Appendix 29-A

Wetland Habitat Information Management (WHIM) Standard Operating Procedure (SOP)

ERM

WHIM-SOP
Wetland Habitat Information Management (WHIM) Standard Operating Procedure (SOP)

Rescan™ Environmental Services Ltd.
P.O. Box 3669 - 3790 Alfred Avenue
Smithers, BC Canada V0J 2N0
Tel: (250) 877-7838 Fax: (250) 877-7833

ERM

June 2013

WHIM-SOP

WETLAND HABITAT INFORMATION MANAGEMENT (WHIM) STANDARD OPERATING PROCEDURE (SOP)

June 1, 2013
Project #0194150-0010

Brief Description:
Methods of data collection, review, processing and storage for wetland data.
Key Contact:
Wade Burnham, Wetland Specialist

Prepared by:

ERM

ERM Rescan
Smithers, BC

Table of Contents

List of Tables

List of Plates

List of Appendices

1. Objectives

The objectives for wetland studies are to map the distribution and class of wetlands, conduct wetland surveys to ground-truth existing remote mapping, and describe wetlands according to their biophysical properties, landscape position, structure, and inferred function for the purpose of classification and assessment.

2. Applicable Standards and Guidelines

The standards and guidelines for wetland field inventories are based upon a variety of federal, provincial and international published standards for wetland identification, classification, and assessment.

Wetlands Class:

Warner, B. G. and C. D. A. Rubec, eds. 1997. The Canadian wetland classification system: The national wetlands working group. Waterloo, ON: Wetlands Research Centre. University of Waterloo.

Wetland Association:

MacKenzie, W. H., and J. R. Moran. 2004. Wetlands of British Columbia: a guide to identification. Res. Br., B.C. Min. For., Victoria, B.C. Land Manage. Handb. No. 52.

Soil moisture regime (SMR), soil nutrient regime (SNR) and wetland hydrodynamic index (HDI):

MacKenzie, W.H. 1999. *Field Description of Wetlands and Related Ecosystems in British Columbia*. Ministry of Forest Research Program. Victoria, B.C.

MacKenzie, W. H., and J. R. Moran. 2004. Wetlands of British Columbia: a guide to identification. Res. Br., B.C. Min. For., Victoria, B.C. Land Manage. Handb. No. 52.

RISC (1998). Standard for Digital Terrestrial Ecosystem Mapping (TEM) Data Capture in British Columbia Ecosystem Technical Standards and Database Manual. R. I. S. Commitee, Province of British Columbia.

Mineral soil drainage classes, mineral soil texture, and soil moisture subclass for organic soils adapted from:

MacKenzie, W.H. 1999. *Field Description of Wetlands and Related Ecosystems in British Columbia*. Ministry of Forest Research Program. Victoria, B.C.

Ministry of Forests (MOF). 1998. Field Manual for Describing Terrestrial Ecosystems. B.C. Min. Env., Lands and Parks and B.C. Min. of For., Land Manage. Handb. No. 25.. Victoria, B.C.

Descriptor for Litter, Fiber, and Humic layers on the soil surface adapted from:

Ministry of Forests (MOF). 1998. Field Manual for Describing Terrestrial Ecosystems. B.C. Min. Env., Lands and Parks and B.C. Min. of For., Land Manage. Handb. No. 25.. Victoria, B.C.

UBC. 2004 Soilweb: Soil Classification. 3.2 Forest Humus forms. Access from: http://www.landfood.ubc.ca/soil200/classification/soil_horizon.htm#3.2humus.

Von Post description of organic soils adapted from:

Ekono. 1981. Report on energy use of peat. Contribution to U.N. Conference on New and Renewable Sources of Energy, Nairobi.

Wetland Function:

Almas, A. R. and B. R. Singh. 2001. Plant Uptake of Cadmium-109 and Zinc-65 at Different Temperature and Organic Matter Levels. J. Environ. Qual. 30: 869-877

Brunham, W.G., L. Bendell. 2010. The Effect of Temperature on the Accumulation of Cadmium, Copper, Zinc, and Lead by *Scirpus acutus* and *Typha latifolia*: A Comparative Analysis. Water Air Soil Pollut (2011) 219: 417-428.

Hanson, A., L. Swanson, D. Ewing, G. Graba, S. Meyer, L. Ross, W. M., and J. Kirby. 2008. *Wetland Ecological Functions Assessment and Overview of Approaches*. Environment Canada Technical Report Series No. 497: Atlantic Region.

Lausen, C. (2006). Bat Survey of Nahanni National Park Reserve and Surrounding Areas, Northwest Territories. N.p., Prepared for Parks Canada and Canadian Parks and Wilderness Society.

Milko, R. 1998. *Wetlands environmental assessment guideline*. Minister of Public Works and Government Services Canada: n.p.

<u>Wetlands Habitat Form modified from:</u>

BC Forestry Ground Inspection Form: FS FS212-2(1) HRE 98/5-7610000694.

3. Required Training and Competency

Field Leader: Requires a minimum of a BSc in Biology, Ecology or a related study, and a combination of course work and field experience in biology, ecology, botany, hydrology, conservation, soil science, wetland identification, wetland delineation, wetland functional assessment, forestry, chemistry, demonstrating ability to identify and assess wetland habitats.

Field assistant: Not required to have specific educational training; the Rescan field leader will provide on-the-job training to the field assistant for required tasks. However, it is desirable that the field assistant have experience in wetland identification, vegetation identification or wetland delineation *or* suitable educational background to support knowledge in plant identification, soil, hydrology, geographic field surveys or habitat inventories.

All field workers are required to have certified First Aid training and receive in-house training for other field safety related topics including driving, use of helicopters and bear awareness.

4. Methods

4.1 WETLAND SURVEY

4.1.1 Equipment Preparation

Prior to field surveys, all equipment and field clothing are cleaned using a 1% Virkon solution to prevent the spread of *Batrachochytrium dendrobatidis* between wetland sites (Plate 4.1-1). *B. dendrobatidis* is a pathogen for amphibians.

Plate 4.1-1. Application of Virkon prior to and between wetland sites.

4.1.2 Selecting Wetland Survey Locations

Potential survey locations are selected by first examining in the office all data available from remote sensing techniques such as satellite imagery and Light Detection and Ranging (LIDAR) surveys, and by examining ecosystem classification maps. These preselected sites are then examined in the field to ensure they contain hydrophytic vegetation and/or water. If the site has either appropriate vegetation or water then a wetland survey is conducted.

Survey plots are established in areas of uniform vegetation in large wetlands (>400 m^2) or at the centre of wetlands smaller than 400 m^2. The edges of small wetlands are used as the survey plot boundary. The survey plot may include different levels of vegetation complexity and open water; however, each individual vegetation community within the wetland is described.

4.1.3 Physical Site Properties

Once a survey location has been selected a Wetland Habitat Information Form (WHIF) is completed (Appendix A). Two levels of survey intensity are used: complete and partial. A completed WHIF is required for a complete survey because this form contains fields for the vegetation, soil, and water properties of wetlands at the level necessary for classification. The partial survey intensity is only used to record the locations of continuously occurring ecosystems previously recorded during multiple complete wetland surveys.

At a minimum, the project ID, names of survey personnel, plot number, survey date, GPS coordinates, elevation, photograph numbers, dominant vegetation, and permanence class are recorded. The photograph numbers are the unique identification number used by a camera after a digital image is saved. A minimum of eight photographs must be taken at every survey location. The first photograph is taken facing true north and then again by turning clockwise and taking a picture every 45^{o}. Photographs of significant features such as soil, water, vegetation, and wildlife are also taken.

A clinometer and a compass adjusted to the appropriate declination are used to measure the slope and aspect of a survey location. An aspect of 0 and slope of -1 indicates level ground. Next, the meso-slope position is recorded. The meso-slope position is the position of the plot relative to the local catchment area (Table 4.1-1).

Table 4.1-1. Meso-Slope Position Descriptions

Meso-slope Position	Definition
Crest	Uppermost portion of a hill, convex in all directions, no distinct aspect.
Upper Slope	Generally the convex upper portion of the slope immediately below the crest of a hill; has a specific aspect.
Middle Slope	Area between the upper and lower slope has a straight or somewhat sigmoid surface profile with a specific aspect.
Lower Slope	The area toward the base of a slope; generally has a concave surface profile with a specific aspect.
Toe	The area demarcated from the lower slope by an abrupt decrease in slope gradient; seepage is typically present.
Depression	Any area, concave in all directions; may be at the base of a meso-scale slope or in a generally level area.
Level	Any level meso-scale area.

Adapted from BC MOF (1998).

The hydrogeomorphic position, which describes the topographic position and hydrology of a site, is then recorded (Table 4.1-2).

The previously described data represent the physical properties of each site and are used to support wetland classification and identification of wetland function.

4.1.4 Wetland Soil Survey

No less than three soil test pits or holes are established within a survey plot. The preferred method is to use an EDELMAN Dutch Auger (Plate 4.1-2). The soil test holes are established to a minimum depth of 40 cm or where significant contact with lithic, parent material, an impermeable layer, or water is made. As the test hole is established, lengths of soil collected in the auger barrel are pulled from the hole and arranged such that the profile of the soil can be examined (Plate 4.1-3).

Table 4.1-2. Hydrogeomorphic Position Descriptions

Hydrogeomorphic Position	Definition
Estuarine	Sites at the confluence of fluvial and marine environments.
Fluvial	Sites associated with flowing water, subject to flooding, erosion, and sedimentation.
Lacustrine	Sites at lakeside.
Basins and Hollows	Sites in depressions or topographic low points, receive water from groundwater or precipitation.
Ponds and Potholes	Sites associated with small water-bodies.
Seepage slopes	Sloping sites with near surface groundwater seepage.

Adapted from MacKenzie and Moran (2004).

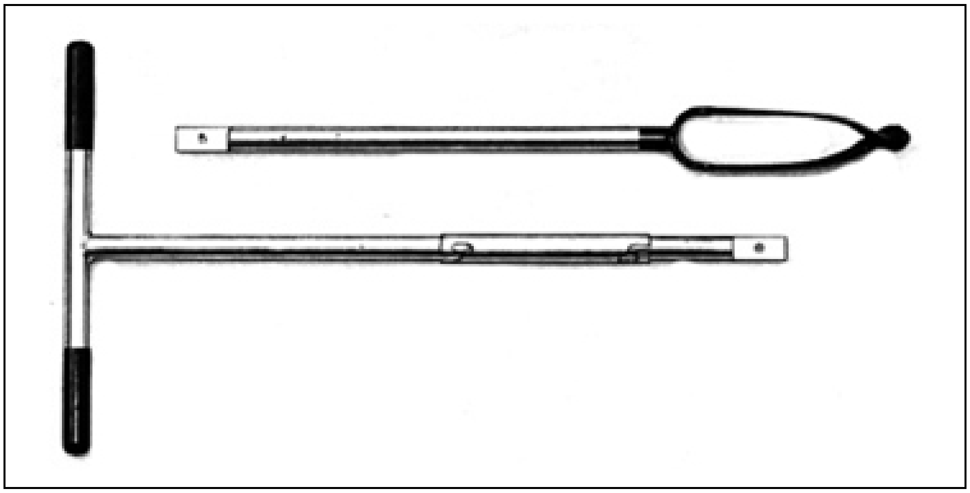

Plate 4.1-2. EDELMAN Dutch Auger

Plate 4.1-3. Soil core example.

Once the soil test holes have been established and the multiple cores have been examined, a representative core is selected for data collection. The soil moisture regime (SMR) is determined (Table 4.1-3).

Table 4.1-3. Soil Moisture Regime Descriptions

Soil Moisture Regime	Code	Definition
Moist	M	No water deficit (demand doesn't exceed supply), temporary groundwater table may be present. Generally supports forest.
Very Moist	VM	Rooting zone groundwater present during growing season. Groundwater table greater than 30 cm below ground surface. Can support limited forest.
Wet	W	Rooting zone groundwater present throughout the year. Groundwater table less than 30 cm below ground surface. Supports forest only on elevated micro-sites.
Very Wet	VW	Sites in depressions or topographic low points, receive water from groundwater or precipitation.

Adapted from MacKenzie and Moran (2004).

The Hydrodynamic Index (HDI) is then determined (Table 4.1-4).

Table 4.1-4. Hydrodynamic Index Descriptions

Hydrodynamic Index	Code	Definition/Indicators
Stagnant	St	Stagnant to very slow moving soil water, vertical fluctuations minimal, no evidence of flooding; lots of organic matter and high bryophyte cover.
Sluggish	Sl	Gradual groundwater movement; patterned fens; brief periods of surface aeration.
Mobile	Mo	Distinct flooding; open water tracks such as rivulets/ponds/potholes; well decomposed peat; patchy bryophyte cover.
Dynamic	Dy	Significant lateral flow and/or strong vertical fluctuations; pothole wetlands in arid climates; riparian/oxbow sites; little organic accumulation.
Very Dynamic	VD	Highly dynamic surface water; exposed tidal sites; shallow potholes that dry completely; no organic matter accumulation or bryophytes.

Adapted from MacKenzie and Moran (2004).

The soil nutrient regime (SNR) is determined (Table 4.1-5).

Table 4.1-5. Soil Nutrient Regime Descriptions

Soil Nutrient Regime	Code	Indicators
Very Poor	A	HDI St, von post 1-3, tea coloured or yellowish water, pH < 5
Poor	B	HDI St-Sl, von post 3-6, tea coloured or yellowish water, possibly green-brown or clear, pH 4.5 - 6
Medium	C	HDI St-Mo, von post 4-7, tea coloured, yellowish, green-brown, or clear water, pH 5-6.5
Rich	D	HDI Sl-Dy, von post 7-10, green-brown and turbid water, pH 6-7.4
Very Rich	E	HDI Mo-Dy, von post 8-10, green-brown and turbid water, pH 6.5-8
Hyper	F	Excess salt accumulation, pH > 8, high conductivity

Adapted from MacKenzie and Moran (2004).

The presence of mineral soils is determined by identifying indicators of mineralization such as gleying, mottling, oxidization, or mineral soil texture (silt, sand, or clay). The mineral soil drainage class is identified (Table 4.1-6).

Table 4.1-6. Drainage Class for Mineral Soils

Drainage Class	Description
Very Rapid	Water is removed from the soil very rapidly in relation to supply. Water source is precipitation and available water storage capacity following precipitation is essentially nil. Soils are typically fragmental or skeletal, shallow, or both.
Rapid	Water is removed from the soil rapidly in relation to supply. Excess water flows downward if underlying material is pervious. Sub-surface flow may occur on steep gradients during heavy rainfall. Water source is precipitation. Soils are generally coarse textured.
Well	Water is removed from the soil readily, but not rapidly. Excess water flows downward readily into underlying pervious material or laterally as sub-surface flow. Water source is precipitation. On slopes, sub-surface flow may occur for short durations, but additions are equalled by losses. Soils are generally intermediate in texture and lack restricting layers.
Mod. Well	Water is removed from the soil somewhat slowly in relation to supply because of imperviousness or lack of gradient. Precipitation is the dominant water source in medium- to fine-textured soils; precipitation and significant additions by sub-surface flow are necessary in coarse-textured soils.
Imperfectly	Water is removed from the soil sufficiently slowly in relation to supply to keep the soil wet for a significant part of the growing season. Excess water moves slowly downward if precipitation is the major source. If sub-surface water or groundwater (or both) is the main source, the flow rate may vary but the soil remains wet for a significant part of the growing season. Precipitation is the main source if available water storage capacity is high; contribution by sub-surface or groundwater flow (or both) increases as available water storage capacity decreases. Soils generally have a wide range of texture, and some mottling is common.
Poorly	Water is removed so slowly in relation to supply that the soil remains wet for much of the time that it is not frozen. Excess water is evident in the soil for a large part of the time. Sub-surface or groundwater flow (or both), in addition to precipitation, are the main water sources. A perched water table may be present. Soils are generally mottled and/or gleyed.
Level	Water is removed from the soil so slowly that the water table remains at or near the surface for most of the time the soil is not frozen. Groundwater flow and sub-surface flow are the major water sources. Precipitation is less important, except where there is a perched water table with precipitation exceeding evapotranspiration. Typically associated with wetlands.

Adapted from BC MOF (1998).

If mineral soils are present within the top 40 cm of the soil surface, then the mineral soil texture is determined using the soil texture triangle (Plate 4.1-4).

If organic soils are present (i.e., no mineral soil indicators within top 40 cm of soil surface), then the moisture sub-class of organic soils is identified (Table 4.1-7).

The organic soil texture is recorded (Table 4.1-8).

The depth of the surface organic layer is measured and recorded. Where the depth of the organic layer exceeds the test pit a plus sign (+) is used. For example, an organic soil depth of +120 cm indicates that 120 cm of organic soil was measured but the organic layer extends beyond that depth.

The humus form is recorded (Table 4.1-9).

The depth to the bottom of the rooting zone and the von post level of decomposition are measured and recorded (Table 4.1-10).

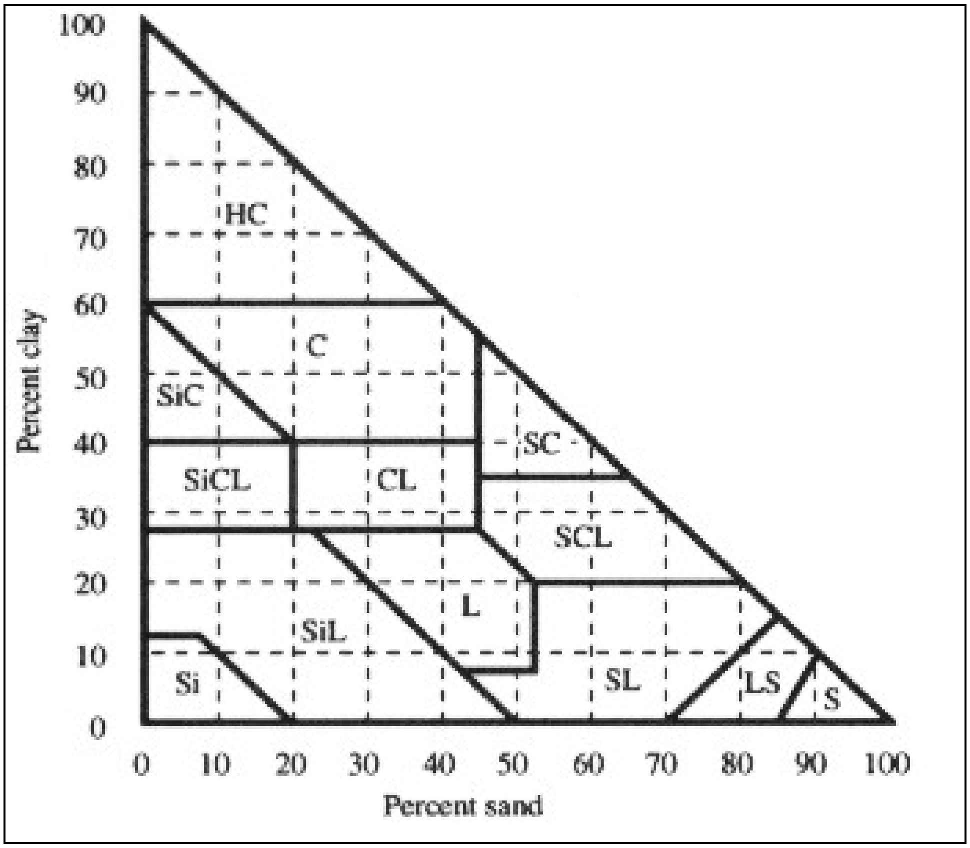

Plate 4.1-4. Soil texture triangle (BC MOF 1998).

Table 4.1-7. Moisture Sub-Class of Organic Soils

Moisture Sub-class	Description	Saturation Period (months)
Aqueous	Free surface water	11.5 to 12
Peraquic	Soils saturated for very long periods	>10
Aquic	Soils saturated for moderately long periods	4-10
Subaquic	Soils saturated for short periods	<4
Perhumid	No significant water deficits in growing season	<2
Humid	Very slight deficit in growing season water availability	<0.5

Adapted from BC MOF (1998).

Table 4.1-8. Organic Soil Texture

Texture	Description	Corresponding Von Post
Fibric	Visible and identifiable plant part, soil water clear	1-3
Mesic	Some visible plant parts, soil water slightly coloured	4-7
Humic	Indiscernible plant parts, dark greasy soil	8-10

Table 4.1-9. Descriptions of Humus Form

Humus Form	LFH Horizons		Transition to Overlying Horizon
	L/F	*H*	
Mull	*Thin or absent*	*Absent*	Gradual
Moder	*Moderate*	*Moderate*	Not abrupt
Mor	*Matted and thick*	*Thin*	Very abrupt

LFH is the breakdown of the Litter, Fiber, and Humic layers on the soil surface.
Adapted from BC MOF (1998) and UBC (2004).

Table 4.1-10. Von Post Description

Von Post	Description
1	Completely undecomposed peat which, when squeezed, releases almost clear water. Plant remains easily identifiable. No amorphous material present.
2	Almost entirely undecomposed peat which, when squeezed, releases clear or yellowish water. Plant remains still easily identifiable. No amorphous material present.
3	Very slightly decomposed peat which, when squeezed, releases muddy brown water, but from which no peat passes between the fingers. Plant remains still identifiable, and no amorphous material present.
4	Slightly decomposed peat which, when squeezed, releases very muddy dark water. No peat is passed between the fingers but the plant remains are slightly pasty and have lost some of their identifiable features.
5	Moderately decomposed peat which, when squeezed, releases very “muddy” water with a very small amount of amorphous granular peat escaping between the fingers. The structure of the plant remains is quite indistinct although it is still possible to recognize certain features. The residue is very pasty.
6	Moderately highly decomposed peat with a very indistinct plant structure. When squeezed, about one-third of the peat escapes between the fingers. The residue is very pasty but shows the plant structure more distinctly than before squeezing.
7	Highly decomposed peat. Contains a lot of amorphous material with very faintly recognizable plant structure. When squeezed, about one-half of the peat escapes between the fingers. The water, if any is released, is very dark and almost pasty.
8	Very highly decomposed peat with a large quantity of amorphous material and very indistinct plant structure. When squeezed, about two-thirds of the peat escapes between the fingers. A small quantity of pasty water may be released. The plant material remaining in the hand consists of residues such as roots and fibres that resist decomposition.
9	Practically fully decomposed peat in which there is hardly any recognizable plant structure. When squeezed it is a fairly uniform paste.
10	Completely decomposed peat with no discernible plant structure. When squeezed, all the wet peat escapes between the fingers.

Adapted from Ekono (1981).

The soil description is completed by estimating the percentage of coarse fragments, measuring the depth of soil horizons (depth of organic layer, depth of mineral layer, depth to water, and rooting depth). A soil profile is drawn in the appropriate location on the WHIF and depth to all features is indicated.

4.1.5 Wetland Vegetation Survey

Vegetation species within the survey plot are identified and their seven letter acronym is recorded in the appropriate section of the field form. For example, common cattail (*Typha latifolia*) is recorded as TYPHLAT in the forb section.

The percent cover of each individual species and species guilds (Tall Tree, Tree/Shrub, Forb, and Bryophyte) are estimated. A tall tree is a tree standing over 5 m. A tree/shrub is a tree less than 5 m tall or any multiple stemmed woody vegetation. A forb is any herbaceous plant including graminoids, *Equisetum*, and club-mosses. Bryophytes are mosses and lichens. The level of vegetation survey is indicated as complete or partial. A complete vegetation list is not essential; however, it is imperative that the dominant and sub-dominant vegetation (upland, emergent, submerged aquatic, and floating-leaved aquatic) be recorded.

4.1.6 Wetland Water Survey

Measurements and documentation of the optical and chemical characteristics of water within the wetland survey location are made. The WHIF includes space for data from up to three water features. The colour of the water is described as: (1) Tea Coloured, (2) Yellow-Deep Brown Turbid, (3) Green-Brown Clear, (4) Green-brown Turbid, or (5) Blue-green Clear.

The pH of open water is measured using a handheld sonde such as an Oakton Instruments pH Testr 10 (Plate 4.1-5). The conductivity of open water is also measured using a handheld sonde such as an Oakton Instruments TDSTestr Low.

Plate 4.1-5. Oakton Instruments pH Testr 10 measuring pH of shallow groundwater in a soil test hole.

4.1.7 Wetland Classification

The water, soils, and vegetation information collected during the field surveys are used to classify the wetlands to federal class (Warner and Rubec 1997) and association type (Thompson and Hansen 2001). Wetland sites are initially assigned to one of five federal classes (Table 4.1-11), in accordance with the Canadian Wetland Classification System (Warner and Rubec 1997). Wetland class is based on general site characteristics such as soil type and the extent and quality of predominant vegetation cover.

Table 4.1-11. Description of Federal Wetland Classes

Federal Wetland Class	Description
Bog	Nutrient poor peatland, receiving water exclusively from precipitation.
Fen	Nutrient medium peatland, receiving water from groundwater and precipitation.
Marsh	Nutrient rich mineral wetland; vegetation dominated by graminoids, forbs, shrubs and emergent plants.
Swamp	Nutrient rich mineral wetland; vegetation dominated by woody plants > 1 m in height.
Shallow open water	Wetland with free surface water up to 2 m depth; less than 25% of surface area occluded by emergent or woody plants.

Source: Warner and Rubec (1997).

Wetland association classification is based on the specific vegetation composition characteristics of a given site. The environmental conditions at a wetland influence the development of plant communities, thereby affecting species reproduction and the floristic diversity throughout the vegetation layers. Thus, sites with similar environmental conditions develop similar vegetation communities.

The dominant vegetation species recorded during the field surveys are matched to an association type described in the classification system prepared by MacKenzie and Moran (2004). The list of species, identified at some sites, may not always match a particular association type. In such cases, sub-dominant vegetation species are used to aid classification.

4.2 WETLAND FUNCTION STUDIES

The determination of wetland function is central to the process of wetland effects analysis. The primary wetland functions within a study area are determined by comparing wetland classification and hydrogeomorphic position data to a list of functions associated with wetland classes prepared by Hanson et. al (2008). Additionally, specific studies are conducted at a sample of wetlands to establish baseline data on the vegetation tissue metal concentrations and wetland hydrology. Milko (1998) identifies four primary functions, and Table 4.2-1 identifies which data are used to support descriptions of these functions.

Table 4.2-1. Wetland Functions and Supporting Data

Wetland Function	Description (Environment Canada 1998)	Supporting Data
Hydrological	Contribution of the wetland to the quantity of surface water and groundwater	Static and continuous hydrology survey; Wetland permanence classification
Biogeochemical	Contribution of the wetland to the quality of surface water and groundwater	Water quality data (pH and Conductivity), Vegetation tissue samples
Habitat	Relative abundance of terrestrial and aquatic habitat and connectivity to surrounding ecosystem	Wildlife observations and Association classification
Ecological	Role of the wetland in the surrounding ecosystem	Association classifications Wetland complex, size, Open water area and permanence

4.2.1 Vegetation Sampling

Plant tissue samples are collected in triplicate at select wetlands within the study area to establish baseline metal concentrations. Sample sites are chosen ensuring a variety wetland sizes and permanence are reflected in the sampling.

Samples are collected by collecting above ground portions of the plant and placing them in individual 1 L Ziploc bags. The individual collecting the samples must wear latex gloves to reduce potential of contamination from one sample to the next. At each site three bags are filled, each containing multiple individuals from three distinct areas within the wetland site. This method ensures adequate individual and geographic variability in sample collection.

Samples are stored in a cool, dark, environment until shipped to ALS Environment in Vancouver, BC, for analysis. Table 4.2-2 lists the analytical parameters and their detection limits.

Table 4.2-2. Metal Analysis and Associated Detection Limits for Plant Tissue Samples

Metal	Abbreviation	Dry Weight Detection Limit (mg/kg)	Average Wet Weight Detection Limit (mg/Wkg)
Aluminum	Al	10	2.7
Antimony	Sb	0.05	0.0135
Arsenic	As	0.05	0.0135
Barium	Ba	0.05	0.0135
Beryllium	Be	0.3	0.135
Bismuth	Bi	0.3	0.0405
Cadmium	Cd	0.03	0.00675
Calcium	Ca	10	2.7
Chromium	Cr	0.5	0.135
Cobalt	Co	0.1	0.027
Copper	Cu	0.05	0.0135
Lead	Pb	0.1	0.027
Lithium	Li	0.5	0.135
Magnesium	Mg	3	1.35
Manganese	Mn	0.05	0.0135
Mercury	Hg	0.005	0.001
Molybdenum	Mo	0.05	0.0135
Nickel	Ni	0.5	0.135
Selenium	Se	1	0.27
Strontium	Sr	0.05	0.0135
Thallium	Tl	0.03	0.0135
Tin	Sn	0.2	0.0675
Uranium	U	0.01	0.0027
Vanadium	V	0.5	0.135
Zinc	Zn	0.5	0.135

All metals with more than 50% of samples below the method detection limit are excluded from further analysis. For the remaining metals, all values below detection limits are replaced by one-half the detection limit. General descriptive statistics of the remaining metals are calculated. Variability is assessed for each wetland site using the coefficient of variation (CV = [Standard Deviation/Mean] x 100).

5. Data Recording, Processing and Storage

Once field data surveys are complete, data sheets are scanned to a pdf document which is stored on the Rescan intranet and data are then entered into MS Excel spreadsheets. The physical site data, soil information, and classification data are entered into a wetland ecosystem master datasheet. The vegetation species list and relative percent cover are entered into a separate sheet, as are any wildlife observations. The wetland ecosystem master sheet is the base information used to generate GIS maps of wetlands.

Wetlands are delineated in ArcGIS 10.0 using available digital spatial data, wetland survey locations, and high resolution satellite imagery. A point file of the wetland ecosystem master data are added to the data view and wetland polygons are delineated by tracing wetland features visible on the satellite image. The area of delineated wetland polygons are then calculated using the geometry function in ArcGIS 10.0. The spatial database containing the delineated wetland polygon information is joined to the ecosystem database through the spatial join function in ArcGIS 10.0.

The electronic files are regularly uploaded to Rescan's intranet and stored in a dedicated folder which is backed up on a daily basis.

6. QA/QC

6.1 DATA QUALITY PROGRAM

Data are entered into an established Excel data sheet with standardized fields to reduce the possibility of transcription errors. Data are screened using pivot table functions within Excel to determine that parameters such as von post, align with SNR, and vegetation species. Ecosystem data are related and can be used to identify transcription or field identification errors. Whenever clarification is required on specific points, the WHIF will be returned to the field crew for editing and will be accepted after the necessary changes are made.

Regular instrument calibration of the pH and conductivity sondes ensures good data quality collected during field recording of pH and conductivity.

Vegetation tissue samples are collected in triplicate to reduce the likelihood of contaminated samples biasing the data from a single wetland. ALS is an accredited laboratory and provides replicate analysis to ensure consistency during the data analysis stage.

6.2 QUALITY INDICATORS

The following Quality Indicators will be measured to track the overall success of the wetlands program:

- the wetlands surveyed are spatially representative of the study area.

6.3 CONTINUAL IMPROVEMENT

The science of wetlands is continuously evolving, resulting in improvements in the techniques of mapping and field data collection. During these projects, predictive models using LIDAR and basin depth structure will be explored to better classify wetland permanence of sites prior to field investigations.

The procedures outlined in this manual will be reviewed and updated annually to account for changes in regulatory requirements, technological advances, and to adhere to the best current scientific practices.

Appendix A

Wetland Habitat Information Form

ERM

WETLAND HABITAT INFORMATION FORM

Rescan Engineers & Scientists

W ☐ T ☐	PHOTO	X:	Y:	DATE

PROJECT ID	SURV.
MAPSHEET	PLOT #

UTM ZONE	NORTH	EAST

ASPECT	ELEVATION

SLOPE %	SMR	HDI	SNR

MESO SLOPE POSITION	☐ Crest ☐ Upper slope	☐ Mid slope ☐ Lower slope ☐ Toe	☐ Depression ☐ Level
HYDROGEO-MORPHIC POSITION	☐ Estuarine ☐ Fluvial	☐ Lacustrine ☐ Ponds & Potholes	☐ Basins & Hollows ☐ Seepage Slopes
DRAINAGE - MINERAL SOILS	☐ Very rapidly ☐ Rapidly	☐ Well ☐ Mod. well ☐ Imperfectly	☐ Poorly ☐ Very poorly

MINERAL SOIL TEXTURE	☐ Sandy (LS,S) ☐ Loamy (SL,L,SCL,FSL)	☐ Silty (SiL,Si) ☐ Clayey (SiCL,CL,SC,SiC,C)

MOISTURE SUBCLASSES ORGANIC SOIL	☐ Aqueous ☐ Peraquic	☐ Aquic ☐ Subaquic	☐ Perhumid ☐ Humid

ORGANIC SOIL TEXTURE			SURF. ORGANIC HORIZON THICKNESS
☐ Fibric	☐ Mesic	☐ Humic	___________ cm
HUMUS FORM			ROOTING DEPTH
☐ Mor	☐ Moder	☐ Mull	Depth ______ cm Type ____________

VON POST	

1	2	3	4	5	6	7	8	9	10

COARSE FRAGMENT CONTENT

☐ < 20% ☐ 20-35% ☐ 35-70% ☐ > 70%

ECOSYSTEM	COMPONENT: ☐ WL1 ☐ WL2 ☐ WL3
BGC UNIT	WETLAND CLASS
SITE SERIES	ASSOCIATION
STRUCTURAL STAGE	MODIFIER

WETLAND POLYGON SUMMARY

	%	CLASS	ASSOCIATION
WL1			
WL2			
WL3			

WB-RES10-01 100510

WETLAND MAP

Features to include: North arrow, wildlife features, open water, slope, vegetation communities, wetland boundary, direction of water flow, soil core locations.

NOTES

DOMINANT / INDICATOR PLANT SPECIES

TOTAL %	TALL TREE	TREE / SHRUB	FORB	BRYOP.

TREE / SHRUB	%	FORB	%	FORB cont'd	%
				BRYOP.	%

☐ COMPLETE ☐ PARTIAL

WATER COLOUR		
	☐ Tea Coloured	☐ Green-Brown Turbid
	☐ Yellow-Deep Brown Turbid	☐ Blue-Green Clear
	☐ Green-Brown Clear	

pH	CONDUCTIVITY	% OPEN WATER	DEPTH TO WATER

SOIL PROFILE	WILDLIFE OBSERVATIONS	
	SPECIES	FEATURE

Adapted from Ground Inspection Form: FS FS212-2(1) HRE 98/5-7610000694