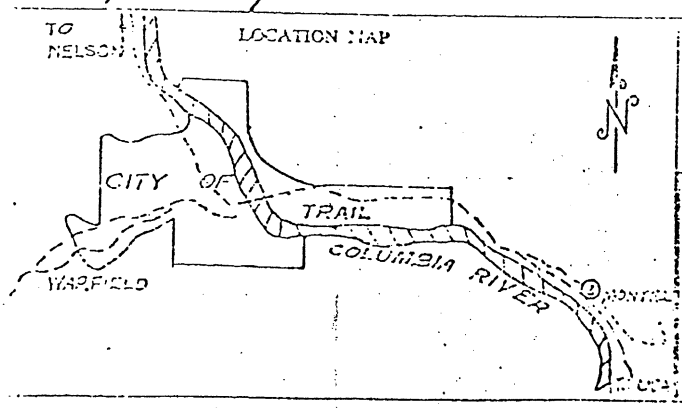
POLLUTION CONTROL BRANCH

SITE PLAN



PLAN
SCALE: 1" = 100' (APPROX)
REDRAWN BY PCB 12 SEP 1978
FROM COMINCO LTD DRAWING
OF 20 JULY 1978

LOCATION MAP



(Name of applicant(s))

(Date) (Signature of applicant(s) or agent)

(FOR OFFICE USE ONLY)

NOV 29 1978

(Date issued) Assistant (Director of Pollution Control)

Appendix A to Permit No. PE-2753

039 1105

File No.

THE GOVERNMENT OF THE PROVINCE OF BRITISH COLUMBIA

DEPARTMENT OF LANDS, FORESTS, AND WATER RESOURCES
WATER RESOURCES SERVICE—POLLUTION CONTROL BRANCH

Registration of a Discharge of Effluent under the Pollution Control Act, 1967

I/We, Cominco Ltd.
(Full name—print or type)

of Trail, B.C.
(Legal address)

(Mailing address, if different to above)

hereby filed with the Director of Pollution Control a registration of a discharge from

Lead and Zinc Smelter complex.
(Local name of industry, housing development, trailer park, etc.—specify)

located at Trail, B.C. to Columbia River
(Name of place)

(Name of creek, river, lake, bay, inlet, etc., or description of land)

The point of discharge is located at 1,840' southeasterly from the N.E. corner of lot 1 plan 4926 KD on the bank of the Columbia River.
(Give distance and direction from some surveyed or known point.)

The land upon which the works are located is Lot 1 Plan 4926 KD.

(Give legal description, or in case of municipal sewage, name of municipality and area thereof. Use reverse side, if necessary.)

The type of effluent being discharged is T-1 Industrial Waste (see reverse side)
(Domestic sewage, cannery, meat packing, etc.)

The quantity of effluent being discharged is as follows:—

Liquid waste (effluent)
- Maximum rate 3,500 (Imperial gallons per minute)
- Maximum 12-hour discharge 2,520,000 (Imperial gallons) Average 24-hour discharge 4,030,000 (Imperial gallons)

The operating season during which the effluent is discharged is continuous

(Continuous, or date to date)

The type of treatment applied to the effluent before discharge is as follows Nil - water used primarily for cooling, some floor washings & coal drier impinger waste water.

This registration, dated the 23 day of October, 1970, is true to the best of my knowledge and belief.

(Signature) R. A. Wahy for L. J. Nicholson

NOTE TO THE REGISTRANT.—Each discharge, i.e., via more than one sewer, must be separately registered with the Director.

FOR OFFICE USE ONLY

Date received
District
Regional District
Municipal ☐
Industrial ☐
Data processed
Priority

File No.

Application for permit sent 039 1106 (Date)

To be received - - - - (Date)

DO NOT DETACH

File No. 17.16.9

- Cominco Ltd.
- Trail, B. C.
-

Dear Sir: Lead and Zinc Smelter complex at Trail T-1 waste

This is your proof of registration of a discharge. Please retain for your records. Quote the above file number when writing to this Branch. You will be advised of further action in due course.

W. N. VENABLES, P.ENG.,
G. M. [illegible] Director.

PCB 2—15M-770-5774 (2)

Average characteristics of Effluent

Suspended solids (ppm)		25
Total solids (ppm)		150
pH range		6.8 - 8.0
Temp. range (degrees F)		60 - 72
Toxic chemicals (ppm)	Total	Soluble
Pb	0.3	<0.1
Zn	0.35	0.30
Cd	<0.1	<0.1
As	0.02	0.02
S	7	7
SO_4/S	7	7

File No.

THE GOVERNMENT OF THE PROVINCE OF BRITISH COLUMBIA

DEPARTMENT OF LANDS, FORESTS, AND WATER RESOURCES
WATER RESOURCES SERVICE—POLLUTION CONTROL BRANCH

Registration of a Discharge of Effluent under the Pollution Control Act, 1967

I/We, Cominco Ltd.
(Full name—print or type)

of Trail, B.C.
(Legal address)

(Mailing address, if different to above)

hereby filed with the Director of Pollution Control a registration of a discharge from

A Lead and Zinc Smelter complex.
(Local name of industry, housing development, trailer park, etc.—specify)

located at Trail, B.C. (Name of place) to Columbia River

(Name of creek, river, lake, bay, inlet, etc., or description of land)

The point of discharge is located at 1,780' southerly from the N.E. corner of Lot 1 Plan 4926 KD on the bank of the Columbia River.
(Give distance and direction from some surveyed or known point.)

The land upon which the works are located is Lot 1 and 2 Plan 4926 KD

(Give legal description, or in case of municipal sewage, name of municipality and area thereof. Use reverse side, if necessary.)

The type of effluent being discharged is T-2 Industrial Waste (see reverse side)
(Domestic sewage, cannery, meat packing, etc.)

The quantity of effluent being discharged is as follows:—

Liquid waste (effluent)
- Maximum rate 4,100 (Imperial gallons per minute)
- Maximum 12-hour discharge 2,950,000 (Imperial gallons) Average 24-hour discharge 4,460,000 (Imperial gallons)

The operating season during which the effluent is discharged is continuous
(Continuous, or date to date)

The type of treatment applied to the effluent before discharge is as follows Nil - water used primarily for cooling and for granulating slag. No toxic chemicals.

This registration, dated the 23 day of October, 19 70 is true to the best of my knowledge and belief.

(Signature) R. Awty for: L.J. Nicholson

NOTE TO THE REGISTRANT.—Each discharge, i.e., via more than one sewer, must be separately registered with the Director.

FOR OFFICE USE ONLY

Date received
District
Regional District
Municipal ☐
Industrial ☐
Data processed
Priority

File No.

Application for permit sent (Date)

To be received - - - - 039 1108 (Date)

DO NOT DETACH

File No. 17-16-10

Cominco Ltd.
Trail, B. C.

Dear Sir: Lead and Zinc smelter complex, Trail - T-2 waste

This is your proof of registration of a discharge. Please retain for your records. Quote the above file number when writing to this Branch. You will be advised of further action in due course.

W. N. VENABLES, P.ENG.,
D. M. Mack Director.

PCB 2—15M-770-5774 (2)

Average characteristics of effluent

Suspended solids (ppm)	21,620 (slag)
Total solids (ppm)	21,705
pH range	6.9 - 8.0
Temp. range - (degrees F)	55 - 83
Toxic chemicals soluble (ppm)	Nil

File No.

THE GOVERNMENT OF THE PROVINCE OF BRITISH COLUMBIA

DEPARTMENT OF LANDS, FORESTS, AND WATER RESOURCES
WATER RESOURCES SERVICE—POLLUTION CONTROL BRANCH

Registration of a Discharge of Effluent under the Pollution Control Act, 1967

I/We, Cominco Ltd.
(Full name—print or type)

of Trail, B.C.
(Legal address)

(Mailing address, if different to above)

hereby filed with the Director of Pollution Control a registration of a discharge from

A Lead and Zinc Smelter complex.
(Local name of industry, housing development, trailer park, etc.—specify)

located at Trail, B.C. to Columbia River
(Name of place)

(Name of creek, river, lake, bay, inlet, etc., or description of land)

The point of discharge is located at 1,320' southerly from the N.E. corner of lot 1 plan 4926 KD on the bank of the Columbia River.
(Give distance and direction from some surveyed or known point.)

The land upon which the works are located is Lot 1 plan 4926 KD

(Give legal description, or in case of municipal sewage, name of municipality and area thereof. Use reverse side, if necessary.)

The type of effluent being discharged is T-4 Industrial Waste (see reverse side)
(Domestic sewage, cannery, meat packing, etc.)

The quantity of effluent being discharged is as follows:—

Liquid waste (effluent)
- Maximum rate 2,500 (Imperial gallons per minute)
- Maximum 12-hour discharge 1,780,000 (Imperial gallons) Average 24-hour discharge 1,440,000 (Imperial gallons)

The operating season during which the effluent is discharged is continuous

(Continuous, or date to date)

The type of treatment applied to the effluent before discharge is as follows Nil - water used mainly for cooling.

This registration, dated the 15 day of December, 1970, is true to the best of my knowledge and belief.

(Signature) R. [signature] for L.J. Nicholson

NOTE TO THE REGISTRANT.—Each discharge, i.e., via more than one sewer, must be separately registered with the Director.

FOR OFFICE USE ONLY

Date received
District
Regional District
Municipal ☐
Industrial ☐
Data processed
Priority

File No.

Application for permit sent (Date)

To be received - - - - (Date)

039 1440

DO NOT DETACH

File No. 17.16.11

Cominco Ltd.
Trail, B. C.

Dear Sir:

This is your proof of registration of a discharge. Please retain for your records. Quote the above file number when writing to this Branch. You will be advised of further action in due course.

Lead and zinc smelter complex - T-4 waste

W. N. VENABLES, P.ENG.,
G. M. Mack Director.

PCB 2—15M-770-5774 (2)

Average characteristics of effluent

Suspended solids (ppm)			3
Total solids (ppm)			87
pH range			6.8 - 7.7
Temp. range (degrees F)			55 - 65
Toxic chemicals (ppm)		Total	Soluble
	Pb	1.0	0.2
	Zn	0.5	0.4
	Cd	0.1	0.1
	As	0.04	0.02
	S	3	3
	SO_4/S	3	3

File No.

THE GOVERNMENT OF THE PROVINCE OF BRITISH COLUMBIA

DEPARTMENT OF LANDS, FORESTS, AND WATER RESOURCES
WATER RESOURCES SERVICE—POLLUTION CONTROL BRANCH

Registration of a Discharge of Effluent under the Pollution Control Act, 1967

I/We, Cominco Ltd. (Full name—print or type)

of Trail, B.C. (Legal address)

(Mailing address, if different to above)

hereby filed with the Director of Pollution Control a registration of a discharge from A Lead and Zinc Smelter complex (Local name of industry, housing development, trailer park, etc.—specify)

located at Trail, B.C. (Name of place) to Columbia River (Name of creek, river, lake, bay, inlet, etc., or description of land)

The point of discharge is located at 1,030' southerly from the N.E. corner of lot 1 plan 4926 KD on the bank of the Columbia River (Give distance and direction from some surveyed or known point.)

The land upon which the works are located is Lot 1 and 2 plan 4926 KD

(Give legal description, or in case of municipal sewage, name of municipality and area thereof. Use reverse side, if necessary.)

The type of effluent being discharged is T-5 Industrial Waste (see reverse side) (Domestic sewage, cannery, meat packing, etc.)

The quantity of effluent being discharged is as follows:—

Liquid waste (effluent)
- Maximum rate 3,500 (Imperial gallons per minute)
- Maximum 12-hour discharge 2,520,000 (Imperial gallons) Average 24-hour discharge 3,610,000 (Imperial gallons)

The operating season during which the effluent is discharged is continuous (Continuous, or date to date)

The type of treatment applied to the effluent before discharge is as follows in-plant treatment - settling tanks and filters

This registration, dated the 15 day of December, 1970, is true to the best of my knowledge and belief.

(Signature) B. N. Wady for L.J. Nicholson

NOTE TO THE REGISTRANT.—Each discharge, i.e., via more than one sewer, must be separately registered with the Director.

FOR OFFICE USE ONLY

Date received
District
Regional District
Municipal ☐
Industrial ☐
Data processed
Priority

File No.

Application for permit sent (Date) 039 1112

To be received - - - - (Date)

DO NOT DETACH

File No. 17.16.12

Cominco Ltd. Trail, B. C.

Lead and zinc smelter complex - T-5 Industrial Waste

Dear Sir:

This is your proof of registration of a discharge. Please retain for your records. Quote the above file number when writing to this Branch. You will be advised of further action in due course.

W. N. VENABLES, P.ENG.,
G. M. Mack. Director.

PCB 2—15M-770-5774 (2)

Average characteristics of effluent

Suspended solids (ppm)		22
Total solids (ppm)		188
pH range		6.5 - 7.5
Temp. range (degrees F)		55 - 68

Toxic chemicals (ppm)		Total	Soluble
	Pb	4.5	0.6
	Zn	9.4	3.4
	Cd	0.14	0.1
	As	0.03	0.01
	S	28	28
	SO_4/S	28	25

File No.

THE GOVERNMENT OF THE PROVINCE OF BRITISH COLUMBIA

DEPARTMENT OF LANDS, FORESTS, AND WATER RESOURCES
WATER RESOURCES SERVICE—POLLUTION CONTROL BRANCH

Registration of a Discharge of Effluent under the Pollution Control Act, 1967

I/We, Cominco Ltd.
(Full name—print or type)

of Trail, B.C.
(Legal address)

(Mailing address, if different to above)

hereby filed with the Director of Pollution Control a registration of a discharge from A Lead and Zinc Smelter complex
(Local name of industry, housing development, trailer park, etc.—specify)

located at Trail, B.C. (Name of place) to Columbia River
(Name of creek, river, lake, bay, inlet, etc., or description of land)

The point of discharge is located at 730' southerly from the N.E. corner of Lot 1 plan 4926 KD on the bank of the Columbia River.
(Give distance and direction from some surveyed or known point.)

The land upon which the works are located is Lot 1 and 2 plan 4926 KD
(Give legal description, or in case of municipal sewage, name of municipality and area thereof. Use reverse side, if necessary.)

The type of effluent being discharged is T-6 Industrial waste (see reverse side)
(Domestic sewage, cannery, meat packing, etc.)

The quantity of effluent being discharged is as follows:—

Liquid waste (effluent)
- Maximum rate 8,000 (Imperial gallons per minute)
- Maximum 12-hour discharge 5,760,000 (Imperial gallons) Average 24-hour discharge 7,210,000 (Imperial gallons)

The operating season during which the effluent is discharged is continuous
(Continuous, or date to date)

The type of treatment applied to the effluent before discharge is as follows in-plant treatment - settling tanks and filters

This registration, dated the 15 day of December, 19 70, is true to the best of my knowledge and belief.

(Signature) R Dewly for L.J. Nicholson

NOTE TO THE REGISTRANT.—Each discharge, i.e., via more than one sewer, must be separately registered with the Director.

FOR OFFICE USE ONLY

Date received
District
Regional District
Municipal ☐
Industrial ☐
Data processed
Priority

File No.

Application for permit sent (Date)

To be received - - - - 039 1114 (Date)

DO NOT DETACH

Cominco Ltd.
Trail, B. C.

File No. 12.16.13

Lead & zinc smelter complex - T-6 waste

Dear Sir:

This is your proof of registration of a discharge. Please retain for your records. Quote the above file number when writing to this Branch. You will be advised of further action in due course.

W. N. VENABLES, P.ENG.,
G. M. Mack Director.

PCB 2—15M-770-5774 (2)

Average characteristics of effluent

Suspended solids (ppm)			12
Total solids (ppm)			175
pH range			6.5 - 7.5
Temp. range (degrees F)			65 - 70
Toxic chemicals (ppm)		Total	Soluble
	Pb	0.3	0.1
	Zn	17	16
	Cd	0.1	0.1
	As	0.02	0.02
	S	22	22
	SO_4/S	22	22

File No.

THE GOVERNMENT OF THE PROVINCE OF BRITISH COLUMBIA

DEPARTMENT OF LANDS, FORESTS, AND WATER RESOURCES
WATER RESOURCES SERVICE—POLLUTION CONTROL BRANCH

Registration of a Discharge of Effluent under the Pollution Control Act, 1967

I/We, Cominco Ltd.
(Full name—print or type)

of Trail, B.C.
(Legal address)

(Mailing address, if different to above)

hereby filed with the Director of Pollution Control a registration of a discharge from

A Lead and Zinc Smelter Complex
(Local name of industry, housing development, trailer park, etc.—specify)

located at Trail, B.C. to Columbia River
(Name of place) (Name of creek, river, lake, bay, inlet, etc., or description of land)

The point of discharge is located at 400' southerly from the N.E. corner of lot 1 Plan 4926 KD on the bank of the Columbia River
(Give distance and direction from some surveyed or known point.)

The land upon which the works are located is Lot 1 plan 4926 KD

(Give legal description, or in case of municipal sewage, name of municipality and area thereof. Use reverse side, if necessary.)

The type of effluent being discharged is T-7 Industrial Waste (see reverse side)
(Domestic sewage, cannery, meat packing, etc.)

The quantity of effluent being discharged is as follows:—

Liquid waste (effluent)
- Maximum rate 6,000 (Imperial gallons per minute)
- Maximum 12-hour discharge 4,330,000 (Imperial gallons) Average 24-hour discharge 5,760,000 (Imperial gallons)

The operating season during which the effluent is discharged is continuous

(Continuous, or date to date)

The type of treatment applied to the effluent before discharge is as follows Nil

This registration, dated the 15 day of December, 19 70, is true to the best of my knowledge and belief.

(Signature) R. Dwyer for L.J. Nicholson

NOTE TO THE REGISTRANT.—Each discharge, i.e., via more than one sewer, must be separately registered with the Director.

FOR OFFICE USE ONLY

Date received
District
Regional District
Municipal ☐
Industrial ☐
Data processed
Priority

File No.

Application for permit sent (Date)

To be received - - - - (Date)

039 1116

DO NOT DETACH

File No. 17:16:14

Cominco Ltd.
Trail, B. C.

Dear Sir: Lead & zinc Smelter Complex - T-7 waste

This is your proof of registration of a discharge. Please retain for your records. Quote the above file number when writing to this Branch. You will be advised of further action in due course.

W. N. VENABLES, P.ENG.,
G. M. Mack Director.

PCB 2—15M-770-5774 (2)

Average characteristics of effluent

Suspended solids (ppm)		30
Total solids (ppm)		1,580
pH range		1.5 - 3.5
Temp. range (degrees F)		77 - 90

Toxic chemicals (ppm)		Total	Soluble
	Pb	13.2	0.3
	Zn	0.2	0.2
	Cd	0.74	0.10
	As	0.07	0.02
	S	810	810
	SO_4/S	320	170

File No.

THE GOVERNMENT OF THE PROVINCE OF BRITISH COLUMBIA

DEPARTMENT OF LANDS, FORESTS, AND WATER RESOURCES
WATER RESOURCES SERVICE—POLLUTION CONTROL BRANCH

Registration of a Discharge of Effluent under the Pollution Control Act, 1967

I/We, Cominco Ltd.
(Full name—print or type)

of Trail, B.C.
(Legal address)

(Mailing address, if different to above)

hereby filed with the Director of Pollution Control a registration of a discharge from

A Lead and Zinc Smelter Complex
(Local name of industry, housing development, trailer park, etc.—specify)

located at Trail, B.C. to Columbia River
(Name of place)

(Name of creek, river, lake, bay, inlet, etc., or description of land)

The point of discharge is located at 20' southerly from the N.E. corner of lot 1 plan 4926 KD on the bank of the Columbia River
(Give distance and direction from some surveyed or known point.)

The land upon which the works are located is Lots 1, 2, 3 and 4 plan 4926 KD

(Give legal description, or in case of municipal sewage, name of municipality and area thereof. Use reverse side, if necessary.)

The type of effluent being discharged is T-8 Industrial Waste (see reverse side)
(Domestic sewage, cannery, meat packing, etc.)

The quantity of effluent being discharged is as follows:—

Liquid waste (effluent)
- Maximum rate 8,700 (Imperial gallons per minute) 11,448,000 (now)
- Maximum 12-hour discharge 6,260,000 (Imperial gallons) Average 24-hour discharge 10,020,000 (Imperial gallons)

The operating season during which the effluent is discharged is continuous

(Continuous, or date to date)

The type of treatment applied to the effluent before discharge is as follows in-plant treatment - settling tanks, settling pond & filters

This registration, dated the 15 day of December, 19 70, is true to the best of my knowledge and belief.

(Signature) R. Hewly for L.J. Nicholson

NOTE TO THE REGISTRANT.—Each discharge, i.e., via more than one sewer, must be separately registered with the Director.

FOR OFFICE USE ONLY

Date received
District
Regional District
Municipal ☐
Industrial ☐
Data processed
Priority

File No.

Application for permit sent
(Date)

To be received - - - - 039 1118
(Date)

DO NOT DETACH

File No. 12.16.15

- Cominco Ltd.
- Trail, B. C.
- Lead and Zinc Smelter Complex - T-8 Waste

Dear Sir:

This is your proof of registration of a discharge. Please retain for your records. Quote the above file number when writing to this Branch. You will be advised of further action in due course.

W. N. VENABLES, P.ENG.,
G. M. Mack Director.

PCB 2—15M-770-5774 (2)

Average characteristics of effluent

Suspended solids (ppm)	23	
Total solids (ppm)	2,319	
pH range	1.5 - 3.0	
Temp. range (degrees F)	65 - 75	
Toxic chemicals (ppm)	Total	Soluble
Pb	13.2	4.3
Zn	105	105
Cd	0.38	0.36
As	0.12	0.08
S	650	650
SO_4/S	650	630
NH_3/N	110	110
NO_3/N	2.4	2.4

File No.

THE GOVERNMENT OF THE PROVINCE OF BRITISH COLUMBIA

DEPARTMENT OF LANDS, FORESTS, AND WATER RESOURCES
WATER RESOURCES SERVICE—POLLUTION CONTROL BRANCH

Registration of a Discharge of Effluent under the Pollution Control Act, 1967

I/We, Cominco Ltd.
(Full name—print or type)

of Trail, B.C.
(Legal address)

(Mailing address, if different to above)

hereby filed with the Director of Pollution Control a registration of a discharge from

A Lead and Zinc Smelter Complex
(Local name of industry, housing development, trailer park, etc.—specify)

located at Trail, B.C. to Columbia River
(Name of place)

(Name of creek, river, lake, bay, inlet, etc., or description of land)

The point of discharge is located at 70' northerly from S.E. corner Lot 4 plan 4926 KD on the bank of the Columbia River
(Give distance and direction from some surveyed or known point.)

The land upon which the works are located is Lot 1 and 4 plan 4926 KD

(Give legal description, or in case of municipal sewage, name of municipality and area thereof. Use reverse side, if necessary.)

The type of effluent being discharged is T-9 Industrial waste (see reverse side)
(Domestic sewage, cannery, meat packing, etc.)

The quantity of effluent being discharged is as follows:—

Liquid waste (effluent)
- Maximum rate 150 (Imperial gallons per minute)
- Maximum 12-hour discharge 108,000 (Imperial gallons) Average 24-hour discharge 144,000 (Imperial gallons)

The operating season during which the effluent is discharged is continuous

(Continuous, or date to date)

The type of treatment applied to the effluent before discharge is as follows Nil - main use is cooling water and waste water from analytical labs.

This registration, dated the 15 day of December, 1970, is true to the best of my knowledge and belief.

(Signature) R H Walsh for L.J. Nicholson

NOTE TO THE REGISTRANT.—Each discharge, i.e., via more than one sewer, must be separately registered with the Director.

FOR OFFICE USE ONLY

Date received
District
Regional District
Municipal ☐
Industrial ☐
Data processed
Priority

File No.

Application for permit sent (Date)

To be received - - - - 039 1120 (Date)

DO NOT DETACH

File No. 17-16-16

Cominco Ltd.
Trail, B. C.
A lead and zinc smelter complex - T-9 waste

Dear Sir:

This is your proof of registration of a discharge. Please retain for your records. Quote the above file number when writing to this Branch. You will be advised of further action in due course.

W. N. VENABLES, P.ENG.,
G. M. Mack Director.

PCB 2—15M-770-5774 (2)

Average characteristics of effluent

Suspended solids (ppm)			8
Total solids (ppm)			206
pH range			6.5 - 7.5
Temp. range (degrees F)			55 - 68
Toxic chemicals (ppm)		Total	Soluble
	Pb	2.6	0.4
	Zn	2.8	2.3
	Cd	0.12	0.12
	As	0.10	0.04
	S	7	7
	SO_4/S	7	7

File No.

THE GOVERNMENT OF THE PROVINCE OF BRITISH COLUMBIA

DEPARTMENT OF LANDS, FORESTS, AND WATER RESOURCES
WATER RESOURCES SERVICE—POLLUTION CONTROL BRANCH

Registration of a Discharge of Effluent under the Pollution Control Act, 1967

I/We, Cominco Ltd.
(Full name—print or type)

of Trail, B.C.
(Legal address)

(Mailing address, if different to above)

hereby filed with the Director of Pollution Control a registration of a discharge from A Lead and Zinc Smelter complex.
(Local name of industry, housing development, trailer park, etc.—specify)

located at Trail, B.C. to Columbia River
(Name of place)

(Name of creek, river, lake, bay, inlet, etc., or description of land)

The point of discharge is located at 300' northerly from S.E. corner Lot 4 Plan 4926 KD on the bank of the Columbia River
(Give distance and direction from some surveyed or known point.)

The land upon which the works are located is Lot 1 & 4 plan 4926 KD

(Give legal description, or in case of municipal sewage, name of municipality and area thereof. Use reverse side, if necessary.)

The type of effluent being discharged is T-10 Industrial Waste (see reverse side)
(Domestic sewage, cannery, meat packing, etc.)

The quantity of effluent being discharged is as follows:—

Liquid waste (effluent)
- Maximum rate 1,000 (Imperial gallons per minute)
- Maximum 12-hour discharge 720,000 (Imperial gallons) Average 24-hour discharge 865,000 (Imperial gallons)

The operating season during which the effluent is discharged is continuous

(Continuous, or date to date)

The type of treatment applied to the effluent before discharge is as follows in-plant treatment - settling tanks & filters.

This registration, dated the 15 day of December, 1970, is true to the best of my knowledge and belief.

(Signature) R.H. Wiley for L.J. Nicholson

NOTE TO THE REGISTRANT.—Each discharge, i.e., via more than one sewer, must be separately registered with the Director.

FOR OFFICE USE ONLY

Date received
District
Regional District
Municipal ☐
Industrial ☐
Data processed
Priority

File No.

Application for permit sent (Date)

To be received - - - - 039 1122 (Date)

DO NOT DETACH

File No. 17.16.17

Cominco Ltd.
Trail, B. C.
Lead and Zinc Smelter complex - T-10 waste

Dear Sir:

This is your proof of registration of a discharge. Please retain for your records. Quote the above file number when writing to this Branch. You will be advised of further action in due course.

W. N. VENABLES, P.ENG.,
G. M. Mack Director.

PCB 2—15M-770-5774 (2)

Average characteristics of effluent

Suspended solids (ppm)			34
Total solids (ppm)			300
pH range			8.0 - 9.3
Temp. range (degrees F)			50 - 68
Toxic chemicals (ppm)		Total	Soluble
	Pb	5	0.3
	Zn	1.7	0.1
	Cd	<0.1	< 0.1
	As	0.80	0.20
	Sb	0.69	0.40
	F	3.5	3.4

File No.

THE GOVERNMENT OF THE PROVINCE OF BRITISH COLUMBIA

DEPARTMENT OF LANDS, FORESTS, AND WATER RESOURCES
WATER RESOURCES SERVICE—POLLUTION CONTROL BRANCH

Registration of a Discharge of Effluent under the Pollution Control Act, 1967

I/We, Cominco Ltd.
(Full name—print or type)

of Trail, B.C.
(Legal address)

(Mailing address, if different to above)

hereby filed with the Director of Pollution Control a registration of a discharge from

Housing development
(Local name of industry, housing development, trailer park, etc.—specify)

located at Trail, B.C. to the Columbia River
(Name of place)

(Name of creek, river, lake, bay, inlet, etc., or description of land)

The point of discharge is located at on part of block B1 plant 623A KD on the bank of the Columbia River
(Give distance and direction from some surveyed or known point.)

The land upon which the works are located is sub-division plan 1644 KD

(Give legal description, or in case of municipal sewage, name of municipality and area thereof. Use reverse side, if necessary.)

The type of effluent being discharged is T-14 Domestic sewage
(Domestic sewage, cannery, meat packing, etc.)

The quantity of effluent being discharged is as follows:—

Liquid waste (effluent)
- Maximum rate 20 (Imperial gallons per minute)
- Maximum 12-hour discharge 5,040 (Imperial gallons) Average 24-hour discharge 6,050 (Imperial gallons)

The operating season during which the effluent is discharged is continuous

(Continuous, or date to date)

The type of treatment applied to the effluent before discharge is as follows

Nil - this flow will eventually be diverted to the Trail sewage treatment plant.

This registration, dated the 15 day of December, 1970, is true to the best of my knowledge and belief.

(Signature) R H Wiley for L. J. Nicholson

NOTE TO THE REGISTRANT.—Each discharge, i.e., via more than one sewer, must be separately registered with the Director.

FOR OFFICE USE ONLY

Date received
District
Regional District
Municipal ☐
Industrial ☐
Data processed
Priority

File No.

Application for permit sent (Date)

To be received - - - - (Date)

039 1124

DO NOT DETACH

File No. 17-16-21

Cominco Ltd.
Trail, B. C.

HOusing Development T-14 Domestic sewage

Dear Sir:

This is your proof of registration of a discharge. Please retain for your records. Quote the above file number when writing to this Branch. You will be advised of further action in due course.

W. N. VENABLES, P.ENG.,
G. M. Mack Director.

PCB 2—15M-770-5774 (2)

MINISTRY OF ENVIRONMENT

PERMIT

Under the Provisions of the Waste Management Act

Cominco Ltd. - Cominco Ltee

#2300 - 200 Granville Square, Vancouver, British Columbia, V6C 2R2

is hereby authorized to discharge effluent

from a fertilizer plant

located at Trail, British Columbia

to the Columbia River

This permit has been issued under the terms and conditions prescribed in the attached appendices 01, A-1, B-1, B-2, C-1 and C-2

Regional Waste Manager

Date issued November 29, 19 78

Amendments dated August 24, 19 79

August 19, 19 81

March 2, 19 83

Permit No. PE 5309

ENV 1988

039 3308

MINISTRY OF ENVIRONMENT
WASTE MANAGEMENT BRANCH

APPENDIX No. 01

to Permit No. PE 5309

(*a*) The discharge of effluent to which this appendix is applicable is from Warfield Fertilizer Plant Sewer IV to the Columbia River
(Source of operation)

as shown on attached Appendix A-1.

(*b*) The quantity of effluent which may be discharged is 97,000 m^3/day maximum

(*c*) The characteristics of the effluent shall be equivalent to or better than

pH	2.5 - 7.5
Total phosphate (as P)	115.0 mg/L
Total Mercury	.010 mg/L
Dissolved Ammonia (as N)	25 mg/L
Dissolved Fluoride	100 mg/L
Dissolved Zinc	5 mg/L

(*d*) The works authorized are a combined sewer, submerged outfall and related appurtenances and any other treatment facilities as required to meet the effluent characteristics specified in (c) above.

approximately as shown on the attached Appendix A-1.

(*e*) The land from which the effluent originates and to which this appendix is appurtenant is Lots 1 and 3 Plans 6446, K.D. and Part Assigned No. 25 and Assigned No. 18, Plan 1425 K.D.

(*f*) Those works authorized and proposed must be completed and in operation on and from the date of this Appendix

Date issued November 29, 19 78
Date amended August 24, 19 79
August 19, 19 81
March 2, 19 83

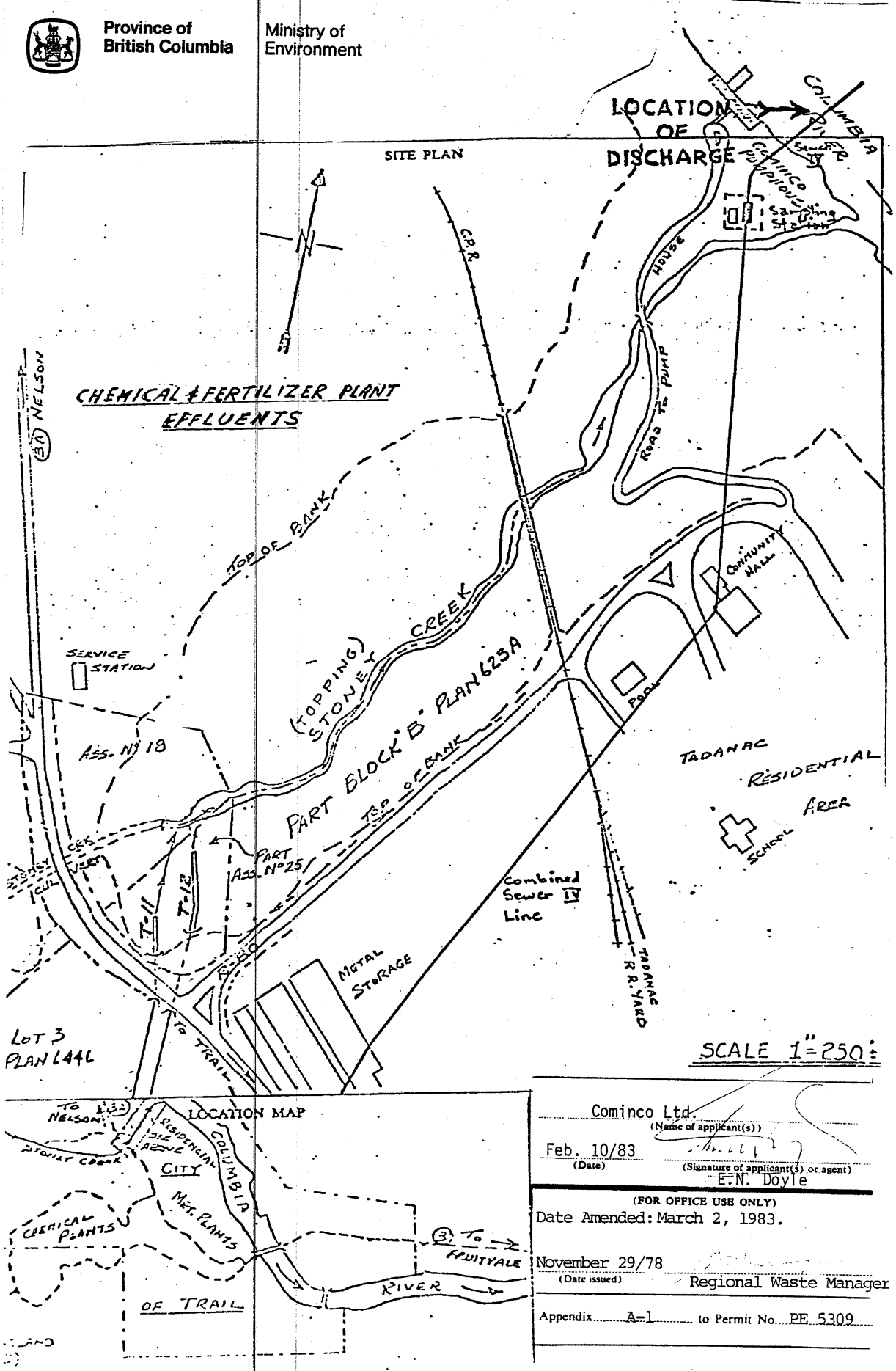
Regional Waste Manager

ENV 1994

039 3309

Province of British Columbia

Ministry of Environment



Cominco Ltd.
(Name of applicant(s))

Feb. 10/83
(Date)

(Signature of applicant(s) or agent)
E.N. Doyle

(FOR OFFICE USE ONLY)

Date Amended: March 2, 1983.

November 29/78
(Date issued)

Regional Waste Manager

Appendix A-1 to Permit No. PE 5309

039 3310

MINISTRY OF ENVIRONMENT

WASTE MANAGEMENT BRANCH

APPENDIX No. B-1

to Permit No. PE 5309

A. TANK CLEANOUT

Prior to the cleanout of any process tank or vessel the Permittee shall obtain representative samples of the material to be disposed of and notify the Regional Waste Manager in order to obtain direction as to the disposal method.

During the period of any tank cleanout involving discharge to the Columbia River the Permittee shall take continuous samples (or sample as required by the Regional Waste Manager), to determine the resultant effect on the final discharge quality. Analysis for contaminants shall be carried out at a frequency determined by the Regional Waste Manager.

B. MAINTENANCE AND EMERGENCY PROCEDURES

Inspect the pollution control works regularly and maintain them in good working order.

In the event of an emergency or condition beyond the control of the Permittee which prevents continuing operation of the approved method of pollution control, the Permittee shall:

1. immediately take appropriate remedial action;
2. immediately notify the Regional Waste Manager and provide such plans and information as may be required by him;
3. take such additional action as is approved or required by the Regional Waste Manager.

C. BYPASSES

The discharge of effluent which has bypassed the designated treatment works is prohibited unless the approval of the Regional Waste Manager is obtained and confirmed in writing.

On each occasion of bypass the Permittee shall fully record the reason, duration and flow rate of the bypass and sample the discharge(s) as required by the Regional Waste Manager.

Regional Waste Manager

Date issued March 2, 19 83

Date amended ....., 19 .....

....., 19 .....

ENV 1993

039 3311

MINISTRY OF ENVIRONMENT

WASTE MANAGEMENT BRANCH

APPENDIX No. B-2

to Permit No. PE 5309

D. FERTILIZER PLANT MODIFICATIONS REPORTS

The Permittee shall submit on or before the first of March annually to the Regional Waste Manager, a report outlining modifications to any portion of the fertilizer complex that may affect the quality of the effluent, as specified in Appendix 01.

Regional Waste Manager

Date issued March 2, 19 83

Date amended ....., 19 .....

....., 19 .....

ENV 1993

039 3312

MINISTRY OF ENVIRONMENT

WASTE MANAGEMENT BRANCH

APPENDIX No. C-1

to Permit No. PE 5309

SAMPLING AND MONITORING PROGRAM

COMINCO LTD. - COMINCO LTEE

A. EFFLUENT MONITORING

(a) All sewers in continuous use shall be sampled (a 24 hour composite) once per month. These samples are to be analyzed for:

(1) total suspended solids
(2) pH
(3) total mercury
(4) dissolved NH_3 (as N)
(5) dissolved fluoride
(6) total phosphate (as P)
(7) ortho phosphate (as P)
(8) dissolved zinc
(9) dissolved sulphate

(b) The effluent discharge rate from Sewer IV shall be determined weekly.

B. RECEIVING WATERS MONITORING

Once every month (on the date of effluent sampling when possible), water samples are to be collected in the Columbia River at the following locations:

(1) Columbia River upstream of Topping (Stoney) Creek.

(2) East side, Columbia River, just upstream of confluence with the Pend D'Oreille River (Waneta).

Each sample is to be analyzed for:

(1) total suspended solids
(2) pH
(3) dissolved zinc
(4) dissolved arsenic
(5) dissolved cadmium
(6) dissolved lead
(7) total PO_4 (as P)
(8) ortho phosphate (as P)
(9) dissolved fluoride
(10) dissolved NH_3 (as N)
(11) total mercury
(12) dissolved sulphate

Regional Waste Manager

Date issued March 2, 19 83

Date amended ....., 19 .....

....., 19 .....

ENV 1993

039 3313

MINISTRY OF ENVIRONMENT

WASTE MANAGEMENT BRANCH

APPENDIX No. C-2

to Permit No. PE 5309

C. ANALYTICAL PROCEDURES

Analyses are to be carried out in accordance with procedures described in the second edition (February 1976) of "A Laboratory Manual for the Chemical Analysis of Waters, Wastewaters, Sediments and Biological Materials", or by suitable alternative procedures as approved by the Regional Waste Manager.

Copies of the above mentioned manual are available from the Environmental Laboratory, 3650 Wesbrook Crescent, Vancouver, British Columbia, V6S 2L2, at a cost of $10.00, and are also available for inspection at all Waste Management Branch offices.

D. REPORTING

All results obtained from effluent and receiving water monitoring specified above are to be tabulated and submitted to the Regional Waste Manager quarterly. In conjunction with this report, the Permittee shall submit those records obtained for any process upset or bypass.

Regional Waste Manager

Date issued March 2, 19 83

Date amended ....., 19 .....

....., 19 .....

039 3314

ENV 1993

THE GOVERNMENT OF THE PROVINCE OF BRITISH COLUMBIA

Pollution Control Branch File No.

DEPARTMENT OF LANDS, FORESTS, AND WATER RESOURCES

WATER RESOURCES SERVICE
POLLUTION CONTROL BRANCH

APPLICATION FOR A PERMIT UNDER THE POLLUTION CONTROL ACT, 1967 (EFFLUENT)

This application is to be filed with the Director, Pollution Control Branch, Parliament Buildings, Victoria, British Columbia. Any person who qualifies as an objector under section 13 (2) of the *Pollution Control Act, 1967* may, within 30 days of the date of application, or within 30 days of the date of publication in *The British Columbia Gazette* or in a newspaper, or, where service is required, within 30 days of the serving of a copy of the application, file with the Director an objection in writing to the granting of a permit, stating the manner in which he is affected. Those who do not so qualify may file with the Pollution Control Board an objection in writing under section 13 (6), in the same manner and time period as described above.

1. I, COMINCO LTD.
(Full name—if a company, British Columbia registered name)
of 1199 West Pender Street, Vancouver, British Columbia
(Address—if a company, British Columbia registered address)
hereby apply to the Director for a permit to discharge effluent from
Lead and Zinc Smelter and a Chemical and Fertilizer Plant
(Type of operation from which effluent evolves)
located Trail, British Columbia (General location) into
the Columbia River (Name of creek, river, lake, bay, inlet, etc.)
which flows southerly (Direction) and discharges into the Pacific Ocean
and give notice of my application to all persons affected.

2. The land upon which the works are located is Lots 1, 2, 3 and 4, Plan 4926, K.D., Lots 1 and 3, Plan 6446, K.D., and Part Assigned No. 25 and Assigned No. 18, Plan 1425, K.D.
(Give legal description)

3. The discharge shall be located at west side of the Columbia River between Stoney Creek outfall and Highway 3A bridge over the Columbia River
(Define relative to some surveyed or commonly known point)

4. The quantity of effluent to be discharged is as follows:
Average annual daily discharge (Based on operating period) 65.31×10^6 (Imperial gallons)
Maximum daily discharge 65.31×10^6 (Imperial gallons)
The operating period during which the effluent will be discharged is continuous
(Continuous, hours per week, or date to date, etc.)

5. The characteristics of the effluent discharged shall be equivalent to or better than (insert values after completion of column (3) of table (*a*) on reverse side) Total suspended solids - 5,700 mg/l; total solids - 6,330 mg/l; pH range - 2.6-2.8; temperature range - 48-73°F; zinc - 4.0 mg/l; arsenic - 0.03 mg/l; lead - 0.2 mg/l; cadmium - 0.14 mg/l; mercury (total) - 0.01 mg/l; ammonia as nitrogen - 2.0 mg/l; fluoride - 2.5 mg/l; phosphorus - 26 mg/l; sulphate - 240 mg/l.

6. The type of treatment to be applied to the effluent before discharge is as follows: The bulk of water discharge is cooling water. Small metallurgical effluents are treated with ammonia and caustic to neutralize acid and recover the contained metals.

7. I, W.B. d'Easum, Administrator
(Name and title of official of regional district)
hereby certify that a copy of this application has been recived by the Regional District of Kootenay Boundary

W B d'Easum
(Signature of official)

8. This application, dated on the 29th day of June, 19 73, was posted on the ground in accordance with the Pollution Control Regulations.

L.J. Nicholson
(Signature of applicant or agent)
L.J. Nicholson

PCB 5— o

039 3315

ADDITIONAL INFORMATION

In support of the application the following information is submitted:

(*a*) The characteristics of the effluent before and after treatment are as follows:

	(1) Before Treatment Average (Annual)	(2) After Treatment Average (Annual)	(3) After Treatment Maximum
Total suspended solids (mg./1.)	5,700	5,700	5,700 *
Total solids (mg./1.)	6,590	6,330	6,330 *
Biochemical oxygen demand (mg./1.)†	Not applicable		*
pH range	2.3-2.6	2.6-2.8	2.6-2.8
Temperature range (degrees F)	48-73	48-73	48-73
Fæcal coliform bacteria (m.p.n. per 100 ml.)			N.A. (Log. mean)

Toxic constituents:

	Units	(1)	(2)	(3)
Zn	(mg/l)	21	4 13 5	4
As	(mg/l)	0.04	0.03 .25	0.03
Pb	(mg/l)	0.5	0.2 .1	0.2
Cd	(mg/l)	0.27	0.14 .01	0.14
Hg (total)	mg/l	0.017	0.01 .003	0.01
F	mg/l	2.5	2.5 5	2.5

Other relevant constituents:

	Units	(1)	(2)	(3)
NH_3/N	(mg/l)	2	2 1	2
P	(mg/l)	26	26 5	26
SO_4	(mg/l)	630	240 250	240
	( )			

(*b*) Miscellaneous information:

Treatment process involves liming of effluents entering T-8a, T-8b and T-5 sewers and also elimination of stripped zinc electrolyte entering T-8a and T-8b sewers.

* These values pertain to a composite sample collected over any operating day during the year.
† Five day 20°C (BOD).

Pollution Control Branch File No._____

DEPARTMENT OF LANDS, FORESTS, AND WATER RESOURCES
WATER RESOURCES SERVICE
POLLUTION CONTROL BRANCH

SUPPLEMENTARY INFORMATION
To Application for a Permit Under the Provisions of Section 5 (2) of the Pollution Control Act, 1967 Involving More Than One Discharge *
(EFFLUENT)

As a supplement to my application dated the 29th day of June, 19 73, which was posted on the ground in accordance with the Pollution Control Regulations,

I, COMINCO LTD.
(Full name—if a company, British Columbia registered name)

of 1199 West Pender Street, Vancouver, British Columbia
(Address—if a company, British Columbia registered address)

hereby provide further particulars and data to the Director respecting my application.

1. The source of effluent is See attached sheet for sources.
(Specific portion of plant, etc.)

   and discharges into Columbia River
(Name of creek, river, lake, bay, inlet, etc.)

2. The land upon which the works are located is Lot 1, Plan 4926, K.D.

(Give legal description—use reverse side if necessary)

3. The point of discharge shall be located T-1: 1,840 feet southeasterly from the northeast corner of Lot 1, Plan 4926, K.D., on the bank of the Columbia River.
(Define relative to some surveyed or commonly known point)

4. The quantity of effluent to be discharged is as follows:

   Average annual daily discharge (Based on operating period) 5,670,000 (Imperial gallons)

   Maximum daily discharge 5,670,000 (Imperial gallons)

   The operating period during which the effluent will be discharged is continuous
(Continuous, hours per week, or date to date; etc.)

5. The type of treatment to be applied to the effluent before discharge is as follows:

Nil

Date June 29, 19 73

L.J. Nicholson
(Signature of applicant or agent)
L.J. Nicholson

This is Supplementary Information form 1 of 12

* One form to be submitted for each discharge.

PCB 8— o

039 3317

ADDITIONAL INFORMATION

In support of the application the following information is submitted:

(*a*) The characteristics of the effluent before and after treatment are as follows:

	(1) Before Treatment Average (Annual)	(2) After Treatment Average (Annual)	(3) After Treatment Maximum
Total suspended solids (mg./1.)	20	20	20 *
Total solids (mg./1.)	124	100	100 *
Biochemical oxygen demand (mg./1.)†	N.A.		*
pH range	7.0-7.3	7.0-7.3	7.0-7.3
Temperature range (degrees F)	55-83	55-83	55-83
Fæcal coliform bacteria (m.p.n. per 100 ml.)			N.A. (Log. mean)

Toxic constituents:

	Units			
Zn	(mg/l)	0.9	0.9	0.9
As	(mg/l)	0.01	0.01	0.01
Cd	(mg/l)	0.03	0.03	0.03
Pb	(mg/l)	0.1	0.1	0.1
Hg (total)	(mg/l)	<0.0005	<0.0005	<0.0005

Other relevant constituents:

	Units			
	( )			
	( )			
	( )			
	( )			

(*b*) Miscellaneous information:

Constituents dissolved except as noted.

* These values pertain to a composite sample collected over any operating day during the year.
† Five day 20°C (BOD).

THE GOVERNMENT OF THE PROVINCE OF BRITISH COLUMBIA

Pollution Control Branch File No.

DEPARTMENT OF LANDS, FORESTS, AND WATER RESOURCES
WATER RESOURCES SERVICE
POLLUTION CONTROL BRANCH

SUPPLEMENTARY INFORMATION
To Application for a Permit Under the Provisions of Section 5 (2) of the Pollution Control Act, 1967 Involving More Than One Discharge *
(EFFLUENT)

As a supplement to my application dated the 29th day of June, 19 73, which was posted on the ground in accordance with the Pollution Control Regulations,

I, COMINCO LTD.
(Full name—if a company, British Columbia registered name)

of 1199 West Pender Street, Vancouver, British Columbia
(Address—if a company, British Columbia registered address)

hereby provide further particulars and data to the Director respecting my application.

1. The source of effluent is See attached sheet for sources.
(Specific portion of plant, etc.)

   and discharges into Columbia River
(Name of creek, river, lake, bay, inlet, etc.)

2. The land upon which the works are located is Lots 1 and 2, Plan 4926, K.D.
(Give legal description—use reverse side if necessary)

3. The point of discharge shall be located T-2: 1,780 feet southerly from the northeast corner of Lot 1, Plan 4926, K.D., on the bank of the Columbia River
(Define relative to some surveyed or commonly known point)

4. The quantity of effluent to be discharged is as follows:

   Average annual daily discharge (Based on operating period) 3,340,000 (Imperial gallons)

   Maximum daily discharge 3,340,000 (Imperial gallons)

   The operating period during which the effluent will be discharged is

   continuous
(Continuous, hours per week, or date to date, etc.)

5. The type of treatment to be applied to the effluent before discharge is as follows:

   nil

Date June 29, 19 73

L.J. Nicholson
(Signature of applicant or agent)

This is Supplementary Information form 2 of 12

* One form to be submitted for each discharge.

PCB 8— o

039 3319

ADDITIONAL INFORMATION

In support of the application the following information is submitted:

(*a*) The characteristics of the effluent before and after treatment are as follows:

	(1) Before Treatment Average (Annual)	(2) After Treatment Average (Annual)	(3) After Treatment Maximum
Total suspended solids (mg./1.)	21,620	21,620	21,620 *
Total solids (mg./1.)	21,700	21,700	21,700 *
Biochemical oxygen demand (mg./1.)†	N.A.		*
pH range	7.0-7.5	7.0-7.5	7.0-7.5
Temperature range (degrees F)	55-83	55-83	55-83
Fæcal coliform bacteria (m.p.n. per 100 ml.)			N.A. (Log. mean)

Toxic constituents:

	Units			
Zn	(mg/l)	1.0	1.0	1.0
As	(mg/l)	0.01	0.01	0.01
Pb	(mg/l)	0.1	0.1	0.1
Hg (total)	(mg/l)	<0.0005	<0.0005	<0.0005

Other relevant constituents:

	Units			
	( )			
	( )			
	( )			
	( )			

(*b*) Miscellaneous information:

Constituents dissolved except as noted.

* These values pertain to a composite sample collected over any operating day during the year.
† Five day 20°C (BOD).

039 3320

THE GOVERNMENT OF THE PROVINCE OF BRITISH COLUMBIA

Pollution Control Branch File No._____

DEPARTMENT OF LANDS, FORESTS, AND WATER RESOURCES
WATER RESOURCES SERVICE
POLLUTION CONTROL BRANCH

SUPPLEMENTARY INFORMATION
To Application for a Permit Under the Provisions of Section 5 (2) of the Pollution Control Act, 1967 Involving More Than One Discharge *
(EFFLUENT)

As a supplement to my application dated the 29th day of June, 19 73, which was posted on the ground in accordance with the Pollution Control Regulations,

I, COMINCO LTD.
(Full name—if a company, British Columbia registered name)

of 1199 West Pender Street, Vancouver, British Columbia
(Address—if a company, British Columbia registered address)

hereby provide further particulars and data to the Director respecting my application.

1. The source of effluent is See attached sheet for sources.
(Specific portion of plant, etc.)

   and discharges into Columbia River
(Name of creek, river, lake, bay, inlet, etc.)

2. The land upon which the works are located is Lot 1, Plan 4926, K.D.

(Give legal description—use reverse side if necessary)

3. The point of discharge shall be located T-4: 1,320 feet southerly from the northeast corner of Lot 1, Plan 4926, K.D., on the bank of the Columbia River
(Define relative to some surveyed or commonly known point)

4. The quantity of effluent to be discharged is as follows:

   Average annual daily discharge (Based on operating period) 1,520,000 (Imperial gallons)

   Maximum daily discharge 1,520,000 (Imperial gallons)

   The operating period during which the effluent will be discharged is continuous
(Continuous, hours per week, or date to date, etc.)

5. The type of treatment to be applied to the effluent before discharge is as follows:

   nil

Date June 29, 19 73

L.J. Nicholson
(Signature of applicant or agent)

This is Supplementary Information form 3 of 12

* One form to be submitted for each discharge.

PCB 8— o

039 3321

ADDITIONAL INFORMATION

In support of the application the following information is submitted:

(*a*) The characteristics of the effluent before and after treatment are as follows:

	(1) Before Treatment Average (Annual)	(2) After Treatment Average (Annual)	(3) After Treatment Maximum
Total suspended solids (mg./1.)	10	10	10 *
Total solids (mg./1.)	510	400	400 *
Biochemical oxygen demand (mg./1.)†	N.A.		*
pH range	7.0-7.5	7.0-7.5	7.0-7.5
Temperature range (degrees F)	55-65	55-65	55-65
Fæcal coliform bacteria (m.p.n. per 100 ml.)			N.A. (Log. mean)

Toxic constituents:

	Units			
Zn	(mg/l)	0.8	0.8	0.8
As	(mg/l)	<0.01	<0.01	<0.01
Pb	(mg/l)	0.3	0.1	0.1
Cd	(mg/l)	0.12	0.1	0.1
Hg (total)	(mg/l)	0.002	0.002	0.002

Other relevant constituents:

	Units			
	( )			
	( )			
	( )			
	( )			

(*b*) Miscellaneous information:

Constituents dissolved except as noted.

Housekeeping will be improved to decrease cadmium and lead levels.

* These values pertain to a composite sample collected over any operating day during the year.
† Five day 20°C (BOD).

039 3322

THE GOVERNMENT OF THE PROVINCE OF BRITISH COLUMBIA

Pollution Control Branch File No._____

DEPARTMENT OF LANDS, FORESTS, AND WATER RESOURCES
WATER RESOURCES SERVICE
POLLUTION CONTROL BRANCH

SUPPLEMENTARY INFORMATION
To Application for a Permit Under the Provisions of Section 5 (2) of the Pollution Control Act, 1967 Involving More Than One Discharge *
(EFFLUENT)

As a supplement to my application dated the 29th day of June, 19 73, which was posted on the ground in accordance with the Pollution Control Regulations,

I, COMINCO LTD.
(Full name—if a company, British Columbia registered name)

of 1199 West Pender Street, Vancouver, British Columbia
(Address—if a company, British Columbia registered address)

hereby provide further particulars and data to the Director respecting my application.

1. The source of effluent is See attached sheet for sources.
(Specific portion of plant, etc.)

   and discharges into Columbia River
(Name of creek, river, lake, bay, inlet, etc.)

2. The land upon which the works are located is Lots 1 and 2, Plan 4926, K.D.

(Give legal description—use reverse side if necessary)

3. The point of discharge shall be located T-5: 1,030 feet southerly from the northeast corner of Lot 1, Plan 4926, K.D., on the bank of the Columbia River
(Define relative to some surveyed or commonly known point)

4. The quantity of effluent to be discharged is as follows:

   Average annual daily discharge (Based on operating period) 4,870,000 (Imperial gallons)

   Maximum daily discharge 4,870,000 (Imperial gallons)

   The operating period during which the effluent will be discharged is continuous
(Continuous, hours per week, or date to date, etc.)

5. The type of treatment to be applied to the effluent before discharge is as follows:

   In-plant treatment - settling tanks and filters.

Date June 29, 19 73

L.J. Nicholson
(Signature of applicant or agent)

This is Supplementary Information form 4 of 12

* One form to be submitted for each discharge.

PCB 8— o

039 3323

ADDITIONAL INFORMATION

In support of the application the following information is submitted:

(*a*) The characteristics of the effluent before and after treatment are as follows:

	(1) Before Treatment Average (Annual)	(2) After Treatment Average (Annual)	(3) After Treatment Maximum
Total suspended solids (mg./1.)	10	10	10 *
Total solids (mg./1.)	300	200	200 *
Biochemical oxygen demand (mg./1.)†	N.A.		*
pH range	6.5-7.5	6.5-7.5	6.5-7.5
Temperature range (degrees F)	55-68	55-68	55-68
Fæcal coliform bacteria (m.p.n. per 100 ml.)			N.A. (Log. mean)

Toxic constituents:

	Units			
Zn	(mg/1)	4.5	1.0	1.0
As	(mg/1)	0.03	0.02	0.02
Cd	(mg/1)	0.14	0.05	0.05
Pb	(mg/1)	0.2	0.1	0.1
Hg (total)	(mg/1)	0.002	0.002	0.002

Other relevant constituents:

	Units			
	( )			
	( )			
	( )			
	( )			

(*b*) Miscellaneous information:

Constituents dissolved except as noted.
Changes from caustic neutralization to burnt lime neutralization is planned.

* These values pertain to a composite sample collected over any operating day during the year.
† Five day 20°C (BOD).

039 3324

THE GOVERNMENT OF THE PROVINCE OF BRITISH COLUMBIA

Pollution Control Branch File No._____

DEPARTMENT OF LANDS, FORESTS, AND WATER RESOURCES
WATER RESOURCES SERVICE
POLLUTION CONTROL BRANCH

SUPPLEMENTARY INFORMATION
To Application for a Permit Under the Provisions of Section 5 (2) of the Pollution Control Act, 1967 Involving More Than One Discharge * (EFFLUENT)

As a supplement to my application dated the 29th day of June, 1973, which was posted on the ground in accordance with the Pollution Control Regulations,

I, COMINCO LTD.
(Full name—if a company, British Columbia registered name)

of 1199 West Pender Street, Vancouver, British Columbia
(Address—if a company, British Columbia registered address)

hereby provide further particulars and data to the Director respecting my application.

1. The source of effluent is See attached sheet for sources.
(Specific portion of plant, etc.)

   and discharges into Columbia River
(Name of creek, river, lake, bay, inlet, etc.)

2. The land upon which the works are located is Lots 1 and 2, Plan 4926, K.D.

(Give legal description—use reverse side if necessary)

3. The point of discharge shall be located T-6: 730 feet southerly from the northeast corner of Lot 1, Plan 4926, K.D., on the bank of the Columbia River.
(Define relative to some surveyed or commonly known point)

4. The quantity of effluent to be discharged is as follows:

   Average annual daily discharge (Based on operating period) 8,600,000 (Imperial gallons)

   Maximum daily discharge 8,600,000 (Imperial gallons)

   The operating period during which the effluent will be discharged is continuous
(Continuous, hours per week, or date to date, etc.)

5. The type of treatment to be applied to the effluent before discharge is as follows:

   In-plant treatment - settling tanks and filters.

Date June 29, 1973

L.J. Nicholson
(Signature of applicant or agent)

This is Supplementary Information form 5 of 12

039 3325

* One form to be submitted for each discharge.

PCB 8— o

ADDITIONAL INFORMATION

In support of the application the following information is submitted:

(*a*) The characteristics of the effluent before and after treatment are as follows:

	(1) Before Treatment Average (Annual)	(2) After Treatment Average (Annual)	(3) After Treatment Maximum
Total suspended solids (mg./1.)	20	20	20 *
Total solids (mg./1.)	240	240	240 *
Biochemical oxygen demand (mg./1.)†	N.A.		*
pH range	5.6-6.4	5.6-6.4	5.6-6.4
Temperature range (degrees F)	65-70	65-70	65-70
Fæcal coliform bacteria (m.p.n. per 100 ml.)			N.A. (Log. mean)

Toxic constituents:

	Units			
Zn	(mg/l)	26	20	20
As	(mg/l)	<0.01	<0.01	<0.01
Cd	(mg/l)	0.01	0.01	0.01
Pb	(mg/l)	0.18	0.1	0.1
Hg (total)	(mg/l)	0.0025	0.0025	0.0025

Other relevant constituents:

	Units			
SO_4	(mg/l)	100	75	75
	( )			
	( )			
	( )			

(*b*) Miscellaneous information:

Constituents dissolved except as noted.
Improved housekeeping planned.

* These values pertain to a composite sample collected over any operating day during the year.
† Five day 20°C (BOD).

039 3326

THE GOVERNMENT OF THE PROVINCE OF BRITISH COLUMBIA

Pollution Control Branch File No._____

DEPARTMENT OF LANDS, FORESTS, AND WATER RESOURCES
WATER RESOURCES SERVICE
POLLUTION CONTROL BRANCH

SUPPLEMENTARY INFORMATION
To Application for a Permit Under the Provisions of Section 5 (2) of the Pollution Control Act, 1967 Involving More Than One Discharge *
(EFFLUENT)

As a supplement to my application dated the 29th day of June, 19 73, which was posted on the ground in accordance with the Pollution Control Regulations,

I, COMINCO LTD.
(Full name—if a company, British Columbia registered name)

of 1199 West Pender Street, Vancouver, British Columbia
(Address—if a company, British Columbia registered address)

hereby provide further particulars and data to the Director respecting my application.

1. The source of effluent is See attached sheet for sources.
(Specific portion of plant, etc.)
and discharges into Columbia River
(Name of creek, river, lake, bay, inlet, etc.)

2. The land upon which the works are located is Lot 1, Plan 4926, K.D.
(Give legal description—use reverse side if necessary)

3. The point of discharge shall be located T-7: 400 feet southerly from the northeast corner of Lot 1, Plan 4926, K.D. on the bank of the Columbia River.
(Define relative to some surveyed or commonly known point)

4. The quantity of effluent to be discharged is as follows:

Average annual daily discharge (Based on operating period) 8,600,000
(Imperial gallons)

Maximum daily discharge 8,600,000
(Imperial gallons)

The operating period during which the effluent will be discharged is
continuous
(Continuous, hours per week, or date to date, etc.)

5. The type of treatment to be applied to the effluent before discharge is as follows:
nil

Date June 29, 19 73

(Signature of applicant or agent)
L.J. Nicholson

This is Supplementary Information form 6 of 12

039 3327

* One form to be submitted for each discharge.

PCB 8— o

ADDITIONAL INFORMATION

In support of the application the following information is submitted:

(*a*) The characteristics of the effluent before and after treatment are as follows:

	(1) Before Treatment Average (Annual)	(2) After Treatment Average (Annual)	(3) After Treatment Maximum
Total suspended solids (mg./1.)	40	40	40 *
Total solids (mg./1.)	950	950	950 *
Biochemical oxygen demand (mg./1.)†	N.A.		*
pH range	2.1-2.3	2.1-2.3	2.1-2.3
Temperature range (degrees F)	77-90	77-90	77-90
Fæcal coliform bacteria (m.p.n. per 100 ml.)			N.A. (Log. mean)

Toxic constituents:

	Units			
Zn	(mg/1)	0.2	0.2	0.2
As	(mg/1)	0.06	0.06	0.06
Cd	(mg/1)	0.7	0.7	0.7
Pb	(mg/1)	0.3	0.3	0.3
Hg (total)	(mg/1)	0.04	0.04	0.04

Other relevant constituents:

	Units			
SO_4	(mg/1)	65	65	65
	( )			
	( )			
	( )			

(*b*) Miscellaneous information:

Constituents dissolved except as noted.

Treatment depends on outcome of flash smelting pilot program.

* These values pertain to a composite sample collected over any operating day during the year.
† Five day 20°C (BOD).

039 3328

Pollution Control Branch File No._____

DEPARTMENT OF LANDS, FORESTS, AND WATER RESOURCES
WATER RESOURCES SERVICE
POLLUTION CONTROL BRANCH

SUPPLEMENTARY INFORMATION
To Application for a Permit Under the Provisions of Section 5 (2) of the Pollution Control Act, 1967 Involving More Than One Discharge *
(EFFLUENT)

As a supplement to my application dated the 29th day of June, 1973, which was posted on the ground in accordance with the Pollution Control Regulations,

I, COMINCO LTD.
(Full name—if a company, British Columbia registered name)

of 1199 West Pender Street, Vancouver, British Columbia
(Address—if a company, British Columbia registered address)

hereby provide further particulars and data to the Director respecting my application.

1. The source of effluent is See attached sheet for sources.
(Specific portion of plant, etc.)

   and discharges into Columbia River
(Name of creek, river, lake, bay, inlet, etc.)

2. The land upon which the works are located is Lots 1, 2, 3 and 4, Plan 4926, K.D.
(Give legal description—use reverse side if necessary)

3. The point of discharge shall be located T-8a: 20 feet southerly from the northeast corner of Lot 1, Plan 4926, K.D., on the bank of the Columbia River.
(Define relative to some surveyed or commonly known point)

4. The quantity of effluent to be discharged is as follows:

   Average annual daily discharge (Based on operating period) 7,000,000
(Imperial gallons)

   Maximum daily discharge 7,000,000
(Imperial gallons)

   The operating period during which the effluent will be discharged is continuous
(Continuous, hours per week, or date to date, etc.)

5. The type of treatment to be applied to the effluent before discharge is as follows:

   In-plant treatment - settling tanks and filters

Date June 29, 1973

L.J. Nicholson
(Signature of applicant or agent)

This is Supplementary Information form 7 of 12

7×10^6
9.6×10^6
16.6

039 3329

* One form to be submitted for each discharge.

PCB 8— 0

ADDITIONAL INFORMATION

In support of the application the following information is submitted:

(*a*) The characteristics of the effluent before and after treatment are as follows:

	(1) Before Treatment Average (Annual)	(2) After Treatment Average (Annual)	(3) After Treatment Maximum
Total suspended solids (mg./1.)	10	10	10 *
Total solids (mg./1.)	2,054	310	310 *
Biochemical oxygen demand (mg./1.)†	N.A.		*
pH range	2.2-2.5	4.0-4.5	4.0-4.5
Temperature range (degrees F)	65-75	65-75	65-75
Fæcal coliform bacteria (m.p.n. per 100 ml.)			N.A. (Log. mean)

Toxic constituents:

	Units			
Zn	(mg/l)	134	8	8
As	(mg/l)	0.04	0.04	0.04
Cd	(mg/l)	0.23	0.1	0.1
Pb	(mg/l)	1.0	0.5	0.5
Hg (total)	(mg/1)	0.019	0.005	0.005

Other relevant constituents:

	Units			
SO_4	(mg/l)	2,050	100	100
	( )			
	( )			
	( )			

(*b*) Miscellaneous information:

Constituents dissolved except as noted.
Wasting of stripped zinc electrolyte to be stopped and
roaster gas scrubbing solution to be treated with burnt lime.

* These values pertain to a composite sample collected over any operating day during the year.
† Five day 20°C (BOD).

Pollution Control Branch File No._____

DEPARTMENT OF LANDS, FORESTS, AND WATER RESOURCES
WATER RESOURCES SERVICE
POLLUTION CONTROL BRANCH

SUPPLEMENTARY INFORMATION
To Application for a Permit Under the Provisions of Section 5 (2) of the Pollution Control Act, 1967 Involving More Than One Discharge * (EFFLUENT)

As a supplement to my application dated the 29th day of June, 1973, which was posted on the ground in accordance with the Pollution Control Regulations,

I, COMINCO LTD.
(Full name—if a company, British Columbia registered name)

of 1199 West Pender Street, Vancouver, British Columbia
(Address—if a company, British Columbia registered address)

hereby provide further particulars and data to the Director respecting my application.

1. The source of effluent is See attached sheet for sources.
(Specific portion of plant, etc.)
and discharges into Columbia River
(Name of creek, river, lake, bay, inlet, etc.)
2. The land upon which the works are located is Lots 1, 2, 3 and 4, Plan 4926, K.D.
(Give legal description—use reverse side if necessary)
3. The point of discharge shall be located T-8b: 20 feet southerly from the northeast corner of Lot 1, Plan 4926, K.D., on the bank of the Columbia River.
(Define relative to some surveyed or commonly known point)
4. The quantity of effluent to be discharged is as follows:
   Average annual daily discharge (Based on operating period) 9,600,000 (Imperial gallons)
   Maximum daily discharge 9,600,000 (Imperial gallons)
   The operating period during which the effluent will be discharged is
   continuous
   (Continuous, hours per week, or date to date, etc.)
5. The type of treatment to be applied to the effluent before discharge is as follows:
   In-plant treatment - settling tanks and filters.

Date June 29, 1973

L.J. Nicholson
(Signature of applicant or agent)
L.J. Nicholson

This is Supplementary Information form 8 of 12

039 3331

* One form to be submitted for each discharge.

PCB 8— o

ADDITIONAL INFORMATION

In support of the application the following information is submitted:

(*a*) The characteristics of the effluent before and after treatment are as follows:

	(1) Before Treatment Average (Annual)	(2) After Treatment Average (Annual)	(3) After Treatment Maximum
Total suspended solids (mg./1.)	10	10	10 *
Total solids (mg./1.)	550	210	210 *
Biochemical oxygen demand (mg./1.)†	N.A.		*
pH range	2.7-2.9	4.0-4.5	4.0-4.5
Temperature range (degrees F)	65-75	65-75	65-75
Fæcal coliform bacteria (m.p.n. per 100 ml.)			N.A. (Log. mean)

Toxic constituents:

	Units			
Zn	(mg/l)	14.0	1	1
As	(mg/l)	0.14	0.1	0.1
Cd	(mg/l)	0.87	0.2	0.2
Pb	(mg/l)	1.9	0.5	0.5
Hg (total)	(mg/l)	0.03	0.005	0.005

Other relevant constituents:

	Units			
SO_4	(mg/l)	1,310	100	100
	( )			
	( )			
	( )			

(*b*) Miscellaneous information:

Constituents dissolved except as noted.
Wasting of stripped zinc electrolyte to be stopped and roaster gas scrubbing solution to be treated with burnt lime.

* These values pertain to a composite sample collected over any operating day during the year.
† Five day 20°C (BOD).

Pollution Control Branch File No._____

DEPARTMENT OF LANDS, FORESTS, AND WATER RESOURCES
WATER RESOURCES SERVICE
POLLUTION CONTROL BRANCH

SUPPLEMENTARY INFORMATION
To Application for a Permit Under the Provisions of Section 5 (2) of the Pollution Control Act, 1967 Involving More Than One Discharge * (EFFLUENT)

As a supplement to my application dated the 29th day of June, 1973, which was posted on the ground in accordance with the Pollution Control Regulations,

I, COMINCO LTD.
(Full name—if a company; British Columbia registered name)

of 1199 West Pender Street, Vancouver, British Columbia
(Address—if a company, British Columbia registered address)

hereby provide further particulars and data to the Director respecting my application.

1. The source of effluent is See attached sheet for sources.
(Specific portion of plant, etc.)
and discharges into Columbia River
(Name of creek, river, lake, bay, inlet, etc.)

2. The land upon which the works are located is Lots 1 and 4, Plan 4926, K.D.
(Give legal description—use reverse side if necessary)

3. The point of discharge shall be located T-9: 70 feet northerly from the southeast corner of Lot 4, Plan 4926, K.D., on the bank of the Columbia River.
(Define relative to some surveyed or commonly known point)

4. The quantity of effluent to be discharged is as follows:

Average annual daily discharge (Based on operating period) 330,000 (Imperial gallons)

Maximum daily discharge 330,000 (Imperial gallons)

The operating period during which the effluent will be discharged is continuous
(Continuous, hours per week, or date to date, etc.)

5. The type of treatment to be applied to the effluent before discharge is as follows:

nil

Date June 29, 1973

L.J. Nicholson
(Signature of applicant or agent)
L.J. Nicholson

This is Supplementary Information form 9 of 12

039 3333

* One form to be submitted for each discharge.

PCB 8— o

ADDITIONAL INFORMATION

In support of the application the following information is submitted:

(*a*) The characteristics of the effluent before and after treatment are as follows:

	(1) Before Treatment Average (Annual)	(2) After Treatment Average (Annual)	(3) After Treatment Maximum
Total suspended solids (mg./1.)	25	25	25 *
Total solids (mg./1.)	200	200	200 *
Biochemical oxygen demand (mg./1.) †	N.A.		*
pH range	5.5-6.9	5.5-6.9	5.5-6.9
Temperature range (degrees F)	55-68	55-68	55-68
Fæcal coliform bacteria (m.p.n. per 100 ml.)			N.A. (Log. mean)

Toxic constituents:

	Units			
Zn	(mg/l)	2.0	2.0	2.0
As	(mg/l)	0.04	0.04	0.04
Cd	(mg/l)	0.07	0.03	0.03
Pb	(mg/l)	0.4	0.1	0.1
Hg	(mg/l)	0.0012	0.0012	0.0012

Other relevant constituents:

	Units			
	( )			
	( )			
	( )			
	( )			

(*b*) Miscellaneous information:

Constituents dissolved except as noted.
Improved plant housekeeping will improve effluent analysis.

* These values pertain to a composite sample collected over any operating day during the year.
† Five day 20°C (BOD).

Pollution Control Branch File No._____

DEPARTMENT OF LANDS, FORESTS, AND WATER RESOURCES
WATER RESOURCES SERVICE
POLLUTION CONTROL BRANCH

SUPPLEMENTARY INFORMATION
To Application for a Permit Under the Provisions of Section 5 (2) of the Pollution Control Act, 1967 Involving More Than One Discharge *
(EFFLUENT)

As a supplement to my application dated the 29th day of June, 1973; which was posted on the ground in accordance with the Pollution Control Regulations,

I, COMINCO LTD.
(Full name—if a company, British Columbia registered name)

of 1199 West Pender Street, Vancouver, British Columbia
(Address—if a company, British Columbia registered address)

hereby provide further particulars and data to the Director respecting my application.

1. The source of effluent is See attached sheet for sources.
(Specific portion of plant, etc.)
and discharges into Columbia River
(Name of creek, river, lake, bay, inlet, etc.)

2. The land upon which the works are located is Lot 4, Plan 4926, K.D.
(Give legal description—use reverse side if necessary)

3. The point of discharge shall be located T-10: 300 feet northerly from the southeast corner of Lot 4, Plan 4926, K.D., on the bank of the Columbia River.
(Define relative to some surveyed or commonly known point)

4. The quantity of effluent to be discharged is as follows:

Average annual daily discharge (Based on operating period) 820,000 (Imperial gallons)

Maximum daily discharge 820,000 (Imperial gallons)

The operating period during which the effluent will be discharged is continuous
(Continuous, hours per week, or date to date, etc.)

5. The type of treatment to be applied to the effluent before discharge is as follows:

In-plant treatment - settling tanks, filters.

Date June 29, 1973

L.J. Nicholson
(Signature of applicant or agent)
L.J. Nicholson

This is Supplementary Information form 10 of 12

039 3335

* One form to be submitted for each discharge.

PCB 8— o

ADDITIONAL INFORMATION

In support of the application the following information is submitted:

(*a*) The characteristics of the effluent before and after treatment are as follows:

	(1) Before Treatment Average (Annual)	(2) After Treatment Average (Annual)	(3) After Treatment Maximum
Total suspended solids (mg./1.)	5	5	5 *
Total solids (mg./1.)	250	250	250 *
Biochemical oxygen demand (mg./1.)†	N.A.		*
pH range	5.0-6.0	5.0-6.0	5.0-6.0
Temperature range (degrees F)	50-68	50-68	50-68
Fæcal coliform bacteria (m.p.n. per 100 ml.)			N.A. (Log. mean)

Toxic constituents:

	Units			
Zn	(mg/l)	33	5	5
As	(mg/l)	0.05	0.05	0.05
Cd	(mg/l)	0.3	0.05	0.05
Pb	(mg/l)	1.3	1.0	1.0
Hg (total)	(mg/l)	0.0015	0.0015	0.0015
F	(mg/l)	3.0	2.0	2.0

Other relevant constituents:

	Units			
	( )			
	( )			
	( )			
	( )			

(*b*) Miscellaneous information:

Constituents dissolved except as noted.
Improved housekeeping planned.

* These values pertain to a composite sample collected over any operating day during the year.
† Five day 20°C (BOD).

Pollution Control Branch File No._____

DEPARTMENT OF LANDS, FORESTS, AND WATER RESOURCES
WATER RESOURCES SERVICE
POLLUTION CONTROL BRANCH

SUPPLEMENTARY INFORMATION
To Application for a Permit Under the Provisions of Section 5 (2) of the Pollution Control Act, 1967 Involving More Than One Discharge *
(EFFLUENT)

As a supplement to my application dated the 29th day of June, 19 73 which was posted on the ground in accordance with the Pollution Control Regulations,

I, COMINCO LTD.
(Full name—if a company, British Columbia registered name)

of 1199 West Pender Street, Vancouver, British Columbia
(Address—if a company, British Columbia registered address)

hereby provide further particulars and data to the Director respecting my application.

1. The source of effluent is Ammonium Sulphate Plant and Phosphate Plant
(Specific portion of plant, etc.)
and discharges into Stoney Creek which flows easterly and discharges into the Columbia River
(Name of creek, river, lake, bay, inlet, etc.)
2. The land upon which the works are located is Lots 1 and 3, Plan 6446, K.D. and part assigned No. 25 and Assigned No. 18, Plan 1425, K.D.
(Give legal description—use reverse side if necessary)
3. The point of discharge shall be located T-11: Part of Assigned No. 25 and Assigned No. 18, Plan 1425, K.D.
(Define relative to some surveyed or commonly known point)
4. The quantity of effluent to be discharged is as follows:
   Average annual daily discharge (Based on operating period) 8,060,000 (Imperial gallons)
   Maximum daily discharge 8,060,000 (Imperial gallons)
   The operating period during which the effluent will be discharged is continuous
(Continuous, hours per week, or date to date, etc.)
5. The type of treatment to be applied to the effluent before discharge is as follows:
   In-plant treatment - settling tanks and filters.

Date June 29, 19 73

L.J. Nicholson
(Signature of applicant or agent)
L.J. Nicholson

This is Supplementary Information form 12 of 12

* One form to be submitted for each discharge.

PCB 8— o

039 3337

ADDITIONAL INFORMATION

In support of the application the following information is submitted:

(*a*) The characteristics of the effluent before and after treatment are as follows:

	(1) Before Treatment Average (Annual)	(2) After Treatment Average (Annual)	(3) After Treatment Maximum
Total suspended solids (mg./1.)	31,400	31,400	31,400 *
Total solids (mg./1.)	33,900	33,900	33,900 *
Biochemical oxygen demand (mg./1.)†	N.A.		*
pH range	2.5-3.5	2.5-3.5	2.5-3.5
Temperature range (degrees F)	70-80	70-80	70-80
Fæcal coliform bacteria (m.p.n. per 100 ml.)			N.A. (Log. mean)

Toxic constituents:

	Units			
Hg (total)	(mg/l)	0.032	0.032	0.032
F	(mg/l)	19	19	19
	( )			
	( )			

Other relevant constituents:

	Units			
P	(mg/l)	210	210	210
NH_3/N	(mg/l)	8	8	8
SO_4	(mg/l)	1,550	1,550	1,550
	( )			

(*b*) Miscellaneous information:

Constituents dissolved except as noted.

* These values pertain to a composite sample collected over any operating day during the year.
† Five day 20°C (BOD).

039 3338

THE GOVERNMENT OF THE PROVINCE OF BRITISH COLUMBIA

Pollution Control Branch File No._____

DEPARTMENT OF LANDS, FORESTS, AND WATER RESOURCES
WATER RESOURCES SERVICE
POLLUTION CONTROL BRANCH

SUPPLEMENTARY INFORMATION
To Application for a Permit Under the Provisions of Section 5 (2) of the Pollution Control Act, 1967 Involving More Than One Discharge * (EFFLUENT)

As a supplement to my application dated the 29th day of June, 1973, which was posted on the ground in accordance with the Pollution Control Regulations,

I, COMINCO LTD.
(Full name—if a company, British Columbia registered name)

of 1199 West Pender Street, Vancouver, British Columbia
(Address—if a company, British Columbia registered address)

hereby provide further particulars and data to the Director respecting my application.

1. The source of effluent is Natural Gas Ammonia Plant and Electrolytic Ammonia Plant
(Specific portion of plant, etc.)
and discharges into Stoney Creek which flows easterly and discharges into the Columbia River
(Name of creek, river, lake, bay, inlet, etc.)
2. The land upon which the works are located is Lots 1 and 3, Plan 6446, K.D., part Assigned No. 25 and Assigned No. 18, Plan 1425, K.D.
(Give legal description—use reverse side if necessary)
3. The point of discharge shall be located T-12: Part of Assigned No. 25 and Assigned No. 18, Plan 1425, K.D.
(Define relative to some surveyed or commonly known point)
4. The quantity of effluent to be discharged is as follows:
   Average annual daily discharge (Based on operating period) 6,900,000 (Imperial gallons)
   Maximum daily discharge 6,900,000 (Imperial gallons)
   The operating period during which the effluent will be discharged is continuous
   (Continuous, hours per week, or date to date, etc.)
5. The type of treatment to be applied to the effluent before discharge is as follows:
   nil

Date June 29, 1973

L.J. Nicholson
(Signature of applicant or agent)

This is Supplementary Information form 11 of 12

* One form to be submitted for each discharge.

PCB 8— o

039 3339

ADDITIONAL INFORMATION

In support of the application the following information is submitted:

(*a*) The characteristics of the effluent before and after treatment are as follows:

	(1) Before Treatment Average (Annual)	(2) After Treatment Average (Annual)	(3) After Treatment Maximum
Total suspended solids (mg./1.)	3	3	3 *
Total solids (mg./1.)	100	100	100 *
Biochemical oxygen demand (mg./1.)†	N.A.		*
pH range	6.8-7.2	6.8-7.2	6.8-7.2
Temperature range (degrees F)	65-77	65-77	65-77
Fæcal coliform bacteria (m.p.n. per 100 ml.)			N.A. (Log. mean)

Toxic constituents:

	Units			
Hg (total)	(mg/l)	0.0006	0.0006	0.0006
F	(mg/l)	0.4	0.4	0.4
	( )			
	( )			

Other relevant constituents:

	Units			
P	(mg/l)	0.6	0.6	0.6
NH_3/N	(mg/l)	4.0	4.0	4.0
SO_4	(mg/l)	31	31	31
	( )			

(*b*) Miscellaneous information:

Constituents dissolved except as noted.

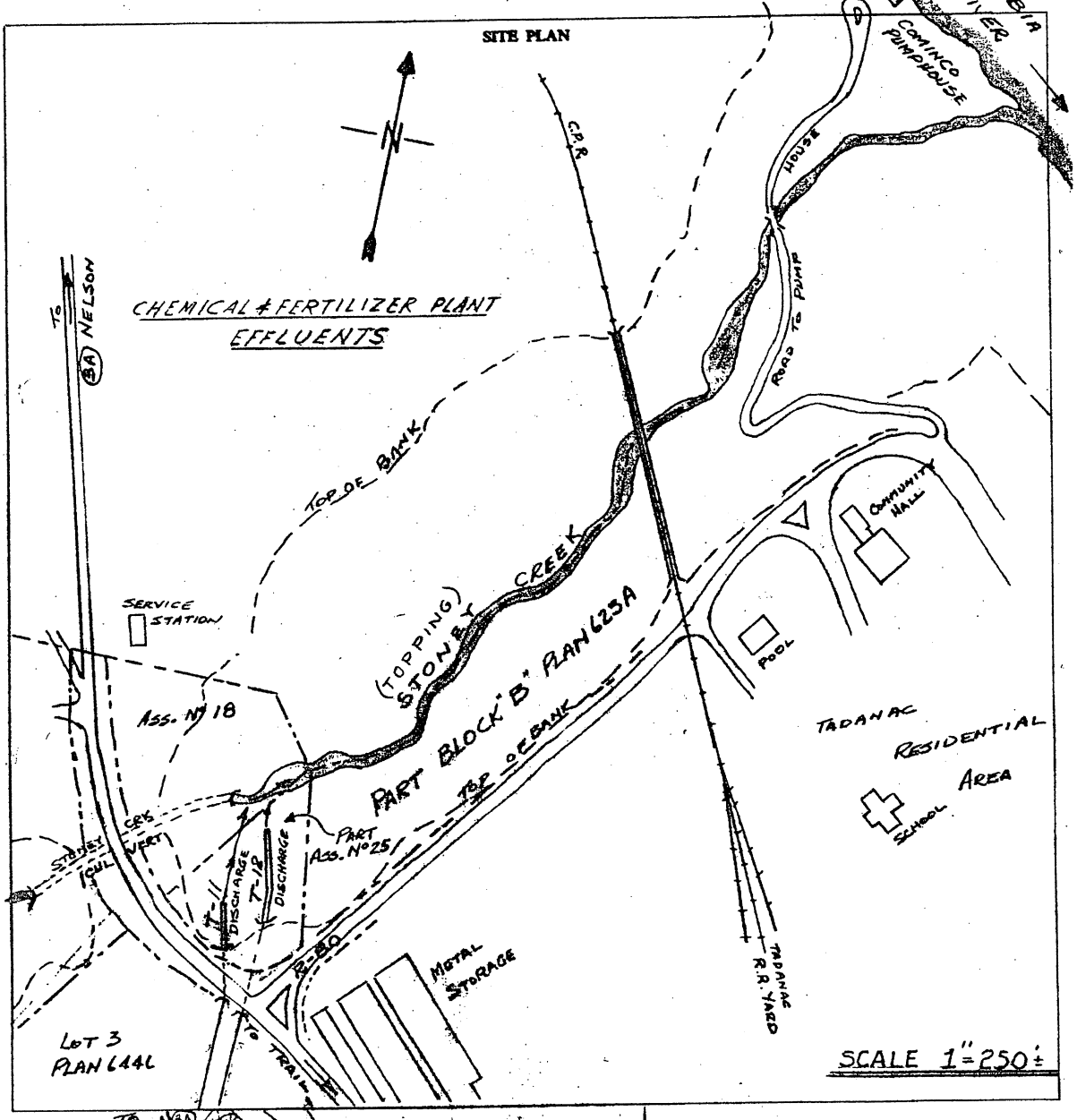
* These values pertain to a composite sample collected over any operating day during the year.
† Five day 20°C (BOD).

THE GOVERNMENT OF THE PROVINCE OF BRITISH COLUMBIA

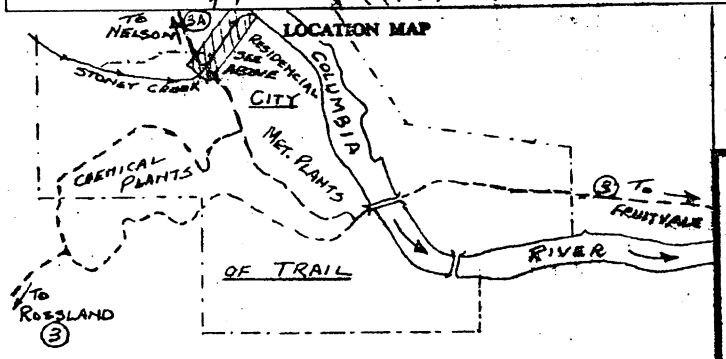
DEPARTMENT OF LANDS, FORESTS, AND WATER RESOURCES
WATER RESOURCES SERVICE

POLLUTION CONTROL BRANCH

SITE PLAN



LOCATION MAP



COMINCO LTD.
(Name of applicant(s))

June 29, 1973
(Date)

(Signature of applicant(s) or agent)
L.J. Nicholson

(FOR OFFICE USE ONLY)

(Date issued) (Director, Pollution Control Branch)

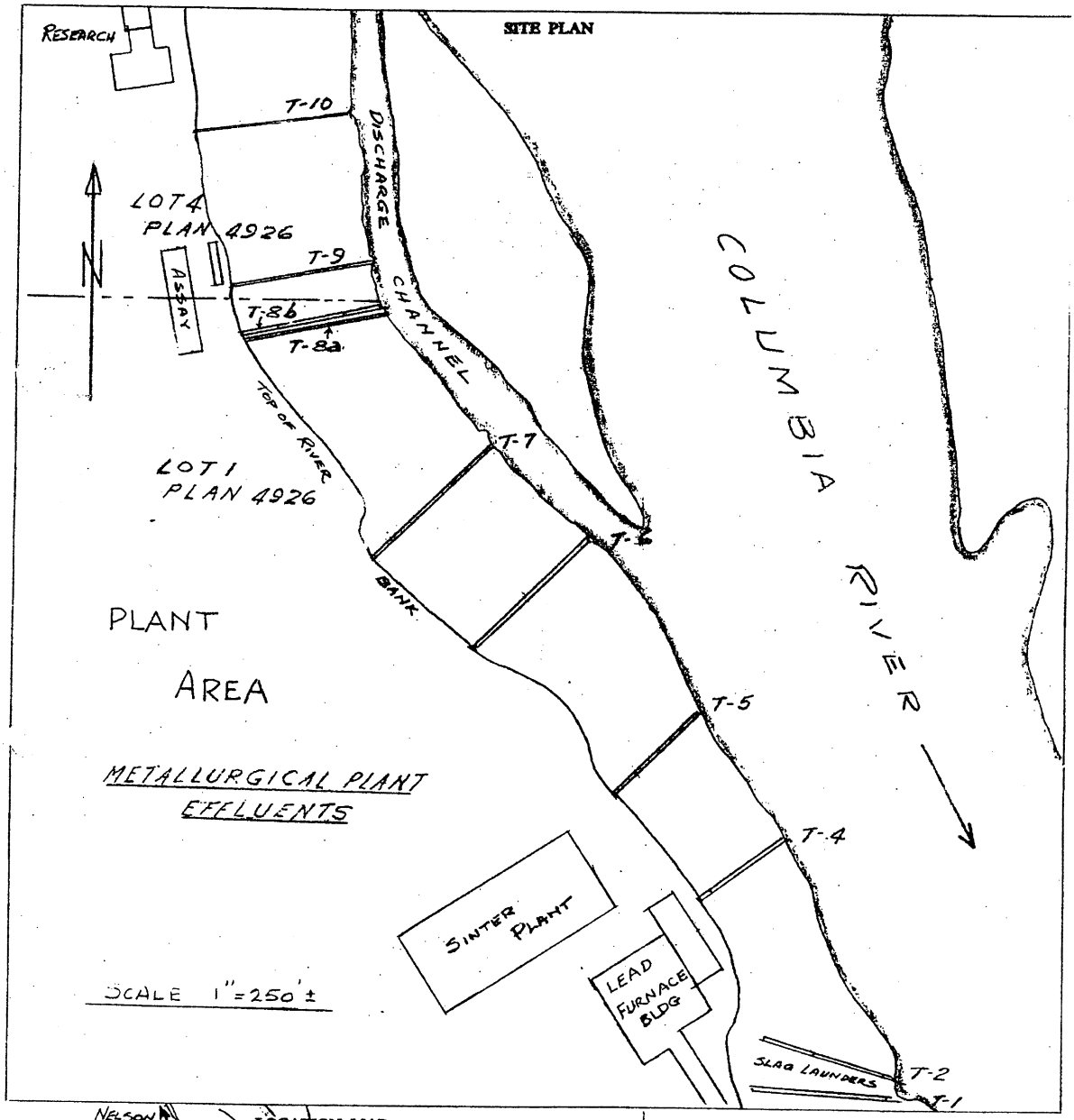
Appendix ..... to Permit No. .....

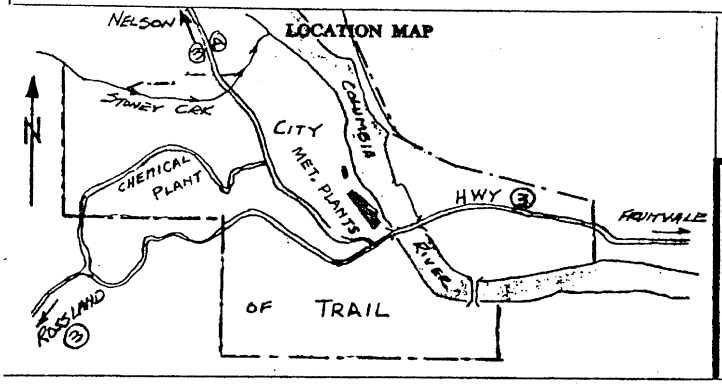
PCB 12—0

039 3341

DEPARTMENT OF LANDS, FORESTS, AND WATER RESOURCES
WATER RESOURCES SERVICE

POLLUTION CONTROL BRANCH





COMINCO LTD.
(Name of applicant(s))

June 29, 1973
(Date)

(Signature of applicant(s) or agent)
L.J. Nicholson

(FOR OFFICE USE ONLY)

(Date issued) (Director, Pollution Control Branch)

Appendix..... to Permit No.....

PCB 12—

039 3342

Province of
British Columbia

BC Environment

Environmental Protection
Kootenay Region
617 Vernon Street
Nelson, British Columbia
V1L 4E9

FEB 12 1991

File: PE-02753

REGISTERED MAIL

Cominco Ltd. - Cominco Ltee.
2600 - 200 Granville Street
Vancouver, British Columbia
V6C 2R2

Gentlemen:

Enclosed is a copy of amended Permit No. PE-02753 issued under the provisions of the Waste Management Act, in the name of Cominco Ltd. - Cominco Ltee. Your attention is respectfully directed to the terms and conditions outlined in the Permit.

The administration of this Permit will be carried out by staff from our Regional Office located at 617 Vernon Street, Nelson, British Columbia, V1L 4E9 (telephone 354-6355). Plans, data and reports pertinent to the Permit are to be submitted to the Regional Waste Manager at this address.

Yours truly,

Jim McLaren

Jim McLaren, P. Eng.
Regional Waste Manager

/sw

BC ENVIRONMENT

PERMIT

Under the Provisions of the Waste Management Act

COMINCO LTD. - COMINCO LTEE.

2600 - 200 GRANVILLE STREET

VANCOUVER, BRITISH COLUMBIA

V6C 2R2

is authorized to discharge effluent from a lead - zinc smelter located in Trail, British Columbia, to the Columbia River, subject to the following terms and conditions outlined in Appendices 01, 02, 03, 04, A-1 and attached pages 2 to 9.

An annual permit fee will be determined on the basis of your industrial code and capacity in accordance with the Waste Management Fees Regulation.

This permit does not authorize entry upon, crossing over, or use for any purpose of private or Crown lands or works, unless and except as authorized by the owner of such lands or works. The responsibility for obtaining such authority shall rest with the Permittee.

Jim McLaren, P. Eng.
Regional Waste Manager

Date Issued: November 29, 1978
Amendment date: FEB 12 1991
(most recent)

Permit Number: PE-02753

SECTION ONE: GENERAL

1.1 MAINTENANCE OF WORKS

The Permittee shall inspect the pollution control works regularly and maintain them in good working order. The Permittee shall notify the Regional Waste Manager of any malfunction of these works.

1.2 EMERGENCY PROCEDURES

In the event of an emergency or condition beyond the control of the Permittee which prevents continuing operation of the approved method of pollution control, the Permittee shall immediately notify the Regional Waste Manager and take appropriate remedial action.

1.3 BYPASSES

The discharge of effluent which has bypassed the designated treatment works is prohibited unless the approval of the Director or the Regional Waste Manager is obtained and confirmed in writing.

1.4 PROCESS MODIFICATIONS

The Permittee shall notify the Regional Waste Manager prior to implementing changes to any process that may affect the quality and/or quantity of the discharge.

1.5 AREA RUNOFF CONTROL

The Permittee is developing a comprehensive drainage collection and treatment strategy as part of an overall effluent management plan for the entire metallurgical complex. The Permittee shall provide, by October 31, 1991 an evaluation of the contribution of area sources (such as but not limited to roof drainage, road washing, stockpile leachate and storm events) to the effluent quality of the various discharges to the Columbia River. The evaluation shall include results of the measurement of quality and quantity of the area sources as well as options for collection and treatment for metals removal prior to discharge to the river. The report, to be submitted to the Regional Waste Manager, shall be written in a form suitable for release to the general public.

Jim McLaren

Jim McLaren, P. Eng.
Regional Waste Manager

Date Issued: November 29, 1978
Amendment date: FEB 12 1991
(most recent)

1.6 VEHICLE CONTAMINANT CONTROL

The Permittee shall insure that contaminants are not transported off the plant site on the wheels and undercarriage of vehicles. The Permittee shall, by June 1, 1991 submit vehicle contamination control plans to the Regional Waste Manager for his approval. Approved plans shall be implemented by December 31, 1991.

1.7 TAIL SLAG DISPOSAL

The Permittee has initiated an assessment of the environmental impacts of continued discharge of slag to the Columbia River and alternate disposal options for tail slag.

The Permittee is required to provide to the Regional Waste Manager, by December 31, 1991, a report on the cost, feasibility and environmental acceptability of slag disposal options exclusive of slag discharge to the Columbia River and on the environmental impacts of slag discharge to the Columbia River. Terms of reference for this study shall be developed and submitted to the Regional Waste Manager for his approval by May 1, 1991.

1.8 TANK CLEANOUT

Prior to the cleanout of any process tank or vessel the Permittee shall obtain representative samples and analyses of the material to be disposed of and shall notify the Regional Waste Manager in order to obtain prior approval for the disposal method.

During the period of any tank cleanout involving discharge to the Columbia River the Permittee shall take continuous samples (or sample) as required by the Regional Waste Manager, to determine the resultant effect on the final discharge quality. Analysis for contaminants shall be carried out at a frequency and for parameters determined by the Regional Waste Manager.

Jim McLaren

Jim McLaren, P. Eng.
Regional Waste Manager

Province of
British Columbia

Environmental Protection Program

1.9 EMERGENCY DISCHARGE OF SULPHURIC ACID TO THE COLUMBIA RIVER

Subject to the written approval of the Regional Waste Manager, the Permittee is authorized to discharge up to 200 tonnes/day of 93% sulphuric acid to the Columbia River via Sewer IV at a controlled rate such that the following conditions are satisfied:

1. All reasonable alternate methods for consumption or disposal of the excess acid have been exhausted.

2. The period of discharge must be approved in writing by the Regional Waste Manager.

3. The pH of the Columbia River at the midpoint of the new Trail bridge shall not be less than 6.5 units and the maximum pH depression at this location compared to the Columbia River upstream of the confluence of Stoney Creek shall not be greater than 1 unit.

4. A monitoring program as specified in Section 2.3 shall be carried out.

Jim McLaren

Jim McLaren, P. Eng.
Regional Waste Manager

Date Issued: November 29, 1978
Amendment date: (most recent) FEB 12 1991

Permit Number: PE-02753

SECTION TWO, MONITORING

2.1 SEWER MONITORING

Commencing immediately, the following monitoring program shall be performed by the Permittee and the results submitted to the Regional Waste Manager. The need for increased or decreased monitoring shall be based on the results of sampling specified below. The Regional Waste Manger may, at his discretion, modify this monitoring program.

SEWER	CONTAMINANT	FREQUENCY
I, II, III, & 07	flow*	
	pH	continuous
	total zinc	monthly
	dissolved zinc	monthly
	total lead	monthly
	dissolved lead	monthly
	total arsenic	monthly
	dissolved arsenic	monthly
	total cadmium	monthly
	dissolved cadmium	monthly
	total copper	monthly
	dissolved copper	monthly
	total mercury	daily

* Flow in Sewers II, III and 07 is to be measured continuously while Sewer I is to be measured using lithium tracer at least once per quarter.

2.2 SPECIAL MONITORING OF EFFLUENTS AFTER STARTUP OF MAJOR PROJECTS

Special effluent and the receiving environment monitoring programs associated with the startup of major new processes or plants may be required as specified by the Regional Waste Manager.

Jim McLaren

Jim McLaren, P. Eng.
Regional Waste Manager

2.3 SPECIAL MONITORING DURING DISCHARGE OF SULPHURIC ACID

During the discharge of sulphuric acid to the Columbia River as authorized by the Regional Waste Manager the following monitoring shall be carried out:

1. Upon commencement of the acid release, the Permittee shall record the pH of the 24 hour composite sample of Sewer IV on a daily basis.

2. Upon commencement of the acid release, the Permittee shall monitor the pH of the Columbia River at the mid point of the new Trail bridge at a frequency of once per hour or as specified by the Regional Waste Manager.

3. Upon commencement of the acid release, the Permittee shall monitor the pH of the Columbia River immediately upstream of its confluence with Stoney Creek at a frequency of twice per day.

4. Upon commencement of the acid release, the Permittee shall will monitor the pH of the Columbia River at Waneta continuously and shall report the pH data collected to the Regional Waste Manager on a daily basis.

5. The Permittee shall determine the daily flow rate of the Columbia River during the acid release.

6. During the release of acid to the Columbia River, Sewer IV shall be sampled daily (24 hour composite) and shall be analyzed for parameters specified in 2.1 and 2.2 above.

2.4 SAMPLING METHOD

All samples for compliance evaluation with the limits specified in Appendices 02, and 03 are to be obtained in a flow proportional 24 hour composite manner except for pH which is to be measured and recorded continuously. Samples of sewers specified in Appendices 01, and 04 shall be 24 hour composite samples.

2.5 DAILY SEWER SAMPLING FOR SPILL OR UPSET ASSESSMENT

The Permittee shall continue a spill/upset monitoring program where all operational sewers are sampled continuously with the daily samples retained for at least one week. Should a spill or other process upset occur, the 24 hour samples from the days of, prior to and following the occurrence shall be analyzed for the specified permit compliance parameters as well as any other parameters specified by the Regional Waste Manager.

Jim McLaren

Jim McLaren, P. Eng.
Regional Waste Manager

Date Issued: November 29, 1978
Amendment date: (most recent) FEB 12 1991

2.6 RECEIVING ENVIRONMENT MONITORING

1a) Obtain monthly 24 hour composite samples (on the date of effluent sampling when possible) of the Columbia River at the following locations:

Columbia River, upstream of Topping (Stoney) Creek. (BCE Site 0200557)
Columbia River at Waneta (BCE Site 0200559)

Each sample is to be analyzed for:

Non filterable residue (Total suspended solids)
pH
Total and dissolved zinc
Total and dissolved arsenic
Total and dissolved cadmium
Total and dissolved lead
Total and dissolved copper
Total mercury
Hardness (mg/l $CaCO_3$)
Total phosphorus (as P)
Ortho phosphate (as P)
Dissolved ammonia (as N)
Dissolved sulphate

1b) The Permittee has stated an intent to voluntarily participate in a proposed Columbia River Integrated Sub-Basin Monitoring Program as tentatively described in a document titled; Columbia River Integrated Monitoring Program, September, 1990, Sigma Engineering Ltd. Any monitoring requirements in Section 2.6, that are met by participation in the proposed Integrated Monitoring Program or as it may be amended will fulfill the requirements of this Permit if approved in writing by the Regional Waste Manager.

2) In the event of a spill or upset condition that the Regional Waste Manager determines has the potential to impact the water quality of the Columbia River, the Permittee shall obtain a sequential series of grab samples at Waneta (BCE site 0200559). Initiation of sampling, sampling frequency and sampling duration will be determined on a case by case basis in consultation with the Regional Waste Manager.

Jim McLaren

Jim McLaren, P. Eng.
Regional Waste Manager

Date Issued: November 29, 1978
Amendment date: FEB 12 1991
(most recent)

3) The permittee shall continue to operate a continuous sampler on the Columbia River at Waneta (BCE site 0200559) and on the Columbia River at Stoney Creek (BCE site 0200557) and shall collect daily 24 hour composite samples. Samples not required for immediate analysis shall be stored for a period of one week after the day of sampling for subsequent analysis if required by the Regional Waste Manager.

4) The permittee is required to conduct an environmental impact assessment of the Columbia River to determine the impacts of existing discharges on the aquatic environment and to provide a baseline for determining future trends. Impacts on sediments, habitat, bioconcentration/bioaccumulation, community structure for plant and animal species are to be determined. Continued voluntary participation by the Permittee in a proposed Government/Industry integrated sub-basin monitoring program as tentatively described in a document titled, Columbia River Integrated Monitoring Program, September 1990, Sigma Engineering Ltd. will fulfil this requirement.

   In the event the proposed integrated monitoring program does not proceed the Permittee will be required to conduct an environmental impact assessment following terms of reference developed in consultation with, and approved by, the Regional Waste Manager.

2.7 ANALYSES

Analyses are to be carried out in accordance with procedures described in the Second Edition Parts I and II of "A Laboratory Manual for the Chemical Analysis of Waters, Wastewaters, Sediments and Biological Materials," or by suitable alternative procedures as approved by the Regional Waste Manager.

Copies of the above mentioned manual are available from the Laboratory Services Group, B.C. Environment, 3800 Wesbrook Mall, Vancouver, British Columbia, V6S 2L9, at a cost of $70.00 (payable to the Minister of Finance) and are also available for inspection at all Environmental Protection Offices.

Minimum detection concentrations for all discharge and receiving environment sample analyses must be approved by the Regional Waste Manager.

Jim McLaren

Jim McLaren, P. Eng.
Regional Waste Manager

Date Issued: November 29, 1978
Amendment date: (most recent) FEB 12 1991

Permit Number: PE-02753

2.8 REPORTING

1. All results obtained from effluent and receiving water monitoring specified above are to be tabulated and submitted to the Regional Waste Manager quarterly. In conjunction with this report, the Permittee shall submit those records obtained for any process upset or use of standby launders.

2. Sulphuric Acid Discharge

   A report detailing the cause of each incident, the pH monitoring data collected and the actions taken to prevent a reoccurrence of a similar incident shall be submitted to the Regional Waste Manager within 10 days after the release of acid has stopped.

3. The Permittee shall prepare an annual report suitable for release to the public, that tabulates and explains the sewer sampling and analyses as well as any results of receiving water quality monitoring carried out by the company.

   This annual report is due by March 31, of the following year.

Jim McLaren

Jim McLaren, P. Eng.
Regional Waste Manager

APPENDIX 01

PERMIT PE-02753

(a) The discharge of effluent to which Appendix 01 is applicable is from Metallurgical Plant Sewer I which replaces sewer T-2 and the Blast Furnace Pond Overflow to the Columbia River as shown on the attached Appendix A-1.

(b) The maximum rate at which effluent may be discharged is 70,000 m^3/day.

(c) The characteristics of a 24 hour composite sample of effluent shall not exceed:

Total Suspended Solids	10,000 mg/l
Dissolved Zinc	1.0 mg/l
Dissolved Arsenic	.05 mg/l
Dissolved Lead	.25 mg/l
Dissolved Cadmium	.05 mg/l
Total Mercury	.001 mg/l
pH Range	6.5 - 8.5

(d) The works authorized are a combined sewer, outfall and related appurtenances, approximately located as shown on the attached Appendix A-1.

(e) The location of the facilities from which the discharge- originates and to which Appendix 01 is appurtenant is Lots 1 and 2, Plan 4926, Kootenay District.

(f) The location of the point of discharge and to which Appendix 01 is appurtenant is Lots 1 and 2, Plan 4926, Kootenay District.

(g) The authority to discharge effluent of the quality specified in (c) above expires on December 31, 1991.

(h) The combination of Sewer I and the Blast Furnace Pond Overflow into a single outfall will be completed when the TLSM project is completed.

Jim McLaren

Jim McLaren, P. Eng.
Regional Waste Manager

Date Issued: November 29, 1978
Amendment date: (most recent) FEB 12 1991

APPENDIX 02

PERMIT PE-02753

(a) The discharge of effluent to which Appendix 02 is applicable is from Metallurgical Plant Sewer II which replaces T-1, T-3, T-4, T-5 and T-6 (effluents from the lead fuming furnaces, sinter plant, and zinc plant) to the Columbia River as shown on the attached Appendix A-1.

(b) The maximum rate at which effluent may be discharged is 55,000 m^3/day.

(c) The characteristics of a 24 hour flow proportional composite sample of the effluent shall not exceed :

Total Suspended Solids	35 mg/l
Dissolved Zinc	5 mg/l
Dissolved Arsenic	.05 mg/l
Dissolved Lead	.5 mg/l
Dissolved Cadmium	.07 mg/l
Total Mercury	.005 mg/l
pH Range	6.5 - 8.5

(d) The works authorized are a combined sewer, outfall, and related appurtenances, approximately located as shown on the attached Appendix A-1.

(e) The location of the facilities from which the discharge originates and to which Appendix 02 is appurtenant is Lots 1, 2, 3 and 4, Plan 4926, Kootenay District.

(f) The location of the point of discharge and to which Appendix 02 is appurtenant is Lots 1, 2, 3 and 4, Plan 4926, Kootenay District.

(g) The authority to discharge effluent of the quality specified in (c) above expires on December 31, 1991.

Date Issued:November 29, 1978
Amendment date: FEB 12 1991
(most recent)

Jim McLaren

Jim McLaren, P. Eng.
Regional Waste Manager

APPENDIX 03

PERMIT PE-02753

(a) The discharge of effluent to which Appendix 03 is applicable is from Metallurgical Plant Sewer III which replaces sewers T-8,T-9, T-10 and T-13 (effluents from the lead and silver refinery, acid plants, zinc plant, assay office and effluent treatment plant) to the Columbia River as shown on the attached Appendix A-1.

(b) The maximum rate at which effluent may be discharged is 110,000 m^3/day.

(c) The characteristics of a 24 hour flow proportional composite sample of the effluent shall not exceed:

Total Suspended Solids	25 mg/l
Dissolved Zinc	5 mg/l
Dissolved Arsenic	.05 mg/l
Dissolved Lead	.3 mg/l
Dissolved Cadmium	.05 mg/l
Total Mercury	.005 mg/l
pH Range	6.5 - 9.5

(d) The works authorized are a combined sewer, outfall, lime water treatment plant, sewer 13 lagoon and related appurtenances approximately located as shown on the attached Appendix A-1.

(e) The location of the facilities from which the discharge originates and to which Appendix 03 is appurtenant is Lots 1, 2, 3 and 4, Plan 4926, Kootenay District.

(f) The location of the point of discharge and to which Appendix 03 is appurtenant is Lots 1, 2, 3 and 4, Plan 4926, Kootenay District.

(g) The authority to discharge effluent of the quality specified in (c) above expires on December 31, 1991.

Date Issued:November 29, 1978
Amendment date: FEB 1 2 1991
(most recent)

Jim McLaren

Jim McLaren, P. Eng.
Regional Waste Manager

APPENDIX 04

PERMIT PE-02753

(a) The discharge of effluent to which Appendix 04 is applicable is from Metallurgical Plant Sewer T-7 (effluent from the lead smelter absorption plant) to the Columbia River as shown on the attached Appendix A-1.

(b) The maximum rate at which effluent may be discharged is 30,000 m^3/day..

(c) The characteristics of a 24 hour composite sample of the effluent shall not exceed:

Total Suspended Solids	25 mg/l
Dissolved Zinc	1.0 mg/l
Dissolved Arsenic	.25 mg/l
Dissolved Lead	1.0 mg/l
Dissolved Cadmium	.5 mg/l
Total Mercury	.035 mg/l
pH Range	2.0 - 8.5

(d) The works authorized are a submerged outfall, air return line and related appurtenances, approximately located as shown on the attached Appendix A-1.

(e) The location of the facilities from which the discharge originates and to which Appendix 04 is appurtenant is Lots 1, 2, 3 and 4, Plan 4926, Kootenay District.

(f) The location of the point of discharge and to which Appendix 04 is appurtenant is Lots 1, 2, 3 and 4, Plan 4926, Kootenay District.

(g) The authority to discharge effluent of the quality specified in (c) above expires on December 31, 1991.

Jim McLaren

Jim McLaren, P. Eng.
Regional Waste Manager

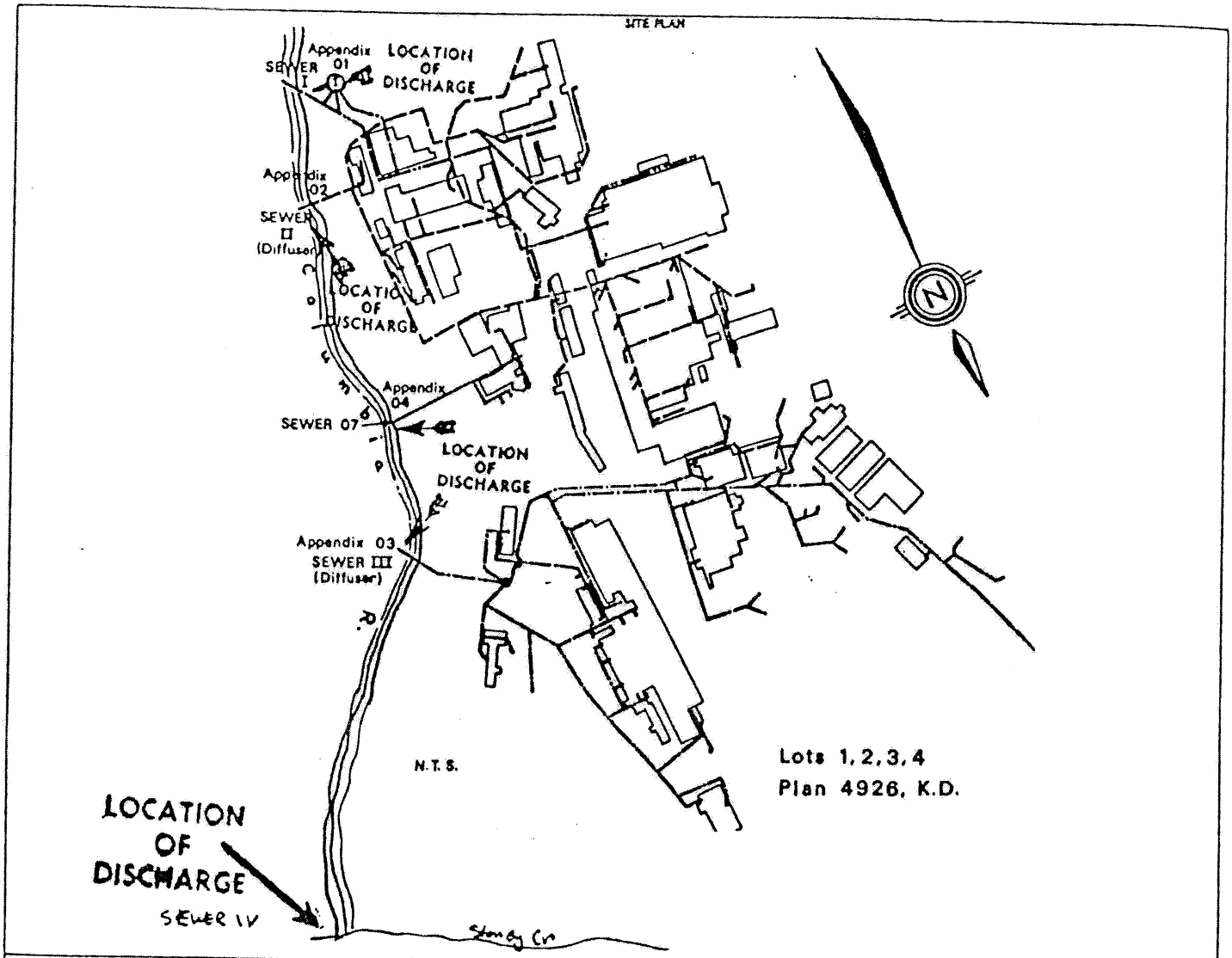
Date Issued: January 20, 1980
Amendment date: (most recent) FEB 12 1991

Province of British Columbia

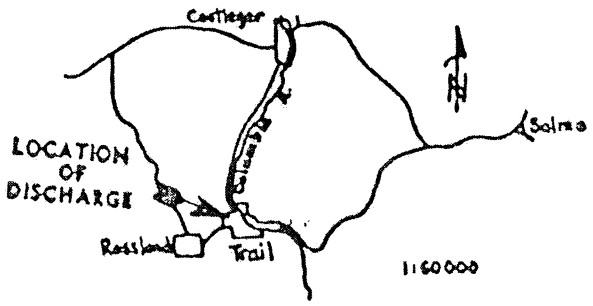
Ministry of Environment

STE MANAGEMENT BRANCH

SITE PLAN



LOCATION MAP



Cominco Ltd. - Cominco Ltee.

(Name of applicant(s)

(Date) (Signature of applicant(s) or agent)

(FOR OFFICE USE ONLY)

Date Issued FEB 12 1991

Date Amended

Jim McLaren, P. Eng.
Regional Waste Manager

Appendix A-1 to Permit No. PE-02753

Approval No.

ENV 1987

PROVINCE OF
BRITISH COLUMBIA

Environmental Protection
#401-333 Victoria Street
Nelson, British Columbia V1L 4K3
Telephone: (604) 354-6355
Fax: (604) 354-6367

73.1

MINISTRY OF ENVIRONMENT,
LANDS AND PARKS

PERMIT
PE-02753

Under the Provisions of the Waste Management Act

COMINCO LTD.-COMINCO LTEE

500 - 200 BURRARD STREET

VANCOUVER, BRITISH COLUMBIA

V6C 3L7

is authorized to discharge effluent from a lead - zinc smelter located in Trail, British Columbia, to the Columbia River, subject to the following terms and conditions outlined in attached Pages 2 to 19 and Site Plan A. Contravention of any of these conditions is a violation of the Waste Management Act and may result in prosecution.

This permit supersedes and amends all previous versions of Permit PE-02753, issued under Part 2 Section 8 of the Waste Management Act.

Date Issued: November 29, 1978
Amended: NOV 29 1996

R.J. Crozier, R.P. Bio.
Regional Waste Manager

1. AUTHORIZED DISCHARGES

1.1. This subsection applies to the discharge of effluent from the **SLAG COLLECTION POND OVERFLOW** as shown on the attached Site Plan A. The site reference number for this discharge is E222658.

1.1.1. The maximum authorized rate of discharge is 30,000 m^3/day.

1.1.2. The characteristics of the discharge shall not exceed:

Non Filterable Residue	maximum daily 10,000 kg/day
	monthly average 5000 kg/day
Dissolved Lead	15 kg/day
Dissolved Zinc	40 kg/day
Dissolved Cadmium	1 kg/day
Dissolved Arsenic	.5 kg/day
Dissolved Copper	1 kg/day
Total Mercury	.015 kg/day

1.1.3. The authorized works are slag collection pond, overflow launder and related appurtenances located approximately as shown on the attached Site Plan A.

1.1.4. The location of the facilities from which the discharge originates is Lots 1 and 2, Plan 4926, Kootenay District.

1.1.5. The location of the point of discharge is Lots 1 and 2, Plan 4926, Kootenay District.

1.2. This subsection applies to the discharge of effluent from the **SLAG COLLECTION POND UNDERFLOW** as shown on the attached Site Plan A. The site reference number for this discharge is E222659.

1.2.1. The maximum authorized rate of discharge is 15,000 m^3/day.

1.2.2. The characteristics of the discharge shall not exceed:

R.J.Crozier, R.P. Bio.
Regional Waste Manager

Non Filterable Residue	maximum daily 50 kg/day
Dissolved Lead	2 kg/day
Dissolved Zinc	4 kg/day
Dissolved Cadmium	.3 kg/day
Dissolved Arsenic	.25 kg/day
Dissolved Copper	.5 kg/day
Total Mercury	.005 kg/day

1.2.3. The authorized works are subdrains, launder, discharge pipe and related appurtenances located approximately as shown on the attached Site Plan A.

1.2.4. The location of the facilities from which the discharge originates is Lots 1 and 2, Plan 4926, Kootenay District.

1.2.5. The location of the point of discharge is Lots 1 and 2, Plan 4926, Kootenay District.

1.3. This subsection applies to the discharge of effluent from the **SLAG FUMING FURNACE COOLING WATER LAUNDER** as shown on the attached Site Plan A. The site reference number for this discharge is E222660.

1.3.1. The maximum authorized rate of discharge is 35,000 m^3/day.

1.3.2. The characteristics of the discharge shall not exceed:

Non Filterable Residue	maximum daily 700 kg/day
Dissolved Lead	2 kg/day
Dissolved Zinc	20 kg/day
Dissolved Cadmium	1 kg/day
Dissolved Arsenic	.25 kg/day
Dissolved Copper	.5 kg/day
Total Mercury	.05 kg/day

R.J.Crozier, R.P. Bio.
Regional Waste Manager

1.3.3. The authorized works are a launder, diversion gate and related appurtenances located approximately as shown on the attached Site Plan A.

1.3.4. The location of the facilities from which the discharge originates is Lots 1 and 2, Plan 4926, Kootenay District.

1.3.5. The location of the point of discharge is Lots 1 and 2, Plan 4926, Kootenay District.

1.4. This subsection applies to the discharge of effluent from **METALLURGICAL PLANT OUTFALL II** as shown on the attached Site Plan A. The site reference number for this discharge is E102983.

1.4.1. The characteristics of a 24 hour flow proportional composite sample of the effluent shall be equivalent to or less than the maximum loading or concentration authorized for each parameter below:

OUTFALL II

ELEMENT	PHASE I	PHASE II
Arsenic, Total	5.0 kg /day	5.0 kg /day
Cadmium, Dissolved	.10 mg/l	.06 mg/l
Cadmium, Dissolved	2.75 kg/d	2.75 kg/d
Copper, Total	8.0kg/d	6.0 kg/d
Lead, Total	150 kg/d	100 kg/d
Mercury, Total	.15 kg/d	.15 kg/d
Zinc, Dissolved	2.0 mg/l	1.4 mg/l
Zinc, Dissolved	100 kg/d	75 kg/d
FLOW	150,000 m3/d	125,000 m3/d
total suspended solids	1925 kg/d	1925 kg/d
pH range	6.5 to 8.5	6.5 to 8.5

Effective December 31, 2000, a grab sample of the effluent from Outfall II shall achieve 100% as measured by a 96 hour LC 50 acute toxicity test using rainbow trout.

Phase I is the period between November 29, 1996 and commencement of Phase II. During this period, the smelting operation consists of sinter plant, blast furnaces and existing slag fuming furnaces, Kivcet Furnace and new fuming furnace and permit limits are in effect until Phase II commences.

R.J.Crozier, R.P. Bio.
Regional Waste Manager

Date Issued: November 29, 1978
Amended: NOV 29 1996

Phase II for this section is defined as the period after the Kivcet furnace has reached 90% of the normal feed rate of 1500 tonnes/day expressed as a 30 day average and is operating on a continuous basis with a new slag fuming furnace and new drossing plant. In addition, the old smelter (sinter plant, blast furnace, old slag fuming furnaces and drossing plant) will have been shut down and prepared for decommissioning.

Daily loading discharges for parameters in this section shall be calculated by multiplication of the daily measured flow and measured sample concentration on the day of sampling. Sampling shall be in accordance with Subsection 3.1, Effluent Monitoring.

1.4.2. The authorized works are combined sewer, outfall and related appurtenances located approximately as shown on the Site Plan A.

1.4.3. The location of the facilities from which the discharge originates is Lots 1, 2, 3 and 4, Plan 4926, Kootenay District.

1.4.4. The location of the point of discharge is Lots 1, 2, 3 and 4, Plan 4926, Kootenay District.

1.5. This subsection applies to the discharge of effluent from **METALLURGICAL PLANT OUTFALL III** as shown on the attached Site Plan A. The site reference number for this discharge is E102984.

1.5.1. The characteristics of a 24 hour flow proportional composite sample of the effluent shall be equivalent to or less than the maximum loading or concentration authorized for each parameter below :

ELEMENT	PHASE I	PHASE II
Arsenic, Total	15 kg/d	15 kg/d
Cadmium, Dissolved	.03 mg/l	.03 mg/l
Cadmium, Dissolved	3.0 kg/d	3.0 kg/d
Copper, Total	11.0 kg/d	8.0 kg/d
Lead, Total	125 kg/d	100 kg/d
Mercury, Total	.55kg/d	.55 kg/d
Zinc, Dissolved	.9 mg/l	.9 mg/l
Zinc, Dissolved	90 kg/d	90 kg/d
FLOW	140,000 m3/d	140,000 m3/d
Total suspended solids	2,000 kg/d	2.000 kg/d
pH range	6.5 to 9.5	6.5 to 9.5

R.J.Crozier, R.P. Bio.
Regional Waste Manager

Effective December 31, 2000, a grab sample of the effluent from Outfall III shall achieve 100% as measured by a 96 hour LC 50 acute toxicity test using rainbow trout.

Phase I is the period between November 29, 1996 and the commencement of Phase II.

Phase II commences when the Copper Products Filtrate Treatment Plant has achieved 95% of capacity based on normal flows of 4.8 m^3/hr.

Daily loading discharges for parameters in this section shall be calculated by multiplication of the daily measured flow and measured sample concentration on the day of sampling. Sampling shall be in accordance with Subsection 3.1., Effluent Monitoring.

1.5.2. The authorized works are a combined sewer, outfall, lime water treatment plant, No. 12 Lagoon, No. 13 Lagoon, Collection Lagoon and related appurtenances located approximately as shown on the Site Plan A.

1.5.3. The location of the facilities from which the discharge originates is Lots 1, 2, 3 and 4, Plan 4926, Kootenay District.

1.5.4. The location of the point of discharge is Lots 1, 2, 3 and 4, Plan 4926, Kootenay District.

1.6. This subsection applies to the discharge of effluent from **METALLURGICAL PLANT OUTFALL 07** as shown on the attached Site Plan A. The site reference number for this discharge is E102985.

1.6.1. The maximum authorized rate of discharge is 60,000 m^3/day.

1.6.2. The characteristics of a 24 hour composite sample of the effluent shall be equivalent to typical non - contact cooling water.

1.6.3. The authorized works are submerged outfall, and related appurtenances located approximately as shown on the Site Plan A.

1.6.4. The location of the facilities from which the discharge originates is Lots 1, 2, 3 and 4, Plan 4926, Kootenay District.

1.6.5. The location of the point of discharge is Lots 1, 2, 3 and 4, Plan 4926, Kootenay District.

Carl Johnson

Carl Johnson, P.Eng.
Assistant Regional Waste Manager

2. GENERAL REQUIREMENTS

2.1. MAINTENANCE OF WORKS

The Permittee shall inspect the pollution control works regularly and maintain them in good working order. The Permittee shall notify the Regional Waste Manager of any malfunction of these works.

2.2. EMERGENCY PROCEDURES

In the event of an emergency or condition beyond the control of the Permittee which prevents continuing operation of the approved method of pollution control, the Permittee shall immediately notify the Regional Waste Manager and take appropriate remedial action. The Permittee shall submit a report to the Regional Waste Manager detailing the circumstances and environmental effects of the incident within 10 working days.

2.3. BYPASSES

The discharge of effluent which has bypassed the designated treatment works is prohibited unless the approval of the Director or the Regional Waste Manager is obtained and confirmed in writing. Until the shutdown of the existing Blast Furnaces, the Permittee shall keep records of the frequency and duration of Blast Furnace slag granulation events and correlate these events with monitoring results associated with the Slag Collection Pond overflow.

2.4. PROCESS MODIFICATIONS

The Permittee shall notify the Regional Waste Manager prior to implementing changes to any process that may affect the quality and/or quantity of the discharge.

2.5. VEHICLE CONTAMINANT CONTROL

The Permittee shall ensure, to the satisfaction of the Regional Waste Manager, that contaminants are not transported off the plant site on the wheels and undercarriage of vehicles.

R.J.Crozier, R.P. Bio.
Regional Waste Manager

2.6. EFFLUENT MANAGEMENT PLAN

Beyond the requirements of this permit, Cominco has initiated an environmental management program that includes identifying and implementing further opportunities for reducing the amount of contaminants discharged to the Columbia River. As part of this program Cominco is preparing an Effluent Management Plan, that complements this Permit, and incorporates input from the Ministry of Environment, Lands and Parks, Environment Canada, and Department of Fisheries and Oceans, Canada. The Plan includes a program of improvements and timelines, comprising both treatment projects and source reduction through pollution prevention and process controls. The object of this Plan is to achieve the discharge quality and loading limits specified in this Permit, and to achieve receiving water quality concentrations that will protect aquatic life in the Columbia River.

Cominco will review the Effluent Management Plan annually with the above parties, and issue a summary progress report to the public. The review will include performance and progress on improvement program, and provide an opportunity for adjustments in light of new scientific knowledge and technology changes at Cominco. A summary of the Effluent Management Plan will be available from Cominco upon its completion.

3. MONITORING AND REPORTING REQUIREMENTS

3.1. EFFLUENT MONITORING

3.1.1. Combined Sewers II and III

Flow and pH measurement shall be continuous.
All samples are to be taken as 24 hour flow proportionate composites.

Parameter	Sample Frequency
Total Arsenic	Every 6 days on the NAPS [2] Schedule
Dissolved Arsenic	Every 6 days on the NAPS [2] Schedule

R.J.Crozier, R.P. Bio.
Regional Waste Manager

Date Issued: November 29, 1978
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Total Cadmium	Every 6 days on the NAPS [2] Schedule
Dissolved Cadmium	Every 6 days on the NAPS [2] Schedule
Total Copper	Every 6 days on the NAPS [2] Schedule
Dissolved Copper	Every 6 days on the NAPS [2] Schedule
Dissolved Fluoride [1]	Every 6 days on the NAPS [2] Schedule
Total Ammonia as N [1]	Every 6 days on the NAPS [2] Schedule
Total Lead	Every 6 days on the NAPS [2] Schedule
Dissolved Lead	Every 6 days on the NAPS [2] Schedule
Total Mercury	Every 6 days on the NAPS [2] Schedule
Total Thallium [1]	Every 6 days on the NAPS [2] Schedule
Dissolved Thallium [1]	Every 6 days on the NAPS [2] Schedule
Total Zinc	Every 6 days on the NAPS [2] Schedule
Dissolved Zinc	Every 6 days on the NAPS [2] Schedule
Non-filterable Residue	Every 6 days on the NAPS [2] Schedule
96 hr Rainbow trout LC_{50} [3]	Quarterly
Temperature [4]	Monthly

Notes:

1. Fluoride, thallium, and total ammonia to be sampled on Combined Sewer III only.
2. NAPS schedule is the National Air Pollution Surveillance pre-set 6 day schedule covering each day of the week.
3. Analysis for the above dissolved metals (thallium on Sewer III only) shall be performed on the bioassay sample before and after the 100 % effluent test.

R.J.Crozier, R.P. Bio.
Regional Waste Manager

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4. Temperature shall be recorded over a 24 hour period once per month and the range (maximum, minimum and average) reported.

3.1.2. Sewer 07

Flow and conductivity measurement shall be continuous.

Temperature shall be recorded over a 24 hour period once per month and the range (maximum, minimum and average) reported.

3.1.3. Slag Collection Pond Overflow

Flow measurement shall be continuous.

All samples in this section shall be 24 hour flow proportionate composites samples.

Parameter	Sample Frequency
Total Arsenic	Every 6 days on the NAPS [1] Schedule
Dissolved Arsenic	Every 6 days on the NAPS [1] Schedule
Total Cadmium	Every 6 days on the NAPS [1] Schedule
Dissolved Cadmium	Every 6 days on the NAPS [1] Schedule
Total Copper	Every 6 days on the NAPS [1] Schedule
Dissolved Copper	Every 6 days on the NAPS [1] Schedule
Total Lead	Every 6 days on the NAPS [1] Schedule
Dissolved Lead	Every 6 days on the NAPS [1] Schedule
Total Mercury	Every 6 days on the NAPS [1] Schedule
Total Zinc	Every 6 days on the NAPS [1] Schedule

R.J.Crozier, R.P. Bio.
Regional Waste Manager

Dissolved Zinc	Every 6 days on the NAPS [1] Schedule
pH	Every 6 days on the NAPS [1] Schedule
Non-filterable Residue	Every 6 days on the NAPS [1] Schedule

Notes:

1. NAPS schedule is the National Air Pollution Surveillance pre-set 6 day schedule covering each day of the week.

3.1.4. Slag Collection Pond Underflow

Flow shall be measured monthly using lithium tracer.

All samples in this section shall be taken as 24 hour composite samples.

Parameter	Sample Frequency
Total Arsenic	Every 6 days on the NAPS [1] Schedule
Dissolved Arsenic	Every 6 days on the NAPS [1] Schedule
Total Cadmium	Every 6 days on the NAPS [1] Schedule
Dissolved Cadmium	Every 6 days on the NAPS [1] Schedule
Total Copper	Every 6 days on the NAPS [1] Schedule
Dissolved Copper	Every 6 days on the NAPS [1] Schedule
Total Lead	Every 6 days on the NAPS [1] Schedule
Dissolved Lead	Every 6 days on the NAPS [1] Schedule
Total Mercury	Every 6 days on the NAPS [1] Schedule
	Every 6 days on the NAPS [1]

Total Zinc	Schedule Every 6 days on the NAPS [1]
Dissolved Zinc	Schedule Every 6 days on the NAPS [1]
pH	Schedule Every 6 days on the NAPS [1]
Non-filterable Residue	Schedule

Notes:

1. NAPS schedule is the National Air Pollution Surveillance pre-set 6 day schedule covering each day of the week.

3.1.5. Slag Fuming Furnace Cooling Water

Flow shall be measured monthly using lithium tracer.

All samples in this section shall be taken as 24 hour composite samples.

Parameter	Sample Frequency
Total Arsenic	Every 6 days on the NAPS [1] Schedule
Dissolved Arsenic	Every 6 days on the NAPS [1] Schedule
Total Cadmium	Every 6 days on the NAPS [1] Schedule
Dissolved Cadmium	Every 6 days on the NAPS [1] Schedule
Total Copper	Every 6 days on the NAPS [1] Schedule
Dissolved Copper	Every 6 days on the NAPS [1] Schedule
Total Lead	Every 6 days on the NAPS [1] Schedule
Dissolved Lead	Every 6 days on the NAPS [1] Schedule
Total Mercury	Every 6 days on the NAPS [1] Schedule Every 6 days on the NAPS [1]

R.J.Crozier, R.P. Bio.
Regional Waste Manager

Total Zinc	Schedule Every 6 days on the NAPS [1]
Dissolved Zinc	Schedule Every 6 days on the NAPS [1]
pH	Schedule Every 6 days on the NAPS [1]
Non-filterable Residue	Schedule

Notes:

1. NAPS schedule is the National Air Pollution Surveillance pre-set 6 day schedule covering each day of the week.

3.2. Stoney Creek

Flow shall be measured continuously at the highway culvert.

Samples in this section shall be taken as discreet grabs.

Sites

E206560 Stoney Cr. above Pumphouse.

Parameter	Sample Frequency
Total Arsenic	Every 6 days on the NAPS [1] Schedule
Dissolved Arsenic	Every 6 days on the NAPS [1] Schedule
Total Cadmium	Every 6 days on the NAPS [1] Schedule
Dissolved Cadmium	Every 6 days on the NAPS [1] Schedule
Total Zinc	Every 6 days on the NAPS [1] Schedule
Dissolved Zinc	Every 6 days on the NAPS [1] Schedule

R.J.Crozier, R.P. Bio.
Regional Waste Manager

Date Issued: November 29, 1978
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Notes:
1. NAPS schedule is the National Air Pollution Surveillance pre-set 6 day schedule covering each day of the week.

3.3. Receiving Environment Monitoring

3.3.1. Water Quality Monitoring

Sites

0200003	Columbia R., Birchbank.
E223758	Columbia R., west bank 135 meters below Stoney Cr.
E209100	Columbia R., Old Trail Bridge, 1/3 of width from west shore.
0200559	Columbia R., east bank at Waneta

Parameter	Sample Frequency
Total Arsenic	Monthly grab sample [1]
Dissolved Arsenic	Monthly grab sample [1]
Total Cadmium	Monthly grab sample [1]
Dissolved Cadmium	Monthly grab sample [1]
Total Copper	Monthly grab sample [1]
Dissolved Copper	Monthly grab sample [1]
Total Lead	Monthly grab sample [1]
Dissolved Lead	Monthly grab sample [1]
Total Thallium	Monthly grab sample [1]
Dissolved Thallium	Monthly grab sample [1]
Total Zinc	Monthly grab sample [1]
Dissolved Zinc	Monthly grab sample [1]
Dissolved Fluoride	Monthly grab sample [1]
Dissolved Sulphate	Monthly grab sample [1]
Hardness	Monthly grab sample [1]
Total Ammonia (NH3 as N)	Monthly grab sample [1]
pH [2]	Monthly grab sample [1]
Temperature [2]	Monthly grab sample [1]

Notes:
1. Monthly grab samples shall be taken on a NAPS day to correspond with effluent sampling.

Carl Johnson

Carl Johnson, P.Eng.
Assistant Regional Waste Manager

Date Issued: November 29, 1978
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2. pH and river temperature at the time of ammonia sampling are necessary to determine the criteria/objective.

3.4. Analyses

Analyses are to be carried out in accordance with procedures described in the third edition of "A Laboratory Manual for the Analysis of Water, Wastewater, Sediment and Biological Materials, (March 1994 Permittee Edition)" or by suitable alternative procedures as authorized by the regional Waste Manager.

A copy of the above manual may be purchased from the Queen's Printer Publication Centre, 2nd Floor, 563 Superior Street, Victoria, British Columbia, V8V 4R6, (1-800-663-6105). The manual is also available for review at all Environmental Protection offices.

3.4.1. Effluent Analytical Detection Limits

The following are minimum requirements for analytical detection limits under Subsections 3.1 and 3.2:

Parameter *	Minimum Detection Limit (mg/L)
Arsenic	0.01
Cadmium	0.001**
Copper	0.01
Fluoride	0.05
Lead	0.01
Mercury	0.0001
Thallium	0.01
Zinc	0.01

* Applies to both total and dissolved forms.
** Equipment and procedures to achieve this level of detection to be operable by December 31, 1997.

R.J.Crozier, R.P. Bio.
Regional Waste Manager

3.4.2. Receiving Environment Analytical Detection Limits

The following are minimum requirements for analytical detection limits under Subsection 3.3.1:

Parameter *	Minimum Detection Limit (mg/L)
Arsenic	0.001
Cadmium	0.00001
Copper	0.001
Lead	0.001
Thallium	0.00001
Zinc	0.001

* Applies to both total and dissolved forms.

3.5. Toxicity

Analyses for determining the toxicity of liquid effluent to fish shall be carried out in accordance with the procedures described in the "Biological Test Method: Reference Method for Determining Acute Lethality of Effluents to Rainbow Trout" EPS 1/RM/13 July 1990. Results for reporting lethal toxicity shall be 96 hour LC_{50} in percent volume/volume effluent concentration plus the 95% confidence limits. Dilution water for the Rainbow trout bioassays required in Subsection 3.1.1 shall be taken from the Columbia River above Cominco operations.

3.6. Sampling Location and Techniques

Sampling and flow measurement shall be carried out in accordance with the procedures described in "Field Criteria for Sampling Effluents and Receiving Waters", April 1989, 17 pp., or by suitable alternative procedures as authorized by the Regional Waste Manager.

A copy of the above manual may be purchased from the Queen's Printer Publication Centre, P.O. Box 9452, Stn. Prov. Govt., Victoria British Columbia, V8W 9V7 (1-800-663-6105 or (250) 387-6409. A copy of the manual is also available for inspection at all Pollution Prevention offices.

Carl Johnson

Carl Johnson, P.Eng.
Assistant Regional Waste Manager

3.7. Quality Assurance/Quality Control

The Permittee shall produce within 60 days of the request of the Regional Waste Manager, 'Laboratory Quality Protocols and Quality Assurance Criteria' acceptable to the Regional Waste Manager. The 'Laboratory Quality Protocols' shall include the procedures used to assess precision, accuracy and blank quality, including frequency of application of those procedures, the procedures for sampling handling (eg. preservation, hold times) and corrective measures to be initiated when deficiencies are indicated. The 'Quality Assurance Criteria' shall include the acceptance criteria for accuracy (based on recoveries for reference samples/spikes), for precision (based on deviation in field and lab duplicates) and method blanks (designed to indicate false positives).

The Permittee shall certify that all data required under Subsections 3.1, 3.2 and 3.4 of this permit are produced in accordance with the 'Laboratory Quality Protocols' and met the 'Quality Assurance Criteria' as approved under Subsection 3.8 above. At the request of the Regional Waste Manager, the Permittee is to provide the laboratory quality assurance data along with the submission of the data required under Subsections 3.1 and 3.2 of this permit, as well as all associated field blanks and duplicate analysis results along with the submission of data required under Subsection 3.4 (receiving environment monitoring).

The Permittee shall ensure that all tests and other data required to be submitted under the permit are conducted by a laboratory acceptable to the Regional Waste Manager.

3.8. Special Monitoring Programs or Evaluations

3.8.1. Special effluent and receiving environment monitoring programs associated with the startup of major new processes or plants may be required as specified by the Regional Waste Manager.

3.8.2. In the event of a spill or upset condition that the Regional Waste Manager determines has the potential to impact the water quality of the Columbia River, the Permittee shall obtain a sequential series of grab samples at Waneta (BCE site 0200559). Initiation of sampling, sampling frequency, sampling duration and parameters will be determined in consultation with the Regional Waste Manager.

R.J.Crozier, R.P. Bio.
Regional Waste Manager

3.8.3. The Permittee shall continue to operate a continuous sampler on the Columbia River at Waneta (BCE site 0200559) and shall collect daily 24 hour composite samples. Samples not required for immediate analysis shall be preserved and stored for a period of one week after the day of sampling for subsequent analysis if required by the Regional Waste Manager.

3.8.4. The Permittee shall carry out a program to evaluate the toxicity of thallium. This evaluation shall involve a search of current scientific literature, contact with appropriate experts and plant and animal bioassay testing including lethal and sub-lethal or long term tests, to determine the potential effects of thallium in the freshwater aquatic environment. Details terms of reference will be developed cooperatively by Ministry of Environment, Lands and Parks and Cominco Ltd. A report of the findings of this study shall be submitted to the Regional Waste Manager by December 31, 1998.

3.9. REPORTING

3.9.1. All results obtained from effluent and receiving water monitoring specified above are to be tabulated and submitted to the Regional Waste Manager monthly within 30 days of the end of the month the samples were obtained. In conjunction with this report, the Permittee shall submit records of use of standby launders.

3.9.2. The Permittee shall prepare an annual report suitable for release to the public, that tabulates and explains the outfall sampling and analyses as well as results of receiving water quality monitoring.

3.9.3. This report shall include an explanation of any installation of works or changes to the process that have taken place over the previous 12 months, and the progress made on programs and plans.

3.9.4. This annual report is due by March 31, of the following year.

R.J.Crozier, R.P. Bio.
Regional Waste Manager

4. DEFINITIONS

4.1 Dissolved Metals

Theoretically refers to dissociated or ionic forms of metals dissolved in water. In practice this refers to the portion of metal in a water sample that passes a 0.45 μm pore filter and is subsequently digested with strong acid and quantified using spectral analysis. A more accurate term sometimes used is 'filtered metal'. This 'dissolved' or filtered portion of the total metal is generally the portion of the total metal considered most available for uptake by aquatic life and thus the portion most responsible for toxic effects, if found in high enough concentrations.

4.2 Total Metals

The entire quantity of a given metal in a sample as determined by strong acid digestion and subsequent spectral analysis of the ionized metal. Subtracting the dissolved metal (filtered metal) from the total metal leaves a fraction of the total referred to as 'particulate metal' and includes sediment bound and colloidal forms. Some of the metal in this fraction may be weakly bound and be eventually released from the sediment or become available upon ingestion by aquatic biota. For this reason, until an analytical technique is developed for 'bioavailable metal', Water Quality Criteria and Objectives set for the total metal.

PROVINCE OF
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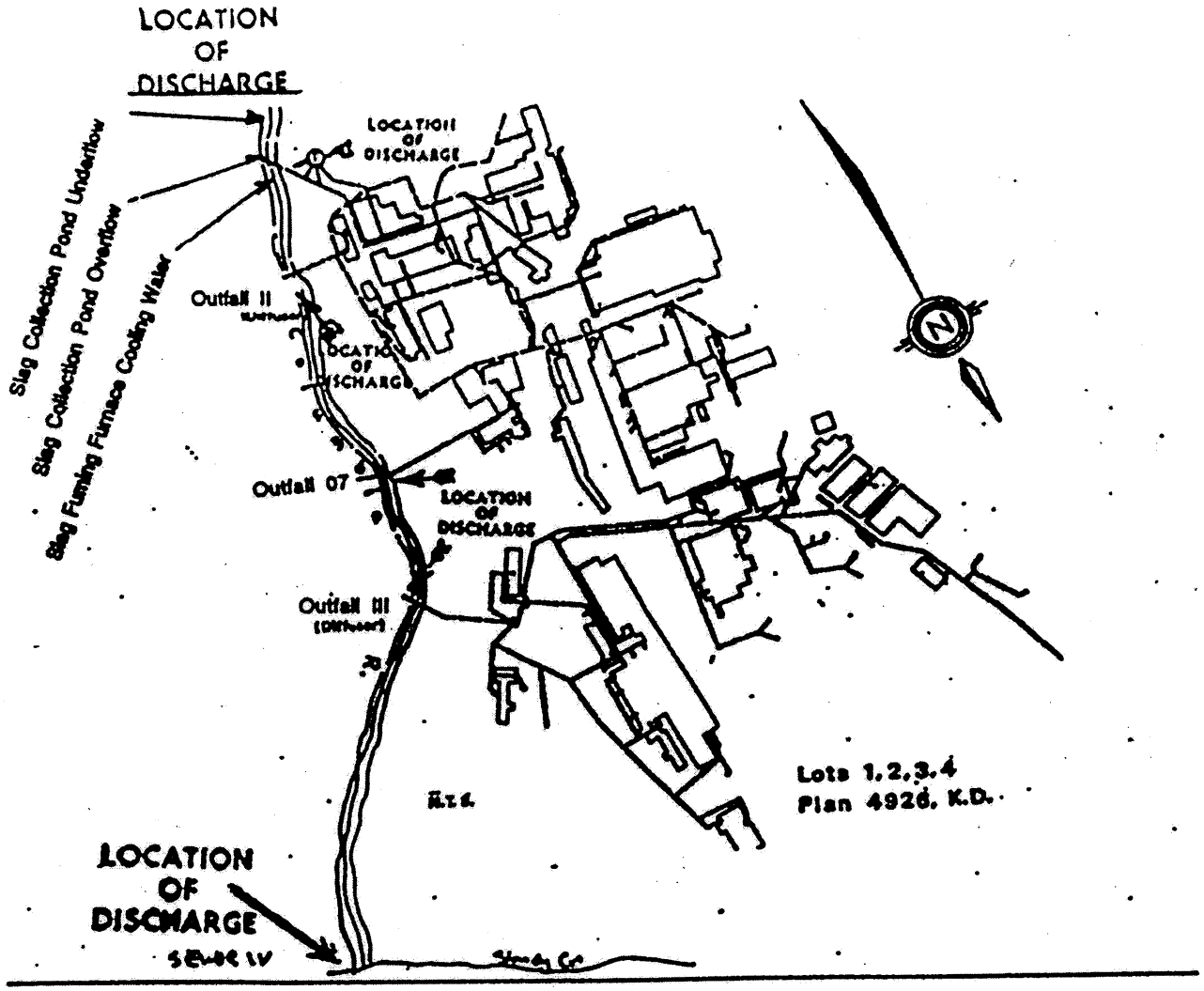
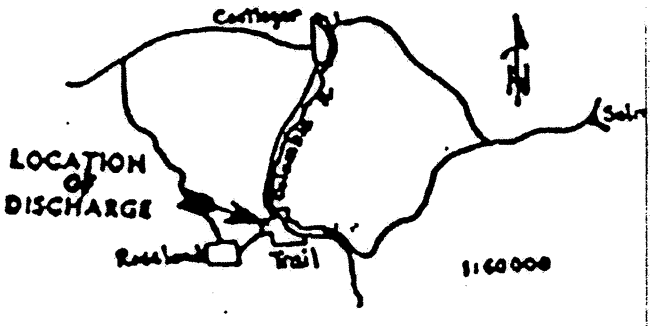
SITE PLAN A



LEGAL DESCRIPTION: Lots 1, 2, 3 and 4, Plan 4926, Kootenay District

GENERAL DESCRIPTION



Scale: Not to Scale

Name of Applicant: **Cominco Ltd.-Cominco Ltee**

PERMIT: PE-02753

Date Issued: November 29, 1978

Amended: NOV 29 1996

R.J. Crozier, R.P. Bio.
Regional Waste Manager
Kootenay Region

BRITISH COLUMBIA

June 8, 2006

File: PE-02753

REGISTERED MAIL

Teck Cominco Metals Ltd.
600-200 Burrard Street
Vancouver, British Columbia V1C 3L9

Dear Permittee:

Enclosed is Amended Permit PE-02753 issued under the provisions of the *Environmental Management Act*. Your attention is respectfully directed to the terms and conditions outlined in the permit. A corresponding effluent permit being PE-05309 has been amalgamated with PE-02753 as addressed in the attached permit. An annual fee will be determined according to the Permit Fees Regulation.

This permit does not authorize entry upon, crossing over, or use for any purpose of private or Crown lands or works, unless and except as authorized by the owner of such lands or works. The responsibility for obtaining such authority rests with the permittee. This permit is issued pursuant to the provisions of the *Environmental Management Act* to ensure compliance with Section 120(3) of that statute, which makes it an offence to discharge waste, from a prescribed industry or activity, without proper authorization. It is also the responsibility of the permittee to ensure that all activities conducted under this authorization are carried out with regard to the rights of third parties, and comply with other applicable legislation that may be in force.

This decision may be appealed to the Environmental Appeal Board in accordance with Part 8 of the *Environmental Management Act*. An appeal must be delivered within 30 days from the date that notice of this decision is given. For further information, please contact the Environmental Appeal Board at (250) 387-3464.

. . . 2

Ministry of Environment

Regional Operations
Kootenay and Okanagan Regions

Mailing/Location Address
401-333 Victoria St.
Nelson, BC V1L 4K3

Telephone: (250) 354-6355
Facsimile: (250) 354-6332
http://www.gov.bc.ca/
http://www.gov.bc.ca/env

Administration of this permit will be carried out by staff from the Kootenay and Okanagan Regions. Plans, data and reports pertinent to the permit are to be submitted to the Regional Manager, Environmental Protection, at Ministry of Environment, Regional Operations, Kootenay and Okanagan Regions, 401-333 Victoria St., Nelson, BC V1L 4K3.

Yours truly,

Carl Johnson

Carl Johnson, P.Eng.
for Director, *Environmental Management Act*
Kootenay and Okanagan Regions

CJ:lkm

Enclosure

cc: Environment Canada
Teck Cominco Metals Ltd., PO Box 1000, Trail BC V1R 4L8 (Hand Delivered)

BRITISH COLUMBIA

MINISTRY OF ENVIRONMENT

Environmental Protection

PERMIT
PE-02753

Under the Provisions of the Environmental Management Act

TECK COMINCO METALS LTD.

600 - 200 BURRARD STREET

VANCOUVER, BRITISH COLUMBIA

V6C 3L9

is authorized to discharge effluent to the Columbia River from a lead-zinc smelter and fertilizer plant located in Trail, British Columbia, subject to the conditions listed below. Contravention of any of these conditions is a violation of the *Environmental Management Act* and may result in prosecution.

This permit supersedes and amends all previous versions of Permits **PE-02753 and PE-05309**, issued under Part 2 Section 10 of the *Waste Management Act*.

1. AUTHORIZED DISCHARGES

1.1 This subsection applies to the discharge of effluent from **METALLURGICAL PLANT OUTFALL II**. The site reference number for this discharge is E102983.

1.1.1 The characteristics of a 24-hour flow proportional composite sample of the effluent shall be equivalent to or less than the maximum loading or concentration authorized for each parameter below:

Element	
Total Cadmium	1.0 kg/d
Total Copper	3.0 kg/d
Total Lead	40 kg/d
Total Mercury	0.1 kg/d
Total Zinc	175 kg/d
FLOW	150,000 m^3/d
pH range	6.5 to 8.5

Date issued: November 29, 1978
Date amended: (most recent) JUN 0 8 2006

Carl Johnson, P. Eng.
For Director, *Environmental Management Act*
Kootenay and Okanagan Regions
Permit Number: PE-02753

A grab sample of the effluent from Outfall II shall achieve 100 % as measured by a single concentration 96-hour LC_{50} pass/fail acute toxicity test using rainbow trout.

Daily loading discharges for parameters in this section shall be calculated by multiplication of the daily measured flow and measured sample concentration on the day of sampling. Sampling shall be in accordance with written instruction of the Director.

1.1.2 The authorized works are a combined outfall, and related appurtenances approximately located as shown on attached Site Plan A.

1.1.3 The authorized works must be complete and in operation when discharge commences.

1.1.4 The location of the facilities from which the discharge originates and the location of the point of discharge is Lots 1, 2, 3 and 4, Kootenay District, Plan 4926.

1.2 This subsection applies to the discharge of effluent from **METALLURGICAL PLANT OUTFALL III**. The site reference number for this discharge is E102984.

1.2.1 The characteristics of a 24-hour flow proportional composite sample of the effluent shall be equivalent to or less than the maximum loading or concentration authorized for each parameter below:

Element	
Non Filterable Residue	1250 kg/d
Total Arsenic	12.0 kg/d
Total Cadmium	4.0 kg/d
Total Copper	6.0 kg/d
Total Lead	60.0 kg/d
Total Mercury	0.4 kg/d
Total Thallium	30 kg/d
Total Zinc	125 kg/d
FLOW	140,000 m^3/d
pH range	6.5 to 9.5

A grab sample of the effluent from Outfall III shall achieve 100% as measured by a single concentration 96-hour LC_{50} pass/fail acute toxicity test using rainbow trout.

Date Issued: November 29, 1978
Date Amended:
(most recent) JUN 0 8 2006

Carl Johnson, P. Eng.
For Director, *Environmental Management Act*
Kootenay and Okanagan Regions
Permit Number: PE-02753

Daily loading discharges for parameters in this section shall be calculated by multiplication of the daily measured flow and measured sample concentration on the day of sampling. Sampling shall be in accordance with written instruction of the Director.

1.2.2 The authorized works are a combined outfall, lime water treatment plant, mercury cleaning area, Main ETP Collection Lagoon, and related appurtenances approximately located as shown on attached Site Plan A.

1.2.3 The authorized works must be complete and in operation when discharge commences.

1.2.4 The location of the facilities from which the discharge originates and the location of the point of discharge is the same location as set out in Subsection 1.1.

1.3 This subsection applies to the discharge of effluent from the **FERTILIZER PLANT OUTFALL IV**. The site reference number for this discharge is E102990.

1.3.1 The characteristics of a 24-hour flow proportional composite sample of the effluent shall be equivalent to or less than the maximum loading or concentration authorized for each parameter below:

Element	
Total Mercury	.05 kg/d
Ammonia as total N	1000 kg/d
Total Zinc	50 kg/d
FLOW	60,000 m^3/d
pH range	6.2 to 8.5

A grab sample of the effluent from Outfall II shall achieve 100 % as measured by a single concentration 96-hour LC_{50} pass/fail acute toxicity test using rainbow trout.

Daily loading discharges for parameters in this section shall be calculated by multiplication of the daily measured flow and measured sample concentration on the day of sampling. Sampling shall be in accordance with written instruction of the Director.

1.3.2 The authorized works are a combined outfall, and related appurtenances approximately located as shown on attached Site Plan B.

1.3.3 The authorized works must be complete and in operation when discharge commences.

Carl Johnson

Carl Johnson, P. Eng.
For Director, *Environmental Management Act*
Kootenay and Okanagan Regions
Permit Number: PE-02753

Date Issued: November 29, 1978
Date Amended: JUN 0 8 2006
(most recent)

1.3.4 The location of the facilities from which the discharge originates and the location of the point of discharge is Lots 1, and 3, Plan 6446, Kootenay District, and Part Assigned No. 25 and No. 18 Plan 1425, Kootenay District.

2. GENERAL REQUIREMENTS

2.1 Maintenance of Works and Emergency Procedures

The permittee shall inspect the authorized works regularly and maintain them in good working order. In the event of an emergency or condition beyond the control of the permittee which prevents effective operation of the approved method of pollution control, the permittee shall immediately take appropriate remedial action and shall notify the Director or an Officer designated by the Director:

a) by telephone if the condition occurs between the hours of 08:00 and 16:30, Monday to Friday;
b) by facsimile transmission if the condition occurs at any other time.

In addition to any reporting requirements under the Spill Reporting Regulation or as otherwise directed by the Director, notification of any occurrence under this section must be reported to the Director within 24 hours of the permittee becoming aware of such occurrence.

Immediately upon becoming aware of an event which results or could be reasonably expected to result, in uncontrolled losses to the Columbia River in excess of the permit parameter quantities listed above, the permittee shall report the event to the Provincial Emergency Program (PEP), in a manner defined in section 2 (3) of the Spill Reporting Regulation.

2.2 Bypasses

The permittee shall ensure that no waste is discharged without being processed through the authorized works unless prior written approval is received from the Director.

2.3 Process Modifications

The permittee shall have written approval from the Director prior to implementing changes to the authorized works that may result in discharges exceeding the characteristics authorized under this permit.

Carl Johnson

Carl Johnson, P. Eng.
For Director, *Environmental Management Act*
Kootenay and Okanagan Regions
Permit Number: PE-02753

2.4 Vehicle Contaminant Control

The permittee shall ensure, to the satisfaction of the Director, that contaminants are not transported off the plant site on the wheels and undercarriage of vehicles.

2.5 Effluent Management Program

Beyond the requirements of this permit, Teck Cominco has initiated an environmental management program that includes identifying and implementing further opportunities for reducing the amount of contaminants discharged to the Columbia River. Teck Cominco will periodically review with the Ministry of Environment and other interested parties such as Environment Canada and Department of Fisheries and Oceans, Canada its significant aspects and its plans for addressing further improvement opportunities. The review will include performance and progress reports on improvement programs and provide an opportunity for adjustments in light of new scientific knowledge and other related technical changes at the Teck Cominco facility.

3. MONITORING AND REPORTING REQUIREMENTS

3.1 Discharge Monitoring

The permittee shall carry out a discharge monitoring program as specified by the Director in writing. This program may be modified from time to time as appropriate and agreed to in writing by both parties.

3.2 Monitoring of the Receiving Environment

3.2.1 Water Quality Monitoring

The Director acknowledges Teck Cominco's voluntary participation and funding contribution to the Columbia River Integrated Monitoring Program (CRIEMP). If CRIEMP monitoring activities are suspended and/or the CRIEMP program ceases to exist, the Director will review receiving environment monitoring programs and will determine the need for Teck Cominco's direct participation in Columbia River monitoring.

3.2.2 The Director may require additional monitoring at any time by specifying such in writing to the permittee.

3.2.3 For the purposes of this permit, the Initial Dilution Zone is defined as the Columbia River between Outfall IV and the City of Trail's "Old Bridge.

Carl Johnson

Carl Johnson, P. Eng.
For Director, *Environmental Management Act*
Kootenay and Okanagan Regions
Permit Number: PE-02753

**PROVINCE OF
BRITISH COLUMBIA**

3.3 Reporting

The permittee shall prepare an annual report suitable for release to the public, that tabulates and explains the outfall sampling and analyses. The report shall include an explanation of any changes to the process or environmental control equipment that have taken place over the previous year. The annual report is due by March 31 of the following year.

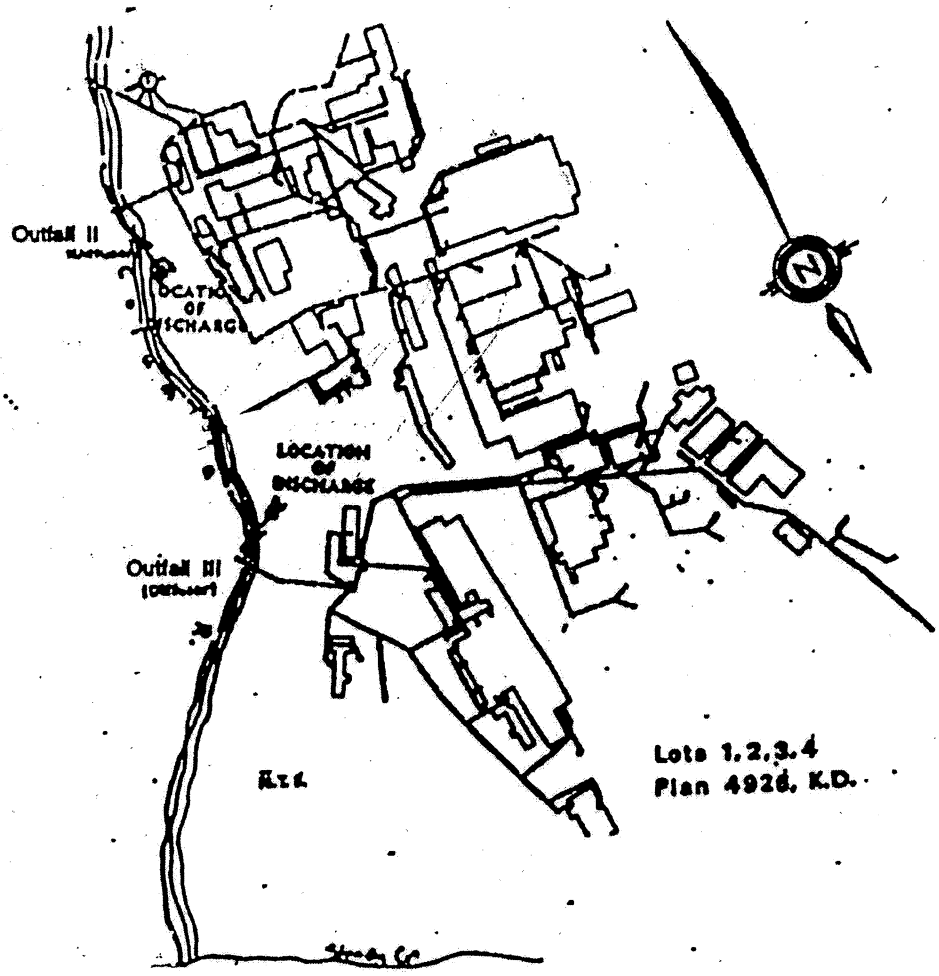
Date Issued: November 29, 1978
Date Amended: JUN 0 8 2006
(most recent)

Carl Johnson, P. Eng.
For Director, *Environmental Management Act*
Kootenay and Okanagan Regions
Permit Number: PE-02753

PROVINCE OF
BRITISH COLUMBIA

Environmental Protection

Site Plan A



LEGAL DESCRIPTION: Lots 1,2,3 and 4, Plan 4926, Kootenay District

Permit: PE-02753

Date Issued: November 29, 1978

Date Amended: JUN 0 8 2006
(most recent)

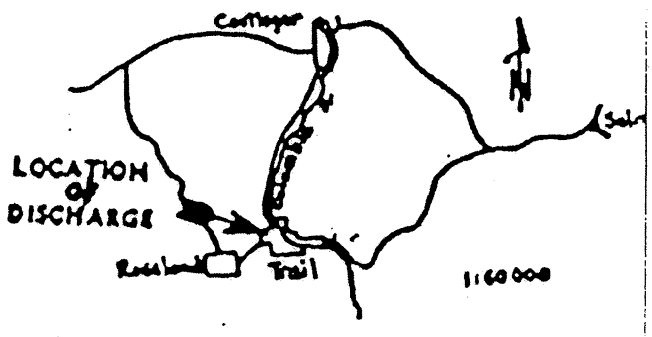
for Director, Environmental Management Act

Carl Johnson

Carl Johnson, P.Eng.

Name of Applicant: Teck Cominco Ltd.

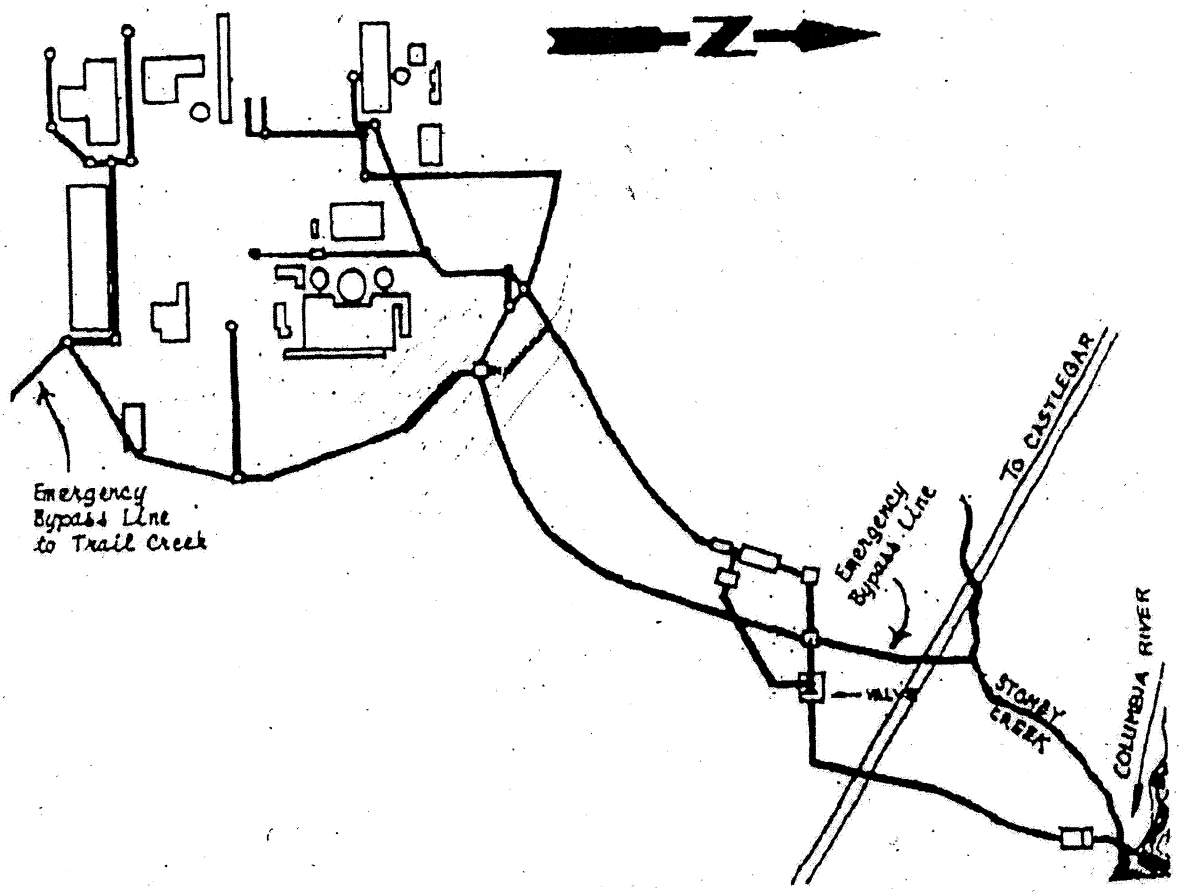
LOCATION MAP



PROVINCE OF
BRITISH COLUMBIA

Environmental Protection

Site Plan B



LEGAL DESCRIPTION: Lot 1 and Lot 3, Plan 6446, kootenay District and part Assigned No. 25 and Assigned No. 18, Plan 1425, Kootenay District

Permits: PE-02753

Date Issued: November 29, 1978

Date Amended: (most recent) JUN 0 8 2006

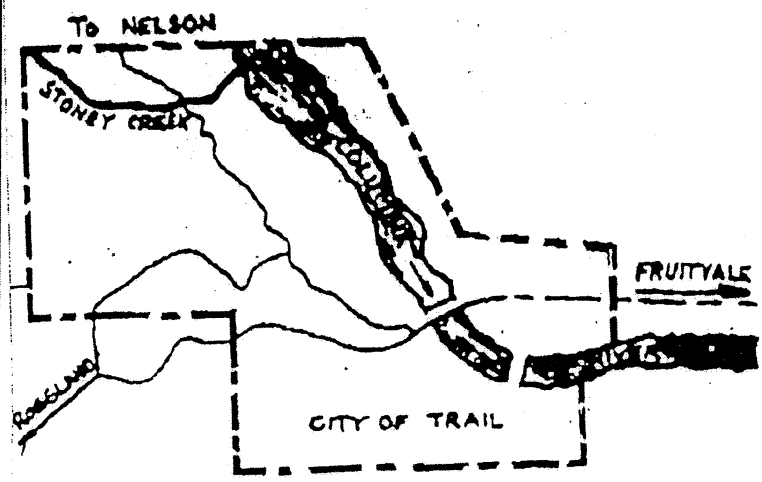
for Director, Environmental Management Act

Carl Johnson

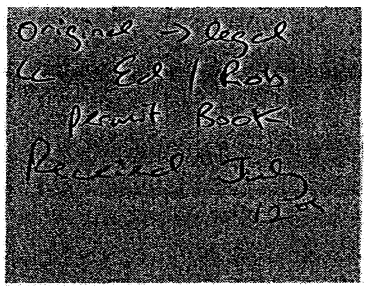
Carl Johnson, P.Eng.

Name of Applicant: Teck Cominco Ltd.

LOCATION MAP



BRITISH COLUMBIA



June 28, 2006 File: PE-02753

Teck Cominco Metals Ltd.
PO Box 1000
Trail BC V1R 4L8

Attention: Ed Kniel, Garry Garwyletz - Environmental Monitoring

Dear Ed and Garry:

Re: Monitoring and Reporting Associated with PE-02753

In reference to Section 3.1 of amended permit PE-02753 which combines PE-02753 and PE-05309, the following effluent monitoring and data reporting programs are to be carried out by the permittee.

Effluent Monitoring of each Outfall II, III and IV

-24 hour flow proportional composite sample taken on NAPS day
-pH and flow measured continuously
-total metals to be analyzed on each sample

-Outfall II – lead, zinc, cadmium, copper, mercury,
-Outfall III – lead, zinc, cadmium, arsenic, copper, mercury, thallium, Total Suspended Solids
-Outfall IV – mercury, zinc, ammonia as total N

On alternate NAPS days the 24-hour composite sample is to be analyzed for dissolved metals (except mercury and Ammonia) as well as total metals. This specific requirement will be reviewed annually to determine the necessity of continuing.

Obtain 6 grab samples of each effluent at approximately equally spaced intervals per year for analysis of acute (pass/fail) rainbow trout 96 hour toxicity using 100 % effluent. Each sample is to be analysed before and after the bioassay period for total and dissolved metals and hardness.

. . . 2

Ministry of Environment | Environmental Protection Kootenay and Okanagan Regions | Mailing/Location Address: 401 - 333 Victoria Street Nelson BC V1L 4K3 | Telephone: 250 354-6355 Facsimile: 250 354-6332

Remotely activated sequential monitoring stations at Waneta and the Old Trail Bridge are to be available for use in the event of spills or process upsets where there is some concern regarding water quality at these locations. The new site at the Old Trail Bridge is to be operational by December 31, 2006.

Reporting

Monitoring data should be submitted electronically by the end of the month following collection and analysis. For example samples collected in January and analyzed in February should be reported before the end of March. The data is to be entered on the Ministry of Environment electronic data base (EMS) in the form of loadings of both total and dissolved contaminants, pH as the calculated 24 hour average of the individual outfall continuous monitor output, and flow volume, all in a format and with units consistent with the Ministry of Environment data base.

A written summary is to continue to be submitted to the Director monthly that highlights environmental performance and non-compliant situations. Continuous pH and flow data are to be retained by the permittee for a minimum of two years and made available on the request of the Director.

For discharge loading calculation purposes, ½ the detection limit or Limit of Quantification is to be used for those analytical results that are less than the acceptable laboratory detection. This is consistent with NPRI protocols.

Yours truly,

Carl Johnson

Carl Johnson, P.Eng.
For Director, *Environmental Management Act*

CJ:lkm

cc: Robyn Roome, A/Head, Environmental Quality Section, Nelson

BRITISH COLUMBIA

JUN 0 4 1997

Our File: PE-05309

REGISTERED MAIL

Cominco Ltd. - Cominco Ltee.
500 - 200 Burrard Street
VANCOUVER BC V6C 3L7

Dear Permittee:

Enclosed is Amended Permit PE-05309 issued under the provisions of the Waste Management Act. Your attention is respectfully directed to the conditions outlined in the permit. An annual permit fee will be determined according to the Waste Management Permit Fees Regulation.

This permit does not authorize entry upon, crossing over, or use for any purpose of private or Crown lands or works, unless and except as authorized by the owner of such lands or works. The responsibility for obtaining such authority rests with the permittee. It is also the responsibility of the permittee to ensure that all activities conducted under this permit are carried out with due regard to the right of the third parties and comply with other applicable legislation that may be in force.

This permit may be appealed by persons who consider themselves aggrieved by this decision in accordance with Part 7 of the Waste Management Act. Written notice of intent to appeal must be received by the Regional Waste Manager within twenty-one (21) days of the date of this decision.

Administration of this permit will be carried out by staff from our Regional Office located at #401-333 Victoria Street, Nelson, British Columbia, V1L 4K3, (telephone: (250) 354-6355). Plans, data and reports pertinent to the permit are to be submitted to the Regional Waste Manager at Nelson, British Columbia.

Yours truly,

R.J. Crozier, R.P. Bio.
Regional Waste Manager
Kootenay Region
/lkf
ENCLOSURE

cc: Cominco Ltd., Trail BC V1R 4L8

Ministry of Environment, Lands and Parks

Environment and Lands
Kootenay Region

Mailing/Location Address:
401 - 333 Victoria Street
Nelson BC VIL 4K3

Telephone: (250) 354-6333
Facsimile: (250) 354-6332
PP Facsimile:(250) 354-6367

PROVINCE OF
BRITISH COLUMBIA

Pollution Prevention
#401-333 Victoria Street
Nelson, British Columbia V1L 4K3
Telephone: (250) 354-6355
Fax: (250) 354-6367

MINISTRY OF ENVIRONMENT,
LANDS AND PARKS

PERMIT
PE-05309

Under the Provisions of the Waste Management Act

COMINCO LTD. - COMINCO LTEE.

500 - 200 BURRARD STREET

VANCOUVER, BRITISH COLUMBIA

V6C 3L7

is authorized to discharge effluent to the Columbia River from a fertilizer plant, steam plant, analytical lab and pure metals processing operation located in Warfield, British Columbia, subject to the conditions listed below. Contravention of any of these conditions is a violation of the Waste Management Act and may result in prosecution.

This permit supersedes and amends all previous versions of Permit **PE-05309**, issued under Part 2, Section 10 of the Waste Management Act.

1. AUTHORIZED DISCHARGES

1.1. This subsection applies to the discharge of effluent from **THE WARFIELD FERTILIZER PLANT, STEAM PLANT, ANALYTICAL LAB AND PURE METALS PROCESSING OPERATION** to the Columbia River. The site reference number for this discharge is E102990.

1.1.1. The maximum authorized rate of discharge is 60,000 m^3/day.

1.1.2. The characteristics of a 24 hour flow proportional composite sample of effluent shall be equivalent to or less than the maximum loading or concentration stipulated in Column 2 for each parameter stipulated in Column 1 as listed below:

Column 1	Column 2
Dissolved Zinc	50 kg/d

R.J. Crozier, R.P. Bio.
Regional Waste Manager

Dissolved Ammonia (as N)	1500 kg/d Maximum Concentration of a 24 hour flow proportional composite sample shall not exceed 25 mg/l
Total Mercury	.097 kg/d
pH Range	Between 6.0 - 8.0

Daily discharges shall be calculated based on a multiplication of the daily measured flow and sample concentration for each of the specified parameters as required in Subsection 3.1., Effluent Monitoring. Compliance assessment is based on evaluation of monitoring data submitted on the NAPS schedule (every 6 days).

1.1.3. The authorized works are a combined sewer, submerged outfall and related appurtenances and any other treatment facilities required to meet the effluent characteristics specified in Subsection 1.1.2. above located approximately as shown on attached Site Plan A.

1.1.4. The location of the facilities from which the discharge originates is Lots 1 and 3, Plan 6446, Kootenay District and Part Assigned No. 25 and Assigned No. 18, Plan 1425, Kootenay District.

1.1.5. The location of the point of discharge is Lots 1 and 3, Plan 6446, Kootenay District and Part Assigned No. 25 and Assigned No. 18, Plan 1425, Kootenay District.

2. GENERAL REQUIREMENTS

2.1. Tank Cleanout

Prior to the cleanout of any process tank or vessel resulting in a potential discharge to the environment, the permittee shall obtain representative samples of the material to be disposed of and notify the Regional Waste Manager in order to obtain direction as to the disposal method.

During the period of any tank cleanout involving discharge to the Columbia River the permittee shall take continuous samples (or sample as directed by the Regional Waste Manager) to determine the resultant effect of the final discharge quality. Analysis for contaminants shall be carried out at a frequency determined by the Regional Waste Manager.

R.J. Crozier, R.P. Bio.
Regional Waste Manager

2.2. Maintenance of Works and Emergency Procedures

The permittee shall inspect the pollution control works regularly and maintain them in good working order. In the event of an emergency or condition beyond the control of the permittee which prevents continuing operation of the approved method of pollution control, the permittee shall immediately notify the Regional Waste Manager and take appropriate remedial action.

2.3. Bypasses

The discharge of effluent which has bypassed the designated treatment works is prohibited unless the approval of the Regional Waste Manager is obtained and confirmed in writing.

On each occasion of bypass the permittee shall fully record the reason, duration and flow rate of the bypass and sample the discharge(s) as required by the Regional Waste Manager.

3. MONITORING AND REPORTING REQUIREMENTS

3.1. Effluent Monitoring

Sewer IV shall be sampled (a 24 hour flow proportional composite) once every 6 days on the NAPS schedule. The site reference number for this discharge is E102990. These samples are to be analyzed for:

a) Total Suspended Solids

b) pH

c) Total Mercury

d) Dissolved NH_3 (as N)

e) Dissolved Zinc

f) Dissolved Sulphate

g) 96 hour LC 50 Rainbow Trout Bioassay *

* Trout bioassay to be done quarterly, using grab samples of effluent, portion of grab sample to be analyzed for above contaminants (a-f) in order to determine cause of toxicity if any.

The effluent discharge rate from Sewer IV shall be determined continuously.

R.J. Crozier, R.P. Bio.
Regional Waste Manager

3.2. Analytical Procedures

Analyses are to be carried out in accordance with procedures described in the latest version of "British Columbia Environmental Laboratory Manual for the Analysis of Water, Wastewater, Sediment and Biological Materials, (March 1994 Permittee Edition)", or by suitable alternative procedures as authorized by the Regional Waste Manager.

A copy of the above manual may be purchased from Queen's Printer Publications Centre, 2nd Floor, 563 Superior Street, Victoria, British Columbia, V8V 4R6, (1-800-663-6105 or (250) 387-4609). A copy of the manual is also available for inspection at all Pollution Prevention offices.

3.3. Toxicity

Analyses for determining the toxicity of liquid effluents to fish shall be carried out in accordance with the procedures described in the "British Columbia Environmental Laboratory Manual for the Analysis of Water, Wastewater, Sediment and Biological Materials, (March 1994 Permittee Edition)", or by suitable alternative procedures as authorized by the Regional Waste Manager.

A copy of the above manual may be purchased from Queen's Printer Publications Centre, 2nd Floor,563 Superior Street, Victoria, British Columbia, V8V 4R6, (1-800-663-6105 or (250) 387-4609). A copy of the manual is also available for inspection at all Pollution Prevention offices.

3.4. Reporting

Maintain data of analyses and flow measurements for inspection and submit the data, suitable tabulated, to the Regional Waste Manager on a monthly basis. All reports shall be submitted within 31 days of the end of the month. In conjunction with the report, the permittee shall submit those records obtained for any process upset or bypass.

R.J. Crozier, R.P. Bio.
Regional Waste Manager

3.5. Quality Assurance

Permittee shall produce within 60 days of the request of the Regional Waste Manager, 'Laboratory Quality Protocols and Quality Assurance Criteria' acceptable to the Regional Waste Manager. The 'Laboratory Quality Protocols' shall include the procedures used to assess precision, accuracy and blank quality, including frequency of application of those procedures, the procedures for sampling handling (eg. preservation, hold times) and corrective measures to be initiated when deficiencies are indicated. The 'Quality Assurance Criteria' shall include the acceptance criteria for accuracy (based on recoveries for reference samples/spikes), for precision (based on deviation in field and lab duplicates) and method blanks (designed to indicate false positives).

Permittee shall certify that all data required under Subsection 3.1. of this permit are produced in accordance with the 'Laboratory Quality Protocols' and met the 'Quality Assurance Criteria' as approved under this section. At the request of the Regional Waste Manager, the permittee is to provide the laboratory quality assurance data along with the submission of the data required under Subsection 3.1. of this permit, as well as all associated field blanks and duplicate analysis results.

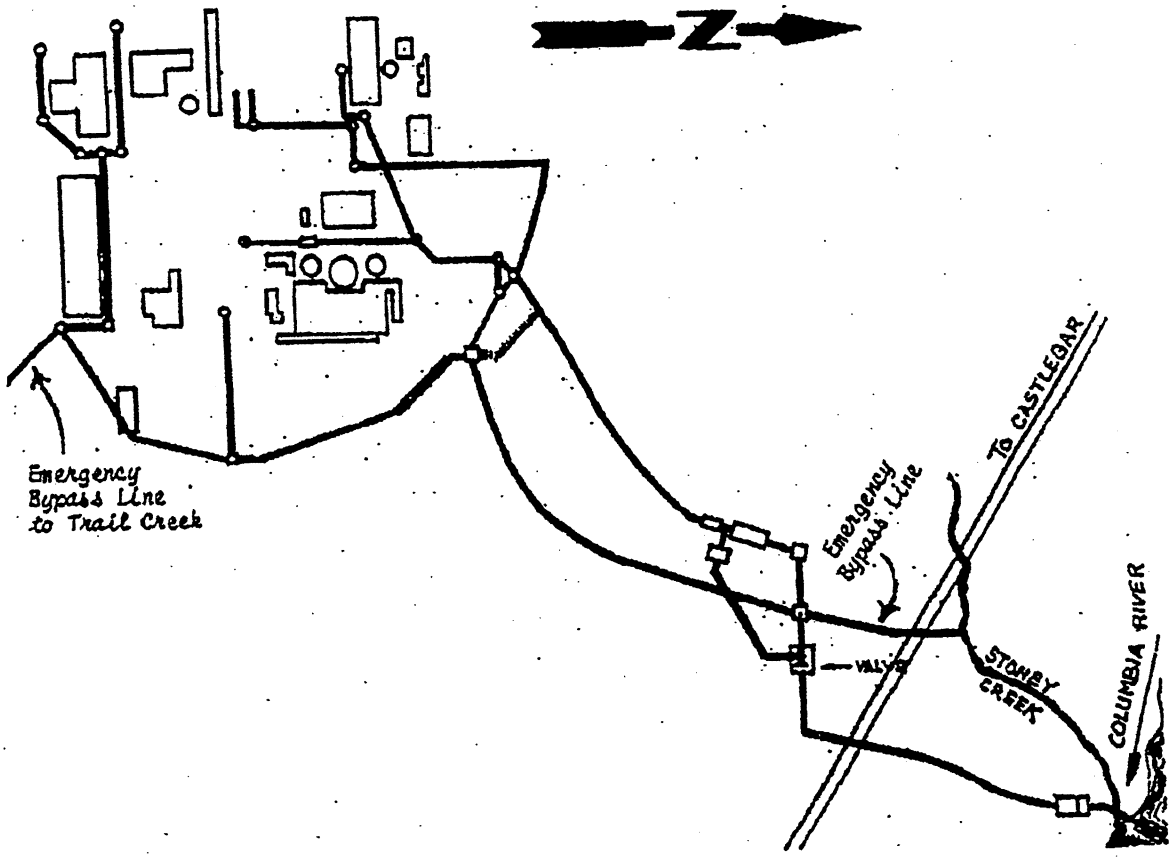
The permittee shall ensure that all tests and other data required to be submitted under the permit are conducted by a laboratory acceptable to the Regional Waste Manager.

R.J. Crozier, R.P. Bio.
Regional Waste Manager

PROVINCE OF BRITISH COLUMBIA

Pollution Prevention

Site Plan A



LEGAL DESCRIPTION: **Lot 1 and Lot 3, Plan 6446, Kootenay District and Part Assigned No. 25 and Assigned No. 18, Plan 1425, Kootenay District.**

Permit: PE-05309

Date Issued: November 29, 1978

Date Amended: JUN 0 4 1997

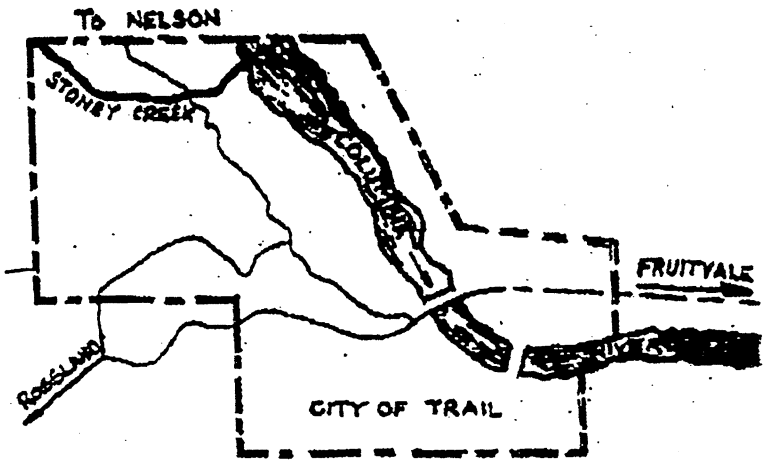
Regional Waste Manager

R.J. Crozier, R.P. Bio.

Name of Applicant:

Cominco Ltd. - Cominco Ltee.

GENERAL DESCRIPTION



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ATTACHMENT D1-2

CURRENT FACILITY PERMITS/LICENSES

ORDER

WATER ACT

Section 15

File No. 0148652

In the matter of Final Water Licence No. 11790, which authorizes the diversion of 40,870,000 gallons per day of water from Columbia River, for industrial and domestic purposes.

Having received an application for an amendment of the domestic purpose of the said licence and being satisfied that no person's rights will be injuriously affected, I hereby amend clauses (d) and (e) of the licence to read as follows:-

(d) The purpose for which the water is to be used is industrial and waterworks.

(e) The maximum quantity of water which may be diverted is 40,870,000 gallons per day;
Industrial (Smelting, etc.) 38,760,000 gallons per day.
Industrial - general 2,000,000 gallons per day.
Waterworks 110,000 gallons per day and such additional quantity as the Engineer may from time to time determine should be allowed for losses.

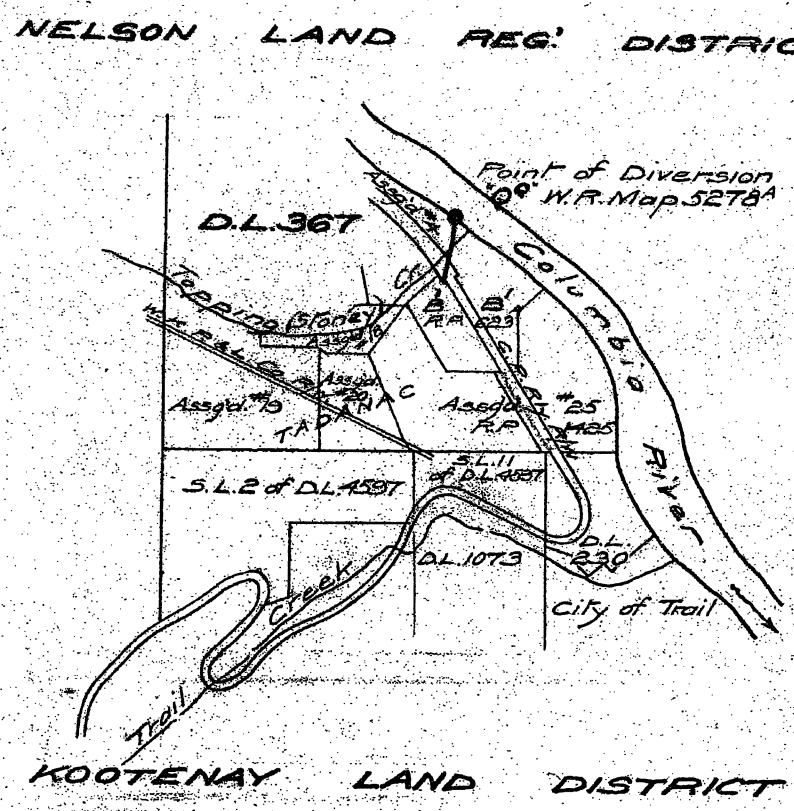
Dated at Victoria, B.C. this 16th day of October, 1961.

V. Raudsepp,
Deputy Comptroller of Water Rights.

To accompany Final Licence No. 11790

NELSON WATER DISTRICT

Scale: 40 Chains to 1 Inch



LEGEND

Point of Diversion ●

Pipe line

.011041.

W.R.B. 1023—5M-640-5757

PROVINCE OF BRITISH COLUMBIA.

WATER RIGHTS BRANCH

DEPARTMENT OF LANDS.

IMPORTANT PLEASE READ YOUR LICENCE

FINAL WATER LICENCE.

THE CONSOLIDATED MINING and SMELTING COMPANY OF CANADA, LIMITED, of Trail, B. C., is

hereby authorized to divert and use water as follows:—

(a.) The source of the water-supply is Columbia River.

(b.) The point of diversion is located as shown on the attached plan.

(c.) The date from which this licence shall have precedence is 19th December, 1942.

(d.) The purpose for which the water is to be used is industrial and domestic.

(e.) The maximum quantity of water which may be diverted is 40,870,000 gallons a day:
Industrial (smelting, etc.) 38,760,000 gallons a day
Industrial--general 2,000,000 gallons a day
Domestic 110,000 gallons a day and such additional quantity as the Engineer may from time to time determine should be allowed for losses.

(f.) The period of the year during which the water may be used is the whole year.

(g.) ~~The land upon which the water is to be used and to which~~ This licence is appurtenant ~~is~~ to the Industrial Undertaking of the licensee, located north of the City of Trail and on the westerly side of the Columbia River.

(h.) The works for the diversion and carriage ~~as shown on the attached plan.~~ of the water are centrifugal pumps and pipe lines.

(i.) This licence is issued in substitution of ~~Conditional~~ Final Water Licence No. 9064 and 10547, also in furtherance of an application for additional water filed 19th December, 1942.

I, K. R. F. Denniston, being a person appointed by the Minister to execute the authority by Section 12 of the Water Act, vested in the Comptroller, do hereby certify the foregoing to be a true copy of Final
Licence No. 11790 issued under the hand of the Comptroller on 15th day of January 19 43

K R F Denniston
Chief Clerk.

E. Davis.
Comptroller of Water Rights.

File No. 0148652 Date issued January 15, 1943. Licence No. 11790

ADDRESS ALL COMMUNICATIONS TO:
DIRECTOR, POLLUTION CONTROL BRANCH
PARLIAMENT BUILDINGS
VICTORIA, BRITISH COLUMBIA
V8V 4S5

THE GOVERNMENT OF
THE PROVINCE OF BRITISH COLUMBIA

WHEN REPLYING PLEASE STATE
OUR FILE No. 0262100-PR-3423
YOUR FILE No.
TELEPHONE 387-5321

DEPARTMENT OF LANDS, FORESTS, AND WATER RESOURCES
WATER RESOURCES SERVICE
POLLUTION CONTROL BRANCH
VICTORIA, BRITISH COLUMBIA

May 16, 1974

Xerox copies to:
May 22, 1974
LJNicholson
FJLMiller
AHBush
GHood
SNewman
WBd'Easum

DOUBLE REGISTERED

Cominco Ltd., Cominco Ltee.
200 Granville Square
Vancouver, British Columbia

Gentlemen:

LETTER OF TRANSMITTAL

Enclosed herewith is a copy of Pollution Control Permit PR-3423 in the name of Cominco Ltd., Cominco Ltee. Your attention is respectfully directed to the conditions outlined in the Permit.

In conjunction with this Permit, you are directed to comply with the following requirements:

A. OPERATION

1) Maintain the works authorized under Appendices 01 and 02 of the Permit as a Level "A" operation in accordance with the "Operational Guidelines for the Discharge of Refuse on Land", dated October, 1971 or as otherwise required by the Director from time to time.

2) An Engineering Report is to be submitted on or before October 1, 1974, and shall cover studies on groundwater, diversion of surface runoff, stability of slopes and dump, and an operations plan and schedule, together with conclusions and proposed solutions to any anticipated problems.

..... 2.

3) Initially, the refuse discharged under Appendices 01 and 02 is to be restricted to the upper end of the gulley and this area is to be adequately drained by the placement of a gravel drain under the active fill area. The Director may allow the refuse to be discharged to the entire site, following receipt and approval of the Engineering Report referred to in A(2).

In addition to compliance with the above requirement, special precautions must be taken to prevent production of leachate in the fill area. An impervious or semi-impervious inert cover material, properly crowned and sloped, must be placed over the active fill area at the end of each day's operation.

4) Divert surface runoff and industrial waste water away from the refuse site before landfill commences.

B. MONITORING

Provide groundwater monitoring wells, the number, type, and location of which shall be determined on site by the Regional Manager.

C. FIRE CONTROL

Provide and maintain a stockpile of soil and/or other facilities acceptable to the Director for use in extinguishing accidental fires.

A regular monitoring program of the receiving environment will be implemented by the Branch in connection with this discharge, and you will be advised of the details in due course.

Once a Permit has been issued, and the appeal period has expired, Branch policy provides that the administration of the Permit is carried out by our Regional Manager who acts under these circumstances for the Director. Therefore all required information respecting this Permit may be submitted to the Regional Manager in lieu of the Director.

Compliance with the terms and conditions of this Permit will be determined through periodic inspections and monitoring. The location of this discharge falls within the bounds of our Kootenay Region. Our offices there are located at 1617 Baker Street, Cranbrook, British Columbia, V1C 1B4 (telephone 426-7203).

This Permit does not authorize entry upon, crossing over, or use for any purpose, of private or Crown lands or works, unless and except as authorized by the owner of such lands or works. The responsibility for obtaining such authority shall lie with the Permittee.

..... 3.

The decisions incorporated in this Permit and Letter of Transmittal are subject to appeal in accordance with the provisions of the Pollution Control Act, 1967, provided that initial notice of intent to appeal is given to the Director of Pollution Control within fifteen days from the date of this letter.

For your reference, enclosed is a copy of the Pollution Control Act, 1967, as amended, and the Regulations thereto.

Yours very truly,

A. J. Chmelauskas, P.Eng.
Assistant Director
Pollution Control Branch

Encl.

THE GOVERNMENT OF
THE PROVINCE OF BRITISH COLUMBIA

DEPARTMENT OF LANDS, FORESTS, AND WATER RESOURCES
WATER RESOURCES SERVICE

POLLUTION CONTROL BRANCH

PERMIT

Under the Provisions of the Pollution Control Act, 1967

Cominco Ltd., Cominco Ltee.

200 Granville Square, Vancouver, British Columbia

is hereby authorized to discharge refuse

from industrial and municipal sources

located in Trail, British Columbia

to the ground

This permit has been issued under the terms and conditions prescribed in the attached appendices

01, 02 and A

Assistant Director, Pollution Control Branch

Date issued May 16, 19 74

Amendments dated ....., 19.....

....., 19.....

....., 19.....

Permit No. PR-3423

PCB 11—0

THE GOVERNMENT OF THE PROVINCE OF BRITISH COLUMBIA

DEPARTMENT OF LANDS, FORESTS, AND WATER RESOURCES
WATER RESOURCES SERVICE

POLLUTION CONTROL BRANCH

APPENDIX No. 01

to Pollution Control Permit No. PR-3423

(*a*) The discharge of refuse applicable to this appendix is to part of Lot 2, Plan 6446, Part of Sub-Lot 2, Plan 4597, Part of reference Plan 50694-I as shown on the attached Appendix A.

(*b*) The quantity of refuse which may be discharged is an average of 125 cubic yards per day.

(*c*) The type of refuse which may be discharged is municipal.
(Municipal, industrial, etc.)

(*d*) The nature or characteristics of the refuse which may be discharged are typical municipal refuse and septic tank pumpage.

(*e*) The works authorized are a landfill operation as directed. approximately located as shown on the attached Appendix A.

(*f*) The land from which the refuse originates and to which this appendix is appurtenant is municipalities and unorganized communities of the Regional District of Kootenay Boundary.

(*g*) Those works authorized and proposed must be completed and in operation when discharge commences.

Date May 16, 19 74
Amended ....., 19....

Assistant Director, Pollution Control Branch

PCB 14—

THE GOVERNMENT OF THE PROVINCE OF BRITISH COLUMBIA

DEPARTMENT OF LANDS, FORESTS, AND WATER RESOURCES
WATER RESOURCES SERVICE

POLLUTION CONTROL BRANCH

APPENDIX No. 02

to Pollution Control Permit No. PR-3423

(*a*) The discharge of refuse applicable to this appendix is to part of Lot 2, Plan 6446, part of Sub-Lot 2, Plan 4597, part of reference Plan 50694-I.

as shown on the attached Appendix A.

(*b*) The quantity of refuse which may be discharged is an average of 180 cubic yards per day.

(*c*) The type of refuse which may be discharged is industrial

(Municipal, industrial, etc.)

(*d*) The nature or characteristics of the refuse which may be discharged are inert slag, demolition material, paper, metal, wood, and glass.

(*e*) The works authorized are a landfill operation as directed.

approximately located as shown on the attached Appendix A.

(*f*) The land from which the refuse originates and to which this appendix is appurtenant is lead smelter and zinc smelter located at Trail, Chemical-Fertilizer plant located at Warfield

(*g*) Those works authorized and proposed must be completed and in operation when discharge commences.

Date May 16, 1974

Amended ....., 19.....

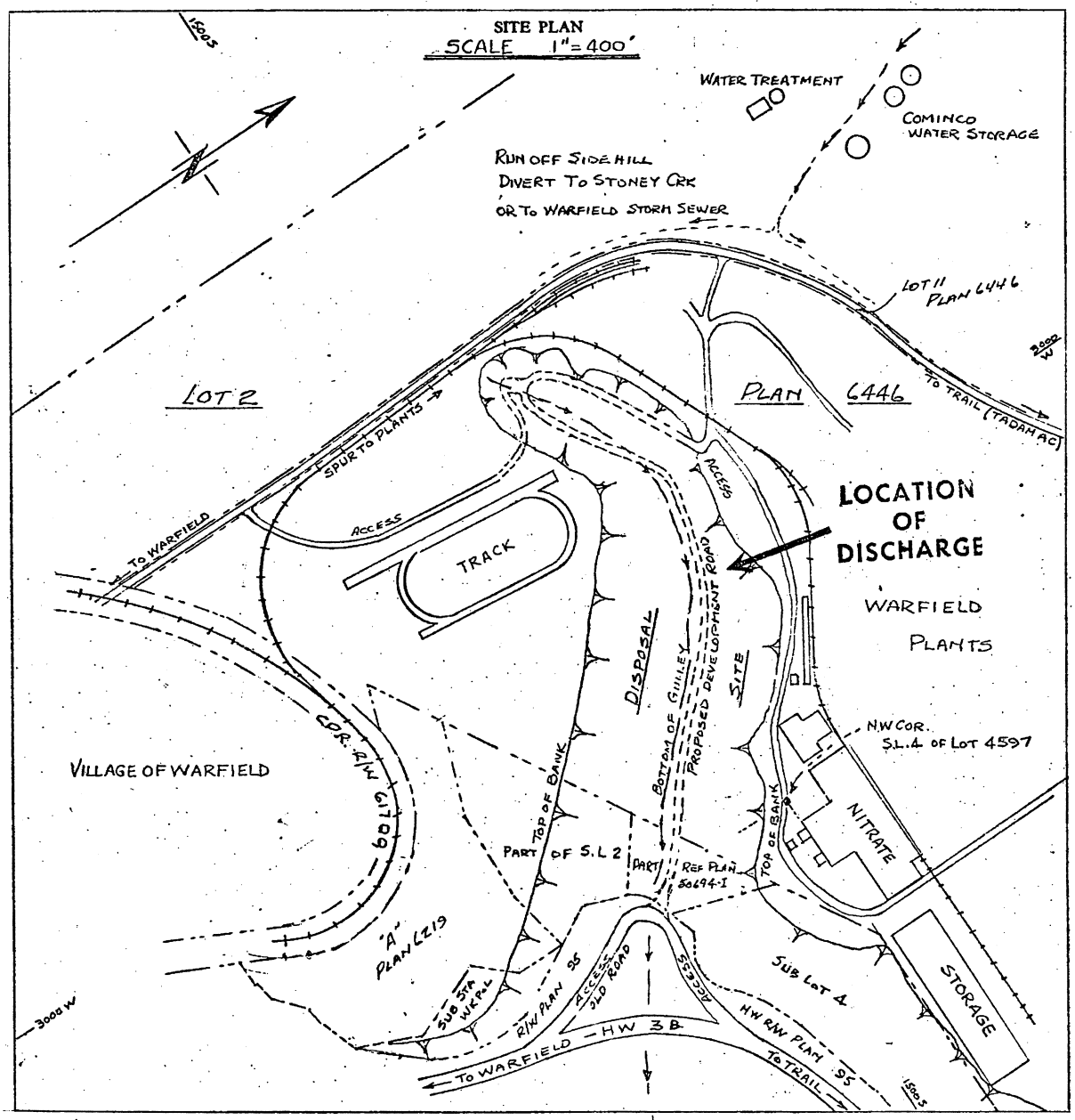
Assistant Director, Pollution Control Branch

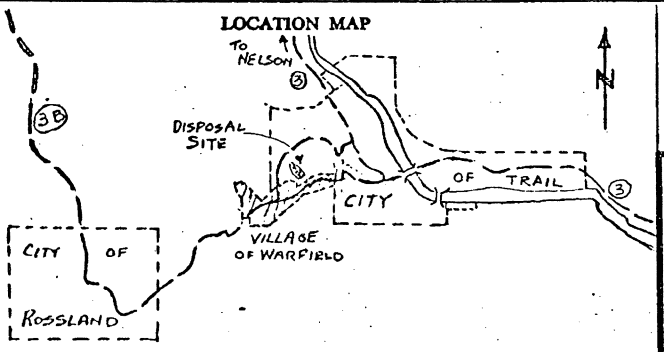
PCB 14—

THE GOVERNMENT OF THE PROVINCE OF BRITISH COLUMBIA

DEPARTMENT OF LANDS, FORESTS, AND WATER RESOURCES
WATER RESOURCES SERVICE

POLLUTION CONTROL BRANCH





COMINCO LTD.
(Name of applicant(s))

January 24/74
(Date)

(Signature of applicant(s) or agent)
L. J. Nicholson

(FOR OFFICE USE ONLY)

May 16, 1974
(Date issued)

Assistant Director, Pollution Control Branch

Appendix A to Permit No. PR-3423

PCB 12—0

MINISTRY OF ENVIRONMENT

PERMIT

Under the Provisions of the Waste Management Act

COMINCO LTD. - COMINCO LTEE

500 - 200 Burrard Street, Vancouver, British Columbia, V6C 3L7

is hereby authorized to discharge contaminants

from a zinc smelter and associated plants

located at Trail, British Columbia

to the air.

This permit has been issued under the terms and conditions prescribed in the attached appendices 01 to 07, 09, 10, 19, 20, 23, 24, 26 to 34, 36 to 42, A-1 to A-12, B-1, B-2, C-1, C-2 and C-3

R.J. Crozier, R.P. Bio.
Regional Waste Manager

Date issued September 9, 19 75

Amendments dated January 5, 19 79

April 8, 19 87

MAY 19 1997

Permit No. PA-02692

MINISTRY OF ENVIRONMENT

WASTE MANAGEMENT BRANCH

APPENDIX No. 01

to Permit No. PA-02692
(Air)

(a) The discharge of contaminants into the air to which this Appendix is applicable is from the main zinc stack identified as Z-1 (the source of the emission is the zinc roaster off gas which has been processed through Hg removal plant, acid plants, gas absorption towers and ancillary facilities as shown on the attached Appendix A-5.

(b) The rate of discharge authorized is:
Maximum: 5,260 m^3/min Duration: Intermittent Frequency: as required.

Average daily (based on the normal operating period) 3,670 m^3/min - the normal operating period is 24 hours/day.

(c) The characteristics of the contaminants shall be equivalent to or better than:

Contaminant	Average daily Concentration based on the normal operating period.	Maximum Concentration	Duration	Frequency
SO_2	Control regime as per Appendix C-1			
Total Particulate	230 mg/m^3	230 mg/m^3	24 hrs/day	continuous

Annual total particulate emissions shall not exceed 75 tonnes per year based on the summation of monthly isokinetic measurements of stack emissions.

NOTE: All air and gaseous volumes specified in items (b) and (c) above are at standard conditions which are:
Standard Temperature = 293.15°K
Standard Pressure = 101.325 KPa
Water Vapour zero unless otherwise stated

(d) The works authorized are fans, ducts, tail gas absorption tower, Brink mist eliminator and Brink mist eliminator bypass system, Hg removal plant, stack and related appurtenances.

(e) The location of the facilities from which the discharge originates and to which this Appendix is appurtenant is Lot 3, Plan 4926, Kootenay District.

(f) The works authorized must be completed and in operation on and from the date of this Appendix.

R.J. Crozier, R.P. Bio.
Regional Waste Manager

Date issued September 9, 19 75
Date amended January 5, 19 79
April 8, 19 87

NOV 19 1992

MINISTRY OF ENVIRONMENT

WASTE MANAGEMENT BRANCH

APPENDIX 02

to Permit No. PA-2692

(Air)

(a) The discharge of contaminants into the air to which this appendix is applicable is from the concentrate unloading ventilation stack identified as Z-3 as shown on the attached Appendix A-2.

(b) The rate of discharge authorized is:

Maximum: 150 m^3/min Duration: 24 hours/day Frequency: continuous.

Average daily (based on the normal operating period) 150 m^3/min - the normal operating period is 24 hours/day.

(c) The characteristics of the contaminants shall be equivalent to or better than:

Contaminant	Average daily concentration based on the normal operating period	Maximum Concentration	Duration	Frequency
Total Particulate	23 mg/m^3	23 mg/m^3	24 hrs/ day	continuous

NOTE: All air and gaseous volumes specified in items (b) and (c) above are at standard conditions which are:
Standard Temperature = 293.15°K
Standard pressure = 101.325 KPa
Water Vapour zero unless otherwise stated

(d) The works authorized are fans, ducts, baghouse and related appurtenances.

(e) The location of the facilities from which the discharge originates and to which this appendix is appurtenant is Lots 2 and 3, Plan 4926, Kootenay District.

(f) The works authorized must be completed and in operation on and from the date of this Appendix.

Date issued: September 9 1975

Date amended: January 5 1979

APR 08 1987 19__

Regional Waste Manager

ENV. 2096 W-817

MINISTRY OF ENVIRONMENT

WASTE MANAGEMENT BRANCH

APPENDIX 03

to Permit No. PA-2692

(Air)

(a) The discharge of contaminants into the air to which this appendix is applicable is from the transfer tower ventilation stack identified as Z-4 as shown on the attached Appendix A-3.

(b) The rate of discharge authorized is:

Maximum: 102 m^3/min Duration: 24 hours/day Frequency: continuous.

Average daily (based on the normal operating period) 102 m^3/min - the normal operating period is 24 hours/day.

(c) The characteristics of the contaminants shall be equivalent to or better than:

Contaminant	Average daily concentration based on the normal operating period	Maximum Concentration	Duration	Frequency
Total Particulate	23 mg/m^3	23 mg/m^3	24 hrs/ day	continuous

NOTE: All air and gaseous volumes specified in items (b) and (c) above are at standard conditions which are:
Standard Temperature = 293.15°K
Standard pressure = 101.325 KPa
Water Vapour zero unless otherwise stated

(d) The works authorized are fans, ducts, baghouse and related appurtenances.

(e) The location of the facilities from which the discharge originates and to which this appendix is appurtenant is Lots 2 and 3, Plan 4926, Kootenay District.

(f) The works authorized must be completed and in operation on and from the date of this Appendix.

Date issued: September 9 1975

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Regional Waste Manager

ENV. 2096 W-817

MINISTRY OF ENVIRONMENT

WASTE MANAGEMENT BRANCH

APPENDIX 04

to Permit No. PA-2692

(Air)

(a) The discharge of contaminants into the air to which this appendix is applicable is from the No. 10 roaster, No. 20 roaster, and No. 30 roaster wet feed bin ventilation stacks identified as Z-5, Z-6 and Z-7 as shown on the attached Appendix A-4.

(b) The rate of discharge authorized is:

Maximum: 470 m^3/min Duration: 24 hours/day Frequency: continuous.

Average daily (based on the normal operating period) 470 m^3/min - the normal operating period is 24 hours/day

(c) The characteristics of the contaminants shall be equivalent to or better than:

Contaminant	Average daily concentration based on the normal operating period	Maximum Concentration	Duration	Frequency
Total Particulate	23 mg/m^3	23 mg/m^3	24 hrs/ day	continuous

NOTE: All air and gaseous volumes specified in items (b) and (c) above are at standard conditions which are:
Standard Temperature = 293.15°K
Standard pressure = 101.325 KPa
Water Vapour zero unless otherwise stated

(d) The works authorized are fans, ducts, three baghouses, three stacks and related appurtenances.

(e) The location of the facilities from which the discharge originates and to which this appendix is appurtenant is Lots 2 and 3, Plan 4926, Kootenay District.

(f) The works authorized must be completed and in operation on and from the date of this Appendix.

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Regional Waste Manager

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MINISTRY OF ENVIRONMENT

WASTE MANAGEMENT BRANCH

APPENDIX 05

to Permit No. PA-2692

(Air)

(a) The discharge of contaminants into the air to which this appendix is applicable is from the product screw conveyors ventilation identified as Z-8 as shown on the attached Appendix A-4.

(b) The rate of discharge authorized is:

Maximum: 150 m^3/min Duration: 24 hours/day Frequency: continuous.

Average daily (based on the normal operating period) 150 m^3/min - the normal operating period is 24 hours/day

(c) The characteristics of the contaminants shall be equivalent to or better than:

Contaminant	Average daily concentration based on the normal operating period	Maximum Concentration	Duration	Frequency
Total Particulate	23 mg/m^3	23 mg/m^3	24 hrs/ day	continuous

NOTE: All air and gaseous volumes specified in items (b) and (c) above are at standard conditions which are:
Standard Temperature = 293.15°K
Standard pressure = 101.325 KPa
Water Vapour zero unless otherwise stated

(d) The works authorized are fans, ducts, baghouse, stack and related appurtenances.

(e) The location of the facilities from which the discharge originates and to which this appendix is appurtenant is Lots 2 and 3, Plan 4926, Kootenay District.

(f) The works authorized must be completed and in operation on and from the date of this Appendix.

Date issued: September 9 1975

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Regional Waste Manager

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MINISTRY OF ENVIRONMENT

WASTE MANAGEMENT BRANCH

APPENDIX 06

to Permit No. PA-2692

(Air)

(a) The discharge of contaminants into the air to which this appendix is applicable is from the No. 10 and No. 20 ball mill ventilation stacks identified as Z-9 and Z-10 as shown on the attached Appendix A-4.

(b) The rate of discharge authorized is:

Maximum: 225 m^3/min Duration: 24 hours/day Frequency: continuous.

Average daily (based on the normal operating period) 225 m^3/min - the normal operating period is 24 hours/day

(c) The characteristics of the contaminants shall be equivalent to or better than:

Contaminant	Average daily concentration based on the normal operating period	Maximum Concentration	Duration	Frequency
Total Particulate	23 mg/m^3	23 mg/m^3	24 hrs/ day	continuous

NOTE: All air and gaseous volumes specified in items (b) and (c) above are at standard conditions which are:
Standard Temperature = 293.15°K
Standard pressure = 101.325 KPa
Water Vapour zero unless otherwise stated

(d) The works authorized are fans, ducts, two baghouses, two stacks and related appurtenances.

(e) The location of the facilities from which the discharge originates and to which this appendix is appurtenant is Lot 3, Plan 4926, Kootenay District.

(f) The works authorized must be completed and in operation on and from the date of this Appendix.

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ENV. 2096 W417

MINISTRY OF ENVIRONMENT

WASTE MANAGEMENT BRANCH

APPENDIX 07

to Permit No. PA-2692

(Air)

(a) The discharge of contaminants into the air to which this appendix is applicable is from the No. 18 and No. 19 calcine storage bin ventilation stacks identified as Z-11 and Z-12 as shown on the attached Appendix A-4.

(b) The rate of discharge authorized is:

Maximum: 82 m^3/min Duration: 24 hours/day Frequency: continuous.

Average daily (based on the normal operating period) 82 m^3/min - the normal operating period is 24 hours/day.

(c) The characteristics of the contaminants shall be equivalent to or better than:

Contaminant	Average daily concentration based on the normal operating period	Maximum Concentration	Duration	Frequency
Total Particulate	23 mg/m^3	23 mg/m^3	24 hrs/ day	continuous

NOTE: All air and gaseous volumes specified in items (b) and (c) above are at standard conditions which are:
Standard Temperature = 293.15°K
Standard pressure = 101.325 KPa
Water Vapour zero unless otherwise stated

(d) The works authorized are fans, ducts, two baghouses, two stacks and related appurtenances.

(e) The location of the facilities from which the discharge originates and to which this appendix is appurtenant is Lot 3, Plan 4926, Kootenay District.

(f) The works authorized must be completed and in operation on and from the date of this Appendix.

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ENV. 2096 W-817

MINISTRY OF ENVIRONMENT

WASTE MANAGEMENT BRANCH

APPENDIX 09

to Permit No. PA-2692

(Air)

(a) The discharge of contaminants into the air to which this appendix is applicable is from the No. 1, No. 2 and No. 3 sulphide electrolyte cooling towers identified as Z-31, Z-32 and Z-33 as shown on the attached Appendix A-1.

(b) The rate of discharge authorized is:

Maximum: 19,730 m^3/min Duration: 12 hours/day Frequency: once/day.

Average daily (based on the normal operating period) 13,100 m^3/min - the normal operating period is 24 hours/day with only 1 or 2 of the towers operating at one time.

(c) The characteristics of the contaminants shall be equivalent to or better than:

Contaminant	Average daily concentration based on the normal operating period	Maximum Concentration	Duration	Frequency
Total Particulate	2.3 mg/m^3	2.3 mg/m^3	24 hrs/ day	continuous

NOTE: All air and gaseous volumes specified in items (b) and (c) above are at standard conditions which are:
Standard Temperature = 293.15°K
Standard pressure = 101.325 KPa
Water Vapour zero unless otherwise stated

(d) The works authorized are mist eliminators (internal tower construction) and related appurtenances.

(e) The location of the facilities from which the discharge originates and to which this appendix is appurtenant is Lot 3, Plan 4926, Kootenay District.

(f) The works authorized must be completed and in operation on and from the date of this Appendix.

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MINISTRY OF ENVIRONMENT

WASTE MANAGEMENT BRANCH

APPENDIX 10

to Permit No. PA-2692

(Air)

(a) The discharge of contaminants into the air to which this appendix is applicable is from the No. 1 and No. 2 Electrolyte Vent stacks identified as Z-34 and Z-35 as shown on the attached Appendix A-1.

(b) The rate of discharge authorized is:

Maximum: 230 m^3/min Duration: 24 hours/day Frequency: continuous.

Average daily (based on the normal operating period) 230 m^3/min - the normal operating period is 24 hours/day.

(c) The characteristics of the contaminants shall be equivalent to or better than:

Contaminant	Average daily concentration based on the normal operating period	Maximum Concentration	Duration	Frequency
Total Particulate	2.3 mg/m^3	2.3 mg/m^3 -	24 hrs/ day	continuous

NOTE: All air and gaseous volumes specified in items (b) and (c) above are at standard conditions which are:
Standard Temperature = 293.15°K
Standard pressure = 101.325 KPa
Water Vapour zero unless otherwise stated

(d) The works authorized are fans, ducts, two stacks and related appurtenances.

(e) The location of the facilities from which the discharge originates and to which this appendix is appurtenant is Lot 3, Plan 4926, Kootenay District.

(f) The works authorized must be completed and in operation on and from the date of this Appendix.

Date issued: September 9 1975

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Regional Waste Manager

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MINISTRY OF ENVIRONMENT

WASTE MANAGEMENT BRANCH

APPENDIX 19

to Permit No. PA-2692

(Air)

(a) The discharge of contaminants into the air to which this appendix is applicable is from the No. 1 furnace and No. 2 furnace exhaust fan stacks (Cadmium Plant) identified as Z-44 and Z-45 as shown on the attached Appendix A-3.

(b) The rate of discharge authorized is:

Maximum: 115 m^3/min Duration: intermittent Frequency: as required.

Average daily (based on the normal operating period) 75 m^3/min - the normal operating period is 24 hours/day.

(c) The characteristics of the contaminants shall be equivalent to or better than:

Contaminant	Average daily concentration based on the normal operating period	Maximum Concentration	Duration	Frequency
Cadmium	11.5 mg/m^3	11.5 mg/m^3	24 hrs/ day	continuous

NOTE: All air and gaseous volumes specified in items (b) and (c) above are at standard conditions which are:
Standard Temperature = 293.15°K
Standard pressure = 101.325 KPa
Water Vapour zero unless otherwise stated

(d) The works authorized are fans, ducts, two stacks and related appurtenances.

(e) The location of the facilities from which the discharge originates and to which this appendix is appurtenant is Lot 2, Plan 4926, Kootenay District.

(f) The works authorized must be completed and in operation on and from the date of this Appendix.

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Regional Waste Manager

ENV. 2096 W-617

MINISTRY OF ENVIRONMENT

WASTE MANAGEMENT BRANCH

APPENDIX 20

to Permit No. PA-2692

(Air)

(a) The discharge of contaminants into the air to which this appendix is applicable is from the crusher and area ventilation stack identified as Z-46 as shown on the attached Appendix A-7.

(b) The rate of discharge authorized is:

Maximum: 480 m^3/min Duration: 24 hours/day Frequency: 5 days/week 8 months/year

Average daily (based on the normal operating period) 480 m^3/min - the normal operating period is 24 hours/day, 5 days/week, 8 months/year.

(c) The characteristics of the contaminants shall be equivalent to or better than:

Contaminant	Average daily concentration based on the normal operating period	Maximum Concentration	Duration	Frequency
Total Particulate	23 mg/m^3	23 mg/m^3	24 hrs/ day	5 days/wk. 8 mths/yr.

NOTE: All air and gaseous volumes specified in items (b) and (c) above are at standard conditions which are:
Standard Temperature = 293.15°K
Standard pressure = 101.325 KPa
Water Vapour zero unless otherwise stated

(d) The works authorized are fans, ducts, scrubbers, stack and related appurtenances.

(e) The location of the facilities from which the discharge originates and to which this appendix is appurtenant is Lot 3, Plan 4926, Kootenay District.

(f) The works authorized must be completed and in operation on and from the date of this Appendix.

Date issued: September 9 1975

Date amended: January 5 1979

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Regional Waste Manager

ENV. 2096 W-817

MINISTRY OF ENVIRONMENT

WASTE MANAGEMENT BRANCH

APPENDIX 23

to Permit No. PA-2692

(Air)

(a) The discharge of contaminants into the air to which this appendix is applicable is from the No. 1 and No. 2 vent fans stack (leaching area - Indium Plant) identified as Z-52 as shown on the attached Appendix A-8.

(b) The rate of discharge authorized is:

Maximum: 325 m^3/min Duration: 24 hours/day Frequency: continuous.

Average daily (based on the normal operating period) 325 m^3/min - the normal operating period is 24 hours/day.

(c) The characteristics of the contaminants shall be equivalent to or better than:

Contaminant	Average daily concentration based on the normal operating period	Maximum Concentration	Duration	Frequency
Total Particulate	23 mg/m^3	23 mg/m^3	24 hrs/ day	continuous

NOTE: All air and gaseous volumes specified in items (b) and (c) above are at standard conditions which are:
Standard Temperature = 293.15°K
Standard pressure = 101.325 KPa
Water Vapour zero unless otherwise stated

(d) The works authorized are fans, ducts, stack and related appurtenances.

(e) The location of the facilities from which the discharge originates and to which this appendix is appurtenant is Lot 3, Plan 4926, Kootenay District.

(f) The works authorized must be completed and in operation on and from the date of this Appendix.

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Regional Waste Manager

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MINISTRY OF ENVIRONMENT

WASTE MANAGEMENT BRANCH

APPENDIX 24

to Permit No. PA-2692

(Air)

(a) The discharge of contaminants into the air to which this appendix is applicable is from the No. 30 Calcine Bin ventilation stack identified as Z-53 as shown on the attached Appendix A-4.

(b) The rate of discharge authorized is:

Maximum: 195 m^3/min Duration: 24 hours/day Frequency: continuous.

Average daily (based on the normal operating period) 195 m^3/min - the normal operating period is 24 hours/day.

(c) The characteristics of the contaminants shall be equivalent to or better than:

Contaminant	Average daily concentration based on the normal operating period	Maximum Concentration	Duration	Frequency
Total Particulate	23 mg/m^3	23 mg/m^3	24 hrs/ day	continuous

NOTE: All air and gaseous volumes specified in items (b) and (c) above are at standard conditions which are:
Standard Temperature = 293.15°K
Standard pressure = 101.325 KPa
Water Vapour zero unless otherwise stated

(d) The works authorized are fans, ducts, baghouse, stack and related appurtenances.

(e) The location of the facilities from which the discharge originates and to which this appendix is appurtenant is Lots 2 and 3 Plan 4926, Kootenay District.

(f) The works authorized must be completed and in operation on and from the date of this Appendix.

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Regional Waste Manager

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MINISTRY OF ENVIRONMENT

WASTE MANAGEMENT BRANCH

APPENDIX 26

to Permit No. PA-2692

(Air)

(a) The discharge of contaminants into the air to which this appendix is applicable is from 12 miscellaneous sources associated with salvage yard storage (identified as numbers 1-12 inclusive) as shown on the attached Appendix A-10.

(b) The rate of discharge authorized is:

Maximum: 60 m^3/min Duration: 24 hours/day Frequency: continuous.

Average daily (based on the normal operating period) 60 m^3/min - the normal operating period is 24 hours/day.

(c) The characteristics of the contaminants are of the nature originating from roof cupolas and vents, natural gas heaters and oil tank vents.

NOTE: All air and gaseous volumes specified in items (b) and (c) above are at standard conditions which are:
Standard Temperature = 293.15°K
Standard pressure = 101.325 KPa
Water Vapour zero unless otherwise stated

(d) The works authorized are fans, ducts, vents, stacks and related appurtenances.

(e) The location of the facilities from which the discharge originates and to which this appendix is appurtenant is Lot 6, Plan 6446, Kootenay District.

(f) The works authorized must be completed and in operation on and from the date of this Appendix.

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Regional Waste Manager

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MINISTRY OF ENVIRONMENT

WASTE MANAGEMENT BRANCH

APPENDIX 27

to Permit No. PA-2692

(Air)

(a) The discharge of contaminants into the air to which this appendix is applicable is from 12 miscellaneous sources associated with the salvage yard, equipment depot, fire hall and thaw sheds (identified as numbers 1-12 inclusive) as shown on the attached Appendix A-9.

(b) The rate of discharge authorized is:

Maximum: 60 m^3/min Duration: 24 hours/day Frequency: continuous.

Average daily (based on the normal operating period) 60 m^3/min - the normal operating period is 24 hours/day.

(c) The characteristics of the contaminants are of the nature originating from steam blowoffs, roof fans, venting paint and welding shops.

NOTE: All air and gaseous volumes specified in items (b) and (c) above are at standard conditions which are:
Standard Temperature = 293.15°K
Standard pressure = 101.325 KPa
Water Vapour zero unless otherwise stated

(d) The works authorized are fans, ducts, vents, stacks and related appurtenances.

(e) The location of the facilities from which the discharge originates and to which this appendix is appurtenant is Lots 3 and 6, Plan 6446, Kootenay District.

(f) The works authorized must be completed and in operation on and from the date of this Appendix.

Date issued: September 9 1975

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Regional Waste Manager

ENV 1993 ec

MINISTRY OF ENVIRONMENT

WASTE MANAGEMENT BRANCH

APPENDIX 28

to Permit No. PA-2692

(Air)

(a) The discharge of contaminants into the air to which this appendix is applicable is from 3 miscellaneous sources associated with the concentrator and ore crushing facilities (identified as numbers 1-3 inclusive) as shown on the attached Appendix A-7.

(b) The rate of discharge authorized is:

Maximum: 140 m^3/min Duration: 24 hours/day Frequency: continuous.

Average daily (based on the normal operating period) 140 m^3/min - the normal operating period is 24 hours/day.

(c) The characteristics of the contaminants are of the nature originating from roof fans and sanitary vents.

NOTE: All air and gaseous volumes specified in items (b) and (c) above are at standard conditions which are:
Standard Temperature = 293.15°K
Standard pressure = 101.325 KPa
Water Vapour zero unless otherwise stated

(d) The works authorized are fans, ducts, vents, stacks and related appurtenances.

(e) The location of the facilities from which the discharge originates and to which this appendix is appurtenant is Lot 6, Plan 6446, Kootenay District and Lot 3, Plan 4926, Kootenay District.

(f) The works authorized must be completed and in operation on and from the date of this Appendix.

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Regional Waste Manager

ENV 1993 ec

MINISTRY OF ENVIRONMENT

WASTE MANAGEMENT BRANCH

APPENDIX 29

to Permit No. PA-2692

(Air)

(a) The discharge of contaminants into the air to which this appendix is applicable is from 5 miscellaneous sources associated with the Indium Plant and acid plant office (identified as numbers 1-5 inclusive) as shown on the attached Appendix A-8.

(b) The rate of discharge authorized is:

Maximum: 90 m^3/min Duration: 24 hours/day Frequency: continuous.

Average daily (based on the normal operating period) 90 m^3/min - the normal operating period is 24 hours/day.

(c) The characteristics of the contaminants are of the nature originating from room ventilation, melting pot vents, natural gas burner and gasometer cupola.

NOTE: All air and gaseous volumes specified in items (b) and (c) above are at standard conditions which are:
Standard Temperature = 293.15°K
Standard pressure = 101.325 KPa
Water Vapour zero unless otherwise stated

(d) The works authorized are fans, ducts, vents, stacks and related appurtenances.

(e) The location of the facilities from which the discharge originates and to which this appendix is appurtenant is Lot 3, Plan 4926, Kootenay District.

(f) The works authorized must be completed and in operation on and from the date of this Appendix.

Date issued: September 9 1975

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Regional Waste Manager

ENV 1993 ce

MINISTRY OF ENVIRONMENT

WASTE MANAGEMENT BRANCH

APPENDIX 30

to Permit No. PA-2692

(Air)

(a) The discharge of contaminants into the air to which this appendix is applicable is from 13 miscellaneous sources associated with the acid plants (identified as numbers 1-13 inclusive) as shown on the attached Appendix A-2.

(b) The rate of discharge authorized is:

Maximum: 1,700 m^3/min Duration: 24 hours/day Frequency: continuous.

Average daily (based on the normal operating period) 1,700 m^3/min - the normal operating period is 24 hours/day.

(c) The characteristics of the contaminants are of the nature originating from oil storage tank vents, H_2SO_4 storage vents, pre-heater stack, SO_3 cooler stacks, lead burner shop ventilation, tinning bench ventilation and Hg removal plant ventilation.

NOTE: All air and gaseous volumes specified in items (b) and (c) above are at standard conditions which are:
Standard Temperature = 293.15°K
Standard pressure = 101.325 KPa
Water Vapour zero unless otherwise stated

(d) The works authorized are fans, ducts, vents, stacks and related appurtenances.

(e) The location of the facilities from which the discharge originates and to which this appendix is appurtenant is Lot 3, Plan 4926, Kootenay District.

(f) The works authorized must be completed and in operation on and from the date of this Appendix.

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Regional Waste Manager

ENV 1993 ec

MINISTRY OF ENVIRONMENT

WASTE MANAGEMENT BRANCH

APPENDIX 31

to Permit No. PA-2692

(Air)

(a) The discharge of contaminants into the air to which this appendix is applicable is from 49 miscellaneous sources associated with the Zinc Oxide leaching plant and the Cadmium plant (identified as numbers 1-49 inclusive) as shown on the attached Appendix A-3.

(b) The rate of discharge authorized is:

Maximum: 1,600 m^3/min Duration: 24 hours/day Frequency: continuous.

Average daily (based on the normal operating period) 1,600 m^3/min - the normal operating period is 24 hours/day.

(c) The characteristics of the contaminants are of the nature originating from filters, tank vents, cyclones, Pachuca vents, room vents, Atomic Absorption vent, Dross Hood, Sponge Cone vents and Sponge leach vent, molten sulfur pit vent.

NOTE: All air and gaseous volumes specified in items (b) and (c) above are at standard conditions which are:
Standard Temperature = 293.15°K
Standard pressure = 101.325 KPa
Water Vapour zero unless otherwise stated

(d) The works authorized are fans, ducts, vents, stacks and related appurtenances.

(e) The location of the facilities from which the discharge originates and to which this appendix is appurtenant is Lots 2 and 3, Plan 4926, Kootenay District.

(f) The works authorized must be completed and in operation on and from the date of this Appendix.

Date issued: September 9 1975

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Regional Waste Manager

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MINISTRY OF ENVIRONMENT

WASTE MANAGEMENT BRANCH

APPENDIX 32

to Permit No. PA-2692

(Air)

(a) The discharge of contaminants into the air to which this appendix is applicable is from 35 miscellaneous sources associated with the Zinc Roasters and Pressure Leach Plants (identified as numbers 1-30 & 1-5 - Pressure Leach Plant) as shown on the attached Appendix A-11.

(b) The rate of discharge authorized is:

Maximum: 970 m^3/min Duration: 24 hours/day Frequency: continuous.

Average daily (based on the normal operating period) 970 m^3/min - the normal operating period is 24 hours/day.

(c) The characteristics of the contaminants are of the nature originating from steam vents, de-aerator vents, boiler water seal rupture release vents, fluid bed cooler, zinc concentrate, vent scrubber, sulphur flash pit vent and sulphur pit vent stack.

NOTE: All air and gaseous volumes specified in items (b) and (c) above are at standard conditions which are:
Standard Temperature = 293.15°K
Standard pressure = 101.325 KPa
Water Vapour zero unless otherwise stated

(d) The works authorized are fans, ducts, vents, stacks, one baghouse and related appurtenances.

(e) The location of the facilities from which the discharge originates and to which this appendix is appurtenant is Lots 2 and 3, Plan 4926, Kootenay District.

(f) The works authorized must be completed and in operation on and from the date of this Appendix.

Date issued: September 9 1975

Date amended: January 5 1979

APR 08 1987 19

Regional Waste Manager

ENV 1993 cc

MINISTRY OF ENVIRONMENT

WASTE MANAGEMENT BRANCH

APPENDIX 33

to Permit No. PA-2692

(Air)

(a) The discharge of contaminants into the air to which this appendix is applicable is from 55 miscellaneous sources associated with the sulphide leaching plant and fume leach plant (identified as numbers 1-55 inclusive) as shown on the attached Appendix A-1.

(b) The rate of discharge authorized is:

Maximum: 3,168 m^3/min Duration: 24 hours/day Frequency: continuous.

Average daily (based on the normal operating period) 3,168 m^3/min - normal operating period is 24 hours/day.

(c) The characteristics of the contaminants are of the nature originating from Shriver filter vents, Sperry filter vents, feed & purification tank vents, mixer tank vents, American filter vents, manganese tank vent, roof vent fans and fume leach plant vents.

NOTE: All air and gaseous volumes specified in items (b) and (c) above are at standard conditions which are:
Standard Temperature = 293.15°K
Standard pressure = 101.325 KPa
Water Vapour zero unless otherwise stated

(d) The works authorized are fans, ducts, vents, stacks, and related appurtenances.

(e) The location of the facilities from which the discharge originates and to which this appendix is appurtenant is Lots 2 and 3, Plan 4926, Kootenay District.

(f) The works authorized must be completed and in operation on and from the date of this Appendix.

Date issued: September 9 1975

Date amended: January 5 1979

APR 08 1987 19

Regional Waste Manager

ENV 1993 ec

MINISTRY OF ENVIRONMENT

WASTE MANAGEMENT BRANCH

APPENDIX 34

to Permit No. PA-2692

(Air)

(a) The discharge of contaminants into the air to which this appendix is applicable is from 7 miscellaneous sources associated with the zinc melting plant (identified as numbers 1-7 inclusive) as shown on the attached Appendix A-6.

(b) The rate of discharge authorized is:

Maximum: 290 m^3/min Duration: 24 hours/day Frequency: continuous.

Average daily (based on the normal operating period) 290 m^3/min - the normal operating period is 24 hours/day.

(c) The characteristics of the contaminants are of the nature originating from steam vents and welding stall vents.

NOTE: All air and gaseous volumes specified in items (b) and (c) above are at standard conditions which are:
Standard Temperature = 293.15°K
Standard pressure = 101.325 KPa
Water Vapour zero unless otherwise stated

(d) The works authorized are fans, ducts, vents, stacks, and related appurtenances.

(e) The location of the facilities from which the discharge originates and to which this appendix is appurtenant is Lot 2, Plan 4926, Kootenay District.

(f) The works authorized must be completed and in operation on and from the date of this Appendix.

Date issued: September 9 1975

Date amended: January 5 1979

APR 08 1987 19

Regional Waste Manager

IDNV 1993 cc

MINISTRY OF ENVIRONMENT

WASTE MANAGEMENT BRANCH

APPENDIX 36

to Permit No. PA-2692

(Air)

(a) The discharge of contaminants into the air to which this appendix is applicable is from the No. 10 and No. 20 Roasters start-up stacks identified as numbers 32 and 33 as shown on the attached Appendix A-4.

(b) The rate of discharge authorized is:

Maximum: 2,400 m^3/min Duration: variable Frequency: infrequent.

Average daily (based on the normal operating period) Not applicable.

(c) The characteristics of the contaminants shall be equivalent to or better than:

Contaminant	Average daily concentration based on the normal operating period	Maximum Concentration	Duration	Frequency
Total Particulate	230 mg/m^3	230 mg/m^3	variable	infrequent

NOTE: All air and gaseous volumes specified in items (b) and (c) above are at standard conditions which are:
Standard Temperature = 293.15°K
Standard pressure = 101.325 KPa
Water Vapour zero unless otherwise stated

(d) The works authorized are ducts, two stacks and related appurtenances.

(e) The location of the facilities from which the discharge originates and to which this appendix is appurtenant is Lot 3, Plan 4926, Kootenay District.

(f) The works authorized must be completed and in operation on and from the date of this Appendix.

Date issued: September 9 1975

Date amended: January 5 1979

APR 08 1987 19

Regional Waste Manager

ENV. 2096 w-417

MINISTRY OF ENVIRONMENT

WASTE MANAGEMENT BRANCH

APPENDIX 37

to Permit No. PA-2692

(Air)

(a) The discharge of contaminants into the air to which this appendix is applicable is from the No. 30 Roaster start-up stack identified as #31 as shown on the attached Appendix A-4.

(b) The rate of discharge authorized is:

Maximum: 650 m^3/min Duration: variable Frequency: infrequent.

Average daily (based on the normal operating period) Not applicable.

(c) The characteristics of the contaminants shall be equivalent to or better than:

Contaminant	Average daily concentration based on the normal operating period	Maximum Concentration	Duration	Frequency
Total Particulate	230 mg/m^3	230 mg/m^3	variable	infrequent

NOTE: All air and gaseous volumes specified in items (b) and (c) above are at standard conditions which are:
Standard Temperature = 293.15°K
Standard pressure = 101.325 KPa
Water Vapour zero unless otherwise stated

(d) The works authorized are ducts, stack and related appurtenances.

(e) The location of the facilities from which the discharge originates and to which this appendix is appurtenant is Lot 3, Plan 4926, Kootenay District.

(f) The works authorized must be completed and in operation on and from the date of this Appendix.

Date issued: September 9 1975

Date amended: January 5 1979

APR 08 1987 19__

Regional Waste Manager

ENV. 2096 W417

MINISTRY OF ENVIRONMENT

WASTE MANAGEMENT BRANCH

APPENDIX 38

to Permit No. PA-2692

(Air)

(a) The discharge of contaminants into the air to which this appendix is applicable is from 2 miscellaneous sources associated with the Zinc Absorption and Acidification Plant (identified as 1 and 2) as shown on the attached Appendix A-5.

(b) The rate of discharge authorized is:

Maximum: 175 m^3/min Duration: 24 hours/day Frequency: continuous.

Average daily (based on the normal operating period) 175 m^3/min - the normal operating period is 24 hours/day.

(c) The characteristics of the contaminants are typical plant ventilation.

NOTE: All air and gaseous volumes specified in items (b) and (c) above are at standard conditions which are:
Standard Temperature = 293.15°K
Standard pressure = 101.325 KPa
Water Vapour zero unless otherwise stated

(d) The works authorized are vents approximately located as shown on the attached Appendix A-5.

(e) The location of the facilities from which the discharge originates and to which this appendix is appurtenant is Lot 3, Plan 4926, Kootenay District.

(f) The works authorized must be completed and in operation on and from the date of this Appendix.

Date issued: APR 08 1987 19__

Date amended: _____ 19__

_____ 19__

Regional Waste Manager

ENV 1993 ce

MINISTRY OF ENVIRONMENT

WASTE MANAGEMENT BRANCH

APPENDIX 39

to Permit No. PA-2692

(Air)

(a) The discharge of contaminants into the air to which this appendix is applicable is from 20 miscellaneous sources associated with the new Zinc Electrolyte and Melting Plant (sources 2, 4, 5-22 inclusive) as shown on the attached Appendix A-12.

(b) The rate of discharge authorized is:

Maximum: 52,560 m^3/min Duration: 24 hours/day Frequency: continuous.

Average daily (based on the normal operating period) 52,560 m^3/min - the normal operating period is 24 hours/day - continuous.

(c) The characteristics of the contaminants are traces of H_2SO_4 mist, welding fume, plant air, minor traces of particulate and zinc.

NOTE: All air and gaseous volumes specified in items (b) and (c) above are at standard conditions which are:
Standard Temperature = 293.15°K
Standard pressure = 101.325 KPa
Water Vapour zero unless otherwise stated

(d) The works authorized are cyclones, stacks, vents, fans and related appurtenances approximately located as shown on the attached Appendix A-12.

(e) The location of the facilities from which the discharge originates and to which this appendix is appurtenant is Lot A, Plan 12693, Kootenay District.

(f) The works authorized must be completed and in operation on and from the date of this Appendix.

Date issued: APR 08 1987 19__

Date amended: _____ 19__

_____ 19__

Regional Waste Manager

ENV 1993 ec

MINISTRY OF ENVIRONMENT

WASTE MANAGEMENT BRANCH

APPENDIX No. 40

to Permit No. PA-02692
(Air)

(a) The discharge of contaminants into the air to which this Appendix is applicable is from the Zinc Melting Plant Furnace Baghouse (Source 1) as shown on the attached Appendix A-12.

(b) The rate of discharge authorized is:

Maximum: 3,000 m^3/min Duration: 24 hours/day : continuous.

Average daily (based on the normal operating period) 3,000 m^3/min - the normal operating period is 24 hours/day - continuous.

(c) The characteristics of the contaminants shall be equivalent to or better than:

Contaminant	Average daily Concentration based on the normal operating period.	Maximum Concentration	Duration	Frequency
Total Particulate	46 mg/m^3	46 mg/m^3	24 hrs/day	continuous
Zinc	7 mg/m^3	7 mg/m^3	24 hrs/day	continuous

Annual total particulate emissions shall not exceed 15 tonnes. Annual zinc emissions shall not exceed 7 tonnes.

NOTE: All air and gaseous volumes specified in items (b) and (c) above are at standard conditions which are:
Standard Temperature = 293.15°K
Standard Pressure = 101.325 KPa
Water Vapour zero unless otherwise stated

(d) The works authorized are baghouse, fans, stack and related appurtenances approximately located as shown on the attached Appendix A-12.

(e) The location of the facilities from which the discharge originates and to which this Appendix is appurtenant is Lot A, Plan 12693, Kootenay District.

(f) The works authorized must be completed and in operation on and from the date of this Appendix.

R.J. Crozier, R.P. Bio.
Regional Waste Manager

Date issued April 8, 19 87
Date amended NOV 19 1992, 19
, 19

MINISTRY OF ENVIRONMENT

WASTE MANAGEMENT BRANCH

APPENDIX 41

to Permit No. PA-2692

(Air)

(a) The discharge of contaminants into the air to which this appendix is applicable is from the zinc dust atomizer baghouse (source 3) as shown on the attached Appendix A-12.

(b) The rate of discharge authorized is:

Maximum: 170 m^3/min Duration: 24 hours/day Frequency: continuous.

Average daily (based on the normal operating period) 170 m^3/min - the normal operating period is 24 hours/day - continuous.

(c) The characteristics of the contaminants shall be equivalent to or better than:

Contaminant	Average daily concentration based on the normal operating period	Maximum Concentration	Duration	Frequency
Zinc	230 mg/m^3	230 mg/m^3	24 hrs/d	continuous

NOTE: All air and gaseous volumes specified in items (b) and (c) above are at standard conditions which are:
Standard Temperature = 293.15°K
Standard pressure = 101.325 KPa
Water Vapour zero unless otherwise stated

(d) The works authorized are baghouse, fans, stack and related appurtenances approximately located as shown on the attached Appendix A-12.

(e) The location of the facilities from which the discharge originates and to which this appendix is appurtenant is Lot A, Plan 12693, Kootenay District.

(f) The works authorized must be completed and in operation on and from the date of this Appendix.

Date issued: APR 0 8 1987 19__

Date amended: _____ 19__

_____ 19__

Regional Waste Manager

ENV. 2096

MINISTRY OF ENVIRONMENT

WASTE MANAGEMENT BRANCH

APPENDIX No. 42

to Permit No. PA-02692
(Air)

(a) On and from the date of issuance of this Appendix the total annual sulphur emissions measured as sulphur dioxide from the zinc smelting operations of Cominco Ltd. in Trail, British Columbia shall not exceed 2,380 tonnes per year.

The total loading limit is based on the following:

(i) An annual summation of the daily average SO_2 concentration of gases in the Z-1 stack multiplied by the gas flow rate as estimated by daily average annubar values correlated to actual gas flow rate measurements.

R.J. Crozier, R.P. Bio.
Regional Waste Manager

Date issued NOV 19 1992, 19

Date amended ....., 19

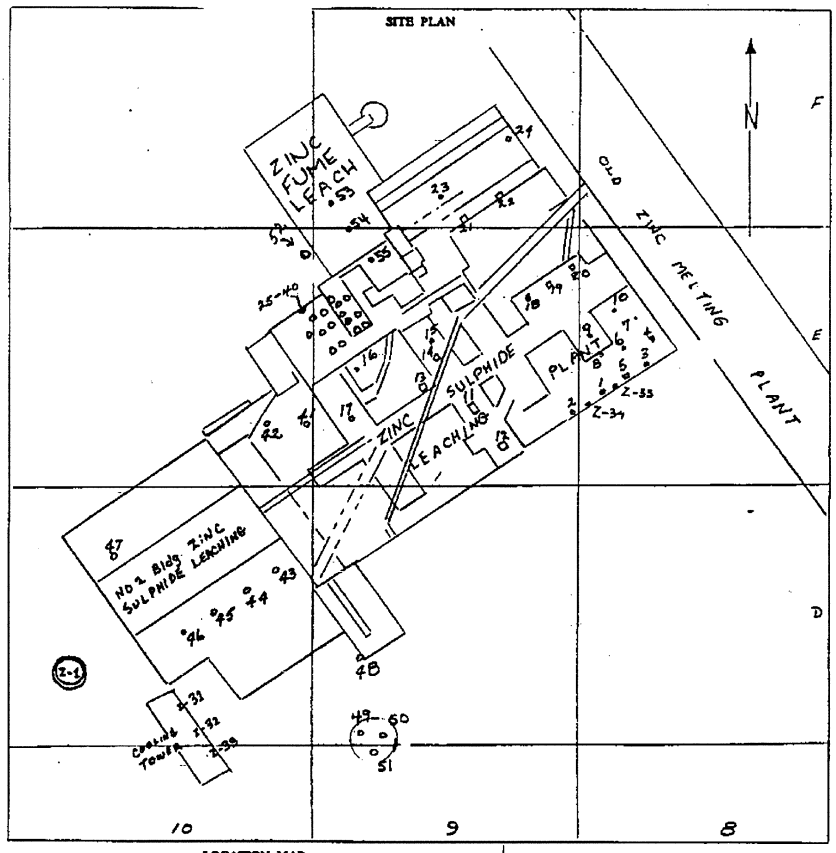
....., 19

Province of British Columbia

Ministry of Environment

WASTE MANAGEMENT BRANCH

SITE PLAN



LOCATION MAP

MISCELLANEOUS EMISSIONS
ZINC SMELTER

GROUP 8

REF: PLAN No 3-310B

SCALE 1" 100'

PCB 13—0

COMINCO LTD.
(Name of applicant(s))

Dec 16/85
(Date)

(Signature of applicant(s) or agent)
G.F. Kenyon

(FOR OFFICE USE ONLY)

APR 08 1987
Date Issued

Date Amended

Regional Waste Manager

Appendix A-1 to Permit No. PA-2692

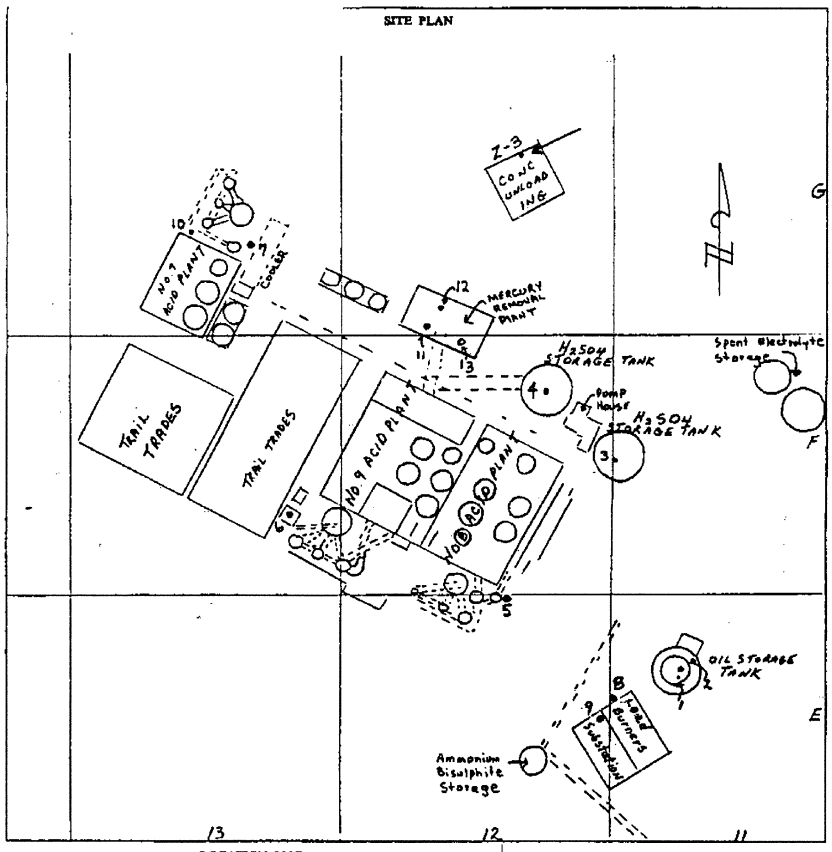
Approval No.

Province of British Columbia

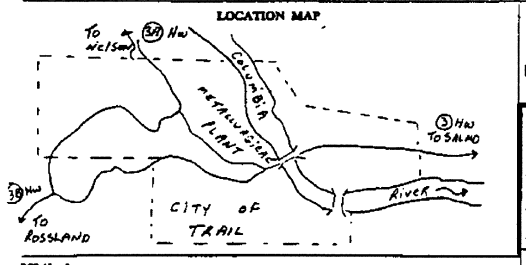
Ministry of Environment

WASTE MANAGEMENT BRANCH

SITE PLAN



LOCATION MAP



PCB 12—0

CONIMCO LTD.
(Name of applicant(s))

Dec 16/85
(Date)

G.F. Kenyon
(Signature of applicant(s) or agent)

(FOR OFFICE USE ONLY)

APR 08 1987
Date Issued

Date Amended

Regional Waste Manager

Appendix A-2 to Permit No. PA-2692

Approval No.

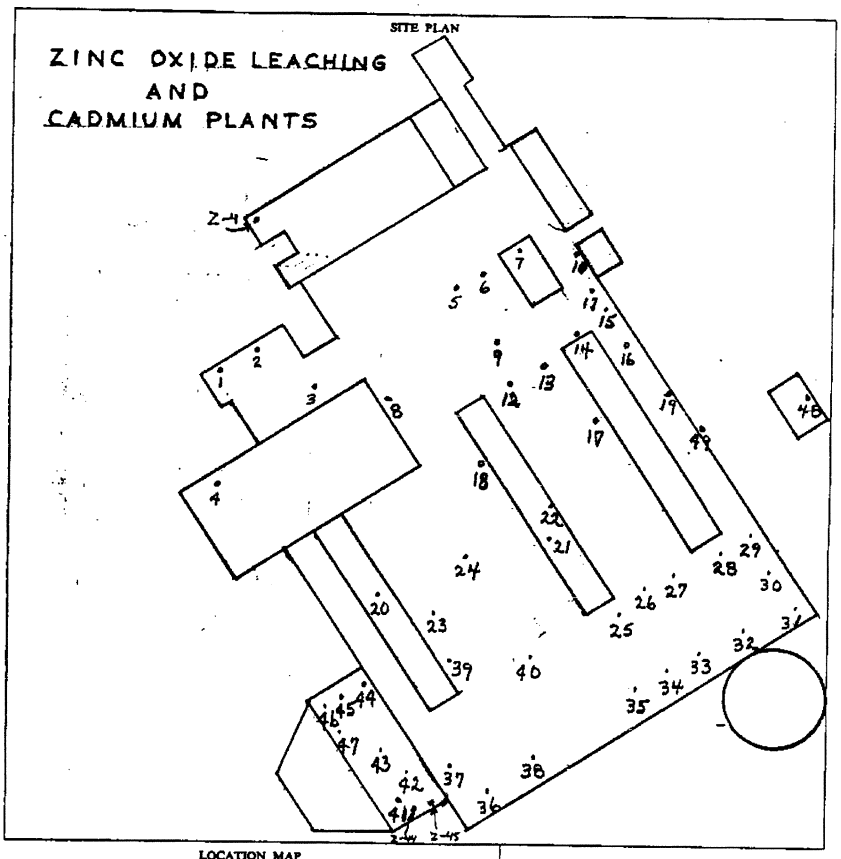
Province of British Columbia

Ministry of Environment

WASTE MANAGEMENT BRANCH

SITE PLAN

ZINC OXIDE LEACHING
AND
CADMIUM PLANTS



LOCATION MAP

ZINC SMELTER

COMINCO LTD.
(Name of applicant(s))

Dec 16/85
(Date)

(Signature of applicant(s) or agent)
G.F. Kenyon

(FOR OFFICE USE ONLY)

APR 08 1987
Date Issued

Date Amended

Regional Waste Manager

Appendix A-3 to Permit No. PA-2692

Approval No.

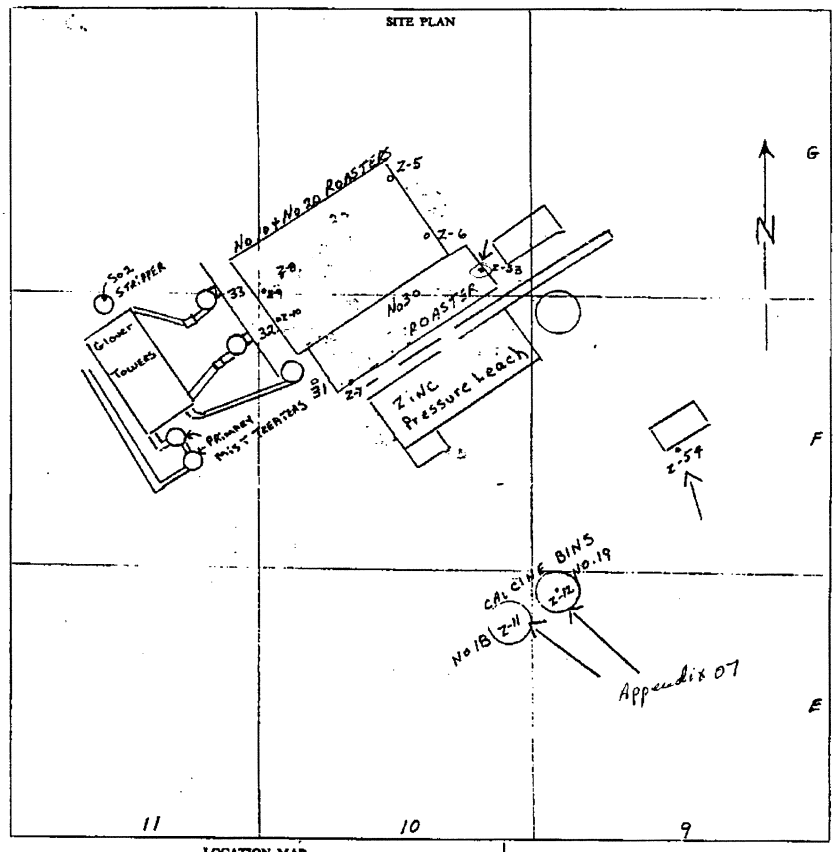
PCB 13—0

Province of British Columbia

Ministry of Environment

WASTE MANAGEMENT BRANCH

SITE PLAN



LOCATION MAP

MISCELLANEOUS EMISSIONS

ZINC SMELTER

Group 7

REF: PLAN No 3-310 B

COMINCO LTD.
(Name of applicant(s))

Dec 16/85
(Date)

G.F. Kenyon
(Signature of applicant(s) or agent)

(FOR OFFICE USE ONLY)

APR 08 1987
Date Issued

Date Amended

Regional Waste Manager

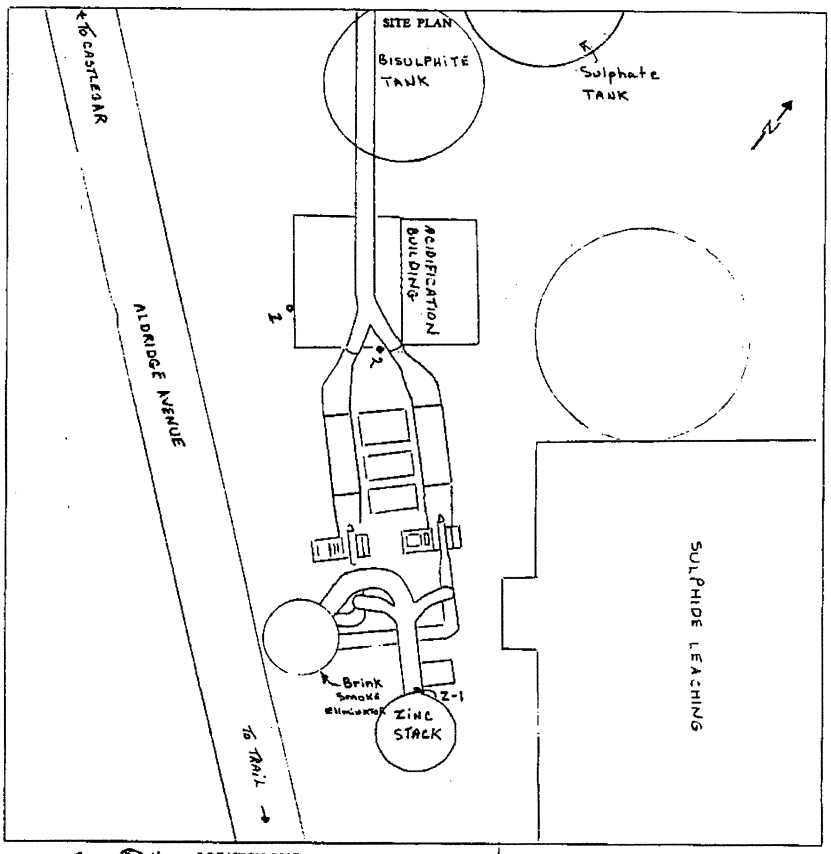
Appendix A-4 to Permit No. PA-2692

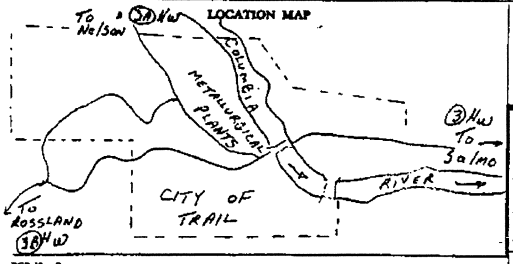
PCB 12—0

Province of British Columbia

Ministry of Environment

WASTE MANAGEMENT BRANCH





PCB 13—0

COMINCO LTD.
(Name of applicant(s))

Dec 16/85
(Date)

(Signature of applicant(s) or agent)
C.F. Kenyon

(FOR OFFICE USE ONLY)

APR 08 1987
Date Issued

Date Amended

Regional Waste Manager

Appendix A-5 to Permit No PA-2692

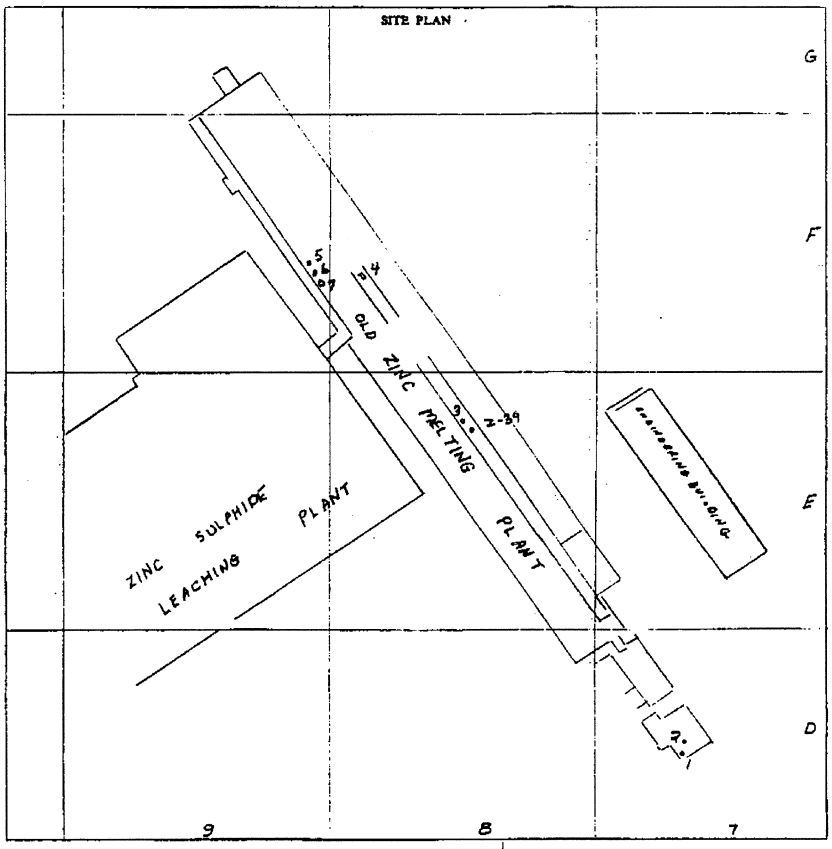
Approval No.

Province of British Columbia

Ministry of Environment

WASTE MANAGEMENT BRANCH

SITE PLAN



LOCATION MAP

MISCELLANEOUS EMISSIONS
ZINC SMELTER

GROUP 9

REF: PLAN No 3-310 B

COMINCO LTD.
(Name of applicant(s))

Dec 16/85
(Date)

G.F. Kenyon
(Signature of applicant(s) or agent)

(FOR OFFICE USE ONLY)

APR 08 1987
Date Issued

Date Amended

Regional Waste Manager

Appendix A and D to Permit No. PA-2692

Approval No.

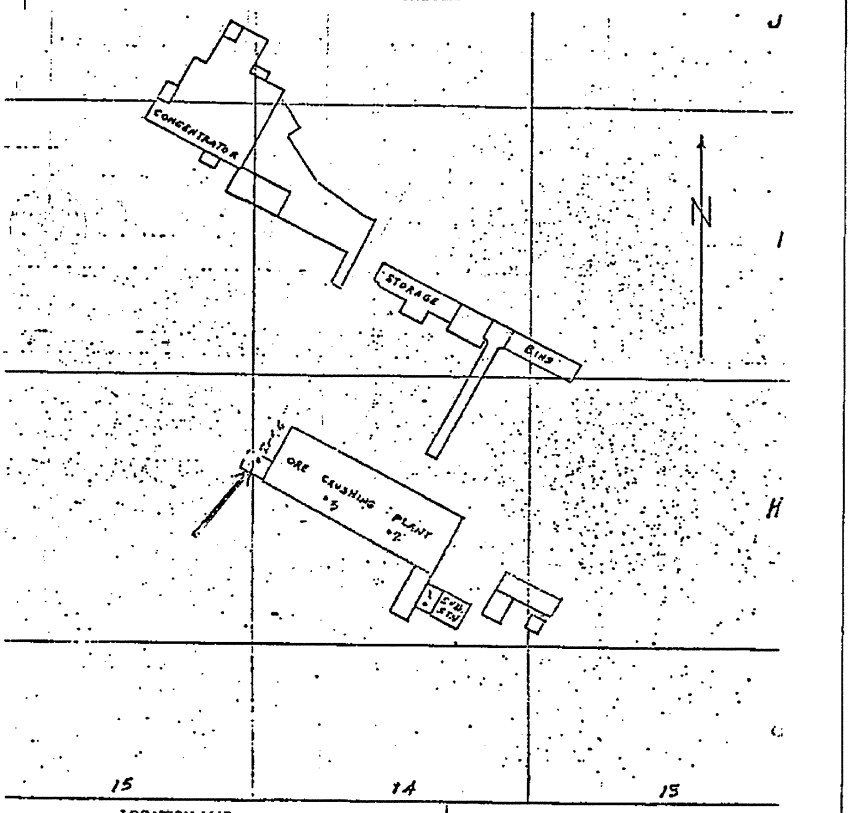
PCB 12—0

Province of British Columbia

Ministry of Environment

WASTE MANAGEMENT BRANCH

SITE PLAN



LOCATION MAP

ZINC SMELTER

REF: PLAN No. 3-310 B

SCALE 1" 100'

COMINCO LTD.
(Name of applicant(s))

Mar. 12/74
(Date)

(Signature of applicant(s) or agent)
L. J. Nicholson

(FOR OFFICE USE ONLY)

APR 08 1987
Date Issued

Date Amended

Regional Waste Manager

Appendix A-7 to Permit No. PA-2692

Approval No.

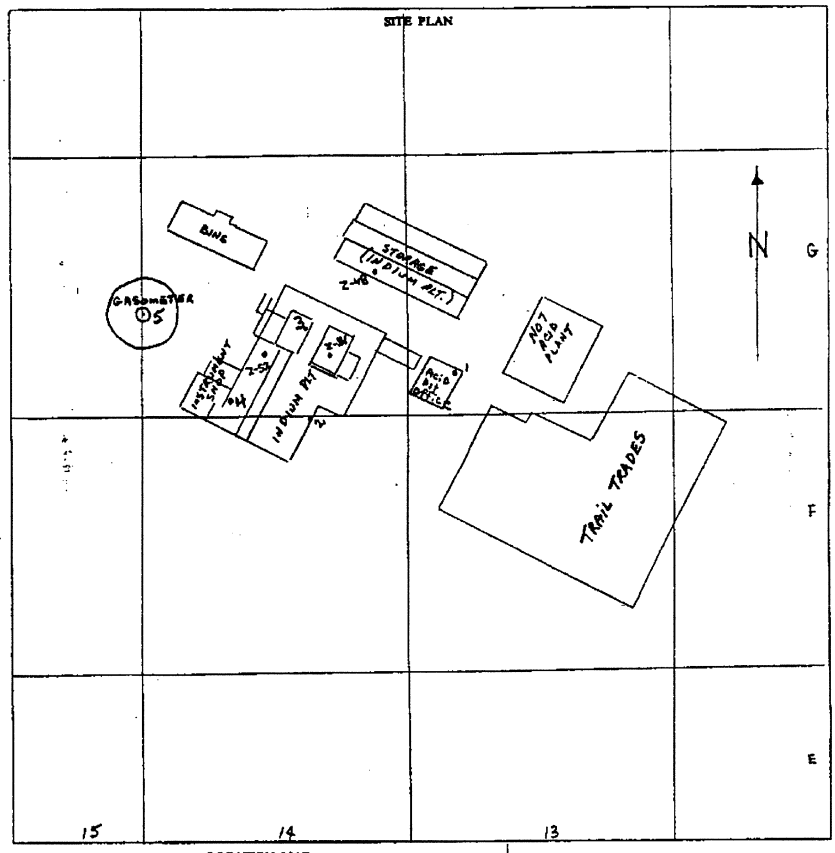
ENV 1987

Province of British Columbia

Ministry of Environment

WASTE MANAGEMENT BRANCH

SITE PLAN



LOCATION MAP

MISCELLANEOUS EMISSIONS
ZINC SMELTER

GROUP 4

REF: PLAN No. 3-310 B

COMINCO LTD.
(Name of applicant(s))

Dec 16/85
(Date)

G.F. Kenyon
(Signature of applicant(s) or agent)

(FOR OFFICE USE ONLY)

APR 08 1987
Date Issued

Date Amended

Regional Waste Manager

Appendix A-8 to Permit No. PA-2692

Approval No.

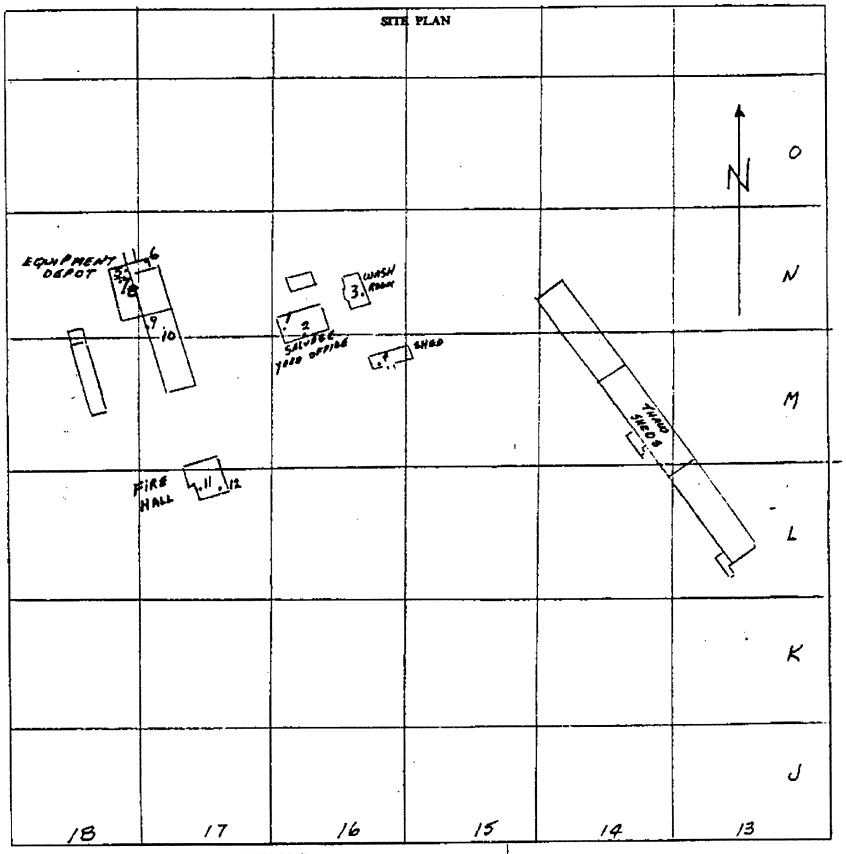
PCB 12—0

Province of British Columbia

Ministry of Environment

WASTE MANAGEMENT BRANCH

SITE PLAN



LOCATION MAP

MISCELLANEOUS EMISSIONS
ZINC SMELTER

GROUP 2

REF: PLAN NO 3-310

SCALE 1" = 200'

PCB 12—0

COMINCO LTD.
(Name of applicant(s))

Dec 16/85
(Date)

(Signature of applicant(s) or agent)
G.F. Kenyon

(FOR OFFICE USE ONLY)

APR 08 1987
Date Issued

Date Amended

Regional Waste Manager

Appendix A-9 to Permit No. PA-2692

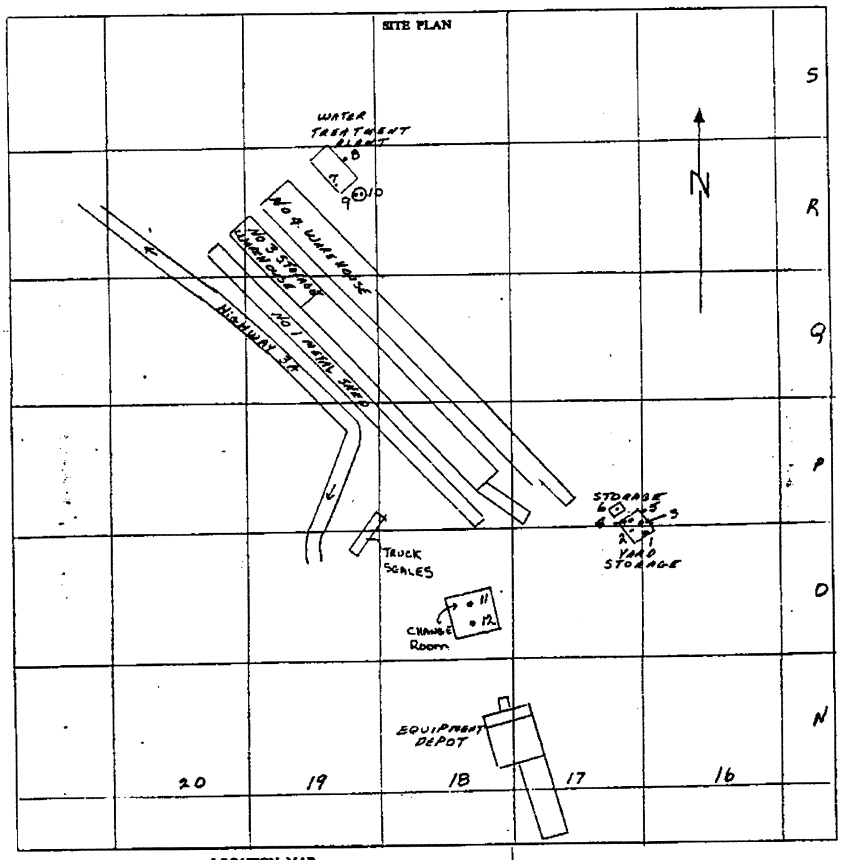
Approval No.

Province of British Columbia

Ministry of Environment

WASTE MANAGEMENT BRANCH

SITE PLAN



LOCATION MAP

MISCELLANEOUS EMISSIONS
ZINC SMELTER

GROUP 1

REF PLAN NO 3-310

SCALE 1" = 200'

COMINCO LTD.
(Name of applicant(s))

Dec 16/85
(Date)

(Signature of applicant(s) or agent)
G.F. Kenyon

(FOR OFFICE USE ONLY)

APR 08 1987
Date Issued

Date Amended

Regional Waste Manager

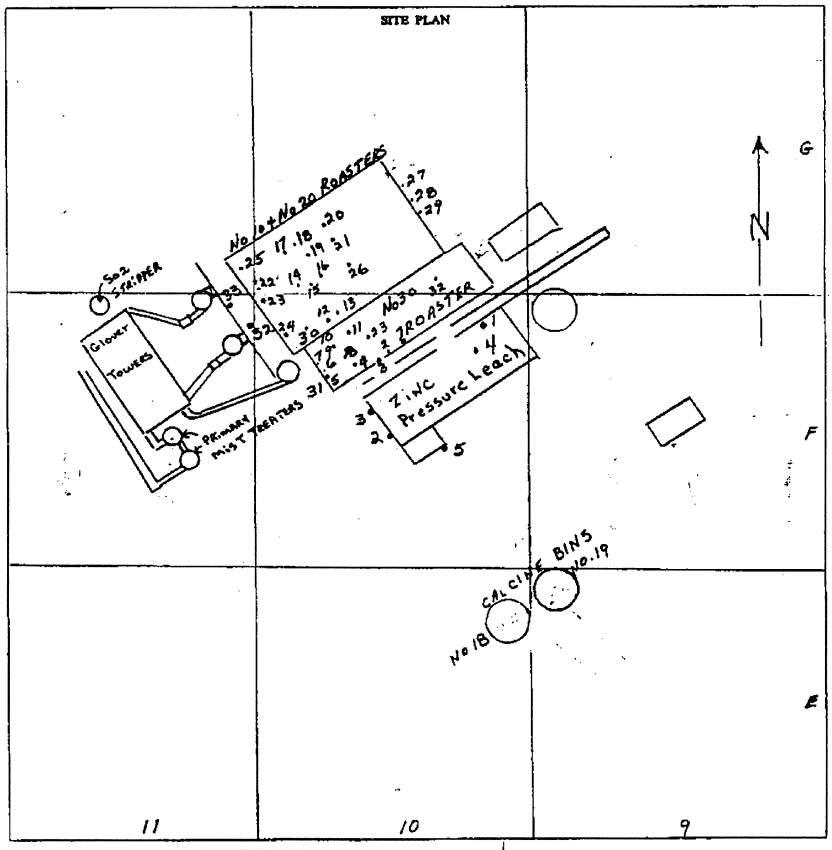
Appendix A-10 to Permit No. PA-2692

Approval No.

FCB 13—0

Province of British Columbia | Ministry of Environment | WASTE MANAGEMENT BRANCH

SITE PLAN



LOCATION MAP

MISCELLANEOUS EMISSIONS
ZINC SMELTER
Group 7

REF: PLAN NO 3-310B

FCB 12—0

COMINCO LTD.
(Name of applicant(s))

Dec 16/85
(Date)

G.F. Kenyon
(Signature of applicant(s) or agent)

(FOR OFFICE USE ONLY)

APR 08 1987
Date Issued

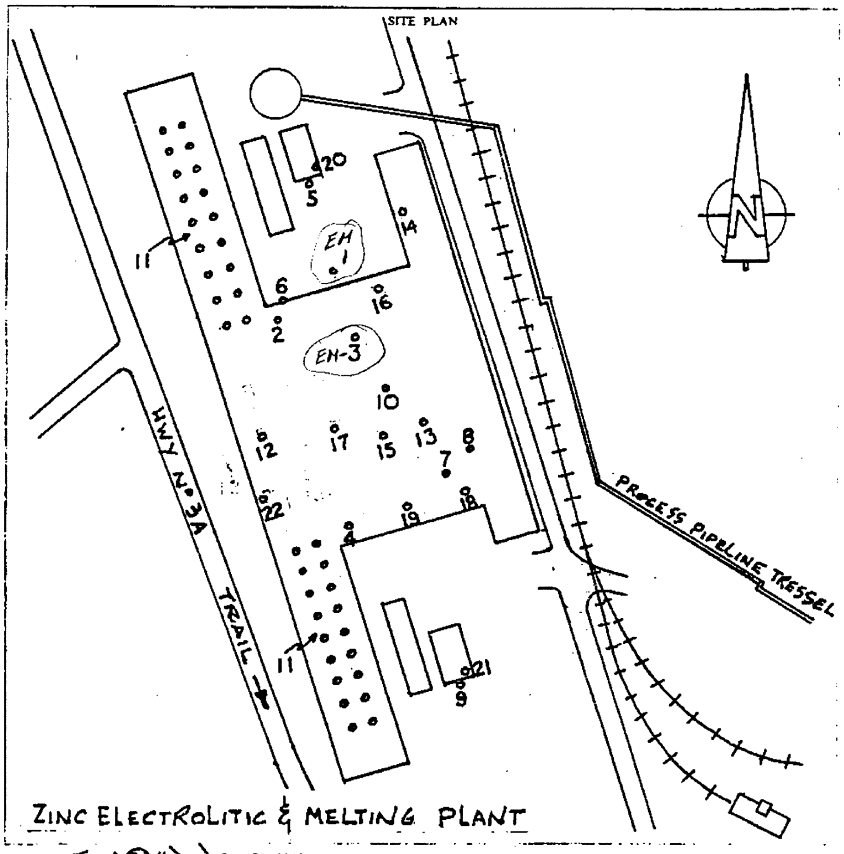
Date Amended

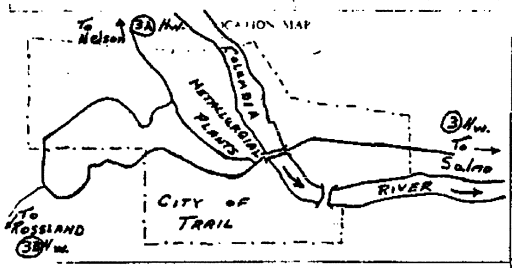
Regional Waste Manager

Appendix A-11 to Permit No. PA-2692

Approval No.

Province of British Columbia | Ministry of Environment | WASTE MANAGEMENT BRANCH





COMINCO LTD.

Dec 16/85 (Date)

G.F. Kenyon

(FOR OFFICE USE ONLY)

APR 08 1987 Date Issued

Date Amended

Regional Waste Manager

Appendix A-12 to Permit No. PA-2692

Approval No.

MINISTRY OF ENVIRONMENT

WASTE MANAGEMENT BRANCH

APPENDIX B-1

to Permit No. PA-2692

A. PROCESS MODIFICATIONS

The Permittee shall notify the Regional Waste Manager prior to implementing changes to any process that may affect the quality and/or quantity of the discharge.

B. BYPASSES

a) The discharge of contaminants which has bypassed the designated treatment works is prohibited unless the approval of the Director or the Regional Waste Manager is obtained and confirmed in writing.

b) Any use of the Zinc Roaster Start-up Stacks that results in a significant discharge of particulate or the Brink filter bypass system is to be recorded as to the time, date, duration and reason for the bypass.

All bypasses that are not part of the regular operating procedure are to be recorded as to time, date, duration and reason for bypass. These records are to be submitted in conjunction with the annual report.

C. MAINTENANCE OF WORKS

The Permittee shall inspect the pollution control works regularly and maintain them in good working order. Notify the Regional Waste Manager of any malfunction of these works.

D. EMERGENCY PROCEDURES

In the event of an emergency or condition beyond the control of the Permittee which prevents continuing operation of the approved method of pollution control or compliance with ambient air quality guidelines, the Permittee shall immediately notify the Regional Waste Manager and take appropriate remedial action.

In addition, when ambient sulphur dioxide exceeds permit levels, and in the judgement of the Permittee, no improvement is forecast, Cominco shall so advise the Medical Health Officer so that the Superintendent of Schools and the general public may be made aware of the situation if deemed necessary.

Regional Waste Manager

Date Issued APR 08 1987 19__

Date Amended _____ 19__

_____ 19__

MINISTRY OF ENVIRONMENT

WASTE MANAGEMENT BRANCH

APPENDIX B-2

to Permit No. PA-2692

E. AMBIENT SULPHUR DIOXIDE CONTROL REGIME

Sulphur dioxide emissions shall be controlled as outlined below. In conjunction with this control regime, the Permittee is required to recover, as a minimum, 80% of the total sulphur input. The actual sulphur recovery percentage shall be determined as an annual average and included in the annual report.

1. The annual arithmetic mean at any continuous ambient sensor shall not exceed 80 $\mu g/m^3$s. (.03 ppm)

2. The 24-hour average concentration at any continuous ambient sensor shall not exceed 375 $\mu g/m^3$s. (.14 ppm)

3. The 3-hour average concentration at any continuous ambient sensor shall not exceed 800 $\mu g/m^3$ (.3 ppm). The 3-hour average concentration is to be updated hourly for each ambient SO_2 sensor.

F. The conditions outlined in the Permit and related Appendices do not relieve the Permittee of any responsibilities pursuant to the Decision of the Trail Smelter Arbitral Tribunal as reported on March 11, 1941.

Regional Waste Manager

Date Issued APR 08 1987 19__

Date Amended _____ 19__

_____ 19__

ENV. 2096 W-817

MINISTRY OF ENVIRONMENT

WASTE MANAGEMENT BRANCH

APPENDIX No. C-1

to Permit No. PA-02692

Commencing on the date of issuance of this Amended Permit, the following source and ambient air monitoring program shall be carried out by the Permittee and the results submitted to the Regional Waste Manager.

A SOURCE MONITORING

Appendix	I.D.	Description	SO_2	Total Particulate	Zn	Cd
01	Z-1	Main Zinc Stack	C	M*		
19	Z-44	#1 Cadmium Furnace				SA
19	Z-45	#2 Cadmium Furnace				SA
40	EM-1	Zinc Melting Plant Baghouse		A	A	
41	EM-3	Zinc Atomizer Stack		A	A	

C = Continuous
M = Monthly
SA = Semi-Annually
A = Annually

NOTE: Continuous SO_2 stack data is to be submitted as the average daily concentration and daily rate of discharge. Record charts are to be retained for a period of 6 months.

* Sampling to be done each month, samples taken when Brink Smoke Eliminator bypassed are not considered for Permit Compliance purposes.

2. Discharge Rate Measurement

Measure and record on the day of sampling of the above emissions, the average daily rate of discharge from each stack in m^3/min. based on the normal operating period.

3. Sampling Facilities

Sampling ports shall be provided with nearby electrical and pneumatic outlets and, where required, approved access ladders and adequately sized platforms, for the discharges covered by Appendices 01, 19, 40 and 41 to enable Waste Management Personnel to monitor these emissions.

R.J. Crozier, R.P. Bio.
Regional Waste Manager

Date issued April 8, 19 87

Date amended NOV 19 1992, 19 ..

, 19 ..

MINISTRY OF ENVIRONMENT

WASTE MANAGEMENT BRANCH

APPENDIX O-1

to Permit No. PA-2692

Commencing on the date of issuance of this amended permit, the following source and ambient air monitoring program shall be carried out by the Permittee and the results submitted to the Regional Waste Manager.

A. Source Monitoring

Appendix	I.D.	Description	SO_2	Tot. Particulate	Zn	Pb	Cd
01	Z-1	Main Zinc Stack	C	M*			
~~14~~	~~Z-39~~	~~#2 Ajax Furnace~~		~~Q**~~	~~Q**~~		
19	Z-44	#1 Cadmium Furnace					SA
19	Z-45	#2 Cadmium Furnace					SA
~~22~~	~~Z-51~~	~~Top Blown Rotary Converter (Indium Plant)~~		~~SA~~		~~SA~~	
~~25~~	~~Z-54~~	~~#12 Copper Roaster Stack~~	~~SA~~	~~SA~~		~~SA~~	
40	EM-1	Zinc Melting Plant Baghouse		A	A		
41	EM-3	Zinc Atomizer Stack		A	A		

C = continuous
M = monthly
SA = semi-annually
Q = quarterly
A = annually

Note: Continuous SO_2 stack data is to be submitted as the average daily concentration and daily rate of discharge. Record charts are to be retained for a period of 6 months.

* sampling to be done each month, samples taken when Brink Smoke Eliminator bypassed are not considered for Permit Compliance purposes.

** Sample only required if total hours of operation projected to exceed 160 hours/month during quarter.

2. Discharge Rate Measurement

Measure and record on the day of sampling of the above emissions, the average daily rate of discharge from each stack in m^3/min based on the normal operating period.

3. Sampling Facilities

Sampling ports shall be provided with nearby electrical and pneumatic outlets and, where required, approved access ladders and adequately sized platforms, for the discharges covered by Appendices 01, 14, 19, 22, 25, 40 and 41 to enable Waste Management personnel to monitor these emissions.

Regional Waste Manager

Date Issued APR 08 1987 19__

Date Amended _____ 19__

_____ 19__

ENV. 2096

MINISTRY OF ENVIRONMENT

WASTE MANAGEMENT BRANCH

APPENDIX No. C-1

to Permit No. PA-02692

Commencing on the date of issuance of this Amended Permit, the following source and ambient air monitoring program shall be carried out by the Permittee and the results submitted to the Regional Waste Manager.

A. SOURCE MONITORING

Appendix	I.D.	Description	SO_2	Total Particulate	Zn	Cd
01	Z-1	Main Zinc Stack	C	M*		
19	Z-44	#1 Cadmium Furnace				SA – Not in Service
19	Z-45	#2 Cadmium Furnace				SA – " " "
40	EM-1	Zinc Melting Plant Baghouse		A	A	
41	EM-3	Zinc Atomizer Stack		A	A	

C = Continuous
M = Monthly
SA = Semi-Annually
A = Annually

NOTE: Continuous SO_2 stack data is to be submitted as the average daily concentration and daily rate of discharge. Record charts are to be retained for a period of 6 months.

* Sampling to be done each month, samples taken when Brink Smoke Eliminator bypassed are not considered for Permit Compliance purposes.

2. Discharge Rate Measurement

Measure and record on the day of sampling of the above emissions, the average daily rate of discharge from each stack in m^3/min. based on the normal operating period.

3. Sampling Facilities

Sampling ports shall be provided with nearby electrical and pneumatic outlets and, where required, approved access ladders and adequately sized platforms, for the discharges covered by Appendices 01, 19, 40 and 41 to enable Waste Management Personnel to monitor these emissions.

MINISTRY OF ENVIRONMENT

WASTE MANAGEMENT BRANCH

APPENDIX C-2

to Permit No. PA-2692

B. AMBIENT MONITORING

STN. LOCATION	PARAMETERS TO BE MEASURED AND FREQUENCY									
	SO_2	Sulphation Plate	Fluoride Plate	Dust Fall	Sus. Particulate Tot.	Pb	Zn	Cd	Gaseous Fluoride	Total Arsenic
1 Downtown Trail	C	M	M	M	W	W	W	W	W	W
2 Oasis	C	M	M	M	W	W	W	W	W	W
3 Warfield Substation	C	M	M	M	W	W	W	W	W	W
4 Sunningdale		M	M	M						
5 Glenmerry		M	M	M						
6 Daniel St.		M	M	M						
7 Columbia Gardens		M	M	M						
8 Trail Hospital		M	M	M						
9 Birchbank		M	M	M						

C = continuous
W = weekly (every six days)
M = monthly (30-days duration)

Note: SO_2 monitoring data is to be submitted as 1-hour average readings, 3-hour average readings which have been updated hourly, and 24 hour averages.

C. PROGRAM OF IMPROVEMENTS

The Permittee shall provide approved Hi-Volume Suspended Particulate monitors to replace existing low volume samples by January 1, 1988.

D. SOURCE TESTING PROCEDURES - (PARTICULATES)

a) Source testing procedures for the determination of particulate matter concentrations and the rate of discharge (flow rate) are to be carried out in accordance with those procedures described in the "Source Testing Code for the Measurement of Emissions of Particulates from Stationary Sources," 1982. Alternative test methods may be used provided that the alternative methods are approved by the Director or Regional Waste Manager prior to performing the actual source testing.

Copies of the above mentioned manual are available from the Waste Management Branch, 810 Blanshard Street, Victoria, British Columbia, V8V 1X5, at a cost of $5.00. The manual is also available for inspection at all Waste Management Offices.

Date Issued APR 08 1987 19__

Date Amended _____ 19__

Regional Waste Manager

MINISTRY OF ENVIRONMENT

WASTE MANAGEMENT BRANCH

APPENDIX C-3

to Permit No. PA-2692

SOURCE TESTING PROCEDURE - SULPHUR DIOXIDE

b) The source testing procedure for the measurement of sulphur dioxide is to be carried out in accordance with procedure described in the "Source Testing Code for the Measurement of Emissions of Sulphuric Acid Mist and Sulphur Dioxide from Stationary Sources, Ministry of Environment Manual 6 (1984)". Alternative test methods may be used provided that the alternative methods are approved by the Director or Regional Waste Manager prior to performing the actual source testing.

Copies of the above mentioned manual are available from the Waste Management Branch, 810 Blanshard Street, Victoria, British Columbia, V8V 1X5, at a cost of $7.50. The manual is also available for inspection at all Waste Management Offices.

E. ANALYSES

Analyses are to be carried out in accordance with procedures described in the third edition (April, 1983) of "A Laboratory Manual for the Chemical Analysis of Ambient Air, Emissions, Precipitation, Soil and Vegetation," or by suitable alternative procedures as approved by the Regional Waste Manager.

Copies of the above mentioned manual are available from the Environmental Laboratory, 3650 Wesbrook Crescent, Vancouver, British Columbia, V6S 2L2, at a cost of $25.00, and are also available for inspection at all Waste Management offices.

F. REPORTING

1. The Permittee shall submit an annual report to the Regional Waste Manager which includes:

   (a) All source testing results.

   (b) A summary of the ambient air results.

   (c) A discussion of remedial measures proposed for those emissions shown to be at variance with the allowable limits.

   This report shall be submitted on or before March 1st. of each year.

2. The Permittee shall submit the results of the ambient air monitoring program to the Regional Waste Manager monthly.

3. Variations in this reporting schedule may be determined by the Regional Waste Manager.

Regional Waste Manager

Date Issued APR 08 1987 19__

Date Amended _____ 19__

_____ 19__

ENV. 2096 W-817

Province of
British Columbia

Ministry of
Environment

Waste Management Branch
Kootenay Region
310 Ward Street
Nelson
British Columbia
V1L 5S4
Telephone: (604) 354-6355

YOUR FILE

OUR FILE PS-8443

OCT 27 1989

REGISTERED MAIL

Cominco Ltd. - Cominco Ltee.
2600 - 200 Granville Street
Vancouver, British Columbia
V6C 2R2

Gentlemen:

LETTER OF TRANSMITTAL

Enclosed is a copy of Permit No. PS-8443 issued under the provisions of the Waste Management Act in the name of Cominco Ltd. - Cominco Ltee. Your attention is respectfully directed to the terms and conditions outlined in the Permit. Operation and performance of the permitted short term storage facility shall comply with all the applicable provisions of the Special Waste Regulation of the Waste Management Act. These provisions generally require, but are not limited to, the following:

1. PLANS

1.1 Plans and specifications of the special waste facility and the related works shall be submitted to the Regional Waste Manager and his approval obtained in writing prior to construction or modification of the works.

2. WASTE INFORMATION

2.1 No special wastes shall be accepted at the facility without taking reasonable measures to identify all hazards associated with the special waste.

2.2 No special wastes shall be accepted at the facility which is described as a quantity more than 100 kilograms or 100 liters without first determining the quantity of the waste delivered by measuring the weight or volume of the shipment.

.../2

3. ACCESS SECURITY

3.1 Access to the facility by unauthorized persons must be prevented at all times.

3.2 Warning signs are to be posted at each entrance to the facility and at other locations as required by the Regional Waste Manager.

4. SPILL PROTECTION AND REPORTING

4.1 Specifications for a spill containment system shall be submitted to the Regional Waste Manager and his approval obtained in writing prior to commencing operation.

4.2 The facility shall be inspected either on a weekly basis, or if a 24 hour spill alarm is provided and maintained, on a monthly basis; and any irregularities are to be immediately reported to the Regional Manager.

5. CONTINGENCY PLAN

5.1 A contingency plan for the facility which documents procedures to be followed during emergencies shall be submitted to the Regional Waste Manager and his approval obtained in writing, prior to commencing operation.

6. EMERGENCY SYSTEMS TESTING

6.1 The facility emergency systems shall be tested at least once per year to ensure that the systems are capable of proper operation in an emergency.

7. CLOSURE

7.1 A closure plan for the facility shall be submitted to the Regional Waste Manager and his approval obtained in writing prior to commencing operation.

8. STORAGE REQUIREMENTS

8.1 Liquid wastes shall be stored in an impervious containment

.../3

system capable of holding twice the volume of the largest container of liquid waste or 25 percent of the total volume of all of the liquid at the facility, whichever is greater.

8.2 Drums used for the storage of polychlorinated biphenyl (PCB) wastes shall have a capacity not greater than 205 liters and shall be painted to prevent rusting. Drums used for the storage of PCB solids shall be of 18 gauge steel or heavier and have securely attached removable steel lids with PCB resistant gaskets. Drums used for the storage of PCB liquids shall be of 16 gauge steel or heavier and shall be closed except for screw plug double bung access holes.

8.3 All PCB wastes and equipment shall be placed on pallets except transformers mounted on skids.

8.4 Containers other than drums shall not be stacked unless designed for stacking and in such cases are not to be stacked more than two high.

8.5 All PCB waste containers and equipment shall be properly labelled.

This permit does not authorize the discharge of any waste stream resulting from the operation of the facility.

The administration of this Permit will be carried out by staff from our Regional Office located at 310 Ward Street, Nelson, British Columbia, V1L 5S4 (telephone 354-6355). Plans, data and reports pertinent to the Permit are to be submitted to the Regional Waste Manager at this address.

You will note that values have been expressed in the International Systems of Units (SI). These units are to be used in submitting reports and any other information in connection with this Permit.

.../4

This Permit does not authorize entry upon, crossing over, or use for any purpose of private or Crown lands or works, unless and except as authorized by the owner of such lands or works. The responsibility for obtaining such authority shall rest with the Permittee.

Yours very truly,

Jim McLaren

Jim McLaren, P. Eng.
Regional Waste Manager

JJ/vp
Enclosure

MINISTRY OF ENVIRONMENT

PERMIT

Under the Provisions of the Waste Management Act

COMINCO LTD. - COMINCO LTEE.

2600 - 200 Granville Street, Vancouver, British Columbia V6C 2R2

is hereby authorized to store special waste

from

located at Trail, British Columbia

to

This permit has been issued under the terms and conditions prescribed in the attached appendices

01, A-1, B-1 and C-1

Regional Waste Manager

Date issued OCT 27 1989, 19

Amendments dated , 19

, 19

, 19

Permit No. PS-8443

ENV 1988

MINISTRY OF ENVIRONMENT
WASTE MANAGEMENT BRANCH

APPENDIX No. 01

to Permit No. PS-8443

(Storage)

(a) The storage facility to which this appendix is applicable is located as shown on attached Appendix A-1.

(b) The maximum quantity of special wastes which may be stored is 5000 kilograms.

(c) Only special wastes defined in the Special Waste Regulation B.C. Reg. 63/88, pursuant to the Waste Management Act, as PCB liquids, PCB solids, PCB equipment and PCB wastes shall be stored.

(d) The works authorized are a short term storage facility including international shipping containers, paved yard area and related appurtenances approximately located as shown on the attached Appendix A-1.

(e) The location of the storage facility to which this appendix is appurtenant is Parts of Lots 13, 14, 16, 17 and 18 of District Lot 367, Plan 1425, K.D.

(f) The works authorized must be completed and in operation prior to commencing operation.

Jim McLaren
Regional Waste Manager

Date issued OCT 27 1989, 19

Date amended ....., 19

....., 19

ENV 1993 cc

MINISTRY OF ENVIRONMENT
WASTE MANAGEMENT BRANCH

APPENDIX No. B-1

to Permit No. PS-8443

SPECIAL WASTE REGULATION REQUIREMENTS

The operation and performance of the short term storage facility shall comply with all applicable provisions of the Special Waste Regulation of the Waste Management Act.

PREVENTION OF FIRE, EXPLOSION AND ACCIDENTAL REACTIONS - FLAMMABLE STORAGE CONTAINER

The facility shall be equipped with a continuous 24 hour fire alarm system with smoke sensing and heat sensing alarms capable of summoning 24 hour external emergency response and automatically stopping the forced air ventilation system and closing the forced air ventilation intake and exhaust dampers.

The facility shall provide and maintain a fire suppression system specified by the Fire Commissioner or a local assistant to the Fire Commissioner as defined in the Fire Services Act, or where not so specified provide and maintain

(i) a permanent, automatic system which uses foam, inert gas or dry chemical, or

(ii) one portable ABC rated fire extinguisher with a minimum 10 kg capacity for every 250 m^2 of the facility's space.

INSPECTION SPACE

Sufficient aisle space shall be provided and maintained between containers of special waste to allow the unobstructed movement of persons, fire protection equipment, spill control equipment and decontamination equipment to any part of the facility.

Jim McLaren
Regional Waste Manager

Date issued OCT 27 1989, 19

Date amended , 19

, 19

ENV 1993 ce

MINISTRY OF ENVIRONMENT

WASTE MANAGEMENT BRANCH

APPENDIX No. C-1

to Permit No. PS-8443

1. REPORTING

Waste records, required pursuant to Section 6 of the Special Waste Regulation, shall be submitted, suitably tabulated, to the Regional Waste Manager and to the local assistant to the fire commissioner on or before January 2 and July 2, of each year for the previous six months of operations.

Jim McKinnon
Regional Waste Manager

Date issued OCT 27 1989, 19

Date amended ....., 19

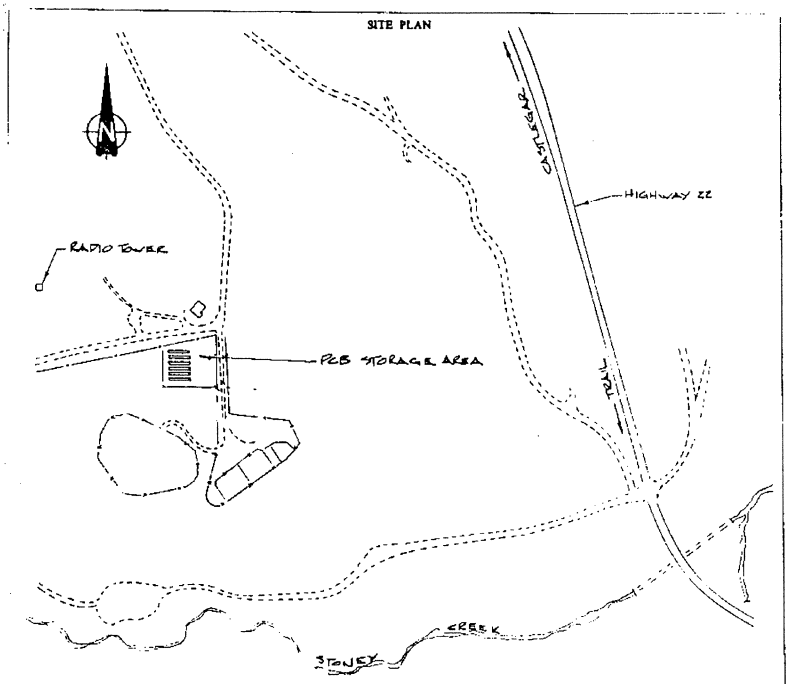
....., 19

ENV 1993 ox

Province of British Columbia | Ministry of the Environment

POLLUTION CONTROL BRANCH

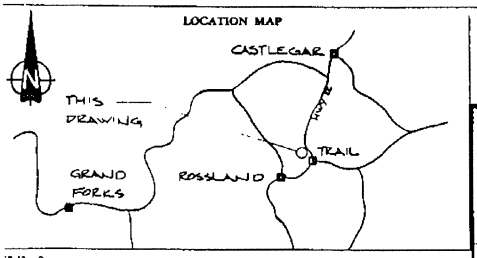
SITE PLAN



Parts of Lots 13, 14, 16, 17 and 18 of District Lot 367, Plan 1425, Kootenay District

0 100 200 m
SCALE

LOCATION MAP



GRAHAM KENYON & CO. INC. LTD
(Name of applicant(s))

15 June '89
(Date)

(Signature(s) of applicant(s) or agent)

(FOR OFFICE USE ONLY)

OCT 27 1989
Date Issued

Regional Waste Manager

Date Amended

Appendix A-1 to Permit No. PS-8443

Approval No.

:B 12—0

MINISTRY OF ENVIRONMENT

PERMIT

Under the Provisions of the Waste Management Act

COMINCO LTD. - COMINCO LTEE.

2600-200 Granville Street

Vancouver, B. C.

V6R 2R2

is authorized to operate a Special Waste Treatment and Storage Facility located at the Salvage Yard area of the Cominco Metallurgical operations in Tadanac. The facility is designed to treat used solvents and is known as the Spent Solvent Treatment Facility.

An annual fee may be determined on the basis of your industrial code and capacity in accordance with the Waste Management Fees Regulation.

This Permit does not authorize entry upon, crossing over, or use for any purpose of private or Crown lands or works, unless and except as authorized by the owner of such lands or works. The responsibility for obtaining such authority shall rest with the Permittee.

Jim McLaren

Date issued:
APR 20 1990

Jim McLaren, P. Eng.
Regional Waste Manager

Page: 1 of 5

Permit No. PS - 8672

Province of
British Columbia

Waste Management Program

SPECIFIC REQUIREMENTS FOR STORAGE OF SPENT AND PRODUCT SOLVENT AND RESIDUES FROM DISTILLATION

The storage of these materials in the storage portion of the solvent reclaim building must comply with the requirements of the Special Waste Regulations. The maximum quantity of used solvents and residuals to be stored at this facility is 2,500 kg.

This includes but is not limited to the need to provide :

-roofed area for storage of solvents
-a non-draining floor area
-curbs to capture any spills from the stored drums of solvents
-an adequate supply of spill cleanup materials and sound drums for receiving spills
-appropriate signage relating to the safety aspects of the materials stored in the facility
-a log book and recording system to maintain control of the inventory of materials stored on site
-an operating and procedure manual for the safe operation of the distillation equipment
-suitable fire fighting equipment

2. LOCATION OF FACILITIES AND POINT OF DISCHARGE

LOT 6, PLAN 6646, CITY OF TRAIL as shown on attached Appendix A-1.

Jim McLaren

Jim McLaren, P. Eng.
Regional Waste Manager

Date issued:
Date amended: APR 20 1990
Page: 2 of 5

Permit No. PS - 8672

3. OPERATIONAL REQUIREMENTS

3.1. Maintenance of Works

The Permittee shall inspect the pollution control works regularly and maintain them in good working order. Notify the Regional Waste Manager of any malfunction of these works.

3.2. Emergency Procedures

In the event of an emergency or condition beyond the control of the Permittee which prevents continuing operation of the approved method of pollution control, the Permittee shall immediately notify the Regional Waste Manager and take appropriate remedial action.

3.3. Bypasses

The discharge of contaminants which has bypassed the designated treatment works is prohibited unless the approval of the Director or the Regional Waste Manager is obtained and confirmed in writing.

3.4. Process Modifications

The Permittee shall notify the Regional Waste Manager prior to implementing changes to any process that may affect the quality and/or quantity of the discharge.

Jim McLaren

Jim McLaren, P. Eng.
Regional Waste Manager

Date issued:
Date amended: APR 20 1990

Permit No. PS - 8672

3.5. Automatic Shutoff of Equipment

The distillation equipment shall be controlled by a system of automatic shutoffs that will shut off the heating power to the oil bath and sound an alarm in the event of the following situations:

-High temperature in the still operating room
-Smoke detector alarm sounds
-Ventilation fan failure
-High level alarm in product receiving drum
-Shut off of condensing water to product condenser
-failure of vacuum pump

3.6 Demonstration of facility

The company shall conduct an approved demonstration of the distillation system to show the effectiveness of the process and alarm systems prior to commencing full time use.

Jim McLaren
Regional Waste Manager

Date Issued:
Date Amended: APR 20 1990
Page 4 of 5

Permit No. PS - 8672

3.7 Sludge Sampling

The residue or still bottoms generated in the distillation process are to be analyzed prior to storage or disposal. A metals scan type analysis is recommended but specific analysis may be required depending on the source of the contaminated solvents.
If the analysis of residue generated in the distillation of non-chlorinated solvents is acceptable to the Regional Waste Manager, this material may be recycled for metals recovery via the lead smelter.

Regional Waste Manager

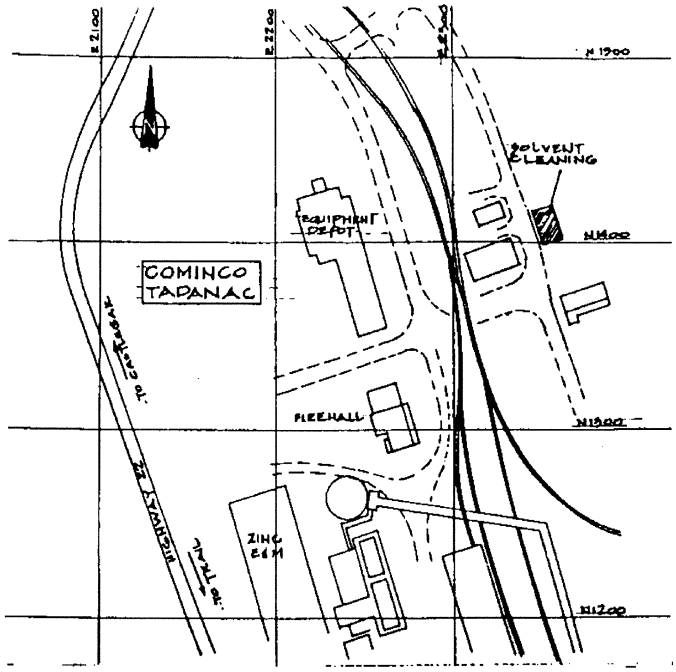
Date Issued:
Date Amended: APR 20 1990

Permit No. PS - 8672

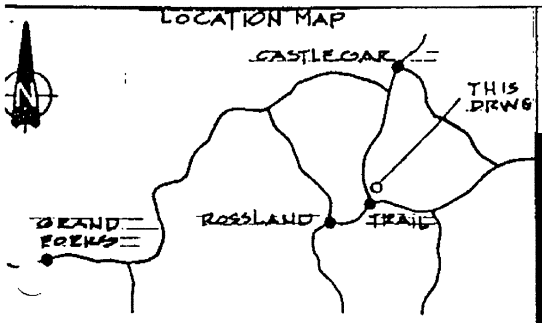
Province of British Columbia | **Ministry of Environment** | **WASTE MANAGEMENT BRANCH**

Lot 6, Plan 6646, City of Trail

SITE PLAN



LOCATION MAP



Cominco Ltd. - Cominco Ltee.
(Name of applicant(s))

(Date) (Signature of applicant(s) or agent)

(FOR OFFICE USE ONLY)

Date Issued APR 20 1990

Jim McKazie
Regional Waste Manager

Date Amended

Appendix A-1 to Permit No. PS - 8672

Approval No.

PROVINCE OF
BRITISH COLUMBIA

Environmental Protection
#401-333 Victoria Street
Nelson, British Columbia
V1L 4K3
Telephone: (604) 354-6355

MINISTRY OF ENVIRONMENT,
LANDS AND PARKS

PERMIT
PR-11898

Under the Provisions of the Waste Management Act

COMINCO LTD. - COMINCO LTEE
500 - 200 BURRARD STREET
VANCOUVER, BRITISH COLUMBIA
V6C 3L7

is authorized to discharge water granulated slag fuming furnace tail slag from a lead smelter located at Trail, British Columbia, to the ground, subject to the conditions listed below. Contravention of any of these conditions is a violation of the Waste Management Act and may result in prosecution.

1. AUTHORIZED DISCHARGE

1.1. This subsection applies to the discharge of water granulated slag fuming furnace tail slag from a **LEAD SMELTER** as shown on the attached Site Plan A. The site reference number for this discharge is E218287.

1.1.1. The maximum quantity of water granulated tail slag that may be discharged to the initial storage area is 1 million tonnes commencing in 1996.

1.1.2. The characteristics of the discharge is typical water granulated fuming furnace tail slag.

Water granulated fuming furnace tail slag is defined as the product material resulting from the process of discharging molten waste slag from a slag fuming furnace into a large stream of high pressure cold water in order to break the molten slag into fine solid particulate for collection.

1.1.3. The works authorized are a lined storage pad, double lined drainage water collection pond, monitoring wells and other related appurtenances approximately located as shown on the attached Site Plan A.

1.1.4. The location of the facilities from which the discharge originates is the lead smelter fuming furnaces.

Date Issued: DEC 0 8 1995

R.J. Crozier, R.P. Bio.
Regional Waste Manager

1.1.5. The location of the point of discharge is Parcel 13, Lot 367, Plan 1425; Parcel 14, Lot 367, Plan 1425; Parcel 17, Lot 367, Plan 1425 except Plan 1609 and Right-of-Way 13, Kootenay District.

2. GENERAL REQUIREMENTS

2.1. Maintenance Of Works

The permittee shall inspect the pollution control works regularly and maintain them in good working order. The permittee shall notify the Regional Waste Manager of any malfunction of these works.

2.2. Emergency Procedures

In the event of an emergency or condition beyond the control of the permittee which prevents continuing operation of the approved method of pollution control, the permittee shall immediately notify the Regional Waste Manager and take appropriate remedial action.

2.3. Bypasses

The discharge of effluent/contaminants (drainage water/ water granulated fuming furnace tail slag) which has bypassed the designated treatment works, other than usage for commercial purposes, is prohibited unless the approval of the Regional Waste Manager is obtained and confirmed in writing.

2.4. Process Modifications

The permittee shall notify the Regional Waste Manager prior to implementing changes to any process that may affect the quality and/or quantity to the detriment of the discharge.

2.5. Plans

Plans and specifications of the works authorized in Subsection 1.1 shall be submitted to the Regional Waste Manager in duplicate and his approval obtained before construction commences. The works shall be constructed in accordance with such plans.

2.6. Fugitive Dust Control

The permittee shall suppress fugitive dust created within the operation area to the satisfaction of the Regional Waste Manager.

Date Issued: DEC 0 8 1995

R.J. Crozier, R.P. Bio.
Regional Waste Manager

2.7. Future Expansion Of Storage Site

On or before December 31, 2001, the permittee shall submit a report to the Regional Waste Manager on the environmental impact of the tail slag pile and the need for continued use of a liner for potential expansions of the tail slag pile beyond the initial pilot facility. A complete assessment of the groundwater, and drainage water quality accumulated prior to and during the first 5 years of operation shall be included in the report.

2.8. Drainage Water Collection And Treatment

The permittee shall capture drainage water from the tail slag pile and provide storage, transport and treatment facilities for this drainage water to the satisfaction of the Regional Waste Manager.

Water collected in the drainage water collection pond shall be analyzed for Dissolved Copper, Dissolved Zinc, and Dissolved Lead and the results of the analysis used to determine whether treatment is required via the Effluent Treatment Plant prior to discharge to the Columbia River via Outfall III.

If analysis of a batch of drainage water indicates the concentrations of all the following parameters are less than:

Dissolved Copper	.10 mg/l
Dissolved Zinc	1.0 mg/l
Dissolved Lead	.10 mg/l

then that batch of collected water may be discharged to a storm sewer that discharges directly to the Columbia River via Outfall III.

If the analysis of any batch of collected water indicates concentrations of any of the above parameters exceed these limits, the collected drainage water shall be discharged into conveyance systems that transport water to the Effluent Treatment Plant.

Outfall III and the Effluent Treatment Plant are works authorized under Section D of Appendix 03 of Permit PE-02753.

Drainage water collected in the pond may be used for dust control on the tail slag storage pile.

2.9. Drainage Water Collection Pond Freeboard

Water levels in the drainage water collection pond shall be controlled to maintain a minimum freeboard of .5 meter.

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Regional Waste Manager

2.10. Diversion Of Clean Water

Clean water from uphill areas on Talus Hill shall be collected and diverted away from the tail slag storage area.

2.11. Limitation Of Public Access To Site

The permittee shall take all reasonable steps such as signage, regular security patrols, and block abandoned roads to minimize access by the public to the tail slag storage pile.

2.12. Intermediate Stockpiles of Tail Slag

The permittee is authorized to store intermediate stockpiles of water granulated fuming furnace tail slag at various locations within the paved Cominco Metallurgical Operation as approved by the Regional Waste Manager provided that adequate drainage water collection and dust control treatment works are used.

3. MONITORING AND REPORTING REQUIREMENTS

3.1. Monitoring

The following receiving environment monitoring program shall be conducted by Cominco Ltd.

3.1.1. Slag Disposal Area Drainage Water

i) Drainage water quality shall be characterized monthly following initiation of tail slag disposal. A grab sample of drainage water shall be analyzed for pH, alkalinity, specific conductivity, sulphate, dissolved and total metals. The metals analysis shall include arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), iron (Fe), lead (Pb) and zinc (Zn). Once per year in late spring during snow melt, a grab sample of drainage water from the pond shall be analyzed for a **full scan** of total and dissolved metals including total mercury (Hg), and total and dissolved aluminum (Al), antimony (Sb), beryllium (Be), fluoride (F), nickel (Ni), thallium (Tl), and silver (Ag).

ii) The permittee shall develop a procedure acceptable to the Regional Waste Manager for determination of the annual volume of drainage water from the tail slag disposal area and calculate this volume on an annual basis.

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3.1.2. Groundwater Monitoring

Cominco Ltd. shall establish a background database of groundwater quality for the detection of significant changes to groundwater quality over the life of the disposal area. Cominco Ltd. shall conduct background monitoring of groundwater wells B-1 (E218291), B-2 (E218303) and B-3 (E218288) and Green (E218307), Durkin (E218305) and McNally (E218306) Springs monthly for at least one year. Once slag disposal commences, the Regional Waste Manager will review and evaluate the background data gathered for groundwater wells (B-1, B-2 and B-3) as well as Green, Durkin and McNally Springs. The Regional Waste Manager will determine any changes required to sampling frequency and variables based on his evaluation.

The analyses of groundwater for the purpose of background data collection shall include:

i) pH, Eh, temperature and conductivity taken in the field on the day of sampling.

ii) Major cations and anions, sulphate (SO4), chloride (Cl), magnesium (Mg), sodium (Na), potassium (K) and bicarb/carbonic (alkalinity).

iii) Total dissolved solids (TDS), and turbidity.

iv) Metals, total and dissolved As, Ca, Cd, Cr, Cu, Fe, Pb, and Zn.

v) Total Mercury (Hg) shall be analyzed once per year

3.1.3. Ambient Air Quality Monitoring

Upon initiation of land disposal of slag, Cominco Ltd. shall install 4 dustfall canisters, two on either side of the slag containment area and parallel to the prevailing wind direction at approximately 200 metres from the edge of the slag piles. The siting of the dustfall containers must be approved by the Regional Waste Manager. The contents of the dustfall containers shall be analyzed for total particulate on a monthly basis. As well, the dustfall contents shall be evaluated qualitatively (visually or microscopically examined) for slag content. The Regional Waste Manager may vary the frequency and variables to be sampled based on the results obtained. ?

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3.2. Laboratory Analysis

3.2.1. Analyses are to be carried out in accordance with procedures described in the "British Columbia Environmental Laboratory Manual for the Analysis of Water, Wastewater, Sediment and Biological Materials (March 1994 Permittee Edition)" or by suitable alternative procedures as authorized by the Regional Waste Manager.

A copy of the above manual may be purchased from Queen's Printer Publications Centre, 2nd Floor, 563 Superior Street, Victoria, B.C., V8V 4R6, (1-800-663-6105). The manual is also available for review at any Environmental Protection Program Office.

3.2.2. Sampling and flow measurement shall be carried out in accordance with the procedures described in "Field Criteria for Sampling Effluents and Receiving Waters", April 1989, 17 pp., or by suitable alternative procedures as authorized by the Regional Waste Manager.

Copies of the above manual may be purchased from the Environmental Protection Division, Ministry of Environment, Lands and Parks, 777 Broughton Street, Victoria, British Columbia, V8V 1X5. The manual is also available for review at any Environmental Protection Program Office.

3.2.3. Groundwater quality monitoring shall be carried out in accordance with procedures described in "Groundwater Quality Monitoring Manual", March 1990 (Piteau 1990), or by suitable alternate procedures as authorized by the Regional Waste Manager.

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Regional Waste Manager

3.3. Quality Control and Quality Assurance (QA/QC)

The following shall constitute a permittee quality control and quality assurance (QA/QC) program.

3.3.1. The permittee shall adhere to all applicable provisions of the Environmental Data Quality Assurance Regulation (EDQA), part of the Environmental Management Act 15(2).

3.3.2. The permittee shall provide, a copy of the "**Laboratory Quality Protocols and Quality Assurance Criteria**", with subsequent updates, for approval of the Regional Waste Manager. The laboratory protocols shall include procedures used (including frequency) to assess precision, accuracy and blank quality, and procedures for sample handling (ie preservation and holding times). The quality assurance criteria shall include acceptable criteria for accuracy (based on recoveries for reference samples/spikes), precision (based on deviation of field and lab duplicates) and method blanks (false positives).

3.3.3. The permittee shall ensure that all data required under Subsection 3.1 (Subsections 3.1.1, 3.1.2, and 3.1.3) of this permit are produced in accordance with the "**Laboratory Quality Protocols and Quality Assurance Criteria**", and as approved by the Regional Waste Manager. Furthermore, the permittee shall provide associated field blanks and duplicate sample analysis along with the submission of data required under Subsection 3.1 of the permit.

3.4. Reporting

3.4.1. All results obtained from analysis of tail slag disposal area drainage, surface, and groundwater as well as ambient air monitoring specified above are to be tabulated and submitted to the Regional Waste Manager quarterly.

3.4.2. The permittee shall prepare an annual report suitable for release to the public, that tabulates and explains the drainage water and ambient air quality sampling and analyses as well as any results of ground water quality monitoring carried out by the company. Total volume of drainage water collected and the percentage requiring treatment via the Effluent Treatment Plant is to be included in the annual report. This annual report is due by March 31 of each following year.

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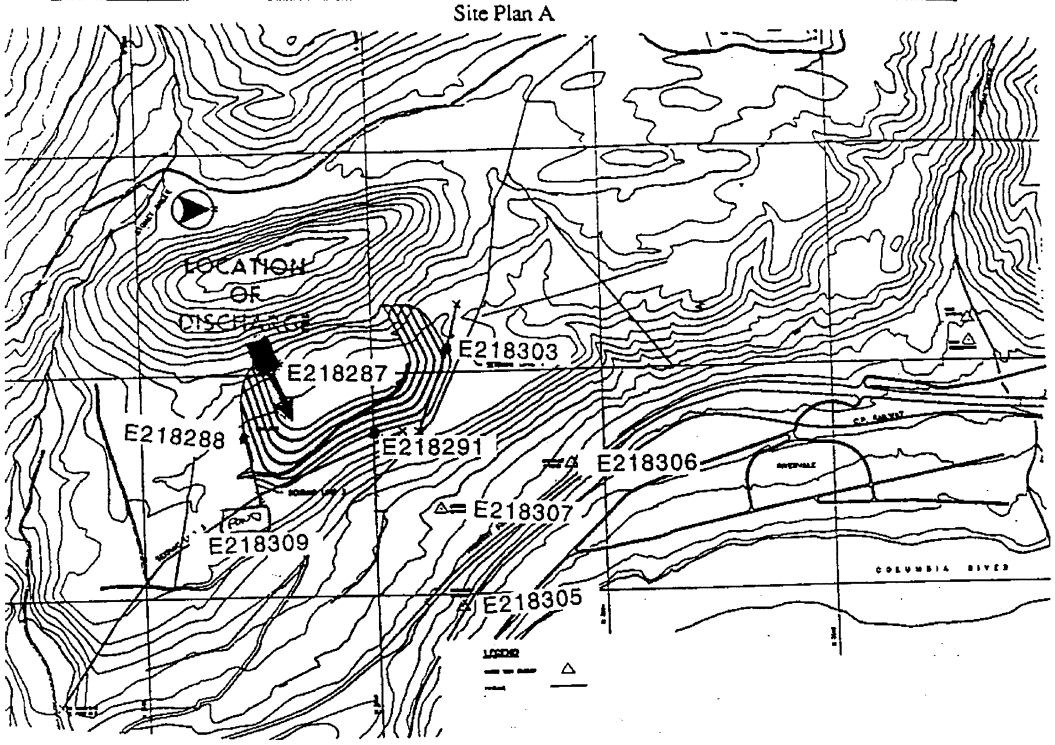
Regional Waste Manager

PROVINCE OF
BRITISH COLUMBIA

Environmental Protection Program

Site Plan A



LEGAL DESCRIPTION: Parcel 13, Lot 367, Plan 1425; Parcel 14, Lot 367, Plan 1425; Parcel 17, Lot 367, Plan 1425 except Plan 1609 and Right-of-Way 13, Kootenay District

Permit: PR-11898

Date Issued: DEC 0 8 1995

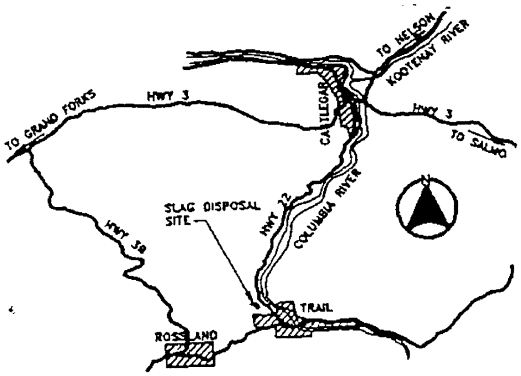
Regional Waste Manager:

R.J. Crozier, R.P. Bio.

Name of Applicant:

Cominco Ltd. - Cominco Ltee

GENERAL DESCRIPTION



PROVINCE OF
BRITISH COLUMBIA

Environmental Protection
#401-333 Victoria Street
Nelson, British Columbia
V1L 4K3
Telephone: (604) 354-6355

MINISTRY OF ENVIRONMENT,
LANDS AND PARKS

PERMIT
PA-02691

Under the Provisions of the Waste Management Act

COMINCO LTD. - COMINCO LTEE
500 - 200 BURRARD STREET
VANCOUVER, BRITISH COLUMBIA
V6C 3L7

is authorized to discharge contaminants to the air from a lead smelter located Trail, British Columbia, subject to the conditions listed below. Contravention of any of these conditions is a violation of the Waste Management Act and may result in prosecution.

1. AUTHORIZED DISCHARGES

1.1. This subsection applies to the discharge of contaminants from the **SINTER PLANT STACK IDENTIFIED AS S-1** as shown on the attached Site Plan A. The Site reference number for this discharge is **E102898.**

1.1.1. The maximum authorized rate of discharge is 8,000 m^3/min.

1.1.2. The characteristics of the discharge shall not exceed:

SO_2	Control Regime as per Subsection 2.5
Total Particulate	400 mg/m^3
Lead	23 mg/m^3

NOTE: All air and gaseous volumes specified in Subsections 1.1.1 and 1.1.2 above are at standard conditions which are:

Standard Temperature = 293.15^0 K
Standard Pressure = 101.325 KPa
Water Vapour zero unless otherwise stated

R. J. Crozier, R. P. Bio.
Regional Waste Manager

Date Issued: September 9, 1975
Date Amended:
(most recent)
DEC 22 1995

1.1.3. The authorized works are ducts, fans, stack, ammonia absorption plant and related appurtenances located approximately as shown on the attached Site Plan A.

1.1.4. The location of the facilities from which the discharge originates is Lot 1, Plan 4926, Kootenay District.

1.1.5. The location of the point of discharge is Lot 1, Plan 4926, Kootenay District.

1.1.6. This emission source will reduce in operating frequency in 1997 and the emission of contaminants from this source will be controlled as defined in Subsection 2.4. Stack S-1 may continue to be used as an emergency stack for the new Kivcet lead smelter. The Sinter Plant stack may be used for venting the new SLAG FUMING FURNACE once a new baghouse is installed.

1.2. This subsection applies to the discharge of contaminants from the **LEAD BLAST FURNACES AND OLD DROSSING PLANT STACK AND/OR THE NEW KIVCET FURNACE, FEED DRYING FACILITY AND NEW DROSSING PLANT, IDENTIFIED AS S-32** as shown on the attached Site Plan B. The site reference number for this discharge is **E102899.**

1.2.1. The maximum authorized rate of discharge is 15,500 m^3/min.

1.2.2. The characteristics of the discharge shall not exceed:

SO_2	Control Regime as per Subsection 2.5
Particulate	23 mg/m^3
Lead	7 mg/m^3

NOTE: All air and gaseous volumes specified in Subsections 1.2.1 and 1.2.2 above are at standard conditions which are:

Standard Temperature = 293.15° K
Standard Pressure = 101.325 KPa
Water Vapour zero unless otherwise stated

1.2.3. The authorized works are fans, ducts, stack, baghouse, bypass stack and related appurtenances located approximately as shown on the attached Site Plan B.

1.2.4. The location of the facilities from which the discharge originates is Lot 1, Plan 4926, Kootenay District.

1.2.5. The location of the point of discharge is appurtenant is Lot 1, Plan 4926, Kootenay District.

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1.3. This subsection applies to the discharge of contaminants from the **SINTER PLANT WET MIX DRYERS STACK IDENTIFIED AS S-8** as shown on the attached Site Plan B. The site reference number for this discharge is **E102900.**

1.3.1. The maximum authorized volume which may be discharged is 3,500 m^3/min.

1.3.2. The characteristics of the discharge shall not exceed:

SO_2	Control Regime as per Subsection 2.5
Lead	7 mg/m^3

NOTE: All air and gaseous volumes specified in Subsections 1.3.1 and 1.3.2 above are at standard conditions which are:

Standard Temperature = 293.15^0 K
Standard Pressure = 101.325 KPa
Water Vapour zero unless otherwise stated

1.3.3. The authorized works are fans, ducts, stack, wet impingers and related appurtenances located approximately as shown on the attached Site Plan B.

1.3.4. The location of the facilities from which the discharge originates is Lot 1, Plan 4926, Kootenay District.

1.3.5. The location of the point of discharge is Lot 1, Plan 4926, Kootenay District.

1.3.6. This emission source will reduce in operating frequency in 1997 and the emission of contaminants from this source will be controlled as defined in Subsection 2.4.

1.4. This subsection applies to the discharge of contaminants from the **OLD SLAG FUMING FURNACES OR THE NEW SLAG FUMING FURNACE BAGHOUSE STACK IDENTIFIED AS S-40** as shown on the attached Site Plan A. The site reference number for this discharge is **E102901.**

1.4.1. The maximum authorized rate of discharged is 6,500 m^3/min.

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Regional Waste Manager

1.4.2. The characteristics of the discharge shall not exceed:

SO_2	Control Regime as per Subsection 2.5
Zinc	11.5 mg/m³

NOTE: All air and gaseous volumes specified in Subsections 1.4.1 and 1.4.2 above are at standard conditions which are:

Standard Temperature = 293.15° K
Standard Pressure = 101.325 KPa
Water Vapour zero unless otherwise stated

1.4.3. The authorized works are fans, ducts, stack, baghouse and related appurtenances located approximately as shown on the attached Site Plan A.

1.4.4. The location of the facilities from which the emission originates is Lot 1, Plan 4926, Kootenay District.

1.4.5. The location of the point of discharge is Lot 1, Plan 4926, Kootenay District.

1.5. This subsection applies to the discharge of contaminants from **SINTER AND COKE CONVEYING, HANDLING, CRUSHING AND STORAGE VENTS IDENTIFIED AS S-2, S-3, S-4, S-5, S-6, S-7, S-9, S-10, S-11 AND S-13** as shown on the attached Site Plan B. The site reference number for this discharge is **E222624.**

1.5.1. The maximum authorized volume which may be discharged is 4,815 m³/min.

1.5.2. The characteristics of the discharges shall not exceed:

Particulate	23 mg/m³

NOTE: All air and gaseous volumes specified in Subsections 1.5.1 and 1.5.2 above are at standard conditions which are:

Standard Temperature = 293.15° K
Standard Pressure = 101.325 KPa
Water Vapour zero unless otherwise stated

1.5.3. The authorized works are fans, ducts, 10 stacks, 10 wet scrubbers and related appurtenances located approximately as shown on the attached Site Plan B.

1.5.4. The location of the facilities from which the discharge originate is Lot 1, Plan 4926, Kootenay District.

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1.5.5. The location of the points of discharge is Lot 1, Plan 4926, Kootenay District.

1.5.6. These emission sources will reduce in operating frequency in 1997 and the emission of contaminants from this source will be controlled as defined in Subsection 2.4.

1.6. This subsection applies to the discharge of contaminants from **SINTER PLANT VENTILATION FANS IDENTIFIED AS S-17 TO S-31 INCLUSIVE** as shown on the attached Site Plan B. The site reference number for this discharge is **E211970.**

1.6.1. The maximum authorized volume which may be discharged is 1,500 m^3/min.

1.6.2. The characteristics of the discharges shall not exceed:

Particulate 23 mg/m^3

NOTE: All air and gaseous volumes specified in Subsections 1.6.1 and 1.6.2 above are at standard conditions which are:

Standard Temperature = 293.15° K
Standard Pressure = 101.325 KPa
Water Vapour zero unless otherwise stated

1.6.3. The authorized works are fans, ducts, 10 stacks, 10 wet scrubbers and related appurtenances located approximately as shown on the attached Site Plan B.

1.6.4. The location of the facilities from which the discharge originate is Lot 1, Plan 4926, Kootenay District.

1.6.5. The location of the points of discharge is Lot 1, Plan 4926, Kootenay District.

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Regional Waste Manager

1.7. This subsection applies to the discharge of contaminants from **SINTER PLANT DRYER AND SINTER MACHINE FEED CONVEYORS AND NODULIZER VENT STACKS IDENTIFIED AS S-12, S-14, S-15 AND S-16** as shown on the attached Site Plan A. The site reference number for this discharge is **E22625.**

1.7.1. The maximum authorized volume which may be discharged is 1,500 m^3/min.

1.7.2. The characteristics of the discharges shall not exceed:

Particulate 23 mg/m^3.

NOTE: All air and gaseous volumes specified in Subsections 1.7.1 and 1.7.2 above are at standard conditions which are:

Standard Temperature = 293.15^0 K
Standard Pressure = 101.325 KPa
Water Vapour zero unless otherwise stated

1.7.3. The authorized works are fans, ducts, 10 stacks, 10 wet scrubbers and related appurtenances located approximately as shown on the attached Site Plan B.

1.7.4. The location of the facilities from which the discharge originate is Lot 1, Plan 4926, Kootenay District.

1.7.5. The location of the points of discharge is Lot 1, Plan 4926, Kootenay District.

1.7.6. These emission sources will reduce in operating frequency in 1997 and the emission of contaminants from this source will be controlled as defined in Subsection 2.4.

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Regional Waste Manager

1.8. This subsection applies to the discharge of contaminants from the **SINTER AND COKE CONVEYING AND STORAGE VENTS IDENTIFIED AS S-57, S-58 AND S-59** as shown on the attached Site Plan B. The site reference number for this discharge is **E222626.**

1.8.1. The maximum authorized volume which may be discharged is 390 m^3/min.

1.8.2. The characteristics of the discharge shall not exceed:

Lead	23 mg/m^3

NOTE: All air and gaseous volumes specified in Subsections 1.8.1 and 1.8.2 above are at standard conditions which are:

Standard Temperature = 293.15° K
Standard Pressure = 101.325 KPa
Water Vapour zero unless otherwise stated

1.8.3. The authorized works are fans, ducts, 3 stacks and related appurtenances located approximately as shown on the attached Site Plan B.

1.8.4. The location of the facilities from which the emissions originate and to which Appendix 08 is appurtenant is Lot 1, Plan 4926, Kootenay District.

1.8.5. The location of the points of discharge is Lot 1, Plan 4926, Kootenay District.

1.8.6. These emission sources will reduce in operating frequency in 1997 and the emission of contaminants from this source will be controlled as defined in Subsection 2.4.

R. J. Crozier, R. P. Bio.
Regional Waste Manager

1.9. This subsection applies to the discharge of contaminants from **LEAD BLAST FURNACE AND SLAG FURNACE VENTS, AND GRANULATING LAUNDER VENTS IDENTIFIED AS S-33, S-34, S-35, S-36, S-42, S-49, S-51 AND S-52** as shown on the attached Site Plan B. The site reference number for this discharge is **E222627.**

1.9.1. The maximum authorized volume which may be discharged is 6,000 m^3/min.

1.9.2. The characteristics of the discharge shall not exceed:

Lead 7 mg/m^3

NOTE: All air and gaseous volumes specified in Subsections 1.9.1 and 1.9.2 above are at standard conditions which are:

Standard Temperature = 293.15° K
Standard Pressure = 101.325 KPa
Water Vapour zero unless otherwise stated

1.9.3. The authorized works are fans, ducts, 8 stacks and related appurtenances, approximately located as shown on the attached Site Plan B.

1.9.4. The location of the facilities from which the emissions originates is Lot 1, Plan 4926, Kootenay District.

1.9.5. The location of the points of discharge is Lot 1, Plan 4926, Kootenay District.

1.9.6. These emission sources will reduce in operating frequency in 1997 and the emission of contaminants from this source will be controlled as defined in Subsection 2.4.

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1.10. This subsection applies to the discharge of contaminants from the **OLD SLAG FUMING FURNACES GRANULATING LAUNDER VENT IDENTIFIED AS S-47** as shown on the attached Site Plan B. The site reference number for this discharge is **E102907**.

1.10.1. The maximum authorized volume which may be discharged is 450 m^3/min.

1.10.2. The characteristics of the discharge shall not exceed:

Particulate 23 mg/m^3

NOTE: All air and gaseous volumes specified in Subsections 1.10.1 and 1.10.2 above are at standard conditions which are:

Standard Temperature = 293.15° K
Standard Pressure = 101.325 KPa
Water Vapour zero unless otherwise stated

1.10.3 The authorized works are fans, duct, stack and related appurtenances, located approximate as shown on the attached Site Plan B.

1.10.4. The location of the facilities from which the emission originates is Lot 1, Plan 4926, Kootenay District.

1.10.5. The location of the point of discharge is Lot 1, Plan 4926, Kootenay District.

1.10.6. This emission source will reduce in operating frequency in 1997 and the emission of contaminants from this source will be controlled as defined in Subsection 2.4.

1.11. This subsection applies to the discharge of contaminants from the **No. 2 and No. 6 CRANE AISLE VENTS IDENTIFIED AS S-37 AND 3-53** as shown on the attached Site Plan B. The site reference numbers for this discharge are **E102908** and **0260071**.

1.11.1. The maximum authorized volume which may be discharged is 3,400 m^3/min.

1.11.2. The characteristics of the discharge shall not exceed:

Lead 7 mg/m^3

NOTE: All air and gaseous volumes specified in Subsections 1.11.1 and 1.11.2 above are at standard conditions which are:

Standard Temperature = 293.15° K
Standard Pressure = 101.325 KPa
Water Vapour zero unless otherwise stated

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Regional Waste Manager

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1.11.3. The authorized works are fans, ducts, 3 stacks and related appurtenances located approximately as shown on the attached Site Plan B.

1.11.4. The location of the facilities from which the emissions originate is Lot 1, Plan 4926, Kootenay District.

1.11.5. The location of the points of discharge is Lot 1, Plan 4926, Kootenay District.

1.11.6. These emission sources will reduce in operating frequency in 1997 and the emission of contaminants from this source will be controlled as defined in Subsection 2.4.

1.12. This subsection applies to the discharge of contaminants from the **SLAG FUMING FURNACES AREA VENTS IDENTIFIED AS S-47A AND S-47B** as shown on the attached Site Plan B. The site reference number for this discharge is **E211972.**

1.12.1. The maximum authorized volume which may be discharged is 180 m^3/min.

1.12.2. The characteristics of the discharge shall not exceed:

Lead	7 mg/m^3
Zinc	7 mg/m^3

NOTE: All air and gaseous volumes specified in Subsections 1.12.1 and 1.12.2 above are at standard conditions which are:

Standard Temperature = 293.15^0 K
Standard Pressure = 101.325 KPa
Water Vapour zero unless otherwise stated

1.12.3. The authorized works are fans, ducts, 2 stacks, 2 baghouses and related appurtenances located approximately as shown on the attached Site Plan B.

1.12.4. The location of the facilities from which the emissions originate is Lot 1, Plan 4926, Kootenay District.

1.12.5. The location of the points of discharge is Lot 1, Plan 4926, Kootenay District.

1.12.6. These emission sources will reduce in operating frequency in 1997 and the emission of contaminants from this source will be controlled as defined in Subsection 2.4.

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Regional Waste Manager

1.13. This subsection applies to the discharge of contaminants from the **FUME LEACH SOLIDS PREPARATION BAGHOUSE IDENTIFIED AS S-41** as shown on the attached Site Plan A. The site reference number for this discharge is **E102910.**

1.13.1. The maximum authorized volume which may be discharged is 130 m^3/min.

1.13.2. The characteristics of the discharge shall not exceed:

Zinc 7 mg/m^3

NOTE: All air and gaseous volumes specified in Subsections 1.13.1 and 1.13.2 above are at standard conditions which are:

Standard Temperature = 293.15° K
Standard Pressure = 101.325 KPa
Water Vapour zero unless otherwise stated

1.13.3. The authorized works are fans, ducts, stack, baghouse and related appurtenances located approximately located as shown on the attached Site Plan A.

1.13.4. The location of the facilities from which the emission originates is Lot 1, Plan 4926, Kootenay District.

1.13.5. The location of the point of discharge is Lot 1, Plan 4926, Kootenay District.

1.14. This subsection applies to the discharge of contaminants from **NEW COAL PREPARATION PLANT STACKS IDENTIFIED AS CV-1 and CV-2** on the attached Site Plan K. The site reference numbers for this discharge are **E222684 and E222685.**

1.14.1. The maximum authorized volume which may be discharged is 100 m^3/min.

1.14.2. The characteristics of the discharge shall not exceed:

Particulate 46 mg/m^3

NOTE: All air and gaseous volumes specified in Subsections 1.14.1 and 1.14.2 above are at standard conditions which are:

Standard Temperature = 293.15° K
Standard Pressure = 101.325 KPa
Water Vapour zero unless otherwise stated

1.14.3. The authorized works are coal drying, pulverizing and conveying system, fans, ducts, 2 stacks, 2 cyclones, 2 baghouses and related appurtenances located approximately as shown on the attached Site Plan D.

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Regional Waste Manager

1.14.4. The location of the facilities from which the emissions originate is Lot 1, Plan 4926, Kootenay District.

1.14.5. The location of the points of discharge is Lot 1, Plan 4926, Kootenay District.

1.15. This subsection applies to the discharge of contaminants from the **HOLDING POT COMBUSTION GAS STACK (S-50A)** as shown on the attached Site Plan B. The site reference number for this discharge is **0260074**.

1.15.1. The maximum authorized volume which may be discharged is 1,360 m^3/min.

1.15.2. The characteristics of the discharge shall not exceed:

Particulate 23 mg/m^3

NOTE: All air and gaseous volumes specified in Subsections 1.15.1 and 1.15.2 above are at standard conditions which are:

Standard Temperature = 293.15^0 K
Standard Pressure = 101.325 KPa
Water Vapour zero unless otherwise stated

1.15.3. The works authorized are fans, ducts, 2 stacks, and related appurtenances located approximately as shown on the attached Site Plan B.

1.15.4. The location of the facilities from which the emissions originate is Lot 1, Plan 4926, Kootenay District.

1.15.5. The location of the points of discharge is Lot 1, Plan 4926, Kootenay District.

1.15.6. This emission source will reduce in operating frequency in 1997 and the emission of contaminants from this source will be controlled as defined in Subsection 2.4.

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Regional Waste Manager

1.16. This subsection applies to the discharge of contaminants from the **ARSENIC RECOVERY SECTION (ANTIMONY PLANT) VENT IDENTIFIED AS R-14** as shown on the attached Site Plan C. The site reference number for this discharge is **E102923.**

1.16.1. The maximum authorized volume which may be discharged is 250 m^3/min.

1.16.2. The characteristics of the discharge shall not exceed:

Arsenic 7 mg/m^3

NOTE: All air and gaseous volumes specified in Subsections 1.16.1 and 1.16.2 above are at standard conditions which are:

Standard Temperature = 293.15° K
Standard Pressure = 101.325 KPa
Water Vapour zero unless otherwise stated

1.16.3. The authorized works are fans, ducts, stack, baghouse and related appurtenances located approximately as shown on the attached Site Plan C.

1.16.4. The location of the facilities from which the emission originates is Lot 4, Plan 4926, Kootenay District.

1.16.5. The location of the point of discharge is Lot 4, Plan 4926, Kootenay District.

1.17. This subsection applies to the discharge of contaminants from **54 MISCELLANEOUS LEAD SMELTER SOURCES IDENTIFIED AS NUMBERS 1 TO 54 INCLUSIVE** as shown on the attached Site Plan B. The site reference number for this discharge is **E211974.**

1.17.1 The maximum authorized volume which may be discharged is 5,800 m^3/min.

1.17.2. The characteristics of the discharge shall not exceed:

These discharges are typical building ventilation, sanitation vents, compressor intake and exhaust vents, steam vents and ash pulverizer vents.

NOTE: All air and gaseous volumes specified in Subsections 1.17.1 and 1.17.2 above are at standard conditions which are:

Standard Temperature = 293.15° K
Standard Pressure = 101.325 KPa
Water Vapour zero unless otherwise stated

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1.17.3. The authorized works are fans, ducts, stacks, a baghouse associated with the ash pulveriser vent (No. 16) and related appurtenances located approximately as shown on the attached Site Plan B.

1.17.4. The location of the facilities from which the emissions originate is Lot 1, Plan 4926, Kootenay District.

1.17.5. The location of the points of discharge is Lot 1, Plan 4926, Kootenay District.

1.17.6. A number of these miscellaneous emission sources will reduce in operating frequency in 1997 and the emission of contaminants from this source will be controlled as defined in Subsection 2.4.

1.18. This subsection applies to the discharge of contaminants from **15 MISCELLANEOUS LEAD SMELTER SOURCES IDENTIFIED AS NUMBERS 1 TO 15 INCLUSIVE** as shown on the attached Site Plan A. The site reference number for this discharge is **E211975**.

1.18.1. The maximum authorized volume which may be discharged is 1,200 m^3/min.

1.18.2. The characteristics of the discharge shall not exceed:

These sources are typical building ventilation, sanitation vents and laboratory fume hood ventilation.

NOTE: All air and gaseous volumes specified in Subsections 1.18.1 and 1.18.2 above are at standard conditions which are:

Standard Temperature = 293.15° K
Standard Pressure = 101.325 KPa
Water Vapour zero unless otherwise stated

1.18.3. The authorized works are fans, ducts, stacks and related appurtenances located approximately as shown on the attached Site Plan A.

1.18.4. The location of the facilities from which the emissions originate is Lot 1, Plan 4926, Kootenay District.

1.18.5. The location of the point of discharges is Lot 1, Plan 4926, Kootenay District.

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1.19. This subsection applies to the discharge of contaminants from **78 MISCELLANEOUS SOURCES FROM THE LEAD REFINERY, SILVER REFINERY, AND ANTIMONY PLANT NUMBERED 1 TO 78 INCLUSIVE** as shown on the attached Site Plan C. The site reference number for this discharge is **E211978.**

1.19.1. The maximum authorized volume which may be discharged is 3,200 m^3/min.

1.19.2. The characteristics of the discharge shall not exceed:

These sources are typical building ventilation, sanitation ventilation, tank vents, fume hood vents, firebox vents, steam vents, pot vents and burner vents.

NOTE: All air and gaseous volumes specified in Subsections 1.19.1 and 1.19.2 above are at standard conditions which are:

Standard Temperature = 293.15° K
Standard Pressure = 101.325 KPa
Water Vapour zero unless otherwise stated

1.19.3. The authorized works are fans, ducts, vents, stacks, baghouses on sources 25 and 26 and related appurtenances located approximately as shown on the attached Site Plan C.

1.19.4. The location of the facilities from which the emissions originate is Lot 4, Plan 4926, Kootenay District.

1.19.5. The location of the points of discharge is Lot 4, Plan 4926, Kootenay District.

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1.20. This subsection applies to the discharge of contaminants from **27 MISCELLANEOUS SOURCES FROM THE CARPENTER SHOP, PAINT SHOP, ENGINEERING BUILDING, AND CHANGE ROOM IDENTIFIED AS NUMBERS 1 TO 27 INCLUSIVE** as shown on the attached Site Plan D. The site reference number for this discharge is **E211979**.

1.20.1. The maximum authorized volume which may be discharged is 450 m^3/min.

1.20.2. The characteristics of the discharge shall not exceed:

These sources are typical building ventilation, sanitation ventilation, sawdust burner ventilation and steam vents.

NOTE: All air and gaseous volumes specified in Subsections 1.20.1 and 1.20.2 above are at standard conditions which are:

Standard Temperature = 293.15° K
Standard Pressure = 101.325 KPa
Water Vapour zero unless otherwise stated

1.20.3. The authorized works are fans, ducts, vents, cyclone on emission Number 19 and related appurtenances located approximately as shown on the attached Site Plan D.

1.20.4. The location of the facilities from which the emissions is Lot 1, Plan 4926, Kootenay District.

1.20.5. The location of the points of discharge is Lot 1, Plan 4926, Kootenay District.

1.21. This subsection applies to the discharge of contaminants from **55 MISCELLANEOUS SOURCES FROM THE RESEARCH - LIBRARY BUILDING AND ASSAY OFFICE IDENTIFIED AS 1 TO 55 INCLUSIVE** as shown on the attached Site Plan E. The site reference number for this discharge is **E211981**.

1.21.1. The maximum authorized volume which may be discharged is 1,200 m^3/min.

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1.21.2. The characteristics of the discharge shall not exceed:

These sources are typical building ventilation, laboratory fume hoods, steam vents and sanitation vents.

NOTE: All air and gaseous volumes specified in Subsections 1.21.1 and 1.21.2 above are at standard conditions which are:

Standard Temperature = 293.15⁰ K
Standard Pressure = 101.325 KPa
Water Vapour zero unless otherwise stated

1.21.2. The authorized works are fans, ducts, vents, stacks, and related appurtenances located approximately as shown on the attached Site Plan E.

1.21.3. The location of the facilities from which the emissions originate are Lots 1 and 4, Plan 4926, Kootenay District.

1.21.4. The location of the points of discharge are Lots 1 and 4, Plan 4926, Kootenay District.

1.22. This subsection applies to the discharge of contaminants from **8 MISCELLANEOUS SOURCES FROM THE METAL PRODUCTS FABRICATION PLANT IDENTIFIED AS NUMBERS 1 TO 8 INCLUSIVE** as shown on the attached Site Plan F. The site reference number for this discharge is **E211983.**

1.22.1. The maximum authorized volume which may be discharged is 60 m^3/min.

1.22.2. The characteristics of the discharge shall not exceed:

These sources are typical melting pot vents, steam vents, burner vents and sanitation vents.

NOTE: All air and gaseous volumes specified in Subsections 1.22.1 and 1.22.2 above are at standard conditions which are:

Standard Temperature = 293.15⁰ K
Standard Pressure = 101.325 KPa
Water Vapour zero unless otherwise stated

1.22.3. The authorized works are fans, ducts, vents, stacks, and related appurtenances located approximately as shown on the attached Site Plan F.

1.22.4. The location of the facilities from which the emissions is Lot 4, Plan 4926, Kootenay District.

1.22.5. The location of the points of discharge is Lot 4, Plan 4926, Kootenay District.

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1.23. This subsection applies to the discharge of contaminants from **87 MISCELLANEOUS SOURCES FROM THE MANUFACTURING SHOPS AND WAREHOUSE IDENTIFIED AS 18 TO 104 INCLUSIVE** as shown on the attached Site Plan G. The site reference number for this discharge is **E211984**.

1.23.1. The maximum authorized volume which may be discharged is 653 m^3/min.

1.23.2. The characteristics of the discharge shall not exceed:

These sources are typical building ventilation, degreasing unit ventilation, sanitation vents, steam vents, foundry grinding area vents, furnace and oven vents and heat treatment vents.

NOTE: All air and gaseous volumes specified in Subsection 1.23.1 above are at standard conditions which are:

Standard Temperature = 293.15° K
Standard Pressure = 101.325 KPa
Water Vapour zero unless otherwise stated

1.23.3. The authorized works are fans, ducts,vents, stacks, cyclones on Numbers 81 and 82, baghouse on Number 83 and related appurtenances located approximately as shown on the attached Site Plan G.

1.23.4. The location of the facilities from which the emissions originates is appurtenant is Lot 1, Plan 4926, Kootenay District.

1.23.5. The location of the points of discharge is Lot 1, Plan 4926, Kootenay District.

1.24. This subsection applies to the discharge of contaminants from the **LEAD REFINERY SCRUBBER IDENTIFIED AS R-1A** as shown on the attached Site Plans A and F. The site reference number for this discharge is **E206935**

1.24.1. The maximum authorized volume which may be discharged is 4,760 m^3/min.

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1.24.2. The characteristics of the discharge shall not exceed:

Particulate	100 mg/m³
Total Arsenic	7 mg/m³
Lead	7 mg/m³
Gaseous Fluoride	7 ppm

NOTE: All air and gaseous volumes specified in Subsections 1.24.1 and 1.24.2 above are at standard conditions which are:

Standard Temperature = 293.15° K
Standard Pressure = 101.325 KPa
Water Vapour zero unless otherwise stated

1.24.3. The authorized works are fans, ducts, scrubber, two old baghouses to be replaced with two new baghouses in 1996, stack and related appurtenances located approximately as shown on the attached Site Plans A and F.

1.24.4. The location of the facilities from which the emission originates is Lot 4, Plan 4926, Kootenay District.

1.24.5. The location of the point of discharge is Lot 4, Plan 4926, Kootenay District.

1.25. This subsection applies to the discharge of contaminants from 7 **MISCELLANEOUS STACKS ASSOCIATED WITH THE SMELTER FEED PLANT IDENTIFIED AS S-60, S-61 AND S-63 TO S-67 INCLUSIVE** as shown on the attached Site Plan A. The site reference number for this discharge is **E211987.**

1.25.1. The maximum authorized volume which may be discharged is 4,320 m³/min.

1.25.2. The characteristics of the discharge shall not exceed:

Particulate	100 mg/m³

NOTE: All air and gaseous volumes specified in Subsections 1.25.1 and 1.25.2 above are at standard conditions which are:

Standard Temperature = 293.15° K
Standard Pressure = 101.325 KPa
Water Vapour zero unless otherwise stated

1.25.3. The authorized works are fans, ducts, stacks, wet scrubbers and related appurtenances located approximately as shown on the attached Site Plan A.

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1.25.4. The location of the facilities from which the emissions originate is Lot 1, Plan 4926, Kootenay District.

1.25.5. The location of the points of discharge is Lot 1, Plan 4926, Kootenay District.

1.26. This subsection applies to the discharge of contaminants from the **SHORT ROTARY FURNACE IN THE LEAD REFINERY ALLOY PLANT IDENTIFIED AS R-2A** as shown on the attached Site Plan C. The site reference number for this discharge is **E215799**.

1.26.1. The maximum authorized volume which may be discharged is 1,100 m^3/min.

1.26.2. The characteristics of the discharge shall not exceed:

Particulate	23 mg/m^3
Lead	7 mg/m^3
Total Arsenic	7 mg/m^3
Gaseous Fluoride	7 ppm

NOTE: All air and gaseous volumes specified in Subsections 1.26.1 and 1.26.2 above are at standard conditions which are:

Standard Temperature = 293.15^0 K
Standard Pressure = 101.325 KPa
Water Vapour zero unless otherwise stated

1.26.3. The authorized works are fans, ducts, baghouse and related appurtenances located approximately as shown on the attached Site Plan C.

1.26.4. The location of the facilities from which the emission originates is Lot 4, Plan 4926, Kootenay District.

1.26.5. The location of the point of discharge is Lot 4, Plan 4926, Kootenay District.

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1.27. This subsection applies to the discharge of contaminants from **VENTILATION ASSOCIATED WITH THE LEAD OPERATIONS CRUSHING PLANT IDENTIFIED AS CP-1** as shown on the attached Site Plan A. The site reference number for this discharge is **E215800.**

1.27.1. The maximum authorized volume which may be discharged is 200 m^3/min.

1.27.2. The characteristics of the discharge shall not exceed:

Particulate	20 mg/m^3
Lead	7 mg/m^3

NOTE: All air and gaseous volumes specified in Subsections 1.27.1 and 1.27.2 above are at standard conditions which are:

Standard Temperature = 293.15^0 K
Standard Pressure = 101.325 KPa
Water Vapour zero unless otherwise state

1.27.3. The authorized works are fans, stack, baghouse and related appurtenances located approximately as shown on the attached Site Plan A.

1.27.4. The location of the facilities from which the emission originates is Lot 1, Plan 4926, Kootenay District.

1.27.5. The location of the point of discharge is Lot 1, Plan 4926, Kootenay District.

1.28. This subsection applies to the discharge of contaminants from **VENTILATION ASSOCIATED WITH THE COPPER SULPHATE/ARSENATE PLANT IDENTIFIED AS R-3A AND R-4A** as shown on the attached Site Plan I. The site reference numbers for this discharge are **E215813** and **E215814.**

1.28.1. The maximum authorized volumes which may be discharged are:

From the flash tank cross flow scrubber	100 m^3/min.
From the production ventilation scrubber	200 m^3/min.

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1.28.2. The characteristics of the discharges shall not exceed:

Arsenic	5 mg/m³
Copper	2 mg/m³

NOTE: All air and gaseous volumes specified in Subsections 1.28.1 and 1.28.2 above are at standard conditions which are:

Standard Temperature = 293.15⁰ K
Standard Pressure = 101.325 KPa
Water Vapour zero unless otherwise stated

1.28.3. The authorized works are fans, ducts, two packed bed scrubbers and related appurtenances located approximately as shown on the attached Site Plan I.

1.28.4. The location of the facilities from which the emissions originate is Lot 4, Plan 4926, Kootenay District.

1.28.5. The location of the points of discharge is Lot 4, Plan 4926, Kootenay District.

1.29. This subsection applies to the discharge of contaminants from **VENTILATION ASSOCIATED WITH THE EFFLUENT TREATMENT PLANT IDENTIFIED AS NUMBERS 1 TO 4 INCLUSIVE** shown on the attached Site Plan H. The site reference number for this discharge is **E215815.**

1.29.1. The maximum authorized volume may be discharged is 50 m³/min.

1.29.2. The characteristics of the discharge shall be air with traces of SO_2.

NOTE: All air and gaseous volumes specified in Subsections 1.29.1 and 1.29.2 above are at standard conditions which are:

Standard Temperature = 293.15⁰ K
Standard Pressure = 101.325 KPa
Water Vapour zero unless otherwise stated

1.29.3. The authorized works are fans ducts, vents scrubber on surge tank vent, baghouse on lime silo, and related appurtenances located approximately as shown on the attached Site Plan H.

1.29.4. The location of the facilities from which the emissions originate is Lot 4, Plan 4926, Kootenay District.

1.29.5. The location of the points of discharge is Lot 4, Plan 4926, Kootenay District.

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1.30. This subsection applies to the discharge of contaminants from **VENTILATION ASSOCIATED WITH THE NEW KIVCET SMELTER AREA IDENTIFIED AS NUMBER 68 TO NUMBER 72 INCLUSIVE** as shown on the attached Site Plan J. The site reference numbers for this discharge are No. 68 - **E215816**, No. 69 - **E215817**, No. 70 - **E215818**, No. 71 - **E215819** and No. 72 - **E215820**.

1.30.1. The maximum authorized volume may be discharged is undefined for emergency bypass stacks but from the Kivcet Slag Granulation Stack is 1,100 m^3/min, from the Kivcet Copper Matte Granulation Stack is 700 m^3/min and from the Smelter Feed Mix Plant Stack is 250 m^3/min.

1.30.2. The characteristics of the discharge shall not exceed:

Smelter Feed Mix Plant Stack (No. 72) - Particulate- 36 mg/m^3

NOTE: All air and gaseous volumes specified in Subsection 1.30.1 above are at standard conditions which are:

Standard Temperature = 293.15^0 K
Standard Pressure = 101.325 KPa
Water Vapour zero unless otherwise stated

1.30.3. The authorized works are fans, stacks, vents, scrubbers and related appurtenances located approximately as shown on the attached Site Plan J.

1.30.4. The location of the facilities from which the emission originates Lot 1, Plan 4926, Kootenay District.

1.30.5. The location of the point of discharge is Lot 1, Plan 4926, Kootenay District.

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1.31. This subsection applies to the discharge of contaminants from the **TOTAL ANNUAL SULPHUR EMISSIONS MEASURED AS SULPHUR DIOXIDE** from the lead smelting operations of Cominco Ltd. in Trail, British Columbia. The site reference number for this discharge is **E217572.**

1.31.1. The maximum authorized rate of discharge shall not exceed 13,680 tonnes per year.

1.31.2. The total sulphur dioxide loading limit from the lead smelting operation is a summation of the following the following:

(i) **Sinter Plant S-1 Stack**

An annual summation of the daily average SO_2 concentration multiplied by the gas flow rate as estimated by daily average fan amperage correlated to actual gas flow rate measurements.

(ii) **Lead Furnaces Stack S-32**

An annual summation of the daily average SO_2 concentration multiplied by the gas flow rate as estimated by the daily single point pitot value correlated to actual gas flow measurements.

(iii) **Slag Furnace Stack S-40**

An annual summation of the daily average SO_2 concentration multiplied by the gas flow rate as estimated by averaging two pitot traverses per week.

2. GENERAL REQUIREMENT

2.1. Maintenance of Works and Emergency Procedures

The permittee shall inspect the pollution control works regularly and maintain them in good working order. In the event of an emergency or condition beyond the control of the permittee which prevents continuing operation of the approved method of pollution control, the permittee shall immediately notify the Regional Waste Manager and take appropriate remedial action.

The permittee shall submit to the Regional Waste Manager by June 30, 1996, contingency plans outlining emergency procedures to be undertaken in the event of foreseeable emergency incidents that may result in significant release of contaminants to the atmosphere.

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2.2. Bypasses

The discharge of contaminants which has bypassed the designated treatment works is prohibited, except as provided for in Subsection 2.1 above, unless the approval of the Regional Waste Manager is obtained and confirmed in writing.

2.3. Process Modifications

The permittee shall notify the Regional Waste Manager prior to implementing changes to any process that may affect the quality and/or quantity of the discharge.

2.4. Phases of Smelter Operation

2.4.1. Phase I

This phase is defined as the period from December 31, 1995 to the startup of Kivcet furnace and allows the use of the existing sinter plant, blast furnaces, slag fuming furnaces and drossing plant and related appurtenances. During this time the Kivcet smelter and new slag fuming furnaces are under construction.

2.4.2. Phase II

This phase is defined as the period from the date of startup of the Kivcet furnace until it reaches approximately 60% of the normal feed rate of 1500 tonnes/day expressed as a 30 day average. Startup of the Kivcet furnace is considered to be 1 month after the first feed is fired in the furnace. This authorizes the emissions from one existing blast furnace and both old slag fuming furnaces, Kivcet furnace, new slag fuming furnace and related appurtenances and limited operation of the sinter plant if necessary.

2.4.3. Phase III

This phase is defined as the period from date of attainment of 60% of normal rate, as defined in PHASE II above, of the Kivcet furnace to the time when the Kivcet furnace reaches 90% of the normal feed rate to the Kivcet furnace of 1500 tonnes per day expressed as a 30 day average. During PHASE III only the operation of the Kivcet furnace, new slag fuming furnace and new CDF (continuous drossing furnace built for QSL project) are authorized to operate on a continuous basis. The old smelter (sinter plant, blast furnaces, old slag fuming furnaces and old CDF) is not normally in operation. Startup of the old smelter for limited operation during Kivcet repairs or modifications may occur following written notification of the Regional Waste Manager and the public.

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2.4.4. Phase IV

This phase is defined as a one year performance period that commences when the Kivcet furnace reaches 90% of design rate as defined above. The old smelter may only be restarted in the event of major operational or design problems associated with the new smelter. Written notification from the company to the Regional Waste Manager and his written authorization is required prior to restarting the old smelter.

2.5. Ambient Sulphur Dioxide Control Regime

Sulphur Dioxide emissions from the entire operation are to be controlled at sites specified in Subsection 2.5.4 below:

2.5.1. The annual arithmetic mean at any one continuous ambient sensor shall not exceed .03 ppm (80 ug/m^3).

2.5.2. The maximum 24 hour (average) concentration at any continuous ambient sensor shall not exceed .14 ppm (375 ug/m^3).

2.5.3. The maximum 3 hour (average) concentration at any continuous ambient sensor shall not exceed .3 ppm (800 ug/m^3). The 3 hour average concentration is to be updated hourly for each ambient SO_2 sensor.

2.5.4. Ambient sulphur dioxide monitoring stations: Oasis (site reference number 0260022), W.K.P.L. (site reference number 0260010), Warfield (site reference number 0260011), and Butler Park (site reference number 0250009) must comply with the above limits.

2.6. Fugitive Dust Control

The permittee shall suppress fugitive dust created within the operation area as required by the Regional Waste Manager.

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2.7. Materials Management Plan

The permittee shall submit to the Regional Waste Manager for his approval on or before September 1, 1996 an updated plan consisting of the following:

- current inventory of materials deemed to have the potential to create airborne contamination by the Regional Waste Manager;
- management proposals for containment and usage of these materials;
- the proposed final disposition location and estimated time frame for disposal or consumption these of materials within the process;
- details of facilities in place and planned to minimize fugitive emissions during transport of materials within the site;
- procedures to control the transport of materials off the site and into the populated areas of Trail, British Columbia.

2.8. Plans - New Works

Plans and specifications for the two new baghouses scheduled to be installed in the Silver Refinery shall be submitted to the Regional Waste Manager and his approval obtained before construction commences. The works shall be constructed in accordance with approved plans.

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2.9. Environmental Performance Review

Eighteen (18) months following the commencement of PHASE IV as defined in Subsection 2.11, or no later than December 31st, 2000, the permittee shall submit a report, prepared using terms of reference approved by the Regional Waste Manager, that contains a comprehensive review of the permit operational requirements, ambient air quality and emission quality and quantities specified in the subsections to this permit by comparing data obtained from sampling of the emissions and ambient air by both the permittee and the Ministry of Environment, Lands and Parks.

The goal of the review is to assess the effectiveness of the new lead smelter and Refineries Abatement Upgrade in reducing emissions of particulate, metals and sulphur dioxide to the atmosphere from both stack and fugitive dust sources.

During Phase IV, and during the assessment period, the permittee shall endeavour to control sulphur dioxide emissions from the entire operation according to the following targets:

The annual arithmetic mean at any one continuous ambient sensor should not exceed 75 ug/m^3. The annual average concentration is to be updated hourly for each ambient SO_2 sensor. .028 PPM

The maximum 24 hour (average) concentration at any continuous ambient sensor should not exceed 260 ug/m^3. The 24 hour average concentration is to be updated hourly for each ambient SO_2 sensor. .097 PPM

The maximum 3 hour (average) concentration at any continuous ambient sensor should not exceed 665 ug/m^3. The 3 hour average concentration is to be updated hourly for each ambient SO_2 sensor. .249 PPM

The maximum 1 hour average concentration at any continuous ambient sensor should not exceed 900 ug/m^3. .337 PPM

Ambient sulphur dioxide data captured at all ambient sulphur dioxide monitoring stations is to be assessed according to the above averaging method. Oasis (Site Reference Number 0260022), W.K.P.L. (Site Reference Number 0260010), Warfield (Site Reference Number 0260011), Butler Park (Site Reference Number 0250009), Genelle (Site Reference Number E222140), Trail Hospital (Site Reference Number 0260023), West Trail (Site Reference Number E222141) Columbia Gardens (Site Reference Number 0260012), Glenmerry (Site Reference Number 0260026) and Robson (Site Reference Number E207879).

2.10. Suspension

The permittee shall ensure that no discharge occurs from or in respect of the works authorized by this permit during any period of suspension under the Waste Management Act.

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3. MONITORING AND REPORTING REQUIREMENTS

3.1. Source Monitoring

The permittee shall carry out the Source Monitoring Program attached as Table 1. The permittee shall develop, within terms of reference developed in cooperation with and approved by the Regional Waste Manager, a program to evaluate potential arsenic emission sources. A report shall be submitted to the Regional Waste Manager by September 15, 1997 of the findings of this evaluation. The source monitoring program may be revised at the discretion of the Regional Waste Manager.

3.2. Ambient Monitoring

The permittee shall carry out the Ambient Air Program attached as Tables 2 and 2A. The permittee shall carry out a lichen monitoring program, as approved by the Regional Waste Manager, to assess impacts of sulphur and metals on sensitive vegetation in the Trail, BC - Northport, Washington area.

The permittee shall establish and fund a PM10 site in the Northport, Washington area at a site to be determined jointly by Washington State Department of Ecology, Cominco, and Ministry of Environment, Lands and Parks.

The ambient air monitoring program may be revised at the discretion of the Regional Waste Manager.

3.3. Source Testing Procedures - Particulate

Source testing procedures for the determination of particulate matter concentrations and the rate of discharge (flow rate) are to be carried out in accordance with those procedures described in the "Source Testing Code for the Measurement of Emissions of Particulates from Stationary Sources", 1982. Alternative test methods may be used provided that the alternative test methods are authorized by the Regional Waste Manager prior to performing the actual source testing.

Copies of the above mentioned manual are available from the Environmental Protection Division, Ministry of Environment, Lands and Parks, 777 Broughton Street, Victoria, British Columbia, V8V 1X5, at a cost of $5.00, and are also available for inspection at all Environmental Protection Program Offices.

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3.4. Source Testing Procedure - Sulphur Dioxide

The source testing procedure for the measurement of sulphur dioxide is to be carried out in accordance with procedures described in the "Source Testing Code for the Measurement of Emissions of Sulphuric Acid Mist and Sulphur Dioxide form Stationary Sources, Ministry of Environment Manual 6 (1984)". Alternative test methods may be used proved that the alternative methods are authorized by the Regional Waste Manager prior to performing the actual source testing.

Copies of the above mentioned manual are available from the Environmental Protection Division, Ministry of Environment, Lands and Parks, 777 Broughton Street, Victoria, British Columbia, V8V 1X5, at a cost of $5.00, and are also available for inspection at all Environmental Protection Program Offices.

3.5. Sampling Facilities

Sampling ports shall be provided with nearby electrical outlets and, where required, approved access ladders and adequately sized platforms, for the discharges covered by Subsections 1.1, 1.2, 1.3, 1.4, 1.26, 1.28, 1.30 and 1.32 of the permit to enable Waste Management personnel to monitor these emissions.

3.6. Sampling Locations and Techniques

All sampling locations, techniques and equipment are to be approved by the Regional Waste Manager prior to use. Sampling and monitoring data, which also should include rate of discharge measurements, shall be accompanied by process data relevant to the operation of the source of the emissions and to the performance of the pollution abatement equipment involved in the testing.

3.7. Discharge Rate Measurement

Measure and record on the day of sampling of the above emissions, the average rate of discharge in m^3/min and the stack emission temperature from the stack based on normal operation of the plant in question for the period of sampling.

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3.9. Quality Assurance/Quality Control

3.9.1. Permittee shall produce within 60 days of the request of the Regional Waste Manager, 'Laboratory Quality Protocols and Quality Assurance Criteria' acceptable to the Regional Waste Manager. The 'Laboratory Quality Protocols' shall include the procedures used to assess precision, accuracy and blank quality, including frequency of application of those procedures, the procedures for sampling handling (e.g. preservation, hold times) and corrective measures to be initiated when deficiencies are indicated. The 'Quality Assurance Criteria' shall include the acceptance criteria for accuracy (based on recoveries for reference samples/spikes), for precision (based on deviation in field and lab duplicates) and method blanks (designed to indicate false positives).

3.9.2. Permittee shall certify that all data required under Subsections 3.1 and 3.2 of this permit are produced in accordance with the 'Laboratory Quality Protocols' and met the 'Quality Assurance Criteria' as approved under Subsection 3.9.1. At the request of the Regional Waste Manager, the permittee is to provide the laboratory quality assurance data along with the submission of the data required under Subsections 3.1 and 3.2 of this permit, as well as all associated field blanks and duplicate analysis results along with the submission of data required under Subsections 3.2 (receiving environment monitoring).

3.9.3. The permittee shall ensure that all tests and other data required to be submitted under the permit are conducted by a laboratory acceptable to the Regional Waste Manager.

3.10. Special Evaluation of Ambient Air Quality

Four times during the calendar years 1996, 1997, 1998, and 1999 (once in each quarter), the permittee shall collect and analyze, using ICP scan techniques similar to those used in the previous survey in 1992, a 24 hour PM10 Total Suspended Particulate sample from each site equipped with a PM10 sampler. The date of sampling shall be co-ordinated with the Ministry of Environment, Lands and Parks in order to facilitate similar sampling at other sites in the Province as background data points. The results of this program are to be reported to the Regional Waste Manager as part of the monthly data submission.

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Regional Waste Manager

3.11. Reporting

3.11.1. The permittee shall submit an annual report to the Regional Waste Manager which includes:

i) All source testing results.

ii) A summary of the ambient air monitoring results.

iii) Documentation of the remedial measures taken to improve those emissions, if any, shown to be in excess of permit limits.

iv) The report is to be written in a form suitable for public release.

v) The report is due by April 1 of the following year.

3.11.2. The permittee shall submit to the Regional Waste Manager monthly the available results of the previous month's ambient air quality and stack emission monitoring. This data is to be submitted in machine readable format as well as hard copy in a form suitable for subsequent release to the public.

R. J. Crozier, R. P. Bio.
Regional Waste Manager

DEC 22 1995

PERMIT: PA-02691

TABLE 1 - Source Monitoring For PA-02691

Stack Description	Cominco No.	Volume	Particulate	Lead	Zinc	Cadmium	Mercury	Antimony	Total Arsenic	Gaseous Fluoride	Copper	Sulphur Dioxide
Sinter Stack	S-1	M	M	M	M	M	M	M	M	M		C
Lead Furnace	S-32	Q	Q	Q	Q	Q	Q	Q	Q	Q		C
Sinter Dryer	S-8	SA	SA	SA	SA	SA	SA	SA	SA	SA		SA
Slag Fuming	S-40	M	M	M	M	M	M	M	M	M		C
Refinery Scrubber	R-1A	M	M	M				M	M	M		
Short Rotary Fce.	R-2A	Q	Q	Q				Q	Q	Q		
Copper Arsenate 2 Stack	R-3 & R-4	Q	Q	Q					Q		Q	
Arsenic Plant	R-14	SA	SA						SA			
Smelter Feed	72	Q	Q	Q					Q			
Mix Plant Stack												
FREQUENCY: C = Continuous, M = Monthly, Q = Quarterly, A = Annually, SA= Semi-Annually												

Date Issued: September 9, 1975
Date Amended: DEC 22 1995

R.J. Crozier, R.P. Bio.
Regional Waste Manager

TABLE 2 - Ambient Air Quality Monitoring Program for PA-02691

Location	Site No.	Parameters To Be Measured And Frequency				Suspended Particulate					
		SO2	Sulphation Plate	Fluoride Plate	Dust Fall	Total	Lead	Zinc	Cadmium	Arsenic	Total Fluoride
W.K.P.L. Building	260010	C	M	M	M	W	W	W	W	W	W-7
Oasis	260022	C	M	M	M	W	W	W	W	W	W-7
Warfield Substation	260011	C	M	M	M	W	W	W	W	W	W-7
Butler Park	250009	C				W	W	W	W	W	
Sunningdale	260025		M	M	M						
Glenmerry	260026		M	M	M						
Daniel Street	260009		M	M	M						
Columbia Gardens	260012		M	M	M						
Trail Hospital	260023		M	M	M						
Birchbank	26004		M	M	M						
FREQUENCY: C = Continuous, W = Weekly (Every 6 Days), W-7 = Weekly (Every 7 Days) M - Monthly (30 Days Duration											

Date Issued: September 9, 1975
Date Amended:
(most recent) DEC 22 1995

R.J. Crozier, R.P. Bio.
Regional Waste Manager

TABLE 2A - Ambient Air Quality Monitoring Program for PA-02691
Lead Modernization Assessment Sampling

Location	Site No.	Parameters To Be Measured And Frequency											
			PM 10 Suspended Particulate					Suspended Particulate					
		SO2	Total	Lead	Zinc	Cadmium	Arsenic	Total	Lead	Zinc	Cadmium	Arsenic	Met station
Genelle	E222140	C	W	W	W	W	W	W	W	W	W	W	C
West Trail	E222141	C						W	W	W	W	W	
Butler Park	250009		W	W	W	W	W						
Oasis	260022		W	W	W	W	W						
Glenmerry	260026	C						W	W	W	W	W	
Columbia Gardens	260012	C						W	W	W	W	W	
Trail Hospital	260023	C											
Northport, Washington	E222689	C	W	W	W	W	W	W	W	W	W	W	C
FREQUENCY: C = Continuous, W = Weekly (Every 6 Days), Met station means wind speed and direction, Temperature													

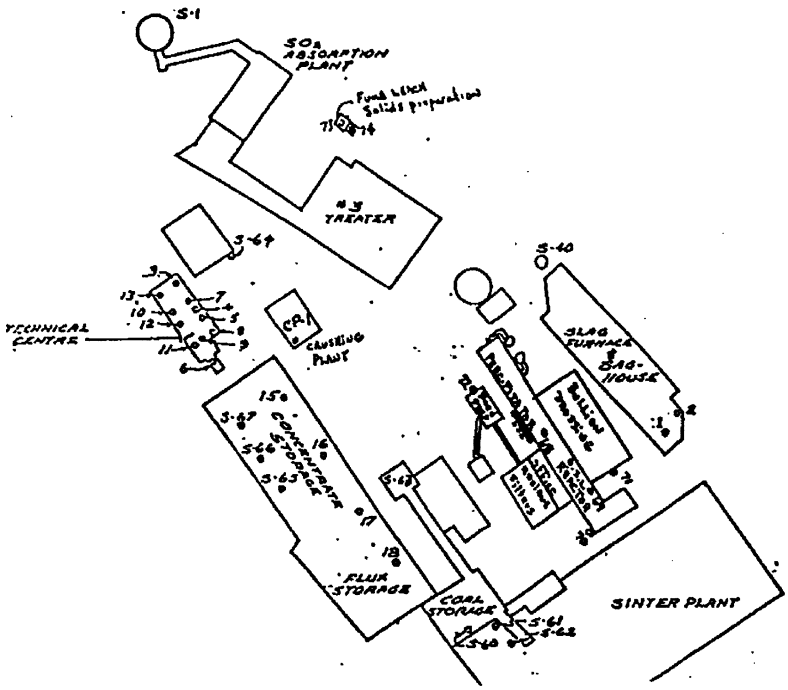
Date Issued: September 9, 1975
Date Amended:
(most recent) DEC 22 1995

R.J. Crozier, R.P. Bio.
Regional Waste Manager

PROVINCE OF
BRITISH COLUMBIA

Environmental Protection Program

Site Plan A



LEGAL DESCRIPTION: Lot 1, Plan 4926, Kootenay District

Permit: PA-02691

Date Issued: September 9, 1975

Date Amended: DEC 22 1995

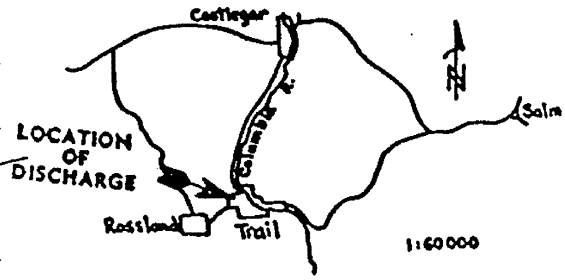
Regional Waste Manager:

R.J. Crozier, R.P. Bio.

Name of Applicant:

Cominco Ltd. - Cominco Ltee

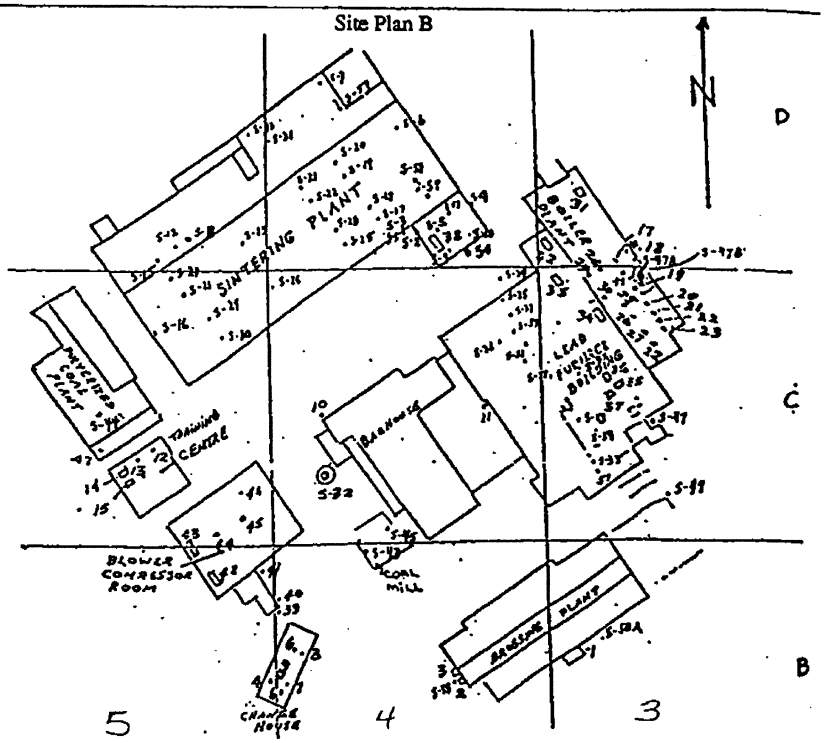
GENERAL DESCRIPTION



PROVINCE OF BRITISH COLUMBIA

Environmental Protection Program

Site Plan B



LEGAL DESCRIPTION: Lot 1, Plan 4926, Kootenay District

Permit: PA-02691

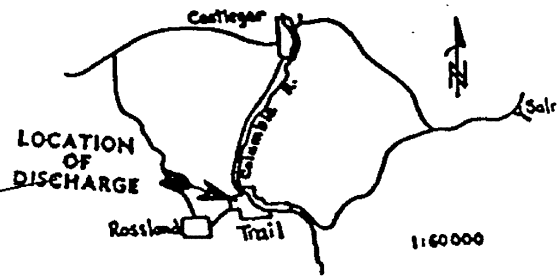
Date Issued: September 9, 1975

Date Amended: DEC 22 1995

Regional Waste Manager:

R.J. Crozier, R.P. Bio.

GENERAL DESCRIPTION



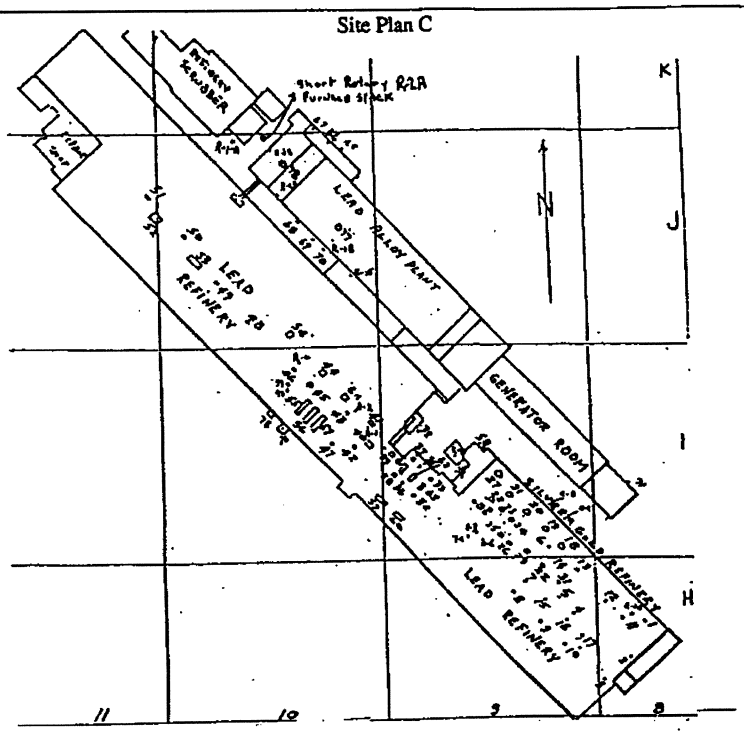
Name of Applicant:

Cominco Ltd. - Cominco Ltee

PROVINCE OF BRITISH COLUMBIA

Enviro...nental Protection Program

Site Plan C



LEGAL DESCRIPTION: Lot 4, Plan 4926, Kootenay District

GENERAL DESCRIPTION

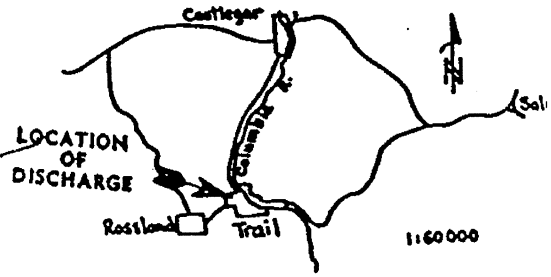
Permit: PA-02691

Date Issued: September 9, 1975

Date Amended: DEC 2 2 1995

Regional Waste Manager:

R.J. Crozier, R.P. Bio.



Name of Applicant:

Cominco Ltd. - Cominco Ltee

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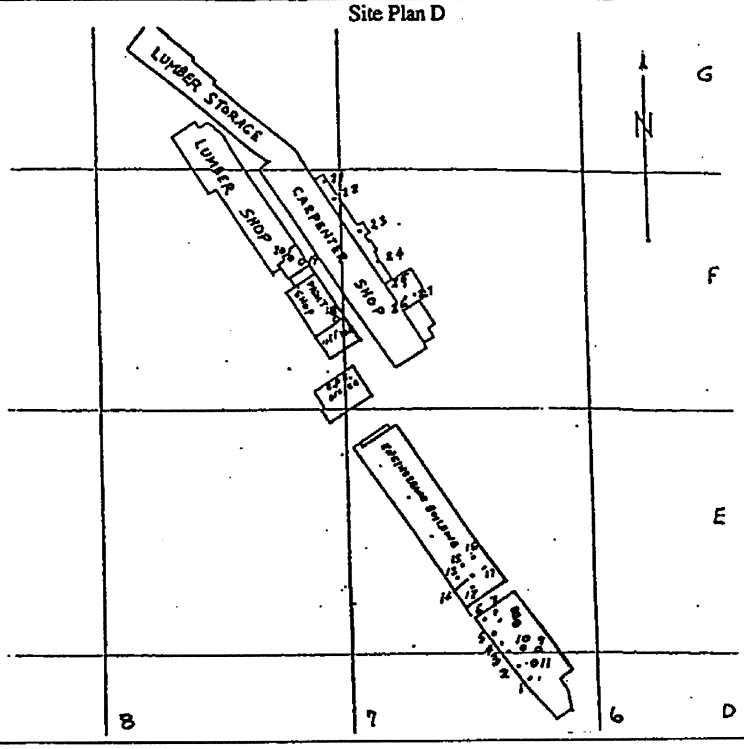
Environmental Protection Program

Site Plan D



LEGAL DESCRIPTION: Lot 1, Plan 4926, Kootenay District

GENERAL DESCRIPTION

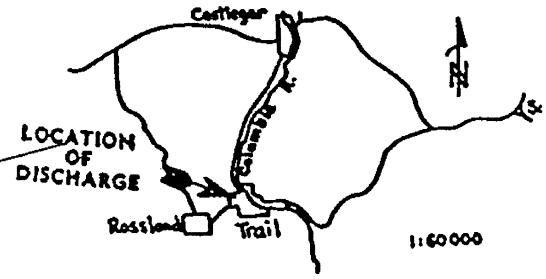
Permit: PA-02691

Date Issued: September 9, 1975

Date Amended: DEC 22 1995

Regional Waste Manager:

R.J. Crozier, R.P. Bio.



Name of Applicant:

Cominco Ltd. - Cominco Ltee

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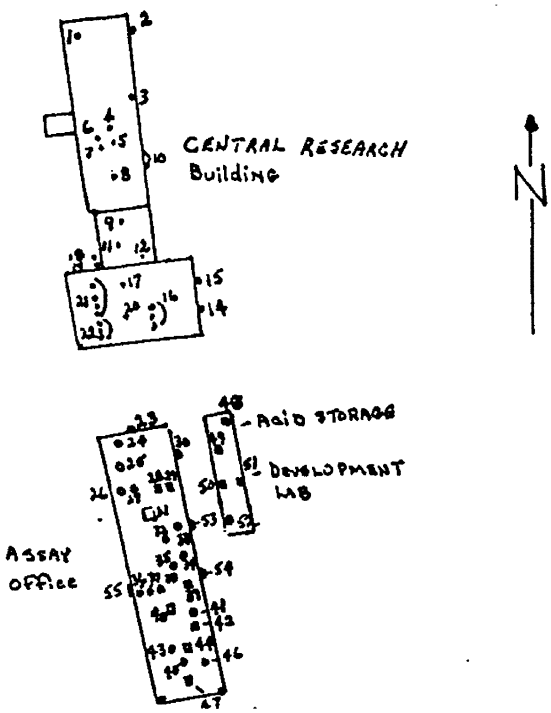
Site Plan E



LEGAL DESCRIPTION: Lots 1 and 4, Plan 4926, Kootenay District

Permit: PA-02691

Date Issued: September 9, 1975

Date Amended: DEC 2 2 1995

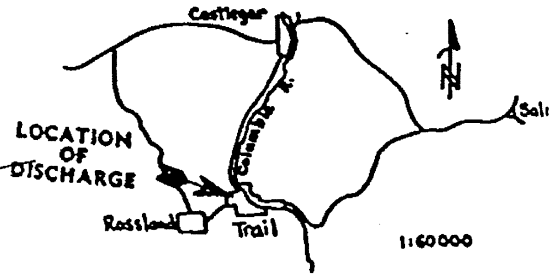
Regional Waste Manager:

R.J. Crozier, R.P. Bio.

Name of Applicant:

Cominco Ltd. - Cominco Ltee

GENERAL DESCRIPTION



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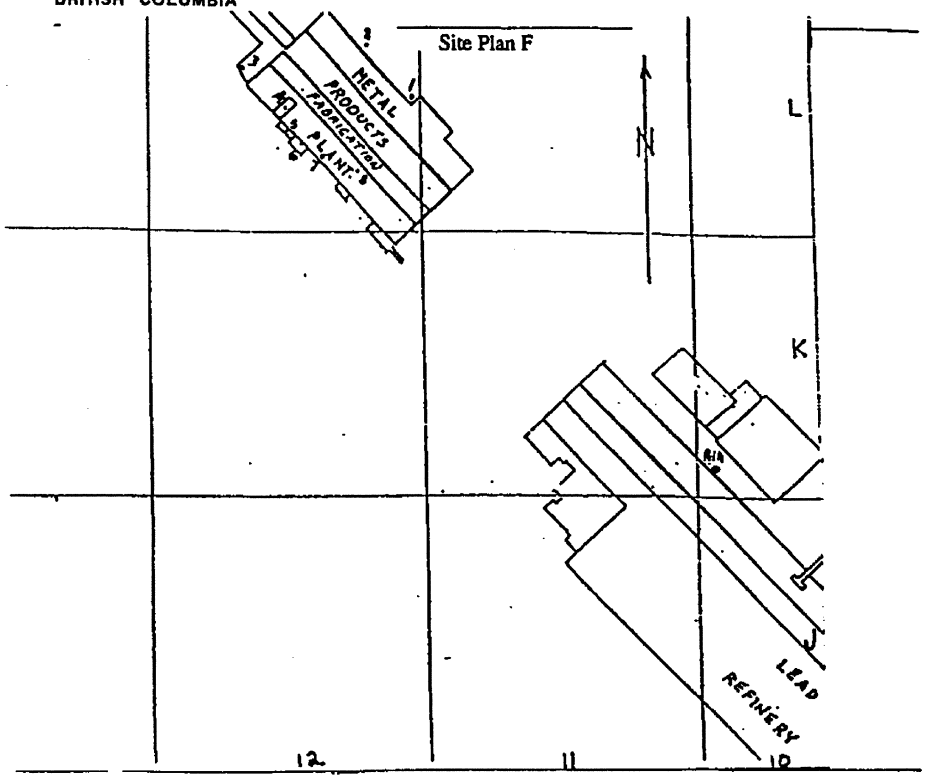


LEGAL DESCRIPTION: Lot 4, Plan 4926, Kootenay District

Permit: PA-02691

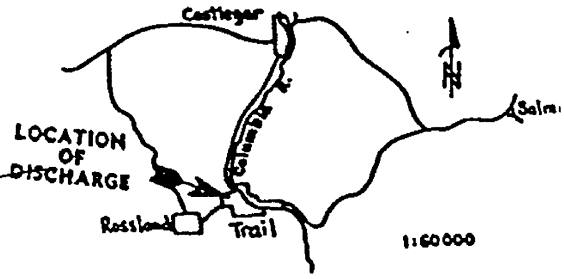
Date Issued: September 9, 1975

Date Amended: DEC 22 1995

Regional Waste Manager:

R.J. Crozier, R.P. Bio.

GENERAL DESCRIPTION



Name of Applicant:

Cominco Ltd. - Cominco Ltee

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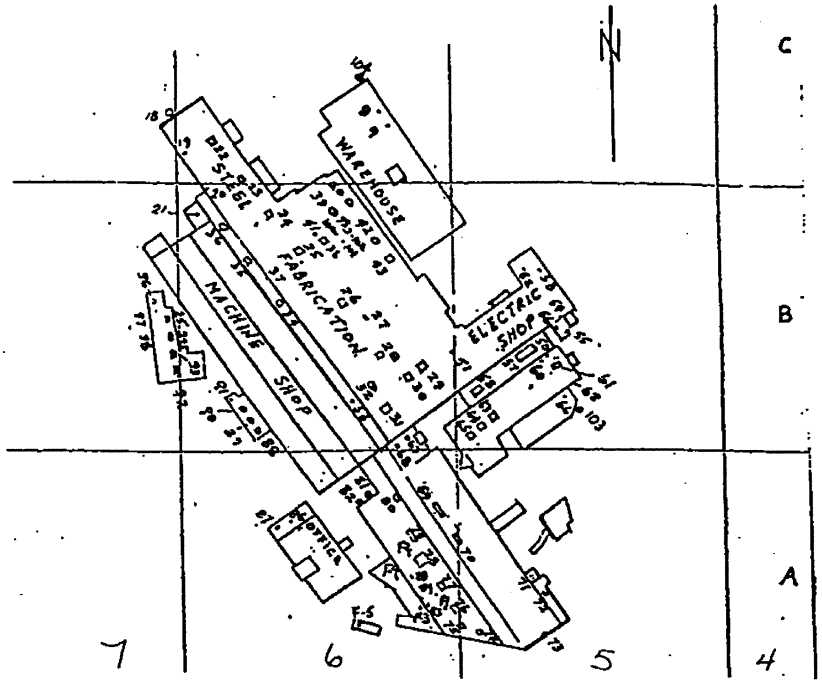
BRITISH COLUMBIA

Environmental Protection Program

Site Plan G



LEGAL DESCRIPTION: Lot 1, Plan 4926, Kootenay District

Permit: PA-02691

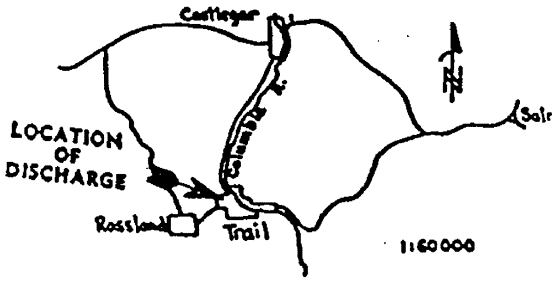
Date Issued: September 9, 1975

Date Amended: DEC 2 2 1995

Regional Waste Manager:

R.J. Crozier, R.P. Bio.

GENERAL DESCRIPTION.



Name of Applicant:

Cominco Ltd. - Cominco Ltee

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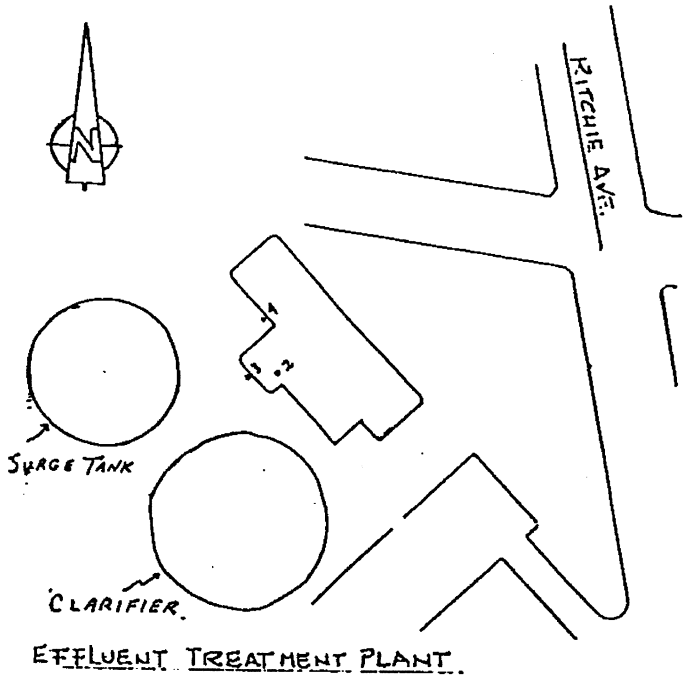
Environmental Protection Program

Site Plan H



LEGAL DESCRIPTION: Lot 4, Plan 4926, Kootenay District

Permit: PA-02691

Date Issued: September 9, 1975

Date Amended: DEC 2 2 1995

Regional Waste Manager

R.J. Crozier, R.P. Bio.

Name of Applicant:

Cominco Ltd. - Cominco Ltee

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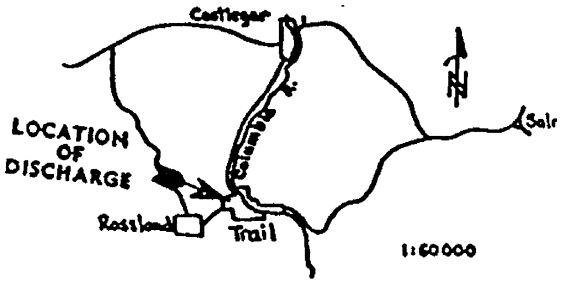

PROVINCE OF
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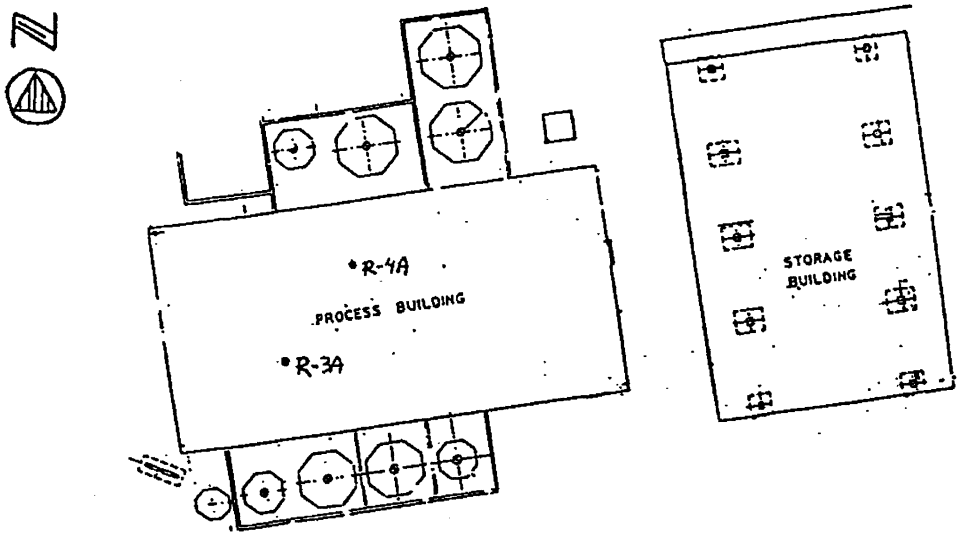
Envi mental Protection Program

Site Plan I



COPPER ARSENATE PLANT

LEGAL DESCRIPTION: Lot 4, Plan 4926, Kootenay District

Permit: PA-02691

Date Issued: September 9, 1975

Date Amended: DEC 2 2 1995

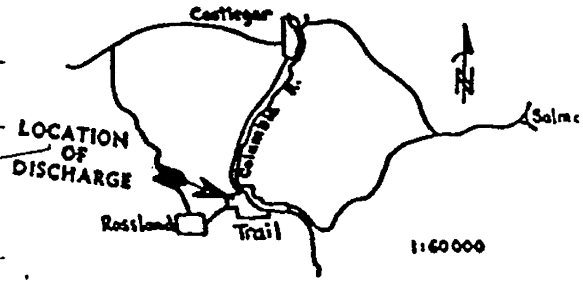
Regional Waste Manager:

R.J. Crozier, R.P. Bio.

Name of Applicant:

Cominco Ltd. - Cominco Ltee

GENERAL DESCRIPTION



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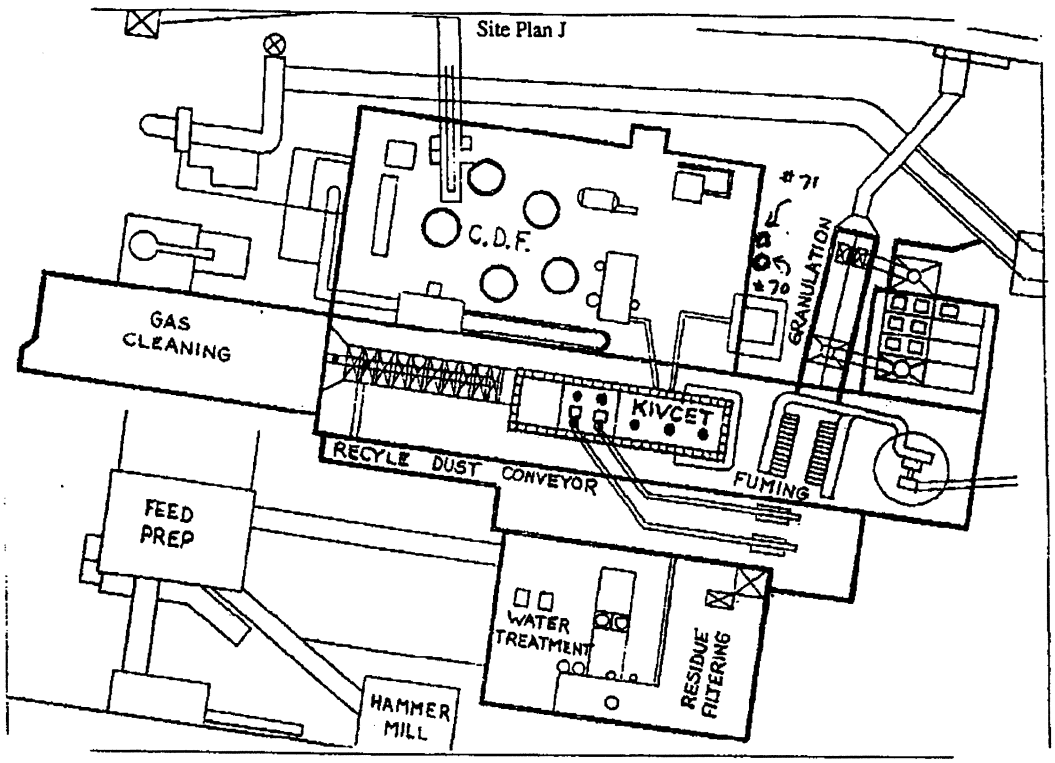
Environmental Protection Program



LEGAL DESCRIPTION: Lot 1, Plan 4926, Kootenay District

Permit: PA-02691

Date Issued: September 9, 1975

Date Amended: DEC 2 2 1995

Regional Waste Manager:

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Name of Applicant:

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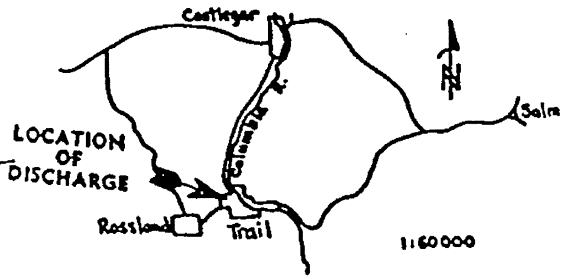
GENERAL DESCRIPTION



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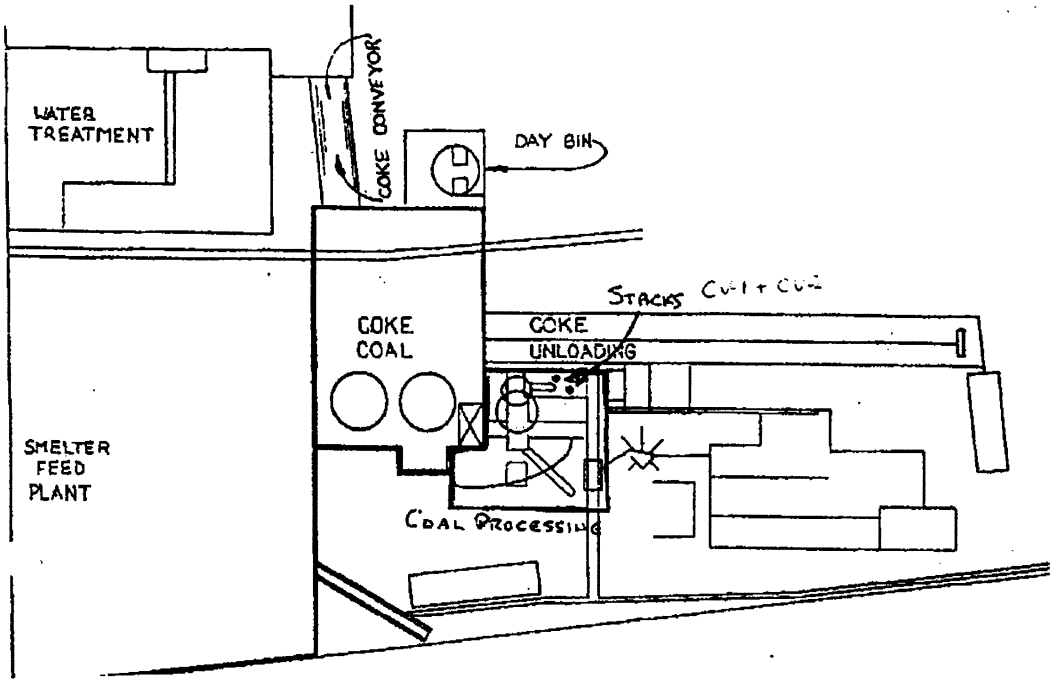
Environmental Protection Program

Site Plan K



LEGAL DESCRIPTION: Lot 1, Plan 4926, Kootenay District

Permit: PA-02691

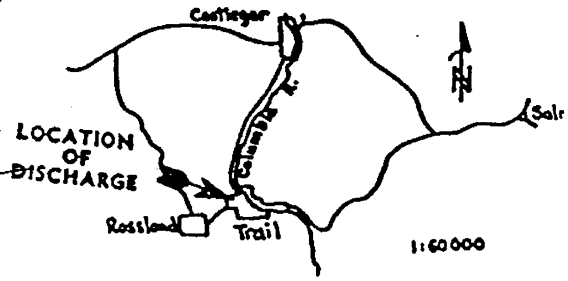
Date Issued: September 9, 1975

Date Amended: DEC 22 1995

Regional Waste Manager:

R.J. Crozier, R.P. Bio.

GENERAL DESCRIPTION



Name of Applicant:

Cominco Ltd. - Cominco Ltee

PROVINCE OF
BRITISH COLUMBIA

Environmental Protection
#401-333 Victoria Street
Nelson British Columbia
V1L 4K3
Telephone: (604) 354-6355

MINISTRY OF ENVIRONMENT,
LANDS AND PARKS

PERMIT
PA-02690

Under the Provisions of the Waste Management Act

COMINCO LTD. - COMINCO LTEE

500 - 200 BURRARD STREET

VANCOUVER, BRITISH COLUMBIA

V6C 3L7

is authorized to discharge contaminants to the air from chemical fertilizer and electronic materials plants located at Warfield, British Columbia, subject to the conditions listed below. Contravention of any of these conditions is a violation of the Waste Management Act and may result in prosecution.

1. AUTHORIZED DISCHARGE

1.1. This subsection applies to the discharge of contaminants into the air from a **STACK ASSOCIATED WITH THE VENTILATION OF THE OSLO CRYSTALLIZERS AND FIRST EFFECT CONDENSATE HOT WELL OF THE AMMONIUM SULPHATE PLANT** (W-1) as shown on Site Plan A. The site reference number for this discharge is E102868.

1.1.1. The maximum authorized rate of discharge is 226 m^3 per minute. The authorized discharge period is 24 hours per day.

Date Issued: September 9, 1975
Date Amended: APR 30 1996
(most recent)
Page: 1 of 20

R.J. Crozier, R.P. Bio.
Regional Waste Manager

PERMIT: PA-02690

1.1.2. The characteristic of the discharge shall not exceed:

Total Particulate 115 mg/m^3

Note: All air and gaseous volumes specified in Subsection 1.1.1 and 1.1.2 above are at standard conditions which are:

Standard Temperature = 293.15° K
Standard Pressure = 101.325 KPa
Water Vapour Zero Unless Otherwise Stated

1.1.3. The authorized works are fan, stack and related appurtenances located approximately as shown on attached Site Plan A.

1.1.4. The location of the facilities from which the discharge originates is Lot 1, Plan 6446, Kootenay District.

1.2. This subsection applies to the discharge of contaminants into the air from a **STACK ASSOCIATED WITH THE CENTRIFUGES OF THE AMMONIUM SULPHATE PLANT** (W-2) as shown on the attached Site Plan A. The site reference number for this discharge is E102869.

1.2.1. The maximum authorized rate of discharge is 238 m^3 per minute. The authorized discharge period is 24 hours per day.

1.2.2. The characteristics of the discharge shall not exceed:

Total Particulate 115 mg/m^3

Note: All air and gaseous volumes specified in Subsection 1.2.1 and 1.2.2 above are at standard conditions which are:

Standard Temperature = 293.15° K
Standard Pressure = 101.325 KPa
Water Vapour Zero Unless Otherwise Stated

1.2.3. The authorized works are knockout box, impinger, mist eliminator, fan, stack and related appurtenances located approximately as shown on attached Site Plan A.

1.2.4. The location of the facilities from which the discharge originates is Lot 1, Plan 6446, Kootenay District.

R.J. Crozier, R.P. Bio.
Regional Waste Manager

1.3. This subsection applies to the discharge of contaminants into the air from a **STACK ASSOCIATED WITH THE AMMONIUM SULPHATE PLANT FERTILIZER DRYERS 1, 2 AND 3** as shown on the attached Site Plan A. The site reference numbers for this discharge are E102870 (W-3) and E208093 (W-4).

1.3.1. The maximum authorized rate of discharge is 569 m^3 per minute. The authorized discharge period is 24 hours per day.

1.3.2. The characteristics of the discharge shall be:

Total Particulate 350 mg/m^3

Note: All air and gaseous volumes specified in Subsection 1.3.1 and 1.3.2 above are at standard conditions which are:

Standard Temperature = 293.15° K
Standard Pressure = 101.325 KPa
Water Vapour Zero Unless Otherwise Stated

1.3.3. The authorized works are cyclones, impinger, scrubber, fans, stacks and related appurtenances located approximately as shown on attached Site Plan A.

1.3.4. The location of the facilities from which the discharge originates is Lot 1, Plan 6446, Kootenay District.

1.4. This subsection applies to the discharge of contaminants into the air from a **STACK ASSOCIATED WITH THE VENTILATION OF THE FERTILIZER STORAGE PLANT #1 and #11 MILLS** as shown on the attached Site Plan A. The site reference numbers for this discharge are E102871(W-6) and 0260086(W-8).

1.4.1. The maximum authorized rate of discharge is 350 m3/min. The authorized discharge period is 8 hours per day, 220 days per year.

R.J. Crozier, R.P. Bio.
Regional Waste Manager

PERMIT: PA-02690

1.4.2. The characteristics of each of the discharges shall not exceed:

Total Particulate Maximum 200 mg/m^3

Note: All air and gaseous volumes specified in Subsection 1.4.1 and 1.4.2 above are at standard conditions which are:

Standard Temperature = 293.15° K
Standard Pressure = 101.325 KPa
Water Vapour Zero Unless Otherwise Stated

1.4.3. The authorized works are cyclones, winnowers, bagfilters, fans, ducts, stacks and related appurtenances located approximately as shown on attached Site Plan A.

1.4.4. The location of the facilities from which the discharge originates is Lot 1, Plan 6446, Kootenay District.

1.5. The subsection applies to the discharge of contaminants into the air from the **STACK ASSOCIATED WITH THE VENTILATION OF THE FERTILIZER STORAGE PLANT MILL #13** (W-10) as shown on the attached Site Plan A. The site reference number for this discharge is E102872.

1.5.1. The maximum authorized rate of discharge is 282 m^3 per minute. The authorized discharge period is 10 hours per day, 5 days per week.

1.5.2. The characteristics of the discharge shall not exceed:

Total Particulate 350 mg/m^3

Note: All air and gaseous volumes specified in Subsection 1.5.1 and 1.5.2 above are at standard conditions which are:

Standard Temperature = 293.15° K
Standard Pressure = 101.325 KPa
Water Vapour Zero Unless Otherwise Stated

1.5.3. The authorized works are cyclones, winnowers, bagfilter, fans, ducts, stacks and related appurtenances located approximately as shown on attached Site Plan A.

1.5.4. The location of the facilities from which the discharge originates is Lot 1, Plan 6446, Kootenay District.

R.J. Crozier, R.P. Bio.
Regional Waste Manager

1.6. This subsection applies to the discharge of contaminants to the air from the **STACK ASSOCIATED WITH THE VENTILATION OF THE FERTILIZER STORAGE PLANT MILL 14** (W-12) as shown on the attached Site Plan A. The site reference number for this discharge is E102873.

1.6.1. The maximum authorized rate of discharge is 141 m^3 per minute. The authorized discharge period is 8 hours per day, 5 days per week.

1.6.2. The characteristics of the discharge shall not exceed:

Total Particulate 350 mg/m^3

Note: All air and gaseous volumes specified in Subsection 1.6.1 and 1.6.2 above are at standard conditions which are:

Standard Temperature = 293.15° K
Standard Pressure = 101.325 KPa
Water Vapour Zero Unless Otherwise Stated

1.6.3. The authorized works are cyclones, winnower, bagfilter, fan, ducts, stacks and related appurtenances located approximately as shown on attached Site Plan A.

1.6.4. The location of the facilities from which the discharge originates is Lot 1, Plan 6446, Kootenay District.

1.7. This subsection applies to the discharge of contaminants to the air from a **STACK ASSOCIATED WITH THE SALT BINS BAGHOUSE OF THE GRANULATED AMMONIUM SULPHATE PLANT** (W-28) as shown on the attached Site Plan A. The site reference number for this discharge is E102874.

1.7.1. The maximum authorized rate of discharge is 170 m^3 per minute. Th authorized discharge period is 24 hours per day.

R.J. Crozier, R.P. Bio.
Regional Waste Manager

1.7.2. The characteristics of the discharge shall not exceed:

Total Particulate 350 mg/m^3

Note: All air and gaseous volumes specified in Subsection 1.7.1 and 1.7.2 above are at standard conditions which are:

Standard Temperature = 293.15° K
Standard Pressure = 101.325 KPa
Water Vapour Zero Unless Otherwise Stated

1.7.3. The authorized works are baghouse, fan, stack and related appurtenances located approximately as shown on attached Site Plan A.

1.7.4. The location of the facilities from which the discharge originates is Lot 1, Plan 6446, Kootenay District.

1.8. This subsection applies to the discharge of contaminants into the air from the **STACKS ASSOCIATED WITH THE VENTILATION OF THE PHOSPHATE PLANT ACID CLARIFIERS** as shown on the attached Site Plan A. The site reference numbers for this discharge are E102876, 0260088 and E208094.

1.8.1. The maximum authorized rate of discharge is 650 m^3 per minute. The authorized discharge period is 24 hours per day.

1.8.2. The characteristics of the discharge are:

Typical Tank Ventilation

Note: All air and gaseous volumes specified in Subsection 1.8.1 and 1.8.2 above are at standard conditions which are:

Standard Temperature = 293.15° K
Standard Pressure = 101.325 KPa
Water Vapour Zero Unless Otherwise Stated

1.8.3. The authorized works are vents, stacks and related appurtenances located approximately as shown on attached Site Plan A.

1.8.4. The location of the facilities from which the discharge originates is Lot 1, Plan 6446, Kootenay District.

R.J. Crozier, R.P. Bio.
Regional Waste Manager

1.9. This subsection applies to the discharge of contaminants into the air from the **STACKS ASSOCIATED WITH THE VENTILATION OF THE GRANULAR AMMONIUM SULPHATE PRODUCT COOLER** (W-46) as shown on the attached Site Plan A. The site reference number for this discharge is 0260092.

1.9.1. The maximum authorized rate of discharge is 1,000 m^3 per minute. The authorized discharge period is 24 hours per day.

1.9.2. The characteristics of the discharge shall not exceed:

Total Particulate 46 mg/m^3

Note: All air and gaseous volumes specified in Subsection 1.9.1 and 1.9.2 above are at standard conditions which are:

Standard Temperature = 293.15° K
Standard Pressure = 101.325 KPa
Water Vapour Zero Unless Otherwise Stated

1.9.3. The authorized works are cyclones, scrubbers, abatement, impingers, ducts, fans, stacks and related appurtenances located approximately as shown on attached Site Plan A.

1.9.4. The location of the facilities from which the discharge originates is Lot 1, Plan 6446, Kootenay District.

1.10. This subsection applies to the discharge of contaminants into the air from the **STACK ASSOCIATED WITH THE VENTILATION OF PROCESS SCREENS, ELEVATORS, AND CONVEYOR TRANSFER POINTS AND IS KNOWN AS THE GRANULATION BAGHOUSE** (W-70) as shown on the attached Site Plan A. The site reference number for this discharge is E222862.

1.10.1. The maximum authorized rate of discharge is 700 m^3 per minute. The authorized discharge period is 24 hours per day.

R.J. Crozier, R.P. Bio.
Regional Waste Manager

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1.10.2. The characteristics of the discharge shall not exceed:

Total Particulate 125 mg/m^3

Note: All air and gaseous volumes specified in Subsection 1.10.1 and 1.10.2 above are at standard conditions which are:

Standard Temperature = 293.15° K
Standard Pressure = 101.325 KPa
Water Vapour Zero Unless Otherwise Stated

1.10.3. The authorized works are baghouse, ducts, fans, stacks and related appurtenances located approximately as shown on attached Site Plan A.

1.10.4. The location of the facilities from which the discharge originates is Lot 1, Plan 6446, Kootenay District.

1.11. This subsection applies to the discharge of contaminants into the air from the **STACK ASSOCIATED WITH THE VENTILATION OF THE GRANULAR AMMONIUM SULPHATE GRANULATOR**(W-71) as shown on the attached Site Plan A. The site reference number for this discharge is E222863.

1.11.1. The maximum authorized rate of discharge is 2,000 m^3 per minute. The authorized discharge period is 24 hours per day.

1.11.2. The characteristics of the discharge shall not exceed:

Total Particulate 46 mg/m^3

Note: All air and gaseous volumes specified in Subsection 1.11.1 and 1.11.2 above are at standard conditions which are:

Standard Temperature = 293.15° K
Standard Pressure = 101.325 KPa
Water Vapour Zero Unless Otherwise Stated

1.11.3. The authorized works are cyclone separator, and venturi scrubber, ducts, fans, stacks and related appurtenances located approximately as shown on attached Site Plan A.

1.11.4. The location of the facilities from which the discharge originates is Lot 1, Plan 6446, Kootenay District.

R.J. Crozier, R.P. Bio.
Regional Waste Manager

1.12. This subsection applies to the discharge of contaminants into the air from **MISCELLANEOUS STACKS ASSOCIATED WITH THE VENTILATION OF THE ELECTROLYTIC AMMONIA PLANT** as shown on the attached Site Plan A. The site reference number for this discharge is E212199.

1.12.1. The maximum authorized rate of discharge is 2,117 m^3 per minute. The authorized discharge period is 24 hours per day.

1.12.2. The characteristic of the discharge are:

Are of the nature originating from the ventilation of the Electrolytic Ammonia Plant and the Air Separation Unit Plant.

Note: All air and gaseous volumes specified in Subsection 1.12.1 and 1.12.2 above are at standard conditions which are:

Standard Temperature = 293.15° K
Standard Pressure = 101.325 KPa
Water Vapour Zero Unless Otherwise Stated

1.12.3. The authorized works are vents, safety vents, ducts, stacks and related appurtenances located approximately as shown on attached Site Plan A.

1.12.4. The location of the facilities from which the discharge originates is Lot 1, Plan 6446, Kootenay District.

1.13. This subsection applies to the discharge of contaminants into the air from the **MISCELLANEOUS STACKS ASSOCIATED WITH THE VENTILATION OF THE GRANULAR AMMONIUM SULPHATE PLANT** as shown on the attached Site Plan A. The site reference number for this discharge is E212202.

1.13.1. The maximum authorized rate of discharge is 1,670 m^3 per minute. The authorized discharge period is 24 hours per day.

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Regional Waste Manager

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1.13.2. The characteristics of the discharge are:

Are of the nature originating from the ventilation of the Granular Ammonium Sulphate Plant.

Note: All air and gaseous volumes specified in Subsection 1.13.1 and 1.13.2 above are at standard conditions which are:

Standard Temperature = 293.15° K
Standard Pressure = 101.325 KPa
Water Vapour Zero Unless Otherwise Stated

1.13.3. The authorized works are vents, safety pressure reliefs, ducts, baghouses on phosphate rock silos A and B, fans, stacks and related appurtenances located approximately as shown on attached Site Plan A.

1.13.4. The location of the facilities from which the discharge originates is Lot 1, Plan 6446, Kootenay District.

1.14. This subsection applies to the discharge of contaminants into the air from the **MISCELLANEOUS STACKS ASSOCIATED WITH THE VENTILATION OF SHOPS AND SERVICE BUILDINGS** as shown on the attached Site Plan A. The site reference number for this discharge is E212204.

1.14.1. The maximum authorized rate of discharge is 1,584 m^3 per minute. The authorized discharge period is 24 hours per day.

1.14.2. The characteristic of the discharge are:

Are of the nature originating from the ventilation of the service buildings and shops.

Note: All air and gaseous volumes specified in Subsection 1.14.1 and 1.14.2 above are at standard conditions which are:

Standard Temperature = 293.15° K
Standard Pressure = 101.325 KPa
Water Vapour Zero Unless Otherwise Stated

1.14.3. The works authorized are ventilators, cyclone on grit blasting stack, vents, ducts, mist pads on paint shop stack, fans, stacks and related appurtenances located approximately as shown on attached Site Plan A.

R.J. Crozier, R.P. Bio.
Regional Waste Manager

1.14.4. The location of the facilities from which the discharge originates is Lot 1, Plan 6446, Kootenay District.

1.15. This subsection applies to the discharge of contaminants into the air from the **MISCELLANEOUS STACKS ASSOCIATED WITH THE VENTILATION OF THE BOILER PLANT** as shown on the attached Site Plan A. The site reference number for this discharge is E212205.

1.15.1. The maximum authorized rate of discharge is 1,411 m^3 per minute. The authorized discharge period is 24 hours per day.

1.15.2. The characteristics of the discharge are:

Are of the nature originating from the ventilation of the Boiler Plant (No. 3 Electric Boiler and No. 8 and No. 9 Gas/Oil Fired Boilers).

Note: All air and gaseous volumes specified in Subsection 1.15.1 and 1.15.2 above are at standard conditions which are:

Standard Temperature = 293.15° K
Standard Pressure = 101.325 KPa
Water Vapour Zero Unless Otherwise Stated

1.15.3. The authorized works are vents, safety relief valves, ducts, fans, stacks and related appurtenances located approximately as shown on attached Site Plan A.

1.15.4. The location of the facilities from which the discharge originates is Lot 1, Plan 6446, Kootenay District.

1.16. This subsection applies to the discharge of contaminants into the air from the **MISCELLANEOUS STACKS ASSOCIATED WITH THE VENTILATION OF THE PLASTIC FABRICATION** as shown on the attached Site Plan A. The site reference number for this discharge is E212207.

1.16.1. The maximum authorized rate of discharge is 3,053 m^3 per minute. The authorized discharge period is 24 hours per day.

R.J. Crozier, R.P. Bio.
Regional Waste Manager

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1.16.2. The characteristics of the discharge are:

Are of the nature originating from the ventilation of the plastic fabrication plant.

Note: All air and gaseous volumes specified in Subsection 1.16.1 and 1.16.2 above are at standard conditions which are:

Standard Temperature = 293.15° K
Standard Pressure = 101.325 KPa
Water Vapour Zero Unless Otherwise Stated

1.16.3. The authorized works are ventilators, fans, stacks and related appurtenances located approximately as shown on attached Site Plan A.

1.16.4. The location of the facilities from which the discharge originates is Lot 1, Plan 6446, Kootenay District.

1.17. This subsection applies to the discharge of contaminants into the air from the **MISCELLANEOUS STACKS ASSOCIATED WITH THE VENTILATION OF BOILERS AND SUBSTATIONS** as shown on the attached Site Plan A. The site reference number for this discharge is E212210.

1.17.1. The maximum authorized rate of discharge is 734 m^3 per minute. The authorized discharge period is 24 hours per day.

1.17.2. The characteristics of the discharge are:

Are of the nature originating from the ventilation of Substations and No. 1 and No. 2 Electric Boilers.

Note: All air and gaseous volumes specified in Subsection 1.17.1 and 1.17.2 above are at standard conditions which are:

Standard Temperature = 293.15° K
Standard Pressure = 101.325 KPa
Water Vapour Zero Unless Otherwise Stated

R.J. Crozier, R.P. Bio.
Regional Waste Manager

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1.17.3. The authorized works are ventilators, vents, fans, stacks and related appurtenances located approximately as shown on attached Site Plan A.

1.17.4. The location of the facilities from which the discharge originates is Lot 1, Plan 6446, Kootenay District.

1.18. This subsection applies to the discharge of contaminants into the air from the **MISCELLANEOUS STACKS ASSOCIATED WITH THE VENTILATION OF THE CRYSTALLINE AMMONIUM SULPHATE PLANT** as shown on the attached Site Plan A. The site reference number for this discharge is E212211.

1.18.1. The maximum authorized rate of discharge is 282 m^3 per minute. The authorized discharge period is 24 hours per day.

1.18.2. The characteristics of the discharge are:

Are of the nature originating from the ventilation of crystalline ammonium sulphate plant.

Note: All air and gaseous volumes specified in Subsection 1.18.1 and 1.18.2 above are at standard conditions which are:

Standard Temperature = 293.15° K
Standard Pressure = 101.325 KPa
Water Vapour Zero Unless Otherwise Stated

1.18.3. The authorized works are rotoclone scrubber on product scales, screen, etc., ventilators, safety relief vents, ducts, fans, stacks and related appurtenances located approximately as shown on attached Site Plan A.

1.18.4. The location of the facilities from which the discharge originates is Lot 1, Plan 6446, Kootenay District.

R.J. Crozier, R.P. Bio.
Regional Waste Manager

PERMIT: PA-02690

1.19. This subsection applies to the discharge of contaminants into the air from the **MISCELLANEOUS STACKS ASSOCIATED WITH THE VENTILATION OF THE FERTILIZER STORAGE PLANT** as shown on the attached Site Plan A. The site reference number for this discharge is E212212.

1.19.1. The maximum authorized rate of discharge is 141 m^3 per minute. The authorized discharge period is 24 hours per day.

1.19.2. The characteristics of the discharge are:

Are of the nature originating from the ventilation of the Fertilizer Storage Plant.

Note: All air and gaseous volumes specified in Subsection 1.19.1 and 1.19.2 above are at standard conditions which are:

Standard Temperature = 293.15° K
Standard Pressure = 101.325 KPa
Water Vapour Zero Unless Otherwise Stated

1.19.3. The authorized works are ventilators, vents, ducts, fans, stacks and related appurtenances located approximately as shown on attached Site Plan A.

1.19.4. The location of the facilities from which the discharge originates is Lot 1, Plan 6446, Kootenay District.

1.20. This subsection applies to the discharge of contaminants into the air from the **MISCELLANEOUS STACKS ASSOCIATED WITH THE VENTILATION OF THE ELECTROLYTIC AMMONIA PLANT GAS HOUSE** as shown on the attached Site Plan A. The site reference number for this discharge is E212213.

1.20.1. The maximum authorized rate of discharge is 71 m^3 per minute. The authorized discharge period is 24 hours per day.

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Regional Waste Manager

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1.20.2. The characteristics of the discharge are:

Are of the nature originating from the Electrolytic Ammonia Plant Gas House.

Note: All air and gaseous volumes specified in Subsection 1.20.1 and 1.20.2 above are at standard conditions which are:

Standard Temperature = 293.15° K
Standard Pressure = 101.325 KPa
Water Vapour Zero Unless Otherwise Stated

1.20.3. The authorized works are vents, pipes, stacks and related appurtenances located approximately as shown on attached Site Plan A.

1.20.4. The location of the facilities from which the discharge originates is Lot 1, Plan 6446, Kootenay District.

1.21. This subsection applies to the discharge of contaminants into the air from the **STACKS ASSOCIATED WITH THE VENTILATION OF THE GERMANIUM REFINING PLANT** (21, 22, 23 and 23A) as shown on the attached Site Plan B. The site reference number for this discharge is E218617.

1.21.1. The maximum authorized rate of discharge is 1,350 m^3 per minute. The authorized discharge period is 24 hours per day.

1.21.2. The characteristics of the discharge shall not exceed:

Traces of Chlorine and HCl from fume hood ventilation stack (23).

Note: All air and gaseous volumes specified in Subsection 1.21.1 and 1.21.2 above are at standard conditions which are:

Standard Temperature = 293.15° K
Standard Pressure = 101.325 KPa
Water Vapour Zero Unless Otherwise Stated

R.J. Crozier, R.P. Bio.
Regional Waste Manager

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1.21.3. The authorized works are scrubbers, fans, stacks, chlorine alarm and related appurtenances located approximately as shown on attached Site Plan B.

1.21.4. The location of the facilities from which the discharge originates is Lot 1, Plan 6446, except 12335, Kootenay District.

1.22. This subsection applies to the discharge of contaminants into the air from the **STACK ASSOCIATED WITH THE VENTILATION OF THE ELECTRONIC LEAD PRODUCTION PLANT** (27) as shown on the attached Site Plan B. The site reference number for this discharge is E218619.

1.22.1. The maximum authorized rate of discharge is 500 m^3 per minute. The authorized discharge period is 24 hours per day, 180 days per year.

1.22.2. The characteristics of the discharge shall not exceed:

Total Lead 11.4 mg/m^3

Note: All air and gaseous volumes specified in Subsection 1.22.1 and 1.22.2 above are at standard conditions which are:

Standard Temperature = 293.15° K
Standard Pressure = 101.325 KPa
Water Vapour Zero Unless Otherwise Stated

1.22.3. The authorized works are bagfilter, ducts, fans, stack and related appurtenances located approximately as shown on attached Site Plan B.

1.22.4. The location of the facilities from which the discharge originates is Lot 1, Plan 6446, except 12335, Kootenay District.

R.J. Crozier, R.P. Bio.
Regional Waste Manager

2. GENERAL REQUIREMENTS

2.1. Maintenance of Works and Emergency Procedures

The permittee shall inspect the pollution control works regularly and maintain them in good working order. In the event of an emergency or conditions beyond the control of the permittee which prevents continuing operation of the approved method of pollution control, the permittee shall immediately notify the Regional Waste Manager and take appropriate remedial action.

2.2. Bypasses

The discharge of contaminants which has bypassed the designated treatment works is prohibited unless the consent of the Regional Waste Manager is obtained and confirmed in writing.

2.3. Process Modifications

The permittee shall notify the Regional Waste Manager prior to implementing changes to any process that may affect the quality and/or quantity of the discharge.

2.4. Suspension

The permittee shall ensure that no discharge occurs from or in respect of the works authorized by this permit during any period of suspension under the Waste Management Act.

R.J. Crozier, R.P. Bio.
Regional Waste Manager

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3. MONITORING AND REPORTING REQUIREMENTS

3.1. Source Monitoring

The permittee shall carry out the following Source Monitoring Program. The source monitoring program may be revised at the discretion of the Regional Waste Manager.

Source	Site Ref. No.	Contaminants To Be Measured	Frequency
Oslo Crystallizer W-1	E102868	Total Particulate	annually
Centrifuges Vent W-2	E102869	Total Particulate	annually
Fertilizer Dryers W-3	E102870	Total Particulate	semi-annually
Fertilizer Dryer W-4	E208093	Total Particulate	semi-annually
# 1 Mill Stack W-6	E102871	Total Particulate	annually
# 11 Mill Stack W-8	0260086	Total Particulate	annually
# 13 Mill Stack W-10	E102872	Total Particulate	annually
# 14 Mill Stack W-12	E102873	Total Particulate	annually
Salt Bins Baghouse W-28	E102874	Total Particulate	semi-annually
G.A.S. Product Cooler W-46	0260092	Total Particulate, Ammonia	annually
Granulation Baghouse W-70	E222862	Total Particulate	annually
Granulation Scrubber W-71	E222863	Total Particulate, Ammonia	semi-annually
Electronic Lead	E218619	Total Particulate, Lead, Arsenic	semi-annually

R.J. Crozier, R.P. Bio.
Regional Waste Manager

PERMIT: PA-02690

3.2. Source Testing Procedures - Particulate

Source testing procedures for the determination of particulate matter concentrations and the rate of discharge (flow rate) are to be carried out in accordance with those procedures described in the "Source Testing Code for the Measurement of Emissions of Particulates from Stationary Sources", 1982. Alternative test methods may be used provided that the alternative test methods are authorized by the Regional Waste Manager prior to performing the actual source testing.

Copies of the above mentioned manual are available from the Environmental Protection Division, Ministry of Environment, Lands and Parks, 777 Broughton Street, Victoria, British Columbia, V8V 1X5, at a cost of $5.00, and are also available for inspection at all Environmental Protection Program Offices.

3.3. Sampling Facilities

Sampling ports shall be provided with nearby electrical outlets and, where required, approved access ladders and adequately sized platforms, for the discharges covered by Subsections 1.1, 1.2, 1.3, 1.4,1.5, 1.6, 1.7, 1.9, 1.10, 1.11, and 1.22 of the permit to enable Waste Management personnel to monitor these emissions.

3.4. Sampling Locations and Techniques

All sampling locations, techniques and equipment are to be approved by the Regional Waste Manager prior to use. Sampling and monitoring data, which also should include rate of discharge measurements, shall be accompanied by process data relevant to the operation of the source of the emissions and to the performance of the pollution abatement equipment involved in the testing.

3.5. Discharge Rate Measurement

Measure and record on the day of sampling of the above emissions, the average rate of discharge in m^3/min and the stack emission temperature from the stack based on normal operation of the plant in question for the period of sampling.

R.J. Crozier, R.P. Bio.
Regional Waste Manager

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3.6. **Quality Assurance/Quality Control**

3.6.1. The permittee shall produce within 60 days of the request of the Regional Waste Manager, 'Laboratory Quality Protocols and Quality Assurance Criteria' acceptable to the Regional Waste Manager. The 'Laboratory Quality Protocols' shall include the procedures used to assess precision, accuracy and blank quality, including frequency of application of those procedures, the procedures for sampling handling (e.g. preservation, hold times) and corrective measures to be initiated when deficiencies are indicated. The 'Quality Assurance Criteria' shall include the acceptance criteria for accuracy (based on recoveries for reference samples/spikes), for precision (based on deviation in field and lab duplicates) and method blanks (designed to indicate false positives).

3.6.2. Permittee shall certify that all data required under Subsections 3.1 of this permit are produced in accordance with the 'Laboratory Quality Protocols' and met the 'Quality Assurance Criteria' as approved under Subsection 3.6.1. At the request of the Regional Waste Manager, the permittee is to provide the laboratory quality assurance data along with the submission of the data required under Subsection 3.1 of this permit.

3.6.3. The permittee shall ensure that all tests and other data required to be submitted under the permit are conducted by a laboratory acceptable to the Regional Waste Manager.

3.7. **Reporting**

3.7.1. The permittee shall submit an annual report to the Regional Waste Manager which includes:

i) All source testing results.

ii) Documentation of the remedial measures taken to improve those emissions, if any, shown to be in excess of permit limits.

iii) The report is to be written in a form suitable for public release.

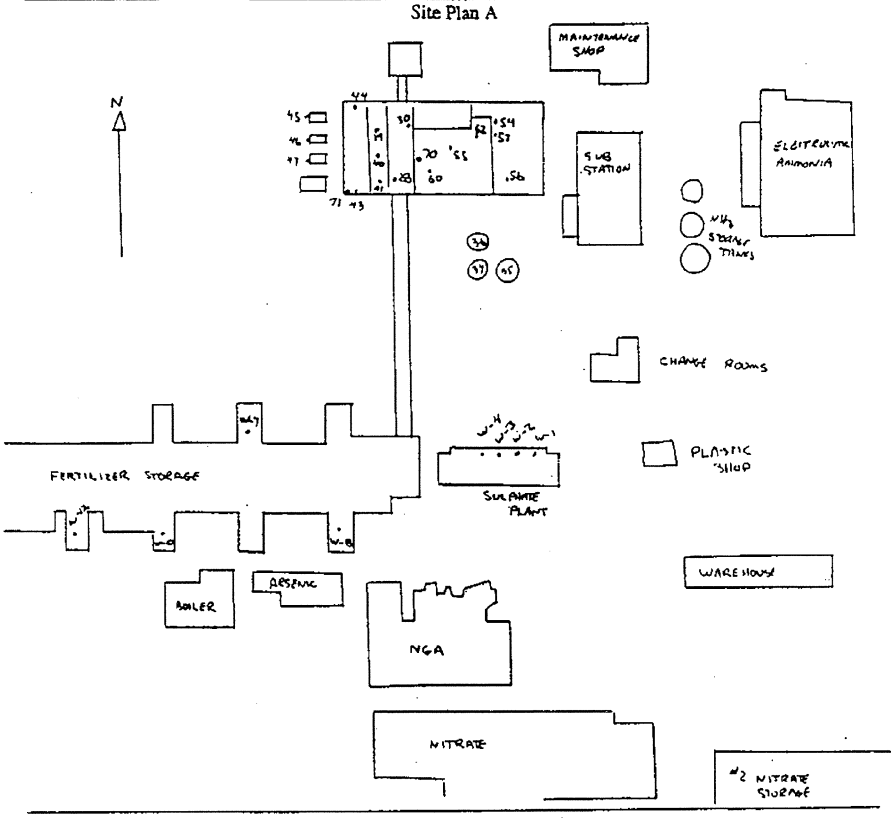
iv) The report is due by April 1 of the following year.

R.J. Crozier, R.P. Bio.
Regional Waste Manager

PERMIT: PA-02690

BRITISH COLUMBIA

Site Plan A



LEGAL DESCRIPTION: Lot 1, Plan 6446, Kootenay District

Permit: PA-02690

Date Issued: September 9, 1975

Date Amended: APR 30 1996

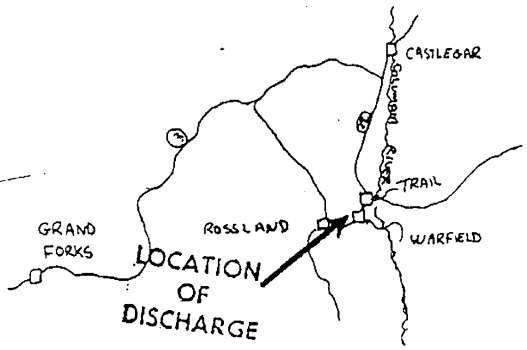
Regional Waste Manager

R.J. Crozier, R.P. Bio.

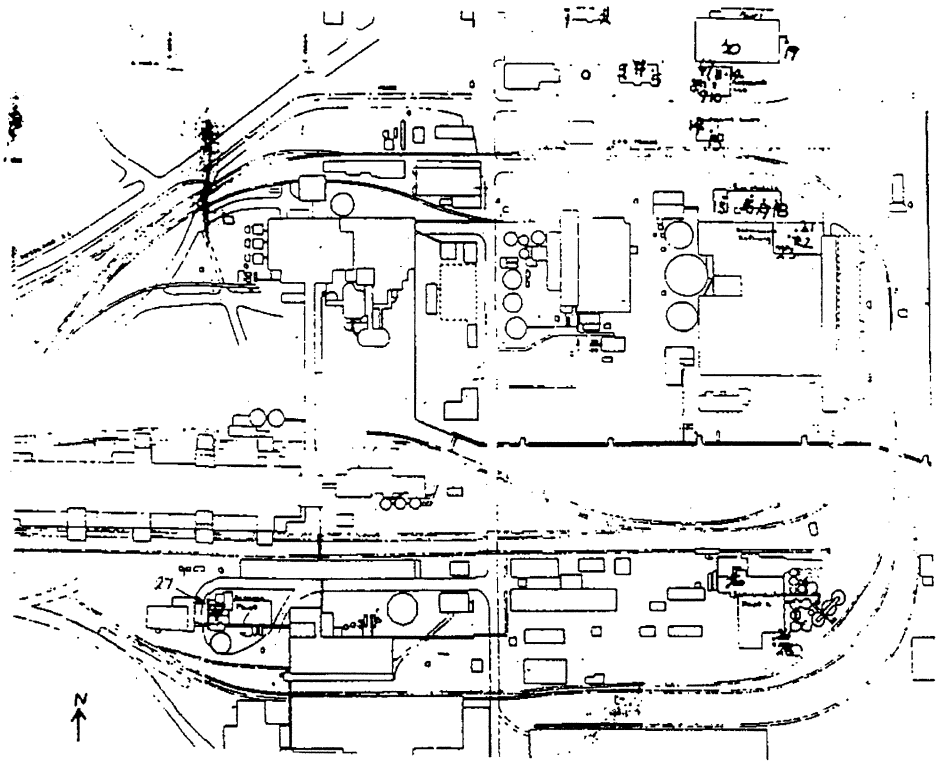
Name of Applicant:

Cominco Ltd. - Cominco Ltee

GENERAL DESCRIPTION



Site Plan B



LEGAL DESCRIPTION: Lot 1, Plan 6446, Kootenay District

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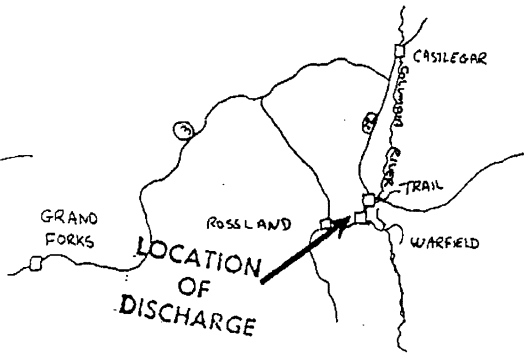


PROVINCE OF
BRITISH COLUMBIA

Environmental Protection
Victoria Street
Nelson, British Columbia V1l 4K3
Telephone: (604) 354-6355
Fax: (604) 354-6367

MINISTRY OF ENVIRONMENT, LANDS AND PARKS

PERMIT
PR-05175

Under the Provisions of the Waste Management Act

COMINCO LTD. - COMINCO LTEE

500 - 200 BURRARD STREET

VANCOUVER, BRITISH COLUMBIA

V6C 3L7

is authorized to discharge refuse to the land from a lead - zinc - fertilizer plant complex located at Trail, British Columbia, and is subject to the conditions listed below. Contravention of any of these conditions is a violation of the Waste Management Act and may result in prosecution.

1. AUTHORIZED DISCHARGE

1.1. The discharge of refuse to which this Sub-Section is applicable is from the lead, zinc and fertilizer plants as shown on the attached Site Plan (Appendix A). The reference number (S.E.A.M. site number) for this discharge is E211772.

1.1.1. The maximum rate at which refuse may be discharged is 200 m^3/day. The characteristics of the discharge shall be equal to or better than:

Typical industrial solid waste.

R.J. Crozier, R.P.Bio..
Regional Waste Manager

Date Issued: November 24, 1978
Date Amended: SEP 17 1996

1.1.2. The works authorized are a landfill operation and windrow compost operation for Celgar Pulpmill primary and secondary sludge, approximately located as shown on Site Plan A.

1.1.3. The location of the facilities from which the discharge originates is Lots 1, 2, 3 and 4, Plan 4926 and Lots 1 and 3, Plan 6446 and Part Assigned No. 25 and Assigned No. 18, Plan 1425, Kootenay District.

1.1.4. The location of the point of discharge is Lots 18 and 19 of District Lot 367, Kootenay District, Plan 1425 and Lots 2 and 3, Plan 6446, City of Trail approximately located as shown on the Site Plan Appendix A.

1.2. The discharge of contaminants to which this Sub-Section is applicable is from an open burn operation as shown on the attached Site Plan (Appendix A). The reference number (S.E.A.M. site number) for this discharge is E219707.

1.2.1. The maximum rate at which solid wood and paper waste may be open burned is 1,000 m^3 per burn.

1.2.2. The characteristics of the discharge shall be equal to or better than:

wood and paper waste.

1.2.3. The works authorized are an open burn operation, as directed below, approximately located as shown on the attached Site Plan A.

1.2.4. The location of the facilities from which the discharge originates and the point of discharge is the same location as set out in Sub-Section 1.1.5.

2. GENERAL REQUIREMENTS

2.1. Operational Requirements For Regulated Open Burning

R.J. Crozier, R.P.Bio..
Regional Waste Manager

2.1.1. Area

The operation shall be restricted to an area on the site which is satisfactory to the Regional Waste Manager. If required, this area shall be fenced to restrict access to the burn area stockpile.

2.1.2. Quantity and Frequency

The maximum quantity of wastes to be treated is 1,000 m^3 per burn at a frequency not to exceed 12 days per year. Each burn shall comprise one continuous period not to exceed 2 days per burn necessary to reduce the stockpiled waste to ashes.

2.1.3. Nature of Wastes

Generally, no waste shall be burned which is unacceptable to the Regional Waste Manager. Acceptable materials may include selected combustible demolition refuse, stumps, trees, waste paper and similar items, but excluding combustibles such as rubber, plastics, tars, insulation, etc.

Only clean non-chlorinated solvents or uncontaminated diesel fuel may be used for ignition of the waste pile.

2.1.4. Timing

Burning shall take place only when an attendant is on duty and when conditions promote rapid combustion and dispersion of combustion products. Materials shall be charged to the facility in a manner to promote best combustion and restrict the uplift of lighter constituents. No burning shall take place during periods of fire hazard nor when burning is prohibited by other government agencies.

R.J. Crozier, R.P.Bio..
Regional Waste Manager

2.1.5. Fire Control

Burning shall take place only when approved by Ministry of Forests who will determine whether it is safe to burn and may specify conditions under which burning may take place.

2.1.6. Residue of Combustion

As soon as the residue of combustion has cooled to ambient temperature it shall be incorporated into a landfill which has been authorized by the Regional Waste Manager.

2.2. Landfill Operation

The Permittee shall compact the refuse and apply cover material at least once per month. Compaction using heavy trucks during covering operations is considered acceptable. The Regional Waste Manager may vary the frequency of covering when freezing conditions adversely affect normal operation or when sufficient quantities of soil material are incorporated with the waste.

2.3. Sludge Composting Operation

The Permittee is authorized to operate a windrow compostion operation using primary and secondary effluent treatment plant sludge from the Celgar Pulpmill in Castlegar, BC. Operational Practices shall be those specified in Sections 3 and 4 of the *Production and Use of Compost Regulation* (BC Reg. 334/93) except that Section 3(5) does not apply. Composted product sludge may not be used in situations for growing food products.

2.4. Operation - Asbestos Landfill

Asbestos wastes shall be packaged, handled and disposed of in accordance with the following requirements:

2.4.1. The waste asbestos shall not be mixed with any other special waste;

2.4.2. The waste asbestos shall be confined during handling, storage and transportation by:

(a) dry airtight containment techniques such as:

(i) packing in 6 mil plastic bags placed within a non-reusable drum and then sealed, or;

(ii) packing in a 6 mil plastic bag placed within a second 6 mil plastic bag and then sealed or;

(b) wet containment techniques such as saturation with water and containment in non-leaking sealed drums or equivalent, or;

(c) other approved containment techniques.

2.4.3. The waste asbestos shall be disposed of at the landfill by being immediately buried with a minimum of 0.5 m of cover material.

2.5. **Process Modifications**

The Permittee shall notify the Regional Waste Manager prior to implementing changes to any process that may affect the quality and/or quantity of the discharge.

2.6. **Maintenance of Works and Emergency Procedures**

The Permittee shall inspect the pollution control works regularly and maintain them in good working order. In the event of an emergency or condition beyond the control of the Permittee which prevents continuing operation of the approved method of pollution control, the Permittee shall immediately notify the Regional Waste Manager and take appropriate remedial action.

R.J. Crozier, R.P.Bio..
Regional Waste Manager

2.7. Surface Water Diversion

The Permittee shall construct and maintain a diversion ditch on the sides of the expanded landfill area to capture and divert potential surface water around the active landfill site itself.

2.8. Reclamation of Completed Areas of the Landfill

The Permittee shall cap the completed areas of the landfill with a minimum of .6 meter of compacted soil. The site shall be sloped so as to promote gradual drainage of rainwater and snowmelt from site. Composted sludge from Celgar Pulp Company Ltd.'s effluent treatment plant may be utilized as a soil amendment on completed sections of the landfill site to provide nutrients and a growth medium. Prior to final abandonment of the site, the surface shall be seeded with drought tolerant seed mixture in order to promote water uptake by plants rather than seepage into the ground. Vegetation shall be maintained to the satisfaction of the Regional Waste Manager.

2.9. Restriction of Public Access to Landfill Site

Public access to the landfill site shall be restricted by fencing and locked gates during the non-working hours in order to minimize scavenging and illegal deposition of material by the general public.

3. MONITORING AND REPORTING REQUIREMENTS

3.1. Closure Plan

The Permittee shall submit to the Regional Waste Manager prior to December 31, 1994 a closure plan for the existing and future landfill sites associated with this Permit. The Plan shall consist of but not be limited to the following:

3.1.1. Anticipated total waste volumes and tonnage and life of the landfill.

3.1.2. Topographic plan showing the final elevation contours of the landfill and surface water diversion and drainage control.

3.1.3. Design of the final cover including the thickness and permeability of barrier layers and drainage layers and information on topsoil, vegetation, and erosion controls.

3.1.4. Proposed end use of the property after closure.

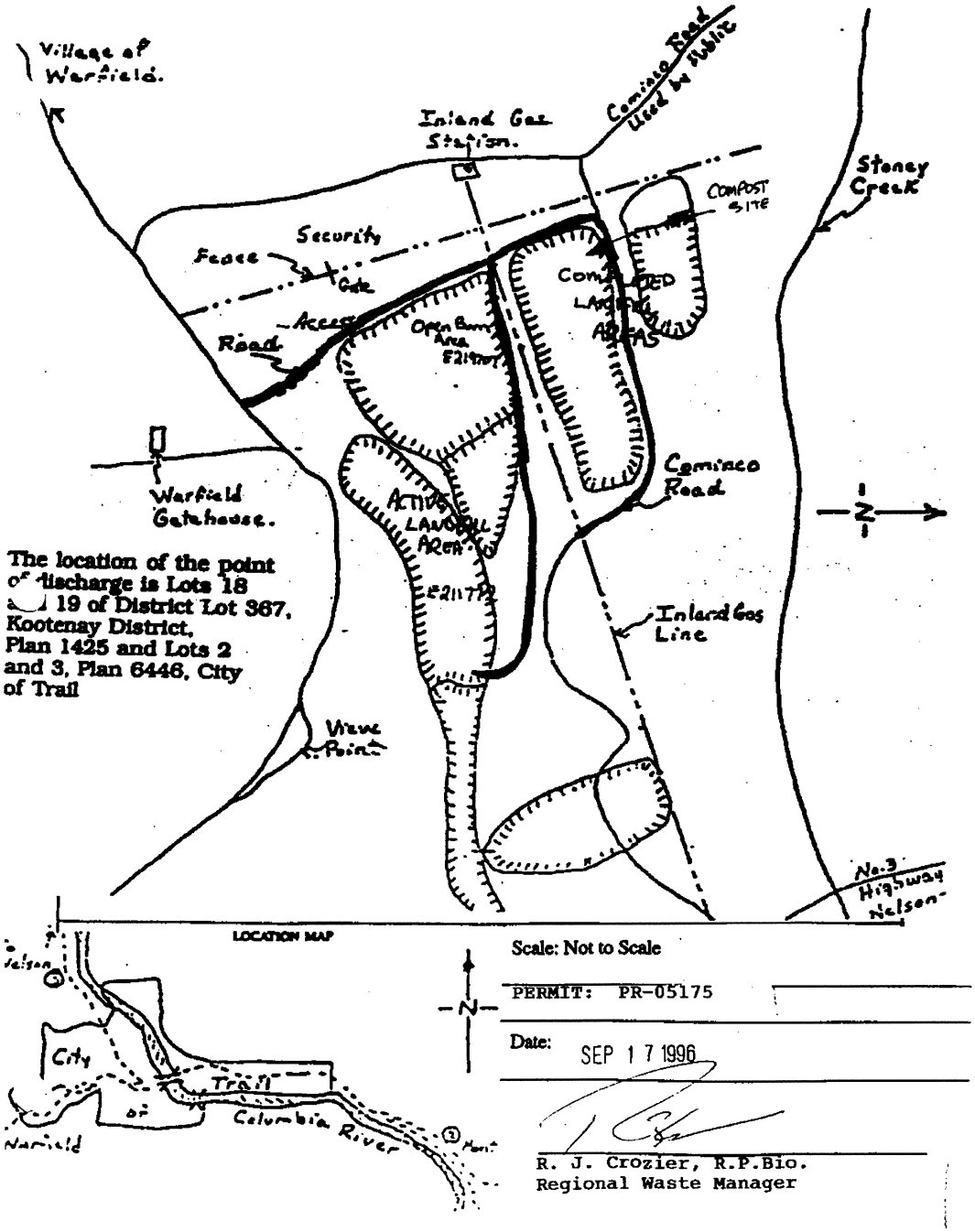
3.1.5. Plans for monitoring groundwater, surface water erosion and settlement.

3.1.6. Plan for operation of any required pollution abatement engineering works such as leachate collection and treatment systems.

Date Issued: November 24, 1978
Date Amended: SEP 17 1996

R.J. Crozier, R.P.Bio..
Regional Waste Manager

PERMIT NO. PE-05175


Village of Warfield.
Inland Gas Station.
Cominco Road Used by Public
Stoney Creek
COMPOST SITE
Security Fence
Gate
Access Road
Open Burn Area
Warfield Gatehouse.
Cominco Road
ACTIVE LANDFILL AREA
Inland Gas Line
The location of the point of discharge is Lots 18 and 19 of District Lot 367, Kootenay District, Plan 1425 and Lots 2 and 3, Plan 6446, City of Trail
View Point
No. 3 Highway Nelson
LOCATION MAP
Nelson
City of Warfield
Trail
Columbia River
Scale: Not to Scale
PERMIT: PR-05175
Date: SEP 17 1996
R. J. Crozier, R.P.Bio.
Regional Waste Manager

BRITISH COLUMBIA

JUN 17 1999

File: PS-11532

REGISTERED MAIL

Randy Sentis
JUN 25 1999
MANAGER ENVIRONMENT & PUBLIC AFFAIRS

Cominco Ltd. - Cominco Ltee
500 - 200 Burrard Street
Vancouver British Columbia V6C 3L7

Dear Permittee:

Enclosed is Amended Permit PS-11532 issued under the provisions of the Waste Management Act. Your attention is respectfully directed to the conditions outlined in the permit. An annual permit fee will be determined according to the Waste Management Permit Fees Regulation.

This permit does not authorize entry upon, crossing over, or use for any purpose of private or Crown lands or works, unless and except as authorized by the owner of such lands or works. The responsibility for obtaining such authority rests with the permittee. It is also the responsibility of the permittee to ensure that all activities conducted under this permit are carried out with due regard to the right of the third parties and comply with other applicable legislation that may be in force.

This decision may be appealed to the Environmental Appeal Board. Notice of the appeal must (1) be in writing, (2) include the grounds for appeal, (3) be directed by registered mail or personally delivered to the Chair, Environmental Appeal Board, 4th Floor, 836 Yates Street, Victoria, British Columbia, V8V 1X4, (4) be delivered within 30 days from the date notice of the decision is given, and (5) be accompanied by a fee of $25, payable to the Minister of Finance and Corporate Relations.

For further information on the appeal process, please phone the Environmental Appeal Board at (250) 387-3464.

Administration of this permit will be carried out by staff from our Regional Office located at #401-333 Victoria Street, Nelson, British Columbia, V1L 4K3, (telephone: (250) 354-6355). Plans, data and reports pertinent to the permit are to be submitted to the Regional Waste Manager at Nelson, British Columbia.

Yours truly,

R.J. Crozier, R.P. Bio.
Regional Waste Manager
Kootenay Region
/lh
ENCLOSURE

Ministry of Environment, Lands and Parks

Environment and Lands
Kootenay Region

Mailing/Location Address:
401 - 333 Victoria Street
Nelson BC VIL 4K3

Telephone: (250) 354-6333
Facsimile: (250) 354-6332
PP Facsimile:(250) 354-6367

PROVINCE OF
BRITISH COLUMBIA

Pollution Prevention
#401-333 Victoria Street
Nelson, British Columbia V1L 4K3
Telephone: (250) 354-6355
Fax: (250) 354-6367

MINISTRY OF ENVIRONMENT,
LANDS AND PARKS

PERMIT
PS-11532

Under the Provisions of the Waste Management Act

COMINCO LTD. - COMINCO LTEE

500 - 200 BURRARD STREET

VANCOUVER, BRITISH COLUMBIA

V6C 3L7

is authorized to store Special Wastes from the, Lead Smelter, Cadmium Plant and Mercury Removal Plant located at Trail, British Columbia, subject to the following terms and conditions outlined in Sections One, Two and Three and attached Site Plan SP-1. Contravention of any of these conditions is a violation of the Waste Management Act and may result in prosecution.

An annual permit fee will be determined on the basis of your industrial code and capacity in accordance with the Waste Management Fees Regulation.

This Permit does not authorize entry upon, crossing over, or use for any purpose of private or Crown lands or works, unless and except as authorized by the owner of such lands or works. The responsibility for obtaining such authority shall rest with the Permittee.

This permit supersedes and amends all previous versions of Permit **PS-11532**, issued under Part 2 Section 10 of the Waste Management Act.

1. AUTHORIZED DISCHARGES

1.1. The storage of dichromate generated thallium filter cake to which this Sub-Section is applicable is from the Cadmium Plant as shown on the attached Site Plan SP-1. The site reference number for this discharge is E217406 .

1.1.1. The maximum quantity which may be stored is 70,000 kilograms/year.

R.J. Crozier, R.P. Bio.
Regional Waste Manager

1.1.2. The typical characteristics of the stored material are:

Thallium	56%
Chromium	14%
Cadmium	1.3%
Zinc	2%
Sodium	.1%
Calcium	.09%
Lead	.5%

1.1.3. The authorized works are 2 short term storage buildings, and related appurtenances approximately located as shown on attached Site Plan SP-1.

1.1.4. The authorized works must be complete and in operation when discharge commences.

1.1.5. The location of the facilities from which the discharge originates is the Cadmium Plant; Lot 3, Kootenay District, Plan 4926.

1.1.6. The location of the short term storage buildings are Lots 14 and 17, District Lot 367, Kootenay District, Plan 1425, known as Duncan Flats.

1.2. The storage of mercurous chloride sludge to which this Sub-Section is applicable is from the Mercury Removal Plant as shown on the attached Site Plan SP-1. The site reference number for this discharge is E217406.

1.2.1. The maximum quantity which may be stored is 20,000 kilograms/year.

1.2.2. The typical characteristics of the stored material are:

Mercury	72 - 80%
Chlorine	15 - 20%
Lead	.15%
Zinc	.07%
Silicon	.05%
Sulphur	.8%
Selenium	.7%
Iron	.015%
Sodium	.05%

1.2.3. The authorized works are 2 short term storage buildings approximately located as shown on attached Site Plan SP-1.

R.J. Crozier, R.P. Bio.
Regional Waste Manager

1.2.4. The authorized works must be complete and in operation when discharge commences.

1.2.5. The location of the facilities from which the discharge originates is the Mercury Removal Plant; Lot 3, Kootenay District, Plan 4926.

1.2.6. The location of the short term storage buildings are Lots 14 and 17, District Lot 367, Kootenay District, Plan 1425, known as Duncan Flats.

1.3. The storage of thallium chloride salts to which this Sub-Section is applicable is from the Lead Smelter Drossing Plant as shown on the attached Site Plan SP-1. The site reference number for this discharge is E217406.

1.3.1. The maximum quantity which may be stored is 175,000 kilograms/year.

1.3.2. The typical characteristics of the stored material are:

Thallium	8-10 %
Zinc	25-35 %
Lead	15-25 %

The above are present mainly as chlorides with small amounts of oxides present.

1.3.3. The authorized works are 2 short term storage buildings approximately located as shown on attached Site Plan SP-1.

1.3.4. The authorized works must be complete and in operation when discharge commences.

1.3.5. The location of the facilities from which the discharge originates is the Lead Smelter Drossing Plant; Lot 3, Kootenay District, Plan 4926.

1.3.6. The location of the short term storage buildings are Lots 14 and 17, District Lot 367, Kootenay District, Plan 1425, known as Duncan Flats.

R.J. Crozier, R.P. Bio.
Regional Waste Manager

2. GENERAL REQUIREMENTS

2.1. Maintenance of Works

The permittee shall inspect the authorized works regularly and maintain them in good working order. Any malfunction which may affect the quality of the material being stored shall be reported to the Regional Waste Manager within a specified time period.

2.2. Maintenance of Works and Emergency Procedures

The permittee shall inspect the authorized works regularly and maintain them in good working order. In the event of an emergency or condition beyond the control of the permittee which prevents effective operation of the approved method of pollution control, the permittee shall immediately take appropriate remedial action and shall notify the Regional Waste Manager or an Officer designated by the Regional Waste Manager:

a) By telephone if the condition occurs between the hours of 08:00 and 16:30, Monday to Friday;

b) by facsimile transmission if the condition occurs at any other time.

In addition to any reporting requirements under the Spill Reporting Regulation, notification of any occurrence under this section must be reported to the Regional Waste Manager within 24 hours of such occurrence.

2.3. Process Modifications

The permittee shall have written approval from the Regional Waste Manager prior to implementing changes to the authorized works that may result in discharges exceeding the characteristics authorized under this permit.

2.4. Plans

Plans and specifications of the works authorized in Sub-Sections 1.1, 1.2, and 1.3 shall be submitted to the Regional Waste Manager in duplicate and his approval obtained. The works shall be constructed in accordance with such plans.

R.J. Crozier, R.P. Bio.
Regional Waste Manager

2.5. Access Restrictions

Access to all storage areas is restricted to authorized personnel only and the long term storage facility authorized in Sub-Section 1.1, 1.2 and 1.3 is to be locked at all times to prevent access by unauthorized persons. The buildings are to be adequately posted with signs warning of the hazards associated with the material stored inside.

2.6. Contingency Plans

An updated contingency plan shall be submitted annually on or before December 31 of each year, to the Regional Waste Manager. Emergency systems including the contingency plan are to be tested and documented at least once per year.

2.7. Closure Plan

A closure plan shall be submitted for the written approval of the Regional Waste Manager.

2.8. Stacking of Containers

Containers may not be stacked more than 3 high except when the container is specifically designed for stacking.

2.9. Access for Inspection

Sufficient aisle space must be provided for between rows of containers for visual inspection. Provision must be made in the design of the building for removal of damaged containers in the event this becomes necessary.

2.10. Other Provisions

The operation is subject to all applicable provisions of the Special Waste Regulation.

R.J. Crozier, R.P. Bio.
Regional Waste Manager

3. MONITORING AND REPORTING REQUIREMENTS

3.1. Monitoring Procedures

(a) Dichromate Generated Thallium Filter Cake

(i) All materials transported to and stored in the storage building must be identified by a system of dates, and weights and recorded in a record keeping system for inspection as requested by the Regional Waste Manager.

(ii) The storage building must be inspected at least biweekly in order to confirm that the material continues to be safely stored and the building is secure.

3.2. Reporting

Reports as required by Part 3, Section 6 of the Special Waste Regulations shall be submitted to the Regional Waste Manager on or before January 30 of each year for the previous 12 months of operation.

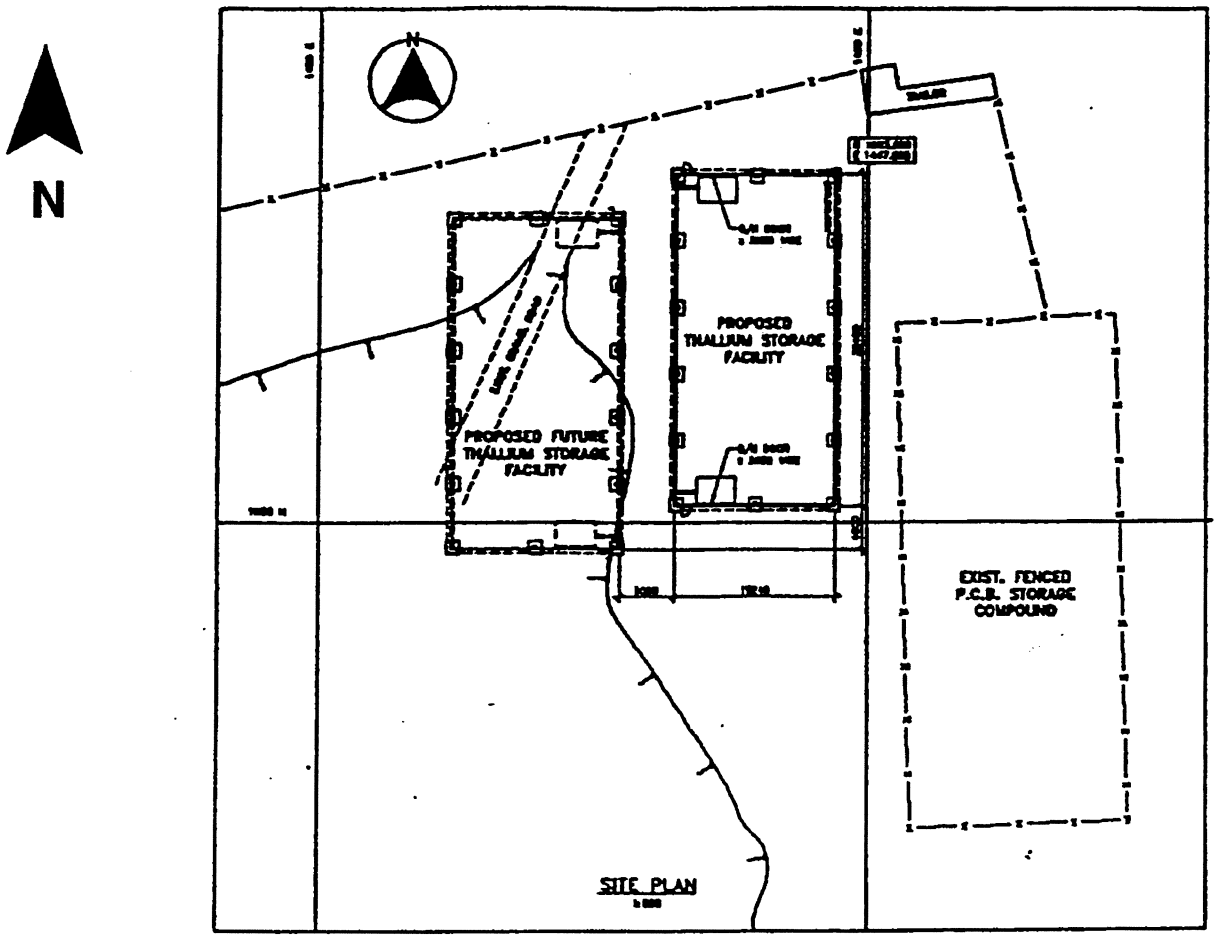
R.J. Crozier, R.P. Bio.
Regional Waste Manager

PERMIT: PS-11532

PROVINCE OF
BRITISH COLUMBIA

Pollution Prevention

Site Plan SP-1



LEGAL DESCRIPTION: Lots 14 and 17, District Lot 367, Kootenay District, Plan 1425

Permit/Approval: PS-11532

Date Issued: November 5, 1992

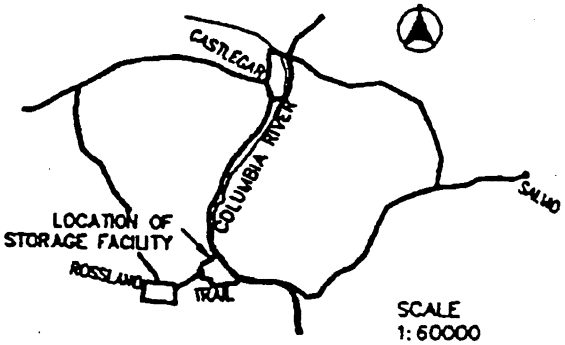
Date Amended: (most recent) JUN 17 1999

Regional Waste Manager:

R.J. Crozier, R.P. Bio.

Name of Applicant: Cominco Ltd. - Cominco Ltee

LOCATION MAP



BRITISH COLUMBIA

APR 22 2004

File: PS-08310

REGISTERED MAIL

Teck Cominco Metals Ltd.
600-200 Burrard Street
VANCOUVER BC V6C 3L9

Dear Permittee:

Enclosed is amended Permit PS-08310 issued under the provisions of the Waste Management Act. Your attention is respectfully directed to the conditions outlined in the permit. An annual permit fee will be determined according to the Waste Management Permit Fees Regulation.

This permit does not authorize entry upon, crossing over, or use for any purpose of private or Crown lands or works, unless and except as authorized by the owner of such lands or works. The responsibility for obtaining such authority rests with the permittee. It is also the responsibility of the permittee to ensure that all activities conducted under this permit are carried out with due regard to the right of the third parties and comply with other applicable legislation that may be in force.

This decision may be appealed to the Environmental Appeal Board. Notice of the appeal must (1) be in writing, (2) include the grounds for appeal, (3) be directed by registered mail or personally delivered to the Chair, Environmental Appeal Board, 4th Floor, 747 Fort Street, PO Box 9425 Stn Prov Govt, Victoria, British Columbia, V8W 9V1, (4) be delivered within 30 days from the date notice of the decision is given, and (5) be accompanied by a fee of $25, payable to the Minister of Finance and Corporate Relations.

For further information on the appeal process, please phone the Environmental Appeal Board at (250) 387-3464 or Fax (250) 356-9923.

Administration of this permit will be carried out by staff from our Regional Office located at #401-333 Victoria Street, Nelson, British Columbia, V1L 4K3, (telephone: (250) 354-6355). Plans, data and reports pertinent to the permit are to be submitted to the Regional Waste Manager at Nelson, British Columbia.

Yours truly,

Carl Johnson

Carl Johnson, P.Eng.
Assistant Regional Waste Manager

CJ/lkm/ENCLOSURE
cc: Teck Cominco, PO Box 1000, Trail BC V1R 4L8

Ministry of Water, Land and Air Protection

Environmental Protection
Kootenay and Okanagan Regions

Mailing/Location Address:
401 - 333 Victoria Street
Nelson BC V1L 4K3

Telephone: 250 354-6355
Facsimile: 250 354-6332

BRITISH COLUMBIA

Environmental Protection
#401-333Victoria Street
Nelson, British Columbia V1L 4K3
Telephone: (250) 354-6355
Fax: (250) 354-6332

MINISTRY OF WATER, LAND AND
AIR PROTECTION

PERMIT
PS-08310

Under the Provisions of the Waste Management Act

TECK COMINCO METALS LTD.

600-200 BURRARD STREET

VANCOUVER, BRITISH COLUMBIA

V6C 3L9

is authorized to store special waste from a lead-zinc fertilizer complex in a permanent storage facility located near Trail, British Columbia, subject to the conditions listed below. Contravention of any of these conditions is a violation of the Waste Management Act and may result in prosecution.

This permit supersedes and amends all previous versions of Permit **PS-08310**, issued under Part 2 Section 10 of the Waste Management Act.

1. AUTHORIZED DISCHARGES

1.1 Covered Pile Permanent Storage Facility

This subsection applies to the storage of special waste from a lead-zinc-fertilizer complex. The site reference number for this discharge is E211789.

1.1.1 The maximum quantity of arsenic bearing special wastes which may be stored is 90,000 m^3.

1.1.2 Arsenic bearing special wastes removed from existing metallurgical stockpiles in Parts of Lots 13, 14, 16, 17 and 18 of District Lot 367, Plan 1425 Kootenay District and in the Little League Park Lot 6, Plan 6446, City of Trail may be stored at this site.

Carl Johnson

Carl Johnson, P.Eng.
Assistant Regional Waste Manager

Date Issued: June 16, 1989
Date Amended:
(most recent) APR 22 2004
Page: 1 of 7

1.1.3 The authorized works are a permanent storage facility constructed on a specially prepared impervious pad of asphalt underlain by a 40 mil HDPE liner, leachate collection system and covered with a single 40 mil HDPE cover in 1990 as shown on Plan Nos. 69-A-14, 15, 16 and 17, and related appurtenances approximately located as shown on attached Site Plan A.

1.1.4 The authorized works must be complete and in operation when discharge commences. The new final cover as outlined in the report titled "Duncan Dome Waste Consolidation Program Design Report – Phases 1,2 and 3" by AMEC dated March 2004 shall be installed no later than December 31, 2008.

1.1.5 The location of the point of discharge is parts of Lots 13, 14 and 16, District Lot 367, Plan 1425, Kootenay District.

1.2 Duncan Dome Permanent Storage Facility

This subsection applies to the storage of special waste from a lead-zinc-fertilizer complex. The site reference number for this discharge is E255473.

1.2.1 The maximum quantity of arsenic bearing special wastes which may be stored is 200,000 m^3.

1.2.2 Arsenic bearing special wastes removed from: existing metallurgical stockpiles in or on Duncan Dome - Parts of Lots 13, 14, 16, 17 and 18 of District Lot 367, Plan 1425 Kootenay District; #2 Nitrate Storage - Lot 1, District Lot 4597, Plan 6446, Kootenay Land District; Laydown area - Parcel 18, District Lot 367, Plan 1425, Kootenay Land District; and Refinery Scrubber Pond - Parcel 16, District Lot 367, Plan 1425, Kootenay Land District may be stored at this site. Any additional arsenic contaminated materials may be added to the storage facility subject to the prior approval of the Director.

1.2.3 The authorized works are a permanent storage facility constructed on top of the Duncan Dome site with two 60 mil HDPE liners, a single 60 mil LLDPE cover, primary and secondary leachate collection systems, seepage collection systems adjacent to Stoney Creek and related appurtenances as outlined in the report titled "Duncan Dome Waste Consolidation Program Design Report – Phases 1,2 and 3" by AMEC dated March 2004 and as approximately located as shown on attached Site Plan B.

1.2.4 The base containment double-liner system must be in place and in operation when discharge commences.

1.2.5 The location of Duncan Dome Permanent Storage Facility is parts of Parcels 14 and 17, District Lot 367, Plan 1425, Kootenay Land District.

Carl Johnson

Carl Johnson, P.Eng.
Assistant Regional Waste Manager

1.3 No. 2 Nitrate Storage Building Interim Storage Facility

This subsection applies to the interim storage of special waste from a lead-zinc-fertilizer complex. The site reference number for this discharge is E255474.

1.3.1 The maximum quantity of arsenic bearing special wastes which may be stored is 50,000 tonnes.

1.3.2 Additional special waste materials may be added to the wastes already in storage provided that the wastes are compatible. The Director shall be notified of substantive changes to the nature or quantity of the materials in storage.

1.3.3 The authorized works are an interim storage facility in a covered building with restricted access as approximately located as shown on attached Site Plan C.

1.3.4 The authorized works must be complete and in operation when discharge commences.

1.3.5 The location of No. 2 Nitrate Storage Building is Lot 1, District Lot 4597, Plan 6446, Kootenay Land District.

2. GENERAL REQUIREMENTS

2.1 Special Waste Regulation Requirements

The permittee shall comply with all applicable provisions of the *Special Waste Regulation* of the Waste Management Act except where specifically exempted under Section 51 or as explicitly stipulated in this permit.

2.1.1 Plans

Plans and specifications of the special waste permanent storage facilities shall be submitted to the Director and approval obtained before modifying any existing works. Work shall only be carried out in accordance with plans approved by the Director.

2.1.2 Access Security

The permittee shall provide adequate security for the facilities and restrict access to authorized personnel only. Devices used in the operational control of a facility (e.g. valves) that are accessible if security were breached, are to be locked.

2.1.3 Warning Signs

Warning signs conforming to Section 8 (d) of the Special Waste Regulation are to be posted at each entrance to the facilities and at other locations as required by the Director.

2.1.4 Prevention of Fire, Accidents, Leaks, Spills, Explosion and Accidental Reactions or Releases

The permittee shall take all necessary precautions in accordance with Section 9 of the Special Waste Regulation to prevent accidents, extreme heat, pressure, dust, fumes, etc. within the facilities that may cause the release of special waste into the environment.

This permit does not authorize the discharge of any waste stream from these facilities arising from their operation.

2.1.5 Material Inventories

Up-to-date inventories of all special waste in storage at the facilities shall be maintained. This includes records of any waste removed from or added to the facilities.

2.1.6 Training of Personnel

All personnel employed in the construction or operation of a facility shall receive an appropriate level of training on the hazards and the spill response, safety, operational or other relevant procedures associated with that facility. Personnel training shall be renewed as necessary. Records of personnel employed at the facility, their duties and levels of training shall be maintained.

2.1.7 Contingency Plans

The permittee shall develop and maintain up-to-date contingency plans to describe actions to be taken in the event of emergencies or failures related to the facilities.

The permittee shall annually test emergency response systems and the contingency plan. Records of the tests shall be maintained.

Carl Johnson

Carl Johnson, P.Eng.
Assistant Regional Waste Manager

2.2 Requirements applicable only to the facilities authorized under Sections 1.1 and 1.2

2.2.1 Truck Wheel Wash Facility

During construction of the facilities, all vehicles and mobile equipment must wash running wheels of arsenic containing materials prior to leaving contaminated areas. The wash water shall be collected and treated in the Teck Cominco Effluent Treatment Plant or wetlands.

2.2.2 Truck Box Washing

During discharge of wastes into the facilities and prior to any truck or mobile equipment used to handle arsenic containing materials being used for other purposes, visible contamination within the truck box or on the vehicle exterior or undercarriage must be removed by washing. The contaminated wash water must be collected and treated in the Teck Cominco Effluent Treatment Plant or wetlands.

2.2.3 Haul Road Clean-up

At the conclusion of hauling contaminated material for the purposes of discharge into a facility, any areas of road contamination arising from the haul must be removed and deposited into the facility.

2.2.4 Final Closure Plan

The permittee shall submit to the Director, at least 90 days prior to the intended closure date of a storage facility, a final closure plan indicating how the facility will be closed. The closure plan shall comply with Section 14 of the Special Waste Regulation.

2.2.5 Notation on Land Title

The permittee shall place a notification on the title of each parcel of land that underlies the permanent storage facilities authorized in 1.1 and 1.2, that the land use is for permanent storage of arsenic contaminated soil. As built survey information should be included in the notation.

Carl Johnson

Carl Johnson, P.Eng.
Assistant Regional Waste Manager

2.2.6 Maintenance of Vegetative Cover

The permittee shall maintain a suitable vegetative cover on the top of both permanent storage facilities authorized in 1.1 and 1.2, following the application of their respective engineered cover systems. Vegetation should not require regular irrigation. If the vegetative cover is disturbed for repair or access to the LLDPE cover, the vegetation shall be re-established within the next growing season. Additional plant nutrient may be added from time to time as needed to ensure healthy growth. The permittee shall make reasonable efforts to prevent burrowing animals from damaging the LLDPE component of the cover systems.

2.2.7 Collection and Treatment of Leachate

The permittee shall collect leachate from both the primary and secondary leachate collection systems and treat the water at either the Effluent Treatment Plant or the wetlands.

2.2.8 Action Leakage Rate

The action leakage rate for the Duncan Dome Permanent Storage Facility is defined as 2.0 m^3 per month. Leakage amounts in excess of this quantity must be reported to the Director. Leakage in excess of this quantity may trigger the implementation of a contingency plan of action as noted in 2.1.7 above. For the purposes of this part, 'leakage' is defined as liquid collected above the secondary (lower) containment system of the facility after September 30, 2006.

2.2.9 Clean Water Diversion to Stoney Creek

Clean water from surface of the top LLDPE, soil and biosolids layers of both permanent storage facilities authorized in 1.1 and 1.2, shall be collected and conveyed to Stoney Creek in a manner to avoid excess transport of solids into the creek.

2.2.10 Construction Records and Inventory

The permittee shall keep records of construction techniques such as, but not limited to, soil compaction and liner testing, as well as a photographic record of the construction process. In addition, an approximate inventory of the various materials placed into the Duncan Dome Permanent Storage Facility and GPS or survey locations of materials within that facility are to be recorded in the event that future recovery of arsenic bearing material is possible or desirable. If possible, physical demarcation of the interfaces between various materials is preferred.

Carl Johnson

Carl Johnson, P.Eng.
Assistant Regional Waste Manager

2.2.11 Financial Security

Financial security in the form of a Letter of Guarantee shall be provided to the Director prior to September 30, 2004. This guarantee shall ensure provision of funds sufficient to address failures of the structure, cover systems and containment systems.

2.2.12 Future Discharge of Wastes to the Duncan Dome Permanent Storage Facility

If additional arsenic bearing wastes are to be added to the Duncan Dome Permanent Storage Facility at some future date, the permittee shall develop and submit to the Director an engineering plan to reopen and reseal the structure such that the integrity of the facility is not compromised.

3. MONITORING

The permittee shall carry out the attached monitoring program until such time as it is amended by the Director in writing.

Inspections of the facilities authorized in Sections 1.1 and 1.2 shall be conducted to ensure that these facilities remain secure, that signage remains legible and in place, and that devices associated with the operation or maintenance of the facilities are in a sound condition.

4. REPORTING

The Contingency Plan, as described in Subsection 2.1.7 above, is to be submitted to the Director within 90 days of the date of issuance of this permit and his approval obtained in writing.

An inventory of the special waste stored in the #2 Nitrate Storage facility, including details of any waste added to or removed from the facility, is to be suitably tabulated and submitted annually to the Director.

A report pertaining to the three storage facilities is to be submitted annually. This report shall summarize the results of inspections, any irregularities noted during the previous calendar year and results of any monitoring programs. Information contained within the report shall be suitably tabulated, interpreted and submitted in a form suitable for release to the public. Copies of all records are to be kept on-site and made available for inspection by Environmental Protection personnel. The annual report is due on March 31st of each year.

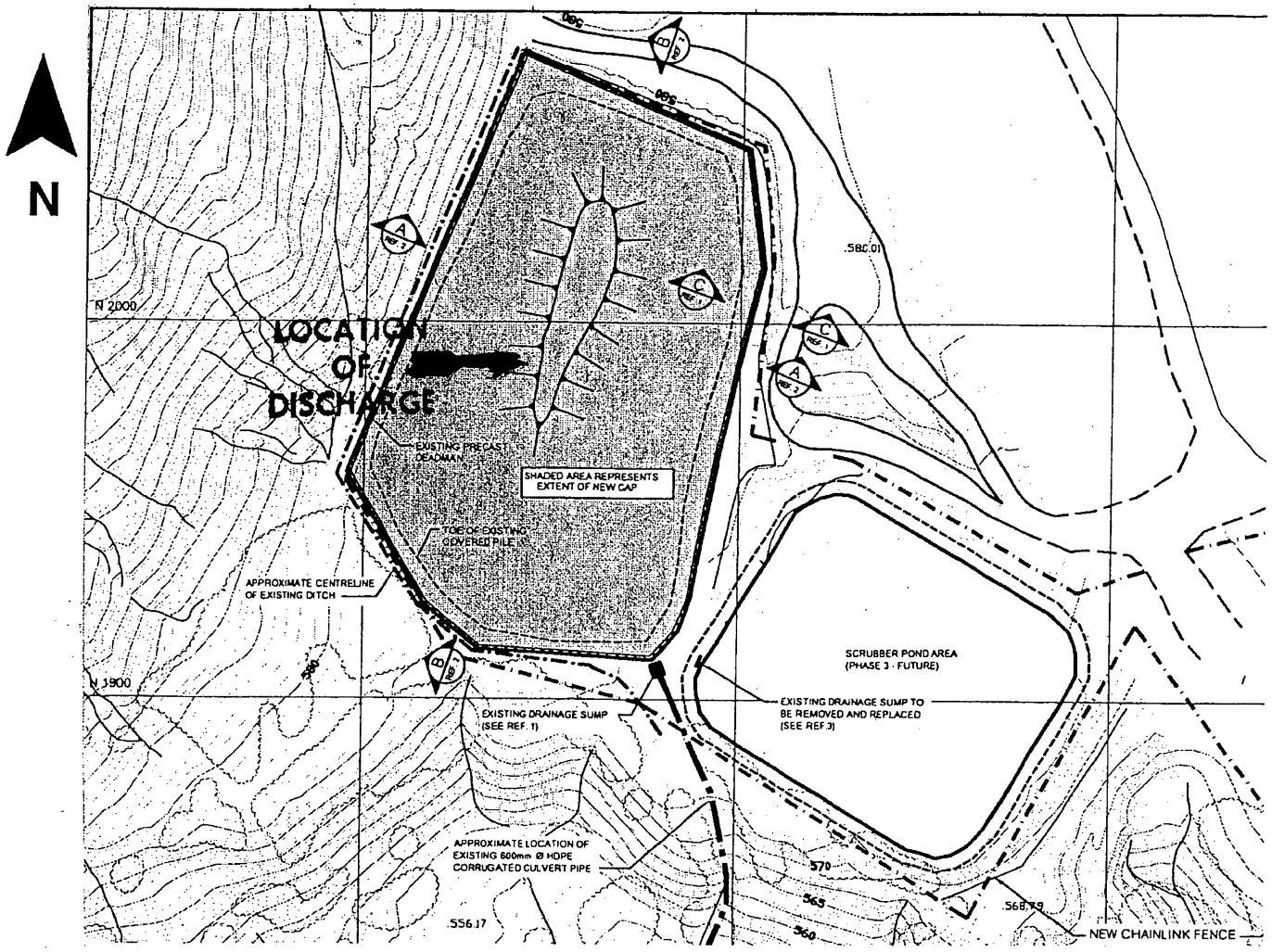
Carl Johnson

Carl Johnson, P.Eng.
Assistant Regional Waste Manager

PROVINCE OF
BRITISH COLUMBIA

Environmental Protection

Site Plan A



LEGAL DESCRIPTION: Lots 13, 14 and 16 of District Lot 367, Plan 1425, Kootenay District

Permit: PS-08310

Date Issued: June 16, 1989

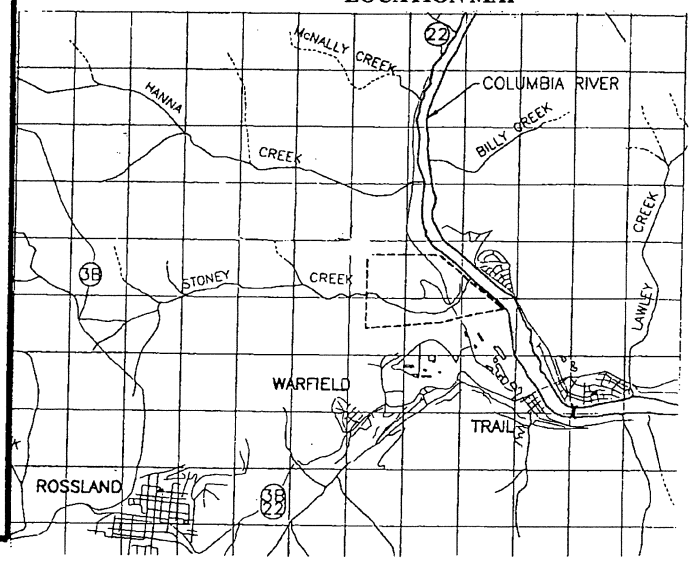
Date Amended: APR 2 2 2004
(most recent)

Assistant Regional Waste Manager:

Carl Johnson, P.Eng.

Name of Applicant: Teck Cominco Metals Ltd.

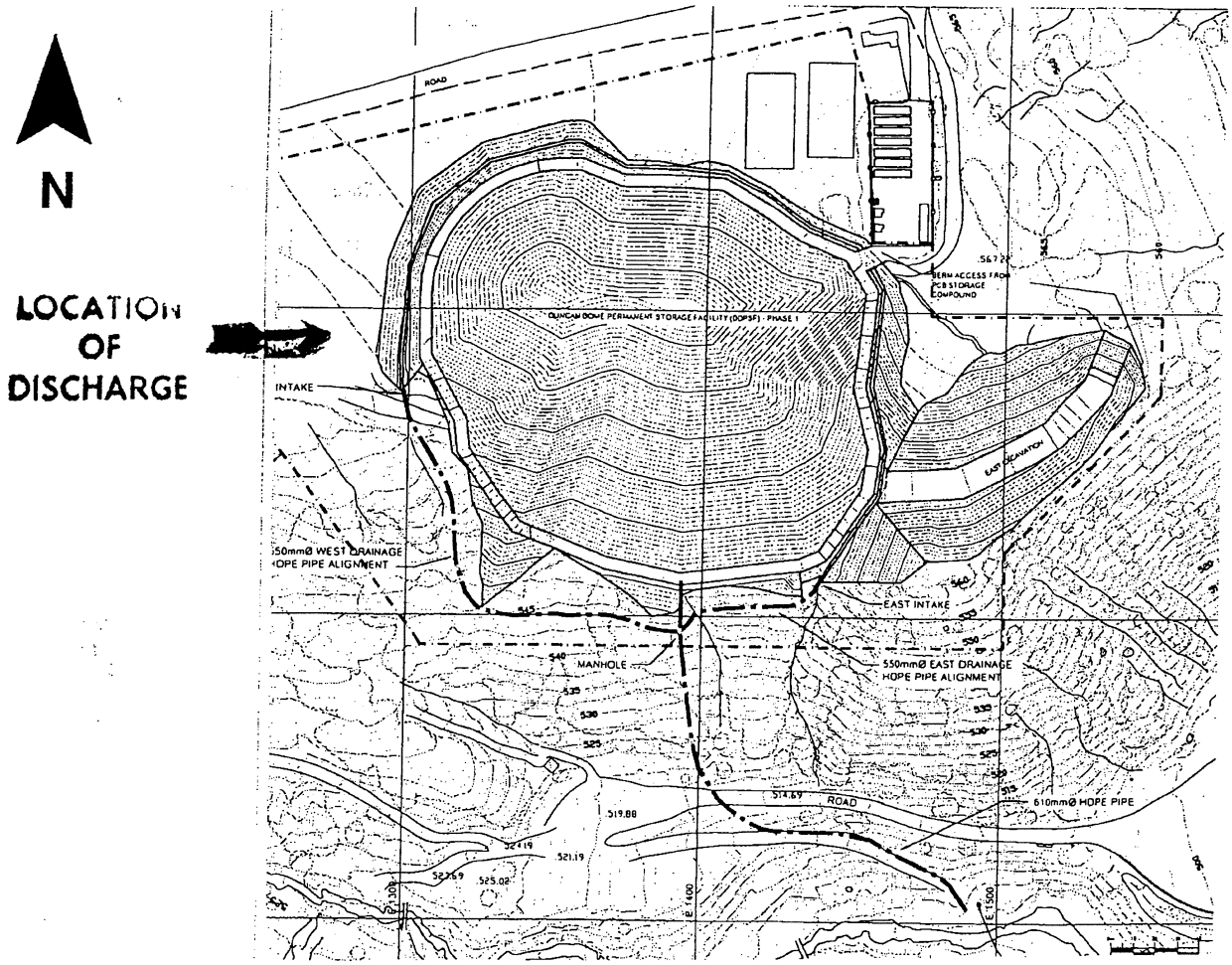
LOCATION MAP



PROVINCE OF
BRITISH COLUMBIA

Environmental Protection

Site Plan B



LEGAL DESCRIPTION: Lot 1 of District Lot 4597, Plan 6446, Kootenay District

Permit: PS-08310

Date Issued: June 16, 1989

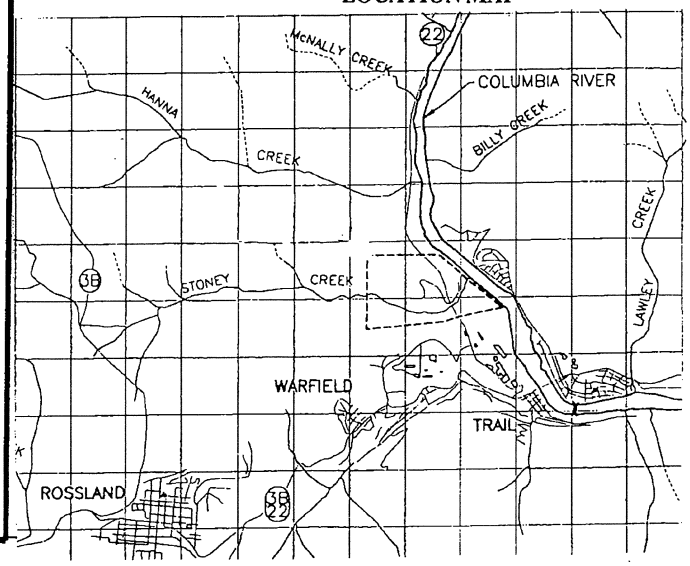
Date Amended: APR 2 2 2004
(most recent)

Assistant Regional Waste Manager:

Carl Johnson, P.Eng.

Name of Applicant: Teck Cominco Metals Ltd.

LOCATION MAP



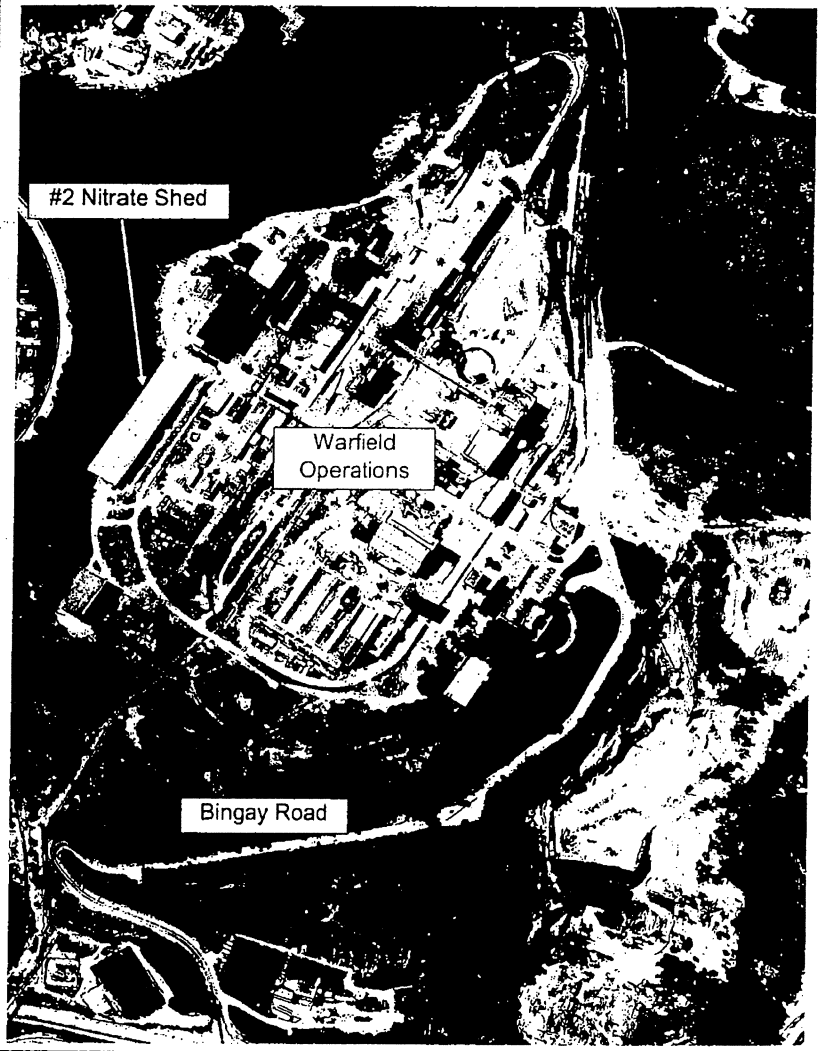
PROVINCE OF
BRITISH COLUMBIA

Environmental Protection

Site Plan C

N

LOCATION
OF
DISCHARGE



LEGAL DESCRIPTION: Lot 1 of District Lot 4597, Plan 6446, Kootenay District

Permit: PS-08310

Date Issued: June 16, 1989

Date Amended: APR 2 2 2004
(most recent)

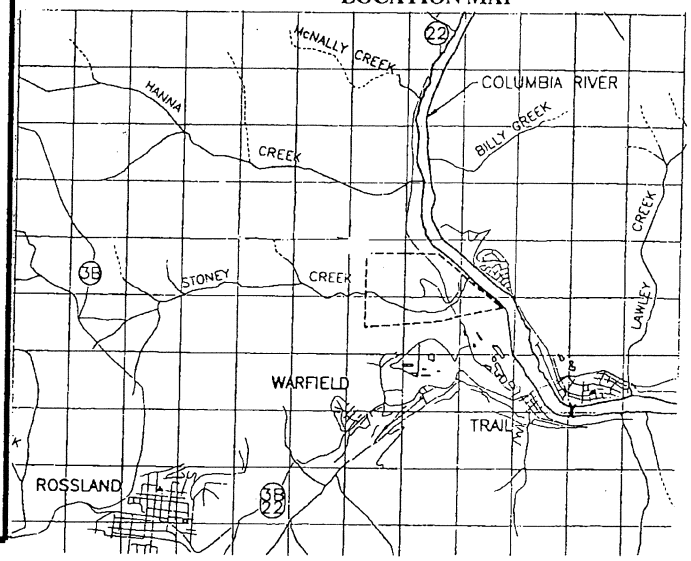
Assistant Regional Waste Manager:

Carl Johnson

Carl Johnson, P.Eng.

Name of Applicant: Teck Cominco Metals Ltd.

LOCATION MAP



BRITISH COLUMBIA

June 28, 2006

File: PE-02753

Teck Cominco Metals Ltd.
PO Box 1000
Trail BC V1R 4L8

Attention: Ed Kniel, Garry Garwyletz - Environmental Monitoring

Dear Ed and Garry:

Re: Monitoring and Reporting Associated with PE-02753

In reference to Section 3.1 of amended permit PE-02753 which combines PE-02753 and PE-05309, the following effluent monitoring and data reporting programs are to be carried out by the permittee.

Effluent Monitoring of each Outfall II, III and IV

-24 hour flow proportional composite sample taken on NAPS day
-pH and flow measured continuously
-total metals to be analyzed on each sample

-Outfall II – lead, zinc, cadmium, copper, mercury,
-Outfall III – lead, zinc, cadmium, arsenic, copper, mercury, thallium, Total Suspended Solids
-Outfall IV – mercury, zinc, ammonia as total N

On alternate NAPS days the 24-hour composite sample is to be analyzed for dissolved metals (except mercury and Ammonia) as well as total metals. This specific requirement will be reviewed annually to determine the necessity of continuing.

Obtain 6 grab samples of each effluent at approximately equally spaced intervals per year for analysis of acute (pass/fail) rainbow trout 96 hour toxicity using 100 % effluent. Each sample is to be analysed before and after the bioassay period for total and dissolved metals and hardness.

. . . 2

Ministry of Environment
Environmental Protection
Kootenay and Okanagan Regions
Mailing/Location Address:
401 - 333 Victoria Street
Nelson BC V1L 4K3
Telephone: 250 354-6355
Facsimile: 250 354-6332

Remotely activated sequential monitoring stations at Waneta and the Old Trail Bridge are to be available for use in the event of spills or process upsets where there is some concern regarding water quality at these locations. The new site at the Old Trail Bridge is to be operational by December 31, 2006.

Reporting

Monitoring data should be submitted electronically by the end of the month following collection and analysis. For example samples collected in January and analyzed in February should be reported before the end of March. The data is to be entered on the Ministry of Environment electronic data base (EMS) in the form of loadings of both total and dissolved contaminants, pH as the calculated 24 hour average of the individual outfall continuous monitor output, and flow volume, all in a format and with units consistent with the Ministry of Environment data base.

A written summary is to continue to be submitted to the Director monthly that highlights environmental performance and non-compliant situations. Continuous pH and flow data are to be retained by the permittee for a minimum of two years and made available on the request of the Director.

For discharge loading calculation purposes, ½ the detection limit or Limit of Quantification is to be used for those analytical results that are less than the acceptable laboratory detection. This is consistent with NPRI protocols.

Yours truly,

Carl Johnson

Carl Johnson, P.Eng.
For Director, *Environmental Management Act*

CJ:lkm

cc: Robyn Roome, A/Head, Environmental Quality Section, Nelson

BRITISH COLUMBIA

June 8, 2006 File: PE-02753

REGISTERED MAIL

Teck Cominco Metals Ltd.
600-200 Burrard Street
Vancouver, British Columbia V1C 3L9

Dear Permittee:

Enclosed is Amended Permit PE-02753 issued under the provisions of the *Environmental Management Act*. Your attention is respectfully directed to the terms and conditions outlined in the permit. A corresponding effluent permit being PE-05309 has been amalgamated with PE-02753 as addressed in the attached permit. An annual fee will be determined according to the Permit Fees Regulation.

This permit does not authorize entry upon, crossing over, or use for any purpose of private or Crown lands or works, unless and except as authorized by the owner of such lands or works. The responsibility for obtaining such authority rests with the permittee. This permit is issued pursuant to the provisions of the *Environmental Management Act* to ensure compliance with Section 120(3) of that statute, which makes it an offence to discharge waste, from a prescribed industry or activity, without proper authorization. It is also the responsibility of the permittee to ensure that all activities conducted under this authorization are carried out with regard to the rights of third parties, and comply with other applicable legislation that may be in force.

This decision may be appealed to the Environmental Appeal Board in accordance with Part 8 of the *Environmental Management Act*. An appeal must be delivered within 30 days from the date that notice of this decision is given. For further information, please contact the Environmental Appeal Board at (250) 387-3464.

. . . 2

Ministry of Environment

Regional Operations
Kootenay and Okanagan Regions

Mailing/Location Address
401-333 Victoria St.
Nelson, BC V1L 4K3

Telephone: (250) 354-6355
Facsimile: (250) 354-6332
http://www.gov.bc.ca/
http://www.gov.bc.ca/env

Administration of this permit will be carried out by staff from the Kootenay and Okanagan Regions. Plans, data and reports pertinent to the permit are to be submitted to the Regional Manager, Environmental Protection, at Ministry of Environment, Regional Operations, Kootenay and Okanagan Regions, 401-333 Victoria St., Nelson, BC V1L 4K3.

Yours truly,

Carl Johnson

Carl Johnson, P.Eng.
for Director, *Environmental Management Act*
Kootenay and Okanagan Regions

CJ:lkm

Enclosure

cc: Environment Canada
Teck Cominco Metals Ltd., PO Box 1000, Trail BC V1R 4L8 (Hand Delivered)

BRITISH COLUMBIA

MINISTRY OF ENVIRONMENT

Environmental Protection

PERMIT
PE-02753

Under the Provisions of the Environmental Management Act

TECK COMINCO METALS LTD.

600 - 200 BURRARD STREET

VANCOUVER, BRITISH COLUMBIA

V6C 3L9

is authorized to discharge effluent to the Columbia River from a lead-zinc smelter and fertilizer plant located in Trail, British Columbia, subject to the conditions listed below. Contravention of any of these conditions is a violation of the *Environmental Management Act* and may result in prosecution.

This permit supersedes and amends all previous versions of Permits **PE-02753 and PE-05309**, issued under Part 2 Section 10 of the *Waste Management Act*.

1. AUTHORIZED DISCHARGES

1.1 This subsection applies to the discharge of effluent from **METALLURGICAL PLANT OUTFALL II**. The site reference number for this discharge is E102983.

1.1.1 The characteristics of a 24-hour flow proportional composite sample of the effluent shall be equivalent to or less than the maximum loading or concentration authorized for each parameter below:

Element	
Total Cadmium	1.0 kg/d
Total Copper	3.0 kg/d
Total Lead	40 kg/d
Total Mercury	0.1 kg/d
Total Zinc	175 kg/d
FLOW	150,000 m^3/d
pH range	6.5 to 8.5

Date issued: November 29, 1978
Date amended: JUN 0 8 2006
(most recent)

Carl Johnson, P. Eng.
For Director, *Environmental Management Act*
Kootenay and Okanagan Regions
Permit Number: PE-02753

A grab sample of the effluent from Outfall II shall achieve 100 % as measured by a single concentration 96-hour LC_{50} pass/fail acute toxicity test using rainbow trout.

Daily loading discharges for parameters in this section shall be calculated by multiplication of the daily measured flow and measured sample concentration on the day of sampling. Sampling shall be in accordance with written instruction of the Director.

1.1.2 The authorized works are a combined outfall, and related appurtenances approximately located as shown on attached Site Plan A.

1.1.3 The authorized works must be complete and in operation when discharge commences.

1.1.4 The location of the facilities from which the discharge originates and the location of the point of discharge is Lots 1, 2, 3 and 4, Kootenay District, Plan 4926.

1.2 This subsection applies to the discharge of effluent from **METALLURGICAL PLANT OUTFALL III**. The site reference number for this discharge is E102984.

1.2.1 The characteristics of a 24-hour flow proportional composite sample of the effluent shall be equivalent to or less than the maximum loading or concentration authorized for each parameter below:

Element	
Non Filterable Residue	1250 kg/d
Total Arsenic	12.0 kg/d
Total Cadmium	4.0 kg/d
Total Copper	6.0 kg/d
Total Lead	60.0 kg/d
Total Mercury	0.4 kg/d
Total Thallium	30 kg/d
Total Zinc	125 kg/d
FLOW	140,000 m^3/d
pH range	6.5 to 9.5

A grab sample of the effluent from Outfall III shall achieve 100% as measured by a single concentration 96-hour LC_{50} pass/fail acute toxicity test using rainbow trout.

Carl Johnson

Carl Johnson, P. Eng.
For Director, *Environmental Management Act*
Kootenay and Okanagan Regions
Permit Number: PE-02753

Daily loading discharges for parameters in this section shall be calculated by multiplication of the daily measured flow and measured sample concentration on the day of sampling. Sampling shall be in accordance with written instruction of the Director.

1.2.2 The authorized works are a combined outfall, lime water treatment plant, mercury cleaning area, Main ETP Collection Lagoon, and related appurtenances approximately located as shown on attached Site Plan A.

1.2.3 The authorized works must be complete and in operation when discharge commences.

1.2.4 The location of the facilities from which the discharge originates and the location of the point of discharge is the same location as set out in Subsection 1.1.

1.3 This subsection applies to the discharge of effluent from the **FERTILIZER PLANT OUTFALL IV**. The site reference number for this discharge is E102990.

1.3.1 The characteristics of a 24-hour flow proportional composite sample of the effluent shall be equivalent to or less than the maximum loading or concentration authorized for each parameter below:

Element	
Total Mercury	.05 kg/d
Ammonia as total N	1000 kg/d
Total Zinc	50 kg/d
FLOW	60,000 m^3/d
pH range	6.2 to 8.5

A grab sample of the effluent from Outfall II shall achieve 100 % as measured by a single concentration 96-hour LC_{50} pass/fail acute toxicity test using rainbow trout.

Daily loading discharges for parameters in this section shall be calculated by multiplication of the daily measured flow and measured sample concentration on the day of sampling. Sampling shall be in accordance with written instruction of the Director.

1.3.2 The authorized works are a combined outfall, and related appurtenances approximately located as shown on attached Site Plan B.

1.3.3 The authorized works must be complete and in operation when discharge commences.

Carl Johnson, P. Eng.
For Director, *Environmental Management Act*
Kootenay and Okanagan Regions
Permit Number: PE-02753

1.3.4 The location of the facilities from which the discharge originates and the location of the point of discharge is Lots 1, and 3, Plan 6446, Kootenay District, and Part Assigned No. 25 and No. 18 Plan 1425, Kootenay District.

2. GENERAL REQUIREMENTS

2.1 Maintenance of Works and Emergency Procedures

The permittee shall inspect the authorized works regularly and maintain them in good working order. In the event of an emergency or condition beyond the control of the permittee which prevents effective operation of the approved method of pollution control, the permittee shall immediately take appropriate remedial action and shall notify the Director or an Officer designated by the Director:

a) by telephone if the condition occurs between the hours of 08:00 and 16:30, Monday to Friday;
b) by facsimile transmission if the condition occurs at any other time.

In addition to any reporting requirements under the Spill Reporting Regulation or as otherwise directed by the Director, notification of any occurrence under this section must be reported to the Director within 24 hours of the permittee becoming aware of such occurrence.

Immediately upon becoming aware of an event which results or could be reasonably expected to result, in uncontrolled losses to the Columbia River in excess of the permit parameter quantities listed above, the permittee shall report the event to the Provincial Emergency Program (PEP), in a manner defined in section 2 (3) of the Spill Reporting Regulation.

2.2 Bypasses

The permittee shall ensure that no waste is discharged without being processed through the authorized works unless prior written approval is received from the Director.

2.3 Process Modifications

The permittee shall have written approval from the Director prior to implementing changes to the authorized works that may result in discharges exceeding the characteristics authorized under this permit.

Carl Johnson

Carl Johnson, P. Eng.
For Director, *Environmental Management Act*
Kootenay and Okanagan Regions
Permit Number: PE-02753

2.4 Vehicle Contaminant Control

The permittee shall ensure, to the satisfaction of the Director, that contaminants are not transported off the plant site on the wheels and undercarriage of vehicles.

2.5 Effluent Management Program

Beyond the requirements of this permit, Teck Cominco has initiated an environmental management program that includes identifying and implementing further opportunities for reducing the amount of contaminants discharged to the Columbia River. Teck Cominco will periodically review with the Ministry of Environment and other interested parties such as Environment Canada and Department of Fisheries and Oceans, Canada its significant aspects and its plans for addressing further improvement opportunities. The review will include performance and progress reports on improvement programs and provide an opportunity for adjustments in light of new scientific knowledge and other related technical changes at the Teck Cominco facility.

3. MONITORING AND REPORTING REQUIREMENTS

3.1 Discharge Monitoring

The permittee shall carry out a discharge monitoring program as specified by the Director in writing. This program may be modified from time to time as appropriate and agreed to in writing by both parties.

3.2 Monitoring of the Receiving Environment

3.2.1 Water Quality Monitoring

The Director acknowledges Teck Cominco's voluntary participation and funding contribution to the Columbia River Integrated Monitoring Program (CRIEMP). If CRIEMP monitoring activities are suspended and/or the CRIEMP program ceases to exist, the Director will review receiving environment monitoring programs and will determine the need for Teck Cominco's direct participation in Columbia River monitoring.

3.2.2 The Director may require additional monitoring at any time by specifying such in writing to the permittee.

3.2.3 For the purposes of this permit, the Initial Dilution Zone is defined as the Columbia River between Outfall IV and the City of Trail's "Old Bridge.

Carl Johnson

Carl Johnson, P. Eng.
For Director, *Environmental Management Act*
Kootenay and Okanagan Regions
Permit Number: PE-02753

3.3 Reporting

The permittee shall prepare an annual report suitable for release to the public, that tabulates and explains the outfall sampling and analyses. The report shall include an explanation of any changes to the process or environmental control equipment that have taken place over the previous year. The annual report is due by March 31 of the following year.

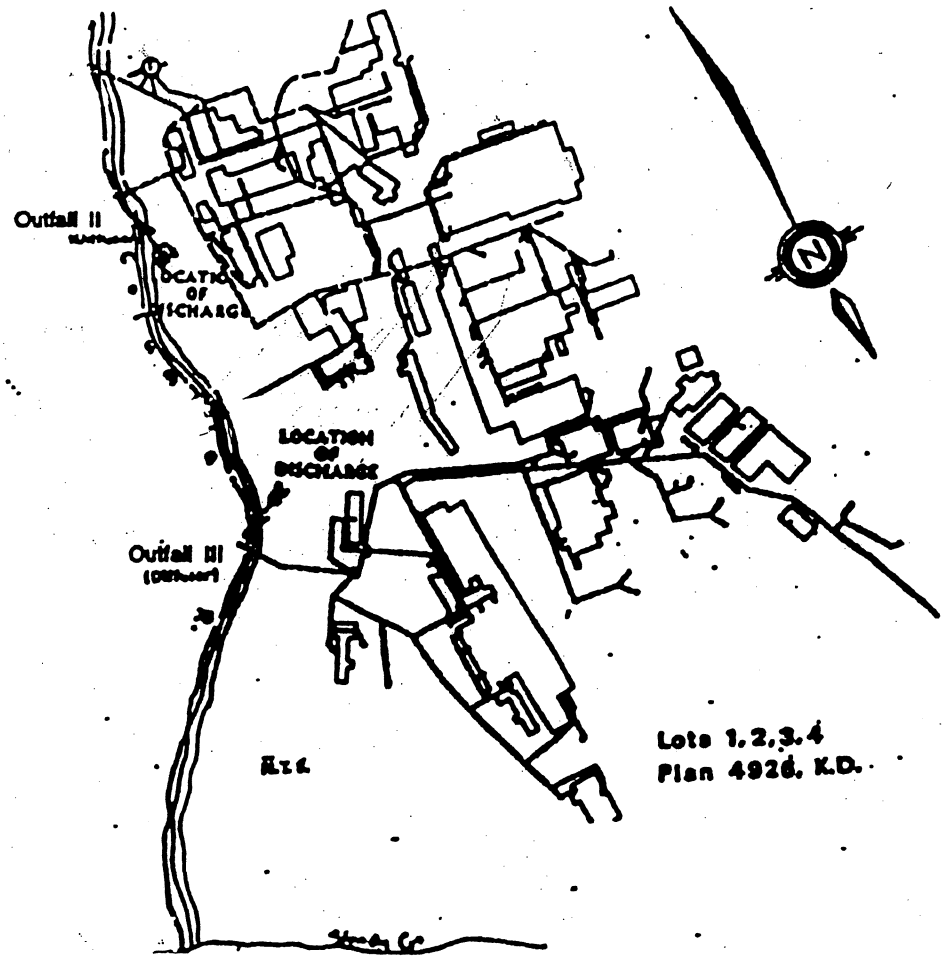
Date Issued: November 29, 1978
Date Amended: JUN 0 8 2006
(most recent)

Carl Johnson, P. Eng.
For Director, *Environmental Management Act*
Kootenay and Okanagan Regions
Permit Number: PE-02753

PROVINCE OF
BRITISH COLUMBIA

Environmental Protection

Site Plan A



LEGAL DESCRIPTION: Lots 1,2,3 and 4, Plan 4926, Kootenay District

Permit: PE-02753

Date Issued: November 29, 1978

Date Amended: JUN 0 8 2006
(most recent)

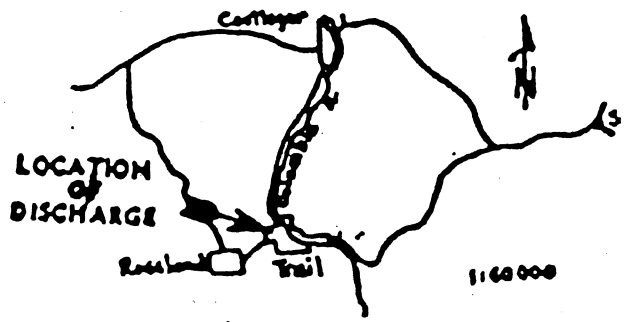
for Director, Environmental Management Act

Carl Johnson

Carl Johnson, P.Eng.

Name of Applicant: Teck Cominco Ltd.

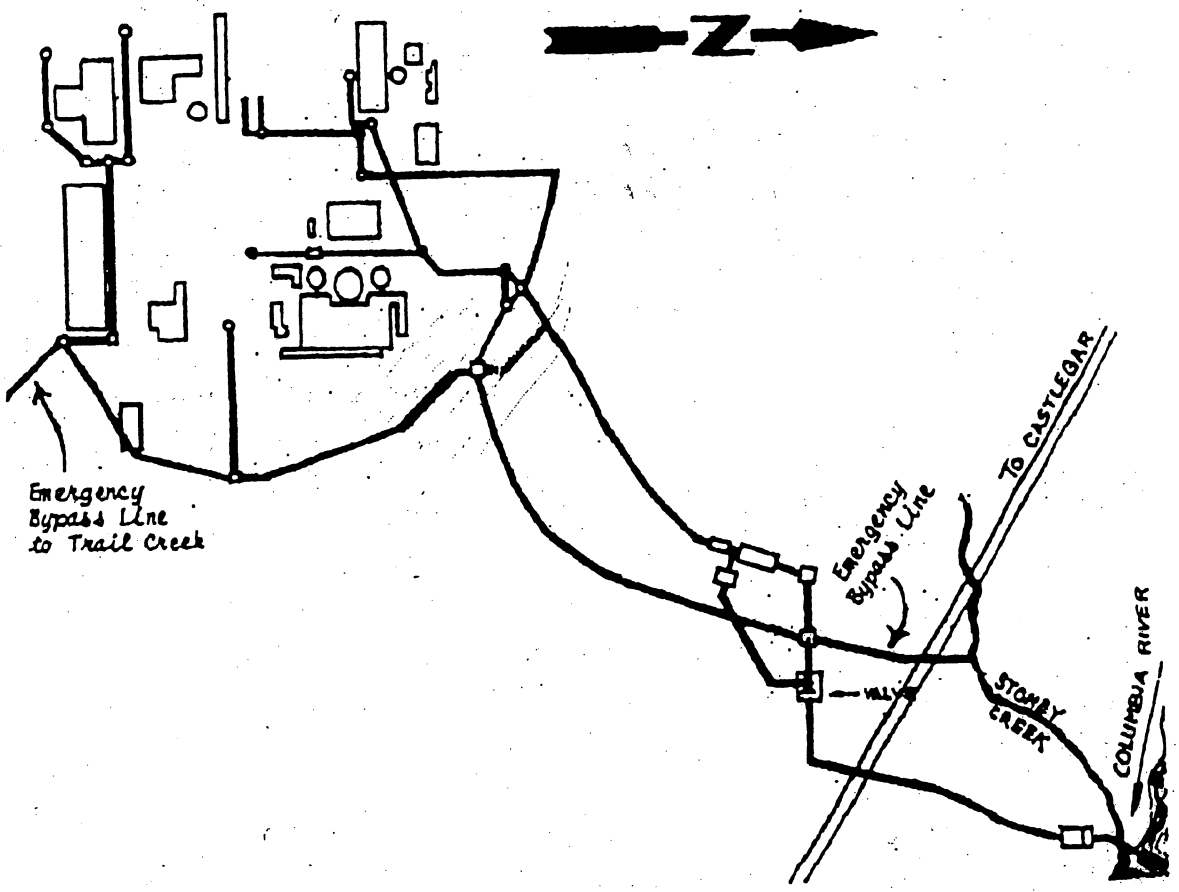
LOCATION MAP



PROVINCE OF
BRITISH COLUMBIA

Environmental Protection

Site Plan B



LEGAL DESCRIPTION: Lot 1 and Lot 3, Plan 6446, kootenay District and part Assigned No. 25 and Assigned No. 18, Plan 1425, Kootenay District

Permits: PE-02753

Date Issued: November 29, 1978

Date Amended: (most recent) JUN 0 8 2006

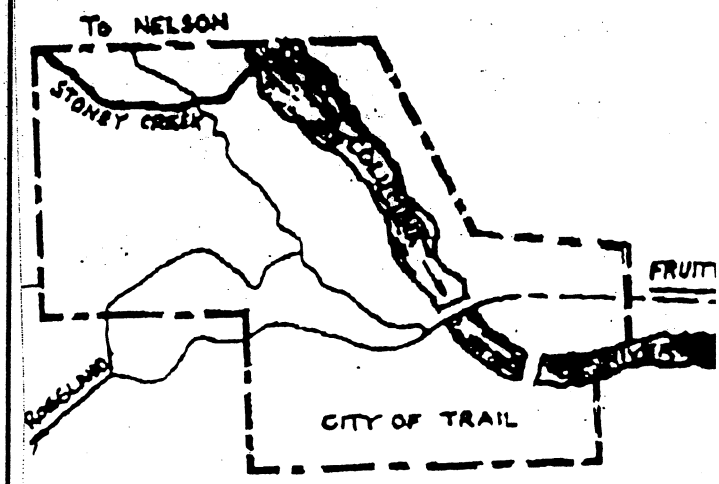
for Director, Environmental Management Act

Carl Johnson

Carl Johnson, P.Eng.

Name of Applicant: Teck Cominco Ltd.

LOCATION MAP



APPENDIX D2

ADDITIONAL TRAIL OPERATING INFORMATION

BUSINESS DEVELOPMENT REPORT – *PROCESSING ELECTRONICS RECYCLE AT #2 SFF: ENVIRONMENTAL MONITORING RESULTS*

CONFIDENTIAL

BUSINESS DEVELOPMENT REPORT

PROCESSING ELECTRONICS RECYCLE AT #2 SFF: ENVIRONMENTAL MONITORING RESULTS

KA Klimchuk

May 13, 2005

PROCESSING ELECTRONICS RECYCLE AT #2 SFF: ENVIRONMENTAL MONITORING RESULTS

SUMMARY

Work is currently underway to implement a Canada wide program for the collection, dismantling, transportation and processing end-of-life electronics and electrical equipment (EEE). A trial was recently conducted at Trail Operations' #2 slag fuming furnace (#2SFF) to confirm the environmentally secure processing of a blended feed material, which contains 5% EEE. Approximately 200 mt of a representative EEE material, which consisted essentially of EEE from Alberta's recently implemented electronics end-of-life program, was processed over 13 days at #2 SFF during Nov.29-Dec.22/04. The raw EEE material was shredded to 4 - 6" strips. The 5% blending of shredded EEE with slag feed was representative of the expected EEE treatment in the coming years.

Using approved regulatory methods, sampling of the Dracco stack gas and particulate, effluent discharge at C-III Outfall and ambient air monitoring at the Birchbank and Butler Park monitoring stations, showed that EEE processing at #2 SFF resulted in emissions of regulated persistant organic pollutants (POPs) at comparable to baseline levels. The regulated POPs discharged from #2 SFF are mainly polyaromatic hydrocarbons (PAHs) and, to a much smaller degree, polychlorinated dioxins/furans (PCDD/PCDFs). A mass partitioning assessment showed that the PCDD/PCDFs dominantly report to fume (Dracco baghouse dust) with only trace levels in the Dracco stack gas (1%). The PAHs are more volatile than PCDD/PCDFs, and therefore a greater amount reports to the Dracco stack gas (47%). Consistent with the current baseline levels for emissions from #2 SFF, the PCDD/PCDFs in stack gas emissions during the EEE trial were lower than Environment Canada's level of quantification (LoQ) of 32 pg TEQ/dsm^3, which, according to Section 65.1 of the Canadian Environmental Protection Act, is the lowest concentration that can be accurately measured using currently available routine sampling and analytical methods. It is also the concentration below which emissions are consistent with the goal of virtual elimination for these compounds. The PAHs in the stack gas are subject to an Environment Canada annual reporting threshold of 50 kg. The production-based release of PAHs to stack gas during the EEE trial were significantly lower than this National Pollutant Release Inventory (NPRI) reporting threshold. Ambient air levels of regulated POPs during the EEE trial were comparable to baseline levels, and also representative of levels at rural locations across Canada, such as Jasper National Park. Metal concentrations in the Dracco stack gas particulate as per routine S-40 compliance monitoring were not impacted by EEE processing, but rather improved by processing low metals content slag from #3 SFF as the principle feed component in the proposed future operation of #2 SFF.

Considering that the regulated POPs mainly report to the Dracco baghouse dust, the downstream processing of the baghouse dust was investigated relative to the partitioning of the POPs between effluent and solids. The most critical survey was done for Fume Leach Area II cake and filtrate, which showed essentially 100% of the regulated POPs reporting to the cake. The Area II filtrate and ultimately the C-III Outfall to the river both showed PCDD/PCDF concentrations significantly lower than Environment Canada's LoQ for effluent of 9 pg TEQ/L. A mass partition assessment for the production-based release of PAHs to the river showed that EEE processing at #2 SFF had a very small impact on the discharge. Further downstream processing of the Area II cake and the blending of other process streams ultimately brings the regulated POPs to the Sulfide Leaching residue (Lasta

filter cake). The residue is processed in KIVCET under conditions which are known to destroy POPs.

Brominated flame retardants (BFRs), and specifically polybrominated diphenylethers (PBDEs), are an additive component of some EEE plastics. PBDEs are ubiquitous in the environment due to their current use in IT and Telecommunications, automobiles, household appliances and textiles. Controlled combustion studies have shown that the PBDEs easily decompose to form other brominated compounds, such as polybrominated dioxins/furans (PBDD/Fs) and hydrogen bromide (HBr) gas. Based on these controlled combustion studies, the PBDE-coated plastics entering the #2 SFF bath were effectively processed in the bath, considering that the PBDD/Fs were below detection limit levels in both the Dracco stack gas and fume. However, the PBDEs measured in the stack gas indicate that a small amount of EEE dust, which was still generated in shredding the raw EEE material to a coarse size, short-circuited to the furnace off-gas, thus bypassing the furnace bath. The levels of PBDEs in the stack gas were comparable to the everyday levels in residential indoor air, as well as indoor air levels in an office or educational facility. The stack gas emissions of PBDEs for the current trial were also comparable to the levels from EEE incinerators in Europe and Asia, which process significant quantities of EEE under strict emission control for the regulated POPs. Currently, there is no environmental legislation in Canada or other countries governing the stack emission or ambient air levels of PBDEs and PBDD/Fs.

The levels of PBDEs measured in ambient air samples at Butler Park and Birchbank during the trial were comparable to baseline levels. The ambient air levels of PBDEs during the trial were also low relative to outdoor air levels in southern Ontario and the Great Lakes area of the US. The dominant source of PBDEs in outdoor ambient air is ventilation of indoor ambient air. Relative to the indoor ambient air levels of PBDEs, the ambient air levels of PBDEs at both Birchbank and Butler Park were several orders of magnitude lower.

The lower bromine-substituted PBDEs are more volatile than the more highly substituted PBDEs, Since the PBDEs in EEE plastics are dominantly highly substituted, the mainly lower bromine-substituted PBDEs, which were measured in the stack gas, were likely the result of the thermal degredation of the more highly substituted PBDEs. The trace concentration of PBDEs adsorbed to fume in the Dracco baghouse partition to solids in the downstream processing, like the regulated POPs. The eventual processing of the PBDEs in KIVCET is also effective for their destruction.

BACKGROUND

Recycling electrical and electronic equipment (EEE) is much less developed in Canada than other parts of the world. In 2002, only 9,400 t of EEE was recycled in Canada and 158,000 t of EEE was landfilled or shipped to Asia as non-hazardous waste.[1] Electronics Product Stewardship Canada (EPS), a non-profit corporation funded by multi-national corporations (including Apple, Dell, IBM, Sony and others) has been formed with the mandate to create a national electronics end-of-life program. Alberta has already implemented the program provincially (Alberta Recyling Management Authority, ARMA) with a visible tax on EEE, starting on Feb.1, 2005, and similar programs are anticipated for other provinces including BC.

TRAIL OPERATIONS' #2 SFF

Having an established reputation for the environmentally sound processing of lead-bearing materials, it would be a natural extension of the current infrastructure at Trail to take on the role of processing

EEE with an estimated 10 wt.% lead. Electronics Product Stewardship Canada (EPS), as well as many provincial and federal government agencies have indicated that they see Trail Operations as being a potential EEE processing solution for the Western provinces. Similar to the proven processing of EEE as a secondary raw material in a zinc fuming furnace at Boliden's Ronnskar Smelter, Trail Operations is currently evaluating the opportunity to process an electronics recycle in its #2 slag fuming furnace (#2 SFF).[2,3]

Trail's #2 SFF consists of a water-cooled floor and side jackets, which contain the molten slag inside the 24 m^2 furnace. There are 52 tuyeres on the sides of the furnace, which allow for the addition of 4 tonnes per hour of pulverized coal providing heat to the furnace. Cold slag is fed into the furnace from an opening in the roof at the rate of about 336 tonnes per day. The off-gas and dust are first cooled in a boiler before entering a dust collection baghouse. The off-gas is discharged through a 4.4-meter diameter stack. The cleaned slag is tapped from the furnace into a granulation and then dewatering system. A side view of the slag furnace and boiler is shown in Figure 1.

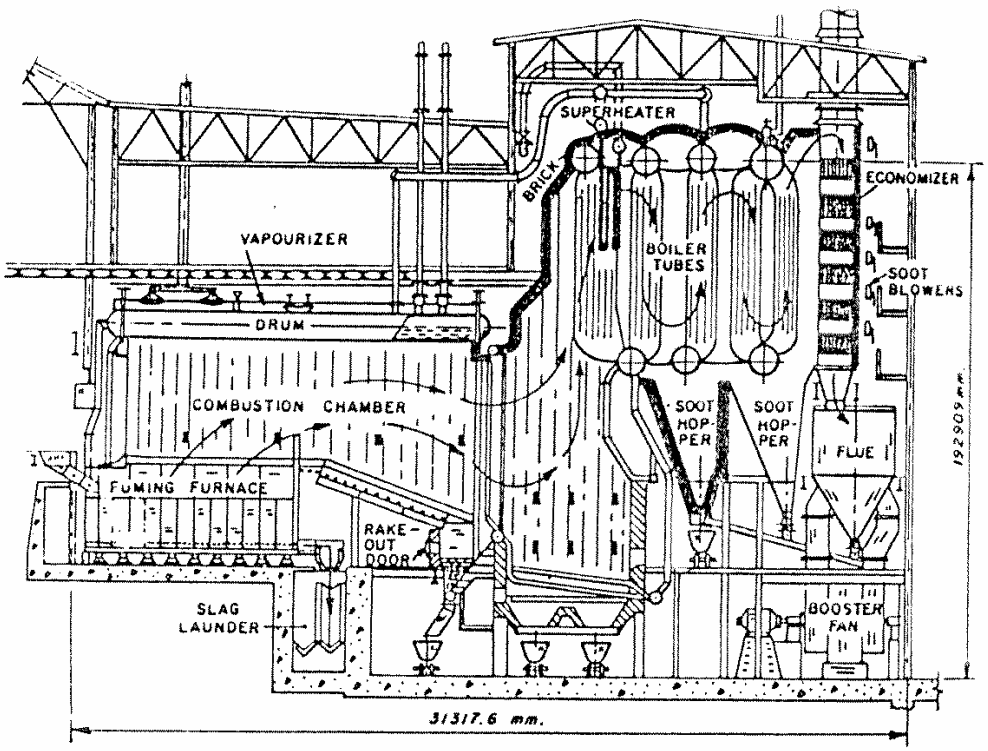


Figure 1 Trail Operations' #2 SFF and recovery boiler[4]

EEE PLASTICS

Critical to processing EEE at Trail's #2 SFF is the effective treatment of the plastics component relative to controlling the formation of persistent organic pollutants (POPs), such as dioxins/furans (PCDD/PCDF) and polyaromatic hydrocarbons (PAHs). Although it is difficult to characterize EEE, it is generally accepted that the currently available material may contain approximately 20% (w/w) plastics.[5] Alberta's ARMA material includes computers, keyboards, monitors, printers, TVs and computer peripheral equipment, although telecommunications equipment may also make their way into the blended material.[6] The structural housings of EEE are mainly composed of ABS (acrylonitrile-butadiene-styrene), PS (polystyrene) and HIPS (high impact polystyrene) plastics,

although telecommunications equipment and earlier IT equipment may contain PVC.[5] In addition, EEE plastics are typically treated with flame retardants, which prior to 1995 were almost exclusively brominated flame retardants (BFRs).[5] According to the data for Western Europe in 2000, phosphorus flame retardants are expected in approximately 66% of the application areas for EEE, as brominated flame retardants are gradually phased-out.[5] Polybrominated diphenyl ethers (PBDEs) are the dominant BFRs consumed by the Americas, and decabromodiphenyl ether (BDE 209), is the dominant PBDE- specific-congener consumed globally.[37] The dominant plastics in waste electrical and electronic equipment (WEEE) for Western Europe have been identified in Figure 2 from 1995 to current.

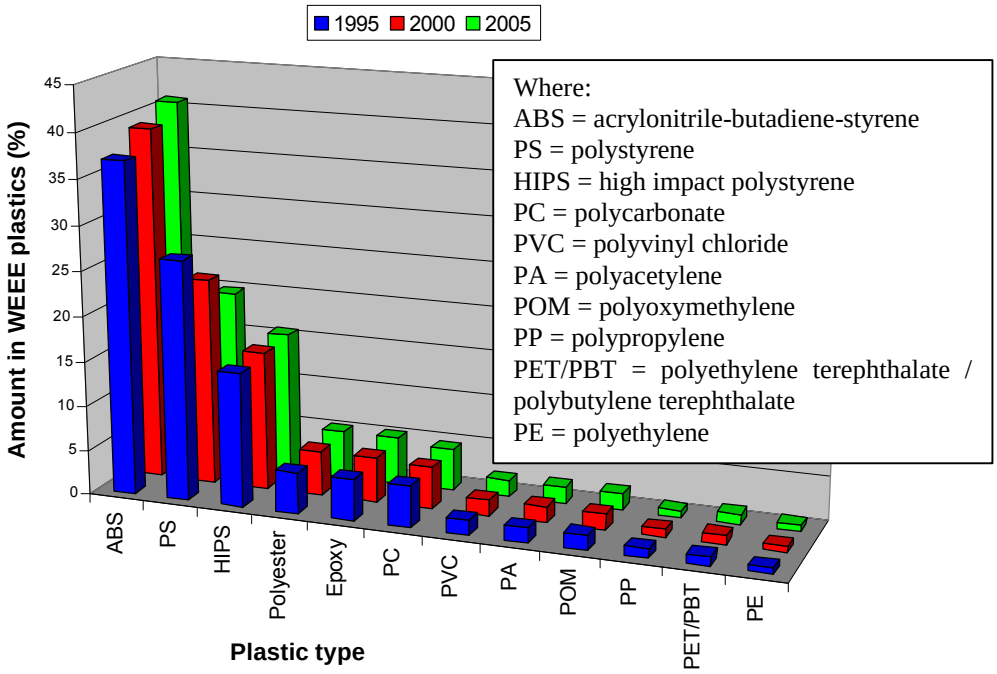


Figure 2 Compositional variation of the plastic component in WEEE as a function of age, based on the Western Europe data [5]

#2 SFF PROCESS STREAMS

Processing in #2 SFF at an operating temperature of 1200 ^{o}C separates all feed material into three process streams. These are fume, matte and slag. Some elements such as zinc or lead are reduced in the furnace and volatilize into the gas phase. The volatilized lead and zinc vapour are then oxidized with oxygen in the boiler and make a solid oxide dust which is collected in the baghouse. Elements that do not fume remain in the furnace as either molten oxides making a slag phase, or molten sulphides making a matte phase. Elements such as iron or silicon are most stable as molten oxides and are the main constituents of the slag phase. Elements such as copper or nickel have an affinity for sulphur and therefore separate into a matte phase.

Processing EEE at Trail's #2 SFF introduces changes to the typical composition of the process streams, which vary according to the age and origin of the electronics recycle, as well as the treatment rate.[5] The inorganic component of EEE is dominantly refractory materials such as silica and alumina, which are found in computer monitors and CRT glass. The refractory materials report to tail slag and do not introduce operational difficulties at the expected EEE treatment rates. Iron will also report to tail slag. Other notable impurities include copper and nickel, which report to the matte/metallics phase in slag, along with trace

amounts of PMs from circuit boards and the like. The lead in CRT glass will fume, with the increase in lead-in-fume depending on the EEE treatment rate. The tin contributed by EEE will report to tail slag in a typical fuming cycle, which is controlled by fuming to a set level of zinc in the bath. The halides will report to fume. However, the halide loading to fume can be reduced by soliciting a more current EEE with minimal PVC and phosphorus-based flame retardants as opposed to the older brominated varieties.[5] The effective soliciting and sorting of EEE will also minimize the mercury content by removing items such as mercury switches from the EEE.

The plastics and wood contained in the EEE will be used as fuel by the furnace. One tonne of plastic has about the same heating value as one tonne of coal. Similar to Boliden's processing of EEE at their Ronnskar smelter, the strategy at Trail involves the controlled addition of EEE to cold slag with the refractory nature of the slag serving to insulate the EEE plastics from pyrolysis in the gas space, thus driving the EEE into the molten bath.[2,3] Like coal, the EEE plastics will be consumed in the bath as chemical reductants, thus liberating carbon dioxide and water vapour from the bath as the degredation products.[2,3] Historically, blast furnace slag was charged to #2 SFF, but as this legacy pile is consumed the new operating strategy involves re-processing #3 tail slag to recover the previously lost metal values. The composition of EEE based on the Western Europe data from 1996, and the two blending strategies used to prove concept at #2 SFF are shown in Table 1.

Table 1 Change in #2 SFF feed composition as a function of adding EEE to either blast furnace slag or #3 SFF tail slag [3]

Element / Compound	Western Europe EEE data (1996) (wt.%)	Blast furnace slag (wt.%)	Blast furnace slag + 5% EEE (wt.%)	% Change in Feed	#3 SFF tail slag (wt.%)	#3 SFF tail slag + 5% EEE (wt.%)	% Change in Feed
Silica	40	23.0	23.9	4	29.1	29.6	2
Iron	3.3	25.3	24.2	-4	28.1	26.9	-4
Aluminum	23		1.2			1.2	
Plastics	20		1.0			1.0	
Lead	10	4.3	4.6	7	0.9	1.4	60
Copper	5.6	0.5	0.8	51	0.7	0.9	30
Zinc	3.6	12.6	12.1	-4	4.4	4.4	-0.9
Tin	1.6	0.14	0.2	52	0.1	0.2	80
Nickel	1.4		0.05			0.07	
Chlorine	0.13 (est.)	0.005	0.01	130		<0.01	
Bromine	0.14 (est.)		0.007			<0.01	
Barium	0.052		0.003			<0.01	
Manganese	0.052	0.60	0.6	-5	0.9	0.9	-5
Cobalt	0.025		0.001			<0.01	
Tantalum	0.025		0.001			<0.01	
Cadmium	0.015	0.06	0.06	-4	0.03	0.03	-3
Antimony	0.015	0.15	0.1	-5	0.09	0.09	-4
Chromium	0.01		0.0005			<0.01	
Bismuth	0.01	0.04	0.04	-4	0.01	0.01	0
Mercury (ppm)	35		2			2	
Indium	0.0026	0.03	0.03	-5	0.011	0.01	-4
Germanium	0.0025	0.018	0.02	-4	0.017	0.02	-4
Arsenic	0.0021	0.08	0.08	-5	0.02	0.02	-4
Gold	0.0013	0.0002	0.0008	300		<0.01	
Sulfur		1.36	1.3		0.9	0.9	

Nov.29 – Dec.22/04 trial included #3 tail slag blended or blast furnace slag blended with 5% EEE

OBJECTIVES

To evaluate the continuous processing of EEE at #2 SFF (Nov.29 – Dec.22/04 trial) with the following requirements;

- processing dominantly Alberta's ARMA material
- shredding the EEE to a coarse size (4"-6" strips) to complement the new charge chute installed at #2 SFF, as well as to minimize dusting.
- blending 5% EEE with slag in the feed to #2 SFF, in order to reflect the expected EEE supply over the next several years.
- comprehensive monitoring of environmental emissions according to approved methods for stack gas, solids, effluent and ambient air
- workplace hygiene monitoring

DETAILS

TRIAL PARTICULARS

Nov. 29 – Dec. 22/04 trial

The continuous processing of EEE over at least (10) days was conducted from Nov.29 - Dec.22/04 in conjunction with further work to prove concept for the processing of #3 tail slag at #2 SFF, according to the proposed future operation of the furnace. The EEE was collected from several locations including ARMA material from Maxus Technology and Recycle Logic located in Red Deer, AB, as well as EEE from AccuShred's Toronto, ON, location. The ARMA material and EEE from AccuShred were essentially computers, monitors, keyboards and other peripheral equipment.[6] The raw EEE was shipped to Trail, and then shredded by Impact Equipment Ltd. to a coarse size (4 – 6" strips), in order to minimize the dust content in the shredded material. The previous screw feeder was replaced with a drop chute on Nov. 5/04 to allow for the processing of the coarse strips. The raw EEE shipped to Trail was sorted prior to shredding, in order to ensure that a consistent material was processed in #2 SFF.

By expediting the development work for processing #3 tail slag at #2 SFF, the continuous processing of EEE was actually conducted in stages (see Table 2). EEE was processed at #2 SFF over (48) hours on Nov. 29–30 with the #3 tail slag blend on charge. On Dec. 1, the cold slag feed was changed to the blast furnace slag blend as downstream deportments from processing the #3 tail slag were being evaluated. On Dec. 6, the #3 tail slag blend was again introduced as the feed to #2 SFF along with the continuous processing of EEE. This processing continued until Dec. 10 with an interruption on Dec. 8 involving a power bump, which forced the furnace to go down for approximately 12 hours. On Dec. 10-11, the blast furnace slag blend with 2.5% battery plastics was charged to #2 SFF, with and without EEE also charged to the furnace. Battery plastics accumulate at Trail as a result of recycling lead acid batteries. Therefore, the combined processing of EEE and battery plastics was necessary to prove concept for the future operation of #2 SFF. Processing EEE was halted over the weekend (Dec. 11 and 12), and then resumed on Dec. 13 with the blast furnace slag blend as the carrier. This blend was processed continuously until Dec. 17, at which point the # 3 tail slag blend was re-introduced as the carrier. Processing EEE with the #3 tail slag blend continued until Dec. 20.

EEE addition only took place during the charging of the furnace, consistent with superior post combustion during the charging stage of processing with off-gas temperatures at 1200-1250ºC and 13% oxygen in the off-gas.[31] Fast melting conditions were used during the charging of the furnace, according to the proposed future operation of #2 SFF. Fast melting reduced the charge time from 3 hours in previous furnace operation to 2 hours in the current test work by incorporating a faster belt rate for feed addition to the furnace, as well as greater blast air, oxygen and coal addition through the tuyeres into the furnace bath. EEE addition was 2.8 mt/charge (5% blending with slag). The particular slag blended with EEE in the Nov.29 – Dec.22 trial was inconsequential relative to environmental emissions monitoring for POPs, and really only impacted processing in terms of extending the fume duration and therefore the cycle time, according to the lead and zinc tenor in the slag (see Table 2).

Table 2 Test particulars for the processing of EEE at #2 SFF during the Nov.29-Dec.22/04 trial

	Slag Feed			Cycle Time
		Zn (wt.%)	Pb (wt.%)	(hrs.)
Nov.29-Dec.22/04				
Nov.29-30	#3 tail slag	4 - 5	1	3.5
Dec.6-10	#3 tail slag	4 - 5	1	3.5
Dec.10-11	BF slag; 2.5% battery plastics	10 - 15	5	4
Dec.13-17	BF slag	10 – 15	5	4
Dec.17-20	#3 tail slag	4 - 5	1	3.5

DRACCO STACK GAS MONITORING

The metal oxide fume from #2 SFF is blown through the flue duct by a 750 hp Howden fan to the Dracco baghouse, which consists of 5000 m^2 cloth area to filter the fume from the process off-gas. The process off-gas is subsequently discharged through a 4.4-meter diameter and 31-meter height stack. The stack gas sampling was conducted at the same stack location as used for current regulatory compliance monitoring.

A. Lanfranco and Associates of Langley, BC, conducted stack gas sampling at the Dracco stack in 2002, as well as most recently for the Nov.29-Dec.22/04 trial. US EPA Method 23 with minor modifications according to stack sampling safety and stack access considerations was used by A. Lanfranco and Associates for the isokinetic sampling of the Dracco stack gas.[10] Although the single sampling port for the Dracco stack allowed only a single traverse of the stack as opposed to traverses at 90º according to EPA Method 23, A. Lanfranco and Associates still considered the stack sampling to conform, in principle, to EPA Method 23.[11] Both AXYS Analytical Services Ltd located in Sidney, BC, and Pacific Rim Laboratories located in Langley, BC, conducted the stack gas analyses according to US EPA Method 1613B for chlorinated dioxins/furans and US EPA Method 8270 modified for PAHs.[12,13] The results for stack gas sampling are presented in Table 3. The International TEQs[1] (I-TEQs) are reported for the chlorinated dioxin/furans concentrations in Table

[1] The stack emissions are reported as the toxic equivalent concentration (TEQ) of dioxins/furans in the stack gas, according to Environment Canada's reporting guidelines. In determining the TEQ concentration of the sample, the concentrations of the 17 regulated dioxins/furans are first multiplied by an assigned toxic equivalency factor (TEF) to obtain compound-specific TEQ concentrations. These concentrations are then added together to give the cumulative TEQ concentration for the sample. The TEF factors are essentially weighting factors, which have been determined scientifically for the regulated dioxins/furans to relate the individual toxicity to the most toxic compound (2,3,7,8-TCDD). The reported units are nanograms (10^{-9} grams) TEQ per dry standard cubic meter.

3, according to the current Environment Canada NPRI (National Pollutant Release Inventory) reporting guidelines.[14] The raw emission results (ND = 0), as well as the results adjusted according to limitations in instrument sensitivity (ND = 1/2DL)[2] are reported in Table 3, according to NPRI reporting requirements.[14]

Table 3 Summary of the analytical results for Dracco stack gas sampling relative to processing EEE at #2 SFF

Trial		PCDD/PCDF			NPRI PAHs	
		pg TEQ/dsm^3	ug TEQ/Mg	g TEQ/y	ug/dsm^3	kg/y
Baseline						
Apr./02	ND = 0	2.1	0.05	0.005	0.005	0.01
Nov.-Dec./04						
Dec.7-9 avg.	**ND = 0**	**1.3**	**0.03**	**0.003**	**0.6**	**1.5**
	ND = 1/2DL	**2.3**	**0.04**	**0.006**		
Dec.10/04	ND = 0	0.8	0.02	0.002	0.3	0.8
(battery plastics + EEE)	ND = 1/2DL	1.6	0.04	0.004		

Environment Canada level of quantification (LoQ) for PCDD/PCDF in a gaseous waste stream is 32 pg TEQ/dsm^3
Environment Canada NPRI reporting threshold for PAHs in a gaseous waste stream is 50 kg/y.
US EPA MACT standard for secondary aluminum is 0.25-15 ug TEQ/dsm^3
PCDD/PCDF - polychlorinated-para-dibenzodioxins / polychlorinated-para-dibenzofurans
PAHS - polyaromatic hydrocarbons

S-40 COMPLIANCE MONITORING

Particulate sampling of the Dracco stack gas at C1 and C2 sampling locations was done as per routine S-40 compliance monitoring, concomitant with processing EEE at #2 SFF. The S-40 compliance monitoring was done by trained Teck Cominco personnel. The results for S-40 compliance monitoring for the EEE trials are shown in Table 4 relative to the 2004 average and concentration range.

Table 4 Results for particulate sampling of the Dracco stack gas during the processing of EEE at #2 SFF and relative to the 2004 average

	Total Particulate mg/Sm^3	Lead mg/Sm^3	Zinc mg/Sm^3	Total Arsenic mg/Sm^3	Gaseous Fluoride ppm	Cadmium mg/Sm^3	Antimony mg/Sm^3	Mercury mg/Sm^3
2004 avg.	19	1.3	2.1	0.04	1.4	0.03	0.01	0.008
2004 range	3.6 – 46	0.3 – 3	0.9 - 5	0.02 – 0.1	0.1 - 10	0.01 – 0.05	0.004 – 0.03	0.003 – 0.02
Dec.7/04	4	0.4	0.9	0.1	4.5	0.02	0.01	0.001

Dec.7/04 – processing the #3 tail slag blend (4-5% Zn; 1% Pb)

SOLIDS SAMPLING

In conjunction with stack gas sampling, various solids were also sampled to determine the partitioning of regulated POPs with the process off-gas and solids at the #2 SFF boiler, as well as the Dracco baghouse. Condensed fume (baghouse dust) was sampled from the long belt at the Dracco baghouse at a mid-point during the charging of #2 SFF with EEE addition. Sampling the solids

[2] TEQ (ND = 0)" means the TEQ is calculated assuming that the non-detected targets all have zero concentration. TEQ (ND = 1/2DL)" means the TEQ is calculated assuming that the non-detected targets all have concentrations equal to one half the detection limit. Some non-detected targets may be present just below the detection limit, and some non-detects may really have zero concentration. One might expect the actual value of non-detected targets to be one-half the detection limit on average.

during the addition of EEE to the furnace was considered the best timing to capture any adsorbed POPs, considering the few seconds it takes for the processing off-gas/fume to reach the Dracco baghouse.[4] Maintenance work was regularly scheduled at the Dracco baghouse just prior to the testing, in order to clear the system of historical fume and therefore increase the probability for sampling fume derived from the tests. Fume was also sampled after charging and into the fuming stage of the batch cycle at #2 SFF, in order to account for any unexpected additional residence time of the fume in the baghouse.[4] According to the recommendations of accredited laboratories for the ultra trace analysis of dioxins/furans, the solids were sampled with a scoop lined with aluminum foil (dull side up) and transferred into precleaned and proofed, amber glass jars.[21] Any residual solid on the lip of the jars was removed with dioxin-free Kimwipes™. Dioxin-free, nitrile examination gloves were used in the handling of the materials. The jars were kept in a cooler prior to shipping to the lab. [22]

In order to determine the downstream deportment of regulated POPs with the further processing of #2 SFF fume, Area II cake was sampled after the #2 SFF fume was previously diluted 4-5 fold with #3 SFF fume and leached as per normal procedure with soda ash at approximately pH 10 at Area I/II. Lasta filter cake was also sampled to reflect further processing of Area II cake at the Oxide Leach Plant, and then the subsequent blending of Oxide Leach Plant and Sulfide Leach Plant residues. The Lasta filter cake represents the accumulation of POPs in solids in downstream processing. If formed, the highly insoluble and chemically resistant dioxins/furans were expected to accumulate in the Lasta filter cake, whereas the remaining less stable POPs would be destroyed in the chemical processing prior to blending streams and filtration at Lasta filter.[22,23] The Lasta filter cake is treated in KIVCET under conditions, which are known to destroy dioxins/furans.[24]

The solid samples were analyzed at AXYS Analytical Services Ltd and Pacific Rim Laboratories according to EPA method 1613B for chlorinated dioxins/furans and EPA Method 8270 modified for NPRI PAHs. Although the condensed fume, Area II cake and Lasta residue are not landfilled, but in-process materials, a kg/y production of regulated POPs in these materials is also given in Table 5 in order to get a sense of the #2 SFF production and downstream deportment relative to NPRI reporting guidelines.

The analytical results for a fume samples taken on June 23/00 and July 14/04 without EEE processing are included in Table 5. The carrier at the time was blast furnace slag and the operating conditions included slower melting (i.e. 3-hr charge) and fuming to 2.5% Zn, as opposed to the current fast melting and fuming to 1% Zn. The baseline emissions of regulated POPs for the June 23/00 and July 14/04 fume samples should not be impacted by the different processing conditions. The June 23/00 fume sample was analyzed at Enviro-Test Laboratories located in Edmonton, AB, according to EPA Method 1613B. The July 14/04 fume sample was analyzed at AXYS Analytical Services Ltd according to EPA Method 8270 modified.

Table 5 Summary of analytical results for solids sampling relative to processing EEE at #2 SFF

Trial		PCDD/PCDF pptr TEQ	PCDD/PCDF kg/y	NPRI PAHs Ppb	NPRI PAHs kg/y
June 23/00					
Fume – baseline	ND = 0	5	0.0001		
	ND = 1/2DL	5.9			
July 14/04					
Fume – baseline				18	0.4
Nov.29 -Dec.22/04					
Dec.7	ND = 0	32	0.0003	180	2
(fume - charging)	ND = 1/2DL	32			
Dec.7	ND = 0	28	0.0003	430	4
(fume - fuming)	ND = 1/2DL	28			
Dec.17	ND = 0	0.9	0.00009	8.9	0.9
(Area II cake)	ND = 1/2DL	1.9	0.0002		
Dec.17	ND = 0	0.5	0.00009	57	10
(Lasta filter cake)	ND = 1/2DL	3.1	0.0005		

Environment Canada level of quantification (LoQ) for PCDD/PCDF in solid materials slated for landfill is 9 pptr TEQ
ppb (parts per billion) - ng/g
pptr (parts per trillion) - pg/g

EFFLUENT SAMPLING

In conjunction with downstream solids sampling to determine the chemical destruction and deportment of regulated POPs, Area II filtrate (ZF03) as well as C-III outfall (EW87) were also sampled relative to baseline conditions and processing EEE at #2 SFF. The Area II filtrate was sampled manually by quickly diverting the downward flow from a pipe into the precleaned and proofed sample bottles. The C-III outfall was sampled with the current automatic sampler at the environmental monitoring station with precleaned and proofed sample bottles inserted into the sampling carrousel. Area II filtrate reports to EW27, which also contains cooling water from other areas. Area II filtrate ultimately reports to C-III outfall.

Both the manual and automatic sampling methods were conducted in accordance with the reference method for determination of PCDD/PCDF in pulp and paper mill effluents.[25] Manual sampling of the Area II filtrate was done as grab samples every 2 hours over an 8 hour period, concomitant with the 8-hour batch cycle at Area II. Automatic sampling of the C-III outfall was done every 3 hours over 24 hours. Sampling was conducted on Dec.15/04 during the continuous processing of EEE at #2 SFF, as well as on Dec.21/04 without EEE processing at #2 SFF (baseline). Downstream processing was purged free of EEE processing fume for approximately 36 hours prior to baseline sampling. Composite samples for each sampling event were prepared, according to the reference method with the additional requirement that the composite samples be prepared from the combined extracts of the individual samples.[23] The sample bottles were shipped in a cooler at 4ºC. The temperature was 5-10ºC upon receipt at the laboratory. The samples were extracted within 28 days of sampling, rather than the 14 days required by the US EPA and and BC MWLAP for measuring PAHs.[23] The delay in extracting the samples was due scheduling constraints at AXYS Analytical Services Ltd and then re-routing the samples to Pacific Rim Laboratories. The samples were however analyzed for PAHs within the required 40 days after extraction.[23] The extraction and analysis of the samples for dioxins/furans conformed to the holding times as required by EPA Method 1613B.[12] The effluent samples were analyzed for the regulated dioxins/furans as well as

PAHs at Pacific Rim Laboratories. The analytical results for the effluent samples are shown in Table 6.

Table 6 Summary of the analytical results for effluent sampling at Area II and C-III Outfall, with and without EEE processing at #2 SFF

Trial		PCDD/PCDF pg TEQ / L	NPRI PAHs ug/L
Baseline			
Dec.21/04 Area II filtrate (ZF03)	ND = 0	ND	0.0007
	ND = 1/2DL	0.48	
Dec.21/04 C-III Outfall (EW87)	ND = 0	ND	1.0
	ND = 1/2DL	1.02	
EEE on charge at #2 SFF			
Dec.15/04 Area II filtrate (ZF03)	ND = 0	0.01	ND
	ND = 1/2DL	0.50	
Dec.15/04 C-III Outfall (EW87)	ND = 0	ND	0.5
	ND = 1/2DL	0.12	

Environment Canada level of quantification (LoQ) for PCDD/PCDF in effluent is 20 pg TEQ/L

C-III OUTFALL

The results for element discharges in the C-III Outfall (EW87) during the processing of EEE at #2 SFF, and relative to the 2004 average are shown in Table 7.

Table 7 Summary of the metal concentrations in the C-III Outfall for processing EEE at #2 SFF and relative to the 2004 average concentrations

	T/As	T/Ca	T/Cd	T/Cu	T/Mg	T/Mn	T/Pb	T/Sb	T/Se	T/Tl	T/Zn	T/Hg
						(mg/L)						
2004 avg.	0.01	82	0.003	0.008	4	0.008	0.04	0.2	0.05	0.04	0.2	0.0004
Dec./04 avg.	0.02	103	0.005	0.01	4	<0.005	0.01	0.1	0.05	0.05	0.1	0.0004

Dec. avg. includes only the days with EEE processed at #2 SFF

AMBIENT AIR MONITORING

Ambient air was sampled at Birchbank and Butler Park according to EPA Method TO-13A during the processing of EEE at #2 SFF, as well as baseline conditions[26]. Both Birchbank and Butler Park are current environmental monitoring stations for Trail Operations. Ambient air monitoring was conducted concomitant with the processing of EEE at #2 SFF on Dec.6-8 and Dec.9-11/04. Baseline ambient air monitoring was conducted on Dec.20-22/04. The Dracco stack emissions were purged free from EEE processing emissions for approximately 24 hours prior to baseline ambient air monitoring.

The Dec./04 wind profile relative to Birchbank and Butler Park sampling stations showed the typical north-westerly flow (i.e. from Birchbank to Butler Park), but also a significant south-easterly component (i.e Butler Park to Birchbank). Both the Dec.6-8 and Dec.9-11 sampling periods for processing EEE at #2 SFF showed predominantly a south-easterly flow (i.e. from Butler Park to Birchbank) with modest to low wind speed. However, the wind direction was also north-westerly for 20 -30% of the time during these sampling periods with a high wind speed. The wind profile for ambient air sampling during Dec.20-22 without EEE processing at #2 SFF was similar to the Dec.6-8 and Dec.9-11 wind profiles, as well as the Dec./04 monthly profile. There does not seem to be any directional bias during the sampling periods.

Andersen high-volume samplers capable of pulling greater than 300 m^3 of ambient air over a 48-hour period were rented from Cherokee Instruments Ltd. located in Fuquay-Varina, NC. Cherokee Instruments Ltd. also supplied the filter/sorbent cartridges, which were packed with a combined PUF and XAD-2 sorbent at AXYS Analytical Services Ltd. The combined PUF and XAD-2 sorbent was previously cleaned and then spiked with surrogate standards at AXYS Analytical Services Ltd. AXYS Analytical Services Ltd. also supplied the cleaned particle filters for the filter/sorbent cartridges. Sample clean up and concentration were conducted at Pacific Rim Laboratories. EPA Method 1613B and EPA Method 8270 modified were used to analyze for chlorinated dioxins/furans and NPRI PAHs, respectively. The analytical results for the ambient air monitoring are shown in Table 8.

Table 8 Summary of analytical results for ambient air monitoring at Birchbank and Butler Park relative to processing EEE at #2 SFF and baseline conditions

Trial		PCDD/PCDF pg TEQ / dsm^3	NPRI PAHs ug / dsm^3
Baseline			
Dec.20-22/04 Butler Park	ND = 0	0.01	0.01
	ND = 1/2DL	0.01	
Dec.20-22/04 Birchbank	ND = 0	0.01	0.01
	ND = 1/2DL	0.01	
EEE processing at #2 SFF			
Dec.6-8/04 Butler Park	ND = 0	0.02	0.01
	ND = 1/2DL	0.02	
Dec.9-11/04 Butler Park	ND = 0	0.01	0.02
	ND = 1/2DL	0.02	
Dec.6-8/04 Birchbank	ND = 0	0.01	0.01
	ND = 1/2DL	0.01	
Dec.9-11/04 Birchbank	ND = 0	0.01	0.01
	ND = 1/2DL	0.01	

Environment Canada Mar./99-May/00 average ambient air level for PCDD/PCDF at Butler Park is 0.03 pg TEQ/dsm^3(ND = DL).
Environment Canada Dec./99 average ambient air level for PCDD/PCDF at Butler Park is 0.10 pg TEQ/dsm^3(ND=DL).

BROMINATED SPECIES

Select stack gas, ambient air, solids and effluent samples were also analyzed for polybrominated diphenylethers (PBDEs) and polybrominated dioxins/furans (PBDD/F) at Pacific Rim Laboratories. Except for the Dec.20-22/04 ambient air baseline samples, all samples analyzed for brominated species were collected during the processing of EEE at #2 SFF.

Much like chlorinated dioxins/furans which have 210 possible congeners, there are 209 possible congeners for PBDEs.[37] Seven of these congeners are commonly reported (BDE-28, -47, -49, -99, -100, -153, and -154).[38] Wellington Laboratories located in Guelph, ON, has also recently added BDE-209 to the list of available surrogate standards for the analysis of PBDEs. The availability of this standard has improved the credibility of the results for PBDEs, considering that BDE-209 is the dominant PBDE used globally.[37,38] Pacific Rim Laboratories reported the concentrations of the 7 common congeners in the various samples, as well as BDE-209 and 12 other less common PBDEs, showing a comprehensive representation of substitution patterns. The cumulative result for the 7 commonly reported PBDEs, BDE-209 and the summation of the concentrations of all analyzed PBDEs are reported in Table 9.[37,39] The brominated analogues of the 17 regulated chlorinated

dioxins/furans were also analyzed by Pacific Rim Laboratories. However, the results were reported on a concentration basis (see Table 9) and not as toxic equivalents (TEQs), considering that TEFs are not yet defined for brominated dioxins/furans.

Table 9 Summary of the analytical results for brominated species in stack gas, ambient air, various solids and effluent samples for processing EEE at #2 SFF

Sample particulars	PBDEs			PBDD/F
	BDE-209	7 common BDEs	S PBDEs	
Dracco stack gas	pg/dsm^3	pg/dsm^3	pg/dsm^3	pg/dsm^3
Dec.7/04	190	6,100	9,100	ND
Ambient air	pg/dsm^3	pg/dsm^3	pg/dsm^3	pg/dsm^3
Baseline				
Dec.20-22 (Butler Park)	2.5	4.8	8.4	ND
Dec.20-22 (Birchbank)	1.4	4.1	6.4	
EEE processing at #2 SFF				
Dec.6-8 (Butler Park)	1.5	10	12	ND
Dec.6-8 (Birchbank)	5.9	6.1	13	
Solids	pg/g	pg/g	Pg/g	pg/g
Dec.7/04 - fume (charging)	ND	16	16	ND
Dec.17/04 – Area II cake	ND	4.7	4.7	ND
Effluent	pg/L	pg/L	Pg/L	pg/L
Dec.15/04 – Area II filtrate	ND	4.3	4.3	ND
Dec.15/04 – C-III Outfall	ND	2.1	2.1	ND

DISCUSSION

Dioxins/furans (PCDD/PCDF) have been identified as Track 1 substances according to the Toxic Substances Management Policy (TSMP) adopted by the Canadian federal government. The TSMP objective for Track 1 substances is the virtual elimination of these substances from the environment, which is achieved by addressing sources of release to the environment or by removing or managing the substance if it is already in the environment. National Pollutant Release Inventory (NPRI) reporting requires that 17 PCDD/PCDF congeners are reported in terms of their cumulative toxic equivalent (TEQ), detailed on page 7. Environment Canada has published a level of quantification (LoQ) of 32 pg/dsm^3 for reporting dioxins/furans in a waste gaseous stream. The LoQ for an effluent stream is 20 pg TEQ/L, and the LoQ for a solid material destined for landfill is 9 pg TEQ/g. As defined in Section 65.1 of the Canadian Environmental Protection Act (CEPA), the LoQ is the "lowest concentration that can be accurately measured using sensitive but routine sampling and analytical methods". It is also the concentration which defines the threshold for virtual elimination under the TSMP. Environment Canada determines LoQ values by carrying out statistical analyses of several sets of measurements from a variety of emission sources. The LoQ is calculated as 10 times the standard deviation of replicated measurements.[14,27]

Polyaromatic hydrocarbons (PAHs) are classified as a group on the List of Toxic Substances under CEPA. PAHs are classified as Track 2 substances because many sources are natural rather than resulting from human activity. NPRI reporting has set alternate reporting criteria for PAHs, since some of these substances are used as commercial chemicals. In the Canada Gazette (17) PAHs are listed as Schedule 1, Part 3 Substances. Since these (17) PAHs are predominantly incidentally manufactured and released or transferred from facilities, the NPRI reporting threshold has been set at 50 kg/y. Anthracene (CAS No. 120-12-7) and naphthalene (CAS No. 91-20-3) are commercial

chemicals used in significant quantities, and are less toxic than the (17) PAHs listed as Schedule 1, Part 3 Substances. Anthracene and naphthalene are listed as Schedule 1, Part 1 Substances with a NPRI reporting threshold of 10 mt/y. The (17) PAHs listed as Schedule 1, Part 3 Substances are reported as NPRI PAHs in this report.[14,27]

Brominated dioxins/furans (PBDD/Fs) and polybrominated diphenylethers (PBDEs) are currently not listed on the List of Toxic Substances under CEPA.[14,27]

DRACCO STACK GAS MONITORING

The concentration of dioxins/furans in the stack gas during the processing of EEE at #2 SFF was lower than baseline (April 2002) for the triplicate sampling done by A. Lanfranco and Associates on Dec.7-9/04 (see Table 3). However, the NPRI PAHs were significantly higher in the Dec.7-9/04 sampling, likely due to a bias toward forming PAHs, based on the controlled combustion studies for the dominant EEE plastics (ABS and HIPS).[28,29] The average dioxin/furan concentration for the Dec.7-9/04 sampling was significantly lower than Environment Canada's LoQ (32 pg TEQ/dsm^3), and also low relative to the other smelter operations across Canada (see Table 10).[30] The NPRI PAHs production (1.5 kg/y) for this same sampling event was also significantly lower than the NPRI reporting threshold of 50 kg/y.[14] Processing battery plastics in addition to EEE on Dec.10/04 did not increase the levels of regulated POPs relative to the Dec.7-9/04 sampling. The additional battery plastics increased the total plastics charged to the furnace by approximately 10% on Dec.10/04. Correspondingly, the concentrations of dioxins/furans and PAHs in the Dec.10/04 stack gas sample are within the range of the Dec.7-9/04 levels.

Table 10 Comparison of PCDD/PCDF releases from smelters across Canada[30]

Province	Facility	Emission Concentration (pg TEQ / m^3)	Test Date	Comments
British-Columbia	Teck Cominco (Trail)	6.8	April 2002	Total stack emissions from Trail Operations
		2.1	April 2002	Baseline – Dracco stack emission testing
		1.3 – 2.3	Dec.7-9/04	EEE processing – Dracco stack gas
Manitoba	Hudson Bay	45.3	June 2002	Main stack emissions (ESP treated)
	Inco (Thompson)	30	Aug. 2001	Main stack emissions (ESP treated)
		12.8	June 2003	
Ontario	Falconbridge (Kidd)	2.3	June. 2001	Acid plant tail gas
	Falconbridge (Sudbury)	559	May 1999	Main stack emissions (ESP treated)
		459	April 2000	
		286	June 2001	
	Inco (Copper Cliff)	50	Nov. 2001	Main stack emissions (ESP treated)
Quebec	Noranda (Horne)	3.2	June 2000	Acid plant tail gas
	Noranda (CEZ)	1.1	Oct. 2001	Acid plant tail gas
	Noranda (CCR)	<10 to <26	June 2002	Anode melt furnace and TBRC off-gas
	Noranda (Gaspe)	82	Aug. 2001	Main stack (mainly smelter off-gas)
New Brunswick	Noranda	<11 to <28	Oct./Nov.2002	Various sources
	Brunswick	<3 to <9	May2003	

The results for regulatory sampling on Dec.7-9/04 relative to processing EEE at #2 SFF were also low relative to US EPA Maximum Achievable Control Technology (MACT) standards for a broad spectrum of source categories (see Table 11). The two categories that most parallel Trail Operations are secondary aluminum and primary magnesium. In the case of secondary aluminum, a gas phase

standard of 800 pg TEQ/dsm^3 is applied to sweat furnaces; however the primary regulatory limit is production based. The Secondary Aluminum MACT rule applies a limit of 0.25 up to 15 ugTEQ/Mg of feed or metal produced. The production based release for Trail during the Dec.7-9/04 sampling is significantly lower than this standard.[15]

Table 11 Comparison of US EPA MACT standards for PCDD/PCDF from various source categories relative to the stack gas release from processing EEE at #2 SFF on Dec.7-9/04 [15]

Industry (USA)	**MACT Standards**	
	pg TEQ/dsm^3	ug TEQ/Mg feed
Aluminum Production – Secondary	800 (@11% O_2) primary standard	0.25 – 15 regulatory standard
Hazardous Waste Combustors	400 (@ 7% O_2)	
Hazardous Waste Kiln - burning cement	400 (@ 7% O_2)	
Hazardous Waste Kiln – burning lightweight aggregates	200 (@ 7% O_2)	
Magnesium Refining – Primary	36,000 (@ 7% O_2)	
Portland Cement Manufacturing Industry	400 (@ 7% O_2)	
Teck Cominco Metals Ltd. Dec.7-9/04 avg.	1.3 – 2.3 (@ 19-20% O_2)	0.03 – 0.04

The projected annual release of PCDD/PCDFs to air from processing EEE at #2 SFF, according to the proposed treatment of 2.8 mt/charge or 6700 mt/y of EEE, is significantly lower than releases from more common activities such as backyard barrel burning.[40] In fact, a recent US EPA study concluded that a single trash-burning barrel in a homeowner's backyard can release as much dioxin into the air as a well-controlled municipal waste incinerator.[47] The US EPA's updated records on sources of dioxins are detailed in Table 12 and compared to the projected annual release to air from processing EEE at #2 SFF.

Table 12 Comparison of the inventory sources of dioxin in the United States to the projected annual release from processing EEE in #2 SFF[40]

Source	Emitted to	PCDD/ PCDF g TEQ/y
Backyard barrel burning	Air	628.0
Sewage sludge applied to land	Land	76.6
Residential wood burning	Air	62.8
Coal fired utilities	Air	60.1
Diesel trucks	Air	35.5
Industrial wood burning	Air	27.6
Chlorine bleached pulp and paper	Water	12.0
Municipal waste incineration	Air	12.0
Crematoria	Air	9.1
Unleaded gasoline	Air	5.9
Cigarette smoke	Air	0.8
Processing EEE at #2 SFF Dec.7-9/04 avg.	Air	0.003 – 0.006

S-40 COMPLIANCE MONITORING

Processing #3 tail slag at #2 SFF along with EEE addition on Dec.7/04 showed much lower element concentrations in the stack particulate than the 2004 avg., which was mainly representative of processing blast furnace slag (see Table 4). The lower zinc and lead concentrations in the #3 tail slag

blend (4-5% Zn; 1% Pb) than for the blast furnace slag blend (10-15% Zn; 5% Pb) resulted in a lower fume loading to the Dracco baghouse on Dec.7/04, and therefore a lower particulate loss from filtration. A notable increase in gaseous fluoride on Dec.7/04 is likely the result of a different fume chemistry in processing #3 tail slag, and depleted element concentrations not complexing the fluoride in fume. Altering the furnace processing parameters for processing #3 tail slag or introducing additional basic metal oxides into the feed may serve as possible strategies to complex the gaseous fluoride.

SOLIDS SAMPLING

Dioxin/furan concentrations in fume approached the "lowest concentration that can be accurately measured using sensitive but routine sampling and analytical methods", according to the Canadian Environmental Protection Act (CEPA).[14] The concentrations of dioxins/furans (pptr TEQ) in the fume samples collected concomitant with the processing of EEE at #2 SFF (see Table 5) were however slightly greater than Environment Canada's published LoQ (9 pg TEQ/g) for reporting dioxin/furan concentrations in materials slated for landfill. The dioxin/furan concentrations in fume for EEE processing at #2 SFF were also greater than baseline levels.

The NPRI PAHs in the Dec.7/04 fume (see Table 5) are much lower than the NPRI reporting threshold of 50 kg/y. The NPRI PAHs for the Dec.7 fume are, however, an order of magnitude greater than baseline levels. This increase can be mainly attributed to the greater coal addition rates on these days. Additional test work has shown that for otherwise equivalent processing parameters, a 10% increase in the coal addition rate constitutes a 60% increase in PAHs. The coal addition rate during the charging of the furnace, and concomitant with EEE addition, was in fact 10% greater on Dec.7/04 than during baseline sampling on July 14/04. The concentration of NPRI PAHs in the Dec.7/04 fume was approximately 30% greater than baseline levels. Not only does the combustion of coal volatiles produce PAHs, but the carbon monoxide loading to the off-gas inhibits post combustion.[31,33] The greater coal rates for processing on Dec.7/04 not only contributed a significant loading of PAHs to the off-gas, but may have also inhibited post combustion of these PAHs, as well as the PAHs generated by the EEE plastics. The greater concentration of dioxins/furans in the Dec.7/04 fume relative to baseline levels may have also been influenced by greater coal rates on Dec.7, and the coal volatiles producing dioxins/furans in the off-gas.[33] Improved control of furnace post combustion, particularly during the charging of the furnace, is likely to effectively reduce the already low releases of PAHs and dioxins/furans. Controlling the CO level to <50 ppm downstream of post combustion is one recommendation to improve the furnace post combustion.[31]

PARTITIONING OF POPS BETWEEN SOLID FUME AND STACK GAS

The partitioning of regulated POPs between Dracco stack gas and fume was determined for sampling on Dec.7/04. The NPRI PAHs partitioning between stack gas and fume were also included in this analysis. The concentrations of dioxins/furans and PAHs in the stack gas sample taken on Dec.7/04 (ND = 0) were converted to kg/y production by first multiplying by the stack gas flow rate and then taking into account 350 days of production at #2 SFF. The concentrations in the fume samples were adjusted according to the daily fume production at #2 SFF on Dec.7/04, and then according to 350 days of production. The production based releases are shown in Table 13.

Table 13 Partitioning of POPs between stack gas and fume for Dec.7/04 sampling

Trial	PCDD/PCDF kg/y	NPRI PAHs kg/y
Dec.7/04		
Dracco stack gas (ND = 0)	0.000003	1.5
Fume (charging)	0.0003	1.7

The partitioning of dioxins/furans was essentially 99% to fume for the Dec.7/04 sampling. The partitioning of NPRI PAHs was 47% to stack gas and 53% to fume during the charging stage of processing. [33] The total release of PAHs to stack gas and fume, as compared to the release of dioxins/furans, is consistent with the results of controlled combustion studies, which show the bias toward forming PAHs in processing the dominant ABS and HIPS plastics in EEE.[29,30]

DOWNSTREAM PARTITIONING OF POPS BETWEEN SOLIDS AND EFFLUENT

The downstream partitioning of regulated POPs between effluent and solids was determined for Area II cake and Area II filtrate, concomitant with EEE processing at #2 SFF. It was assumed that the deportments of POPs were essentially the same on Dec.15 and 17 sampling days. The production based release for Area II cake was determined by multiplying the concentrations of dioxins/furans and PAHs in the solid by the total daily fume production and then converting units. The total daily fume production at Area I (Dec.17/04 - 180 mt total fume) was considered equivalent to cake production at Area II. POPs in the Area II filtrate were converted to production based releases by using an estimate of 1000 m^3 as the daily filtrate flow for Area II. In addition, the true emission for the Area II filtrate (ND = 0) was below the detection limit of the current analytical instrumentation (see Table 6). Therefore, an estimate (ND = 1/2DL) was used to calculate the production based release for Area II filtrate. The production based releases are shown in Table 14.

Table 14 Partitioning of POPs between effluent and solids in the downstream processing of #2 SFF fume

Trial	PCDD/PCDF kg/y	NPRI PAHs kg/y
Dec.17/04		
Area II cake (ND = 0)	0.00009	0.6
Dec.15/04		
Area II filtrate (ND = 0)	0.000000004	0.002

The partitioning of dioxins/furans and PAHs to Area II cake was essentially 100% for the Dec.15 and 17/04 sampling. The relative concentration of PAHs to dioxins/furans in Area II cake for Dec.17 sampling is slightly lower than the relative concentration in fume for Dec.7 sampling. The PAHs are not as chemically inert as dioxins/furans. Therefore, it is likely that there was some minor degredation of PAHs in the downstream processing at Area I and II.[33]

EFFLUENT SAMPLING

The Area II cake filtrate and the C-III Outfall effluent samples taken on Dec.15/04 with EEE processing at #2 SFF did not show significant variation in concentrations of regulated POPs relative to baseline samples taken on Dec.21/04 (see Table. 6). The concentrations of dioxins/furans (PCDD/PCDF) in the effluent samples were significantly lower than Environment Canada's published LoQ of 20 pg TEQ/L.[14] In fact, dioxins/furans were not detected in the C-III Outfall

effluent sample taken on Dec.15/04. The concentration of NPRI PAHs in the C-III Outfall sample was converted to a production based release by multiplying the concentration by the Dec./04 daily average of the C-III Outfall flow rate. The projected annual release of NPRI PAHs in the C-III Outfall was 0.5 kg/y, which is significantly lower than the NPRI reporting threshold of 50 kg/y. The production release from Area II was estimated at only 0.002 kg (ND=1/2DL).

C-III OUTFALL

The metal concentrations in the C-III Outfall (EW87) for processing EEE at #2 SFF did not vary significantly from the 2004 average (see Table 7).

AMBIENT AIR MONITORING

Ambient air monitoring at Butler Park and Birchbank sampling stations during the current EEE trial showed levels of dioxins/furans (PCDD/PCDF) that were comparable to current and historical baseline levels (see Table 8). The concentrations of NPRI PAHs were equivalent to baseline on both sampling events at both locations. Analysis of the wind rose charts did not show any directional bias during the sampling periods.

As a component of the National Air Pollution Surveillance (NAPS) network, the Analysis and Air Quality Division (AAQD), Environmental Protection, Environment Canada operates an ambient air measurement program for PAHs and dioxins/furans (PCDD/PCDF).[35] Historical data was collected from Trail's Butler Park monitoring station from Mar./99-May/00.[36] This historical data was compared to the dioxin/furan concentrations at Butler Park for the Dec./04 trial in Table 15. The dioxin/furan concentrations were reported as the substituted concentrations (ND = DL) in agreement with Environment Canada's reporting for the Mar./99-May/00 data. The dioxin/furan (PCDD/PCDF) concentrations in ambient air at Butler Park during the current EEE processing at #2 SFF (Dec./04) were slightly lower than the Mar./99-May/00 average, but were significantly lower than Environment Canada's Dec./99 average, which represents comparable seasonal conditions.

Table 15 Comparison between Environment Canada's ambient air monitoring results for dioxin/furan concentrations for 1999-2000 at Butler Park relative to the concentrations for the current Dec./04 trial for EEE processing at #2 SFF

	PCDD/PCDF (ND = DL) (pg TEQ/dsm^3)
Environment Canada	
Mar./99-May/00 average.	0.03
Dec./99 average	0.10
EEE processing at #2 SFF	
Baseline – Dec.20-22/04	0.01
Dec.6-8/04	0.02
Dec.9-11/04	0.02

A further comparison was made to the ambient air dioxin/furan concentrations for Environment Canada data collected between 1987 and 1997 for 34 urban and rural sites across Canada.[35] The overall, mean TEQ (ND = 1/2DL) concentrations ranged from 0.01 pg TEQ/dsm^3 (rural) to 0.1 pg TEQ/dsm^3 (urban). The dioxin/furan concentrations for ambient air monitoring at Butler Park and Birchbank during EEE processing at #2 SFF were consistent with the overall, mean TEQ for rural locations, such as Kejimkujik, NS, Saint Andrews, NB, Gray, SK, and Jasper, AB. Similar to the

results of the Environment Canada survey in 1999 - 2000, hepta-PCDD was the dominant congener detected in the Dec./04 samples at Birchbank and Butler Park ambient air monitoring locations. Hepta-PCDD is in the group of least toxic congeners.[14,35]

The NPRI PAHs (Schedule 1, Part 3 Substances) with a reporting threshold of 50 kg/y were compared in Table 16 for the current Dec./04 trial and the historical baseline of Mar./99-May/00. The NPRI PAHs for the Dec./04 trial were slightly greater than the values reported by Environment Canada for Mar./99-May/00. However, this is likely due to differences in sampling methodology as the Environment Canada samples may have been biased toward lower concentrations since the sorbent used in the samplers was only PUF, which is suspect for poor recoveries of select PAHs.[26,35] The current Dec./04 trial incorporated a PUF/XAD-2 "sandwich" as the sorbent, which reportedly gives better recovery of PAHs.[26]

Table 16 Comparison between Environment Canada's ambient air monitoring results for NPRI PAHs for 1999-2000 at Butler Park relative to the concentrations for the current Dec./04 trial for EEE processing at #2 SFF

	NPRI PAHs (ug/dsm^3)
Environment Canada	
Mar./99-May/00 average.	0.006
Dec./99 average	0.008
EEE processing at #2 SFF	
Baseline – Dec.20-22/04	0.011
Dec.6-8/04	0.012
Dec.9-11/04	0.015

The total PAHs in the ambient air samples were also compared to the values for Environment Canada data collected between 1987 and 1997 for 34 urban and rural sites across Canada (see Table 17).[35] The total PAHs also included the Schedule 1, Part 1 Substances with a NPRI reporting threshold of 10 mt/y.[14] The Environment Canada data shows mean total PAH concentrations, which vary by more than three orders of magnitude for rural locations, depending on their proximity to industrial sites. The data for urban locations varies according to population with the higher population areas experiencing the higher PAH concentrations.

Table 17 Comparison between Environment Canada's ambient air monitoring results for total PAHs for 1987-1997 across Canada relative to the concentrations at Butler Park for the current Dec./04 trial for EEE processing at #2 SFF

	Total PAHs (ug/dsm^3)
Environment Canada	
1987-1997, Mean (rural)	0.0009 – 0.8
1987-1997, 90th Percentile (rural)	0.005 – 2.7
1987-1997, Mean (urban)	0.01 – 0.07
1987-1997, 90th Percentile (urban)	0.01 – 0.1
EEE processing at #2 SFF	
Baseline – Dec.20-22/04	0.02
Dec.6-8/04	0.02
Dec.9-11/04	0.03

The total PAHs in the ambient air samples taken at Butler Park during the EEE processing at #2 SFF are consistent with the low end of the range of Environment Canada data for both rural and urban locations across Canada.

BROMINATED SPECIES

Stack gas emissions

The levels of brominated dioxins/furans (PBDD/Fs) in stack gas, ambient air, solids and effluent samples, which were collected during the processing of EEE at #2 SFF were all below the detection limit (see Table 9). Literature reports suggest that brominated flame retardants (BFRs) will easily decompose in incinerators to form other brominated compounds, such as hydrogen bromide and PBDD/Fs.[39] Measurable levels of polybrominated diphenylethers (PBDEs) were detected in the Dracco stack gas. This suggests that some of the EEE plastics are bypassing the #2 SFF bath and reporting to the off-gas. It is likely that some EEE dust from the shredding of the raw EEE is being directed to the off-gas under the negative furnace pressure. The dominant PBDE-specific congener in the stack gas sample was BDE-47. Since the more highly substituted PBDEs (i.e. BDE-209) are more labile to thermal and photolytic degredation, it is likely that the high levels of BDE-47 in the Dec.7/04 stack emissions are due to the degredation of commercial DBDE (= 97% BDE-209), which is the dominant BFR in EEE in the Americas.[37] The partitioning of the PBDEs was 99% to the stack gas and 1% to fume (see Table 18). This is unlike the partitioning of dioxins/furans and PAHs due to the greater vapour pressure of the PBDEs detected.[44]

Considering that PBDEs are ubiquitous in the environment and especially indoors, the stack gas sampling train may be easily contaminated with PBDEs using the current cleaning and proofing procedures[37,41-45] The recoveries of the surrogate standards used to spike the stack gas samples ranged from 20% recovery for BDE-209 to 140% for BDE-47. This range in surrogate standard recoveries suggests some complications in the extraction procedure of the BDE-specific congeners from the sorbent and underlies the fact that sampling and analytical protocols for PBDEs are still in the development stage.[30]

Table 18 Partitioning of PBDEs between stack gas and fume for Dec.7/04 sampling

Trial	PBDEs kg/y
Dec.7/04	
Dracco stack gas	0.023
Fume (charging)	0.0002

The levels of PBDEs measured in the stack gas on Dec.7/04, concomitant with the processing of EEE at #2 SFF were comparable to the levels reported for EEE incineration in Europe and Asia (see Table 19).[37, 41-45] The stack emission results for EEE incinerators in Europe and Asia may however be biased to lower concentrations, considering that PBDEs are a less significant component of plastics in Europe and Asia than in the Americas.[37] Five BFRs constitute the overwhelming majority of current BFR production. The five major BFRs are tetrabromobisphenol A (TBBPA), hexabromocyclododecane (HBCD) and three commercial mixtures of PBDEs.[37] The consumption patterns for Asia in 2001 included 76% TBBPA and only 21% PBDEs, whereas the Americas consumed 34% TBBPA and 61% PBDEs.[37] In addition to the potential for a different compositional bias relative to BFRs in Europe and Asia, the dominant BFR in Europe and Asia,

TBBPA, is a reactive component of plastic manufacture, and therefore it is incorporated into the polymer matrix and less readily released to the environment.[37] In contrast, PBDEs are additive coatings to polymers, and therefore are not part of the polymer matrix. Thus, the PBDEs are more readily released to the environment.[37] In Table 19, the congener-specific PBDEs contributing to the reported total emission of PBDEs to stack gas for the incineration plant in Japan are unknown. The levels emitted by the EEE incinerators in Norway include the dominant BDE-209 congener, and therefore represent a better comparison to the Trail results.

Table 19 Comparison of the stack emissions of PBDEs from EEE incinerators in Europe and Asia relative to the PBDE emissions at Trail during the EEE trial

Location	Capacity (mt waste / y)	S PBDEs (pg/dsm^3)
Norway (Klemetsrud Plant)	155,000	14,000-22,000
Norway (Energos Plant)	10,000	5,000
Japan	n/a	3,500
Trail, #2SFF (Dec.7/04)	10,000	9,100

The EEE incinerator in Japan also reported 8000 pg/dsm^3 of TBBPA

Ambient air monitoring

The ambient air levels of PBDEs during the processing of EEE at #2 SFF were comparable to baseline levels. The uncertainties in the analytical results for PBDEs ranged from 30-50% for the less substituted PBDEs (BDE-28, -47, -49, -99, -100, -153, -154) to 100% for the more highly substituted PBDEs (BDE-209).[46] Therefore, it may be argued that the ambient air levels of PBDEs during the processing of EEE at #2 SFF and the baseline emissions are within statistical uncertainties. The PBDEs measured at Butler Park and Birchbank during the processing of EEE at #2 SFF are also consistent with the low end of the ambient air levels reported for southern Ontario, Canada, the Canadian Artic and both rural and urban locations in the Great Lakes area of the United States (see Table 20).[44] The ambient air levels of PBDEs at both Birchbank and Butler Park locations, during the processing of EEE at #2 SFF, were presented with and without the BDE-209 concentration in Table 20 to present a better comparison to the data for southern Ontario.

Table 20 Comparison of the ambient air levels of PBDEs during the processing of EEE at #2 SFF to ambient outdoor air levels of PBDEs at southern Ontario, Canada, the Canadian Artic and the Great Lakes area of the US.

Location	PBDEs	Sampling Period	Mean Concentrations pg/dsm^3	Min-Max Concentrations pg/dsm^3
Canada, southern Ontario	sum of 21 congeners, excluding BDE-209	Apr.-May/00	295	88 - 1300
Canada, southern Ontario	sum of 37 congeners, excluding BDE-209	Feb.-Nov./00	n/a	3.4 – 46
USA, Great Lakes area	sum of 7 congeners, including BDE-209	May/97-Oct./99	n/a	4.4 – 77
Canada, Artic- Tagish	sum of 5 congeners, excluding BDE-209	Jan./94-Jan.99	n/a	4.2 – 2200
Canada, Trail (Butler Park and Birchbank)	sum of 20 congeners, including BDE-209	Dec.6-8/04	n/a	12 – 13
	sum of 20 congeners, excluding BDE-209	Dec.6-8/04	n/a	7.1 – 10.5

Considering that BFRs are used as additive or reactive components of plastics, which are used in a variety of applications including IT and telecommunications, automotive parts and textiles, it has been reported that the indoor air quality is significantly worse than outdoor air quality relative to exposure to PBDEs.[44] In fact, the dominant source of PBDEs in outdoor air is by ventilation of indoor air.[42] The ambient air levels of PBDEs during the processing of EEE at #2 SFF are compared to various indoor air levels of PBDEs in Table 21. The levels of PBDEs during the EEE trial are several orders of magnitude lower than the reported indoor air levels.

Table 21 Comparison of the ambient air levels of PBDEs during the processing of EEE at #2 SFF to ambient indoor air levels of PBDEs at southern Ontario, Canada, the Canadian Artic and the Great Lakes area of the United States.[44]

Location	PBDEs	Sampling Period	Mean Concentrations pg/dsm^3	Min-Max Concentrations pg/dsm^3
UK, Univ. of Birmingham (domestic)	sum of 5 congeners, excluding BDE-209	June/99-Sept./01	1100	760 – 1,600
UK, Univ. of Birmingham (workplace)	sum of 5 congeners, excluding BDE-209	June12-28/01	4400	771 – 15,500
Sweden (electronic dismantling plant)	sum of 8 congeners, including BDE-209	n/a	n/a	11,000-21,000
Offices with 1-2 computers	n/a	n/a	3010	n/a
Emissions from an old stored television case	n/a	n/a	9350	n/a
Canada, Trail (Butler Park, Birchbank)	sum of 20 congeners, including BDE-209	Dec.6-8/04	n/a	12 – 13
	sum of 20 congeners, excluding BDE-209	Dec.6-8/04	n/a	7.1 – 10.5

Fume samples

The concentration of PBDEs adsorbed to fume in the Dec.7/04 sample, which was obtained during the processing of EEE at #2 SFF, is significantly lower than the concentration of PBDEs in other materials described in the literature, such as household dust and even agricultural soil.[34,44] To further detail the ubiquitous nature of PBDEs in the environment, the PBDEs in the Dec.7/04 fume sample are compared to the concentrations in other solids in Table 22.

Table 22 Comparison of concentration of PBDEs in fume due to processing EEE at #2 SFF to concentrations in household dust and agricultural soil.

Location	PBDEs	Sampling Period	Mean Concentrations pg/g (ppt)	Min-Max Concentrations pg/g (ppt)
Dust				
USA, Cape Cod, MA (residential)	BDE-47, -99 and -100	June/99-Sept./01	n/a	530,000 – 29,000,000
Germany, Rhein-Main area (residential)	sum of 9 congeners, including BDE-209	n/a	n/a	17,000 – 550,000
USA, Mid-Atlantic (near PU foam manufacturing plant)				
Soil				
USA, Mid-Atlantic region (near PU foam manufacturing facility)	BDE-47, -99 and -100	2000	30,000	ND – 76,000
Sweden, agricultural	sum of 7 congeners, excluding BDE-209	2000	87	29 – 190
Canada, Trail Dracco baghouse, Dec.7/04 fume	sum of 20 congeners, including BDE-209	Dec.7/04	16	n/a

Effluent samples

Similar to dioxins/furans, PBDEs are highly insoluble in water, and therefore the PBDEs in fume should report to the solids in the downstream processing. The levels of PBDEs measured in the Area II filtrate and C-III Outfall (see Table 9) were actually lower than the lab blank. The lab blank showed 12 pg/L of PBDEs as BDE-47 and BDE-99. The concentration of PBDEs in the lab blank were within the range of PBDEs in surface water for Lake Ontario (4 – 13 pg/L).[44] Since BDE-47 was also the only PBDE-specific congener present in the Area II filtrate and C-III outfall samples, it is likely that the ubiquitous nature of PBDEs in the environment was the source of PBDEs in the Area II filtrate and C-III outfall samples and not due to processing EEE at #2 SFF. Similar to the dioxins/furans and PAHs, the low level of PBDEs, which reported to solids in the downstream processing, accumulate in the Sulfide Leaching residue (Lasta filter cake), which is then processed in KIVCET under conditions, which are known to destroy the PBDEs.[39]

CONCLUSIONS

The following conclusions can be drawn from the environmental monitoring results:

- Processing EEE at #2 SFF results in emissions comparable to baseline levels.
  - Regulated persistent organic pollutants (POPs) consist primarily of polyaromatic hydrocarbons (PAHs), which partition equally to stack gas and fume, and polychlorinated dioxins/furans (PCDD/PCDFs), which report dominantly to fume.
    - Dioxin/furan (PCDD/PCDF) concentrations in stack gas emissions are less than the Environment Canada LoQ for NPRI reporting (32 pg TEQ / dsm^3) and below the “virtual elimination” threshold.
    - PAH concentrations in the stack gas yield a very low production-based annual release, which is significantly lower than the NPRI reporting threshold of 50 kg/y.

  - Regulated POPs in ambient air at Birchbank and Butler Park are consistent with Environment Canada baseline data for Butler Park as well as across Canada.
  - Routine S-40 compliance monitoring of the Dracco stack particulate is not effected by EEE processing.

- The levels of regulated POPs in Dracco baghouse dust are greater than baseline levels
  - Essentially 100% of the regulated POPs report to Area II cake in downstream processing.
  - PCDD/PCDF concentrations in Area II filtrate and ultimately C-III Outfall are very low and significantly lower than Environment Canada's LoQ for effluent (9 pg TEQ/L).
  - The further downstream processing of Area II cake and the blending of other process streams ultimately concentrates the regulated POPs in the Lasta filter cake. The Lasta filter cake is processed in KIVCET under conditions, which are known to destroy POPs.

- The brominated flame retardants (PBDEs), which are currently prominent in EEE plastics, were effectively processed in the #2 SFF bath, considering that the known brominated dioxin/furan (PBDD/PBDFs) combustion products were below detection limit levels in both Dracco stack gas and fume. However, it is possible that a small amount of EEE dust from the shredding of the raw EEE material was directed to the furnace off-gas, thus bypassing the furnace bath. The EEE dust carried PBDEs, which contributed to the following environmental emissions.
  - The concentration of PBDEs in the Dracco stack gas due to processing EEE at #2 SFF was comparable to the levels as reported in the literature for residential indoor air, and significantly lower than levels in an electronics dismantling plant.
  - Essentially 100% of the PBDEs in the #2 SFF off-gas report to stack gas at levels comparable to EEE incinerators in Europe and Asia, although the Dracco stack emissions were likely biased to higher concentrations due to greater application of PBDEs in the Americas than Europe and Asia.
  - The PBDEs in ambient air samples were comparable to baseline levels, and also comparable to the low end of the range of PBDEs in outdoor ambient air in southern Ontario, the Canadian Artic and the Great Lakes area of the United States.
  - The ambient air PBDEs concentrations during the processing of EEE at #2 SFF were significantly lower than the levels in residential indoor air, which themselves are a mere fraction of the levels in household dust. The environmental impact of PBDEs due to processing EEE at #2 SFF is essentially insignificant relative to the ubiquitous nature of PBDEs in the environment.

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SUMMARY MEMORANDUM OF COPCs IDENTIFIED FOR THE TRAIL TERRESTRIAL RISK ASSESSMENT

MEMORANDUM

To: Steve Hilts, Teck Cominco Metals Ltd.

From: Ruth Hull, Cantox Environmental Inc.

Date: 4/13/2007

Re: Potential Chemicals of Concern for Terrestrial Wildlife in the Trail Wide-area Site ERA

1. INTRODUCTION

Potential chemicals of concern (PCOC) for the terrestrial wildlife risk modelling were identified during the problem formulation stage (Cantox Environmental *et al*. 2001) and again at the beginning of the LOR2 stage (Cantox Environmental 2003a). The processes used to screen PCOC are described below. The changes in PCOC assessed at each LOR also are summarized.

2. PCOC SCREENING FOR THE PROBLEM FORMULATION

The original list of 15 PCOC in LOR1 (Cantox Environmental *et al*. 2001) was developed according to procedures as outlined in the CSR (B.C. MELP 1997). Maximum chemical concentrations in soil, measured between 1995 and 1999 within the area of interest (AOI), were screened against regional background (B.C. MELP 2000) and then screened against the lowest generic numeric soil standard (Schedule 4) or the matrix numeric soil standard (Schedule 5), regardless of land use designation (see Appendix A, Cantox Environmental *et al*. 2001). The results of the chemical screening are presented in Table 1.

Table 1. Results of LOR1 Chemical Screening Against Regional Background and Numeric Standards

Chemical[1]	Exceeds Background[2]	Exceeds Criteria[3]	PCOC for the Terrestrial Ecological Risk Assessment
Antimony	Yes	Schedule 4	Yes
Arsenic	Yes	Schedule 5	Yes
Barium	Yes	Schedule 4	Yes
Beryllium	No	Schedule 4	No
Boron	Yes	Schedule 4	Yes
Cadmium	Yes	Schedule 5	Yes
Chromium	Yes	Schedule 5	Yes
Cobalt	No	Schedule 4	No
Copper	Yes	Schedule 5	Yes
Fluoride	NA	Schedule 4	Yes
Lead	Yes	Schedule 5	Yes
Mercury	Yes	Schedule 4	Yes
Molybdenum	Yes	<Schedule 4	No
Nickel	Yes	<Schedule 4	No
Selenium	Yes	Schedule 4	Yes
Silver	Yes	<Schedule 4	No
Sulphur	NA	NA	Yes due to prolonged sulphur emissions
Thallium	Yes	Schedule 4	Yes
Tin	Yes	Schedule 4	Yes
Vanadium	Yes	<Schedule 4	No
Zinc	Yes	Schedule 5	Yes

(1) List of PCOCs for which CSR has established background or Schedule 4 or 5 standards
(2) Screened maximum 1995-1999 measured soil concentrations against regional Kootenay or site-specific background concentrations
(3) Screened maximum 1995-1999 measured soil concentrations against CSR Schedule 4 or Schedule 5

3. PCOC SCREENING FOR LOR2

The PCOC screening was conducted again at the beginning of LOR2, because new soil data were obtained in 2001 and 2002. The results obtained from the 1995 to 1999 soil surveys were excluded because the sampling methodologies were inconsistent across the time period and restricted to sampling locations at low elevations in the valley. The 2001 and 2002 field programs were consistently sampled with similar methodology. The 2001 and 2002 soil concentrations represent the largest, most homogeneous and unbiased data set available for the terrestrial ERA (for sampling locations see Appendix B; Figure B1.1 of Cantox Environmental 2003a).

Prior to LOR2 modelling (Cantox Environmental 2003a), an effort was made to identify which chemicals in the AOI exceeded background concentrations as well as CSR standards, and which could be attributed to historical Teck Cominco smelter activities. This was done by:

- screening against background concentrations as well as CSR standards;
- simple correlation analysis of soil concentrations *versus* distance, in an attempt to identify which metal concentrations in the AOI do not appear to have been influenced by historical smelter activities; and
- mapping of soil concentrations throughout the AOI to provide a visual aid in assessing concentrations in relation to the smelter (Enns 2003).

The measured 95th percentile composite soil concentrations from the 2001 and 2002 field program were screened against 95th percentile background concentrations. Chemicals found to exceed the range observed in background were screened against numeric standards (*i.e.*, measured maximum concentrations). Measured metal concentrations from the 2001 to 2002 field program were compared to background concentrations and numeric standards identified in Table 2 to determine which chemicals in the AOI are elevated; these are identified in Table 3.

Table 2. Numeric Standards and Background Concentrations Assumed for LOR2 Screening [ppm]

Chemical	Regional Bkg[1]	Site-specific Bkg[2]	Schedule 4 - Generic Numerical Soil Standards[3]	Schedule 5: - Matrix Numerical Soil Standards[4]			
				Inverte-brates and plants	Livestock ingesting soil and fodder	Microbial functional impairment	Ground water
Antimony	3.0	1.5	20				
Arsenic	15	19.7		50	25		15
Barium	400		750				
Beryllium	1.5		4				
Boron[7]	30[5]		2				
Cadmium	2.0	1.67		70	9		2
Chromium	20			300	150	50	60
Cobalt	10	16.6	40				
Copper	30	51.5		150	150		90
Fluoride			200				
Lead	100	37.9		1,000	350		150
Mercury	<MDC (0.025)[6]	0.07		100	0.6	20	
Molybdenum	1.0	2.82	5				
Nickel	40	42	150				
Selenium	<MDC (4.0)[6]		2				
Silver	<MDC (1.0)[6]	0.39	20				
Sulphur	650		500				
Thallium	<MDC	0.25	2				
Tin	5.0	1.2	5				
Vanadium	65		200				
Zinc	250	168		450	200	320	150

(1) 95th percentile Kootenay Background with strong acid leachable metals method – SALM; n=56 (B.C. MWLAP 2003a)
(2) 95th percentile; n= 33-36 (GSC 2001)
(3) Lowest numerical standard for agricultural (AL) environmental protection (B.C. MWLAP 2002)
(4) Lowest numerical standard for toxicity to terrestrial organisms (*i.e.*, invertebrates, plants, microbial function, ingestion of soil and fodder by livestock) and the lowest numerical standard for protection of groundwater (*i.e.*, livestock watering and irrigation, and use by aquatic life) (B.C. MWLAP 2002)
(5) 95th percentile for Kootenay Region using aqua regia method; n=20 (B.C. MWLAP 2003a)
(6) Less than Method Detection Concentration (MDC); value in table represents one-half the detection limit concentration for Kootenay - Region 4 (B.C. MELP 2000)
(7) Hot water extraction method

Table 3. Statistical Summary for LOR2 Metal Concentrations in Soil in the Area of Interest [ppm]

Chemical	Average	Range	95th Percentile Measured	% Below Analytical Detection	95th Percentile Background[1]	B.C. Soil Standard[2]	Chemical of Concern
Antimony	6.1	0.5 to 92	13	82%	1.5	20	Yes
Arsenic	17.2	1.2 to 130	48	0%	19.7	15	Yes
Barium	161.9	14 to 595	341	0%	400	750	No
Beryllium	0.81	0.5 to 2	nc	nc	1.5	4	No
Boron[3]	0.14	0.1 to 0.2	0.2	nc	30	2	No
Cadmium	2.8	0.1 to 25.8	9	2%	1.67	2	Yes
Chromium	18.8	1 to 76	34	<1%	20	50	Yes
Cobalt	2.86	0.5 to 26	nc	nc	16.6	40	No
Copper	20.1	2 to 326	53	0%	51.5	90	Yes
Lead	177.1	2 to 3,330	662	0%	37.9	150	Yes
Mercury	0.1	0.0005 to 1.45	0.2	1%	0.07	0.6	Yes
Molybdenum	2.0	2 to 5	nc	nc	2.82	5	No
Nickel	15.7	1 to 73	nc	nc	42	150	No
Selenium	0.3	0.1 to 1.9	0.8	34%	4.0	2	No
Silver	0.29	0.05 to 4.9	nc	nc	0.39	20	No
Total Sulphur	176	10 to 1,640	566	0%	650	500	No
Thallium	0.2	0.05 to 1.5	0.5	17%	0.25	2	No
Tin	3.2	0.25 to 21	10	75%	1.2	5	Yes
Vanadium	26.5	4 to 443	46	0%	65	200	No
Zinc	149.0	14 to 1,330	401	0%	168	150	Yes

(1) Selected background value from Table 2 used in comparison to measured 95th percentile
(2) Lowest standard from Table 2 used in comparison to maximum measured concentration (B.C. MWLAP 2002)
(3) Result with hot water extraction method
nc indicates value not calculated
95th percentile indicates the value were only 5% of values are higher than the value shown - for example only 5% of the values measured for lead in the AOI are higher than 662 ppm

Site-specific background concentrations were not used to eliminate any PCOC (Table 3). Regional background concentrations were used to eliminate sulphur and vanadium, since the 95th percentile measured concentration for both chemicals was less than the 95th percentile regional background concentration (Table 3).

The boron results obtained from the 2001 to 2002 field program were not analysed according to the hot-water extraction method specified in the contaminated site regulations (B.C. MWLAP 2002). Soil samples were analysed using the strong acid leachable metals (SALM) extraction method. Five soil samples with the highest boron concentrations using the SALM method were re-analyzed using the hot-water extraction method. All sample results using the hot-water extraction were below standards, thus it was assumed that remaining soil samples in the area of

interest would yield similar or lower results. Therefore, boron was screened out based on these results.

Fluoride was excluded from the LOR2 model based on results reported in the problem formulation (Cantox Environmental *et al*. 2001). The screening level ERA did not generate ER values above the threshold of 1.0 for any of the receptors or scenarios; therefore, further evaluation of fluoride was not required.

For the remaining PCOC (antimony, arsenic, cadmium, chromium, copper, lead, mercury, tin, zinc), correlation and spatial analyses were used to explore the relationship between distance from smelter and concentrations of PCOC in soil. The assumption was that metals emitted from the smelter are dispersed predominantly in the form of particulate, and that metal deposition decreases with distance from the smelter.

Two-way semi-logarithmic scatter plots of chemical concentrations in soil and distance from the smelter illustrate the relationship between these two variables (Appendix A of Cantox Environmental 2003a). Correlation analysis was used to explore the relationships between these two variables, and the degree in which a change in one variable (distance from smelter) causes a change in the other (concentration of metal in soil). The linear (Pearson's) and rank (Spearman's) correlation coefficients for each chemical concentration in soil with distance are provided in Table 4. A negative correlation coefficient indicates that soil concentrations are inversely related to distance from smelter (*i.e.*, lower metal concentrations are found farther from the smelter).

Table 4. Correlation Coefficients for Metal Concentration in Soil *versus* Distance from Smelter

Chemical	Correlation Coefficients ('r')	
	Pearson's	Spearman's
Antimony	-0.147*	-0.052*
Arsenic	-0.378*	-0.484*
Cadmium	-0.316*	-0.443*
Chromium	0.015	-0.029
Copper	-0.272*	-0.443*
Lead	-0.299*	-0.457*
Mercury	-0.256*	-0.485*
Tin	-0.028	0.096
Zinc	-0.371*	-0.490*

*Significant value at the level of significance alpha=0.050 (Two-tailed test)

The results shown in Table 4 confirm that almost all of the PCOC concentrations in soil decrease with distance from smelter. The linear correlation coefficient is strongly influenced by extreme values; therefore, the rank correlation coefficient was calculated, which is not as sensitive to extreme values (Huntsberger and Billingsley 1973). In combination, the two statistical measures can be used to provide insight into the skewness of a distribution by observing the difference

between the linear and rank correlation coefficients (B.C. Environment 1995). The histograms provided in Appendix A1 of Cantox Environmental (2003) demonstrate the fact that most of the PCOCs are positively skewed or have a lot of low values and a decreasing proportion of high values.

The results (provided in Table 4 above and Appendix A1 of Cantox Environmental 2003a) indicate that chromium and tin concentrations in soil are not related to smelter activities. In addition, the two-way scatter plots in Appendix A1 (Cantox Environmental 2003a) for chromium and tin demonstrate that concentrations of these metals in soil do not vary with distance or elevation and that chromium is normally distributed in the AOI. In addition, the kriging (Enns 2003) maps of chromium (Figure B2.4) and tin (Figure B2.8) in Appendix B (Cantox Environmental 2003a) indicate no relationship between these metal concentrations in soil and past smelter activities.

For all remaining chemicals in Table 4, significant inverse relationships between metal concentrations in soil and distance from the smelter were observed. The two-way scatter plots and the kriging maps in Cantox Environmental (2003a) demonstrate these relationships. However, the correlation analysis does not provide evidence of a ‘strong’ relationship between metal concentration in soil and distance from smelter. All correlation coefficients are less than -0.5 and there is substantial scatter or variability within the data. A number of factors were thought to contribute including: physiography and prevailing winds, precipitation, bedrock geology, smelter process activities and fugitive dust (GSC 2001). However, with evidence provided by the two-way scatter plots and correlation analysis, in combination with kriging maps (Enns 2003) it is concluded that metal concentrations of antimony, arsenic, cadmium, copper, lead, mercury, and zinc in soil are related to past smelter activities. These seven PCOC were assessed quantitatively in LOR2.

In addition to the metals listed above, B.C. MWLAP (2003b) raised concerns over 10 chemicals measured in the AOI for which no numeric standards exist, but for which regional background concentrations were available (Table 5). All of these metals, with the exception of manganese and phosphorous, were found to have concentrations below or within the range observed for regional background. The two-way scatter plots for manganese and phosphorous (Appendix A1 of Cantox Environmental 2003a) demonstrate no relationship between metal concentrations and distance. However, a statistically significant result was observed between phosphorous concentrations and distance using the Spearman’s correlation coefficient (Table 6).

Table 5. Summary of Measured and Reported Background Concentrations for Chemicals of Potential Concern Without Soil Guidelines

Chemical	Measured Concentration in AOI (2001 to 2002) [μg/g][1]		Reported Background Concentrations [μg/g][2]	
	Average	95th Percentile	Average	95th Percentile
Aluminium	14,585	26,080	30,112	60,000
Calcium	1,873	4,664	23,804	85,000
Iron	16,401	25,080	21,405	40,000
Magnesium	3,100	6,490	10,540	25,000
Manganese	555	1,192	428	1,000
Phosphorus	4,177[3]	8,498[3]	846	2,000
Potassium	855	1,846	6,850	16,000
Sodium	103	197	943	2,000
Strontium	21	44	139	100
Titanium	593	1,242	2,650	2,000

(1) Sample size is 305
(2) Background concentrations obtained with nitric perchloric acid; n= 56 (B.C. MWLAP 2003a)
(3) Results obtained with the strong acid leachable metals method – SALM

Table 6. Correlation Coefficients for Manganese and Phosphorous Concentrations in Soil with Distance from Smelter

Chemical	Correlation Coefficients ('r')	
	Pearson's	Spearman's
Manganese	-0.083	-0.083
Phosphorous	-0.084	-0.12*

*Significant value at the level of significance alpha=0.050 (Two-tailed test)

Phosphorous was found to exceed background concentrations and was weakly correlated with distance from smelter. However, based on the following factors, phosphorous was dropped as a PCOC for the ERA:

- phosphorous is an essential nutrient required for proper maintenance of good health in plants and animals;
- phosphorous tends to undergo sequential reactions in acid and alkaline soils that produce phosphorous-containing compounds with lower and lower solubility. The lower the solubility of phosphorous in soil, the less phosphorous is available for plant uptake; and,
- inorganic phosphorous in weathered soils is far too insoluble to contribute to plant uptake (Brady and Weil 1999).

Based on the revised PCOC screening, the following PCOC were included in the LOR2 exposure modelling of terrestrial receptors:

- Antimony
- Arsenic
- Cadmium
- Copper
- Lead
- Mercury
- Zinc

4. PCOC RETAINED AT THE CONCLUSION OF EACH LOR

The PCOC for wildlife remaining at the completion of each LOR is summarized in Table 7. LOR2 wildlife risk modelling resulted in the elimination of antimony as a PCOC (Cantox Environmental 2003a). Completion of LOR3 wildlife risk modelling resulted in only two remaining PCOC, cadmium and lead (Cantox Environmental 2006). The wildlife receptors for which risks could not be ruled out at the completion of LOR3 will be assessed in the Final Terrestrial ERA (SALE; Sequential Analysis of Lines of Evidence) Report.

Table 7. Potential Chemicals of Concern at Completion of each Level of Refinement (LOR) of the Direct Toxicity Modelling for Wildlife

Chemical	PCOC at completion of LOR1	PCOC at completion of LOR2	PCOC at completion of LOR3
Antimony	Yes		
Arsenic	Yes	Yes	
Barium	Yes		
Boron	Yes		
Cadmium	Yes	Yes	Yes
Chromium	Yes		
Copper	Yes	Yes	
Fluoride	Yes		
Lead	Yes	Yes	Yes
Mercury	Yes	Yes	
Selenium	Yes		
Sulphur	Yes		
Thallium	Yes		
Tin	Yes		
Zinc	Yes	Yes	

5. ORGANIC COMPOUNDS

The ERA of smelter emissions has focussed on releases of inorganic chemicals and SO_2. Emissions of polychlorinated dibenzo dioxins and furans (PCDD/F) were addressed in a memorandum in 2003 (Cantox Environmental, 2003b). Briefly, the PCDD/F emissions from the Trail smelter were below Environment Canada's source targets for virtual elimination, and as such were not considered further.

6. SUMMARY OF PCOC SCREENING

In summary, a total of 31 elements were considered when screening to identify PCOC: aluminium, antimony, arsenic, barium, beryllium, boron, cadmium, calcium, chromium, cobalt, copper, fluoride, iron, lead, magnesium, manganese, mercury, molybdenum, nickel, phosphorus, potassium, selenium, silver, sodium, strontium, sulphur, thallium, tin, titanium, vanadium, zinc. At the end of LOR3, cadmium and lead were identified as the chemicals most likely to cause direct toxicity to wildlife. However, antimony, arsenic, cadmium, copper, lead, mercury, and zinc all remain as PCOC for the assessment of risks to plants and soil invertebrates, because the LOR2 and LOR3 modelling assessed only direct toxicity risks to wildlife.

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CANTOX ENVIRONMENTAL

MEMORANDUM

To: TeckCominco Management Team

From: Gord Brown

Date: 5/3/2007

Re: Proposal for Organic Screening

PCDD/PCDF Screening TeckCominco, Trail

1) The Lanfranco emissions survey report (2002) reported maximum PCDD/PCDF TEQ at 0.00040 ng/dscm (dry standard cubic meter) in the fuming furnace stack, 0.0080 ng/dscm in the lead baghouse stack, 0.0005 ng/dscm in the lead refinery scrubber stack, 0.0055 ng/dscm in the Dracco baghouse stack. Lanfranco reported that only the one test each at the lead baghouse stack and the Dracco baghouse stack showed any appreciable dioxin/furan TEQ, and all tests from all sources were below the federal LoQ of 0.032 ng/scm.

2) The source of the federal LoQ is "Level of Quantification Determination: PCDD/PCDF and Hexachlorobenzene" (Environment Canada, 1999). The LoQ is considered as a "baseline to assist in establishing a virtual elimination target, for Track 1 toxic substances that are persistent, bioaccumulative and anthropogenic". The federal LoQ of 32 pg/m^3 TEQ is lower than the Canada Wide Standard for incineration, which is 80 pg/m^3 TEQ.

3) Since all source emission tests yielded results that were quite consistent, and in all cases at least four times lower than the federal LoQ, current PCDD/PCDF emissions can be considered "extremely low" as stated by Lanfranco (2002).

4) Mean PCDD/PCDF concentrations in the 53 emission tests referred to in the Environment Canada, 1999 report ranged from 1.2 to 69.8 pg/m^3. Of these, only nine tests exhibited mean concentrations less than the 8 pg/m^3 achieved at the Trail smelter.

5) Environment Canada's dioxin inventory (1999) indicates that about 290 g TEQ were released to the Canadian atmosphere in 1997. The major anthropogenic sources identified in the inventory included municipal waste incineration, residential wood combustion, iron sintering and steel manufacturing, and combustion of salt laden wood. It was estimated that base metals smelting contributed only 0.1 g TEQ to the total.

6) Based on the emission survey, Lanfranco estimated a maximum PCDD/PCDF TEQ of 0.000041 g/day, equivalent to 0.015 g/year TEQ. This would represent about 0.005 % of the total 290 g/year emitted in Canada.

7) Since the PCDD/PCDF emissions from Trail are below Environment Canada's source targets for virtual elimination, further chemical screening of emissions from a health or ecological risk perspective is not considered necessary.

8) Additional evidence of low PCDD/PCDF ambient air concentrations in Trail are found in Environment Canada (1998). Measured mean TEQ concentrations in Trail were approximately 20 fg/m^3, compared to 105 fg/m^3 in Toronto (highest measured concentration) and 10 fg/m^3 in rural New Brunswick (lowest measured concentration).

9) Limited sampling and analysis of environmental media around the Trail smelter may be considered by TeckCominco to account for historic emissions. Factors to consider include the relatively high cost of PCDD/PCDF analysis, the potential impact of recent and historic forest fires in the region on background PCDD/PCDF concentrations, the contribution of other sources including residential wood combustion and vehicle traffic, and the "half life" of "persistent" organics (in comparison to metals) in the environment.

<u>PAH Screening TeckCominco Trail</u>

1) The Lanfranco report (2002) reported maximum total PAH concentrations of 1.2 to 5.7 μg/m^3 in emissions from the lead refinery scrubber stack. Maximum benzo(a)pyrene concentration in emissions 0.12 μg/m^3 from the lead refinery scrubber. Lanfranco reported that PAH concentrations in emissions "were low - *except for the lead refinery scrubber stack*". (No reference "emission limit" was provided by Lanfranco.)

2) Environment Canada's PAH inventory (1990) estimated about 4,386 t/year PAH emissions in Canada. Primary sources listed were forest fires, aluminum plants, residential heating and open air burning of wood, teepee burners and transportation. Base metal smelting was not listed.

3) Evidence of low PAH ambient air concentrations in Trail are found in Environment Canada (1998). Measured mean PAH concentrations in Trail were approximately 8 ng/m^3, compared to 801 ng/m^3 in Jonqueire (highest measured concentration) and 0.9 ng/m^3 in Jasper (lowest measured concentration).

4) Chemical screening of PAH emissions from the smelter (*e.g.*, lead refinery scrubber stack) would not be useful at this time as they would provide no indication of potential impact. Air dispersion modeling of emissions would be required to estimate maximum potential PAH air concentrations and deposition rates, prior to estimating risks.

5) Limited sampling and analysis of environmental media around the Trail smelter may be considered by TeckCominco to account for historic emissions. Factors to consider include the potential impact of recent and historic forest fires in the region on background PAH concentrations, the contribution of other sources including residential wood combustion and vehicle traffic, and the "half life" of "persistent" organics (in comparison to metals) in the environment.

APPENDIX E

GIS MAPS OF VARIOUS INFORMATION FROM THE UCR STUDY AREA

APPENDIX E

GIS MAPS OF VARIOUS INFORMATION FROM THE UCR STUDY AREA

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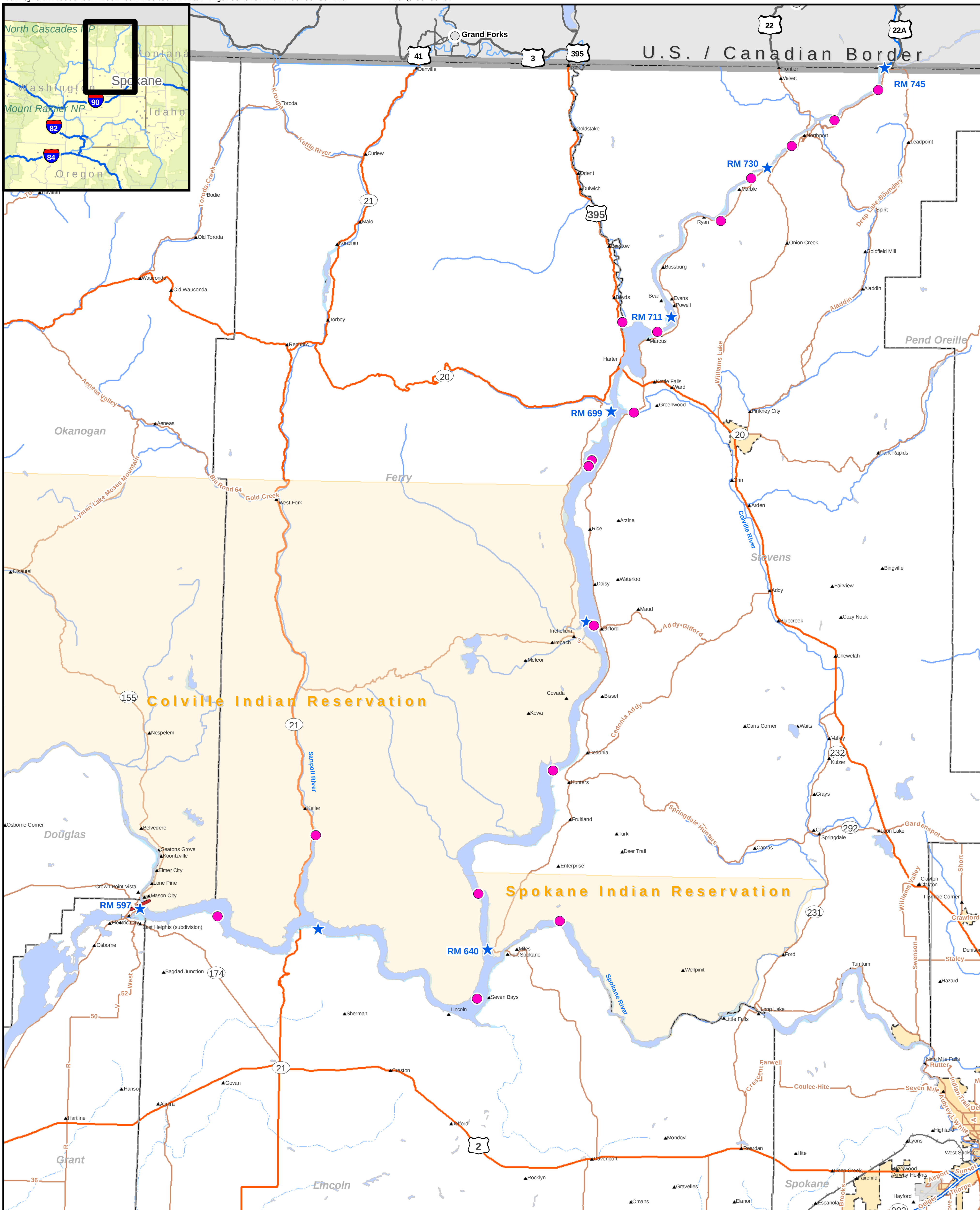

Legend

- 1986 UCR Sediment Sampling Stations *(Johnson et al. 1988)*
- River Reach Delineations (USGS)
- Grand Coulee Dam
- Populated Places
- County Lines
- Reservations

(*NOTE*: station coordinates are based on source document figures and/or coordinate tabulations)

Integral **Parametrix**

Km 0 5 10
Miles 0 5 10

N

Map E1

1986 UCR Sediment Sampling Stations
(Source: Johnson *et al.* 1989)
Upper Columbia River, WA

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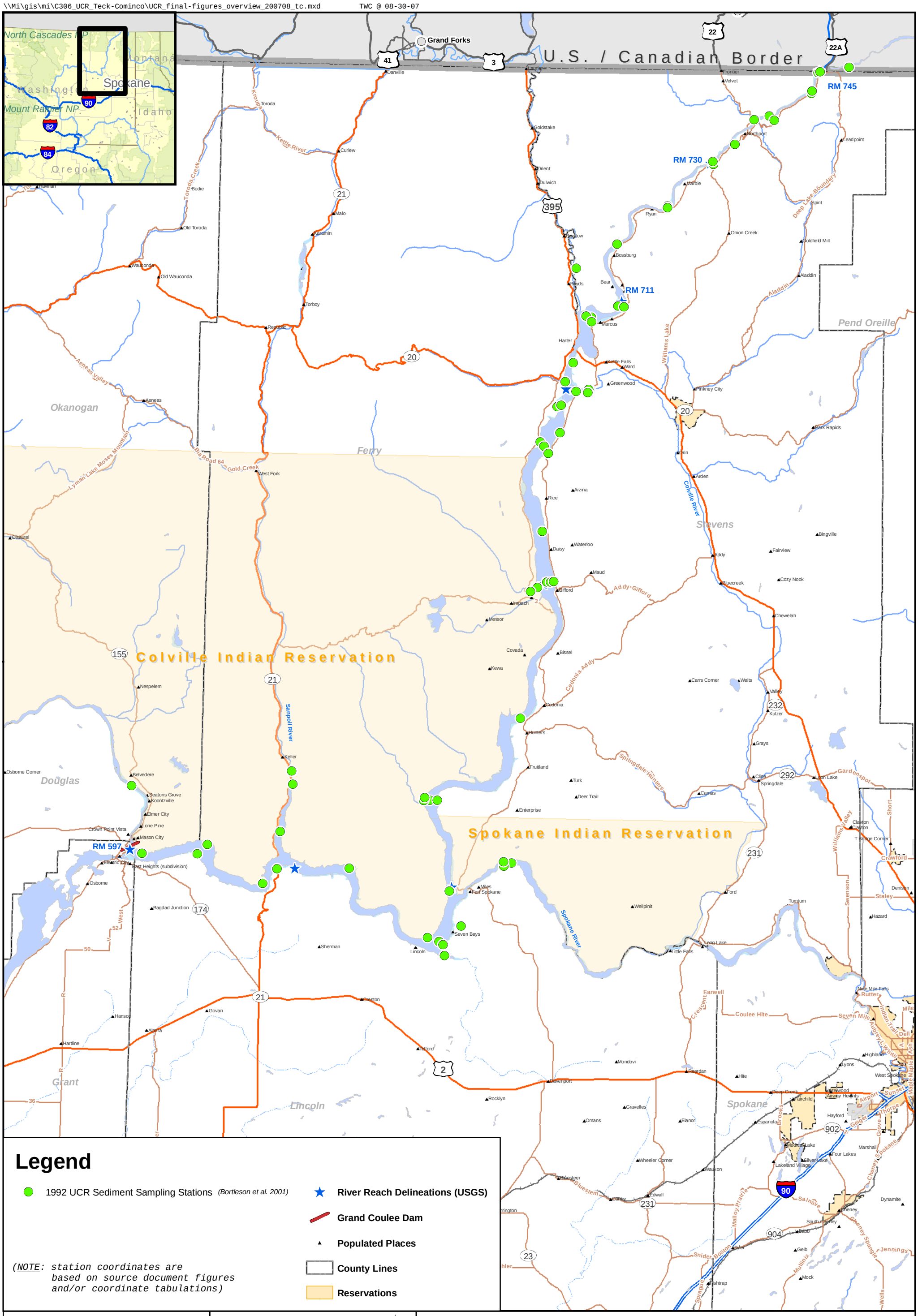

Integral Parametrix

Map E2

1992 UCR Sediment Sampling Stations (Source: Bortleson *et al.* 2001)

Upper Columbia River, WA

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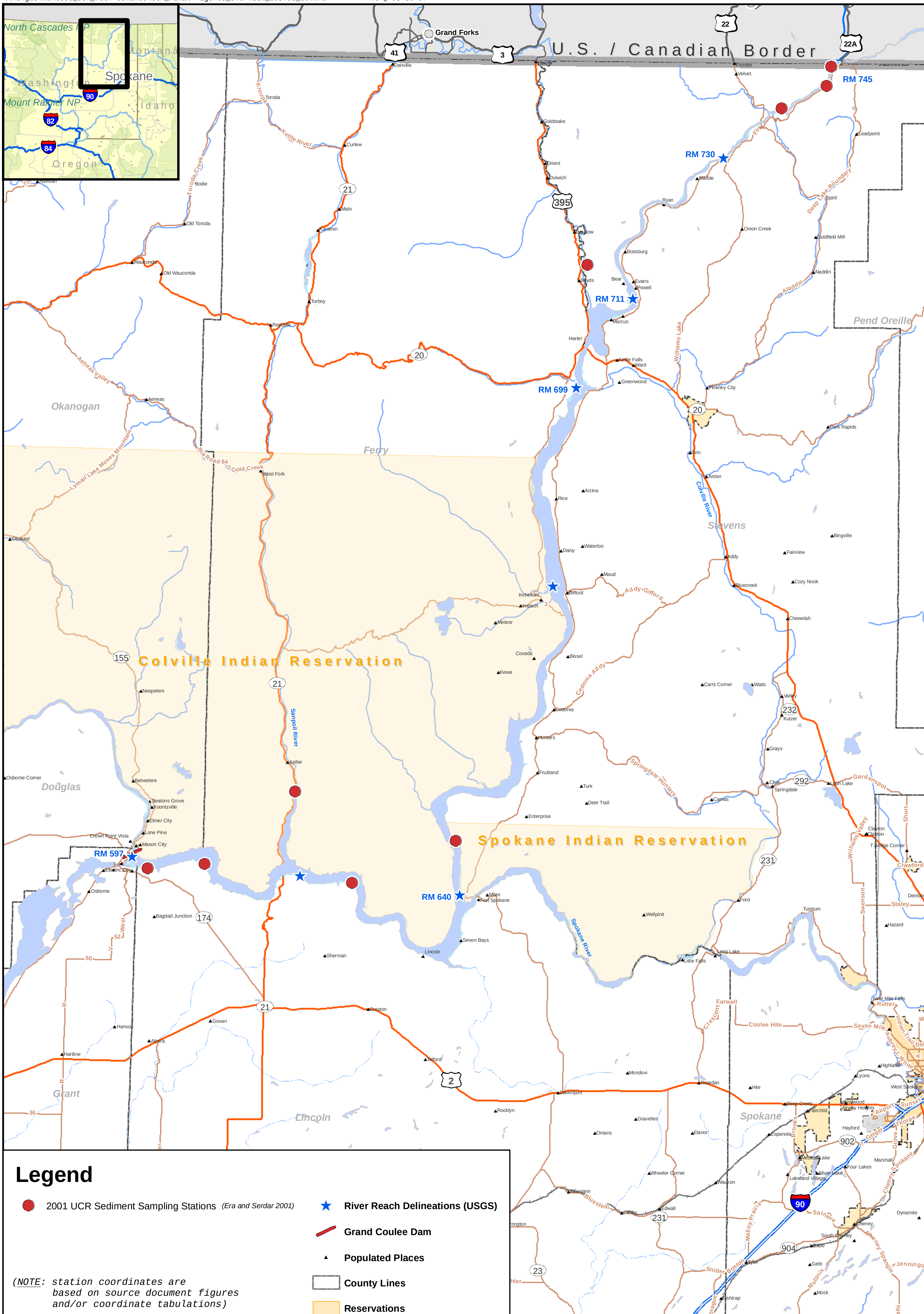

Integral Parametrix

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Miles 0 5 10

N

Map E3

2001 UCR Sediment Sampling Stations (Source: Era and Serdar 2001)

Upper Columbia River, WA

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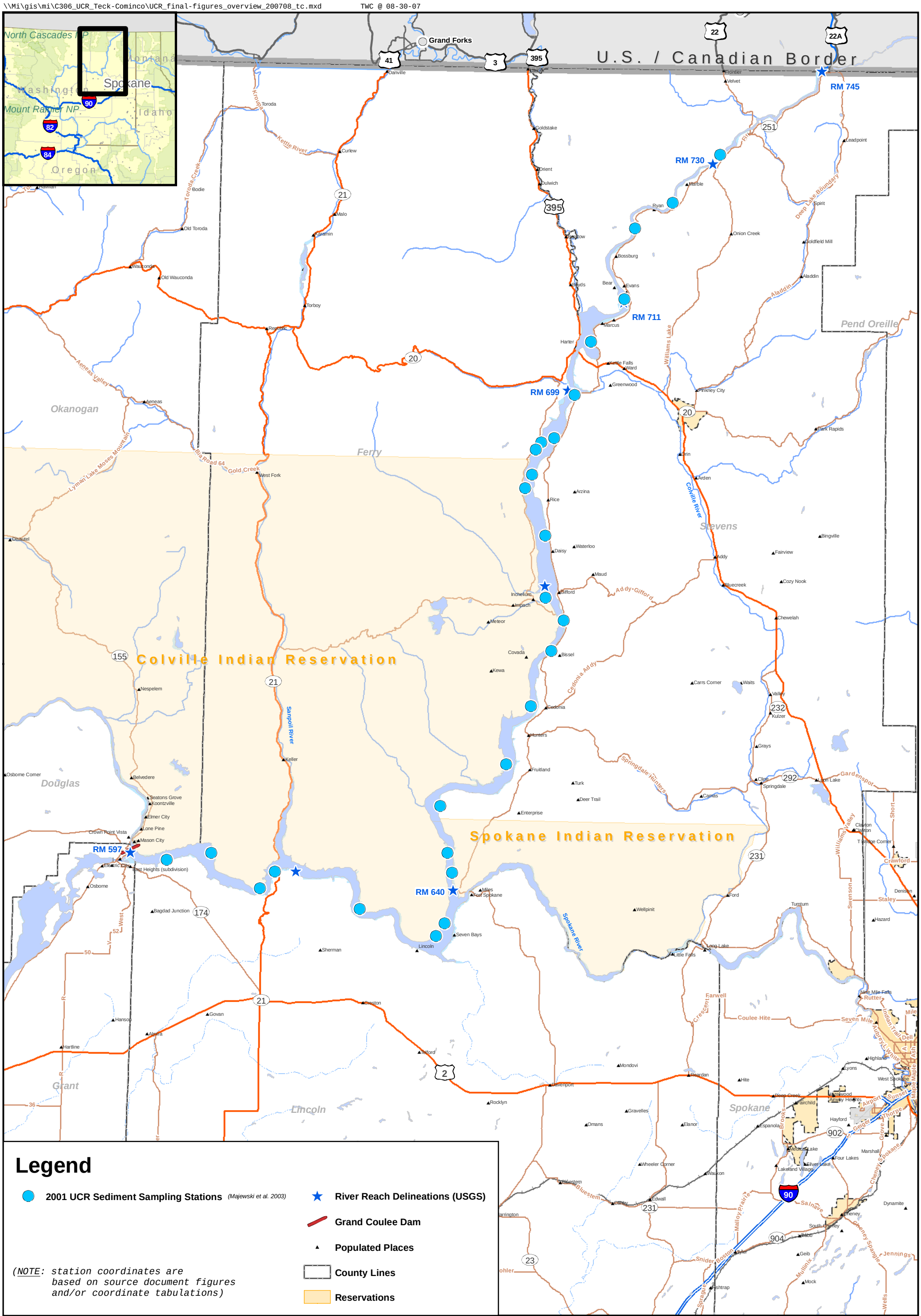

Integral Parametrix

Map E4

2001 UCR Sediment Sampling Stations (Source: Majewski *et al.* 2003)

Upper Columbia River, WA

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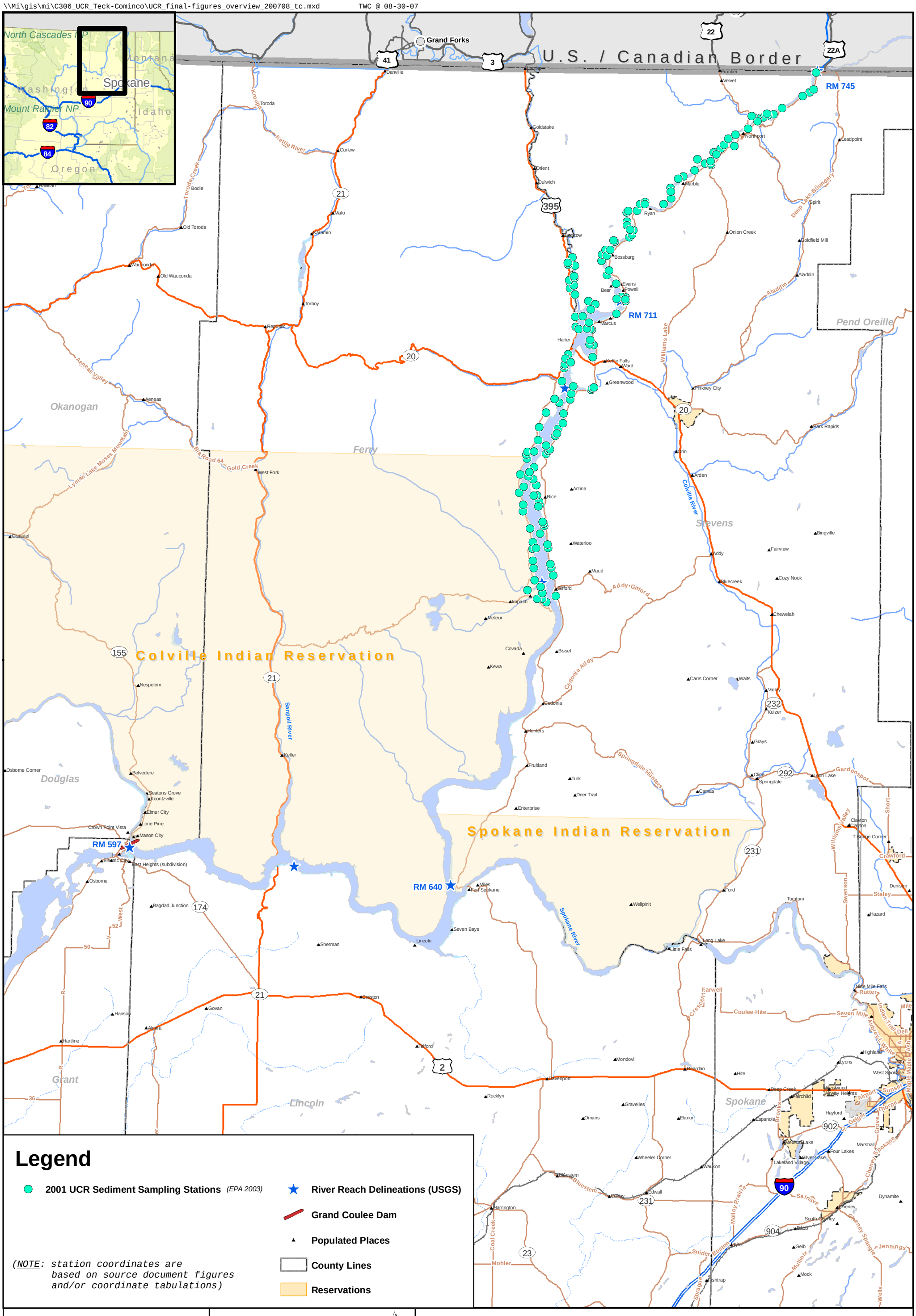

Integral Parametrix

Map E5 **2001 UCR Sediment Sampling Stations (Source: EPA 2003)**

Upper Columbia River, WA

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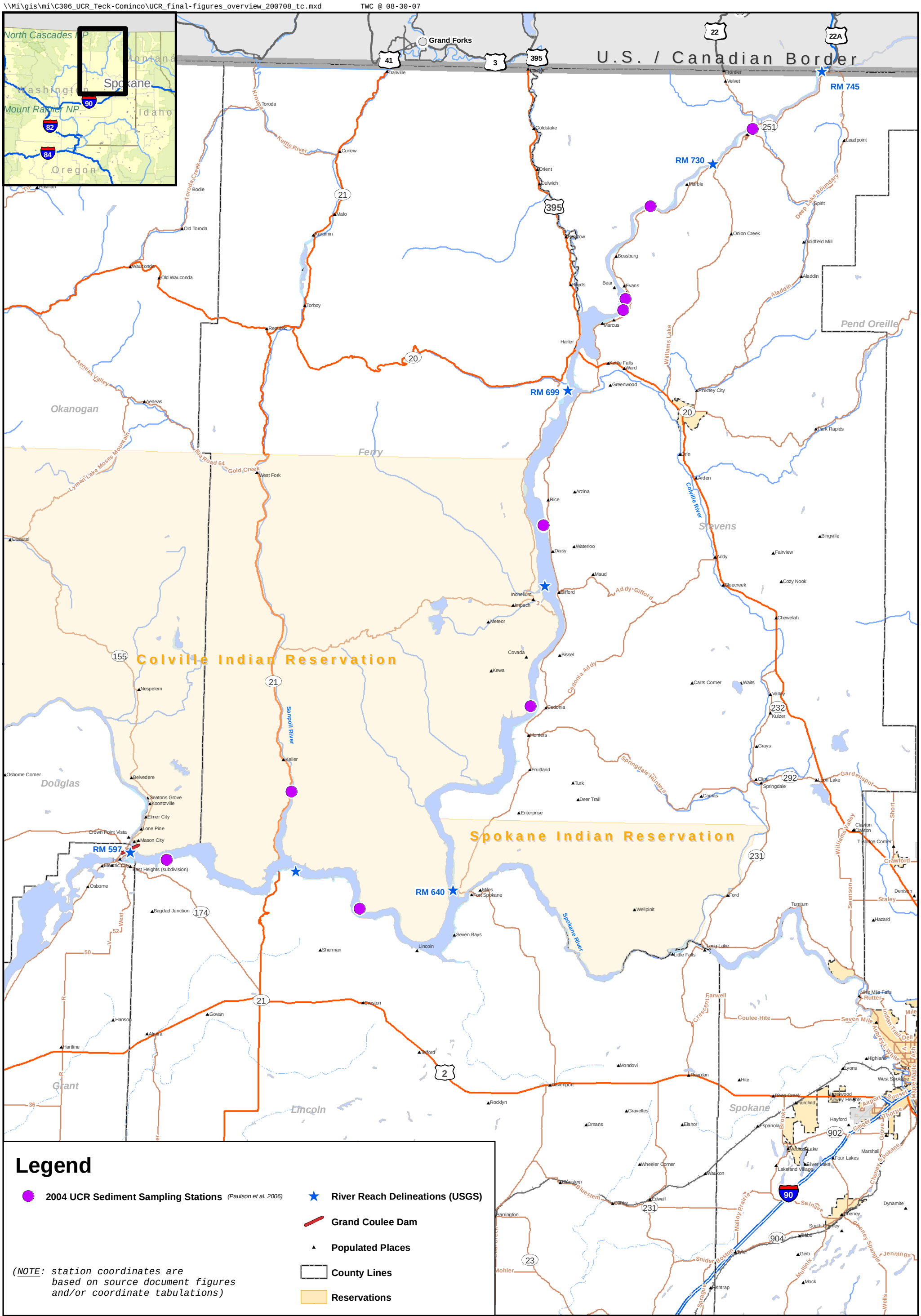

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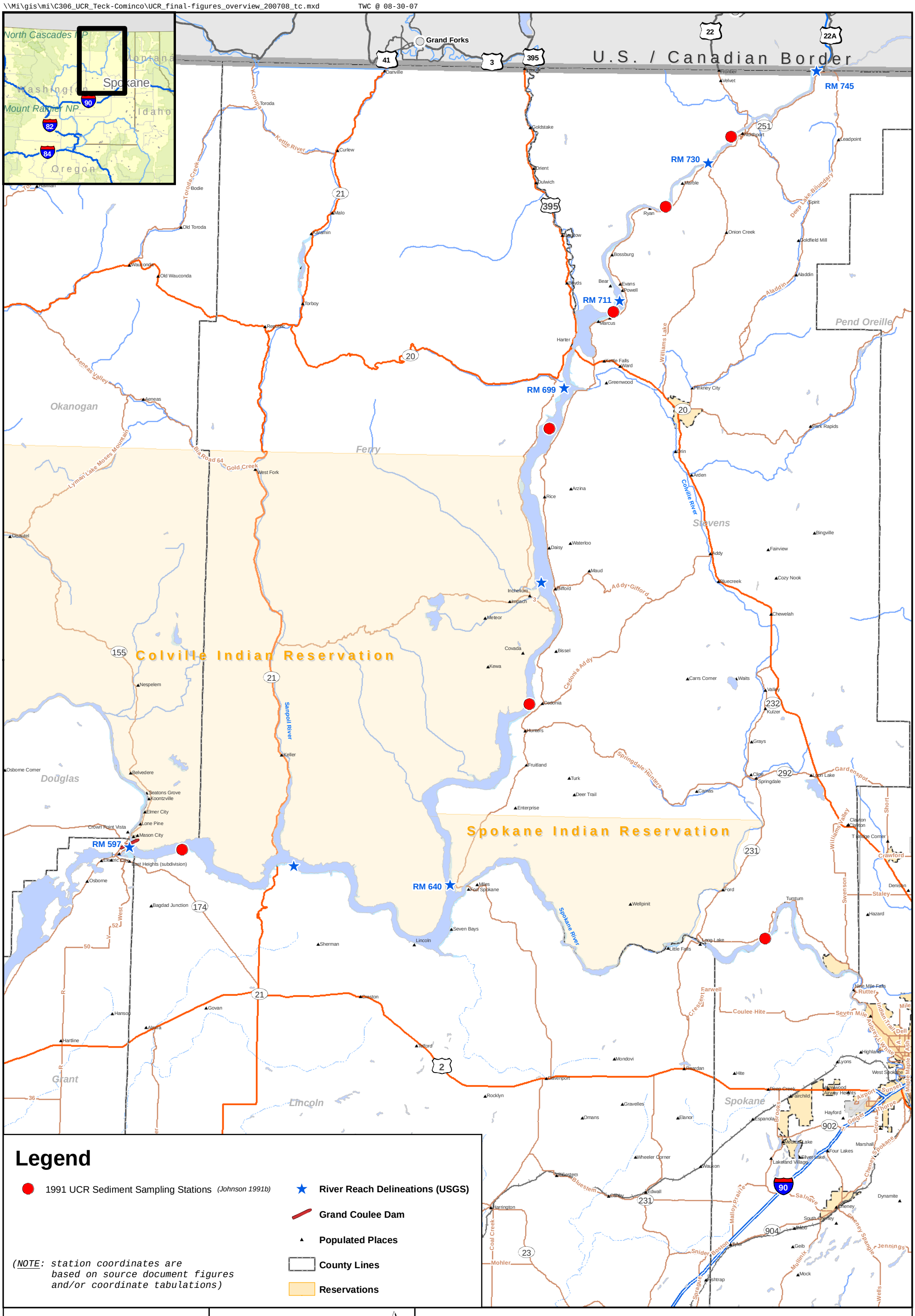
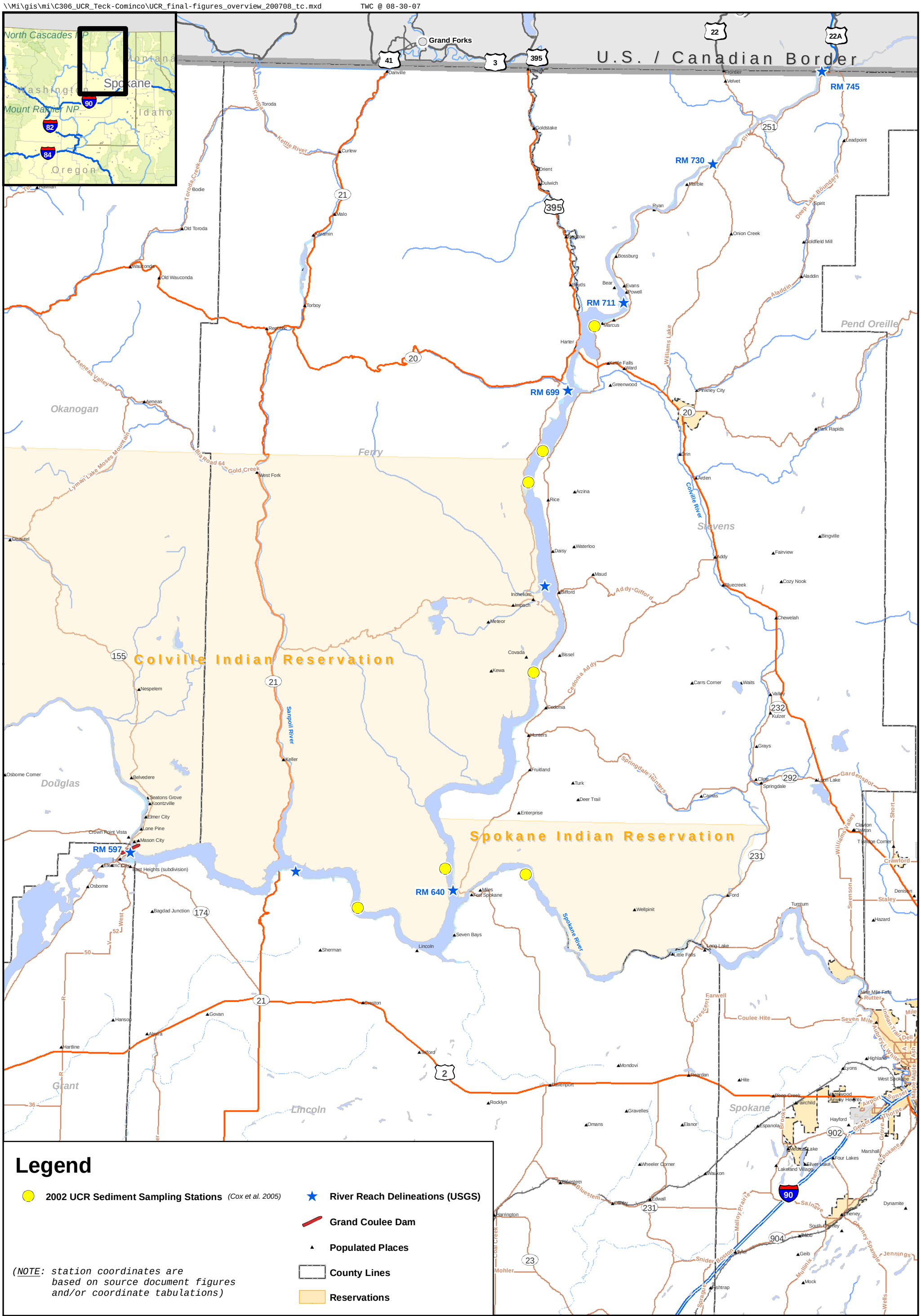


Integral Parametrix

Map E7

1991 UCR Sediment Sampling Stations (Source: Johnson 1991b)

Upper Columbia River, WA


U.S. / Canadian Border
Grand Forks
RM 745
RM 730
RM 711
RM 699
RM 597
RM 640
Colville Indian Reservation
Spokane Indian Reservation
Okanogan
Ferry
Stevens
Pend Oreille
Douglas
Lincoln
Spokane
Grant
Legend
2002 UCR Sediment Sampling Stations (Cox et al. 2005)
River Reach Delineations (USGS)
Grand Coulee Dam
Populated Places
County Lines
Reservations
(NOTE: station coordinates are based on source document figures and/or coordinate tabulations)
Integral Parametrix
Km
0 5 10
Miles
0 5 10
N
Map E8
2002 UCR Sediment Sampling Stations
(Source: Cox et al. 2005)
Upper Columbia River, WA

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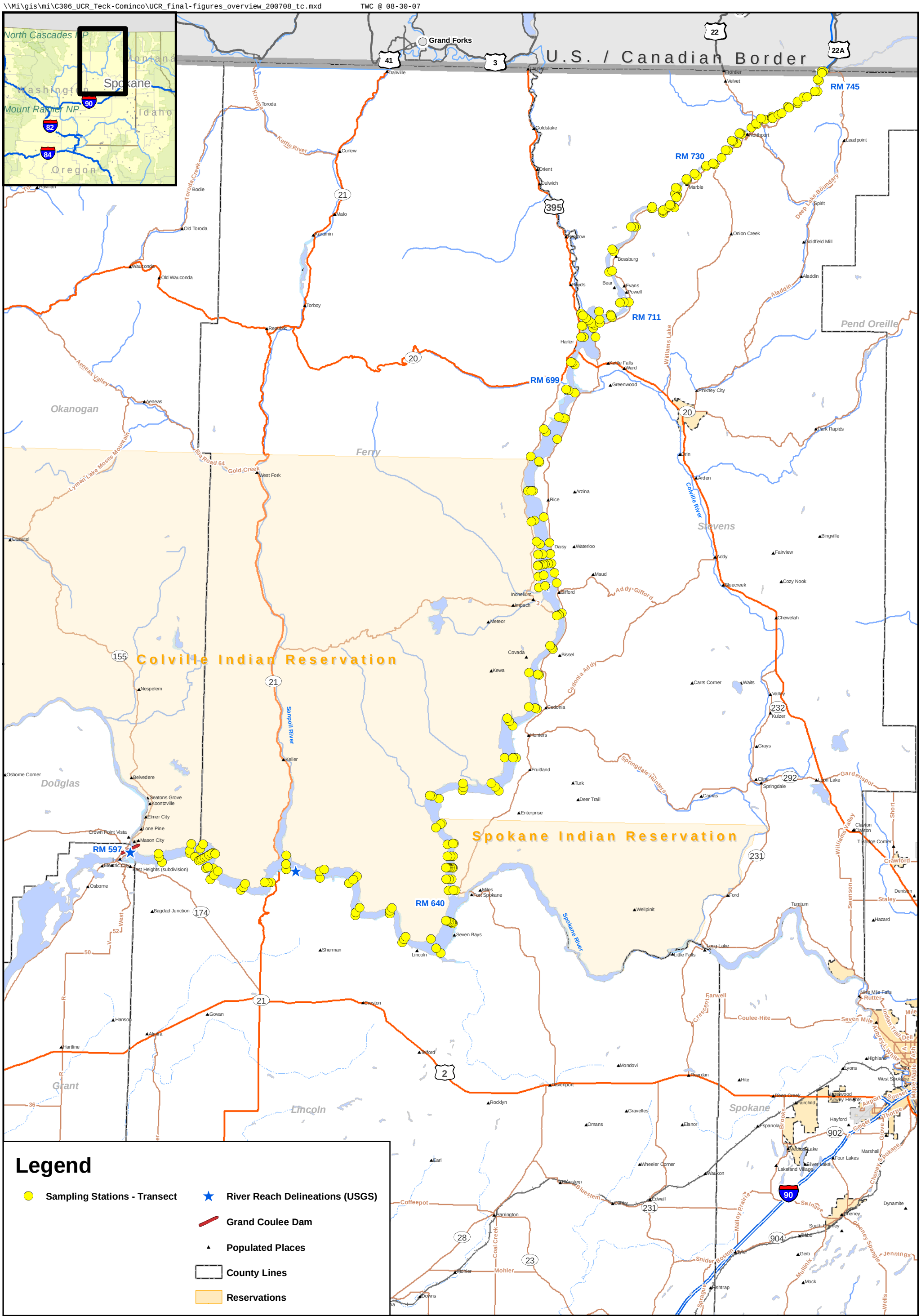

Integral Parametrix

Map E9

Transect Sampling Stations
2005 Phase 1 Study
Upper Columbia River, WA

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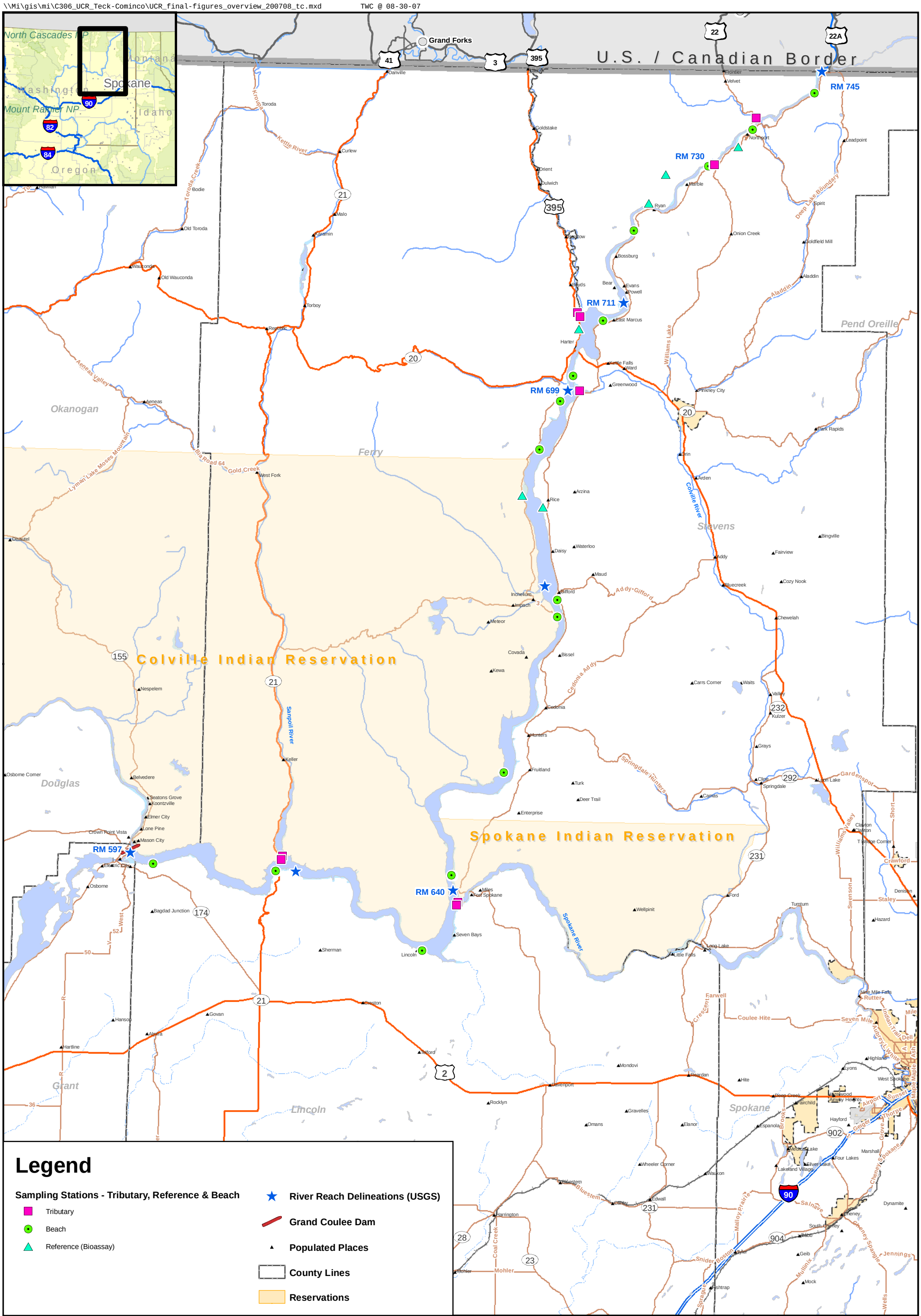

Integral Parametrix

Km 0 5 10

Miles 0 5 10

N

Map E10

Tributary, Reference and Beach Sampling Stations
2005 Phase 1 Study
Upper Columbia River, WA

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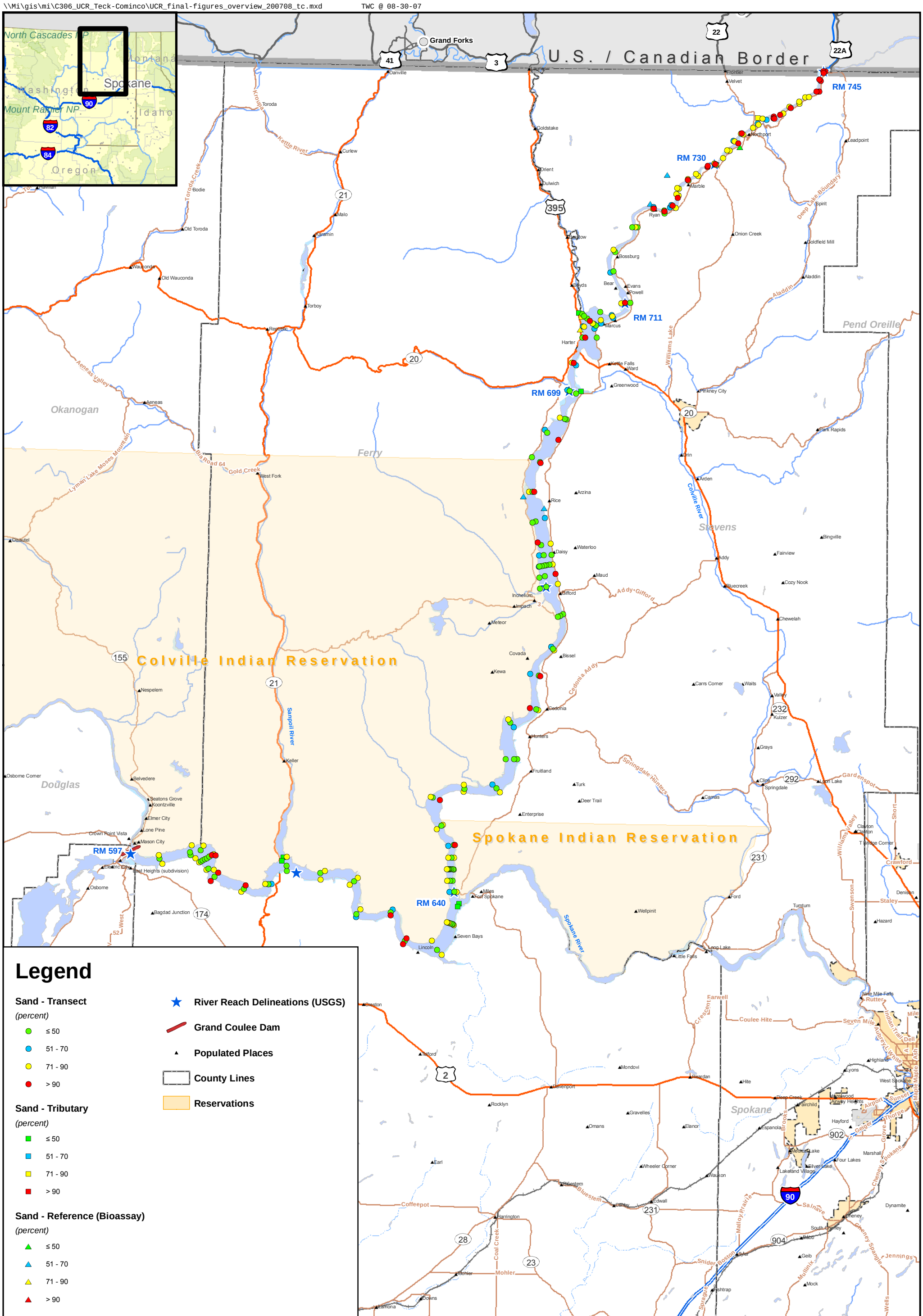

Legend

Sand - Transect
(percent)
- ≤ 50
- 51 - 70
- 71 - 90
- > 90

Sand - Tributary
(percent)
- ≤ 50
- 51 - 70
- 71 - 90
- > 90

Sand - Reference (Bioassay)
(percent)
- ≤ 50
- 51 - 70
- 71 - 90
- > 90

- River Reach Delineations (USGS)
- Grand Coulee Dam
- Populated Places
- County Lines
- Reservations

Integral Parametrix

Km: 0 5 10
Miles: 0 5 10
N

Map E11

Percentage Sand in Surface Sediments
2005 Phase 1 Study
Upper Columbia River, WA

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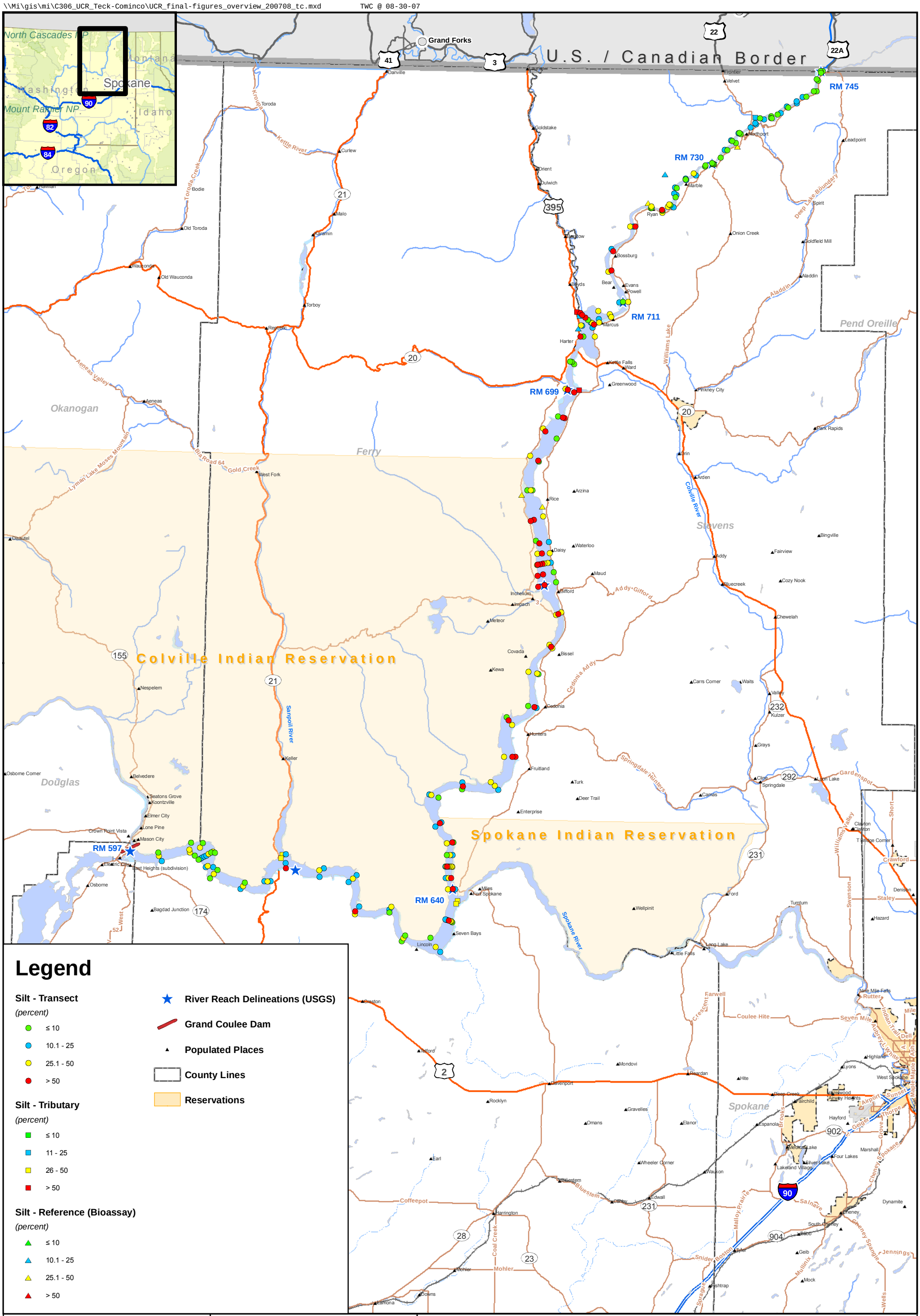

Integral Parametrix

Map E12

Percentage Silt in Surface Sediments
2005 Phase 1 Study
Upper Columbia River, WA

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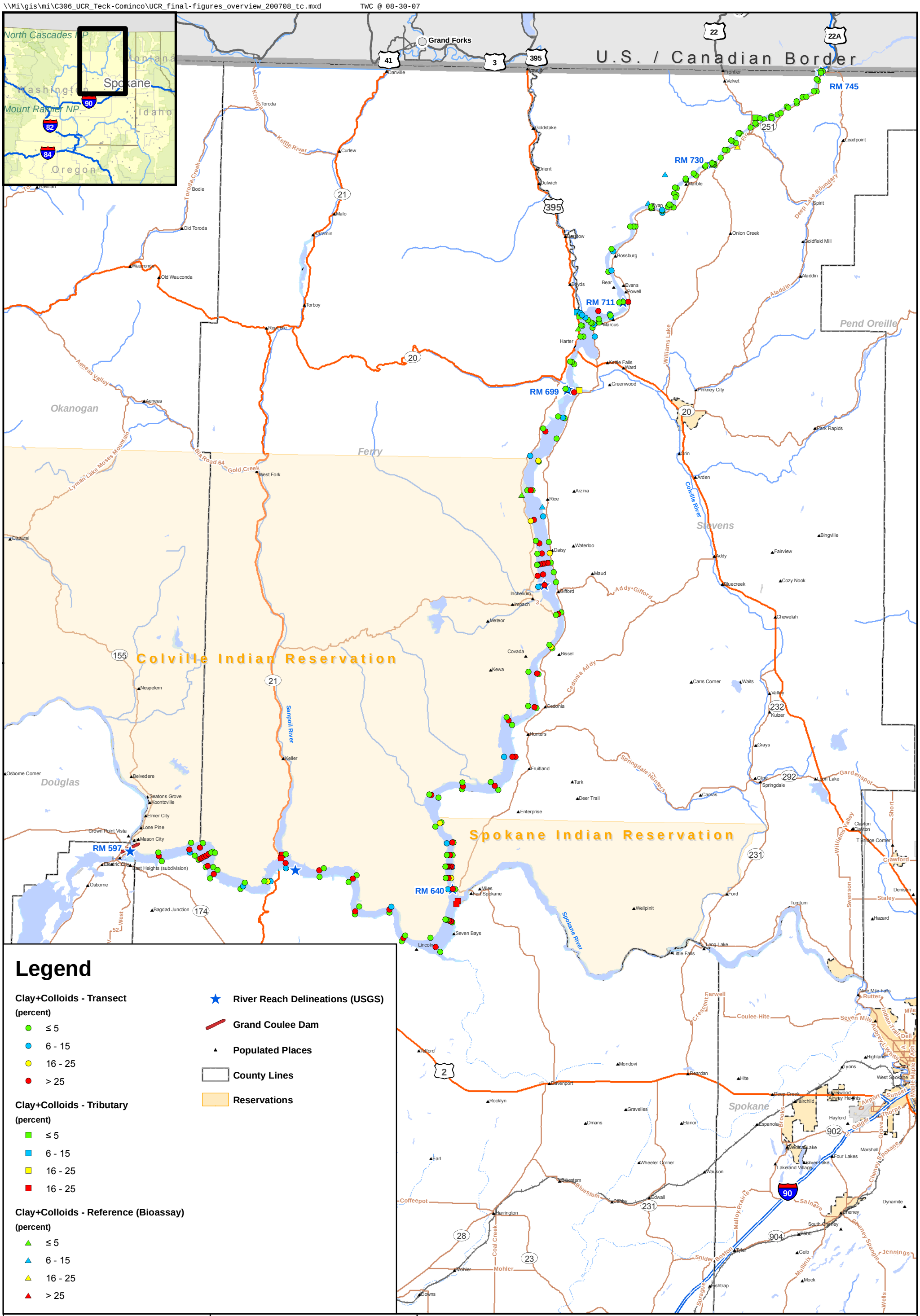

Integral Parametrix

Map E13

Percentage Clay + Colloids in Surface Sediments
2005 Phase 1 Study
Upper Columbia River, WA

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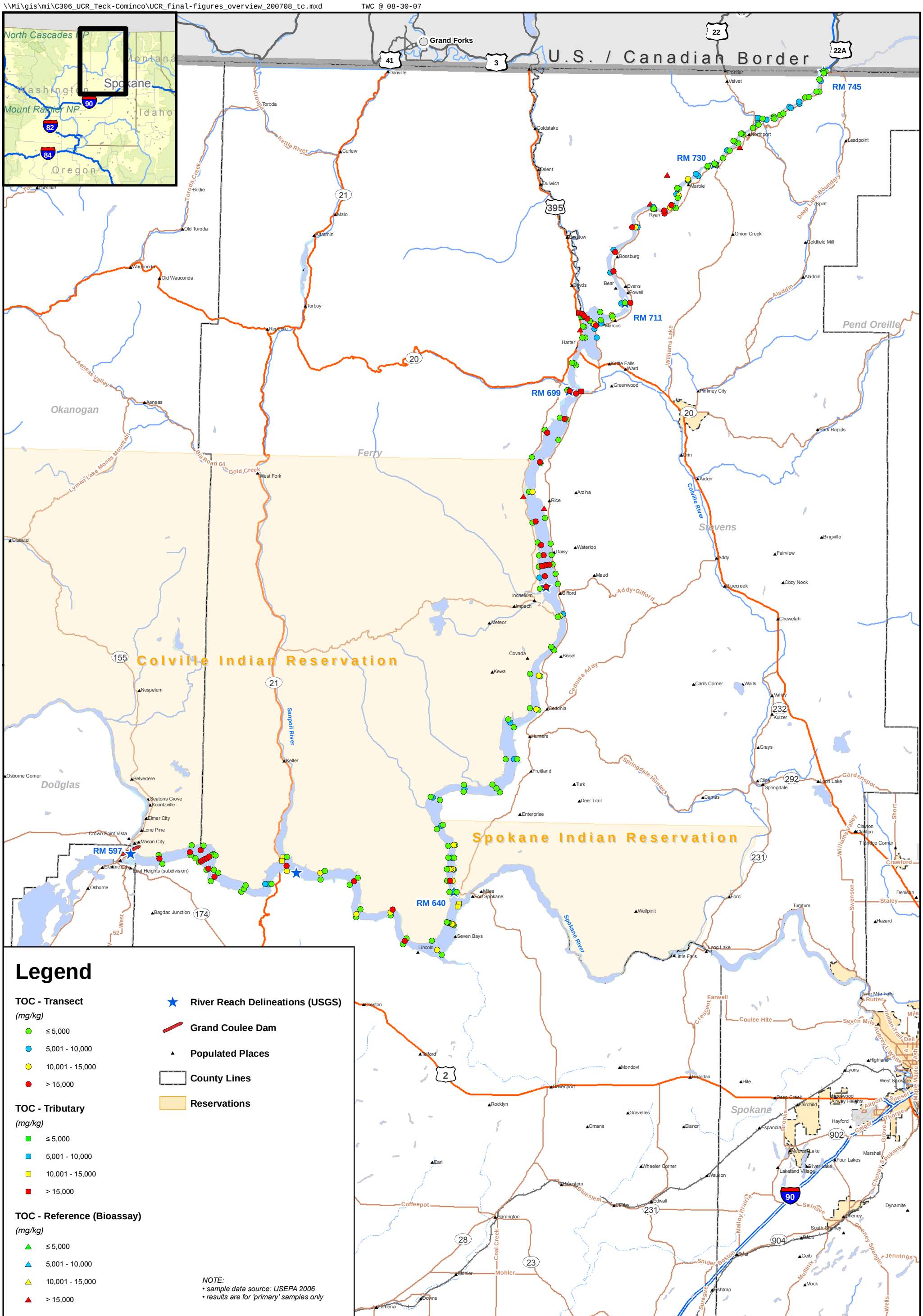

Integral Parametrix

Map E14

Percentage Total Organic Carbon in Surface Sediments
2005 Phase 1 Study
Upper Columbia River, WA

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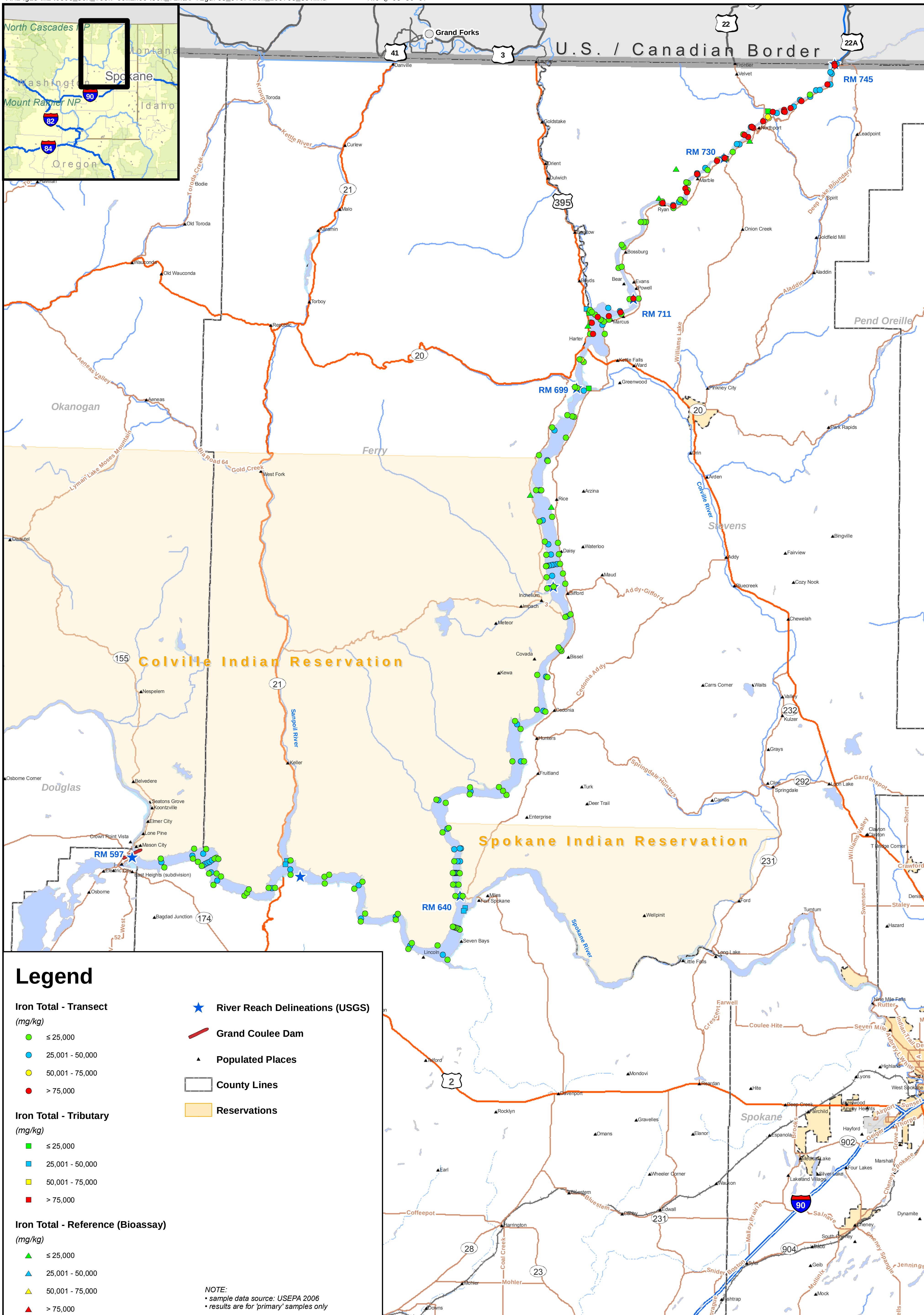

Legend

Iron Total - Transect
(mg/kg)
- ≤ 25,000
- 25,001 - 50,000
- 50,001 - 75,000
- > 75,000

Iron Total - Tributary
(mg/kg)
- ≤ 25,000
- 25,001 - 50,000
- 50,001 - 75,000
- > 75,000

Iron Total - Reference (Bioassay)
(mg/kg)
- ≤ 25,000
- 25,001 - 50,000
- 50,001 - 75,000
- > 75,000

- River Reach Delineations (USGS)
- Grand Coulee Dam
- Populated Places
- County Lines
- Reservations

NOTE:
• sample data source: USEPA 2006
• results are for 'primary' samples only

Integral **Parametrix**

Km 0 5 10
Miles 0 5 10

N

Map E15

Iron Concentrations in Surface Sediments
2005 Phase 1 Study
Upper Columbia River, WA

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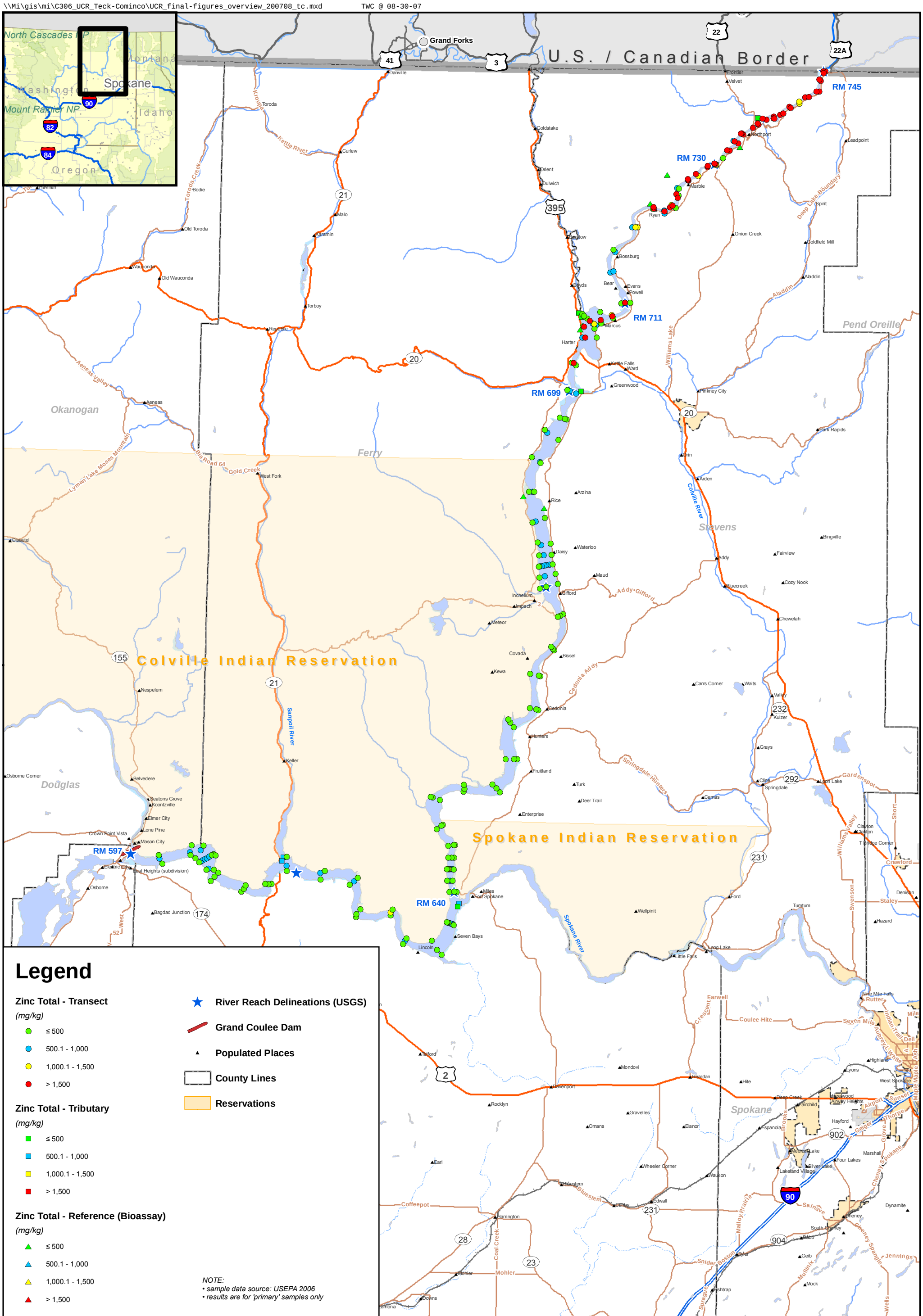

Integral Parametrix

Map E16

Zinc Concentrations in Surface Sediments
2005 Phase 1 Study
Upper Columbia River, WA

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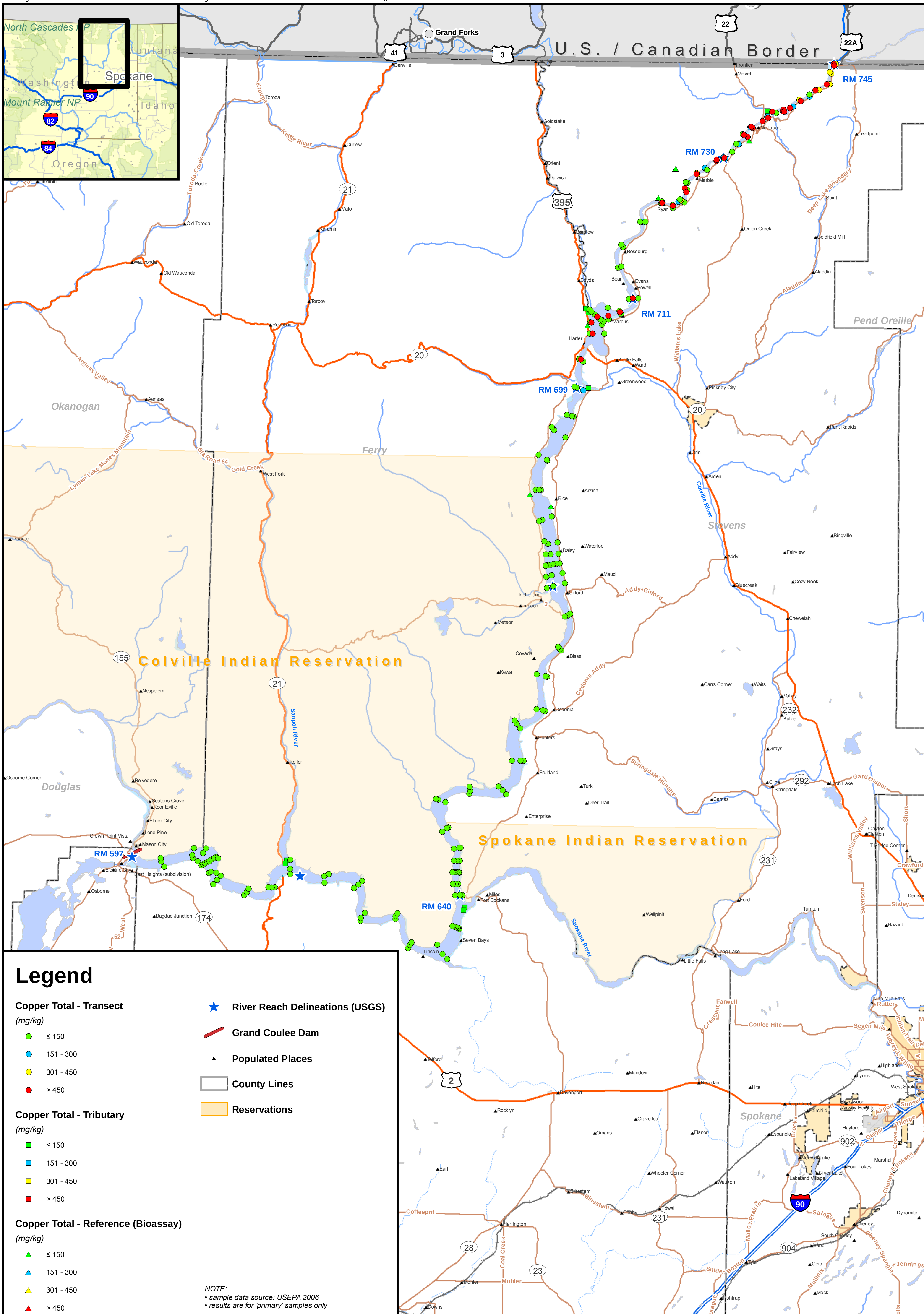

Integral Parametrix

Km 0 5 10

Miles 0 5 10

N

Map E17

Copper Concentrations in Surface Sediments
2005 Phase 1 Study
Upper Columbia River, WA

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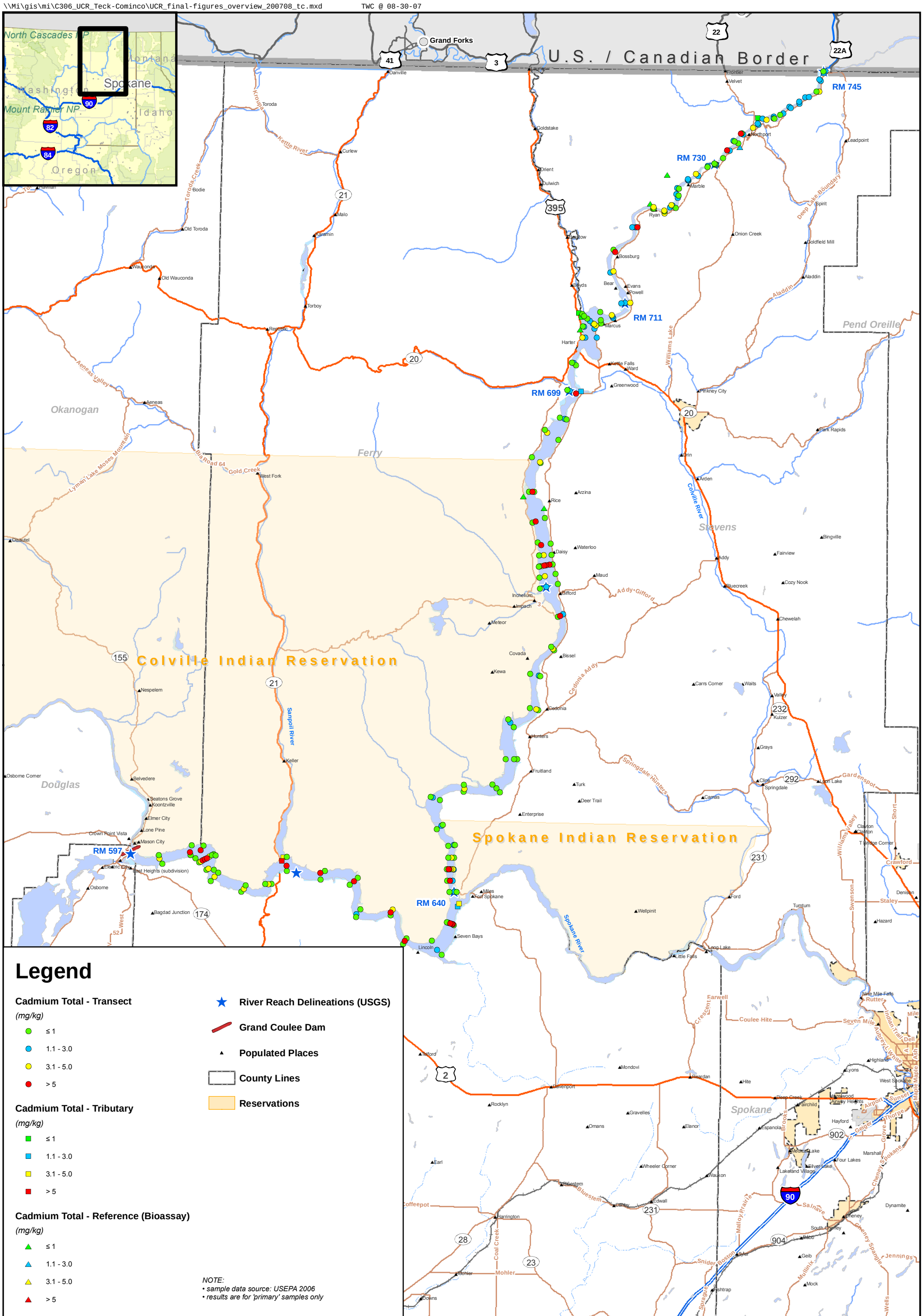
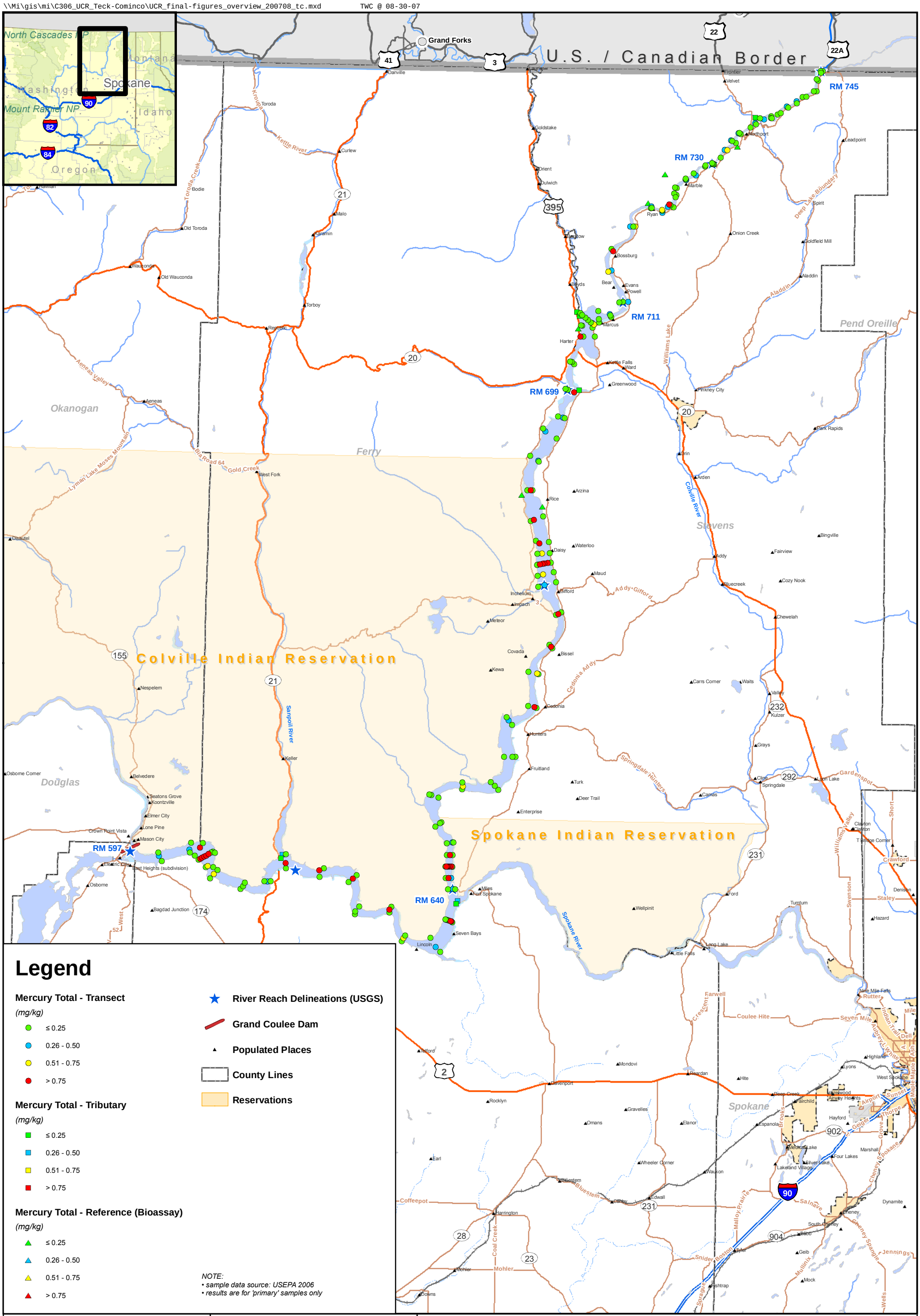


Integral Parametrix

Map E18

Cadmium Concentrations in Surface Sediments
2005 Phase 1 Study
Upper Columbia River, WA



Integral Parametrix

Map E19

Mercury Concentrations in Surface Sediments
2005 Phase 1 Study
Upper Columbia River, WA

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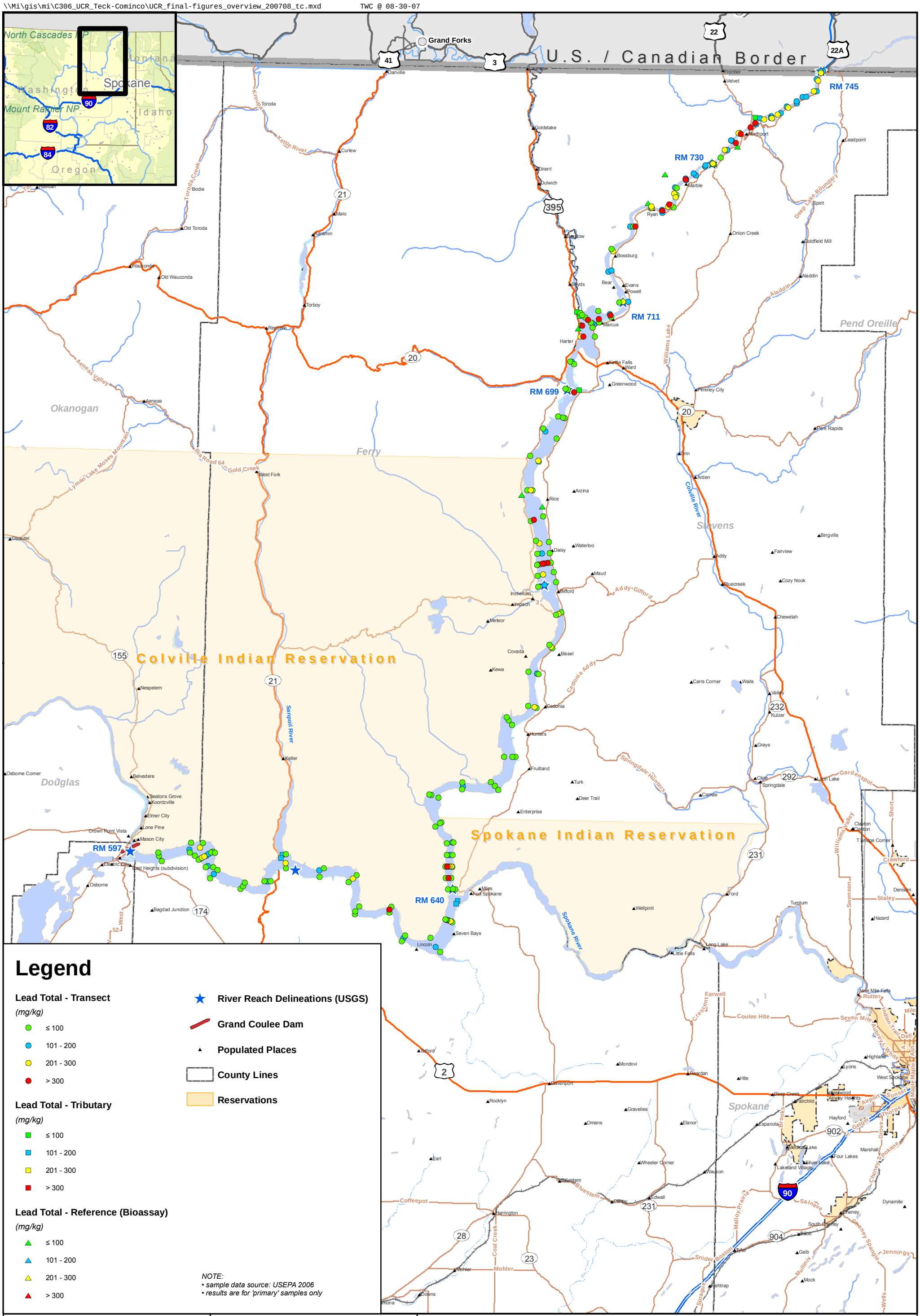


Legend

Lead Total - Transect
(mg/kg)
- ≤ 100
- 101 - 200
- 201 - 300
- > 300

Lead Total - Tributary
(mg/kg)
- ≤ 100
- 101 - 200
- 201 - 300
- > 300

Lead Total - Reference (Bioassay)
(mg/kg)
- ≤ 100
- 101 - 200
- 201 - 300
- > 300

- River Reach Delineations (USGS)
- Grand Coulee Dam
- Populated Places
- County Lines
- Reservations

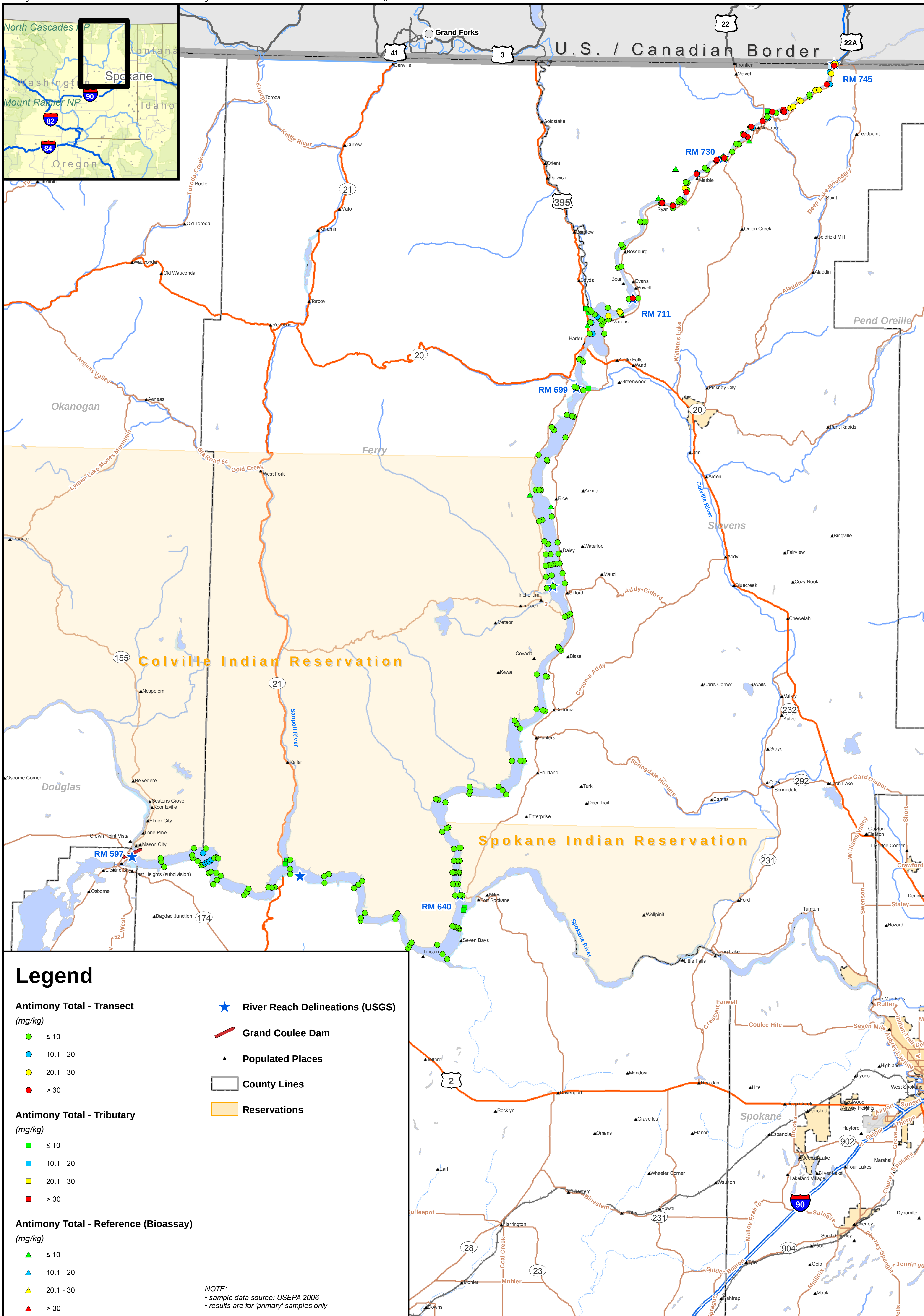
NOTE:
• sample data source: USEPA 2006
• results are for 'primary' samples only

Integral Parametrix

Km: 0 5 10
Miles: 0 5 10
N

Map E20

Lead Concentrations in Surface Sediments
2005 Phase 1 Study
Upper Columbia River, WA



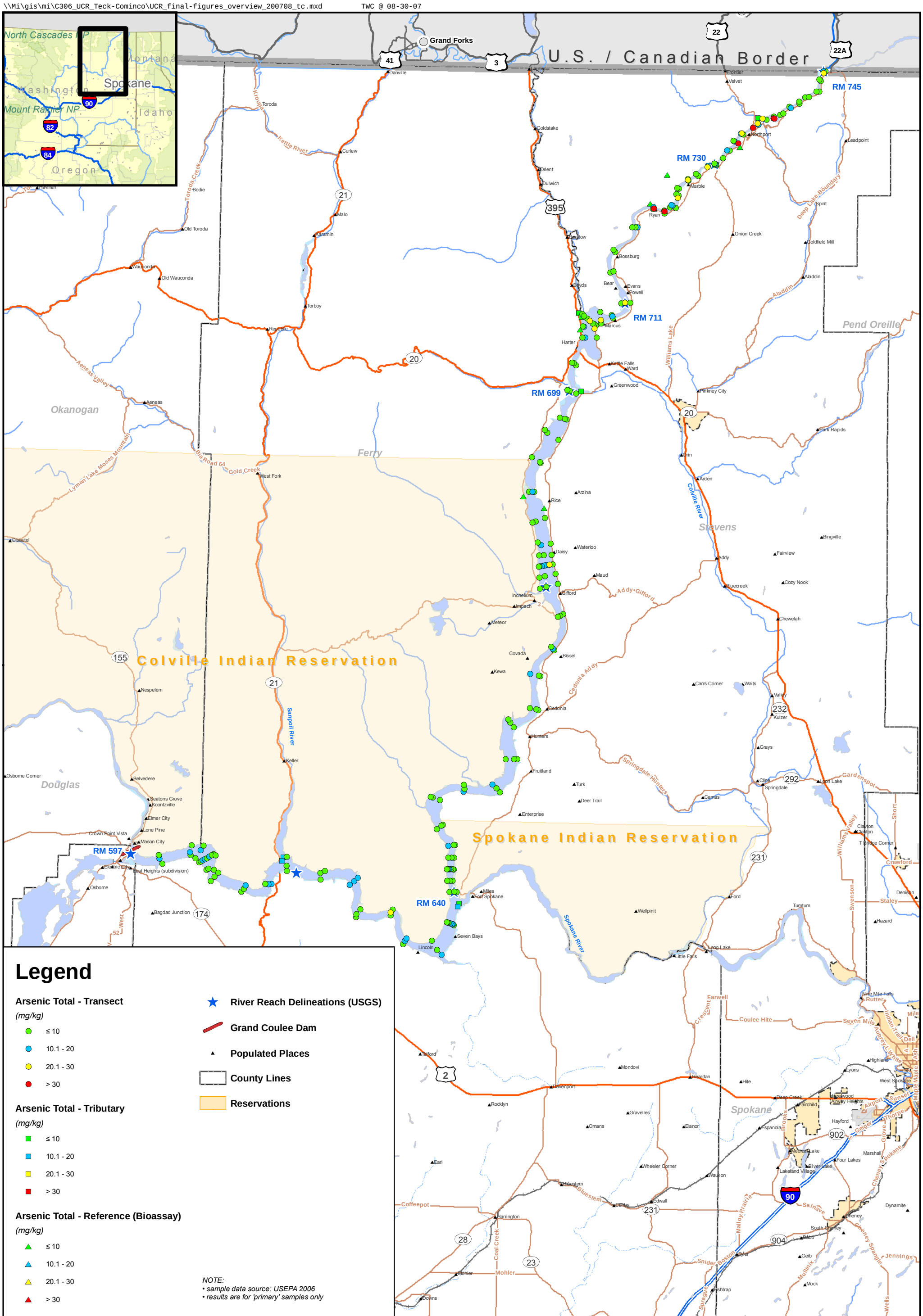
Integral Parametrix

Km 0 5 10
Miles 0 5 10
N

Map E21

Antimony Concentrations in Surface Sediments
2005 Phase 1 Study
Upper Columbia River, WA

\\Mi\gis\mi\C306_UCR_Teck-Cominco\UCR_final-figures_overview_200708_tc.mxd TWC @ 08-30-07

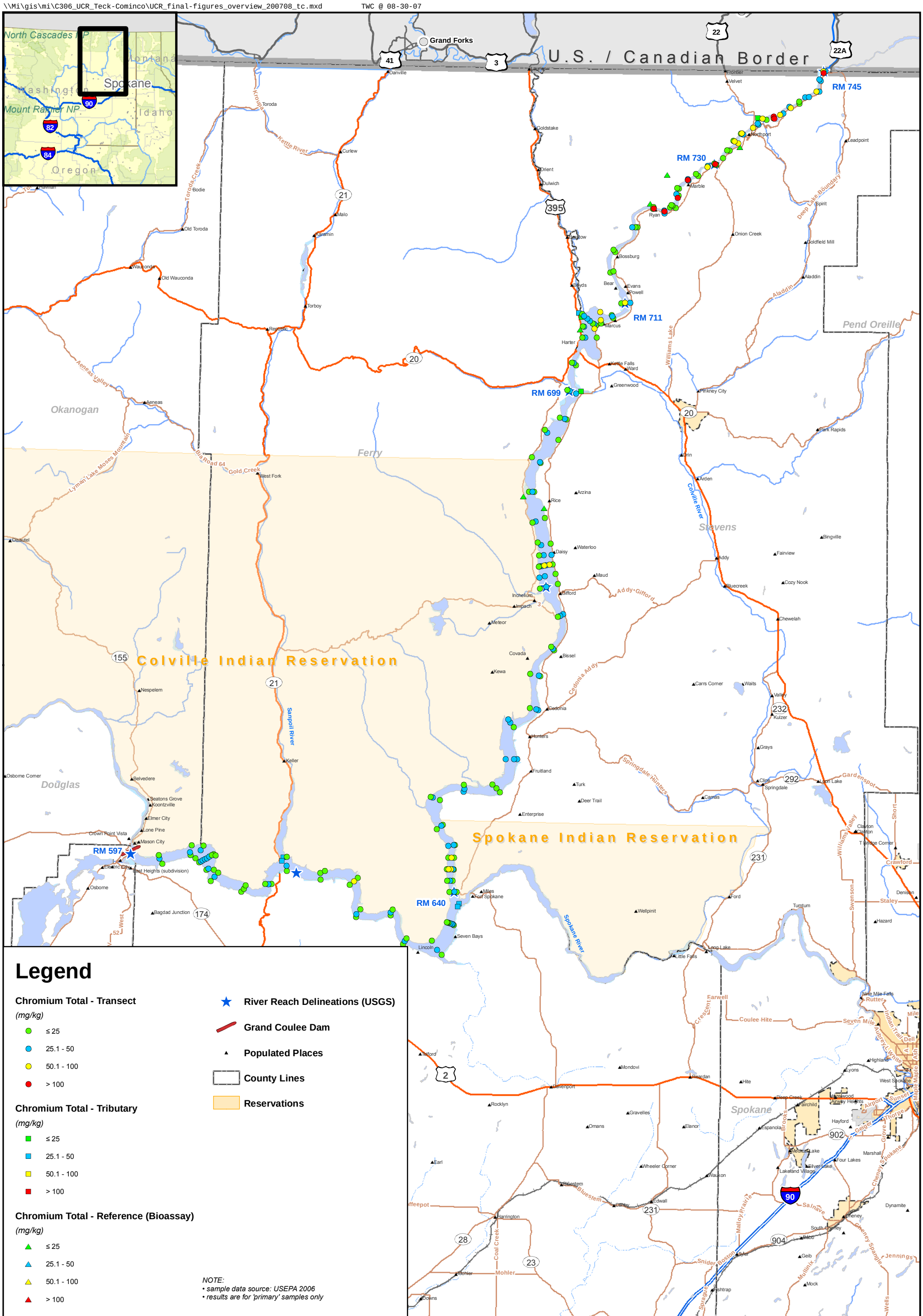


Integral Parametrix

Map E22

Arsenic Concentrations in Surface Sediments
2005 Phase 1 Study
Upper Columbia River, WA

\\Mi\gis\mi\C306_UCR_Teck-Cominco\UCR_final-figures_overview_200708_tc.mxd TWC @ 08-30-07

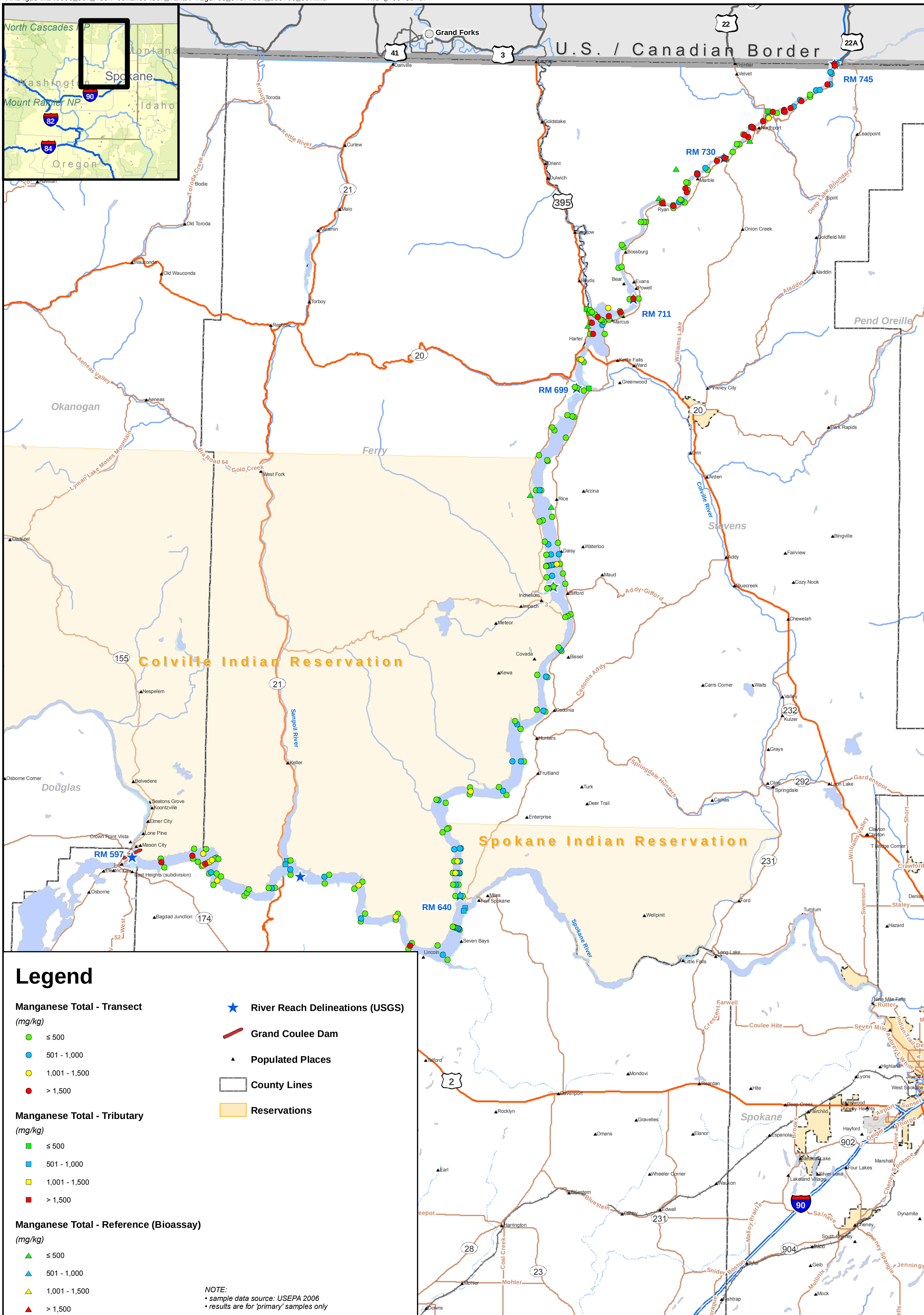


Integral Parametrix

Map E23

Chromium Concentrations in Surface Sediments
2005 Phase 1 Study
Upper Columbia River, WA

\\Mi\gis\mi\C306_UCR_Teck-Cominco\UCR_final-figures_overview_200708_tc.mxd TWC @ 08-30-07



Legend

Manganese Total - Transect

(mg/kg)

- ≤ 500
- 501 - 1,000
- 1,001 - 1,500
- > 1,500

Manganese Total - Tributary

(mg/kg)

- ≤ 500
- 501 - 1,000
- 1,001 - 1,500
- > 1,500

Manganese Total - Reference (Bioassay)

(mg/kg)

- ≤ 500
- 501 - 1,000
- 1,001 - 1,500
- > 1,500

River Reach Delineations (USGS)

Grand Coulee Dam

Populated Places

County Lines

Reservations

NOTE:
- *sample data source: USEPA 2006*
- *results are for 'primary' samples only*

Integral **Parametrix**

Km: 0 5 10

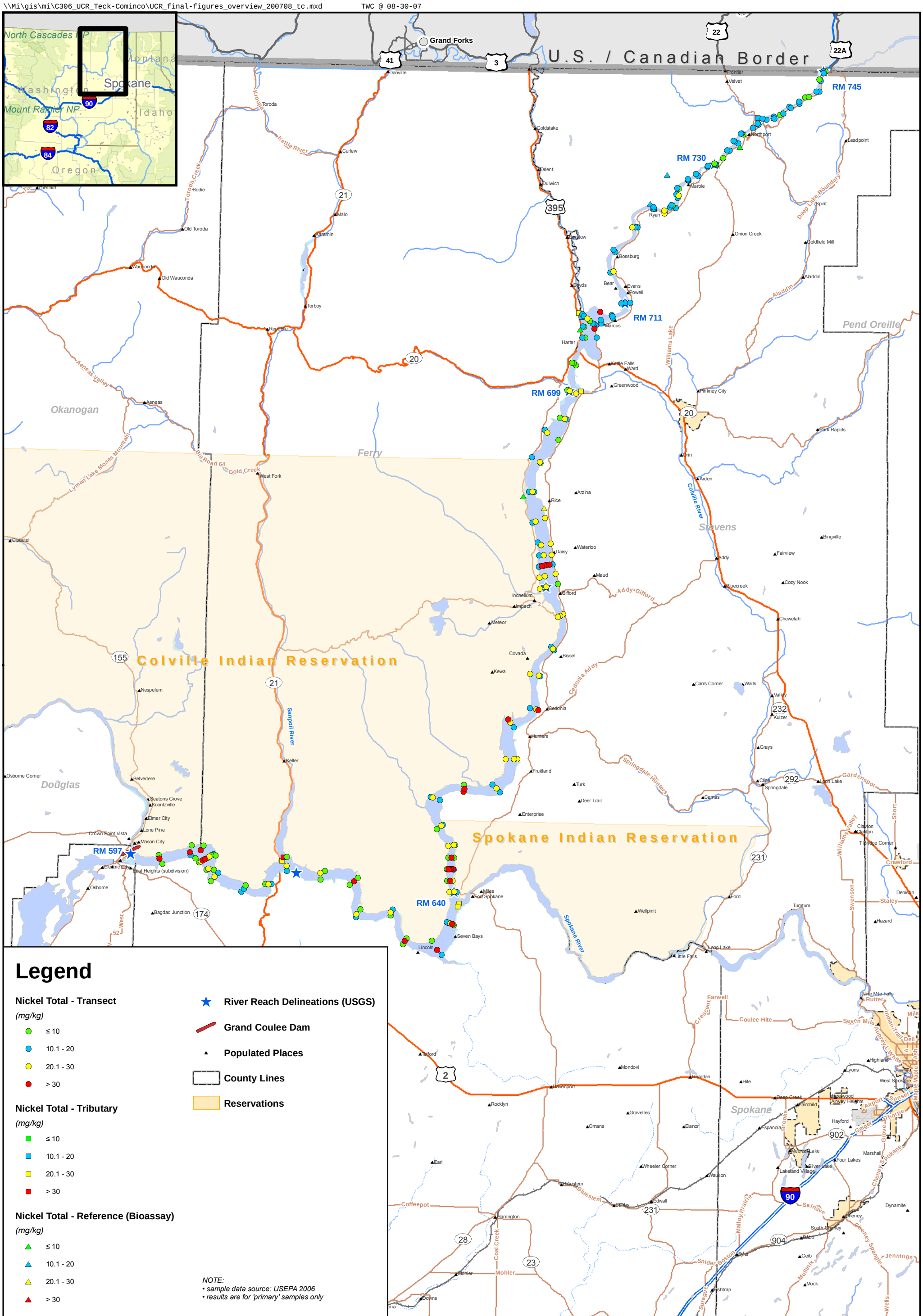
Miles: 0 5 10

N

Map E24

Manganese Concentrations in Surface Sediments
2005 Phase 1 Study
Upper Columbia River, WA

\\Mi\gis\mi\C306_UCR_Teck-Cominco\UCR_final-figures_overview_200708_tc.mxd TWC @ 08-30-07

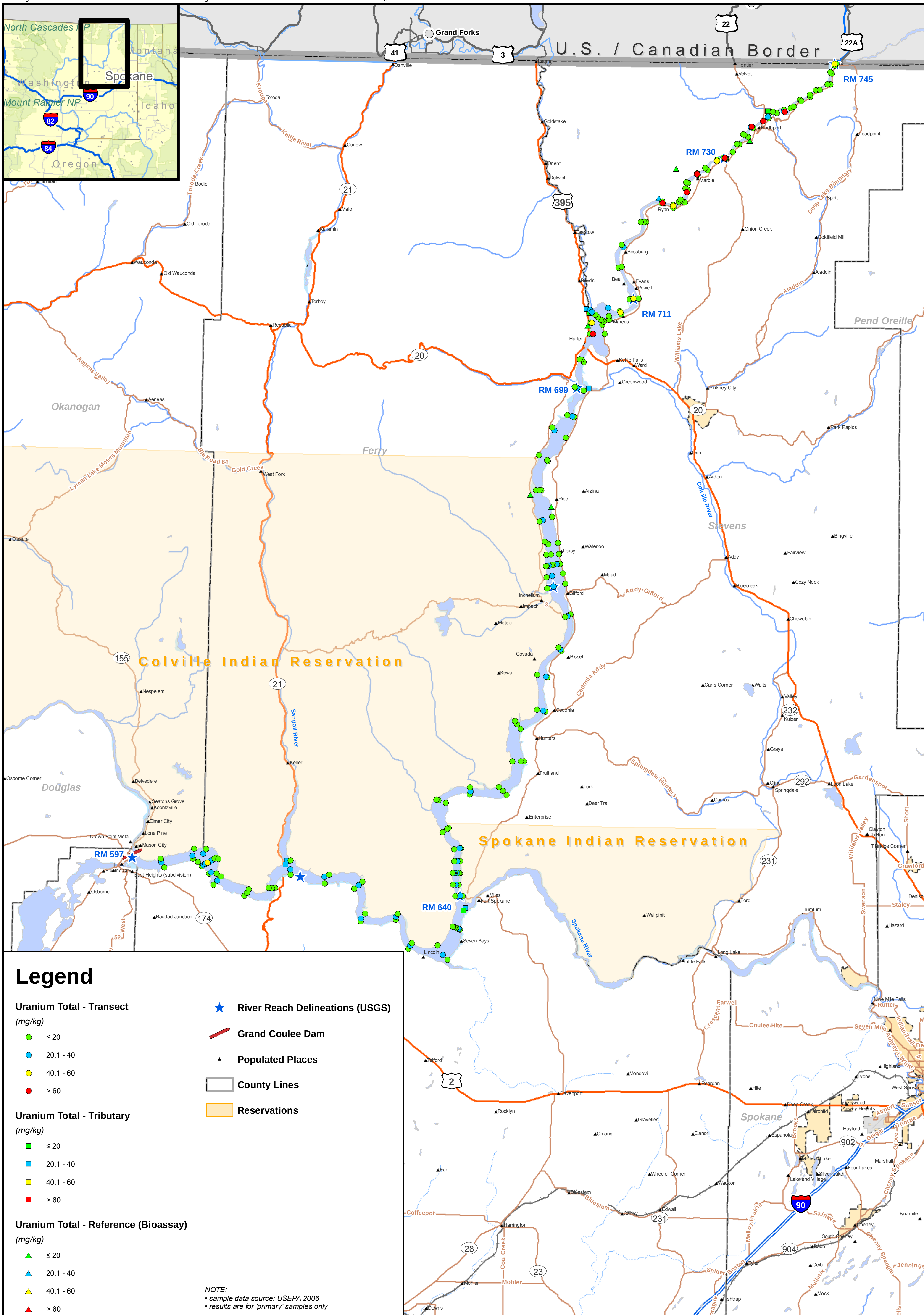


Integral Parametrix

Map E25

Nickel Concentrations in Surface Sediments
2005 Phase 1 Study
Upper Columbia River, WA

\\Mi\gis\mi\C306_UCR_Teck-Cominco\UCR_final-figures_overview_200708_tc.mxd TWC @ 08-30-07



Integral Parametrix

Km 0 5 10
Miles 0 5 10
N

Map E26

Uranium Concentrations in Surface Sediments
2005 Phase 1 Study
Upper Columbia River, WA

ATTACHMENT E1

ORIGINAL STATION MAPS FROM USEPA (2006h)

CONTENTS

Figure 2-3. 2005 Sediment Sample Locations and Types, River Miles 732 to 744
Figure 2-4. 2005 Sediment Sample Locations and Types, River Miles 716 to 731
Figure 2-5. 2005 Sediment Sample Locations and Types, River Miles 697 to 715
Figure 2-6. 2005 Sediment Sample Locations and Types, River Miles 679 to 696
Figure 2-7. 2005 Sediment Sample Locations and Types, River Miles 663 to 678
Figure 2-8. 2005 Sediment Sample Locations and Types, River Miles 642 to 662
Figure 2-9. 2005 Sediment Sample Locations and Types, River Miles 634 to 641
Figure 2-10. 2005 Sediment Sample Locations and Types, River Miles 622 to 633
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Figure 2-22. AA Campground, 2005 Beach Sample Locations
Figure 2-23. Rogers Bar Campground, 2005 Beach Sample Locations
Figure 2-24. Columbia Campground, 2005 Beach Sample Locations
Figure 2-25. Lincoln Mill Boat Ramp, 2005 Beach Sample Locations
Figure 2-26. Kellers Ferry, 2005 Beach Sample Locations
Figure 2-27. Spring Canyon Campground, 2005 Beach Sample Locations

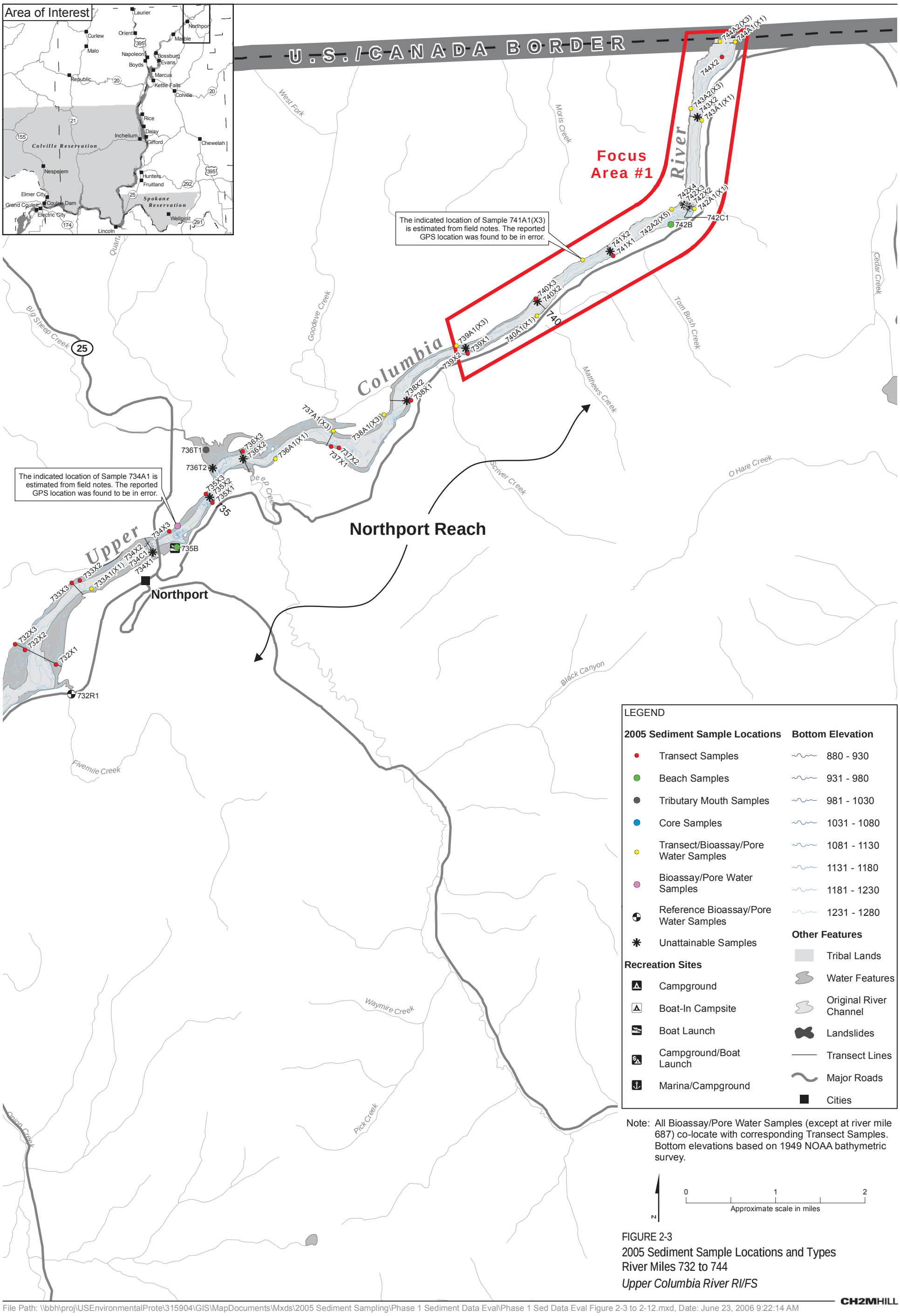

FIGURE 2-3
2005 Sediment Sample Locations and Types
River Miles 732 to 744
Upper Columbia River RI/FS

CH2MHILL

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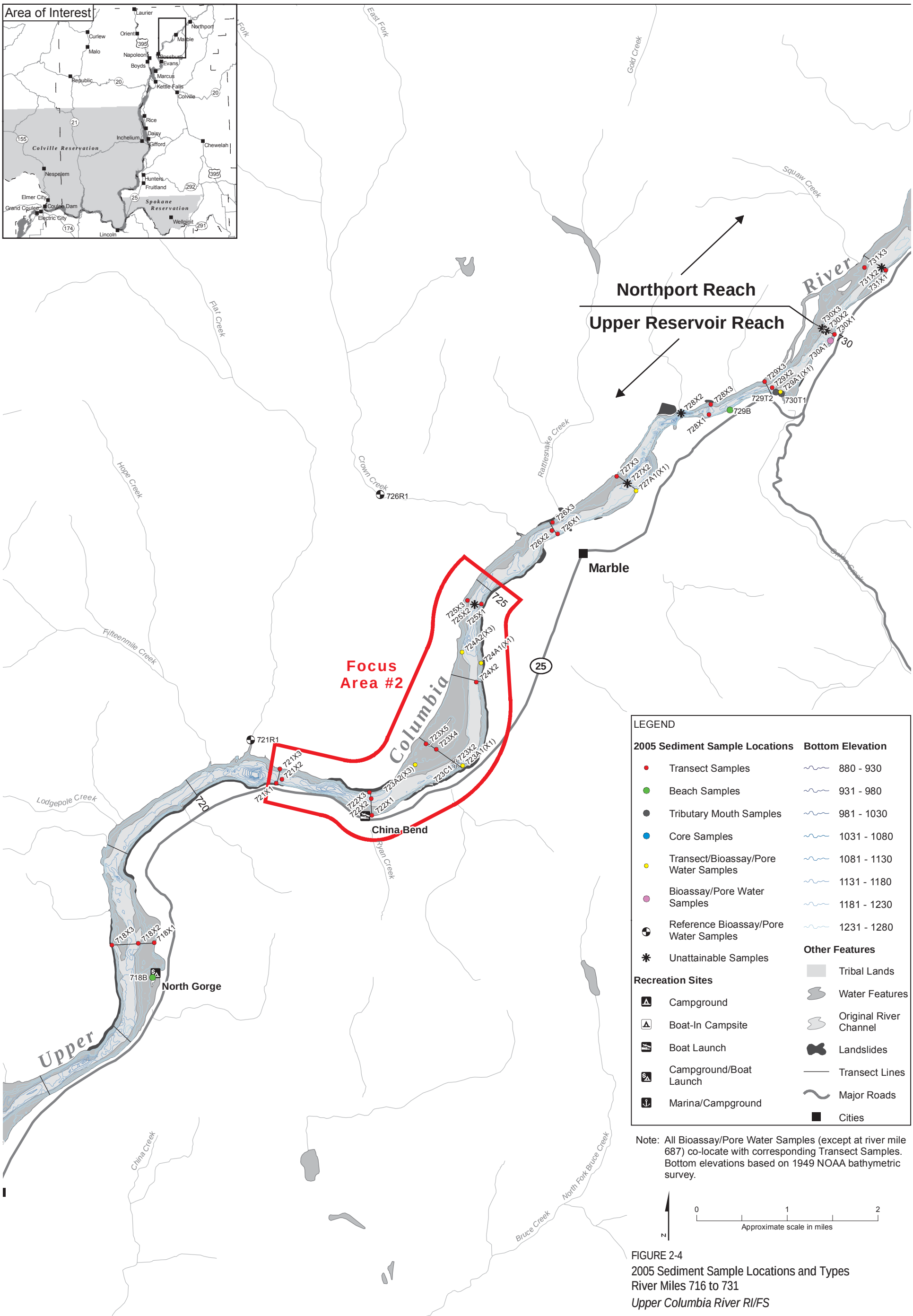

FIGURE 2-4
2005 Sediment Sample Locations and Types
River Miles 716 to 731
Upper Columbia River RI/FS

CH2MHILL

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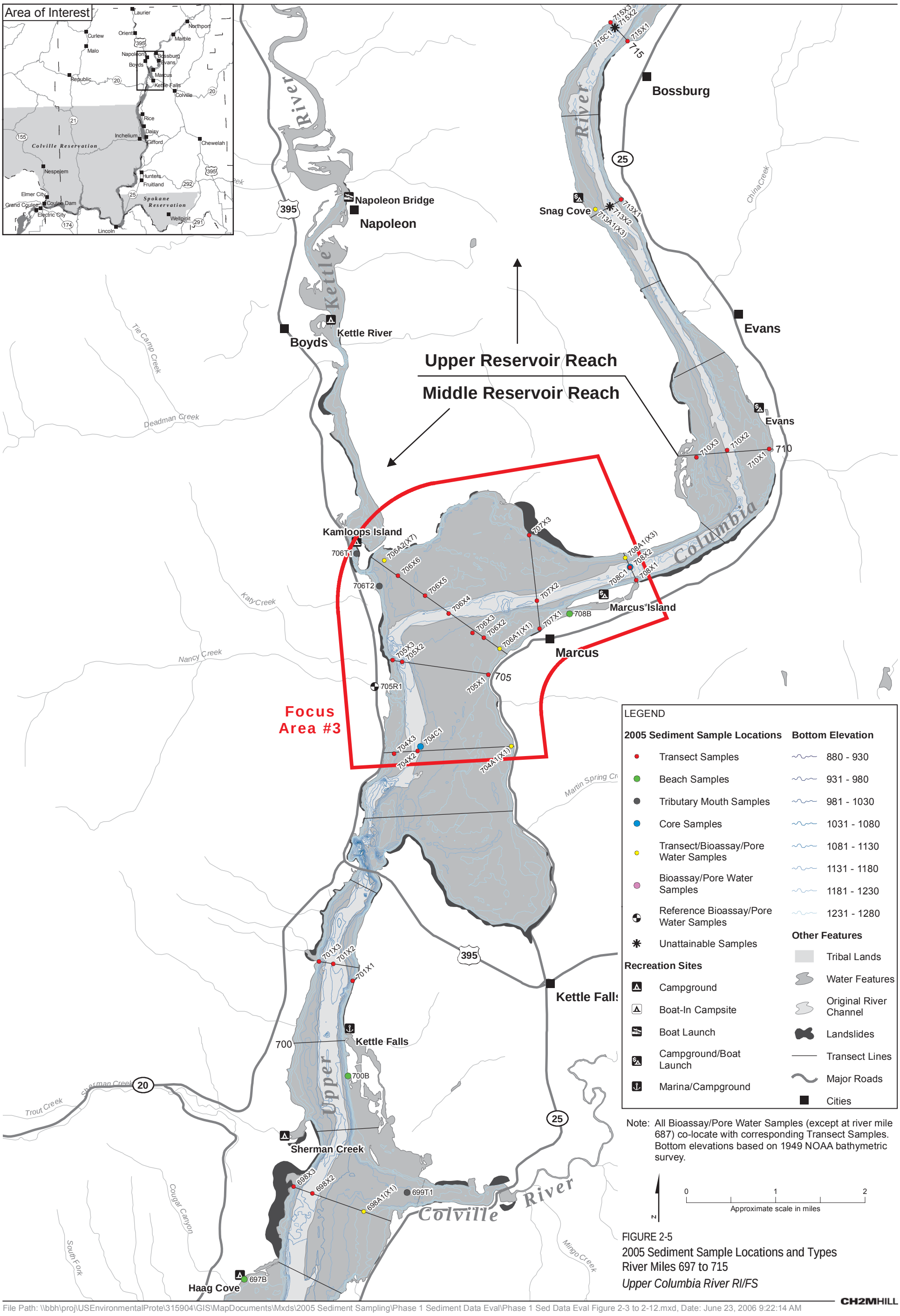

FIGURE 2-5
2005 Sediment Sample Locations and Types
River Miles 697 to 715
Upper Columbia River RI/FS

CH2MHILL

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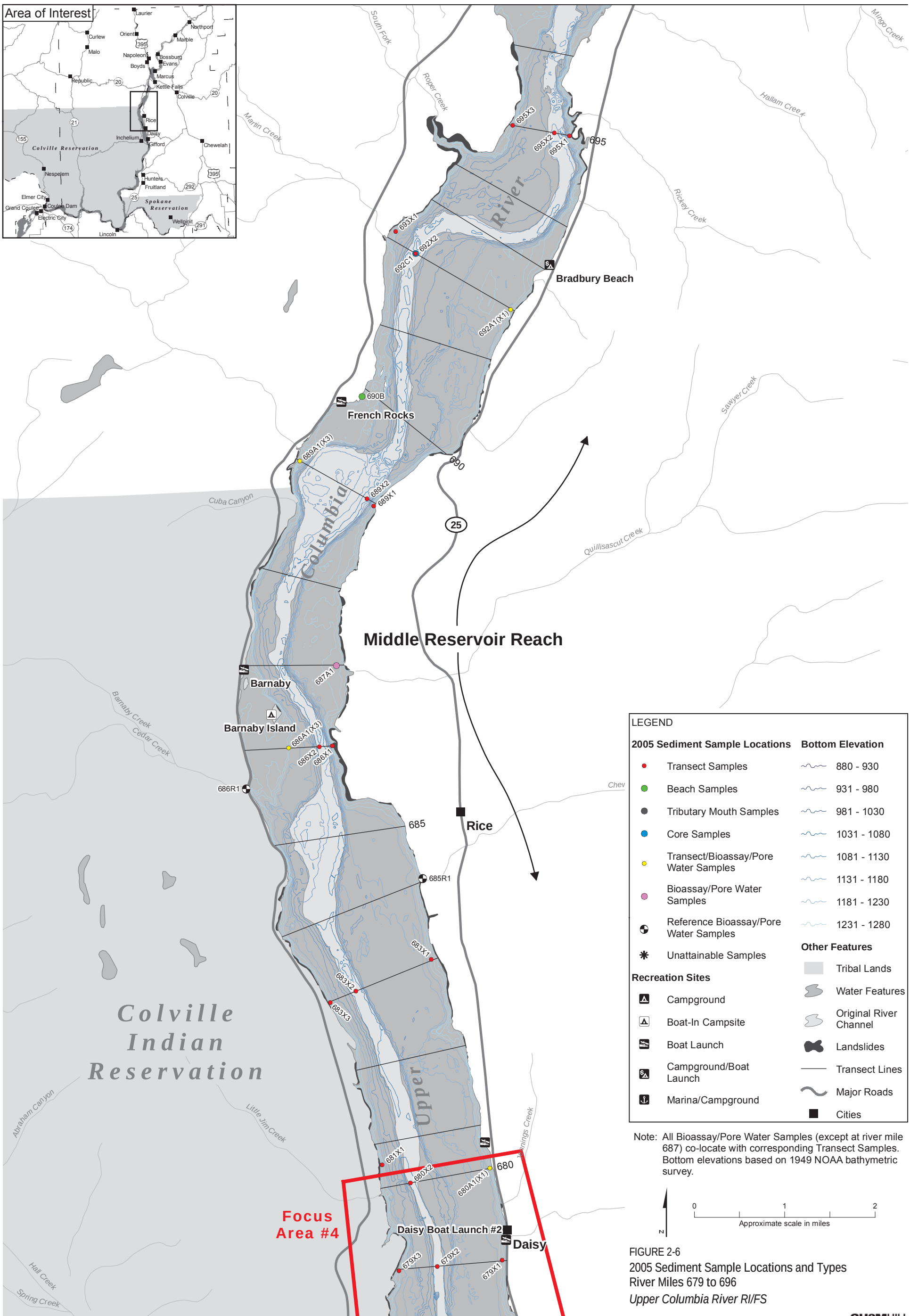

FIGURE 2-6
2005 Sediment Sample Locations and Types
River Miles 679 to 696
Upper Columbia River RI/FS

CH2MHILL

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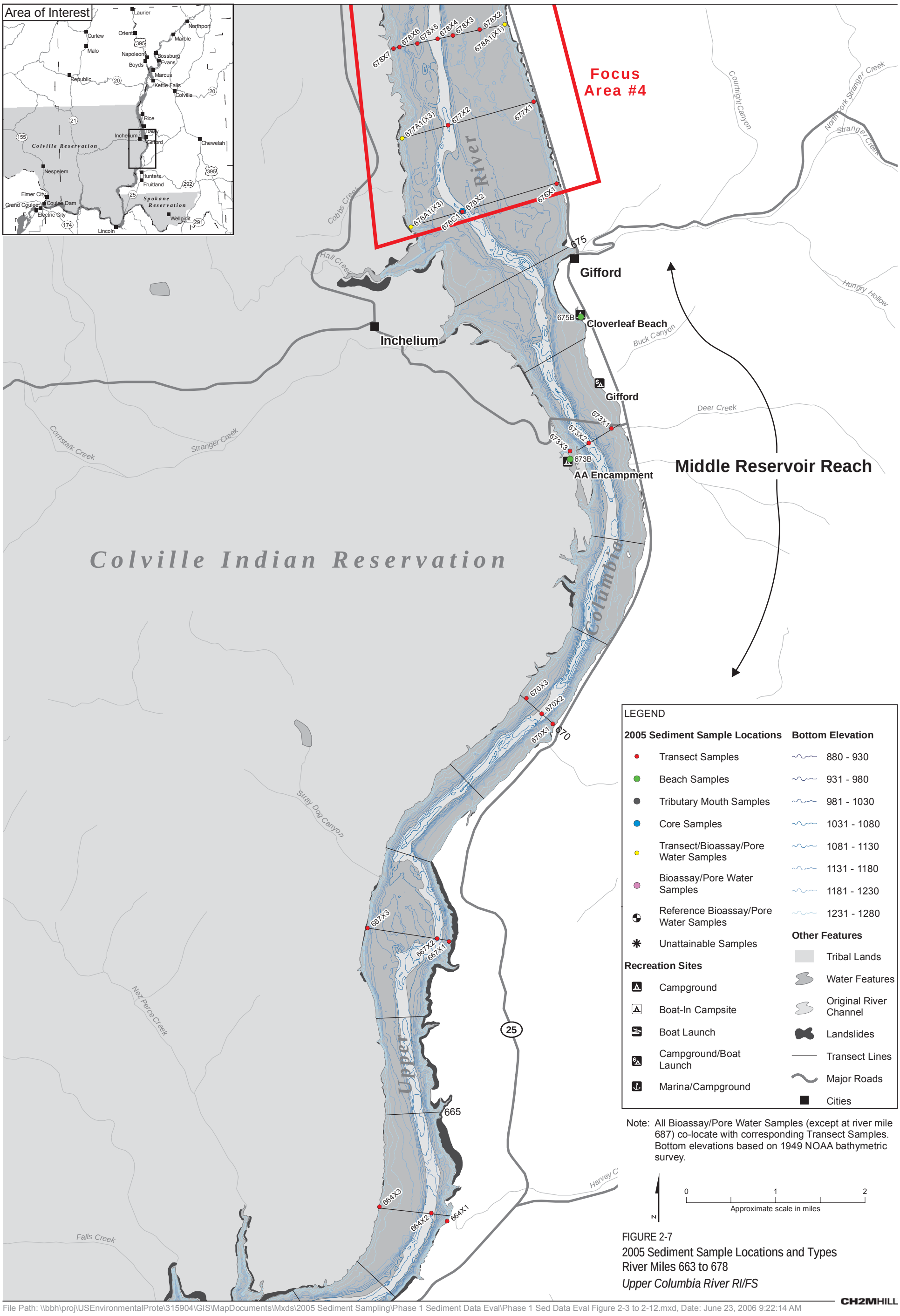

FIGURE 2-7
2005 Sediment Sample Locations and Types
River Miles 663 to 678
Upper Columbia River RI/FS

CH2MHILL

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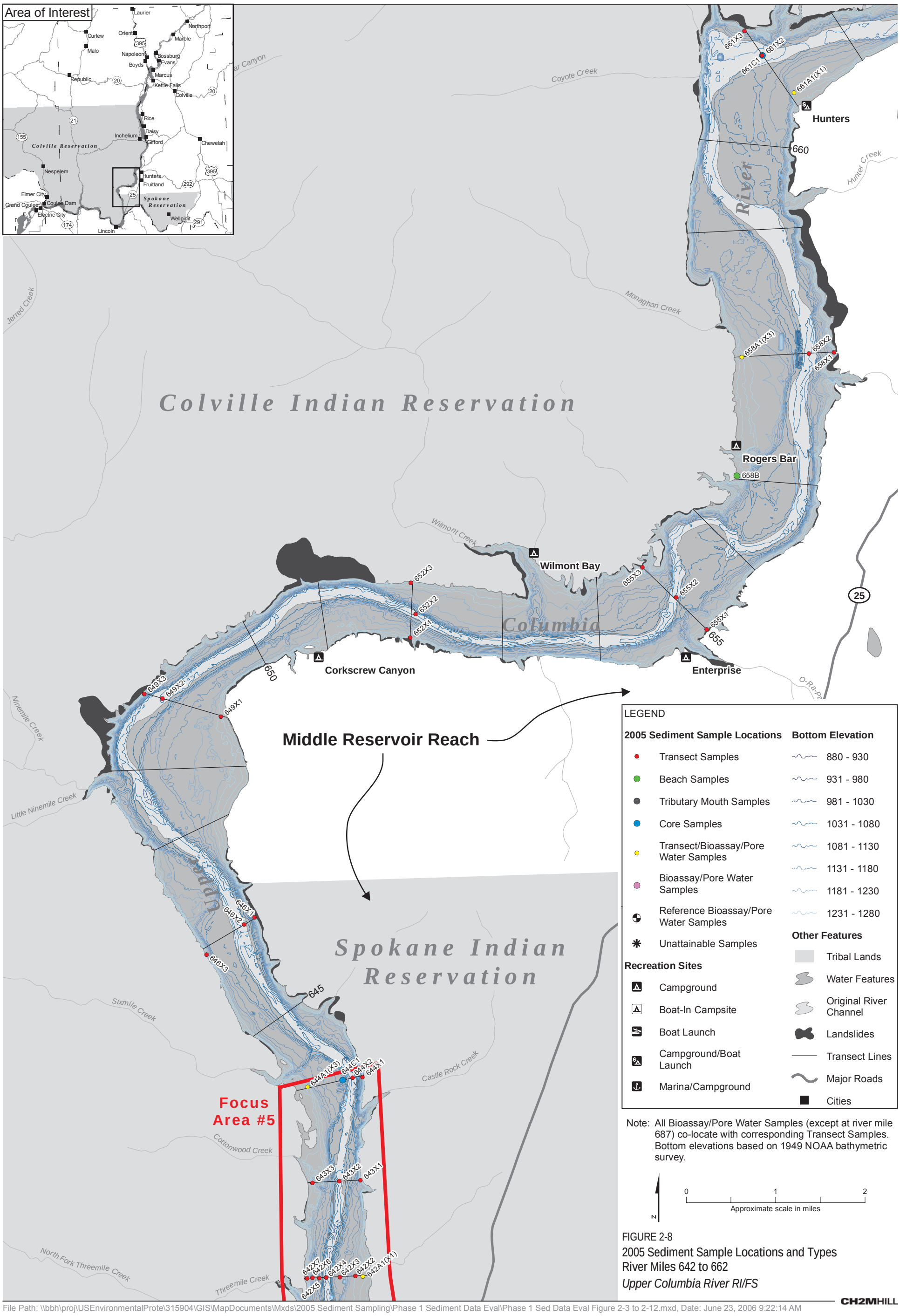

FIGURE 2-8
2005 Sediment Sample Locations and Types
River Miles 642 to 662
Upper Columbia River RI/FS

CH2MHILL

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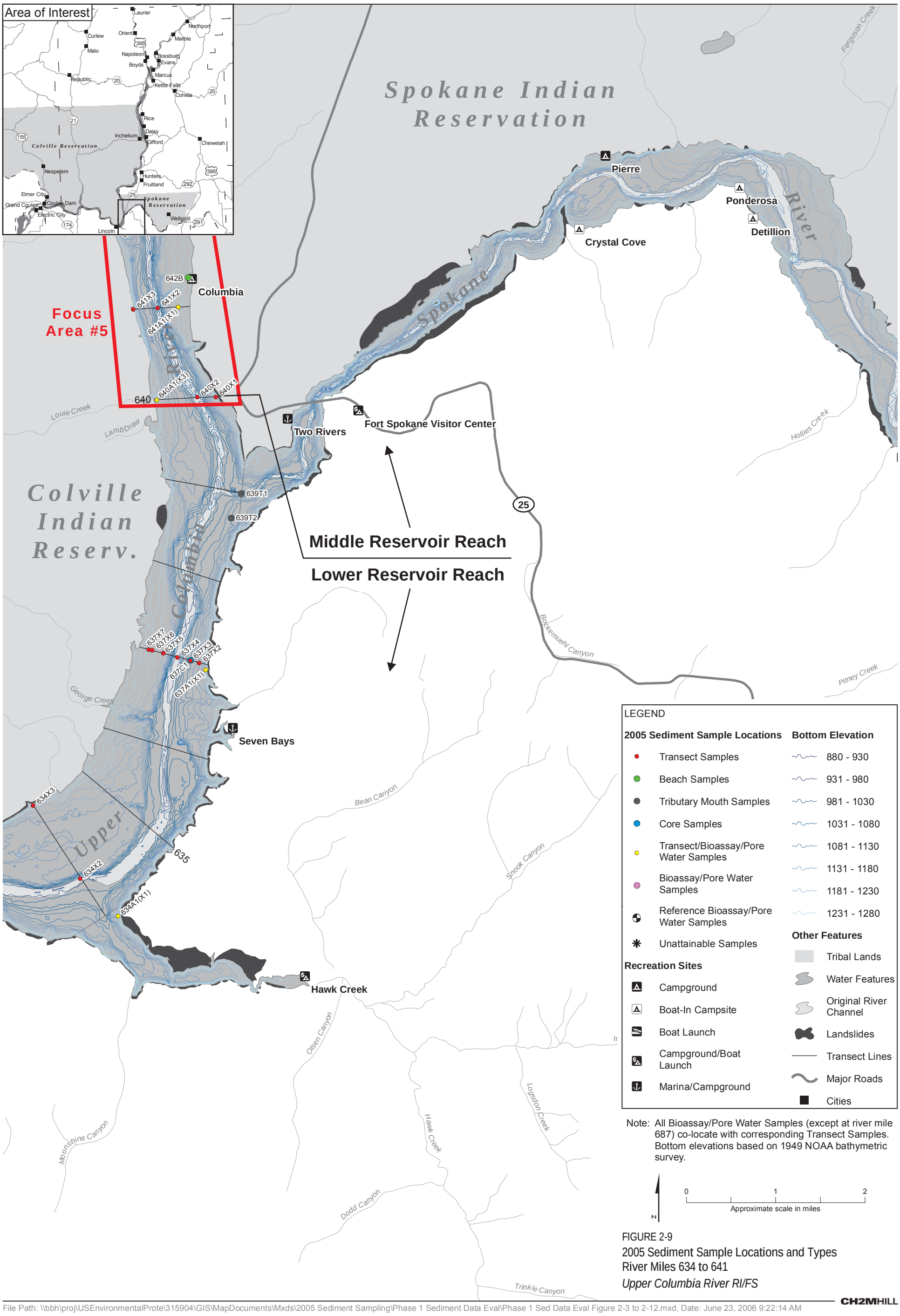

FIGURE 2-9
2005 Sediment Sample Locations and Types
River Miles 634 to 641
Upper Columbia River RI/FS

CH2MHILL

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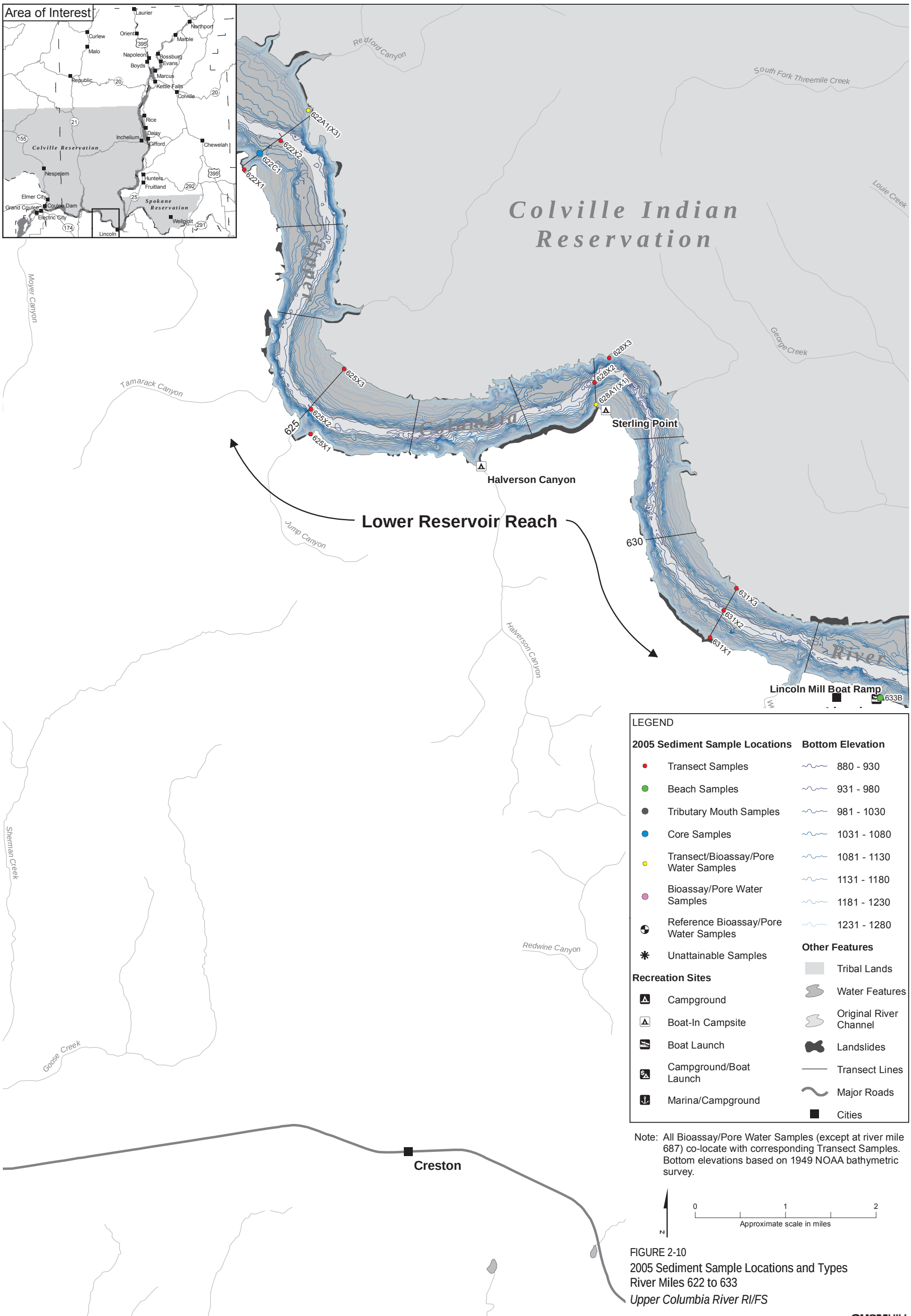

FIGURE 2-10
2005 Sediment Sample Locations and Types
River Miles 622 to 633
Upper Columbia River RI/FS

CH2MHILL

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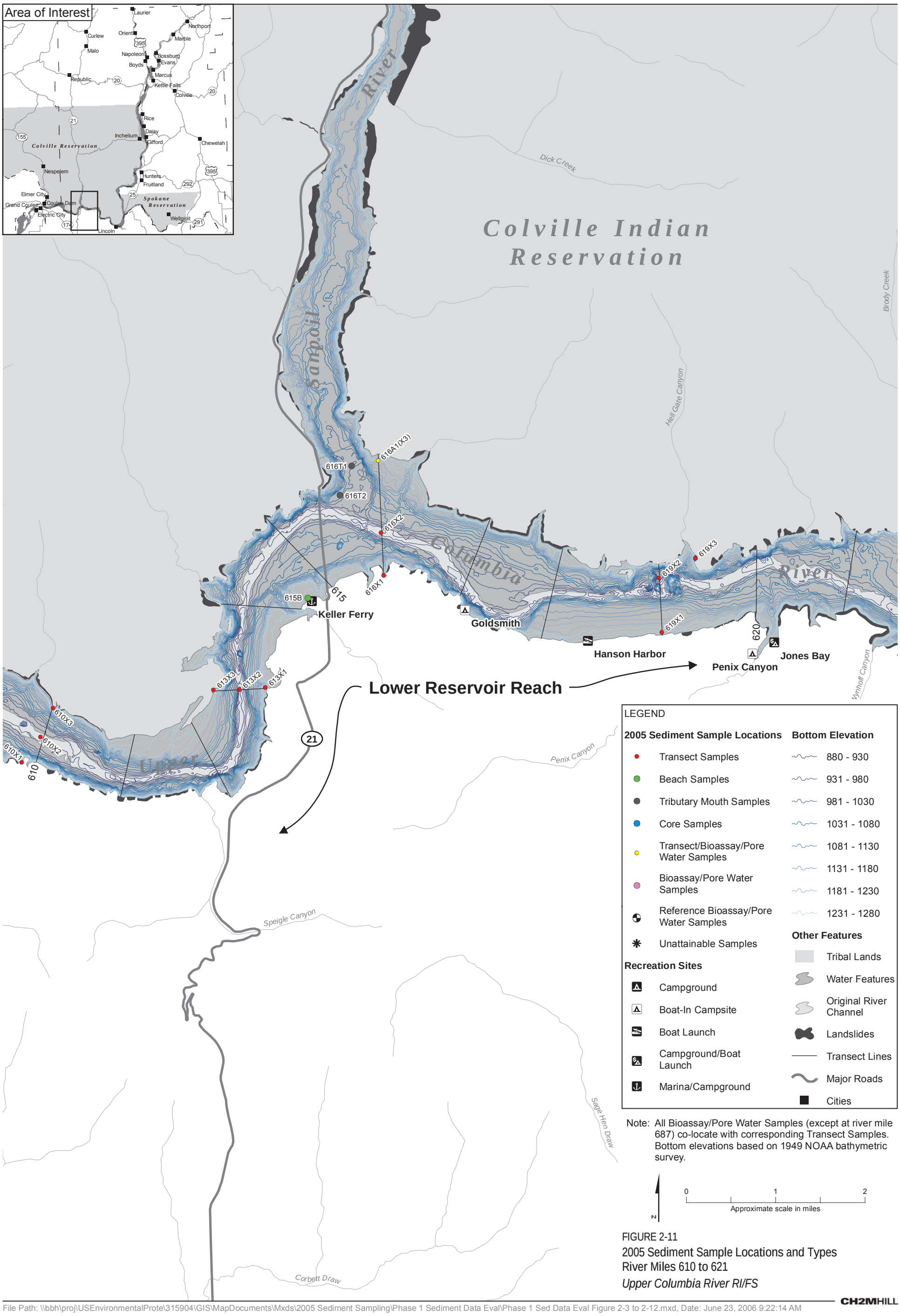

FIGURE 2-11
2005 Sediment Sample Locations and Types
River Miles 610 to 621
Upper Columbia River RI/FS

CH2MHILL

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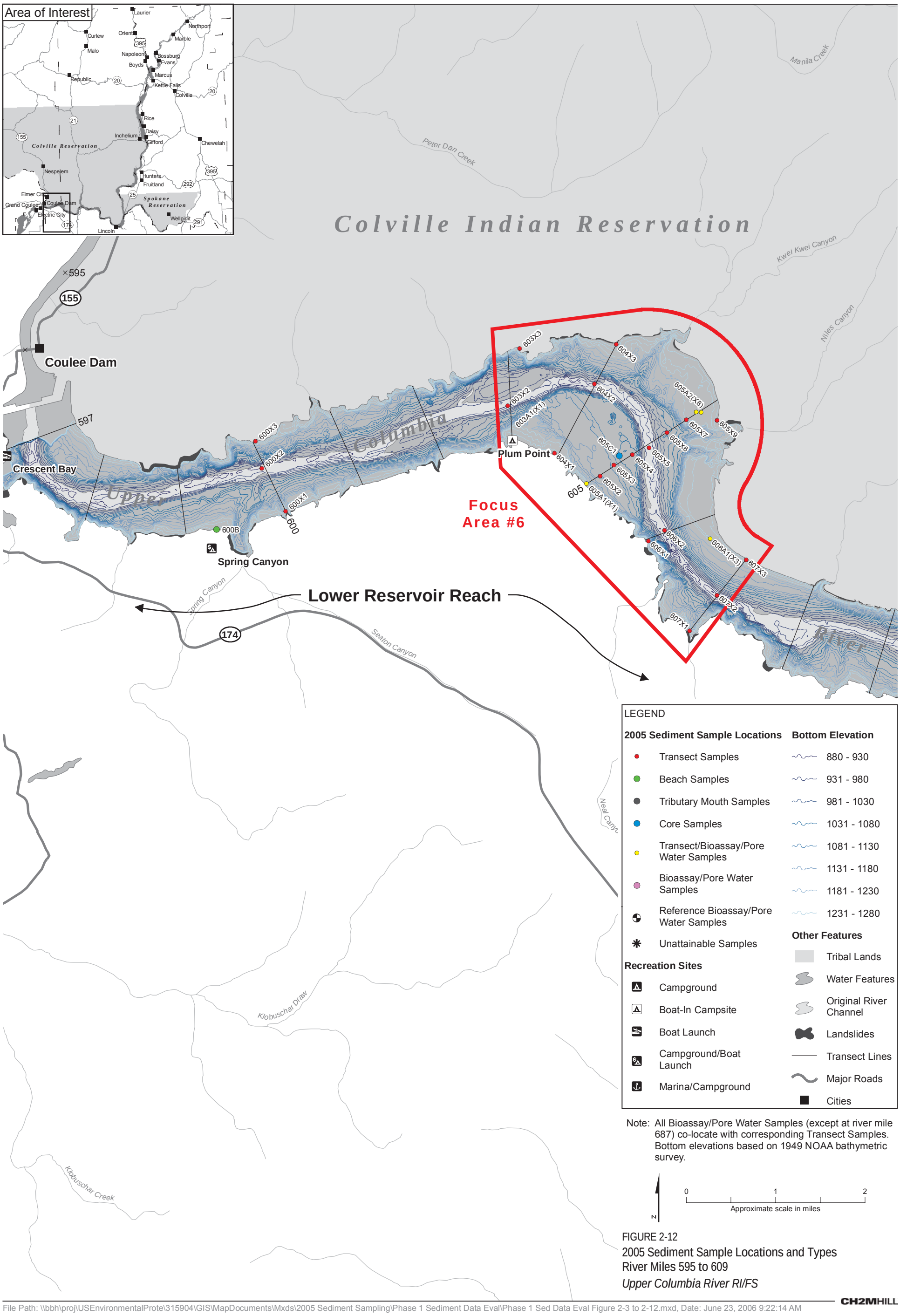

FIGURE 2-12
2005 Sediment Sample Locations and Types
River Miles 595 to 609
Upper Columbia River RI/FS

CH2MHILL

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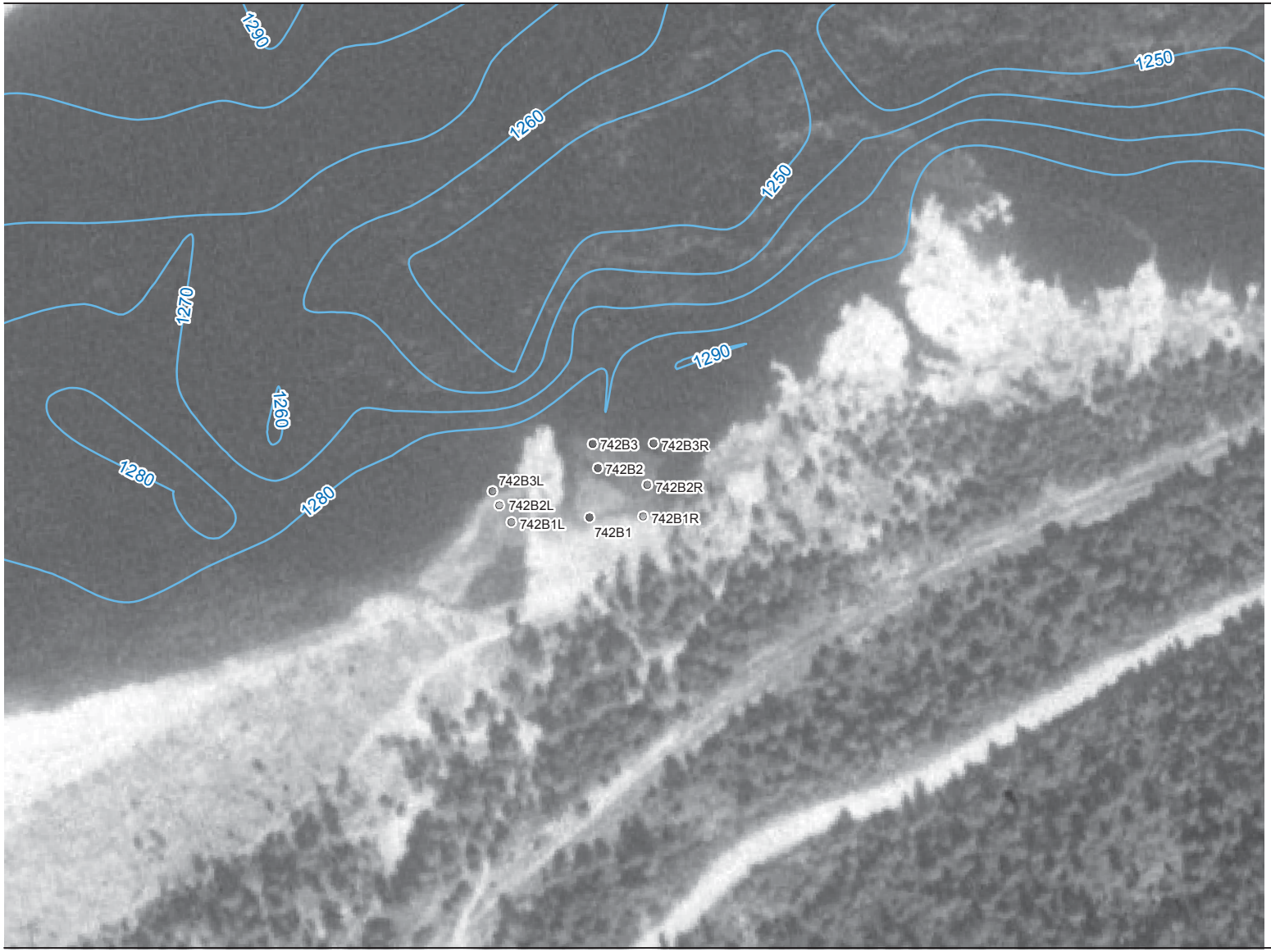


2005 Beach Sediment Sample Locations

LEGEND

2005 Beach Sampling

- Beach Subsample Composites
- Beach Subsamples

1949 NOAA Bathymetry

- 10-foot Bottom Elevation Contours

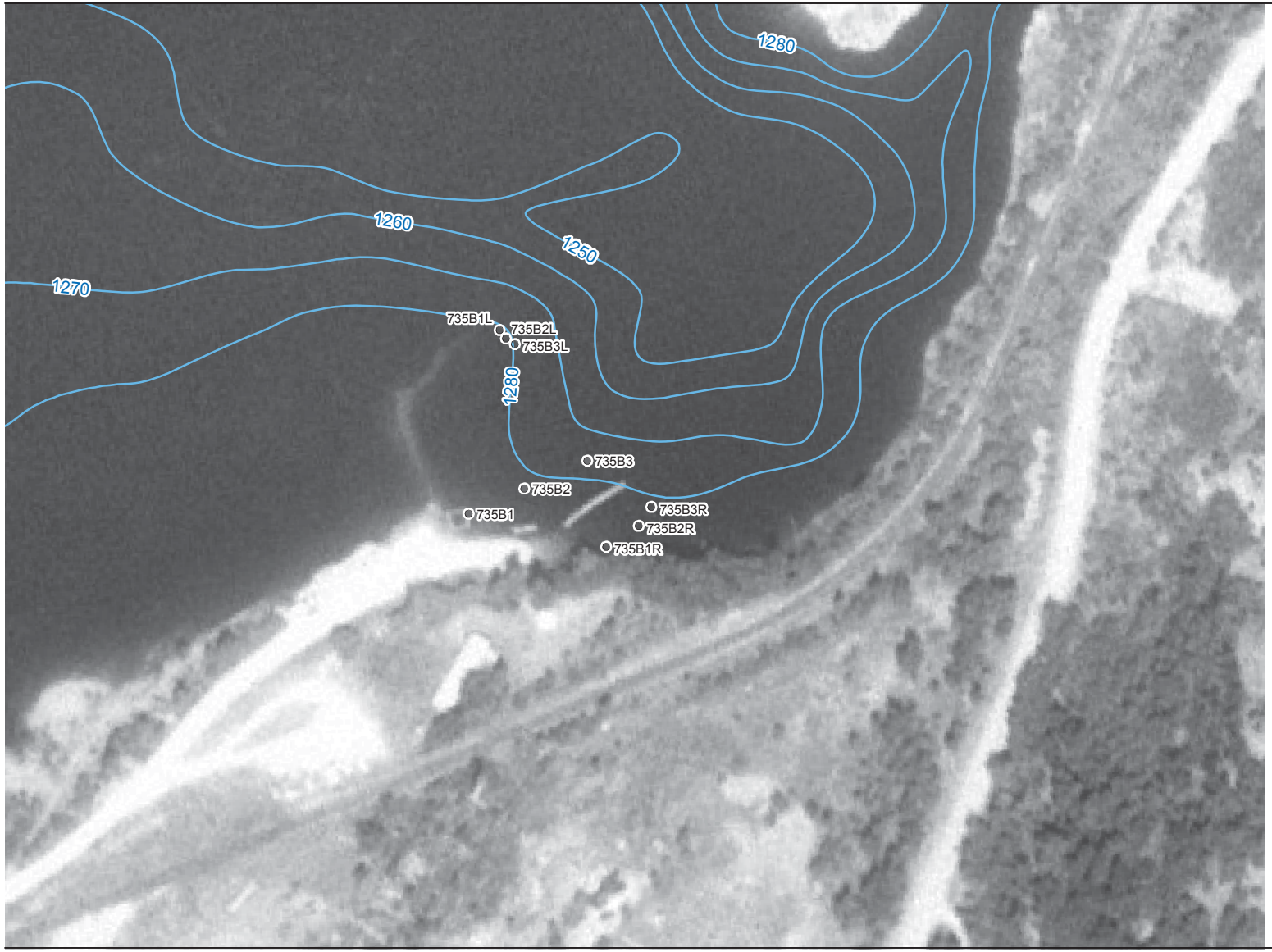
N

0 100 200
Approximate scale in feet

FIGURE 2-13
Black Sand Beach - RM 742
2005 Beach Sample Locations
Upper Columbia River RI/FS

CH2MHILL

File Path: \\bbh\proj\USEnvironmentalProte\315904\GIS\MapDocuments\Mxds\2005 Sediment Sampling\Phase 1 Sediment Data Eval\Phase 1 Sed Data Eval Beaches Figure 2-13 to 2-27.mxd, Date: June 23, 2006 9:32:19 AM



2005 Beach Sediment Sample Locations

LEGEND

2005 Beach Sampling

- Beach Subsample Composites
- Beach Subsamples

1949 NOAA Bathymetry

- 10-foot Bottom Elevation Contours

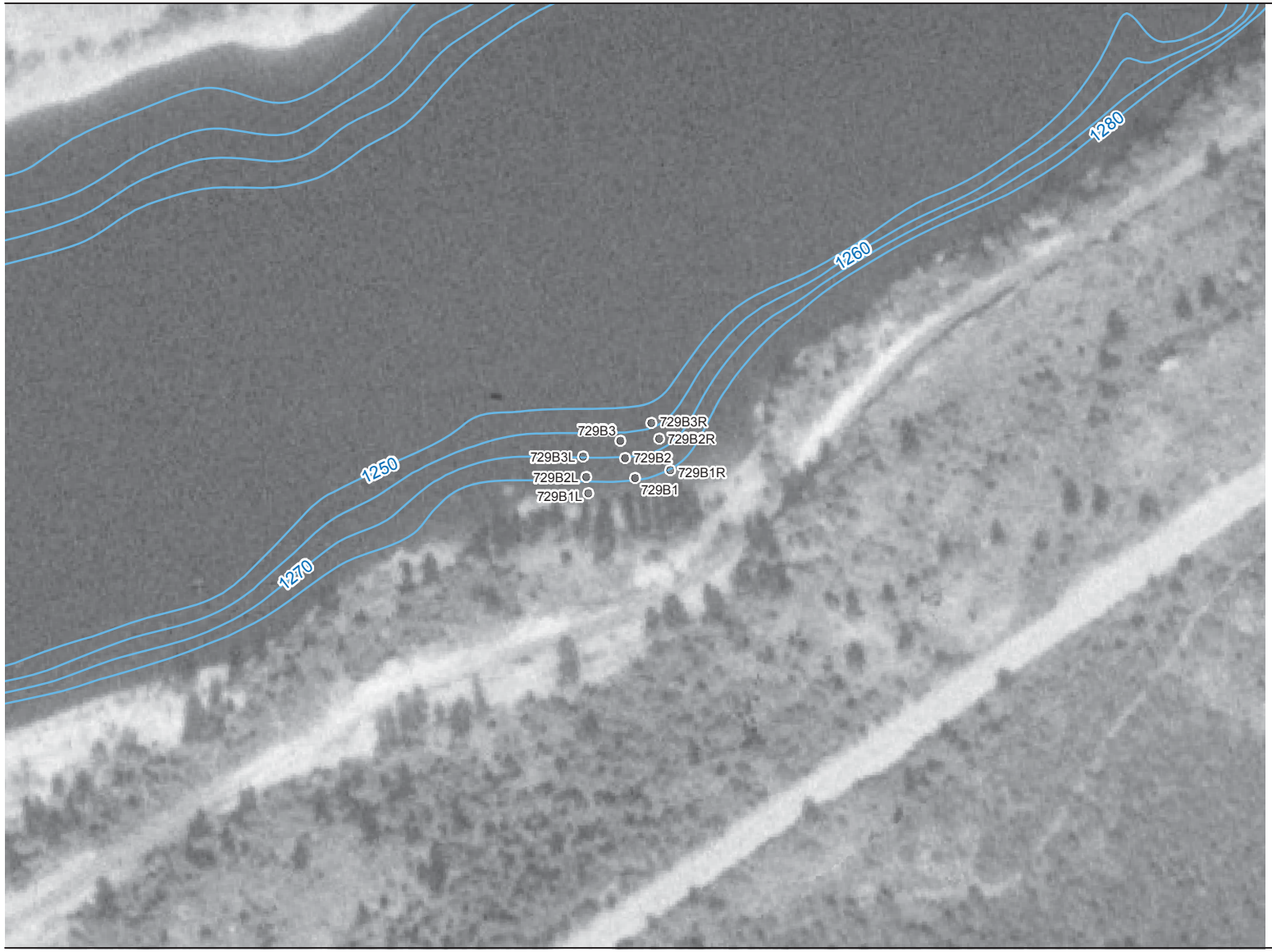
N

0 100 200
Approximate scale in feet

FIGURE 2-14
Northport City Boat Launch
2005 Beach Sample Locations
Upper Columbia River RI/FS

CH2MHILL

File Path: \\bbh\proj\USEnvironmentalProte\315904\GIS\MapDocuments\Mxds\2005 Sediment Sampling\Phase 1 Sediment Data Eval\Phase 1 Sed Data Eval Beaches Figure 2-13 to 2-27.mxd, Date: June 23, 2006 9:32:19 AM



2005 Beach Sediment Sample Locations

LEGEND

2005 Beach Sampling

- Beach Subsample Composites
- Beach Subsamples

1949 NOAA Bathymetry

- 10-foot Bottom Elevation Contours

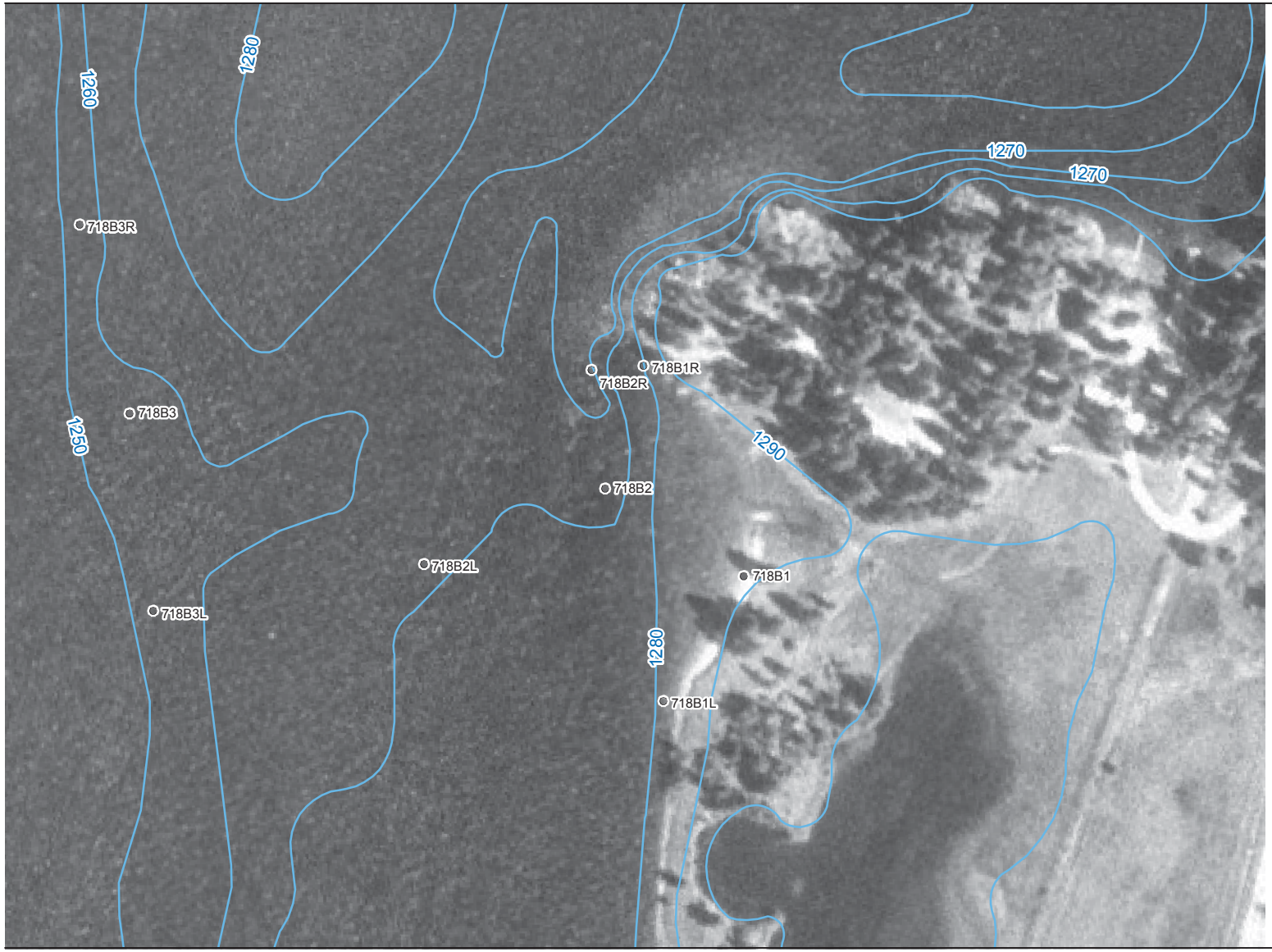
N

0 100 200
Approximate scale in feet

FIGURE 2-15
Dalles Orchard
2005 Beach Sample Locations
Upper Columbia River RI/FS

CH2MHILL

File Path: \\bbh\proj\USEnvironmentalProte\315904\GIS\MapDocuments\Mxds\2005 Sediment Sampling\Phase 1 Sediment Data Eval\Phase 1 Sed Data Eval Beaches Figure 2-13 to 2-27.mxd, Date: June 23, 2006 9:32:19 AM



2005 Beach Sediment Sample Locations

LEGEND

2005 Beach Sampling

- Beach Subsample Composites
- Beach Subsamples

1974 USBR Bathymetry

- 10-foot Bottom Elevation Contours

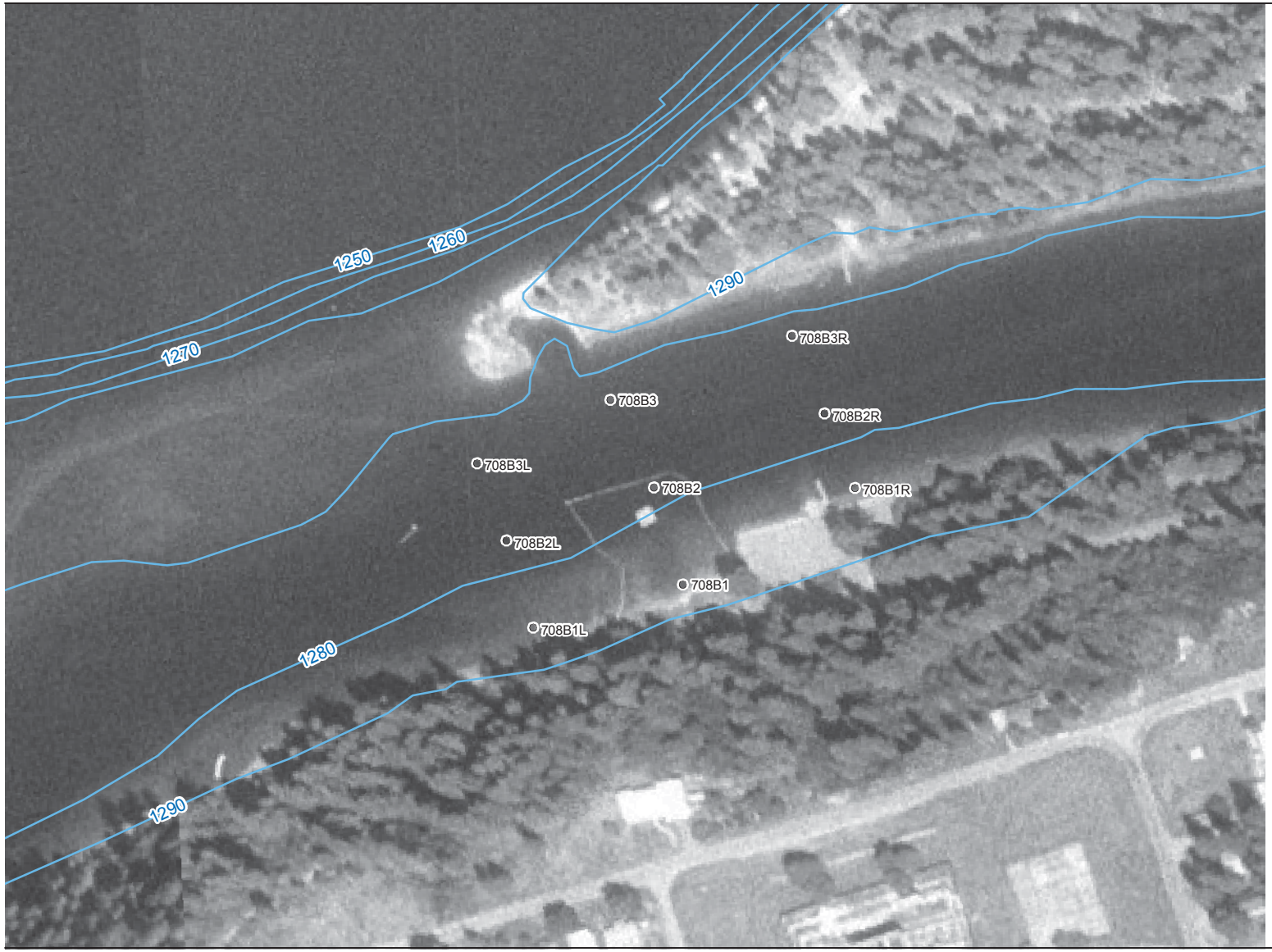
N

0 100 200
Approximate scale in feet

FIGURE 2-16
North Gorge Campground
2005 Beach Sample Locations
Upper Columbia River RI/FS

CH2MHILL

File Path: \\bbh\proj\USEnvironmentalProte\315904\GIS\MapDocuments\Mxds\2005 Sediment Sampling\Phase 1 Sediment Data Eval\Phase 1 Sed Data Eval Beaches Figure 2-13 to 2-27.mxd, Date: June 23, 2006 9:32:19 AM



2005 Beach Sediment Sample Locations

LEGEND

2005 Beach Sampling

- Beach Subsample Composites
- Beach Subsamples

1974 USBR Bathymetry

- 10-foot Bottom Elevation Contours

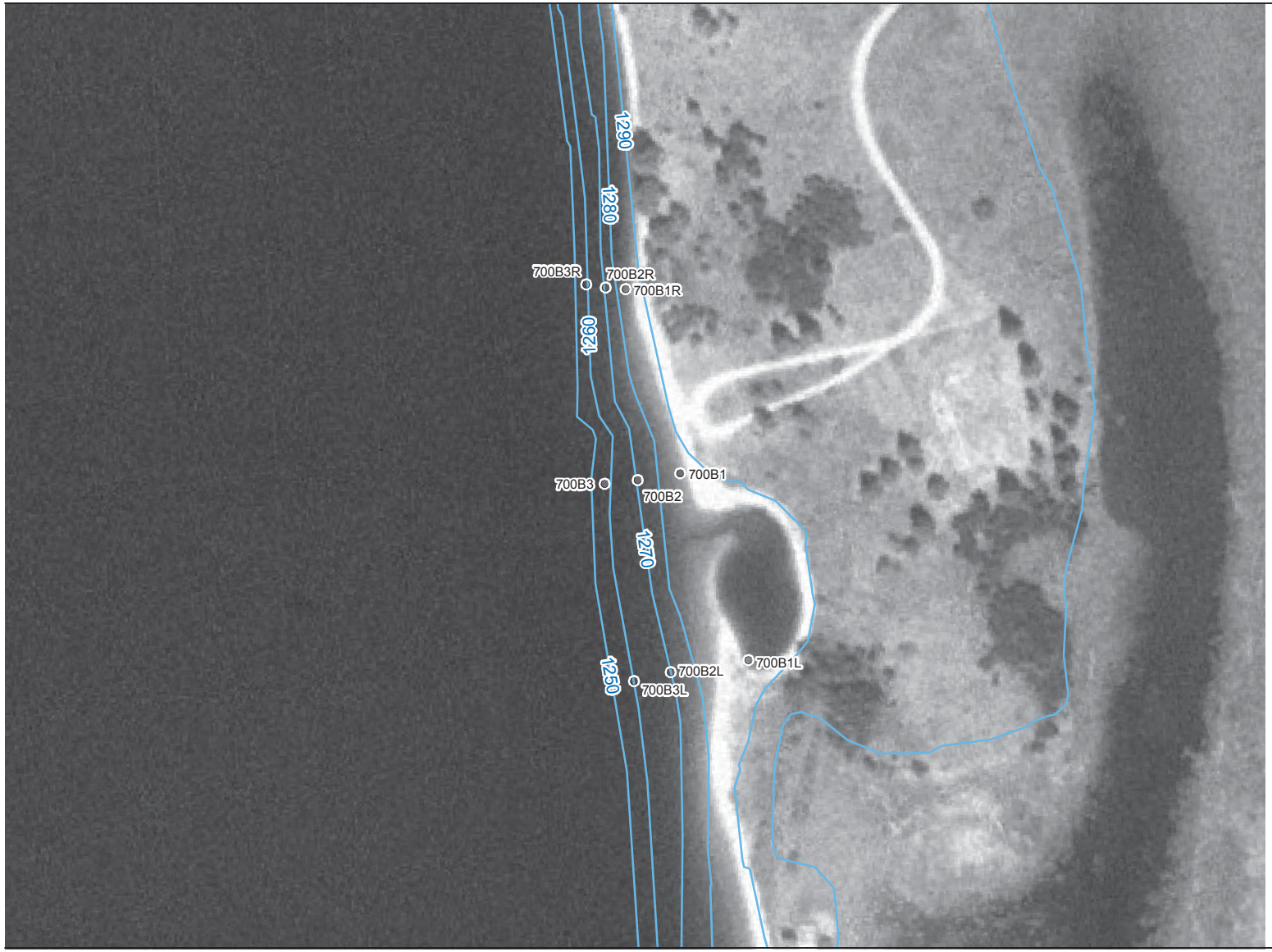
N

0 100 200
Approximate scale in feet

FIGURE 2-17
Marcus Island Campground
2005 Beach Sample Locations
Upper Columbia River RI/FS

CH2MHILL

File Path: \\bbh\proj\USEnvironmentalProte\315904\GIS\MapDocuments\Mxds\2005 Sediment Sampling\Phase 1 Sediment Data Eval\Phase 1 Sed Data Eval Beaches Figure 2-13 to 2-27.mxd, Date: June 23, 2006 9:32:19 AM



2005 Beach Sediment Sample Locations

LEGEND

2005 Beach Sampling

- Beach Subsample Composites
- Beach Subsamples

1974 USBR Bathymetry

- 10-foot Bottom Elevation Contours

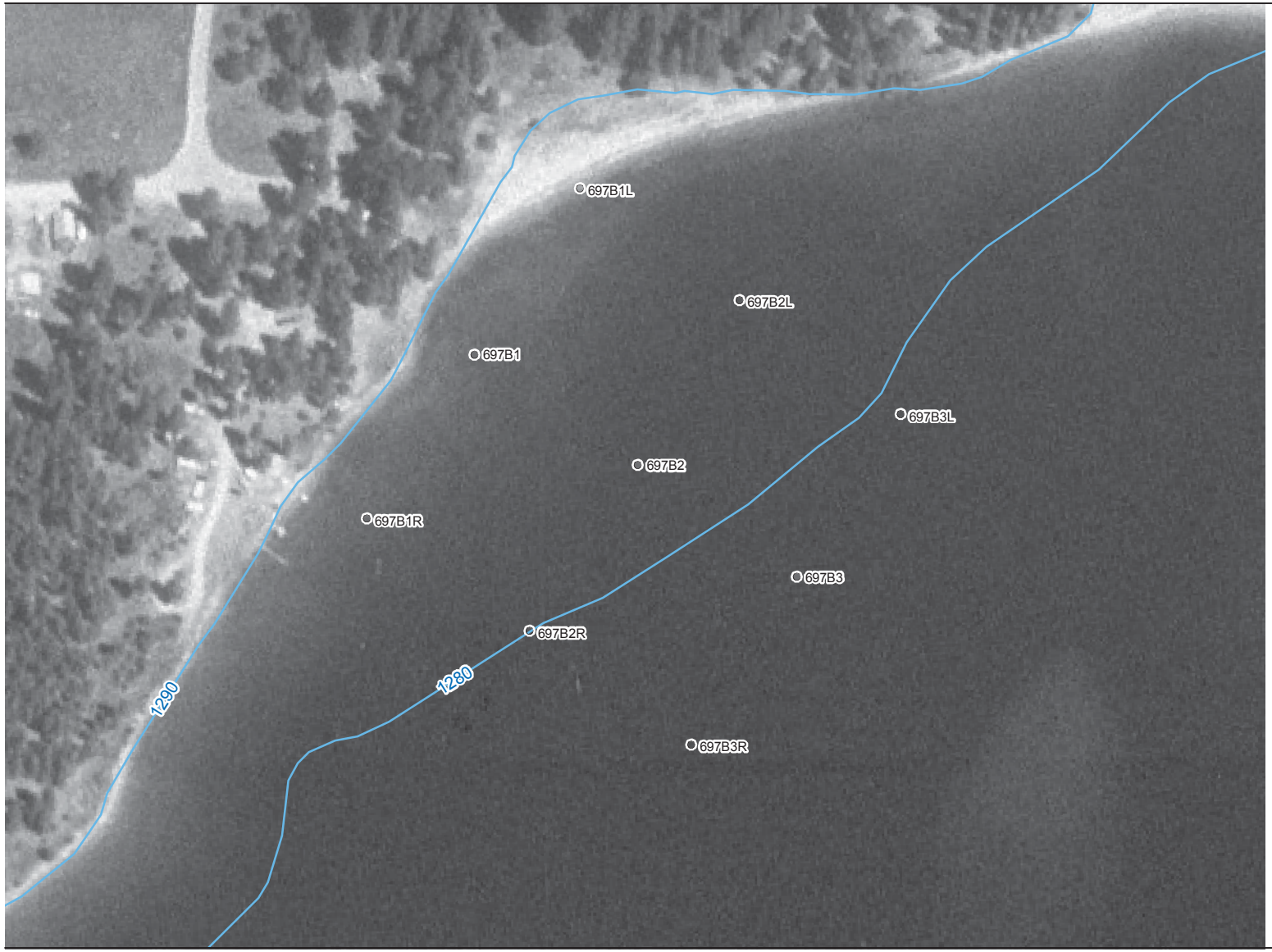
N

0 100 200
Approximate scale in feet

FIGURE 2-18
Kettle Falls Swim Beach
2005 Beach Sample Locations
Upper Columbia River RI/FS

CH2MHILL

File Path: \\bbh\proj\USEnvironmentalProte\315904\GIS\MapDocuments\Mxds\2005 Sediment Sampling\Phase 1 Sediment Data Eval\Phase 1 Sed Data Eval Beaches Figure 2-13 to 2-27.mxd, Date: June 23, 2006 9:32:19 AM



2005 Beach Sediment Sample Locations

LEGEND

2005 Beach Sampling

- Beach Subsample Composites
- Beach Subsamples

1974 USBR Bathymetry

- 10-foot Bottom Elevation Contours

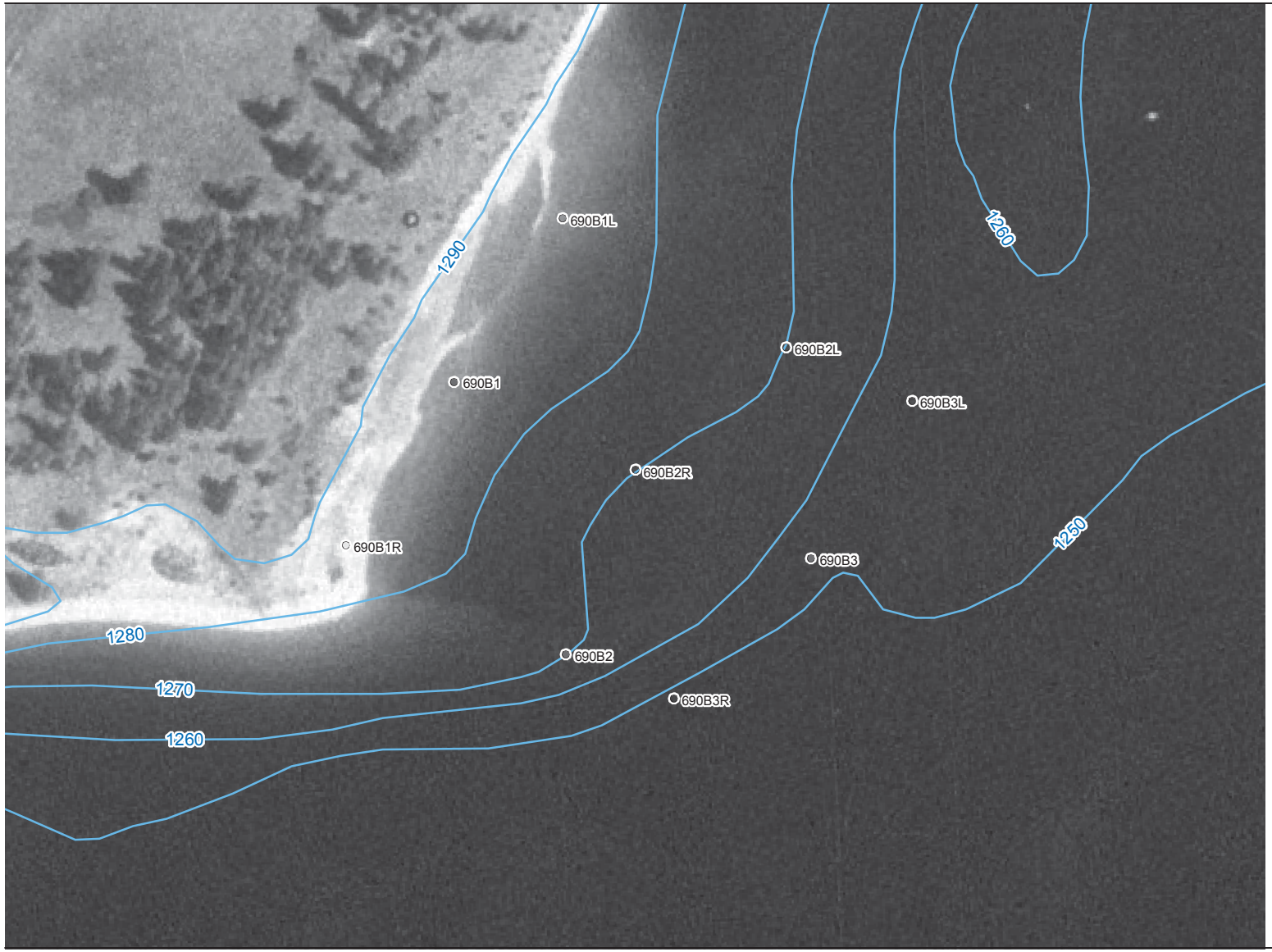
N

0 100 200
Approximate scale in feet

FIGURE 2-19
Haag Cove
2005 Beach Sample Locations
Upper Columbia River RI/FS

CH2MHILL

File Path: \\bbh\proj\USEnvironmentalProte\315904\GIS\MapDocuments\Mxds\2005 Sediment Sampling\Phase 1 Sediment Data Eval\Phase 1 Sed Data Eval Beaches Figure 2-13 to 2-27.mxd, Date: June 23, 2006 9:32:19 AM



2005 Beach Sediment Sample Locations

LEGEND

2005 Beach Sampling

- Beach Subsample Composites
- Beach Subsamples

1974 USBR Bathymetry

- 10-foot Bottom Elevation Contours

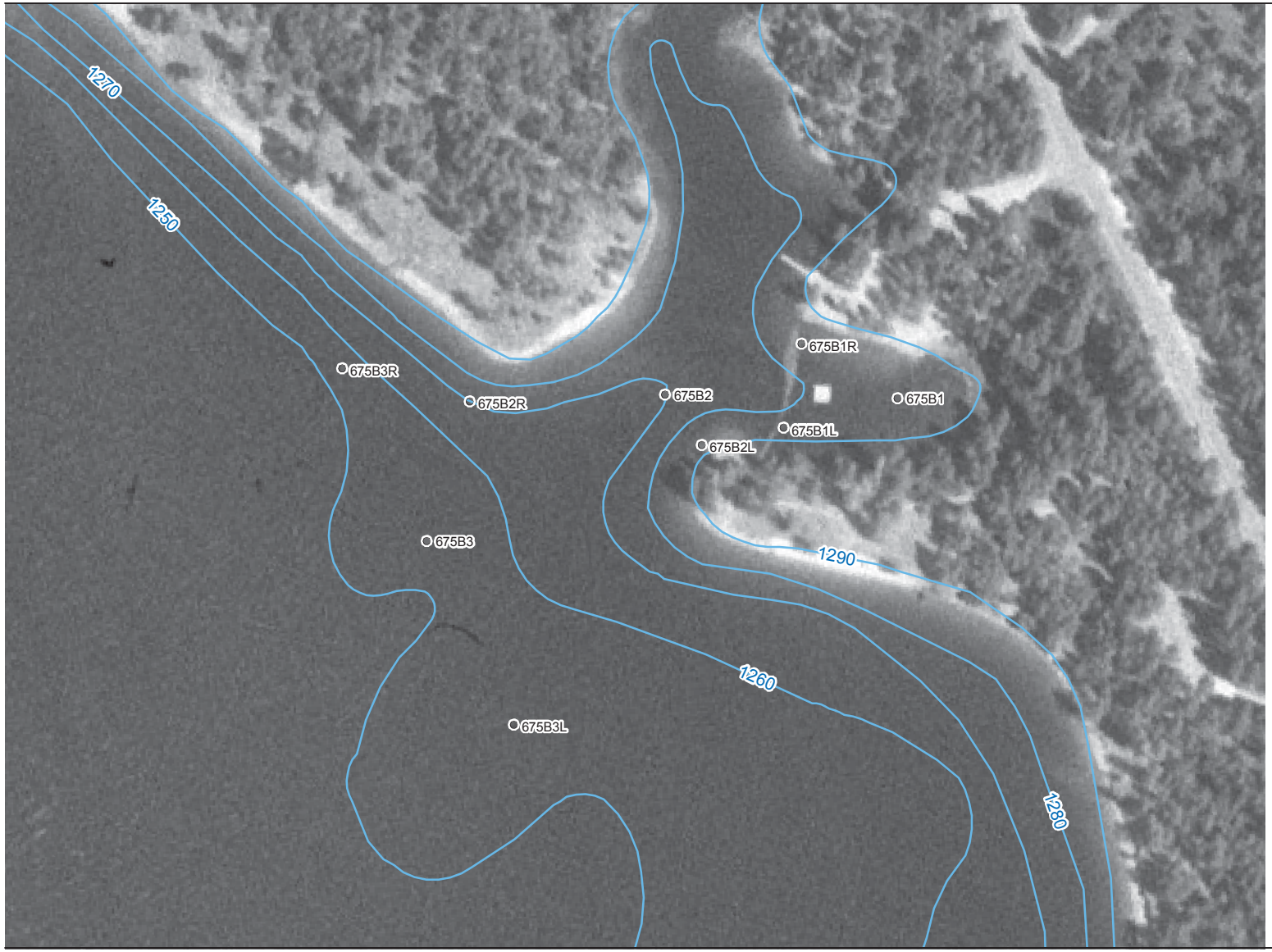
N

0 100 200
Approximate scale in feet

FIGURE 2-20
French Rocks Boat Launch
2005 Beach Sample Locations
Upper Columbia River RI/FS

CH2MHILL

File Path: \\bbh\proj\USEnvironmentalProte\315904\GIS\MapDocuments\Mxds\2005 Sediment Sampling\Phase 1 Sediment Data Eval\Phase 1 Sed Data Eval Beaches Figure 2-13 to 2-27.mxd, Date: June 23, 2006 9:32:19 AM



2005 Beach Sediment Sample Locations

LEGEND

2005 Beach Sampling

- Beach Subsample Composites
- Beach Subsamples

1974 USBR Bathymetry

- 10-foot Bottom Elevation Contours

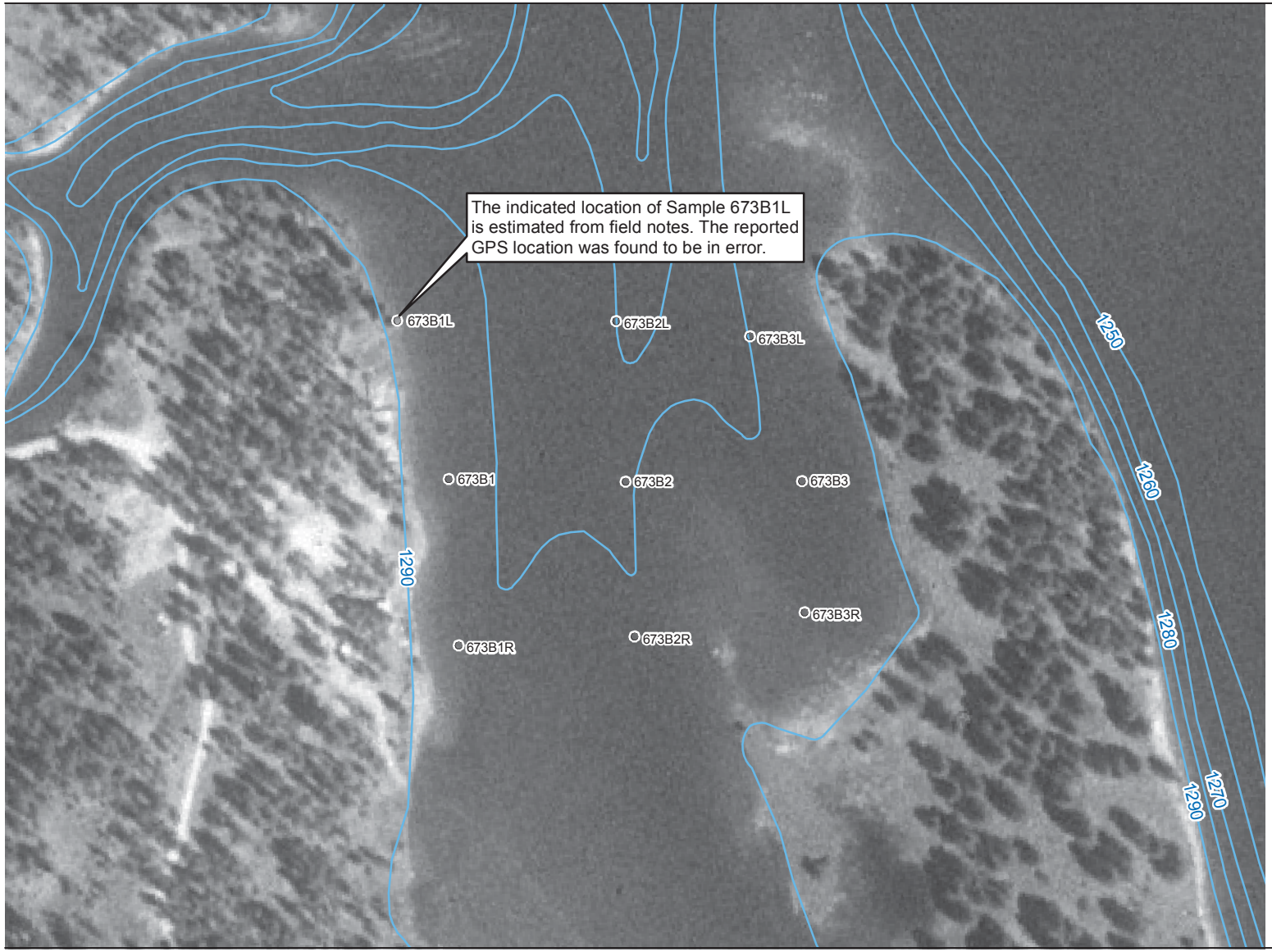
N

0 100 200
Approximate scale in feet

FIGURE 2-21
Cloverleaf Beach
2005 Beach Sample Locations
Upper Columbia River RI/FS

CH2MHILL

File Path: \\bbh\proj\USEnvironmentalProte\315904\GIS\MapDocuments\Mxds\2005 Sediment Sampling\Phase 1 Sediment Data Eval\Phase 1 Sed Data Eval Beaches Figure 2-13 to 2-27.mxd, Date: June 23, 2006 9:32:19 AM



2005 Beach Sediment Sample Locations

LEGEND

2005 Beach Sampling

- Beach Subsample Composites
- Beach Subsamples

1974 USBR Bathymetry

- 10-foot Bottom Elevation Contours

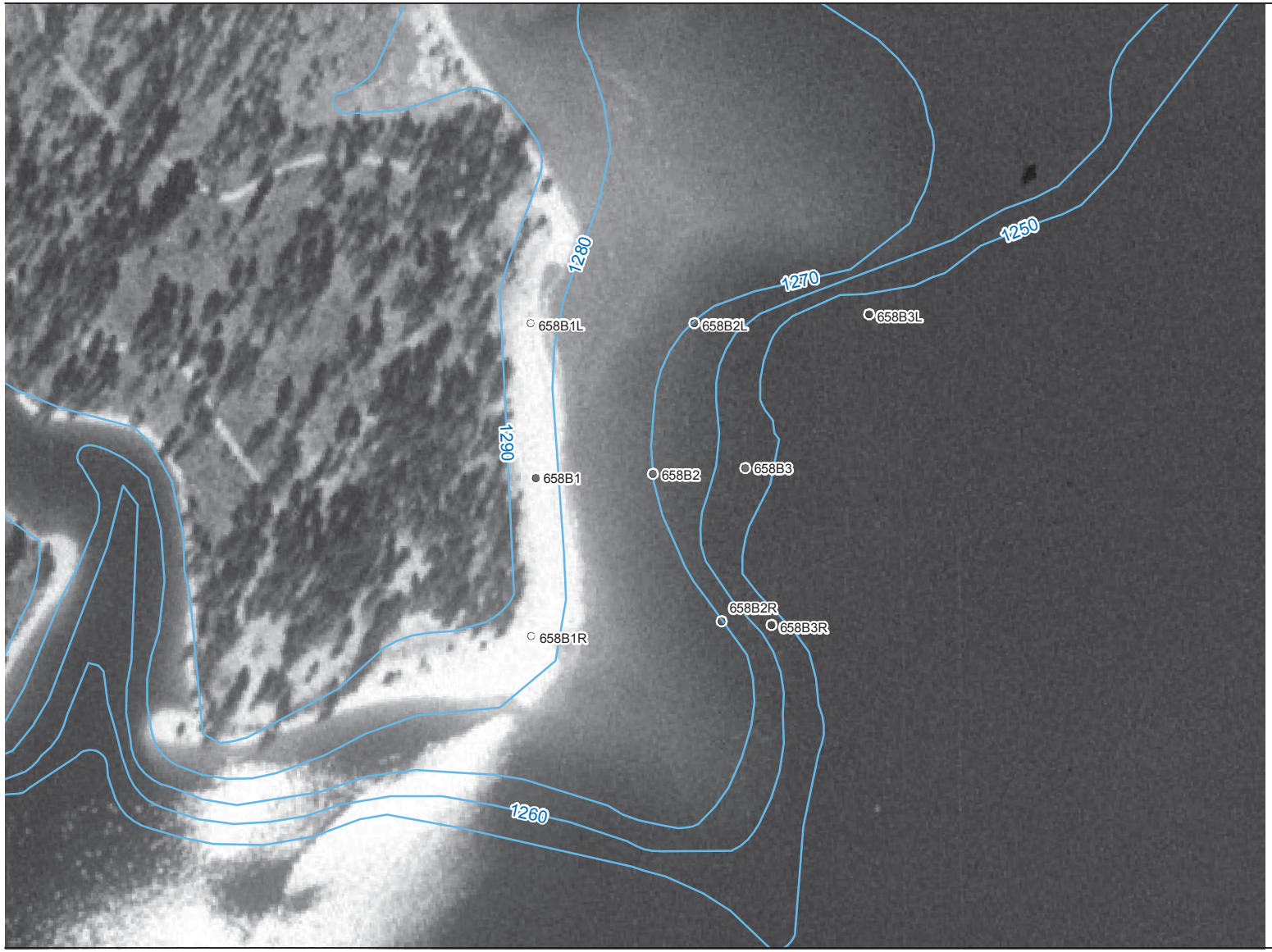
N

0 100 200
Approximate scale in feet

FIGURE 2-22
AA Campground
2005 Beach Sample Locations
Upper Columbia River RI/FS

CH2MHILL

File Path: \\bbh\proj\USEnvironmentalProte\315904\GIS\MapDocuments\Mxds\2005 Sediment Sampling\Phase 1 Sediment Data Eval\Phase 1 Sed Data Eval Beaches Figure 2-13 to 2-27.mxd, Date: June 23, 2006 9:32:19 AM



2005 Beach Sediment Sample Locations

LEGEND

2005 Beach Sampling

- Beach Subsample Composites
- Beach Subsamples

1974 USBR Bathymetry

- 10-foot Bottom Elevation Contours

N

0 100 200
Approximate scale in feet

FIGURE 2-23
Rogers Bar Campground
2005 Beach Sample Locations
Upper Columbia River RI/FS

CH2MHILL

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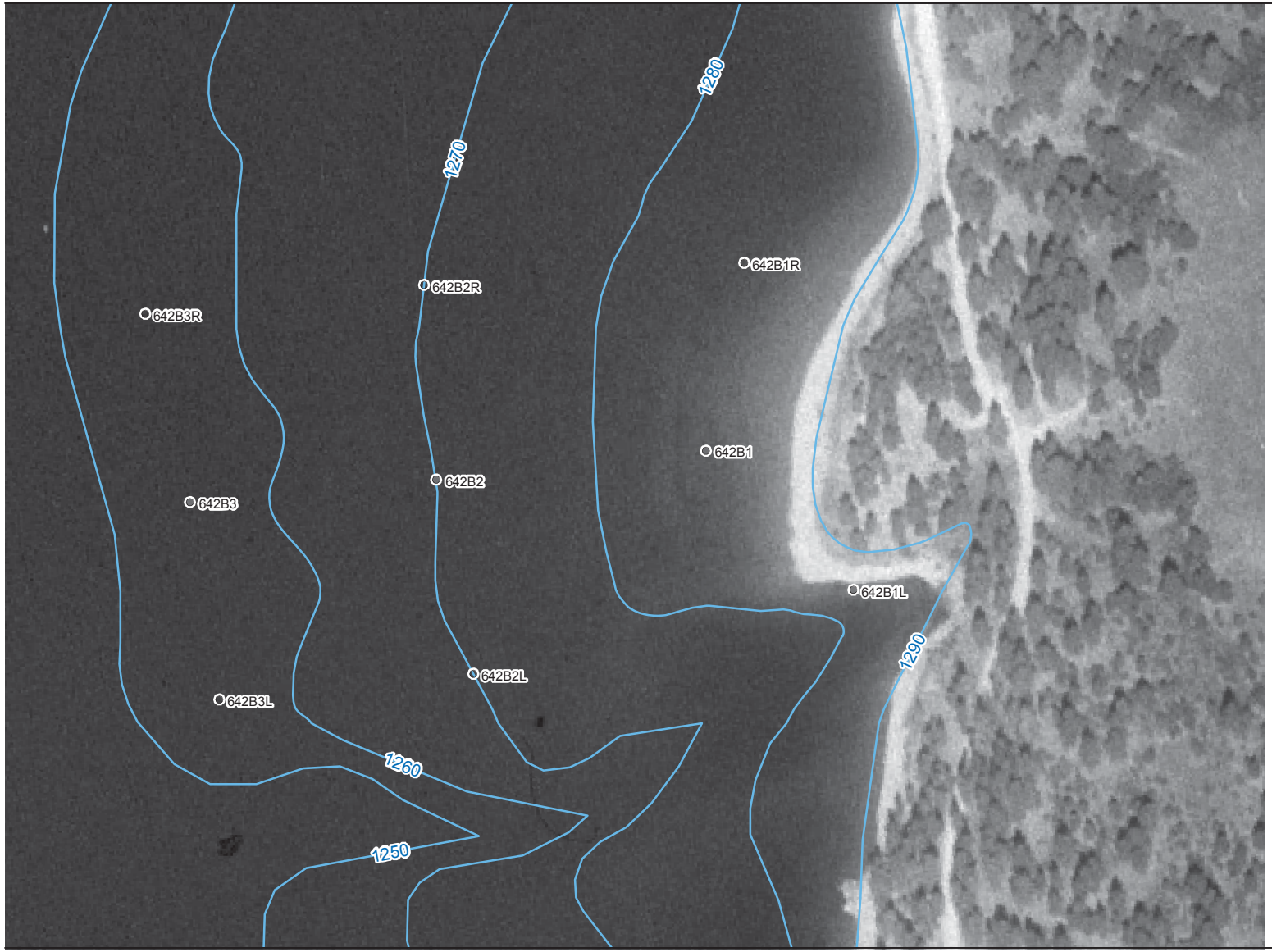

2005 Beach Sediment Sample Locations

LEGEND

2005 Beach Sampling

- Beach Subsample Composites
- Beach Subsamples

1974 USBR Bathymetry

- 10-foot Bottom Elevation Contours

N

0 100 200
Approximate scale in feet

FIGURE 2-24
Columbia Campground
2005 Beach Sample Locations
Upper Columbia River RI/FS

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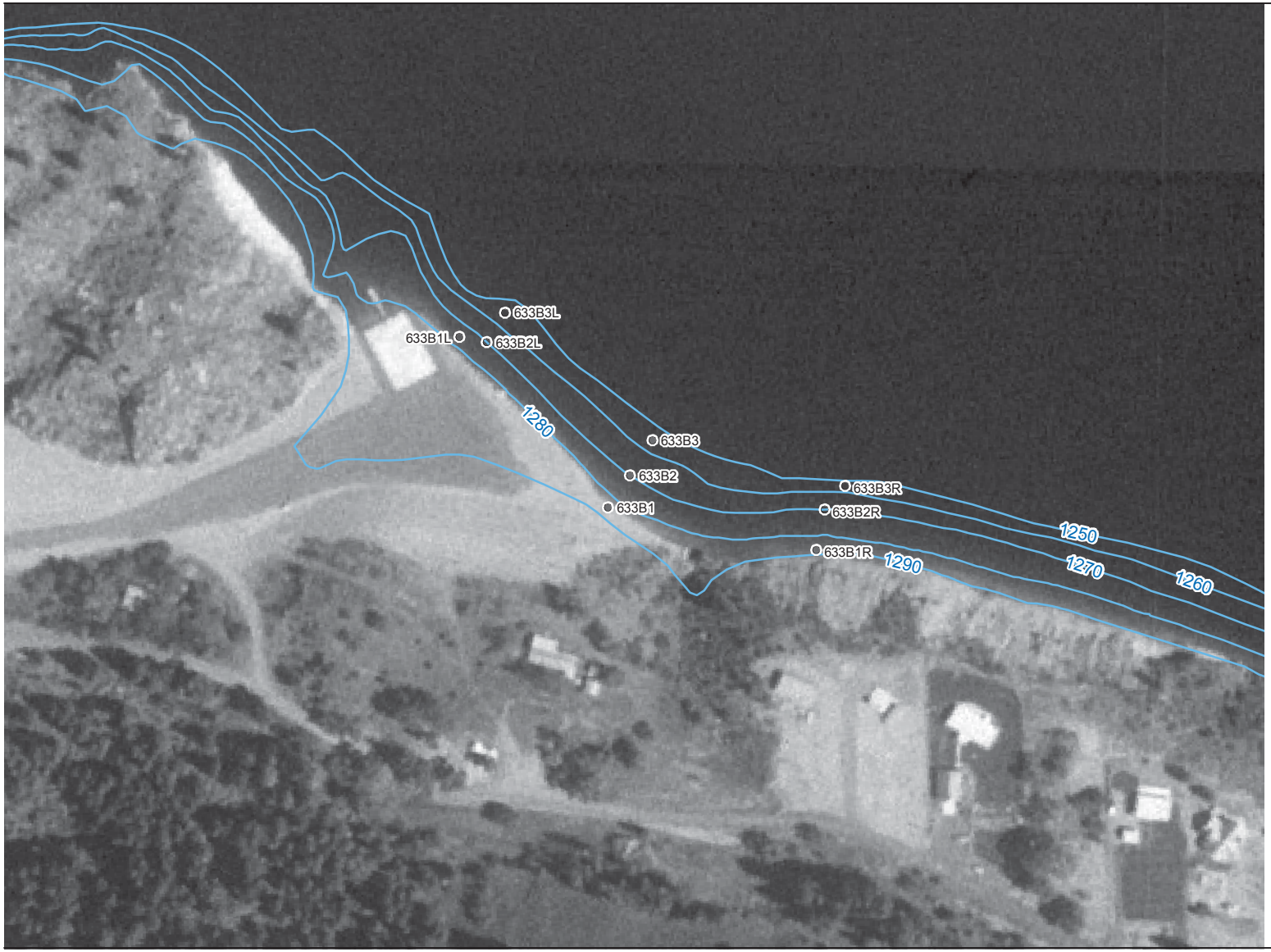

2005 Beach Sediment Sample Locations

LEGEND

2005 Beach Sampling

- Beach Subsample Composites
- Beach Subsamples

1974 USBR Bathymetry

- 10-foot Bottom Elevation Contours

N

0 100 200
Approximate scale in feet

FIGURE 2-25
Lincoln Mill Boat Ramp
2005 Beach Sample Locations
Upper Columbia River RI/FS

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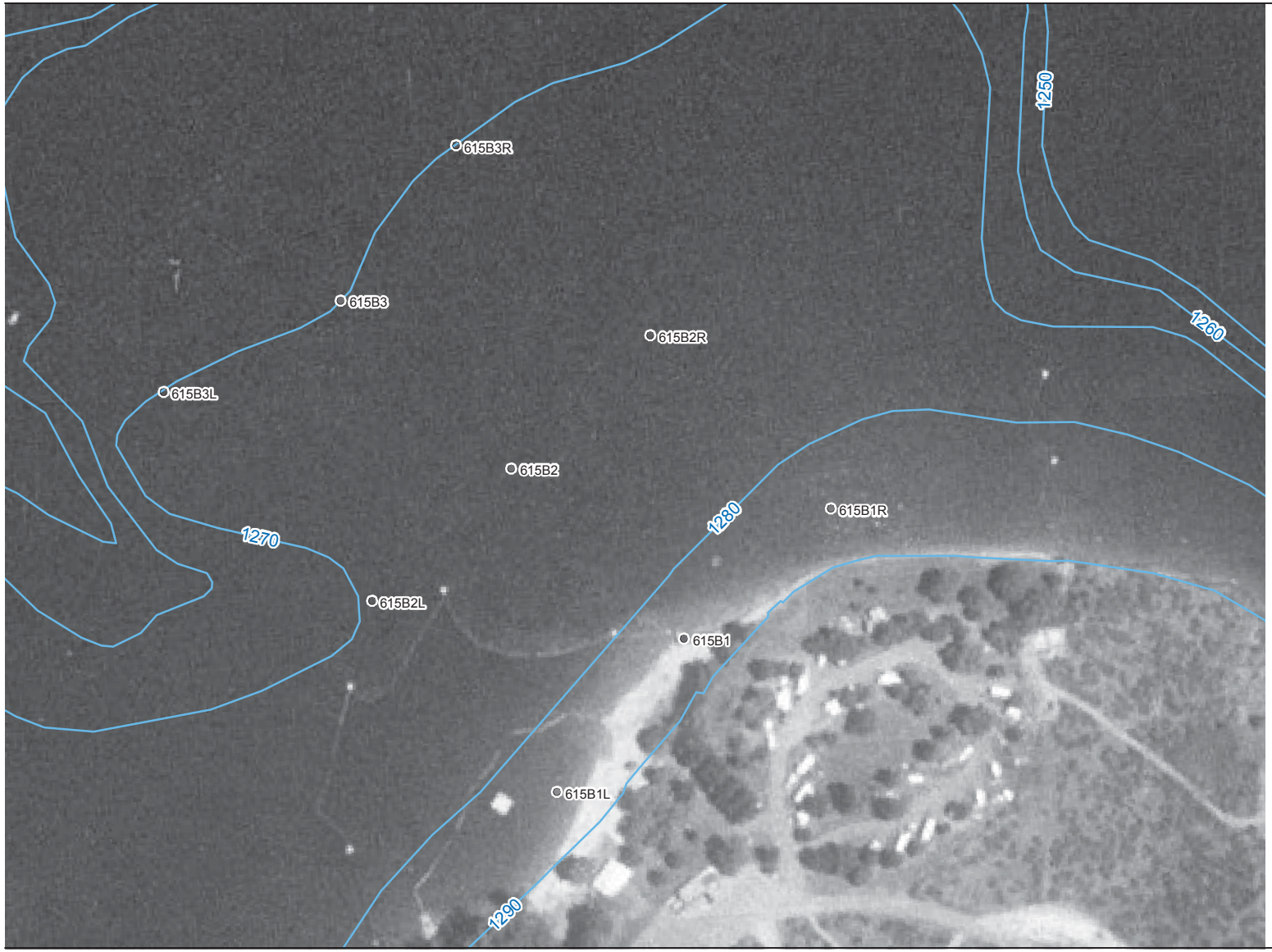

2005 Beach Sediment Sample Locations

LEGEND

2005 Beach Sampling

- Beach Subsample Composites
- Beach Subsamples

1974 USBR Bathymetry

- 10-foot Bottom Elevation Contours

N

0 100 200
Approximate scale in feet

FIGURE 2-26
Kellers Ferry
2005 Beach Sample Locations
Upper Columbia River RI/FS

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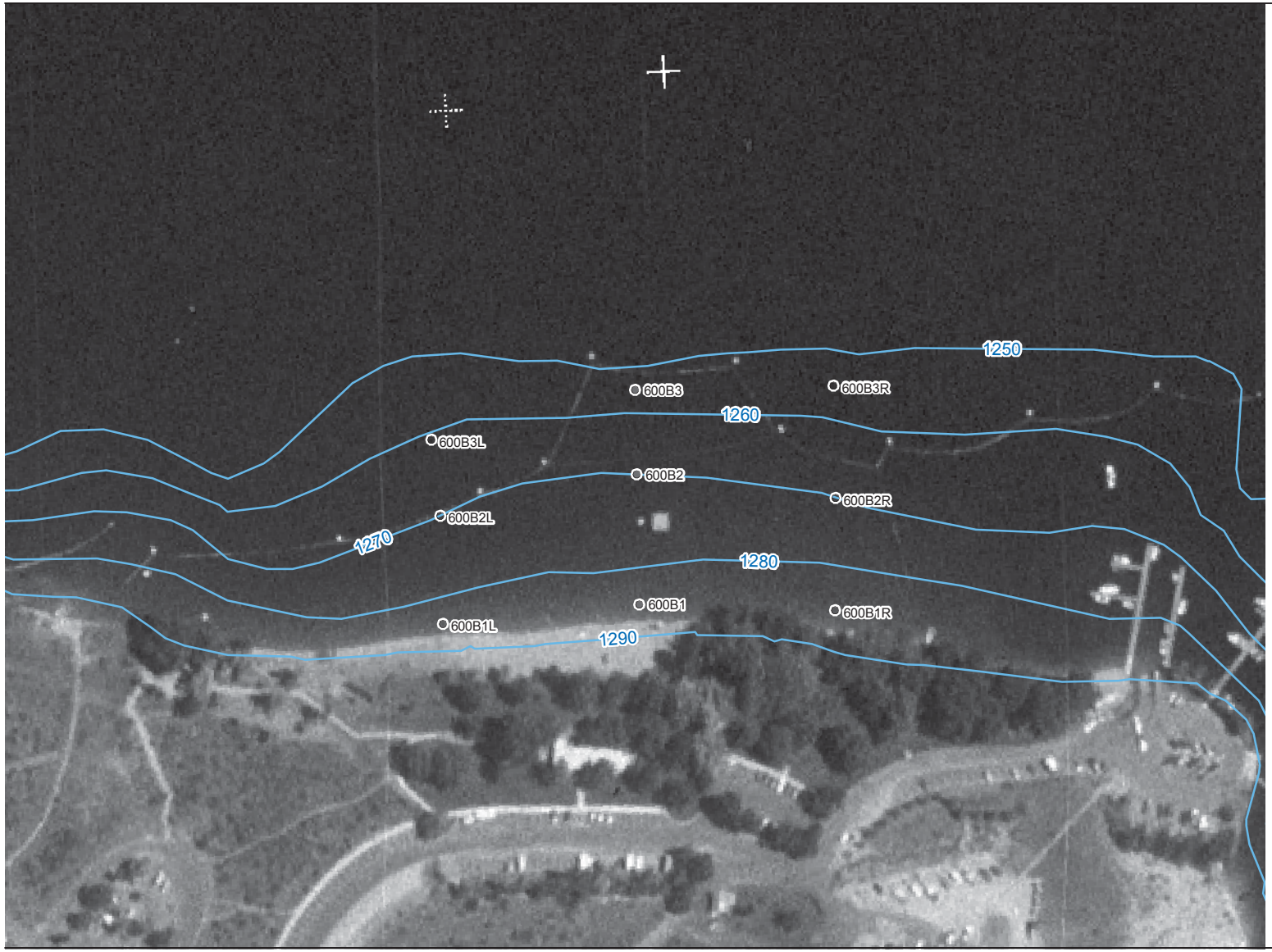
File Path: \\bbh\proj\USEnvironmentalProte\315904\GIS\MapDocuments\Mxds\2005 Sediment Sampling\Phase 1 Sediment Data Eval\Phase 1 Sed Data Eval Beaches Figure 2-13 to 2-27.mxd, Date: June 23, 2006 9:32:19 AM



2005 Beach Sediment Sample Locations

LEGEND

2005 Beach Sampling

- Beach Subsample Composites
- Beach Subsamples

1974 USBR Bathymetry

- 10-foot Bottom Elevation Contours

N

0 100 200
Approximate scale in feet

FIGURE 2-27
Spring Canyon Campground
2005 Beach Sample Locations
Upper Columbia River RI/FS

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APPENDIX F

SUMMARY OF ANALYTICAL DATA FOR EPA 2005 FISH COMPOSITE SAMPLES

APPENDIX F

SUMMARY OF ANALYTICAL DATA FOR EPA 2005 FISH COMPOSITE SAMPLES

Summary of Analytical Data for EPA 2005 Fish Composite Samples

In September and October 2005, six species of fish (burbots, largescale sucker, wild and hatchery-reared rainbow trout, lake whitefish, mountain whitefish, and walleye) were collected from six collection areas on the Upper Columbia River (UCR). The collection areas approximately corresponded to areas where sediments were intensively sampled, described as fish sample collection areas (FSCAs), during the Phase I study. The two FSCAs farthest upstream, Areas 1 (including 1A) and 2, were located in the riverine portion of the UCR. Area 3 was located at Marcus Flats near the confluence of the UCR and the Kettle River, where the river widens and slows. Areas 4, 5, and 6 were located within Lake Roosevelt.

This appendix contains tables of summarized analytical data for the six species of fish collected in 2005. Tables F1 through F5 present metals data for each fish species (note that lake whitefish and mountain whitefish are presented in a single table). Table F6 presents 2,3,7,8 TCDF, Aroclor 1254/1260, and total polychlorinated biphenyl congener data for the six species.

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Table F6. Summary Statistics for 2,3,7,8-TCDF, Aroclor 1254/1260, and Total PCB Congeners in Fish Tissue Collected by EPA in 2005

Table F1. Summary of Analytical Data for Burbot

Burbot	Collection Area	2		3		4		5		6	
	River Mile	723		706		678		635		605	
	Fish per composite	3		5		5		5		5	
	comp	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q
Aluminum											
	1	5.0		4.7		5.5		5.3		11	
	2	5.5		8.1		5.0		20		6.0	
	3	3.7		14		4.9		7.5		8.6	
	4			3.8		6.2		8.5		8.6	
	5			4.8				11.1		6.8	
	median	*5.0*		*4.8*		*5.2*		*8.5*		*8.6*	
	mean	*4.7*		*7.0*		*5.4*		10		*8.3*	
	se	*0.5*		*2.2*		*0.3*		*3.2*		*1.1*	
Arsenic											
	1	0.78		0.62		0.88		0.80		0.71	
	2	0.67		0.68		0.64		0.68		0.94	
	3	0.73		0.65		0.76		0.96		0.73	
	4			0.72		0.94		0.85		0.96	
	5			0.52				0.87		0.86	
	median	0.70		0.66		0.76		0.86		0.90	
	mean	0.70		0.64		0.78		0.84		0.87	
	se	*0.03*		*0.03*		*0.07*		*0.05*		*0.05*	
Barium											
	1	5.4		5.3		6.6		5.1		6.2	
	2	3.9		6.1		5.9		5.9		7.3	
	3	5.6		6.0		5.0		8.1		6.3	
	4			5.2		6.2		5.6		5.8	
	5			3.2				8.5		7.1	
	median	*5.4*		*5.3*		*6.1*		*5.9*		*6.3*	
	mean	*5.0*		*5.2*		*5.9*		*6.6*		*6.5*	
	se	*1.3*		*1.1*		*1.2*		*1.3*		*1.3*	
Cadmium											
	1	0.030		0.021		0.032		0.088		0.037	
	2	0.025		0.048		0.046		0.023		0.038	
	3	0.020		0.039		0.043		0.047		0.065	
	4			0.024		0.043		0.042		0.044	
	5			0.032				0.040		0.053	
	median	*0.025*		*0.032*		*0.043*		*0.042*		*0.044*	
	mean	*0.025*		*0.033*		*0.041*		*0.048*		*0.047*	
	se	*0.003*		*0.006*		*0.003*		*0.014*		*0.006*	
Calcium											
	1	8390	J	9120	J	9700	J	7080	J	10100	
	2	7710	J	7990	J	7260	J	10300	J	10400	
	3	9240	J	8610	J	6690	J	10300	J	7780	
	4			7840	J	8180	J	8350		7390	
	5			4900	J			11600		8830	
	median	*8390*		*7990*		*7720*		*10300*		*8830*	
	mean	*8450*		*7690*		*7958*		*9530*		*8900*	
	se	*443*		*295*		*657*		*790*		*776*	

Table F1. Summary of Analytical Data for Burbot

Burbot	Collection Area	2		3		4		5		6	
	River Mile	723		706		678		635		605	
	Fish per composite	3		5		5		5		5	
	comp	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q
Chromium											
	1	0.39		0.30		0.44		0.29		0.45	
	2	0.50		0.37		0.26		1.49		0.34	
	3	0.41		0.42		0.31		0.27		0.26	
	4			0.33		0.29		0.40		0.48	
	5			0.34				0.34		0.27	
	median	0.41		0.34		0.30		0.34		0.34	
	mean	0.43		0.35		0.33		0.56		0.36	
	se	*0.03*		*0.03*		*0.04*		*0.29*		*0.05*	
Cobalt											
	1	0.041		0.028		0.038		0.035		0.029	
	2	0.027		0.042		0.038		0.037		0.030	
	3	0.028		0.044		0.037		0.039		0.040	
	4			0.033		0.035		0.032		0.035	
	5			0.029				0.036		0.033	
	median	*0.028*		*0.033*		*0.037*		*0.036*		*0.033*	
	mean	*0.032*		*0.035*		*0.037*		*0.036*		*0.033*	
	se	*0.004*		*0.004*		*0.001*		*0.002*		*0.003*	
Copper											
	1	1.2		0.9		1.2		1.3		1.0	
	2	1.1		1.4		1.4		0.8		0.9	
	3	1.0		1.4		1.0		1.2		1.5	
	4			1.0		1.0		1.0		1.0	
	5			1.3				0.9		1.1	
	median	*1.1*		*1.3*		*1.1*		*1.0*		*1.0*	
	mean	*1.1*		*1.2*		*1.1*		*1.0*		*1.1*	
	se	*0.0*		*0.1*		*0.1*		*0.1*		*0.1*	
Iron											
	1	22		18		21		30		26	
	2	18		34		24		36		24	
	3	17		37		23		28		28	
	4			22		23		26		32	
	5			21				29		26	
	median	*18*		*22*		*23*		*29*		*26*	
	mean	*19*		*27*		*23*		*30*		*27*	
	se	*1*		*5*		*1*		*2*		*2*	
Lead											
	1	0.073		0.066		0.082		0.092		0.078	
	2	0.064		0.13		0.084		0.056		0.089	
	3	0.065		0.17		0.10		0.12		0.091	
	4			0.087		0.11		0.062		0.083	
	5			0.070				0.11		0.084	
	median	*0.065*		*0.087*		*0.094*		*0.092*		*0.084*	
	mean	*0.067*		*0.10*		*0.095*		*0.088*		*0.085*	
	se	*0.003*		*0.023*		*0.007*		*0.015*		*0.003*	

Table F1. Summary of Analytical Data for Burbot

Burbot	Collection Area	2		3		4		5		6	
	River Mile	723		706		678		635		605	
	Fish per composite	3		5		5		5		5	
	comp	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q
Magnesium											
	1	350	J	350	J	365	J	341	J	332	
	2	347	J	335	J	322	J	364	J	354	
	3	358	J	348	J	310	J	363	J	305	
	4			353	J	334	J	320		300	
	5			294	J			370		324	
	median	*350*		*348*		*328*		*363*		*324*	
	mean	*352*		*336*		*333*		*352*		*323*	
	se	*3.3*		*4.0*		*12*		*10*		*13*	
Manganese											
	1	2.1		1.9		3.2		2.1		2.4	
	2	2.2		2.1		2.4		2.8		2.8	
	3	2.1		2.9		2.1		3.0		1.9	
	4			1.9		2.5		1.8		2.5	
	5			1.3				2.8		2.6	
	median	*2.1*		*1.9*		*2.4*		*2.8*		*2.5*	
	mean	*2.1*		*2.0*		*2.6*		*2.5*		*2.4*	
	se	*0.0*		*0.2*		*0.2*		*0.3*		*0.2*	
Mercury											
	1	0.18		0.14		0.17		0.24		0.21	
	2	0.11		0.20		0.23		0.13		0.15	
	3	0.12		0.18		0.18		0.18		0.23	
	4			0.12		0.18		0.18		0.18	
	5			0.16				0.22		0.24	
	median	*0.12*		*0.16*		*0.18*		*0.18*		*0.21*	
	mean	*0.14*		*0.16*		*0.19*		*0.19*		*0.20*	
	se	*0.02*		*0.02*		*0.01*		*0.02*		*0.02*	
Nickel											
	1	0.30		0.32		0.38		0.27		0.35	
	2	0.32		0.31		0.26		0.42		0.32	
	3	0.30		0.33		0.25		0.37		0.26	
	4			0.24		0.29		0.28		0.25	
	5			0.18				0.36		0.31	
	median	*0.30*		*0.31*		*0.27*		*0.36*		*0.31*	
	mean	*0.31*		*0.28*		*0.29*		*0.34*		*0.30*	
	se	*0.01*		*0.02*		*0.03*		*0.04*		*0.02*	
Potassium											
	1	3140		2900		2960		3160		2640	
	2	3120		2950		3060		2700		2600	
	3	2990		2950		2990		2720		2870	
	4			3170		3170		2880		2860	
	5			3160				2810		2710	
	median	*3120*		*2950*		*3025*		*2810*		*2710*	
	mean	*3080*		*3030*		*3045*		*2850*		*2740*	
	se	*47*		*60*		*47*		*106*		*71*	

Table F1. Summary of Analytical Data for Burbot

Burbot	Collection Area	2		3		4		5		6	
	River Mile	723		706		678		635		605	
	Fish per composite	3		5		5		5		5	
	comp	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q
Selenium											
	1	0.58		0.59		0.59		0.52		0.41	
	2	0.71		0.58		0.56		0.42		0.49	
	3	0.77		0.83		0.63		0.43		0.42	
	4			0.71		0.58		0.51		0.46	
	5			0.57				0.52		0.39	
	median	0.71		0.59		0.59		0.51		0.42	
	mean	0.68		0.66		0.59		0.48		0.43	
	se	*0.06*		*0.06*		*0.02*		*0.03*		*0.02*	
Sodium											
	1	1360		1360		1340		1640		1300	
	2	1330		1360		1330		1400		1460	
	3	1540		1550		1300		1560		1490	
	4			1420		1470		1460		1490	
	5			1220				1510		1370	
	median	*1360*		*1360*		*1335*		*1510*		*1460*	
	mean	*1410*		*1380*		*1360*		*1510*		*1420*	
	se	*66*		*45*		*38*		*53*		*46*	
Uranium											
	1	0.0046		0.0042		0.0054		0.0052		0.0051	
	2	0.0045		0.0053		0.0038		0.0045		0.0070	
	3	0.0031		0.011		0.0039		0.0063		0.0045	
	4			0.0044		0.0048		0.0043		0.0037	
	5			0.0030				0.0051		0.0051	
	median	*0.0045*		*0.0044*		*0.0043*		*0.0051*		*0.0051*	
	mean	*0.0041*		*0.0057*		*0.0045*		*0.0051*		*0.0051*	
	se	*0.0005*		*0.0017*		*0.0004*		*0.0005*		*0.0007*	
Vanadium											
	1	0.084	U	0.085		0.099		0.086		0.08	U
	2	0.11		0.11		0.076	U	0.079	U	0.097	
	3	0.13		0.17		0.080		0.10		0.091	
	4			0.093		0.080	U	0.10		0.089	U
	5			0.09	U			0.10		0.084	U
	median	*0.11*		*0.09*		*0.08*		*0.10*		*0.09*	
	mean	*0.11*		*0.11*		*0.08*		*0.09*		*0.09*	
	se	*0.01*		*0.02*		*0.01*		*0.01*		*0.00*	
Zinc											
	1	12		12		13		14		12	J
	2	12		13		13		11		12	J
	3	12		14		11		13		13	J
	4			13		12		13	J	12	J
	5			11				13	J	14	J
	median	*12*		*13*		*12*		*13*		*12*	
	mean	*12*		*12*		*12*		*13*		*12*	
	se	*0.2*		*0.4*		*0.4*		*0.5*		*0.3*	

Table F1. Summary of Analytical Data for Burbot

Burbot	Collection Area	2		3		4		5		6	
	River Mile	723		706		678		635		605	
	Fish per composite	3		5		5		5		5	
	comp	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q
Moisture %	1	79		79		79		80		80	
	2	77		79		80		79		79	
	3	78		79		81		80		80	
	4			78		79		79		79	
	5			77				79		80	
	median	*78*		*79*		*80*		*79*		*80*	
	mean	*78*		*79*		*80*		*79*		*79*	
	se	*0.4*		*0.3*		*0.3*		*0.3*		*0.2*	
Lipids %	1	1.3		6.3		1.1		0.8		1.6	
	2	2.4		1.3		0.6		1.4		2.0	
	3	2.2		1.2		0.9		0.9		1.3	
	4			2.3		1.3		1.9		1.6	
	5			2.5				1.4		1.0	
	median	*2.2*		*2.3*		*1.0*		*1.4*		*1.6*	
	mean	*2.0*		*2.7*		*1.0*		*1.3*		*1.5*	
	se	*0.3*		*1.2*		*0.1*		*0.3*		*0.1*	
Age years	1	3.7		4.0		3.8		8.0		4.6	
	2	3.3		7.2		5.2		3.8		5.4	
	3	3.7		6.6		5.0		7.0		6.8	
	4			4.2		5.2		8.2		5.2	
	5			4.8				7.2		7.2	
	median	*3.7*		*4.8*		*5.1*		*7.2*		*5.4*	
	mean	*3.6*		*5.4*		*4.8*		*6.8*		*5.8*	
	se	*0.1*		*0.8*		*0.3*		*1.0*		*0.5*	
Length mm	1	597		734		490		872		621	
	2	781		650		492		758		593	
	3	602		714		584		781		637	
	4			735		619		796		659	
	5			1042				706		616	
	median	602		734		538		781		621	
	mean	660		775		546		783		625	
	se	*60*		*20*		*33*		*25*		*14*	
Weight g	1	484		515		471		573		496	
	2	536		523		493		527		495	
	3	490		541		498		569		507	
	4			513		540		557		510	
	5			553				550		503	
	median	*490*		*523*		*495*		*557*		*503*	
	mean	*503*		*529*		*501*		*556*		*502*	
	se	*16*		*6.2*		*14*		*10*		*3.7*	

Notes: Q = Laboratory qualifier
U = reported value is at or below the limit of detection

Table F2. Summary of Analytical Data for Largescale Sucker

Largescale Sucker	Collection Area	1		1(A)		2		3		4		5		6	
	River Mile	741		735		723		706		678		635		605	
	Fish per composite	5		5		5		5		5		5		5	
		mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q
Aluminum	whole body composite														
	1	138	J	64	J	12	J	51	J	46	J	22	J	40	J
	2	81	J			24	J	48	J	79	J	79	J	88	J
	3					19	J	13	J	86	J	23	J	50	J
	4					42	J	20	J	86	J	13	J	47	J
	5									89	J	9	J		
	median	109		64		21		34		86		22		49	
	mean	109		64		24		33		77		29		56	
	se	29				6		10		8		13		11	
	gutless individual														
	1	20	J	3.7	U			4.3	J					4.8	U
	2	7.1	J	5.1				3.6	J					3.7	U
	3	113	J	4.5				15	J					14	
	4	6.8	J	5.2				5.8	J					3.9	U
	5	8.2	J	3.8				4.5	J					4.0	U
	median	8.2		4.5				4.5						4.0	
	mean	31		4.5				6.7						6.0	
	se	21		0.3				2.2						2.0	
	gut														
	1	2860		213				609						56	
	2	1870		450				346						29	
	3	744		246				183						1180	
	4	1410		424				324						117	
	5	6490		297				65						150	
	median	1870		297				324						117	
	mean	2670		326				305						307	
	se	1000		47				91						220	
	reconstructed whole body														
	1	232		20				38						8	
	2	150		39				23						5	
	3	138		27				27						107	
	4	94.5		32				31						13	
	5	401		32				8.3						11	
	median	150		32				27						11	
	mean	203		30				26						29	
	se	54		3				5						20	

Table F2. Summary of Analytical Data for Largescale Sucker

Largescale Sucker	Collection Area	1		1(A)		2		3		4		5		6	
	River Mile	741		735		723		706		678		635		605	
	Fish per composite	5		5		5		5		5		5		5	
		mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q
Arsenic	whole body composite														
	1	0.33		0.16		0.16		0.16		0.18		0.17		0.18	
	2	0.28				0.15		0.19		0.19		0.23		0.22	
	3					0.14		0.16		0.18		0.20		0.18	
	4					0.20		0.13		0.22		0.19		0.21	
	5									0.20		0.13			
	median	0.31		0.16		0.16		0.16		0.19		0.19		0.20	
	mean	0.31		0.16		0.16		0.16		0.19		0.18		0.20	
	se	0.03				0.01		0.01		0.01		0.02		0.01	
	gutless individual														
	1	0.15		0.10				0.19						0.21	
	2	0.20		0.18				0.21						0.20	
	3	0.12		0.18				0.21						0.15	
	4	0.18		0.10				0.12						0.14	
	5	0.15		0.19				0.14						0.15	
	median	0.15		0.18				0.19						0.15	
	mean	0.16		0.15				0.18						0.17	
	se	0.01		0.02				0.02						0.02	
	gut														
	1	2.4		0.61				0.67						0.47	
	2	1.7		0.73				0.39						0.25	
	3	1.1		0.81				0.63						1.6	
	4	1.5		1.0				0.50						0.38	
	5	5.0		0.083				0.26						0.35	
	median	1.7		0.73				0.50						0.38	
	mean	2.3		0.65				0.49						0.62	
	se	0.7		0.16				0.08						0.26	
	reconstructed whole body														
	1	0.31		0.14				0.22						0.23	
	2	0.31		0.22				0.22						0.20	
	3	0.16		0.24				0.24						0.27	
	4	0.26		0.16				0.15						0.16	
	5	0.44		0.25				0.15						0.16	
	median	0.31		0.22				0.22						0.20	
	mean	0.30		0.20				0.20						0.20	
	se	0.04		0.02				0.02						0.02	

Table F2. Summary of Analytical Data for Largescale Sucker

Largescale Sucker	Collection Area	1		1(A)		2		3		4		5		6	
	River Mile	741		735		723		706		678		635		605	
	Fish per composite	5		5		5		5		5		5		5	
		mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q
Barium	whole body composite														
	1	12		5.1	J	2.0		2.6		4.0	J	3.3	J	2.8	J
	2	7.7				2.8		3.1		4.3	J	4.1	J	3.7	J
	3					2.5		1.6		2.6	J	3.7	J	3.8	J
	4					3.5		1.9		3.4	J	2.3	J	3.5	J
	5									4.2	J	3.3	J		
	median	9.7		5.1		2.7		2.2		4.0		3.3		3.6	
	mean	9.7		5.1		2.7		2.3		3.7		3.3		3.5	
	se	1.9				0.3		0.3		0.3		0.3		0.2	
	gutless individual														
	1	2.6		1.1				4.1						2.0	
	2	1.7		2.3				2.2						1.7	
	3	3.2		1.2				1.5						2.5	
	4	3.0		1.8				0.97						3.3	
	5	2.2		1.9				2.3						2.6	
	median	2.6		1.8				2.2						2.5	
	mean	2.6		1.7				2.2						2.4	
	se	0.3		0.2				0.5						0.3	
	gut														
	1	2.4		0.61				0.67						0.47	
	2	1.7		0.73				0.39						0.25	
	3	1.1		0.81				0.63						1.6	
	4	1.5		1.0				0.50						0.38	
	5	5.0		0.83				0.26						0.35	
	median	1.7		0.81				0.50						0.38	
	mean	2.3		0.80				0.49						0.62	
	se	0.7		0.068				0.075						0.26	
	reconstructed whole body														
	1	21		2.1				4.4						2.0	
	2	11		3.4				2.9						1.6	
	3	4.9		2.0				1.8						3.7	
	4	7.0		3.2				1.2						3.3	
	5	39		3.5				2.2						2.7	
	median	11		3.2				2.2						2.7	
	mean	16		2.9				2.5						2.7	
	se	6		0.3				0.6						0.4	

Table F2. Summary of Analytical Data for Largescale Sucker

Largescale Sucker	Collection Area	1		1(A)		2		3		4		5		6	
	River Mile	741		735		723		706		678		635		605	
	Fish per composite	5		5		5		5		5		5		5	
		mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q
Cadmium	whole body composite														
	1	0.20		0.31		0.29		0.29		0.28		0.28		0.29	
	2	0.27				0.45		0.30		0.30		0.29		0.30	
	3					0.37		0.31		0.37		0.29		0.26	
	4					0.34		0.39		0.27		0.28		0.26	
	5									0.33		0.26			
	median	0.24		0.31		0.35		0.31		0.30		0.28		0.275	
	mean	0.24		0.31		0.36		0.32		0.31		0.28		0.277	
	se	0.04				0.03		0.02		0.02		0.01		0.01	
	gutless individual														
	1	0.27		0.29				0.20						0.30	
	2	0.41		0.26				0.27						0.15	
	3	0.34		0.25				0.11						0.33	
	4	0.41		0.35				0.03						0.17	
	5	0.038		0.24				0.10						0.15	
	median	0.34		0.26				0.11						0.17	
	mean	0.30		0.28				0.14						0.22	
	se	0.07		0.02				0.04						0.04	
	gut														
	1	1.6		1.4				1.1						2.0	
	2	2.1		1.7				1.2						0.97	
	3	2.3		1.0				0.89						0.69	
	4	1.6		2.0				0.21						0.78	
	5	2.5		1.3				0.44						1.0	
	median	2.1		1.4				0.89						0.97	
	mean	2.0		1.5				0.77						1.1	
	se	0.2		0.2				0.19						0.23	
	reconstructed whole body														
	1	0.37		0.37				0.25						0.41	
	2	0.54		0.36				0.32						0.19	
	3	0.42		0.33				0.17						0.36	
	4	0.49		0.45				0.043						0.22	
	5	0.51		0.35				0.13						0.19	
	median	0.49		0.36				0.17						0.22	
	mean	0.47		0.37				0.18						0.27	
	se	0.03		0.02				0.05						0.05	

Table F2. Summary of Analytical Data for Largescale Sucker

Largescale Sucker	Collection Area	1		1(A)		2		3		4		5		6	
	River Mile	741		735		723		706		678		635		605	
	Fish per composite	5		5		5		5		5		5		5	
		mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q
Calcium	whole body composite														
	1	8650		13200	J	9810		10600		15700	J	11700	J	6830	J
	2	8120				11300		12800		13000	J	13600	J	9890	J
	3					11400		9810		8010	J	10900	J	10700	J
	4					10300		8830		8200	J	9300	J	12700	J
	5									12000	J	14100	J		
	median	8390		13200		10800		10200		12000		11700		10300	
	mean	8390		13200		10700		10500		11400		11900		10000	
	se	270				390		840		1500		880		1200	
	gutless individual														
	1	9660		7730				11100						7840	
	2	8910		8110				10600						11700	
	3	14000		10500				12400						7730	
	4	10600		9410				9520						12600	
	5	8240		9890				10600						10300	
	median	9660		9410				10600						10300	
	mean	10300		9130				10800						10000	
	se	1000		530				470						990	
	gut														
	1	7740		17800				3070						2560	
	2	6350		8930				8320						167	
	3	8990		18800				10900						2250	
	4	5360		27800				407						1700	
	5	21100		14100				514						735	
	median	7740		17800				3070						1700	
	mean	9910		17500				4640						1480	
	se	2900		3100				2100						450	
	reconstructed whole body														
	1	9510		8490				10500						7510	
	2	8710		8170				10500						11100	
	3	13800		11200				12300						7290	
	4	10300		10600				8810						11700	
	5	9020		10300				10000						9840	
	median	9510		10300				10500						9840	
	mean	10300		9750				10400						9490	
	se	920		600				560						900	

Table F2. Summary of Analytical Data for Largescale Sucker

Largescale Sucker	Collection Area	1		1(A)		2		3		4		5		6	
	River Mile	741		735		723		706		678		635		605	
	Fish per composite	5		5		5		5		5		5		5	
		mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q
Chromium	whole body composite														
	1	3.1	J	1.3		0.67	J	1.0	J	0.71		1.1		1.8	
	2	1.7	J			1.6	J	0.86	J	1.2		1.5		1.8	
	3					1.1	J	0.65	J	1.3		0.95		1.3	
	4					1.0	J	0.60	J	1.6		0.51		1.7	
	5									2.1		0.47			
	median	2.4		1.3		1.1		0.76		1.3		0.95		1.8	
	mean	2.4		1.3		1.1		0.79		1.4		0.89		1.7	
	se	0.7				0.2		0.10		0.2		0.18		0.1	
	gutless individual														
	1	0.64	J	0.47				0.50	J					0.81	
	2	0.66	J	0.68				0.43	J					0.76	
	3	0.75	J	0.59				0.36						1.5	
	4	0.63	J	0.33				0.50						0.46	
	5	0.55	J	0.61				0.37						0.95	
	median	0.64		0.59				0.43						0.81	
	mean	0.64		0.53				0.44						0.89	
	se	0.03		0.06				0.03						0.16	
	gut														
	1	54		3.2				46						1.3	
	2	99		8.6				4.7						2.0	
	3	54		3.5				3.5						21	
	4	38		4.6				24						6.8	
	5	102		3.3				1.9						5.6	
	median	54		3.5				4.7						5.6	
	mean	69		4.6				16						7.3	
	se	13		1.0				8.4						3.5	
	reconstructed whole body														
	1	4.6		0.68				3.0						0.84	
	2	8.2		1.3				0.68						0.82	
	3	2.9		0.86				0.58						3.0	
	4	3.0		0.60				2.3						0.99	
	5	6.7		0.87				0.47						1.2	
	median	4.6		0.86				0.68						0.99	
	mean	5.1		0.86				1.4						1.4	
	se	1.1		0.12				0.52						0.41	

Table F2. Summary of Analytical Data for Largescale Sucker

Largescale Sucker	Collection Area	1		1(A)		2		3		4		5		6	
	River Mile	741		735		723		706		678		635		605	
	Fish per composite	5		5		5		5		5		5		5	
		mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q
Cobalt	whole body composite														
	1	0.36		0.12		0.040		0.065		0.063		0.054		0.061	
	2	0.18				0.056		0.067		0.081		0.099		0.080	
	3					0.045		0.034		0.086		0.061		0.058	
	4					0.064		0.039		0.11		0.036		0.063	
	5									0.11		0.050			
	median	0.27		0.12		0.050		0.052		0.086		0.054		0.062	
	mean	0.27		0.12		0.051		0.051		0.091		0.060		0.065	
	se	0.09				0.006		0.009		0.009		0.011		0.005	
	gutless individual														
	1	0.052		0.03				0.050						0.035	
	2	0.036		0.03				0.027						0.023	
	3	0.058		0.05				0.029						0.069	
	4	0.041		0.04				0.016						0.046	
	5	0.035		0.04				0.034						0.027	
	median	0.041		0.037				0.029						0.035	
	mean	0.044		0.038				0.031						0.040	
	se	0.005		0.005				0.006						0.008	
	gut														
	1	8.7		0.44				0.86						0.10	
	2	5.0		0.45				0.24						0.06	
	3	1.9		0.36				0.17						0.80	
	4	2.5		0.58				0.39						0.15	
	5	18.8		0.33				0.06						0.16	
	median	5.000		0.440				0.240						0.150	
	mean	7.380		0.432				0.344						0.255	
	se	3.096		0.044				0.140						0.137	
	reconstructed whole body														
	1	0.70		0.057				0.096						0.039	
	2	0.42		0.065				0.039						0.025	
	3	0.13		0.083				0.039						0.128	
	4	0.19		0.074				0.045						0.055	
	5	1.18		0.066				0.036						0.033	
	median	0.416		0.066				0.039						0.039	
	mean	0.524		0.069				0.051						0.056	
	se	0.191		0.004				0.011						0.019	

Table F2. Summary of Analytical Data for Largescale Sucker

Largescale Sucker	Collection Area	1		1(A)		2		3		4		5		6	
	River Mile	741		735		723		706		678		635		605	
	Fish per composite	5		5		5		5		5		5		5	
		mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q
Copper	whole body composite														
	1	13	J	3.1		0.91	J	0.95	J	0.71		0.77		1.2	
	2	8.1	J			1.4	J	0.91	J	0.83		0.81		1.0	
	3					1.2	J	0.72	J	0.86		0.67		0.79	
	4					1.5	J	0.79	J	0.83		0.60		0.96	
	5									0.82		0.71			
	median	10		3.1		1.3		0.85		0.83		0.71		1.0	
	mean	10		3.1		1.3		0.84		0.81		0.72		0.99	
	se	2.3				0.1		0.05		0.03		0.04		0.08	
	gutless individual														
	1	1.9	J	0.61				0.50	J					0.61	
	2	0.92	J	0.59				0.65	J					0.37	
	3	1.2	J	0.81				0.49						0.94	
	4	0.77	J	0.74				0.40						0.54	
	5	1.0	J	0.70				0.45						0.35	
	median	1.0		0.70				0.49						0.54	
	mean	1.2		0.69				0.50						0.56	
	se	0.2		0.04				0.04						0.11	
	gut														
	1	307		25				13						3.9	
	2	164		14				7.5						7.4	
	3	71		14				6.9						4.2	
	4	83		26				6.0						2.7	
	5	785		7.4				5.7						5.9	
	median	164		14				6.9						4.2	
	mean	282		17				7.8						4.8	
	se	130		4				1.3						0.8	
	reconstructed whole body														
	1	25		2.4				1.2						0.81	
	2	13		1.6				1.0						0.72	
	3	3.9		2.0				0.95						1.2	
	4	5.9		2.3				0.83						0.72	
	5	49		1.4				0.78						0.62	
	median	13		2.0				0.95						0.72	
	mean	19		2.0				0.96						0.81	
	se	8		0.2				0.07						0.10	

Table F2. Summary of Analytical Data for Largescale Sucker

Largescale Sucker	Collection Area	1		1(A)		2		3		4		5		6	
	River Mile	741		735		723		706		678		635		605	
	Fish per composite	5		5		5		5		5		5		5	
		mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q
Iron	whole body composite														
	1	1060		301		44		89		67		38		86	
	2	585				69		93		93		120		151	
	3					56		29		122		46		91	
	4					92		46		130		25		90	
	5									131		19			
	median	823		301		63		67		122		38		90	
	mean	823		301		65		64		109		49		104	
	se	240				10		16		12		18		16	
	gutless individual														
	1	139		14	J			11						11	J
	2	30		23	J			26						10	J
	3	70		22	J			11						28	J
	4	34		44	J			9.7						11	J
	5	62		15	J			16						12	J
	median	62		22				11						11	
	mean	67		24				15						15	
	se	20		5				3						4	
	gut														
	1	25000		833				1080						96	
	2	14100		1210				677						102	
	3	4980		728				304						2030	
	4	7770		1390				617						259	
	5	66700		665				146						352	
	median	14100		833				617						259	
	mean	23700		965				565						568	
	se	11000		140				160						370	
	reconstructed whole body														
	1	1990		76				71						16	
	2	1100		113				63						15	
	3	265		88				32						188	
	4	517		129				57						32	
	5	4100		79				24						28	
	median	1100		88				57						28	
	mean	1590		97				49						56	
	se	690		10				9						33	

Table F2. Summary of Analytical Data for Largescale Sucker

Largescale Sucker	Collection Area	1		1(A)		2		3		4		5		6	
	River Mile	741		735		723		706		678		635		605	
	Fish per composite	5		5		5		5		5		5		5	
		mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q
Lead	whole body composite														
	1	6.4	J	6.5	J	3.6	J	3.3	J	2.1	J	0.72	J	0.43	J
	2	3.2	J			4.1	J	3.0	J	1.4	J	0.74	J	0.55	J
	3					4.3	J	2.0	J	1.1	J	0.72	J	0.81	0
	4					3.7	J	3.5	J	1.1	0	0.45	J	0.95	J
	5									1.5	J	0.63	J		
	median	4.8		6.5		3.9		3.2		1.4		0.72		0.68	
	mean	4.8		6.5		3.9		3.0		1.5		0.65		0.69	
	se	1.6				0.2		0.3		0.2		0.05		0.12	
	gutless individual														
	1	5.0	J	3.2				0.71	J					0.35	
	2	7.3	J	6.8				4.3	J					0.29	
	3	14	J	4.1				2.0	J					0.52	
	4	6.3	J	7.8				0.12	J					0.52	
	5	7.8	J	3.5				1.7	J					0.27	
	median	7.3		4.1				1.7						0.35	
	mean	8.0		5.1				1.8						0.39	
	se	1.5		0.93				0.72						0.05	
	gut														
	1	35		2.4				0.80						0.14	
	2	22		5.0				1.9						0.070	
	3	12		2.1				1.4						1.0	
	4	14		4.8				0.66						0.17	
	5	116		2.2				0.29						0.20	
	median	22		2.4				0.80						0.17	
	mean	40		3.3				1.0						0.32	
	se	19		0.66				0.29						0.18	
	reconstructed whole body														
	1	7.3		3.1				0.72						0.34	
	2	8.4		6.6				4.2						0.28	
	3	13		3.9				2.0						0.56	
	4	6.8		7.6				0.16						0.49	
	5	14		3.4				1.7						0.27	
	median	8.4		3.9				1.7						0.34	
	mean	10		4.9				1.7						0.39	
	se	1.6		0.9				0.7						0.06	

Table F2. Summary of Analytical Data for Largescale Sucker

Largescale Sucker	Collection Area	1		1(A)		2		3		4		5		6	
	River Mile	741		735		723		706		678		635		605	
	Fish per composite	5		5		5		5		5		5		5	
		mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q
Magnesium whole body composite															
	1	367		383		337		370		394		339		305	
	2	353				356		398		382		397		364	
	3					356		337		346		327		351	
	4					338		324		343		289		369	
	5									398		369			
	median	360		383		347		354		382		339		358	
	mean	360		383		347		357		373		344		347	
	se	7				5		17		12		18		15	
	gutless individual														
	1	357		305				334						289	
	2	332		319				362						307	
	3	412		347				385						291	
	4	369		319				389						318	
	5	328		321				374						340	
	median	357		319				374						307	
	mean	359		322				369						309	
	se	15		7				10						9	
	gut														
	1	1200		363				505						173	
	2	885		536				348						129	
	3	498		417				295						887	
	4	854		595				262						174	
	5	2020		422				146						214	
	median	885		422				295						174	
	mean	1090		467				311						316	
	se	260		43				59						140	
	reconstructed whole body														
	1	420		310				343						282	
	2	374		335				361						299	
	3	415		353				378						339	
	4	399		336				379						306	
	5	430		331				360						334	
	median	415		335				361						306	
	mean	408		333				364						312	
	se	9.8		7				7						11	

Table F2. Summary of Analytical Data for Largescale Sucker

Largescale Sucker	Collection Area	1		1(A)		2		3		4		5		6	
	River Mile	741		735		723		706		678		635		605	
	Fish per composite	5		5		5		5		5		5		5	
		mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q
Manganese whole body composite															
	1	28		14	J	6.7		7.6		8.9	J	6.3	J	4.4	J
	2	23				7.5		8.3		9.3	J	9.3	J	6.5	J
	3					6.9		4.3		6.6	J	7.7	J	6.3	J
	4					7.5		5.3		7.3	J	4.3	J	8.2	J
	5									9.1	J	6.1	J		
	median	25		14		7.2		6.5		8.9		6.3		6.4	
	mean	25		14		7.1		6.4		8.2		6.7		6.3	
	se	2				0.2		0.9		0.5		0.8		0.8	
gutless individual															
	1	8.7		4.5	J			4.5						2.4	J
	2	12		11	J			5.8						2.6	J
	3	15		5.4	J			6.8	J					7.5	J
	4	12		9.9	J			2.0	J					4.6	J
	5	10		5.1	J			5.9	J					2.4	J
	median	12		5.4				5.8						2.6	
	mean	12		7.1				5.0						3.9	
	se	1.1		1.3				0.8						1.0	
gut															
	1	504	J	26	J			47	J					11	J
	2	284	J	28	J			22	J					1.7	J
	3	100	J	22	J			19	J					47	
	4	166	J	43	J			13						12	J
	5	1250	J	17	J			3.1	J					8.8	J
	median	284		26				19						10.6	
	mean	461		27				21						16.0	
	se	210		5				7						7.9	
reconstructed whole body															
	1	46		6.1				6.9						2.9	
	2	33		12				6.7						2.6	
	3	19		6.9				7.6						11	
	4	22		12				2.9						5.2	
	5	85		6.2				5.7						2.8	
	median	33		6.9				6.8						2.9	
	mean	41		8.7				6.0						4.8	
	se	12		1.4				0.8						1.5	

Table F2. Summary of Analytical Data for Largescale Sucker

Largescale Sucker	Collection Area	1		1(A)		2		3		4		5		6	
	River Mile	741		735		723		706		678		635		605	
	Fish per composite	5		5		5		5		5		5		5	
		mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q
Mercury	whole body composite														
	1	0.077		0.19		0.22		0.28		0.30		0.24		0.21	
	2	0.093				0.21		0.23		0.26		0.23		0.25	
	3					0.17		0.28		0.25		0.21		0.23	
	4					0.17		0.29		0.22		0.20		0.21	
	5									0.26		0.26			
	median	0.085		0.19		0.19		0.28		0.26		0.23		0.22	
	mean	0.085		0.19		0.19		0.27		0.26		0.23		0.23	
	se	0.008				0.01		0.01		0.01		0.01		0.01	

Table F2. Summary of Analytical Data for Largescale Sucker

Largescale Sucker	Collection Area	1		1(A)		2		3		4		5		6	
	River Mile	741		735		723		706		678		635		605	
	Fish per composite	5		5		5		5		5		5		5	
		mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q
Nickel	whole body composite														
	1	0.89		0.60		0.35		0.57		0.58		0.54		0.61	
	2	0.40				0.84		0.54		0.54		0.73		0.58	
	3					0.63		0.39		0.49		0.50		0.57	
	4					0.53		0.37		0.58		0.30		0.60	
	5									0.89		0.41			
	median	0.65		0.60		0.58		0.46		0.58		0.50		0.59	
	mean	0.65		0.60		0.59		0.47		0.62		0.50		0.59	
	se	0.24				0.10		0.05		0.07		0.07		0.01	
	gutless individual														
	1	0.29		0.24				0.38						0.21	
	2	0.30		0.31				0.36						0.25	
	3	0.42		0.34				0.34						0.63	
	4	0.35		0.29				0.34						0.30	
	5	0.09		0.11				0.09						0.12	
	median	0.30		0.29				0.34						0.25	
	mean	0.29		0.26				0.30						0.30	
	se	0.06		0.04				0.05						0.09	
	gut														
	1	20	J	1.8	J			30	J					0.47	J
	2	64	J	4.7	J			2.6	J					0.70	J
	3	33	J	2.0	J			2.1	J					10	J
	4	20	J	2.3	J			17	J					3.8	J
	5	39	J	1.8	J			0.70	J					3.1	J
	median	33		2.0				2.7						3.1	
	mean	35		2.5				11						3.7	
	se	8		0.6				5.8						1.8	
	reconstructed whole body														
	1	1.7		0.36				2.0						0.23	
	2	5.2		0.64				0.49						0.27	
	3	1.7		0.49				0.46						1.4	
	4	1.6		0.41				1.7						0.59	
	5	2.6		0.47				0.34						0.36	
	median	1.7		0.47				0.49						0.36	
	mean	2.6		0.48				1.0						0.57	
	se	0.7		0.05				0.36						0.22	

Table F2. Summary of Analytical Data for Largescale Sucker

Largescale Sucker	Collection Area	1		1(A)		2		3		4		5		6	
	River Mile	741		735		723		706		678		635		605	
	Fish per composite	5		5		5		5		5		5		5	
		mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q
Potassium	whole body composite														
	1	3280		2700		3210		3420		2910		2880		3110	
	2	3420				3160		3070		3040		2890		3180	
	3					3250		3180		3310		2880		2800	
	4					3240		3150		3210		2810		2730	
	5									3200		2670			
	median	3350		2700		3230		3170		3200		2880		2960	
	mean	3350		2700		3220		3210		3130		2830		2960	
	se	70				20		75		71		42		110	
	gutless individual														
	1	3480		3367				3389						2922	
	2	3206		3596				3736						3207	
	3	3353		2961				3458						3020	
	4	3440		3418				3551						2712	
	5	3767		2932				3498						3400	
	median	3440		3370				3500						3020	
	mean	3450		3250				3530						3050	
	se	92		130				59						120	
	gut														
	1	20	J	1.8	J			30	J					0.47	J
	2	64	J	4.7	J			2.6	J					0.70	J
	3	33	J	2.0	J			2.1	J					10	J
	4	20	J	2.3	J			17	J					3.8	J
	5	39	J	1.8	J			0.70	J					3.1	J
	median	33		2.0				2.7						3.1	
	mean	35		2.5				11						3.7	
	se	8		0.6				5.8						1.8	
	reconstructed whole body														
	1	3424		3272				3348						2868	
	2	3154		3501				3673						3162	
	3	3331		2863				3370						2919	
	4	3399		3357				3397						2641	
	5	3716		2850				3422						3339	
	median	3400		3270				3400						2920	
	mean	3400		3170				3440						2990	
	se	91		130				59						120	

Table F2. Summary of Analytical Data for Largescale Sucker

Largescale Sucker	Collection Area	1		1(A)		2		3		4		5		6	
	River Mile	741		735		723		706		678		635		605	
	Fish per composite	5		5		5		5		5		5		5	
		mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q
Selenium	whole body composite														
	1	0.36		0.57		0.58		0.73		0.45		0.44		0.49	
	2	0.60				0.61		0.68		0.57		0.50		0.52	
	3					0.58		0.73		0.46		0.47		0.54	
	4					0.64		0.59		0.55		0.48		0.63	
	5									0.62		0.36			
	median	0.48		0.57		0.60		0.70		0.55		0.47		0.53	
	mean	0.48		0.57		0.60		0.68		0.53		0.45		0.54	
	se	0.12				0.01		0.03		0.03		0.03		0.03	
	gutless individual														
	1	0.55		0.50				0.58						0.61	
	2	0.52		0.59				0.77						0.48	
	3	0.68		0.68				0.49						0.44	
	4	0.66		0.47				0.42						0.54	
	5	0.52		0.70				0.56						0.30	
	median	0.55		0.59				0.56						0.48	
	mean	0.59		0.59				0.56						0.47	
	se	0.04		0.05				0.06						0.05	
	gut														
	1	1.1		1.2				1.06						0.93	
	2	0.81		1.5				0.94						0.95	
	3	1.0		1.2				0.83						0.93	
	4	0.84		1.0				0.82						0.87	
	5	1.5		1.5				0.94						1.2	
	median	1.1		1.2				0.94						0.93	
	mean	1.1		1.3				0.92						0.97	
	se	0.1		0.1				0.04						0.05	
	reconstructed whole body														
	1	0.59		0.55				0.60						0.63	
	2	0.54		0.65				0.78						0.50	
	3	0.70		0.73				0.52						0.48	
	4	0.67		0.51				0.45						0.57	
	5	0.58		0.78				0.58						0.34	
	median	0.59		0.65				0.58						0.50	
	mean	0.62		0.64				0.59						0.50	
	se	0.03		0.05				0.06						0.05	

Table F2. Summary of Analytical Data for Largescale Sucker

Largescale Sucker	Collection Area	1		1(A)		2		3		4		5		6	
	River Mile	741		735		723		706		678		635		605	
	Fish per composite	5		5		5		5		5		5		5	
		mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q
Sodium	whole body composite														
	1	1020		1300		1050		1360		1290		1340		1180	
	2	1050				1360		1350		1270		1290		1300	
	3					1380		1410		1170		1240		1310	
	4					1320		1380		1150		1210		1290	
	5									1300		1430			
	median	1040		1300		1340		1370		1270		1290		1300	
	mean	1040		1300		1280		1380		1240		1300		1270	
	se	15				77		13		32		39		30	
	gutless individual														
	1	1020		987				1230						1070	
	2	1120		1060				1370						1180	
	3	1390		122				1080						985	
	4	1230		1280				836						1490	
	5	1200		1230				1040						1290	
	median	1200		1060				1080						1180	
	mean	1190		936				1110						1200	
	se	61		210				90						88	
	gut														
	1	1310		1610				1380						1650	
	2	1500		1420				1750						1680	
	3	1450		1560				1390						943	
	4	1590		1750				961						1680	
	5	1860		1650				1250						1450	
	median	1500		1610				1380						1650	
	mean	1540		1600				1350						1480	
	se	92		54				130						140	
	reconstructed whole body														
	1	1040		1030				1240						1110	
	2	1150		1090				1390						1200	
	3	1400		1250				1110						982	
	4	1340		1300				846						1500	
	5	1240		1270				1050						1300	
	median	1240		1250				1110						1200	
	mean	1230		1190				1130						1220	
	se	65		54				91						88	

Table F2. Summary of Analytical Data for Largescale Sucker

Largescale Sucker	Collection Area	1		1(A)		2		3		4		5		6	
	River Mile	741		735		723		706		678		635		605	
	Fish per composite	5		5		5		5		5		5		5	
		mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q
Uranium	whole body composite														
	1	0.033		0.028		0.018		0.018		0.018		0.016		0.013	
	2	0.024				0.018		0.026		0.021		0.019		0.018	
	3					0.014		0.016		0.015		0.014		0.014	
	4					0.016		0.015		0.014		0.015		0.017	
	5									0.020		0.0092			
	median	0.028		0.028		0.017		0.017		0.018		0.015		0.015	
	mean	0.028		0.028		0.017		0.019		0.017		0.015		0.015	
	se	0.004				0.001		0.002		0.001		0.002		0.001	
	gutless individual														
	1	0.015		0.0078				0.019						0.011	
	2	0.027		0.010				0.019						0.0068	
	3	0.030		0.011				0.024						0.015	
	4	0.018		0.024				0.0028						0.010	
	5	0.011		0.011				0.022						0.0066	
	median	0.018		0.011				0.019						0.010	
	mean	0.020		0.013				0.018						0.010	
	se	0.004		0.003				0.004						0.002	
	gut														
	1	0.66		0.10				0.058						0.010	
	2	0.39		0.11				0.12						0.0059	
	3	0.20		0.14				0.050						0.096	
	4	0.31		0.16				0.024						0.016	
	5	1.4		0.11				0.0097						0.019	
	median	0.39		0.12				0.050						0.016	
	mean	0.60		0.13				0.053						0.030	
	se	0.22		0.01				0.020						0.017	
	reconstructed whole body														
	1	0.063		0.015				0.021						0.011	
	2	0.055		0.018				0.025						0.007	
	3	0.036		0.023				0.026						0.022	
	4	0.036		0.033				0.004						0.011	
	5	0.098		0.021				0.022						0.007	
	median	0.055		0.021				0.022						0.011	
	mean	0.058		0.022				0.020						0.012	
	se	0.011		0.003				0.004						0.003	

Table F2. Summary of Analytical Data for Largescale Sucker

Largescale Sucker	Collection Area	1		1(A)		2		3		4		5		6	
	River Mile	741		735		723		706		678		635		605	
	Fish per composite	5		5		5		5		5		5		5	
		mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q
Vanadium	whole body composite														
	1	0.33		0.18		0.10	U	0.21		0.17		0.12		0.16	
	2	0.27				0.13		0.21		0.20		0.25		0.33	
	3					0.12		0.14		0.29		0.11	U	0.15	J
	4					0.18		0.14		0.28		0.12	U	0.20	
	5									0.30		0.11	U		
	median	0.30		0.18		0.13		0.18		0.28		0.12		0.18	
	mean	0.30		0.18		0.14		0.18		0.25		0.14		0.21	
	se	0.03				0.02		0.02		0.03		0.03		0.04	
	gutless individual														
	1	0.11	U	0.10	U			0.12						0.12	U
	2	0.11	U	0.10	U			0.12						0.10	U
	3	0.11	U	0.11	U			0.10	U					0.17	U
	4	0.11	U	0.10				0.11	U					0.10	U
	5	0.11	U	0.10	U			0.10	U					0.11	U
	median	0.11		0.10				0.11						0.11	
	mean	0.11		0.10				0.11						0.12	
	se	0.00		0.00				0.00						0.01	
	gut														
	1	6.9		0.77				2.1						0.15	
	2	5.3		1.5				1.1						0.13	
	3	2.8		1.1				0.51						3.0	
	4	4.5		1.4				1.2						0.35	
	5	11.5		1.1				0.25						0.44	
	median	5.3		1.1				1.1						0.35	
	mean	6.2		1.2				1.0						0.81	
	se	1.5		0.1				0.3						0.54	
	reconstructed whole body														
	1	0.62		0.15				0.23						0.13	
	2	0.50		0.20				0.17						0.10	
	3	0.21		0.20				0.13						0.39	
	4	0.38		0.19				0.19						0.12	
	5	0.80		0.20				0.11						0.12	
	median	0.50		0.20				0.17						0.12	
	mean	0.50		0.19				0.17						0.17	
	se	0.10		0.01				0.02						0.06	

Table F2. Summary of Analytical Data for Largescale Sucker

Largescale Sucker	Collection Area	1		1(A)		2		3		4		5		6	
	River Mile	741		735		723		706		678		635		605	
	Fish per composite	5		5		5		5		5		5		5	
		mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q
Zinc	whole body composite														
	1	126	J	45		23	J	21	J	24		18		19	
	2	68	J			28	J	21	J	22		22		20	
	3					27	J	18	J	21		21		17	
	4					25	J	21	J	23		18		19	
	5									21		18			
	median	97		45		26		21		22		18		19	
	mean	97		45		26		20		22		19		19	
	se	29				1.0		0.84		0.67		0.94		0.53	
	gutless individual														
	1	40	J	23				22	J					18	
	2	51	J	40				24	J					19	
	3	55	J	21				23						17	
	4	37	J	29				13						18	
	5	49	J	21				24						18	
	median	49		23				23						18	
	mean	46		27				21						18	
	se	3		4				2						0	
	gut														
	1	1950		58				28						15	
	2	1040		60				26						17	
	3	331		39				26						21	
	4	460		74				16						13	
	5	5170		32				17						17	
	median	1040		58				26						17	
	mean	1790		53				23						17	
	se	890		8				3						1	
	reconstructed whole body														
	1	183		26				22						18	
	2	126		41				24						19	
	3	66		23				23						18	
	4	64		32				13						18	
	5	360		22				24						18	
	median	126		26				23						18	
	mean	160		29				21						18	
	se	55		4				2						0	

Table F2. Summary of Analytical Data for Largescale Sucker

Largescale Sucker	Collection Area	1		1(A)		2		3		4		5		6	
	River Mile	741		735		723		706		678		635		605	
	Fish per composite	5		5		5		5		5		5		5	
		mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q
Lipids %	whole body composite														
	1	5.8		4.0		3.5		5.7		4.1		4.6		8.3	
	2	2.7				2.8		11		5.1		7.7		6.4	
	3					3.6		4.3		7.5		8.1		6.6	
	4					5.3		3.1		6.4		11		8.3	
	5									5.2		6.7			
	median	4.3		4.0		3.6		5.0		5.2		7.7		7.5	
	mean	4.3		4.0		3.8		6.0		5.7		7.5		7.4	
	se	1.6				0.5		1.7		0.6		1.0		0.5	
Age years	whole body composite														
	1	12		30		24		28		26		27		32	
	2	14				27		31		30		29		30	
	3					25		23		24		31		23	
	4					29		30		26		27		29	
	5									28		31			
	median	13		30		26		29		26		29		29	
	mean	13		30		26		28		27		29		29	
	se	1				1		2		1		1		2	
Length mm	whole body composite														
	1	453		553		518		548		500		550		533	
	2	444				592		579		521		532		521	
	3					537		522		508		541		559	
	4					575		566		518		523		521	
	5									533		573			
	median	449		553		556		557		518		541		527	
	mean	449		553		556		554		516		544		534	
	se	5				17		12		6		9		9	
Weight g	whole body composite														
	1	1078		1854		1414		1684		1301		1732		1921	
	2	1088				1918		1893		1602		1603		1487	
	3					1664		1628		1324		1781		1745	
	4					2029		1674		1619		1566		1546	
	5									28		31			
	median	1083		1854		1666		1789		1451		1667		1704	
	mean	1083		1854		1666		1789		1451		1667		1704	
	se	5				252		105		151		65		217	

Notes: Q = Laboratory qualifier
U = reported value is at or below the limit of detection

Table F3. Summary of Analytical Data for Rainbow Trout

Rainbow Trout			Collection	1		2		3		4		5		6	
			River Mile	741		723		706		678		635		605	
	Origin	Tissue	comp	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q
Aluminum															
	Wild	WB	1	4.7	2u	4.4	U	8.8	1u			5.1		5.7	1u
	Wild	WB	2	6.6	1u	4.8	U	6.5	1u						
	Wild	WB	3	5.7	2u	4.8	U								
	Wild	WB	4	4.4	2u	4.8									
	Wild	WB	5	5.5	1u	9.3									
			median	*5.5*		*4.8*		*7.7*				*5.1*		*5.7*	
			mean	*5.4*		*5.6*		*7.7*				*5.1*		*5.7*	
			se	*0.4*		*0.9*		*1.1*							
	Wild	F	1	4.2	U			3.6	U					3.1	U
	Wild	F	2	3.8	U			3.8	U						
	Wild	F	3	3.9	U										
	Wild	F	4	4.1	U										
	Wild	F	5	4	U										
			median	*4.0*				*3.7*						*3.1*	
			mean	*4.0*				*3.7*						*3.1*	
			se	*0.1*				*0.1*							
	Wild	O	1	5.2	U			*14*						8.2	
	Wild	O	2	9.3				8.9							
	Wild	O	3	7.5	U										
	Wild	O	4	4.8	U										
	Wild	O	5	7.2											
			median	*7.2*				*11*						*8.2*	
			mean	*6.8*				*11*						*8.2*	
			se	*0.8*				*2*							
	Hatchery	WB	1					29	1u	4.5		11		6.2	1u
	Hatchery	WB	2					13	1u	18		4.8		6.1	1u
	Hatchery	WB	3					34	1u	8.2		24		5.6	1u
	Hatchery	WB	4							5.4		4.7		5.5	1u
	Hatchery	WB	5							8.9		6.5			
			median					*29*		*8.2*		*6.5*		*5.9*	
			mean					*25*		*9.0*		*10*		*5.9*	
			se					*6.5*		*2.4*		*3.5*		*0.18*	
	Hatchery	F	1					3.8	U					3.7	U
	Hatchery	F	2					3.7	U					3.7	U
	Hatchery	F	3					3.7	U					3.7	U
	Hatchery	F	4											3.7	U
	Hatchery	F	5												
			median					*3.7*						*3.7*	
			mean					*3.7*						*3.7*	
			se					*0.0*						*0.0*	
	Hatchery	O	1					55						9.5	
	Hatchery	O	2					23						8.8	
	Hatchery	O	3					61						7.6	
	Hatchery	O	4											7.5	
	Hatchery	O	5												
			median					*55*						*8.2*	
			mean					*46*						*8.4*	
			se					12						*0.48*	

Table F3. Summary of Analytical Data for Rainbow Trout

Rainbow Trout			Collection	1		2		3		4		5		6	
			River Mile	741		723		706		678		635		605	
	Origin	Tissue	comp	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q
Zinc															
	Wild	WB	1	24		20		22				21.8		28.1	
	Wild	WB	2	30		22		23							
	Wild	WB	3	26		21									
	Wild	WB	4	24		23									
	Wild	WB	5	24		22									
			median	*24*		*22*		*23*				*21.800*		*28.100*	
			mean	*26*		*22*		*23*				*21.800*		*28.100*	
			se	*1*		*0*		*0*							
	Wild	F	1	8.5				6.5						6.33	
	Wild	F	2	7.9				6.3							
	Wild	F	3	8.0											
	Wild	F	4	8.4											
	Wild	F	5	8.6											
			median	*8.4*				*6.4*						*6.330*	
			mean	*8.3*				*6.4*						*6.330*	
			se	*0.1*				*0.1*							
	Wild	O	1	40				37						49.7	
	Wild	O	2	51				37							
	Wild	O	3	45											
	Wild	O	4	41											
	Wild	O	5	41											
			median	*41*				*37*						*49.700*	
			mean	*44*				*37*						*49.700*	
			se	*2*				*0*							
	Hatchery	WB	1					25		21.2		24.5		21.7	
	Hatchery	WB	2					20		24.4		23.5		25.4	
	Hatchery	WB	3					23		24.5		26.2		25.5	
	Hatchery	WB	4							22.2		22.9		24.8	
	Hatchery	WB	5							22.8		22			
			median					*23*		*22.800*		*23.500*		*25.100*	
			mean					*23*		*23.000*		*23.800*		*24.400*	
			se					*1*		*0.637*		*0.721*		*0.897*	
	Hatchery	F	1					7.7						6.52	
	Hatchery	F	2					6.5						7.92	
	Hatchery	F	3					8.0						7.05	
	Hatchery	F	4											6.4	
	Hatchery	F	5												
			median					*7.7*						*6.790*	
			mean					*7.4*						*6.970*	
			se					*0*						*0.346*	
	Hatchery	O	1					41						41.6	
	Hatchery	O	2					36						44.2	
	Hatchery	O	3					37						44.5	
	Hatchery	O	4											45.7	
	Hatchery	O	5												
			median					*37*						*44.400*	
			mean					*38*						*44.000*	
			se					*2*						*0.863*	

Table F3. Summary of Analytical Data for Rainbow Trout

Rainbow Trout			Collection	1		2		3		4		5		6	
			River Mile	741		723		706		678		635		605	
	Origin	Tissue	comp	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q
Vanadium															
	Wild	WB	1	0.12	2u	0.12	U	0.12	1u			0.12	U	0.12	1u
	Wild	WB	2	0.12	1u	0.13	U	0.11	1u						
	Wild	WB	3	0.12	2u	0.13	U								
	Wild	WB	4	0.12	2u	0.12	U								
	Wild	WB	5	0.12	2u	0.11	U								
			median	*0.12*		*0.12*		*0.11*				*0.12*		*0.12*	
			mean	*0.12*		*0.12*		*0.11*				*0.12*		*0.12*	
			se	*0.00*		*0.00*		*0.00*							
	Wild	F	1	0.11	U			0.10	U					0.08	U
	Wild	F	2	0.10	U			0.10	U						
	Wild	F	3	0.10	U										
	Wild	F	4	0.11	U										
	Wild	F	5	0.11	U										
			median	*0.11*				*0.10*						*0.08*	
			mean	*0.11*				*0.10*						*0.08*	
			se	*0.00*				*0.00*							
	Wild	O	1	0.14	U			0.14	0					0.15	0
	Wild	O	2	0.14				0.12	0						
	Wild	O	3	0.13	U										
	Wild	O	4	0.13	U										
	Wild	O	5	0.13	U										
			median	*0.13*				*0.13*						*0.15*	
			mean	*0.13*				*0.13*						*0.15*	
			se	*0.00*				*0.01*							
	Hatchery	WB	1					0.13	1u	0.11	U	0.11	U	0.11	2u
	Hatchery	WB	2					0.10	2u	0.12	U	0.11	U	0.11	2u
	Hatchery	WB	3					0.13	1u	0.11	U	0.11	U	0.11	2u
	Hatchery	WB	4							0.11	U	0.11	U	0.11	2u
	Hatchery	WB	5							0.11	U	0.12	U		
			median					*0.13*		*0.11*		*0.11*		*0.11*	
			mean					*0.12*		*0.11*		*0.11*		*0.11*	
			se					*0.01*		*0.00*		*0.00*		*0.00*	
	Hatchery	F	1					0.10	U					0.10	U
	Hatchery	F	2					0.10	U					0.10	U
	Hatchery	F	3					0.10	U					0.10	U
	Hatchery	F	4											0.10	U
	Hatchery	F	5												
			median					*0.10*						*0.10*	
			mean					*0.10*						*0.10*	
			se					*0.00*						*0.00*	
	Hatchery	O	1					0.16						0.12	U
	Hatchery	O	2					0.11	U					0.12	U
	Hatchery	O	3					0.16						0.11	U
	Hatchery	O	4											0.12	U
	Hatchery	O	5												
			median					*0.16*						*0.12*	
			mean					*0.15*						*0.12*	
			se					*0.02*						*0.00*	

Table F3. Summary of Analytical Data for Rainbow Trout

Rainbow Trout			Collection	1		2		3		4		5		6	
			River Mile	741		723		706		678		635		605	
	Origin	Tissue	comp	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q
Uranium															
	Wild	WB	1	0.0028	1u	0.0015		0.0023	1u			0.0016	U	0.0019	1u
	Wild	WB	2	0.0039	1u	0.0032		0.0020	1u						
	Wild	WB	3	0.0030	1u	0.0018									
	Wild	WB	4	0.0022	1u	0.0035									
	Wild	WB	5	0.0027	1u	0.0042									
			median	*0.0028*		*0.0032*		*0.0022*				*0.0016*		*0.0019*	
			mean	*0.0030*		*0.0028*		*0.0022*				*0.0016*		*0.0019*	
			se	*0.0003*		*0.0005*		*0.0001*							
	Wild	F	1	0.0014	U			0.0012	U					0.0011	U
	Wild	F	2	0.0013	U			0.0013	U						
	Wild	F	3	0.0013	U										
	Wild	F	4	0.0014	U										
	Wild	F	5	0.0013	U										
			median	*0.0013*				*0.0012*						*0.0011*	
			mean	*0.0013*				*0.0012*						*0.0011*	
			se	*0.0000*				*0.0000*							
	Wild	O	1	0.0044				0.0033						0.0027	
	Wild	O	2	0.0064				0.0027							
	Wild	O	3	0.0049											
	Wild	O	4	0.0032											
	Wild	O	5	0.0042											
			median	*0.0044*				*0.0030*						*0.0027*	
			mean	*0.0046*				*0.0030*						*0.0027*	
			se	*0.0005*				*0.0003*							
	Hatchery	WB	1					0.0084	1u	0.0014	U	0.0014		0.0016	1u
	Hatchery	WB	2					0.0027	1u	0.0014	U	0.0014	U	0.0018	2u
	Hatchery	WB	3					0.0087	1u	0.0014	U	0.0020		0.0013	2u
	Hatchery	WB	4							0.0014	U	0.0014	U	0.0014	2u
	Hatchery	WB	5							0.0014	U	0.0016	U		
			median					*0.0084*		*0.0014*		*0.0014*		*0.0015*	
			mean					*0.0066*		*0.0014*		*0.0016*		*0.0015*	
			se					*0.0019*		*0.0000*		*0.0001*		*0.0001*	
	Hatchery	F	1					0.0013	U					0.0012	U
	Hatchery	F	2					0.0012	U					0.0012	U
	Hatchery	F	3					0.0012	U					0.0012	U
	Hatchery	F	4											0.0012	U
	Hatchery	F	5												
			median					*0.0012*						*0.0012*	
			mean					*0.0012*						*0.0012*	
			se					*0.0000*						*0.0000*	
	Hatchery	O	1					0.0155						0.0021	
	Hatchery	O	2					0.0044						0.0025	U
	Hatchery	O	3					0.0152						0.0014	U
	Hatchery	O	4											0.0015	U
	Hatchery	O	5												
			median					*0.0152*						*0.0018*	
			mean					*0.0117*						*0.0019*	
			se					*0.0036*						*0.0003*	

Table F3. Summary of Analytical Data for Rainbow Trout

Rainbow Trout			Collection	1		2		3		4		5		6	
			River Mile	741		723		706		678		635		605	
	Origin	Tissue	comp	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q
Sodium															
	Wild	WB	1	807		811		877				808		1040	
	Wild	WB	2	920		819		921							
	Wild	WB	3	831		781									
	Wild	WB	4	840		786									
	Wild	WB	5	787		858									
			median	*831.000*		*811.000*		*899.000*				*808.000*		*1040.000*	
			mean	*837.000*		*811.000*		*899.000*				*808.000*		*1040.000*	
			se	*22.731*		*13.780*		*22.000*							
	Wild	F	1	382				407						497	
	Wild	F	2	434				431							
	Wild	F	3	390											
	Wild	F	4	424											
	Wild	F	5	397											
			median	*397.000*				*419.000*						*497.000*	
			mean	*405.000*				*419.000*						*497.000*	
			se	*10.048*				*12.000*							
	Wild	O	1	1260				1320						1570	
	Wild	O	2	1380				1330							
	Wild	O	3	1300											
	Wild	O	4	1280											
	Wild	O	5	1210											
			median	*1280.000*				*1330.000*						*1570.000*	
			mean	*1290.000*				*1330.000*						*1570.000*	
			se	*27.857*				*5.000*							
	Hatchery	WB	1					898		811		976		857	
	Hatchery	WB	2					763		841		868		1040	
	Hatchery	WB	3					879		837		924		934	
	Hatchery	WB	4							906		868		876	
	Hatchery	WB	5							917		844			
			median					*879.000*		*841.000*		*868.000*		*905.000*	
			mean					*847.000*		*862.000*		*896.000*		*927.000*	
			se					*42.191*		*20.769*		*23.933*		*41.149*	
	Hatchery	F	1					414						409	
	Hatchery	F	2					350						486	
	Hatchery	F	3					373						454	
	Hatchery	F	4											412	
	Hatchery	F	5												
			median					*373.000*						*433.000*	
			mean					*379.000*						*440.000*	
			se					*18.717*						*18.386*	
	Hatchery	O	1					1380	0					1440	
	Hatchery	O	2					1230	0					1630	
	Hatchery	O	3					1320						1430	
	Hatchery	O	4											1400	
	Hatchery	O	5												
			median					*1320.000*						*1440.000*	
			mean					*1310.000*						*1480.000*	
			se					*43.589*						*52.361*	

Table F3. Summary of Analytical Data for Rainbow Trout

Rainbow Trout			Collection	1		2		3		4		5		6	
			River Mile	741		723		706		678		635		605	
	Origin	Tissue	comp	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q
Selenium															
	Wild	WB	1	0.82		0.62		0.71				0.53		0.54	
	Wild	WB	2	0.76		0.58		0.68							
	Wild	WB	3	0.75		0.64									
	Wild	WB	4	0.69		0.64									
	Wild	WB	5	0.75		0.60									
			median	*0.75*		*0.62*		*0.69*				*0.53*		*0.54*	
			mean	*0.75*		*0.61*		*0.69*				*0.53*		*0.54*	
			se	*0.02*		*0.01*		*0.02*							
	Wild	F	1	0.61				0.46						0.38	
	Wild	F	2	0.43				0.40							
	Wild	F	3	0.45											
	Wild	F	4	0.49											
	Wild	F	5	0.49											
			median	*0.49*				*0.43*						*0.38*	
			mean	*0.49*				*0.43*						*0.38*	
			se	*0.03*				*0.03*							
	Wild	O	1	1.0				0.95						0.70	
	Wild	O	2	1.1				0.91							
	Wild	O	3	1.1											
	Wild	O	4	0.91											
	Wild	O	5	1.0											
			median	*1.0*				*0.93*						*0.70*	
			mean	*1.0*				*0.93*						*0.70*	
			se	*0.03*				*0.02*							
	Hatchery	WB	1					0.56		0.41		0.40		0.32	
	Hatchery	WB	2					0.46		0.46		0.31		0.28	
	Hatchery	WB	3					0.50		0.50		0.39		0.31	
	Hatchery	WB	4							0.41		0.44		0.27	
	Hatchery	WB	5							0.54		0.37			
			median					*0.50*		*0.46*		*0.39*		*0.29*	
			mean					*0.51*		*0.46*		*0.38*		*0.29*	
			se					*0.03*		*0.03*		*0.02*		*0.01*	
	Hatchery	F	1					0.43						0.29	
	Hatchery	F	2					0.34						0.22	
	Hatchery	F	3					0.32						0.24	
	Hatchery	F	4											0.22	
	Hatchery	F	5												
			median					*0.34*						*0.23*	
			mean					*0.36*						*0.24*	
			se					*0.03*						*0.02*	
	Hatchery	O	1					0.68						0.36	
	Hatchery	O	2					0.60						0.36	
	Hatchery	O	3					0.66						0.37	
	Hatchery	O	4											0.33	
	Hatchery	O	5												
			median					*0.66*						*0.36*	
			mean					*0.65*						*0.35*	
			se					*0.02*						*0.01*	

Table F3. Summary of Analytical Data for Rainbow Trout

Rainbow Trout			Collection	1		2		3		4		5		6	
			River Mile	741		723		706		678		635		605	
	Origin	Tissue	comp	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q
Potassium															
	Wild	WB	1	3410		3540		3730				3410	0	3540	
	Wild	WB	2	3320		3360		3570							
	Wild	WB	3	3420		3350									
	Wild	WB	4	3380		3390									
	Wild	WB	5	3290		3460									
			median	*3380*		*3390*		*3650*				*3410*		*3540*	
			mean	*3360*		*3420*		*3650*				*3410*		*3540*	
			se	*25*		*36*		*80*							
	Wild	F	1	4100				4570						4530	
	Wild	F	2	4170				4440							
	Wild	F	3	4300											
	Wild	F	4	4270											
	Wild	F	5	4160											
			median	*4170*				*4510*						*4530*	
			mean	*4200*				*4510*						*4530*	
			se	*37*				*65*							
	Wild	O	1	2680				2940						2560	
	Wild	O	2	2530				2840							
	Wild	O	3	2500											
	Wild	O	4	2450											
	Wild	O	5	2360											
			median	*2500*				*2890*						*2560*	
			mean	*2500*				*2890*						*2560*	
			se	*53*				*50*							
	Hatchery	WB	1					3830		3550		3780		3500	
	Hatchery	WB	2					3620		3820		3610		3480	
	Hatchery	WB	3					3690		3470		3660		3570	
	Hatchery	WB	4							3810		3740		3450	
	Hatchery	WB	5							3530		3530			
			median					*3690*		*3550*		*3660*		*3490*	
			mean					*3710*		*3640*		*3660*		*3500*	
			se					*62*		*74*		*45*		*25*	
	Hatchery	F	1					4870						4260	
	Hatchery	F	2					4330						4350	
	Hatchery	F	3					4590						4400	
	Hatchery	F	4											4300	
	Hatchery	F	5												
			median					*4590*						*4330*	
			mean					*4600*						*4330*	
			se					*156*						*30*	
	Hatchery	O	1					2780						2500	
	Hatchery	O	2					2820						2560	
	Hatchery	O	3					2900						2730	
	Hatchery	O	4											2490	
	Hatchery	O	5												
			median					*2820*						*2530*	
			mean					*2830*						*2570*	
			se					*35*						*56*	

Table F3. Summary of Analytical Data for Rainbow Trout

Rainbow Trout			Collection	1		2		3		4		5		6	
			River Mile	741		723		706		678		635		605	
	Origin	Tissue	comp	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q
Nickel															
	Wild	WB	1	0.21	1u	0.16		0.19				0.14		0.24	
	Wild	WB	2	0.28		0.21		0.21	1u						
	Wild	WB	3	0.23	1u	0.17									
	Wild	WB	4	0.17	1u	0.21									
	Wild	WB	5	0.20	1u	0.37									
			median	*0.21*		*0.21*		*0.20*				*0.14*		*0.24*	
			mean	*0.22*		*0.22*		*0.20*				*0.14*		*0.24*	
			se	*0.02*		*0.04*		*0.01*							
	Wild	F	1	0.042	U			0.039						0.033	
	Wild	F	2	0.053				0.038	U						
	Wild	F	3	0.039	U										
	Wild	F	4	0.041	U										
	Wild	F	5	0.040	U										
			median	*0.041*				*0.038*						*0.033*	
			mean	*0.043*				*0.038*						*0.033*	
			se	*0.003*				*0.000*							
	Wild	O	1	0.38				0.34						0.44	
	Wild	O	2	0.49				0.35							
	Wild	O	3	0.43											
	Wild	O	4	0.31											
	Wild	O	5	0.37											
			median	*0.38*				*0.34*						*0.44*	
			mean	*0.40*				*0.34*						*0.44*	
			se	*0.03*				*0.00*							
	Hatchery	WB	1					0.37		0.15		0.18		0.16	1u
	Hatchery	WB	2					0.22		0.18		0.21		0.21	1u
	Hatchery	WB	3					0.39	1u	0.14		0.24		0.16	1u
	Hatchery	WB	4							0.12		0.15		0.19	1u
	Hatchery	WB	5							0.19		0.15			
			median					*0.37*		*0.15*		*0.18*		*0.17*	
			mean					*0.33*		*0.16*		*0.19*		*0.18*	
			se					*0.05*		*0.01*		*0.02*		*0.01*	
	Hatchery	F	1					0.13						0.037	U
	Hatchery	F	2					0.06						0.041	U
	Hatchery	F	3					0.04	U					0.037	U
	Hatchery	F	4											0.037	U
	Hatchery	F	5												
			median					*0.06*						*0.037*	
			mean					*0.08*						*0.038*	
			se					*0.03*						*0.001*	
	Hatchery	O	1					0.60						0.33	
	Hatchery	O	2					0.41						0.38	
	Hatchery	O	3					0.70						0.29	
	Hatchery	O	4											0.35	
	Hatchery	O	5												
			median					*0.60*						*0.34*	
			mean					*0.57*						*0.34*	
			se					*0.08*						*0.02*	

Table F3. Summary of Analytical Data for Rainbow Trout

Rainbow Trout			Collection	1		2		3		4		5		6	
			River Mile	741		723		706		678		635		605	
	Origin	Tissue	comp	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q
Manganese															
	Wild	WB	1	1.4		1.2		1.3				1.3		2.4	
	Wild	WB	2	1.4		1.7		1.1							
	Wild	WB	3	1.7		1.2									
	Wild	WB	4	1.0		2.1									
	Wild	WB	5	1.2		2.2									
			median	*1.4*		*1.7*		*1.2*				*1.3*		*2.4*	
			mean	*1.3*		*1.7*		*1.2*				*1.3*		*2.4*	
			se	*0.1*		*0.2*		*0.1*							
	Wild	F	1	0.14				0.14						0.17	
	Wild	F	2	0.13				0.12							
	Wild	F	3	0.12											
	Wild	F	4	0.15											
	Wild	F	5	0.13											
			median	*0.13*				*0.13*						*0.17*	
			mean	*0.13*				*0.13*						*0.17*	
			se	*0.00*				*0.01*							
	Wild	O	1	2.6				2.3						4.5	
	Wild	O	2	2.6				1.9							
	Wild	O	3	3.3											
	Wild	O	4	1.8											
	Wild	O	5	2.3											
			median	*2.6*				*2.1*						*4.5*	
			mean	*2.5*				*2.1*						*4.5*	
			se	*0.2*				*0.2*							
	Hatchery	WB	1					2.4		1.0		1.8		1.2	
	Hatchery	WB	2					1.4		1.6		1.3		1.4	
	Hatchery	WB	3					2.9		1.0		1.8		1.1	
	Hatchery	WB	4							0.9		1.5		1.4	
	Hatchery	WB	5							1.1		1.6			
			median					*2.4*		*1.0*		*1.6*		*1.3*	
			mean					*2.2*		*1.1*		*1.6*		*1.3*	
			se					*0.5*		*0.1*		*0.1*		*0.1*	
	Hatchery	F	1					0.16						0.14	
	Hatchery	F	2					0.11						0.14	
	Hatchery	F	3					0.18						0.13	
	Hatchery	F	4											0.19	
	Hatchery	F	5												
			median					*0.16*						*0.14*	
			mean					*0.15*						*0.15*	
			se					*0.02*						*0.01*	
	Hatchery	O	1					4.7						2.7	
	Hatchery	O	2					2.8						2.7	
	Hatchery	O	3					5.3						2.1	
	Hatchery	O	4											2.9	
	Hatchery	O	5												
			median					*4.7*						*2.7*	
			mean					*4.3*						*2.6*	
			se					*0.8*						*0.2*	

Table F3. Summary of Analytical Data for Rainbow Trout

Rainbow Trout			Collection	1		2		3		4		5		6	
			River Mile	741		723		706		678		635		605	
	Origin	Tissue	comp	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q
Magnesium															
	Wild	WB	1	303		289		303	1J			304	J	336	2J
	Wild	WB	2	296		309		308	1J						
	Wild	WB	3	312		296									
	Wild	WB	4	287		293									
	Wild	WB	5	270		310									
			median	*296*		*296*		*306*				*304*		*336*	
			mean	*294*		*299*		*306*				*304*		*336*	
			se	*7*		*4*		*3*							
	Wild	F	1	265				283	J					273	J
	Wild	F	2	262				267	J						
	Wild	F	3	272											
	Wild	F	4	275											
	Wild	F	5	258											
			median	*265*				*275*						*273*	
			mean	*266*				*275*						*273*	
			se	*3*				*8*							
	Wild	O	1	343				323	J					397	J
	Wild	O	2	328				342	J						
	Wild	O	3	353											
	Wild	O	4	299											
	Wild	O	5	283											
			median	*328*				*333*						*397*	
			mean	*321*				*333*						*397*	
			se	*13*				*10*							
	Hatchery	WB	1					355		303		307		287	
	Hatchery	WB	2					305		324		319		304	
	Hatchery	WB	3					332		302		303		290	
	Hatchery	WB	4							286		292		306	
	Hatchery	WB	5							307		291			
			median					*332*		*303*		*303*		*297*	
			mean					*331*		*304*		*302*		*297*	
			se					*14*		*6*		*5*		*5*	
	Hatchery	F	1					306						257	
	Hatchery	F	2					272						259	
	Hatchery	F	3					283						265	
	Hatchery	F	4											262	
	Hatchery	F	5												
			median					*283*						*261*	
			mean					*287*						*261*	
			se					*10*						*2*	
	Hatchery	O	1					404						326	
	Hatchery	O	2					343						353	
	Hatchery	O	3					375						316	
	Hatchery	O	4											357	
	Hatchery	O	5												
			median					*375*						*340*	
			mean					*374*						*338*	
			se					*18*						*10*	

Table F3. Summary of Analytical Data for Rainbow Trout

Rainbow Trout			Collection	1		2		3		4		5		6	
			River Mile	741		723		706		678		635		605	
	Origin	Tissue	comp	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q
Lead															
	Wild	WB	1	0.12		0.06		0.032	1u			0.015	U	0.025	1u
	Wild	WB	2	0.16		0.12		0.034	1u						
	Wild	WB	3	0.18	1u	0.08									
	Wild	WB	4	0.11		0.11									
	Wild	WB	5	0.13		0.11									
			median	*0.13*		*0.11*		*0.033*				*0.015*		*0.025*	
			mean	*0.14*		*0.10*		*0.033*				*0.015*		*0.025*	
			se	*0.01*		*0.01*		*0.001*							
	Wild	F	1	0.018				0.012	U					0.011	U
	Wild	F	2	0.016				0.013	U						
	Wild	F	3	0.013	U										
	Wild	F	4	0.018											
	Wild	F	5	0.016											
			median	*0.016*				*0.012*						*0.011*	
			mean	*0.016*				*0.012*						*0.011*	
			se	*0.00*				*0.000*							
	Wild	O	1	0.22				0.051						0.039	
	Wild	O	2	0.30				0.052							
	Wild	O	3	0.37											
	Wild	O	4	0.20											
	Wild	O	5	0.26											
			median	*0.26*				*0.052*						*0.039*	
			mean	*0.27*				*0.052*						*0.039*	
			se	*0.03*				*0.001*							
	Hatchery	WB	1					0.21	1u	0.014	U	0.014	U	0.014	1u
	Hatchery	WB	2					0.07	1u	0.017		0.014	U	0.020	1u
	Hatchery	WB	3					0.21	1u	0.015		0.022		0.014	1u
	Hatchery	WB	4							0.014		0.014	U	0.016	1u
	Hatchery	WB	5							0.014	U	0.015	U		
			median					*0.21*		*0.014*		*0.014*		*0.015*	
			mean					*0.16*		*0.015*		*0.016*		*0.016*	
			se					*0.05*		*0.001*		*0.002*		*0.002*	
	Hatchery	F	1					0.013	U					0.012	U
	Hatchery	F	2					0.012	U					0.012	U
	Hatchery	F	3					0.012	U					0.012	U
	Hatchery	F	4											0.012	U
	Hatchery	F	5												
			median					*0.012*						*0.012*	
			mean					*0.012*						*0.012*	
			se					*0.000*						*0.000*	
	Hatchery	O	1					0.41						0.016	
	Hatchery	O	2					0.13						0.029	
	Hatchery	O	3					0.38						0.015	
	Hatchery	O	4											0.021	
	Hatchery	O	5												
			median					*0.38*						*0.018*	
			mean					*0.31*						*0.020*	
			se					*0.09*						*0.003*	

Table F3. Summary of Analytical Data for Rainbow Trout

Rainbow Trout			Collection	1		2		3		4		5		6	
			River Mile	741		723		706		678		635		605	
	Origin	Tissue	comp	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q
Iron															
	Wild	WB	1	20		19		25				17		22	
	Wild	WB	2	29		19		20							
	Wild	WB	3	38		18									
	Wild	WB	4	21		24									
	Wild	WB	5	30		30									
			median	*29*		*19*		*22*				*17*		*22*	
			mean	*28*		*22*		*22*				*17*		*22*	
			se	*3*		*2*		*3*							
	Wild	F	1	4.1				3.8						5.2	
	Wild	F	2	6.3				4.1							
	Wild	F	3	5.2											
	Wild	F	4	5.5											
	Wild	F	5	4.9											
			median	*5.2*				*3.9*						*5.2*	
			mean	*5.2*				*3.9*						*5.2*	
			se	*0.4*				*0.1*							
	Wild	O	1	37				46						38	
	Wild	O	2	51				33							
	Wild	O	3	72											
	Wild	O	4	37											
	Wild	O	5	58											
			median	*51*				*39*						*38*	
			mean	*51*				*39*						*38*	
			se	*7*				*7*							
	Hatchery	WB	1					43		15		19		15	
	Hatchery	WB	2					21		28		15		18	
	Hatchery	WB	3					45		18		34		17	
	Hatchery	WB	4							15		16		15	
	Hatchery	WB	5							16		17			
			median					*43*		*16*		*17*		*16*	
			mean					*37*		*18*		*20*		*16*	
			se					*8*		*2*		*3*		*1*	
	Hatchery	F	1					5.0						3.3	
	Hatchery	F	2					3.4						4.5	
	Hatchery	F	3					4.0						3.9	
	Hatchery	F	4											3.6	
	Hatchery	F	5												
			median					*4.0*						*3.8*	
			mean					*4.1*						*3.8*	
			se					*0.5*						*0.3*	
	Hatchery	O	1					81						30	
	Hatchery	O	2					42						33	
	Hatchery	O	3					81						31	
	Hatchery	O	4											27	
	Hatchery	O	5												
			median					*81*						*30*	
			mean					*68*						*30*	
			se					*13*						*1*	

Table F3. Summary of Analytical Data for Rainbow Trout

Rainbow Trout			Collection	1		2		3		4		5		6	
			River Mile	741		723		706		678		635		605	
	Origin	Tissue	comp	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q
Copper															
	Wild	WB	1	1.2		1.3		1.3				0.56		0.42	
	Wild	WB	2	1.9		1.3		1.0							
	Wild	WB	3	1.4		1.5									
	Wild	WB	4	1.1		1.8									
	Wild	WB	5	1.3		1.9									
			median	*1.3*		*1.5*		*1.2*				*0.56*		*0.42*	
			mean	*1.4*		*1.6*		*1.2*				*0.56*		*0.42*	
			se	*0.2*		*0.1*		*0.1*							
	Wild	F	1	0.36				0.34						0.27	
	Wild	F	2	0.33				0.33							
	Wild	F	3	0.34											
	Wild	F	4	0.35											
	Wild	F	5	0.32											
			median	*0.34*				*0.33*						*0.27*	
			mean	*0.34*				*0.33*						*0.27*	
			se	*0.01*				*0.01*							
	Wild	O	1	2.0				2.2						0.58	
	Wild	O	2	3.5				1.6							
	Wild	O	3	2.5											
	Wild	O	4	1.8											
	Wild	O	5	2.3											
			median	*2.3*				*1.9*						*0.58*	
			mean	*2.4*				*1.9*						*0.58*	
			se	*0.3*				*0.3*							
	Hatchery	WB	1					2.5		0.61		0.56		0.41	
	Hatchery	WB	2					1.6		0.90		0.45		0.39	
	Hatchery	WB	3					2.6		0.71		0.86		0.42	
	Hatchery	WB	4							0.54		0.55		0.42	
	Hatchery	WB	5							0.56		0.58			
			median					*2.5*		*0.61*		*0.56*		*0.42*	
			mean					*2.2*		*0.66*		*0.60*		*0.41*	
			se					*0.3*		*0.06*		*0.07*		*0.01*	
	Hatchery	F	1					0.40						0.27	
	Hatchery	F	2					0.32						0.27	
	Hatchery	F	3					0.32						0.27	
	Hatchery	F	4											0.27	
	Hatchery	F	5												
			median					*0.32*						*0.27*	
			mean					*0.35*						*0.27*	
			se					*0.03*						*0.00*	
	Hatchery	O	1					4.61						0.60	
	Hatchery	O	2					2.99						0.52	
	Hatchery	O	3					4.55						0.57	
	Hatchery	O	4											0.59	
	Hatchery	O	5												
			median					*4.55*						*0.58*	
			mean					*4.05*						*0.57*	
			se					*0.53*						*0.02*	

Table F3. Summary of Analytical Data for Rainbow Trout

Rainbow Trout			Collection	1		2		3		4		5		6	
			River Mile	741		723		706		678		635		605	
	Origin	Tissue	comp	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q
Cobalt															
	Wild	WB	1	0.026	1u	0.015	U	0.019	1u			0.018		0.025	
	Wild	WB	2	0.032	1u	0.016	U	0.018	1u						
	Wild	WB	3	0.030	1u	0.011	U								
	Wild	WB	4	0.018	1u	0.017	U								
	Wild	WB	5	0.023	1u	0.022									
			median	*0.026*		*0.016*		*0.018*				*0.018*		*0.025*	
			mean	*0.026*		*0.016*		*0.018*				*0.018*		*0.025*	
			se	*0.002*		*0.002*		*0.001*							
	Wild	F	1	0.008	U			0.004	U					0.005	
	Wild	F	2	0.010	U			0.004	U						
	Wild	F	3	0.007	U										
	Wild	F	4	0.007	U										
	Wild	F	5	0.008	U										
			median	*0.008*				*0.004*						*0.005*	
			mean	*0.008*				*0.004*						*0.005*	
			se	*0.001*				*0.000*							
	Wild	O	1	0.045				0.034						0.044	
	Wild	O	2	0.052				0.029							
	Wild	O	3	0.053											
	Wild	O	4	0.030											
	Wild	O	5	0.040											
			median	*0.045*				*0.032*						*0.044*	
			mean	*0.044*				*0.032*						*0.044*	
			se	*0.004*				*0.003*							
	Hatchery	WB	1					0.034		0.017		0.025		0.022	
	Hatchery	WB	2					0.021		0.022		0.018		0.021	
	Hatchery	WB	3					0.034		0.018		0.033		0.018	
	Hatchery	WB	4							0.014		0.021		0.025	
	Hatchery	WB	5							0.017		0.021			
			median					*0.034*		*0.017*		*0.021*		*0.021*	
			mean					*0.030*		*0.018*		*0.023*		*0.022*	
			se					*0.004*		*0.001*		*0.003*		*0.001*	
	Hatchery	F	1					0.009						0.006	
	Hatchery	F	2					0.006						0.006	
	Hatchery	F	3					0.006						0.006	
	Hatchery	F	4											0.008	
	Hatchery	F	5												
			median					*0.006*						*0.006*	
			mean					*0.007*						*0.007*	
			se					*0.001*						*0.001*	
	Hatchery	O	1					0.060						0.042	
	Hatchery	O	2					0.038						0.037	
	Hatchery	O	3					0.058						0.031	
	Hatchery	O	4											0.044	
	Hatchery	O	5												
			median					*0.058*						*0.039*	
			mean					*0.052*						*0.039*	
			se					*0.007*						*0.003*	

Table F3. Summary of Analytical Data for Rainbow Trout

Rainbow Trout			Collection	1		2		3		4		5		6	
			River Mile	741		723		706		678		635		605	
	Origin	Tissue	comp	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q
Chromium															
	Wild	WB	1	0.81		0.62		0.68				0.69		0.48	
	Wild	WB	2	0.81		0.58		0.62							
	Wild	WB	3	0.86		0.81									
	Wild	WB	4	0.73		0.73									
	Wild	WB	5	0.98		0.91									
			median	*0.81*		*0.73*		*0.65*				*0.69*		*0.48*	
			mean	*0.84*		*0.73*		*0.65*				*0.69*		*0.48*	
			se	*0.04*		*0.06*		*0.03*							
	Wild	F	1	0.53				0.41						0.44	
	Wild	F	2	0.51				0.40							
	Wild	F	3	0.58											
	Wild	F	4	0.54											
	Wild	F	5	0.72											
			median	*0.54*				*0.41*						*0.44*	
			mean	*0.57*				*0.41*						*0.44*	
			se	*0.04*				*0.00*							
	Wild	O	1	1.1				0.92						0.52	0
	Wild	O	2	1.1				0.80							
	Wild	O	3	1.2											
	Wild	O	4	0.9											
	Wild	O	5	1.3											
			median	*1.1*				*0.86*						*0.52*	
			mean	*1.1*				*0.86*						*0.52*	
			se	*0.05*				*0.06*							
	Hatchery	WB	1					0.77		0.50		0.40		0.38	
	Hatchery	WB	2					0.42		0.52		0.53		0.36	
	Hatchery	WB	3					0.72		0.53		0.63		0.35	
	Hatchery	WB	4							0.41		0.55		0.31	
	Hatchery	WB	5							0.51		0.57			
			median					*0.72*		*0.51*		*0.55*		*0.35*	
			mean					*0.64*		*0.49*		*0.54*		*0.35*	
			se					*0.11*		*0.02*		*0.04*		*0.01*	
	Hatchery	F	1					0.53						0.37	
	Hatchery	F	2					0.27						0.33	
	Hatchery	F	3					0.27						0.37	
	Hatchery	F	4											0.30	
	Hatchery	F	5												
			median					*0.27*						*0.35*	
			mean					*0.35*						*0.34*	
			se					*0.09*						*0.02*	
	Hatchery	O	1					1.0						0.39	
	Hatchery	O	2					0.6						0.38	
	Hatchery	O	3					1.1						0.34	
	Hatchery	O	4											0.33	
	Hatchery	O	5												
			median					*1.0*						*0.36*	
			mean					*0.9*						*0.36*	
			se					*0.16*						*0.02*	

Table F3. Summary of Analytical Data for Rainbow Trout

Rainbow Trout			Collection	1		2		3		4		5		6	
			River Mile	741		723		706		678		635		605	
	Origin	Tissue	comp	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q
Calcium															
	Wild	WB	1	5310	2j	3810	J	4620				4190		6970	
	Wild	WB	2	6200	2j	5600	J	5540							
	Wild	WB	3	5910	2j	4340	J								
	Wild	WB	4	4630	2j	5050	J								
	Wild	WB	5	4630	2j	8610	J								
			median	*5310*		*5050*		*5080*				*4190*		*6970*	
			mean	*5340*		*5480*		*5080*				*4190*		*6970*	
			se	*322*		*839*		*460*							
	Wild	F	1	296	J			341						249	
	Wild	F	2	340	J			196							
	Wild	F	3	272	J										
	Wild	F	4	370	J										
	Wild	F	5	380	J										
			median	*340*				*269*						*249*	
			mean	*332*				*269*						*249*	
			se	*21*				*73*							
	Wild	O	1	10700	J			8630						13600	
	Wild	O	2	11800	J			10000							
	Wild	O	3	11800	J										
	Wild	O	4	9120	J										
	Wild	O	5	9220	J										
			median	*10700*				*9320*						*13600*	
			mean	*10500*				*9320*						*13600*	
			se	*590*				*685*							
	Hatchery	WB	1					7520	1j	3930	J	5250		4490	
	Hatchery	WB	2					4800	1j	4330	J	5850		5460	
	Hatchery	WB	3					6770	1j	3610	J	4950		4410	
	Hatchery	WB	4							3430		4010		5510	
	Hatchery	WB	5							5580		4340			
			median					*6770*		*3930*		*4950*		*4980*	
			mean					*6360*		*4180*		*4880*		*4970*	
			se					*811*		*383*		*326*		*299*	
	Hatchery	F	1					341	J					243	
	Hatchery	F	2					250	J					299	
	Hatchery	F	3					442	J					311	
	Hatchery	F	4											311	
	Hatchery	F	5												
			median					*341*						*305*	
			mean					*344*						*291*	
			se					*55*						*16*	
	Hatchery	O	1					14700	J					10000	
	Hatchery	O	2					9970	J					11000	
	Hatchery	O	3					12300	J					8610	
	Hatchery	O	4											11400	
	Hatchery	O	5												
			median					*12300*						*10500*	
			mean					*12300*						*10300*	
			se					*1365*						*622*	

Table F3. Summary of Analytical Data for Rainbow Trout

Rainbow Trout			Collection	1		2		3		4		5		6	
			River Mile	741		723		706		678		635		605	
	Origin	Tissue	comp	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q
Cadmium															
	Wild	WB	1	0.023	1u	0.033		0.053	1u			0.066	0	0.048	1u
	Wild	WB	2	0.054	1u	0.035		0.045	1u						
	Wild	WB	3	0.024	1u	0.039									
	Wild	WB	4	0.020	1u	0.035									
	Wild	WB	5	0.022	1u	0.048									
			median	*0.023*		*0.035*		*0.049*				*0.066*		*0.048*	
			mean	*0.029*		*0.038*		*0.049*				*0.066*		*0.048*	
			se	*0.006*		*0.003*		*0.004*							
	Wild	F	1	0.014	U			0.012	U					0.011	U
	Wild	F	2	0.064	U			0.013	U						
	Wild	F	3	0.013	U										
	Wild	F	4	0.014	U										
	Wild	F	5	0.013	U										
			median	*0.014*				*0.012*						*0.011*	
			mean	*0.023*				*0.012*						*0.011*	
			se	*0.010*				*0.000*							
	Wild	O	1	0.034				0.091						0.086	
	Wild	O	2	0.046				0.073							
	Wild	O	3	0.035											
	Wild	O	4	0.028											
	Wild	O	5	0.032											
			median	*0.034*				*0.082*						*0.086*	
			mean	*0.035*				*0.082*						*0.086*	
			se	*0.003*				*0.009*							
	Hatchery	WB	1					0.068	1u	0.061		0.051		0.052	1u
	Hatchery	WB	2					0.063	1u	0.055		0.022		0.057	1u
	Hatchery	WB	3					0.060	1u	0.059		0.047		0.039	1u
	Hatchery	WB	4							0.038		0.041		0.043	1u
	Hatchery	WB	5							0.040		0.036			
			median					*0.063*		*0.055*		*0.041*		*0.047*	
			mean					*0.063*		*0.050*		*0.039*		*0.048*	
			se					*0.002*		*0.005*		*0.005*		*0.004*	
	Hatchery	F	1					0.013	U					0.012	U
	Hatchery	F	2					0.012	U					0.012	U
	Hatchery	F	3					0.012	U					0.012	U
	Hatchery	F	4											0.012	U
	Hatchery	F	5												
			median					*0.012*						*0.012*	
			mean					*0.012*						*0.012*	
			se					*0.000*						*0.000*	
	Hatchery	O	1					0.123						0.105	
	Hatchery	O	2					0.121						0.105	
	Hatchery	O	3					0.101						0.066	
	Hatchery	O	4											0.077	
	Hatchery	O	5												
			median					*0.121*						*0.091*	
			mean					*0.115*						*0.088*	
			se					*0.007*						*0.010*	

Table F3. Summary of Analytical Data for Rainbow Trout

Rainbow Trout			Collection	1		2		3		4		5		6	
			River Mile	741		723		706		678		635		605	
	Origin	Tissue	comp	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q
Barium															
	Wild	WB	1	0.73	1u	0.61		0.57	1u			0.38	0	0.76	1u
	Wild	WB	2	0.97	1u	0.69		0.47	1u						
	Wild	WB	3	1.01	1u	0.50									
	Wild	WB	4	0.59	1u	1.20									
	Wild	WB	5	0.70	1u	1.74									
			median	*0.73*		*0.69*		*0.52*				*0.38*		*0.76*	
			mean	*0.80*		*0.95*		*0.52*				*0.38*		*0.76*	
			se	*0.08*		*0.23*		*0.05*							
	Wild	F	1	0.14	U			0.12	U					0.11	U
	Wild	F	2	0.13	U			0.13	U						
	Wild	F	3	0.13	U										
	Wild	F	4	0.14	U										
	Wild	F	5	0.13	U										
			median	*0.13*				*0.12*						*0.11*	
			mean	*0.13*				*0.12*						*0.11*	
			se	*0.00*				*0.00*							
	Wild	O	1	1.37	0			0.99						1.42	
	Wild	O	2	1.78	0			0.76							
	Wild	O	3	1.94	0										
	Wild	O	4	1.07	0										
	Wild	O	5	1.32	0										
			median	*1.37*				*0.87*						*1.42*	
			mean	*1.50*				*0.87*						*1.42*	
			se	*0.16*				*0.11*							
	Hatchery	WB	1					1.6	1u	0.35		0.69		0.46	1u
	Hatchery	WB	2					0.6	1u	0.62		0.40		0.52	1u
	Hatchery	WB	3					1.6	1u	0.34		0.88		0.41	1u
	Hatchery	WB	4							0.28		0.36		0.42	1u
	Hatchery	WB	5							0.47		0.43			
			median					*1.6*		*0.35*		*0.43*		*0.44*	
			mean					*1.3*		*0.41*		*0.55*		*0.45*	
			se					*0.3*		*0.06*		*0.10*		*0.02*	
	Hatchery	F	1					0.13	U					0.12	U
	Hatchery	F	2					0.12	U					0.12	U
	Hatchery	F	3					0.12	U					0.12	U
	Hatchery	F	4											0.12	U
	Hatchery	F	5												
			median					*0.12*						*0.12*	
			mean					*0.12*						*0.12*	
			se					*0.00*						*0.00*	
	Hatchery	O	1					3.0	0					0.91	0
	Hatchery	O	2					1.2	0					0.95	0
	Hatchery	O	3					2.9						0.70	0
	Hatchery	O	4											0.76	0
	Hatchery	O	5												
			median					*2.9*						*0.83*	
			mean					*2.4*						*0.83*	
			se					*0.6*						*0.06*	

Table F3. Summary of Analytical Data for Rainbow Trout

Rainbow Trout			Collection	1		2		3		4		5		6	
			River Mile	741		723		706		678		635		605	
	Origin	Tissue	comp	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q
Arsenic															
	Wild	WB	1	0.15		0.10		0.16				0.18		0.14	
	Wild	WB	2	0.14		0.11		0.15							
	Wild	WB	3	0.14		0.13									
	Wild	WB	4	0.13		0.11									
	Wild	WB	5	0.15		0.16									
			median	*0.14*		*0.11*		*0.15*				*0.18*		*0.14*	
			mean	*0.14*		*0.12*		*0.15*				*0.18*		*0.14*	
			se	*0.01*		*0.01*		*0.00*							
	Wild	F	1	0.10				0.08						0.08	
	Wild	F	2	0.07				0.07							
	Wild	F	3	0.07											
	Wild	F	4	0.10											
	Wild	F	5	0.10											
			median	*0.10*				*0.07*						*0.08*	
			mean	*0.09*				*0.07*						*0.08*	
			se	*0.01*				*0.01*							
	Wild	O	1	0.22				0.23						0.20	
	Wild	O	2	0.21				0.22							
	Wild	O	3	0.20											
	Wild	O	4	0.16											
	Wild	O	5	0.21											
			median	*0.21*				*0.22*						*0.20*	
			mean	*0.20*				*0.22*						*0.20*	
			se	*0.01*				*0.01*							
	Hatchery	WB	1					0.10	1u	0.09		0.14		0.12	0
	Hatchery	WB	2					0.09	1u	0.09		0.11		0.09	1u
	Hatchery	WB	3					0.11	1u	0.13		0.14		0.08	1u
	Hatchery	WB	4							0.09		0.14		0.10	1u
	Hatchery	WB	5							0.13		0.16			
			median					*0.10*		*0.09*		*0.14*		*0.10*	
			mean					*0.10*		*0.10*		*0.14*		*0.10*	
			se					*0.00*		*0.01*		*0.01*		*0.01*	
	Hatchery	F	1					0.063	U					0.081	0
	Hatchery	F	2					0.061	U					0.061	U
	Hatchery	F	3					0.061	U					0.061	U
	Hatchery	F	4											0.062	U
	Hatchery	F	5												
			median					*0.061*						*0.061*	
			mean					*0.062*						*0.066*	
			se					*0.001*						*0.005*	
	Hatchery	O	1					0.15						0.16	
	Hatchery	O	2					0.13						0.13	
	Hatchery	O	3					0.15						0.11	
	Hatchery	O	4											0.15	
	Hatchery	O	5												
			median					*0.15*						*0.14*	
			mean					*0.14*						*0.14*	
			se					*0.00*						*0.01*	

Table F3. Summary of Analytical Data for Rainbow Trout

Rainbow Trout			Collection	1		2		3		4		5		6	
			River Mile	741		723		706		678		635		605	
	Origin	Tissue	comp	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q
Mercury															
	Wild	WB	1	0.057		0.051		0.056				0.070		0.098	
	Wild	WB	2	0.086		0.041		0.070							
	Wild	WB	3	0.066		0.038									
	Wild	WB	4	0.073		0.048									
	Wild	WB	5	0.073		0.036									
			median	*0.073*		*0.041*		*0.063*				*0.070*		*0.098*	
			mean	*0.071*		*0.043*		*0.063*				*0.070*		*0.098*	
			se	*0.005*		*0.003*		*0.007*							
	Wild	F	1	0.065				0.068						0.120	
	Wild	F	2	0.108				0.084							
	Wild	F	3	0.080											
	Wild	F	4	0.087											
	Wild	F	5	0.089											
			median	*0.087*				*0.076*						*0.120*	
			mean	*0.086*				*0.076*						*0.120*	
			se	*0.007*				*0.008*							
	Wild	O	1	0.048				0.044						0.076	
	Wild	O	2	0.064				0.058							
	Wild	O	3	0.050											
	Wild	O	4	0.058											
	Wild	O	5	0.055											
			median	*0.055*				*0.051*						*0.076*	
			mean	*0.055*				*0.051*						*0.076*	
			se	*0.003*				*0.007*							
	Hatchery	WB	1					0.054		0.072		0.071		0.068	
	Hatchery	WB	2					0.061		0.075		0.067		0.103	
	Hatchery	WB	3					0.053		0.057		0.059		0.085	
	Hatchery	WB	4							0.058		0.060		0.069	
	Hatchery	WB	5							0.065		0.062			
			median					*0.054*		*0.065*		*0.062*		*0.077*	
			mean					*0.056*		*0.065*		*0.064*		*0.081*	
			se					*0.002*		*0.004*		*0.002*		*0.008*	
	Hatchery	F	1					0.063						0.080	
	Hatchery	F	2					0.074						0.122	
	Hatchery	F	3					0.063						0.104	
	Hatchery	F	4											0.081	
	Hatchery	F	5												
			median					*0.063*						*0.093*	
			mean					*0.067*						*0.097*	
			se					*0.004*						*0.010*	
	Hatchery	O	1					0.045						0.054	
	Hatchery	O	2					0.046						0.083	
	Hatchery	O	3					0.045						0.066	
	Hatchery	O	4											0.054	
	Hatchery	O	5												
			median					*0.045*						*0.060*	
			mean					*0.045*						*0.064*	
			se					*0.000*						*0.007*	

Table F3. Summary of Analytical Data for Rainbow Trout

Rainbow Trout			Collection	1		2		3		4		5		6	
			River Mile	741		723		706		678		635		605	
	Origin	Tissue	comp	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q
Age															
	Wild	WB	1	2.2		1.2		2.0				2.8		5.0	
	Wild	WB	2	2.8		1.0		2.3							
	Wild	WB	3	3.2		1.4									
	Wild	WB	4	3.0		1.2									
	Wild	WB	5	3.0		1.0									
			median	*3.0*		*1.2*		*2.2*				*2.8*		*5.0*	
			mean	*2.8*		*1.2*		*2.2*				*2.8*		*5.0*	
			se	*0.2*		*0.1*		*0.2*							
	Wild	F	1	2.2				2.0						5.0	
	Wild	F	2	2.8				2.3							
	Wild	F	3	3.2											
	Wild	F	4	3.0											
	Wild	F	5	3.0											
			median	*3.0*				*2.2*						*5.0*	
			mean	*2.8*				*2.2*						*5.0*	
			se	*0.2*				*0.2*							
	Wild	O	1	2.2				2.0						5.0	
	Wild	O	2	2.8				2.3							
	Wild	O	3	3.2											
	Wild	O	4	3.0											
	Wild	O	5	3.0											
			median	*3.0*				*2.2*						*5.0*	
			mean	*2.8*				*2.2*						*5.0*	
			se	*0.2*				*0.2*							
	Hatchery	WB	1					1.2		1.4		1.2		1.3	
	Hatchery	WB	2					1.0		1.2		1.2		1.8	
	Hatchery	WB	3							1.0		1.4		1.6	
	Hatchery	WB	4							1.0		1.0		1.2	
	Hatchery	WB	5							1.0		1.3			
			median					*1.1*		*1.0*		*1.2*		*1.5*	
			mean					*1.1*		*1.1*		*1.2*		*1.5*	
			se					*0.1*		*0.1*		*0.1*		*0.1*	
	Hatchery	F	1					1.2						1.3	
	Hatchery	F	2					1.0						1.8	
	Hatchery	F	3											1.6	
	Hatchery	F	4											1.2	
	Hatchery	F	5												
			median					*1.1*						*1.5*	
			mean					*1.1*						*1.5*	
			se					*0.1*						*0.1*	
	Hatchery	O	1					1.2						1.3	
	Hatchery	O	2					1.0						1.8	
	Hatchery	O	3											1.6	
	Hatchery	O	4											1.2	
	Hatchery	O	5												
			median					*1.1*						*1.5*	
			mean					*1.1*						*1.5*	
			se					*0.1*						*0.1*	

Table F3. Summary of Analytical Data for Rainbow Trout

Rainbow Trout			Collection	1		2		3		4		5		6	
			River Mile	741		723		706		678		635		605	
	Origin	Tissue	comp	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q
Length															
	Wild	WB	1	913		662		496				860		572	
	Wild	WB	2	1024		600		595							
	Wild	WB	3	907		689									
	Wild	WB	4	969		662									
	Wild	WB	5	1018		600									
			median	*969*		*662*		*546*				*860*		*572*	
			mean	*966*		*642*		*546*				*860*		*572*	
			se	*25*		*18*		*49*							
	Wild	F	1	913				496						572	
	Wild	F	2	1024				595							
	Wild	F	3	907											
	Wild	F	4	969											
	Wild	F	5	1018											
			median	*969*				*546*						*572*	
			mean	*966*				*546*						*572*	
			se	*25*				*49*							
	Wild	O	1	913				496						572	
	Wild	O	2	1024				595							
	Wild	O	3	907											
	Wild	O	4	969											
	Wild	O	5	1018											
			median	*969*				*546*						*572*	
			mean	*966*				*546*						*572*	
			se	*25*				*49*							
	Hatchery	WB	1					662		966		710		652	
	Hatchery	WB	2					600		867		748		772	
	Hatchery	WB	3							700		838		852	
	Hatchery	WB	4							658		598		607	
	Hatchery	WB	5							770		747			
			median					*631*		*770*		*747*		*712*	
			mean					*631*		*792*		*728*		*721*	
			se					*31*		*56*		*39*		*56*	
	Hatchery	F	1					662						652	
	Hatchery	F	2					600						772	
	Hatchery	F	3											852	
	Hatchery	F	4											607	
	Hatchery	F	5												
			median					*631*						*721*	
			mean					*631*						*721*	
			se					*31*						*56*	
	Hatchery	O	1					662						652	
	Hatchery	O	2					600						772	
	Hatchery	O	3											852	
	Hatchery	O	4											607	
	Hatchery	O	5												
			median					*631*						*721*	
			mean					*631*						*721*	
			se					*31*						*56*	

Table F3. Summary of Analytical Data for Rainbow Trout

Rainbow Trout			Collection	1		2		3		4		5		6	
			River Mile	741		723		706		678		635		605	
	Origin	Tissue	comp	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q
Weight															
	Wild	WB	1	440		380		462				410		370	
	Wild	WB	2	459		480		429							
	Wild	WB	3	438		394									
	Wild	WB	4	446		380									
	Wild	WB	5	458		480									
			median	*446*		*394*		*445*				*410*		*370*	
			mean	*448*		*422*		*445*				*410*		*370*	
			se	*4*		*23*		*17*							
	Wild	F	1	440				462						370	
	Wild	F	2	459				429							
	Wild	F	3	438											
	Wild	F	4	446											
	Wild	F	5	458											
			median	*446*				*445*						*370*	
			mean	*448*				*445*						*370*	
			se	*4*				*17*							
	Wild	O	1	440				462						370	
	Wild	O	2	459				429							
	Wild	O	3	438											
	Wild	O	4	446											
	Wild	O	5	458											
			median	*446*				*445*						*370*	
			mean	*448*				*445*						*370*	
			se	*4*				*17*							
	Hatchery	WB	1					380		412		391		378	
	Hatchery	WB	2					480		399		397		426	
	Hatchery	WB	3							384		410		423	
	Hatchery	WB	4							374		364		381	
	Hatchery	WB	5							397		390			
			median					*430*		*397*		*391*		*402*	
			mean					*430*		*393*		*390*		*402*	
			se					*50*		*7*		*8*		*13*	
	Hatchery	F	1					380						378	
	Hatchery	F	2					480						426	
	Hatchery	F	3											423	
	Hatchery	F	4											381	
	Hatchery	F	5												
			median					*430*						*402*	
			mean					*430*						*402*	
			se					*50*						*13*	
	Hatchery	O	1					380						378	
	Hatchery	O	2					480						426	
	Hatchery	O	3											423	
	Hatchery	O	4											381	
	Hatchery	O	5												
			median					*430*						*402*	
			mean					*430*						*402*	
			se					*50*						*13*	

Notes: Q = Laboratory qualifier
U = reported value is at or below the limit of detection

Table F4. Summary of Analytical Data for Walleye.

Walleye		Collection Area	1		2		3		4		5		6	
		River Mile	741		723		706		678		635		605	
	Tissue	comp	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q
Aluminum														
	WB	1	126	1u	5.1		3.2	2u	3.3	U	3.1	U	3.0	1u
	WB	2	3.1	2u	5.7		2.9	2u	6.5		25.9		5.5	1u
	WB	3	2.9	2u	3.1	U	4.1	1u	5.0		3.0	U	4.3	1u
	WB	4	3.2	2u	3.1	U	4.5	1u	6.8		3.0	U	4.5	1u
	WB	5	2.9	2u	3.1	U	3.8	1u	5.2		5.5		3.6	1u
	WB	6											7.5	
	WB	7											3.2	U
	WB	*median*	*3.1*		*3.1*		*3.8*		*5.2*		*3.1*		*4.3*	
	WB	*mean*	*27.6*		*4.0*		*3.7*		*5.4*		*8.1*		*4.5*	
	WB	*se*	*25*		*0.6*		*0.3*		*0.6*		*4.5*		*0.6*	
	F	1	280				2.6	U					2.5	U
	F	2	2.6	U			2.4	U					2.5	U
	F	3	2.5	U			2.5	U					2.5	U
	F	4	2.6	U			2.5	U					2.6	U
	F	5	2.4	U			2.5	U					2.5	U
	F	*median*	*2.6*				*2.5*						*2.5*	
	F	*mean*	*58.0*				*2.5*						*2.5*	
	F	*se*	*55.5*				*0.0*						*0.0*	
	O	1	3.6	U			3.6	U					3.5	
	O	2	3.6	U			3.4	U					8.3	
	O	3	3.3	U			5.6						5.7	
	O	4	3.7	U			6.0						6.0	
	O	5	3.3	U			4.9						4.5	
	O	*median*	*3.6*				*4.9*						*5.7*	
	O	*mean*	*3.5*				*4.7*						*5.6*	
	O	*se*	*0.1*				*0.5*						*0.8*	
Zinc														
	WB	1	13		14		11		14		12		12	
	WB	2	13		14		11		16		14		13	
	WB	3	13		12		12		14		12		12	
	WB	4	13		13		11		12		12		12	
	WB	5	13		13		13		12		13		11	
	WB	6											11	
	WB	7											12	
	WB	*median*	*13*		*13*		*11*		*14*		*12*		*12*	
	WB	*mean*	*13*		*13*		*12*		*14*		*13*		*12*	
	WB	*se*	*0.1*		*0.4*		*0.3*		*0.7*		*0.4*		*0.2*	
	F	1	7.7				6.3						6.4	
	F	2	7.7				5.7						6.6	
	F	3	6.7				6.4						6.4	
	F	4	7.3				5.2						6.2	
	F	5	7.0				6.7						6.5	
	F	*median*	*7.3*				*6.3*						*6.4*	
	F	*mean*	*7.3*				*6.1*						*6.4*	
	F	*se*	*0.2*				*0.3*						*0.1*	
	O	1	18				15						18	
	O	2	17				16						18	
	O	3	18				18						17	
	O	4	18				16						17	
	O	5	18				18						16	
	O	*median*	*18*				*16*						*17*	
	O	*mean*	*18*				*16*						*17*	
	O	*se*	*0.2*				*0.6*						*0.5*	

Table F4. Summary of Analytical Data for Walleye.

Walleye		Collection Area	1		2		3		4		5		6	
		River Mile	741		723		706		678		635		605	
	Tissue	comp	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q
Uranium														
	WB	1	0.0009	1u	0.0008		0.0008	1u	0.0010		0.0008		0.0008	1u
	WB	2	0.0008	1u	0.0007		0.0009	1u	0.0012		0.0012		0.0009	1u
	WB	3	0.0008	1u	0.0006	U	0.0010	1u	0.0009		0.0007		0.0008	1u
	WB	4	0.0008	1u	0.0006	U	0.0012	1u	0.0010		0.0008		0.0013	1u
	WB	5	0.0012	1u	0.0007	U	0.0015	1u	0.0007		0.0009		0.0009	1u
	WB	6											0.0020	
	WB	7											0.0013	
	WB	*median*	*0.0008*		*0.0007*		*0.0010*		*0.0010*		*0.0008*		*0.0009*	
	WB	*mean*	*0.0009*		*0.0007*		*0.0011*		*0.0010*		*0.0009*		*0.0011*	
	WB	*se*	*0.0001*		*0.0000*		*0.0001*		*0.0001*		*0.0001*		*0.0002*	
	F	1	0.0005	U			0.0005	U					0.0005	U
	F	2	0.0005	U			0.0005	U					0.0005	U
	F	3	0.0005	U			0.0005	U					0.0005	U
	F	4	0.0005	U			0.0005	U					0.0005	U
	F	5	0.0005	U			0.0005	U					0.0005	U
	F	*median*	*0.0005*				*0.0005*						*0.0005*	
	F	*mean*	*0.0005*				*0.0005*						*0.0005*	
	F	*se*	*0.0000*				*0.0000*						*0.0000*	
	O	1	0.0013				0.0010						0.0011	
	O	2	0.0010				0.0013						0.0012	
	O	3	0.0011				0.0014						0.0009	
	O	4	0.0010				0.0017						0.0019	
	O	5	0.0017				0.0023						0.0012	
	O	*median*	*0.0011*				*0.0014*						*0.0012*	
	O	*mean*	*0.0012*				*0.0015*						*0.0013*	
	O	*se*	*0.0001*				*0.0002*						*0.0002*	
Sodium														
	WB	1	968		1100		982		1010		1090		967	
	WB	2	917		1000		902		936		1020		945	
	WB	3	911		1040		944		913		937		983	
	WB	4	892		979		890		949		967		1030	
	WB	5	948		971		962		974		945		932	
	WB	6											919	
	WB	7											1010	
	WB	*median*	*917*		*1000*		*944*		*949*		*967*		*967*	
	WB	*mean*	*927*		*1020*		*936*		*956*		*992*		*969*	
	WB	*se*	*14*		*24*		*18*		*17*		*29*		*15*	
	F	1	411				430						460	
	F	2	392				434						428	
	F	3	377				479						500	
	F	4	388				375						529	
	F	5	390				485						477	
	F	*median*	*390*				*434*						*477*	
	F	*mean*	*392*				*441*						*479*	
	F	*se*	*5.5*				*20*						*17*	
	O	1	1410				1370						1400	
	O	2	1350				1360						1410	
	O	3	1360				1370						1370	
	O	4	1330				1280						1420	
	O	5	1400				1350						1310	
	O	*median*	*1360*				*1360*						*1400*	
	O	*mean*	*1370*				*1350*						*1380*	
	O	*se*	*15*				*17*						*20*	

Table F4. Summary of Analytical Data for Walleye.

Walleye		Collection Area	1		2		3		4		5		6	
		River Mile	741		723		706		678		635		605	
	Tissue	comp	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q
Selenium														
	WB	1	0.42		0.51		0.43		0.72		0.55		0.50	
	WB	2	0.39		0.47		0.41		0.75		0.37		0.50	
	WB	3	0.42		0.52		0.51		0.80		0.58		0.52	
	WB	4	0.42		0.44		0.66		0.54		0.50		0.40	
	WB	5	0.43		0.48		0.59		0.80		0.50		0.33	
	WB	6											0.62	
	WB	7											0.51	
	WB	*median*	*0.42*		*0.48*		*0.51*		*0.75*		*0.50*		*0.50*	
	WB	*mean*	*0.41*		*0.48*		*0.52*		*0.72*		*0.50*		*0.48*	
	WB	*se*	*0.01*		*0.01*		*0.05*		*0.05*		*0.04*		*0.04*	
	F	1	0.39				0.37						0.57	
	F	2	0.32				0.39						0.42	
	F	3	0.37				0.42						0.38	
	F	4	0.37				0.43						0.30	
	F	5	0.38				0.44						0.30	
	F	*median*	*0.37*				*0.42*						*0.38*	
	F	*mean*	*0.37*				*0.41*						*0.39*	
	F	*se*	*0.01*				*0.01*						*0.05*	
	O	1	0.45				0.48						0.44	
	O	2	0.45				0.43						0.56	
	O	3	0.47				0.59						0.63	
	O	4	0.46				0.82						0.48	
	O	5	0.46				0.70						0.36	
	O	*median*	*0.46*				*0.59*						*0.48*	
	O	*mean*	*0.46*				*0.60*						*0.49*	
	O	*se*	*0.00*				*0.07*						*0.05*	
Potassium														
	WB	1	3300		3690		3320		3300		3290		3370	
	WB	2	3290		3240		3360		3200		3180		3250	
	WB	3	3190		3370		3540		3220		3230		3340	
	WB	4	3350		3320		3290		3320		3370		3210	
	WB	5	3300		3330		3270		3250		3250		3200	
	WB	6											3320	
	WB	7											3310	
	WB	*median*	*3300*		*3330*		*3320*		*3250*		*3250*		*3310*	
	WB	*mean*	*3290*		*3390*		*3360*		*3260*		*3260*		*3290*	
	WB	*se*	*26*		*78*		*48*		*23*		*32*		*25*	
	F	1	4390				4360						4330	
	F	2	4390				4340						4240	
	F	3	4160				4430						4280	
	F	4	4470				4220						4300	
	F	5	4460				4300						4240	
	F	*median*	*4390*				*4340*						*4280*	
	F	*mean*	*4370*				*4330*						*4280*	
	F	*se*	*56*				*35*						*17*	
	O	1	2430				2590						2550	
	O	2	2380				2380						2350	
	O	3	2360				2710						2600	
	O	4	2370				2590						2370	
	O	5	2360				2420						2340	
	O	*median*	*2370*				*2590*						*2370*	
	O	*mean*	*2380*				*2540*						*2440*	
	O	*se*	*13*				*61*						*55*	

Table F4. Summary of Analytical Data for Walleye.

Walleye		Collection Area	1		2		3		4		5		6	
		River Mile	741		723		706		678		635		605	
	Tissue	comp	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q
Nickel														
	WB	1	0.46		0.41		0.38		0.36		0.34		0.36	
	WB	2	0.47		0.44		0.35		0.39		0.37		0.38	
	WB	3	0.44		0.34		0.31		0.42		0.35		0.48	
	WB	4	0.37		0.36		0.42		0.40		0.36		0.47	
	WB	5	0.42		0.33		0.45		0.44		0.38		0.43	
	WB	6											0.34	
	WB	7											0.35	
	WB	*median*	*0.44*		*0.36*		*0.38*		*0.40*		*0.36*		*0.38*	
	WB	*mean*	*0.43*		*0.38*		*0.38*		*0.40*		*0.36*		*0.40*	
	WB	*se*	*0.02*		*0.02*		*0.02*		*0.01*		*0.01*		*0.02*	
	F	1	0.17				0.16						0.06	
	F	2	0.10				0.07						0.06	
	F	3	0.15				0.08						0.13	
	F	4	0.10				0.14						0.10	
	F	5	0.16				0.10						0.13	
	F	*median*	*0.15*				*0.10*						*0.10*	
	F	*mean*	*0.14*				*0.11*						*0.10*	
	F	*se*	*0.01*				*0.02*						*0.02*	
	O	1	0.68				0.54						0.61	
	O	2	0.78				0.63						0.66	
	O	3	0.69				0.53						0.75	
	O	4	0.61				0.63						0.75	
	O	5	0.63				0.73						0.69	
	O	*median*	*0.68*				*0.63*						*0.69*	
	O	*mean*	*0.68*				*0.61*						*0.69*	
	O	*se*	*0.03*				*0.04*						*0.03*	
Manganese														
	WB	1	1.5		1.5		1.0		1.9		1.4		1.2	
	WB	2	1.3		1.1		1.2		2.3		1.4		1.3	
	WB	3	1.1		1.0		1.0		1.9		1.4		1.5	
	WB	4	0.9		1.2		1.3		1.6		1.2		1.7	
	WB	5	1.1		1.1		1.2		1.5		1.3		1.2	
	WB	6											1.1	
	WB	7											1.2	
	WB	*median*	*1.1*		*1.1*		*1.2*		*1.9*		*1.4*		*1.2*	
	WB	*mean*	*1.2*		*1.2*		*1.1*		*1.8*		*1.3*		*1.3*	
	WB	*se*	*0.1*		*0.1*		*0.1*		*0.1*		*0.0*		*0.1*	
	F	1	0.20				0.15						0.13	
	F	2	0.16				0.12						0.14	
	F	3	0.16				0.15						0.15	
	F	4	0.19				0.47						0.15	
	F	5	0.20				0.15						0.17	
	F	*median*	*0.19*				*0.15*						*0.15*	
	F	*mean*	*0.18*				*0.21*						*0.15*	
	F	*se*	*0.01*				*0.07*						*0.01*	
	O	1	2.5				1.6						2.1	
	O	2	2.2				2.2						2.4	
	O	3	1.9				1.8						2.5	
	O	4	1.6				1.9						2.8	
	O	5	1.8				2.0						2.0	
	O	*median*	*1.9*				*1.9*						*2.4*	
	O	*mean*	*2.0*				*1.9*						*2.4*	
	O	*se*	*0.2*				*0.1*						*0.1*	

Table F4. Summary of Analytical Data for Walleye.

Walleye		Collection Area	1		2		3		4		5		6	
		River Mile	741		723		706		678		635		605	
	Tissue	comp	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q
Magnesium														
	Tissue	comp	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	
	WB	1	372		394		352		388		363		360	
	WB	2	368		383		371		356		368		342	
	WB	3	368		352		342		370		360		349	
	WB	4	350		373		344		364		360		375	
	WB	5	361		364		364		369		342		360	
	WB	6											344	
	WB	7											368	
	WB	*median*	*368*		*373*		*352*		*369*		*360*		*360*	
	WB	*mean*	*364*		*373*		*355*		*369*		*359*		*357*	
	WB	*se*	*3.9*		*7.3*		*5.6*		*5.3*		*4.4*		*4.7*	
	F	1	280				280						266	
	F	2	281				264						260	
	F	3	269				281						265	
	F	4	282				268						272	
	F	5	277				274						270	
	F	*median*	*280*				*274*						*266*	
	F	*mean*	*278*				*273*						*267*	
	F	*se*	*2.4*				*3.3*						*2.1*	
	O	1	446				402						441	
	O	2	440				478						416	
	O	3	452				398						416	
	O	4	409				402						454	
	O	5	429				436						435	
	O	*median*	*440*				*402*						*435*	
	O	*mean*	*435*				*423*						*432*	
	O	*se*	*7.6*				*15*						*7.4*	
Lead														
	WB	1	0.030	1u	0.033		0.032		0.072		0.16		0.051	
	WB	2	0.029	1u	0.023		0.045		0.107		0.013		0.024	1u
	WB	3	0.039	1u	0.036		0.038		0.085		0.048		0.036	
	WB	4	0.038	1u	0.047		0.053	1u	0.12		0.051		0.020	1u
	WB	5	0.041	1u	0.055		0.054	1u	0.22		0.024		0.016	1u
	WB	6											0.015	
	WB	7											0.015	
	WB	*median*	*0.038*		*0.036*		*0.045*		*0.11*		*0.048*		*0.020*	
	WB	*mean*	*0.035*		*0.039*		*0.044*		*0.12*		*0.060*		*0.025*	
	WB	*se*	*0.002*		*0.005*		*0.004*		*0.027*		*0.027*		*0.005*	
	F	1	0.011	U			0.022						0.062	
	F	2	0.011	U			0.053						0.011	U
	F	3	0.010	U			0.012						0.040	
	F	4	0.011	U			0.010	U					0.011	U
	F	5	0.010	U			0.011	U					0.011	U
	F	*median*	*0.011*				*0.012*						*0.011*	
	F	*mean*	*0.011*				*0.021*						*0.027*	
	F	*se*	*0.000*				*0.008*						*0.011*	
	O	1	0.045				0.039						0.041	
	O	2	0.045				0.037						0.036	
	O	3	0.063				0.062						0.033	
	O	4	0.061				0.085						0.028	
	O	5	0.066				0.089						0.021	
	O	*median*	*0.061*				*0.062*						*0.033*	
	O	*mean*	*0.056*				*0.062*						*0.032*	
	O	*se*	*0.005*				*0.011*						*0.003*	

Table F4. Summary of Analytical Data for Walleye.

Walleye		Collection Area	1		2		3		4		5		6	
		River Mile	741		723		706		678		635		605	
	Tissue	comp	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q
Iron														
	WB	1	11		9.2		9.2		9.7		8.6		12	
	WB	2	9.6		9.1		7.1		13		8.7		10	
	WB	3	9.4		12		11		10		7.1		9.8	
	WB	4	10		9.1		12		10		12		10	
	WB	5	11		8.2		10		9.4		10		8.4	
	WB	6											11.2	
	WB	7											9.1	
	WB	*median*	*10*		*9.1*		*10*		*10*		*8.7*		*10*	
	WB	*mean*	*10*		*9.4*		*9.8*		*11*		*9.3*		*10*	
	WB	*se*	*0.4*		*0.6*		*0.8*		*0.7*		*0.8*		*0.4*	
	F	1	4.7				3.4						2.3	
	F	2	2.3				2.6						2.1	
	F	3	3.3				2.5						2.9	
	F	4	3.7				5.6						3.0	
	F	5	3.4				2.5						3.0	
	F	*median*	*3.4*				*2.6*						*2.9*	
	F	*mean*	*3.5*				*3.3*						*2.7*	
	F	*se*	*0.4*				*0.6*						*0.2*	
	O	1	16				13						20	
	O	2	16				12						17	
	O	3	15				19						15	
	O	4	16				17						15	
	O	5	18				16						13	
	O	*median*	*16*				*16*						*15*	
	O	*mean*	*16*				*15*						*16*	
	O	*se*	*1*				*1*						*1*	
Copper														
	WB	1	0.34		0.38		0.32		0.36		0.34		0.35	
	WB	2	0.34		0.34		0.26		0.57		0.40		0.36	
	WB	3	0.30		0.29		0.35		0.45		0.30		0.39	
	WB	4	0.32		0.36		0.42		0.48		0.35		0.40	
	WB	5	0.33		0.29		0.38		0.44		0.36		0.36	
	WB	6											0.31	
	WB	7											0.37	
	WB	*median*	*0.33*		*0.34*		*0.35*		*0.45*		*0.35*		*0.36*	
	WB	*mean*	*0.33*		*0.33*		*0.35*		*0.46*		*0.35*		*0.36*	
	WB	*se*	*0.01*		*0.02*		*0.03*		*0.03*		*0.02*		*0.01*	
	F	1	0.24				0.18						0.20	
	F	2	0.21				0.18						0.21	
	F	3	0.20				0.19						0.23	
	F	4	0.24				0.25						0.21	
	F	5	0.24				0.20						0.21	
	F	*median*	*0.24*				*0.19*						*0.21*	
	F	*mean*	*0.23*				*0.20*						*0.21*	
	F	*se*	*0.01*				*0.01*						*0.00*	
	O	1	0.42				0.42						0.47	
	O	2	0.45				0.34						0.50	
	O	3	0.38				0.50						0.51	
	O	4	0.40				0.54						0.54	
	O	5	0.41				0.52						0.48	
	O	*median*	*0.41*				*0.50*						*0.50*	
	O	*mean*	*0.41*				*0.46*						*0.50*	
	O	*se*	*0.01*				*0.04*						*0.01*	

Table F4. Summary of Analytical Data for Walleye.

Walleye		Collection Area	1		2		3		4		5		6	
		River Mile	741		723		706		678		635		605	
	Tissue	comp	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q
Cobalt														
	WB	1	0.021		0.026		0.020		0.025		0.020		0.023	
	WB	2	0.020		0.023		0.021		0.039		0.020		0.021	
	WB	3	0.020		0.021		0.022		0.029		0.020		0.022	
	WB	4	0.020		0.023		0.029		0.028		0.023		0.024	
	WB	5	0.021		0.020		0.025		0.030		0.021		0.022	
	WB	6											0.020	
	WB	7											0.021	
	WB	*median*	*0.020*		*0.023*		*0.022*		*0.029*		*0.020*		*0.022*	
	WB	*mean*	*0.020*		*0.023*		*0.023*		*0.030*		*0.021*		*0.022*	
	WB	*se*	*0.000*		*0.001*		*0.002*		*0.002*		*0.001*		*0.000*	
	F	1	0.0060				0.0056						0.0044	
	F	2	0.0051				0.0037						0.0040	
	F	3	0.0051				0.0044						0.0052	
	F	4	0.0048				0.0074						0.0048	
	F	5	0.0060				0.0038						0.0057	
	F	*median*	*0.0051*				*0.0044*						*0.0048*	
	F	*mean*	*0.0054*				*0.0050*						*0.0048*	
	F	*se*	*0.0003*				*0.0007*						*0.0003*	
	O	1	0.033				0.030						0.038	
	O	2	0.033				0.037						0.036	
	O	3	0.033				0.038						0.036	
	O	4	0.034				0.045						0.039	
	O	5	0.033				0.043						0.036	
	O	*median*	*0.033*				*0.038*						*0.036*	
	O	*mean*	*0.033*				*0.039*						*0.037*	
	O	*se*	*0.000*				*0.003*						*0.001*	
Chromium														
	WB	1	0.56		0.41		0.53		0.53		0.47		0.84	
	WB	2	0.56		0.44		0.38		0.47		0.45		0.55	
	WB	3	0.49		0.97		0.47		0.53		0.48		0.68	
	WB	4	0.55		0.41		0.80		0.63		0.84		0.47	
	WB	5	0.49		0.38		0.55		0.63		0.55		0.42	
	WB	6											0.47	
	WB	7											0.40	
	WB	*median*	*0.55*		*0.41*		*0.53*		*0.53*		*0.48*		*0.47*	
	WB	*mean*	*0.53*		*0.52*		*0.55*		*0.56*		*0.56*		*0.55*	
	WB	*se*	*0.02*		*0.11*		*0.07*		*0.03*		*0.07*		*0.06*	
	F	1	0.51				0.57						0.46	
	F	2	0.26				0.39						0.42	
	F	3	0.45				0.40						0.54	
	F	4	0.52				0.90						0.39	
	F	5	0.52				0.40						0.46	
	F	*median*	*0.51*				*0.40*						*0.46*	
	F	*mean*	*0.45*				*0.53*						*0.45*	
	F	*se*	*0.05*				*0.10*						*0.02*	
	O	1	0.59				0.51						1.17	
	O	2	0.81				0.37						0.66	
	O	3	0.52				0.53						0.79	
	O	4	0.58				0.73						0.54	
	O	5	0.46				0.67						0.39	
	O	*median*	*0.58*				*0.53*						*0.66*	
	O	*mean*	*0.59*				*0.56*						*0.71*	
	O	*se*	*0.06*				*0.06*						*0.13*	

Table F4. Summary of Analytical Data for Walleye.

Walleye		Collection Area	1		2		3		4		5		6	
		River Mile	741		723		706		678		635		605	
	Tissue	comp	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q
Calcium														
	WB	1	11600		12400		10100		13600		12200		11200	
	WB	2	11200		13200		11500		11700		11900		10500	
	WB	3	11500		10800		8930		11800		12000		10600	
	WB	4	10100		12100		10100		11700		11200		12800	
	WB	5	11100		11400		11800		12400		10500		11800	
	WB	6											10500	
	WB	7											12200	
	WB	*median*	*11200*		*12100*		*10100*		*11800*		*11900*		*11200*	
	WB	*mean*	*11100*		*12000*		*10500*		*12200*		*11600*		*11400*	
	WB	*se*	*266*		*413*		*523*		*364*		*314*		*347*	
	F	1	847				516						468	
	F	2	547				264						397	
	F	3	502				559						393	
	F	4	393				424						540	
	F	5	456				551						874	
	F	*median*	*502*				*516*						*468*	
	F	*mean*	*549*				*463*						*534*	
	F	*se*	*79*				*55*						*89*	
	O	1	20100				16800						20300	
	O	2	20100				22600						19600	
	O	3	20900				16600						18700	
	O	4	18500				17400						22300	
	O	5	19800				21000						21000	
	O	*median*	*20100*				*17400*						*20300*	
	O	*mean*	*19900*				*18900*						*20400*	
	O	*se*	*390*				*1226*						*613*	
Cadmium														
	WB	1	0.026	1u	0.038		0.019	1u	0.022		0.022		0.021	1u
	WB	2	0.021	1u	0.017		0.018	1u	0.042		0.020		0.021	1u
	WB	3	0.019	1u	0.018		0.026	1u	0.032		0.014		0.025	1u
	WB	4	0.026	1u	0.026		0.036	1u	0.028		0.021		0.025	1u
	WB	5	0.024	1u	0.019		0.023	1u	0.026		0.021		0.024	1u
	WB	6											0.017	
	WB	7											0.017	
	WB	*median*	*0.024*		*0.019*		*0.023*		*0.028*		*0.021*		*0.021*	
	WB	*mean*	*0.023*		*0.024*		*0.024*		*0.030*		*0.019*		*0.021*	
	WB	*se*	*0.001*		*0.004*		*0.003*		*0.003*		*0.001*		*0.001*	
	F	1	0.011	U			0.011	U					0.010	U
	F	2	0.011	U			0.010	U					0.011	U
	F	3	0.010	U			0.011	U					0.011	U
	F	4	0.011	U			0.010	U					0.011	U
	F	5	0.010	U			0.011	U					0.011	U
	F	*median*	*0.011*				*0.011*						*0.011*	
	F	*mean*	*0.011*				*0.011*						*0.011*	
	F	*se*	*0.000*				*0.000*						*0.000*	
	O	1	0.039				0.024						0.029	
	O	2	0.030				0.025						0.031	
	O	3	0.026				0.041						0.036	
	O	4	0.040				0.054						0.036	
	O	5	0.036				0.034						0.036	
	O	*median*	*0.036*				*0.034*						*0.036*	
	O	*mean*	*0.034*				*0.036*						*0.034*	
	O	*se*	*0.003*				*0.006*						*0.001*	

Table F4. Summary of Analytical Data for Walleye.

Walleye		Collection Area	1		2		3		4		5		6	
		River Mile	741		723		706		678		635		605	
	Tissue	comp	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q
Barium														
	WB	1	0.91	1u	0.96		0.78	1u	1.06		1.02		0.80	1u
	WB	2	0.82	1u	0.88		0.81	1u	1.03		0.82		0.83	1u
	WB	3	0.85	1u	0.80		0.74	1u	0.97		0.79		0.83	1u
	WB	4	0.73	1u	0.88		0.86	1u	0.95		0.80		1.03	1u
	WB	5	0.86	1u	0.79		0.91	1u	0.88		0.83		0.85	1u
	WB	6											0.78	
	WB	7											0.90	
	WB	*median*	*0.85*		*0.88*		*0.81*		*0.97*		*0.82*		*0.83*	
	WB	*mean*	*0.83*		*0.86*		*0.82*		*0.98*		*0.85*		*0.86*	
	WB	*se*	*0.03*		*0.03*		*0.03*		*0.03*		*0.04*		*0.03*	
	F	1	0.086	U			0.086	U					0.083	U
	F	2	0.085	U			0.081	U					0.084	U
	F	3	0.082	U			0.084	U					0.084	U
	F	4	0.087	U			0.082	U					0.086	U
	F	5	0.080	U			0.084	U					0.084	U
	F	*median*	*0.085*				*0.084*						*0.084*	
	F	*mean*	*0.084*				*0.084*						*0.084*	
	F	*se*	*0.001*				*0.001*						*0.001*	
	O	1	1.6				1.3						1.4	
	O	2	1.4				1.5						1.5	
	O	3	1.5				1.4						1.4	
	O	4	1.3				1.5						1.8	
	O	5	1.5				1.6						1.5	
	O	*median*	*1.5*				*1.5*						*1.5*	
	O	*mean*	*1.5*				*1.4*						*1.5*	
	O	*se*	*0.0*				*0.1*						*0.1*	
Arsenic														
	WB	1	0.11		0.15		0.12		0.21		0.16		0.16	
	WB	2	0.10		0.09		0.14		0.31		0.12		0.16	
	WB	3	0.11		0.13		0.14		0.23		0.19		0.16	
	WB	4	0.07		0.11		0.19		0.20		0.16		0.12	
	WB	5	0.07		0.09		0.15		0.25		0.16		0.13	
	WB	6											0.20	
	WB	7											0.16	
	WB	*median*	*0.10*		*0.11*		*0.14*		*0.23*		*0.16*		*0.16*	
	WB	*mean*	*0.09*		*0.12*		*0.15*		*0.24*		*0.16*		*0.16*	
	WB	*se*	*0.01*		*0.01*		*0.01*		*0.02*		*0.01*		*0.01*	
	F	1	0.11				0.11						0.18	
	F	2	0.10				0.13						0.14	
	F	3	0.10				0.11						0.12	
	F	4	0.07				0.10						0.10	
	F	5	0.06				0.12						0.12	
	F	*median*	*0.10*				*0.11*						*0.12*	
	F	*mean*	*0.09*				*0.11*						*0.13*	
	F	*se*	*0.01*				*0.01*						*0.01*	
	O	1	0.12				0.12						0.14	
	O	2	0.10				0.15						0.19	
	O	3	0.12				0.18						0.19	
	O	4	0.08				0.25						0.14	
	O	5	0.07	U			0.18						0.13	
	O	*median*	*0.10*				*0.18*						*0.14*	
	O	*mean*	*0.10*				*0.18*						*0.16*	
	O	*se*	*0.01*				*0.02*						*0.01*	

Table F4. Summary of Analytical Data for Walleye.

Walleye		Collection Area	1		2		3		4		5		6	
		River Mile	741		723		706		678		635		605	
	Tissue	comp	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q
Age														
	WB	1	3.3		3		3.8		3.8		3.2		3.2	
	WB	2	3.6		3.4		2.5		4		2.5		3.5	
	WB	3	3.8		3.4		3.8		3.3		2.2		3.2	
	WB	4	4		2.6		3.4		4		3.2		3.6	
	WB	5	3.6		3.6		3.8		3.2		3.5		3.3	
	WB	6											3	
	WB	7											3.6	
	WB	*median*	*3.6*		*3.4*		*3.8*		*3.8*		*3.2*		*3.3*	
	WB	*mean*	*3.7*		*3.2*		*3.5*		*3.7*		*2.9*		*3.3*	
	WB	*se*	*0.1*		*0.2*		*0.3*		*0.2*		*0.2*		*0.1*	
	F	1	3.3				3.8						3.2	
	F	2	3.6				2.5						3.5	
	F	3	3.8				3.8						3.2	
	F	4	4				3.4						3.6	
	F	5	3.6				3.8						3.3	
	F	*median*	*3.6*				*3.8*						*3.3*	
	F	*mean*	*3.7*				*3.5*						*3.4*	
	F	*se*	*0.1*				*0.3*						*0.1*	
	O	1	3.3				3.8						3.2	
	O	2	3.6				2.5						3.5	
	O	3	3.8				3.8						3.2	
	O	4	4				3.4						3.6	
	O	5	3.6				3.8						3.3	
	O	*median*	*3.6*				*3.8*						*3.3*	
	O	*mean*	*3.7*				*3.5*						*3.4*	
	O	*se*	*0.1*				*0.3*						*0.1*	
Length														
	WB	1	499		435		538		555		508		547	
	WB	2	512		404		512		502		598		559	
	WB	3	431		409		514		536		430		558	
	WB	4	539		344		448		553		547		585	
	WB	5	394		477		482		510		559		566	
	WB	6											574	
	WB	7											623	
	WB	*median*	*499*		*409*		*512*		*536*		*547*		*566*	
	WB	*mean*	*475*		*414*		*499*		*531*		*528*		*573*	
	WB	*se*	*27*		*22*		*16*		*11*		*29*		*9.5*	
	F	1	499				538						547	
	F	2	512				512						559	
	F	3	431				514						558	
	F	4	539				448						585	
	F	5	394				482						566	
	F	*median*	*499*				*512*						*559*	
	F	*mean*	*475*				*499*						*563*	
	F	*se*	*27*				*16*						*6.3*	
	O	1	499				538						547	
	O	2	512				512						559	
	O	3	431				514						558	
	O	4	539				448						585	
	O	5	394				482						566	
	O	*median*	*499*				*512*						*559*	
	O	*mean*	*475*				*499*						*563*	
	O	*se*	*27*				*16*						*6.3*	

Table F4. Summary of Analytical Data for Walleye.

Walleye		Collection Area	1		2		3		4		5		6	
		River Mile	741		723		706		678		635		605	
	Tissue	comp	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q
Weight														
	WB	1	382		384		405		405		392		412	
	WB	2	396		365		400		399		420		409	
	WB	3	376		367		391		399		373		409	
	WB	4	397		355		377		397		412		419	
	WB	5	362		388		391		392		409		411	
	WB	6											401	
	WB	7											418	
	WB	*median*	*382*		*367*		*391*		*399*		*409*		*411*	
	WB	*mean*	*382*		*372*		*393*		*398*		*401*		*411*	
	WB	*se*	*6.5*		*6.2*		*4.8*		*2.0*		*8.4*		*2.2*	
	F	1	382				405						412	
	F	2	396				400						409	
	F	3	376				391						409	
	F	4	397				377						419	
	F	5	362				391						411	
	F	*median*	*382*				*391*						*411*	
	F	*mean*	*382*				*393*						*412*	
	F	*se*	*6.5*				*4.8*						*1.8*	
	O	1	382				405						412	
	O	2	396				400						409	
	O	3	376				391						409	
	O	4	397				377						419	
	O	5	362				391						411	
	O	*median*	*382*				*391*						*411*	
	O	*mean*	*382*				*393*						*412*	
	O	*se*	*6.5*				*4.8*						*1.8*	

Notes:

U = result not detected, reported at detection limit converted from dry weight to wet weight using sample-specific moisture content

1U = one sample used to estimate value was below detection limit

2U = both samples used to estimate value were below detection limit

Table F5. Summary of Analytical Data for Whitefish Species.

		Mountain		Lake		Lake		Lake		Lake		Lake	
Whitefish species	Collection Area	1		2		3		4		5		6	
	River Mile	741		723		706		678		635		605	
	composite	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q
Aluminum													
	1	19		4.8		3.8	U	7.1		5.2		3.9	U
	2	13		3.9	U	3.8	U	5.9		3.7	U	4.0	U
	3	4.9		3.8	U	3.9		4.8		6.0			
	4	20		4.1	U	3.5	U	5.2		4.5			
	5	17		3.9	U	5.8		7.8		4.2	U		
	median	*17*		*3.9*		*3.8*		*5.9*		*4.5*		*4.0*	
	mean	*15*		*4.1*		*4.2*		*6.2*		*4.7*		*4.0*	
	se	*2.6*		*0.18*		*0.42*		*0.56*		*0.40*		*0.1*	
Arsenic													
	1	*0.17*		*0.27*		*0.27*		*0.29*		*0.30*		*0.19*	
	2	*0.16*		*0.20*		*0.28*		*0.26*		*0.30*		*0.31*	
	3	*0.14*		*0.26*		*0.24*		*0.22*		0.23			
	4	*0.15*		*0.26*		*0.28*		*0.25*		*0.30*			
	5	0.12		*0.19*		*0.24*		*0.23*		*0.29*			
	median	*0.15*		*0.26*		*0.27*		*0.25*		*0.30*		*0.25*	
	mean	*0.15*		*0.24*		*0.26*		*0.25*		*0.28*		*0.25*	
	se	*0.01*		*0.02*		*0.01*		*0.01*		*0.01*		*0.06*	
Barium													
	1	1.0		*0.51*		*0.51*		*0.70*		*0.55*		*0.35*	
	2	1.8		*0.55*		*0.53*		*0.62*		*0.63*		*0.32*	
	3	0.46		*0.41*		*0.52*		*0.55*		*0.67*			
	4	1.3		*0.54*		*0.58*		*0.85*		*0.58*			
	5	2.8		*0.45*		*0.62*		0.7		*0.56*			
	median	*1.3*		*0.51*		*0.53*		*0.7*		*0.58*		*0.33*	
	mean	*1.5*		*0.49*		*0.55*		*0.68*		*0.60*		*0.33*	
	se	*0.39*		*0.03*		*0.02*		*0.05*		*0.02*		*0.01*	
Cadmium													
	1	0.13		0.024		0.019		0.02		0.018		0.017	
	2	0.11		0.016	U	0.018	J	0.029		0.016	U	0.024	
	3	0.092		0.016	U	0.020		0.022		0.017	U		
	4	0.13		0.017	U	0.016		0.024		0.015	U		
	5	0.092		0.020		0.017		0.032		0.017	U		
	median	*0.11*		*0.017*		*0.018*		*0.024*		*0.017*		*0.020*	
	mean	*0.11*		*0.019*		*0.018*		*0.025*		*0.017*		*0.020*	
	se	*0.01*		*0.002*		*0.001*		*0.002*		*0.000*		*0.003*	
Calcium													
	1	*6070*		*4550*	J	*5690*		*5070*		*5570*		*4860*	
	2	*4870*		*5150*	J	*5470*		*4760*		*7410*		*6000*	J
	3	*4120*		*4650*	J	*4840*		*4650*		*6280*			
	4	*6290*		*4610*	J	*4980*		*6490*		*4420*			
	5	*5490*		*4960*	J	*4600*		*4500*		*7500*			
	median	*5490*		*4650*		*4980*		*4760*		*6280*		*5430*	
	mean	*5370*		*4780*		*5120*		*5090*		*6240*		*5430*	
	se	*398*		*116*		*202*		*361*		*580*		*570*	
Chromium													
	1	1.2		0.72		0.66		0.88		0.92		0.91	
	2	0.95		0.52		0.69		0.84		0.82		0.64	
	3	1.0		0.66		0.65		0.86		0.80			
	4	1.1		0.64		0.70		0.82		0.90			
	5	1.1		0.55		0.94		0.75		0.92			
	median	*1.1*		*0.64*		*0.69*		*0.84*		*0.90*		*0.78*	
	mean	*1.1*		*0.62*		*0.73*		*0.83*		*0.87*		*0.78*	
	se	*0.0*		*0.04*		*0.05*		*0.02*		*0.02*		*0.14*	
Cobalt													
	1	0.059		0.029	JK	0.025	JK	0.025	JK	0.030	JK	0.020	JK
	2	0.062		0.025	JK	0.023	JK	0.029	JK	0.037	JK	0.026	JK
	3	0.028		0.024	JK	0.019	JK	0.024	JK	0.032	JK		
	4	0.072		0.022	JK	0.024	JK	0.028	JK	0.027	JK		
	5	0.067		0.023	JK	0.033	JK	0.029	JK	0.031	J		
	median	*0.062*		*0.024*		*0.024*		*0.028*		*0.031*		*0.023*	
	mean	*0.058*		*0.025*		*0.025*		*0.027*		*0.032*		*0.023*	
	se	*0.008*		*0.001*		*0.002*		*0.001*		*0.002*		*0.003*	

Table F5. Summary of Analytical Data for Whitefish Species.

		Mountain		Lake		Lake		Lake		Lake		Lake	
Whitefish species	Collection Area	1		2		3		4		5		6	
	River Mile	741		723		706		678		635		605	
	composite	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q
Copper													
	1	1.2	J	0.82		0.44		0.68		0.73		0.45	
	2	1.5	J	0.65		0.53		0.72		0.54		0.57	
	3	0.56	J	0.54		0.65		0.72		0.67			
	4	2.0	J	0.64		0.51		0.65		0.67			
	5	1.3	J	0.75		0.85		0.65		0.56			
	median	*1.3*		*0.65*		*0.53*		*0.68*		*0.67*		*0.51*	
	mean	*1.3*		*0.68*		*0.60*		*0.68*		*0.63*		*0.51*	
	se	*0.23*		*0.05*		*0.07*		*0.02*		*0.04*		*0.06*	
Iron													
	1	112	J	17		11		18		17		11	
	2	113	J	12		12		17		13		18	
	3	30	J	11		15		15		16			
	4	147	J	15		12		17		19			
	5	109	J	15		22		19		11			
	median	*112*		*15*		*12*		*17*		*16*		*15*	
	mean	*102*		*14*		*15*		*17*		*15*		*15*	
	se	*19*		*1*		*2*		*1*		*2*		*4*	
Lead													
	1	0.45		0.075		0.089		0.068		0.048		0.071	
	2	0.40		0.058		0.057		0.049		0.047		0.040	
	3	0.18		0.06		0.049		0.041		0.053			
	4	0.34		0.081		0.067		0.062		0.038			
	5	0.30		0.062		0.12		0.11		0.053			
	median	*0.34*		*0.062*		*0.067*		*0.062*		*0.048*		*0.056*	
	mean	*0.34*		*0.067*		*0.077*		*0.067*		*0.048*		*0.056*	
	se	*0.047*		*0.0046*		*0.013*		*0.013*		*0.0027*		*0.016*	
Magnesium													
	1	314		277		297		286		279		258	
	2	344		284		276		289		282		268	
	3	296		269		278		267		280			
	4	336		274		276		296		265			
	5	322		271		271		270		297			
	median	*322*		*274*		*276*		*286*		*280*		*263*	
	mean	*322*		*275*		*280*		*282*		*281*		*263*	
	se	*8*		*3*		*5*		*6*		*5*		*5*	
Manganese													
	1	4		*1.1*		0.81	J	1.7	J	2.0	J	1.0	J
	2	*4.9*		0.68		0.90	J	2.0	J	1.7	J	*0.99*	
	3	*1.6*		0.63		0.87	J	1.2	J	1.7	J		
	4	*4.3*		0.85		0.67	J	3.8	J	2.4	J		
	5	*3.7*		0.81		1.6	J	2.1	J	1.3	J		
	median	*4.0*		*0.81*		*0.87*		*2.0*		*1.7*		*0.99*	
	mean	*3.7*		*0.81*		*0.97*		*2.2*		*1.8*		*0.99*	
	se	*0.6*		*0.08*		*0.17*		*0.4*		*0.2*		*0.01*	
Mercury													
	1	0.082		0.065		0.051		0.045		0.080		0.094	
	2	0.083		0.069		0.056		0.058		0.067		0.095	
	3	0.063		0.052		0.054		0.070		0.065			
	4	0.080		0.055		0.051		0.066		0.069			
	5	0.075		0.058		0.050		0.057		0.066			
	median	*0.080*		*0.058*		*0.051*		*0.058*		*0.067*		*0.094*	
	mean	*0.077*		*0.060*		*0.052*		*0.059*		*0.069*		*0.094*	
	se	*0.004*		*0.003*		*0.001*		*0.004*		*0.003*		*0.000*	
Nickel													
	1	0.27		0.17		0.24		0.23		0.21		0.24	
	2	0.21		0.18		0.21		0.19		0.27		0.21	
	3	0.17		0.17		0.16		0.19		0.26			
	4	0.29		0.16		0.17		0.25		0.18			
	5	0.27		0.17		0.30		0.17		0.25			
	median	*0.27*		*0.17*		*0.21*		*0.19*		*0.25*		*0.23*	
	mean	*0.24*		*0.17*		*0.22*		*0.20*		*0.23*		*0.23*	
	se	*0.02*		*0.00*		*0.03*		*0.01*		*0.02*		*0.01*	

Table F5. Summary of Analytical Data for Whitefish Species.

		Mountain		Lake		Lake		Lake		Lake		Lake	
Whitefish	Collection Area	1		2		3		4		5		6	
species	River Mile	741		723		706		678		635		605	
	composite	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q
Potassium													
	1	3020		2980		3160		3000		3040		2970	
	2	3430		3170		2990		3110		2750		2790	
	3	3050		3110		3020		2900		2910			
	4	3040		3120		3070		3010		3010			
	5	3220		2990		3070		3000		2810			
	median	*3050*		*3110*		*3070*		*3000*		*2910*		*2880*	
	mean	*3150*		*3070*		*3060*		*3000*		*2900*		*2880*	
	se	*78*		*38*		*29*		*33*		*56*		*90*	
Selenium													
	1	1.0		0.86		0.78		0.87		0.59		0.49	
	2	1.1		0.71		0.65		0.78		0.64		0.44	
	3	1.0		0.70		0.59		0.75		0.67			
	4	1.2		0.75		0.80		0.86		0.84			
	5	0.85		0.62		0.88		0.78		0.70			
	median	*1.0*		*0.71*		*0.78*		*0.78*		*0.67*		*0.46*	
	mean	*1.0*		*0.73*		*0.74*		*0.81*		*0.69*		*0.46*	
	se	*0.1*		*0.04*		*0.05*		*0.02*		*0.04*		*0.03*	
Silver													
	1	0.052	U	0.092	U	0.076	U	0.081	U	0.080	U	0.081	U
	2	0.055	U	0.081	U	0.077	U	0.078	U	0.078	U	0.084	U
	3	0.053	U	0.079	U	0.079	U	0.086	U	0.084	U		
	4	0.052	U	0.085	U	0.073	U	0.082	U	0.077	U		
	5	0.053	U	0.081	U	0.079	U	0.081	U	0.085	U		
	median	*0.053*		*0.081*		*0.077*		*0.081*		*0.080*		*0.082*	
	mean	*0.053*		*0.084*		*0.077*		*0.081*		*0.080*		*0.082*	
	se	*0.001*		*0.002*		*0.001*		*0.001*		*0.002*		*0.001*	
Sodium													
	1	742	J	677		762	JK	665	JK	720		791	JK
	2	732	J	687		692	JK	688	JK	809		690	
	3	648	J	657		674		657	JK	698			
	4	751	J	658		729		737	JK	707			
	5	722	J	690		700		642	JK	753	JK		
	median	*732*		*677*		*700*		*665*		*720*		*741*	
	mean	*719*		*674*		*711*		*678*		*737*		*741*	
	se	*18*		*7*		*15*		*17*		*20*		*51*	
Thallium													
	1	0.086	U	0.092	U	0.076	U	0.081	U	0.080	U	0.081	U
	2	0.092	U	0.081	U	0.077	U	0.078	U	0.078	U	0.084	U
	3	0.088	U	0.079	U	0.079	U	0.086	U	0.084	U		0
	4	0.087	U	0.085	U	0.073	U	0.082	U	0.077	U		0
	5	0.088	U	0.081	U	0.079	U	0.081	U	0.085	U		0
	median	*0.088*		*0.081*		*0.077*		*0.081*		*0.080*		*0.082*	
	mean	*0.088*		*0.084*		*0.077*		*0.081*		*0.080*		*0.082*	
	se	*0.001*		*0.002*		*0.001*		*0.001*		*0.002*		*0.001*	
Uranium													
	1	0.0096	0	0.0025	0	0.0047	0	0.0019	0	0.0025	0	0.0016	U
	2	0.012	0	0.0024	0	0.0023	0	0.0016	U	0.0031	0	0.0017	U
	3	0.0046	0	0.0022	0	0.0017	0	0.0017	U	0.0025	0		0
	4	0.0104	0	0.0022	0	0.0014	U	0.0021	0	0.0021	0		0
	5	0.0075	0	0.0018	0	0.0038	0	0.0017	0	0.0018	U		0
	median	*0.0096*		*0.0022*		*0.00227*		*0.00172*		*0.0025*		*0.0017*	
	mean	*0.0089*		*0.0022*		*0.0028*		*0.0018*		*0.0024*		*0.0017*	
	se	*0.0013*		*0.0001*		*0.0006*		*0.0001*		*0.0002*		*0.0000*	
Vanadium													
	1	0.14	U	0.15	U	0.12	U	0.13	U	0.14		0.13	U
	2	0.15	U	0.13	U	0.12	U	0.13	U	0.16		0.13	U
	3	0.14	U	0.13	U	0.12	U	0.14	U	0.14			
	4	0.14	U	0.14	U	0.11	U	0.13	U	0.12	U		
	5	0.14	U	0.13	U	0.13	U	0.13	U	0.14	U		
	median	*0.14*		*0.13*		*0.12*		*0.13*		*0.14*		*0.13*	
	mean	*0.14*		*0.13*		*0.12*		*0.13*		*0.14*		*0.13*	
	se	*0.00*		*0.00*		*0.00*		*0.00*		*0.01*		*0.00*	

Table F5. Summary of Analytical Data for Whitefish Species.

		Mountain		Lake		Lake		Lake		Lake		Lake	
Whitefish	Collection Area	1		2		3		4		5		6	
species	River Mile	741		723		706		678		635		605	
	composite	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q	mg/kg ww	Q
Zinc													
	1	29	J	14	0	14	0	14	0	14	0	13	0
	2	32	J	12	0	13	0	12	0	14	0	12	0
	3	20	J	12	0	13	0	11	0	13	0		0
	4	28	J	12	0	14	0	12	0	12	0		0
	5	40	J	13	0	14	0	11	0	13	0		0
	median	*29*		*12*		*14*		*12*		*13*		*12*	
	mean	*30*		*13*		*14*		*12*		*13*		*12*	
	se	*3*		*0*		*0*		*1*		*0*		*0*	
Lipids													
%	1	7.6	0	13	0	7.8	0	11	0	10	0	13	0
	2	8.3	0	12	0	11	0	12	0	13	0	14	0
	3	8.9	0	11	0	12	0	15	0	14	0		0
	4	7.8	0	14	0	11	0	13	0	12	0		0
	5	10	0	1.4	0	6	0	12	0	16	0		0
	median	*8.3*		*12*		*11*		*12*		*13*		*13*	
	mean	*8.6*		*10*		*9.6*		*12*		*13*		*13*	
	se	*0.5*		*2*		*1*		*1*		*1*		*1*	
Age													
years	1	6.5		2.8		1.6		1.4		2.6		2	
	2	6.3		2.4		2		1.4		2.6		3.7	
	3	ND		2.8		2		2		2			
	4	ND		2.2		1.6		1.2		1.8			
	5	ND		2.4		2		1.6		2.4			
	median	*6.4*		*2.4*		*2*		*1.4*		*2.4*		*2.9*	
	mean	*6.4*		*2.5*		*1.8*		*1.5*		*2.3*		*2.9*	
	se	*0.1*		*0.1*		*0.1*		*0.1*		*0.2*		*0.9*	
Length													
mm	1	928		499		427		401		469		462	
	2	923		473		438		406		487		505	
	3	834		492		464		448		468			
	4	978		483		435		423		431			
	5	978		484		448		410		484			
	median	*928*		*484*		*438*		*410*		*469*		*483*	
	mean	*928*		*486*		*442*		*418*		*468*		*483*	
	se	*26*		*4*		*6*		*8*		*10*		*22*	
Weight													
g	1	422		1500		892		772		1170		1139	
	2	416		1106		970		800		1194		1523	
	3	407		1232		1144		1032		1108			
	4	423		1234		957		897		921			
	5	417		1342		1044		804		1253			
	median	*417*		*1234*		*970*		*804*		*1170*		*1331*	
	mean	*417*		*1280*		*1000*		*861*		*1130*		*1330*	
	se	*2.9*		*66*		*43*		*48*		*57*		*192*	

Table F6. Summary Statistics for 2,3,7,8-TCDF, Aroclor 1254/1260, and Total PCB Congeners in Fish Tissues Collected by EPA in 2005.

Analyte	Collection Area = / River Mile = / Composite	1 / 738		2 / 728	3 / 706		4 / 680	5 / 635	6 / 606	
Burbot (whole body)										
Lipids (%)	1	-		1.30	6.30		1.10	0.80	1.60	
	2	-		2.40	1.30		0.60	1.40	2.00	
	3	-		2.20	1.20		1.30	0.90	1.30	
	4	-		-	2.30		0.90	1.90	1.60	
	5	-		-	2.50		-	1.40	1.00	
2,3,7,8-TCDF	1	-		3.97	2.71		5.71	1.59	4.93	
(ng/kg-ww)	2	-		5.11	3.65		4.12	3.90	3.96	
	3	-		5.48	3.03		4.78	2.19	3.26	
	4	-		-	4.03		3.14	3.89	4.67	
	5	-		-	3.67		-	3.41	3.92	
2,3,7,8-TCDF	1	-		305.38	43.02		519.09	198.75	308.13	
(ng/kg lipid)	2	-		212.92	280.77		686.67	278.57	198.00	
	3	-		249.09	252.50		531.11	243.33	250.77	
	4	-		-	175.22		241.54	204.74	291.88	
	5	-		-	146.80		-	243.57	392.00	
Aroclor 1254/1260	1	-		20.00	18.00		28.00	20.00	20.00	
(ug/kg-ww)	2	-		43.00	32.00		21.00	26.00	19.00	
	3	-		27.00	35.33		11.00	20.00	21.00	
	4	-		-	21.00		33.00	58.00	27.00	
	5	-		-	28.00		-	28.00	27.00	
Aroclor 1254/1260	1	-		1538.46	285.71		2545.45	2500.00	1250.00	
(ug/kg lipid)	2	-		1791.67	2461.54		3500.00	1857.14	950.00	
	3	-		1227.27	2944.44		846.15	2222.22	1615.38	
	4	-		-	913.04		3666.67	3052.63	1687.50	
	5	-		-	1120.00		-	2000.00	2700.00	
Total PCB Congeners	1	-		27.89	26.68		14.87	22.96	24.78	
(ug/kg-ww)	2	-		-	-		-	-	-	
Total PCB Congeners	1	-		1267.67	2223.07		2478.74	1640.14	2477.58	
(ug/kg lipid)	2	-		-	-		-	-	-	
Walleye (whole body)										
Lipids (%)	1	2.94	E	2.10	3.68	E	2.70	3.10	3.30	
	2	2.54	E	2.20	2.51	E	3.00	3.60	3.50	
	3	1.29	E	2.60	3.11	E	3.50	3.00	2.27	E
	4	2.94	E	2.10	2.36	E	5.10	-	5.37	E
	5	1.21	E	2.27	3.65	E	4.00	-	3.53	E
	6	-		-	-		-	-	3.94	E
	7	-		-	-		-	-	3.07	E
2,3,7,8-TCDF	1	1.15	E	1.13	1.38	E	2.62	1.57	2.05	
(ng/kg-ww)	2	1.31	E	0.89	1.12	E	2.35	1.56	2.06	
	3	0.92	E	1.36	1.13	E	1.59	1.98	1.39	E
	4	1.01	E	1.27	1.37	E	2.37	-	2.79	E
	5	0.67	E	1.14	1.10	E	1.29	-	2.37	E
	6	-		-	-		-	-	2.06	E
	7	-		-	-		-	-	1.49	E
2,3,7,8-TCDF	1	168.86	E	53.81	50.78	E	97.04	50.65	62.12	
(ng/kg lipid)	2	106.15	E	40.45	63.03	E	78.33	43.33	58.86	
	3	171.28	E	52.31	54.02	E	45.43	66.00	70.21	E
	4	72.58	E	60.48	88.52	E	46.47	-	79.15	E
	5	110.62	E	50.29	48.75	E	32.25	-	108.62	E
	6	-		-			-	-	74.24	E
	7	-		-			-	-	77.25	E
Aroclor 1254/1260	1	34.79	E	33.00	13.55	E	18.30	21.00	22.00	
(ug/kg-ww)	2	24.80	E	22.00	8.89	E	20.90	33.00	33.00	
	3	18.81	E	26.00	6.46	E	16.40	28.00	20.13	E
	4	27.42	E	27.00	10.63	E	20.80	-	54.81	E
	5	19.17	E	47.67	11.59	E	16.50	-	27.53	E
	6	-		-	-		-	-	35.32	E
	7	-		-	-		-	-	27.69	E

Table F6. Summary Statistics for 2,3,7,8-TCDF, Aroclor 1254/1260, and Total PCB Congeners in Fish Tissues Collected by EPA in 2005.

Analyte	Collection Area = / River Mile = / Composite	1 / 738		2 / 728	3 / 706		4 / 680	5 / 635	6 / 606	
Aroclor 1254/1260	1	2058.93	E	1571.43	380.03	E	677.78	677.42	666.67	
(ug/kg lipid)	2	1615.66	E	1000.00	499.36	E	696.67	916.67	942.86	
	3	2887.51	E	1000.00	343.75	E	468.57	933.33	653.56	E
	4	1622.93	E	1285.71	2120.70	E	407.84	-	803.55	E
	5	2956.06	E	2102.94	446.76	E	412.50	-	891.86	E
	6	-		-	-		-	-	839.18	E
	7	-		-	-		-	-	869.01	E
Total PCB Congeners	1	246.05	E	38.39	37.46	E	37.03	35.65	37.82	E
(ug/kg-ww)	2	3.70	E	-	-		-	-	-	
Total PCB Congeners	1	6545.75	E	1693.89	1464.19	E	726.11	990.41	1248.49	E
(ug/kg lipid)	2	3366.36	E	-	-		-	-	-	
Walleye (fillet)										
Lipids (%)	1	0.10		-	0.50		-	-	0.60	
	2	0.20		-	0.40		-	-	0.70	
	3	0.11		-	0.50		-	-	0.40	
	4	0.23		-	0.30		-	-	0.60	
	5	0.11		-	0.40		-	-	0.40	
2,3,7,8-TCDF	1	0.34	U	-	0.36		-	-	0.51	
(ng/kg-ww)	2	0.36	U	-	0.34	U	-	-	0.80	
	3	0.33	U	-	0.39		-	-	0.67	
	4	0.28	U	-	0.40		-	-	0.65	
	5	0.20	U	-	0.30	U	-	-	0.47	U
2,3,7,8-TCDF	1	338.00		-	72.80		-	-	84.67	
(ng/kg lipid)	2	177.50		-	85.50		-	-	113.71	
	3	300.00		-	77.00		-	-	167.50	
	4	120.00		-	134.67		-	-	108.00	
	5	185.45		-	74.50		-	-	117.00	
Aroclor 1254/1260	1	3.20		-	2.00		-	-	1.70	
(ug/kg-ww)	2	4.90		-	2.70		-	-	3.70	
	3	5.20		-	2.60		-	-	4.20	
	4	5.70		-	14.00		-	-	4.50	
	5	5.30		-	2.50		-	-	3.30	
Aroclor 1254/1260	1	3200.00		-	400.00		-	-	283.33	
(ug/kg lipid)	2	2450.00		-	675.00		-	-	528.57	
	3	4727.27		-	520.00		-	-	1050.00	
	4	2478.26		-	4666.67		-	-	750.00	
	5	4818.18		-	625.00		-	-	825.00	
Total PCB Congeners	1	9.81		-	5.73		-	-	6.00	
(ug/kg-ww)	2	8.27		-	-		-	-	-	
Total PCB Congeners	1	4266.61		-	1433.13		-	-	1498.87	
(ug/kg lipid)	2	7522.04		-	-		-	-	-	
Walleye (offal)										
Lipids (%)	1	5.20		-	5.90		-	-	3.70	
	2	4.50		-	4.60		-	-	9.60	
	3	2.30		-	5.50		-	-	6.00	
	4	5.30		-	3.90		-	-	6.50	
	5	2.10		-	6.30		-	-	5.30	
2,3,7,8-TCDF	1	1.79		-	2.09		-	-	2.14	
(ng/kg-ww)	2	2.10		-	1.88		-	-	4.60	
	3	1.42		-	1.81		-	-	3.72	
	4	1.65		-	2.10		-	-	3.14	
	5	1.05		-	1.75		-	-	2.34	
2,3,7,8-TCDF	1	34.42			35.42				57.84	
(ng/kg lipid)	2	46.67			40.87				47.92	
	3	61.74			32.91				62.00	
	4	31.13			53.85				48.31	
	5	50.00			27.78				44.15	
Aroclor 1254/1260	1	59.90			21.60				35.90	
(ug/kg-ww)	2	41.40			15.00				101.00	
	3	30.40			10.00				46.00	
	4	46.40			8.10				59.00	
	5	30.40			19.00				48.00	
Aroclor 1254/1260	1	1151.92			366.10				970.27	
(ug/kg lipid)	2	920.00			326.09				1052.08	
	3	1321.74			181.82				766.67	
	4	875.47			207.69				907.69	
	5	1447.62			301.59				905.66	

Table F6. Summary Statistics for 2,3,7,8-TCDF, Aroclor 1254/1260, and Total PCB Congeners in Fish Tissues Collected by EPA in 2005.

Analyte	Collection Area = / River Mile = / Composite	1 / 738		2 / 728	3 / 706		4 / 680	5 / 635	6 / 606	
Total PCB Congeners	1	452.49		-	68.76		-	-	63.02	
(ug/kg-ww)	2	-		-	-		-	-	-	
Total PCB Congeners	1	8537.46		-	1494.82		-	-	1050.26	
(ug/kg lipid)	2	-		-	-		-	-	-	
Wild Rainbow Trout (whole body)										
Lipids (%)	1	8.86	E	7.60	4.16	E	-	8.20	3.86	E
	2	6.58	E	10.70	5.24	E	-	-	-	
	3	6.54	E	9.87	-		-	-	-	
	4	5.76	E	6.70	-		-	-	-	
	5	7.69	E	4.80	-		-	-	-	
2,3,7,8-TCDF	1	3.39	E	2.25	1.03	E	-	1.84	0.97	E
(ng/kg-ww)	2	1.01	E	1.54	1.17	E	-	-	-	
	3	1.02	E	3.28	-		-	-	-	
	4	0.93	E	3.95	-		-	-	-	
	5	1.15	E	4.67	-		-	-	-	
2,3,7,8-TCDF	1	38.79	E	29.61	27.27	E	-	22.44	30.79	E
(ng/kg lipid)	2	16.10	E	14.39	24.55	E	-	-	-	
	3	15.72	E	33.21	-		-	-	-	
	4	15.34	E	58.96	-		-	-	-	
	5	14.73	E	97.29	-		-	-	-	
Aroclor 1254/1260	1	59.27	E	25.50	12.22	E	-	16.00	10.37	E
(ug/kg-ww)	2	35.15	E	27.90	12.17	E	-	-	-	
	3	25.82	E	30.37	-		-	-	-	
	4	22.56	E	34.30	-		-	-	-	
	5	27.39	E	24.00	-		-	-	-	
Aroclor 1254/1260	1	654.00	E	335.53	324.37	E	-	195.12	322.22	E
(ug/kg lipid)	2	603.45	E	260.75	255.23	E	-	-	-	
	3	425.92	E	307.77	-		-	-	-	
	4	406.87	E	511.94	-		-	-	-	
	5	387.75	E	500.00	-		-	-	-	
Total PCB Congeners	1	39.21	E	63.80	8.94	E	-	13.14	-	
(ug/kg-ww)	2	-		-	-		-	-	-	
Total PCB Congeners	1	646.12	E	952.24	227.05	E	-	160.25	-	
(ug/kg lipid)	2	-		-	-		-	-	-	
Wild Rainbow Trout (fillet)										
Lipids (%)	1	6.00		-	2.10		-	-	1.40	
	2	3.10		-	2.80		-	-	-	
	3	4.10		-	-		-	-	-	
	4	4.50		-	-		-	-	-	
	5	4.45		-	-		-	-	-	
2,3,7,8-TCDF	1	2.42		-	0.68		-	-	0.56	
(ng/kg-ww)	2	0.54		-	0.84		-	-	-	
	3	0.66		-	-		-	-	-	
	4	0.53		-	-		-	-	-	
	5	0.63		-	-		-	-	-	
2,3,7,8-TCDF	1	40.33		-	32.57		-	-	39.93	
(ng/kg lipid)	2	17.52		-	30.11		-	-	-	
	3	16.15		-	-		-	-	-	
	4	11.87		-	-		-	-	-	
	5	14.19		-	-		-	-	-	
Aroclor 1254/1260	1	36.60		-	8.20		-	-	5.70	
(ug/kg-ww)	2	23.00		-	8.80		-	-	-	
	3	20.70		-	-		-	-	-	
	4	21.30		-	-		-	-	-	
	5	20.35		-	-		-	-	-	
Aroclor 1254/1260	1	610.00		-	390.48		-	-	407.14	
(ug/kg lipid)	2	741.94		-	314.29		-	-	-	
	3	504.88		-	-		-	-	-	
	4	473.33		-	-		-	-	-	
	5	457.30		-	-		-	-	-	
Total PCB Congeners	1	23.15		-	5.32		-	-	-	
(ug/kg-ww)	2	-		-	-		-	-	-	
Total PCB Congeners	1	746.63		-	253.51		-	-	-	
(ug/kg lipid)	2	-		-	-		-	-	-	

Table F6. Summary Statistics for 2,3,7,8-TCDF, Aroclor 1254/1260, and Total PCB Congeners in Fish Tissues Collected by EPA in 2005.

Analyte	Collection Area = / River Mile = / Composite	1 / 738	2 / 728	3 / 706	4 / 680	5 / 635	6 / 606
Wild Rainbow Trout (offal)							
Lipids (%)	1	11.90	-	6.10	-	-	6.30
	2	9.90	-	7.30	-	-	-
	3	9.10	-	-	-	-	-
	4	7.10	-	-	-	-	-
	5	11.20	-	-	-	-	-
2,3,7,8-TCDF	1	4.42	-	1.36	-	-	1.37
(ng/kg-ww)	2	1.46	-	1.45	-	-	-
	3	1.39	-	-	-	-	-
	4	1.35	-	-	-	-	-
	5	1.72	-	-	-	-	-
2,3,7,8-TCDF	1	37.14	-	22.30	-	-	21.75
(ng/kg lipid)	2	14.75	-	19.86	-	-	-
	3	15.27	-	-	-	-	-
	4	19.01	-	-	-	-	-
	5	15.31	-	-	-	-	-
Aroclor 1254/1260	1	83.40	-	16.00	-	-	15.00
(ug/kg-ww)	2	46.70	-	15.00	-	-	-
	3	31.20	-	-	-	-	-
	4	23.90	-	-	-	-	-
	5	35.00	-	-	-	-	-
Aroclor 1254/1260	1	700.84	-	262.30	-	-	238.10
(ug/kg lipid)	2	471.72	-	205.48	-	-	-
	3	342.86	-	-	-	-	-
	4	336.62	-	-	-	-	-
	5	312.50	-	-	-	-	-
Total PCB Congeners	1	54.50	-	12.33	-	-	-
(ug/kg-ww)	2	-	-	-	-	-	-
Total PCB Congeners	1	550.51	-	202.20	-	-	-
(ug/kg lipid)	2	-	-	-	-	-	-
Hatchery Rainbow Trout (whole body)							
Lipids (%)	1	-	-	7.70 E	5.20	6.30	5.57 E
	2	-	-	3.40 E	5.20	6.50	5.45 E
	3	-	-	3.66 E	5.20	5.30	5.17 E
	4	-	-	-	4.90	5.20	5.34 E
	5	-	-	-	6.20	9.37	-
2,3,7,8-TCDF	1	-	-	1.16 E	1.24 U	1.55	1.52 E
(ng/kg-ww)	2	-	-	0.97 E	1.41	1.40	1.36 E
	3	-	-	1.71 E	0.91	1.54	1.82 E
	4	-	-	-	1.25	0.97	0.97 E
	5	-	-	-	1.25	1.50	-
2,3,7,8-TCDF	1	-	-	21.38 E	23.85	24.60	29.90 E
(ng/kg lipid)	2	-	-	29.91 E	27.12	21.54	26.04 E
	3	-	-	51.07 E	17.42	29.06	42.18 E
	4	-	-	-	25.51	18.65	17.67 E
	5	-	-	-	20.16	15.98	-
Aroclor 1254/1260	1	-	-	10.50 E	12.00	7.30	9.36 E
(ug/kg-ww)	2	-	-	7.20 E	7.60	9.20	13.51 E
	3	-	-	7.70 E	6.70	17.10	15.84 E
	4	-	-	-	7.40	6.30	10.66 E
	5	-	-	-	7.50	10.30	-
Aroclor 1254/1260	1	-	-	170.47 E	230.77	115.87	197.43 E
(ug/kg lipid)	2	-	-	223.79 E	146.15	141.54	294.89 E
	3	-	-	243.30 E	128.85	322.64	374.79 E
	4	-	-	-	151.02	121.15	223.52 E
	5	-	-	-	120.97	109.96	-
Total PCB Congeners	1	-	-	15.60 E	11.26	9.10	17.29 E
(ug/kg-ww)	2	-	-	-	-	-	-
Total PCB Congeners	1	-	-	429.29 E	229.89	97.18	354.45 E
(ug/kg lipid)	2	-	-	-	-	-	-

Table F6. Summary Statistics for 2,3,7,8-TCDF, Aroclor 1254/1260, and Total PCB Congeners in Fish Tissues Collected by EPA in 2005.

Analyte	Collection Area = / River Mile = / Composite	1 / 738	2 / 728	3 / 706	4 / 680	5 / 635	6 / 606
Hatchery Rainbow Trout (fillet)							
Lipids (%)	1	-	-	11.00	-	-	2.75
	2	-	-	2.00	-	-	2.50
	3	-	-	1.90	-	-	2.20
	4	-	-	-	-	-	2.20
	5	-	-	-	-	-	-
2,3,7,8-TCDF	1	-	-	0.73 U	-	-	0.93 U
(ng/kg-ww)	2	-	-	0.65	-	-	0.70
	3	-	-	1.16	-	-	1.19
	4	-	-	-	-	-	0.37 U
	5	-	-	-	-	-	-
2,3,7,8-TCDF	1	-	-	6.61	-	-	33.96
(ng/kg lipid)	2	-	-	32.65	-	-	27.88
	3	-	-	61.05	-	-	54.09
	4	-	-	-	-	-	16.91
	5	-	-	-	-	-	-
Aroclor 1254/1260	1	-	-	10.00	-	-	6.65
(ug/kg-ww)	2	-	-	5.00	-	-	9.40
	3	-	-	6.10	-	-	10.80
	4	-	-	-	-	-	5.70
	5	-	-	-	-	-	-
Aroclor 1254/1260	1	-	-	90.91	-	-	241.82
(ug/kg lipid)	2	-	-	250.00	-	-	376.00
	3	-	-	321.05	-	-	490.91
	4	-	-	-	-	-	259.09
	5	-	-	-	-	-	-
Total PCB Congeners	1	-	-	8.28	-	-	8.54
(ug/kg-ww)	2	-	-	-	-	-	-
Total PCB Congeners	1	-	-	435.55	-	-	388.28
(ug/kg lipid)	2	-	-	-	-	-	-
Hatchery Rainbow Trout (offal)							
Lipids (%)	1	-	-	4.40	-	-	9.25
	2	-	-	5.00	-	-	8.60
	3	-	-	5.20	-	-	8.20
	4	-	-	-	-	-	8.90
	5	-	-	-	-	-	-
2,3,7,8-TCDF	1	-	-	1.59 U	-	-	2.28
(ng/kg-ww)	2	-	-	1.34	-	-	2.07
	3	-	-	2.20 U	-	-	2.46
	4	-	-	-	-	-	1.65
	5	-	-	-	-	-	-
2,3,7,8-TCDF	1	-	-	36.14	-	-	24.59
(ng/kg lipid)	2	-	-	26.80	-	-	24.07
	3	-	-	42.31	-	-	30.00
	4	-	-	-	-	-	18.54
	5	-	-	-	-	-	-
Aroclor 1254/1260	1	-	-	4.40	-	-	9.25
(ug/kg-ww)	2	-	-	5.00	-	-	8.60
	3	-	-	5.20	-	-	8.20
	4	-	-	-	-	-	8.90
	5	-	-	-	-	-	-
Aroclor 1254/1260	1	-	-	11.00	-	-	12.90
(ug/kg lipid)	2	-	-	9.70	-	-	17.90
	3	-	-	9.10	-	-	21.00
	4	-	-	-	-	-	16.30
	5	-	-	-	-	-	-
Total PCB Congeners	1	-	-	22.04	-	-	26.23
(ug/kg-ww)	2	-	-	-	-	-	-
Total PCB Congeners	1	-	-	423.79	-	-	319.87
(ug/kg lipid)	2	-	-	-	-	-	-

Table F6. Summary Statistics for 2,3,7,8-TCDF, Aroclor 1254/1260, and Total PCB Congeners in Fish Tissues Collected by EPA in 2005.

Analyte	Collection Area = / River Mile = / Composite	1 / 738	2 / 728	3 / 706	4 / 680	5 / 635	6 / 606
Whitefish (whole body)							
Lipids (%)	1	7.60	13.00	7.80	11.30	13.00	12.80
	2	8.30	12.00	11.33	11.70	13.50	14.00
	3	8.90	11.00	12.00	14.70	11.50	-
	4	7.83	14.00	10.90	12.80	15.80	-
	5	10.20	1.40	6.00	11.60	-	-
2,3,7,8-TCDF	1	4.28	4.93	2.12	5.26	7.76	7.35
(ng/kg-ww)	2	3.32	4.92	3.40	6.79	8.19	8.35
	3	6.00	4.55	3.46	7.45	7.02	-
	4	3.48	4.67	4.15	4.80	5.30	-
	5	2.58	3.56	3.04	6.87	6.96	-
2,3,7,8-TCDF	1	56.32	37.92	27.18	46.55	77.60	57.42
(ng/kg lipid)	2	40.00	41.00	29.97	58.03	63.00	59.64
	3	67.42	41.36	28.83	50.68	52.00	-
	4	44.43	33.36	38.07	37.50	46.09	-
	5	25.29	254.29	50.67	59.22	44.05	-
Aroclor 1254/1260	1	57.30	31.00	15.00	20.60	26.90	30.50
(ug/kg-ww)	2	49.00	14.90	20.95	13.70	48.00	38.00
	3	55.70	15.00	13.40	17.30	28.40	-
	4	45.35	15.00	9.50	11.00	21.80	-
	5	58.20	5.50	21.30	18.90	28.10	-
Aroclor 1254/1260	1	753.95	238.46	192.31	182.30	269.00	238.28
(ug/kg lipid)	2	590.36	124.17	184.85	117.09	369.23	271.43
	3	625.84	136.36	111.67	117.69	210.37	-
	4	578.94	107.14	87.16	85.94	189.57	-
	5	570.59	392.86	355.00	162.93	177.85	-
Total PCB Congeners	1	97.35	25.97	24.80	22.24	37.07	47.28
(ug/kg-ww)	2	-	-	-	-	-	-
Total PCB Congeners	1	1280.97	1854.83	218.82	190.12	322.38	369.34
(ug/kg lipid)	2	-	-	-	-	-	-
Largescale Sucker (whole body)							
Lipids (%)	1	5.80	3.50	5.70	4.10	4.60	8.30
	2	2.70	2.83	11.00	5.10	7.70	6.40
	3	4.00	3.60	4.30	7.50	8.10	6.60
	4	-	5.30	3.10	6.40	10.50	8.30
	5	-	-	-	5.20	6.70	-
2,3,7,8-TCDF	1	0.92	1.60	1.90	2.57	3.83	6.52
(ng/kg-ww)	2	1.53	6.39	3.12	3.73	3.72	5.63
	3	1.22	11.50	1.57	4.28	3.45	3.71
	4	-	2.33	1.93	3.92	5.44	4.70
	5	-	-	-	3.35	3.54	-
2,3,7,8-TCDF	1	15.79	45.71	33.33	62.68	83.26	78.55
(ng/kg lipid)	2	56.67	225.41	28.36	73.14	48.31	87.97
	3	30.50	319.44	36.51	57.07	42.59	56.21
	4	-	43.96	62.26	61.25	51.81	56.63
	5	-	-	-	64.42	52.84	-
Aroclor 1254/1260	1	55.00	40.00	31.00	126.00	102.00	103.00
(ug/kg-ww)	2	89.00	80.00	56.00	73.00	123.00	146.00
	3	58.00	419.00	61.00	142.00	154.00	79.33
	4	-	74.00	68.00	76.00	164.00	87.00
	5	-	-	-	154.00	93.00	-
Aroclor 1254/1260	1	948.28	1142.86	543.86	3073.17	2217.39	1240.96
(ug/kg lipid)	2	3296.30	2823.53	509.09	1431.37	1597.40	2281.25
	3	1450.00	11638.89	1418.60	1893.33	1901.23	1202.02
	4	-	1396.23	2193.55	1187.50	1561.90	1048.19
	5	-	-	-	2961.54	1388.06	-
Total PCB Congeners	1	104.96	126.86	108.81	152.31	133.85	172.39
(ug/kg-ww)	2	-	-	-	-	-	-
Total PCB Congeners	1	3887.52	2393.65	989.16	2929.10	1738.31	2693.54
(ug/kg lipid)	2	-	-	-	-	-	-

Notes:
" - " = No data collected
E = Estimated from fillet and offal tissues
U = Not-detected

APPENDIX G

SUMMARY OF AIR MONITORING DATA FOR NORTHPORT, WASHINGTON, PROVIDED BY TECK COMINCO METALS, LTD. ON AUGUST 21, 2006, AND DECEMBER 14, 2006

APPENDIX G

SUMMARY OF AIR MONITORING DATA FOR NORTHPORT, WASHINGTON

Summary of Air Monitoring Data for Northport, Washington

Teck Cominco Metals Limited (TCM) has been operating an air monitoring station at Northport, Washington, continuously since 1994. Total suspended particulates, particulate matter with a diameter less than 10 microns (PM10), trace metals, and sulfur dioxide are measured at the station. This appendix lists the TCM air monitoring data for PM10, arsenic, lead, cadmium, and zinc for the period of January 1994 through August 2006.

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Table G1. Northport PM-10 Data 1994

Sample report date	TSP µg/m³	Pb µg/m³	Zn µg/m³	Cd µg/m³	As µg/m³
01/02	3	0.0060[a]	0.0310	0.0060[a]	0.0050[a]
01/08	13	0.0060[a]	0.2600	0.0060[a]	0.0060[a]
01/14	4	0.0060[a]	0.1100	0.0050[a]	0.0060[a]
01/20	21	0.5700	0.2700	0.0100	0.060
01/26	9	0.2200	0.0100	0.0080[a]	0.020
02/01	17	0.1200	0.0800	0.0060[a]	0.050
02/07	9	0.0400	0.0500	0.0050[a]	0.0050[a]
02/13	7	0.0200	0.0200	0.0060[a]	0.0060[a]
02/19	6	0.0060[a]	0.0800	0.0060[a]	0.0060[a]
02/25	NA	NA	NA	NA	NA
03/03	NA	NA	NA	NA	NA
03/09	24	0.2900	0.3200	0.0100	0.070
03/15	11	0.0700	0.1000	0.0100	0.0050[a]
03/21	6	0.1500	0.0800	0.0100	0.020
03/27	12	0.1100	0.1300	0.0050[a]	0.040
04/02	19	0.2200	0.1600	0.0100	0.050
04/08	10	0.3300	0.4500	0.0200	0.150
04/14	6	0.0700	0.0400	0.0060[a]	0.012
04/20	17	0.1300	0.1400	0.0100	0.010
04/26	6	0.0900	0.0800	0.0060[a]	0.020
05/02	5	0.0800	0.0400	0.0100	0.010
05/08	NA	NA	NA	NA	NA
05/14	NA	NA	NA	NA	NA
05/20	NA	NA	NA	NA	NA
05/26	35	0.3400	0.5200	0.0200	0.030
06/01	9	0.0200	0.0050[a]	0.0050[a]	0.0050[a]
06/07	5	0.2200	0.0300	0.0200	0.0050[a]
06/13	9	0.0400	0.0500	0.0050[a]	0.0050[a]
06/19	9	0.0600	0.1000	0.0050[a]	0.040
06/25	24	0.0500	0.1100	0.0050[a]	0.030
07/01	30	0.0100	0.0500	0.0050[a]	0.0050[a]
07/07	22	0.0500	0.0700	0.0050[a]	0.0050[a]
07/13	16	0.0400	0.1200	0.0050[a]	0.010
07/19	21	0.1400	0.1700	0.0100	0.0050[a]
07/25	66	0.1900	0.2400	0.0200	0.010
07/31	96	0.0200	0.0600	0.0050[a]	0.0050[a]
08/06	54	0.0050[a]	0.0400	0.0050[a]	0.010
08/12	34	0.2100	0.1900	0.0100	0.030
08/18	26	0.1500	0.2900	0.0100	0.020
08/24	30	0.1600	0.1500	0.0050[a]	0.020
08/30	16	0.1100	0.2100	0.0100	0.020
09/05	16	0.5600	0.4500	0.0400	0.020

Table J1. Northport PM-10 Data 1994

Sample report date	TSP µg/m³	Pb µg/m³	Zn µg/m³	Cd µg/m³	As µg/m³
09/11	9	0.1600	0.1100	0.0100	0.010
09/17	NA	NA	NA	NA	NA
09/23	NA	NA	NA	NA	NA
09/29	42	0.3400	0.3900	0.0100	0.020
10/05	23	0.1300	0.1300	0.0100	0.020
10/11	17	0.2600	0.1200	0.0100	0.010
10/17	12	0.2000	0.2000	0.0200	0.020
10/23	6	0.1000	0.0700	0.0050[a]	0.010
10/29	4	0.0400	0.0200	0.0050[a]	0.0050[a]
11/04	7	0.0200	0.0200	0.0060[a]	0.010
11/10	17	0.2700	0.2000	0.0400	0.050
11/16	6	0.0100	0.1000	0.0100	0.020
11/22	NA	NA	NA	NA	NA
11/28	10	0.0060[a]	0.9300	0.0060[a]	0.020
12/04	4	0.1900	0.1000	0.0100	0.020
12/10	24	0.8100	1.8700	0.0500	0.180
12/16	17	0.6800	0.3900	0.0050[a]	0.190
12/22	15	0.2500	0.5700	0.0060[a]	0.030
12/28	9	0.1800	0.4200	0.0100	0.160

Notes: NA = Sampling data was not available for this date.
[a] Reflects non-detect concentrations where detection limits were not provided.

Table G2. Northport PM-10 Data 1995

Sample report date	TSP µg/m³	Pb µg/m³	Zn µg/m³	Cd µg/m³	As µg/m³
01/03	17	0.1400	0.1600	0.0100	0.0400
01/09	17	0.9300	0.9300	0.0300	0.3900
01/15	6	0.0300	0.0600	0.006[a]	0.0200
01/21	25	0.6000	0.1400	0.0200	0.0500
01/27	46	1.6800	2.8600	0.0700	0.2600
02/02	19	0.0100	1.4900	0.005[a]	0.0400
02/08	17	0.1900	0.2600	0.005[a]	0.0200
02/14	29	0.0300	0.0700	0.005[a]	0.0300
02/20	5	0.2600	0.3100	0.0200	0.005[a]
02/26	4	0.0800	0.1400	0.0100	0.0100
03/04	11	0.2300	0.2100	0.0200	0.0100
03/10	13	1.1200	0.5700	0.1400	0.1500
03/16	6	0.0200	0.0300	0.005[a]	0.0200
03/22	12	0.4700	0.3700	0.0300	0.0700
03/28	10	0.2500	0.1700	0.0100	0.0400
04/03	10	0.0100	0.0100	0.005[a]	0.005[a]
04/09	1	0.005[a]	0.0200	0.005[a]	0.005[a]
04/15	1	0.005[a]	0.005[a]	0.005[a]	0.005[a]
04/21	11		0.0700	0.0200	0.005[a]
04/27	15	0.2100	0.1700	0.005[a]	0.0200
05/03	3	0.005[a]	0.0200	0.005[a]	0.0100
05/09	14	0.0600	0.1500	0.005[a]	0.0200
05/15	21	0.0100	0.0200	0.005[a]	0.005[a]
05/21	19	0.0700	0.1300	0.005[a]	0.0100
05/27	33	0.0900	0.1300	0.005[a]	0.005[a]
06/02	25	0.3300	0.2800	0.0100	0.0400
06/08	11	0.1100	0.1100	0.005[a]	0.0200
06/14	9	0.6000	0.3400	0.0100	0.0800
06/20	5	0.005[a]	0.0200	0.005[a]	0.0200
06/26	16	0.0600	0.1400	0.005[a]	0.0100
07/02	28	0.1200	0.2200	0.0100	0.0600
07/08	27	0.3100	0.1900	0.0100	0.0100
07/14	26	0.0800	0.0800	0.0100	0.0100
07/20	19	0.0700	0.0200	0.005[a]	0.0100
07/26	16	0.0200	0.0900	0.005[a]	0.005[a]
08/01	19	0.005[a]	0.0300	0.005[a]	0.005[a]
08/07	12	0.4000	0.2500	0.0100	0.0100
08/13	7	0.0200	0.0200	0.005[a]	0.0100
08/19	19	0.0100	0.0400	0.005[a]	0.005[a]
08/25	29	0.0400	0.1300	0.005[a]	0.0200
08/31	22	0.0900	0.0900	0.005[a]	0.0200
09/06	27	0.3700	0.2000	0.0400	0.0400

Table G2. Northport PM-10 Data 1995

Sample report date	TSP µg/m³	Pb µg/m³	Zn µg/m³	Cd µg/m³	As µg/m³
09/12	49	0.1600	0.1200	0.005[a]	0.0500
09/18	47	0.0500	0.1100	0.005[a]	0.005[a]
09/24	43	0.0700	0.1200	0.0100	0.0400
09/30	4	0.005[a]	0.0100	0.005[a]	0.0100
10/06	14	0.0600	0.0700	0.0100	0.005[a]
10/12	5	0.005[a]	0.0800	0.005[a]	0.005[a]
10/18	5	0.005[a]	0.0500	0.005[a]	0.0300
10/24	10	0.005[a]	0.0200	0.005[a]	0.005[a]
10/30	7	0.2000	0.0700	0.005[a]	0.0200
11/05	29	0.0700	0.1100	0.005[a]	0.0400
11/11	21	0.5400	0.2400	0.0200	0.1600
11/17	18	1.2400	0.5900	0.0400	0.1500
11/23	24	0.0900	0.0500	0.005[a]	0.005[a]
11/29	4	0.0100	0.1600	0.005[a]	0.005[a]
12/05	6	0.5400	0.3500	0.005[a]	0.0400
12/11	22	1.2500	0.5200	0.0600	0.0900
12/17	10	2.6200	0.4300	0.0400	0.0900
12/23	8	0.0800	0.2100	0.005[a]	0.0400
12/29	25	0.8100	0.5100	0.0500	0.1100

Notes:

[a] Reflects non-detect concentrations where detection limits were not provided.

Table G3. Northport PM-10 Data 1996

Sample report date	TSP µg/m³	Pb µg/m³	Zn µg/m³	Cd µg/m³	As µg/m³
01/04	24	0.005[a]	0.0300	0.005[a]	0.0100
01/10	4	0.0600	0.0300	0.005[a]	0.0100
01/16	2	0.0100	0.0300	0.005[a]	0.0100
01/22	4	0.2600	0.1000	0.0100	0.0200
01/28	6	0.1400	0.1400	0.005[a]	0.0100
02/03	12	0.6200	0.4600	0.0400	0.0600
02/09	17	0.0800	0.1000	0.005[a]	0.0200
02/15	24	1.1200	0.5900	0.0500	0.3400
02/21	6	0.1500	0.0800	0.0200	0.0100
02/27	8	0.0800	0.2100	0.005[a]	0.0200
03/04	7	0.0700	0.1100	0.005[a]	0.005[a]
03/10	14	0.4400	0.1500	0.005[a]	0.0200
03/16	1	0.005[a]	0.0100	0.005[a]	0.0100
03/22	12	0.2200	0.1900	0.0100	0.005[a]
03/28	11	0.2900	0.1800	0.0100	0.0300
04/03	8	0.1500	0.1200	0.005[a]	0.005[a]
04/09	22	0.8100	0.9400	0.0600	0.0500
04/15	14	0.4100	0.3900	0.0200	0.0200
04/21	4	0.005[a]	0.0300	0.005[a]	0.005[a]
04/27	1	0.005[a]	0.0100	0.005[a]	0.005[a]
05/03	2	0.0200	0.0200	0.005[a]	0.005[a]
05/09	4	0.1100	0.0900	0.005[a]	0.0100
05/15	11	0.2600	0.2100	0.0100	0.0400
05/21	12	0.2700	0.2400	0.0100	0.0200
05/27	26	0.2000	0.2500	0.0100	0.005[a]
06/02	35	0.1600	0.3000	0.0100	0.0200
06/08	34	0.0100	0.0900	0.005[a]	0.0100
06/14	39	0.1100	0.1400	0.005[a]	0.0200
06/20	24	0.0400	0.0700	0.005[a]	0.0200
06/26	17	0.0800	0.0800	0.005[a]	0.005[a]
07/02	27	0.8700	0.6200	0.0200	0.0600
07/08	24	0.2000	0.3100	0.0100	0.0200
07/14	32	0.1700	0.2300	0.005[a]	0.0100
07/20	8	0.0400	0.0400	0.005[a]	0.0100
07/26	31	0.1400	0.1600	0.005[a]	0.0200
08/01	41	0.1100	0.1100	0.005[a]	0.0100
08/07	14	0.1100	0.1100	0.005[a]	0.0100
08/13	28	0.1100	0.2900	0.005[a]	0.0100
08/19	1	0.0200	0.005[a]	0.005[a]	0.005[a]
08/25	86	0.4000	0.2900	0.0100	0.005[a]
08/31	37	0.005[a]	0.0200	0.005[a]	0.005[a]
09/06	16	0.0200	0.0100	0.005[a]	0.005[a]

Table G3. Northport PM-10 Data 1996

Sample report date	TSP µg/m³	Pb µg/m³	Zn µg/m³	Cd µg/m³	As µg/m³
09/12	25	0.6200	0.2900	0.0200	0.0400
09/18	2	0.005[a]	0.0100	0.005[a]	0.005[a]
09/24	12	0.3100	0.1300	0.005[a]	0.005[a]
09/30	34	0.1100	0.1400	0.005[a]	0.0400
10/06	16	0.3900	0.3000	0.005[a]	0.0500
10/12	23	0.1900	0.8100	0.005[a]	0.0300
10/18	16	0.2300	0.1400	0.0100	0.0100
10/24	1	0.005[a]	0.005[a]	0.005[a]	0.005[a]
10/30	6	0.0600	0.0900	0.005[a]	0.0300
11/05	6	0.005[a]	0.0200	0.005[a]	0.005[a]
11/11	14	0.8100	0.2700	0.0700	0.0100
11/17	5	0.5900	0.3200	0.0200	0.0400
11/23	10	0.2500	0.6200	0.005[a]	0.0100
11/29	2	0.1400	0.0600	0.0100	0.005[a]
12/05	9	0.5000	0.0900	0.0100	0.0100
12/11	6	0.0200	0.0200	0.005[a]	0.0100
12/17	7	0.3600	0.2500	0.0100	0.005[a]
12/23	11	0.5500	0.3500	0.0400	0.0300
12/29	11	0.5200	0.1700	0.0100	0.0400

Notes:

[a] Reflects non-detect concentrations where detection limits were not provided.

Table G4. Northport PM-10 Data 1997

Sample report date	TSP µg/m³	Pb µg/m³	Zn µg/m³	Cd µg/m³	As µg/m³
01/04	1	0.005[a]	0.005[a]	0.005[a]	0.005[a]
01/10	4	0.005[a]	0.0200	0.005[a]	0.005[a]
01/16	24	0.3600	0.4100	0.0100	0.0400
01/22	4	0.005[a]	0.0200	0.005[a]	0.005[a]
01/28	19	0.9400	0.6900	0.0200	0.0200
02/03	4	0.1600	0.1600	0.0100	0.005[a]
02/09	27	0.4600	0.2000	0.0300	0.0300
02/15	5	0.0700	0.0400	0.0100	0.0100
02/21	9	0.0700	0.0400	0.005[a]	0.0100
02/27	6	0.1600	0.1800	0.005[a]	0.0300
03/05	17	0.4200	0.2000	0.0200	0.0300
03/11	19	0.7500	0.6900	0.0400	0.0200
03/17	15	0.5000	0.1900	0.0100	0.005[a]
03/23	4	0.0400	0.0600	0.006[a]	0.006[a]
03/29	8	0.0300	0.0400	0.005[a]	0.005[a]
04/04	9	0.0500	0.1100	0.005[a]	0.005[a]
04/10	11	0.0200	0.0900	0.005[a]	0.0200
04/16	8	0.2400	0.3000	0.0100	0.0100
04/22	9	0.1000	0.1100	0.005[a]	0.0200
04/28	4	0.0400	0.0600	0.005[a]	0.0100
05/04	9	0.2000	0.3300	0.005[a]	0.005[a]
05/10	21	0.0300	0.0700	0.005[a]	0.005[a]
05/16	29	0.0800	0.0900	0.005[a]	0.0200
05/22	21	0.005[a]	0.0800	0.005[a]	0.0200
05/28	9	0.0200	0.0400	0.005[a]	0.005[a]
06/03	13	0.1900	0.3200	0.005[a]	0.0400
06/09	15	0.0400	0.0500	0.005[a]	0.005[a]
06/15	12	0.0400	0.0700	0.005[a]	0.0100
06/21	9	0.0500	0.2500	0.005[a]	0.005[a]
06/27	NA	NA	NA	NA	NA
07/03	16	0.0600	0.0600	0.005[a]	0.0300
07/09	9	0.005[a]	0.005[a]	0.005[a]	0.005[a]
07/15	23	0.0100	0.0600	0.005[a]	0.005[a]
07/21	4	0.0900	0.1600	0.005[a]	0.005[a]
07/27	21	0.0400	0.0900	0.005[a]	0.005[a]
08/02	29	0.0600	0.7500	0.005[a]	0.0100
08/08	10	0.0300	0.0600	0.005[a]	0.005[a]
08/14	21	0.005[a]	0.0500	0.005[a]	0.005[a]
08/20	NA	NA	NA	NA	NA
08/26	16	0.0700	0.1200	0.005[a]	0.005[a]
09/01	21	0.2200	0.9400	0.005[a]	0.0200

Table G4. Northport PM-10 Data 1997

Sample report date	TSP µg/m³	Pb µg/m³	Zn µg/m³	Cd µg/m³	As µg/m³
09/07	12	0.0800	0.1900	0.005[a]	0.005[a]
09/13	8	0.0700	0.1000	0.005[a]	0.005[a]
09/19	6	0.0200	0.0500	0.005[a]	0.005[a]
09/25	31	0.1200	0.2700	0.005[a]	0.005[a]
10/01	17	0.0700	0.3000	0.005[a]	0.005[a]
10/07	9	0.0600	0.0800	0.005[a]	0.005[a]
10/13	8	0.005[a]	0.005[a]	0.005[a]	0.005[a]
10/19	12	0.0400	0.1100	0.005[a]	0.005[a]
10/25	19	0.0300	0.0600	0.005[a]	0.005[a]
10/31	14	0.0300	0.0700	0.005[a]	0.0100
11/06	13	0.0600	0.1800	0.005[a]	0.0100
11/12	9	0.0700	0.0900	0.005[a]	0.005[a]
11/18	11	0.0300	0.0600	0.005[a]	0.0100
11/24	4	0.0300	0.0200	0.005[a]	0.0300
11/30	6	0.0600	0.0500	0.005[a]	0.005[a]
12/06	15	0.0500	0.1100	0.005[a]	0.005[a]
12/12	2	0.005[a]	0.005[a]	0.005[a]	0.0200
12/18	NA	NA	NA	NA	NA
12/24	4	0.0400	0.0400	0.005[a]	0.0300
12/30	8	0.2600	0.3200	0.0400	0.0400

Notes: NA = Sampling data was not available for this date.
[a] Reflects non-detect concentrations where detection limits were not provided.

Table G5. Northport PM-10 Data 1998

Sample report date	T/Part µg/m³	Pb µg/m³	Zn µg/m³	Cd µg/m³	As µg/m³
01/05	5	0.0300	0.005[a]	0.005[a]	0.005[a]
01/11	31	0.1100	0.2300	0.005[a]	0.0100
01/17	7	0.0500	0.1200	0.005[a]	0.005[a]
01/23	9	0.0600	0.0800	0.005[a]	0.0500
01/29	17	0.0700	0.0900	0.0100	0.005[a]
02/04	7	0.2200	0.1700	0.005[a]	0.0100
02/10	17	0.0600	0.2500	0.005[a]	0.0400
02/16	9	0.0300	0.0800	0.005[a]	0.005[a]
02/22	1	0.0100	0.0600	0.005[a]	0.005[a]
02/28	10	0.1700	0.3600	0.005[a]	0.0400
03/06	10	0.0200	NA	0.005[a]	0.0100
03/12	12	0.0400	0.1200	0.005[a]	0.005[a]
03/18	11	0.0300	0.1200	0.005[a]	0.005[a]
03/24	4	0.0400	0.1000	0.005[a]	0.0100
03/30	9	0.005[a]	0.0200	0.005[a]	0.005[a]
04/05	6	0.005[a]	0.0100	0.005[a]	0.005[a]
04/11	3	0.0500	0.0500	0.005[a]	0.005[a]
04/17	5	0.005[a]	0.0300	0.005[a]	0.005[a]
04/23	27	0.0600	0.1400	0.005[a]	0.0200
04/29	60	0.005[a]	0.0900	0.005[a]	0.0300
05/05	30	0.0300	0.1100	0.005[a]	0.005[a]
05/11	26	0.0200	0.0100	0.005[a]	0.005[a]
05/17	5	0.005[a]	0.0300	0.005[a]	0.005[a]
05/23	12	0.005[a]	0.005[a]	0.005[a]	0.005[a]
05/29	8	0.005[a]	0.0900	0.005[a]	0.005[a]
06/04	14	0.0900	0.0100	0.005[a]	0.005[a]
06/10	22	0.0600	0.1500	0.005[a]	0.0600
06/16	12	0.005[a]	0.0700	0.005[a]	0.005[a]
06/22	29	0.0300	0.1500	0.005[a]	0.005[a]
06/28	6	0.0600	0.005[a]	0.005[a]	0.005[a]
07/04	17	0.005[a]	0.005[a]	0.005[a]	0.0300
07/10	20	0.0600	0.1900	0.005[a]	0.005[a]
07/16	NA	NA	NA	NA	NA
07/22	NA	NA	NA	NA	NA
07/28	28	0.0500	0.0900	0.005[a]	0.005[a]
08/03	22	0.005[a]	0.0400	0.005[a]	0.005[a]
08/09	25	0.0300	0.0400	0.005[a]	0.005[a]
08/15	35	0.0400	0.0300	0.005[a]	0.005[a]
08/21	24	0.0700	0.0900	0.005[a]	0.005[a]
08/27	16	0.005[a]	0.0100	0.005[a]	0.005[a]

Table G5. Northport PM-10 Data 1998

Sample report date	T/Part µg/m³	Pb µg/m³	Zn µg/m³	Cd µg/m³	As µg/m³
09/02	38	0.005[a]	0.0400	0.005[a]	0.005[a]
09/08	36	0.005[a]	0.0300	0.005[a]	0.005[a]
09/14	27	0.1700	0.1600	0.0100	0.0300
09/20	NA	NA	NA	NA	NA
09/26	6	0.0100	0.0400	0.005[a]	0.005[a]
10/02	NA	NA	NA	NA	NA
10/08	NA	NA	NA	NA	NA
10/14	NA	NA	NA	NA	NA
10/20	NA	NA	NA	NA	NA
10/26	NA	NA	NA	NA	NA
11/01	NA	NA	NA	NA	NA
11/07	NA	NA	NA	NA	NA
11/13	NA	NA	NA	NA	NA
11/19	NA	NA	NA	NA	NA
11/25	NA	NA	NA	NA	NA
12/01	NA	NA	NA	NA	NA
12/07	NA	NA	NA	NA	NA
12/13	NA	NA	NA	NA	NA
12/19	NA	NA	NA	NA	NA
12/25	NA	NA	NA	NA	NA
12/31	NA	NA	NA	NA	NA

Notes: NA = Sampling data was not available for this date.

[a] Reflects non-detect concentrations where detection limits were not provided.

Table G6. Northport PM-10 Data 1999

Sample report date	T/Part µg/m³	Pb µg/m³	Zn µg/m³	Cd µg/m³	As µg/m³
01/06	6	0.005[b]	0.019	0.0062	0.0062
01/12	7	0.01[a]	0.043	0.0062	0.0062
01/18	6	0.005[b]	0.006	0.0062	0.0062
01/24	10	0.093	0.105	0.0062	0.0124
01/30	7	0.087	0.149	0.0062	0.0062
02/05	2	0.005[b]	0.01[a]	0.0005[b]	0.0005[b]
02/11	44	0.01[a]	0.037	0.0005[b]	0.0005[b]
02/17	4	0.062	0.056	0.0005[b]	0.0112
02/23	4	0.01[a]	0.025	0.0005[b]	0.0005[b]
03/01	6	0.025	0.025	0.0005[b]	0.001[a]
03/07	7	0.029	0.065	0.001[a]	0.001[a]
03/13	9	0.213	0.341	0.0061	0.0170
03/19	6	0.134	0.213	0.0037	0.0104
03/25	7	0.005[b]	0.005[b]	0.0005[b]	0.0005[b]
03/31	4	0.01[a]	0.037	0.0005[b]	0.0018
04/06	14	0.005[b]	0.018	0.0005[b]	0.0005[b]
04/12	9	0.005[b]	0.01[a]	0.0005[b]	0.0005[b]
04/18	22	0.030	0.030	0.001[a]	0.0037
04/24	16	0.018	0.055	0.0005[b]	0.0005[b]
04/30	11	0.005[b]	0.018	0.0005[b]	0.0005[b]
05/06	13	0.079	0.128	0.0049	0.0030
05/12	9	0.005[b]	0.006	0.0005[b]	0.0005[b]
05/18	4	0.005[b]	0.018	0.0005[b]	0.001[a]
05/24	23	0.061	0.122	0.001[a]	0.0030
05/30	52	0.037	0.085	0.001[a]	0.0030
06/05	18	0.01[a]	0.030	0.0005[b]	0.0030
06/11	5	0.018	0.030	0.0005[b]	0.0030
06/17	21	0.018	0.067	0.0005[b]	0.0030
06/23	9	0.005[b]	0.055	0.0005[b]	0.0030
06/29	6	0.037	0.177	0.0005[b]	0.0049
07/05	12	0.005[b]	0.073	0.0005[b]	0.0030
07/11	45	0.043	0.074	0.001[a]	0.0043
07/17	19	0.018	0.067	0.0005[b]	0.0030
07/23	24	0.005[b]	0.024	0.0005[b]	0.0030
07/29	21	0.005[b]	0.055	0.0005[b]	0.0031
08/04	15	0.030	0.067	0.0005[b]	0.0067
08/10	12	0.049	0.177	0.001[a]	0.0055
08/16	12	0.01[a]	0.049	0.0005[b]	0.0030
08/22	21	0.055	0.134	0.001[a]	0.0152
08/28	24	0.037	0.104	0.0018	0.0183

Table G6. Northport PM-10 Data 1999

Sample report date	T/Part µg/m³	Pb µg/m³	Zn µg/m³	Cd µg/m³	As µg/m³
09/03	29	0.030	0.043	0.0005[b]	0.0067
09/09	30	0.128	0.170	0.0037	0.0189
09/15	19	0.024	0.104	0.001[a]	0.0043
09/21	15	0.049	0.134	0.0018	0.0055
09/27	4	0.005[b]	0.024	0.0005[b]	0.0030
10/03	15	0.005[b]	0.018	0.0018	0.0037
10/09	5	0.005[b]	0.018	0.0005[b]	0.0030
10/15	9	0.005[b]	0.030	0.0005[b]	0.0030
10/21	26	0.122	0.170	0.0037	0.0322
10/27	10	0.261	0.188	0.0322	0.0176
11/02	13	0.067	0.128	0.001[a]	0.0189
11/08	13	0.030	0.055	0.0005[b]	0.0067
11/14	17	0.146	0.365	0.0037	0.0462
11/20	9	0.020	0.050	0.0010	0.0005[b]
11/26	46	0.005[b]	0.006	0.0005[b]	0.0031
12/02	6	0.005[b]	0.01[a]	0.0005[b]	0.0031
12/08	10	0.031	0.080	0.0018	0.0221
12/14	8	0.01[a]	0.037	0.001[a]	0.0098
12/20	14	0.018	0.055	0.0005[b]	0.0043
12/26	4	0.018	0.037	0.0005[b]	0.0031

Notes:

[a] Concentration detected at the method detection limit.

[b] Result reported was less than the method detection limit; concentration represents 1/2 the method detection limit.

Table G7. Northport PM-10 Data 2000

Sample report date	T/Part µg/m³	Pb µg/m³	Zn µg/m³	Cd µg/m³	As µg/m³
01/01	8.614	0.003	0.01	0.001[a]	0.04
01/07	8.614	0.003	0.01	0.001[a]	0.01
01/13	9.844	0.042	0.15	0.002	0.1
01/19	22.685	0.007	0.04	0.002	0.13
01/25	6.153	0.029	0.06	0.002	0.14
01/31	7.993	0.018	0.03	0.001	0.12
02/06	9.844	0.019	0.05	0.006	0.14
02/12	47.99	0.004	0.05	0.002	0.11
02/18	31.356	0.003	0.02	0.001[a]	0.07
02/24	3.076	0.003	0.01[a]	0.001[a]	0.01[a]
03/01	4.922	0.003	0.01[a]	0.001[a]	0.01
03/07	11.69	0.003	0.03	0.001[a]	0.09
03/13	7.383	0.003	0.01[a]	0.001[a]	0.01[a]
03/19	1.846	0.003	0.01[a]	0.001[a]	0.01[a]
03/25	6.153	0.003	0.02	0.001[a]	0.07
03/31	11.113	0.003	0.02	0.001[a]	0.02
04/06	8.62	0.003	0.01[a]	0.001[a]	0.02
04/18	11.698	0.004	0.09	0.006	0.15
04/24	3.078	0.003	0.01[a]	0.001[a]	0.03
04/30	11.698	0.003	0.01	0.001[a]	0.05
05/06	3.049	0.003	0.01[a]	0.001[a]	0.02
05/12	3.536	0.003	0.01[a]	0.001[a]	0.03
05/18	21.097	0.003	0.01[a]	0.001[a]	0.02
05/24	12.186	0.003	0.01[a]	0.001[a]	0.02
05/30	5.244	0.003	0.06	0.002	0.15
06/05	19.511	0.007	0.11	0.01	0.22
06/11	2.498	0.003	0.01[a]	0.001[a]	0.02
06/17	18.036	0.003	0.02	0.001[a]	0.04
06/23	24.86	0.003	0.02	0.001[a]	0.03
06/29	21.95	0.003	0.03	0.001[a]	0.05
07/05	6.398	0.003	0.01[a]	0.001[a]	0.02
07/11	9.268	0.003	0.01	0.001[a]	0.04
07/17	20.96	0.003	0.02	0.001[a]	0.04
07/23	22.56	0.003	0.01[a]	0.001[a]	0.02
07/29	14.817	0.003	0.02	0.001[a]	0.05
08/04	29.206	0.003	0.05	0.001	0.07
08/10	35.377	0.003	0.01	0.001[a]	0.04
08/16	23.686	0.003	0.03	0.001	0.06
08/22	18.34	0.003	0.02	0.001[a]	0.05
08/28	12.613	0.003	0.01	0.001[a]	0.02
09/03	9.932	0.003	0.02	0.001[a]	0.01
09/09	3.775	0.003	0.01[a]	0.001[a]	0.01[a]
09/15	18.584	0.003	0.04	0.002	0.15
09/21	0.244	0.003	0.01	0.001[a]	0.02
09/27	21.377	0.003	0.02	0.001[a]	0.05

Table G7. Northport PM-10 Data 2000

Sample report date	T/Part µg/m³	Pb µg/m³	Zn µg/m³	Cd µg/m³	As µg/m³
10/03	5.788	0.003	0.03	0.001	0.03
10/09	20.969	0.004	0.06	0.002	0.1
10/15	2.035	0.003	0.01[a]	0.001[a]	0.02
10/21	2.072	0.003	0.01[a]	0.001[a]	0.02
10/27	11.447	0.004	0.04	0.001	0.05
11/02	12.491	0.001	0.01	0.001[a]	0.01
11/08	14.674	0.005	0.05	0.001	0.1
11/14	17.475	0.002	0.02	0.001[a]	0.04
11/20	21.433	0.001	0.02	0.001[a]	0.02
11/26	2.86	0.001[a]	0.01[a]	0.001[a]	0.01[a]
12/02	2.801	0.001[a]	0.01[a]	0.001[a]	0.01[a]
12/08	7.064	0.001[a]	0.01	0.001	0.01
12/14	25.948	0.002	0.02	0.001[a]	0.04
12/20	5.294	0.005	0.02	0.001[a]	0.04

Notes:

[a] Reflects non-detect concentrations where detection limits were not provided.

Table G8. Northport PM-10 Data 2001

Sample report date	T/Part µg/m³	Pb µg/m³	Zn µg/m³	Cd µg/m³	As µg/m³
01/01	0.001[a]	0.002	0.02	0.001[a]	0.04
01/07	12.839	0.005	0.04	0.001[a]	0.06
01/13	8.579	0.015	0.1	0.006	0.1
01/19	0.73	0.001[a]	0.01[a]	0.001[a]	0.01
01/25	8.759	0.009	0.05	0.002	0.12
01/31	2.554	0.001[a]	0.01[a]	0.001[a]	0.01[a]
02/06	6.993	0.001[a]	0.01[a]	0.001[a]	0.01[a]
02/12	12.645	0.004	0.01[a]	0.001[a]	0.04
02/18	7.601	0.005	0.02	0.001[a]	0.08
02/24	4.259	0.001	0.01	0.001[a]	0.01
03/02	6.997	0.002	0.01	0.001[a]	0.02
03/08	6.146	0.002	0.02	0.001[a]	0.05
03/14	1.643	0.001[a]	0.01[a]	0.001[a]	0.01
03/20	1.886	0.001[a]	0.01[a]	0.001[a]	0.01[a]
03/26	0.001[a]	0.001[a]	0.01[a]	0.001[a]	0.01[a]
04/01	1.521	0.001[a]	0.01[a]	0.001[a]	0.01[a]
04/07	3.831	0.002	0.01	0.001[a]	0.01
04/13	0.061	0.001[a]	0.01[a]	0.001[a]	0.01[a]
04/19	10.607	0.001	0.01	0.001[a]	0.01
04/25	25.79	0.001[a]	0.03	0.001[a]	0.01
05/01	1.581	0.001[a]	0.01[a]	0.001[a]	0.01[a]
05/07	16.788	0.001[a]	0.01[a]	0.001[a]	0.02
05/13	19.228	0.002	0.01	0.001[a]	0.03
05/19	16.003	0.001[a]	0.01[a]	0.001[a]	0.01[a]
05/25	41.924	0.002	0.01	0.001[a]	0.02
05/31	17.755	0.001	0.01	0.001[a]	0.02
06/06	3.651	0.001[a]	0.01[a]	0.001[a]	0.01[a]
06/12	3.953	0.002	0.01[a]	0.001[a]	0.01
06/18	6.327	0.001[a]	0.01[a]	0.001[a]	0.01[a]
06/24	25.173	0.001[a]	0.01[a]	0.001[a]	0.01[a]
06/30	251.125	0.004	0.14	0.001[a]	0.07
07/06	37.667	0.002	0.01[a]	0.001[a]	0.01
07/12	22.142	0.001[a]	0.01[a]	0.001[a]	0.01[a]
07/18	9.121	0.001[a]	0.01[a]	0.001[a]	0.01[a]
07/24	7.545	0.001[a]	0.01[a]	0.001[a]	0.01[a]
07/30	10.767	0.001[a]	0.01[a]	0.001[a]	0.01[a]
08/05	18.19	0.001[a]	0.01[a]	0.001[a]	0.01[a]
08/11	24.887	0.001[a]	0.01[a]	0.001[a]	0.01
08/17	54.884	0.001	0.04	0.001[a]	0.04
08/23	5.902	0.001[a]	0.01[a]	0.001[a]	0.01[a]
08/29	11.956	0.001[a]	0.01[a]	0.001[a]	0.01[a]
09/04	9.127	0.001[a]	0.01[a]	0.001[a]	0.01[a]
09/10	16.49	0.001[a]	0.01[a]	0.001[a]	0.01[a]
09/16	21.966	0.001[a]	0.01[a]	0.001[a]	0.01

Table G8. Northport PM-10 Data 2001

Sample report date	T/Part µg/m³	Pb µg/m³	Zn µg/m³	Cd µg/m³	As µg/m³
09/22	20.384	0.001[a]	0.01[a]	0.001[a]	0.01
09/28	6.753	0.001	0.03	0.001	0.07
10/04	17.512	0.001[a]	0.01	0.001	0.04
10/10	4.258	0.001[a]	0.01[a]	0.001[a]	0.01[a]
10/16	17.578	0.001[a]	0.01	0.001[a]	0.03
10/22	3.403	0.001[a]	0.01[a]	0.001[a]	0.01[a]
10/28	6.567	0.002	0.01[a]	0.001[a]	0.01
11/03	14.776	0.01	0.04	0.001	0.06
11/15	8.737	0.001	0.01[a]	0.001[a]	0.02
11/21	3.709	0.001[a]	0.01[a]	0.001[a]	0.01
11/27	2.921	0.001[a]	0.01[a]	0.001[a]	0.01[a]
12/09	4.868	0.001[a]	0.01[a]	0.001[a]	0.01
12/15	3.223	0.001[a]	0.01[a]	0.001[a]	0.01[a]
12/21	5.11	0.016	0.04	0.003	0.05
12/27	17.646	0.002	0.03	0.001[a]	0.07

Notes:

[a] Reflects non-detect concentrations where detection limits were not provided.

Table G9. Northport PM-10 Data 2002

Sample report date	T/Part µg/m³	Pb µg/m³	Zn µg/m³	Cd µg/m³	As µg/m³
01/02	8.945	0.0020	0.0400	0.0010	0.1100
01/08	2.677	0.001[a]	0.01[a]	0.001[a]	0.01[a]
01/14	12.965	0.0040	0.0100	0.001[a]	0.0500
01/20	6.755	0.0020	0.01[a]	0.001[a]	0.0100
01/26	14.958	0.001[a]	0.0100	0.001[a]	0.0100
02/01	14.908	0.0100	0.0400	0.0020	0.0800
02/07	4.198	0.0030	0.0200	0.001[a]	0.0400
02/13	25.269	0.0010	0.0200	0.001[a]	0.0400
02/19	6.572	0.0010	0.01[a]	0.001[a]	0.0200
02/25	13.684	0.001[a]	0.0200	0.001[a]	0.0400
03/03	6.933	0.001[a]	0.01[a]	0.001[a]	0.0200
03/09	13.203	0.0020	0.0200	0.0010	0.0500
03/15	1.277	0.001[a]	0.01[a]	0.001[a]	0.01[a]
03/21	10.823	0.0020	0.0500	0.0010	0.0700
03/27	0.851	0.001[a]	0.01[a]	0.001[a]	0.01[a]
04/02	7.601	0.001[a]	0.01[a]	0.001[a]	0.0200
04/08	10.222	0.001[a]	0.01[a]	0.001[a]	0.0200
04/14	5.537	0.001[a]	0.01[a]	0.001[a]	0.0100
04/20	11.439	0.001[a]	0.0200	0.001[a]	0.0200
04/26	13.063	0.0010	0.0200	0.001[a]	0.0500
05/02	15.398	0.001[a]	0.01[a]	0.001[a]	0.0100
05/08	0.122	0.001[a]	0.01[a]	0.001[a]	0.01[a]
05/14	6.936	0.001[a]	0.01[a]	0.001[a]	0.0200
05/20	6.267	0.001[a]	0.01[a]	0.001[a]	0.0300
05/26	16.429	0.0010	0.01[a]	0.001[a]	0.0300
06/01	14.406	0.0010	0.0200	0.001[a]	0.0700
06/07	14.289	0.001[a]	0.01[a]	0.001[a]	0.0200
06/13	33.829	0.0030	0.0100	0.001[a]	0.0700
06/19	8.087	0.001[a]	0.01[a]	0.001[a]	0.0100
06/25	18.31	0.0010	0.0100	0.001[a]	0.0300
07/01	10.585	0.0010	0.01[a]	0.001[a]	0.0200
07/07	18.974	0.0040	0.0300	0.0020	0.1000
07/13	39.341	0.0050	0.0700	0.0040	0.2400
07/19	27.929	0.001[a]	0.01[a]	0.001[a]	0.01[a]
07/25	33.109	0.0170	0.4500	0.0190	1.9900
08/06	9.661	0.001[a]	0.01[a]	0.001[a]	0.01[a]
08/18	20.248	0.001[a]	0.01[a]	0.001[a]	0.0200
08/30	15.981	0.0010	0.0200	0.0010	0.0900
09/05	23.061	0.001[a]	0.01[a]	0.001[a]	0.0200
09/11	34.987	0.0010	0.0300	0.001[a]	0.0500
09/17	4.688	0.0010	0.0300	0.0020	0.0200
09/23	19.775	0.0010	0.0200	0.0010	0.0400
09/29	10.412	0.001[a]	0.01[a]	0.001[a]	0.01[a]
10/05	9.431	0.001[a]	0.01[a]	0.001[a]	0.0100

Table G9. Northport PM-10 Data 2002

Sample report date	T/Part µg/m³	Pb µg/m³	Zn µg/m³	Cd µg/m³	As µg/m³
10/11	55.55	0.001[a]	0.01[a]	0.001[a]	0.0100
10/17	28.486	0.0020	0.01[a]	0.001[a]	0.0200
10/23	10.423	0.0010	0.0200	0.001[a]	0.0300
10/29	5.537	0.001[a]	0.01[a]	0.001[a]	0.01[a]
11/04	30.099	0.0040	0.0200	0.0010	0.0400
11/10	9.303	0.001[a]	0.01[a]	0.001[a]	0.01[a]
11/16	27.362	0.0020	0.0300	0.0020	0.0600
11/22	15.942	0.0020	0.0200	0.0010	0.0300
11/28	13.012	0.0020	0.0200	0.001[a]	0.0300
12/04	18.802	0.0020	0.0200	0.001[a]	0.0500
12/10	9.364	0.0020	0.0100	0.0010	0.0500
12/16	6.506	0.0100	0.0400	0.0020	0.0600
12/22	14.109	0.0070	0.0800	0.0030	0.1300
12/28	9.545	0.0070	0.0700	0.0020	0.0500

Notes:
[a] Reflects non-detect concentrations where detection limits were not provided.

Table G10. Northport PM-10 Data 2003

Sample report date	T/Part µg/m³	T/As µg/m³	T/Pb µg/m³	T/Cd µg/m³	T/Zn µg/m³
01/03	3.162	0.0040	0.01[a]	0.001[a]	0.0200
01/09	10.831	0.0020	0.0200	0.0010	0.0300
01/15	5.089	0.0010	0.0100	0.001[a]	0.0300
01/21	8.278	0.0020	0.0200	0.001[a]	0.0300
01/27	2.575	0.001[a]	0.01[a]	0.001[a]	0.01[a]
02/02	6.147	0.0010	0.01[a]	0.001[a]	0.0200
02/08	13.386	0.0010	0.0200	0.001[a]	0.0400
02/14	22.379	0.0080	0.0300	0.0010	0.1700
02/26	26.364	0.0020	0.0100	0.001[a]	0.0300
03/04	10.402	0.001[a]	0.01[a]	0.001[a]	0.01[a]
03/10	12.592	0.0050	0.0200	0.001[a]	0.0600
03/16	1.042	0.001[a]	0.01[a]	0.001[a]	0.0100
03/22	1.217	0.0010	0.01[a]	0.001[a]	0.01[a]
03/28	3.831	0.0010	0.0100	0.001[a]	0.0400
04/03	1.471	0.001[a]	0.01[a]	0.001[a]	0.0200
04/09	9.319	0.0020	0.0200	0.0010	0.0600
04/15	2.085	0.001[a]	0.01[a]	0.001[a]	0.01[a]
04/21	11.588	0.0010	0.0200	0.0010	0.0800
04/27	1.521	0.001[a]	0.01[a]	0.001[a]	0.01[a]
05/03	9.258	0.0010	0.0200	0.0010	0.0600
05/09	12.232	0.0060	0.0400	0.0040	0.0800
05/15	7.242	0.001[a]	0.01[a]	0.001[a]	0.01[a]
05/21	10.852	0.001[a]	0.0100	0.001[a]	0.0700
05/27	30.656	0.0020	0.0200	0.001[a]	0.0500
06/02	6.146	0.001[a]	0.01[a]	0.001[a]	0.01[a]
06/08	20.517	0.0010	0.0200	0.001[a]	0.0300
06/14	16.738	0.001[a]	0.01[a]	0.001[a]	0.0100
06/20	17.831	0.001[a]	0.01[a]	0.001[a]	0.01[a]
06/26	19.865	0.001[a]	0.01[a]	0.001[a]	0.0200
07/02	26.977	0.001[a]	0.01[a]	0.001[a]	0.01[a]
07/08	23.605	0.001[a]	0.01[a]	0.001[a]	0.0200
07/14	19.497	0.001[a]	0.01[a]	0.001[a]	0.0200
07/20	57.983	0.001[a]	0.01[a]	0.001[a]	0.0100
07/26	55.733	0.0010	0.0100	0.001[a]	0.0300
08/01	29.552	0.001[a]	0.01[a]	0.001[a]	0.0100
08/07	11.711	0.001[a]	0.01[a]	0.001[a]	0.0200
08/13	44.906	0.0010	0.0100	0.0010	0.0300
08/19	57.458	0.001[a]	0.0200	0.001[a]	0.0200
08/25	19.804	0.001[a]	0.0200	0.001[a]	0.0500
08/31	92.275	0.0010	0.01[a]	0.001[a]	0.0200
09/06	40.773	0.001[a]	0.01[a]	0.001[a]	0.0200
08/01	29.347	0.001[a]	0.0100	0.001[a]	0.0100
08/07	11.634	0.0010	0.0100	0.001[a]	0.0200
08/13	44.909	0.0010	0.0100	0.0010	0.0300

Table G10. Northport PM-10 Data 2003

Sample report date	T/Part µg/m³	T/As µg/m³	T/Pb µg/m³	T/Cd µg/m³	T/Zn µg/m³
08/19	57.462	0.0010	0.0200	0.001[a]	0.0200
08/25	19.679	0.0010	0.0200	0.001[a]	0.0500
08/31	91.695	0.0010	0.0100	0.001[a]	0.0200
09/06	40.477	0.001[a]	0.0100	0.001[a]	0.0200
09/12	10.168	0.001[a]	0.01[a]	0.001[a]	0.0100
10/18	14.55	0.0060	0.0300	0.0020	0.1000
10/24	4.992	0.001[a]	0.01[a]	0.001[a]	0.0100
10/30	2.921	0.001[a]	0.01[a]	0.001[a]	0.01[a]
11/05	37.408	0.0020	0.0100	0.001[a]	0.0300
11/11	3.409	0.001[a]	0.01[a]	0.001[a]	0.0100
11/17	6.635	0.001[a]	0.01[a]	0.001[a]	0.01[a]
11/23	20.572	0.0100	0.0500	0.0010	0.1000
11/29	5.355	0.0010	0.01[a]	0.001[a]	0.0100
12/05	12.841	0.0070	0.0600	0.0020	0.1000
12/11	18.333	0.0070	0.1500	0.0070	0.4700
12/17	2.681	0.001[a]	0.01[a]	0.001[a]	0.0200
12/23	5.482	0.0020	0.0300	0.001[a]	0.0600
12/29	3.897	0.001[a]	0.0100	0.001[a]	0.0300

Notes:

[a] Reflects non-detect concentrations where detection limits were not provided.

Table G11. Northport PM-10 Data 2004

Sample report date	T/Part µg/m³	T/As µg/m³	T/Pb µg/m³	T/Cd µg/m³	T/Zn µg/m³
01/04	1.34	0.002	0.01[a]	0.001[a]	0.02
01/10	16.323	0.006	0.04	0.001[a]	0.14
01/16	3.715	0.001	0.01	0.001[a]	0.03
01/28	13.945	0.007	0.05	0.002	0.12
02/03	30.27	0.013	0.26	0.013	0.33
02/15	7.491	0.005	0.01	0.001[a]	0.02
02/21	7.184	0.007	0.06	0.001	0.11
03/16	6.388	0.001[a]	0.01	0.001[a]	0.01
03/22	15.945	0.001	0.03	0.001	0.05
03/28	0.974	0.001[a]	0.01	0.001[a]	0.01
04/03	11.692	0.004	0.02	0.001	0.06
04/09	12.354	0.001	0.01	0.001[a]	0.03
04/21	0.182	0.001[a]	0.01	0.001[a]	0.03
04/27	12.29	0.001[a]	0.01	0.001[a]	0.02
05/03	33.328	0.001	0.01	0.001[a]	0.02
05/09	31.441	0.001	0.02	0.001[a]	0.02
05/15	9.736	0.002	0.01	0.001[a]	0.03
05/21	6.267	0.001	0.01[a]	0.001[a]	0.01
05/27	5.299	0.001[a]	0.01[a]	0.001[a]	0.01
06/02	9.865	0.002	0.02	0.001	0.04
06/08	8.953	0.003	0.01	0.001	0.04
06/14	5.297	0.001	0.01	0.001[a]	0.01
06/20	41.204	0.001	0.01	0.001[a]	0.01
07/02	67.578	0.004	0.03	0.001	0.04
07/08	3.226	0.001	0.01	0.001[a]	0.03
07/14	20.455	0.004	0.02	0.001	0.04
07/26	54.515	0.001[a]	0.01[a]	0.001[a]	0.01
08/01	42.364	0.001[a]	0.01	0.001[a]	0.01
08/07	4.564	0.001	0.01	0.001[a]	0.01
08/13	19.421	0.002	0.02	0.001	0.06
08/19	14.551	0.001	0.01[a]	0.001[a]	0.01
08/25	4.987	0.001[a]	0.01[a]	0.001[a]	0.01
08/31	16.604	0.002	0.02	0.001[a]	0.03
09/06	22.139	0.002	0.01	0.001[a]	0.05
09/12	10.583	0.001	0.01	0.001	0.01
09/18	6.444	0.03	0.01	0.001[a]	0.02
09/24	23.653	0.004	0.02	0.001	0.05
09/30	18.665	0.001	0.01	0.001[a]	0.02
10/06	19.651	0.001[a]	0.01	0.002	0.01
10/12	18.42	0.002	0.02	0.001	0.03
10/18	6.325	0.004	0.01	0.001[a]	0.01
10/24	4.562	0.001[a]	0.01[a]	0.001[a]	0.01[a]
10/30	4.378	0.001[a]	0.01	0.001[a]	0.01
11/05	14.298	0.001	0.01	0.001	0.02
11/11	5.294	0.002	0.03	0.004	0.04

Table G11. Northport PM-10 Data 2004

Sample report date	T/Part µg/m³	T/As µg/m³	T/Pb µg/m³	T/Cd µg/m³	T/Zn µg/m³
11/18	6.998	0.0005	0.005	0.0005	0.01
11/23	10.71	0.001	0.02	0.001	0.03
11/29	6.085	0.001	0.01	0.001[a]	0.03
12/05	3.47	0.001[a]	0.01	0.001[a]	0.01
12/11	2.739	0.001[a]	0.01[a]	0.001[a]	0.01
12/17	3.226	0.001	0.01[a]	0.001[a]	0.01
12/23	11.679	0.002	0.01	0.001[a]	0.01
12/29	6.085	0.003	0.03	0.001	0.03

Notes:

[a] Reflects non-detect concentrations where detection limits were not provided.

Table G12. Northport PM-10 Data 2005

Sample report date	T/Part µg/m³	T/As µg/m³	T/Pb µg/m³	T/Cd µg/m³	T/Zn µg/m³
01/04	6.018	0.003	0.02	0.001	0.07
01/16	8.333	0.009	0.02	0.001	0.05
01/28	13.807	0.018	0.03	0.002	0.07
02/03	11.438	0.001	0.01	0.001[a]	0.04
02/09	10.634	0.004	0.02	0.001	0.04
02/15	10.095	0.002	0.02	0.001	0.03
02/21	11.732	0.004	0.02	0.001	0.04
02/27	11.608	0.01	0.07	0.018	0.09
03/05	8.151	0.001	0.01	0.001[a]	0.01
03/12	8.518	0.002	0.01	0.002	0.02
03/17	3.222	0.005	0.06	0.002	0.03
03/23	3.465	0.001[a]	0.01[a]	0.001[a]	0.01
03/30	29.162	0.018	0.18	0.018	2.37
04/10	8.205	0.001	0.01	0.001[a]	0.04
04/16	7.658	0.004	0.02	0.002	0.08
04/22	15.073	0.001[a]	0.01	0.001	0.04
04/29	9.117	0.005	0.005	0.001[a]	0.01
05/04	11.852	0.007	0.03	0.001	0.07
05/10	18.736	0.004	0.02	0.001[a]	0.04
05/16	6.871	0.001[a]	0.01[a]	0.001[a]	0.01
05/22	2.431	0.001[a]	0.01[a]	0.001[a]	0.01
06/09	5.653	0.001[a]	0.01[a]	0.001[a]	0.01[a]
06/15	4.99	0.001	0.01[a]	0.001[a]	0.01
06/21	20.059	0.004	0.02	0.001	0.07
06/27	10.511	0.003	0.01	0.001	0.03
07/03	29.539	0.003	0.02	0.001[a]	0.03
07/09	5.107	0.001[a]	0.01[a]	0.001[a]	0.01
07/15	18.523	0.002	0.01	0.001[a]	0.04
10/19	14.475	0.005	0.07	0.003	0.04
10/25	21.783	0.005	0.09	0.007	0.14
10/31	6.262	0.001	0.01	0.001[a]	0.02
11/12	2.98	0.001[a]	0.01[a]	0.001[a]	0.01
11/24	6.139	0.001	0.01	0.001[a]	0.02
11/30	4.376	0.001[a]	0.01	0.001[a]	0.01
12/12	13.014	0.003	0.02	0.001	0.04
12/18	6.322	0.002	0.01	0.001[a]	0.04
12/24	5.656	0.012	0.02	0.001	0.04
12/30	8.639	0.013	0.03	0.001	0.05

Notes:
[a] Reflects non-detect concentrations where detection limits were not provided.

Table G13. Northport PM-10 Data 2006

Sample report date	T/Part µg/m³	T/As µg/m³	T/Pb µg/m³	T/Cd µg/m³	T/Zn µg/m³
01/05	6.995	0.002	0.03	0.001	0.11
01/11	1.095	0.001[a]	0.01[a]	0.001[a]	0.01
01/17	10.584	0.005	0.02	0.001	0.03
01/23	4.622	0.001[a]	0.01[a]	0.001[a]	0.01[a]
01/29	1.885	0.001[a]	0.01[a]	0.001[a]	0.01[a]
02/04	7.785	0.005	0.02	0.001	0.04
02/10	14.642	0.004	0.04	0.001	0.08
02/16	20.761	0.001	0.01	0.001	0.03
02/22	17.076	0.001	0.01	0.001	0.04
02/28	6.325	0.004	0.03	0.001	0.05
03/06	10.035	0.01	0.06	0.002	0.08
03/12	10.469	0.002	0.02	0.001	0.04
03/18	1.459	0.001[a]	0.01[a]	0.001[a]	0.01[a]
03/24	11.739	0.002	0.02	0.002	0.08
03/30	11.364	0.001	0.01	0.001[a]	0.03
04/05	9.723	0.004	0.04	0.002	0.09
04/11	4.621	0.002	0.01	0.001[a]	0.01
04/17	4.559	0.001	0.01	0.001[a]	0.02
04/23	14.891	0.001	0.02	0.001[a]	0.02
04/29	8.448	0.001	0.01	0.001[a]	0.02
05/05	45.944	0.001	0.02	0.002	0.02
05/11	14.832	0.006	0.03	0.001	0.07
05/17	48.749	0.002	0.03	0.001	0.05
05/23	18.839	0.004	0.01	0.001[a]	0.01
05/29	6.321	0.001[a]	0.01[a]	0.001[a]	0.01[a]
06/04	12.397	0.004	0.01	0.001[a]	0.03
06/10	16.048	0.007	0.02	0.001	0.09
06/16	7.169	0.001	0.01	0.001[a]	0.01
06/22	21.078	0.001	0.01	0.001[a]	0.03
06/28	25.213	0.001[a]	0.01[a]	0.001[a]	0.01
07/04	53.536	0.005	0.02	0.001[a]	0.03
07/16	24.67	0.001	0.01	0.001[a]	0.01
07/22	44.366	0.002	0.02	0.001	0.04
07/28	98.315	0.002	0.03	0.001	0.03
08/03	30.748	0.001	0.02	0.001[a]	0.03
08/09	23.456	0.001	0.01	0.001[a]	0.01
08/15	21.202	0.001	0.01	0.001[a]	0.02

Notes:

[a] Reflects non-detect concentrations where detection limits were not provided.

Table G1. Northport PM-10 Data 1994

Sample report date	TSP µg/m³	Pb µg/m³	Zn µg/m³	Cd µg/m³	As µg/m³
01/02	3	0.0060[a]	0.0310	0.0060[a]	0.0050[a]
01/08	13	0.0060[a]	0.2600	0.0060[a]	0.0060[a]
01/14	4	0.0060[a]	0.1100	0.0050[a]	0.0060[a]
01/20	21	0.5700	0.2700	0.0100	0.060
01/26	9	0.2200	0.0100	0.0080[a]	0.020
02/01	17	0.1200	0.0800	0.0060[a]	0.050
02/07	9	0.0400	0.0500	0.0050[a]	0.0050[a]
02/13	7	0.0200	0.0200	0.0060[a]	0.0060[a]
02/19	6	0.0060[a]	0.0800	0.0060[a]	0.0060[a]
02/25	NA	NA	NA	NA	NA
03/03	NA	NA	NA	NA	NA
03/09	24	0.2900	0.3200	0.0100	0.070
03/15	11	0.0700	0.1000	0.0100	0.0050[a]
03/21	6	0.1500	0.0800	0.0100	0.020
03/27	12	0.1100	0.1300	0.0050[a]	0.040
04/02	19	0.2200	0.1600	0.0100	0.050
04/08	10	0.3300	0.4500	0.0200	0.150
04/14	6	0.0700	0.0400	0.0060[a]	0.012
04/20	17	0.1300	0.1400	0.0100	0.010
04/26	6	0.0900	0.0800	0.0060[a]	0.020
05/02	5	0.0800	0.0400	0.0100	0.010
05/08	NA	NA	NA	NA	NA
05/14	NA	NA	NA	NA	NA
05/20	NA	NA	NA	NA	NA
05/26	35	0.3400	0.5200	0.0200	0.030
06/01	9	0.0200	0.0050[a]	0.0050[a]	0.0050[a]
06/07	5	0.2200	0.0300	0.0200	0.0050[a]
06/13	9	0.0400	0.0500	0.0050[a]	0.0050[a]
06/19	9	0.0600	0.1000	0.0050[a]	0.040
06/25	24	0.0500	0.1100	0.0050[a]	0.030
07/01	30	0.0100	0.0500	0.0050[a]	0.0050[a]
07/07	22	0.0500	0.0700	0.0050[a]	0.0050[a]
07/13	16	0.0400	0.1200	0.0050[a]	0.010
07/19	21	0.1400	0.1700	0.0100	0.0050[a]
07/25	66	0.1900	0.2400	0.0200	0.010
07/31	96	0.0200	0.0600	0.0050[a]	0.0050[a]
08/06	54	0.0050[a]	0.0400	0.0050[a]	0.010
08/12	34	0.2100	0.1900	0.0100	0.030
08/18	26	0.1500	0.2900	0.0100	0.020
08/24	30	0.1600	0.1500	0.0050[a]	0.020
08/30	16	0.1100	0.2100	0.0100	0.020
09/05	16	0.5600	0.4500	0.0400	0.020

Table G1. Northport PM-10 Data 1994

Sample report date	TSP µg/m³	Pb µg/m³	Zn µg/m³	Cd µg/m³	As µg/m³
09/11	9	0.1600	0.1100	0.0100	0.010
09/17	NA	NA	NA	NA	NA
09/23	NA	NA	NA	NA	NA
09/29	42	0.3400	0.3900	0.0100	0.020
10/05	23	0.1300	0.1300	0.0100	0.020
10/11	17	0.2600	0.1200	0.0100	0.010
10/17	12	0.2000	0.2000	0.0200	0.020
10/23	6	0.1000	0.0700	0.0050[a]	0.010
10/29	4	0.0400	0.0200	0.0050[a]	0.0050[a]
11/04	7	0.0200	0.0200	0.0060[a]	0.010
11/10	17	0.2700	0.2000	0.0400	0.050
11/16	6	0.0100	0.1000	0.0100	0.020
11/22	NA	NA	NA	NA	NA
11/28	10	0.0060[a]	0.9300	0.0060[a]	0.020
12/04	4	0.1900	0.1000	0.0100	0.020
12/10	24	0.8100	1.8700	0.0500	0.180
12/16	17	0.6800	0.3900	0.0050[a]	0.190
12/22	15	0.2500	0.5700	0.0060[a]	0.030
12/28	9	0.1800	0.4200	0.0100	0.160

Notes: NA = Sampling data was not available for this date.

[a] Reflects non-detect concentrations where detection limits were not provided.

Table G10. Northport PM-10 Data 2003

Sample report date	T/Part µg/m³	T/As µg/m³	T/Pb µg/m³	T/Cd µg/m³	T/Zn µg/m³
01/03	3.162	0.0040	0.01[a]	0.001[a]	0.0200
01/09	10.831	0.0020	0.0200	0.0010	0.0300
01/15	5.089	0.0010	0.0100	0.001[a]	0.0300
01/21	8.278	0.0020	0.0200	0.001[a]	0.0300
01/27	2.575	0.001[a]	0.01[a]	0.001[a]	0.01[a]
02/02	6.147	0.0010	0.01[a]	0.001[a]	0.0200
02/08	13.386	0.0010	0.0200	0.001[a]	0.0400
02/14	22.379	0.0080	0.0300	0.0010	0.1700
02/26	26.364	0.0020	0.0100	0.001[a]	0.0300
03/04	10.402	0.001[a]	0.01[a]	0.001[a]	0.01[a]
03/10	12.592	0.0050	0.0200	0.001[a]	0.0600
03/16	1.042	0.001[a]	0.01[a]	0.001[a]	0.0100
03/22	1.217	0.0010	0.01[a]	0.001[a]	0.01[a]
03/28	3.831	0.0010	0.0100	0.001[a]	0.0400
04/03	1.471	0.001[a]	0.01[a]	0.001[a]	0.0200
04/09	9.319	0.0020	0.0200	0.0010	0.0600
04/15	2.085	0.001[a]	0.01[a]	0.001[a]	0.01[a]
04/21	11.588	0.0010	0.0200	0.0010	0.0800
04/27	1.521	0.001[a]	0.01[a]	0.001[a]	0.01[a]
05/03	9.258	0.0010	0.0200	0.0010	0.0600
05/09	12.232	0.0060	0.0400	0.0040	0.0800
05/15	7.242	0.001[a]	0.01[a]	0.001[a]	0.01[a]
05/21	10.852	0.001[a]	0.0100	0.001[a]	0.0700
05/27	30.656	0.0020	0.0200	0.001[a]	0.0500
06/02	6.146	0.001[a]	0.01[a]	0.001[a]	0.01[a]
06/08	20.517	0.0010	0.0200	0.001[a]	0.0300
06/14	16.738	0.001[a]	0.01[a]	0.001[a]	0.0100
06/20	17.831	0.001[a]	0.01[a]	0.001[a]	0.01[a]
06/26	19.865	0.001[a]	0.01[a]	0.001[a]	0.0200
07/02	26.977	0.001[a]	0.01[a]	0.001[a]	0.01[a]
07/08	23.605	0.001[a]	0.01[a]	0.001[a]	0.0200
07/14	19.497	0.001[a]	0.01[a]	0.001[a]	0.0200
07/20	57.983	0.001[a]	0.01[a]	0.001[a]	0.0100
07/26	55.733	0.0010	0.0100	0.001[a]	0.0300
08/01	29.552	0.001[a]	0.01[a]	0.001[a]	0.0100
08/07	11.711	0.001[a]	0.01[a]	0.001[a]	0.0200
08/13	44.906	0.0010	0.0100	0.0010	0.0300
08/19	57.458	0.001[a]	0.0200	0.001[a]	0.0200
08/25	19.804	0.001[a]	0.0200	0.001[a]	0.0500
08/31	92.275	0.0010	0.01[a]	0.001[a]	0.0200
09/06	40.773	0.001[a]	0.01[a]	0.001[a]	0.0200
08/01	29.347	0.001[a]	0.0100	0.001[a]	0.0100
08/07	11.634	0.0010	0.0100	0.001[a]	0.0200
08/13	44.909	0.0010	0.0100	0.0010	0.0300

Sample report date	T/Part µg/m³	T/As µg/m³	T/Pb µg/m³	T/Cd µg/m³	T/Zn µg/m³
08/19	57.462	0.0010	0.0200	0.001[a]	0.0200
08/25	19.679	0.0010	0.0200	0.001[a]	0.0500
08/31	91.695	0.0010	0.0100	0.001[a]	0.0200
09/06	40.477	0.001[a]	0.0100	0.001[a]	0.0200
09/12	10.168	0.001[a]	0.01[a]	0.001[a]	0.0100
10/18	14.55	0.0060	0.0300	0.0020	0.1000
10/24	4.992	0.001[a]	0.01[a]	0.001[a]	0.0100
10/30	2.921	0.001[a]	0.01[a]	0.001[a]	0.01[a]
11/05	37.408	0.0020	0.0100	0.001[a]	0.0300
11/11	3.409	0.001[a]	0.01[a]	0.001[a]	0.0100
11/17	6.635	0.001[a]	0.01[a]	0.001[a]	0.01[a]
11/23	20.572	0.0100	0.0500	0.0010	0.1000
11/29	5.355	0.0010	0.01[a]	0.001[a]	0.0100
12/05	12.841	0.0070	0.0600	0.0020	0.1000
12/11	18.333	0.0070	0.1500	0.0070	0.4700
12/17	2.681	0.001[a]	0.01[a]	0.001[a]	0.0200
12/23	5.482	0.0020	0.0300	0.001[a]	0.0600
12/29	3.897	0.001[a]	0.0100	0.001[a]	0.0300

Notes:

[a] Reflects non-detect concentrations where detection limits were not provided.

Table G11. Northport PM-10 Data 2004

Sample report date	T/Part µg/m³	T/As µg/m³	T/Pb µg/m³	T/Cd µg/m³	T/Zn µg/m³
01/04	1.34	0.002	0.01[a]	0.001[a]	0.02
01/10	16.323	0.006	0.04	0.001[a]	0.14
01/16	3.715	0.001	0.01	0.001[a]	0.03
01/28	13.945	0.007	0.05	0.002	0.12
02/03	30.27	0.013	0.26	0.013	0.33
02/15	7.491	0.005	0.01	0.001[a]	0.02
02/21	7.184	0.007	0.06	0.001	0.11
03/16	6.388	0.001[a]	0.01	0.001[a]	0.01
03/22	15.945	0.001	0.03	0.001	0.05
03/28	0.974	0.001[a]	0.01	0.001[a]	0.01
04/03	11.692	0.004	0.02	0.001	0.06
04/09	12.354	0.001	0.01	0.001[a]	0.03
04/21	0.182	0.001[a]	0.01	0.001[a]	0.03
04/27	12.29	0.001[a]	0.01	0.001[a]	0.02
05/03	33.328	0.001	0.01	0.001[a]	0.02
05/09	31.441	0.001	0.02	0.001[a]	0.02
05/15	9.736	0.002	0.01	0.001[a]	0.03
05/21	6.267	0.001	0.01[a]	0.001[a]	0.01
05/27	5.299	0.001[a]	0.01[a]	0.001[a]	0.01
06/02	9.865	0.002	0.02	0.001	0.04
06/08	8.953	0.003	0.01	0.001	0.04
06/14	5.297	0.001	0.01	0.001[a]	0.01
06/20	41.204	0.001	0.01	0.001[a]	0.01
07/02	67.578	0.004	0.03	0.001	0.04
07/08	3.226	0.001	0.01	0.001[a]	0.03
07/14	20.455	0.004	0.02	0.001	0.04
07/26	54.515	0.001[a]	0.01[a]	0.001[a]	0.01
08/01	42.364	0.001[a]	0.01	0.001[a]	0.01
08/07	4.564	0.001	0.01	0.001[a]	0.01
08/13	19.421	0.002	0.02	0.001	0.06
08/19	14.551	0.001	0.01[a]	0.001[a]	0.01
08/25	4.987	0.001[a]	0.01[a]	0.001[a]	0.01
08/31	16.604	0.002	0.02	0.001[a]	0.03
09/06	22.139	0.002	0.01	0.001[a]	0.05
09/12	10.583	0.001	0.01	0.001	0.01
09/18	6.444	0.03	0.01	0.001[a]	0.02
09/24	23.653	0.004	0.02	0.001	0.05
09/30	18.665	0.001	0.01	0.001[a]	0.02
10/06	19.651	0.001[a]	0.01	0.002	0.01
10/12	18.42	0.002	0.02	0.001	0.03
10/18	6.325	0.004	0.01	0.001[a]	0.01
10/24	4.562	0.001[a]	0.01[a]	0.001[a]	0.01[a]
10/30	4.378	0.001[a]	0.01	0.001[a]	0.01
11/05	14.298	0.001	0.01	0.001	0.02
11/11	5.294	0.002	0.03	0.004	0.04

Sample report date	T/Part µg/m³	T/As µg/m³	T/Pb µg/m³	T/Cd µg/m³	T/Zn µg/m³
11/18	6.998	0.0005	0.005	0.0005	0.01
11/23	10.71	0.001	0.02	0.001	0.03
11/29	6.085	0.001	0.01	0.001[a]	0.03
12/05	3.47	0.001[a]	0.01	0.001[a]	0.01
12/11	2.739	0.001[a]	0.01[a]	0.001[a]	0.01
12/17	3.226	0.001	0.01[a]	0.001[a]	0.01
12/23	11.679	0.002	0.01	0.001[a]	0.01
12/29	6.085	0.003	0.03	0.001	0.03

Notes:

[a] Reflects non-detect concentrations where detection limits were not provided.

Table G12. Northport PM-10 Data 2005

Sample report date	T/Part µg/m³	T/As µg/m³	T/Pb µg/m³	T/Cd µg/m³	T/Zn µg/m³
01/04	6.018	0.003	0.02	0.001	0.07
01/16	8.333	0.009	0.02	0.001	0.05
01/28	13.807	0.018	0.03	0.002	0.07
02/03	11.438	0.001	0.01	0.001[a]	0.04
02/09	10.634	0.004	0.02	0.001	0.04
02/15	10.095	0.002	0.02	0.001	0.03
02/21	11.732	0.004	0.02	0.001	0.04
02/27	11.608	0.01	0.07	0.018	0.09
03/05	8.151	0.001	0.01	0.001[a]	0.01
03/12	8.518	0.002	0.01	0.002	0.02
03/17	3.222	0.005	0.06	0.002	0.03
03/23	3.465	0.001[a]	0.01[a]	0.001[a]	0.01
03/30	29.162	0.018	0.18	0.018	2.37
04/10	8.205	0.001	0.01	0.001[a]	0.04
04/16	7.658	0.004	0.02	0.002	0.08
04/22	15.073	0.001[a]	0.01	0.001	0.04
04/29	9.117	0.005	0.005	0.001[a]	0.01
05/04	11.852	0.007	0.03	0.001	0.07
05/10	18.736	0.004	0.02	0.001[a]	0.04
05/16	6.871	0.001[a]	0.01[a]	0.001[a]	0.01
05/22	2.431	0.001[a]	0.01[a]	0.001[a]	0.01
06/09	5.653	0.001[a]	0.01[a]	0.001[a]	0.01[a]
06/15	4.99	0.001	0.01[a]	0.001[a]	0.01
06/21	20.059	0.004	0.02	0.001	0.07
06/27	10.511	0.003	0.01	0.001	0.03
07/03	29.539	0.003	0.02	0.001[a]	0.03
07/09	5.107	0.001[a]	0.01[a]	0.001[a]	0.01
07/15	18.523	0.002	0.01	0.001[a]	0.04
10/19	14.475	0.005	0.07	0.003	0.04
10/25	21.783	0.005	0.09	0.007	0.14
10/31	6.262	0.001	0.01	0.001[a]	0.02
11/12	2.98	0.001[a]	0.01[a]	0.001[a]	0.01
11/24	6.139	0.001	0.01	0.001[a]	0.02
11/30	4.376	0.001[a]	0.01	0.001[a]	0.01
12/12	13.014	0.003	0.02	0.001	0.04
12/18	6.322	0.002	0.01	0.001[a]	0.04
12/24	5.656	0.012	0.02	0.001	0.04
12/30	8.639	0.013	0.03	0.001	0.05

Notes:

[a] Reflects non-detect concentrations where detection limits were not provided.

Table G13. Northport PM-10 Data 2006

Sample report date	T/Part µg/m³	T/As µg/m³	T/Pb µg/m³	T/Cd µg/m³	T/Zn µg/m³
01/05	6.995	0.002	0.03	0.001	0.11
01/11	1.095	0.001[a]	0.01[a]	0.001[a]	0.01
01/17	10.584	0.005	0.02	0.001	0.03
01/23	4.622	0.001[a]	0.01[a]	0.001[a]	0.01[a]
01/29	1.885	0.001[a]	0.01[a]	0.001[a]	0.01[a]
02/04	7.785	0.005	0.02	0.001	0.04
02/10	14.642	0.004	0.04	0.001	0.08
02/16	20.761	0.001	0.01	0.001	0.03
02/22	17.076	0.001	0.01	0.001	0.04
02/28	6.325	0.004	0.03	0.001	0.05
03/06	10.035	0.01	0.06	0.002	0.08
03/12	10.469	0.002	0.02	0.001	0.04
03/18	1.459	0.001[a]	0.01[a]	0.001[a]	0.01[a]
03/24	11.739	0.002	0.02	0.002	0.08
03/30	11.364	0.001	0.01	0.001[a]	0.03
04/05	9.723	0.004	0.04	0.002	0.09
04/11	4.621	0.002	0.01	0.001[a]	0.01
04/17	4.559	0.001	0.01	0.001[a]	0.02
04/23	14.891	0.001	0.02	0.001[a]	0.02
04/29	8.448	0.001	0.01	0.001[a]	0.02
05/05	45.944	0.001	0.02	0.002	0.02
05/11	14.832	0.006	0.03	0.001	0.07
05/17	48.749	0.002	0.03	0.001	0.05
05/23	18.839	0.004	0.01	0.001[a]	0.01
05/29	6.321	0.001[a]	0.01[a]	0.001[a]	0.01[a]
06/04	12.397	0.004	0.01	0.001[a]	0.03
06/10	16.048	0.007	0.02	0.001	0.09
06/16	7.169	0.001	0.01	0.001[a]	0.01
06/22	21.078	0.001	0.01	0.001[a]	0.03
06/28	25.213	0.001[a]	0.01[a]	0.001[a]	0.01
07/04	53.536	0.005	0.02	0.001[a]	0.03
07/16	24.67	0.001	0.01	0.001[a]	0.01
07/22	44.366	0.002	0.02	0.001	0.04
07/28	98.315	0.002	0.03	0.001	0.03
08/03	30.748	0.001	0.02	0.001[a]	0.03
08/09	23.456	0.001	0.01	0.001[a]	0.01
08/15	21.202	0.001	0.01	0.001[a]	0.02

Notes:

[a] Reflects non-detect concentrations where detection limits were not provided.

Table G2. Northport PM-10 Data 1995

Sample report date	TSP µg/m³	Pb µg/m³	Zn µg/m³	Cd µg/m³	As µg/m³
01/03	17	0.1400	0.1600	0.0100	0.0400
01/09	17	0.9300	0.9300	0.0300	0.3900
01/15	6	0.0300	0.0600	0.006[a]	0.0200
01/21	25	0.6000	0.1400	0.0200	0.0500
01/27	46	1.6800	2.8600	0.0700	0.2600
02/02	19	0.0100	1.4900	0.005[a]	0.0400
02/08	17	0.1900	0.2600	0.005[a]	0.0200
02/14	29	0.0300	0.0700	0.005[a]	0.0300
02/20	5	0.2600	0.3100	0.0200	0.005[a]
02/26	4	0.0800	0.1400	0.0100	0.0100
03/04	11	0.2300	0.2100	0.0200	0.0100
03/10	13	1.1200	0.5700	0.1400	0.1500
03/16	6	0.0200	0.0300	0.005[a]	0.0200
03/22	12	0.4700	0.3700	0.0300	0.0700
03/28	10	0.2500	0.1700	0.0100	0.0400
04/03	10	0.0100	0.0100	0.005[a]	0.005[a]
04/09	1	0.005[a]	0.0200	0.005[a]	0.005[a]
04/15	1	0.005[a]	0.005[a]	0.005[a]	0.005[a]
04/21	11		0.0700	0.0200	0.005[a]
04/27	15	0.2100	0.1700	0.005[a]	0.0200
05/03	3	0.005[a]	0.0200	0.005[a]	0.0100
05/09	14	0.0600	0.1500	0.005[a]	0.0200
05/15	21	0.0100	0.0200	0.005[a]	0.005[a]
05/21	19	0.0700	0.1300	0.005[a]	0.0100
05/27	33	0.0900	0.1300	0.005[a]	0.005[a]
06/02	25	0.3300	0.2800	0.0100	0.0400
06/08	11	0.1100	0.1100	0.005[a]	0.0200
06/14	9	0.6000	0.3400	0.0100	0.0800
06/20	5	0.005[a]	0.0200	0.005[a]	0.0200
06/26	16	0.0600	0.1400	0.005[a]	0.0100
07/02	28	0.1200	0.2200	0.0100	0.0600
07/08	27	0.3100	0.1900	0.0100	0.0100
07/14	26	0.0800	0.0800	0.0100	0.0100
07/20	19	0.0700	0.0200	0.005[a]	0.0100
07/26	16	0.0200	0.0900	0.005[a]	0.005[a]
08/01	19	0.005[a]	0.0300	0.005[a]	0.005[a]
08/07	12	0.4000	0.2500	0.0100	0.0100
08/13	7	0.0200	0.0200	0.005[a]	0.0100
08/19	19	0.0100	0.0400	0.005[a]	0.005[a]
08/25	29	0.0400	0.1300	0.005[a]	0.0200
08/31	22	0.0900	0.0900	0.005[a]	0.0200
09/06	27	0.3700	0.2000	0.0400	0.0400

Sample report date	TSP µg/m³	Pb µg/m³	Zn µg/m³	Cd µg/m³	As µg/m³
09/12	49	0.1600	0.1200	0.005[a]	0.0500
09/18	47	0.0500	0.1100	0.005[a]	0.005[a]
09/24	43	0.0700	0.1200	0.0100	0.0400
09/30	4	0.005[a]	0.0100	0.005[a]	0.0100
10/06	14	0.0600	0.0700	0.0100	0.005[a]
10/12	5	0.005[a]	0.0800	0.005[a]	0.005[a]
10/18	5	0.005[a]	0.0500	0.005[a]	0.0300
10/24	10	0.005[a]	0.0200	0.005[a]	0.005[a]
10/30	7	0.2000	0.0700	0.005[a]	0.0200
11/05	29	0.0700	0.1100	0.005[a]	0.0400
11/11	21	0.5400	0.2400	0.0200	0.1600
11/17	18	1.2400	0.5900	0.0400	0.1500
11/23	24	0.0900	0.0500	0.005[a]	0.005[a]
11/29	4	0.0100	0.1600	0.005[a]	0.005[a]
12/05	6	0.5400	0.3500	0.005[a]	0.0400
12/11	22	1.2500	0.5200	0.0600	0.0900
12/17	10	2.6200	0.4300	0.0400	0.0900
12/23	8	0.0800	0.2100	0.005[a]	0.0400
12/29	25	0.8100	0.5100	0.0500	0.1100

Notes:

[a] Reflects non-detect concentrations where detection limits were not provided.

Table G3. Northport PM-10 Data 1996

Sample report date	TSP µg/m³	Pb µg/m³	Zn µg/m³	Cd µg/m³	As µg/m³
01/04	24	0.005[a]	0.0300	0.005[a]	0.0100
01/10	4	0.0600	0.0300	0.005[a]	0.0100
01/16	2	0.0100	0.0300	0.005[a]	0.0100
01/22	4	0.2600	0.1000	0.0100	0.0200
01/28	6	0.1400	0.1400	0.005[a]	0.0100
02/03	12	0.6200	0.4600	0.0400	0.0600
02/09	17	0.0800	0.1000	0.005[a]	0.0200
02/15	24	1.1200	0.5900	0.0500	0.3400
02/21	6	0.1500	0.0800	0.0200	0.0100
02/27	8	0.0800	0.2100	0.005[a]	0.0200
03/04	7	0.0700	0.1100	0.005[a]	0.005[a]
03/10	14	0.4400	0.1500	0.005[a]	0.0200
03/16	1	0.005[a]	0.0100	0.005[a]	0.0100
03/22	12	0.2200	0.1900	0.0100	0.005[a]
03/28	11	0.2900	0.1800	0.0100	0.0300
04/03	8	0.1500	0.1200	0.005[a]	0.005[a]
04/09	22	0.8100	0.9400	0.0600	0.0500
04/15	14	0.4100	0.3900	0.0200	0.0200
04/21	4	0.005[a]	0.0300	0.005[a]	0.005[a]
04/27	1	0.005[a]	0.0100	0.005[a]	0.005[a]
05/03	2	0.0200	0.0200	0.005[a]	0.005[a]
05/09	4	0.1100	0.0900	0.005[a]	0.0100
05/15	11	0.2600	0.2100	0.0100	0.0400
05/21	12	0.2700	0.2400	0.0100	0.0200
05/27	26	0.2000	0.2500	0.0100	0.005[a]
06/02	35	0.1600	0.3000	0.0100	0.0200
06/08	34	0.0100	0.0900	0.005[a]	0.0100
06/14	39	0.1100	0.1400	0.005[a]	0.0200
06/20	24	0.0400	0.0700	0.005[a]	0.0200
06/26	17	0.0800	0.0800	0.005[a]	0.005[a]
07/02	27	0.8700	0.6200	0.0200	0.0600
07/08	24	0.2000	0.3100	0.0100	0.0200
07/14	32	0.1700	0.2300	0.005[a]	0.0100
07/20	8	0.0400	0.0400	0.005[a]	0.0100
07/26	31	0.1400	0.1600	0.005[a]	0.0200
08/01	41	0.1100	0.1100	0.005[a]	0.0100
08/07	14	0.1100	0.1100	0.005[a]	0.0100
08/13	28	0.1100	0.2900	0.005[a]	0.0100
08/19	1	0.0200	0.005[a]	0.005[a]	0.005[a]
08/25	86	0.4000	0.2900	0.0100	0.005[a]
08/31	37	0.005[a]	0.0200	0.005[a]	0.005[a]

Sample report date	TSP µg/m³	Pb µg/m³	Zn µg/m³	Cd µg/m³	As µg/m³
09/06	16	0.0200	0.0100	0.005[a]	0.005[a]
09/12	25	0.6200	0.2900	0.0200	0.0400
09/18	2	0.005[a]	0.0100	0.005[a]	0.005[a]
09/24	12	0.3100	0.1300	0.005[a]	0.005[a]
09/30	34	0.1100	0.1400	0.005[a]	0.0400
10/06	16	0.3900	0.3000	0.005[a]	0.0500
10/12	23	0.1900	0.8100	0.005[a]	0.0300
10/18	16	0.2300	0.1400	0.0100	0.0100
10/24	1	0.005[a]	0.005[a]	0.005[a]	0.005[a]
10/30	6	0.0600	0.0900	0.005[a]	0.0300
11/05	6	0.005[a]	0.0200	0.005[a]	0.005[a]
11/11	14	0.8100	0.2700	0.0700	0.0100
11/17	5	0.5900	0.3200	0.0200	0.0400
11/23	10	0.2500	0.6200	0.005[a]	0.0100
11/29	2	0.1400	0.0600	0.0100	0.005[a]
12/05	9	0.5000	0.0900	0.0100	0.0100
12/11	6	0.0200	0.0200	0.005[a]	0.0100
12/17	7	0.3600	0.2500	0.0100	0.005[a]
12/23	11	0.5500	0.3500	0.0400	0.0300
12/29	11	0.5200	0.1700	0.0100	0.0400

Notes:

[a] Reflects non-detect concentrations where detection limits were not provided.

Table G4. Northport PM-10 Data 1997

Sample report date	TSP µg/m³	Pb µg/m³	Zn µg/m³	Cd µg/m³	As µg/m³
01/04	1	0.005[a]	0.005[a]	0.005[a]	0.005[a]
01/10	4	0.005[a]	0.0200	0.005[a]	0.005[a]
01/16	24	0.3600	0.4100	0.0100	0.0400
01/22	4	0.005[a]	0.0200	0.005[a]	0.005[a]
01/28	19	0.9400	0.6900	0.0200	0.0200
02/03	4	0.1600	0.1600	0.0100	0.005[a]
02/09	27	0.4600	0.2000	0.0300	0.0300
02/15	5	0.0700	0.0400	0.0100	0.0100
02/21	9	0.0700	0.0400	0.005[a]	0.0100
02/27	6	0.1600	0.1800	0.005[a]	0.0300
03/05	17	0.4200	0.2000	0.0200	0.0300
03/11	19	0.7500	0.6900	0.0400	0.0200
03/17	15	0.5000	0.1900	0.0100	0.005[a]
03/23	4	0.0400	0.0600	0.006[a]	0.006[a]
03/29	8	0.0300	0.0400	0.005[a]	0.005[a]
04/04	9	0.0500	0.1100	0.005[a]	0.005[a]
04/10	11	0.0200	0.0900	0.005[a]	0.0200
04/16	8	0.2400	0.3000	0.0100	0.0100
04/22	9	0.1000	0.1100	0.005[a]	0.0200
04/28	4	0.0400	0.0600	0.005[a]	0.0100
05/04	9	0.2000	0.3300	0.005[a]	0.005[a]
05/10	21	0.0300	0.0700	0.005[a]	0.005[a]
05/16	29	0.0800	0.0900	0.005[a]	0.0200
05/22	21	0.005[a]	0.0800	0.005[a]	0.0200
05/28	9	0.0200	0.0400	0.005[a]	0.005[a]
06/03	13	0.1900	0.3200	0.005[a]	0.0400
06/09	15	0.0400	0.0500	0.005[a]	0.005[a]
06/15	12	0.0400	0.0700	0.005[a]	0.0100
06/21	9	0.0500	0.2500	0.005[a]	0.005[a]
06/27	NA	NA	NA	NA	NA
07/03	16	0.0600	0.0600	0.005[a]	0.0300
07/09	9	0.005[a]	0.005[a]	0.005[a]	0.005[a]
07/15	23	0.0100	0.0600	0.005[a]	0.005[a]
07/21	4	0.0900	0.1600	0.005[a]	0.005[a]
07/27	21	0.0400	0.0900	0.005[a]	0.005[a]
08/02	29	0.0600	0.7500	0.005[a]	0.0100
08/08	10	0.0300	0.0600	0.005[a]	0.005[a]
08/14	21	0.005[a]	0.0500	0.005[a]	0.005[a]
08/20	NA	NA	NA	NA	NA
08/26	16	0.0700	0.1200	0.005[a]	0.005[a]
09/01	21	0.2200	0.9400	0.005[a]	0.0200

Sample report date	TSP µg/m³	Pb µg/m³	Zn µg/m³	Cd µg/m³	As µg/m³
09/07	12	0.0800	0.1900	0.005[a]	0.005[a]
09/13	8	0.0700	0.1000	0.005[a]	0.005[a]
09/19	6	0.0200	0.0500	0.005[a]	0.005[a]
09/25	31	0.1200	0.2700	0.005[a]	0.005[a]
10/01	17	0.0700	0.3000	0.005[a]	0.005[a]
10/07	9	0.0600	0.0800	0.005[a]	0.005[a]
10/13	8	0.005[a]	0.005[a]	0.005[a]	0.005[a]
10/19	12	0.0400	0.1100	0.005[a]	0.005[a]
10/25	19	0.0300	0.0600	0.005[a]	0.005[a]
10/31	14	0.0300	0.0700	0.005[a]	0.0100
11/06	13	0.0600	0.1800	0.005[a]	0.0100
11/12	9	0.0700	0.0900	0.005[a]	0.005[a]
11/18	11	0.0300	0.0600	0.005[a]	0.0100
11/24	4	0.0300	0.0200	0.005[a]	0.0300
11/30	6	0.0600	0.0500	0.005[a]	0.005[a]
12/06	15	0.0500	0.1100	0.005[a]	0.005[a]
12/12	2	0.005[a]	0.005[a]	0.005[a]	0.0200
12/18	NA	NA	NA	NA	NA
12/24	4	0.0400	0.0400	0.005[a]	0.0300
12/30	8	0.2600	0.3200	0.0400	0.0400

Notes: NA = Sampling data was not available for this date.

[a] Reflects non-detect concentrations where detection limits were not provided.

Table G5. Northport PM-10 Data 1998

Sample report date	T/Part µg/m³	Pb µg/m³	Zn µg/m³	Cd µg/m³	As µg/m³
01/05	5	0.0300	0.005[a]	0.005[a]	0.005[a]
01/11	31	0.1100	0.2300	0.005[a]	0.0100
01/17	7	0.0500	0.1200	0.005[a]	0.005[a]
01/23	9	0.0600	0.0800	0.005[a]	0.0500
01/29	17	0.0700	0.0900	0.0100	0.005[a]
02/04	7	0.2200	0.1700	0.005[a]	0.0100
02/10	17	0.0600	0.2500	0.005[a]	0.0400
02/16	9	0.0300	0.0800	0.005[a]	0.005[a]
02/22	1	0.0100	0.0600	0.005[a]	0.005[a]
02/28	10	0.1700	0.3600	0.005[a]	0.0400
03/06	10	0.0200	NA	0.005[a]	0.0100
03/12	12	0.0400	0.1200	0.005[a]	0.005[a]
03/18	11	0.0300	0.1200	0.005[a]	0.005[a]
03/24	4	0.0400	0.1000	0.005[a]	0.0100
03/30	9	0.005[a]	0.0200	0.005[a]	0.005[a]
04/05	6	0.005[a]	0.0100	0.005[a]	0.005[a]
04/11	3	0.0500	0.0500	0.005[a]	0.005[a]
04/17	5	0.005[a]	0.0300	0.005[a]	0.005[a]
04/23	27	0.0600	0.1400	0.005[a]	0.0200
04/29	60	0.005[a]	0.0900	0.005[a]	0.0300
05/05	30	0.0300	0.1100	0.005[a]	0.005[a]
05/11	26	0.0200	0.0100	0.005[a]	0.005[a]
05/17	5	0.005[a]	0.0300	0.005[a]	0.005[a]
05/23	12	0.005[a]	0.005[a]	0.005[a]	0.005[a]
05/29	8	0.005[a]	0.0900	0.005[a]	0.005[a]
06/04	14	0.0900	0.0100	0.005[a]	0.005[a]
06/10	22	0.0600	0.1500	0.005[a]	0.0600
06/16	12	0.005[a]	0.0700	0.005[a]	0.005[a]
06/22	29	0.0300	0.1500	0.005[a]	0.005[a]
06/28	6	0.0600	0.005[a]	0.005[a]	0.005[a]
07/04	17	0.005[a]	0.005[a]	0.005[a]	0.0300
07/10	20	0.0600	0.1900	0.005[a]	0.005[a]
07/16	NA	NA	NA	NA	NA
07/22	NA	NA	NA	NA	NA
07/28	28	0.0500	0.0900	0.005[a]	0.005[a]
08/03	22	0.005[a]	0.0400	0.005[a]	0.005[a]
08/09	25	0.0300	0.0400	0.005[a]	0.005[a]
08/15	35	0.0400	0.0300	0.005[a]	0.005[a]
08/21	24	0.0700	0.0900	0.005[a]	0.005[a]

Sample report date	T/Part µg/m³	Pb µg/m³	Zn µg/m³	Cd µg/m³	As µg/m³
08/27	16	0.005[a]	0.0100	0.005[a]	0.005[a]
09/02	38	0.005[a]	0.0400	0.005[a]	0.005[a]
09/08	36	0.005[a]	0.0300	0.005[a]	0.005[a]
09/14	27	0.1700	0.1600	0.0100	0.0300
09/20	NA	NA	NA	NA	NA
09/26	6	0.0100	0.0400	0.005[a]	0.005[a]
10/02	NA	NA	NA	NA	NA
10/08	NA	NA	NA	NA	NA
10/14	NA	NA	NA	NA	NA
10/20	NA	NA	NA	NA	NA
10/26	NA	NA	NA	NA	NA
11/01	NA	NA	NA	NA	NA
11/07	NA	NA	NA	NA	NA
11/13	NA	NA	NA	NA	NA
11/19	NA	NA	NA	NA	NA
11/25	NA	NA	NA	NA	NA
12/01	NA	NA	NA	NA	NA
12/07	NA	NA	NA	NA	NA
12/13	NA	NA	NA	NA	NA
12/19	NA	NA	NA	NA	NA
12/25	NA	NA	NA	NA	NA
12/31	NA	NA	NA	NA	NA

Notes: NA = Sampling data was not available for this date.

[a] Reflects non-detect concentrations where detection limits were not provided.

Table G6. Northport PM-10 Data 1999

Sample report date	T/Part µg/m³	Pb µg/m³	Zn µg/m³	Cd µg/m³	As µg/m³
01/06	6	0.005[b]	0.019	0.0062	0.0062
01/12	7	0.01[a]	0.043	0.0062	0.0062
01/18	6	0.005[b]	0.006	0.0062	0.0062
01/24	10	0.093	0.105	0.0062	0.0124
01/30	7	0.087	0.149	0.0062	0.0062
02/05	2	0.005[b]	0.01[a]	0.0005[b]	0.0005[b]
02/11	44	0.01[a]	0.037	0.0005[b]	0.0005[b]
02/17	4	0.062	0.056	0.0005[b]	0.0112
02/23	4	0.01[a]	0.025	0.0005[b]	0.0005[b]
03/01	6	0.025	0.025	0.0005[b]	0.001[a]
03/07	7	0.029	0.065	0.001[a]	0.001[a]
03/13	9	0.213	0.341	0.0061	0.0170
03/19	6	0.134	0.213	0.0037	0.0104
03/25	7	0.005[b]	0.005[b]	0.0005[b]	0.0005[b]
03/31	4	0.01[a]	0.037	0.0005[b]	0.0018
04/06	14	0.005[b]	0.018	0.0005[b]	0.0005[b]
04/12	9	0.005[b]	0.01[a]	0.0005[b]	0.0005[b]
04/18	22	0.030	0.030	0.001[a]	0.0037
04/24	16	0.018	0.055	0.0005[b]	0.0005[b]
04/30	11	0.005[b]	0.018	0.0005[b]	0.0005[b]
05/06	13	0.079	0.128	0.0049	0.0030
05/12	9	0.005[b]	0.006	0.0005[b]	0.0005[b]
05/18	4	0.005[b]	0.018	0.0005[b]	0.001[a]
05/24	23	0.061	0.122	0.001[a]	0.0030
05/30	52	0.037	0.085	0.001[a]	0.0030
06/05	18	0.01[a]	0.030	0.0005[b]	0.0030
06/11	5	0.018	0.030	0.0005[b]	0.0030
06/17	21	0.018	0.067	0.0005[b]	0.0030
06/23	9	0.005[b]	0.055	0.0005[b]	0.0030
06/29	6	0.037	0.177	0.0005[b]	0.0049
07/05	12	0.005[b]	0.073	0.0005[b]	0.0030
07/11	45	0.043	0.074	0.001[a]	0.0043
07/17	19	0.018	0.067	0.0005[b]	0.0030
07/23	24	0.005[b]	0.024	0.0005[b]	0.0030
07/29	21	0.005[b]	0.055	0.0005[b]	0.0031
08/04	15	0.030	0.067	0.0005[b]	0.0067
08/10	12	0.049	0.177	0.001[a]	0.0055
08/16	12	0.01[a]	0.049	0.0005[b]	0.0030
08/22	21	0.055	0.134	0.001[a]	0.0152
08/28	24	0.037	0.104	0.0018	0.0183

09/03	29	0.030	0.043	0.0005[b]	0.0067
09/09	30	0.128	0.170	0.0037	0.0189
09/15	19	0.024	0.104	0.001[a]	0.0043
09/21	15	0.049	0.134	0.0018	0.0055
09/27	4	0.005[b]	0.024	0.0005[b]	0.0030
10/03	15	0.005[b]	0.018	0.0018	0.0037
10/09	5	0.005[b]	0.018	0.0005[b]	0.0030
10/15	9	0.005[b]	0.030	0.0005[b]	0.0030
10/21	26	0.122	0.170	0.0037	0.0322
10/27	10	0.261	0.188	0.0322	0.0176
11/02	13	0.067	0.128	0.001[a]	0.0189
11/08	13	0.030	0.055	0.0005[b]	0.0067
11/14	17	0.146	0.365	0.0037	0.0462
11/20	9	0.020	0.050	0.0010	0.0005[b]
11/26	46	0.005[b]	0.006	0.0005[b]	0.0031
12/02	6	0.005[b]	0.01[a]	0.0005[b]	0.0031
12/08	10	0.031	0.080	0.0018	0.0221
12/14	8	0.01[a]	0.037	0.001[a]	0.0098
12/20	14	0.018	0.055	0.0005[b]	0.0043
12/26	4	0.018	0.037	0.0005[b]	0.0031

Notes:

[a] Concentration detected at the method detection limit.

[b] Result reported was less than the method detection limit; concentration represents 1/2 the method detection limit.

Table G7. Northport PM-10 Data 2000

Sample report date	T/Part µg/m³	Pb µg/m³	Zn µg/m³	Cd µg/m³	As µg/m³
01/01	8.614	0.003	0.01	0.001[a]	0.04
01/07	8.614	0.003	0.01	0.001[a]	0.01
01/13	9.844	0.042	0.15	0.002	0.1
01/19	22.685	0.007	0.04	0.002	0.13
01/25	6.153	0.029	0.06	0.002	0.14
01/31	7.993	0.018	0.03	0.001	0.12
02/06	9.844	0.019	0.05	0.006	0.14
02/12	47.99	0.004	0.05	0.002	0.11
02/18	31.356	0.003	0.02	0.001[a]	0.07
02/24	3.076	0.003	0.01[a]	0.001[a]	0.01[a]
03/01	4.922	0.003	0.01[a]	0.001[a]	0.01
03/07	11.69	0.003	0.03	0.001[a]	0.09
03/13	7.383	0.003	0.01[a]	0.001[a]	0.01[a]
03/19	1.846	0.003	0.01[a]	0.001[a]	0.01[a]
03/25	6.153	0.003	0.02	0.001[a]	0.07
03/31	11.113	0.003	0.02	0.001[a]	0.02
04/06	8.62	0.003	0.01[a]	0.001[a]	0.02
04/18	11.698	0.004	0.09	0.006	0.15
04/24	3.078	0.003	0.01[a]	0.001[a]	0.03
04/30	11.698	0.003	0.01	0.001[a]	0.05
05/06	3.049	0.003	0.01[a]	0.001[a]	0.02
05/12	3.536	0.003	0.01[a]	0.001[a]	0.03
05/18	21.097	0.003	0.01[a]	0.001[a]	0.02
05/24	12.186	0.003	0.01[a]	0.001[a]	0.02
05/30	5.244	0.003	0.06	0.002	0.15
06/05	19.511	0.007	0.11	0.01	0.22
06/11	2.498	0.003	0.01[a]	0.001[a]	0.02
06/17	18.036	0.003	0.02	0.001[a]	0.04
06/23	24.86	0.003	0.02	0.001[a]	0.03
06/29	21.95	0.003	0.03	0.001[a]	0.05
07/05	6.398	0.003	0.01[a]	0.001[a]	0.02
07/11	9.268	0.003	0.01	0.001[a]	0.04
07/17	20.96	0.003	0.02	0.001[a]	0.04
07/23	22.56	0.003	0.01[a]	0.001[a]	0.02
07/29	14.817	0.003	0.02	0.001[a]	0.05
08/04	29.206	0.003	0.05	0.001	0.07
08/10	35.377	0.003	0.01	0.001[a]	0.04
08/16	23.686	0.003	0.03	0.001	0.06
08/22	18.34	0.003	0.02	0.001[a]	0.05
08/28	12.613	0.003	0.01	0.001[a]	0.02
09/03	9.932	0.003	0.02	0.001[a]	0.01
09/09	3.775	0.003	0.01[a]	0.001[a]	0.01[a]
09/15	18.584	0.003	0.04	0.002	0.15
09/21	0.244	0.003	0.01	0.001[a]	0.02

Sample report date	T/Part µg/m³	Pb µg/m³	Zn µg/m³	Cd µg/m³	As µg/m³
09/27	21.377	0.003	0.02	0.001[a]	0.05
10/03	5.788	0.003	0.03	0.001	0.03
10/09	20.969	0.004	0.06	0.002	0.1
10/15	2.035	0.003	0.01[a]	0.001[a]	0.02
10/21	2.072	0.003	0.01[a]	0.001[a]	0.02
10/27	11.447	0.004	0.04	0.001	0.05
11/02	12.491	0.001	0.01	0.001[a]	0.01
11/08	14.674	0.005	0.05	0.001	0.1
11/14	17.475	0.002	0.02	0.001[a]	0.04
11/20	21.433	0.001	0.02	0.001[a]	0.02
11/26	2.86	0.001[a]	0.01[a]	0.001[a]	0.01[a]
12/02	2.801	0.001[a]	0.01[a]	0.001[a]	0.01[a]
12/08	7.064	0.001[a]	0.01	0.001	0.01
12/14	25.948	0.002	0.02	0.001[a]	0.04
12/20	5.294	0.005	0.02	0.001[a]	0.04

Notes:

[a] Reflects non-detect concentrations where detection limits were not provided.

Table G8. Northport PM-10 Data 2001

Sample report date	T/Part µg/m³	Pb µg/m³	Zn µg/m³	Cd µg/m³	As µg/m³
01/01	0.001[a]	0.002	0.02	0.001[a]	0.04
01/07	12.839	0.005	0.04	0.001[a]	0.06
01/13	8.579	0.015	0.1	0.006	0.1
01/19	0.73	0.001[a]	0.01[a]	0.001[a]	0.01
01/25	8.759	0.009	0.05	0.002	0.12
01/31	2.554	0.001[a]	0.01[a]	0.001[a]	0.01[a]
02/06	6.993	0.001[a]	0.01[a]	0.001[a]	0.01[a]
02/12	12.645	0.004	0.01[a]	0.001[a]	0.04
02/18	7.601	0.005	0.02	0.001[a]	0.08
02/24	4.259	0.001	0.01	0.001[a]	0.01
03/02	6.997	0.002	0.01	0.001[a]	0.02
03/08	6.146	0.002	0.02	0.001[a]	0.05
03/14	1.643	0.001[a]	0.01[a]	0.001[a]	0.01
03/20	1.886	0.001[a]	0.01[a]	0.001[a]	0.01[a]
03/26	0.001[a]	0.001[a]	0.01[a]	0.001[a]	0.01[a]
04/01	1.521	0.001[a]	0.01[a]	0.001[a]	0.01[a]
04/07	3.831	0.002	0.01	0.001[a]	0.01
04/13	0.061	0.001[a]	0.01[a]	0.001[a]	0.01[a]
04/19	10.607	0.001	0.01	0.001[a]	0.01
04/25	25.79	0.001[a]	0.03	0.001[a]	0.01
05/01	1.581	0.001[a]	0.01[a]	0.001[a]	0.01[a]
05/07	16.788	0.001[a]	0.01[a]	0.001[a]	0.02
05/13	19.228	0.002	0.01	0.001[a]	0.03
05/19	16.003	0.001[a]	0.01[a]	0.001[a]	0.01[a]
05/25	41.924	0.002	0.01	0.001[a]	0.02
05/31	17.755	0.001	0.01	0.001[a]	0.02
06/06	3.651	0.001[a]	0.01[a]	0.001[a]	0.01[a]
06/12	3.953	0.002	0.01[a]	0.001[a]	0.01
06/18	6.327	0.001[a]	0.01[a]	0.001[a]	0.01[a]
06/24	25.173	0.001[a]	0.01[a]	0.001[a]	0.01[a]
06/30	251.125	0.004	0.14	0.001[a]	0.07
07/06	37.667	0.002	0.01[a]	0.001[a]	0.01
07/12	22.142	0.001[a]	0.01[a]	0.001[a]	0.01[a]
07/18	9.121	0.001[a]	0.01[a]	0.001[a]	0.01[a]
07/24	7.545	0.001[a]	0.01[a]	0.001[a]	0.01[a]
07/30	10.767	0.001[a]	0.01[a]	0.001[a]	0.01[a]
08/05	18.19	0.001[a]	0.01[a]	0.001[a]	0.01[a]
08/11	24.887	0.001[a]	0.01[a]	0.001[a]	0.01
08/17	54.884	0.001	0.04	0.001[a]	0.04
08/23	5.902	0.001[a]	0.01[a]	0.001[a]	0.01[a]
08/29	11.956	0.001[a]	0.01[a]	0.001[a]	0.01[a]
09/04	9.127	0.001[a]	0.01[a]	0.001[a]	0.01[a]
09/10	16.49	0.001[a]	0.01[a]	0.001[a]	0.01[a]

09/16	21.966	0.001[a]	0.01[a]	0.001[a]	0.01
09/22	20.384	0.001[a]	0.01[a]	0.001[a]	0.01
09/28	6.753	0.001	0.03	0.001	0.07
10/04	17.512	0.001[a]	0.01	0.001	0.04
10/10	4.258	0.001[a]	0.01[a]	0.001[a]	0.01[a]
10/16	17.578	0.001[a]	0.01	0.001[a]	0.03
10/22	3.403	0.001[a]	0.01[a]	0.001[a]	0.01[a]
10/28	6.567	0.002	0.01[a]	0.001[a]	0.01
11/03	14.776	0.01	0.04	0.001	0.06
11/15	8.737	0.001	0.01[a]	0.001[a]	0.02
11/21	3.709	0.001[a]	0.01[a]	0.001[a]	0.01
11/27	2.921	0.001[a]	0.01[a]	0.001[a]	0.01[a]
12/09	4.868	0.001[a]	0.01[a]	0.001[a]	0.01
12/15	3.223	0.001[a]	0.01[a]	0.001[a]	0.01[a]
12/21	5.11	0.016	0.04	0.003	0.05
12/27	17.646	0.002	0.03	0.001[a]	0.07

Notes:

[a] Reflects non-detect concentrations where detection limits were not provided.

Table G9. Northport PM-10 Data 2002

Sample report date	T/Part µg/m³	Pb µg/m³	Zn µg/m³	Cd µg/m³	As µg/m³
01/02	8.945	0.0020	0.0400	0.0010	0.1100
01/08	2.677	0.001[a]	0.01[a]	0.001[a]	0.01[a]
01/14	12.965	0.0040	0.0100	0.001[a]	0.0500
01/20	6.755	0.0020	0.01[a]	0.001[a]	0.0100
01/26	14.958	0.001[a]	0.0100	0.001[a]	0.0100
02/01	14.908	0.0100	0.0400	0.0020	0.0800
02/07	4.198	0.0030	0.0200	0.001[a]	0.0400
02/13	25.269	0.0010	0.0200	0.001[a]	0.0400
02/19	6.572	0.0010	0.01[a]	0.001[a]	0.0200
02/25	13.684	0.001[a]	0.0200	0.001[a]	0.0400
03/03	6.933	0.001[a]	0.01[a]	0.001[a]	0.0200
03/09	13.203	0.0020	0.0200	0.0010	0.0500
03/15	1.277	0.001[a]	0.01[a]	0.001[a]	0.01[a]
03/21	10.823	0.0020	0.0500	0.0010	0.0700
03/27	0.851	0.001[a]	0.01[a]	0.001[a]	0.01[a]
04/02	7.601	0.001[a]	0.01[a]	0.001[a]	0.0200
04/08	10.222	0.001[a]	0.01[a]	0.001[a]	0.0200
04/14	5.537	0.001[a]	0.01[a]	0.001[a]	0.0100
04/20	11.439	0.001[a]	0.0200	0.001[a]	0.0200
04/26	13.063	0.0010	0.0200	0.001[a]	0.0500
05/02	15.398	0.001[a]	0.01[a]	0.001[a]	0.0100
05/08	0.122	0.001[a]	0.01[a]	0.001[a]	0.01[a]
05/14	6.936	0.001[a]	0.01[a]	0.001[a]	0.0200
05/20	6.267	0.001[a]	0.01[a]	0.001[a]	0.0300
05/26	16.429	0.0010	0.01[a]	0.001[a]	0.0300
06/01	14.406	0.0010	0.0200	0.001[a]	0.0700
06/07	14.289	0.001[a]	0.01[a]	0.001[a]	0.0200
06/13	33.829	0.0030	0.0100	0.001[a]	0.0700
06/19	8.087	0.001[a]	0.01[a]	0.001[a]	0.0100
06/25	18.31	0.0010	0.0100	0.001[a]	0.0300
07/01	10.585	0.0010	0.01[a]	0.001[a]	0.0200
07/07	18.974	0.0040	0.0300	0.0020	0.1000
07/13	39.341	0.0050	0.0700	0.0040	0.2400
07/19	27.929	0.001[a]	0.01[a]	0.001[a]	0.01[a]
07/25	33.109	0.0170	0.4500	0.0190	1.9900
08/06	9.661	0.001[a]	0.01[a]	0.001[a]	0.01[a]
08/18	20.248	0.001[a]	0.01[a]	0.001[a]	0.0200
08/30	15.981	0.0010	0.0200	0.0010	0.0900
09/05	23.061	0.001[a]	0.01[a]	0.001[a]	0.0200
09/11	34.987	0.0010	0.0300	0.001[a]	0.0500
09/17	4.688	0.0010	0.0300	0.0020	0.0200
09/23	19.775	0.0010	0.0200	0.0010	0.0400
09/29	10.412	0.001[a]	0.01[a]	0.001[a]	0.01[a]
10/05	9.431	0.001[a]	0.01[a]	0.001[a]	0.0100

Sample report date	T/Part µg/m³	Pb µg/m³	Zn µg/m³	Cd µg/m³	As µg/m³
10/11	55.55	0.001[a]	0.01[a]	0.001[a]	0.0100
10/17	28.486	0.0020	0.01[a]	0.001[a]	0.0200
10/23	10.423	0.0010	0.0200	0.001[a]	0.0300
10/29	5.537	0.001[a]	0.01[a]	0.001[a]	0.01[a]
11/04	30.099	0.0040	0.0200	0.0010	0.0400
11/10	9.303	0.001[a]	0.01[a]	0.001[a]	0.01[a]
11/16	27.362	0.0020	0.0300	0.0020	0.0600
11/22	15.942	0.0020	0.0200	0.0010	0.0300
11/28	13.012	0.0020	0.0200	0.001[a]	0.0300
12/04	18.802	0.0020	0.0200	0.001[a]	0.0500
12/10	9.364	0.0020	0.0100	0.0010	0.0500
12/16	6.506	0.0100	0.0400	0.0020	0.0600
12/22	14.109	0.0070	0.0800	0.0030	0.1300
12/28	9.545	0.0070	0.0700	0.0020	0.0500

Notes:

[a] Reflects non-detect concentrations where detection limits were not provided.

APPENDIX H

AQUATIC ECOLOGICAL COMMUNITY INFORMATION

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Aquatic Ecological Community Information

This appendix provides information about the historical studies that have contributed to the current understanding of aquatic ecological communities within the Upper Columbia River (UCR) Site.

Periphyton

Following reports of floating mats of green algae in the UCR and concerns that these mats might be related to large phosphorus inputs to the system, the Washington State University Department of Zoology began the first studies of periphyton distribution and abundance in the UCR in the 1980s (Broch and Loescher 1988; Broch and Loescher 1990; Broch and Loescher 1992; Loescher and Broch 1993). In the preliminary work in 1988, qualitative samples of benthic algae were taken by raking the surface of bottom substrates in bays, shoals, and major tributaries of the UCR between Spring Canyon Shoal (USGS river mile [RM] 600) near Grand Coulee Dam to Chimney Shoal (USGS RM 648). In 1989, sampling was expanded upstream to the U.S.-Canadian border (Loescher and Broch 1993). These studies documented the presence of nuisance growths of *Cladophora*, also known as blanket weed, in the UCR for the first time. *Cladophora* grows in the form of long strands of algae that form mats, which commonly break free from the bottom and float on the surface, impairing recreational and aesthetic values. Algal biomass exceeding 100 milligrams (mg) of chlorophyll *a*[1] per square meter (m^2) is considered a nuisance (Welch et al. 1988). The 1988 work found *Cladophora* present in 92 of 105 samples taken from late July through October, at depths ranging from 2 to 10 meters (Broch and Loescher 1988). Cold water temperatures and reservoir level fluctuations limited early summer productivity, but the increased abundance observed as the season progressed supported the hypothesis that *Cladophora* may be the most important benthic alga in the littoral zone of the UCR (Broch and Loescher 1988).

Welch et al. (1992) collected periphyton samples from 20 locations between Grand Coulee Dam and the U.S.-Canadian border, and analyzed the samples for chlorophyll *a* to estimate periphyton standing crop (i.e., biomass). Periphyton chlorophyll *a* concentrations in August ranged from 6 to 87 mg/m^2, showed no observable trend with distance along the UCR, and were less than nuisance levels (i.e., < 100 mg/m^2). Welch et al. (1992) speculated that higher concentrations may have been found had sampling occurred in early fall, after the substrate was inundated for a longer period. *Cladophora* was observed at only a few sampling stations, where it was either floating free or lodged in debris along the shoreline. Periphyton biomass modeling provided a preliminary indication that with a one-half reduction in phosphorus

[1] Chlorophyll *a*, a photosynthetic pigment common to all green plants, is a common indicator of phytoplankton and periphyton productivity.

loading to the UCR, *Cladophora* biomass should be reduced below a perceived nuisance level (Welch et al. 1992).

The high levels of periphyton productivity (and associated concerns about nuisance growths of *Cladophora*) in the UCR reported in the late 1980s and early 1990s have not been present during more recent monitoring. The STI added periphyton to the scope of its UCR monitoring efforts in 1997, measuring attached algae colonization of artificial substrates (i.e., glass slides) placed in littoral habitats near Gifford, Porcupine Bay, Seven Bays (USGS RM 636), and Spring Canyon (BPA 1999). Annual mean periphyton chlorophyll *a* has ranged from 2.0 to 15.1 mg/m^2 between 1997 and 2004 (Lee et al. 2006), below the 20 mg/m^2 oligotrophic/mesotrophic threshold identified by Dodds et al. (Teck Cominco 2005). The attached algae have been dominated numerically by diatoms (95.9 percent), followed by green algae (4.0 percent, including 2.1 percent *Cladophora* sp.), and cyanobacteria (0.1 percent; BPA 2003a).

In summary, the nuisance growths of *Cladophora* that contributed to periphyton chlorophyll *a* concentrations greater than 100 mg/m^2 in the late 1980s and early 1990s (Loescher and Broch 1993) have not been documented in periphyton monitoring since 1997. Similar to the productivity level indicated by phytoplankton chlorophyll *a* in recent years of monitoring, annual mean periphyton concentrations between 1997 and 2004 have also indicated oligotrophy (Lee et al. 2006).

Phytoplankton and Zooplankton

The earliest documented studies of phytoplankton and zooplankton in the UCR described low biological productivity, except in the lower portion of the UCR. Gangmark and Fulton (USFWS 1949), using vertical tows with a plankton net in the upper 10 meters of the water column, observed that "meager plankton hauls in the upper reservoir were not indicative of good productivity in that portion of the lake" and "plankton hauls revealed fair-to-good abundance in the lower reservoir as compared to rather sparse concentrations in the upper reservoir." The authors did not specify whether they were referring to phytoplankton, zooplankton, or both in their characterizations of plankton samples. The upper UCR sampling stations were located near the mouths of Flat Creek (USGS RM 730), the Kettle River (USGS RM 705), and the Colville River (USGS RM 698), and lower UCR sampling stations were located near the mouths of the Spokane River (USGS RM 639) and Sanpoil River (USGS RM 614).

In addition to low concentrations of nutrients in the water column, USDHEW (1953) identified the high ratio of inflowing water to reservoir capacity, and other physical factors as contributing to "very poor" biological conditions in late September 1952, as evidenced by few phytoplankton, sparse bottom fauna (compared to other Columbia River reaches), and few game fish. USDHEW (1953) collected 6-liter composite samples from the water surface and near the bottom of the water column, centrifuged the samples to concentrate the plankton, and identified, counted, and weighed the organisms. They observed phytoplankton to be extremely limited throughout the UCR, but noted a buildup of zooplankton in the lower portion (i.e., from USGS RM 644 through 597), where cladocerans and copepods (i.e., micro-

crustaceans) were abundant, especially near the shoreline (USDHEW 1953). Near Northport (USGS RM 732), phytoplankton and zooplankton were described as "very sparse" (11 organisms/milliliter [mL]). No crustaceans were observed upstream from the station below the Colville River mouth (USGS RM 694). Additional sampling in mid-April 1953 found much higher phytoplankton densities (167 to 1,124 organisms/mL) near Northport (USGS RM 732), below the Colville River mouth (USGS RM 694) and above Grand Coulee Dam (USGS RM 597), compared to the previous late summer sampling event (7 to 66 organisms/mL). Later studies described below have shown that UCR total phytoplankton densities consistently decrease from spring through summer as they consume available nutrients.

The next evaluations of plankton in the UCR were reported from monthly sampling between December 1962 and November 1963 at four approximately equally spaced locations (Earnest et al. 1966). While recognizing the major limiting factors of seasonal water level fluctuations and changes in the temperature regime and turbidity that were deleterious to the sport fishery in the UCR, zooplankton abundance was characterized as being only 2.5 percent of that found in productive natural lakes, with the resident zooplankton being very small and suitable as food only for very small fish. Zooplankton were collected by towing a plankton net horizontally at 5-, 10-, and 20-foot depths near Keller Ferry (USGS RM 613), Miles (USGS RM 640), Gifford (USGS RM 672), and Marcus Bay (USGS RM 699), and were then identified and counted to provide estimates of abundance (Earnest et al. 1966). Copepods (i.e., *Diaptomus* spp.) were the most abundant zooplankton taxa, along with immature cladocerans (i.e., *Daphnia* spp.). Earnest et al. (1966) attributed the lack of adult *Daphnia*, an important food source for rainbow trout, kokanee (non-anadromous sockeye salmon), and other planktivorous fish, to water flows carrying the developing organisms beyond the collection stations before they reached maturity. The presence of *Leptodora kindtii*, the largest known cladoceran, was also observed in samples from each station.

In monthly sampling from December 1979 to September 1980 at sites between the Grand Coulee Dam forebay and Evans (USGS RM 596 to 712), Stober et al. (1981) found that average phytoplankton standing crops over the study period, as indicated by chlorophyll *a,* were highest near the mouth of the Spokane River (USGS RM 634) and decreased both upstream and downstream from this nutrient source. Peak chlorophyll *a* concentrations in the upstream areas of the UCR (USGS RM 649 to 712) averaged 7 mg/m^3 in June, with phytoplankton productivity limited, in part, by turbulence (Stober et al. 1981). By contrast, peak chlorophyll *a* concentrations averaged 14 mg/m^3 downstream from the Spokane Arm (USGS RM 596 to 634), with phytoplankton limited predominantly by nitrogen availability in the euphotic zone. Late spring declines in chlorophyll *a* concentrations to below 5 mg/m^3 were attributed to nutrient depletion. Overall, phytoplankton productivity, as estimated by chlorophyll *a* concentrations, indicated a mesotrophic (i.e., moderately productive) classification over the entire UCR, with diatoms dominating the phytoplankton community over most of the study period. *Asterionella*, *Fragillaria*, and *Melosira* were the dominant diatom genera, collectively accounting for more than 65 percent of the phytoplankton biovolume (i.e., total cell volume per liter of sample water) over all stations and dates. Green algae, dominated by *Chlorella* spp., increased in the lower UCR (USGS RM 596 to 634) through the summer, and contributed up to 74 percent of

the algal biovolume[2] by September. Phytoplankton biovolumes and cell densities generally exhibited comparable seasonal patterns, but because of their small sample sizes, the chlorophyll *a* results were considered a better estimate of phytoplankton standing crop (Stober et al. 1981). The authors noted that cell densities were similar to previously reported densities in Porcupine Bay of the Spokane Arm (USGS RM 13, Ecology 1972) and in the main body of the UCR (Robeck et al. 1954).

Stober et al. (1981) concluded that their data confirmed earlier observations of the importance of hydraulic residence time on the development of zooplankton populations in the UCR. Total zooplankton densities at the main reservoir stations increased during spring to a peak in June (246,400 organisms/m^3 at USGS RM 649), and subsequently declined to generally below 20,000 organisms/m^3 by August. Average total zooplankton densities at reservoir stations consisted of 71 percent rotifers during the spring, becoming most abundant near Gifford Ferry (USGS RM 673) and persisting throughout the lower UCR. Copepods constituted 95 percent of total zooplankton densities during summer, becoming most abundant near USGS RM 649. Cladoceran abundances increased downstream from Gifford Ferry (USGS RM 673) and increased from spring to summer, representing up to 12 percent of the total zooplankton density (Stober et al. 1981). Peak *Daphnia* density in the UCR was 4,710 organisms/m^3, from a tow sample 10 meters below the water surface, and comparable to peak densities at Lake Pend Oreille and Banks Lake (Stober et al. 1981).

Phytoplankton sampling by USBR (1985) in the early 1980s found similar spatial patterns of cell densities in the UCR, compared to earlier studies. Phytoplankton cell densities were lowest at the Colville River mouth (USGS RM 698) and increased progressively downstream, with highest densities observed in the Spokane Arm (USGS RM 13). Diatoms dominated the phytoplankton community, with *Asterionella* and *Synedra* being the most common genera. Phytoplankton densities peaked in June and July 1983 at all locations and rapidly declined by August.

In 1980 through 1982 monitoring, USBR (1985) found that microcrustacean zooplankton (i.e., cyclopoid and calanoid copepods, and cladocerans) densities were higher in May through August in the lower UCR (36,166 organisms/m^3 at USGS RM 614) and the Spokane Arm (17,069 organisms/m^3 at USGS RM 13), compared to the upper UCR (i.e., 4,784 organisms/m^3 at Gifford USGS RM 673 and 4,153 organisms/m^3 at the Colville River mouth USGS RM 698). Density increases from late spring through the summer of each monitoring year were more pronounced in the lower UCR. Cladocerans were the most abundant taxon collected in the UCR, and over 80 percent of the cladocerans were *Daphnia* spp. USBR (1985) found that increased hydraulic residence times consistently resulted in increased densities of zooplankton. They concluded that zooplankton populations were adequate to support a kokanee sport fishery.

[2] Biovolume was estimated by assigning similar geometric forms to dominant genera, measuring cell dimensions for a subsample of each dominant genus, and multiplying by the cell density.

Compared to previous studies, Wilson et al. (1996) attributed lower phytoplankton production, as evidenced by lower chlorophyll *a* concentrations, to reduced nutrient levels in 1994 and 1995. The lower UCR (USGS RM 599 to 633) chlorophyll *a* concentrations peaked at 9.0 mg/m^3 in April 1995 and then dropped to an average of 1.8 mg/m^3 in June and 0.9 mg/m^3 in August of the same year. Summer chlorophyll *a* concentrations averaged 2.2 mg/m^3 in the upper UCR (USGS RM 648 to 713) in August 1995. Similar to previous studies, phytoplankton communities were dominated by diatoms, representing an average of 85 percent of the total densities. As in earlier studies, the dominant diatom genera were *Asterionella*, *Fragilaria*, *Melosira*, and *Synedra*. Again, reservoir populations were highest in the spring, with total cell densities decreasing through summer (Wilson et al. 1996).

Wilson et al. (1996) reported that the composition of zooplankton communities sampled in the UCR in 1994 and 1995 was similar to the composition of communities found in the 1980 sampling by Stober et al. (1981). The zooplankton communities were dominated by rotifers in the upper UCR at the Colville River mouth (USGS RM 698) and Evans Landing (USGS RM 713) during both years of the study, where they accounted for more than 67 percent of total zooplankton densities during the April or May through October sampling seasons (Wilson et al. 1996). Rotifers also dominated the zooplankton communities in the lower UCR during both spring sampling events, usually composing more than 66 percent of the communities sampled downstream from Ninemile Reach (USGS RM 648). Rotifers were almost absent from the lower UCR during both summers, but increased to just over 10 percent of the lower UCR community in October of 1994 and 1995. Copepod densities accounted for about 70 percent of total zooplankton densities in summer and fall both years. Cladocerans rarely constituted more than 30 percent of total zooplankton densities and were usually the second most abundant taxon. Their relative abundances ranged from less than 10 percent in spring to more than 25 percent in summer, and these organisms were usually most numerous in the middle portion of the UCR (Ninemile Reach, USGS RM 648) and the Spokane Arm (USGS RM 13). However, cladocerans accounted for at least 70 percent of the zooplankton biomass collected below Ninemile Reach (USGS RM 648) in both years of the study. Cladoceran populations in the UCR were dominated by *Daphnia*, which accounted for 78 percent of cladoceran density and 94 percent of cladoceran biomass.

Underwood et al. (2004) noted a rapid decline in *Daphnia* abundance beginning in 1997, 3 years after elimination of phosphate releases from the fertilizer plant in Trail, B.C. The *Daphnia* density averaged 458 organisms/m^3 between 1997 and 1999, compared to an average of 5,590 organisms/m^3 between 1988 and 1996. Consistent with this trend, annual mean *Daphnia* biomass reported by Lee et al. (Lee et al. 2006) averaged 4,989 micrograms per cubic meter (μg/m^3) from 1997 through 2004, compared to an average of 27,256 μg/m^3 from 1994 through 1996. WDFW (2002) noted that although large *Daphnia* were present in the UCR, low densities of edible-size *Daphnia* (i.e., > 1.1 millimeters [mm]) indicated that *Daphnia* biomass and population structure were limited by cool water temperatures, low phytoplankton productivity, and high flows, rather than by fish predation.

Annual mean chlorophyll *a* concentrations calculated from data collected between May and October at four UCR monitoring locations between Spring Canyon (USGS RM 600) and

Gifford (USGS RM 674) have been at or below 2.5 mg/m^3 since 1997, and consistently below 1.5 mg/m^3 during the most recent 4 years of monitoring (Lee et al. 2006). Wetzel (2001) classified chlorophyll *a* concentrations within the range of 0.3 to 4.5 mg/m^3 as oligotrophic, a classification that is therefore applicable to the UCR. Mean monthly chlorophyll *a* concentrations peaked in May 2004 at 1.9 mg/m^3 and declined to 0.6 mg/m^3 by September of that year (Lee et al. 2006). Annual mean chlorophyll *a* concentrations decreased from Gifford (0.8 mg/m^3) downstream to Spring Canyon (0.5 mg/m^3).

Mean annual zooplankton density across all four monitoring locations was 539 organisms/m^3 in 2004, with the highest density reported in May (Lee et al. 2006). Similar to previous studies, copepods were the most abundant taxa, accounting for 83 percent of total zooplankton density, followed by *Daphnia,* which represented 15 percent of total density. *Daphnia* accounted for the majority of overall zooplankton biomass (52 percent) and copepods accounted for 46 percent of total biomass. As described above, the overall productivity of zooplankton and production of *Daphnia* in recent years remains much lower than before 1997. Although productivity is lower, the presence of large-bodied *Daphnia* in the zooplankton community during all seasons indicates that size-selective fish predation has not removed all of these nutritionally important organisms, and that food is not likely limiting the production of zooplanktivorous fish in the UCR (BPA 2005b; WDFW 2002).

In summary, dating back to the late 1940s fishery managers have identified low productivity of phytoplankton and zooplankton among the limiting factors in their efforts to enhance the UCR sport fisheries, particularly upstream from the Spokane River mouth (USGS RM 640). The first comprehensive limnological study of the UCR concluded that overall phytoplankton productivity, as estimated by chlorophyll *a* concentrations, indicated a mesotrophic classification (Stober et al. 1981). More recent sampling has shown that average chlorophyll *a* concentrations in the UCR below Gifford (USGS RM 674) have indicated an oligotrophic classification since 1997 and have continued to decline since 2001 (Lee et al. 2006). The overall productivity of zooplankton and production of *Daphnia* have also declined since 1997 (Lee et al. 2006; Underwood et al. 2004).

Benthic Macroinvertebrates

This section examines the currently available data on benthic macroinvertebrate communities in the UCR. Historical studies of the UCR have focused on evaluating how potential stressors affect the richness and diversity of various aquatic invertebrate species.

Historical Studies

Four studies conducted between 1989 and 1993 evaluated benthic macroinvertebrate communities in the UCR between the U.S.-Canadian boundary and the Grand Coulee Dam, and an additional study was completed above Trail, B.C.

Methods

In 1989, Johnson (1991) evaluated benthic macroinvertebrates collected using a Ponar grab sampler from four UCR sites between USGS RM 728 and 605, from one site on the Spokane River Arm (USGS RM 8), and from one site on the Sanpoil River Arm (USGS RM 4). All samples collected by Johnson (1991) were sieved through a 0.5-mm mesh screen. In 1991, Griffith et al. (1992) studied benthic macroinvertebrates collected using a Ponar grab sampler at three UCR sites (USGS RM 678 to 601) and one Spokane River Arm site (USGS RM 21). The samples collected by Griffith et al. (1992) were sieved through a 0.5-mm mesh screen. In 1992, Bortleson et al. (2001) studied macroinvertebrate communities at three UCR sites (USGS RM 745 to 738) using a Hess sampler[3] and at 16 UCR sites (USGS RM 730 to 605) using Ponar and van Veen grab samplers. All samples collected by Bortleson et al. (2001) were sieved through a 0.25-mm mesh screen. Similar to Griffith et al. (1992), in 1993 Voeller (1993) studied benthic macroinvertebrates collected using a Ponar sediment sampler at three UCR sites (USGS RM 678 to 601) and one Spokane River Arm site (USGS RM 21). The samples collected by Voeller (1993) were sieved through a 0.5-mm mesh screen. Emergence traps[4] were also used by Voeller (1993) to collect macroinvertebrates from the same locations in the UCR.

Results—Johnson (1991)

Johnson (1991) found low abundances of macroinvertebrates representing few species. Dipterans and oligochaetes dominated most samples. However, nematodes and bivalves within the family *Sphaeriidae*, were abundant at some sites. Because most of the samples were collected in relatively deep water (80 feet), it was not possible to distinguish the effect of depth (and hence pool level) on their spatial distribution. Insects such as stoneflies (*Plecoptera*) were not observed, and mayflies (*Ephemeroptera*) were found only at one location.

Results—Griffith et al. (1992)

Griffith et al. (1992) studied benthic macroinvertebrates in 1991 in the UCR to evaluate differences in the macroinvertebrate community at varying water depths (<49, 50–79, and 80 feet). They concluded that the communities were primarily composed of dipterans and oligochaetes. Larger, longer-lived insects such as stoneflies and short-lived insects such as mayflies were not observed. There appeared to be a depth-related trend for some species. In general, snails were more abundant at shallow-water sites (0–49 feet) and bivalves were more abundant at deep-water sites (80 feet). However, gastropods (snails) were abundant at the Gifford (USGS RM 678) and Porcupine Bay (USGS RM 21) shallow-water sites and at all Spring Canyon (USGS RM 601) sites. The gastropod families included *Lymnaeidae*, *Planorbidae*, and *Physidae*. Bivalves (*Sphaeriidae*) were also important at the Gifford, Porcupine Bay, and Spring Canyon deepwater sites. Another important result from this study was the collection of gastropods and dipterans from 80-foot depths.

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[3] A Hess sampler is a cylindrical device that encloses an area of sediment to be sampled.

[4] Emergence traps are used to collect aquatic macroinvertebrate adults as they emerge from the water surface.

Results—Bortleson et al. (2001)

Bortleson et al. (2001) also observed low richness[5] and abundance of benthic macroinvertebrates, which they suggested was due to annual changes in reservoir level. However, depths where samples were collected were not identified in the report. Dipterans and oligochaetes were dominant in most of the samples. At one location, China Bend (USGS RM 724), bivalves were numerically dominant. Bortleson et al. also attributed the low species diversity in the upper sections of the UCR) to pollution associated with metals mining. However, Bortleson et al. found no relationship between the low species richness in the lower portions of the UCR and metals concentrations in sediments.

Results—Voeller (1993)

Benthic macroinvertebrates in the UCR were studied by Voeller (1993) to evaluate potential differences in the macroinvertebrate community at varying water depths (<49, 50–85, and 85 feet). Similar to Griffith (1992), it was concluded that most samples were primarily composed of midges (*Chironomidae*) and aquatic worms (*Oligochaeta*). As with Griffith et al. (1992), there appeared to be a trend in the species or abundance of organisms found at the different depths (Voeller 1993). Specifically, *Chironomidae* were generally most abundant at mid-depth (50– to 85-foot) sites and *Oligochaeta* were most abundant at deep-water (85-foot) sites. This suggests that *Chironomidae* and *Oligochaeta* were affected at the shallow sites (0–49 feet). Contrary to what was found in 1991 by Griffith et al. (1992), bivalves (*Sphaeriidae*) were not found and gastropods (*Lymnaeidae*, *Planorbidae*, and *Physidae*) were low in abundance at all sites in 1993 (Voeller 1993). Amphipods (*Gammarus* spp.) were found at all sites and depths except Gifford (USGS RM 676), where they were found only at the shallow depth. Amphipods were not found in any of the other UCR studies cited above. Emergence traps were also used to collect macroinvertebrates from the same locations in the UCR. Dipterans and odonates were the only two insect groups captured with the traps. However, Voeller (1993) stated that many of the traps were lost or vandalized, so some taxa may have been lost.

Studies in Canada

Similar conditions for macroinvertebrates in the Columbia River may exist upstream of the U.S.-Canadian border. In April and October 1992, as a component of the Brilliant Expansion Project, the benthic macroinvertebrate community structure was evaluated at five nearshore sites in the Columbia River between the Hugh L. Keenleyside Dam and the Columbia-Kootenay rivers confluence (R.L. & L. Environmental 2000). This study was developed to evaluate baseline conditions before upstream reservoir management changes were implemented.

The changes would cause variable flow conditions due to reservoir management that may dry out the littoral zone for varying time periods. The river section of the UCR could be affected by the same upstream reservoir management-based water level fluctuations. These studies are useful to put river water level changes into context relative to other stressors. Most samples were collected with a Waters-Knapp sampler (0.22-mm mesh net) in shallow areas

[5] Richness refers to the number of species identified in a sample or area.

(< 30 centimeters [cm] depth). In addition, some samples were collected with a modified Surber/Hess sampler (0.20-mm mesh net) that allowed sample collection with substrate larger than 20 cm diameter (Norecol 1993). All samples were sieved with a 0.2-mm mesh sieve (Norecol 1993).

In general, chironomids, oligochaetes, round worms (nematodes), harpacticoid copepods, gastropods, and cnidarians (*Hydra*) were the dominant taxonomic groups found (R.L. & L. Environmental 2000). *Ephemeroptera*, *Plecoptera*, and *Trichoptera* (caddisflies) were generally not abundant. These taxa contributed between 0 and 16 percent of the total number of benthic macroinvertebrates during the two 1992 surveys (R.L. & L. Environmental 2000). Other long-term studies of nearshore areas between the Hugh L. Keenleyside Dam and the Columbia-Kootenay rivers confluence cited in the R.L. & L. Environmental (2000) report found that dipterans, oligochaetes, nematodes, snails, and water mites contributed from 84 to 100 percent of the macroinvertebrates collected. However, caddisfly taxa have been collected in this river reach, downstream from Castlegar, B.C., and at Waneta, when ultraviolet light traps were used (Aquametrix Research Ltd. 1994; R.L.& L. Environmental 2000). The R.L. & L. Environmental (2000) report suggests that caddisflies may inhabit deeper water in this reach of the river and are not affected by daily flow fluctuations of the river.

Colville Confederated Tribes and Spokane Tribes Studies

The CCT and STI began studies in the 1990s to determine the effects of the spring drawdown on habitat availability, aquatic macroinvertebrates, and aquatic macrophytes (Voeller 1993). Results of those studies have not been released. Submerged and emergent macrophytes occur in relatively shallow water and can provide cover and food for many macroinvertebrate species. Few of these macrophyte communities have been observed within the reservoir, with the exception of a small number of embayments and areas within the Spokane and Sanpoil arms. The limited distribution of macrophyte communities combined with the adverse effects of reservoir drawdown limits the kinds and numbers of benthic macroinvertebrates that can successfully inhabit the littoral zone of the UCR.

Conclusions

Benthic macroinvertebrate communities in many parts of the UCR appear severely affected by the annual reservoir drawdown. Johnson (1991) and Bortleson et al. (2001) observed both low abundances of macroinvertebrates, and relatively few species. The taxa were dominated by dipterans and oligochaetes. These species are assumed to be short-lived and capable of rapidly colonizing disturbed habitats (Anderson 1992; Camargo and Garcia De Jalon 1995; McCabe and Gotelli 2004; Miller and Golladay 1996). The general pattern of low macroinvertebrate richness and abundance may reflect a UCR-wide stressor, such as reservoir drawdown (Camargo and Garcia De Jalon 1995).

Fish

Lake Roosevelt has been the subject of extensive study with regard to the fish community and the fisheries it provides. This section reviews specific historical information on Lake Roosevelt fisheries.

Prior to 1930, an annual average of 1.1 million adult Chinook, coho, sockeye, and steelhead migrated past the current site of Grand Coulee Dam. The second-largest Native American fishery in the Columbia River basin was located at Kettle Falls, roughly 108 river miles upstream of the dam site. Approximately 300,000 to perhaps 1.5 million adult salmon were harvested annually at Kettle Falls and in the Spokane River, with the majority at Kettle Falls (Scholz et al. 1986). The Kettle Falls fishery was managed by the "Salmon Chief" of the Lakes Tribe. The Salmon Chief allowed an adequate number of fish to pass the Kettle Falls tribal fishery and spawn naturally upstream. Fish migrated hundreds of miles north of the U.S.-Canadian border to spawn (Scholz et al. 1986). Other fish species that maintained significant populations in the area included white sturgeon, Pacific lamprey, cutthroat, and redband/rainbow trout (Gillin and Pizzimenti 2004).

The Grand Coulee Dam was not outfitted with a fish ladder or other device to allow passage of adult salmon upstream, and consequently permanently blocked anadromous fish from 1,149 miles of spawning and rearing habitat in the UCR. Populations of UCR Chinook, coho, sockeye, and steelhead were eliminated (Scholz et al. 1986).

Grand Coulee Dam instantly disrupted the natural ecology of the UCR. The dam changed the UCR from a primarily lotic (running) to semi-lentic (standing) system, and one with a greatly altered instream and riparian habitat and ecosystem function. The loss of indigenous anadromous fishes along with formation of the reservoir resulted in a substantial ecosystem perturbation. This once salmonid-based ecosystem became a predominantly cyprinid (minnows), centrarchid (sunfish), and catostomid (sucker)-based system, with remnant populations of redband trout[6] and kokanee (USFWS 1949).

The first known fish survey in Lake Roosevelt was conducted in 1948 by USFWS (1949). Based on gill net samples, the most prominent fish species were cyprinids: northern pikeminnow (*Ptychocheilus oregonensis*; 59 percent) and peamouth (*Mylocheilus caurinus*; 22 percent). Another cyprinid, the common carp (*Cyprinus carpio*), was also believed to be dominant, but was not captured using gill nets. USFWS (1949) reported that the Washington State Department of Game seined 50 tons of carp in 1947 and 100 tons in 1948 from Lake Roosevelt near the Kettle River.

USFWS (1949) interviewed anglers who claimed to have caught kokanee and rainbow trout in the Sanpoil River. The Washington Department of Game stocked nearly 7.5 million kokanee fry from Lake Whatcom, located in northwest Washington, into Lake Roosevelt from 1942 through 1945 (Earnest et al. 1966). USFWS (1949) suggested kokanee were not producing

[6] A subspecies of rainbow trout (*Oncorhynchus mykiss gairdneri*).

adequate fisheries due to the entrainment[7] they observed at Grand Coulee Dam. However, they suggested rainbow trout may produce a reservoir fishery if a resident stock was available and capable of avoiding entrainment.

Walleye (*Sander vitreum*) were not detected during the 1948 survey (USFWS 1949), but were first reported by Earnest et al. (1966). Scholz et al. (1986) speculated that walleye were likely introduced in the 1950s and the population reached sufficient size in the 1960s to be detected.

Earnest et al. (1966) conducted fish surveys in 1962 through 1963 and concluded that Lake Roosevelt was biologically sterile and unfit to support large fisheries based on failed kokanee and trout hatchery plants, and limited zooplankton and benthic macroinvertebrate production. In contrast, Snyder (1967), as reviewed by USBR (1985), noted that sizable numbers of adult kokanee were sampled in the Lake Roosevelt forebay in 1966 and 1967, suggesting that Lake Roosevelt was capable of producing a kokanee fishery.

However, beginning in 1969 and running through the late 1970s, the reservoir was drawn down well below its normal operating range to add a third powerhouse to expand power production. The lowest drawdown on record occurred during construction, at an elevation of 1,160 feet above mean sea level, roughly 130 feet below full pool. Stober et al. (1977b) observed reduced numbers of kokanee, which he attributed to increased entrainment from these drawdowns.

Additional attempts were made to enhance Lake Roosevelt fisheries beginning in the early 1950s. For example, in 1956 and 1961, a total of 104,000 Kamloops stock rainbow trout were released by private citizens who held recreational fishing interests. There were few benefits to fisheries resulting from these releases. During 1972 and 1975, the Washington Department of Fisheries experimented with the release of fall Chinook, stocking a total of 1.8 million fish. As with the Kamloops stock releases, few fish were captured by sport anglers and the releases were considered failures (USBR 1985). By the mid 1970s, walleye were recognized by anglers as a prize fish in Lake Roosevelt that received national publicity (Scholz et al. 1986).

The first of six turbines of the third powerhouse became operational in 1975 and by 1978 all units were operational. The dramatic change in dam operations as a result of the new turbines likely had an effect on reservoir biota, but this effect was not documented by researchers until the 1990s via a study commissioned by the CCT to estimate entrainment at the dam (LeCaire 2003). The study identified the third powerhouse as a major source of entrainment.

USBR (1985) conducted comprehensive fishery and limnological studies from 1980 to 1984. The goal was to determine the effects of water management on the biota of Lake Roosevelt and to recommend methods to protect and enhance the sport fishery. From 1980 to 1983, the most abundant fish captured in bottom-set gill nets were suckers (34 percent) followed by walleye (29 percent) and northern pikeminnow (15 percent). The relative abundance of northern pikeminnow had fallen from 65 percent in 1949 to 15 percent in the 1980s, while the abundance of peamouth had fallen from 64 percent in 1949 to 7 percent. Diet studies

[7] Unwanted passage downstream of the dam

conducted by USBR (1983) indicated sculpin, yellow perch, and suckers were the primary fish consumed by walleye. Northern pikeminnow and peamouth constituted a small fraction of the walleye diet.

The Washington Department of Game began enhancement of both rainbow trout and kokanee releases shortly after Beckman's (USBR 1985) report was completed. Annual releases of Spokane stock rainbow trout began in 1986 and have ranged from 50,000 to 276,500 catchable fish. Annual releases of Lake Whatcom stock kokanee from the Ford, Washington, hatchery began in 1988. From 1988 through 1996, releases ranged from 872,150 to 1,025,400 fry annually (BPA 1996a).

During the early to mid 1980s, the NWPPC (now Northwest Power and Conservation Council) initiated plans to implement fish restoration and enhancement projects in Lake Roosevelt. These projects were to be funded by the BPA as mitigation for impacts to anadromous and native fish populations due to the federal hydroelectric projects on the Columbia River basin. Scholz et al. (1986) submitted a proposal to the NWPPC, on behalf of the CCT and STI, for funding a comprehensive Lake Roosevelt fish restoration program. The proposed Lake Roosevelt program intended to achieve the following: 1) build and operate two hatcheries to rear and release kokanee and rainbow trout into Lake Roosevelt, 2) improve habitat of Lake Roosevelt tributaries, and 3) monitor and evaluate fish population dynamics and harvest in the reservoir and tributaries. The NWPPC approved the proposal, which was initiated in 1988 with the Lake Roosevelt Monitoring and Evaluation Program.

The Spokane Tribal Hatchery in Wellpinit began operation in 1991 and the WDFW operated Sherman Creek Hatchery in Kettle Falls the following year in 1992. These hatcheries depended upon each other to rear and release both hatchery kokanee and rainbow trout. The original combined release goal was 8 million kokanee fry and 500,000 rainbow trout yearlings. However, the limited water supply at the Spokane Tribal Hatchery limited fry releases, so the goals were revised in 1994 to 1 million kokanee yearling and 500,000 rainbow trout. Net pens were installed in the reservoir, and Ford Hatchery, a hatchery operated by WDFW and located adjacent to the Spokane Tribal Hatchery, was used to augment rearing space. Thereafter, the hatchery program included a mix of nonnative Lake Whatcom kokanee and a coastal-derived rainbow trout, as well as native Kootenai Lake kokanee and Kettle Falls redband/rainbow trout. Wild native kokanee and redband/rainbow trout are found throughout the reservoir. Reservoir elevation changes likely preclude shoreline spawning and therefore wild fish originate from upstream reservoirs and/or tributaries to Lake Roosevelt (Underwood 2000).

Current Fish Community

The primary purpose of the Lake Roosevelt Fisheries Evaluation Program is to collect fisheries and limnological data. The program began in 1988 and is expected to continue. The program seeks to better understand the effect of hydropower operation on the biota of the reservoir. The program has produced a wealth of data and numerous reports (BPA 1990, 1991, 1992, 1996a, 1996b, 1996c, 1997b, 1999, 2002a, 2002b, 2002c, 2002d, 2003b, 2004a, 2004b, 2004c, 2005a, 2005b, 2006b, 2006c, 2006d; Voeller 1993)

The Lake Roosevelt Fisheries Evaluation Program conducts spring, summer, and fall electrofishing and gill net surveys to study fish throughout the reservoir. The systematic survey is repeated annually and is designed to detect changes in species composition throughout the reservoir and at specific sites. Samples are taken from 9 to 11 sites over the length of Lake Roosevelt from Grand Coulee Dam (USGS RM 597) to Evans (USGS RM 708). Walleye, largescale suckers, rainbow trout, kokanee, and smallmouth bass are the dominant species captured via electrofishing surveys. Lake whitefish, burbot, walleye, and longnose suckers have dominated the gill net catches. Each sampling method collects a biased (not necessarily representative) sample because each selects for specific sizes and captures fish only in habitats where the sampling method is applicable. For example, electrofishing tends to capture species of fish that reside along the shore versus deep water. The true relative abundance for each particular species is somewhere between those reported for electrofish and gill net surveys.

Species abundance is not uniform throughout the length of the reservoir, likely due to shifts in habitat types. From a macrohabitat perspective, the upper 46 miles of Lake Roosevelt (U.S.-Canadian border, USGS RM 745, and upstream into Canada to Evans, USGS RM 708) is riverine-like (high energy with cobble/bolder substrate), supporting species typical of large northwest rivers such as rainbow trout. The depositional zone between Evans (USGS RM 711) and Gifford (USGS RM 676) is a lower energy environment, which changes the character of the substrate. In the transitional zone, species composition shifts to increased abundance of walleye, yellow perch, kokanee, and suckers, and decreased abundance of rainbow trout. The lower portion of the reservoir from Gifford (USGS RM 676) to Grand Coulee Dam (USGS RM 597) is most reservoir-like (low energy and variable substrates). In this area, the relative abundance of smallmouth bass and rainbow trout increases while that of walleye and suckers decreases.

Focal and Dominant Species Descriptions

Kokanee, rainbow trout, walleye, and white sturgeon represent the species of primary concern to Lake Roosevelt fishery managers and anglers. Burbot, whitefish, suckers, and smallmouth bass have received limited attention, primarily because the populations were assumed to be stable or targeted to a lesser extent by anglers. These high- and low-profile species are discussed below.

Kokanee (*Oncorhynchus nerka*)

Kokanee are the adfluvial life history form of sockeye salmon. That is, unlike sockeye salmon, kokanee spend their entire life in fresh water, never visiting the ocean.

There is some uncertainty as to where and how kokanee originally became established in Lake Roosevelt. One belief is that kokanee native to Arrow and Kootenai lakes, which are upstream of Lake Roosevelt, colonized the lake. Wild fish from these stocks are assumed to have established the spawning population in the Sanpoil River, a tributary to Lake Roosevelt. Others have argued that kokanee in Lake Roosevelt originated from the Lake Whatcom Hatchery stock that was released in the 1940s. Recent genetic evidence suggests that wild

kokanee residing in Lake Roosevelt have ancestral ties to the upstream populations and little to no relationship to the Lake Whatcom stock (Young et al. 2002). In recent years, only a handful of kokanee (8 to 15) have spawned in the Sanpoil River, too few to sustain the number of wild fish harvested in Lake Roosevelt. No other tributaries to Lake Roosevelt are believed to support substantial numbers of spawners and no shoreline spawning populations have been documented. Furthermore, successful shoreline spawning is unlikely due to the winter drawdowns of the reservoir, which desiccate the eggs. A plausible explanation for the continued abundance of wild kokanee in Lake Roosevelt is that they are produced in tributaries and lakes in the Canadian portion of the upper Columbia River and migrate downstream to Lake Roosevelt. Kokanee are well known for their downstream migration and entrainment tendencies (BPA 1996d; BPA 2001a).

Typically, kokanee adults spawn naturally between August and November. Hatchery and wild fish spawning behavior is similar; however, wild fish tend to spawn earlier than hatchery fish based on studies conducted by the Lake Roosevelt Fisheries Evaluation Program (BPA 2001b, 2002a, 2002d, 2002e, and 2003b). Wild spawners are typically 4 to 5 years old, whereas hatchery spawners are typically 3 to 4 years old. The few successfully constructed redds in Lake Roosevelt tributaries (primarily in the Sanpoil River) produce emerging fry in late winter or early spring. The fish migrate out of the tributaries during the first year of life, live within the reservoir until age 4 or 5, and then return to their natal stream.

Lake Whatcom hatchery fish were originally introduced into Lake Roosevelt from 1942 through 1946, but apparently did not develop a sustainable population. Recent attempts to build a hatchery-based kokanee fishery began in 1988, once again using fry (250 to 500 to the pound) from Lake Whatcom Hatchery stock. The hatchery fish were not readily distinguishable from wild fish and therefore the contributions of hatchery fish to the fishery and natural spawning areas were not defined. However, fish tagged with coded wire tags, which accounted for a small fraction of the released fish, did not contribute to the fishery or to adult spawner returns (BPA 1995). It is generally believed that fry plants did not contribute significantly to the fishery due to poor survival. Walleye, burbot, and rainbow trout predation and entrainment during the first year of kokanee fry life may be the factors responsible for the low survival. In response, the hatcheries began rearing kokanee to yearling age before release. They hoped the larger and older fish would have higher survival by avoiding predation and entrainment.

While the researchers did detect a greater number of adult kokanee from yearling releases at the Sherman Creek Hatchery, the returning adults were mainly precocial fish maturing a year earlier than expected (BPA 1997a; BPA 2006a; Underwood et al. 2004). The rate of yearling precocity has been as high as 70 percent (Underwood 2000). The precocious fish, which returned to the release site 3 months after release, were primarily males. Consequently, they did not contribute to either harvest or natural production. As of 2003, the hatchery program continued to release yearlings. However, an alternate kokanee stock from Meadow Creek, B.C., is being tested in Lake Roosevelt. Fish managers hope the Meadow Creek stock will have less of a tendency to entrainment and precocity. Study results have not yet been published.

Rainbow Trout (*Oncorhynchus mykiss*)

Rainbow trout are the most prominent game fish in Lake Roosevelt, providing approximately 50 percent of total angler harvest. Most of the harvested fish are of hatchery origin, but wild rainbow trout also exist. For the most part, the hatchery and wild fish differ by subspecies, where the hatchery fish are coastal rainbow trout (*Oncorhynchus mykiss irideus*) and the wild fish are predominantly redband trout (*Oncorhynchus mykiss gairdneri*) (Behnke 2002).

Lake Roosevelt has primarily been stocked with a non-native stock maintained at the WDFW Spokane Hatchery. This stock is a derivative of coastal stocks and the timing of spawning has been manipulated from spring to fall. Selective breeding for fall spawning has allowed the hatcheries to grow fish to a larger size for spring releases (Behnke 2002). This stock is not believed to successfully spawn in the wild during the fall. However, hatchery fish have been observed spawning in the spring and are likely contributing to the wild population. The extent of the contribution is not known, but is believed to be limited because fish captured in Lake Roosevelt either have the appearance of the wild stock (strong, long, sleek, and darkly spotted) or are hatchery fish (short, fat, and silvery with an adipose clip). In 2001, the hatchery began producing sterile rainbow trout by triploiding their chromosomes. Triploids are unable to produce viable gametes and therefore put energy into growth rather than gamete production. The triploid fish are released in areas believed to contain significant populations of wild fish, such as those near Kettle Falls.

Recently, effort has been directed towards developing redband stocks for the hatchery from local stocks. Redband are a subspecies of rainbow trout native to certain streams in eastern Washington. Redband trout from Phalon Lake, Washington (originally stocked with trout from the Kettle River), are being reared and experimentally released (less than 10 percent of the total lower river release) into Lake Roosevelt to assess this stock's performance in the fishery and reservoir environment. The coastal stock appears to adapt readily to the reservoir environment, and feeds primarily on zooplankton. The redband stock may not adapt as well because they are believed to retain their riverine feeding behavior (i.e., prefer sediment-dwelling or benthic macroinvertebrates for food). This may limit their distribution to the riverine reach in upper Lake Roosevelt, where macroinvertebrates experience less impact from reservoir drawdown than macroinvertebrates downstream.

Wild rainbow trout are believed to be primarily redband trout and naturalized hatchery fish. The Sanpoil River contains the largest population of redband trout. Based on the morphological attributes of the Sanpoil redband, the CCT believes it is derived from a remnant steelhead population. Redband trout found in other tributaries throughout the reservoir are generally smaller and deeper bodied than the Sanpoil stock, and better fit Behnke's definition of a redband trout.

Redband trout inhabit many Lake Roosevelt tributaries and are found within the reservoir itself near tributary mouths. The native fish exhibit a mix of adfluvial and fluvial life history patterns. The adfluvial fish rear in their natal stream for 1 to 2 years and then migrate to the reservoir until becoming adults at age 4 or older. Fluvial fish remain in their natal tributary from birth to death. Adfluvial fish are generally of larger size than fluvial life forms,

suggesting that rainbow trout grow faster in the reservoir than in the tributaries. Wild redband spawn in Lake Roosevelt tributaries during the spring. Fry emerge from redds in late spring through early summer. If adfluvial, the juvenile fish reside in the tributary for approximately 1 to 2 years and then migrate to the reservoir. Adult fish return to the tributary at age 3 or older and spawn.

Walleye (*Sander vitreum*)

Walleye are not native to the Columbia River (Scott and Crossman 1998) and were believed to be introduced into Lake Roosevelt during the 1950s by USFWS (Williams and Brown 1983). Over the past 40+ years, walleye have become one of the predominant species in Lake Roosevelt, and are currently managed to maximize harvestable numbers.

Walleye normally spawn from late March through early May. The preferred spawning temperature ranges from 4.4 to 10°C. Males arrive at the spawning grounds before females and tend to stay a little later (Scott and Crossman 1998; Wydoski and Whitney 2003). Spawning generally occurs in water less than 15 feet deep over a variety of substrates, such as flooded vegetation, coarse gravel, and boulders. Although walleye do not have a restricted home range, they tend to spawn in the same location each year (Wydoski and Whitney 2003). Walleye primarily spawn near Little Falls Dam in the Spokane Arm in Lake Roosevelt, but also likely spawn in the Sanpoil Arm and upper reservoir near the U.S.-Canadian border where the reservoir is most river-like.

Egg development varies with water temperature. Hatching occurs from 7 days at water temperatures greater than 12.8°C to 26 days at 4.4°C (Wydoski and Whitney 2003). The yolk sac of walleye fry is relatively small and is usually fully absorbed within 2 to 3 days (Becker 1983). Fry initially feed on zooplankton and within the first few months of life progress to larger forms of invertebrates and small fish (BPA 1999). From that point on, their diet is composed almost exclusively of fish. The dietary transition from invertebrates to fish coincides with movement from the surface to a bottom habitat (Scott and Crossman 1998).

Walleye can live longer than 15 years, but do not typically live longer than 8 years in Lake Roosevelt (BPA 1999). They can tolerate a variety of environmental conditions, but prefer shallow, turbid waters (Scott and Crossman 1998). Walleye have a special eye configuration that allow them to see exceptionally well at night and therefore feed at dawn, dusk, and night (Scott and Crossman 1998). In open water, walleye travel in loose aggregations and schooling is common when feeding and spawning (Becker 1983).

First spawning occurs at ages 2 or 3 for males and ages 3 or 4 for females (Williams and Brown 1983), and appears to be mainly size- rather than age-dependent. Female walleye deposit 25,000 to 40,000 eggs per pound of body weight (Becker 1983). Spawning occurs at night and usually involves one female and up to two males, or two females and up to six males (Scott and Crossman 1998). Most females broadcast their eggs over the stream bed in one night, while males spawn over a longer period (Ellis and Giles 1965). After release, the sticky eggs attach to one another and to adjacent vegetation or streambed material. After an hour or two, they water-harden, lose their adhesive properties, and settle onto weed mats or drop into

crevices in the substrate (Scott and Crossman 1998). After spawning, walleye adults can migrate great distances. Spawners from the Spokane Arm were recovered over 150 miles away near the U.S.-Canadian border within weeks of being tagged (USBR 1985).

White Sturgeon (*Acipenser transmontanus*)

White sturgeon are the largest and longest-lived freshwater species in North America (Scott and Crossman 1998). They can grow up to 6 meters long, weigh more than 800 kg, and live beyond 100 years. They have a cartilaginous skeleton, a tube-like mouth with barbells, and a hard protruding snout. White sturgeon are shielded with bony plates called scutes.

The white sturgeon is a facultative anadromous species that inhabits large rivers, estuaries, and nearshore areas of the Pacific Ocean from Ensenada, Mexico, to the Aleutian Islands. The Columbia, Fraser, and Sacramento rivers contained historically large spawning populations. The construction of Grand Coulee Dam isolated them from downriver feeding and rearing areas and from breeding with downriver fish. This isolated population is believed to be unique and considered by many to be part of a distinct population that resides in Lake Roosevelt upstream to Hugh Keenleyside Dam, 35 river miles upstream of the U.S.-Canadian border.

White sturgeon genetic studies have consistently documented decreasing genetic differences with distance upstream (Anders and Powell 2002; Barley et al. 1985; BPA 1987; Brown et al. 1990; McKay et al. 2002). The total number of haplotypes[8] was negatively correlated with inland distance from the Pacific Ocean in all rivers systems that have been studied (Anders and Powell 2002). The frequency of anadromy appears to decrease in upper portions of basins, which may be an expression of genetic differences with lower river populations. BPA (1987) found that Lake Roosevelt white sturgeon were genetically distinct from other Columbia River sturgeon populations.

White sturgeon typically mature and begin spawning at 25 to 30 years old. They spawn during spring and early summer in fast-flowing river reaches. The only well documented spawning site for the Lake Roosevelt population is the Waneta Dam tailrace at the mouth of the Pend Oreille River. A recent survey indicates that spawning also occurs near Northport (McLellan 2006, pers. comm.). The females and males congregate and release their eggs and sperm over the streambed. The fertilized eggs cling to the streambed by a sticky coating until water-hardened, and then they lose the sticky coating and fall into spaces within the substrate. Hatching occurs 5 to 10 days later, and is dependant on water temperature. After hatching, the larvae swim up into the water column and are dispersed downstream by the currents. The dispersed sturgeon hide in the substrate for 20 to 25 days until they absorb the yolk sac. After yolk absorption, the fry move out from under the substrate to forage for food. During the first year of life, sturgeon remain associated with rough substrate for cover. They live on or near the bottom throughout their life.

[8] Haplotype is a combination of very closely linked alleles or markers that tend to be transmitted as a unit to the next generation.

In the UCR, no effective recruitment of juvenile sturgeon has been documented since 1985, although successful spawning has been documented annually (UCWSRI 2002a). Due to the recruitment failures, UCR white sturgeon are considered imperiled and a plan has been developed to recover the population (UCWSRI 2002b). A key strategy of the recovery plan is rearing juvenile sturgeon in a hatchery to reestablish the population. Juveniles are released as 1-year-olds, when they no longer appear to be susceptible to high rates of mortality. Release of tagged hatchery fish also allows researchers to conduct studies. At this point, unnatural low flows during the spring, lack of spring riparian flooding, water temperatures, low turbidity, limited food availability, predation, and contaminants are considered possible reasons for the failed recruitment of young fish.

Burbot (*Lota lota*)

Burbot, which have a single barbel under their chin, are the only freshwater member of the cod family in Washington State. The species has a circumpolar distribution. In North America, the species inhabits the northern part of the contiguous United States, Canada, and Alaska. In Washington, the species occupies several deep lakes and reservoirs within the Columbia River Basin, including the Spokane River drainage (Wydoski and Whitney 2003). Little attention has been paid to this species in the Pacific Northwest and few data are available about occurrence and abundance in Lake Roosevelt. Between 4 and 15 percent of fish collected during recent gill net surveys in Lake Roosevelt were burbot (Baldwin et al. 2003; BPA 1997b, 1999, 2002d, 2002e, 2005b, and 2006c). The Lake Roosevelt population appears to have increased from 4 to 12 percent of the gill net survey catch during the period 1994 to 2004 (Lee et al. 2006). The increased burbot population may be attributed to an increase in available prey items due to stocking of kokanee and rainbow trout (Wydoski and Whitney 2003).

Burbot home range appears to be small. Burbot occupy the same local area within seasons and between years based on sonic tracking studies conducted over 3 years in Lake Opeonogo, Ontario, Canada (Carl 1995). According to Wydoski and Whitney (2003), home range is limited and foraging areas are small and vary little from year to year. During gill surveys conducted in Lake Roosevelt in August 2004, burbot were found as deep as 110 meters, while surveys conducted in October observed burbot at 31 to 40 meters (BPA 2006c). The relatively dramatic shift in vertical position from summer to fall is likely due to thermal conditions because cooler waters found at deeper depths are preferred during summer months (BPA 2006c).

According to Scott and Crossman (1973), optimal growth temperatures for burbot range from 15.6 to 18.3°C. The life span and size of the burbot appear to vary considerably based on location; however, in Washington State, fish may live up to 14 years and attain sizes in the range of 22 inches long and up to 17 lb (although most weigh much less) (Wydoski and Whitney 2003). WDFW (2002) analyzed burbot (ages 2 to 9) in Lake Roosevelt from 1998 to 1999 and determined that the fish ranged in length from 347 to 560 mm (13.6 to 22.0 inches) and weighed between 252 and 900 grams (g) (0.6 to nearly 2 lb). In 2003, otolith analyses conducted on burbot collected in Lake Roosevelt determined that captured burbot (generally

collected by gill nets below 60 meters) were ages 3 to 6, and ranged in length from 400 to 700 mm (15.7 to 27.5 inches) (BPA 2006c).

Males generally mature at age 3 and females at age 4. Spawning typically occurs in the winter to early spring, December/January to early March, when water temperatures reach approximately 1.7°C. Mean fecundities are relatively high, from 64,000 to more than 1.4 million eggs depending on the size of the female. Eggs are deposited in shallows of the lake and adjacent tributary mouths at night over clean sand, gravel, or rocky substrates. At 6.1°C, eggs incubate for about 30 days; incubation periods are longer or shorter depending on temperature. Burbot hatch in early to late spring, generally from April through May.

Young burbot feed mainly on insects and other invertebrates, but by the age of 5, the diet transitions to become primarily piscivorous (ADFG 2005). Fish consumed by burbot include sculpin, whitefish, stickleback, perch, kokanee, rainbow trout, and other burbot (ADFG 2005; WDFW 2002; Wydoski and Whitney 2003). In Lake Roosevelt, the burbot diet consists primarily of fish (sculpin, suckers, smallmouth bass, walleye, kokanee, and rainbow trout) with smaller contributions of cottids, chironomids, crayfish, vegetation and organic matter, and a variety of terrestrial and aquatic insects (BPA 2005a and 2006b; Wydoski and Whitney 2003). In a 2001 Lake Roosevelt survey, burbot fed mainly on perch, although salmonids were also prey items (BPA 2004b). These results were confirmed during a 2004 stomach contents analysis in which Lee et al. (2006) determined that perch was the most important diet item for burbot.

Lake Roosevelt burbot were observed congregating near kokanee spawning areas, consuming kokanee weighing up to 1 lb (Scholz 2000, as cited in Wydoski and Whitney 2003). According to WDFW (2002), one potential limiting factor for hatchery salmonid success in Lake Roosevelt includes piscivory by burbot, walleye, and smallmouth bass.

Smallmouth Bass (*Micropterus dolomieu*)

As the name implies, this species has a relatively small mouth compared to the largemouth bass. The native range for this species extended east of Minnesota as far north as Quebec and south to Georgia; however, the range was expanded by plantings in the Pacific Northwest in the 1800s and 1900s (EPA 2002a). In Washington, it was introduced into several western lakes including Lake Washington and stocked into the Yakima River, thereby becoming established in the Columbia River and its tributaries (Simpson and Wallace 1982; Wydoski and Whitney 2003).

The smallmouth bass occurs in cool, clear lakes and reservoirs as well as cool streams with moderate to swift current over gravel or rocks. In streams, it prefers deep, still pools and appears to display little migratory behavior, with limited home range. Tagging studies conducted by Munther (1970) in the Snake River determined that most smallmouth bass remained in the same pool or location as where they were tagged, while the remainder of fish tagged moved less than 0.75 mile from the tagging site. Todd and Rabeni (1989) monitored the movement of stream-dwelling smallmouth bass in Missouri and determined that individuals

occupied restricted home ranges for most of the year but dispersed in spring, with 75 percent returning to their home pool during the same season.

In lakes, smallmouth bass generally move within a definite home range that may increase significantly depending on the size of the lake and available resources. Home ranges in an 877-acre lake in Maine ranged from nearly 950 yards for 11-inch fish to 2,654 yards for fish over 16 inches (Wydoski and Whitney 2003). Other reported home ranges in lakes have been estimated at less than 2.5 to approximately 106 acres (Wydoski and Whitney 2003); however, Ridgway and Shuter (1996) observed larger home ranges (175 to 733 acres) in a 14,500-acre oligotrophic lake. Ridgway and Shuter (1996) also determined that relocated smallmouth bass return to their home ranges after spending approximately 1 week at a release site. Such strong fidelity to home ranges has also been observed in relocation and tracking studies conducted in Washington. In Lake Sammamish, 41 percent of smallmouth bass relocated up to 6 miles away from capture sites returned to the area of original capture within a year (Wydoski and Whitney 2003). Lake Roosevelt smallmouth home range has not been explored, but is assumed to be similar to that of fish inhabiting other large lakes.

In Washington, smallmouth bass may live over 14 years and attain lengths of 17 to 19 inches with weights up to 8 lb (although most are considerably lighter). In a study conducted by EPA (2002a), the body weight of smallmouth bass collected from the Columbia River ranged from 1,300 to 1,400 g (2.9 to 3.1 lb). In 2004, BPA (2006c) collected scales from several smallmouth bass in Lake Roosevelt. Analysis of the scales determined that the fish were all age 3 and averaged 301 mm (11.8 inches) in length.

According to Carlander (1977), the optimal temperature for smallmouth bass growth is 26.4°C. Sexual maturity is reached at age 3 or 4. Spawning occurs in the spring when water temperatures are between 12.7 and 18.3°C. Females produce between 2,000 and nearly 21,000 eggs that are deposited into nests excavated down to coarse rubble or bedrock along the shoreline (Wydoski and Whitney 2003). If eggs fail to hatch, a second spawning may occur. Eggs incubate for about 1 month depending on temperature, and the fry generally emerge between July and August. Males guard the nests until the young emerge and exit, and in some cases, the male may continue to guard fry up to 28 days, but more typically for 2 to 10 days. Nests are usually located near overhead cover and along the margins of deeper pools where the current is slow. In areas where low-velocity pools are not present, spawning will not occur.

The smallmouth bass is essentially carnivorous. Fry initially consume copepods and cladocerans and transition to insects and small fish when they attain lengths of 2 to 5 cm (Hubbs and Bailey 1938; EPA 2002a). Adults feed on insects, crayfish, and fishes. In Lake Roosevelt, fish account for between 34 and 67 percent of the species' diet. Fish consumed in Lake Roosevelt included sculpin, minnows, salmonids, yellow perch, black crappie, and bass (WDFW 2002; Wydoski and Whitney 2003). In a 2001 diet analysis conducted in Lake Roosevelt, BPA (2004b) determined that smallmouth bass fed mainly on *Cottidae*, although salmonids were also prey items. During a 2004 stomach contents analysis, Lee et al. (2006) determined that *Daphnia* was the most important diet item for smallmouth bass and that

Osteichthyes was the most common fish consumed. According to WDFW (2002), one potential limiting factor for hatchery salmonid success in Lake Roosevelt includes piscivory by smallmouth bass, along with walleye and burbot.

Lake Whitefish (*Coregonus clupeaformis*)

Lake whitefish are distinguished from other species of whitefish in the state of Washington by their unique morphology. The species has two flaps between the nostrils versus the single flap present in mountain whitefish. The historical range of lake whitefish included much of northern North America, from British Columbia east and extending north of northern Minnesota. In Washington, lake whitefish are in the UCR system throughout Lake Roosevelt and the McNary Reservoir. It appears that the species was not directly stocked into Lake Roosevelt, but that the Columbia River system was colonized by fish that entered the system via Lake Pend Oreille, Idaho (Wydoski and Whitney 2003).

Lake whitefish occur in large rivers, lakes, and reservoirs, preferring deep, cold habitats. In deep pelagic habitats of Lake Roosevelt, lake whitefish are prevalent. As reported by BPA (2006c), recent horizontal and vertical gill net surveys revealed that lake whitefish was the predominant species captured throughout the reservoir, followed by walleye and rainbow trout. The majority of captured lake whitefish ranged from 201 to 700 mm (7.9 to 27.5 inches) (BPA 2006c). In August and October 2004, BPA (2006d) surveyed the limnetic zone of Lake Roosevelt using a combination of gill nets and hydroacoustics. In August, numerical species composition showed walleye were most abundant, followed by lake whitefish and rainbow trout. Most captured lake whitefish ranged from 401 to 700 mm in length (15.8 to 27.5 inches). In October, species composition by number revealed that lake whitefish was most abundant, followed by walleye.

The species can live up to 17 years and, on average, attain a size of 24 inches and 3 to 5 lb (Wydoski and Whitney 2003). In 2003, scale analysis conducted on lake whitefish collected in Lake Roosevelt (generally captured below 60 meters) determined that individuals were juvenile to 8 years old and ranged from 122 to 580 mm in length (BPA 2006c).

Lake whitefish is a fall spawner and appears to have strong fidelity to spawning sites (Wydoski and Whitney 2003). Congregations of lake whitefish are observed annually in the Hawk Creek embayment (USGS RM 633) where spawning is believed to occur (based on data provided in BPA 2006c). Other Lake Roosevelt spawning sites have not been documented. Although sexual maturity generally occurs between 4 and 5 years, males may become mature as early as age 2. Spawning is dependent upon local conditions and may not occur annually. Spawning occurs from October to January when water temperatures reach 5°C (Wydoski and Whitney 2003). Females broadcast semi-buoyant eggs over substrates of silt covered stones, boulders, cobbles, and detritus. Wydoski and Whitney (2003) report that spawning in an Ontario, Canada, lake occurred in the littoral zone at mean depths of approximately 9 feet. Average fecundity is about 10,000 eggs per female per pound of fish. Eggs incubate for approximately 1 month prior to hatching at temperatures of 10°C (Wydoski and Whitney 2003).

The diet of juvenile whitefish appears to consist primarily of zooplankton including *Daphnia* (Wydoski and Whitney 2003). As they grow larger, they transition to bottom feeders and the diet becomes much more opportunistic and variable. Stomach content analyses conducted in Lake Roosevelt in 2003 revealed that lake whitefish fed primarily on isopods, followed by *Daphnia* (BPA 2006c). During a similar analysis conducted in 2004, Lee et al. (2006) determined that *Daphnia* was the most important diet item. It appears that whitefish feed primarily on isopods in August and on both amphipods and isopods in October (BPA 2006d). Small fish (sculpin and stickleback), cladocera (water fleas), clams, chironomids, spiders, worms, fish eggs, and a variety of terrestrial insects are also consumed by lake whitefish in Lake Roosevelt (Wydoski and Whitney 2003).

Mountain Whitefish (*Prosopium williamsoni*)

The mountain whitefish is native to Washington and is distinguished by a single flap between the nostrils. This species inhabits northern North America, generally west of the continental divide (Scott and Crossman 1973). In Washington, it is common in coldwater lakes, streams, and rivers, and is the most abundant whitefish in the state. In Lake Roosevelt, mountain whitefish are primarily observed from Gifford (USGS RM 676) to the U.S.-Canadian border (USGS RM 745) (Lee et al. 2006).

The species prefers riffles in the summer and large pools and slow-velocity glides in the winter. Wydoski and Whitney (2003) report that mountain whitefish in Box Canyon Reservoir, Washington, were located along gravel bars near the mouths of tributaries. Pettit and Wallace (1975) observed mature mountain whitefish in the North Fork Clearwater River moving upstream (82 km) in late spring and early summer and remained in the upper reaches until spawning in November. Following spawning, fish moved downstream (88 km) to overwinter in the deeper pools of the lower river. This study suggests relatively large home ranges for stream-dwelling mountain whitefish. Mountain whitefish likely follow a similar upstream migration from the transition zone to the riverine zone upstream of Evans (USGS RM 708) during the fall where preferred spawning habitat exists.

Mountain whitefish may live up to 11 years and attain sizes up to 22 inches and 6 lb (Wydoski and Whitney 2003). As cited in EPA (2002a), 7-year-old fish collected in tributaries in Canada and Idaho ranged in length from 307 to 387 mm (12.1 to 15.2 inches) and weighed between 475 and 890 g (about 1 to 2 lb), while 8-year-olds ranged in length from 330 to 410 mm (12.9 to 16.1 inches) and weighed between 501 and 944 g, or about 1.1 to 2.1 lb (Pettit and Wallace 1975; Scott 1960; Thompson and Davies 1976). During limnetic surveys conducted in Lake Roosevelt in 1999, a small number of mountain whitefish were captured, ranging in size from 200 to 700 mm (7.8 to 27.6 inches) (WDFW 2002). Lee et al. (2006) conducted electrofishing and gill net surveys in Lake Roosevelt in 2004, which yielded six mountain whitefish averaging 396 mm (15.6 inches) in length (± 22 mm standard deviation [SD]) and 702 g (1.63 lb) in weight (± 191 g SD).

Mountain whitefish become sexually mature between the ages of 3 and 5. Males typically reach maturity a year before females. Adults appear to demonstrate relatively high homing fidelity to spawning sites (Pettit and Wallace 1975). Although dependent on elevation and

latitude, spawning generally occurs from September to December when water temperatures are between 4.4 and 7.2°C. Average fecundities vary by location, but appear to be between 5,000 and 8,000 eggs per pound of fish. Eggs are broadcast over gravel substrates in stream riffles or on gravel shoals along beaches of lakes. Incubation periods vary based on temperature; at 8.8°C eggs hatch in about a month. Fry emerge and drift until they encounter suitable habitat, including shallow backwater areas (Wydoski and Whitney 2003).

Mountain whitefish feed on a variety of organisms including bottom-dwelling aquatic insects such as flies, mayflies, caddisflies, and stoneflies (Cirone et al. 2001) as well as crayfish, fish eggs, and occasionally small fish. In Lake Roosevelt, the species was found to consume chironomids, fish (primarily suckers), and a variety of other aquatic and terrestrial insects (Wydoski and Whitney 2003). Lee et al. (Lee et al. 2006) found that mountain whitefish consume predominantly isopods followed by aquatic snails (Physidae).

Largescale Sucker (*Catostomus macrocheilus*)

The largescale sucker differs from the longnose sucker in having a subterminal mouth that is not overhung by the snout. The largescale sucker also has more rays in the dorsal fin and larger scales than does the longnose. It is native to the Pacific Northwest in tributaries from the Skeena River in British Columbia to the Sizes River in Oregon (Scott and Crossman 1973). The largescale sucker is found throughout the entire state of Washington and is the predominant sucker species in the Columbia River and its tributaries. The species accounted for 94 percent of all suckers in the Columbia main stem, Lake Roosevelt, and the Spokane River (Wydoski and Whitney 2003). In recent gill net and electrofishing surveys, the fish community in Lake Roosevelt has been dominated by largescale suckers (BPA 2006c); however, Lee et al. (2006) report that the population of largescale suckers in Lake Roosevelt has decreased annually as determined through creel surveys. Lee et al. (2006) conducted electrofishing and gill net surveys in Lake Roosevelt in 2004, which yielded 139 largescale suckers averaging 500 mm (19.7 inches) in length (± 109 mm SD) and 1,513 g (3.3 lb) in weight (± 639 g SD).

Largescale suckers live in close association with the lake or stream bottom and prefer habitat near the mouths of streams entering lakes. The species prefers shallow water but can be found as deep as 80 feet. Adults appear to move toward shorelines at night and deeper habitats during the day. Larvae are pelagic and are found primarily along the shorelines of river systems where water velocity is relatively low. Largescale sucker fry occupy the mud and cobble substrate of shallow pools and backwaters of river systems.

In tagging studies performed in Lake Roosevelt and Box Canyon Reservoir, the majority of adults were recaptured at or near tagging locations (Wydoski and Whitney 2003). The remaining fish were generally recaptured within 6 miles of the tagging location, indicating relatively limited home ranges for fish in that system. More extensive movement has been observed in other areas, including upper and lower reaches of the Columbia River, indicating a less sedentary lifestyle compared to those in Lake Roosevelt (Wydoski and Whitney 2003).

According to Black (1953), the optimal growth temperature for the largescale sucker is 18.9°C. Age at maturity for largescale suckers appears to differ based on geographic location. Whereas suckers in Montana mature at 4 or 5 years, those in British Columbia appear to mature at 5 or 6 years, depending on sex. Spawning occurs in April and June, depending on location, generally in shallow water about 8 inches deep. Spawning generally occurs along the edges and downstream ends of pools in streams having a bottom of fine gravel and sand, with occasional boulders. Females may produce from 6,000 to 20,000 eggs depending on size, and generally broadcast their eggs along the substrate. Eggs hatch in about 2 weeks. Yolk sac larvae generally drift for a few days after hatching before occupying warmer, low-velocity shoreline and backwater habitats for rearing.

When near the surface, small largescale suckers forage on zooplankton. As they grow larger and transition to a bottom-dwelling lifestyle, their diet switches to aquatic insect larvae, with small diatoms and other plant material; larger fish feed on crustaceans, larvae, earthworms, snails, and detritus (Dauble 1986; Scott and Crossman 1973; EPA 2002a). In a 2001 diet analysis conducted in Lake Roosevelt, BPA (2004b) determined that largescale suckers consume *Daphnia* and other cladocerans, aquatic and terrestrial insects, aquatic worms, and aquatic snails. Due to drawdowns associated with flood control and hydropower operations, benthic macroinvertebrates are often unavailable to bottom-feeding fish in Lake Roosevelt, resulting in an adaptation to a pelagic feeding lifestyle. This species has been observed in embayments of Lake Roosevelt while feeding near the surface near dense clusters of zooplankton (Behnke 2002).

Longnose Sucker (*Catostomus catostomus*)

Longnose suckers have long snouts that overhang a subterminal mouth, and they are found east of the Cascades, primarily in the Columbia River system. Compared to the largescale sucker, occurrence is somewhat limited in some of the larger river systems as longnose suckers constituted only 3 percent of the total number of suckers in the Columbia River, Lake Roosevelt, and the Spokane River (Wydoski and Whitney 2003).

During limnetic surveys in Lake Roosevelt, a small number of longnose sucker were captured, ranging in size from 200 to 700 mm (7.8 to 27.6 inches) (WDFW 2002). According to Lee et al. (2006), the relative abundance of longnose sucker in Lake Roosevelt has increased annually since 2002. Based on Lee et al. (2006), in 2004 longnose suckers were primarily observed from Hunters (USGS RM 660) upstream to the U.S.-Canadian border, and largescale suckers are most common downstream of Hunters. Gill net studies in 2003 revealed most longnose suckers were captured below 60 meters (BPA 2006c).

The longnose sucker is found in coldwater lakes and streams. Wydoski and Whitney (2003) report that longnose suckers recaptured during tagging studies in Box Canyon Reservoir were generally recaptured at the tag site or within 3 miles of the tagging location. A small number of fish were recaptured up to 6 miles from the tagging location. In the British Columbia reach of the Columbia River, nearly 33 percent of fish were recaptured near the tagging location, while the majority of the remaining fish were located 5 miles or less from the tagging location.

However, one fish in this study was located 20 miles from the tagging site, indicating that some individuals may have much more extensive home ranges (Wydoski and Whitney 2003).

Adult longnose suckers reach a length of 25 inches and weigh up to 7 lb, with females generally reaching larger sizes than males (Wydoski and Whitney 2003). Lee et al. (2006) conducted electrofishing and gill net surveys in Lake Roosevelt in 2004, which yielded 190 longnose suckers averaging 357 mm (14.0 inches) in length (± 92 mm SD) and 632 g (1.4 lb) in weight (± 357 g SD). The average lifespan is 8 years and the age at maturity appears to vary based on location (Wydoski and Whitney 2003). In a study conducted in Lake Roosevelt in 2004, 40 longnose sucker opercles (gill plates) indicated age ranged from 3 to 17 (BPA 2006d). However, these results were not considered reliable and it was recommended that scales be collected along with opercles to provide more accurate estimations.

In more northern latitudes, males appear to mature at age 4 and females at age 5 (Wydoski and Whitney 2003). Spawning takes place in swift riffles of streams where early spawners from lakes may remain up to 3 weeks. During spawning, females are accompanied by several males, who fertilize eggs broadcast on gravel substrate. The number of eggs per female correlates to the size of the fish and varies considerably from 10,000 eggs for smaller females to more than 60,000 for larger fish. Eggs broadcast on the gravel are whitish in color and cohesive. Hatched young may remain in the substrate for 1 to 2 weeks before moving from the spawning area (Wydoski and Whitney 2003).

Longnose suckers feed on a variety of materials including plants, bottom-dwelling organisms, small crustaceans, and fish eggs. In Lake Roosevelt, longnose sucker were found to feed primarily on midge larvae, with zooplankton, snails, caddisflies, bugs, spiders, stoneflies, and plant seeds constituting supplemental food (Wydoski and Whitney 2003). BPA (2004b) determined that longnose suckers consume cladocerans, copepods, aquatic worms, and snails. This diet overlapped significantly with bridgelip suckers (BPA 2004b).

Northern Pikeminnow (*Ptychocheilus oregonensis*)

The northern pikeminnow occurs north of southern Oregon and east to the Peace River in Alberta, Canada. In Washington, the species is found in the Columbia River system and coast and Puget Sound drainages, where they occupy lakes and areas of streams with slow to moderate currents. Pikeminnows are generally found in the shallows near shore in the summer, and move off to benthic habitats in the winter.

Based on tagging studies conducted in the UCR drainage, pikeminnow do not appear to have large home ranges. In the Box Canyon Reservoir, of the fish recaptured during a tagging study, over 25 percent were captured near tagging sites, while the remaining fish were recaptured 3 to 9 miles from the tagging location (Wydoski and Whitney 2003). However, only 1.1 percent of all fish tagged were recaptured, suggesting that those who were not recaptured may have traveled well beyond the recapture study area. Historically, the northern pikeminnow was the primary fish captured in gill net surveys in Lake Roosevelt, accounting for up to 65 percent of the total sample in 1948 (USFWS 1949), 54 percent in 1976 (Stober et al. 1977b), and 15 percent from 1980 to 1983 (USBR 1985). In recent studies, however, the northern

pikeminnow has generally constituted less than 5 percent of the species captured in gill nets (BPA 1997b and 1999).

According to Vigg and Burley (1991), the optimal growth temperature for northern pikeminnow is 21.5°C. In the Columbia and Snake rivers, females of this species appear to have longer life spans than males, with an average 16 years for females and 13 for males (Wydoski and Whitney 2003). WDFW (2002) analyzed northern pikeminnow ranging in age from 1 to 12 in Lake Roosevelt from 1998 to 1999 and determined that the fish ranged in length from 58 to 521 mm (2.2 to 20.5 inches) and weighed between 2 and 1,293 g (0.004 to nearly 2.9 lb). Lee et al. (2006) conducted electrofishing and gill net surveys in Lake Roosevelt in 2004, which yielded 46 pikeminnows averaging 263 mm (10.3 inches) in length (± 178 mm SD) and 461 g (roughly 1 lb) in weight (± 627 g SD). In 2004, BPA (2006c) collected scales from one northern pikeminnow, which was determined to be age 1 and 206 mm in length (8.1 inches).

Males begin to mature at age 3 and females at age 4, with all fish, regardless of sex, mature by age 5. Spawning generally occurs from May through early August, when water temperatures are within the range of 13.8 to 17.7°C. Spawning occurs over gravel, cobble, and rubble substrates in streams and lake shorelines. Females broadcast eggs, which many males attempt to fertilize. Fecundity ranges from 6,700 to 83,000 eggs per female, depending on the size of fish. In the Columbia River, eggs were observed to hatch in 7 days at 18.3°C. Following hatching, the yolk sac larvae drift for several days before settling in to warm, low-velocity shoreline and backwater habitats. The young become free-swimming 14 days after hatching (Wydoski and Whitney 2003).

Depending on life history stage, the diet of the northern pikeminnow is variable and opportunistic. Younger, smaller fish generally feed on aquatic and terrestrial insects (Wydoski and Whitney 2003). However, as the fish grow larger (generally over 4 inches long), the pikeminnow becomes piscivorous. Studies conducted in Lake Roosevelt revealed that the species consumes fish (including a high percentage of salmonids), leeches, worms, terrestrial insects, and crayfish (BPA 2005a and 2006c; WDFW 2002; Wydoski and Whitney 2003). BPA (2004b) determined that pikeminnows consume fish, daphnids, decapods, and aquatic worms. In addition, BPA (2004b) found that a moderate diet overlap exists between northern pikeminnow and smallmouth bass. During a 2004 survey, Lee et al. (2006) determined that snails (Physidae) were the most important diet item for the northern pikeminnow and that Castostomidae (suckers) were the most common fish consumed.

During studies conducted in Lake Roosevelt in 1997, salmonid prey constituted 17 percent of the northern pikeminnow diet by weight (Baldwin et al. 1999), indicating that they had the greatest individual potential as a salmonid predator due to their high consumption; however, their overall impact was limited because of their low relative abundance (BPA 2002b). In October 1999, northern pikeminnow in Lake Roosevelt consumed rainbow trout following a fall release of net pen rainbow trout (WDFW unpublished data, as cited in WDFW 2002).

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APPENDIX I

UCR CHEMICAL STRESSORS

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This appendix provides an overview of the chemical stressors present in environmental media of the Upper Columbia River (UCR). General concepts for stressor characterization outlined in the ERA guidance developed by EPA (1998) as well as elements of the EPA (2000) general framework for stressor identification have been used to develop this overview of stressors that are important in defining current conditions of the UCR.

Stressors are defined as the chemical, physical, or biological factors that singularly or cumulatively induce adverse biological responses in an ecological system (EPA 2000). In any given location, it is the interaction of stressors and the biological responses to them that, in part, influence the composition of ecosystems and the biological communities within them. A number of regional stressors present in the UCR are natural (e.g., stream flow, diseases), others reflect historical activities, and others are current activities. Chemical stressors reflect different sources of chemical contaminants. Physical stressors derive not only from operation of dams, but also from modification of habitat, erosion of banks along the UCR, and potentially from the physical effects of slag. Biological stressors can derive from management of the UCR's fisheries for desired species, introduced (invasive) species, and disease organisms. This appendix focuses solely on chemical stressors that have significant potential for adversely affecting the plants and animals in the UCR; an evaluation of important physical and biological stressors as they interact with and alter biotic responses to chemical stressors will be included in the baseline ecological risk assessment (BERA).

Prior investigations conducted by state and federal agencies have identified a number of chemicals (metals, metalloids, dioxins, furans, polycyclic aromatic hydrocarbons [PAHs], PCBs, and pesticides) that have been detected in the water, sediments, and tissues of aquatic organisms of the UCR. Many, including metals (e.g., copper, lead), metalloids (e.g., arsenic), and organic compounds (e.g., dioxins, PCBs), exhibit elevated concentrations that may pose stress to plants and animals (Cox et al. 2005; Era and Serdar 2001; Erickson et al. 2003). These chemicals can elicit a broad range of effects on organism growth, survival, and reproduction, depending on the magnitude and duration of chemical concentration, the bioavailability of the chemicals, and the types of species exposed (especially their life histories, life stages, and physiologies).

The distributions of chemical stressors evaluated in earlier studies of the UCR and in EPA's Phase I study conducted in 2005 (EPA 2006) are discussed in Section 5 of this work plan. Potential risks posed by the chemical stressors to both humans and ecological receptors will be evaluated as part of the risk assessment process.

Metals/Metalloids

A summary of the general toxicological and ecological effects on fish and wildlife receptors of metals and metalloids identified in the UCR is provided below.

Metals

Metals are ubiquitous in the UCR because they constitute the inorganic constituents of soil and rock, and are generated by point and nonpoint sources such as smelters, municipalities, and runoff from roads and highways. Some of the metals found in the UCR are metabolically essential (e.g., copper, zinc) and others (e.g., barium, magnesium) are not very toxic (Jones 1964; Tarzwell and Henderson 1960). Some of the essential elements (e.g., copper, selenium) have a narrow window of tolerance and can be toxic at relatively low doses. Other metals, such as cadmium or mercury, have no known biological function and are highly toxic. Aquatic life exposed to high levels of metals for short periods (i.e., acute exposures) suffer from improper sodium balance and subsequent osmoregulatory problems when the metals bind to the gill membranes (Di Toro et al. 2001).

Metals have a variety of modes of toxic action that vary by species and can stress organisms by impairing physiological function. In fish, for example, cadmium, copper, lead, inorganic mercury, nickel, silver, and zinc deactivate enzymes involved in fluid and electrolyte balance at specific surface membrane surfaces (Di Toro et al. 2001). They can also divert energy from growth into enzyme production, because organisms use metal-binding proteins and other processes to regulate, store, and excrete bioaccumulated metals (Munkittrick and Dixon 1988).

Metalloids

Metalloids in the UCR include arsenic, antimony, and selenium. They also occur naturally and are released from point and nonpoint sources. Arsenic and selenium are essential for certain biochemical functions of many organisms at low concentrations. In fish, the prominent effect of elevated arsenic is on enzyme function in the liver and bile duct (Cockell et al. 1992; Cockell and Bettger 1993). Consequently, fish consume less food, convert food to energy more poorly, and therefore grow more slowly. Selenium's effect on fish and wildlife appears to be similar. It is converted to organoselenium compounds in anoxic sediments and taken up by macroinvertebrates, and in turn is bioaccumulated by the fish and birds (e.g., sandpiper family, dabbling ducks) that feed on these macroinvertebrates (Fan et al. 2002). Its most pronounced and sensitive effect is on the development of fish and bird embryos (Lemly 2002; Spallholz and Hoffman 2002). Selenium and lead concentrate in the liver and substitute for sulfur or calcium in enzymes and other metabolic pathways, thereby disrupting reproduction and other life functions.

Organic Metals and Metalloids (Mercury, Selenium)

The primary toxic forms of mercury and selenium in aquatic environments appear to be as methyl mercury and organic selenium (e.g., selenomethionine). Both are methylated by bacteria in anoxic sediments, and biomagnified in the food chain. Methylmercury is well known for its neurological developmental effects. When present at sufficient concentrations, selenium counteracts the effects of mercury. Selenium exerts its effects through the organic forms, primarily selenomethionine. Fan et al. (2002) suggest that protein-bound selenomethionine rather than free selenomethionine is the form bioaccumulated in aquatic food chains.

Organic Compounds

A summary of the general toxicological and ecological effects on fish and wildlife receptors of organic compounds identified in the UCR is provided below.

Dioxins/Furans

Dioxins and furans are byproducts of incineration, such as burning of municipal waste, and are formed as a result of chlorination of wood in pulp mills. Dioxins and furans are among the most toxic chemicals to aquatic life and wildlife. They readily bioaccumulate in organisms, and because they resist degradation and excretion, they have the potential to biomagnify in aquatic and wildlife food chains. Their effects are similar to those of PCBs and possibly PAHs (Billiard et al. 2000), namely carcinogenesis, alteration of immune function, and impairment of embryonic development. A prominent effect in fish is blue sac disease (dioxins and furans reach the egg via maternal transfer), which causes high rates of mortality in young fish (Walker et al. 1996).

Polychlorinated Biphenyls

PCBs were historically widely used in a variety of industrial applications (e.g., as fire retardants and insulating fluids in transformers and capacitors). Because PCBs are resistant to degradation, they persist in the environment, and hence residues in the UCR may reflect historical uses. Their environmental persistence, biomagnification, and toxicity were first recognized in the late 1960s, when it was discovered that they behaved similar to highly chlorinated insecticides like 1,1,1-trichloro-2,2-bis(*p*-chlorophenyl)ethane (DDT) and chlordane. They mainly affect immune function and embryo development in fish and wildlife (Halter and Johnson 1974; Tilson and Kodavanti 1997). The most widely known effect is that on hatching success of bird eggs, specifically calcium deposition in the shells of eggs of fish-eating birds like osprey and bald eagles.

Pesticides

DDT and its degradation products dichloro-diphenyl-dichloroethane (DDD) and dichloro-diphenyl-dichloroethylene (DDE) are the principal pesticides detected in the UCR. Sources of DDT and its degradation products likely include point and nonpoint sources, runoff, and atmospheric deposition. These chemicals are extremely resistant to degradation and hence persist in the environment. For similar reasons, they are biomagnified in aquatic food chains and in wildlife (Biddinger and Gloss 1984; Hamelink et al. 1971). Like PCBs, dioxins, and furans, DDT and its degradation products affect embryonic development of fish and wildlife and eggshell formation in birds (Tilson and Kodavanti 1997).

Polycyclic Aromatic Hydrocarbons

PAHs are a broad class of compounds that are produced both naturally and by humans. Natural PAHs are produced by burning natural vegetation, with the soot from such fires as the source. Man-made PAHs are formed in internal combustion engines and in petroleum products including oil, grease, and asphalt. Creosoted timber and wood preservative manufacturing facilities historically also have been significant sources. PAHs tend to persist in the environment when they are present in forms that are not available to microorganism breakdown, such as in soot and when sorbed to or buried with organic matter. Because they

are readily metabolized by microorganisms, invertebrates, fish, and wildlife, they do not bioaccumulate significantly unless there is an active source. PAHs are known to affect liver function, alter immune function, and induce cancer in fish and wildlife, when they occur at high enough concentrations. Billiard et al. (2000) suggested that the effects of PAHs may share the same mechanism of toxicity as the more persistent and toxic chlorinated PAH compounds and dioxins. These effects consist of oxidative stress due to prolonged induction of the enzyme CYP1A1. It has been difficult to detect effects solely from PAHs and to interpret their significance because they are sublethal and in some ways similar to those of other hydrocarbons.

Polybrominated Diphenyl Ethers (PBDEs)

PBDE flame retardants are used in a wide variety of products, including electronics, foam, and textiles, and have been found to be widely distributed in the environment. The three most common commercial products are penta-BDE, octa-BDE and deca-BDE. These compounds are widespread and are associated with both point and nonpoint sources.

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