



**PRE-DEVELOPMENT ASSESSMENT PROTOCOL
FOR WELL SITES AND ACCESS ROADS FOR THE
MIST MOUNTAIN COALBED GAS PROJECT**

**Report Prepared for:
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1.0 INTRODUCTION

BP Canada Energy Company (BP Canada) is undertaking a project to explore the commercial viability of coalbed gas (CBG) production in the Crowsnest Coal Field of southeastern British Columbia. The feasibility of BP Canada's Mist Mountain Project (the project) will, in part, be determined by the drilling of exploration wells over a period of several years starting as early as 2008.

As part of BP Canada's on-going environmental assessment program, Matrix Solutions Inc. (Matrix) was contracted by BP Canada to develop a pre-development assessment (PDA) process and protocols in advance of the proposed start of the exploration drilling program in 2008.

2.0 SCOPE OF WORK (OBJECTIVES)

The primary objective of this work plan is to document the protocols and procedures for collecting baseline information that will be used: (1) to describe the current biophysical setting; (2) to identify project-specific impacts; and (3) to provide impact mitigation recommendations and procedures for each well lease and access road prior to development. A secondary objective includes the collection of biophysical data in the immediate vicinity of the proposed disturbances (i.e., well site and access road) that will be provided to the project sub-consultants for their on-going baseline "regional" studies for the entire Mist Mountain Project area.

3.0 LITERATURE REVIEW

Protocols were developed following a review of regulatory requirements and procedures for PDAs in both British Columbia and Alberta.

In British Columbia, British Columbia Oil and Gas Commission (OGC) documents, although applicable to the Mist Mountain project very generally, provide specific requirements for only the conventional oil and gas operating areas of northeast British Columbia. The OGC (2005a;



2005b) provide directions and guidance for best management practices (BMPs) for oil and gas exploration in British Columbia while the *Application Resource Book* (OGC, 2007) provides general information for archaeological assessments, stream crossings, timber salvage, and reclamation practices.

In Alberta, the Energy Resources Conservation Board (ERCB) (formerly Alberta Energy and Utilities Board [AEUB]) requires that applicants assess each well site and access road and develop plans to conserve, reclaim and mitigate the effects of its activities (AEUB, 2007). Prior to construction or preparation of a well lease site or a well access road, the applicant is expected to meet the requirements and guidelines in all current and applicable Alberta Environment (AENV) informational letters (e.g., environmentally sensitive areas, revegetation with native species, and natural recovery methods). Alberta Sustainable Resource Development (ASRD) (2004) through *Instructions for Submission of Environmental Field Reports with Surface Disposition Applications Under the Public Lands Act* and AENV (2005) through the *Code of Practices for Exploration Operations* provide guidelines, but limited procedural information, on the collection and reporting of environmental information for exploration developments in Alberta.

In summary, the reviewed documents provide guidance for heritage resources, timber harvesting, stream crossing assessments, and reclamation practices but a standardized comprehensive PDA process with detailed sampling and reporting protocols does not exist in either jurisdiction. To provide BP Canada and stakeholders with reference criteria, a comprehensive PDA work plan was prepared specific to the Mist Mountain Project based on BMPs.

4.0 METHODOLOGY

4.1 Introduction

All personnel working for Matrix on this project will follow the safe work practices detailed in the Matrix and BP Canada Health, Safety, Security, and Environmental (HSSE) Assurance Plans for the project. Any additional safety standards and requirements presented by BP Canada will be reviewed and respected throughout the PDA process.



The general approach to PDAs will follow the tasks listed below.

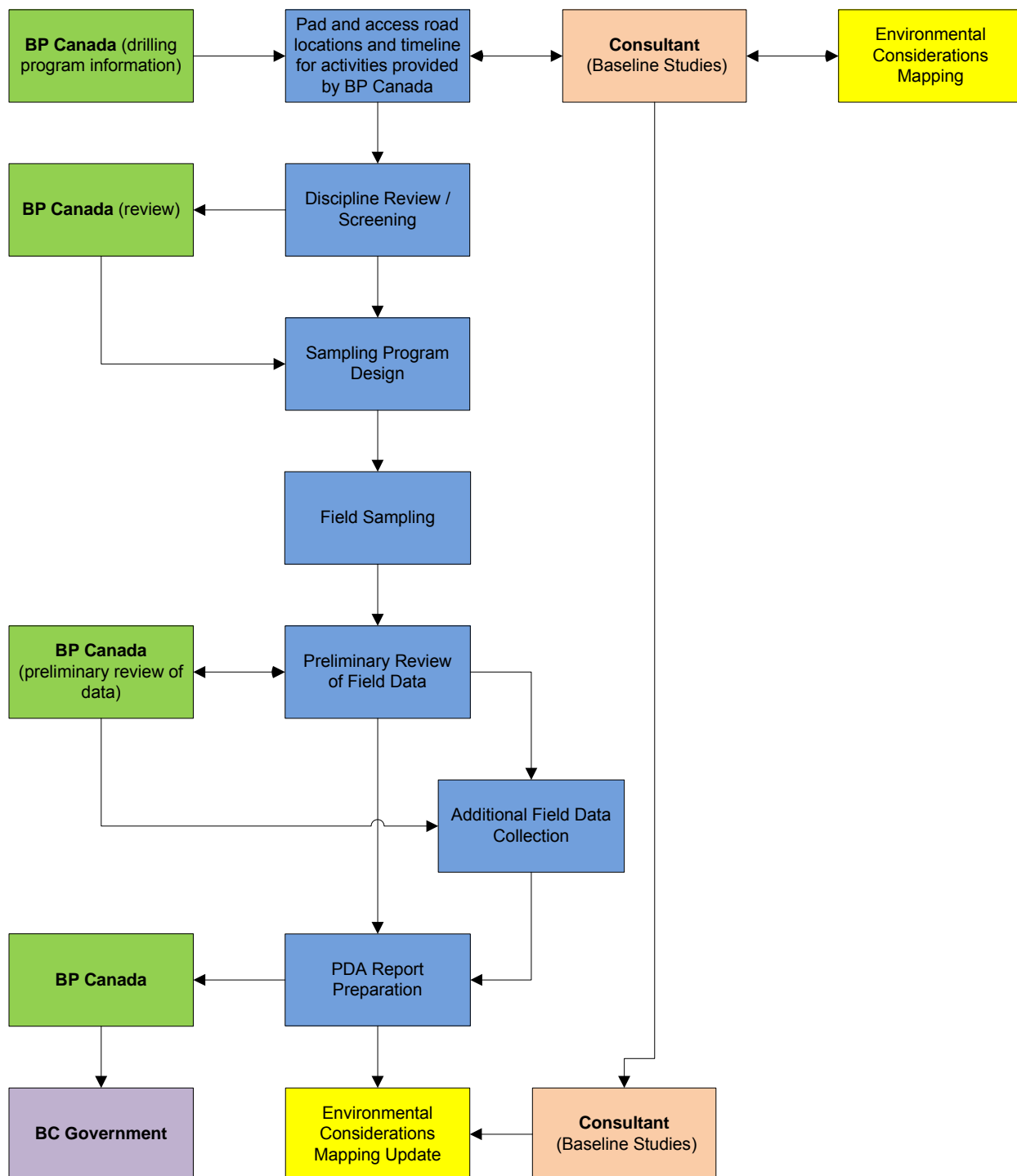
- obtain electronic copies of site diagrams (well and road locations) from BP Canada;
- request copies of data and reports for the proposed well and road locations from BP Canada and from Tembec Forest Industries (Tembec) and/or Elk Valley Coal Corporation (EVCC) via BP Canada;
- establish a PDA team, including identified leaders for each discipline;
- the PDA project manager will compile relevant documentation (i.e., budget, scope-of-work, tenure information as it becomes available, supporting technical, and regulatory reports) and provide to identified discipline leaders;
- discipline leaders will review provided documentation;
- complete an impact screening meeting to determine level of effort required for each discipline;
- in cooperation with BP Canada, contact regulators (i.e., regional discipline specialists) for input into the sampling program;
- design the office (desktop) and field program;
- meet with the client to discuss the proposed approach;
- revise the office and field program;
- prepare field maps using well site and access road disturbance layers, LIDAR, Predictive Ecosystem Mapping (PEM) and/or Terrestrial Ecosystem Mapping (TEM) maps;
- arrange for line location at proposed sites;
- conduct field assessments using Full, Ground Inspection (GIF), and Visual forms during snow free months with active vegetative growth;
- summarize results and prepare maps (results will be summarized in a technical document with tables designed so that information can be transferred easily to the OGC data forms);
- update the environmental considerations mapping database; and
- prepare a report, including recommendations.

Throughout the process, Matrix personnel will keep BP Canada apprised of field schedules and findings. Discipline-specific procedures are described in the following sections.

A general work flow diagram is provided in Figure 1.



FIGURE 1. General Work Flow Diagram



4.2 Assessment Areas

Based on the proposed exploration plans provided by BP Canada, detailed assessments will be conducted within the exploration well sites and the 100 m and 500 m buffer areas as well as along new access roads and/or along existing roads which need to be upgraded. Examples of road upgrades include road width changes, road grade or slope changes, and culvert repairs. Visual inspections will be conducted along existing roads where only general road maintenance is required. Access roads, well sites, aquatic setbacks (50 m or 100 m) and a 500 m wildlife buffer will be delineated on field maps prior to field work.

4.3 Surficial Geology and Soil Sampling

Surficial geology (terrain) and soil data will be collected for each well site and access road. The focus of the terrain and soil sampling program will be to identify geographical information system (GIS) map polygons within the proposed well sites and road access areas. Typically, two or more physical attributes (e.g., topographic attributes such as slope, aspect, and / or slope profile curvature) are used to identify homogeneous and heterogeneous patterns, thereby establishing “representative” plot locations. Plots will be established and inspected in each polygon to ensure that a topsoil stripping plan can be provided (i.e., stripping depths are determined) which can be effectively implemented during the construction of the well site or access road (if construction is required). Soil stockpile volumes will be calculated from the sample data, and a stockpile management plan will be developed.

The sampling of linear disturbances such as access roads will involve the establishment of plots established along transects at 100 m intervals. The spacing between sampling points may be either equal (preferred methodology), nested or random. Changes in topography or other biophysical features may necessitate a change in sampling density. The proposed sampling program is more or less consistent with the very detailed survey intensity level 1 (SIL1) described by the Resource Inventory Committee (1995). Map polygons will be delineated in the field where possible.

Soil pits will be hand dug with a shovel and/or soil auger to a depth of one metre because of the need to identify topsoil and subsoil stripping depths. Terrain and soil profile descriptions will be recorded on British Columbia Ministry of Forests and Range (MFR) FS882 field data forms and



samples will be collected at each plot. A subset of the collected samples will be analysed for physical and chemical properties (i.e., texture, pH, soil nutrients, cation exchange capacity [CEC], sodicity, calcium [Ca], magnesium [Mg] and manganese [Mn]). Terrain and soil profile data coding will follow Howes and Kenk (1997) and the Province of British Columbia (1998). Soil classification will follow the *Canadian System of Soil Classification* (Soil Classification Working Group, 1998). All ground disturbance activities will follow BP Canada's safety protocols and will be cleared by BP Canada safety representatives prior to conducting field activities. Line location assessments will be undertaken prior to any ground disturbances.

Existing terrain (Ryder, 1981) and soils (Lacelle, 1990) maps as well as Tembec pre-harvest silvicultural prescriptions (PHSPs) will be reviewed during sampling program design.

A work flow diagram for terrain and soils is provided in Figure 2.

4.4 Ecosystem Sampling and Rare Plant Surveys

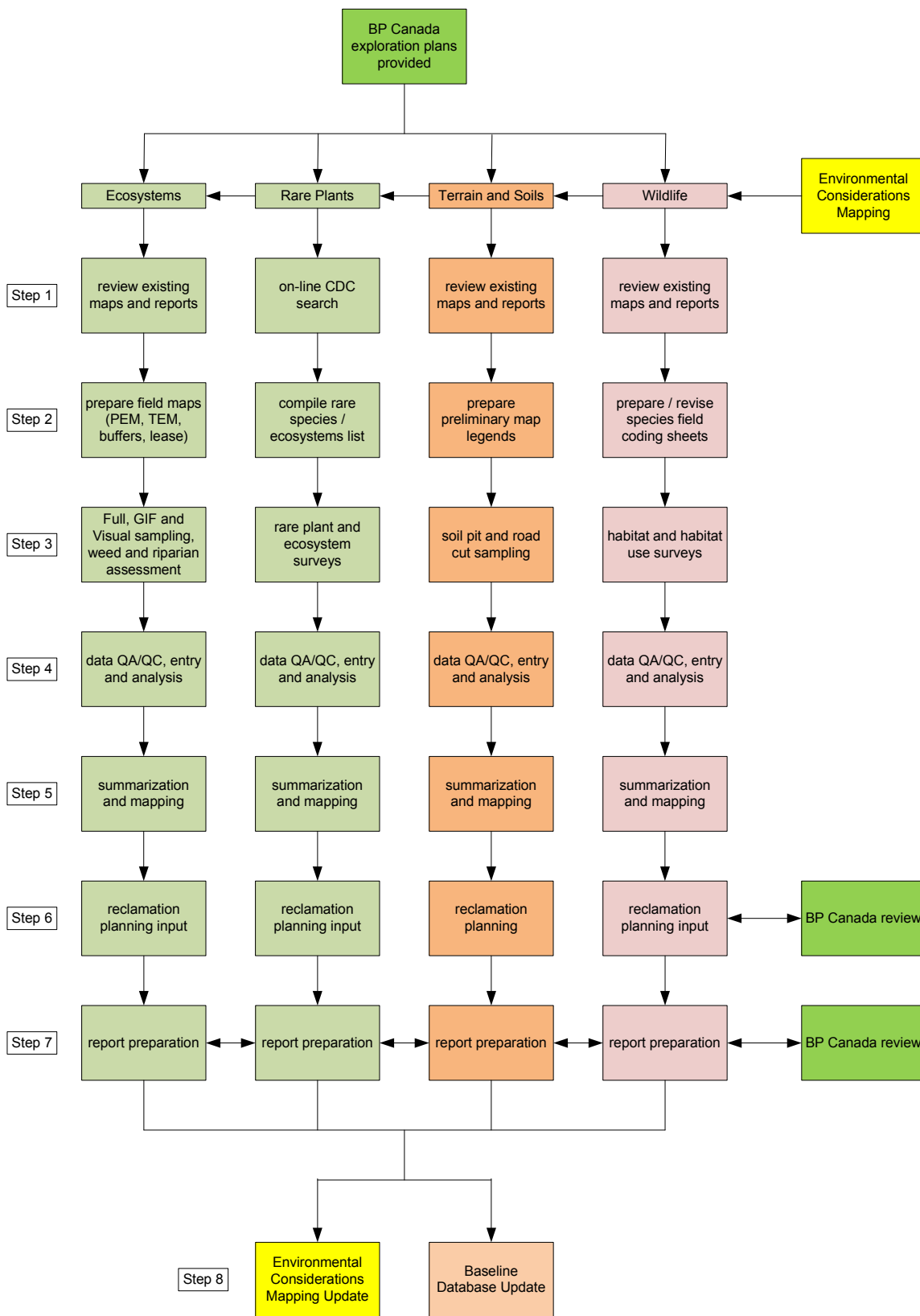
4.4.1 Ecosystems

The ecosystem sampling system will follow the procedures described previously for terrain and soils. Prior to sampling, biogeoclimatic subzone and variant maps will be reviewed and ecosystem unit working legends will be prepared. Well site and access road site plans, and silvicultural plans and/or developments provided by the Forest Tenure Holder (Tembec) will be reviewed for site specific information where available.

Field data will be recorded on the British Columbia MFR FS882 data forms according to the procedures described by Luttmerding et al. (1990) and the Province of British Columbia (1998). Species cover by layer will be recorded within 10 m x 20 m or 20 m x 20 m macroplots. Environmental data (e.g., transect number, date, northing and easting, elevation [metres], aspect [°], slope [%], macro-slope and meso-slope position, ecological moisture and nutrient regime, succession status and structural stage, surface substrate [bedrock, rocks, mineral soil, wood, organic matter and water], exposure, flooding hazard, soil drainage and perviousness) will be recorded as well. Re-colonization and revegetation potential of native vegetation species will be assessed. Ecosystems will be classified according to Lloyd et al. (2006).



FIGURE 2. Work Flow Diagram for Terrestrial Resources



4.4.2 Rare Plants and Ecosystems

The primary objective of the rare plant survey (RPS) will be to locate British Columbia Conservation Data Centre (CDC) listed plants and ecosystems that would be directly affected by the well site and access road construction.

The E-Flora BC qualitative and quantitative RPS sampling protocols (Klinkenberg, 2007) will be followed.

Prior to conducting the RPS, an on-line search of the British Columbia CDC database will be completed and tabular summaries of listed vascular plants and ecosystems will be prepared. A compilation of listed bryophyte species will be prepared by reviewing Schofield (1994) and Ryan (1996) while a compilation of listed lichens will be prepared by reviewing Goward (1994a) and Goward (1996). Pressed plant specimens will be examined at the herbarium located at the University of Calgary. As well, field guides and general species distribution reports (i.e., Schofield, 1968a; Schofield, 1968b; Schofield, 1976; Noble et al., 1987) as well as rare plant distribution reports (i.e., Straley et al., 1985; Argus and Pryer, 1990; Douglas et al., 2002b) will be checked prior to field sampling.

Transect and plot sampling will be conducted in conjunction with the terrain, soil and ecosystem sampling programs described previously. Macroplot data collected in the ecosystem data collection will be treated as rare plant sampling nodes. Traverses between macroplots will be treated as rare plant transects. Transect data will involve simply listing species observed as encountered along a 10 m wide belt transect. Potential listed plants, if observed, will trigger an additional patterned search. All species within the macroplots transects and patterned searches will be identified.

Where field identification is uncertain, a specimen will be collected and processed using standard herbaria preservation methods as recommended by the Alberta Native Plant Council (ANPC; Lancaster, 2000). Caution will be exercised in determining when the specimen of a potential listed plant could be collected. Alberta Native Plant Council guidelines (Lancaster, 2000) suggests that a voucher should be collected if the immediate population can withstand the loss (<4% loss of individuals) and if the population is not small. Small is not defined in these guidelines; consequently, extra caution will be taken when deciding on whether specimen



collection is an option or whether other means of collecting species information (as described in these guidelines) is necessary. Where present, location and abundance estimates for each listed plant will be recorded.

Vascular plant taxonomy will follow Douglas et al. (1998a; 1998b; 1999a; 1999b; 2000; 2001a; 2001b; 2002). Schofield (1992) and Vitt et al. (1988) will be used to identify mosses while Schofield (2002) will be used to identify liverworts. Goward (1994b), Goward et al. (1994), McCune and Goward (1995), and Brodo et al. (2001) will be used to identify lichen species.

Ground Inspection Forms (GIFs) will be completed at sites where a rare plant or ecosystem is encountered. Unknown plant specimens will be identified and the data entered into the British Columbia Ministry of Forests VENUS 5.0 database program and summarized. Habitat characterization for listed plants also will be undertaken following field activities. Plant communities will be scored to reflect their potential for containing listed plant species based on a literature review and field observations.

4.4.3 Weed Inventory

The British Columbia *Weed Control Act* requires that natural resources in the province be protected from the negative impact of weeds and that areas of infestation must be identified and managed. Therefore, a weed assessment is proposed as part of the PDA protocols.

Weed assessment estimates of population numbers and aerial extent will be recorded in the field within the proposed well site location and surrounding area and along existing and proposed access roads. Global Positioning System (GPS) coordinates North American Datum (NAD) 83 and waypoints will be recorded for each observation. The list of weed species for the East Kootenays (British Columbia Ministry of Agriculture, Food and Fisheries [MAFF], 2002) will be reviewed prior to the field sampling.

The evaluation of weed infestations will be conducted concurrently with the detailed vegetation assessments. The weed assessment will be conducted via a walk through of the PDA area and adjacent areas for all listed weeds. Detailed observations of weed infestation will record the degree of infestation in hectares or, if linear, in metres according to levels that follow. Growth stage of the weeds must also be recorded (e.g., seedling, bolt, bud, flower, seed set, mature).



Nuisance or noxious weeds, as defined by the British Columbia *Weed Control Act*, should be identified separately within each Degree of Weed Infestation category. The categories of Degree of Weed Infestation are as follows:

- Trace (rare): < 1 percent cover;
- Low (occasional plants): ≥ 1 percent and < 5 percent cover;
- Moderate (scattered plants): ≥ 5 percent cover and < 25 percent cover;
- High (dense infestation of plants): ≥ 25 percent cover; and
- Linear (access roads): length of infestation in metres.

Further evaluation will be conducted on the potential movement of weed species. The degree of weed infestation between the initial disturbance and adjacent undisturbed areas will be evaluated. All weeds found will be documented and included in the PDA report.

4.4.4 Riparian Assessment

Riparian areas are the interfaces between terrestrial and aquatic ecosystems (Gregory et al., 1991) and provide critical wildlife habitat for many species (Malanson, 1993). Therefore, special attention will be paid to these landscape elements within the lease study areas. Classification of riparian management areas (e.g., stream/river, lakes, or wetlands) will be undertaken following the procedures outlined in the *Riparian Management Area Guidebook* (British Columbia Ministry of Environment [MOE], 1995g). A Level I watershed assessment using the Interior Watershed Assessment Procedure (IWAP; MOE, 1995b) will be completed to assist in interpretation.

4.5 **Wildlife Surveys**

Wildlife habitat use and assessment will include both field sampling and a review of previous studies for the area. The focal species have been identified previously (Matrix, 2007b). Prior to field work, a desktop review of species life-requisites and habitat requirements, and a reference card that defines resource criteria will be developed for each selected indicator. As well, a review of existing maps for the area will be completed.

Currently no standard procedures for conducting pre-disturbance assessments exist. However, best management practices are recommended when considering wildlife resources. Matrix



recommends the following approach for conducting a wildlife habitat pre-disturbance assessment:

Step 1: Estimate the existing resource conditions for wildlife habitat in or near the sites of planned industrial activities and developments. This step defines what resources are available in the disturbance area for wildlife.

Step 2: Identify planned project activities and developments and consider the effects that the proposed developments and activities will have on wildlife and their resources.

Step 3: Develop mitigation strategies to minimize the spatial and temporal overlap between available wildlife resources and planned project activities and developments (or minimize the project effects).

Whenever possible, wildlife field work will be coordinated with the terrain, soil and ecosystem field work. The ecosystem macroplots will function as the location for ecosystem within-plot habitat use descriptions. A 500 m buffer around the proposed well sites and along either side of the proposed road access routes will be used for the “plot-in-context” habitat descriptions. Evidence of wildlife presence or use will include indirect observations (e.g., sounds, home-site, browse utilization, territorial markings, and excavations [presence / absence]). Indirect evidence of wildlife presence will be recorded specifically within the plots as well as in the surrounding habitats (polygons), and recorded opportunistically along transect traverses. Tree attributes for wildlife, simple coarse woody debris transects and pellet group transects will be conducted within the macroplot or in the immediate vicinity. Special features such as wildlife trees, coarse woody debris, migration corridors, birthing areas, raptor nesting areas, old growth attributes, mineral licks, and denning sites will be documented and GPS coordinates provided when observed. Rangefinders will be used to determine distances of important habitat features such as ungulate winter range, mineral licks or escape terrain from proposed well sites and access roads. Wildlife trails will be followed when encountered to determine ungulate habitat use and movement patterns within the well site and the 500 m wildlife buffer. All data will be recorded on FS882 data forms and entered into VENUS 5.0 database for data summarization. All observations will be documented with NAD 83 GPS coordinates. These field observations will be used to identify spatial wildlife constraints and to supplement information collected in the on-going baseline studies. Data collected will conform to Resource Inventory Committee (1999)



and Province of British Columbia (1998) standards. Timing windows for wildlife are provided in Table 1.

4.6 Aquatics and Fisheries Surveys

Fish and fish habitat values and the functionality of aquatic and riparian ecosystems must not be affected adversely by oil and gas exploration and production in British Columbia (OGC, 2004). Exploration and production activities fall under the jurisdiction of the Ministry of Energy, Mines and Petroleum Resources (MEMPR) and are governed by the OGC. The OGC requires proponents to ensure their projects are in compliance with environmental standards outlined in provincial and federal legislation. Proponents are expected to be in consultation with appropriate local jurisdictions to ensure environmental requirements are being met (e.g., Ministry of Water, Land and Air Protection [WLAP]; MOE; MFR). In British Columbia, all work in and around a stream must also be in compliance with Federal legislation (e.g., *Fisheries Act*).

4.6.1 Legislation

The *Water Act* is applied to all streams and is intended to protect water quality, fish, amphibians and rare or endangered species, and complex ecosystem functions. Under the *Water Act*, habitat is defined as “the areas in and about a stream, including (a) the quantity and quality of water on which fish or wildlife depend directly or indirectly in order to carry out their life processes, and (b) spawning grounds and the nursery, rearing, food supply and migration areas.” This definition also includes the riparian area along the stream which is considered an integral part of the fish habitat.



TABLE 1. Timing Considerations for Mitigation of Impacts to Wildlife

Areas	Month																								
	January		February		March		April		May		June		July		August		September		October		November		December		
	1-15	16-30	1-15	16-28	1-15	16-30	1-15	16-30	1-15	16-31	1-15	16-30	1-15	16-31	1-15	16-31	1-15	16-30	1-15	16-31	1-15	16-30	1-15	16-30	
Ungulate Winter Ranges *																									
Sheep Ranges**																									
Goat Ranges **																									
All Vegetated Areas ***																									

MWLAP Kootenay Region Period of Least Risk for Wildlife Habitat

Least Risk

* Section 12(1) and 9(2) of the Government Actions Regulation (British Columbia Reg. 582/2004). Note: Forest Retention Guidelines

** British Columbia goat and sheep guidelines = Restricted activity guidelines are recommended for helicopter within 1500 m and wildlife mitigation should be considered for road developments within 500 m of these habitats

*** Federal Migratory Birds and Convention Act and Regulations



The *Fish Protection Act* is intended to protect British Columbia's fish stocks. The objectives of the Act are to (1) protect in-stream flows for fish habitat, (2) protect and restore fish habitat, (3) protect and restore riparian habitat, and (4) assist local jurisdictions in environmental planning.

The *Forest and Range Practices Act* governs forestry and grazing licensees in British Columbia. Activities include road building, logging reforestation and grazing. Some activities in the Riparian management zone are covered under the statutes of this act.

Federal legislation includes the *Fisheries Act* which is administered by Fisheries and Oceans Canada (DFO). Work in and about a stream that will impact fish habitat or is considered a harmful alteration, disruption or destruction of fish habitat or HADD (e.g., culvert installations, bank armoring, installing bridge abutments in the channel, etc.) will require approval from DFO under the *Federal Fisheries Act* Section 35(2).

Transport Canada has jurisdiction under the *Navigable Waters Act* to approve works that may affect the navigability of watercraft in rivers and lakes.

4.6.2 Fish Assessments

Any works in and about a stream, ravine, active floodplain of a stream or its riparian or streamside area is subject to Section 9 of the *Water Act* (Approvals and Notifications in and about a stream). Under the *Water Act*, "changes in and about a stream" means:

- any modification to the nature of the stream including the land, vegetation, natural environment or flow of water within the stream; or
- any activity or construction within the stream channel that has or may have an impact on a stream.

A fisheries survey is intended to identify the level of sensitivity a stream may have to proposed in-stream activities. The assessment provides site specific fish and fish habitat information to ensure activities in and around streams and lakes include measures protective of that habitat and are in compliance with regulatory requirements (MOE, 2005).



Oil and gas operations (well sites and other associated disturbances) must be setback from watercourses and water bodies as outlined in the *Riparian Management Area Guidebook* (Tables 2, 3 and 4) (MOF, MWLAP and MEMPR, 1995). Disturbances within the Riparian Management Area (RMA) of a stream must be limited (Table 5) and be justified by the proponent. Project plans must ensure surface runoff does not impact streams or cause erosion to banks (OGC, 2006). Additionally, any hazardous fluids that are released must be contained. Any work in a stream channel or riparian area will require a fisheries assessment to be submitted with the application to the OGC (OGC, 2006). In addition, any watercourses within 100 m of all proposed disturbances should be identified and classified (OGC, 2006). Specific setbacks are outlined in the following tables.

TABLE 2. Specified Distances for Stream Riparian Classes

Riparian Class	Average Channel Width (m)	Reserve Zone Width (m)	Management Zone Width (m)	Total RMA width (m)
S1 Large Rivers	≥ 100	0	100	100
S1 (except Large Rivers)	>20	50	20	70
S2	$> 5 \leq 20$	30	20	50
S3	$1.5 \leq 5$	20	20	40
S4	<1.5	0	30	30
S5	>3	0	30	30
S6	≤ 3	0	20	20

TABLE 3. Specified Distances for Wetland Riparian Management Areas

Riparian Class	Reserve Zone Width (m)	Management Zone Width (m)	Total RMA width (m)
W1*	10	40	50
W2	10	20	30
W3	0	30	30
W4	0	30	30
W5*	10	40	50

* no riparian reserve or riparian management zone is required for upland terrain within a bog dominated or muskeg dominated wetland larger than 1000 ha in boreal, sub-boreal, or hyper-maritime climates. However, where a reserve or management zone is established by the district manager, the RMA should reflect the landscape level management strategy as outlined in the Biodiversity Guidebook (MFR and MOE, 1995c).



TABLE 4. Specified Minimum Distance for Lake Riparian Classes

Riparian Class	Reserve Zone Width (m)	Management Zone Width (m)	Total RMA width (m)
L1*	10	0	10
L2	10	20	30
L3	0	30	30
L4	0	30	30

* L1 Lakes <1000 ha in area, have a 10 m reserve zone and a lakeshore management zone established by the district manager.

* L1 lakes >1000 ha in area only have a lakeshore management zone.

TABLE 5. Acceptable Overall Average Levels of Basal Area Retention within the Riparian Management Zone*

Riparian Class	Maximum overall Retention (%)
Stream	
S1	50
S2	50
S3	50
S4	25
S5	25
S6	5
Wetland and lake	-
All classes combined	25

*Acceptable overall average levels of basal area retention within the Riparian Management Zone for each riparian class of stream, wetland, and lake (overall average is calculated as the average for all cut block within a forest development plan).

In-stream work windows protect fisheries by providing a temporal guideline that outlines periods of time that are the least sensitive in a fish's lifecycle (Table 6; WLAP, 2005; MOE, 2005). An in-stream work window only provides a general guide. Working within this window does not "relieve the proponent of the responsibility to contact local fisheries agencies for information on site-specific mitigation requirements (MOF, MOE and MEMPR, 1995)." In addition, the actual work needs to be carried out in a manner that avoids the destruction of fish habitat, even if the approved in-stream activities occur in the period of least risk for in-stream works window. If work in and about a stream is to happen outside of the period of least risk for in-stream works, a variance from the OGC must be obtained. BP Canada needs to include time in their planning to obtain these variance approvals from OGC.

4.6.3 Protocols to Determine Aquatics Needs in the Field

An environmental considerations map with aquatic setbacks (based on 1:20,000 scale TRIM data) has been developed to assist BP Canada in locating well pads and access roads. All



streams were buffered to identify areas within 50 m of all streams. The larger watercourses, i.e., the Elk River, and the lower portions of the Flathead River and Michel Creek, were buffered to identify areas within 100 m. The intent of the aquatic setback layer on the environmental considerations map is to assist BP Canada planners in placing exploration disturbances away from water bodies and water courses. If the pad area is close or adjacent to a buffered aquatic area, field crews will investigate further while in the field.

As discussed previously, access roads, well sites, aquatic setbacks (50 m or 100 m) and the 500 m wildlife buffer will be delineated on field maps prior to field work. If not surveyed in the field by land surveyors, environmental field crews will identify and delineate a 100 m buffer around the pad area. The area within the buffer and the pad area will be investigated for streams. The term “stream” carries a broad meaning under the *Water Act*. A stream is defined as “a natural watercourse or source of water supply, whether usually containing water or not, ground water, and a lake, river, creek, spring, ravine, swamp, and gulch” (WLAP, 2004; MOE, 2005). The TRIM maps should identify most small watercourses; however, ground-truthing during PDA studies will confirm any stream presence.

Any streams within 100 m of the well site (lease) must be identified and classed (MOF, WLAP and MEMPR, 1998; OGC, 2006). The identification and classification will be completed by a qualified environmental professional. Ephemeral waterways also will be identified. These may not contain fish habitat; however, they will be important for other aquatic species and aquatic processes and they may pose issues related to surface water runoff which need to be considered in the pad development.

Based on the pre-field screening process and preliminary ground-truthing, reconnaissance fish and fish habitat inventories will be conducted only for those lease areas where stream courses or water bodies are within 100 m of the proposed lease boundary, where upgrading of existing bridges, or where new road access requires the construction of bridges. During the ground-truthing portion of the screening process, photographs of the stream will be taken looking upstream, downstream and of the general stream area located within 100 m of the pad area. Photos will be taken of other potential works in and around a stream (e.g., pipeline crossings, bridge crossings or bridge upgrades [approximately 200 m] upstream and downstream and along the crossing area). GPS (NAD 83) waypoints will be recorded at each location. This



information will be provided to a qualified environmental professional so that a field assessment can be prepared.

The fish assessment includes identifying and mapping fish-bearing stream reaches and lakes, and will use both existing and new field information. Additional information will be assembled as it becomes available to create a fish and fish habitat database. Prior to any field assessments, staff can use this information to establish if stream class has already been determined and potentially confirm the presence of fish species in the area.

Field inventory in streams includes sampling for fish species presence and characteristics (e.g., size, age, relative abundance), stratified by channel type, with emphasis on species diversity and the determination of upper distribution limits. In lakes, sampling includes sampling for fish presence in all field-sampled lakes, and for species composition and characteristics in primary or main lakes within the watershed.

Assessing fish habitat includes: (1) identifying and coding all water bodies (at 1:20,000) and, where necessary, augmenting the mapped stream network; (2) in streams, identifying and characterizing all reaches (e.g., confinement, order, pattern, and gradient); and (3) recording site characteristics at a sample of reaches stratified by reach type. Field work for streams and rivers includes: (1) classifying channels (channel assessment procedure [CAP] type); (2) locating and identifying obstructions; (3) describing riparian area properties (e.g., vegetation, presence of fisheries sensitive zones); and (4) mapping critical habitat locations. In lakes, field work includes: (1) identifying all lakes; determining lake size (i.e., surface area), elevation, and biogeoclimatic zone; (2) characterizing lake riparian area (e.g., vegetation, land use, and access); and (3) assessing fish production potential. Field work for all field-sampled lakes includes sampling to determine maximum depth, water quality (dissolved oxygen, pH, temperature, Secchi depth), and tributary presence while for primary lakes, lake bathymetric characteristics, lake tributary quality, and additional water quality (e.g., nutrients, total dissolved solids [TDS], and alkalinity) to determine fish production potential.

The work flow for the aquatics assessment is illustrated in Figure 3.



FIGURE 3. Work Flow Diagram for Aquatics Resources

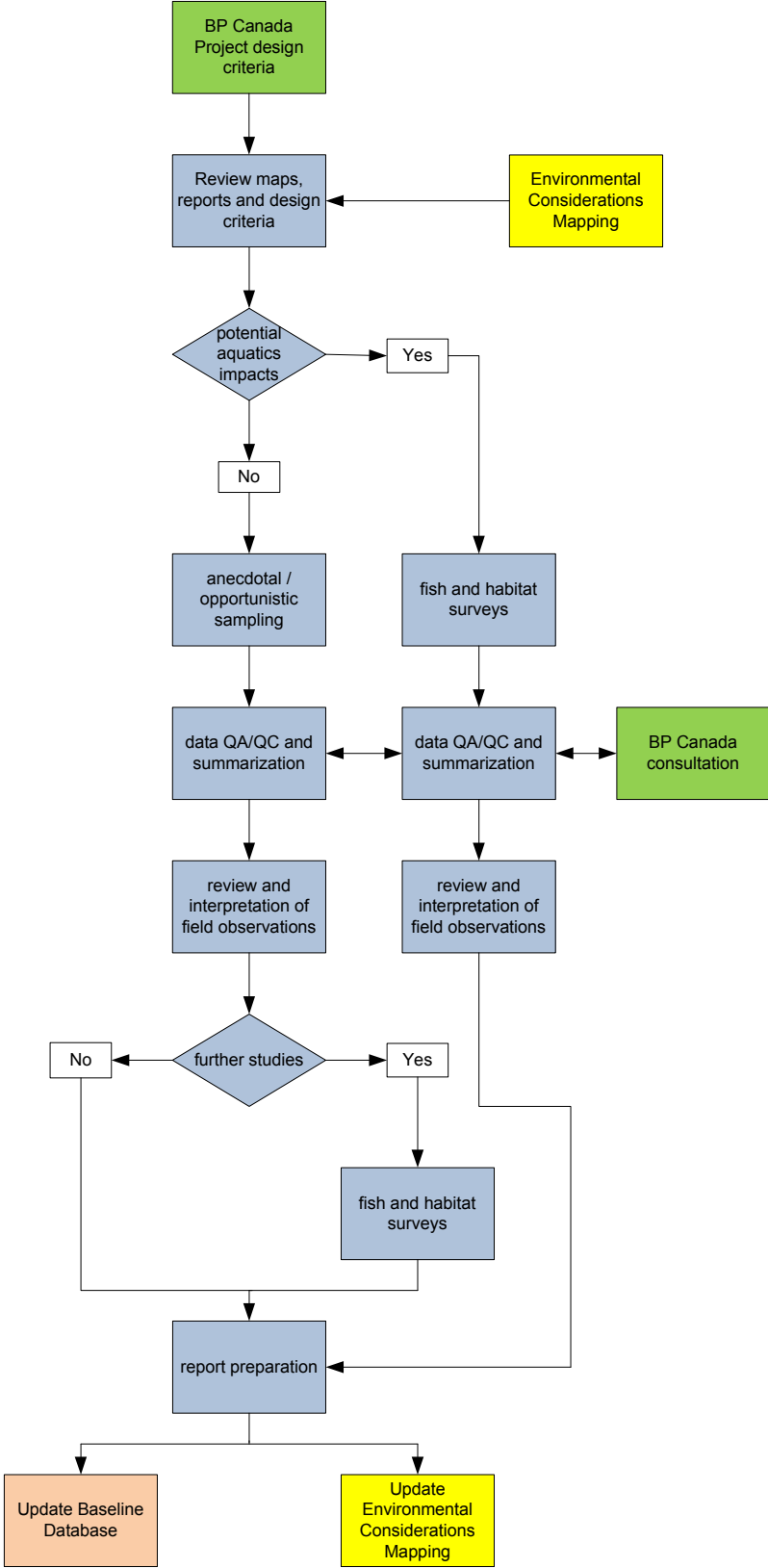


TABLE 6. Periods of Least Risk for In-stream Work for the Kootenay Region; Ministry of Water Land and Air Protection

Fish Species	April		May		June		July		August		September		October		November	
	1 - 15	16 - 30	1 - 15	16 - 31	1 - 15	16 - 30	1 - 15	16 - 31	1 - 15	16 - 31	1 - 15	16 - 30	1 - 15	16 - 31	1 - 15	16 - 30
Bull Trout / Dolly Varden																
Rainbow Trout																
Rainbow Trout *										20 th						
Cutthroat Trout																
Cutthroat Trout *										20 th						
Kokanee																
Mountain Whitefish																
Burbot																
Brook Trout																

Source: WLAP (2004)

Applicable in-stream work window where these species occur within the "Delayed In-stream Work Window Zone."

- The Delayed In-stream Work Window includes most areas outside of the Elk River and tributaries reaches in close proximity to the Elk River
- Much of the Delayed In-stream Work Window is above 1100 m in elevation and includes most of the Elk Basin and of the Michel and Flathead Basins

If changes in and about a stream that supports fish must occur outside of the specified in-stream work window, the proponent must retain the services of a Qualified Professional to develop a impact mitigation plan that completely mitigates any harmful alteration, disruption, or destruction of fish habitat. In addition, a variance from the Oil and Gas Commission will be required.



4.7 Hydrology and Hydrogeology

CBG extraction has the potential to impact surface water and groundwater. Issues such as stream flow reduction or depletion from groundwater pumping, sedimentation of streams and rivers due to construction of well pads, facilities, access roads and pipeline crossings, and changes in water chemistry due to the mixing of water from the producing formation with fresh ground water may be associated with CBG projects. BP Canada has initiated a program to characterize the baseline hydrological and hydrogeological conditions in the study area. In addition to the baseline program, a screening tool has been developed to rapidly highlight potential impacts associated with the project footprint. The screening tool is an iterative process linking proposed works with actual field conditions, and to develop mitigations or re-design options that will minimize impacts. The tool also identifies the additional specific field data that may need to be collected as part of the PDA program. Studies for the hydrology and hydrogeology PDA programs will be completed in conjunction with the aquatics and fish team so that there are synergies in data collection and sharing. The information will feed back into the larger baseline programs that establish regional relationships at a larger watershed scale.

4.7.1 Hydrology

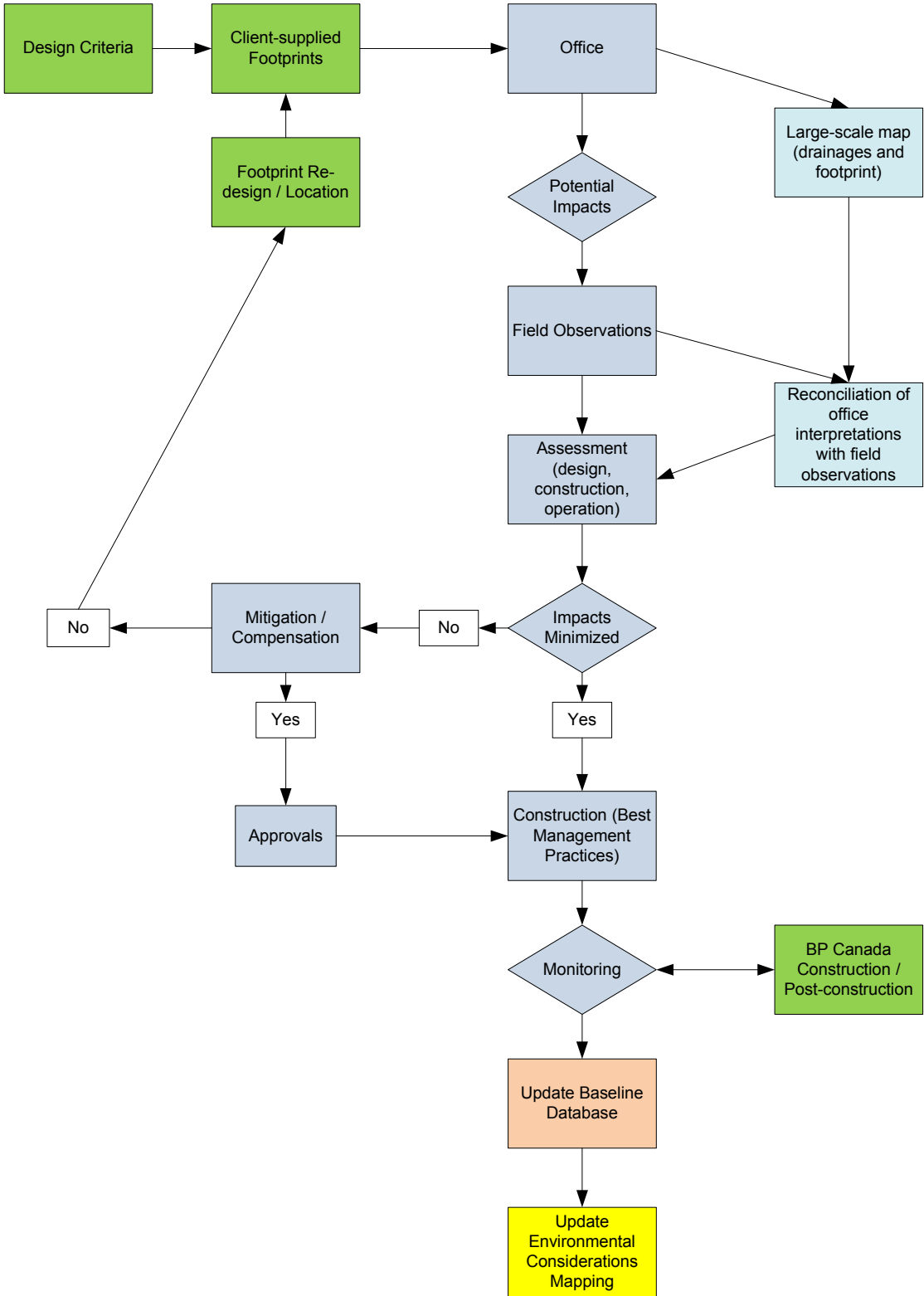
A flowchart for screening potential hydrologic impacts is provided in Figure 4, which consists of a client supplied footprint, and office, field and assessment components.

The start point is an exploration development (i.e., well site and access road) footprint supplied by BP Canada. General criteria to assist the client to minimize hydrologic impacts in footprint design include the following:

- locate development at least 100 m from mapped water courses and water bodies;
- use existing disturbed areas where possible; and
- avoid known sensitive areas such as naturally unstable slopes and vulnerable riparian zones.



FIGURE 4. Work Flow Diagram for Hydrology and Hydrogeology



The office component of the hydrology PDA screening tool involves an initial filtering of the potential hydrological impacts associated with the project footprint. The interpretations of the initial screening process will be refined following the incorporation of field data. The general steps of the office component of the process will be the following:

- overlay the project footprint onto a 1:5,000 (or larger) scale map;
- identify streams or water bodies that are coupled to or within 100 m of proposed lease boundaries;
- identify drainage patterns within sub-basins;
- inventory disturbance by sub-basin;
- assess potential hydrologic impacts associated with both existing conditions and proposed works to streams; and
- specify field work required to assess potential impacts.

A possible outcome of the office phase will be a map of sufficient resolution (e.g., 1:5,000 scale or larger) to detect some of the smaller streams that are not apparent from the 1:60,000 (or smaller scale) baseline maps. While this exercise is somewhat dependent on the accuracy of the digital map information, topography can be used to infer potential hydraulic and sediment delivery connections between proposed works and streams.

The footprint of the proposed exploration activities also will be evaluated in relationship to current baseline program results. As the overall project moves forward, activities will always be compared to the updated baseline. The approach will include assessing the proximity of proposed development(s) to: (1) established baseline hydrology and aquatics sampling stations; (2) known sediment sources (e.g., landslides, road, and slumps); (3) avalanche paths; and (4) other areas of upstream or upslope hydrologic interest that have been identified in the baseline field surveys. The combined information will form the basis of the potential cumulative hydrologic impact of existing conditions and proposed works, and will be used to develop an appropriate field verification program.

Objectives of the field component of the hydrology PDA screening tool are to: (1) confirm the office results; (2) locate potential stream flow and sediment sampling locations (if necessary, more local data will be obtained); and (3) develop options to mitigate hydrologic impacts. One activity will be to identify the channel network on the ground. The ground-truthing activities



likely will result in the location of small channels not apparent on the 1:5,000 scale map created during the office screening phase. The field surveys outlined in step form are as follows:

- map the channels (e.g., intermittent and permanent) within 100 m of (or connected to) proposed exploration disturbances;
- identify potential areas that may require additional assessment (e.g., terrain stability), or mitigation measures (e.g., sediment control);
- identify sensitive riparian areas vulnerable to development; and
- locate potential sites for new stream flow measurement and suspended sediment sampling, if needed, to characterize local conditions (e.g., low flow, sediment load).

The field surveys will follow the proposed footprint and drainage map of the office component to map the actual hydrology and field conditions on the ground. Field crews will use a handheld GPS to map features and photograph field conditions. Major (or potentially major) sediment sources to streams such as landslides, road washouts, slumps, heavily eroded sections of roads, and crossings will be documented. Upslope or upstream areas of concern will be identified. Vulnerable or sensitive riparian areas will be located (e.g., mountain pine beetle infested conifer stands) and potential sites for stream flow monitoring and sediment sampling will be flagged. Using professional judgements, new sampling locations will be selected, as needed, in consultation with the aquatics and fisheries group. Should the project proceed, stream flow and sediment sampling will follow the same procedures, schedules and laboratory analysis as outlined in the Hydrology Work Plan. Stream flow stations will be monitored continuously and verified by manual spot measurements. Grab samples will be used to characterize suspended sediment, and will be sampled at the same time as the manual flow measurement. Resource Inventory Standards Committee (RISC) protocols will be used in all field and analytical measurements. The data from new flow and sampling stations will be compared to the relationships established at the baseline stations. This process will help determine the temporal longevity of new stations, or if more sampling is required.

The final stage of the hydrology PDA screening component is to assess footprint design to minimize hydrologic impact. This could include re-location of roads, pads or pipelines, the creation of larger than 100 m buffers around streams, avoiding sensitive riparian areas, establishing work windows, erosion and sediment control programs, or the development of approved mitigation/compensation options. The outcome will be a revised map showing field



results, location of any new sampling locations and accompanied by a brief narrative with a listing of best management practices for construction, and measures required for monitoring and reporting during construction and post construction phases. If extensive re-design is required, then new field surveys will be carried out, and the screening process will revert back to the steps of the field component outlined above. This iterative process would lead to a new map and a revised monitoring prescription and reporting timelines.

4.7.2 Hydrogeology

In addition to the surface water assessment of potential well sites, shallow groundwater conditions will be evaluated. The purpose of this assessment will be to identify areas of groundwater discharge that could be problematic for lease construction or reclamation, are unsuitable for ongoing operation of the site, or potentially result in groundwater impacts. In addition, data gathered during this assessment will be used to provide additional information for BP Canada's ongoing baseline environmental assessment of the entire project area.

In general, the hydrogeological work will consist of the following: (1) a desk survey to determine if there are known hydrogeological features or wells in the area; and (2) field transects to identify groundwater discharge features such as springs and seeps or existing wells. For the purposes of this work, a spring shall be defined as a groundwater discharge feature that has a measured outflow greater than $3 \text{ m}^3/\text{d}$, whereas a seep will have less than $3 \text{ m}^3/\text{d}$ and might have no visible outflow or be a wet area. Where possible, springs and seeps will be tested for flow rate using a portable V-notch weir or a current meter and be sampled and analyzed for field parameters (electrical conductivity [EC], dissolved oxygen [DO], and pH). Springs will also be analyzed for routine parameters at a laboratory. In addition, any water well used for domestic purposes would be sampled.

The initial field transect work would not necessarily need to be conducted by hydrogeological personnel. If a suspected spring, seep or other hydrogeological feature were identified by another member of the environmental assessment team, this feature would be brought to the attention of the hydrogeological team member(s) and a decision made at that time as to whether or not a site visit by a groundwater specialist was warranted.



The presence of a groundwater discharge feature such as a spring or seep in the immediate vicinity of a well site can be problematic for cut and fill construction, site traffic and site reclamation. Not all of these features can be identified from the ground surface; however, by avoiding the placement of well sites on top of known springs or seeps, and within 50 m upgradient (typically uphill) of known springs, flowing conditions on the lease can often be circumvented.

4.8 Methane Seeps

Regional-scale remote sensed (Matrix, 2007c) and follow-up ground-based active methane gas pedestrian surveys (S.S. Papadopoulos and Associates, 2007) are a part of BP Canada's baseline studies program. The objective of the methane seepage baseline studies is to identify areas for more detailed ground surveys and investigations.

If evidence of methane seeps in the vicinity of a proposed well site is noted through remote sensing or if a suspected methane seep is encountered while performing the baseline work for the PDA, subsequent ground investigations of the feature will be conducted. Indications of methane seeps include unexplained stressed vegetation or bare areas. Follow-up methane sampling would consist of analyzing subsurface air samples from a small-diameter borehole using a hand-held four gas monitor, as per S.S. Papadopoulos and Associates (2007). A summary and interpretation of the results will then be provided in the PDA report.

4.9 Avalanche Assessment

Due to the environmental setting of the Mist Mountain CBG Project, snow avalanches are a safety concern. Snow avalanche activity is a dominant geomorphic process that occurs throughout the study area. Chris Stethem & Associates Ltd. (CS&A) was retained by Matrix to conduct avalanche hazard mapping in the study area. An Avalanche Locator Map and corresponding Avalanche Path Table, which provide estimated magnitude and frequency of avalanches, were constructed by CS&A for the study area (CS&A, 2007).

A total of 465 avalanche paths (Class 3 or higher) were identified in the study area and mapped on the Avalanche Locator Map. These avalanche paths are found throughout the study area and may pose a significant hazard to workers and infrastructure during the avalanche season



(mid-November to late May). Therefore, the ecosystems of the avalanche accumulation zones, chutes, and run-out zones will be mapped where present within a well site or access road as part of the PDA process. These landscape features provide important habitat for rare plants and wildlife.

4.10 Conservation and Reclamation Plan

A Conservation and Reclamation Plan (C&R) will be developed based on the data collected and the mapping completed for the Surficial Geology and Soils, Ecosystems and Rare Plants and Wildlife Components. The C&R will contain soil handling, vegetation management, engineering, and site construction prescriptions. A natural recovery index (Smyth, 2007) will be determined for each lease and used to develop native seed mixes and seedling transplant prescriptions. Best management practices for exploration activities will be incorporated into the plan (OGC, 2006; MEMPR and MOE, 2006).

5.0 ASSUMPTIONS AND LIMITATIONS

The assumptions and limitations associated with the information provided in the PDA reports are provided below.

- PDAs will be done when there is no snow on the ground.
- Vegetation will be assessed during an active growth period.
- The area of investigation is limited to the lease and the road, plus 10 m on all sides except for wildlife, which includes a 500 m buffer.
- Methane seeps will be assessed for the lease and access road plus 10 m buffer.
- Surface water, aquatics, and fish habitat assessment will be conducted whenever these components will be affected directly by exploration activities or where streams or water bodies are within 100 m of the well sites. The pre-field screening process and preliminary ground-truthing activities will determine the needs for detailed sampling.



- Site-specific avalanche assessment will be required for road and lease areas.

6.0 REPORTING

The assessment information will be summarized in a report that will include text, tables, and maps. The general table of contents of the report will be as follows:

Introduction

Scope of Work

Study Area Description

Methodology

Safety

Environmental Screening / Scoping

Surficial Geology (Terrain) and Soils

Ecosystems, Rare Plants and Endangered Ecosystems

Wildlife

Aquatics and Fish

Hydrology and Hydrogeology

Methane Seeps

Avalanches

Baseline Conditions

Biophysical Setting

Surficial Geology (Terrain) and Soils

Ecosystems and Rare Plants

Wildlife

Aquatics and Fish

Hydrology and Hydrogeology

Methane Seeps

Avalanches

Conservation and Reclamation

Environmental Protection Plan

Construction Measures

Approvals and Licenses

Project Schedule

Construction Timing/Wet Area Constraints

Notification and Concerned Parties

Construction Meetings



Environmental Inspectors/Biologists
Environmental Resources
Use of Workspace
Access and Traffic Management
Speed Limits
Dust
Wildlife Passage
Wildlife Management Concerns
Clean Equipment
Equipment and Servicing
Waste Management
Spill Response and Fire Hazard
Weather Contingency
Erosion Control
Rare Plants
Rare Plant Communities
Historical and Paleontological Resources
Non-compliances and Resolution

Summary (i.e., assessment of possible impacts and proposed mitigation measures)

Literature Cited

7.0 TRAINING AND COMPETENCY

All personnel (sub-consultants and Matrix personnel) working on the components of the PDA meet the required training standards for their respective disciplines.

8.0 SCHEDULE / TIMING

Timing windows exist for each discipline and so field data collection times will vary. In general, field data will need to be collected during the summer although field activities for soils, wildlife and fish habitat characterization and some components of vegetation can be undertaken in the spring and fall. Rare plant surveys, in particular, have specific early and late sampling timing windows.



9.0 SUMMARY

A review of legislation and supporting documents specific to the oil and gas industry in Alberta and British Columbia was completed. Based on this review, a comprehensive PDA protocol was prepared for terrain, soils, ecosystems, rare plants and rare or endangered ecosystems, wildlife, aquatics, fish habitat, surface water (hydrology), hydrogeology, methane seeps, avalanche, and reclamation. Checklists for each component of the PDA process are provided in Appendix A.

10.0 REFERENCES

Alberta Energy and Utilities Board (AEUB), 2007. *Directive 056. Energy Development Applications and Schedules*. Revised Edition May 1, 2007. Energy and Utilities Board, Calgary. 299 pp.

Alberta Environment (AENV), 2005. *Code of Practices for Exploration Operations* (made under the Environmental Protection and Enhancement Act, RSA 2000, c.E-12, as amended and Conservation and Reclamation Regulation (AR 115/93) as amended. Alberta Government, Edmonton. 16 pp.

Alberta Sustainable Resource Development (ASRD), 2004. *Instructions for Submission of Environmental Field Reports with Surface Dispositions Applications Under the Public Lands Act*. Alberta Sustainable Resource Development, Edmonton. 61 pp.

Alberta Sustainable Resource Development (ASRD), 2007. *A Guide to Reclamation Criteria for Wellsites and Associated Facilities – 2007 – Forested Lands in the Green Area Update*. Alberta Sustainable Resource Development, Edmonton. 20 pp.

Argus, G.W. and K.M. Pryer., 1990. *Rare Vascular Plants in Canada. Our Natural Heritage*. Canadian Museum of Nature, Ottawa. 191 pp.

BP Group Practice, 2006. *Environmental Requirements for New Projects*. BP p.l.c., London. 77 pp.



- British Columbia Ministry of Agriculture, Food and Fisheries (MAFF), 2002. *Guide to the Weeds of British Columbia*. British Columbia Ministry of Agriculture, Food and Fisheries and the Open Learning Agency, Victoria. 200 pp.
- British Columbia Ministry of Energy, Mines and Petroleum Resources (MEMPR) and British Columbia Ministry of Environment (MOE), 2006. *Handbook for Mineral and Coal Exploration in British Columbia*. British Columbia Ministry of Energy, Mines and Petroleum Resources and British Columbia Ministry of Environment in association with the Association for Mineral Exploration in British Columbia and the Mining Association of British Columbia, Vancouver. 143 pp.
- British Columbia Ministry of Environment (MOE), 1995c. *Forest Practices Code of British Columbia. Biodiversity Guidebook*. British Columbia Ministry of Environment, Victoria. 99 pp.
- British Columbia Ministry of Environment (MOE), 2005 (update 2007). *A Users' Guide to Working In and Around Water: Understanding the Regulations under British Columbia's Water Act*. British Columbia Ministry of Environment, Water Stewardship Division. Victoria. 38 pp.
- British Columbia Ministry of Forests (MOF), 1996. *Techniques and Procedures for Collecting, Preserving, Processing and Storing Botanical Specimens*. British Columbia Ministry of Forests, Research Branch Working Paper 18/1996, British Columbia Ministry of Forests, Research Branch, Victoria. 39 pp.
- British Columbia Ministry of Forests and the Ministry of Environment (MOF and MOE), 1995a. *Forest Practices Code of British Columbia. Fish-stream Identification Guidebook*. British Columbia Ministry of Environment, Victoria. 39 pp.
- British Columbia Ministry of Forests and the Ministry of Environment (MOF and MOE), 1995b. *Forest Practices Code of British Columbia. Interior Watershed Assessment Procedure Guidebook (IWAP) Level 1 Analysis*. British Columbia Ministry of Environment, Victoria. 82 pp.



- British Columbia Ministry of Forests and the Ministry of Environment (MOF and MOE), 1995e. *Forest Practices Code of British Columbia. Stand Management Prescription Guidebook.* British Columbia Ministry of Environment, Victoria. 45 pp.
- British Columbia Ministry of Forests and the Ministry of Environment (MOF and MOE), 1995f. *Forest Practices Code of British Columbia. Range Management Guidebook.* Second Edition. British Columbia Ministry of Environment, Victoria. 34 pp.
- British Columbia Ministry of Forests and the Ministry of Environment (MOF and MOE), 1995g. *Forest Practices Code of British Columbia. Riparian Area Management Guidebook.* British Columbia Ministry of Environment, Victoria. 39 pp.
- British Columbia Ministry of Forests and the Ministry of Environment (MOF and MOE), 1998. *Fish-stream Identification Guidebook.* Forest Practices Code of British Columbia. Version 2.1. British Columbia Ministry of Environment, Victoria. 170 pp.
- British Columbia Ministry of Forests, Ministry of Water, Land and Air Protection and the Ministry of Energy and Mines (MOF, WLAP and MEMPR), 1998. *Fish-stream Crossing Guidebook.* Forest Practices Code of British Columbia. British Columbia Ministry of Environment, Victoria. 74 pp.
- British Columbia Ministry of Forests, the Ministry of Water, Land, Air Protection and the Ministry of Energy and Mines (MOF, WLAP and MEMPR), 1995. *Forest Practices Code of British Columbia. Riparian Area Management Guidebook.* British Columbia Ministry of Environment, Victoria. 39 pp.
- British Columbia Ministry of Water, Land and Air Protection (WLAP), 2004. *Standards and Best Practices for In-stream Works.* WLAP BMP Series. Water, Land and Air Protection, Victoria. 168 pp. (Timing windows and maps from Version 2.5, February 8, 2005).
- British Columbia Ministry of Water, Land and Air Protection (WLAP), 2005. *Terms and Conditions for Changes In and About a Stream Specified by MWLAP Habitat Officers, Kootenay Region (Region 4).* British Columbia Ministry of Water, Land and Air Protection, Victoria. 6 pp.



- Brodo, I.M., S.D. Sharnoff and S. Sharnoff., 2001. *Lichens of North America*. Yale University Press, New Haven. 818 pp.
- Chris Stethem & Associates Ltd. (CS&A), 2007. *BP Canada Energy Company – Mist Mountain Coalbed Project Snow Avalanche Hazard Assessment DRAFT*. Chris Stethem & Associates Ltd. 23 pp.
- Conservation Data Centre (CDC), 2006. *British Columbia Species and Ecosystem Explorer*. <http://srmapps.gov.bc.ca/apps/eswp/>
- Douglas, G.W., D.V. Meidinger and J. Pojar, (Editors), 1999a. *Illustrated Flora of British Columbia. Volume 3: Dicotyledons (Diapensiaceae through Onagraceae)*. British Columbia Ministry of Environment, Lands and Parks and British Columbia Ministry of Forests, Victoria. 423 pp.
- Douglas, G.W., D.V. Meidinger and J. Pojar, (Editors), 1999b. *Illustrated Flora of British Columbia. Volume 4: Dicotyledons (Orobanchaceae through Rubiaceae)*. British Columbia Ministry of Environment, Lands and Parks and British Columbia Ministry of Forests, Victoria. 427 pp.
- Douglas, G.W., D.V. Meidinger and J. Pojar, (Editors), 2000. *Illustrated Flora of British Columbia. Volume 5: Dicotyledons (Salicaceae through Zygophyllaceae) and Pteridophytes*. British Columbia Ministry of Environment, Lands and Parks and British Columbia Ministry of Forests, Victoria. 389 pp.
- Douglas, G.W., D.V. Meidinger and J. Pojar, (Editors), 2001a. *Illustrated Flora of British Columbia. Volume 6: Monocotyledons (Acoraceae through Najadaceae)*. British Columbia Ministry of Environment, Lands and Parks and British Columbia Ministry of Forests, Victoria. 361 pp.
- Douglas, G.W., D.V. Meidinger and J. Pojar, (Editors), 2001b. *Illustrated Flora of British Columbia. Volume 7: Monocotyledons (Orchidaceae through Zosteraceae)*. British Columbia Ministry of Environment, Lands and Parks and British Columbia Ministry of Forests, Victoria. 379 pp.



- Douglas, G.W., D.V. Meidinger and J. Pojar, (Editors), 2002a. *Illustrated Flora of British Columbia. Volume 8: General Summary, Maps and Keys*. British Columbia Ministry of Sustainable Resource Management and British Columbia Ministry of Forests, Victoria. 457 pp.
- Douglas, G.W., D.V. Meidinger and J.L. Penny, 2002b. *Rare Native Vascular Plants of British Columbia*. Second Edition. British Columbia Ministry of Sustainable Resource Management and the British Columbia Ministry of Forests, Victoria. 359 pp.
- Douglas, G.W., G.B. Straley, D.V. Meidinger and J. Pojar, (Editors), 1998a. *Illustrated Flora of British Columbia. Volume 1: Gymnosperms and Dicotyledons (Aceraceae through Asteraceae)*. British Columbia Ministry of Environment, Lands and Parks and British Columbia Ministry of Forests, Victoria. 436 pp.
- Douglas, G.W., G.B. Straley, D.V. Meidinger and J. Pojar, (Editors), 1998b. *Illustrated Flora of British Columbia. Volume 2: Dicotyledons (Balsaminaceae Through Cucurbitaceae)*. British Columbia Ministry of Environment, Lands and Parks and British Columbia Ministry of Forests, Victoria. 401 pp.
- Gorley, A., S. Spalding and J. Gagne, 2004. *A Practical Guide to Effective Coordination of Resource Tenures*. Oil and Gas Commission, Ministry of Water, Land and Air Protection, Land and Water BC, Ministry of Sustainable Resource Management, Ministry of Forests, Ministry of Energy and Mines, Canadian Association of Petroleum Producers, Small Explorers and Producers Association of Canada and the Canadian Association of Geophysical Contractors, Fort St. John. 88 pp.
- Goward, T., 1994a. Chapter 8. Rare and endangered lichens in British Columbia. *Biodiversity in British Columbia. Our Changing Environment*. (L.E Harding and E. McCullum, Editors). Environment Canada, Canadian Wildlife Service, Ottawa. pp. 77 – 80.
- Goward, T., 1994b. *The Lichens of British Columbia. Illustrated Keys, Part 2 – Fruticose Species*. Ministry of Forests Research Program, British Columbia Ministry of Forests, Victoria. 324 pp.



- Goward, T., 1996. *The Lichens of British Columbia: Rare Species and Priorities Inventory*. Working Paper 08/1996. Research Branch, British Columbia Ministry of Forests and Habitat Protection Branch, British Columbia Ministry of Environment, Lands and Parks, Victoria. 34 pp.
- Goward, T., B. McCune and D. Meidinger, 1994. *The Lichens of British Columbia. Illustrated Keys, Part 1 – Foliose and Squamulose Species*. British Columbia Ministry of Forests, Victoria. 181 pp.
- Gregory, S.V., F.J. Swanson W.A. McKee and K.W. Cummins, 1991. An ecosystem perspective of riparian zones. *Bioscience*, 41, 8, 540-551.
- Harding, L.E. and E. McCullum, (Editors), 1994. *Biodiversity in British Columbia. Our Changing Environment*. Environment Canada, Canadian Wildlife Service, Ottawa. 426 pp.
- Howes, D.E. and E. Kenk, (Editors), 1997. *Terrain Classification System for British Columbia. Version 2*. Ministry of Environment Manual MOE 10. Province of British Columbia, Fisheries Branch of the Ministry of Environment and Surveys and Resources Mapping Branch of the Ministry of Crown Lands, Victoria. 111 pp.
- Jacques Whitford-AXYS, 2007. *Mist Mountain Coalbed Gas Project. Access Stage Environmental and Social Impact Assessment*. Prepared for BP Canada by Jacques Whitford-AXYS, Calgary. 105 pp.
- Klinkenberg, B., (Editor), 2007. *E-Flora BC: Electronic Atlas of the Plants of British Columbia* [www.eflora.bc.ca] Lab for Advanced Spatial Analysis, Department of Geography, University of British Columbia, Vancouver.
- Lacelle, L.E.H., 1990. *Biophysical Resources of the East Kootenay Area: Soils*. Wildlife Technical Monograph TM-1. Report No. 20. British Columbia Soil Survey. British Columbia Soil Survey. Habitat Inventory Section, Wildlife Branch, British Columbia Ministry of Environment, Victoria. 359 pp.



- Lancaster, J., 2000. *Guidelines for Rare Plant Surveys*. Alberta Native Plant Council (ANPC), Edmonton. 12 pp.
- Lloyd, D., M. Ryan, M. Doney, N. Brand and K. Johnston., 2006. *A Field Guide to Site Identification for Nine Biogeoclimatic Units in the East Kootenays*. Draft. Research Branch. British Columbia Ministry of Forests and Range, Kamloops. 308 pp.
- Luttmerding, H.A., D.A. Demarchi, E.C. Lea, D.V. Meidinger and T. Vold, 1990. *Describing Ecosystems in the Field*. Ministry of Environment Manual 11. Province of British Columbia Ministry of Environment and Ministry of Forests. Victoria. 213 pp.
- Malanson, G.P., 1993. *Riparian Landscapes*. Cambridge University Press, Cambridge. 296 pp.
- Matrix Solutions Inc. (Matrix), 2007a. *“Health, Safety and Environment Manual.”* Part of Matrix Solutions’ In-house Safety Program Developed and Updated to Maintain Qualification for the Alberta Human Resources and Employment’s Partnerships in Health and Safety Certificate of Recognition (COR). Current COR No.20050831-11081, valid to August 31, 2008.
- Matrix Solutions Inc. (Matrix), 2007b. *Wildlife Environmental Baseline Work Program and 2007 Work Plan for BP Canada Mist Mountain Coal Bed Gas Project*. Matrix Solutions Inc., Calgary. 12 pp.
- Matrix Solutions Inc. (Matrix), 2007c. *Hydrology, Hydrogeology and Methane Seep Environmental Baseline Work Program and 2007 Work Plan for the BP Canada Mist Mountain Project*. Prepared for BP Canada and Summit Environmental Ltd. By Matrix Solutions Inc., Calgary. 30 pp.
- McCune, B. and T. Goward., 1995. *Macrolichens of the Northern Rocky Mountains*. Mad River Press, Eureka. 208 pp.



Ministry of Energy, Mines and Petroleum Resources (MEMPR), 2005. *Coal Bed Gas in British Columbia, Environmental Resource Information Project*. Ministry of Energy, Mines and Petroleum Resources, Victoria. 4 pp.

Ministry of Sustainable Resource Management (MSRM), 2003. *Southern Rocky Mountain Management Plan*. British Columbia Ministry of Sustainable Resource Management, Cranbrook. 121 pp.

Noble, W.J., T. Ahti, G.F. Otto and I.M. Brodo, 1987. *A Second Checklist and Bibliography of the Lichens and Allied Fungi of British Columbia*. Syllogeus Series No. 61. Natural Museums of Canada, Ottawa. 95 pp.

Oil and Gas Commission (OGC), 2001. *Surface Rights in British Columbia: A Guide to the Legislation and Regulations for the Oil Gas Industry 10 July, 2001*. Stakeholder Relations and Communication Branch, Oil and Gas Commission, Fort St. John. 11 pp.

Oil and Gas Commission (OGC), 2004. *Stream Crossing Planning Guide*. Oil and Gas Commission, Fort St. John. 28 pp.

Oil and Gas Commission (OGC), 2005a. *Operational Guidance for Oil and Gas Exploration and Development for Northeast BC*. Oil and Gas Commission, Fort St. John. 4 pp.

Oil and Gas Commission (OGC), 2005b. *Landowner's Information Guide for Oil and Gas Activities in British Columbia*. Oil and Gas Commission, Fort St. John. 107 pp.

Oil and Gas Commission (OGC), 2006. *Oil and Gas Commission Planning and Construction Guide – December 2006: For Oil and Gas Operations in British Columbia*. Oil and Gas Commission, Fort St. John. 14 pp.

Oil and Gas Commission (OGC), 2007. *Application Resource Book*. Oil and Gas Commission, Fort St. John. 93 pp.

Papadopoulos and Associates Inc., 2007. *Field Methane Seepage Survey Protocols*. Prepared for Matrix Solutions Inc. by S.S. Papadopoulos and Associates Inc., Boulder. 14 pp.



- Province of British Columbia, 1998. *Field Manual for Describing Terrestrial Ecosystems*. Land Management Handbook Number 25. British Columbia Ministry of Environment, Lands, and Parks and the British Columbia Ministry of Forests, Victoria. 240 pp.
- Resource Inventory Committee (RIC), 1995. *Soil Inventory Methods for British Columbia*. Prepared for the Resources Inventory Committee by the Surficial Geology Task Group, Earth Sciences Task Force of British Columbia, Victoria. 131 pp.
- Resource Inventory Committee (RIC), 1999. *British Columbia Wildlife Habitat Rating Standards*. Version 2.0. Prepared by the Ministry of Environment, Lands and Parks Resources Inventory Branch for the Terrestrial Ecosystems Task Force Resources Inventory Committee, Victoria. 111 pp.
- Resource Inventory Committee (RIC), 2001. *Reconnaissance (1:20,000) Fish and Fish Habitat Inventory: Standards and Procedures*. Version 2.0. Prepared by BC Fisheries Information Services Branch for the Resource Inventory Committee, Victoria. 170 pp.
- Ryan, M., 1996. *Bryophytes of British Columbia: Rare Species and Priorities for Inventory*. Working Paper 12/1996. Province of British Columbia Ministry of Forests Research Program, Victoria. 100 pp.
- Ryder, J.M., 1981. *Biophysical Resources of the East Kootenay Area: Terrain*. APD Bulletin 7. Terrestrial Studies Branch, Assessment and Planning Division, Province of British Columbia Ministry of Environment, Victoria. 153 pp.
- Schofield, W.B., 1968a. A checklist of Hepaticae and Anthocerotae of British Columbia. *Syesis*, 1, 157-162.
- Schofield, W.B., 1968a. A selectively annotated checklist of British Columbia mosses. *Syesis*, 1, 163-176.
- Schofield, W.B., 1976. Bryophytes of British Columbia III: habitat and distributional information for selected mosses. *Syesis*, 9, 317-354.



Schofield, W.B., 1992. *Some Common Mosses of British Columbia*. Royal British Columbia Museum Handbook. Royal British Columbia Museum, Victoria. 394 pp.

Schofield, W.B., 1994. Chapter 7. Rare and endangered bryophytes in British Columbia. *Biodiversity in British Columbia. Our Changing Environment*. (L.E. Harding and E. McCullum, Editors). Environment Canada, Canadian Wildlife Service, Ottawa. pp. 72-76.

Schofield, W.B., 2002. *Field Guide to Liverwort Genera of the Pacific North America*. Global Forest Society and the University of Washington Press, Seattle. 228 pp.

Smyth, C.R., 2007. Natural colonization of high-elevation coal mine exploration disturbances in the Elk and Flathead River drainages, British Columbia. *Ecological Restoration in Southeastern British Columbia: Grasslands to Mountaintops, October 11-13, 2007, Cranbrook, British Columbia*. Columbia Mountains Institute, Revelstoke. 9 pp.

Soil Classification Working Group, 1998. *The Canadian System of Soil Classification*. Third Edition. Research Branch, Agriculture and Agri-Food Canada Publication 1646. National Research Council Press, Ottawa. 187 pp.

Straley, G.B., R.L. Taylor and G.W. Douglas, 1985. *The Rare Vascular Plants of British Columbia*. Syllogeus No. 59, National Museums of Canada, Ottawa. 160 pp.

Vitt, D.H., J.E. Marsh and R.B. Bovey, 1988. *Mosses, Lichens and Ferns of Northwestern North America*. Lone Pine Publishing, Edmonton. 296 pp.



APPENDIX A

PRE-DEVELOPMENT ASSESSMENT TASK CHECKLIST

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PRE-DEVELOPMENT ASSESSMENT TASK CHECKLIST

General Tasks	Specific Tasks	Required Activity	Task Assignment	
Project Management	Project kick-off / initiation meeting			
	Preparation of detailed work plan			
	Inter-disciplinary preliminary screening			
Pre-field Activities	Desktop study / literature review			
	Acquisition of existing baseline spatial and non-spatial data			
	Acquisition of remote sensed imagery			
	Acquisition of digital disturbance layer			
	Review of existing spatial and non-spatial data			
	Review terrain / surficial geology maps			
	Review soil maps			
	Prepare site-specific and review			
	Review broad-scale wildlife habitat suitability maps			
	Review predictive-ecosystem (PEM) maps			
	Air photo interpretation and pre-typing			
	On-screen digitizing of polygons			
	Preparation of map working legend			
	Download and review rare element lists			
	Contact CDC for rare element occurrences in study area			
	Review weed species list			
	Field map and imagery preparation			
	Pre-field equipment and supplies organization			
	Evaluate / review study area access			
	Field-work logistics and sampling discussion with other disciplines			
	Design of field sampling program			
	Review previous projects to evaluate implications of study area overlap			
	Field-work travel logistics			
	Field equipment check			
	Safety certification check			
	Field Sampling	Ecosystem sampling		
		Rare plant survey sampling		
Health/risk plant tissue sampling				
Wetland delineation and classification sampling				
Soil sampling				
Riparian health assessment				
Weed assessment				
Wildlife habitat use assessment				
Impact monitoring				
Fish species presence and abundance sampling				
Fish habitat sampling				
Reconnaissance fish habitat sampling				
HADD assessment				
Water quality sampling				
Sediment source sampling				
Stream flow sampling				
Water quality sampling				
Methane seep sampling				
Post-field Activities		GPS waypoint digital download		
	Digital camera photo download			
	Unknown plant identification			
	Field data QA/QC and editing			
	Submission of GPS way points to GIS			
	Cataloging and organization of digital photographs			
	Soil sample preparation and submission to analytical lab			
	Provide opportunistic field observations and samples to discipline leads			
Opportunistic sample analysis				



General Tasks	Specific Tasks	Required Activity	Task Assignment
	Post-field inter-disciplinary discussions		
Data Entry / Analysis	Import of analytical lab results		
	Database entry		
	Database QA / QC		
	Database (data extraction / export)		
	Data analysis		
	Data summarization and tabulation		
	Report rare element occurrences to CDC		
Mapping	Sample point location mapping		
	On-screen digitizing edits		
	Bioterrain polygon coding		
	Ecosystem polygon attribution		
	Ecosystem mapping cartography discussions		
	Ecosystem attribute data / mapping QA / QC		
	Ecosystem map review and editing		
	Ecosystem map analysis		
	ELC map interpretation		
	Wetland delineation/assessment mapping		
	Old growth mapping cartography discussions		
	Old growth attribute data / mapping QA / QC		
	Old growth map review and editing		
	Old growth map analysis		
	Old growth map interpretation		
	Rare element map occurrence preparation		
	Rare plant habitat potential mapping cartography discussions		
	Rare plant habitat potential attribute data / mapping QA / QC		
	Rare plant habitat potential baseline map review and editing		
	Rare plant habitat potential map analysis		
	Rare plant habitat potential map analysis		
	Rare plant habitat potential map interpretation		
	Weed population mapping cartography discussions		
	Weed population mapping		
	Watershed / fish habitat mapping		
	Soil mapping cartography discussions		
	Soil attribute data / mapping QA / QC		
	Soil mapping		
	Soil map review and editing		
	Soil map analysis		
	Soil map interpretation		
	Disturbance delineation mapping		
	Soil / vegetation map correlation interpretation		
	Ecosystem mapping consultation with soil scientists		
	Ecosystem maps to wildlife biologists		
	Ecosystem mapping consultation with wildlife biologists		
	Rare plant mitigation planning		
	Conservation and reclamation consultation		
	Reclamation materials management		
Table Preparation	Ecosystem / vegetation map tabular summary		
	Rare plant habitat potential tabular summary		
	Old growth tabular summary		
	Weed occurrence		
	Watershed parameters summary		
	Hydrology and surface water summary		
	Methane seep summary		
	Impacted ecosystem tabular summary		
Report Writing	Executive summary		
	Introduction		
	Objectives		
	Literature review		
	Methodology		
	Results and Discussion		
	Conservation and reclamation planning		



General Tasks	Specific Tasks	Required Activity	Task Assignment
	Environmental management / emergency response planning		
	Recommendations		
	References / literature cited		
Report Review / Editing	Peer review of reports		
	Discipline lead review of submitted report (internal)		
	Report editing (internal)		
	Senior review (internal)		
	Response to client questions / comments (external)		
	Response to regulator questions / comments (external)		

