Golder Associates Ltd.

1944 - 10 Avenue SW
Calgary, Alberta, Canada T3C 0J8
Telephone (403) 244-3233
Toll Free 1-800-933-3992
Fax (403) 244-3234

Golder Associates

REPORT

BIOPHYSICAL INVENTORY OF THE RESTWELL PROPERTY, CANMORE, ALBERTA

Submitted to:

Frank Kernick
Restwell Trailer Park and Cabins Ltd.
1A, 502 – 3rd Avenue
Canmore, AB
T1W 2G2

DISTRIBUTION:

3 Copies	**Frank Kernick** **Canmore, Alberta**
2 Copies	**Ralf Southwell** **Calgary, Alberta**
4 Copies	**Golder Associates Ltd.** **Calgary, Alberta**

November 2003

022-2295-7620

EXECUTIVE SUMMARY

Restwell Trailer Park & Cabins (2002) Ltd. (Restwell) has proposed to redevelop its property in Canmore, Alberta. To fulfil partial requirements for Phase I of the Restwell Area Redevelopment Plan Terms of Reference, Golder Associates Ltd. (Golder) was contracted to assess the biophysical resources of the Restwell property.

The objective of the study was to provide a description of existing environmental conditions for consideration in the preparation of the Restwell Area Redevelopment Plan. This report includes results of the late summer and spring rare plant survey, wildlife sign survey, winter track survey, breeding bird survey, amphibian survey and fish and fish habitat survey. Vegetation communities were also delineated according to the Alberta vegetation classification system and ranked for environmental sensitivities. The results of these investigations were used to develop recommendations for mitigation of potential impacts to biophysical resources.

The Restwell property is located immediately south of the Canmore Town Centre. The current land use on the property is predominantly a mobile home park, rental cabins and a campground. Two watercourses, Policeman's Creek and Spring Creek, are located within the study area.

Policeman's Creek occurs as a linear pond and marsh complex in the north-eastern portion of the study area, and as a flowing channel in the south-eastern portion of the study area. Along Policeman's Creek, a narrow band of shrubland bounds the marsh complex, while the flowing portion of the creek is bordered on the east by white spruce stands with inclusions of shrubland. Vegetation on the western bank consists primarily of grass lawns with some modified white spruce stands adjacent to the trailer park.

One potentially rare plant community, wolf-willow (*Elaegnus commutata*) group, was identified on the Restwell property, outside of the development area. At present, this community is classed as "status uncertain" by Alberta Natural Heritage Information Centre. No rare plants were recorded during the rare plant surveys.

Spring Creek occurs as a narrow pond and a marsh in the north-western part of the study area, and as a flowing channel in the south-western part of the study area. Spring Creek forms most of the study area's western boundary. Grass lawns are located on the eastern shoreline of the narrow

pond portion adjacent to the trailer park, while shrubland and small patches of coniferous woodland occur on the eastern bank of the stream, farther south. The sedge wetland/shrubland potentially provides important habitat for ungulates and amphibians in the area.

The sedge wetland and riparian shrubland bordering Policeman's Creek are environmentally sensitive due to high rare plant potential, proximity to water and a low likelihood of success in reclamation. The level floodplain of Policeman's Creek is dominated by white spruce woodland, with minor inclusions of balsam poplar woodland and shrublands. The majority of the white spruce woodland is located in the south-eastern portion of the study area and its well-developed shrub layer provides potential winter habitat for ungulates. A disturbed meadow is located in the south-eastern corner of the study area. These areas are bounded by the existing development, thus are generally used only by species that tolerate human disturbance.

A wildlife survey was conducted in early September 2002. Observed wildlife included mule deer, red squirrels, mallard ducks, white-crowned sparrows, black-capped, boreal and mountain chickadees, crows, ravens, kingfishers, gray and blue jays, dark-eyed juncos, ruby-crowned kinglets, yellow-rumped warblers, Wilson's (common) snipes, feral rabbits and ring-billed gulls. Other wildlife sign indicated the presence of elk, beavers, woodpeckers and great blue herons.

Results from a winter wildlife survey indicated that the area is used by red squirrels, elk, deer, beavers, canines and a variety of birds.

A May 2003 amphibian survey identified wood frogs on the Restwell property. Evidence of breeding was observed for this species.

The June 2003 breeding bird survey resulted in 164 bird observations representing 29 species, many of which were observed during the September 2002 reconnaissance visit.

The wildlife survey results and evaluation of habitat potential of the Restwell property indicates that the area provides low to moderate quality habitat for ungulates and small and medium-sized carnivores. No evidence was found to indicate that the area is used as a wildlife corridor.

The riparian habitats were the only habitats rated as highly sensitive to development, largely because they provide habitat for listed species, are in good condition and are important for the maintenance of ecological function in the area and are well used by a variety of wildlife species including amphibians, beavers, shorebirds and waterfowl.

The treed habitats within the undeveloped area east of Policeman's Creek are rated as being moderately sensitive to development in part because they have a relatively restricted local distribution and provide a diversity of habitats. The large, mature trees provide nesting opportunities for birds, such as the listed pileated and black-backed woodpeckers, and an elk rub was also observed in this area. These habitats support small and medium sized carnivores and a variety of songbirds in both the tree and shrub layers.

The disturbed meadow and shrubland habitats were well used by ungulates as evidenced by both browsed plants and pellets. The latter habitat is rated as highly sensitive to development because it is restricted to areas adjacent to the creeks and is a transitional zone that is important for a variety of aquatic and terrestrial wildlife species. The southeastern disturbed meadow patch is linked to the South Canmore Local Habitat Patch and is well used by a variety of wildlife species, and therefore was rated as moderately sensitive.

The main sensitivity for redevelopment of the Restwell property for wildlife is the proximity to the South Canmore Local Habitat Patch to the south of the property. This area is also designated as an Environmentally Sensitive Area under the Canmore Municipal Development Plan because of its importance as a key component in the regional wildlife corridor system. As such, this area will require consideration in the Restwell Area Redevelopment Plan.

Fish and fish habitat surveys were conducted on Spring and Policeman's creeks in early October, 2002. The fish and fish habitat survey included fish capture, fish habitat mapping, and identification of anthropogenic impacts to the creeks. The Spring Creek fish survey captured juvenile mountain whitefish and one juvenile brown trout. The Policeman's Creek fish survey captured juvenile brown trout. Adequate fish habitat was available to support all life stages of salmonids (e.g., brown trout, brook trout, mountain whitefish). One brook trout redd was observed. Anthropogenic impacts to Policeman's and Spring creeks included in-stream structures

(e.g., groynes, bridges, docks) and encroachment of roads and structures into the streams and their riparian zones.

Both Spring and Policeman's creeks are classified as Class "B" watercourses by Alberta Sustainable Resource Development. Class "B" watercourses are considered to have a high sensitivity, as they provide habitat areas important to the continued viability of a population of fish species in the area. This classification permits development as long as the sensitivity and vulnerability of the system is accounted for and avoidance and mitigation of any potential impacts are included in the redevelopment plan.

Environmental sensitivities for vegetation, wildlife, and fish and fish habitat exist on and adjacent to the Restwell property and potential impacts and mitigation for these resources will be addressed further in the Environmental Assessment.

ACKNOWLEDGEMENTS

The vegetation and wildlife field surveys were conducted by Mark Sherrington, Kelly Gurski, Stephen Glendinning and Mitch Firman, who also assisted in the reporting and analysis of results. The fish and fish habitat survey was conducted by Ken Allen and Gerry Ball. Melanie Neufeld prepared the fisheries section of the report, which was reviewed by Peter Eaton, Gordon Walder and Doug Clay. Word processing was completed by Carole Collins, and project management and reporting were conducted by Carol Stefan and Sandra Marken. Michael Raine provided senior review. Thanks is extended to Selwyn Rose for providing local expertise to the amphibian survey.

TABLE OF CONTENTS

SECTION **PAGE**

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1. INTRODUCTION

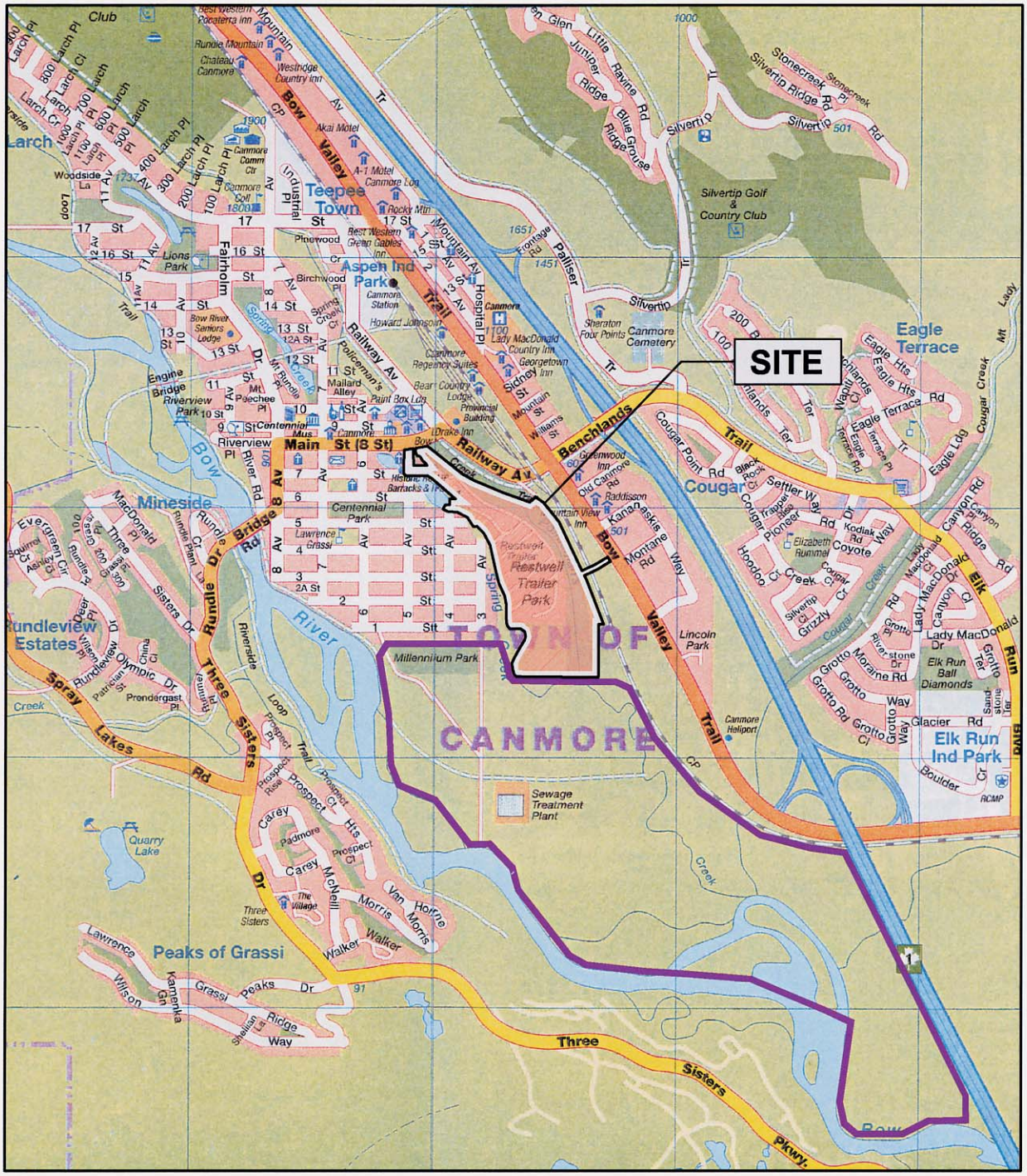
Restwell Trailer Park & Cabins (2002) Ltd. (Restwell) has proposed to redevelop its property in Canmore, Alberta. To fulfil partial requirements for Phase I of the Restwell Area Redevelopment Plan Terms of Reference, Golder Associates Ltd. (Golder) were retained to assess the biophysical resources of the Restwell property.

1.1 Objectives

The objective of the study was to provide a description of existing environmental conditions for consideration in the preparation of the Restwell Area Redevelopment Plan. This interim report includes results of spring and late summer rare plant and vegetation surveys, a wildlife survey, a winter track survey, a breeding bird survey, an amphibian survey and a fish and fish habitat survey. Environmental sensitivities and constraints were identified for each resource. The results of these investigations were used in the Environmental Assessment (Golder 2003) to identify potential impacts to environmental resources, and to develop recommendations for mitigation.

1.2 Location of the Restwell Property

The Restwell property is located south of Main Street in Canmore, Alberta (Figure 1-1). The legal boundaries for the property were used to define the study area for this assessment, and covers 26.5 ha. The property is bounded by Spring Creek to the west and the Canadian Pacific Railway (CPR) railway tracks to the east. Policeman's Creek runs through the property. This property is located within the upper floodplain of the Bow River on the north side of the river. The majority of the study area consists of paved roadways, housing (mobile homes), cabins and a campground. There are a few administration buildings in the northern portion of the site. In many areas along both the east and west branches of Policeman's Creek, grass lawns occur along the streambanks adjacent to some mobile homes.



LEGEND

SOUTH CANMORE LOCAL HABITAT PATCH

500 0 500
SCALE METRES

REFERENCE

SITE LOCATION PLAN SCANNED FROM AN ORIGINAL OBTAINED FROM MapArt Publishing Corp. 2002 EDITION

PROJECT
RESTWELL TRAILER PARK AND CABINS
AREA REDEVELOPMENT PLAN
CANMORE, ALBERTA

TITLE
SITE LOCATION PLAN

Golder Associates
Calgary, Alberta

PROJECT No. 022-2295.7620			FILE No.	Site Location	
DESIGN	KG	02/12/02	SCALE	AS SHOWN	REV. 5
CADD	GMF	23/10/03			
CHECK	SM	27/11/03			
REVIEW	MR	27/11/03			

FIGURE: 1-1

R:\CAD\2200\022-2295\7620 Baseline\2003 Report\ Drawing file: Site Location.dwg Nov 27, 2003 - 9:44pm

2. METHODS

The biophysical inventory included an examination of historical data and field surveys to assess and map vegetation, wildlife and fisheries resources.

The review of historical data was based on existing literature and was conducted as part of the background information gathering. Discussions were also held with individuals from Alberta Sustainable Resource Development (ASRD) and the Alberta Natural Heritage Information Centre, as well as with local residents.

Field data collection focused on the creek habitat and other undeveloped parts of the site, particularly lands to the east of the existing mobile home park. Field surveys included:

- a late summer rare plant and vegetation survey;
- a spring rare plant survey;
- a fall wildlife survey;
- a winter track count;
- an amphibian survey;
- a breeding bird survey, and
- a fish and fish habitat survey.

Lands adjacent to the site were evaluated to identify local resources that may be affected by redevelopment of the Restwell property. Environmental sensitivities and constraints were identified for each resource.

2.1 Vegetation Assessment

The vegetation assessment included:

- a literature review;
- a delineation of preliminary vegetation community types on an aerial photograph to establish preliminary vegetation/landform units (ecosite phases and wetland types) and identify sampling sites;

- an assessment of rare plant potential of vegetation types;
- rare plant and vegetation community surveys; and
- identification of sensitivities and constraints to development for the ecosite phases and wetlands types, including riparian zones of the Spring and Policemen creeks.

2.1.1 Pre-Field Investigation

2.1.1.1 Literature Review

The methods used to identify vegetation habitat conditions and their sensitivities to development were preceded by a review of the literature in order to describe the study area and similar areas within the region. The review of previous literature and datasets included:

- the Spring Creek Environmental Impact Assessment (EIA) (Golder 1995), and the Canmore South Area Structure Plan Environmental Assessment (EMA 1993);
- the Alberta Natural Heritage Information Centre (ANHIC 2002a, b) for existing rare plant and community type occurrence information for the site and surrounding area. Known occurrences were mapped onto topographic maps or photo mosaics, which were taken into the field;
- the Field Guide to Ecosites of Southwestern Alberta (Archibald et al. 1996);
- discussions with a vegetation expert from ANHIC (John Rintoul, pers. comm.); and
- a list of potential rare species derived from floras, distribution maps (Moss 1983), published reports (Packer and Bradley 1984) and existing species lists for the area.

2.1.1.2 Rare Plant Community Types

Natural plant communities are defined as recurring assemblages of plant species; the species occurring together because they respond similarly to a variety of site attributes (ANHICb 2002). To develop an initial tracking list of natural plant community elements, publications describing vegetation types in Alberta were reviewed and discussions were held with John Rintoul (ANHIC, pers. comm.). Vegetation types that have been described as 'unusual', 'uncommon', 'of limited extent' or 'encountered infrequently' (ANHIC 2000b) were considered for inclusion on the Preliminary Plant Community Tracking List. Vegetation types that have been described as 'in

decline' or 'threatened' were also considered for inclusion. Only natural communities were considered.

A request was made to the Alberta Natural Heritage Information Centre (ANHIC) for records of previously identified rare plant communities within a 10 km radius of the Restwell Property. ANHIC indicated they have no recorded occurrences in their database for this area. However, the absence of records could be due to the few inventories or surveys for rare plant community types that have been done in this part of the province (John Rintoul, ANHIC, pers. comm.).

2.1.1.3 Rare Plants

The following two steps were taken prior to the field survey:

- collect information on potential rare plant species; and
- map the project area.

The Alberta Native Plant Council (ANPC) defines rare plants as "[a] native species which, due to biological or geographical characteristics, is found in restricted areas, or at the edge of its range, or for other reasons is found in low numbers within the province of Alberta" (ANPC 2000).

A request was made to the Alberta Heritage Inventory Committee (ANHIC) for records of previously identified rare plants within a 10 km radius of the Restwell Property. This rare plant list was referred to during the field survey along with reference material (Kershaw et al. 2001; Moss 1983). These references provided information to help select the areas of highest rare plant potential, for survey focus. In addition, the distribution maps in these references (Kershaw et al. 2001; Moss 1983) were checked for existing rare species in the Canmore area.

Of the 34 rare plants known to occur within 10 km of Canmore (Appendix I), 19 occur in habitats similar to those found in the study area. These habitats include streambanks, calcareous fens, marshes and open coniferous forest. The other rare plant species recorded within 10 km of Canmore occur in alpine and upper subalpine areas, predominantly on scree and rock outcrops – conditions that do not occur in the study area.

2.1.1.4 Delineation of Vegetation Communities

A pre-field map of the plant communities in the study area was prepared in order to identify vegetation communities that exist in the study area, and to identify those communities with the highest rare plant potential (i.e., sedge fens, marshes and open coniferous forest). This map allowed the surveyor to prioritize the field program, ensuring that areas of high rare plant potential were visited, and that the survey collected information on the range of community types that exist. Following the field surveys, these vegetation types were classified to ecosite phase and wetlands type based on moisture and nutrient characteristics and dominant plant species for each site.

The Field Guide to Ecosites of Southwestern Alberta (Archibald et al. 1996) was used to describe terrestrial vegetation in the study area. This classification is based on the principles of ecological land classification (ELC). The system uses a mixture of biotic and abiotic variables to create a hierarchical, or nested, ecological classification structure. At the coarsest level of classification, ecological areas and subregions are defined on the basis of broad ecoclimatic factors. At this level of generalization, the study area is located in the Montane Natural Subregion.

Ecosites are ecological units that develop under similar environmental influences such as climate, moisture, and nutrient regime. They are subdivided into ecosite phases according to the dominant species in the forest canopy or the tallest vegetation layer, and further into plant community type based on the occurrence and abundance of characteristic plant species. These vegetation types are denoted by an alphanumeric code. For example, the c4.1 code represents the Canada buffaloberry/hairy wild rye aspen-white spruce-lodgepole pine-Douglas fir community type. Archibald et al. (1996) recognized seven upland ecosites in the Montane Natural Subregion

Wetlands in the study area were described using Alberta Wetlands Inventory (AWI) Standards (Halsey and Vitt 1996). In the AWI system, five primary wetlands types, bog, fen, marsh, swamp and shallow open-water, are defined in terms of inter-relationships among the hydrologic, chemical and biotic processes that control wetlands structure and function.

2.1.2 Field Surveys

The field component included a vegetation type and summer rare plant survey conducted on September 6, 2002, and, a spring rare plant survey conducted in June, 2003.

2.1.2.1 Rare Plant Surveys

The rare plant surveys were floristic in nature, meaning that the focus of the surveys were to identify and then survey those areas of highest rare plant potential. Based on past rare plant occurrences in the Bow Valley in the vicinity of Canmore (ANHIC 2002a), the sedge wetland, shrubland, and Canada buffaloberry/hairy wild rye aspen-white spruce-lodgepole pine-Douglas fir (c4.1) had the highest rare plant potential. These plant communities were targeted for more intensive surveys during the spring and summer rare plant surveys.

Two rare plant surveys were conducted: the first was conducted in late summer to sample for late-flowering species such as composites, grasses, sedges and others; the second survey was conducted in the spring to sample for early-flowering species such as orchids, violets and lilies.

The transects meander to allow for coverage of more habitat variations within the study area, and to focus on likely microsites, as they are encountered. A floristic survey was used to identify all the plant species observed in the survey area to the species level, so that rarity could be determined (ANHIC 2002a).

2.1.2.2 Vegetation Community Survey

Fieldwork was designed to collect floristic information from all ecosites within the property boundaries. This information was then used to determine the vegetation community type. This involved an inventory of the presence, cover and structure of all plant species encountered within the ecosite. Photographs of representative ecosites are presented in Appendix II.

2.1.3 Vegetation Sensitivities and Constraints

The sensitivities of the ecosites identified in EMA (1993) were reviewed and considered appropriate. They were then applied to the same ecosites identified during the survey of the

Restwell property. The environmental sensitivities identified in that report were developed as part of the ecological land classification in which vegetation units were identified and mapped, based on field observations, background literature and air photo analysis. Each of the ecosites were then assessed for sensitivity to development based on a number of parameters, including unique features, rare plant potential, rareness of the vegetation community within the region, diversity of communities, condition (natural vs. modified) and development limitations due to flooding potential (EMA 1993).

2.2 Wildlife Survey

The wildlife surveys were designed to capture wildlife use and habitat potential in the study area over the range of seasonal conditions that occur in the region. The approach followed to conduct the wildlife assessment included:

- a literature review;
- identification of wildlife sampling sites from the preliminary vegetation community map;
- the following field surveys:
  - fall reconnaissance survey for wildlife use according to vegetation community type;
  - winter track and wildlife sign survey;
  - spring amphibian survey;
  - spring breeding bird survey; and
- determination of sensitivities and constraints for wildlife habitat within and adjacent to the Restwell study area.

2.2.1 Literature Review

A review of the literature was conducted to identify critical habitat for key wildlife species in the area, and local and regional environmental sensitivities. Background review included:

- the Spring Creek EIA (Golder 1995);
- the Canmore South Area Structure Plan Environmental Assessment (EMA 1993);

- wildlife field guides [Amphibians and Reptiles of Alberta (Russell and Bauer 2000), Birds of Alberta (Fisher and Acorn 1998); Mammals of Alberta (Pattie and Fisher 1999); Hoofed Mammals of Alberta (Stelfox 1993)];
- regional wildlife reports (BCEAG 1998);
- Canmore municipal development (Canmore 1998) and land use plans (Canmore 2002); and
- discussions with the local office of Alberta Sustainable Resource Development (Jon Jorgenson, pers. comm.) for additional wildlife information for the area.

2.2.2 Field Surveys

To gather preliminary information on wildlife use of the Restwell property by terrestrial vertebrate species, four separate surveys were conducted. All incidental wildlife observations were recorded during all field programs. All observations were recorded to habitat type and global positioning (GPS) locations were recorded of key observations. Photographs are provided in Appendix III.

2.2.2.1 Wildlife and Wildlife Habitat Survey

A one-day wildlife sign and habitat survey was conducted on September 6, 2002. The survey was conducted in conjunction with the vegetation and late summer rare plant survey. Wildlife sign (e.g., scat, tracks, game trails, nests, dens, ungulate browse) was recorded along transects located to bisect all habitats within the Restwell property. All wildlife sign and associated vegetation community types were recorded. The sampling design was adjusted as necessary, based on field observations, in order to obtain wildlife information for all communities identified within the study area. Key wildlife observations were recorded using a GPS unit.

2.2.2.2 Winter Track Survey

A one-day track survey was conducted on February 11, 2003 to assess ungulate, furbearer and general wildlife distribution and habitat use. The survey was timed to occur after a recent snowfall to ensure that tracks were readily identifiable. Transects were situated using vegetation classification maps from Golder (2003) and GPS units were used to locate and measure each

transect. The track survey was conducted on foot. Information recorded included species, number of animals, and community type. Key wildlife observations were recorded using a GPS unit.

2.2.2.3 Amphibian Survey

On May 30, 2003 a visual survey was conducted for amphibian adults, eggs and tadpoles. Policeman's Creek, Spring Creek and wetlands areas within the study area were surveyed. An observer experienced with identifying all the life stages of locally present amphibian species conducted the survey by walking the bank of the creeks and flooded wetland areas. All amphibian observations, including species, location and habitat were mapped and recorded on datasheets.

2.2.2.4 Breeding Bird Survey

On June 18, 2003 a breeding bird survey was conducted to determine avian use of the Restwell property and immediate surroundings. The survey commenced at sunrise (5:28 AM) and was competed by mid-morning (9:03 AM). An experienced observer, familiar with bird species of the region by both sight and sound, circumnavigated the property by walking adjacent to Spring and Policeman's creeks, and then worked through the body of the property. All bird observations, including species, location and relevant behaviour were recorded on an 18" × 32" map of the property.

2.2.3 Wildlife Sensitivities and Constraints

Wildlife sensitivities were based on the vegetation classification system. Vegetation community types were rated based on the following factors as per EMA (1993):

- rareness of the vegetation community within the region;
- provides habitat for rare species (ASRD 2001);
- provides critical habitat for wildlife;
- condition (natural vs. modified);
- important for the maintenance of ecological function; and

- provides habitat for a diversity of wildlife species.

Canmore municipal development (Canmore 1998) and land use plans (Canmore 2002), and wildlife reports for the area were also reviewed to identify local and regionally important wildlife habitat, and designated environmentally sensitive areas.

2.3 Fish and Fish Habitat Assessment

The approach followed to conduct the fish and fish habitat assessment included:

- a literature review of the fisheries data for the Restwell property;
- a fish inventory of Spring and Policeman's creeks in the vicinity of the Restwell property;
- watercourse habitat mapping of Spring and Policeman's creeks within the vicinity of the Restwell property;
- determination of sensitivities and constraints for Spring and Policeman's creeks; and
- incidental wildlife observations.

2.3.1 Literature Review

Historical information on the fish communities and spawning activity associated with Spring and Policeman's creeks was derived from a review of previous reports (Westworth 2000, Golder 1995, Brewin 1994, EMA 1993, Stelfox 1979) and through conversations with staff of Alberta Sustainable Resource Development (ASRD).

2.3.2 Fish Inventory

A fish inventory was conducted on October 1, 2002 to document fish populations in key habitats of Spring and Policeman's creeks. A Smith-Root Model 12-B backpack electrofishing unit and four baited Standard Gee minnow traps set for the duration of the fish habitat survey were used to capture fish. Sampling effort for all electrofishing operations was recorded as the number of seconds of electrofishing. Sampling effort for each minnow trap was recorded as the duration of the set.

Electrofishing on Spring Creek was conducted in two reaches representing the dichotomous habitat present in Spring Creek). Reach 1 was located from the creek's confluence with Policeman's Creek to a point 133 m upstream, where the most downstream set of stream enhancement structures were located. Reach 2 was located at the midpoint of Spring Creek in a stream section with abundant overhanging cover and was 234 m in length, about 150 m from the end of Reach 1.

Electrofishing on Policeman's Creek was initiated in one 413 m long reach that had its downstream end located just upstream of the Spring Creek confluence.

Voltage, pulse, and duty cycle settings on the backpack electrofisher were adjusted to effectively anodotax fish without causing physical damage to the fish. The conductivity of Spring Creek was moderately high (325 µS/cm), so the electrofishing settings were set as shown in Table 2-1. Conductivity was not measured in Policeman's Creek, but due to similar surficial and geological influences it was assumed that the conductivity of both creeks would be similar. The similar current output (Table 2-1) indicates that conductivity in the two creeks was about 20% different.

Two minnow traps were set amongst submerged woody debris in both Spring Creek and Policeman's Creek.

Table 2-1
Electrofishing Settings for Work Conducted in Spring and Policeman's Creeks, October 2002

Location	Length of Stream Sampled (m)	Sampling Effort (sec)	Battery Voltage (v)	P.O.W. Mode	Output Voltage (v)	Frequency (Hz)	Pulse Width (ms)	Current (amps)
Spring Creek – Reach 1	133	538	24	12B	300	60	6	0.62
Spring Creek – Reach 2	234	1158	24	12B	300	60	6	0.62
Policeman's Creek	413	1554	24	12B	300	60	6	0.53

Water quality characteristics were measured along both creeks in accordance with Golder's Technical Procedure 8.3-1: "Surface Water Sampling Methods" (Appendix IV). Data collected

included pH, conductivity (only Spring Creek), and temperature (including the time of day the readings were taken).

All fish captured were identified and measured for length and identified to life history stage (fry, juvenile, or adult) and sex when discernible by external examination. Fork length (mm) and body weight (g) were measured for larger fish. All fish were subsequently released live at the point of capture.

2.3.3 Fish Habitat Mapping

A fish habitat map provides an inventory of available habitats in an area and insight into the potential use of the habitat by fish throughout the year, not just for the period of the field investigation. It allows for the early identification of areas that may be sensitive to construction activities or elevated sedimentation so that construction techniques and mitigation measures can be identified to best protect those areas.

The fish habitat survey was conducted according to Golder's Technical Procedures for Watercourse Habitat Mapping System (TP 8.5-1) "Stream Habitat Mapping and Classification System" (Appendix IV) and included the following tasks:

- fish habitat mapping of Spring Creek from its spring source to its confluence with Policeman's Creek (1.3 km);
- fish habitat mapping of Policeman's Creek from 500 m upstream of Restwell to the Policeman's Creek – Bow River confluence (3.6 km);
- documentation of representative habitat types with photographs wherever possible to record habitat conditions; and
- collection of field water quality parameters (i.e., temperature, pH, and conductivity) at three sites with fish habitat potential.

The stream habitat mapping system records the presence and location of the individual channel units (i.e., riffle, run, flat, pool) in combination with depth, substrate characteristics, and instream and overhead cover. Photographs were also taken to illustrate physical characteristics such as bank conditions, bank profiles, riparian areas, and channel characteristics (Appendix V).

2.3.4 Determining the Sensitivity of the Watercourse to Redevelopment Activities

Discussions were held with Brian Lajeunesse (ASRD, pers. comm.) to determine potential environmental sensitivities of Policeman's and Spring creeks. Existing impacts to fish and fish habitat located in the vicinity of the Restwell property were noted, such as disturbed riparian zones, disturbed banks, man-made structures in streams, debris/garbage in streams, road run-off, building encroachment, campground encroachment, or sewage/nutrient inputs. Redevelopment, if done properly, with increased setbacks and new infrastructure, could reduce the existing impacts on the watercourses.

3. RESULTS AND DISCUSSION

3.1 Vegetation

The following sections discuss the results and their significance, based on the information collected during the literature review and field surveys conducted for the Spring Creek Redevelopment Plan. Plant community type, rare plant communities and rare plants are described, as well as the significance of the local vegetation and its sensitivity to disturbance.

3.1.1 Rare Plant Community Types

Natural plant communities are defined as recurring assemblages of plant species; the species occurring together because they respond similarly to a variety of site attributes (ANHIC 2002b).

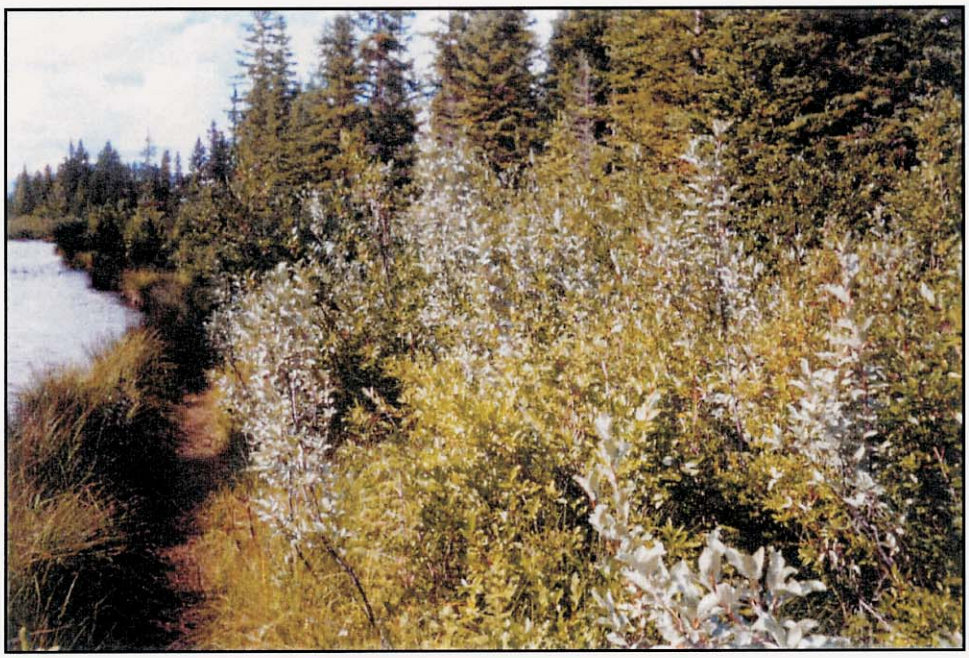
Although there were no records of previously identified rare communities within a 10 km radius of the Restwell Property (ANHIC 2002a), a rare community type was observed on a low stream terrace immediately east of Policeman's's Creek (Figure 3-1, Figure 3-2). The wolf-willow (*Elaegnus commutata*) group, often including willow (*Salix* spp.), Saskatoon (*Amelanchier alnifolia*) and chokecherry (*Prunus virginiana*), forms "stringers" on stream terraces in the Foothills and Montane Natural Subregions. Although chokecherry was not observed in this representative site, the other species present combined with the location on a stream terrace supports the community being classed into the wolf-willow group. At present, this community is classed as "status uncertain" by ANHIC (2003b). ANHIC considers the wolf-willow group as a community of interest (John Rintoul, ANHIC, pers. comm.). Further data is required to assess the rarity of this community type, as there is currently little information available for site locations.

3.1.2 Rare Plants

No rare plants were observed along transects surveyed during the late summer and spring rare plant surveys. Based on regional findings, rare plant potential exists in the sedge wetland, riparian shrubland bordering Policeman's Creek, and the white spruce - horsetail (g1.1) community types.

A search of past findings indicated that nineteen rare vascular plant species were found within 10 km of Canmore in habitats present on the Restwell Property (Rintoul, pers. comm.). For a listing of the rare vascular plants that have been observed in the Canmore area during past surveys, refer to Appendix II.

Figure 3-1
Wolf-willow - Shrub Rare Plant Community Type



3.1.3 Plant Community and Wetlands Types

Most of the vegetation classes identified and mapped in the study area correspond to Archibald et al. (1996) and Halsey and Vitt (1996) (Figure 3-2). However, the Shrubland, Urban and Disturbed Meadow classes mapped in the study area do not correspond to either of these classification systems. The sedge wetland and open water classes fit within the graminoid marsh and shallow open water types described in the Alberta Wetland Inventory (Halsey and Vitt 1996). The remaining classes correspond to the terrestrial plant communities of Archibald et al. (1996) for the Montane Natural Subregion.

100 0 100
SCALE METRES

LEGEND

PROPOSED RESTWELL ARP BOUNDARY

VEGETATION CLASSIFICATION

REFERENCES

AIR PHOTO OBTAINED FROM CLIENT. PROVIDED BY FOTO FLIGHT SURVEYS AUGUST 12, 2002; ORIGINAL SCALE 1:5000

PROJECT
RESTWELL TRAILER PARK AND CABINS
AREA REDEVELOPMENT PLAN
CANMORE, ALBERTA

TITLE
STUDY AREA AND VEGETATION CLASSIFICATION

Golder Associates
Calgary, Alberta

PROJECT No. 022-2295.7620			FILE No.	Vegetation survey
DESIGN	KG	26/11/02	SCALE AS SHOWN	REV. 6
CADD	GMF	24/10/03		
CHECK	SM	27/11/03		
REVIEW	MR	27/11/03		

FIGURE: 3-2

The study area covers an area of approximately 28.37 ha. The areal extent of each vegetation community and disturbed area is provided in Table 3-1. A total of eight vegetation types were mapped in the study area, as well as open water, railroad, and urban polygon types. Photos of key plant community or wetlands types are in Appendix III.

Table 3-1
Areal Extent of Vegetation Communities, Disturbed and Developed Areas on the Restwell Property

Type	Area (ha)
sedge wetland	1.35
shrubland	0.93
wolf-willow	0.06
Canada buffaloberry - hairy wild rye – aspen - white spruce (c4.1)	2.22
disturbed - Canada buffaloberry – hairy wild rye-aspen – white spruce (c4.1)	0.20
horsetail - white spruce – balsam poplar – (g1.1)	0.54
balsam poplar – snowberry (f1.1)	0.24
disturbed meadow	0.13
open water	2.67
urban	19.99
Total	**28.37**

3.1.3.2 Sedge Wetland

The moderate-rich sedge wetland (marsh) covers 1.35 ha and is located along the east bank of Policeman's Creek in the northern portion of the Restwell property (Figure 3-2). It includes areas of brown mosses, namely hook mosses (*Drepanocladus aduncus* and *Drepanocladus vernicosus*), giant water moss (*Calliergon stramineum*) *and* clay pigtail moss (*Hypnum lindbergii*), with no *Sphagnum* species present. The dominant sedge species is water sedge (*Carex aquatilis*) forming a 60 – 70% cover. Other graminoid species comprising the sedge wetland are beaked sedge (*Carex utriculata*), cottongrass (*Eriophorum brachyantherum*) and northern bog sedge (*Carex gynocrates*). Forb species, including elephant's head (*Pedicularis groenlandica*), shooting star (*Dodecathon pauciflorum*), bracted bog-orchid (*Habenaria viridis*) and a shrub species, myrtle-leaved willow (*Salix myrtillifolia*) occur on the drier hummocks in the sedge wetland.

3.1.3.3 Shrubland

Two main community types of riparian shrubland community were observed. On subhydric, gravel stream terraces, the riparian shrubland community is dominated by willows (*Salix* spp.)

and wolf-willow (*Elaegnus commutata*) up to 2 m tall. The understory is comprised of a 25% cover of grasses, dominated by sedges including short-beaked sedge (*Carex simulata*). The 10% forb species cover includes smooth aster (*Aster laevis*). This type runs along the banks of both Spring and Policeman's creeks transitioning into the other riparian community. Some polygons were too small to map so are included within the shrubland community type. The largest polygon of the wolf-willow community occurs along the eastern bank of Policeman's Creek and is approximately 0.06 ha (Figure 3-2).

Along the sedge meadow margins where there is a hydric moisture regime, a second riparian shrubland type is dominated by willow species including Booth's willow (*Salix boothii)* 3 to 4 metres tall. This type of shrubland has an area of 0.93 ha in the study area. The dense willow cover limits most herbaceous species except horsetail (*Equisetum* sp.) that occurs with less than a 5% cover.

Included in the shrubland category is a narrow band along the 1 m high bank of Policeman's Creek, which is made-up of low shrub, herbaceous and graminoid species. The primary low shrubs are Canada buffaloberry (*Shepherdia canadensis*), wolf-willow, and common willow species including Macall's willow (*Salix maccalliana*). The herb layer includes several forb species, including Franklin's lady slipper (*Cypripedium passerinum*), woolly everlasting (*Antennaria lanata*), rush-like sedge (*Carex scirpoidea*), common blue-eyed grass (*Sisyrinchium montanum*) and round-leaved orchid (*Orchis rotundifolia*). The graminoid cover ranges from 20 to 40% including single-spiked sedge (*Carex scirpoidea*), Holm's Rocky Mountain sedge (*Carex scopularum*), creeping spike-rush (*Eleocharis palustris*), and sloughgrass (*Beckmannia syzigachne*). Herbaceous species have a 10% cover comprised of wild strawberry (*Fragaria virginiana*), northern grass-of-parnassus (*Parnassia palustris*), and other species.

3.1.3.4 Canada Buffaloberry - Hairy Wild Rye – Aspen - White spruce (c4.1)

The aspen – white spruce community type is the largest community type (2.22 ha) on the Restwell property. It borders the east bank of Policeman's Creek for more than 500 m (Figure 3-2). White spruce (*Picea glauca*), 20 to 25 m tall, forms a 20-30% forest canopy in this community type. Prickly rose (*Rosa acicularis*) and Canada buffaloberry dominate the low shrub layer. The graminoid layer has a 10% cover, including single-spiked sedge and fuzzy-spiked wild

rye (*Elymus innovatus*). The forb layer has a 10% cover, dominated by cream-coloured vetchling (*Lathyrus ochroleucus*), wild strawberry, and northern bedstraw (*Galium boreale*).

The moss layer is well developed in some locations with a 70% cover including hairy screw moss (*Tortula ruralis*), ragged wood moss (*Brachythecium* sp.), and wiry fern moss (*Thuidium abietinum*). In more shaded locations, with over a 50% canopy closure, there is only a 10% moss cover present.

Adjacent to this community type, towards the railroad tracks is a small polygon that represents a disturbed portion of the c4.1 community type, labelled c4.1(d). This rectangular polygon, of 0.2 ha, bridges the study area with the portion of Canmore on the east side of the tracks, and represents a possible access route. The area is disturbed by road and railroad right-of-ways, trails, cleared patches, and other signs of surface disturbance. White spruce dominates the canopy in this area.

3.1.3.5 Horsetail - White Spruce – Balsam Poplar (g1.1)

This community type is represented by a 0.54 ha polygon located to the east of the Policeman's Creek and adjacent to the C.P.R. tracks (Figure 3-2). White spruce, 20 to 25 m tall, forms a 30 to 40% forest canopy and willow dominates the low shrub layer. The graminoid layer is sparse, including single-spiked sedge and marsh reed grass (*Calamagrostis canadensis*). The forb layer has up to a 25% cover dominated by horsetail and blue columbine (*Aquilega brevistylis*). The moss layer is well developed in some locations with a 70% cover including hairy screw moss, ragged wood moss, and wiry fern moss. In more shaded locations, with over a 50% canopy closure, there is only a 10% moss cover present.

3.1.3.6 Balsam Poplar – Snowberry (f1.1)

A small, but structurally complex balsam poplar (*Populus balsamifera*) stand is located within the more extensive white spruce stands in the eastern portion of the study area (Figure 3-2). This community covers 0.24 ha and has a well-developed low shrub layer comprised of prickly rose and common snowberry (*Symphoricarpos albus*). Smooth aster comprises a large portion of the

forb layer, graminoids are poorly represented in the area, and the sparse moss layer is dominated by ragged wood moss.

3.1.3.7 Disturbed Meadow

This type is comprised of exotic species including smooth brome (*Bromus inermis*) and Canada thistle (*Cirsium arvense*). The disturbed meadow covers an area of 0.13 ha and occurs along the southeastern-most corner of the Restwell property (Figure 3-2).

3.1.3.8 Open Water

The shallow open water area consists of Policeman's and Spring creeks and covers 2.67ha within the Restwell property. The portions of Policeman's Creek and Spring Creek located in the northern half of the study area are essentially linear waterbodies with very little current. A more detailed description of the creeks is presented in the fish and fish habitat section.

3.1.3.9 Urban

The urban area (19.99 ha) consists of non-vegetated surfaces and residences. Approximately 10% of the area classed "urban" is vegetated with lawn grass, planted trees and residual trees. In general, where the urban polygon is adjacent to the creeks and not separated by a band of shrubland, there are tall, non-native grasses within the first 1 to 2 m of the open water (e.g., northwest corner along Spring Creek). These grass species come from the planting of lawn seed and sod.

3.1.4 Vegetation Sensitivities and Constraints

The environmental sensitivities of vegetation communities and other land cover types in the Restwell property are presented in Table 3-2. The ELC units described in EMA (1993) are presented in Table 3-2 with the corresponding vegetation communities (Archibald et al. 1996) and wetlands types (Halsey and Vitt 1996) used in vegetation mapping of the Restwell property. Figure 3-3 provides a colour coded map of the environmental sensitivity ratings of the vegetation types in the Restwell study area.

The sedge wetland, shrubland, and open water have been ranked as high for environmental sensitivities. The sedge wetland and the adjacent open water zone is restricted in its distribution, is in a relatively undisturbed condition, and as such, presents a high limitation to development. One of the existing disturbances includes the Town of Canmore boardwalk, which runs parallel to Policeman Creek within the sedge wetland community type. As the sedge wetland and open water types are located within the riparian zone, they will fall under the protection of the new 6 to 10 metre setback for Policeman's and Spring creeks, as part of the Area Redevelopment Plan.

The vegetation types assigned a moderate sensitivity rating include the four forest vegetation types located on the east side of Policeman's Creek (Figure 3-3). The Canada buffaloberry - hairy wild rye - aspen - white spruce (c4.1) and balsam poplar - snowberry (f1.1) community types are components of the A4 vegetation type [moderately closed (20-40%) white spruce/shrubby cinquefoil-willow/bearberry] that was rated moderate by EMA (1993). This classification was assigned due to a moderate classification for distribution, a low to moderate designation for natural condition, a moderate diversity of habitat, a moderate rare plant potential, moderate to high limitations to development, and a low occurrence of unique features.

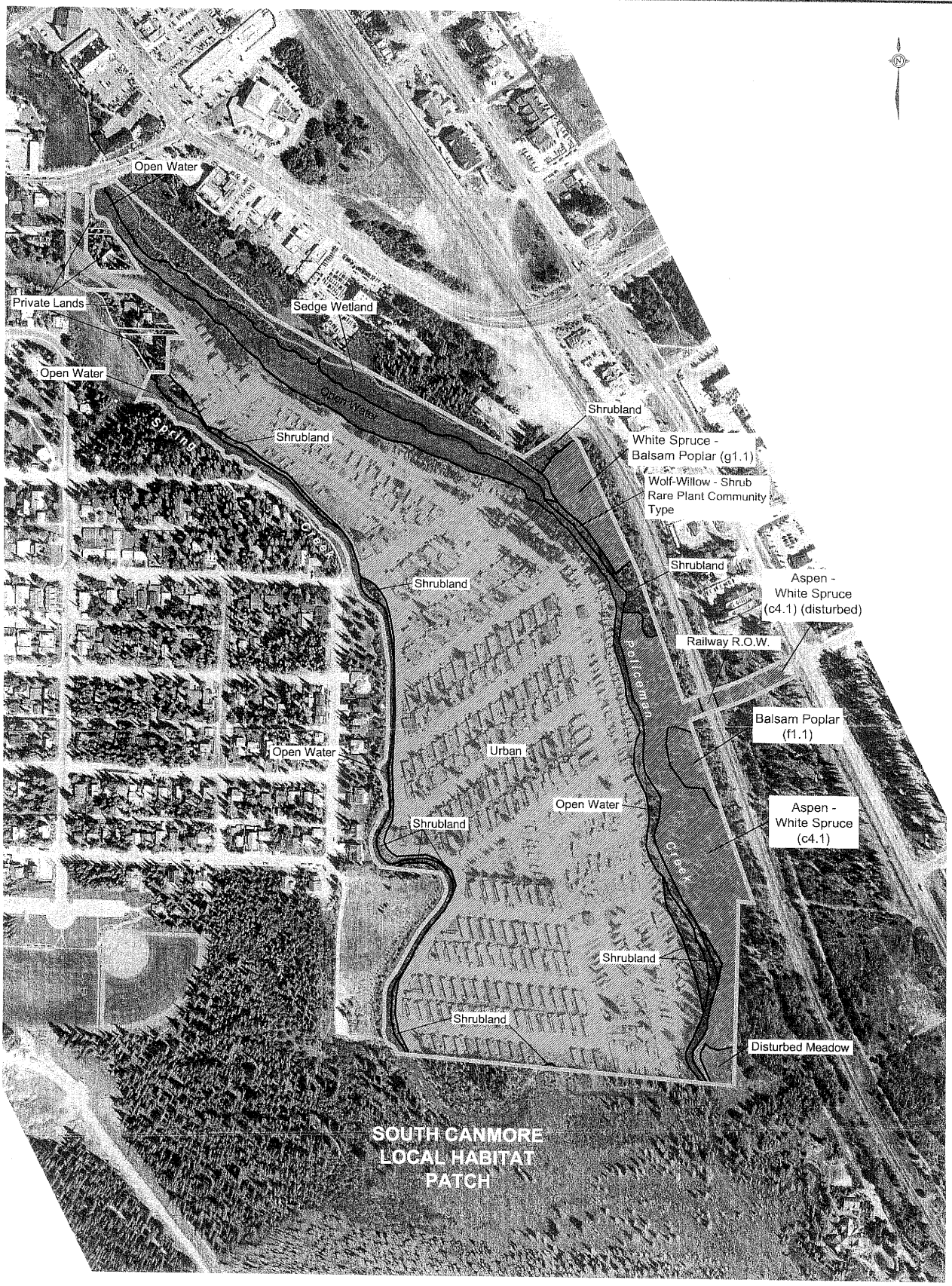
The horsetail - white spruce - balsam poplar (g1.1) community type was equated with the A5 ecosite [closed (>40%) white spruce - horsetail - feather moss] (EMA 1993) and rated as moderate environmental sensitivity. This community type is somewhat restricted in distribution, is in relatively undisturbed condition, has moderate rare plant potential and presents moderate to high limitations to development.

Table 3-2
Environmental Sensitivity Ratings of Vegetation Types on the Restwell Property

Plant Community/ Wetlands Type	ELC unit (code)[a]	Restricted Distribution	Natural Condition	Diversity of Habitat	Rare Plant Potential	Limitations to Development	Unique Features	Sensitivity Rating[a)]
sedge wetland	sedge meadow (F10)	H[b]	H	L	L	H	H	H
shrubland	tall willow (F6)	H	L - M	L	L	H	L	H
	willow/sedge/aquatic emergents (F9)	H	L - M	M	M	H	L	
	wolf willow/ bearberry – yellow dryad (R2)	H	M	M	L	H	M	
open water	willow/sedge/aquatic emergents (F9)	H	L-M	M	M	H	L	H
horsetail - white spruce – balsam poplar – (g1.1)	closed (>40%) white spruce/horsetail/feathermos s (A5)	M - H	M - H	M	L – M	M	L - M	M
Canada buffaloberry - hairy wild rye – aspen - white spruce (c4.1)	moderately closed (20 to 40%) white spruce-shrubby cinquefoil/willow/ bearberry (A4)	M	L-M	M	M	M - H	L	M
	closed white spruce/feather moss (A5)	M	M - H	L-M	M	M - H	L	
balsam poplar – snowberry (f1.1)	moderately closed (20 to40%) white spruce / shrubby cinquefoil – willow / bearberry (A4)	M	L - M	M	M	M - H	L	M
disturbed meadow	grassland – partially disturbed (A1)	M	L	L	L	M - L	L	L
	low shrub / mixed grass (A3)	M	L	L	L	M	L	L
urban	none	n/a	n/a	n/a	n/a	n/a	n/a	L

[a] Reference: Ecological Land Classification units and codes, and sensitivity categories and ratings from EMA (1993).
[b] H = high; M = moderate; L= low

R:\CAD\2200\022-2295\7620 Baseline\2003 Report\ Drawing file: Env Sens Ratings.dwg Nov 27, 2003 - 9:54pm



LEGEND

- PROPOSED RESTWELL ARP BOUNDARY
- VEGETATION CLASSIFICATION
- HIGH ENVIRONMENTAL SENSITIVITY RATING
- MODERATE ENVIRONMENTAL SENSITIVITY RATING
- LOW ENVIRONMENTAL SENSITIVITY RATING

100 0 100
SCALE METRES

REFERENCES

AIR PHOTO OBTAINED FROM CLIENT. PROVIDED BY FOTO FLIGHT SURVEYS AUGUST 12, 2002; ORIGINAL SCALE 1:5000

PROJECT: RESTWELL TRAILER PARK AND CABINS AREA REDEVELOPMENT PLAN CANMORE, ALBERTA

TITLE: ENVIRONMENTAL SENSITIVITY RATINGS OF VEGETATION TYPES ON THE RESTWELL PROPERTY

Golder Associates Calgary, Alberta

PROJECT No. 022-2295.7620			FILE No.	Env Sens Ratings
DESIGN	SM	28/10/03	SCALE	AS SHOWN REV. 1
CADD	GMF	29/10/03		
CHECK	SM	27/11/03		
REVIEW	MR	27/11/03		

FIGURE: 3-3

The wolf willow/bearberry – yellow dryad (the R2 ELC unit) was assigned a high environmental sensitivity rating by EMA (1993). This vegetation type corresponds to the wolf-willow group identified in this survey and is classified as a rare plant community type of unknown distribution in the province (ANHIC 2002b, see Section 3.1.1). In addition, it is restricted in distribution, is relatively undisturbed and has a moderate rare plant potential.

The environmental sensitivities of the area immediately south of the Restwell Property (South Canmore Local Habitat Patch) were ranked as moderate for most forest and shrubland ELC units except the closed white spruce – horsetail-feathermoss (F3) (EMA 1993). In this ELC classification, the sparsely vegetated gravel bars and wolf-willow/ bearberry – yellow dryad ELC units within the Bow River were assigned a high sensitivity. The high-ranked units are located more than 500 m from the Restwell Property. In comparison, the terrestrial ELC units adjacent to, and including the southeast portion of the Restwell Property, were ranked from low to moderate for environmental sensitivity. Policeman's and Spring creeks were assigned a high sensitivity to environmental disturbance (EMA 1993), in this region of the study area.

3.2 Wildlife Resources

A one-day reconnaissance survey was conducted on September 6, 2002. Other surveys included a one-day survey to assess winter tracks, a one-day survey for breeding birds and a one-day survey for amphibians along Spring and Policeman's creeks. Photographs of significant wildlife observations are presented in Appendix III.

3.2.1 September 2002 Reconnaissance Visit

A reconnaissance survey was conducted during the summer of 2002, for general wildlife observations and habitat use throughout the study area. Incidental wildlife observations included mule deer, red squirrels, mallard ducks, black-capped chickadees, crows, ravens, kingfishers, gray jays, ring-billed gulls and feral rabbits (Table 3-3). The rabbits were observed in the disturbed meadow and adjacent aspen grove. Other signs indicated the presence of elk and great blue heron.

Table 3-3
Wildlife Observations: September 2002 Reconnaissance Visit

Habitat	Number of Observations	Wildlife Sign
sedge wetland	3	yellow-rumped warbler visual observation
	1	black-capped chickadee visual observation
	2	Wilson's (common) snipe visual observation
shrubland	7	Wilson's warbler visual observation
	1	ruby-crowned kinglet visual observation
	1	deer tracks
	10	yellow-rumped warbler visual observation
	2	white-crowned sparrow visual observation
	1	black-billed magpie visual observation
Canada buffaloberry – hairy wild rye – aspen – white spruce (c4.1)	3	red squirrel midden
	1	red squirrel calling
	1	elk rub on willow
	1	red squirrel food cache
	2	red squirrel visual observation
	1	American robin visual observation
	1	elk pellet group (old)
	1	dark-eyed junco visual observation
	1	blue jay calling
	1	woodpecker species feeding excavations
horsetail – white spruce – balsam poplar (g1.1)	1	elk pellet group
	1	red squirrel visual observation
	9	black-capped chickadee visual observation
	6	boreal chickadee visual observation
	3	mountain chickadee visual observation
	1	blue jay visual observation
disturbed meadow	1	blue jay visual observation
	8	elk pellet groups
Policeman's creek	3	beaver activity (willow cuttings)
	7	mallard duck visual observation
spring creek	1	beaver activity (balsam poplar cuttings)
	1	beaver food cache

3.2.2 Winter Track Survey Results

Winter track counts were completed in the study area February 11, 2003. Overall, weather and snow conditions ranged from fair to poor with 2 to 3 cm of new snow falling three days prior and partially melting. In total, 2,190 meters were sampled within eight vegetation community types (Table 3-4). Track numbers were only sufficient to conduct habitat preference analysis on red squirrels and this was forgone as red squirrel habitat needs are well understood.

Table 3-4
Wildlife Observations: February 2003 Winter Transects

Restwell Study Area Habitat / Transect Length	Number of Observations	Wildlife Sign
sedge wetland – 580m	3	common raven tracks
	4	canid tracks[a]
shrubland – 80m	4	red squirrel tracks
	2	mice tracks
	1	common raven visual
	3	black-billed magpie visual
	1	rabbits species tracks
	1	woodpecker species excavation on dead spruce
	1	duck species tracks
	6	elk pellet groups
	2	ungulate browse on Salix
Canada buffaloberry – hairy wild rye – aspen – white spruce (c4.1) – 540m	32	red squirrel tracks and calling
	1	red squirrel nest
	3	elk tracks
horsetail – white spruce – balsam poplar (g1.1) – 160m	6	red squirrel tracks
balsam poplar – snowberry (f1.1) - 80m	16	red squirrel tracks and calling
disturbed meadow -80m	4	elk pellet groups
Policeman's Creek – off transect	1	red squirrel tracks
	1	black-billed magpie
	2	beaver (old run)
	2	boreal chickadee
	1	beaver (old bank den)
	1	beaver tracks
	1	american dipper visual
urban – off transect	1	domestic cat
	3	domestic rabbits
Spring Creek – off transect	70+	mallards visual
	4	canid tracks
	2	common goldeneye visual
Habitat Patch		
white spruce stand – 345m	1	elk track
	7	canines
	1	mouse track
	11	red squirrel tracks
white spruce old burn – 50m	-	no tracks
shrubland -275m	5	Clarke's nutcracker
	3	elk pellet groups
	1	ungulate browse on willow
	3	elk rub on willow
	2	red squirrel tracks
	2	canid tracks
Spring Creek – off transect	1	beaver lodge and food cache

[a] canine family = domestic dogs or coyote or fox (unable to determine due the high amount of dog-walking traffic)

Elk sign was noted mainly in shrubland habitat in both the habitat patch and along the east side of Spring Creek in the study area. Four elk pellet groups were also located in the disturbed meadow. No deer sign was seen during the survey. Potential carnivore tracks were limited to the canine family but the preponderance of domestic dog tracks eliminated species identification. Beaver activity was noted on both Spring and Policeman's creeks.

3.2.3 Amphibian Survey Results

A visual survey was conducted for amphibians on May 30, 2003. Weather conditions were excellent with partly cloudy skies and a high of 20 degrees Celsius. The only species of amphibian identified on the property was the wood frog. An adult wood frog was observed calling and egg masses were located in two separate areas. Amphibian results are summarized in Table 3-5.

Table 3-5
Wildlife Observations: May 2003 Amphibian Survey

Habitat	Number of Observations	Wildlife Sign
sedge wetland	0	
shrubland	1	adult wood frog calling in beaver flooded shrubland, adjacent to Spring Creek
Policeman's Creek	10	wood frog egg masses on sedges at edge of sedge meadow
Spring Creek (pond)	1	wood frog egg mass on sedge at pond edge

Amphibian breeding habitat is limited in the study area because the current is too strong in the majority of aquatic habitats. Suitable habitat does exist in the Spring Creek pond at the north end of the property and in the slow current at the eastern edge of Policeman's's Creek where it is adjacent to the sedge meadow. Additionally, the beaver flooded shrubland at the southern end of the property provides breeding habitat for amphibians. An elk trail was noted incidentally during the amphibian survey. The trail crossed the confluence of Spring and Policeman's creeks between the habitat patch and disturbed meadow.

3.2.4 Breeding Bird Survey Results

A breeding bird survey was conducted on the morning of June 18, 2003. Optimal survey conditions included mild temperatures (11 – 12°C), and low winds (0 – 5 km/hr). The survey included birds observed within and in the vicinity (0 – 100 m) of the Restwell property. A total of 29 bird species, consisting of 164 individuals were observed during the morning survey (Table 3 – 6). Evidence of three-toed woodpecker foraging behaviour was also observed within the property, although no individuals were seen.

The most abundant species observed included: mallard duck, American robin, yellow warbler, tree swallow, yellow-rumped warbler, mountain chickadee and brown-headed cowbird. The greatest species diversity was noted in the aspen – white spruce (c4.1) community type (14 species) followed closely by the shrubland community (12 species). Observations of note include the 16 mallard ducklings along Spring Creek, indicating successful waterfowl breeding on, or near the property, and the nesting behaviour of the Wilson's snipe in the sedge meadow community adjacent to Policeman's Creek. A tree swallow was also observed occupying a nestbox within the trailer park portion of the property.

Incidental wildlife observations during the breeding bird survey included 13 red squirrels and a few feral rabbits.

Table 3-6
Wildlife Observations: June 2003 Breeding Bird Survey

Bird Species	Sedge wetland	Shrubland	Canada buffaloberry – hairy wild rye – aspen – white spruce (c4.1)	Horsetail – white spruce – balsam poplar (g1.1)	Disturbed meadow	Policeman's Creek	Spring Creek	Residential areas (within trailer park)	Residential area (mature community bordering Project area)	Fly-over (no habitat association)	TOTAL
American crow			1					1		4	6
American robin	1		3	1				6	2	3	16
black-billed magpie		1			1			1	3		6
blackpoll warbler									1		1
blue jay			1						1		2
boreal chickadee			2								2
Brewer's blackbird		1									1
brown-headed cowbird			6					3			9
chipping sparrow					1						1
Clark's nutcracker			1								1
common raven									3	1	4
dark-eyed junco		1							1		2
house sparrow								6			6
mallard						9	10				19
mallard ducking							16				16
mountain chickadee		1	3					3	2		9
northern flicker		1	1	1							3
orange-crowned warbler		1	1								2
pine siskin			2								2

Bird Species	Sedge wetland	Shrubland	Canada buffaloberry – hairy wild rye – aspen – white spruce (c4.1)	Horsetail – white spruce – balsam poplar (g1.1)	Disturbed meadow	Policeman's Creek	Spring Creek	Residential areas (within trailer park)	Residential area (mature community bordering Project area)	Fly-over (no habitat association)	TOTAL
red-winged blackbird	2					1					3
ruby-crowned kinglet			5								5
rufous hummingbird		1									1
song sparrow	1										1
three-toed woodpecker				sign							0
tree swallow						4		nest		9	13
white-crowned sparrow		1	1						1		3
white-throated sparrow		1			1						2
willow flycatcher		3									3
Wilson's (common) snipe	2										2
yellow warbler	4	4	3	1			1				13
yellow-rumped warbler		2	6	1				1			10
TOTAL	10	18	36	4	3	14	27	21	14	17	164

3.2.5 Wildlife Habitat Conditions

The wildlife habitat capability of the Bow River floodplain south of Canmore has been described as providing medium capability for summer wildlife and high capability for winter wildlife use. A brief description of the wildlife habitat conditions and species utilization information within the Restwell property are described in the following sections by vegetation community type.

3.2.5.1 Sedge Wetland

The sedge wetland provides little forage or cover habitat for ungulates and no evidence of ungulates was observed in this vegetation type during the field surveys. This habitat may provide potential hunting areas for small- and medium-sized carnivores (e.g., fox and coyote) but provides little to no cover or denning habitat. Shore birds and waterfowl use this habitat for feeding, nesting and loafing. Two Wilson's (common) snipe and several mallards were observed feeding within this vegetation type (Table 3-3) during the reconnaissance survey, and again during the breeding bird survey (Table 3-6).

The sedge wetland and creeks may provide breeding and overwintering habitat for a variety of amphibians. Amphibian species that have the potential to occur in the area include the long-toed salamander, tiger salamander, boreal chorus frog, Columbia spotted frog, wood frog, and western toad (Russell and Bauer 2000). Wood frogs were the only amphibians identified during field surveys and their egg masses were located in the Policeman Creek / sedge wetland border. Long toed salamanders and Columbia spotted frogs were observed in ponds associated with Canmore Creek during Recording Amphibian Numbers in Alberta (RANA) surveys conducted in 2002 (Selwyn Rose, RANA Project, pers. comm.). The Columbia spotted frog, long-toed salamander and western toad are listed as "Sensitive" in Alberta (ASRD 2001). This status category is defined as "any species that is not at risk of extinction or extirpation but may require special attention or protection to prevent it from becoming at risk". Northern leopard frogs historically occurred in the Canmore area, but have been extirpated (Kris Kendell, ACA, pers. comm).

3.2.5.2 Shrubland

The riparian shrubland is comprised of a variety of shrubs that provide potential winter forage for ungulates. This area is bounded by the Restwell development and the CPR tracks, so does not represent pristine habitat conditions. However, evidence of deer and elk was most common in riparian shrubland habitat type during the field surveys (Table 3-3). Riparian vegetation habitats provide cover and potential hunting areas for small carnivores. Conversations with local residents familiar with this area indicated that coyotes were often observed along the creek during the winter months. Willows and numerous other shrub species grow along creeks, providing food and construction materials for beavers. Fresh beaver cuttings of willow and evidence of an old bank den were observed along Policeman's Creek during the surveys (Table 3-3, Table 3-4). The creeks may also provide feeding areas for mink, and potential denning sites are available along the creek banks. Red squirrel tracks were common in the shrubland community during the winter survey.

The abundance of shrubs within the riparian habitat provides a number of nesting and foraging habitats for songbirds. During the reconnaissance survey a wide variety of songbirds were observed feeding in the riparian habitat including: Wilson's warblers, American robins, yellow rumped warblers and ruby crowned kinglets (Table 3-3). Previous surveys in the area recorded high densities of songbirds, such as olive-sided flycatchers, yellow-rumped warblers and song sparrows (EMA 1993). During the 2003 breeding bird survey 12 species (Table 3-4), including: yellow warbler, willow flycatcher, yellow-rumped warbler, and rufous hummingbird were observed in shrubby habitat adjacent to both Spring and Policeman's creek. Numerous mallards ducks were observed feeding along the creeks. As there is open water in the creeks year round, the ducks have started overwintering here. Recreational use of the shoreline within the study area may limit the amount of potential nesting habitat.

3.2.5.3 Canada Buffaloberry - Hairy Wild Rye – Aspen - White Spruce (c4.1)

Potential wildlife habitat within this ecosite has been altered through recreational activities (e.g., walking, biking, wildlife viewing). Numerous narrow trails have been created, resulting in the disturbance of some of the vegetation. Shrubs within this habitat type provide forage and cover for ungulates, and elk tracks, pellets and an elk rub were observed during the field surveys.

This moderately closed vegetation type also provides good cover and forage habitat for small mammals, particularly red squirrels (Table 3-3. Table 3-4).

Large spruce trees provide some nesting opportunities for larger birds such as raptors and corvids, while shrubs provide nesting habitat for songbirds. During the June 2003 breeding bird survey, this habitat type contained the greatest number of bird species and total individuals (Table 3-5). A previous winter track survey conducted in the area in a similar ecosite found that this habitat was also important to grouse (EMA 1993).

Long-toed salamanders may make use of closed white spruce habitats if they occur near suitable breeding riparian areas (Russell and Bauer 2000). No evidence of long-toed salamanders was observed during the amphibian survey keeping in mind that terrestrial searches were not done.

3.2.5.4 Horsetail - White Spruce – Balsam Poplar – (g1.1)

As with the aspen-white spruce community type, there are nesting opportunities for a variety of bird species in the large trees and shrubs. Evidence of three-toed woodpecker foraging behaviour (bark flaking) was evident within the stand. The well-developed shrub layer in this community also provides good potential winter forage for ungulates, and cover and potential hunting areas for small carnivores. Squirrel tracks and one elk pellet group were noted during field surveys. Due to the proximity to development, these areas are influenced by the noise and activity of human and rail traffic, so are likely only utilized by species that can adapt to these conditions (e.g., elk, coyotes).

3.2.5.5 Balsam Poplar – Snowberry (f1.1)

This small stand is located within the more extensive white spruce stands in the eastern portion of the study area. Dead balsam poplar trees within this stand currently provide feeding and nesting sites for woodpeckers and other cavity nesters. This community type has a well-developed low shrub layer that potentially provides good potential forage for ungulates as well as cover and hunting habitat for small carnivores. Only red squirrel tracks were observed during field surveys. However, as discussed above, these areas are most likely used only by species that tolerate human influences.

3.2.5.6 Disturbed Meadow

Introduced grasses dominate this community type and the few shrubs that occur here were heavily browsed by ungulates. This habitat contained the highest concentration of elk pellet groups observed within the Restwell property. An elk trail also connected this area to the habitat patch south of the Restwell property, travelling across the confluence of Spring and Policeman's creeks. By contrast, results from a previous winter track survey conducted immediately south of the Restwell property found few ungulate, furbearers or small mammal tracks in disturbed habitats (EMA 1993). Feral rabbits were observed in this and the adjacent aspen stand. This community type is linked to the adjacent habitat patch, so may get well used by a variety of wildlife species.

3.2.5.7 Open Water

Wildlife species occurring in many of the vegetation communities use open water. A large beaver cache and dam was noted on Spring Creek (Photograph III-5) and recent attempts to dismantle the dam have failed. Areas of permanent open water have created conditions that attract waterfowl and mallard ducks were numerous during the February survey. During other seasons, waterfowl continue to use both creeks, particularly Mallard ducks. Section 4.0 discusses fish and fish habitat in both Spring and Policeman's creeks.

3.2.5.8 Habitat Patch

The habitat patch was assessed during the winter track transects (Table 3-4). As with shrubland habitat inside the study area, ungulate sign was more common in the habitat patch shrubland (elk rubs, pellet groups and browse). The white spruce habitat in the habitat patch yielded few tracks, including one elk, and 11 red squirrels. Dog walking was common in this area and 11 sets of canine tracks were noted.

3.2.6 Habitat Assessment Summary

Overall, the undeveloped portions of the study area are considered moderately important to wildlife. Human disturbances including development, garbage, campfire rings, numerous trails and the proximity to the CPR tracks have reduced the quality of wildlife habitat within the Restwell

property. Although the area is currently being used extensively by the public, wildlife habitat remains.

The study area provides low to moderate quality habitat for deer and elk. Forest understory species provide forage habitat for ungulates while the trees and shrubs provide cover. Potential habitat for small- and medium-sized carnivores (e.g., foxes and coyotes) exists in the study area. Grasslands, riparian vegetation and the understory of forested habitats provide cover and potential hunting areas for small carnivores. Potential habitat for semi-aquatic species (e.g., beavers and mink) is present along both creeks. Willow species, and numerous other shrub species grow along the creeks, providing food and construction materials for beavers. The creeks may provide feeding areas for mink, while the banks along the shoreline may provide potential denning sites. Mallard ducks and other waterfowl use the open water of the creeks, year-round.

Although no evidence of birds of prey were observed in the study area, large trees on the Restwell property could support such species. Smaller species of birds may use the shrubs, snags and riparian area for nesting, foraging and shelter. The creeks and associated shoreline provide habitat for birds such as shorebirds and waterfowl.

The sedge meadow and creeks may provide habitat for a variety of amphibians, and use by wood frogs was confirmed during the 2003 spring survey.

3.2.7 Wildlife Sensitivities and Constraints

Wildlife sensitivities on the Restwell property focus on riparian areas and the older treed stands with well-developed shrub layers. Table 3-7 outlines the wildlife sensitivities by vegetation type following the ranking process described by EMA (1993) for the same area.

The sedge wetland and creek habitats were the only habitats rated as highly sensitive to development, largely because they provide habitat for listed species, are in good condition and are important for the maintenance of ecological function in the area. These habitats may support several amphibian species, including the listed Columbia spotted frog, long-toed salamander and western toad (ASRD 2001).

The treed vegetation types are rated as being moderately sensitive to development in part because they have a relatively restricted distribution and provide a diversity of habitats. The large, mature trees provide nesting opportunities for birds, such as the listed pileated and black-backed woodpeckers and ungulates, and small and medium-sized carnivores use the shrub layer in these habitats for forage and cover. As these communities are generally in good condition, they may be locally important for a few individuals, but do not provide unique or critical habitat for wildlife in the region. Habitat suitability in these areas is compromised by the high human use and by the high amount of local development, also restricting corridor movement.

The shrubland vegetation type is rated as moderately sensitive to development because it is restricted to areas adjacent to the creeks and is a transitional zone that is important for a variety of aquatic and terrestrial wildlife species. The meadow patches have already been altered by development or disturbance and are rated as low to moderate for sensitivity to development (Table 3-7). The southeastern patch is linked to the local habitat patch and is well used by a variety of wildlife species, so would be rated as moderately sensitive.

The main constraint to redevelopment of the Restwell property is that it is adjacent to the South Canmore Local Habitat Patch. This habitat patch is a key component of the regional wildlife corridor system (BCEAG 1998, Canmore 1998) and is an important winter area for elk and deer (Jon Jorgensen, ASRD, pers. comm.). This area is also classified as a Conservation Area and Environmentally Sensitive Area (ESA) under the Canmore Municipal Development Plan (Canmore 1998) due to its regional importance for wildlife. An Environmental Impact Statement is required for development applications adjacent to ESAs [Section 8.4 (c), Part 4, Canmore MDP]. Permitted and discretionary uses for this area fall under the Town of Canmore Land Use Bylaw (Canmore 2002).

Table 3-7
Rating of Wildlife Habitat Sensitivity to Development for the Restwell Property

Plant Community / Wetlands Type	Habitat Unit - Code[A]	Habitat Regional Rarity	Habitat for Rare Species	Critical Habitat	Natural Condition	Maintenance of Ecological Function	Diversity of Species	Sensitivity Rating[a]
sedge wetland open water	riparian[a]	H	H	H	H	H	H	H
shrubland	willow-dominated shrub SB(w)	H	M	H	L - M	M	M	M
horsetail - white spruce – balsam poplar – (g1.1)	semi-closed and closed white spruce WS(c)	M - H	M	H	M	H	M - H	M
Canada buffaloberry - hairy wild rye – aspen - white spruce (c4.1) balsam poplar – snowberry (f1.1)	open white spruce WS(o)-SB	M	M	H	M	H	H	M
disturbed meadow	grassland	H	L - M	M	L - M	M	M	M
urban	none	n/a	n/a	n/a	n/a	n/a	n/a	L

[a] reference: habitat units and codes, and sensitivity categories and ratings from EMA (1993).
[b] H = high; M = moderate; L= low Fisheries Resources

3.3 Fisheries Resources

The Restwell study area includes both Spring and Policeman's creeks, including their confluence. As such, fish habitat and habitat use are considered in this environmental assessment.

3.3.1 Fish and Fish Habitat

Alberta Environment classifies Spring and Policeman's creeks as Class "B" watercourses (Brian Lajeunesse, ASRD, pers. comm.). A Class "B" watercourse is considered to have a high sensitivity, as it provides habitat areas important to the continued viability of a population of fish species in a given area.

3.3.1.1 Spring Creek

Spring Creek is a tributary to Policeman's Creek, which also flows through the town of Canmore. The creek is entirely spring-fed (Brewin 1994). In some years Spring Creek runs dry (Brian Lajeunesse, ASRD, pers. comm.).

Spring Creek provides habitat for all life stages of brook trout (*Salvelinus fontinalis*) and mountain whitefish (*Prosopium williamsoni*) (Westworth 2000, Golder 1995, Brewin 1994, EMA 1993, Stelfox 1979). In 1979, more than 300 brook trout and 200 mountain whitefish were documented in Spring Creek, mostly in the upper 500 m portion (Stelfox 1979). The upper reach of Spring Creek has been characterized as a natural channel with wide, shallow flats with riffles (Stelfox 1979). In 1994, the lower reach of the creek consisted of shallow run (i.e., R2 and R3; see Appendix IV for category definitions) habitats, and had been seriously degraded by siltation (Brewin 1994).

The importance of Spring Creek brook trout habitat was evident from the 450 documented redds present in 1979 (Stelfox 1979). During the early 1990s, considerable numbers of juvenile brook trout in Spring Creek were also observed, but not quantified (Golder 1995). Spring Creek is not as important for brown trout (*Salmo trutta*) spawning, as only three, one and four brown trout redds were documented in 1989, 1990 and 1991, respectively (Brewin 1994). Lack of brown trout spawning activities may be due to poor habitat as considerable siltation of the stream bed

has occurred (Brewin 1994; Stelfox 1979) and continues to occur (Golder 1995). Deterioration of spawning habitat has been exacerbated by unauthorized bank alteration of portions of Spring Creek (Brewin 1994).

Over the past 15 years, spawning and rearing habitat for salmonids has deteriorated in Spring Creek, due to the accumulation of silt as the result of activities in the town of Canmore (Brewin 1994). At the time of Brewin's (1994) survey, the lower reach of Spring Creek was rated as unsuitable for spawning salmonids and as having limited suitability as rearing habitat. The upstream-most section of the lower reach of Spring Creek passes through a disturbed area where riparian vegetation and bank cover has been removed. Consequently, the entire lower reach of the creek has a heavy silt bedload, which has significantly degraded the fisheries potential of the stream. Incidental observations and study surveys in the lower reach of Spring Creek over the past 15 years have noted less than 10 redds in any given year (Brewin 1994; Brian Lajeunesse, ASRD, pers. comm.). The overall gradient of the lower reach of Spring Creek is low and the habitat consists almost entirely of shallow run habitat (R3) with low to medium velocities. Overhead cover from floating or overhanging debris is fairly common in the lower reach. However, much of this cover is lumber and other assorted debris introduced to the stream from human activities in Canmore.

3.3.1.2 Policeman's Creek

Policeman's Creek is entirely spring-fed despite a weir that can divert surface flow from the Bow River to the creek. The weir has been used to augment stream flow in Policeman's Creek, because in some years Policeman's Creek runs dry (Brian Lajeunesse, ASRD, pers. comm.). The weir gates have been closed since the mid-1980s because the weir consistently ices up due to the distinctive temperature differences in the Bow River and Policeman's Creek (Brian Lajeunesse, ASRD pers. comm.). Alberta Environment keeps the weir closed to avoid the potential for thermal shock on fall spawning fish species and their redds in Policeman's Creek (Brian Lajeunesse, ASRD pers. comm.).

Much of the upper portion of Policeman's Creek is comprised of wide, shallow pools or reconstructed banks (Brewin 1994). The portion of Policeman's Creek downstream of the Spring Creek confluence consists of deep pools (i.e., P1 and P2) and is considered as some of the best

refugia habitat for resident salmonids (Stelfox 1979). The lowermost section of the creek flows through a broad, scoured channel that was once part of the Bow River, which during high stream flow events would function as a side channel of the Bow River.

Policeman's Creek provides habitat for all life stages of brown trout. The creek also provides important spawning habitat for upper Bow River brown trout, second only in importance to Bill Griffiths Creek (Brewin 1994). In 1989, 1990 and 1991, 10.5%, 10.4% and 11.9%, respectively, of all brown trout redds documented in representative study areas in the Bow River system from Bow Falls to the Seebee Dam were counted in Policeman's and Spring creeks (Brewin 1994). Little brown trout spawning now occurs in Spring Creek, thus all the local brown trout spawning activity now occurs in Policeman's Creek.

Brown trout redds are evenly split between the upper (above the Spring Creek confluence) and lower (below the Spring Creek confluence) sections of Policeman's Creek, although little activity has been found in the lowermost 500 m near the confluence with the Bow River (Brewin 1994). In 1999, 54 and 64 brown trout redds were tallied in the upper and lower portions of Policeman's Creek, respectively (Brian Lajeunesse, pers. comm.). In 1991, 116 and 109 redds were counted in upper and lower portions, respectively (Brewin 1994). In 1990, 74 and 83 brown trout redds were counted in the upper and lower portions of Policeman's Creek, respectively (Brewin 1994). In 1989, before the elimination of a beaver dam, the lower portion of Policeman's Creek was more important, as only 35 redds were found upstream and 138 redds were found downstream. Maps showing the locations of redds that were observed during redd surveys conducted in 1989, 1990 and 1991 (Brewin 1994) show that brown trout have been utilizing the areas in Policeman's Creek that were observed to provide suitable spawning habitat. Historically, a small number of redds have been observed in areas that Brewin (1994) classified as unsuitable due to silt deposition. The increase in importance of Policeman's Creek for brown trout over the 15-year period from Stelfox's (1979) to Brewin's (1994) studies is very apparent as brown trout redd counts in lower Policeman's Creek increased from 20 in 1979 to 83-109 in 1989-91.

Policeman's Creek is also important habitat for brook trout and mountain whitefish. Stelfox (1979) found more than 1,400 brook trout and 1,800 mountain whitefish in this creek in 1979. At that time, most of the brook trout and all of their redds were found in the upper portion of the creek, whereas brown trout and all of their redds were found in the lower portion of Policeman's

Creek. Stelfox (1979) also considered upper Policeman's Creek to be important rearing habitat for juvenile brook trout and mountain whitefish, while the lower portion was more important for juvenile brown trout.

3.3.2 Fish Inventory Assessment

3.3.2.1 Spring Creek

The fish inventory was conducted in two representative sites in Spring Creek. Site 1 was a shallow riffle, 133 m in length, located downstream of the stream enhancement structures (i.e., log deflectors) and characterized by silt and submerged woody debris (Photograph V-1). Site 2 was also a shallow riffle, 234 m in length, but with overhanging cover on both banks and with a boulder v-weir and strategically located boulders providing midstream habitat (Photograph V-2). This type of habitat was sporadically dispersed along the length of Spring Creek.

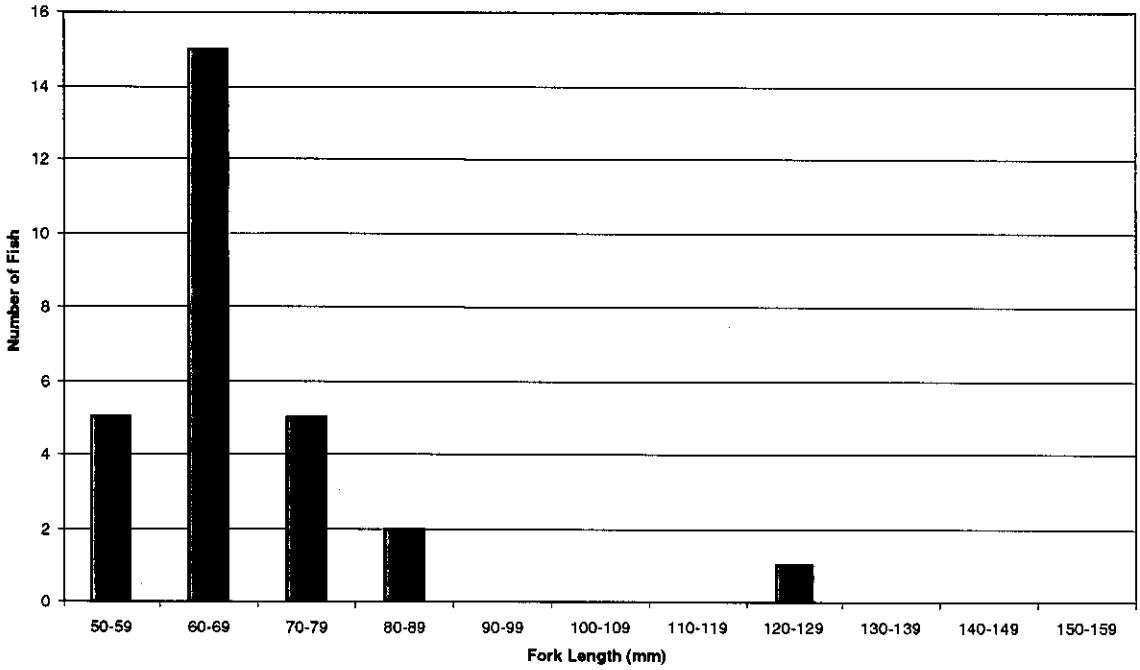
During the fish inventory assessment conducted in October 2002, one juvenile brown trout and 28 young-of-the-year mountain whitefish were captured in Spring Creek (Table 3-8 and Figure 3-4). Young-of-the-year mountain whitefish were utilizing sites with overhanging cover. Although not observed or captured, brook trout are known to utilize Spring Creek for spawning and a possible brook trout redd was observed (Photograph V-3).

Table 3-8
Summary of Fish Collected from Spring Creek, October 1, 2002

Species	Number	% Composition	Fork Length (mm)		
			Minimum	Maximum	Mean
brown trout	1	3	102	102	70.0
mountain whitefish	28	97	50	127	68.5

In Spring Creek, the total catch per unit effort was 1.02 fish/min.

Figure 3-4
Length-frequency Distribution for Young-of-the-year Mountain Whitefish Sampled from Spring Creek (n=28)



3.3.2.2 Policeman's Creek

The fish habitat assessment was conducted in a 413 m section of moderate-depth riffle and pool habitats. This type of habitat is abundant in this section of Policeman's Creek (Figure 3-7, Photograph V-4).

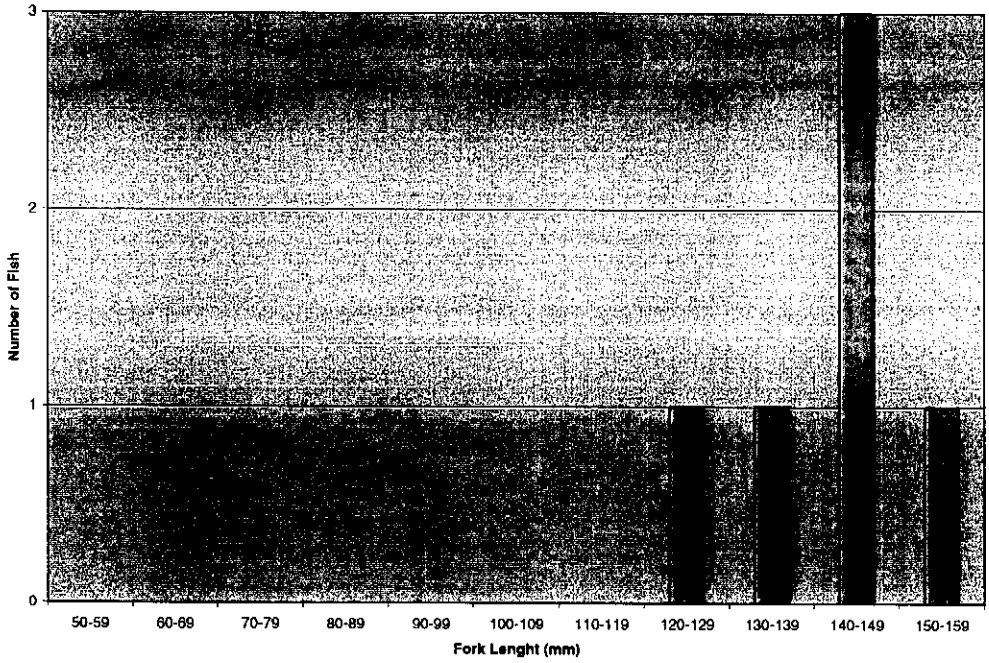
In Policeman's Creek, a total of six fish (i.e., juvenile brown trout) were captured (Table 3-9 and Figure 3-5). The juvenile brown trout were caught amongst shoreline riprap (Photograph V-5). Although mountain whitefish were not captured, three young-of-the-year mountain whitefish were observed. Juvenile brown trout and mountain whitefish were also observed in the section of Policeman's Creek adjacent to the Restwell property.

Table 3-9
Summary of Fish Collected from Policeman's Creek, October 1, 2002

Species	Number	% Composition	Fork Length (mm)		Mean
			Minimum	Maximum	
Brown trout	6	100	125	150	142.2

In Policeman's Creek, the total catch-per-unit-effort was 0.23 fish/min.

Figure 3-5
Length-frequency Distribution for Juvenile (Age 1) Brown Trout Sampled from Policeman's Creek (n=6)



3.3.3 Fish Habitat

3.3.3.1 Spring Creek

The October 2002 field survey found that Spring Creek was predominantly comprised of shallow run habitats (i.e., R3 with some R2). Both stream banks along the entire length of Spring Creek generally were stable, with the exception of a few stream enhancement structures that were beginning to fall away from the stream banks. Localized areas of undercut banks were noted on

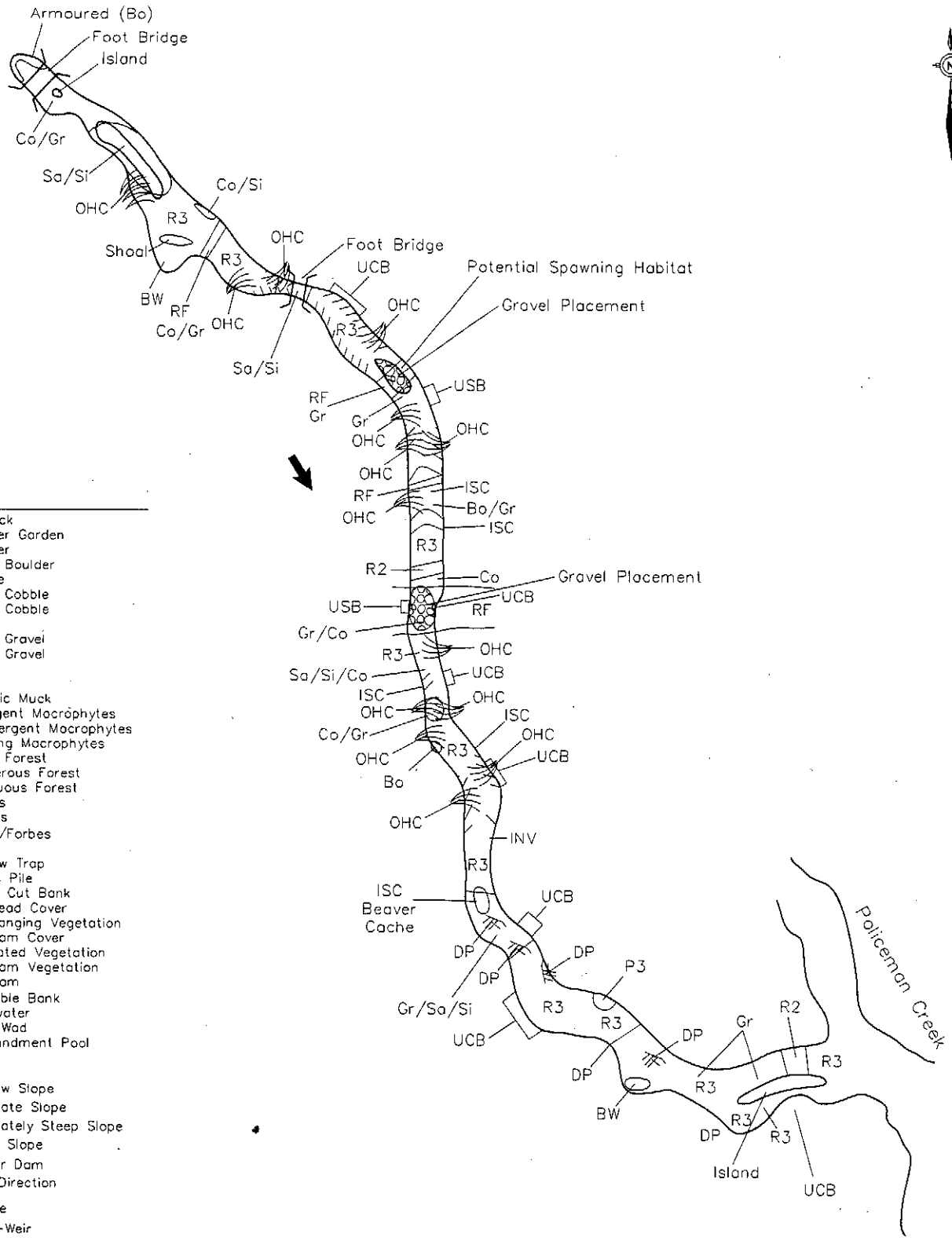
alternating sides of the creek. Instream cover and overhanging cover, comprised mainly of willows (*Salix* spp.), grasses and occasional conifers, were abundant in the midsection of this creek. Much of the substrate was composed of a thin layer of silt and refuse overtop of cobble and gravel. Small, dispersed patches of gravel were also observed in the middle section of the creek (Figure 3-6).

In 1997, log deflectors and boulder v-weirs were installed into Spring Creek to improve flow to self-scour the substrate to provide improved trout habitat. Stream flow in Spring Creek in subsequent years was very low, leaving the instream structures exposed and subject to the elements including frost heaves (Brian Lajeunesse, ASRD pers. comm.).

3.3.3.2 Policeman's Creek

The October 2002 field survey found that Policeman's Creek consisted of riffle, run and pool habitats, exhibiting all classes of run habitat (i.e., R1, R2, and R3), and both low and moderate grade pool habitats (i.e., P2 and P3). Both stream banks along the survey site on Policeman's Creek were generally moderately stable, with several sites of undercut and unstable banks. Substrate was composed of a thin layer of silt, sand, and mud over cobble and gravel. There are a few sections along the length of the creek that have been reinforced with riprap armouring (Photograph V-5) and log crib walls (Photograph V-6). Instream cover and overhanging cover were abundant along the lower 2.5 km of Policeman's Creek, where there has been limited development. The riparian habitat along this section includes thick stands of shrubs, and coniferous and deciduous trees. Where the creek flows through developed areas, it is more anthropogenically influenced with road and foot bridges, fords, and riparian habitat clearing. Small, dispersed patches of gravel and cobble were observed in the middle section of the creek and along the bank edges (Figure 3-7).

Policeman's Creek has a larger channel and flow volume than Spring Creek. The results of the habitat evaluation conducted in 1993 indicate that Policeman's Creek downstream of the confluence with Spring Creek is higher gradient with better habitat conditions relative to Spring Creek.



LEGEND

Bd	Bedrock
BG	Boulder Garden
Bo	Boulder
L.Bo	Large Boulder
Co	Cobble
S.Co	Small Cobble
L.Co	Large Cobble
Gr	Gravel
S.Gr	Small Gravel
L.Gr	Large Gravel
Sa	Sand
Si	Silt
Or	Organic Muck
Em	Emergent Macrophytes
Sm	Submergent Macrophytes
Fm	Floating Macrophytes
MF	Mixed Forest
CF	Coniferous Forest
DF	Deciduous Forest
Sh	Shrubs
Se	Sedges
Gf	Grass/Forbes
Mo	Moss
MT	Minnow Trap
DP	Debris Pile
UCB	Under Cut Bank
OHC	Overhead Cover
OHV	Overhanging Vegetation
ISC	Instream Cover
INV	Inundated Vegetation
IV	Instream Vegetation
LJ	Log Jam
USB	Unstable Bank
BW	Backwater
RW	Root Wad
IP	Impoundment Pool
SN	Snye
CH	Chute
	Shallow Slope
	Moderate Slope
	Moderately Steep Slope
	Steep Slope
BD/XX	Beaver Dam
	Flow Direction
	Groyne
	Rock-Weir
RA	Rapids
RF	Riffle
R1	Class 1 Run
R2	Class 2 Run
R3	Class 3 Run
P1	Class 1 Pool
P2	Class 2 Pool
P3	Class 3 Pool
FL	Flat
FA	Falls
	Bridge

SCHEMATIC ONLY, NOT TO SCALE

PROJECT
SOUTHWELL TRAPP
RESTWELL ARP
CANMORE, ALBERTA

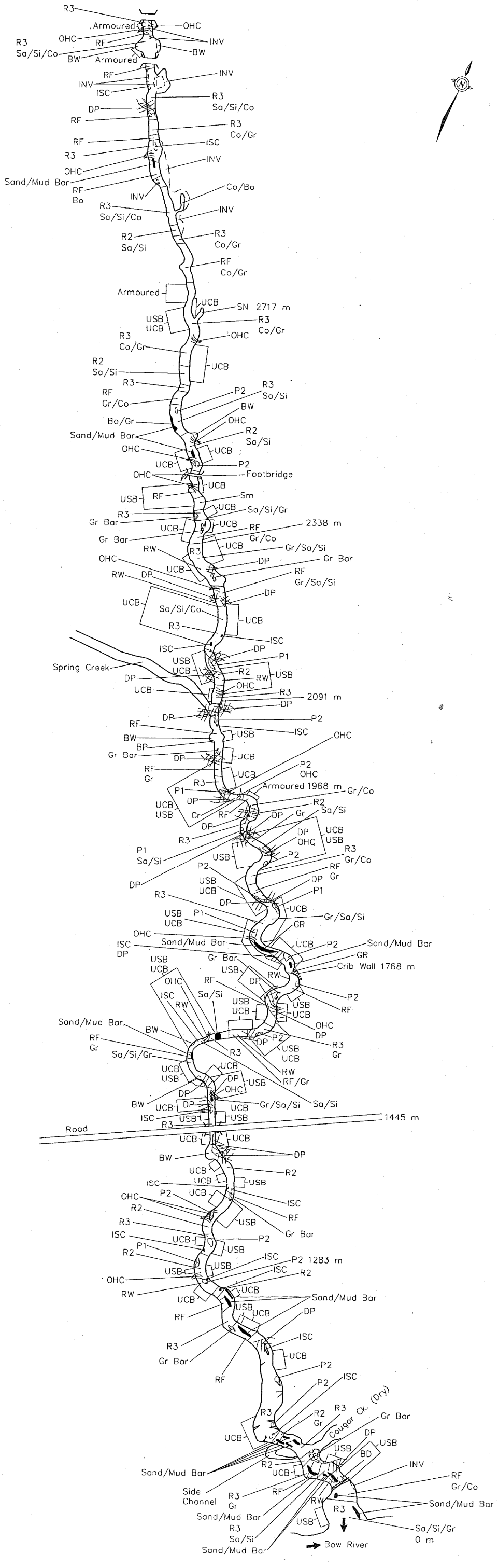
TITLE
HABITAT MAP
SPRING CREEK

Golder Associates
Calgary, Alberta

PROJECT No. 022-2295.7620			FILE No.	HabMap Spring Ck	
DESIGN	KA/GB	30/09/02	SCALE	NTS	REV. 0
CADD	JEF	13/11/03			
CHECK	SM	27/11/03			
REVIEW	SM	27/11/03			

FIGURE: 3-6

R:\CAD\2200\022-2295\7620 Baseline\2003 Report\ Drawing file: HabMap Spring Ck.dwg Nov 27, 2003 - 4:43pm Image: SpringCk.tif



LEGEND

Bd	Bedrock
BG	Boulder Garden
Bo	Boulder
L.Bo	Large Boulder
Co	Cobble
S.Co	Small Cobble
L.Co	Large Cobble
Gr	Gravel
S.Gr	Small Gravel
L.Gr	Large Gravel
Sa	Sand
Si	Silt
Or	Organic Muck
Em	Emergent Macrophytes
Sm	Submergent Macrophytes
Fm	Floating Macrophytes
MF	Mixed Forest
CF	Coniferous Forest
DF	Deciduous Forest
Sh	Shrubs
Se	Sedges
Gf	Grass/Forbes
Mo	Moss
MT	Minnow Trap
DP	Debris Pile
UCB	Under Cut Bank
OHC	Overhead Cover
OHV	Overhanging Vegetation
ISC	Instream Cover
INV	Inundated Vegetation
IV	Instream Vegetation
LJ	Log Jam
USB	Unstable Bank
BW	Backwater
RW	Root Wad
IP	Impoundment Pool
SN	Snye
CH	Chute
→	Shallow Slope
→+	Moderate Slope
→++	Moderately Steep Slope
→+++	Steep Slope
BD/XX	Beaver Dam
➡	Flow Direction
RA	Rapids
RF	Riffle
R1	Class 1 Run
R2	Class 2 Run
R3	Class 3 Run
P1	Class 1 Pool
P2	Class 2 Pool
P3	Class 3 Pool
FL	Flat
FA	Falls
	Bridge
	Groyne

SCHEMATIC ONLY, NOT TO SCALE

PROJECT
SOUTHWELL TRAPP
RESTWELL ARP
CANMORE, ALBERTA

TITLE
HABITAT MAP
POLICEMAN CREEK

Golder Associates
Calgary, Alberta

PROJECT No. 022-2295.7620			FILE No.	Policeman Ck
DESIGN	PE	09/10/02	SCALE AS SHOWN	REV. 0
CADD	JEF	13/11/03		
CHECK	SM	27/11/03		
REVIEW	MR	27/11/03		

FIGURE: 3-7

Policeman's Creek enters a side channel of the Bow River. Downstream of the mouth of Policeman's Creek is a strong control riffle which creates a pool that encompasses the mouth of Policeman's Creek and which acts as a settling pool for any silt transported. Below this riffle is a section of swift riffle/run sequences with clean spawning-sized substrate that leads to the mainstem river. Some spawning activity by Bow River brown trout has been observed in this lower-most section, but this activity has been limited as it has been determined that most fish migrate to farther upstream portions of Policeman's Creek to spawn.

The riffle areas and higher velocity runs in Policeman's Creek provided substrate and velocity characteristics that would be suitable for spawning activity by all salmonid species. All low velocity habitats (including low velocity runs, peripheral areas, backwater areas and pool habitats) are silt laden. Silt deposition was most apparent in pool and backwater habitats and in lower gradient areas that consisted of long glides. In these habitats the substrate was almost entirely covered with silt. This indicates that habitat degradation due to silt deposition is continuing in Policeman's Creek.

3.3.3.3 Water Quality in Spring and Policeman's creeks

Water quality in both Spring and Policeman's creeks was slightly alkaline (pH 8.24 and 8.51, respectively) and moderately conductive (325 µs/cm) (Table 3-10).

Table 3-10
Water Quality Characteristics

Location	Air Temperature (°C)	Water Temperature (°C)	pH	Conductivity (µS/cm)
Spring Creek	12	8.4	8.24	325
Policeman's Creek	10	8.2	8.51	N/A

3.3.4 Fish and Fish Habitat Sensitivities and Constraints

Approximately 75% of the length of Spring Creek has been affected by anthropogenic factors. Nearly 50% of its banks have been artificially enhanced with wing deflectors and rock weirs. The upper 75% of the left downstream bank has been incorporated into the landscaping of

adjacent residential homes (Photograph V-7). The right downstream bank is paralleled by a road for approximately 400 m (e.g., Photograph V-8), including sections within the Restwell property. Other anthropogenic impacts observed in Spring Creek included discarded Christmas trees and lumber. Fish were holding in areas of overhead cover, especially where willows provide overbank cover (Photograph V-9).

Policeman's Creek remains mostly natural. However, instream enhancement projects have been conducted slightly upstream of the Policeman's Creek - Bow River confluence (beyond the Restwell boundary). Other human activities were noted along the banks of Policeman's Creek, such as earthworks (Photograph V-10), vehicle fords (Photograph V-4), and the Town of Canmore boardwalk (Photograph II-3).

As discussed, the Class "B" designation of Spring and Policeman's creeks poses the main constraint to redevelopment of the Restwell property. These watercourses are rated as highly sensitive because they provide habitat for brown and brook trout, and mountain whitefish. This classification permits development as long as the sensitivity and vulnerability of the system is accounted for and avoidance and mitigation of any potential impacts are incorporated into a redevelopment plan.

4. SUMMARY

Restwell is planning to redevelop its Restwell Trailer Park property in Canmore, Alberta. Golder was contracted to assess the biophysical resources for the Restwell property in partial fulfilment of the Restwell Area Redevelopment Plan Terms of Reference. This report includes results of the late summer rare plant and vegetation survey, spring rare plant survey, wildlife sign survey, winter track survey, amphibian survey, breeding bird survey, and fish and fish habitat survey. Environmental sensitivities and constraints were identified for each resource.

The majority of the Restwell property is comprised of residential and recreational properties. The presence of Policeman's and Spring creeks, plus the undeveloped eastern portion of the property, provides habitat for a variety of wildlife and fish species.

The sedge wetland, shrubland and open water have high environmental sensitivity ratings thus are areas with the highest constraints to development. The horsetail - white spruce – balsam poplar – (g1.1), Canada buffaloberry - hairy wild rye – aspen - white spruce (c4.1) and balsam poplar – snowberry (f1.1) have moderate environmental sensitivities thus are areas with moderate constraints to development. The disturbed meadow and urban areas have low environmental sensitivities thus are areas with the lowest constraints to development in the Restwell Property.

A wildlife sign survey was conducted in early September 2002, in conjunction with the rare plant survey. Wildlife observations included deer and elk; small mammals, including feral rabbits; a variety of songbirds, corvids, woodpeckers and waterfowl; and, beavers. The study area provides low to moderate quality habitat for ungulates and small and medium-sized carnivores. The riparian habitats along both creeks are well used by a variety of wildlife species including shorebirds and waterfowl, and a beaver cache was observed on Spring Creek. The large trees within the undeveloped area east of Policeman's Creek showed signs of use by woodpeckers and other cavity nesters, and elk sign was also observed. Small and medium sized carnivores and supports a variety of songbird in both the tree and shrub layers. The disturbed meadow and shrubland were well used by ungulates as evidenced by both browse and pellets.

The main sensitivity for redevelopment of the Restwell property for wildlife is the proximity to the South Canmore Local Habitat Patch. This area, bordering the property to the south, has been

designated as a Conservation Area and Environmentally Sensitive Area in the Canmore MDP (Canmore 1998) because it is a key component in the regional wildlife corridor system.

An assessment of fish and fish habitat was conducted for Spring and Policeman's creeks to document the existing fish population and habitat prior to development. Spring Creek was predominantly comprised of shallow run habitats (i.e., R3 with some R2) containing instream and overhanging cover with generally stable banks. Several sections of the creek have been enhanced with instream structures that were beginning to deteriorate. The substrate was composed primarily of silt and refuse overtop of cobble and gravel. Although the flow is quite low in this creek, salmonid spawning potential is improving as gravel becomes exposed due to the scouring influence of the instream enhancement structures.

Policeman's Creek consisted of riffle, run and pool habitats, exhibiting all classes of run habitat and both low and moderate grade pool habitats. Generally, the stream banks were moderately stable, with abundant instream and overhanging cover along the lower 2.5 km of Policeman's Creek, where there has been limited development. Where the creek flows through developed areas, it is anthropogenically influenced with road bridges, foot bridges, fords, and riparian habitat clearing. Substrate was composed of a thin layer of silt, sand, and mud over cobble and gravel. There are a few sections along the length of the creek that have been reinforced with riprap armouring and log crib walls. Policeman's Creek has a larger channel and larger flow volume than Spring Creek and is more frequently utilized by spawning salmonids.

Based on historical information, both Spring and Policeman's creeks are known to support fall spawning brown trout. Approximately 10% of the local adult brown trout population from the Bow River use Spring and Policeman's creeks for spawning. During the fish and fish habitat assessment conducted in the October 2002, it was apparent in two representative sections of Spring Creek that young-of-the-year mountain whitefish utilize sites of overhanging cover. Juvenile brown trout were also present in the upper site in lower numbers. In Policeman's Creek, the reach adjacent to the Restwell property was used by juvenile brown trout. The juvenile brown trout were caught amongst shoreline riprap. Mountain whitefish were also observed.

The Class "B" designation for Policeman's and Spring creeks produces a constraint to development. These watercourses are considered to have a high sensitivity because they provide

habitat for brown and brook trout, and mountain whitefish. This classification permits development as long as the sensitivity and vulnerability of the system is accounted for and avoidance and mitigation of any potential impacts are incorporated into a redevelopment plan. Re-development could, if done correctly, enhance the habitat quality of the creeks by removing existing development and roads that are currently immediately adjacent to both creeks.

Environmental sensitivities for vegetation, wildlife, and fish and fish habitat exist on and adjacent to the Restwell property and potential impacts and mitigation for these resources are addressed further in the EIA.

5. CLOSURE

We trust the above meets your present requirements. If you have any questions or require additional details, please contact the undersigned.

GOLDER ASSOCIATES LTD.

Report prepared by:

Sandra Marken, M.Sc., P.Biol.
Ecologist

Report reviewed by:

Michael Raine, M.Sc., P. Biol.
Associate; Terrestrial Ecologist

6. REFERENCES

ANHIC (Alberta Natural Heritage Information Centre). 2002a. Alberta Natural Heritage Information Centre Plant Species of Special Concern. Compiled by Joyce Gould. Alberta Natural Heritage Information Centre. Edmonton, AB. February 2001. 36 pp. Viewed at website http://www.gov.ab.ca /env/parks/anhic/plant.pdf (Updated July 2, 2002).

ANHIC (Alberta Natural Heritage Information Centre). 2002b. Alberta Natural Heritage Information Centre Preliminary Plant Community Tracking List. Compiled by Joyce Gould. Alberta Natural Heritage Information Centre. Edmonton, AB. February 2001. 36 pp. Viewed at website http://www.gov.ab.ca /env/parks/anhic/plant.pdf (Updated May 30, 2002).

ANPC (Alberta Native Plant Council). 2000. Guidelines for Rare Plant Surveys. Alberta Native Plant Council. Edmonton, AB. 4 pp. Viewed at website http://www/anpc.ab.ca/rareplant.pdf

Archibald, J.H. Klappstein, G.D. and Corns, I.G.W. 1996. Field Guide to Ecosites of Southwestern Alberta. Northern Forestry Centre, Forestry Canada. Northwest Region. Edmonton, AB.

ASRD (Alberta Sustainable Resource Development). 2001. The General Status of Alberta Wild Species 2000. Alberta Sustainable Resource Development. Fish and Wildlife Service. Edmonton, AB. 46 pp.

BCEAG (Bow Corridor Ecosystem Advisory Group). 1998. Wildlife Corridor and Habitat Parch Guidelines for the Bow Valley. Prepared Jointly by Alberta Agriculture, food and Rural Development, Alberta Environmental Protection, Banff National Park, Town of Canmore and Municipal District of Bighorn. 33 pp.

Brewin, M.K. 1994. Reproductive ecology of brown trout (*Salmo trutta*) and brook trout (*Salvelinus fontinalis*) in Alberta's upper Bow River and tributaries. Edmonton, Alberta. 146 pp.

Canmore (Town of Canmore). 2002. Land Use Bylaw 09-99 (Updated 9 September 2002). Internet: http://www.canmore.ca/html/Town_Departments/Planning_&_Development/Land_Use_Bylaw.html Accessed November 2002.

Canmore (Town of Canmore). 1998. Canmore Municipal Development Plan. Internet: http://www.gov.canmore.ab.ca/html/Town_Departments/Planning_&_Development/Municipal%20Development%20Plan.pdf Accessed November and December 2002.

EMA (Environmental Management Associates). 1993. South Canmore Area Structure Plan: Environmental Assessment. Prepared for IBI Group. November 1993. 99 pp.

Fisher, C.C., and J. Acorn. 1998. Birds of Alberta. Lone Pine Publishing. Edmonton, AB. 384 pp.

Golder (Golder Associates Ltd.) 1995. Spring Creek Village environmental impact assessment, Canmore, Alberta. Prepared for Spring Creek Properties Inc. Calgary, Alberta. 57 pp.

Golder. 2003. Spring Creek Mountain Village environmental assessment, Canmore, Alberta. Prepared for Restwell Trailer Park and Cabins Ltd.

Government of Alberta. 2002. Fishing Regulations. Internet: http://www3.gov.ab.ca/srd/fw/fishing/reg.html Accessed November 2002.

Halsey, L. and D.H. Vitt. 1996. Alberta Wetlands Inventory Standards – Version 1.0. In: Alberta Vegetation Inventory Standards Manual.

Jorgenson. Jon. 2002. Alberta Sustainable Resource Development. Personal communication with Kelly Gurski (Golder) on 5 December, 2002.

Kershaw, L., J. Gould, D. Johnson and J. Lancaster. 2001. Rare Vascular Plants of Alberta. University of Alberta Press. ISBN 0-88864-319-5.

Kendell, Kris. 2002. Alberta Conservation Association. Personal communication with Carol Stefan (Golder) on December 12, 2002.

Lajeunesse, Brian. 2002. Alberta Sustainable Resources Development. Personal communication with Melanie Neufeld (Golder) on November 12, 2002.

Moss, E.H. 1983. Flora of Alberta. 2nd Edition (Revised by Packer, J.G.). University of Toronto Press. Toronto, ON. 687 pp.

Pattie, D., and C. Fisher. 1999. Mammals of Alberta. Lone Pine Publishing. Edmonton, AB. 240 pp.

Packer, J.G. and C.E. Bradley. 1984. A Checklist of the Rare Vascular Plants of Alberta with Maps. Provincial Museum of Alberta. Natural History Occasional Paper No. 4. 112 pp.

Rintoul, John. 2002. Alberta Natural Heritage Information Centre. Personal communication with Mark Sherrington (Golder) on 5 September, 2002.

Rose, Selwyn. 2002. Researching Amphibian Numbers in Alberta Project. Personal communication with Carol Stefan (Golder) on December 13, 2002.

Russell, A.P. and A.M. Bauer. 2000. The Amphibians and Reptiles of Alberta. University of Calgary Press. Calgary, AB. 279 pp.

Stelfox, J. 1979. Policeman's Creek and Spring Creek fall spawning study. Prepared for Alberta Fish and Wildlife Division. Energy and Natural Resources, Calgary, Alberta.

Stelfox, J.B. 1993. Hoofed Mammals of Alberta. Lone Pine Publishing. Edmonton, AB. 242 pp.

Westworth Associates Environmental Ltd. 2000. A fish and fish habitat assessment of Policeman's Creek. Prepared for ATCO Pipelines Edmonton Alberta. 26 pp.

APPENDIX I

RARE PLANTS OBSERVED IN THE CANMORE AREA FROM ANHIC DATABASE

Table I-1 ANHIC Records of Vascular Plants Observed Within 10 Km Of Canmore

Latin Name[a]	Common Name	Habitat [b]
Antennaria corymbosa[c]	corymbose everlasting	Moist open woods and meadow, elsewhere moist or wet subalpine meadows
Hieracium cynoglossoides[c]	woolly hawkweed	Open woods and montane slopes
Aster eatonii[c]	Eaton's aster	Moist montane woodland and streambanks
Draba porsildii	Porsild's whitlow-grass	Moist, turfy alpine sites, elsewhere in mesic to dry, rocky subalpine to alpine sites
Anenaria longipedunculata	low sandwort	Moist gravelly areas at higher elevations, elsewhere in wet, often mossy places along rivers and streams in tundra, on moist calcareous or serpentine gravel and in moist rock crevices
Epilobium luteum[c]	yellow willowherb	Moist woods and streambanks in the mountains
Orobanche uniflora[c]	one-flowered cancer-root	Moist woods, with stonecrops (Sedum spp.) saxifrages (Saxifraga spp.), species of the aster family (Asteraceae) and other vacular plants, elsewhere, in open, moist to dry sites or woods.
Potentilla hookeriana	Hooker's cinquefoil	Dry, rocky alpine slopes
Potentilla villosa	hairy cinquefoil	Alpine slopes and ridges, elsewhere on rocky slopes and ridges
Potentilla macounii	Macoun's cinquefoil	Dry rocky slopes on the eastern slopes of the Rocky Mountains
Potentilla multisecta	smooth-leaved cinquefoil	Dry alpine slopes
Parnassia parviflora[c]	small northern grass-of - parnassus	Bogs and streambanks, elsewhere, in wet meadows
Saxifraga nivalis	alpine saxifrage	Moist open slopes, ridges and rock crevices
Castilleja lutescens	downy paintbrush	Grassy slopes
Mimulus guttatus[c]	yellow monkeyflower	Wet meadows, springs, streambanks
Pedicularis flammea[c]	flame-coloured lousewort	Calcareous alpine meadows, elsewhere, also in moist sites such as snow beds and lake shores
Larix occidentalis[c]	western larch	Moist to dry, often gravelly or sandy sites in upper foothill and montane zones

Latin Name[a]	Common Name	Habitat [b]
Carex parryana[c]	Parry's sedge	Moist open meadow, swales and low ground near water, from plains to moderate elevations in the mountains, elsewhere, on alkaline silt and marl flats
Carex petasata[c]	pasture sedge	Dry grassland and open woods
Carex petricosa[c]	stone sedge	Dry to moist alpine habitats – SW Alberta
Eleocharis engelmannii[c]	Engelmann's Spike-Rush	Wet places
Trichophorum pumilum[c]	dwarf bulrush	Calcareous fens
Sisyrinchium septentrionale[c]	pale blue-eyed grass	Moist meadows and grassy streambanks
Alopecurus alpinus[c]	alpine foxtail	Shores and open woodland, elsewhere, in moist to wet montane, subalpine, and alpine areas
Potamogeton foliosus[c]	leafy pondweed	Shallow lakes and ponds, often growing in organic sediment
Cryptogramma stelleri	Steller's rock brake	Cool, shaded, calcareous sites, on rock or in springs
Pellaea glabella	smooth cliff-brake	Calcareous cliffs and ledges
Pellaea glabella ssp occidentalis	smooth cliff-brake	Calcareous cliffs and ledges
Pellaea glabella ssp simplex	smooth cliff-brake	Calcareous cliffs and ledges
Pellaea gastonyi	Gaston's cliff brake	Calcareous cliffs and ledges
Woodsia glabella	smooth woodsia	Moist, shaded, usually calcareous sites, among boulders, on cliff ledges, and in crevices
Botrychium lanceolatum[c]	lance-leaved grape-fern	Open fields and peaty slopes
Botrychium minganense[c]	Mingan grape fern	Many habitats
Botrychium spathulatum[c]	spatulate grape fern	Fields and grassy openings in the mountains

[a] Source: Alberta Natural Heritage Information Centre-ANHIC (2002)

[b] Source: Kershaw *et al.*, 2001

[c] Highest potential species to occur on the Restwell Property based on the rare plant species occurrences elsewhere in the Canmore area in the habitats similar to those found on the Restwell Property.

APPENDIX II

VEGETATION PHOTOGRAPHS

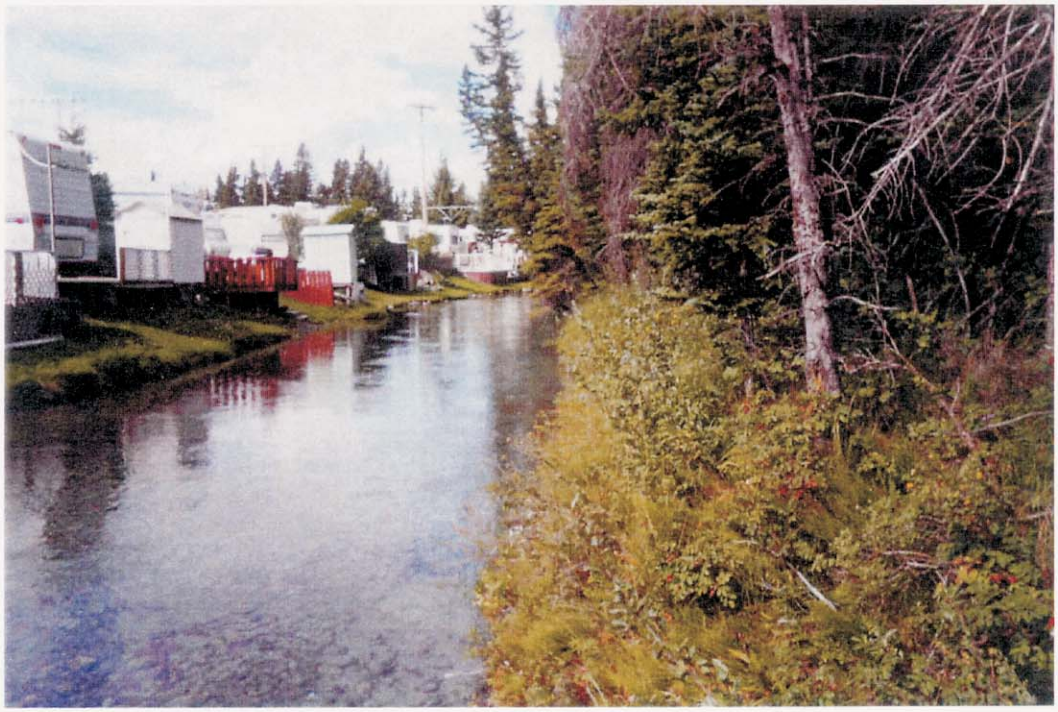


Photo II-1 Policeman's Creek and Riparian Communities

Photo II-2 Wolf-willow Shrubland Community

Photo II-1 Policeman's Creek and Riparian Communities

Photo II-2 Wolf-willow Shrubland Community

APPENDIX III

WILDLIFE PHOTOGRAPHS

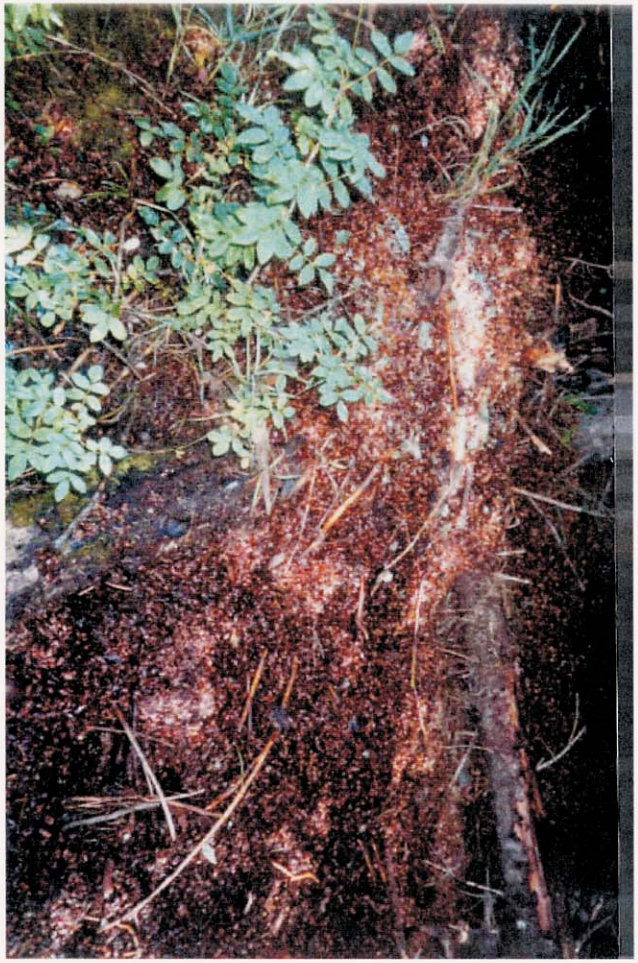


Photo III-1 Red Squirrel Food Cache

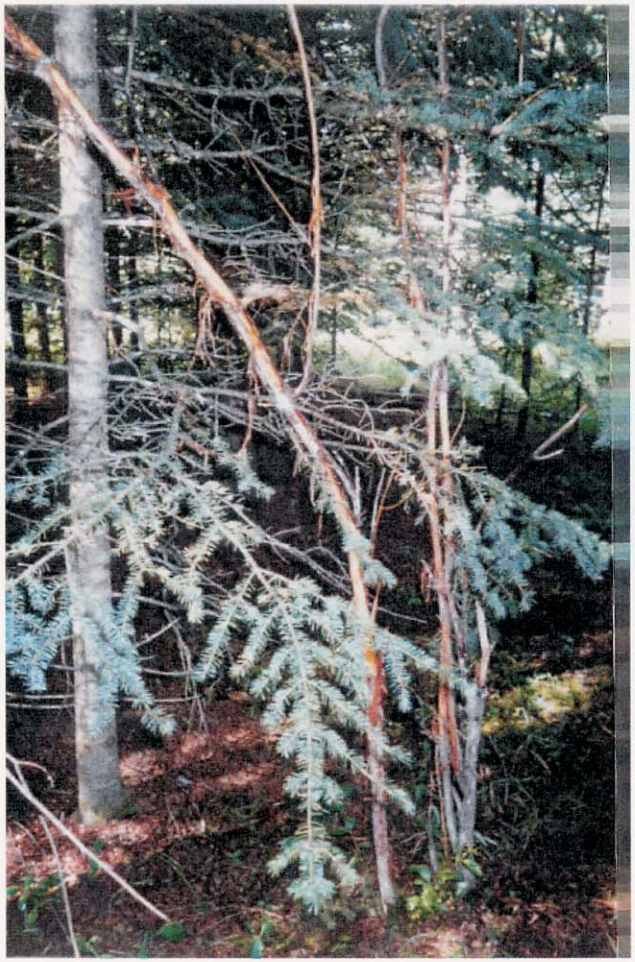


Photo III-2 Elk Rub on Willow

Photo III-3 Elk Pellets

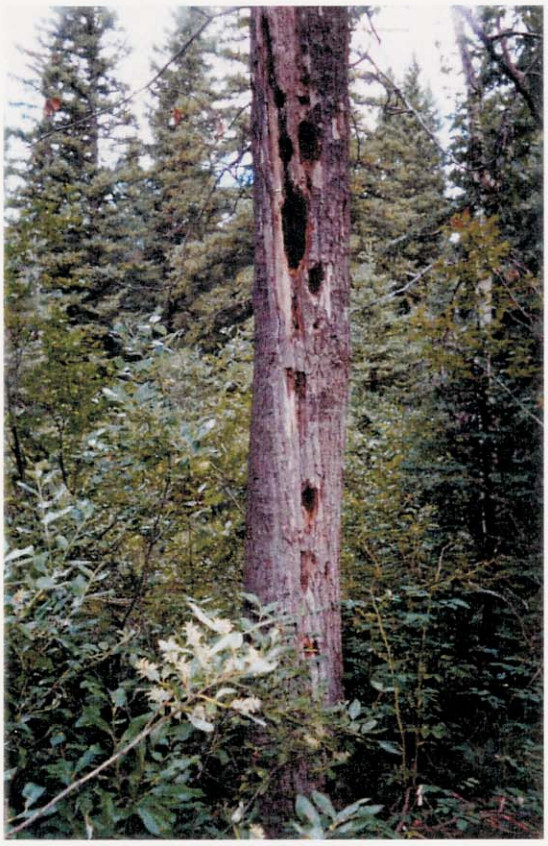


Photo III-4 Woodpecker Holes on Balsam Poplar Snag

Photo III-5 Active Beaver Dam and Cache Site on Spring Creek near Confluence with Policeman's Creek

APPENDIX IV

TECHNICAL PROCEDURES

TECHNICAL PROCEDURE 8.3-1
SURFACE WATER SAMPLING METHODS

1 PURPOSE

This document describes the sampling protocols used by Golder Associates to collect surface water samples. It contains sampling instructions and information concerning appropriate containers, preservation and handling of water quality samples.

2 APPLICABILITY

This technical procedure is applicable to any persons involved in the collection of surface water samples. It is applicable to all geographic areas.

3 DEFINITIONS

3.1 Analytical Request Form

Standard form provided by analytical laboratories. This form is filled out by the person collecting samples and is used to indicate how each sample is to be analyzed. This form is often combined with the Chain-of-Custody Form in a single document.

3.2 Chain-of-Custody Form

Standard form used to track the movement of sample containers from the time they leave the field until they arrive at the specified laboratory. The Chain-of-Custody form provides a clear record of sample transport and handling, thereby reducing the risk of sample loss during transport. This form may be combined with the Analytical Request Form in a single document.

3.3 Chemical Analysis

Analytical procedure used to measure the *amount* of a certain compound, or group of compounds, present in a sample.

3.4 Preservatives

Preservatives are used to maintain sample integrity from the time a sample is collected until it is analyzed. Sample preservation may involve adding acid or other fixatives to collected waters or simply keeping them refrigerated. Sample-specific requirements are outlined in this document (Table 1); preservatives, when required, are provided by the analytical laboratory.

3.5 Quality Assurance/Quality Control (QA/QC)

Quality Assurance refers to a detailed protocol used to produce high quality products, while Quality Control refers to the process by which this protocol is tested to ensure that final products are of the

specified quality. With reference to water sampling, QA protocol includes the use trained personnel, proper sampling methods, clean containers and equipment, proper sample preservation and transportation and detailed documentation of the entire process; field, travel and other assorted test blanks are used for Quality Control testing.

3.6 Sample Types

3.6.1 Grab Samples

Sample containing water collected during a single sampling event (i.e., water taken from a given place at a given time).

3.6.2 Composite Samples

Sample containing a mixture of water collected from multiple locations or from different times at the same location.

3.6.3 Equipment Blanks

Equipment blanks are used to detect contamination from sampling equipment. They are prepared by rinsing precleaned equipment with laboratory-provided deionized water and collecting the rinsate into an appropriate container.

3.6.4 Field Blanks

Field blanks are used to detect contamination during sample collection and transport. They are prepared during a sampling event by filling the appropriate container with laboratory-provided deionized water. Field blanks are usually used in situations where there is reason to suspect that contamination will occur during sample collection and transport.

3.6.5 Travel (Trip) Blanks

Travel blanks detect sample contamination during transport. Travel blanks consist of pre-filled bottles provided by the analytical lab. They accompany empty sample bottles to the field site, where they are left intact and unopened inside the shipping cooler. The unopened travel blanks are then returned to the analytical lab to be analyzed along with collected samples.

3.6.6 Field Spikes

Field spikes are used to measure the performance of the complete analytical system, including sample handling, preservation and storage, as well as interference from the sample matrix. To generate a field spike, field personnel fill the usual sampling container with sample, leaving a small amount of space at

the top. They then add a specified amount of the chemical or compound of interest to the bottle and submit it with the rest of the samples. In general, field spikes are not recommended due to the logistical difficulties of transporting concentrated solutions in the field. If there is reason to doubt the performance of the sampling system, then a separate study involving field spikes should be carried out.

3.6.7 Standard Reference Samples

Standard reference samples, or blind QA samples, are samples of known concentration that are submitted to the analytical lab as a normal sample. The lab is not informed about the identity of the sample until after all analyses are complete.

3.6.8 Replicate Samples

Replicate samples are used to evaluate within-site and analytical variation. Replicate samples are collected by filling multiple containers at a single site. They are labelled and preserved individually and are submitted separately to the analytical laboratory.

3.6.9 Split Samples

Split samples are used to check analytical variation. A single sample (e.g., grab) is collected and is split into two sample containers. These are labelled and preserved individually and are submitted separately to the analytical laboratory or to two different laboratories.

3.7 Specific Work Instructions (SWI)

Detailed instructions in a standardized format provided to field personnel. The SWI describe all aspects of the work to be conducted, including personnel allocation, procedures to be used, time allocation and any additional information deemed necessary by the project or task manager.

3.8 Toxicity Analysis

Analytical procedure specifically designed to examine how the health of living organisms may be affected by exposure to a given substance or sample. Toxicity tests can be based on either: acute exposures (short-term exposures lasting only a small portion of the animals life cycle, e.g., 96 hours for rainbow trout); or, chronic exposures (longer-term exposures meant to represent a significant portion of the animal's life cycle, or a particularly sensitive portion of the animal's life cycle, e.g., 28 days for *Daphnia magna*). Responses measured in toxicity tests can be lethal (e.g., mortality), or sublethal (e.g., reduced growth or reproduction). Unlike other procedures, toxicity testing evaluates the sample as a whole, rather than describing its chemical make-up.

4 REFERENCES AND SUGGESTED READING

4.1 Sampling Methodology

Environment Canada. 1993. Quality Assurance in Water Quality Monitoring. Ecosystem Sciences and Evaluation Directorate Conservation and Protection. Ottawa, Ontario, Canada.

Clesceri, L.S., A.E. Greenberg and R.R. Trussell. 1989. Standard Methods for the Examination of Water and Wastewater. American Public Health Association, Washington, D.C., U.S.A.

5 DISCUSSION

5.1 General Safety

Refer to Golder Associates Ltd. Health and Safety Manual.

5.2 Sampling Procedures

Samples are collected as representative pieces of a larger puzzle. Ideally, they should describe all of the characteristics of the larger body from which they originate, which, by its very definition, is too large to analyze directly. As a result, it is very important to follow a well-organized sampling plan and to preserve sample integrity throughout the collection and transportation process.

5.2.1 General Practices

Usually, analytical laboratories will provide pre-cleaned sample containers, shipping containers, required forms for sample submission and specific sample shipping instructions. It is important to check with the lab that these arrangements have been made. Similarly, field crews should familiarize themselves with the SWI before initiating a sampling program. By reviewing the instructions, personnel can ensure that they have all of the equipment they require to fulfill the objectives of the sampling program. Field crews will also then be aware of the types of samples they are being asked to collect, be they grab samples, composite samples or QA/QC test blanks. Finally, sample crews should organize themselves such that samples will be collected and shipped during the early part of the work week (Monday to Wednesday) to help avoid delays caused by weekend shipping.

Sampling Locations

General sampling locations are described in the SWI. However, field crews will have a certain degree of freedom in choosing the exact locations from which to take the samples. When selecting these sites, personnel should consider the layout of the local environment, project objectives and personal safety. They should then choose areas that are both easily accessible and representative of the target waterbody or waterbodies.

Once sampling sites have been identified, they must be accurately described relative to permanent landmarks, such as groundwater wells, outfalls or distinctive landscape features; measuring the distance from permanent landmarks to each site with an appropriate compass heading is recommended. Ideally, one should try to use the Global Positioning System (GPS), but locations can also be recorded as the perpendicular distance from the shoreline and the distance upstream or downstream of a permanent landmark.

Sample Collection

- Start sampling at the least contaminated site (i.e., the reference site) and move from there to the more contaminated areas.

- If sampling equipment must be used, then it must be cleaned before and after use. This may involve rinsing with ambient water, cleaning with soap and water, acid washing, rinsing with organic solvents or pure water, or a combination of these. Refer to the SWI for details.

- Each sample bottle must be labelled at the time of collection with either waterproof, permanent marker or using pre-printed waterproof labels. See section 5.3.2 for details of label format.

- When sampling, it is important to rinse sample containers 3 times before actually taking a sample. Rinse each bottle by partially filling it with ambient water, loosely attaching the cap and shaking the bottle; drain the water and repeat the process. As a general rule, rinse plastic bottles unless instructed otherwise by the analytical laboratory. Bottles that already contain the preservatives and containers for the following analyses should *not* be rinsed prior to taking the sample:
  - volatile organic compounds (VOCs), including total volatile hydrocarbons (TVH), total extractable hydrocarbons (TEH), BTEX (benzene, toluene, ethylbenzene and xylene) and total petroleum hydrocarbons (TPH; includes TVH, TEH and BTEX); and
  - bacteriological testing (e.g., fecal coliforms).

- Carefully fill sample containers, without splashing, leaving only enough space for preservatives (if required - see Table 1). Be sure to keep hands and fingers downstream of bottle opening and sample upstream of bridges, boats and yourself to prevent sample contamination. If no preservatives need to be added, completely fill the bottles and cap tightly. There should be as little air in the containers as possible, as it can affect sample integrity.

- Whenever possible, fill sample containers directly from the source, without using an intermediate container to transfer the sample. This avoids potential sample contamination due to carry-over from one sample to the next. Also, take care to avoid contaminating sample waters through contact with rubber, oil, gasoline and other machinery fluids, metal-based paints, cigarette ash, paper tissues and other such material.

- Sample bottles should then be stored appropriately (Table 1). In most cases, this will involve keeping the sample cool (4°C) and dark. Samples should never be allowed to freeze and should be shipped as soon as possible to the appropriate analytical lab, in coolers with reusable ice packs. If possible, avoid using bags of ice purchased from convenience stores; the water that leaks out of these bags as the ice melts may ruin sample labels.

- Chain-of-Custody and Analytical Request forms must accompany all samples (one set of forms per sample shipment). Prior to shipping, the person submitting the sample should inform the analytical lab by telephone or fax that the samples will be arriving. As well, he or she should check back later to confirm arrival of the samples and to explain analysis requests if needed.

5.2.2 Sampling for Metals

When collecting samples for a metals analysis, it is important that sample waters do not come into contact with any metal products. Samples for metals analysis also have other stringent collection and preservation requirements (Table 1). For example, waters collected for dissolved metal analysis have to be field-filtered using a 0.45 µm polycarbonate or cellulose acetate filter and then preserved with acid. Field crews need to be aware of these restrictions to ensure that samples are taken correctly and that they maintain their integrity until they can be analyzed. Special sampling and preservation instructions should be included in the SWI.

5.2.3 Sampling for Organic Chemicals

In addition to the general principles outlined above, there are specific protocols associated with sampling for organic measurements. As described above, sample bottles should *not* be rinsed prior to taking samples for certain organics analyses. It is also very important to completely fill each bottle, as certain organics will volatilize into the overlying air space and will be lost after opening the bottle. Finally, proper containers must be used when sampling for organics, since some bottles will release or absorb organic compounds when filled with water. Generally, glass containers are used, but certain tests may require other materials; be sure to obtain the appropriate sample bottles from the analytical laboratory and refer to the SWI.

5.3 Sample Documentation

The importance of proper sample documentation cannot be overemphasized. Lack of careful documentation can lead to misunderstandings and questionable test results. Components of proper documentation of field activities are described below.

5.3.1 Field Notebooks

Field notebooks must be kept, describing all field activities. Format of field notes and information to be recorded should follow Golder Associates' specific guidelines. During the field survey, field notes must be maintained in a permanent, safe location at the field site where samples are collected. If possible, new entries in the field note book should be photocopied at the end of each field day and copies should be stored in a safe place.

5.3.2 Sample Labels

Sample labels must contain the following information:

- Sample identifier (name of site or sample code);
- Date (written as day/month/year; month abbreviated as three letters) and time (24 hour clock) of collection;
- Initials of collector; and
- Analysis requested (this is usually done by the analytical laboratory in the form of a code on the sample bottle).

Fill out labels at the time of collection using waterproof ink and affix a label to each sample container. Plastic bottles may be labelled by writing directly on the bottle using a waterproof marker; however, this approach is not recommended if samples are transported over long distances (friction may rub label off) or if bags of ice are used to keep the samples cool (water may damage label information).

5.3.3 Custody Seals

If required for a project, numbered seals should be used to detect unauthorized tampering with samples in transit. Attach the seal in a way that it is necessary to break it to open the cooler containing the samples. The number on the custody seal should be recorded in the field note book and on the Chain-of-Custody and Analytical Request forms.

5.3.4 Chain-of-Custody Forms and Analytical Request Forms

Chain-of-Custody and Analytical Request forms must accompany all samples submitted for analysis. These forms are usually combined as a single document. An example of Golder Associates' combined Chain-of-Custody and Analytical Request Form is provided in Appendix 1.

The combined form must be filled out completely and the white and yellow copies should be sent along with the samples being submitted. Field personnel should retain the pink copy after it is signed by the shipper. Depending on the shipping container, these forms can either be enclosed inside the sealed container or attached firmly to the outside of the container. In either case, it is advisable to enclose the forms within a waterproof plastic bag to guard against damage. It is important that each person having custody or control of the samples identify themselves on this form. This means that the person collecting the sample, any intermediate persons involved in packaging, storing or transporting the sample and the person accepting the sample on behalf of the analytical lab must all be identified.

5.4 Sample QA/QC

The main goal of sample QA/QC is to monitor for various sources of contamination during sample collection, transport and analysis. This process will involve the use of field, travel and other test blanks. QA/QC programs are designed on a project-specific basis. Details of individual QA/QC programs are described in the SWI.

6 EQUIPMENT AND MATERIALS

6.1 Sampling

The following is a list of sampling equipment generally recommended for surface water sampling:

- Pre-cleaned sample bottles and required preservatives (usually supplied by the analytical laboratory)
- Coolers and reusable ice packs
- Waterproof labels and permanent markers
- Sampling equipment (e.g., Kemmerer or Van Dorn bottles)

6.2 Site Location and Sample Documentation

For proper sample site identification and sample documentation, field crews may need:

- Bound, water-proof field logbooks
- Maps
- Air photos
- Indelible ink pens and pencils
- Long tape measure
- Survey flagging tape
- Compass
- GPS unit
- Combined Analytical Request and Chain-of-Custody forms

6.3 Health and Safety

The following health and safety equipment is recommended for surface water sampling:

- Waders and waterproof gloves
- Heavy socks, warm pants, rain gear and other articles of clothing suitable for prolonged water work
- Extra set of clothes
- First aid kit
- Approved personal floatation device for deep water or boat work

Table 1
Summary of Sample Collection, Preservation and Storage Requirements

PARAMETER	BOTTLE TYPE	ETL[1] LABEL	SAMPLE PRESERVATION	PRESERVATIVE CODE (ETL)[1]	HOLDING TIME	COMMENTS
Conventional Chemistry						
pH to TDS + DOC	500 mL plastic	"routine"	in the dark at 4°C	-	48 hrs.	Note short holding time
TOC	100 mL amber glass	unlabelled	1 mL H_2SO_4	Fluorescent Red	5 days	Do not triple rinse
Major Ions						
Calcium to Sulphate	in "routine" bottle	n/a	-	-	-	
Sulphide	100 mL plastic	"Sulphide"	1 mL NaOH+ 2 mL zinc acetate	Orange	5 days	
Nutrients						
Ammonia, TKN & Total P	500 mL plastic	"nutrients"	2 mL H_2SO_4	Purple	10 days	Indicate on label that sample is preserved
Nitrate + Nitrite & Dissolved P	in "routine" bottle	n/a	-	-	-	
Bacterial						
Biochemical Oxygen Demand	1 L plastic	unlabelled	in the dark at 4°C	-	48 hrs.	Note short holding time
Coliforms	300 mL sterilized glass	unlabelled	in the dark at 4°C	-	48 hrs.	Note short holding time
Toxicity						
Daphnia magna 48 h. Static Acute	1 L clear glass / plastic	unlabelled	in the dark at 4°C	-	5 days	
Rainbow trout 24 and 96h Static Acute	20 L collapsible carboy	unlabelled	in the dark at 4°C	-	5 days	
Algal Growth 72h Inhibition/Stimulation	1 L clear glass / plastic	unlabelled	in the dark at 4°C	-	3 days	
Ceriodaphnia dubia 7d Growth and Reproduction	20 L collapsible carboy	unlabelled	in the dark at 4°C	-	3 days	
Fathead Minnow 7d Survival/Growth	20 L collapsible carboy	unlabelled	in the dark at 4°C	-	3 days	
Bacterial Luminescence (Microtox IC50 and IC20)	1 L clear glass	unlabelled	in the dark at 4°C	-	48 hrs.	Note short holding time
Other						
Total Recoverable Hydrocarbons	1 L amber glass	"oil & grease"	2 mL H_2SO_4	Purple	5 days	Do not triple rinse
Naphthenic acids	1 L amber glass	unlabelled	0.5g ascorbic acid + 2 NaOH pellets		10 days	Do not triple rinse; preservative in bottle
Total Phenolics	100 mL amber glass	unlabelled	1 mL H_2SO_4	Fluorescent Red	24 hrs.	Note short holding time Do not triple rinse
Chlorophyll *a*	500 mL plastic	"nutrient"	in the dark at 4°C	-	48 hrs.	Note short holding time Indicate on label that sample is unpreserved
Total Metals						
Aluminum to Zinc + Sb, As & Se	500 mL plastic	"metals"	2 mL NO_3	Blue	6 months	
Mercury (Hg)	250 mL plastic	"mercury"	2 mL NO_3 + dichromate	Yellow	30 days	
Dissolved metals						
Aluminum to Zinc + Sb, As & Se	500 mL plastic	"metals"	filter, 2 mL NO_3	Blue	6 months	See dissolved metals sampling protocol
Mercury (Hg)	250 mL plastic	"mercury"	filter, 2 mL NO3 + dichromate	Yellow	30 days	See dissolved metals sampling protocol
PAHs						
Naphthalene....	2 L clear glass	unlabelled	in the dark at 4°C	-	14 days	Bottle may be 4 L Do not triple rinse
Phenolics						
Phenol....	in PAH bottle	unlabelled	-	-	-	
Volatile Organics						
Acetone...	40 mL amber glass	unlabelled	Na2S2O3, 2 crystals, dark, 4°C	-	14 days	Do not triple rinse; preservative in bottle

NOTE: [1]ETL = Enviro-Test Laboratories.

TECHNICAL PROCEDURE 8.5-1
WATER COURSE HABITAT MAPPING SYSTEM

1 PURPOSE

This technical procedure details the classification system and map coding system to be used for habitat mapping a watercourse and provides instructions on habitat mapping procedures and standards. The habitat mapping system consists of two components: 1) The **Large River Habitat Classification System** - a general system for mapping large mainstem rivers; and, 2) The **Stream Habitat Classification and Rating System** - a more detailed system for mapping discrete channels units which is primarily used for intermediate rivers and smaller streams.

2 APPLICABILITY

This technical procedure is applicable to all personnel involved in habitat mapping of all sizes of watercourses in Alberta. The technique was developed primarily in Alberta in consultation with Alberta Fish and Wildlife. With respect to describing aquatic habitats it is applicable to some areas outside of Alberta but may be superseded by local criteria (e.g., B.C. MOE guidelines). This procedure may not be applicable to low gradient streams in the plains areas east of Alberta without some modification. Portions of the stream classification system were developed in relation to salmonid species and would require interpretation in order to be suitable for evaluating habitat conditions for other fish species.

3 DEFINITIONS

Each of the habitat mapping system components includes a set of habitat types or categories, the definitions of which are included in the two different classification systems in Tables 1 and 2. Some more general definitions are presented here.

3.1 Bank

Banks are components of a watercourse. Banks comprise the borders of the stream channel and form the typical boundaries of the channel. The banks are only in contact with the water during high flow or flood events. They typically have rooted vegetation to distinguish them from the normally active channel. Certain bank features can influence the quality of instream fish habitat, particularly with respect to cover for fish.

3.2 Bank Stability

The stability or erodability of the banks is based on factors such as bank slope, bank material, evidence of seepages, undercutting, erosion and slumping. Unstable banks are banks which shed material (bank material or vegetation) into the watercourse. The input of fine sediments into rivers and streams can result in detrimental sedimentation of instream habitats. Alternatively, vegetation and other bank materials which fall in the channel may be beneficial by providing cover for fish or may be detrimental by causing blockages.

3.3 Channel

The channel is the main component of a watercourse. It is the area of the watercourse that typically has flowing water, on at least a seasonal basis, and is usually defined by the area of the stream substrate. The channel is distinguishable from the banks since it has contact with flowing water for at least a portion of each season which usually prevents establishment of permanent vegetation.

3.4 Channel Form

Channel form refers to the cross-sectional shape of the channel as defined by the width:depth ratio of the channel. Channel form will range from deeply incised (low width:depth) to broad (high width:depth).

3.5 Channel Unit (sometimes referred to as habitat type)

Channel units are the hydraulic and morphological features of a stream channel. A channel unit is a section of channel which is homogeneous with respect to water depth, velocity and cover and is separated from other channel units by gradients in these parameters. Channel units are sometimes referred to as habitat types. The most common channel units are **pool, riffle** and **run**, although a total of 12 channel units have been defined (Table 2).

The pressure or absence of channel units in a watercourse is the determining factor when choosing which component of the habitat mapping system to employ when working on large rivers. If a river does not show any channel unit differentiation, the *Large River Habitat Classification System* is used. If channel units are present, then the *Stream Habitat Classification and Rating System* is used.

3.6 Channel Width

The horizontal distance along a transect line from stream bank to stream bank (rooted vegetation to rooted vegetation) at the normal high water marks measured at right angles to the direction of flow.

3.7 Cover

Cover is defined as aspects of the physical environment which provide resting places or protection from predators for fish. Cover consists of two categories: 1) **Instream Cover** - any feature which provides a velocity shelter (e.g., large substrate particles, submerged debris, etc.); 2) **Overhead Cover** - any feature which provides visual isolation for the fish (e.g., overhanging vegetation, undercut bank, turbulence, water depth, etc.).

When habitat mapping a watercourse, available cover for fish is evaluated for each section of the channel as it is assigned a classification. For the *Large River Habitat Classification System*, near-shore cover is a part of assigning shoreline habitat types. For the *Stream Habitat Classification and Rating System*, cover is evaluated when assigning a channel unit rating for pool and run channel units.

Cover is assessed by the visual examination and estimation of the quality and quantity of the available features with respect to instream and overhead cover for different fish life stages. Smaller life stages such as fry require smaller cover compared to adult fish. Areas of high quality cover would provide cover for a number of individuals of all life stages. Areas of moderate cover would provide little or no cover for adults but some cover for juveniles and fry. Areas of poor cover would not provide cover for adults and only limited cover for juveniles and fry.

3.8 Discharge

A measurement of the volume of surface water flowing in the stream channel, measured as the volume flowing past a specific point over a given time (i.e., m^3/s). Stream discharge has significant effect on water level and depth in the various habitat types. In order to reduce the effects of variable discharge levels on habitat mapping, it is recommended that habitat mapping be conducted during the late summer low flow period.

3.9 Habitat Associations

Habitat associations are the relationships between habitat categories and fish presence, abundance and use. If the habitat mapping activities are conducted in conjunction with fisheries inventory sampling, the species, numbers and life stages of fish captured should be assessed by habitat type. That is, for each habitat type (either shoreline habitat type or channel unit type and class) the types of fish captured should be recorded. This not done for each individual habitat area but for each general type (e.g., fish captured in all Class 1 Pool channel units, versus Class 2 Pools or each class of run habitat or in riffle channel units).

3.10 Habitat Map

A habitat map is a map of a section of watercourse showing the location and extent (i.e., boundaries) of each habitat type. What constitutes a habitat type depends on which of the two mapping systems is employed. With the *Large River Habitat Classification System*, habitat types are the bank habitat features as described in Table 1. With the *Stream Habitat Classification and Rating System*, the habitat types are the channel units described in Table 2.

3.11 Stream Confinement

Stream confinement refers to the confinement of the watercourse within the boundaries of the floodplain. It is the degree to which the lateral movement of the stream channel is limited by terraces or valley walls.

3.12 Stream Habitat

The physical stream environment which provides a place for aquatic biota (fish, invertebrates, plants, etc.) to live, grow and reproduce. Several types of fish habitat should be considered when habitat mapping and include **spawning habitat**, **fry nursery habitat**, **juvenile rearing habitat**, **adult feeding habitat** and **overwintering habitat**.

3.13 Stream Gradient

The slope of the streambed over which the stream runs. Some channel characteristics are directly related to the gradient. Examples include average velocity, substrate coarseness, and presence and extent of various channel units. Gradient classification: low <2%; medium 2-5%; high >5%.

3.14 Stream Pattern

Channel pattern describes the sinuosity of the channel or the degree to which the channel deviates from straightness. Sinuosity is the channels meander pattern which can range from straight to tortuously meandering.

3.15 Substrate

Stream substrate is the material found on the bottom of the channel portion of the watercourse. It refers to the surficial deposits that can be seen when viewing the streambed. As part of the habitat evaluation process, the substrate is evaluated with respect to particle size composition. Particle size composition refers to the proportions of the substrate particles within each category from a series of size categories. The size categories employed are presented on Table 4. These range from fine sediments (fines are particles <2 mm in size and include clay, silt and sand) through gravels, cobbles, boulders and bedrock. A substrate evaluation is conducted by visual observation. The observer estimates the percentage of the substrate particles, by surface area, in each of the size categories.

3.16 Undercut Bank

An undercut bank has been eroded at the base by flowing water, allowing water to be present underneath a portion of the bank. Although undercutting usually adds to bank instability, it may also provide cover for fish. If the overhanging portion of the bank provides and effective with >9 cm over water with a depth of >0.15 m, it provides a cover feature.

3.17 Watercourse

A natural or artificial waterway which periodically or continuously contains moving water. It has a definite channel, banks which normally confine water and displays evidence of fluvial processes.

3.18 Wetted Width

The width of the water surface measured at right angles to the direction of flow. Multiple channel widths are summed to obtain total wetted width.

4 REFERENCES AND SUGGESTED READING

Hamilton, K., and E.P. Bergersen. 1984. Methods to estimate aquatic habitat variables. Colorado Cooperative Fishery Research Unit. Colorado State University.

Hawkins, C.P., J.L. Kershner, P.A. Bison, M.D. Bryant, L.M. Decker, S.V. Gregory, D.A. McCullough, C.K. Overton, G.H. Reeves, R.J. Steedman, and M.K. Young. 1993. A hierarchical approach to classifying stream habitat features. Fisheries 18(6):3-12.

Northern River Basins Study. 1994. A general fish and riverine habitat inventory; Athabasca River, October 1993. Prepared by R.L.& L. Environmental Services Ltd. for the NRBS, Edmonton. Northern River Basins Study Project Report No. 40. 129 pp. + App.

Roper, B.B., and D.L. Scarnecchia. 1995. Observer variability in classifying habitat types in stream surveys. N.A. Journal of Fish. Manag. 15(1):49-53.

R.L.& L Environmental Services Ltd. 1994. A general fish and riverine habitat inventory, Athabasca River, April to May, 1992. NRBS Project Report No. 32, Edmonton, Alberta. 74 pp. + App.

R.L.& L Environmental Services Ltd. 1986. Fisheries resources upstream of the Oldman Dam: Prepared for Alberta Environment Planning Division, Edmonton. 131 pp. + App.

5 DISCUSSION

The habitat mapping and classification system is used to provide an ecologically relevant inventory of stream habitats within a designated study area. The mapping procedure is meant to describe the habitats available within the stream and to detail the location and extent of each habitat type/class. The habitat classification system is intended to be ecologically meaningful with respect to describing and cataloguing physical habitats in relation to the requirements of fish species and their various life stages (spawning, incubation, nursery, rearing, summer feeding, holding, overwintering, migration); and also to a lesser extent the relationship between physical habitat and benthic invertebrate productivity, at least with respect to fish food production. Researchers have determined that fish distinguish between the habitat types and sub-classes of habitat types that have been used to map streams. It is intended that this classification system will provide an ecological association of habitat characteristics and fish use/abundance.

Streams are habitat mapped to provide an inventory of the available habitats and to show the locations of habitats that are of importance to fish such as migration routes, spawning habitats and rearing habitats. Habitat maps are used in several applications. A habitat map can be used to show the habitat types that may be impacted by a proposed point disturbance such as a pipeline crossing or bridge construction. A habitat map of a length of stream can also be used to evaluate alternate locations of disturbances in order to minimize the impacts. Habitat maps may be applied to document changes to a stream environment over time, from disturbances or due to habitat rehabilitation or improvement programs. A primary use of the habitat mapping procedure is to provide an inventory of the habitats present in a stream that is subject to a proposed impact in order to ensure compliance with the Federal Regulations stating that "No Net

Loss" of productive fish habitat is to occur as a result of a proposed disturbance or alteration of the stream.

The habitat mapping and classification system is composed of two components. The first is a general system called the **"Large River Habitat Classification System"** which is used to map large mainstem rivers such as the Peace or Athabasca rivers where habitat heterogeneity is less than for smaller streams, and use of a more detailed system is not appropriate. The second component is a the more detailed **"Stream Habitat Classification and Rating System"**, which is used for watercourses with a greater degree of channel complexity and which display different types of channel units. Whether the Large River Habitat Classification System (Table 1) is used or the Stream Habitat Classification and Rating System (Table 2) is used will depend on the size of the watercourse and the types of available habitats.

5.1 How to Draw a Habitat Map

It is best to have a **base map** prepared on which to record the habitat map. This is much preferred to drawing a free-hand schematic diagram of the watercourse while in the field. Base maps must usually be prepared in the office before heading out for the field. Air photos provide a good template to prepare basemaps. Air photos can be borrowed from the University Photo Library and photocopied to avoid having to purchase the photos. Topographical maps may also be used to prepare a base map but usually need to be enlarged on a photocopier to provide a map. For small streams which appear on the map as only a single line, it is still best to make an enlargement and then to draw in a second line parallel to the line on the map, approximating the channel. Base maps should be sufficiently large to allow for sufficient detail to be recorded.

Once a map or air photo has been obtained and the enlargement has been made, the watercourse can be traced onto a mylar overlay then traced onto waterproof paper to provide a base map for use in the field. Do not photocopy the mylar tracing onto waterproof paper as you will not be able to erase the lines. You may need to do to redraw portions of the channel if changes have occurred since the photo or map was made. It may be possible to reduce the number of steps here if you can use a light table to trace the map or photo directly to waterproof paper. While producing the base map, be sure to record the scale of the map, particularly if the original map was enlarged to make the base map. If the map used to produce the base map has a scale drawn on it, enlarge this scale along with the map to provide the scale for the base map.

Base maps are very important to provide an accurate representation of the watercourse, to aid in drawing in the boundaries between habitat types, the location of each habitat type and the area and length of each habitat type. This type of accuracy is very difficult with free-hand drawings made onto blank paper. If base maps are not available and this type of accuracy is required, a tape measure or hip chain can be used to measure the lengths for each habitat type. This will help ensure the free-hand drawing is accurate and to scale. Simple free-hand schematic drawings are acceptable if this type of accuracy is not required of a large number of streams are to be mapped making the preparation of a base map for each stream impractical.

The habitat map is produced by **delineating on the base map the location and extent of each of the habitat features**. To do this, the channel is divided into a continuous series of habitat types by drawing on the base map the boundaries of each habitat type and attaching a label to identify the habitat type.

The habitat types to be drawn on the map depend on which of the two habitat mapping systems is being employed. For the *Large River Habitat Classification System*, bank habitat types are delineated. For the *Stream Habitat Classification and Rating System*, channel units are delineated. The habitat types to be included, the definitions of these features, and the abbreviations (map symbols) used to label each feature on the habitat map are detailed in Tables 1 and 2. It is important to draw on the map the boundary of each habitat type so that the length of each habitat type can be measured during the data analysis and interpretation process.

Also to be recorded during on the habitat map are the following: **Project Number/Title, Watercourse Name** or some type of identifier if the stream is unnamed, **Location** of the stream or section of stream being mapped, **Date**, and **Personnel (Crew)**. If more than one page is required to complete the habitat map for a given watercourse, record the **page number** on each page (i.e., Page 1 of 2, Page 2 of 2, etc.). If possible, the discharge or relative water level at the time of mapping should be recorded since the water level greatly affects the depths, and potentially the classification of the habitat types. For this reason, it **is preferable to conduct all habitat mapping procedures under late summer base flow conditions.**

Other information to be recorded on the habitat map in order to standardize the maps between projects and observers. The map must show a **North arrow**, an arrow showing the **direction of flow** in the channel, a **scale** or the words 'schematic diagram-not to scale, and a **legend** explaining the abbreviations and symbols used on the map. Before turning the map into drafting for preparation for inclusion in a report, add a **Figure Name** and **Number**.

In addition to habitat types, qualitative descriptions of substrate conditions can be recorded on to the habitat maps the general substrate conditions. Typically, this process would be applied during use of the *Stream Habitat Classification and Rating System* to describe the substrate conditions for specific areas, such as potential spawning habitats, or to describe the substrate type within each individual channel unit. Substrate composition is presented as the percent occurrence (visual estimation) of each substrate size category. Substrate particle sizes are presented on Table 4.

5.2 Large River Habitat Classification System

This is a general system based on gross morphology and habitat types along the river banks and shoreline. It consists of two primary components: 1) "major habitat type", which defines the type of channel present; and, 2) "bank habitat type", which details the structure of the bank and near shore habitats. "Special habitat features" considered significant to fish distribution/use in these large rivers are also to be included on the map. Table 1 presents the details of the large river habitat classification system.

The Large River Habitat Classification System is to be used on large rivers which do not show any differentiation of channel units; distinct pool, riffle and run habitats are absent. In most large rivers, such as the Peace or Athabasca Rivers, the lower segments of the river are wide with relatively low gradients and large flow volumes. Channels do not contain physical or hydraulic features which create riffle/pool sequences. There is little or no differentiation of habitat types in the channel. It should be realized, however, that at any given point, depths across the width of the channel may vary. Habitat features that

fish might use are generally associated with shoreline areas, areas of instream islands and tributary confluences. These features should be identified on the habitat map.

Shoreline habitats change as the structure of the banks change, providing one of the few characteristics that can be mapped. Elements of the bank structure which affect fish habitat include: water depth along the shoreline, substrate type and cover features to substrate, fallen debris/vegetation, and protrusions from the bank which create low velocity related habitats. Therefore, bank features are the basis of the Large River Habitat Classification System.

To draw a habitat map using the large river system, begin by **dividing the length of the watercourse in the study area into *Major Habitat Types***, depending on the number of permanent/vegetated islands present. This can often be done from the base map or air photo which will normally show all permanent islands. Any islands not on the original base map should be drawn onto the habitat map. Next, the **shorelines should be divided into *Bank Habitat Types*** according to the criteria in Table 1. This should be done for both shorelines as well as the shorelines around all permanent islands. Remember to show the boundaries of each Bank Habitat Type. This is usually done by demarcating the boundaries with a short line drawn at the shoreline, perpendicular to the shoreline, and labelling the area inside the boundaries with the appropriate Bank Habitat Type (e.g., A1, E5, etc.). Bank Habitat Types should be a continuous series along the shorelines without any blank, unlabelled sections. For any tributaries which enter the river within the study area, examine the tributary mouth and **label the tributary confluence according to the categories in Table 1**. To complete the map, **draw in the location and extent, again showing the boundaries, of all *Special Habitat Features***, as defined in Table 1.

5.3 Stream Habitat Classification and Rating System

This is a detailed mapping system based on individual channel units. These units are defined as sections of stream of homogenous with respect to depth, velocity and cover. The extent of each channel unit should be delineated on the map, as should the class rating for each unit (where appropriate). Some of the channel units also have modifiers (types) which should also be recorded. Table 2 presents the details of the stream habitat classification and rating system. This system is employed for mapping all watercourses which have distinct channel units such as pool, riffle and run habitats.

To draw a habitat map using the stream mapping system, the **length of stream in the study area is divided into a continuous series of channel units**. Table 2 presents the definitions for each of the 12 types of channel unit. Lines drawn across the channel are used to delineate the location and extent of each channel unit. The appropriate channel unit symbol (abbreviation) is used to label the channel unit. In addition to the channel unit type, three types of channel units have different sub-classes. **Run, pool and impoundment channel unit types should be further divided into Class 1, Class 2 or Class 3, depending on water depth and available cover for fish**, as described in Table 2. The classification should be included in the label on the habitat map (e.g., a riffle would simply be labelled RF on the map but a pool would be labelled as P1, P2 or P3, depending on the Class). Make sure the entire length of the channel in the study area has been divided into channel units on the map, including boundary lines, and that each unit has a complete label. In order to better define the available habitats in the study area, **record the maximum water depth in each channel unit and include it in the channel unit label** (e.g., a Class 1 pool that has a maximum depth of 4.0m should be labelled P1-4.0m).

Dividing the run, pool and impoundment units into subclasses is based on water depth and the quality of available cover for fish. Some general water depth guidelines are included in Table 2 to assist in classifying these channel units. However, these depths are not the only criteria. The classification of each channel unit is also based on its potential use by different life stages of fish (Table 1). For example, if a run channel unit is slightly shallower than the minimum depth for a Class 1 (Table 3), but high quality cover for adult fish is present, it would be classified as Class 1. Conversely, a run channel unit that is deeper than the minimum depth for a Class 1 run but with very poor cover would be classified as a Class 2 run.

The use of the channel unit and class categories are meant to relate instream habitats to the potential utilization by fish species and life stages. Much of the criteria used to establish the classifications are based on the habitat requirements of salmonid species. In Alberta, this includes non-anadromous trout and whitefish. Table 5 provides the fish utilization expected for each of the habitat types. The overall goal of the Stream Habitat Classification and Rating System is to provide habitat classifications that relate to fish utilization. Therefore, the associations within Table 5 should be kept in mind when assigning classifications.

From Table 5 it can be seen that the potential utilization of some channel units, particularly those suitable for spawning, depends on substrate particle size. Therefore, a quick assessment of substrate size should be made for each channel unit. **For each channel unit record the dominant and co-dominant substrate size classes** and include this information with the channel unit label. For some projects, substrate particle sizes should be recorded in full detail as presented on Table 4. However, for most projects general substrate sizes could be used such as fines, gravel, cobble and boulder, without further dividing the substrate particles. For example, a Class 2 run channel unit with a maximum depth of 0.8 m and a cobble dominant and gravel co-dominant substrate would be labelled *R2-0.8m, cobble/gravel.*

Table 3 presents additional habitat features along with their symbols and abbreviations. These features include structures that would occur at specific points rather than for sections of the channel such as beaver dams or ledges. Other relevant features in Table 4 include aspects of cover such as areas of undercut or unstable banks, overhanging vegetation, inundated vegetation, debris piles or root wads. **Draw the appropriate symbol on the map to show the location of these features.**

5.4 Habitat Map Interpretation

Once the habitat map is completed, it is analyzed to determine the relative proportion of each habitat type in the study area. Measure the overall length of watercourse in the study area (i.e., section of watercourse habitat mapped) and the length of each habitat type; either bank habitat type (if using the large river system) or channel unit type (stream system). Sum the lengths of stream in each habitat type and calculate the percent composition, by length, of each habitat type for the study area as a whole. For the large river mapping system, the results will be presented as the percent composition of each bank type: e.g., 60% E5, 30% A1, and 10% D1. For the stream mapping system, the results are presented for each type and class of channel unit; e.g., 40% RF, 5% R1, 10% R2, 20% R3, 5% P1, 15% P2 and 5% P3.

If a coincidental fisheries inventory was conducted during the classification of fish habitat associations, observed fish use for each habitat type along with the proportion of each type should be included for a more accurate assessment of fish use in the study area. Otherwise, Table 5 can be compared to the habitat composition of the stream to evaluate the potential fish use in the study area.

TABLE 1: LARGE RIVER HABITAT CLASSIFICATION SYSTEM
(From R.L.&L. 1994)

MAJOR HABITAT TYPES

Type	Symbol	Description
Unobstructed channel	U	single main channel, no permanent islands, side bars occasionally present, limited development of exposed mid-channel bars at low flow
Singular island	S	two channels around single, permanent island, side and mid-channel bars often present at low flow
Multiple island	M	more than two channels and permanent islands, generally extensive side and mid-channel bars at low flow

BANK HABITAT TYPES

Type	Symbol	Description
Armoured/Stable	A1	largely stable and at repose; cobble/s.boulder/gravel predominant; uniform shoreline configuration; bank velocities low-moderate; instream/overhead cover limited to substrate and turbidity
	A2	cobble/s.-l.boulder predominant; irregular shoreline due to cob/boulder outcrops producing BW habitats; bank velocity low (BW)-mod; instream/overhead cover from depth, substrate and turbidity
	A3	similar to A2 with more l.boulder/bedrock; very irregular shoreline; bank velocities mod-high with low velocity BW/eddy pools providing instream cover; overhead cover from depth/turbidity
	A4	artificial rip-rap substrates consisting of angular boulder sized fill; often associated with high velocity areas; shoreline usually regular; instream cover from substrate; overhead cover from depth/turbulence
Canyon	C1	banks formed by valley walls; l.cobble/boulder bedrock; stable at bank-water interface; typically deep/high velocity water offshore; abundant velocity cover from substrate/bank irregularities
	C2	steep, stable bedrock banks; regular shoreline; mod-deep/mod-fast water offshore; occasional velocity cover from bedrock fractures
	C3	banks formed by valley walls, primarily fines with some gravel/cobble at base; moderately eroded at bank-water interface; mod-high velocities; no instream cover
Depositional	D1	low relief, gently sloping bank; shallow/slow offshore; primarily fines; instream cover absent or consisting of shallow depressions or embedded cobble/boulder; generally associated with bars
	D2	similar to D1 with gravel/cobble substrate; some areas of higher velocities producing riffles; instream/overhead cover provided by substrate/turbulence; often associated with bars/shoals
	D3	similar to D2 with coarser substrates (cobble/boulder); boulders often imbedded; mod-high velocities offshore; instream cover abundant from substrate; overhead cover from turbulence
Erosional	E1	high, steep eroded banks with terraced profile; unstable; fines; mod-high offshore velocity; deep immediately offshore; instream/overhead cover from submerged bank materials/vegetation/depth
	E2	similar to E1 without the large amount of instream vegetative debris; offshore depths shallower
	E3	high, steep eroding banks; loose till deposits (gravel/cobble/sand); mod-high velocities and depths; instream cover limited to substrate roughness; overhead cover provided by turbidity
	E4	steep, eroding/slumping highwall bank; primarily fines; mod-high depths/velocities; instream cover limited to occasional BW formed by bank irregularities; overhead cover from depth/turbidity
	E5	low, steep banks, often terraced; fines; low velocity; shallow-moderate; no instream cover; overhead cover from turbidity
	E6	low slumping/eroding bank; substrate either cobble/gravel or silt with cobble/gravel patches; moderate depths; mod- high velocities; instream cover from abundant debris/boulder; overhead cover from depth/turbidity/overhanging vegetation

SPECIAL HABITAT FEATURES

Type	Symbol	Description
Tributary confluences	TC	confluence area of tributary entering mainstem
[sub-classified according	TC1	intermittent flow, ephemeral stream
to tributary flow and	TC2	flowing, width <5m
wetted width at mouth at	TC3	flowing, width 5-15m
the time of the survey]	TC4	flowing, width 16-30m
	TC5	flowing, width 31-60m
	TC6	flowing, width >60m
Shoal	SH	shallow (<1m deep), submerged areas in mid-channel or associated with depositional areas around islands/side bars
	SHC	submerged area of coarse substrates
	SHF	submerged area of fine substrates
Backwater	BW	discrete, localized area exhibiting reverse flow direction and, generally, lower velocity than main current; substrate similar to adjacent channel with more fines
Rapid	RA	area with turbulent flow, broken surface (standing waves, chutes etc.), high velocity (>1 m/s), armoured substrate (large boulder/bedrock) with low fines
Snye	SN	discrete section of non-flowing water connected to a flowing channel only at its downstream end, generally formed in a side channel or behind a peninsula (bar)
Slough	SL	non-flowing water body isolated from flowing waters except during flood events; oxbows
Log Jam	LJ	accumulation of woody debris; generally located on island tips, heads of sidechannels, stream meanders; provide excellent instream cover

TABLE 2: STREAM HABITAT CLASSIFICATION AND RATING SYSTEM
(Adapted from R.L.&L. 1986 & Hawkins et al. 1993)

Channel Unit	Type	Class	Map Symbol	Description
Falls			FA	Highest water velocity; involves water falling over a vertical drop; impassable to fish
Cascade			CA	Extremely high gradient and velocity; extremely turbulent with entire water surface broken; may have short vertical sections, but overall is passable to fish; armoured substrate; may be assoc. with chute (RA/CH)
Chute			CH	Area of channel constriction, usually due to bedrock intrusions; associated with channel deepening and increased velocity
Rapids			RA	Extremely high velocity; deeper than riffle; substrate extremely coarse (l.cobble/boulder); instream cover in pocket eddies and associated with substrate
Riffle			RF	High velocity/gradient relative to run habitat; surface broken due to submerged or exposed bed material; shallow relative to other channel units; coarse substrate; usually limited instream or overhead cover for juvenile or adult fish (generally ≤0.5m deep)
Run (glide)			R	Moderate to high velocity; surface largely unbroken; usually deeper than RF; substrate size dependent on hydraulics
	Depth/Velocity. Type			Run habitat can be differentiated into one of 4 types: deep/slow, deep/fast shallow/slow, or shallow/fast
		Class 1	R1	Highest quality/deepest run habitat; generally deep/slow type; coarse substrate; high instream cover from substrate and/or depth (generally >1.0 m deep)
		Class 2	R2	Moderate quality/depth; high-mod instream cover except at low flow; generally deep/fast or moderately deep/slow type (generally 0.75-1.0m deep)
		Class 3	R3	Lowest quality/depth; generally shallow/slow or shallow/fast type; low instream cover in all but high flows (generally 0.5-0.75m deep)
Flat			FL	Area characterized by low velocity and near-laminar flow; differentiated from pool habitat by high channel uniformity; more depositional than R3 habitat
Pool			P	Discrete portion of channel featuring increased depth and reduced velocity relative to riffle/run habitats; formed by channel scour
		Class 1	P1	Highest quality pool habitat based on size and depth; high instream cover due to instream features and depth; suitable holding water for adults and for overwintering (generally >1.5m deep)
		Class 2	P2	Moderate quality; shallower than P1 with high-mod instream cover except during low flow conditions, not suitable for overwintering
		Class 3	P3	Low quality pool habitat; shallow and/or small; low instream cover at all but high flow events
Impoundment		Class 1-3	IP (1-3)	Includes pools which are formed behind dams; tend to accumulate sediment/organic debris more than scour pools; may have cover associated with damming structure; identify as Class 1, 2 or 3 as for scour pools
	Dam Type			Three types of impoundments have been identified based on dam type; debris, beaver and landslide
Backwater			BW	Discrete, localized area of variable size exhibiting reverse flow direction; generally produced by bank irregularities; velocities variable but generally lower than main flow; substrate similar to adjacent channel with higher percentage of fines
Snye			SN	Discrete section of non-flowing water connected to a flowing channel only at its downstream end; generally formed in a side-channel or behind a peninsula
Boulder Garden			BG	Significant occurrence of large boulders providing significant instream cover; always in association with an overall channel unit such as a riffle (RF/BG) or run (e.g., R1/BG)

TABLE 3
ADDITIONAL HABITAT MAPPING SYMBOLS

Feature	Abbr.	Symbol	Description
Ledge	LE		Area of bedrock intrusion into the channel; often associated with chute or plunge pool habitat, may have a vertical drop affecting fish passage
Overhead Cover	OHC		Area of extensive or high quality overhead cover
Instream Cover	ISC		Area of high quality instream cover (velocity shelter) for all life stages
Undercut Bank	UCB		Area of extensive/high quality undercut bank providing overhead cover
Unstable Bank	USB		Area of unstable bank with potential to collapse instream, affecting instream habitat or producing sedimentation
Overhanging Veg.	OHV		Area of high quality overhanging vegetation providing overhead cover and stream shading
Inundated Veg.	INV		Area of inundated vegetation; either submergent macrophytes or flooded terrestrial
Debris Pile	DP		Debris pile (e.g., log jam) which influences instream habitat; include effect on cover
Root Wad	RW		Fallen terrestrial vegetation large enough to provide cover for fish
Beaver Dam	BD	XX	Include effect on fish passage

Considerations

Overhead cover includes overhanging vegetation, undercut bank or debris which has an effective width >9 cm over water with a depth > 0.15 m.

Instream cover is provided by aquatic vegetation or by substrate particles as large or larger than small cobbles when associated with water depths >0.15 m.

Deep water may provide cover if depth is >0.5 m.

Vertical drops >0.8 m are potentially impassable for resident trout species.

Generally, suitable spawning sites for trout occur in pool tail-outs, riffles and the transition areas from runs to riffles where the dominant substrate sizes range from small gravel to small cobble, fines (particles <2 mm) comprise <30% of the substrate, minimum water depths exceed 0.15 m, and velocities range from 0.3 to 1.0 m/s. Individual patches of gravel must be 1-2 m^2 to be considered as spawning habitat.

TABLE 4
SUBSTRATE CRITERIA
SUBSTRATE DEFINITIONS, CODES AND SIZE-RANGE CATEGORIES

CLASS NAME	SIZE RANGE	
	MM	INCHES
Clay/Silt	<0.06	<0.0024
Sand	0.06-2.0	0.0024-0.08
Small Gravel	2-8	0.08-0.3
Medium Gravel	8-32	0.3-1.3
Large Gravel	32-64	1.3-2.5
Small Cobble	64-128	2.5-5
Large Cobble	128-256	5-10
Small Boulder	256-762	10-30
Large Boulder	>762	>30
Bedrock	-	-

TABLE 5
CHANNEL UNIT CLASSIFICATION AND HABITAT ASSOCIATIONS FOR SALMONIDS

Spawning		Nursery/Rearing	Adult Feeding	Overwintering
Trout (gravel sub.)	Whitefish (cobble sub.)			
RF	R2	RF	R1	P1
RF/BG	R2/BG	RF/BG	R2	R1
R3	RF	R1	R2/BG	R2
R3/BG		R2	P1	R2/BG
		R2/BG		
		R3/BG		

APPENDIX V

FISHERIES PHOTOGRAPHS

Photo V-1 Typical Spring Creek Reach 1 Habitat

Photo V-2 Typical Spring Creek Reach 2 Habitat

Photo V-3 Suspected Brook Trout Spawning Redd in Spring Creek

Photo V-4 Typical Habitat in Policeman Creek (Note Foreign Bed Material at Site of Creek Ford)

Photo V-5 **Riprap Bank Armouring along Right Downstream Bank, Approximately 2 km Upstream of the Policeman Creek – Bow River Confluence (not part of Restwell property)**

Photo V-6 **Log Crib Wall Retaining the Right Downstream Bank of Policeman Creek in the Vicinity of a Private Residence (not part of Restwell property)**

Photo V-7 Example of Incorporation of Spring Creek into Residential Landscaping (not part of Restwell property)

Photo V-8 Example of Road Encroachment on Spring Creek, which occurs Inside and Outside the Restwell Boundary (this section is not part of Restwell property)

Photo V-9 Example of Spring Creek Mountain Whitefish Capture Site

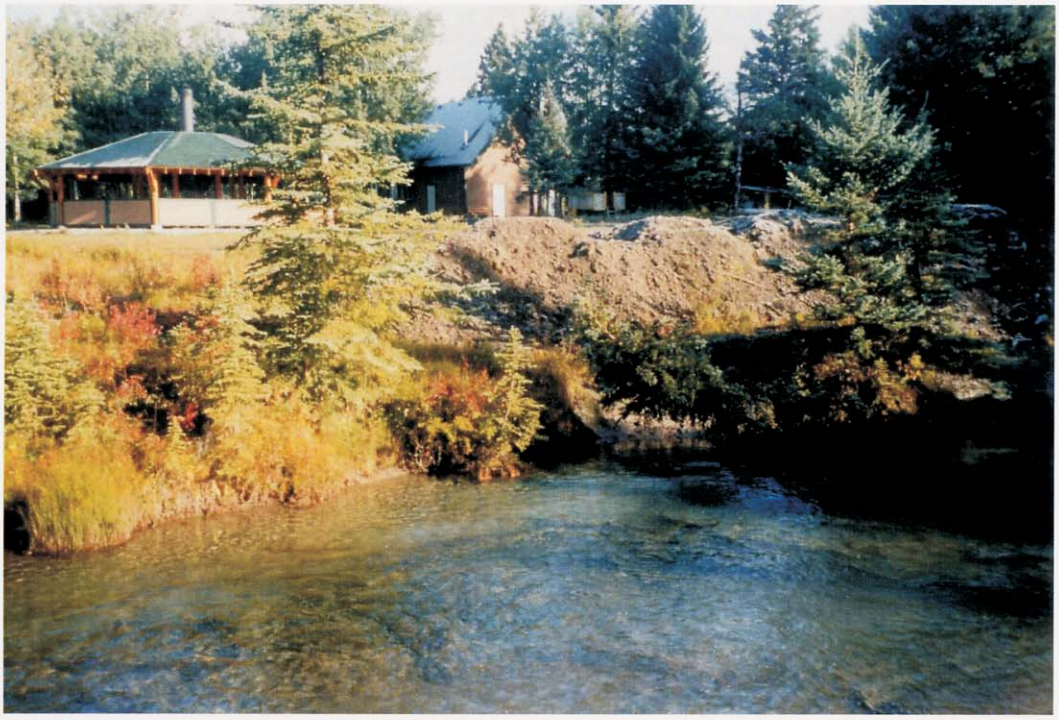


Photo V-10 Exposed Soil Along the Left Downstream Bank of Policeman Creek (not part of Restwell property)