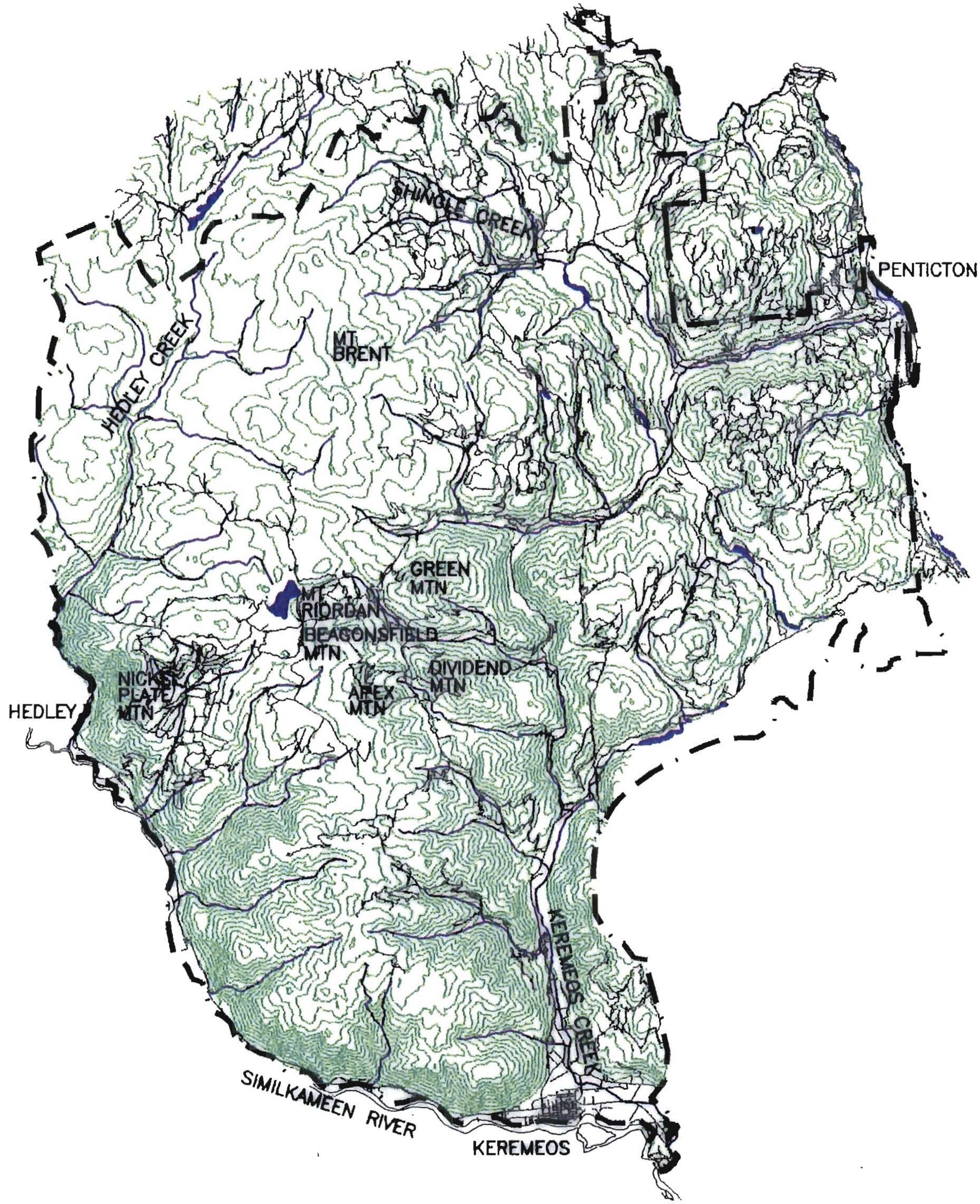
SEVEN PEAKS
ENVIRONMENTAL BASELINE AUDIT



MINISTRY OF ENVIRONMENT LANDS & PARKS
PENTICTON, B.C.

Reid Crowther

IN ECOCAT

SEVEN PEAKS
BASELINE ENVIRONMENTAL
AUDIT

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EXECUTIVE SUMMARY

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EXECUTIVE SUMMARY

Reid Crowther was retained by the Ministry of Environment, Lands and Parks to prepare an environmental baseline audit of the Seven Peaks Area. The purpose of the baseline audit is to provide sufficient information of the study area to allow managers to evaluate future development proposals and to understand the interactions between natural processes and human land uses.

It appears that the Seven Peaks Area is not experiencing the conflicts of urbanization as severely as the Southern Interior as a whole, however, there are special conflicts with the Aboriginal people who have blockaded roads leading to the Apex Mountain Resort over the past several winters. Also, the issues associated with urbanization could change with the completion of Apex Mountain Resort's Master Plan which would more than double the size of the existing facility. The recreational pressures exerted by people from out side of the area are likely to increase rather than decrease in the future. The conflicts between wildlife and agriculture are also not likely to decrease in the future as both land uses compete for valley bottoms and alpine grassland. There is potential for water use and water quality issues to be exacerbated in the future. The fishery resource, although closely managed, is stressed through loss of habitat and declining populations.

Atmospheric Environment

The climate and weather of the Seven Peaks Area varies considerably with elevation. In general, mean daily temperatures decrease with elevation while precipitation increases; particularly with respect to snowfall in the winter months. Air quality information is limited to dustfall, particulates and some ground level ozone. Overall, air quality is generally good. Due to mitigative measures, dustfall does not appear to have increased with the re-opening of the Nickel Plate Mine and the start-up of the Candorado Tailings project.

Geology and Mining

The primary mining interests are for gold, silver, copper, molybdenum and garnet. Exploration and mining has been on-going since before the turn of the century. There are several active sand and gravel pits. The only active mine is the Nickel

Plate Mine near Hedley. Candorado Mines Ltd. runs a gold recovery operation from stockpiled mine tailings along Hedley Creeks and the Similkameen River. Future Mining activity is proposed for Mt. Riordan where a high grade garnet deposit has been identified by Polestar Exploration Inc.

Hydrology

There are four separate hydrological regions within the study area, they include Hedley Creek, Keremeos Creek, Shingle/Shatford Creek and the Marron Valley.

Water use in the Seven Peaks area is approximately two-thirds of the licensed supply. The highest demand is in the Keremeos Valley. The groundwater table appears to recover with each spring freshet. Runoff estimates for the Shatford/Shingle Creek watershed appears questionable as there is a significant volume of water that is unaccounted for. The Marron Valley catchment area produces minimal runoff.

The only major storage reservoir in the area is Nickel Plate Lake. There is limited opportunity for development of additional cost effective reservoir storage due to the lack of suitable sites because of the steep topography.

Water Quality

Generally, the water quality for the Seven Peaks Area meets objectives set by the Ministry of Environment. Parameters not meeting objectives include fecal coliform counts in lower Keremeos Creek and lower Similkameen River, sulphates, nitrates and total dissolved solids have increased in Red Top Gulch Creek and Cahill Creek and some of its tributaries over background levels due to operations at the Nickel Plate Mine and in some cases exceed objectives. Winter sanding appears to be responsible for elevated chloride levels in upper Keremeos Creek (levels do not exceed proposed objectives). Also, nutrients in lower Keremeos Creek increase due to agricultural activities along the creek.

Fisheries

The Similkameen River and the lakes in the study area are by far the most important water bodies in terms of fish production and maintenance of a sport fishery. The lakes depend heavily on stocking programs. Rainbow trout are the most important game fish in the region. Waterbodies in this region are currently near their maximum fish productivity. There are three species of fish known to exist within the study that are registered as rare species with the BC Conservation Data Center.

There are several areas of potential impact to the fisheries of the Seven Peaks area. These include mining, recreation and residential development. Impacts include loss of habitat and degradation of water quality.

Vegetation

The study area contains a range of biogeoclimatic zones from hot dry valleys to near alpine forests. The grassland portion of the area is an uncommon and highly sensitive ecosystem that has suffered from competing land uses. Good information is available for the forest cover aspects of the study area, but much weaker information exists for other aspects such as the grasslands, understorey vegetation and riparian cover. A number of rare and endangered plant species have been identified. Forest harvest in the area have been somewhat restricted in recent years due to uncertain road access but increased harvesting is planned for the future.

Wildlife

The area has long been used by hunters and trappers but perhaps the main wildlife issues relate to the very rare and sensitive dry land ecosystems and microclimatic areas that support a relatively large number of species that are rare in B.C., Canada and the world. These include all classes from invertebrates to mammals. The data base for wildlife populations and habitats is very weak.

Agriculture

Some valuable agricultural land exists in the study area and has been included in the Agriculture Land Reserve. Little information is available regarding the types or extent of farming operations. Grazing permits cover most of the study area and cattle are present almost everywhere, including in riparian habitats and water courses. There is little information regarding impacts of cattle grazing on habitats or native animal species in the study area.

Recreation

The study area contains a small provincial park and a provincial recreation area that contains a large commercial ski hill. There are also many hiking and winter-use trails, a stocked lake and other outdoor recreational opportunities. A small village has developed near the ski hill, and there have been proposals for additional facilities such as golf courses in Keremeos Valley and a high altitude athletes training centre at the ski hill.

Community Activities and Infrastructure

Three Indian Reserves border the study area, and all roads that access the study area go through them. For several years there have been conflicts between reserve residents and non-native users of the roads.

Indians have claimed historical use of most of the study area. Several recent studies have attempted to understand the extent of these uses and have identified hunting areas and traditional campsite locations.

Most of the study area was examined under the Protected Areas Strategy and the northern part was determined to have high value for conservation, recreation and cultural heritage features. This rating provides for stringent evaluation of further proposed land uses.

The Regional District of Okanagan-Similkameen has jurisdiction over zoning. Most of the study area is zoned for a wide range of land uses such as forestry, grazing and residential development.

Monitoring Change

Recommendations have been made regarding the types of environmental parameters that need to be monitored in the future to better evaluate trends and changes occurring in the environment. These parameters are listed under the headings of biodiversity; clean and safe air, land and water; and sustainability.

Under biodiversity the parameters include protecting 12% of the unique and essential ecosystems, assessing species at risk, and key habitats. Under clean water the parameters include a water quality index and groundwater quality. Under sustainability the parameters include water use, land use and compliance with environmental regulations.

SECTION 1.0

INTRODUCTION

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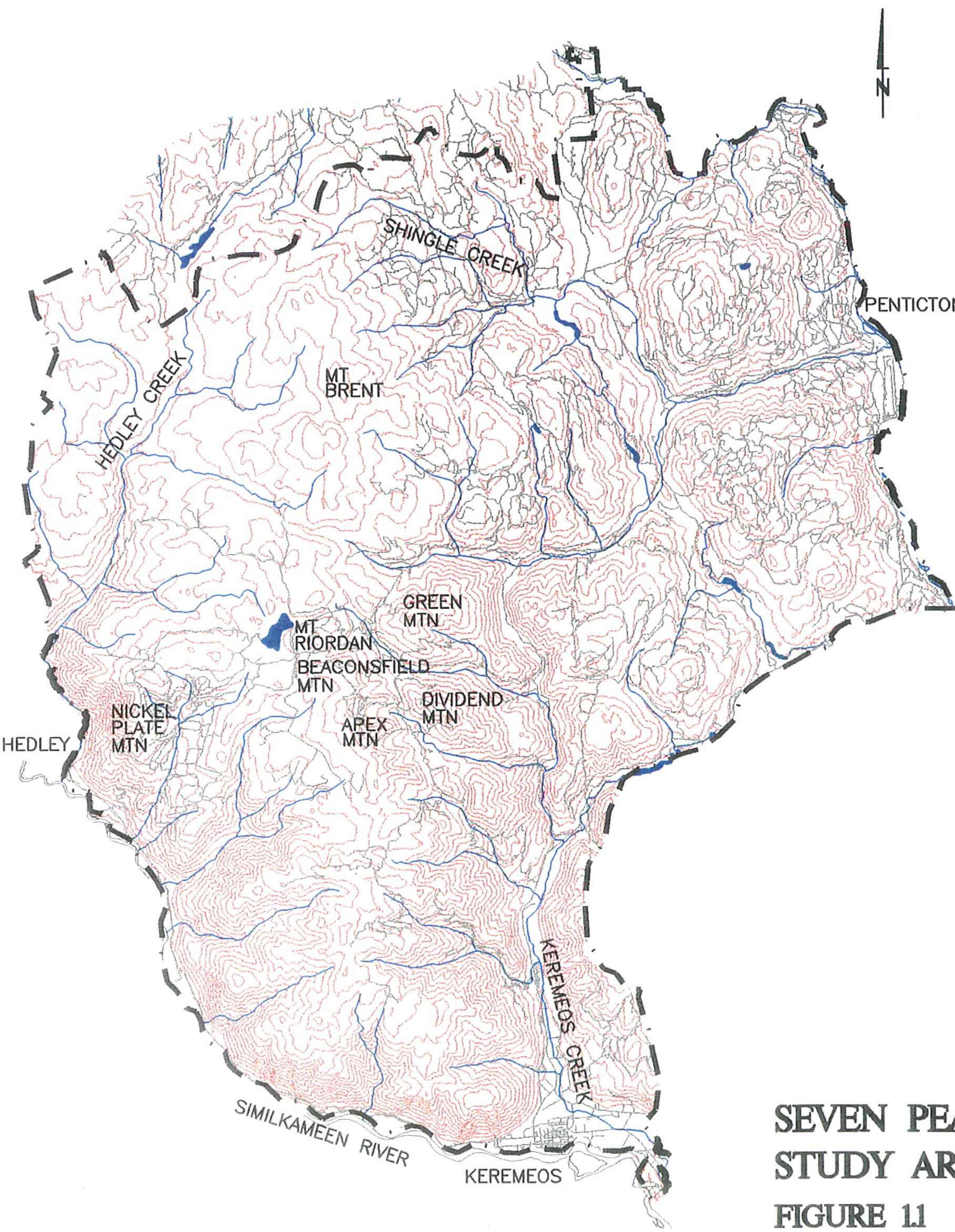
INTRODUCTION

1.1 BACKGROUND

An Initial Agreement was signed on December 14, 1994 between the Province of British Columbia and the Lower Similkameen Indian Band, the Upper Similkameen Indian Band and the Penticton Indian Band of the Okanagan Nation (the "Bands") to address development and environmental concerns in the Seven Peaks Area. The Initial Agreement stated that the parties would work together to undertake several assessments in the Seven Peaks Area. These assessments were to include a baseline environmental audit (EBA) addressing past and existing developments; an assessment of the proposed phases of the Apex Resort Master Plan and all other options under the Land Use Agreement between Apex Resort and the Province dated July 1, 1990; and an assessment of other proposed developments in the study area.

Following the signing of the Initial Agreement several meetings were held by the Ministry of Aboriginal Affairs, the Bands and Reid Crowther to define the terms of reference for the above studies but the actual EBA was not completed within the time frame of the Initial Agreement. These meetings also resulted in preparation of Briefing Notes on the Apex Ski Resort Master Plan (Agra Earth and Environment, 1995).

Subsequent to the termination of the Initial Agreement, Reid Crowther was requested in September 1995 by the Ministry of Environment, Lands and Parks (Ministry of Environment) to undertake an environmental baseline audit of the Seven Peaks Area. The scope of the audit followed the terms of reference that had been developed during the term of the Initial Agreement. However, the three Bands decided not to participate in the study and did not provide information and agree to interviews during the study. Therefore, information relative to the Bands concerns was not available to the study team and could not be incorporated into the results of the audit.



SEVEN PEAKS STUDY AREA

FIGURE 1.1

SCALE 1:250,000

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This audit is a significant departure from typical environmental impact assessments which focus on a specific project at a specific location. It is more similar to a state of the environment report in that it presents baseline information for a relatively large area but unlike the state of the environment report, it is sufficiently focused to be a planning tool.

1.2 PURPOSE

The purpose of this baseline audit is to provide sufficient information and understanding of the study area to allow managers to evaluate specific developments that are proposed in the future and to understand the more gradual effects of natural processes and human land uses.

The audit will provide the database with which to review environmental impact assessment reports of proposed developments such as mines, golf courses, expansion of the existing ski resort, and other significant projects. The audit will allow these specific projects at specific locations to be evaluated and their effects described in the context of the larger study area, something the typical impact assessment can rarely do.

The more difficult environmental conditions to identify are the gradual changes that occur in the study area. These could be caused by natural succession in a plant community where some tree species gradually invade a grassland, a lake or swamp gradually becomes eutrophic and overgrown with emergent vegetation, forest fire suppression results in changes to tree cover, or deer populations follow a natural population cycle.

Other gradual changes in environmental conditions will be caused by human activities. These could include the effects on native vegetation by cattle grazing, conversion of natural vegetation cover to cropland, withdrawal of steam or lake water for irrigation or other purposes, introduction of various pollutants or sediments into streams, a general increase in human activity and consequent disturbance to animal populations, and many other such effects.

In order to understand the effects of both specific projects and gradual changes to the environment, the audit would ideally provide two things: a database of existing conditions, and a history of those conditions so that trends in their values could be understood and projected into the future. This approach would help identify those environmental features that are slowly being degraded, and it would allow an understanding of the cumulative effects that a variety of land uses have had. It would help identify sensitive resources that should be protected, such as specific habitats of the many rare and endangered species that live in this ecoregion. It may identify the rate of change in quantity or quality of some resource before it reaches a critical level. Where standards have been developed for specific environmental parameters, the present and projected values identified in the audit can be compared and evaluated.

The baseline audit will also identify subjects for which inadequate information is available. These are of two types; those for which very little information exists to understand the quantity and quality of the resource, and those for which baseline information exists but not over a sufficiently long period to indicate recent changes or trends in the quantity or quality of it. The study will identify these subjects and will recommend specific parameters for which data should be collected in order to develop an understanding of future trends.

In summary, the overall propose of this study is to collect a database of existing information about the study area and to present historical data to show recent changes or trends in environmental conditions. The significance of these changes can be described and perhaps compared with standards that may exist. Where background information is lacking and trends cannot be developed, specific environmental parameters that could be measured in the future are identified.

1.3 OBJECTIVES

The primary objectives of the baseline audit are the following:

- to map and describe the existing conditions of physical, biological and community features of the study area;
- to identify recent trends in the values of environmental parameters, where data allow, and compare with existing standards; and
- to identify specific parameters that would be useful to monitor to understand changes that may occur in the study area in the future.

1.4 METHODOLOGY

This project was carried out by collecting available information from government and industrial sources, libraries, archives and from interviews with people knowledgeable with natural resources and land use in the area. A number of tables (and statistics) and simplified GIS resource maps were prepared by the Ministry of Environment in Penticton to describe the existing condition of the resources. Several tours of the Seven Peaks area were carried out to familiarize the project team with the geographic/environmental setting and the major developments of the area. The Nickel Plate Mine and Apex Ski Resort were toured to familiarize the project team with these facilities and to get a better understanding of their operations.

Some of the data used in this report were in the Ministry of Environment's GIS and initial analyses of that data were begun. Other information developed from various sources during this project is provided for inclusion in the GIS. Once those data are included, additional analyses will be possible. These have been recommended in this report. Eventually macro programs can be prepared so that the GIS analyses can be carried out on regularly updated databases and both existing conditions and trend projections displayed.

1.5 ENVIRONMENTAL SETTING

The Study Area is located in the Southern Interior ecoprovince and covers and area that is approximately 50 km east to west and 60 kms north to south. It is dominated by the seven peaks known as Apex, Beaconsfield, Dividend, Brent, Nickel Plate and Green Mountains and Mount Riordan (Figure 1.1). It is bordered on the east by Penticton and Highway 3A which runs south to Keremeos and on the west by Hedley and Highway 3 which runs south-east to Keremeos. The main water bodies consist of Nickel Plate Lake, Yellow Lake, Similkameen River, Hedley Creek, Keremeos Creek, Shingle Creek and Shatford Creek. Forestry, mining, ranching and recreation are the primary industries influencing land use and settlement patterns.

In addition to the Provincial Highways the Study Area is bisected by roads from Penticton to Hedley which is itself bisected to join Highway 3A north of Keremeos. The interior roads include Green Mountain Road which runs between Penticton to Highway 3A north of Keremeos, Apex Road which intersects Green Mountain Road and runs to the ski resort and Hedley Nickel Plate Road which runs form the ski resort past the Nickel Plate mine and down to Hedley.

The Southern Interior is the most densely populated interior region of the province making up 11% (over 380,000 people) of the total population. It has experienced a 45% increase in population over the past 20 years and 2.5% increase between 1986 and 1991. The Okanagan River Basin is heavily influenced by forestry, agriculture (particularly fruit crop production and cattle ranching), and mining, tourism, construction, high-tech services and considerable manufacturing. In addition to the industrial and commercial base the area supports important sports fishing, seasonal game hunting and a wide range of recreational activities.

Urbanization is in direct conflict with agriculture throughout the Southern Interior and overall the amount of farmland declined by close to 200,000 hectares or 26% between 1971 and 1986. This conflict is of provincial significance because less than 5% of the total land base of the province is suitable for agricultural purposes. The land use conflicts in the Seven Peaks Area are less severe at this time, however, as the Apex Mountain Resort completes its Master Plan and other recreation oriented development proposals are constructed these conflicts will increase. The area is serviced by an excellent road system and the lure of skiing, hiking, wildlife viewing, fishing and hunting is attracting people from outside the area. The population centres in the Lower Mainland and even Alberta are exerting recreational pressure on this area.

In addition to the direct land use conflicts between urbanization and agriculture both bring significant environmental issues. Urbanization brings with it the threat of air pollution from automobiles and wood smoke from stoves and fire places as well as sewage and solid wastes. Agriculture brings with it water demands for irrigation and potentially contaminated runoff from field and orchards treated with fertilizers and pesticides.

Over half (58%) of the threatened and endangered species and 14% of the vulnerable species in BC are found in this ecoprovince. The greatest pressure facing wildlife in this ecoprovince is directed at those species which require valley habitat, the lands which receive the greatest pressure from urbanization. The conflicts in land use are not likely to decrease as valley bottoms (primary wildlife habitat) represents less than 1% of the total ecoprovince. Wetlands now comprise less than 15% of their original area in the southern Okanagan and their loss is particularly noticeable in the lower Keremeos Creek. Less than 9% of the ecoprovince is undisturbed.

There are significant issues with both water quantity and water quality that may be exacerbated in the future. Water shortages have been a major concern in recent years and may become more acute in the future. Water quality is already a significant concern in a number of lakes (Okanagan, Skaha) in the region and could have impacts on fisheries, wildlife and future recreation potential. Degradation of fish habitat and declines in fish populations have been noted in several river systems. Despite stocking programs, the density of rainbow trout in the Similkameen River has declined over the past decade.

The intent of the Protected Areas Strategy is more complicated than simply protecting 12% of the province. It is designed to protect all major ecosystems and most unique characteristics in each ecoprovince. The purpose is to satisfy cultural and recreational needs, and environmental goals to protect essential ecological processes, biological diversity and promote the sustainable use of the natural environment (MOE, 1993). Only 2% of the Southern Interior ecoprovince has been protected compared to approximately 9% on average for the province as a whole. The management of the Seven Peaks Area must ensure, wherever possible, the protection of cultural and ecologically unique features that are not found in other regions of the province.

SECTION 2.0

ATMOSPHERIC ENVIRONMENT

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SECTION 2.0
ATMOSPHERIC ENVIRONMENT

2.1 CLIMATE AND WEATHER OF STUDY AREA

The Seven Peaks study area is located approximately 200 km inland from the Pacific Coast within the Interior Plateau climate regime of British Columbia. To the west of the area are the Coast Mountains which effectively serve to block weather systems from the Pacific Ocean carrying precipitation eastward. Consequently, air reaching the Seven Peaks area contains less water vapour than coastal air and a corresponding reduction in precipitation is noticeable, especially over the winter months. Summers, as in most parts of B.C. tend to be warm and dry while winters, albeit dryer, tend to be cooler than they are along the Coast. (Chilton, 1981)

Notwithstanding the above generalization, the complex terrain of the study area makes it impossible to describe its weather based simply on global air flow patterns. Because mountains modify surface atmospheric pressure patterns significantly different weather can be experienced at high and low elevations.

2.1.1 Monitoring Stations

Weather monitoring stations are located within or adjacent to the study area at both high and low. The lower elevation stations are located in or near the major population centres which are located near the study area borders. Higher elevation weather monitoring stations are located at the Nickel Plate Mine, Apex Lodge and Mt. Kobau (located southeast of the study area). Data from the Apex Lodge station is limited and therefore must be interpreted with caution. Mt. Kobau, although not actually located within the study area, has been included because it is representative of the weather experienced at higher elevations.

2.1.2 Temperature

Table 2.1 shows the available maximum and minimum daily temperature extremes recorded at multi-year weather stations within or bordering the study area. Table 2.2 shows the mean daily temperature normals. All data has been collected by Environment Canada's Atmospheric Environment Service and is representative of the time period for which the corresponding weather station has been in operation.

Table 2.1 Mean Daily Maximum/Minimum Temperature (°C)

STATION	ELEV (M)		J	F	M	A	M	J	J	A	S	O	N	D
Penticton	344	Max	0.7	4.4	9.9	15.4	20.4	25.0	28.2	27.6	21.7	14.5	6.5	1.4
		Min	-4.8	-3.0	-1.0	2.0	6.1	10.1	12.3	12.1	7.6	2.8	-0.3	-3.7
Keremeos	430	Max	-0.3	4.9	10.0	16.1	21.1	24.7	29.0	28.0	23.0	15.2	6.3	1.4
		Min	-6.5	-3.0	-0.2	3.9	8.2	11.8	14.2	13.8	9.7	4.2	-0.8	-4.3
Hedley	518	Max	-0.8	4.0	10.2	15.5	20.3	24.3	28.2	27.8	22.2	14.4	5.1	-0.5
		Min	-8.0	-5.1	-1.8	1.5	5.4	9.2	11.3	11.1	6.8	1.8	-2.5	-6.8
N. Plate Mine	1768	Max	-3.6	-0.9	1.3	5.9	11.8	16.2	19.8	18.7	14.1	8.7	1.5	-1.2
		Min	-12.3	-8.9	-8.8	-4.8	-0.7	2.3	5.5	4.6	1.8	-2.1	-7.9	-10.0
Apex Lodge	1890	Max	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Mt. Kobau	1862	Max	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table 2.2 Mean Daily Temperature Normals (°C)

STATION	PERIOD	ELEV (M)	J	F	M	A	M	J	J	A	S	O	N	D
Penticton	1941-1990	344	-2.0	0.7	4.5	8.7	13.3	17.6	20.3	19.9	14.7	8.7	3.2	-1.1
Keremeos	1951-1980	430	-3.4	1.0	5.0	10.0	14.7	18.2	21.6	20.9	16.4	9.7	2.8	-1.5
Hedley	1904-1990	518	-4.3	-0.5	4.2	8.5	12.9	16.8	19.8	19.5	14.5	8.1	1.3	-3.6
N. Plate Mine	1961-1990	1768	-8.0	-4.8	-3.7	0.5	5.5	9.3	12.6	11.7	8.0	3.3	-3.2	-5.5
Apex Lodge		1890	-7.6	-6.1	3.8	4.8	3.1	6.5	11.6	11.9	6.4	3.3	Miss	-9.0
Mt. Kobau		1862	-8.5	-6.0	-5.5	-1.3	4.4	8.2	12.2	12.1	7.8	2.2	-4.6	-7.6

Figure 2.1 graphically displays the mean daily temperature extremes for each station throughout the year given in Table 2.1. Through the months November to February, daily temperature variations are small compared to the months March through October. The temperature at the higher elevation station at Nickel Plate Mine does not fluctuate to the same degree as at the lower elevation stations.

Figure 2.1 Mean Daily Maximum/Minimum Temperatures °C

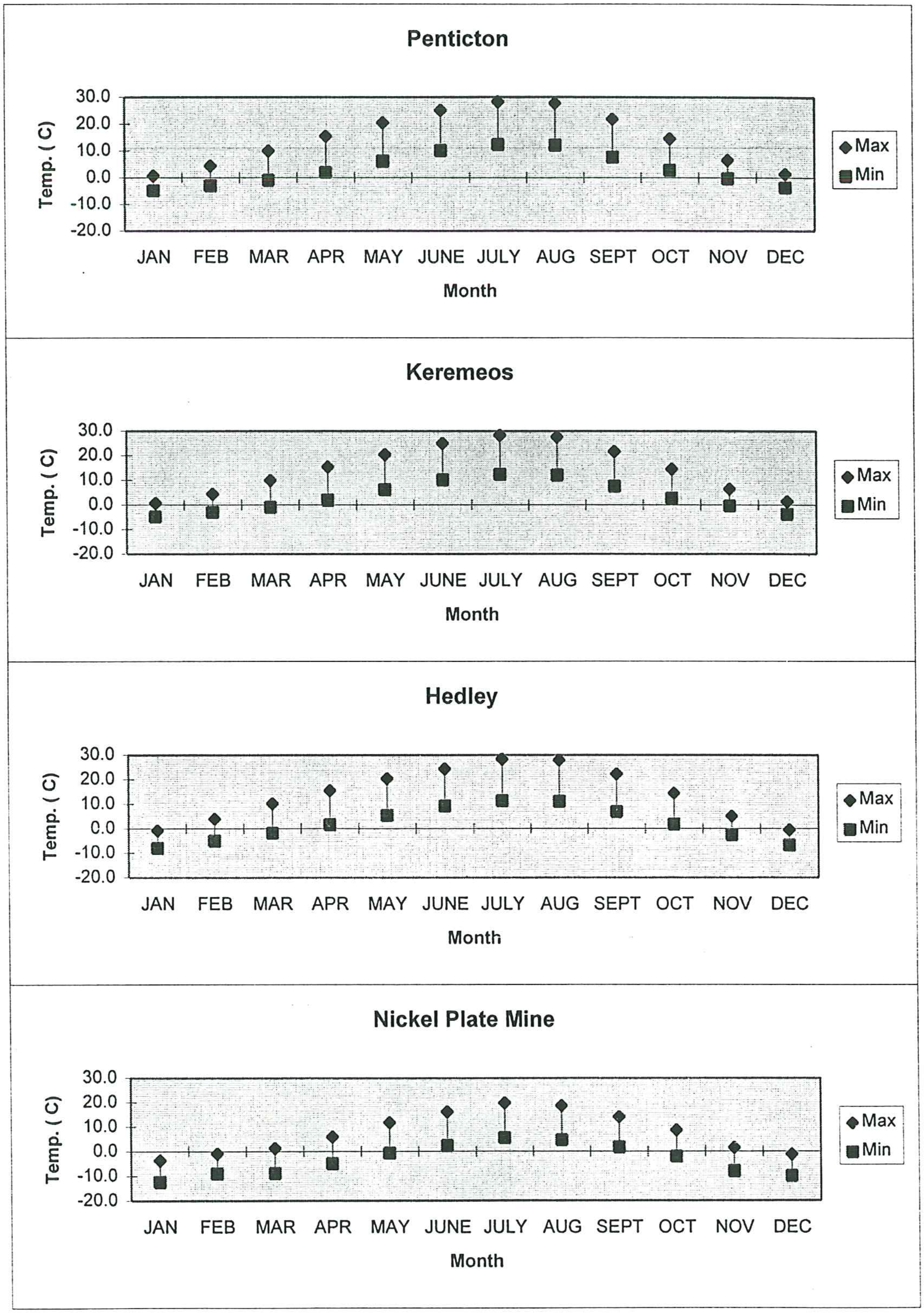
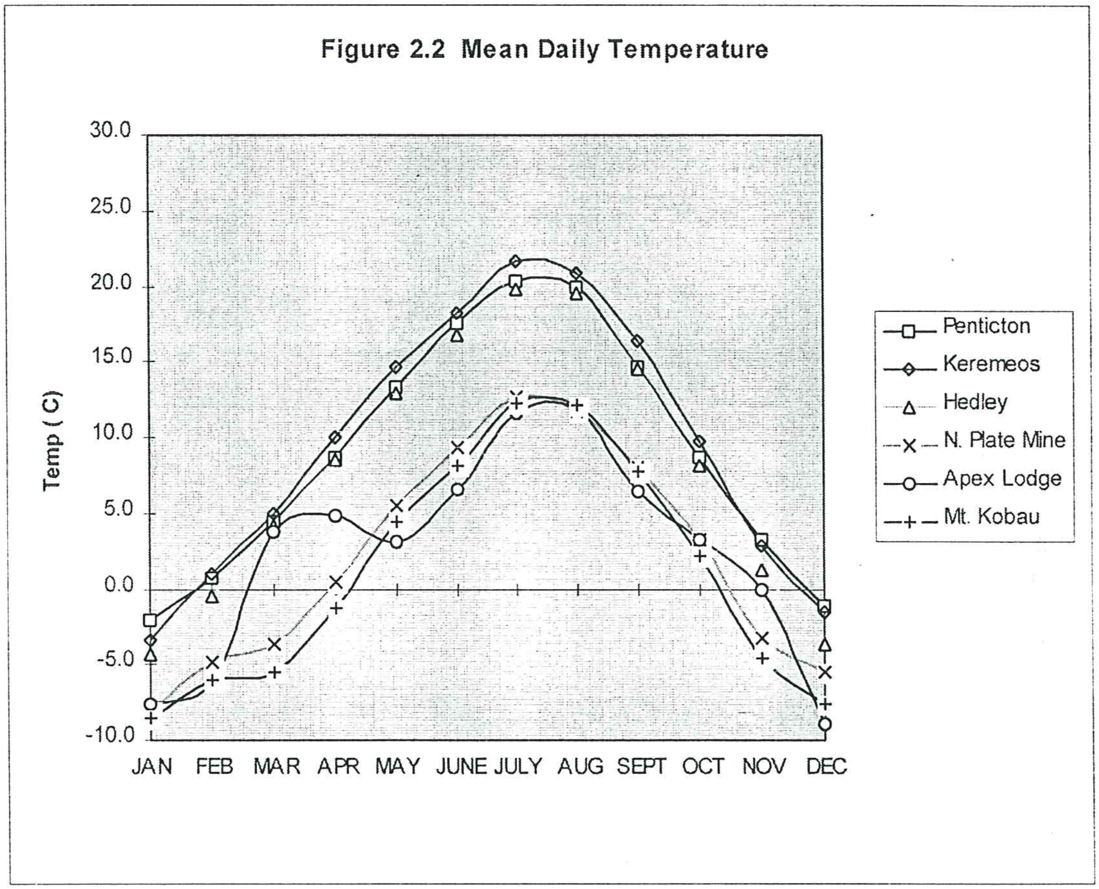


Figure 2.2 graphically displays the mean daily temperature data from Table 2.2. As would be expected, average temperatures throughout the year are typically lower as elevations increase. On a year round basis, Keremeos is consistently the warmest station while Mt. Kobau and Apex Lodge are the coolest. Temperatures at all stations peak in July and August and drop to their lowest in December and January.

Figure 2.2 Mean Daily Temperature



2.1.3 Precipitation

Tables 2.3, 2.4 and 2.5 show the mean daily precipitation as rainfall, snowfall and total precipitation respectively. The tables compare the data from several monitoring locations with the climate normals based on the mean of the multi-year monitoring data for each station.

It can be seen from Figure 2.3 that rainfall in the Seven Peaks study area is highest during the months May through September. The higher elevations stations receive slightly more precipitation as rain than the lower elevations stations through the middle of the year while the opposite is true at the end and beginning of each year.

Table 2.3 Precipitation As Rainfall (mm)

STATION	J	F	M	A	M	J	J	A	S	O	N	D	Total
Penticton	8.3	12.0	17.3	25.5	33.0	34.4	23.3	28.4	23.0	15.5	17.6	11.8	250.1
Keremeos	8.9	8.1	9.5	14.1	20.6	27.1	20.3	22.2	12.8	10.6	12.2	11.6	178.0
Hedley	7.5	7.1	15.0	25.6	33.8	38.3	33.6	33.6	23.5	17.3	17.5	7.2	260.0
N. Plate Mine	1.0	0.5	0.8	2.3	35.6	61.2	38.3	34.3	21.8	15.0	3.3	0.2	214.3
Apex Lodge	0.0	0.0	0.0	0.0	-	38.1	41.4	38.9	28.8	21.0	0.0	0.0	168.2
Mt. Kobau	8.9	-	10.9	6.2	29.8	39.7	31.3	39.9	21.6	8.3	7.2	-	203.8

Figure 2.3 Precipitation as Rainfall

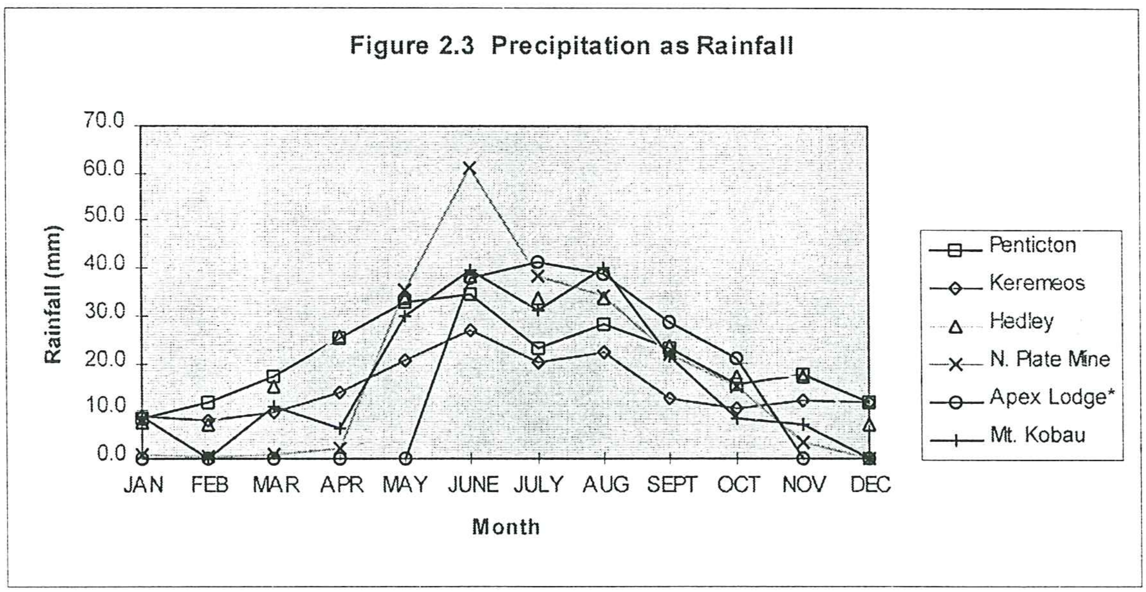
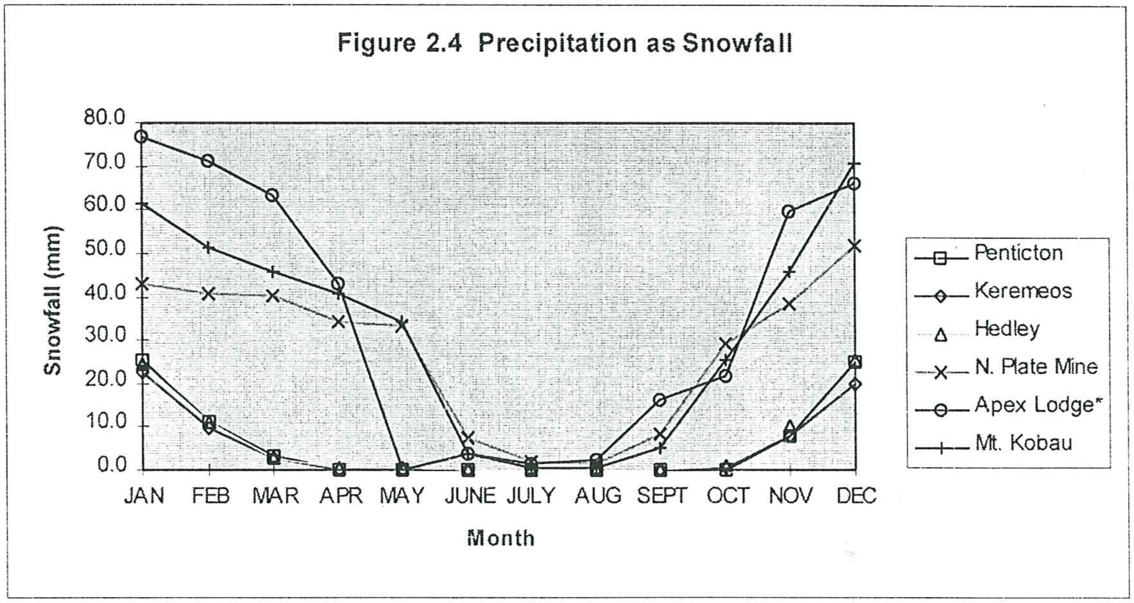


Figure 2.4 illustrates that during the months October through May precipitation as snowfall is high in the mountains with the most snow falling in December and January. In the valleys the majority of the snowfall occurs during the months November through March.

Table 2.4 Precipitation As Snowfall (Water Equivalent - mm)

STATION	J	F	M	A	M	J	J	A	S	O	N	D	Total
Penticton	25.5	11.0	3.3	0.2	0.0	0.0	0.0	0.0	0.0	0.2	7.8	25.2	73.2
Keremeos	22.8	9.7	3.0	0.2	0.0	0.0	0.0	0.0	0.0	0.4	8.0	20.0	64.1
Hedley	24.4	10.9	3.0	0.4	0.3	0.0	0.0	0.0	0.07	0.9	10.4	25.5	75.9
N. Plate Mine	43.2	40.9	40.1	34.3	33.3	7.6	2.0	1.3	8.1	29.2	38.6	51.6	330.2
Apex Lodge	76.9	71.1	63.5	43.2		3.6	1.3	2.5	16.1	21.6	59.7	66.1	-
Mt. Kobau	61.6	-	45.6	40.8	34.2	3.7	0.6	0.6	5.0	25.6	45.6	70.7	-

Figure 2.4 Precipitation as Snowfall

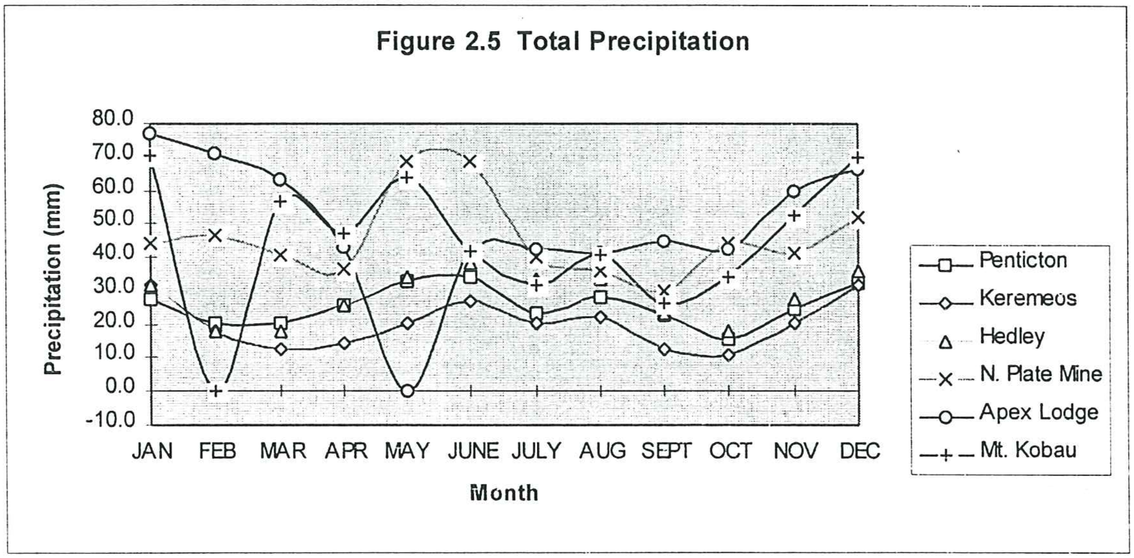


Total precipitation can be seen in Figure 2.5 to follow generally the same pattern regardless of elevations throughout the year. However, it is clear that significantly more precipitation falls in the mountains as opposed to the valleys in any given month of the year.

Table 2.5 Total Precipitation (mm)

STATION	J	F	M	A	M	J	J	A	S	O	N	D	Total
Penticton	27.3	20.6	20.4	25.8	33.0	34.4	23.3	28.4	23.0	15.7	24.3	32.1	308.3
Keremeos	31.7	17.8	12.4	14.3	20.6	27.1	20.3	22.2	12.8	11.0	20.1	32.0	242.3
Hedley	31.9	18.1	18.0	26.0	34.1	38.3	33.6	33.6	23.5	18.2	27.8	36.0	339.1
N. Plate Mine	44.2	46.5	40.9	36.6	68.8	68.8	39.9	35.6	30.0	44.2	41.4	51.8	548.7
Apex Lodge	76.9	71.1	63.5	43.2	-	41.7	42.7	41.4	44.9	42.6	59.7	66.1	-
Mt. Kobau	70.5	-	56.5	47.0	69.0	41.6	31.9	40.5	26.6	33.9	52.8	70.1	-

Figure 2.5 Total Precipitation



2.2 AIR QUALITY

Available information on the air quality of the Seven Peaks study area is very limited. Generally, air quality monitoring has been carried out in the past to assess existing or potential future impacts of industrial development and in most cases, has been limited to concerns related to particulate and dust fall.

The Nickel Plate Mine and Candorado Tailings Recovery Operations represent the two major operating emission sources in the study area and as such are the only two industrial operations with Ministry of Environment permits to discharge contaminants under the Waste Management Act. Other existing sources of air pollution in the area are predominantly related to transportation and space heating activity. Consistent with the existing sources, there are concerns in the area, particularly with the operators of the Apex Ski Resort, over additional dust and particulate emissions associated with the proposed Crystal Peak garnet quarry development.

2.2.1 Monitoring Stations

Monitoring of air quality parameters in or near the study area can only be described as intermittent at best. Parameters monitored have been limited to dustfall, particulate and ozone with monitoring stations located in or near Penticton, Hedley and Mt. Riordan. With the exception of the National Air Pollution Survey (NAPS) station in Penticton, air monitoring programs in the study area have usually been carried out as a component of a much larger environmental assessment or monitoring program associated with a particular industrial development or as part of a public sector research program. Past industrial programs include baseline dustfall monitoring carried out by Mascot Gold Mines Ltd., Candorado Mines Ltd., and Polestar Exploration Inc. as components of Stage I submissions to the Ministry of Environment. Monitoring for particulate and ozone in Penticton was conducted as part of a Children's Health Study carried out by Health Canada and the Harvard School of Public Health in 1988-1989. The results of both the industrial and public sector monitoring programs will be discussed in detail in the sections that follow.

2.2.2 Industrial Monitoring

<u>Nickel Plate Mine</u>

Homestake Canada Inc. the current owner/operator of the Nickel Plate Mine has been issued Waste Discharge Permit PA07612(02) by the Ministry of Environment for a variety of air contaminants as summarized in Table 2.6.

Table 2.6 Nickel Plate Mine - Authorized Discharges

Source	Contaminant	Disch. Rate (m^3/min)	Hrs per Days	Days per Week	Conc. mg/m^3
• Ore crushing and screening	particulate	630	24	7	115
• Reverbatory furnace	particulate	250	12	5	230
• Reverbatory furnace	sulfur dioxide	250	12	5	250ppm
• Lime Silo	particulate	42	2	7	115
• Cyanide mixing tank	hydrogen cyanide	25	24	7	100
• Cyanide holding tank	hydrogen cyanide	25	24	7	100
• Laboratory bucking room	particulate	113	24	7	115
• Laboratory fume hoods	particulate	62	24	7	115
• Standby diesel generator	typical diesel exhaust	83	24	0.25	typ
• Laboratory fusion furnaces	particulate	130	24	7	115
• Laboratory fusion furnaces	hydrogen cyanide	100	24	7	100

Prior to reopening the mine in 1987, Mascot carried out a dust fall sampling program between May and September 1985. The two selected monitoring points are referred to as the Exploration Camp area and the Bulldog Portal area. In each area, dustfall collections were set out for one month periods and then analyzed. The results of the analysis are given in Table 2.7. (Mascot, 1985)

Table 2.7 Nickel Plate Mine Baseline Dustfall

SAMPLE COLLECTION PERIOD											
Parameter	May 7-June 7/85		June 7-July 7/85		July-Aug 7/85		Aug 7-Sept 7/85		BC Pollution Control Objective		
	Camp	Bulldog	Camp	Bulldog	Camp	Bulldog	Camp	Bulldog	A*	B**	C***
Total Dustfall $mg/dm^2/day$	0.30	0.48	2.19	0.80	3.03	1.17	1.98	7.36	1.75	2.90`	

* Maximum desirable level ($mg/dm^2/day$)

** Maximum acceptable level ($mg/dm^2/day$)

*** Maximum tolerable level ($mg/dm^2/day$)

The results of the 1985 baseline dustfall monitoring study indicate that before the mine reopened, dustfall at the Camp site already exceeded the federal "Maximum Desirable Level" (1.75 mg/dm^2/day) three of the four months for which monitoring occurred. It was however below the "Maximum Acceptable Level" (2.90 mg/dm^2/day). Monitoring of particulate, rather than dustfall, is required under the Waste Management Permit issued to Homestake Canada Inc. by the Ministry of Environment.

<u>Candorado Heap Leach Recovery Operations</u>

Candorado Mines Ltd. currently holds the Ministry of Environment issued Waste Discharge Permit PA-7893 and is authorized to discharge contaminants to the atmosphere from a laboratory stack as summarized in Table 2.8.

Table 2.8 Candorado Mines Ltd - Authorized Discharges

Contaminant	Avg. daily conc. based on the daily operating period	Maximum Concentration	Duration	Frequency
Total particulates	<0.01 ppm	<0.01 ppm	1 hour	twice/day
Lead	<0.01 ppm	<0.01 ppm	1 hour	twice/day
Arsenic	<0.01 ppm	<0.01 ppm	1 hour	twice/day
Carbon Dioxide	1%	1%	4 hours	sporadic
Hydrochloric Acid	<0.01 ppm	<0.01 ppm	4 hours	sporadic
Nitric Acid	<0.01 ppm	<0.01 ppm	4 hours	sporadic

As a component of a Stage I submission to the Ministry of Environment, Candorado Mines Ltd. carried out dustfall monitoring in July 1987 to establish the baseline air quality at the site. Because extreme dust problems, particularly with the "new" tailings pile had been experienced in the past, a dustfall collector was located on the flank of the "new" pile to obtain a true impression of the degree of the existing dust problem. A second collector was located in a cemetery downwind of the processing site. The results of the baseline and follow-up sampling programs are summarized in Table 2.9. (Candorado 1987 and BC Environment 1994)

Table 2.9 Candorado Mines Baseline Dustfall

Sample Collection Period	Total Dustfall mg/dm²/day		BC Pollution Control Objective		
	New Tailings Pile	Cemetery	A*	B**	C***
July 15 to Aug 15, 1987	235.0	2.067	1.75	2.90	--
May 19 to Aug 26, 1993	1.921	1.377	1.75	2.90	--
Aug 26 to Sept 24, 1993	1.649	1.582	1.75	2.90	--
Sept 24 to Oct 19, 1993	0.855	0.542	1.75	2.90	--
Oct 29 to Dec 16, 1993	0.287	0.047	1.75	2.90	--
Dec 16 to Jan 18, 1994	1.089	0.048	1.75	2.90	--

* Maximum desirable level ($mg/dm^2/day$)

** Maximum acceptable level ($mg/dm^2/day$)

*** Maximum tolerable level ($mg/dm^2/day$)

Dustfall monitoring carried out by Candorado Mines Ltd. since operation began indicate that mitigative measures put in place to control dust in the area have in fact resulted in an improved atmospheric environment with respect to dust from what previously existed.

Crystal Peak Garnet Mine

In the 1991 Stage I Report for the Crystal Peak Garnet Project as submitted to the Ministry of Environment by Polestar Exploration Inc., dustfall and noise were identified and addressed as air quality concerns associated with the proposed development. To provide baseline dustfall data, two sites in the plant area were monitored for two two-week periods between July 25 and September 5, 1990. The results of this sampling program are shown in Table 2.10. (Polestar, 1991)

Table 2.10 Crystal Peak Garnet Mine Baseline Dustfall

Parameter	Sample Collection Period				BC Pollution Control Objective		
	July 25 - Aug 8, 1990		Aug 22 - Sept. 5, 1990		A*	B**	C***
	Site A	Site B	Site A	Site B			
Total Dustfall mg/dm²/day	22.73	3.82	1.56	2.49	1.75	2.90	--

* Maximum desirable level ($mg/dm^2/day$)

** Maximum acceptable level ($mg/dm^2/day$)

*** Maximum tolerable level ($mg/dm^2/day$)

Baseline dustfall levels are already high in the area of the proposed development due to existing traffic associated with the Nickel Plate Mine and Apex Ski Resort. Additional traffic would result in increased dustfall however, it is not expected to increase significantly (Karasiuk, 1990). Other dust producing activities such as blasting and processing raw product will generate some dust, but the nature of the material (i.e. it is heavy relative to other minerals) is that it generally settles out of the atmosphere quickly and close to the source (Polestar, 1991). Notwithstanding the assurances provided by Polestar with respect to minimal anticipated dustfall impacts, the operators of the Apex Ski Resort maintain concerns that garnet dust from the Crystal Park project could impact upon ski conditions.

Noise associated with blasting on Mount Riordan has been measured during test blasts in the quarry area in November 1990. The tests were conducted under a "worst case" scenario with low cloud cover and winds gusting at about 20 km/hr. During the test blasts, noise level readings of 112 and 110 dB were recorded at two monitoring points. However, background wind noise alone was registering similar levels as the noise from the test blasts could not be discerned as it was overpowered by the wind (Polestar, 1991). If blasting noise is a problem when the mine becomes operational, mitigative measures could be employed to minimize any impact on receptors.

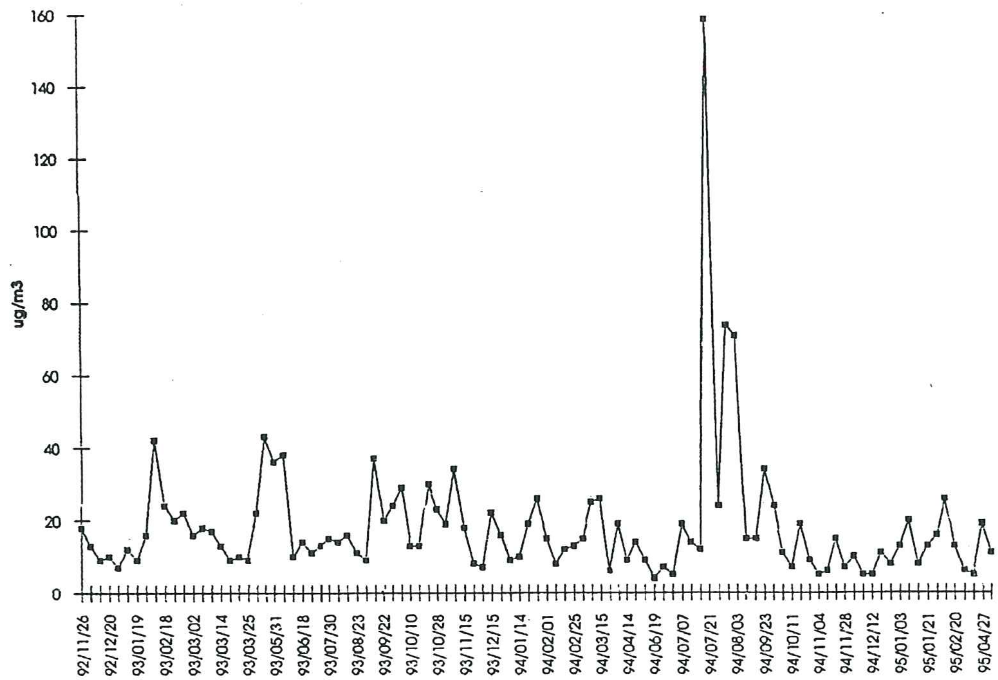
2.2.3 Government Monitoring

Penticton has been the site of a National Air Pollution Survey (NAPS) monitoring station for Total Suspended Particulates (TSP) since the early 1970's. TSP includes airborne particles in the 0.1 to 100 um size range. Particulate sources in the atmosphere can be both naturally occurring and anthropogenic. Examples include residential wood heaters, combustion of fossil fuels, mining, slash burning, forest fires and pollen. Particulate related environmental impacts can range from aesthetic issues, such as impaired visibility, to human health issues usually associated with respiratory illnesses. (Richardson, 1991)

The health implications of particulate in the atmosphere is related to the size of the particles. Generally, the more serious respiratory difficulties are associated with particles smaller than 10 um measured as PM10. Figure 2.6 shows that from

November 1992 to May 1995, PM10 levels have been consistently below the Ministry of Environment provincial air quality objective of 50 ug/m^3 (24 hour). The only exception was a three month period in the summer of 1994 during the Garnet forest fire when PM10 levels reached levels exceeding 150 ug/m^3 (MOE, 1995).

Figure 2.6 PM10 Levels - Penticton, 1992 - 1995



In 1988-1989, as part of a Children's Health Study which was conducted by Health Canada and the Harvard School of Public Health ambient, air quality testing for particulate and ozone was carried out in Penticton. The particulate results were consistent with NAPS monitoring data, with mean PM10 concentrations of 19.8 ug/m^3 and maximum concentrations of 44 ug/m^3 (Bryan, personal communication). The results of the ozone monitoring are given in Table 2.11 along with the corresponding B.C. Pollution Control Objectives for ozone.

Table 2.11 Ozone Measurement Data - Penticton, 1988-1989

Parameter	Mean (ug/m^3)	Max (ug/m^3)	B.C. Pollution Control Objective (Mg/m^3)		
			A*	B**	C***
Ozone 8 hr av g	28.7	50			
Ozone 24 hr av g	21.5	40			
Ozone max 1 hr	33.5	55	100	160	300

* Maximum desirable level ($mg/dm^2/day$)

** Maximum acceptable level ($mg/dm^2/day$)

*** Maximum tolerable level ($mg/dm^2/day$)

2.2.4 Discussion

The air quality in the valleys of the Seven Peaks area is susceptible to impacts associated with emissions from the various activities and developments that have and will continue to occur. Dustfall associated with traffic traveling to and from recreational and industrial areas as well as activities associated with mining and mineral processing stands out as the primary emission of concern and as such, is the most commonly monitored air quality parameter in the area. However, it does not appear that dustfall levels have increased since the re-opening of the Nickel Plate Mine or the start up of the Candorado Heap Leach Recovery project. This is likely due to the fact that mitigative measures to control dust, in the areas of these developments have been successful.

Air quality in Penticton appears to be good with respect to particulate and ozone. Based on data from the NAPS station and the 1988-1989 Health Canada study, these parameters were measured to be within recognized ambient air quality standards.

Although no monitoring data exists for the upper elevations in the study area, it is reasonable to assume that local emission sources would not impact upon the air quality. The higher elevations would however experience some impact due to regional and long range transport of pollutants but such impact would be minimal and it would therefore be reasonable to assume the existence of only background concentrations of pollutants.

SECTION 3.0

GEOLOGY AND SOILS

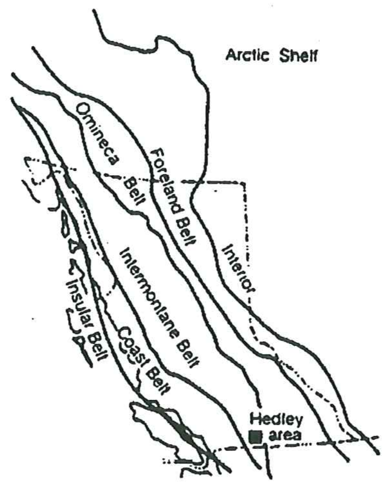
Reid Crowther

SECTION 3.0
GEOLOGY AND MINING

3.1 GENERAL GEOLOGICAL SETTING

The Seven Peaks Area is located at the southern tip of the Intermontane Belt of the Canadian Cordillera. The Intermontane Belt is located between the Coast Belt and the Omineca Belt as shown in Figure 3.1. (Legun et al, 1990)

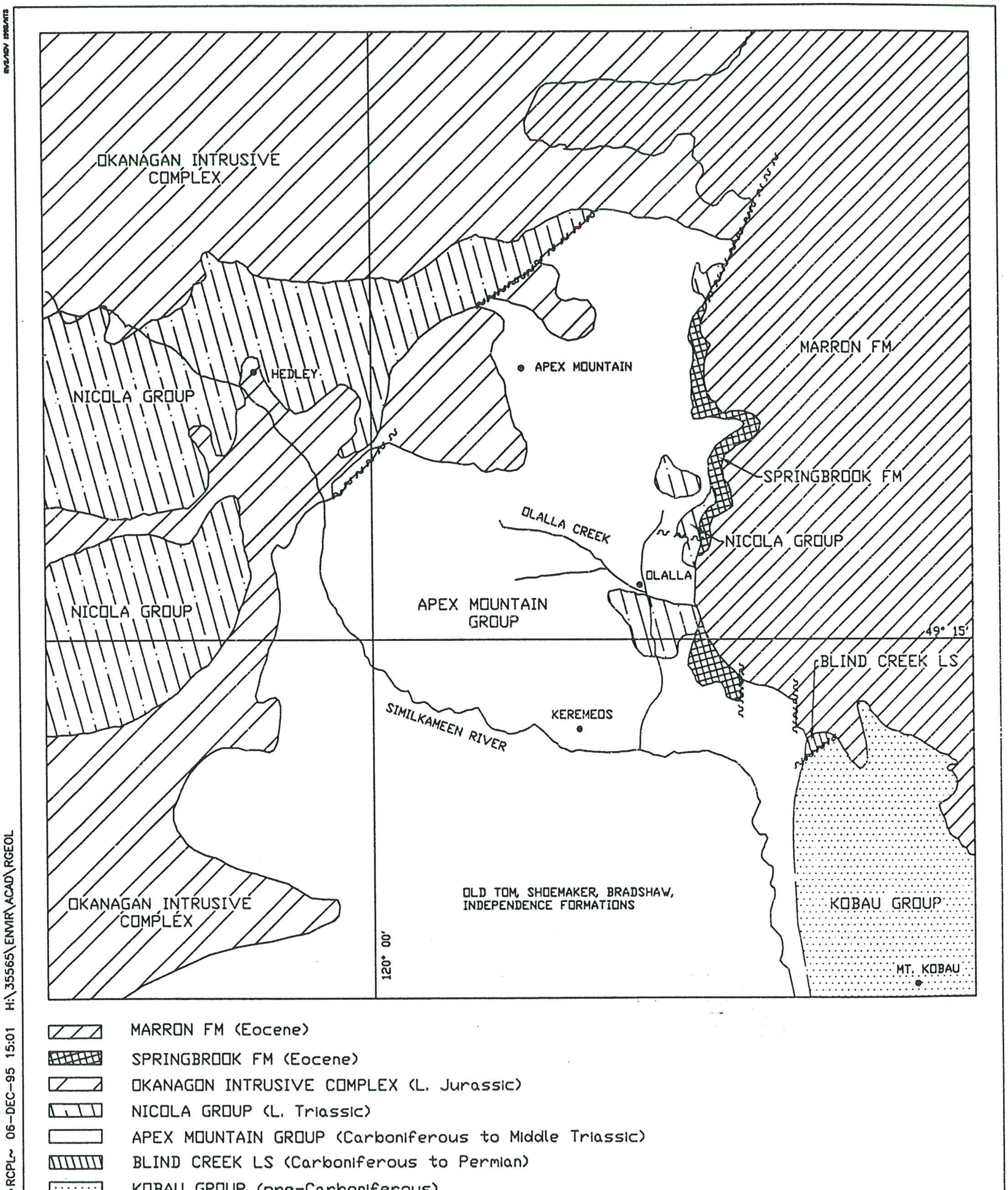
Figure 3.1. Canadian Cordillera



3.2 GEOLOGY OF STUDY AREA

The regional geology of the Seven Peaks Area as described by J.C. Milford in 1984, is comprised primarily of the rocks of the centrally located Apex Mountain Group. To the north, the study area is intruded by the Upper Jurassic granodiorite of the Okanagan Intrusive Complex. To the northwest, the Upper Triassic sediments of the Nicola Group intrude the rocks of the Apex Mountain Group, and to the east, intrusions are by the nearly flat lying Eocene conglomerate and volcanic units of the Springbrook and Marron formations. Figure 3.2 graphically summarizes the general geological setting of the study area as described above (Milford, 1984).

FIGURE 3.2 REGIONAL GEOLOGY OF STUDY AREA
(FROM MILFORD, 1984)



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Reid Crowther

3.3 MINERAL OCCURRENCES

Church (1995) has mapped the high priority areas of mineral potential (mineral assessment tracts) for the Okanagan-Similkameen area. Three of the forty eight tracts that Church documented comprise the majority of the Seven Peaks study area. Figure 3.3 outlines the boundaries of the tracts within the study area and lists the mineral resources associated with each tract (Church, 1995).

In the Hedley area, two distinct types of skarn related mineralization are notable with respect to mining. The first is the arsenic rich, gold bearing skarns that occur around the Nickel Plate Mine and the second is the garnet and tungsten rich skarns of the Mt. Riordan (Karasiuk, 1990).

In the Apex Mountain area, the principle minerals of are gold, silver, copper and molybdenum. However few of the mineral occurrences in this area have resulted in producing mines of any long term significance or value (Karasiuk, 1990).

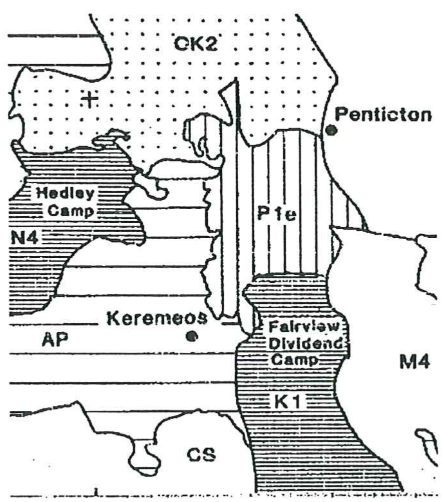
In the eastern portion of the study area running north-south, uranium deposits have been identified and mining claims have been staked as documented in the Ministry of Energy, Mines and Petroleum Resources MINFILE database. These uranium deposits are typically found either to be small and scattered but in relatively high concentrations under water or sodden layers of peat, or in larger deposits (with lower concentrations) in rock formations (Rix, 1995).

To the northeast of the study area, Riddle and Shingle Creeks run through noteworthy deposits of uranium and thorium. Between Brent and Farleigh Lake reservoirs, there is a rich underwater deposit of uranium with little thorium or radium. To the mid-east of the study area, through the Marron Valley, outcroppings along the ridges show signs of being rich in uranium and thorium. To the south, there are post glacial deposits of uranium in the White Lake and Willowbrook areas, pockets of uranium under alkaline bogs or ponds, and detectable levels of radioactivity in surrounding ridges (Rix, 1995).

Concerns over the risks associated with exploration and mining of uranium have been expressed by a variety of groups and individuals since an intense period of uranium exploration in the Okanagan Valley in the late 1970's (Rix, 1995). The concerns encompass the potential for subsurface uranium and thorium deposits to adversely impact upon surface water, groundwater or soils.

Risks associated with exploration for uranium and thorium in designated areas within the study area are regulated under the Health, Safety and Reclamation Code for Mines in British Columbia. This Code defines exploration and sets out requirements designed to comprehensively control all aspects of uranium/thorium exploration including notification of intent to commence exploration, documentation of pre-exploration gamma radiation baseline conditions, documentation of conditions encountered and monitored during exploration, controls to prevent contamination of ground and surface waters, and exploration site decommissioning and closure requirements. The controls provided in the Health, Safety and Reclamation Code ensure that the risks of each individual case is assessed by the appropriate authorities prior to commencement of exploration. This existing mechanism should serve to see that uranium deposits disturbed by exploration and development do not threaten baseline environmental conditions.

Figure 3.3. Mineral Tracts Of The Study Area



Tract	Tract Name	Units	Resources
AP	Keremeos	Apex Mountain Group, Cahill (South) pluton, Penticton Group	Copper, molybdenum, gold, silver
N4	Hedley	Nicola Group, Cahill Creek pluton, Skwell Pekens Group, Hedley Intrusions	garnet and gold skarns
P1e	Penticton	Penticton Group	epithermal gold-silver veins

3.4 SOILS AND TOPOGRAPHY

The majority of the Seven Peaks Area is comprised of six soil landscapes which represent four basic Great Groups. The six soil landscapes include Skaist soils, Lawless soils and Pasayten which are classified as orthic humo-ferric podsols; Etches soils which are classified as typic mesisols; Bonnevier soils which are classified as orthic sombric brunisols; and Banker soils which are orthic eutric brunisols.

The Seven Peaks Area is part of the Thompson Plateau, the southernmost subdivision of the Interior Plateau physiographic region of British Columbia. The Interior Plateau is characterized as a "broad rolling upland between the Columbia Mountains to the east and the Coast and Cascade Mountains to the west" (Karasiuk, 1990).

The mountains surrounding the Okanagan and Similkameen Valleys are typically flat topped, with maximum elevations ranging from 1400 to 2000 m (Karasiuk, 1990). They generally consist of hard rock that has resisted erosion by water and ice and therefore has maintained an elevation slightly higher than the surrounding plateau. The flat tops of the mountains are in fact what remains of the plateau surface following erosion forces that cut box canyons and V-shaped valley's into the landscape (Karasiuk, 1990).

3.5 EXPLORATION AND MINING

Exploration and mining has been a major industrial activity within the study area since before the turn of the century. Table 3.1 lists all producing mines on record for the period 1904 to present. Detailed Minfile descriptions and corresponding production records are included as Appendix A of this report.

3.5.1 Early History

Exploration and mining for gold, silver and copper has long been associated with many regions of the Seven Peaks study area. The history of mining for gold in the Hedley District dates back to the 1860's when placer gold was discovered near Hedley Creek by early prospectors (Mascot, 1985).

In 1894, a period of exploration for lode gold deposits began as the first mineral claim was staked in the Hedley Camp. This exploration resulted in the construction of a mine on Nickel Plate Mountain in 1899. This mine operated continuously from 1904 until 1931, when all the known reserves were exhausted and the mine was closed (Mascot, 1985).

Three other mines within the study area also operated within this early period. The Golconda Mine near Olalla produced small quantities of silver, lead, and zinc in the late 1920's; the Dolphin Mine also near Olalla produced small quantities of silver and copper in the years between 1915 and 1920; and the Hedley Limestone mine produced significant quantities of limestone from 1926 to 1937. These mines are shown in Figure 3.4.

TABLE 3.1 Producing Mines - Seven Peaks Study Area, 1904-Present

		Years Operating			
Mine	MINFILE	Span	Total	Mined (Tonnes)	Commodities
Dolphin	12	1916-1918	3	145	Cu/Ag
Sunrise	15	1948	1	231	Cu/Au/Ag
Golconda	16	1917-1969	6	55	Cu/Au/Ag/ Pb/Mo
Apex	47	1945	1	99	Au/Ag/Cu
Ouala Creek Limestone	85	1968	1	604	Limestone
Olallo	96	1935-1956	2	19	Au/Ag
Mascot Fraction	36	1936-1987	15	1,100,091	Au/Ag/Cu
Nickel Plate	38	1904-present	61	10,773,819*	Au/Ag/Cu
French	59	1950-1983	12	69,508	Au/Ag/Cu
Good Hope	60	1945-1982	4	11,115	Au/Ag/Cu
Canty	64	1939-1941	2	1,483	Au/Ag
Candorado	144	1988-present	5	n/a Tailings	Au/Ag
Hedley Limestone	149	1926-1937	9	2,385	Limestone

* Total for the years 1904 to 1993.

Figure 3.4 inserted here.

3.5.2 Recent History

Further exploration on Nickel Plate Mountain in the early 1930's resulted in the re-opening of the Nickel Plate Mine by the middle of the decade. Around the same time, Hedley Mascot Gold Mines Ltd. also began the Mascot Fraction Mine on Nickel Plate Mountain. Both of these operations were active until the middle of the century when production was halted for economic reasons (Mascot, 1985).

In addition to mining activity on Nickel Plate Mountain during the mid-1900's, several other mines produced varying quantities of gold, silver, copper, lead, zinc, molybdenum, limestone, and manganese. These mines, also shown in Figure 3.4 are listed as follows: Sunrise, Golconda, Apex, Olalla Creek Limestone, Olalla, French, Good Hope, and Canty.

3.5.3 Present Situation

Present mining activity of any significance in the Seven Peaks study area has been limited to the Nickel Plate Mine on Nickel Plate Mountain and Candorado Mines Heap Leach Recovery operations near Hedley. There are also several active sand and gravel excavation pits that are currently being mined.

Nickel Plate Mine

Wholly owned by Homestake Canada Inc., the Nickel Plate Mine is an open pit gold mining operation located near Hedley, some 50 km west of Penticton. The mine property holdings, which opened at the turn of the century, currently covers approximately 2,995 ha (7,400 acres). It was an underground operation prior to 1930 and from 1934 to 1955 at which time the mine closed. In 1987, with the rise in gold prices, the mine was re-opened by Mascot Gold Mines Limited. It will close again in 1996.

The geological ore reserves for the mine were 5.1 million tonnes averaging 2.98 grams per tonne of gold (Church, 1994). The ore to waste rock ratio is 1:9. Ore is processed through a 4,000 ton per day mill which yielded 85,000 fine ounces of gold per year.

The mine operates a zero discharge, closed circuit water balance. Tailings pond supernatant (water) is recycled back to the process with minimal fresh water make-up. Water is supplied from nearby creeks under license.

Rock disposal occurred in three main areas. These include the North, South and Canty Dumps. The North and Canty Dumps are fully reclaimed and the South Dump is 50% reclaimed with the balance scheduled for completion in 1996.

The reclamation program is directed towards creating range land for grazing, forestry use and wildlife use at a productivity level at least equal to that which existed before mining. Reclamation of all completed and inactive disturbances is an on going process at the mine.

The INCO Sulphur Dioxide/Air Treatment Process is used to treat process water to reduce cyanide levels and metal complexes from solution prior to discharge into the tailings pond. Copper catalyses the production of the oxidizer required to break down the cyanide complexes.

The tailings impoundment was built from compacted glacial till and covers an area of approximately 29 ha (72 acres).It has been built to an elevation of 1,394 metres (4,570 feet) above sea level. No tailings have been used in the construction. In 1996 when the mine is scheduled to close, approximately 11.9 million short tons of tailings will have been stored behind the dam.

Reclaim water is returned to the plant site from the impoundment area. Fresh water intake is minimal.

Rock removed from the pits has residual nitrates on it from the blasting activity. A wetland was constructed to manage the levels of nitrate before discharge to nearby creeks. The wetland system consists of an in-vessel treatment system and a conventional wetland. The in-vessel system simulates the bottom anaerobic layer of a natural wetland (bog) where nitrates are utilized by bacteria. The conventional open air engineered wetland with aquatic plants continues the removal of nitrates.

Candorado Mines Heap Leach Recovery

Over the years of operating the Nickel Plate Mine and as a result of approximately 2.8 million tonnes of ore having been mined and milled, large amounts of tailings have been deposited in two piles located between Highway #3 and the Similkameen River. Figure 3.5 (Ash & Associates, 1987) shows the locations of the "old" tailings pile, deposited between 1904 and 1931 adjacent to Hedley creek, and the "new" tailings pile, deposited between 1935 and 1961 adjacent to the Similkameen River. Although 2.8 million tonnes of ore was processed from Nickel Plate, only 1.5 million tonnes of tailings in total remain. It is assumed that the quantity of tailings unaccounted for has washed into the river over the years (Ash & Associates, 1987).

The process to recover gold from the tailings involves excavating and hauling material to a processing facility directly across Highway #3 from the "new" tailings pile. Processing involves crushing excavated tailings into management size agglomerate nuclei, adding water and portland cement and combining in a drum agglomerator to form porous spheroids which are then placed on a lined leach pad and sprayed with a cyanide solution. As the cyanide solution leaches through the agglomerates, it dissolves any gold that may be present. The leached solution is then collected and pumped through activated carbon. The gold is absorbed into the carbon and subsequently recovered through desorbtion and further processing (Ash & Associates, 1987).

Once processed, the spent tailings normally remain on the leach pad. The cement content in the agglomerates helps to produce a rather dense material when dampened and tamped.

Sand and Gravel Excavation Pits.

Table 3.2 lists the locations of all sand and gravel pits in the Seven Peaks study area that are currently registered with the B.C. Ministry of Transportation and Highways (BC Transportation and Highways, 1995).

Figure 3.5 Tailing Pile Locations

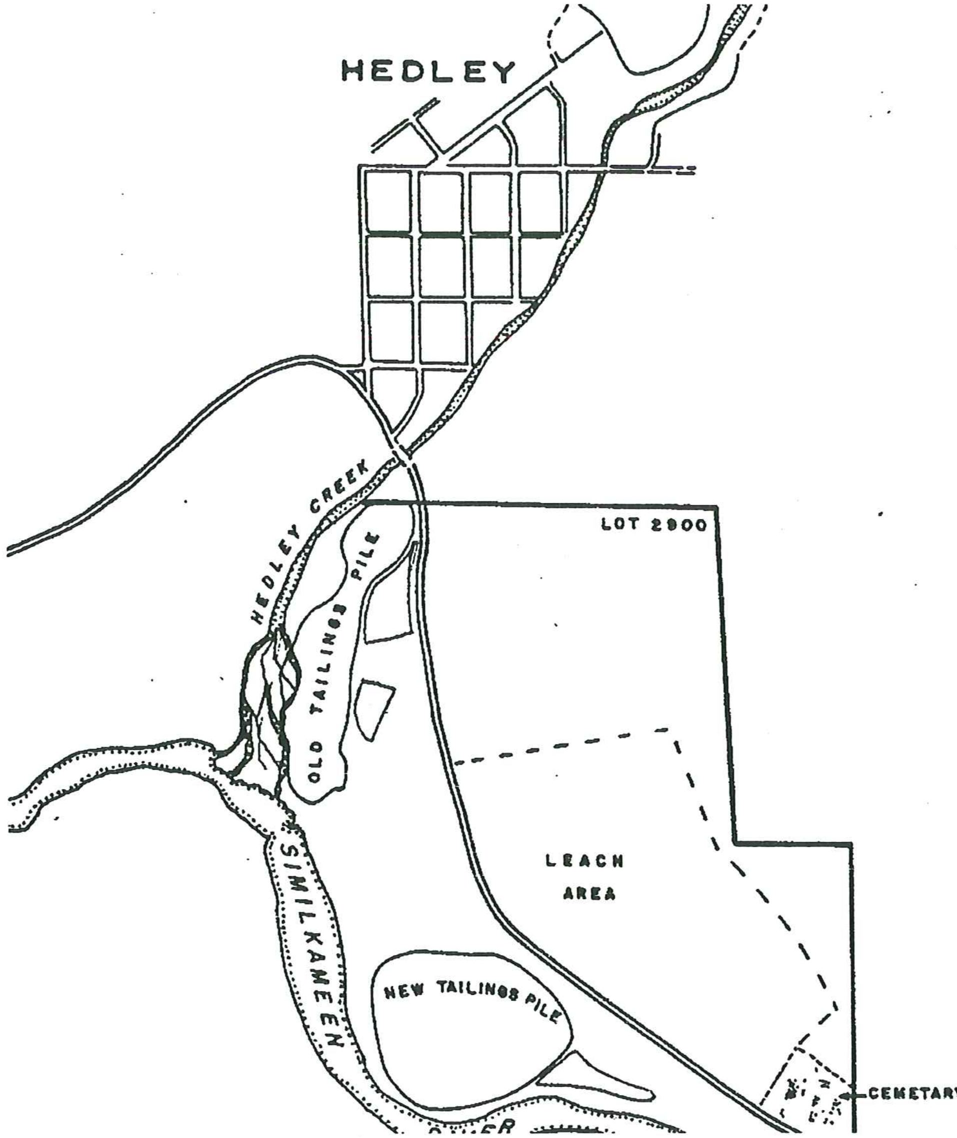


Table 3.2 Sand/Gravel Pits In Study Area

Pit Name	#	Gradation	Quantity
Bathville Road	2947	Area 1 - 45%G, 53%S, 2%F Area 2 - 37%G, 61%S, 2%F	50,000m^3 proven 125,000m^3 proven
Nickel Plate Pit	2405	44%G, 52%S, 4%F	Not available
Bluebell Mineral Claim Pit	2453	Not available	Not available
Green Mtn. Pit	2429	Not available	Not available
Yellow Lake Pit	2433	56%G, 33%S, 11%F	75,000m^3 proven
Riordan Pit	2455	23-58%G, 37-67%S, 2-12%F	60,000m^3 proven
Boulder Creek Pit	2477	Area A - 27%G, 66%S, 7%F Area B - 21%G, 72%S, 7%F	35,000m^3 proven 120,000m^3 proven
Experimental Farm Pit	2417	Area A - 23-45%G, 53-75%S, 2%F Area B - 16-23%G, 75-78%S, 2-6%F	16,000m^3 proven 16,000m^3 proven
Lund Pit	2409	71%G, 26%S, 3%F	58,000m^3 proven
Keremeos Creek Pit	2481	38%G, 58%S, 4%F	40,000m^3 proven
Keremeos Village Pit	2406	Not available	Not available

3.5.4 Future

Future exploration and mining related activities within the Seven Peaks study area are anticipated to encompass a continuation of current activities at Candorado and the various excavation pits, closure of the Nickel Plate Mine in 1996 and subsequent reclamation over a five year period thereafter, and the possibility of development of a major garnet mining operation on Mt. Riordan referred to as the Crystal Peak Garnet Project.

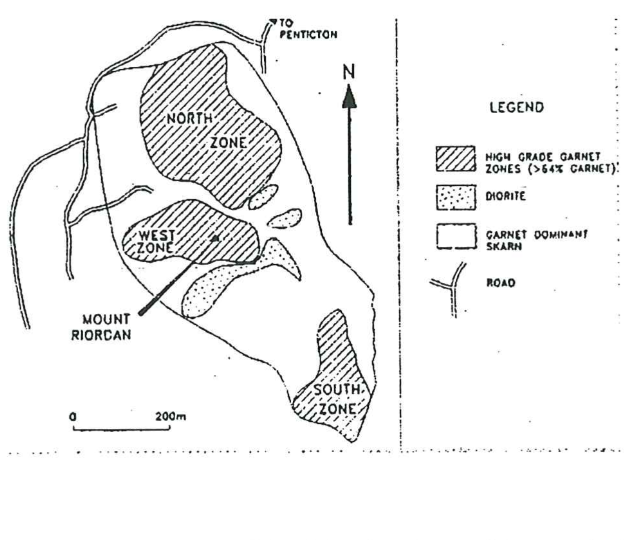
Nickel Plate Mine Closure

Since early in 1995, Homestake Canada Inc. has employed an Environmental Coordinator whose role is to oversee the environmental aspects of the planned closure in 1996 and final reclamation of the site. Site reclamation, which has actually been underway since 1993, includes the resloping, stabilizing, seeding and planting indigenous seedlings in waste rock areas, hydroseeding disturbed areas along active access roads, closing/seeding/fertilizing inactive roads, revegetation of the tailings area, tailings water treatment, tailings surface vegetation trials, and applied research to optimize remedial options. Once the mine is closed in late 1996, no additional disturbance of the site will occur and the only areas that will remain active during reclamation will be the administration areas.

Crystal Peak Garnet Project

Mt. Riordan is located northwest of the Apex Mountain Recreation Area. In 1989, Polestar Exploration Inc., discovered an exceptionally pure garnet deposit on Mt. Riordan (Crystal Peak), situated between Hedley and Penticton and now wish to develop the find into an active quarry and processing facility. The Mt. Riordan garnet skarn outcrops extensively over an area of approximately 800 metres by 300 metres. Figure 3.6 (Mathiew et al, 1991) shows three high grade zones of Mt. Riordan which averages almost 80% garnet. (Mathieau, Boisclair and Wolfe, 1991). With proven garnet reserves of approximately 40 million tonnes and potentially an additional 60 million tonnes in reserves, the value of the deposit is worth up to $10 billion.

Figure 3.6 Mt. Riordan Garnet Zones



The garnet quarry would be located inside the Apex Mountain Recreation Area, on land that is not available for timber harvesting or for livestock grazing.

Garnet is a very hard, heavy and inert mineral. This makes it valuable for use as a "sandblasting" abrasive, a water jet cutting abrasive and a water filtration medium, among many other uses (Polestar Exploration, March 1991).

As proposed, the quarrying of garnet will take place over a period of approximately six weeks each year in May and June. For the remainder of the year the quarry site will remain dormant, including throughout the entire skiing season. Garnet will be hauled 1 km west of the skiing recreation area to a processing plant, which will produce 60,000 tonnes of finished product annually on a continuous year-round basis.

Processing will consist of crushing, screening and/or hydrosizing and magnetic separation but it will not involve the use of any chemicals. Finished product will be bagged and transported by truck to market.

The primary environmental concerns include potential impacts to air quality, water quality, terrestrial resources and land use (Polestar Exploration, 1991). The operational phase of the project will create twenty-seven jobs for the anticipated 20 year duration of the operation.

The potential sources of dust arise from blasting operations, loading and unloading of raw materials, processing and truck haulage. Blasting will take place in late spring/summer when skiing in the area is finished and other forms of recreation are minimal. However, as year -round recreational opportunities at Apex are developed, this issue may be continuous in the near future.

Tests have shown that blast dust settles quickly within the perimeter of the quarry site (Polestar Exploration, 1991). Minimal dust will be generated during loading raw material onto trucks. Dust levels at and in the processing plant will be subject to strict rules under the jurisdiction of the Inspector of Mines.

ANFO (ammonium nitrate/fuel oil) explosives will be used at a powder rate of 0.25 kg per tonne or 18,750 kg per year. This will result in approximately 1% or 60 kg to be left on the blast rock which is less than the amount recommended by the Ministry of Energy, Mines and Petroleum Resources for fertilizer use in mine reclamation. The impact from nitrate is expected to be negligible (Polestar Exploration, 1991).

Despite concerns raised by the Apex Alpine Ski operators in relation to the proposed Crystal Peak garnet project, mitigative measures to control dust at the Nickel Plate Mine and the Candorado Heap Leach Recovery project have been successful. This is especially so at Candorado, where measures have resulted in an improved atmospheric environment with respect to dust from what previously existed (Jarman 1995). Mines are the only types of industrial activity in the study area whose air emissions are monitored and regulated under the Waste Management Act. Such monitoring serves to prove that air quality in the Penticton area is very good, and that airborne dust which does exist is more attributable to ordinary truck traffic than mining operations.

The Candorado Heap Leach project is near completion. With its reserves depleted, Nickel Plate Mine is also scheduled to close at the end of 1996. This would mean that, without the opening of the Crystal Peak Garnet quarry, there would be no active mines in the study area.

The affected area falls entirely within the engelmann spruce-subalpine fir biogeoclimatic zone which is widely distributed on the lower slopes of Mt. Riordan. The development of the project will have some short term impact on wildlife as they adapt to the development and operations however this impact is not expected to be significant (Polestar Exploration, 1991).

The Crystal Peak garnet project entered the Mine Development Assessment Process (MDAP) in 1989. In 1993 the MDAP Project Committee concluded that the development plan for the Crystal Peak garnet project was environmentally acceptable, and would not impact unacceptably on adjacent ski operations or other outdoor recreation activities.

3.6 IMPACT OF MINING AND EXCAVATION ON BASELINE GEOLOGY

The nature of the geology of the Seven Peaks study area is such that mining activity of significance typically occurs at the surface. Economic mineral deposits in the study area include two fundamental types: gold-skarns which are pyroxene dominant and associated with the Hedley intrusions, and the younger garnet-dominated skarns, such as at Mt. Riordan, which contains some tungsten and copper but no gold. Past producing gold mines in the study area such as French, Canty, and Good Hope were also skarn-related however, zones of infiltration are smaller and narrower than the larger envelopes associated with the Nickel Plate gold and Crystal Peak garnet skarn deposits.

The past, present and future impacts of mining and excavation on the baseline geology of the study area are primarily related to the aesthetics of former mines and the resulting reclaimed landscape that remains once active mining has ceased. In some cases, mining excavations fill with water and become reservoirs or holding basins which discharge water through seepages or spillways to existing drainage courses. In other cases, reclaimed landscape is contoured and seeded to grow grass but presumably through natural succession it will revert to forest land. The current reclamation program being implemented at the Nickel Plate Mine is a good example of a more comprehensive restoration program to return the land to a modified sustaining natural state that will support the integrated use of the land for forestry, grazing, and diversified wildlife use.

In the long term, mining can be considered a temporary use of the land after which it is returned to its natural state or a further approved land use. Mining contributes to the local, provincial and national economies and is a valuable component of a sustainable economy. Although historically the industry has a bad reputation for creating pollution, modern environmental requirements for emission controls and effluent discharges are designed to protect human health and the environment.

The other issues including impacts to wildlife, water use and water quality, air quality (dust and heavy metals) from mining operations and transportation are addressed in other sections of this report.

SECTION 4.0

HYDROLOGY

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SECTION 4.0
HYDROLOGY

4.1 INTRODUCTION

This section provides an overview of the water resource with respect to water and groundwater quantities used and available for use within the Seven Peaks area.

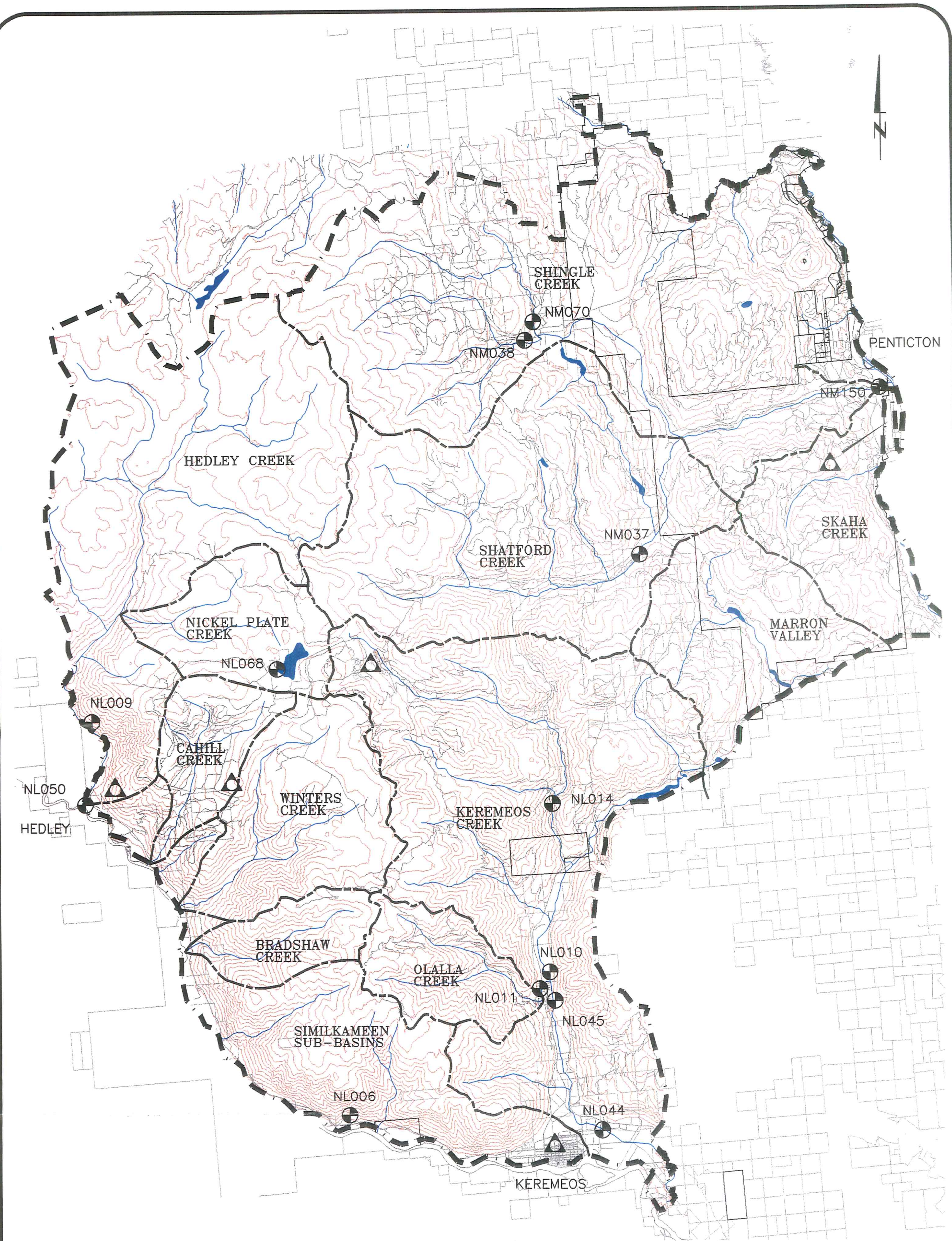
To assess hydrology in the Seven Peaks Study area, a review of the larger regional watersheds was necessary to obtain a more complete understanding of the local characteristics. The Seven Peaks Study Area falls within two major watersheds in the Southern B.C. Interior, the Similkameen River watershed, and the Okanagan Basin watershed.

4.1.1 Silkameen River Watershed

The Similkameen River flows from its headwaters in Manning Park north to Princeton where it is joined by the Tulameen River. Here it turns to the southeast to flow towards the border where it crosses near Nighthawk, Washington. The headwaters of the Ashnola River and Pasayten Rivers, which are both subbasins of the Similkameen, both originate in Washington and cross the US-Canada border. With 7,600 km^2 drainage area in Canada and the remaining 2,000 km^2 in the US, the Similkameen is an international river.

In British Columbia, both the federal and provincial governments are responsible for managing and developing the water resource. In Washington state, the state and federal governments manage the water resource. The International Joint Commission (IJC) has jurisdiction under authority of the Boundary Water Treaty of 1909. The Commission consists of six commissioners, 3 from Canada and 3 from the US. Any developments that affect flow or level of the Similkameen River must meet the approval of the IJC (Fanning,1985).

With a significant amount of agriculture occurring downstream of Hedley, large volumes of water are withdrawn from the river and from groundwater for irrigation. Historically, water shortages have been common in the drier years.



WSC FLOW MONITORING STATION 08_____

PRECIPITATION MEASUREMENT LOCATION

DRAINAGE BASIN BOUNDARIES

FIGURE 4.1

SCALE: 1:150,000

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The Canadian portion of the Similkameen River is considered fully licensed during the summer months. This includes the creeks within the Seven Peaks area that flow to the Similkameen River. In order to obtain additional water from the river or creeks, additional water storage would have to be developed.

The Similkameen basin consists of two hydrological zones, a western higher wet zone with orographic precipitation from the Cascade Mountain Range, and an eastern drier zone caused by a rainshadow effect of clouds descending from the higher western areas. The eastern zone of the Similkameen basin, which the Seven Peaks Area falls within, is considered semi-arid at the lower elevations.

The drainage basins in the Similkameen River watershed that are investigated in more detail include:

- Keremeos Creek;
- Olalla Creek
- Hedley Creek (excluding McNulty Creek);
- Nickel Plate Creek;
- Nickel Plate Lake;
- Bradshaw Creek;
- Cahill Creek;
- Winters Creek;
- Remaining gulleys located along the Similkameen River between Keremeos and Hedley including Red Top Gulch, Seventeen Mile, Old Tom, Shuttle, and Shoemaker Creeks.

4.1.2 Okanagan Basin Watershed

The Okanagan Basin covering an area of 7700 km^2 is defined in this report as the catchment area that is above Osoyoos Lake. Okanagan Lake is the main hydrologic feature in the basin. The basin hydrology is typical to the southern interior with the majority of annual runoff occurring during snow melt from April to July. Snow accumulates in the winter months from elevations in the basin over 4000 feet.

The basin has approximately 140,000 da-m^3 (da-m^3 = 1000 m^3) of headwater storage above the larger valley lakes that is used to supplement low summer flows in the creeks and supply water for domestic and irrigation water users (Thomson, 1974).

The Seven Peaks Study Area is in a rainshadow in the southwest portion of the Okanagan basin caused by the divide of the Similkameen and Okanagan basins. The Okanagan basin is somewhat drier than the adjacent Similkameen basin to the west.

Figure 4.1 presents drainage boundaries of creeks that are investigated in detail including:

- Shingle Creek;
- Shatford Creek; and
- Marron River.

4.1.3 Objectives

Objectives for the hydrology portion of this baseline audit are to:

- Quantify annual runoff for the prominent creeks in the study area;
- Determine by means of a frequency analysis, 1:10 wet, mean and 1:10 dry annual flows for the creeks;
- Review water licenses and estimate amount actually used;
- Comment on effects of snow making related to apex mountain resort operations on area hydrology;
- Comment on the changes in peak run-off from the effects of forestry activities;
- Comment on groundwater use and demand in the region;
- Comment on the past and current impacts of the nickel plate/homestake mine on water resources;
- Discuss storage possibilities in the watersheds.

Annual flows from the watersheds is estimated based on the best available meterological and hydrometric data. Mean year runoff volumes are presented and a frequency analysis has been carried out for 1:10 year dry and 1:10 wet years runoff volumes.

4.2 AVAILABLE DATA

Four types of data were reviewed is the hydrology assessment:

- Precipitation records;
- Stream flow records; and
- Snowpack records; and
- Groundwater records.

Data gaps are identified where information is insufficient, inconclusive or missing.

Precipitation characteristics in the region are dependant on elevation, local and general slope, slope orientation, slope exposure, topographic barriers for incoming moisture and the distance from the water source. Elevation is the factor of highest influence on precipitation.

Precipitation records from 13 locations in the region are presented in Table 4.1.

Table 4.1
Regional Meterological Stations

Station Description	Latitude	Longitude	Yrs of Record	Elev.	Total Annual Precipitation
Osoyoos	49-02	119-26	36		340.2
Osoyoos West	49-02	119-26	23	297	303.6
Oliver	49-11	119-33	66	297	307.8
Oliver Sewage Treatment	49-10	119-33	52	315	301.1
Penticton Airport	49-28	119-36	49	344	308.5
Keremeos	49-12	119-49	-	430	242.3
Summerland CDA	49-34	119-39	74	454	315.0
Hedley	49-21	120-04	86	517	339.3
Princeton Airport	49-28	120-31	54	700	343.0
Peachland Brenda Mines	49-52	120-00	22	1,520	634.6
Nickel Plate Mine	49-20	119-59	26	1,767	544
*Mt. Kobau Observatory	49-06	119-40	-	1,862	585.9
*Apex Alpine Lodge	49-24	119-55	-	1,890	650

* (Karasiuk, 1990)

Precipitation in this region, as in most of Interior B.C. is orographic which is a result of clouds rising to pass over the higher land masses, in this case the Cascade Mountain Range. Although a high amount of precipitation falls within the western portions of the Similkameen River basin, the Seven Peaks area lies within the rainshadow of the Cascade Mountains. With clouds descending after passing over the Cascade Mountains, the area experiences somewhat lower precipitation.

Stream flow data from Water Survey of Canada monitoring stations presented in Table 4.2 was reviewed during the analysis. WSC stations 08NL010, 08NL022, 08NL045, 08NL050, 08NM037, and 08NM150 were used for the majority of the analysis. The locations of stations within the study boundaries is illustrated on Figure 4.1.

Table 4.2
Regional WSC Stations

Station No.	Description	Latitude	Longitude	Yrs of Record	Area (km^2)	Reg/ Nat Flow
08NL006	Similkameen River near Keremeos	49-13-16	119-57-28	*19	5,960	Nat
08NL009	Hedley Creek near Hedley	49-23-20	120-04-50		-	Nat
08NL010	Keremeos Creek near Olalla	49-15-52	119-49-28	*20/34	183	Reg
08NL011	Olalla Creek near Olalla	49-15-50	119-50-00	*3	-	Nat
08NL014	Keremeos Crk above Marsel Crk	49-20-00	119-49-00	*8	68.6	Nat
08NL022	Similkameen near Nighthawk	48-59-05	119-37-02	77/77	9,190	Reg
08NL038	Similkameen River near Hedley	49-22-39	120-09-06	*22	5,590	Nat
08NL044	Keremeos Crk at Middle Bench Rd	49-12-37	119-47-54	*7	221	Reg
08NL045	Keremeos Crk below Willis Int	49-15-33	119-49-32	17/20	183	Reg
08NL050	Hedley Creek at Mouth	49-21-54	120-03-59	15/17	389	Nat
08NL068	Nickel Plate Reservoir Overflow	49-23-39	119-57-58	*2	6.73	Reg
08NM037	Shatford Creek near Penticton	49-25-42	119-45-00	*22/35	101	Reg
08NM038	Shingle Creek above Kaleden Div	49-30-37	119-47-42		44.8	Nat.
08NM049	Horn Creek near Kaleden	49-24-00	119-39-00	*1	-	Nat
08NM070	Riddle Creek near W.Summerland	49-30-30	119-47-30	*2	33.4	Nat
08NM147	Horn Creek near Olalla	49-18-11	119-45-13	*10	15	Nat
08NM150	Shingle Creek at Mouth	49-28-49	119-36-00	*4/8	308	Reg

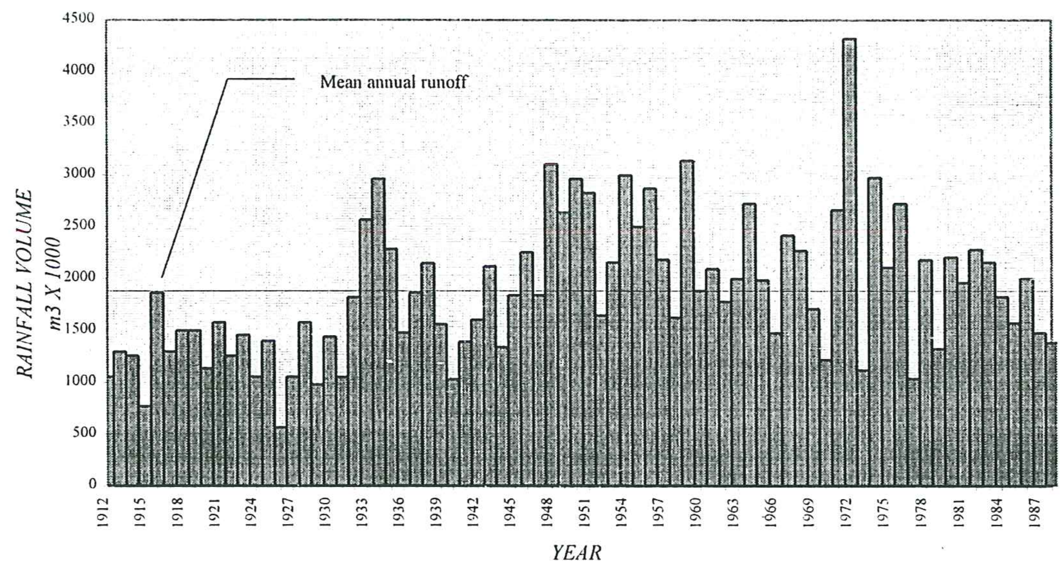
(yrs analysed / total years of record)

* Incomplete records in some years

Where insufficient flow records were available, the short term records were compared with the station of longest record, Similkameen River near Nighthawk (WSC 08NL022) to validate the average annual flows. The WSC stations listed are either "natural" streams with no gates, control structures or storage above on the streams or; "regulated" streams where some form of flow control exists. Figure 4.2 presents the annual flow and mean flow for the Similkameen River at Nighthawk from 1912 to 1987.

Figure 4.2

Similkameen River Flow at Nighthawk



Snow course data stations located near the study area that were used as reference data:

Table 4.3

Regional Snow Course Data Stations

Station No.	Description	Latitude	Longitude	Yrs of Record	Elev. (m)
2G01A	Sunday Summit	49-17	120-35	26	1,310
-	Mt. Kobau	49-06	119-40	-	1,862
2G02	Nickel Plate No. 1	49-23	102-02	25	1,890
2G04	Lost Horse Mountain	49-17	120-08		1,920

Figure 4.3 provides an estimate of the depth of annual precipitation throughout the study area.

4.2.1 Groundwater

The Ministry of Environment, Water Management Branch, Groundwater section has an inventory of all known wells that exist within the study area. Data summary sheets and mapping were reviewed to determine the location of larger wells and areas of high groundwater use.

4.2.2 Effect of Forest Harvesting on Hydrology

For the study area, the effect of forest harvesting on hydrology varies with elevation. The times of highest impact are usually the times of highest runoff. For the Seven Peaks area, the highest runoff occurs usually during spring freshet although it can occasionally occur with some of the larger storm events.

The effect of forest harvesting is the most prominent in the first several years after harvesting. Before harvesting, the tree canopy shelters and delays the snowmelt and runoff to some extent. The interception of snowfall by the forest canopy reduces snowfall accumulation on the ground and increases the evaporation to atmosphere. Once an area is harvested, the snowpack and the rate of snowmelt is higher resulting in higher runoff flows.

As the harvested areas are restocked, the higher runoff flows and snowmelt rates are reduced. Once the runoff characteristic of an area are where they were prior to harvesting, the second growth forests are hydrologically recovered.

In general terms, for the study area there will be increased yield in runoff from harvested areas during the spring freshet, but this will reduce as the harvested areas are replanted and regrow.

4.2.3 Data Gaps

In review of the precipitation records, there are no meterological stations in the region located between the elevations of 700 and 1,500 metres. Regionally, there is a notable increase in precipitation with elevation. This is not well defined and subject to topography and orientation of slopes immediate to the sites.

The majority of Water Survey of Canada stations in the region are regulated. Only the station at the mouth of Hedley Creek provides a significant period of complete annual measurement for an unregulated creek. The data on unregulated streams provides the best base data for assessing watershed capacity.

Limited information is available on the diversion of water from Shatford Creek to Marron Valley. A 1200mm diameter steel diversion pipe several kilometres in length was used and the capacity and amount diverted is not known.

Recorded water measurements at the mouth of Shingle Creek are lower than what regional values would create. Additional flow recording should be conducted at this site.

Groundwater data was reviewed but the actual amount of water drawn is not known. Run times on the largest wells would be useful information in assessing total water demand for an area.

4.2.4 Method of Assessment

A simplistic approach for estimating water balance within each of the creek basins was made using the following formula.

$$P - AE - R = 0$$

where

- **P** = Mean Precipitation
- **AE** = Mean Actual Evapotranspiration
- **R** = Mean Runoff

To determine the volume of runoff produced on an annual basis, it is assumed that there is no change in groundwater storage. Because of the relatively steep valley slopes, it is assumed that groundwater flow would eventually surface in the valley creeks.

Total precipitation was estimated for each watershed based on elevation. The Thornwaite model was used to estimate potential evapotranspiration. The model has limitations in that water supply is assumed to be non-limiting over the course of the year. This in fact is not the case as there are extended dry periods of time, particularly at the lower elevations. Evapotranspiration is normally higher in the wetter years as more free water is available to the soil and plants.

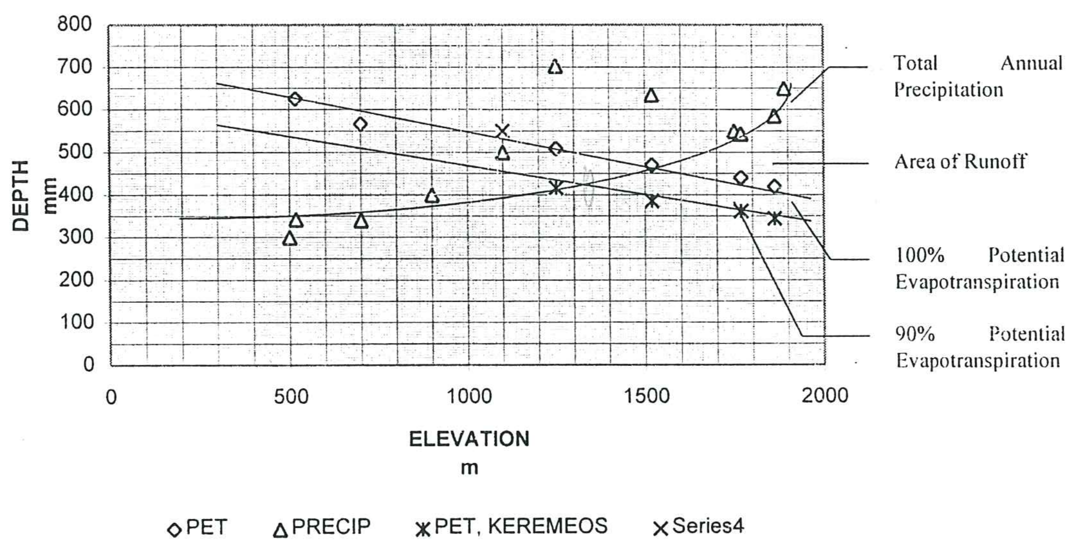
Typically potential evapotranspiration is overestimated or there is an underestimation of snow and rainfall catchment at the higher elevations due to the increases in wind and weather movement (Thomson, 1974). Evapotranspiration is estimated to be in the range from 80 to 95% of the actual amount varying with the region.

Runoff data from WCS stations was used to adjust the evapotranspiration component. Figure 4.4 illustrates the annual amount of precipitation and evapotranspiration at various elevations. The area of higher elevation in Figure 4.4 between the precipitation and evapotranspiration lines is the estimated depth of runoff at specific elevations.

If the potential evapotranspiration is realized, the elevation producing runoff is estimated at 1350 metres. This is not the case and an estimate of 90% is more realistic. Previous reports have identified 1200 metres as the runoff-producing elevation (Obedkoff, 1995).

Table 4.4

Rainfall vs Potential Evapotranspiration



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4.3 WATER LICENSES

In the present water licensing system, the right to use surface water is granted only to those that have applied and received a water license. The license allows the licensee to use a specified volume and rate of water over a specific period of time at a specified location. The licenses are priority dated usually in the order of issuance and the person with the earliest priority date license has first rights to the water. A listing of all water licenses in the study area is presented on Table 4.4.

Table 4.4
Water Licenses

License Type	License Description/Location	No Lic	Withdrawl Time Annually	Quantity (units)	Water demand (L/s)	Comments
	Hedley Creek (Excluding Nickel Plate Creek and Lake)					
WWKLA	Waterworks Local Authority at Hedley	2	Jan 1- Dec 31	63,875,000 GY	9.21	Licenses by Hedley Improvement Dist not in use. District fed by wells.
IRR	Irrigation 5.6 km up Hedley Creek	1	Apr 1-Sept 30	0.50 cfs	180 AF	Not in use. Chilanko Mining Claim
	Cahill Creek					
IRR	Cahill Creek	2	Apr 1-Sept 30	930 AF	930 AF	Intake on lower creek, 310 acres irrigated
MNORE	Mining and ore Production on Sunset Creek, Mascot Ditch, Cahill Creek and Nickel Plate Mine Creek	4	Jan 1- Dec 31	115,350 GD	7.122	In use
STONP	Mining and ore Production, Cahill Creek	2	Apr.1- June 15	72 AF	72 AF	One new license in use by mine withdrawn and stored during freshet. Reused during the year
STONP	Mascot Ditch	1	Oct 1 -June 30	22 AF		

License Type	License Description/Location	No Lic	Withdrawl Time Annually	Quantity (units)	Water demand (L/s)	Comments
	Nickel Plate Creek/Lake					
PCOM	Power for commercial sale	1	Jan 1- Dec. 31	4.40 cfs	124.60	Not in use, original power supply for Hedley
WWKS	Apex license from Nickel Plate Lake	1	Jan 1- Dec. 31	8,954,000 GY	33AF	Water accessed from Nickel Plate Lake for domestic water works purposes to a maximum of 224,000 GD
REC	Apex license for industrial snowmaking	1	Oct 15-Apr 30	67 AF		
STONP	Storage on Nickel Plate Lake	1	Oct 1 - June 15	100 AF		Water allotted to Apex Alpine
STONP	Existing Storage on Nickel Plate Lake	1	Oct 1 -June 15	0.00 cfs	**3,300 AF	3400 AF licensed, 1654 AF constructed, approximately 754 AF released to Similkameen River every year in late summer. **recently revised as part of agreement with Apex
	Bradshaw Creek					
DOM	Bradshaw Creek	3	Jan 1 - Dec 31	2,500 GD		
IRR	Bradshaw Creek	2	Apr 1-July 31	42 AF		Intake on creek to supply 14 acres of irrigation
IRR	Bradshaw Creek	3	Apr 1-Sept 30	110.4 AF		Intakes on creek to supply 16 acres of irrigation
	Winters Creek					
DOM	Winters Creek		Jan 1- Dec 31	500 GD		Intake on Creek, One domestic connection
IRR	Winters Creek		Apr 1- Sept 30	1,010 AF		Intake on creek, irrigation for 337.7 acres

License Type	License Description/Location	o Lic	Withdrawl Time Annually	Quantity (units)	Water demand (L/s)	Comments
	Keremeos Creek					
WWKLA	Waterworks Local Authority	3	Jan 1- Dec 31	5,475,000 GY	0.79	
WWKLA	Waterworks Local Authority	2	Nov 1- Apr 30	9,050,000 GY	2.60	
DOM	Domestic users	24	Jan 1- Dec 31	21,500 GD	1.13	10,500 GD not used
PONDS	Fish Rearing Ponds	1	Jan 1- Dec 31	2.0 CS	56.63	
IRRMU	Irrigation municipal supply	3	Apr 1- Sept 30	892 AF	0	Keremeos I.D. 369 acres
IRR	Irrigation	20	Apr 1- Sept 30	999 AF	0	Keremeos. 780 acres of land to be irrigated
STONP	Storage non potable	5	Oct 1- June 15	20 AF	0	
	Shatford Creek					
DOM	Shatford Creek domestic users	10	Jan 1- Dec 31	8,500 GD	0.45	Domestic users along Green Mountain Road
DOM	Farleigh Lake	7	Jan 1- Dec 31	3,500 GD	0.184	Withdrawls from lake
DOM	Clark Creek	2	Jan 1- Dec 31	500 GD	0.026	Creek intakes
IRR	Shatford Creek Irrigation	1	May 1-Sept 30	140 AF	0.00	70 acres irrigated
IRR	Shatford Creek Irrigation	19	Apr 1-Sept 30	1302 AF	0.00	952 acres irrigated
IRR	Clark Creek	2	Apr 1- Sept 30	24.5 AF	0.00	19.6 acres irrigated
STONP	Clark Creek	1	Oct 1- June 15	5 AF	0.00	Storage, non potable water
STONP	Shatford Creek Irrigation storage	18	Oct 1- June 15	1,090 AF	0.00	Storage non potable water
STONP	Farleigh Lake	3	Oct 1- June 15	1,130 AF	0.00	Storage non potable water
	Shingle Creek (Excluding Shatford)					
DOM	Shingle Creek	6	Jan 1 - Dec 31	32,000	1.68	Single family residence
DOM	Riddle Creek		Jan 1 - Dec 31	1,500 GD	0.079	1 SF Residence
SW	Rickenbacker Creek		Jan 1 - Dec 31	2,000 GD	0.105	Livestock Watering
SW	Ridley Creek		Jan 1 - Dec 31	4,000 GD	0.210	Livestock Watering
SW	Shingle Creek		Jan 1 - Dec 31	1,000 GD	0.052	Livestock Watering
IRR	Shingle Creek	0	Apr 1- Sept 30	1,621 AF	0.00	1,846 acres irrigated
IRR	Shingle Creek		Apr 1-June 30	603 AF	0.00	812 acres irrigated
IRR	Riddle Creek		Apr1 - Sept 30	260 AF	0.00	163 acres irrigated
IRR	Beaulah Creek		Apr 1- Sept 30	35 AF	0.00	17.5 acres irrigated
STONP	Riddle Creek		Oct 1- June 15	150 AF	0.00	
STONP	Shingle Creek		Oct 1-June 15	1,270 AF	0.00	
STONP	Deschamps Creek		Oct 1- June 15	50 AF	0.00	
STONP	Brent Lake		Oct1 -June 15	1,140 AF	0.00	

License Type	License Description/Location	No	Withdrawl Time Annually	Quantity (units)	Water demand (L/s)	Comments
	Marron Valley					
DOM	Marron River	3	Jan 1 - Dec 31	1,500 GD	0.078	
IRR	Marama Creek	2	Jan 1 - Dec 31	108 AF	0.00	
LDIMP		1	Jan 1 - Dec 31	0 AF	0.00	Land improvement, pond for aesthetic purposes.
IRR	Marron River	20	Apr 1-Sept 30	1,257 AF	0.00	416 acres irrigated
IRR	Marron Lake	11	Apr 1-Sept 30	394 AF	0.00	94 acres irrigated
IRR	Marama Creek	1	Apr 1-Sept 30	20 AF	0.00	10 acres irrigated
STONP	Aeneas Lake	17	Oct 1-June 15	1,079 AF	0.00	
STONP	Marron Lake	28	Oct 1-June 15	1,473 AF	0.00	
STONP	Marron River	1	Oct 1-June 15	25 AF	0.00	

4.4 HYDROLOGY SUMMARY

A brief summary is presented for each of the major creeks in the Seven Peaks area. Presented are the drainage area, annual flow, runoff yield, groundwater wells, and major water users for each area.

Hedley Creek

With a catchment area of 389 km^2, Hedley Creek is the largest creek in the study area both in terms of runoff volume and drainage area. Major creeks contributing to Hedley include McNulty Creek, Nickel Plate Creek and Broken Creek. McNulty Creek is excluded from the Seven Peaks Study area and Nickel Plate Creek will be discussed in the next subsection.

The Seven Peaks Area of the Hedley Creek watershed is approximately 184 km^2 in size with an elevation range of 517 metres at Hedley up to 2,000 metres at the summit of highest mountains. Approximately 75 % of the drainage area is located above the 1,250 metre elevation. A runoff yield of 200 da-m^3/km^2 is estimated for Hedley Creek within the study area.

Good flow record information is available at WSC Station 08NL050 where Hedley Creek discharges into the Similkameen River but flow information in the above watershed is limited. Excluding the contribution of runoff from McNulty

Creek, the annual mean flow is estimated at 36,800 da-m^3. Total annual flow in Hedley Creek is estimated to be 72,400 da-m^3.

Presently there are only 7 water licenses issued in the Hedley Creek watershed, three on the creek and 5 near Nickel Plate Lake. Table 4.4 summarizes the licenses and their use.

There are 2 groundwater wells in the watershed that supply the town of Hedley with water. The well capacities are 1,000 USgpm and 100 USgpm. The Hedley Improvement District services 185 residential and 15 commercial customers in the town. Annual water use is approximately 250 da-m^3. Approximately 925 da-m^3 is released from Nickel Plate Lake to the Similkameen River each year plus 123 da-m3 is licensed to Apex Mountain Resorts. Total water accounted for annually is 1,300 da-m^3.

There are no major users of water from the creek. Storage has been investigated in the watershed. A 5,600 da-m^3 site outside the study area on the McNulty arm of Hedley Creek was identified in earlier reports (Wild, 1964).

Nickel Plate Creek (sub basin to Hedley Creek)

Nickel Plate Creek drains an area of 35 km^2 flowing into Hedley Creek at the 1,025 metre elevation. With 90 % of the area above the 1,250 metre elevation, the watershed produces an estimated annual runoff yield of 257 da-m^3/km^2. The annual mean flow in the creek is estimated at 9,000 da-m^3.

There is only one flow monitoring station in the basin. Data from Station 08NL068 located at the release of Nickel Plate Lake is limited to two seasons.

Nickel Plate Lake, which is the major hydrological feature in the watershed, was raised by construction of a dam at the mouth of Nickel Plate Creek. The dam was constructed in the early 1960's to increase storage capacity by collecting runoff from an 8.1 km^2 watershed. Average annual runoff generated from the snowpack is estimated at 1,500 da-m^3. Using precipitation records from the Hedley Nickel Plate mine, and factoring in the increase in precipitation with elevation, the total average annual run off is estimated at 2,750 da-m^3.

Presently there are several licenses on Nickel Plate Lake as presented on Table 4.4. Apex Alpine has licensing for 123 da-m^3 (100 AF) that is transferred to the Keremeos drainage basin and used for snowmaking and domestic service.

Presently 2,040 da-m^3 of useable storage is available in the lake above the low level outlet. The lake level is controlled by the Similkameen Improvement District (SID) who operate the gate on a dam at the southwest end. The SID uses the dam to collect snowmelt water in the spring and releases it to augment flows in the Similkameen River in August and September each year. The SID has not been utilizing the full storage capacity of the reservoir each year. Typically, water is released to a level equal with the bottom of the upper gate (925 da-m^3).

There is sufficient water in Nickel Plate Lake to meet the current licensing. It appears however, that raising of the dam to store more water could be impractical due to the small contributing catchment area and the possibility of not filling the reservoir in dry years. No groundwater wells are noted in the Nickel Plate Creek drainage area.

Cahill Creek

Cahill Creek drains an area of 23.5 km^2 flowing into the Similkameen River 4.0 km southeast of Hedley. Elevations in the watershed range from 500 metres at the Similkameen River up to 1,900 metres at the highest mountains. Over 80 % of the area is above the 1,250 metre elevation. Based on runoff measured in the region, a runoff yield of 149 da-m^3/km^2 is predicted resulting in 3,500 da-m^3 of annual runoff. The annual mean flow, however based on a limited record of flows near the mouth of Cahill Creek, is estimated at 2,000 da-m^3. The watershed has a southwestern exposure and the potential evapotranspiration in the southern reaches is expected to be very high throughout the spring and summer months.

The Nickel Plate Homestake mine has an extensive operation with 30 km^2 of land within their claim. Approximately 3.0 km^2 of this land is disturbed by the mining operation. The runoff from much of the disturbed area is contained in local depression storage and a large tailings pond located immediately north of the creek at the 1,380 metre elevation. Water contained on-site reduces the capacity of the watershed.

There are 27 groundwater wells noted in the watershed, all located within the mine site. No large capacity wells are noted with the maximum capacity at 100 USgpm or lower. The majority of wells on the mine site are for tailing pond seepage control or are not in use.

The mine is the second largest user of water in the Cahill Creek drainage area. The largest is for 1,150 da-m^3 of water for for irrigation of 310 acres near the mouth of the creek. It is estimated that annually, 1,450 da-m^3 of water is licensed and used.

Potential for the development of storage is small. The creek is very steep and the storage developed would be expensive to construct.

Winters Creek

Winters Creek drains a medium sized area of 55 km^2 to the Similkameen River. Elevations in the watershed range from 495 metres at the Similkameen River up to 2,200 metres at the top of Apex Mountain. Over 80 % of the area is above the 1,250 metre elevation. An estimated 10,300 da-m^3 of runoff is expected annually based on a runoff yield of 187 da-m^3/km^2.

The watershed collects runoff from much of the high plateau in the vicinity of Mt. Riordan, Apex and Beaconsfield Mountains.

Four licenses are noted on the creek near the Similkameen River where creek intakes exist. The largest license is 1,245 da-m^3 for irrigation of 338 acres along the river. Potential for the development of storage is low as the creek is very steep and the storage developed would be expensive. No groundwater wells are noted in the watershed.

Bradshaw Creek

Bradshaw Creek drains an area of 20.1 km^2 flowing into the Similkameen River 8 km southeast of Hedley. Elevations in the watershed range from 490 metres at the Similkameen Rivere up to 2,100 for the highest areas. Approximately 90 % of the area is above the 1,250 metre elevation. An estimated 3,600 da-m^3 of runoff is expected annually based on a runoff yield of 180 da-m^3/km^2.

The watershed has a southwestern exposure and the potential evapotranspiration in the southern reaches is expected to be very high throughout the spring and summer months.

Eight licenses are noted on the creek with 3 intakes on the lower reaches of the creek. Water licensed for irrigation amounts to 187 da-m^3 annually.

Potential for the development of storage is low. The creek is very steep and there are no suitable sites for cost effective development of storage. There are no groundwater wells noted in the upper reaches of the watershed.

Minor Creeks Adjacent to Similkameen River

The remaining areas consist of Old Tom Creek, Cold Creek, Shoemaker Creek, Redtop Gulch and several unnamed gulleys that flow from lands on the northeast side of the river into the Similkameen. The remaining area is 90 km^2 with only 22 % of the area above the 1,250 metre elevation. Runoff yield from these creeks is low, estimated at 2,275 da-m^3 of runoff, or a runoff yield of only 25 da-m^3/km^2.

These drainage areas are relatively low in elevation with a southwestern exposure. Evapotranspiration is expected to be very high throughout the spring and summer months.

There are numerous licenses on the Similkameen River but these are not noted in this report. Approximately 35 groundwater wells exist along the river between Hedley and Keremeos. The largest capacity wells are near the mouths of Cahill and Bradshaw Creeks.

The largest consumer of water along the river is the Similkameen Improvement District. The District has approximately 790 ha within its boundaries. The primary source of water is frm wells along the Similkameen River.

Keremeos Creek

Keremeos Creek drains an area of 232 km^2 with the major tributaries including Armstrong, Shuttle, Olalla, Cedar, Loak, Marsel, Yellowlake, South Keremeos, McKay, and Klohtelt Creeks. Keremeos Creek originates near Apex Alpine at the 1,860 metre elevation and discharges to the Similkameen River 3.5 km south of the town at the 430 metre elevation. The average annual runoff from the watershed above Olalla as measured at Station 08NL045 (183 km^2) is 20,000 da-m^3. This area is the most populated within the Seven Peaks area and has the highest irrigation demand.

The watershed has a relatively low runoff yield estimated at 95 da-m^3/km^2. Approximately 50 % of the total drainage area is above the 1,250 metre elevation. The Keremeos valley is somewhat sheltered and is further into the rainshadow area created by the Cascade Mountains.

Yellow Lake, which is a major hydrological feature in the area, is 35 ha in area with a variable storage of 662 da-m^3. Toy Lake, which is much smaller, is located immediately east of Yellow Lake and overflows into Yellow Lake. Ford Lake is another lake that provides a small amount of local storage for irrigation in the north fork of Keremeos Creek.

There are 20 irrigation licenses, 24 licenses for domestic use, 1 license for fish rearing ponds, plus 5 licenses issued to the local water supply authorities, 3 for irrigation for municipal supply and 5 for non potable storage.

The major licensees on Keremeos Creek are:

- The Keremeos Irrigation District is the largest supplier of water with approximately 750 domestic and 50 commercial users in the town of Keremeos, and 250 agricultural water service connections. The Keremeos Irrigation District has 892.4 ac-ft of licensed storage for irrigation, and 10,500

GD (Imperial gallons/day) for domestic supply. Their water is drawn from high capacity wells.

- Lower Similkameen Indian Band with one license for 23 ac-ft irrigation and 1,000 Igpd for domestic;
- Other Licensees totaling 1,200 da-m^3 irrigation and 10,500 GD for 16 dwellings.

Groundwater wells are extensively used for water supply in the study area and do affect the creek. Monitoring wells in the Keremeos valley show a seasonal increase of 1.5 metres in groundwater levels every spring during freshet. In the following summer months, with draws from groundwater, the level decreases by approximately the same amount.

There are approximately 69 groundwater wells in the immediate vicinity of the town. Between Keremeos and Olalla there are another 25 wells, and above Olalla 26 more, with 9 located at Apex Ski Resort. Ten high capacity wells are located in Keremeos, each with a capacity of 500 USgpm or larger. There are 10 high capacity wells north of Keremeos in the upper valley.

The total annual water used from the Keremeos drainage basin, based on irrigated area and number of domestic connections including the town of Keremeos, is estimated as follows:

• Keremeos Irrigation District (domestic)	0.80 da-m3/connection	625 da-m^3
• Keremeos Irrigation District (irrigation)	0.75m x 493 ha	3,700 da-m^3
• Upstream Irrigation		1,230 m^3
• Total estimated water use		5,550 da-m^3

The development of storage in the upper areas of the creek is limited. Raising of the level of dam at Yellow Lake is possible. Construction of water storage will be costly due to the steep valley slopes and steep grades on the creeks. Presently, the largest storage source in Keremeos Creek is groundwater which appears to be effectively recharged during the spring freshet.

Shingle Creek

Shingle Creek drains an area of 308 km^2 to the Okanagan River Channel in Penticton. Major tributaries to Shingle Creek include Shatford, Clark, Deschamps, Riddle, June, and Farleigh Creeks. Elevations in the watershed range from 338 metres at the outlet to the Okanagan River Channel up to 2,050 metres at the top of Green Mountain. With only 50 % of the area above the 1,750 metre elevation, runoff is estimated to be low. Approximately 22,000 da-m^3 of runoff is predicted annually with a runoff yield of 75 da-m^3/km^2. The measured runoff has been lower due to diversions to the Marron Valley and irrigation draws.

The largest storage reservoir is Brent Lake which has a variable capacity of 1,215 dam^3. It is filled by water diverted from Shingle Creek through a flume over the natural topographic divide. Increasing storage at Brent Lake will be difficult as the divide is near high water level for the lake. Farleigh Lake located below Brent Lake has a storage capacity of 343 dam^3. It is filled by releases from Brent Lake. In the 1975 report on water useage from Shingle creek, licensing was allowed for 3,650 dam^3 while an estimated 2,500 dam^3 was actually used (MOE, 1975).

Licenses include 46 domestic, 4 for stock watering, 75 for irrigation and 22 for storage. Total irrigated area is estimated at 1,570 ha. With less water intense farming in the area, a lesser volume of water is required per irrigated area. Total annual water use is estimated at 5,500 dam^3. In addition, an unquantified volume has been diverted through the Kaleden Diversion to the Marron Valley.

Twenty eight (28) groundwater wells are noted in the watershed with none having capacities above 100 USgpm.

There are no obvious sites for storage on Shingle Creek At the present time, development of additional storage is not necessary.

Shatford Creek (sub basin to Shingle Creek)

Shatford Creek is the largest tributary to the Shingle Creek watershed and drains an area of 148 km^2. Elevations in the watershed range from 620 metres at the intersection with Shingle Creek, up to 2,050 metres at the top of Green Mountain.

With only 58 % of the drainage area above the 1,250 metre elevation 12,000 da-m^3 of runoff is expected annually based on a runoff yield of 81 da-m^3/km^2.

Licenses include 10 domestic users along Green Mountain Road, 7 domestic licenses around Farleigh Lake, 1,800 da-m^3 of water licensed for irrigation and 2,743 da-m^3 of water for storage. In addition to the water drawn off for irrigation, there is a 1,200 mm steel conduit that was used to divert water from Shatford Creek into the Marron Valley and to Kaleden. Kaleden now obtains water from other sources.

Thirteen (13) groundwater wells noted in the watershed with none having capacities above 100 USgpm.

Marron Valley

The Marron Valley consists of an area of 72 km^2. Elevations in the drainage area range from 338 metres at Skaha Lake to 1,566 metres at the highest elevations. Approximately 75 % of the area is below the 1,250 metre elevation. Based on elevation, runoff of 2,000 da-m^3 is expected from the watershed on an annual basis.

The significant hydrological features in the basin are Aeneas and Marron Lakes. The lakes are man made, created by dams located at the south end of each lake. Trout Lake, located at the western limits of the drainage area, is a sinkhole with runoff water escaping through ground infiltration and or evapotranspiration.

The storage volume in Aeneas Lake is approximately 555 da-m^3. The dam on Aeneas Lake is in poor shape and water levels are kept at low levels as recommended by B.C. Environment. Marron Lake has a variable storage capacity of 713 da-m^3 and is used for supplying irrigation water to the local area.

Licenses include 3 for domestic use, 34 for irrigation, and 46 for storage. Approximately 520 acres of land is allowed 2,190 da-m^3 of water annually.

The majority of domestic users in the valley obtain water from groundwater wells. There are 58 groundwater wells in the area. None of the wells are of high capacity and the number is use is not known.

The development of additional storage is not feasible unless water is diverted from other watersheds. Because water demand is not high in this area, it is unlikely that additional storage will be developed in the near future.

Summary

Total annual runoff is estimated for various creeks in the study area based on elevation and percentage of land. Table 4.5 summarizes the total annual runoff that each of the creeks will produce on an annual basis excluding diversions, storage, and withdrawls.

A frequency analysis was conducted using a number of cumulative distribution analysis methods. The best fit for all runs on the creeks was the Log Pearson III method. The best fit for the Similkameen River was the 3 parameter Log Normal cumulative distribution.

Table 4.5
Total Annual Runoff

Description	Drainage Area (km2)	Drainage Basin Yield (da-m³/km³)	Mean Annual Runoff (da-m³)	1:10 Dry Year Runoff (da-m3)	1:10 Wet Year Runoff (da-m3)	Est. water use (da-m³)
Similkameen River Sub-basins						
Hedley Creek (Excluding McNulty)	190	200	36,800	20,800	55,800	1,300
Nickel Plate Creek	35	257	9,000	5,400	13,500	1,050
Nickel Plate Lake	8.1	339	2,750	1,650	4,160	1,050
Cahill Creek	23.5	149	3,500	2,100	5,250	1,450
Winters Creek	55.0	187	10,300	6,200	15,400	1,250
Bradshaw Creek	20.4	180	3,600	2,200	5,400	187
Remaining Creeks	90	25	2,275	1,300	3,400	-
Keremeos Creek	232	95	22,000	13,400	32,120	5,000
Okanagan Sub-basin						
Shingle Creek at Mouth	308	75	22,000	9,900	30,800	5,500
Shatford Creek	142	81	12,000	5,500	21,600	1,800
Marron River Valley	72	28	2,000	-	-	2,200

4.5 CONCLUSIONS AND RECOMMENDATIONS

Upon review of hydrology in the region, the following is concluded:

- Annual water use within the Seven Peaks area has been consistent in recent years with no major expansion or development projects in the valleys and nearby towns;
- In review of precipitation, evapotranspiration and runoff characteristics in the area, it appears that the elevation of zero runoff is in the range of 1250 metres.
- There are 4 major areas within the study boundaries, Hedley Creek, Keremeos Creek, the Shatford/Shingle Creek area and Marron Valley.
- The Hedley Creek watershed is the least habited and least disturbed area with the highest runoff yield. Marron Valley is the driest area.
- Within the study area, irrigation creates the highest demands from the water resource.

- Groundwater withdrawals are highest in the Keremeos valley. The groundwater table appears to recover with each spring freshet. Groundwater monitoring well data confirms this.
- The only major storage reservoir in the area is Nickel Plate Lake. There is limited opportunity for development of additional cost effective reservoir storage.
- The diversion of 123 da-m^3 from the Hedley to Keremeos Creek basin will have a minimal effect on either creek. In terms of total annual runoff, flows would be affected by less than 0.25 % on either creek. Runoff from additional snow making would likely occur in the last quarter of spring freshet on Keremeos Creek. This would produce more runoff for groundwater recharge of the acquifers along Keremeos Creek which would be particularly beneficial during drier years.
- For forest harvested areas within the study area, there will be increased yield in runoff during the spring freshet but this will reduce and eventually recover to original levels as the harvested areas are replanted and regrow.
- Information is limited at the WSC station at the mouth of Shingle Creek. It appears that there is a significant volume of water that is unaccounted for, even with the exclusion of irrigation demands and diversions to the Marron Valley. With only four years of full record, the results are erratic with a wide variance of flow. A longer period of flow recording would be needed to properly assess the volume of water now available at the mouth of Shingle Creek.

SECTION 5.0

WATER QUALITY

Reid Crowther

SECTION 5.0
WATER QUALITY

5.1 INTRODUCTION

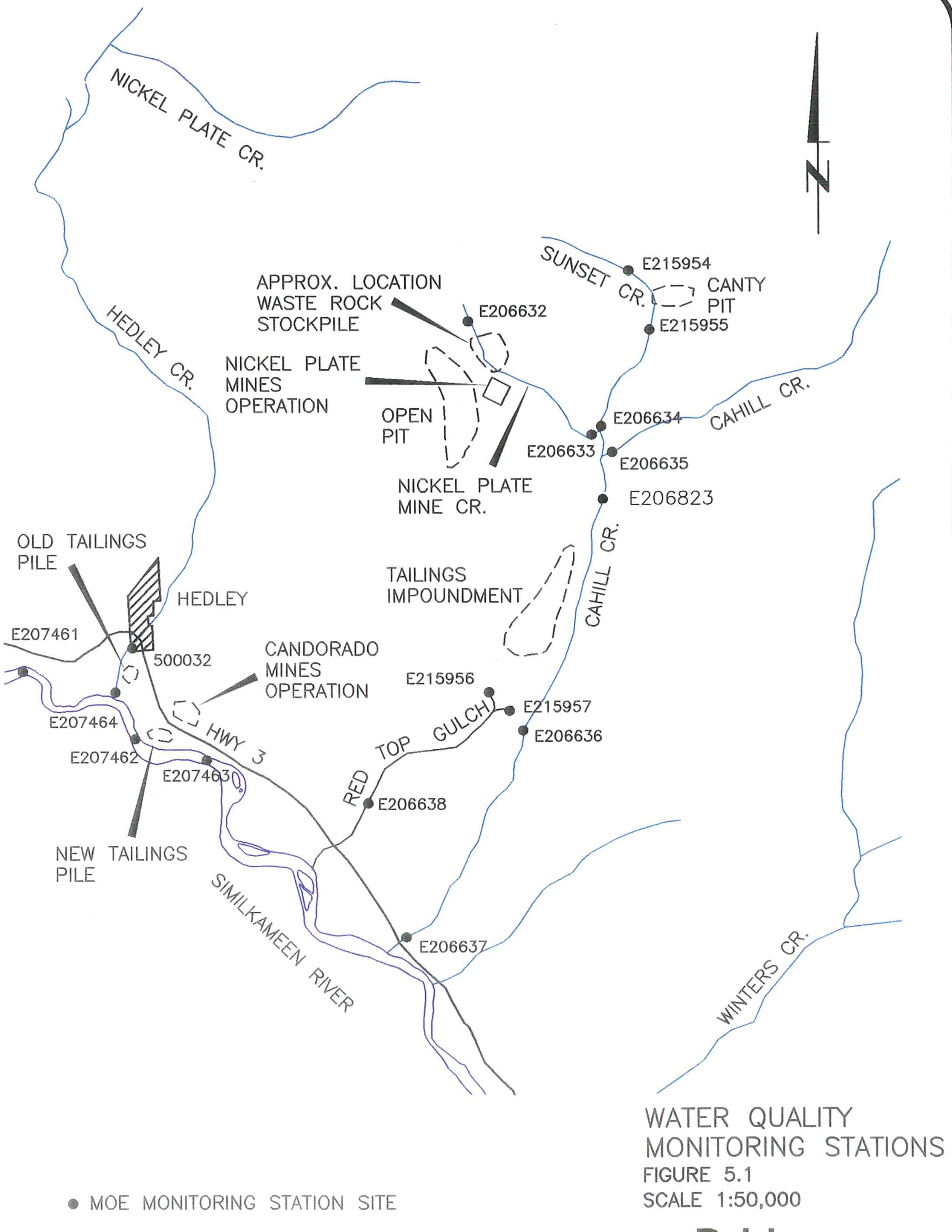
This section summarizes water quality data for the major water bodies within the Seven Peaks Study Area. The impacts of discharges from a number of point sources has been discussed and, the trends and effects observed at various monitoring stations have been summarized where there is sufficient data to do so. This section also summarizes the overall water quality of the study area, identifies important data gaps and makes recommendations to improve the data base.

The Ministry of Environment has indicated that land use and water characteristics are the most important factors in determining when and where future water quality data is collected.

There is no water quality data available for the lakes in the Study Area, although dissolved oxygen has been monitored as part of a fisheries project in Yellow Lake. Also, there is no water quality data for Winters, Bradshaw, and Shoemaker Creeks or the Marron Valley Watershed.

Water quality data is available as follows:

Similkameen River Sub-basin:	Hedley Creek, Red Top Gulch Creek, Cahill Creek, Nickel Plate Mine Creek, Sunset Creek and Ashnola River.
Keremeos Creek:	Upper Keremeos Creek, South Keremeos Creek, Olalla Creek, Cedar Creek, Marsel Creek and Lower Keremeos Creek.
Shingle Creek:	Shingle Creek and Shatford Creek.
Groundwater Data:	Hedley area, Keremeos area and the Apex area.



WATER QUALITY MONITORING STATIONS

FIGURE 5.1

SCALE 1:50,000

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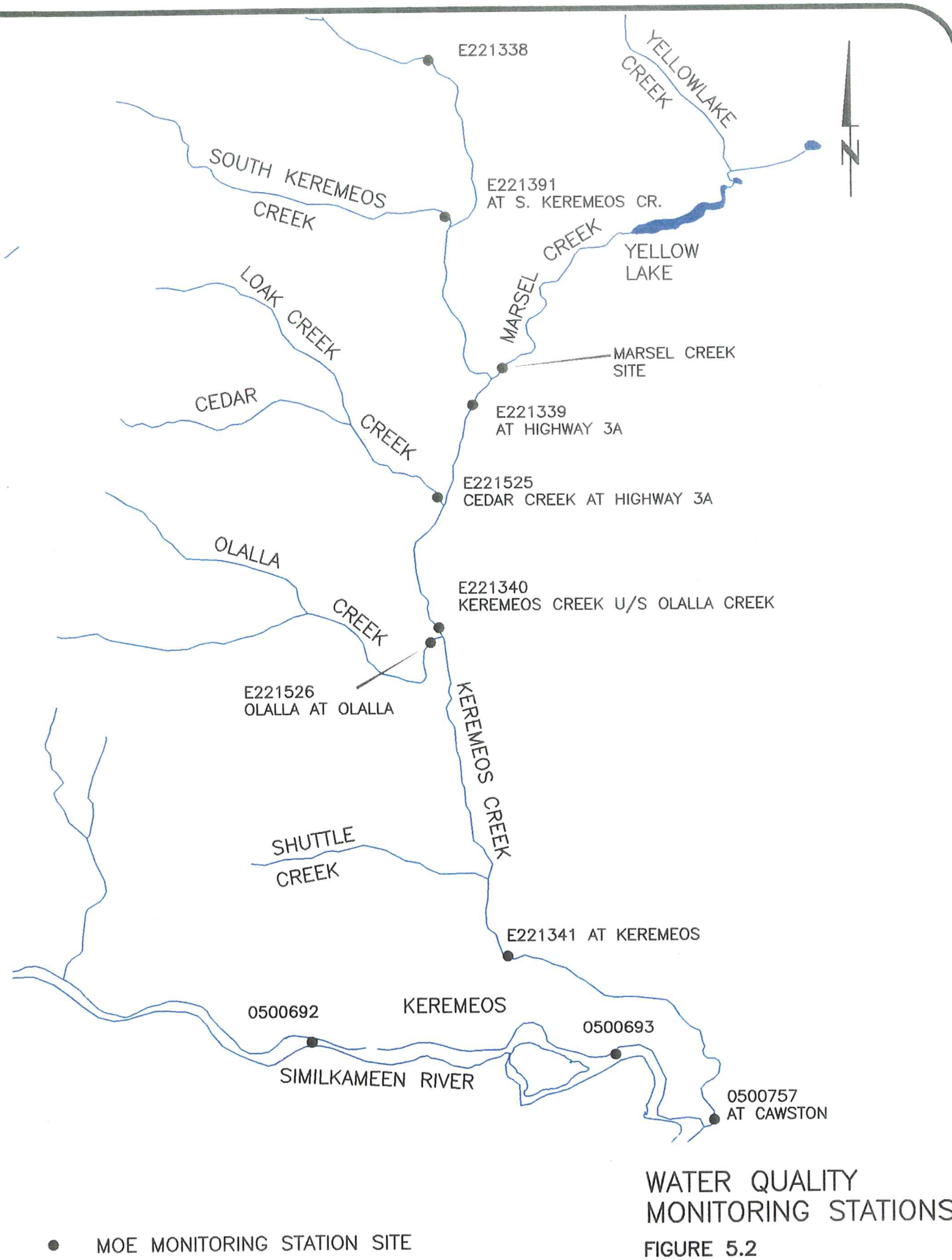

WATER QUALITY MONITORING STATIONS

FIGURE 5.2

SCALE 1:100,000

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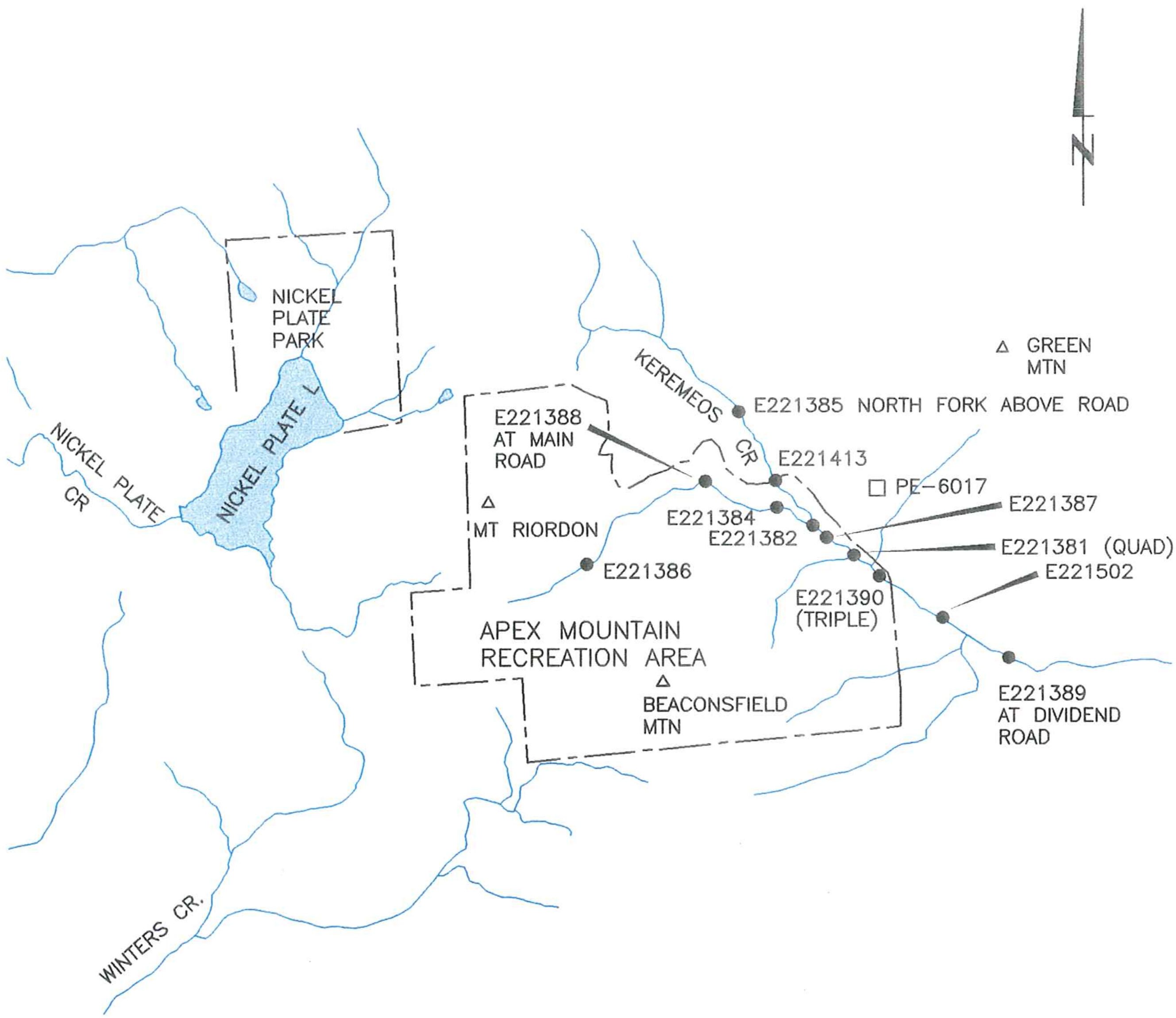

WATER QUALITY MONITORING STATIONS

FIGURE 5.3
SCALE 1:50,000

● MOE MONITORING STATION SITE
□ SEWAGE TREATMENT PLANT PERMIT PE-6017

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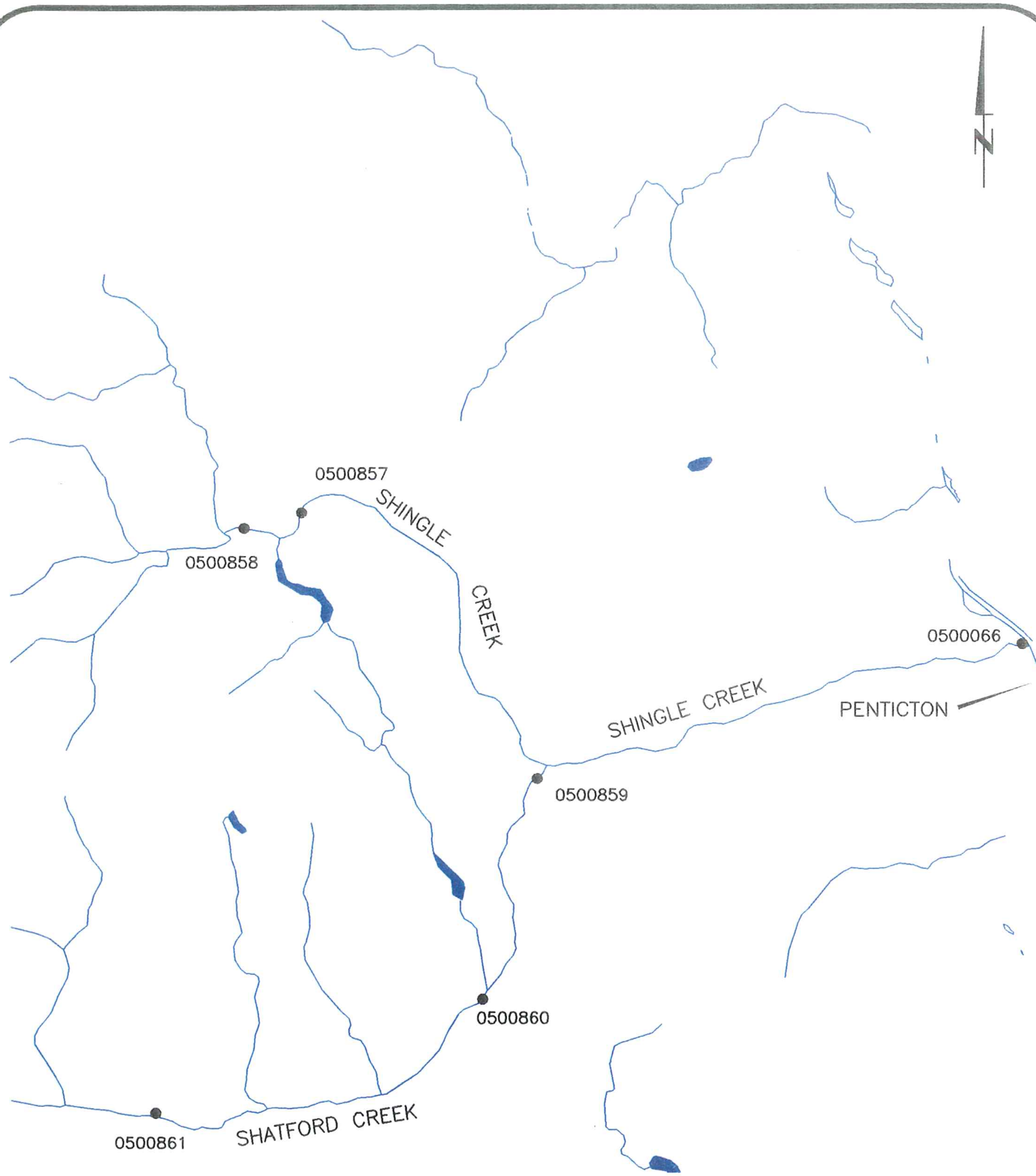

WATER QUALITY MONITORING STATIONS

FIGURE 5.4

SCALE 1:100,000

● MOE MONITORING STATION SITE

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There is a record of all pesticide use, since 1978, in the Study Area kept on file at the Ministry of Environment in Penticton. There is no water quality information on pesticides in the Study Area (S. Craig, pers. comm.).

5.2 SIMILKAMEEN RIVER SUB-BASIN WATERSHED

The Similkameen River flows over 200 kilometers and drains approximately 9,600 km^2 of southern interior British Columbia and northern Washington State (Sherwood, 1983). The river starts in the Cascade Mountains and passes through Princeton, Hedley, and Keremeos before crossing the border and converging with the Okanagan River in northern Washington State. The portion of the Similkameen River included in the study is from Hedley to Keremeos. As listed above, water quality information is available for: Similkameen River, Hedley Creek, Red Top Gulch Creek, Cahill Creek and its tributaries, as well as Ashnola River which is outside the Study Area, but is a major tributary to the Similkameen River.

The water uses of the Similkameen River Sub-basin include domestic supply/drinking water, irrigation, recreation and fisheries (Swain, 1990). The Similkameen River is an important sports fishing resource. Drinking water is obtained from groundwater wells and there are ranching activities along the Similkameen River Valley. The river eventually flows across the border to Washington State and therefore is of international concern.

The Ministry of Environment has developed water quality objectives for the Similkameen River Sub-basin to protect irrigation, livestock watering, wildlife, recreation, fisheries habitat and drinking water quality. The objectives include suspended solids, nutrients, turbidity, cyanide compounds and metals.

The Ministry of Environment has created several monitoring stations to assess ambient water quality throughout the sub-basin. These stations are shown in Figures 5.1, 5.2, 5.3 and 5.4. The Ministry of Environment has a methodology by which they collect their monitoring data: water samples are collected from May to August and usually consist of five sampling events over a thirty day period.

The main references for the water quality data summarized in this section are the Water Quality Assessment and Objectives Attainment Reports prepared annually by Water Management Branch, Ministry of Environment, Victoria. *All of the data presented in the attainment reports has been reviewed, however only data which presents the current or latest state of water quality or data which indicates trends in the water quality has been summarized in this report.*

5.2.1 Hedley Creek

Hedley Creek converges from the north with the Similkameen River at the town of Hedley. The designated water uses for Hedley Creek are for domestic supply/drinking water, aquatic life, wildlife, livestock and irrigation (Swain, 1990). Hedley Creek water quality objectives were implemented in 1990 to prevent impacts from the recent start up of Candorado Mines Ltd. which is a heap leach process to extract gold from old tailing piles located adjacent to Hedley Creek and the Similkameen River. The leaching process started in 1988, operations shutdown between 1991 - 1992 and resumed again in 1992. These operations are located just east of Hedley. There are also domestic septic discharges to land along Hedley Creek.

Water Quality Objectives for Hedley Creek specifically include cyanide compounds, heavy metals and physical parameters (pH, conductivity, temperature, etc.) to prevent potential impacts from mining operations. Ministry of Environment monitoring data is summarized in Table 5.1. Candorado Mines collects data form groundwater monitoring wells and Hedley Creek and the Similkameen River to fulfill the requirements for their operating permit (PA-7893). The data for groundwater is reviewed and presented in Section 5.5.

The Ministry of Environment has collected data on Hedley Creek in 1990 and 1993. The two sample locations shown on Figure 5.1. The first (500032) is upstream of the mining operation at Highway 3. This site is used as a control site for the second sample station (E207464) at the confluence of Hedley Creek and the Similkameen River. These sample locations are used to monitor for possible impacts of Candorado's mining operation. Ministry of Environment has also collected historical water quality data in the 1970's, however the data is not in a readily usable form to be summarized.

The sampling results indicate that total aluminum has been slightly above objectives set for Hedley Creek at both sampling locations. Total arsenic levels are higher downstream of the mining operation, however the levels are below objectives set for the creek. The level for suspended solids from upstream was exceeded during one sampling event in 1993. Also, suspended solids increased at station 500032 between 1990 and 1993.

Table 5.1 - MOE Monitoring Data for Hedley Creek

Parameter	Objective	500032 1990 (n=4,5)	E207464 1990 (n=4,5)	500032 1993 (n=5)	E207464 1993 (n=5)
Suspended Solids	max. increase 10 mg/L or 10%	1 - 4	1 - 7	43 - 56	max. inc. not on one event
Turbidity (NTU)	max. increase 1-5 NTU or 10%	0.3 - 9.8	0.3 - 1.0	0.2 - 0.4	0.2 - 0.4
WAD-CN	<0.005 mg/L av, 0.01 mg/L max.	<0.005	<0.005 - 0.005	<0.005	<0.005 av. 0.006 max.
SAD-CN + thiocyanate (as CN)	0.2 mg/L max. or 20% increase	<0.032	<0.031	<0.045	<0.038
Cyanate (as CN)	0.45 mg/L max.	<0.05	<0.05	<0.05	<0.05
Ammonia	<1.09 mg/L av., 5.68 mg/L max.	<0.005 - 0.011	0.006 av. 0.011 max.	<0.005	<0.005
pH (pH units)	6.5 - 8.5	7.4 - 7.7	7.4 - 7.7	---	---
Arsenic - T	0.05 mg/L max.	<0.001	0.005 - 0.016	<0.001	<0.002 - 0.006
Aluminum - D	<0.05 mg/L av., 0.1 mg/L max. or 20 % inc.	0.02 - 0.09 0.07 av.	0.01 - 0.11 0.07 av.	0.06 av. 0.09 max.	0.054 av. 0.09 max.
Chromium - T	<0.002 mg/L av., 0.02 mg/L max. or 20 % inc.	<0.01	<0.01	<0.002 - 0.002	<0.002 - 0.002
Copper - T	<0.002 mg/L av, 0.006 mg/L max. or 20 % inc.	<0.001 - 0.002	0.001 av. 0.002 max.	0.002 av. 0.004 max./	<0.002 - 0.002
Iron - T	0.3 mg/L max. or 20 % inc.	0.11 - 0.17	0.10 - 0.17	0.09 - 0.17	0.10 - 0.18
Lead - T	<0.004 mg/L av., 0.007 mg/L max. or 20 % inc.	0.001 - 0.006	0.001 av. 0.002 max.	<0.003	<0.003
Manganese - T	0.05 mg/L max. or 20 % inc.	<0.01	<0.01	<0.002 - 0.003	<0.002 - 0.004
Mercury - T (μg/L)	<0.02μg/L av., 0.1 μg/L max.	<0.05	<0.05	<0.005 - 0.005	<0.005 - 0.006
Molybdenum - T	<0.01 mg/L av., 0.05 mg/L max.	<0.01	<0.01	<0.004	<0.004
Nickel - T	0.02 mg/L av., 0.05 mg/L max. or 20 % inc.	<0.05	<0.05	<0.01	<0.01
Uranium - T	<0.01 mg/L av., 0.1 mg/L max. or 20 % inc.	<0.0002 - 0.0007	0.0005 av. 0.001 max.	0.0003 -0.0005	0.0003 - 0.0008
Zinc - T	<0.01 mg/L av., 0.03 mg/L max. or 20 % inc.	<0.005 - 0.015	0.018 av. 0.07 max.	0.01 av. <0.01 - 0.02	<0.01 - 0.01

n = number of sampling events, D = dissolved metals, T = total metals.
All results reported in mg/L (ppm), except where noted.

5.2.2 Red Top Gulch Creek

Red Top Gulch Creek converges from the north with the Similkameen River approximately two kilometers east of Hedley as shown in Figure 5.1. The head waters of the creek are down gradient of a tailings pond operated by Homestake Mines Inc., who operate the Nickel Plate Mine. Water quality objectives were developed in 1986 by the Ministry of Environment for this creek to prevent impacts from seepage discharges which may occur from the mine operation. The designated water uses for this creek are aquatic life, wildlife, livestock watering, drinking water and irrigation (Swain, 1987).

The water quality objectives for this water course specifically include cyanide compounds, heavy metals and nutrients to prevent potential impacts from mining operations of Nickel Plate Mine which restarted operations in 1987 after a shut-down in 1956. The creek has been monitored at station E206638 by the Ministry of Environment annually since 1987. Homestake Mines also collects monthly monitoring data as part of the requirements under their operating permit (PE-07613-03).

The intermittent flow of the creek is sampled just upstream of its confluence with the Similkameen River above Highway 3 (station E206638). There are two other stations at the headwaters of the creek, monitored by Homestake Mines: E215956 on the West Fork and E215957 an the East Fork. These sample locations are just down gradient of the Nickel Plate Mine Tailings Pond.

Ministry of Environment monitoring data is presented in Table 5.2 and is summarized for 1987, 1989, 1992 and 1994. We have not included data from Homestake Mines because it was not available in a readily usable summarized form. The data is comparable to Ministry of Environment's data and does not alter the results of the analysis.

The sampling results for Red Top Gulch Creek indicate that most of the objectives are being met. The results for nitrates and total dissolved solids have increased since startup of operations in 1987, however they are still well below the MOE objectives. The sulphate have also increased since start up and the levels greatly exceeded the objective for average sulphates in 1992. Homestake Mines monitoring results for sulphates, nitrates and total dissolved solids indicate that the levels have decreased since 1993 and have remained stable for the last two years, however they also show that the sulphates exceed objectives. Homestake Mines sampling results from stations upstream (E215956, E215957) at the headwaters show that objectives are being exceeded for cyanide (weak-acid dissociable, WAD), sulphates and total dissolved solids. These levels are being attenuated before it reaches station E206638.

Table 5.2 - MOE Monitoring Data for Red Top Gulch Creek

Parameter	Objective	E206638 1987 (n=5,6)	E206638 1989 (n=9)	E206638 1992 (n=5)	E206638 1994 (n=5)
Suspended Solids	10 mg/L or 10% max. increase	<1 - 13	1 - 8	---	<4
Turbidity (NTU)	5 NTU or 10% max. increase	0.2 - 0.9	0.2 - 2.4	---	0.2 - 0.3
Dissolved Solids	500 mg/L max.	190 - 248	134 - 246	---	410 - 452
Sulphates	<50 mg/L av., 150 mg/L max.	25.7 max.	30.4 av. 34.5 max.	156 av.	137 av.
WAD-CN	<0.005 mg/L av, 0.01 mg/L max.	<0.005 av. 0.006 max.	<0.005 av. 0.007 max.	0.006 av. 0.008 max.	<0.001 - 0.003
SAD-CN + thiocyanate(as CN)	0.2 mg/L max.	---	<0.030 - 0.116	0.035 - 0.052	<0.025 thiocyan. only
Cyanate (as CN)	0.45 mg/L max.	<0.1	<0.05 - 0.52	<0.05	<0.05
Ammonia	<0.491 mg/L av., 3.61 mg/L max.	<0.005 av. 0.007 max.	0.053 av. 0.138 max.	---	---
pH (pH units)	6.5 - 8.5	7.8 - 8.4	7.6 - 8.5	7.4 - 8.4	8.2 - 8.3
Nitrite - N	<0.02 mg/L av., 0.06 mg/L max.	<0.005 max.	0.009 av. 0.011 max.	<0.005 - 0.005	<0.005 - 0.006
Nitrate - N	10 mg/L max.	0.05 max.	0.06 - 1.23	5.62 - 6.04	5.92 - 6.11
Arsenic - T	0.05 mg/L max.	0.009 - 0.014	0.002 - 0.013	<0.04	<0.0005
Aluminum - T	<0.3 mg/L max.	0.23 - 0.32	0.02 - 0.12	0.02 - 0.04	<0.06
Cadmium - T	0.0002 mg/L max.	<0.0003	<0.0005	<0.0005	<0.002
Copper - T	<0.005 mg/L av, 0.007 mg/L max. or 20 % inc.	0.002 max.	0.004 av. 0.012 max.	0.003 av. 0.004 max.	<0.002
Iron - D	0.3 mg/L max.	<0.01	<0.005 - 0.091	0.027 - 0.048 (Iron - T)	<0.05
Lead - T	<0.005 mg/L av., 0.015 mg/L max. or 20 % inc.	0.002 - 0.004	0.004 max.	0.003 max.	<0.03
Mercury-T (µg/L)	<0.1 µg/L max.	0.25	<0.05	<0.005 - 0.006	---
Molybdenum - T	0.01 mg/L av., 0.05 mg/L max.	0.014 av. 0.02 max.	0.01 av. 0.02 max.	0.005 av. 0.007 max.	<0.004 - 0.006
Selenium - T	0.001 mg/L max.	<0.01	<0.005	<0.005 - 0.008	<0.03
Silver - T	0.0001 mg/L or 20 % inc	<0.0005	---	<0.0005	<0.03
Zinc - T	0.05 mg/L max.	0.01 max.	<0.01	<0.002 - 0.007	<0.01 - 0.01

n = number of sampling events, D = dissolved metals, T = total metals.
All results reported in mg/L (ppm), except where noted.

5.2.3 Nickel Plate Mine Creek

Nickel Plate Mine Creek flows into Cahill Creek. The creek, about 1.6 km in total length, flows between Nickel Plate Mountain and Lookout Mountain and is the closest creek to the Nickel Plate Mine. The designated uses for Nickel Plate Mine Creek are for protection of wildlife and livestock (Swain, 1987). The Ministry of Environment developed criteria for the creek in 1987.

Nickel Plate Mine Creek was monitored by both Ministry of Environment and Homestake Mines annually from 1987 to 1992. The Ministry of Environment collected data from two stations, E206632 upstream of the waste rock piles and E206633 at the confluence with Sunset Creek annually from 1987 to 1989 and additional data for the downstream location in 1993 and 1994. The upstream station is used as a control site to monitor impacts of waste rock drainage on Nickel Plate Mine Creek. Homestake Mines has monitored the downstream station monthly since 1987 as part of the requirements under their operating permit (PE-07613-03). The sample locations are shown in Figure 5.1. Table 5.3 summarizes Ministry of Environment monitoring data for station E206633 for 1987, 1989 and 1993. It also summarizes monitoring data for station E206632 for 1987 and 1989, which is the upstream location. The comparison indicates the impact the waste rock drainage is having on water quality.

Most water quality objectives for Nickel Plate Mine Creek are being met with exception of sulphates and total dissolved solids. The sampling results indicate that there is an increase in the levels of sulphates, nitrates and total dissolved solids both with time and distance along the creek itself. These increases are also being seen downstream in Cahill Creek. The monitoring data indicates that this watercourse is the primary source of the increase in sulphates, nitrates and total dissolved solids in Cahill Creek.

Although not used in the analysis, the Homestake Mine monitoring data is comparable to Ministry of Environment data. Homestake Mines' monitoring data for 1994 and 1995 show continuing increases in the levels for sulphates, nitrates and total dissolved solids. Based on the results of the 1993 monitoring data which had exceeded the MOE objectives, Homestake Mines diverted the flow of Nickel

Plate Mine Creek to the tailings pond in 1994 to reduce the levels of sulphates, nitrates and total dissolved solids entering Cahill Creek. This has resulted in lower levels of nitrates and sulphates at stations E206636 and E206637 downstream on Cahill Creek. The mine is now meeting the MOE water quality objectives for Nickel Plate Mine Creek.

Table 5.3 - MOE Monitoring Data for Nickel Plate Mine Creek

Parameter	Objective	E206632 1987 (n=5)	E206633 1987 (n=5,6)	E206632 1989 (n=5)	E206633 1989 (n=5)	E206633 1993 (n=5)
Suspended Solids	max. increase 20 mg/L or 20%	<1	<1 - 5	<1 - 6	<1 - 4	<4
Turbidity (NTU)	max. increase 5 NTU or 10%	0.2	0.2 - 0.6	0.1 - 0.5	0.1 - 0.4	<0.1 - 0.4
Dissolved Solids	500 mg/L max.	88 - 102	236 - 286	72 - 118	390 - 492	976 - 1090
Sulphates	<50 mg/L av., 150 mg/L max.	4.1 max.	33.3 av. 43.4 max.	2.9 - 4.0	96.0 av. 99.0 max.	258 av. 312 max.
pH (pH units)	6.5 - 8.5	7.4 - 7.9	7.6 - 8.3	7.3 - 8.1	7.6 - 8.6	8.2 - 8.3
Nitrite - N	10 mg/L max.	<0.005	<0.005 max.	<0.005	<0.005	<0.005 - 0.011
Nitrate - N	100 mg/L max.	<0.02 - 0.03	0.51 - 0.72	<0.02 - 0.1	7.65 - 17.9	56.9 - 66.0
Arsenic - T	0.5 mg/L max.	<0.001 - 0.002	0.014 - 0.018	<0.001 - 0.003	<0.001 - 0.02	<0.04
Cadmium - T	0.02 mg/L max.	<0.0005 - 0.005	<0.0005	<0.0005	<0.0005	<0.0002
Copper - T	0.3 mg/L max.	---	---	0.004 max.	0.003 max.	<0.002 - 0.007
Iron - D	0.3 mg/L max.	<0.01	<0.01	<0.005 - 0.005	<0.005 - 0.005	<0.003 - 0.008
Lead - T	0.1 mg/L max.	0.002 - 0.003	<0.001 - 0.003	0.009 max.	0.002 max.	<0.03
Mercury-T (μg/L)	3 μg/L max.	0.27 max.	0.28 max.	<0.05	<0.05	<0.005 - 0.013
Molybdenum - T	0.05 mg/L max.	<0.01	<0.01 - 0.02	<0.01	<0.01	<0.004
Selenium - T	0.05 mg/L max.	---	<0.01	<0.005	<0.005	0.023 - 0.045
Silver - T	0.05 mg/L or 20 % inc.	<0.0005	<0.0005	---	---	<0.0001
Zinc - T	0.05 mg/L max.	0.01 max.	0.01 max.	<0.01 - 0.12	<0.01	<0.01

n = number of sampling events, D = dissolved metals, T = total metals.
All results reported in mg/L (ppm), except where noted.

5.2.4 Sunset Creek

Sunset Cree
k flows along the east side of Lookout Mountain and converges with Nickel Plate Mine Creek and ultimately with Cahill Creek. There are no water quality objectives for this creek except for suspended solids and turbidity. The designated water uses for Sunset Creek are for wildlife and livestock watering (Swain, 1987). Sunset Creek is thought to have been influenced by drainage from waste rock associated with the former Canty Mine (1939 -1941). Sunset Creek now flows through an open pit and is affected by leachate and run-off from the pit and waste rock dump (J. Bryan, MOE - Penticton, pers. comm.).

There are three monitoring stations on Sunset Creek as shown on Figure 5.1. Station E206634 is at the mouth of the creek, and stations E215954 and E215955 are above and below the Canty Pit respectively. The Ministry of Environment has collected suspended solids and turbidity data at the mouth Sunset Creek in 1987 and 1988, and turbidity changes annually through the Canty Pit between 1991 and 1994. Homestake Mines has collected monitoring data at the three stations on Sunset Creek monthly from 1987 to fulfill the requirements of their operating permit (PE-07613-03). Homestake Mines samples for additional parameters similar to those on other creeks.

The Ministry of Environment and Homestake Mine monitoring data meet the objectives set for suspended solids and turbidity. Homestake Mine's monitoring data indicates that the levels of sulphates, nitrates and total dissolved solids, in Sunset Creek at the mouth, are higher than in 1987 but have not increased over the past three years and are substantially lower than Nickel Plate Mine Creek. Dissolved arsenic levels have increased in Sunset Creek and exceed objectives for the stations on lower Cahill Creek, however, arsenic levels are being attenuated downstream in Cahill Creek as measured at station E206637. All other parameters analyzed are below the water quality objectives set for lower Cahill Creek. The results for stations E215954 and E215955 indicate that nitrate, sulphate, total dissolved solids and dissolved arsenic levels increase through the Canty Pit. Homestake Mine monitoring data was not included because it was not available in a readily usable summarized form, however it is on file with the Ministry of Environment - Penticton.

5.2.5 Cahill Creek

Cahill Creek is a tributary of the Similkameen River and receives flow from Nickel Plate Mine and Sunset Creeks. Cahill Creek flows along the east side of the mine tailings pond. The Ministry of Environment developed water quality objectives for all of Cahill Creek in 1987 for the protection of drinking water, wildlife, irrigation and livestock (Swain, 1987). In the reach of Cahill Creek, downstream of Highway 3, water quality objectives were also set to protect aquatic life. The objectives for this water course specifically include cyanide compounds, heavy metals and nutrients to prevent potential impacts from mining operations of Nickel Plate Mine.

The Ministry of Environment has four monitoring stations on Cahill Creek. The stations are shown in Figure 5.1. The Ministry of Environment has collected data at the mouth of the creek, station E206637, annually since 1986. Data has been collected annually for station E206636 from 1986 to 1989 and 1993 and 1994. This station is directly downstream of the tailings pond. Monitoring data for station E206635 has been collected for 1993 and 1994, this station is upstream of the mine operations and is used as a control site for lower Cahill Creek. All water quality objectives set for the creek are being met at this station. The Ministry of Environment also collects water quality data from a station, E206823, downstream of the confluence of Nickel Plate Mine Creek, Sunset Creek and upper Cahill Creek and upstream of the tailings pond. The water quality data for this station is kept on file by the Ministry of Environment - Penticton. Homestake Mines has collected monitoring data for the four stations annually since 1987 to fulfill requirements under their operating permit (PE-07613-03).

Table 5.4 summarizes Ministry of Environment monitoring data for stations E206637 and E206636 for 1987 and 1994 and E206635 for 1994. The data indicates that there has been an increase in the levels of sulphates, nitrates and total dissolved solids over this period. All water quality objectives are being met except for the objective for nitrates was exceeded at E206637 in 1994. Although not included in this report, Homestake Mine monitoring data is comparable to Ministry of Environment monitoring data. Homestake Mines monitoring data indicates that the levels of sulphates, nitrates and total dissolved solids have decreased from 1993 levels and all water quality objectives are being met, since Nickel Plate Mine Creek was diverted into the tailings pond in 1994. The diversion of Nickel Plate Mine Creek was to reduce the high levels of nitrates entering into Cahill Creek.

Table 5.4 - MOE Monitoring Data for Cahill Creek

Parameter	Objective	E206636 1987 (n=5)	E206637 1987 (n=5-8)	E206635 1994 (n=5)	E206636 1994 (n=5)	E206637 1994 (n=5)
Suspended Solids	max. increase 10 mg/L or 10%	1 - 2*	<1 - 13	---	<4*	<4 - 7
Turbidity (NTU)	max. increase 5 NTU or 10%	0.3 - 1.3	0.3 - 2	0.3 - 0.8	0.3 - 0.7	0.5 - 2.5
Dissolved Solids	500 mg/L max.	104 - 130	108 - 160	---	346 - 512	368 - 500
Sulphates	<50 mg/L av., 150 mg/L max.	10.8 av. 12.0 max.	10.9 av. 17.4 max.	7.7 av. 9.4 max.	---	64 av. 117 max.
WAD-CN	<0.005 mg/L av, 0.01 mg/L max.	---	0.006 av. 0.009 max.	<0.001	---	0.001 av. 0.003 max.
SAD-CN + thiocyanate (as CN)	0.2 mg/L max.	0.03 - 0.04	0.03 - 0.04	<0.025 thiocyan. only	---	<0.025 thiocyan. only
Cyanate (as CN)	0.45 mg/L max.	---	<0.1	<0.05	---	<0.05
Ammonia	<0.491 mg/L av., 3.61 mg/L max.	---	0.005 av.	---	---	---
pH (pH units)	6.5 - 8.5	7.7 - 8.4	7.7 - 8.6	---	---	8.1 - 8.2
Nitrite - N	<0.02 mg/L av., 0.06 mg/L max.	<0.005*	<0.005	<0.005 (obj. is 1 mg/L max.)	---	0.01 av. 0.018 max.
Nitrate - N	10 mg/L max.	<0.02 - 0.06	<0.02	<0.02	---	12.5 - 22.4
Arsenic - T	0.05 mg/L max.	0.006 - 0.009	0.007 - 0.009	<0.04	<0.04	<0.0005
Aluminum - T	0.3 mg/L max.	---	0.15 - 0.27	---	---	<0.06
Cadmium - T	0.0002 mg/L max.	<0.0005*	<0.0005	<0.002 (obj. is 0.005)	---	<0.002
Copper - T	<0.005 mg/L av, 0.007 mg/L max. or 20 % inc.	0.002 av.* 0.02 max.	0.002 av. 0.01 max.	<0.002 - 0.003 (obj. is 0.2 max)	<0.002*	0.002 av. 0.003 max.
Iron - D	0.3 mg/L max.	<0.01 - 0.04	<0.01 - 0.06	<0.05 - 0.11	0.08	<0.05 - 0.15
Lead - T	<0.005 mg/L av., 0.015 mg/L max. or 20 % inc.	---	0.002 av. 0.005 max.	<0.03 (obj. is 0.05 max.)	<0.03*	<0.03
Mercury-T (µg/L)	<0.1 µg/L max.	0.26 max.*	0.05 max.	---	---	---
Molybdenum - T	0.01 mg/L av., 0.05 mg/L max.	0.01 av. 0.01 max.	0.01 av. 0.01 max.	<0.004	<0.004	<0.004
Selenium - T	0.001 mg/L max.	<0.01*	<0.01 - 0.03	<0.03	<0.03*	<0.03
Silver - T	0.0001 mg/L or 20 % inc	<0.0005*	<0.0005	<0.03 (obj. is 0.05 max.	<0.03*	<0.03
Zinc - T	0.05 mg/L max.	0.02 max.	<0.1 max.	<0.01 - 0.04	0.01	<0.01 - 0.04

n = number of sampling events, D = dissolved metals, T = total metals.
All results reported in mg/L (ppm), except where noted.
* = Objective are higher for some upstream parameters.

5.2.6 Similkameen River

The Similkameen River is an important fisheries, irrigation and primary contact recreation water course. There are municipal and storm discharges, ranching, and mining activities in the Similkameen River Sub-basin. There are septic discharge to land permits issued by the Ministry of Health along the Similkameen River Valley. There are also two discharge permits to land issued by the Ministry of Environment Waste Management Branch, this includes the sewage treatment plant in Keremeos and one for an R.V. park septic system 13 kilometers west of Keremeos.

In 1985, the Ministry of Environment developed water quality objectives for the Similkameen River for the protection of wildlife, aquatic life, livestock and drinking water (Swain, 1985). The parameters include fecal coliforms, solids and turbidity, heavy metals, nutrients and cyanide. There are Ministry of Environment monitoring stations along the length of the river. The stations within the study are shown in Figures 5.1 and 5.2. Station E207461 acts as a control site for the study area. Station E202462 monitors impacts from Hedley Creek. Station E202463 monitors possible impacts from operations of Candorado Mines Ltd. along the Similkameen River. Stations 0500692 and 0500693 monitor for possible impacts from the sewage treatment plant in the Village of Keremeos. There was no monitoring data collected on the Similkameen River in 1994 by Ministry of Environment.

Table 5.5 summarizes Ministry of Environment monitoring data for stations E207461 and E207463. Ministry of Environment has collected monitoring data from these stations annually from 1990 to 1993. The data indicates that there are no present impacts associated with Hedley Creek and the tailings piles, except for elevated f. coliform levels in 1993.

Table 5.5 - MOE Monitoring Data for Similkameen River near Hedley

Parameter	Objective	E207461 1990 (n=4)	E207463 1990 (n=5)	E207461 1993 (n=5)	E207463 1993 (n=4,5)
F. Coli.	<10/100 mL (np)	5- 8/100mL	600/100mL np	---	---
Suspended Solids	max. increase 10 mg/L or 10%	6 -21	8 - 23	55 - 107	10 - 22
Turbidity (NTU)	max. increase 1 - 5 NTU or 10%	1.3 - 6.0	1.4 - 7.5	0.3 - 1.6	0.2 - 0.7
WAD-CN	<0.005 mg/L av, 0.01 mg/L max.	<0.005	<0.005	<0.005	<0.005
SAD-CN + thiocyanate (as CN)	0.2 mg/L max.	<0.03	<0.03	<0.032	<0.038
Cyanate (as CN)	0.45 mg/L max.	<0.05	<0.05	<0.05	<0.05
Ammonia	<1.09 mg/L av., 5.68 mg/L max.	<0.005	0.008 max.	<0.005	<0.005
pH (pH units)	6.5 - 8.5	7.8 - 8.1	7.7 - 8.0	---	---
Dissolved Oxygen	8 mg/L July - Mar. 11 mg/L Apr. - June	---	---	9.5 - 11	8 - 11.2
Arsenic - T	0.05 mg/L max. or 20 % inc.	<0.001 - 0.001	<0.001 - 0.002	<0.001	<0.001 - 0.001
Aluminum - D	<0.05 mg/L av., 0.10 mg/L max. or 20 % inc.	0.02 - 0.06	0.04 av. 0.06 max.	<0.02	<0.02 - 0.04
Chromium - T	<0.002 mg/L av., 0.02 mg/L max. or 20 % inc.	<0.01 - 0.01	<0.01 - 0.01	0.002 av. 0.003 max.	0.002 av. 0.003 max.
Copper - T	<0.002 mg/L av, 0.006 mg/L max. or 20 % inc.	<0.001 - 0.002	0.001 av. 0.002 max.	0.002 av. 0.003 max.	<0.002 av. 0.002 max.
Iron - T	0.3 mg/L max. or 20 % inc.	0.13 - 0.64	0.14 - 0.57	0.05 - 0.19	<0.005 - 0.16
Lead - T	0.004 mg/L av., 0.03 mg/L max. or 20 % inc.	<0.001 - 0.002	0.003 av. 0.005 max.	<0.003	<0.003
Manganese - T	0.05 mg/L max. or 20 % inc.	<0.01 - 0.02	<0.01 - 0.02	0.003 - 0.007	<0.002 - 0.006
Mercury-T (µg/L)	<0.02 µg/L av., 0.1 µg/L max.	<0.05	<0.05	<0.005 - 0.006	<0.005 av. 0.007 max.
Molybdenum - T	<0.01 mg/L av., 0.05 mg/L max.	<0.01	<0.01	<0.004	<0.004
Nickel - T	0.025 mg/L max. or 20% inc.	<0.05	<0.05	<0.01	<0.01
Uranium - T	<0.01 mg/L av., 0.1 mg/L max. or 20 % inc	<0.0002- 0.001	0.0008 max.	0.0003- 0.0006	0.0007 max.
Zinc - T	<0.01 mg/L av., 0.03 mg/L max. or 20 % inc.	<0.005	0.006 av. 0.01 max.	<0.01 - 0.01	<0.02 av. 0.05 max.

n = number of sampling events, np = ninetieth percentile.
D = dissolved metals, T = total metals.
All results reported in mg/L (ppm), except where noted.

Table 5.6 summarizes the Ministry of Environment monitoring data near the sewage treatment plant (STP) in Keremeos near the Similkameen River. Ministry of Environment has collected monitoring data from these stations annually since 1987. The data indicate that the sewage treatment plant is not impacting the Similkameen River. There is also groundwater monitoring data down gradient of the STP, discussed in Section 5.5. The microbiological parameters (enterococci, f. coliform and e. coliform) are the same upstream and downstream of the sewage treatment plant and any increase in the microbiological results are from upstream impacts. The levels of microbiological parameters have increased over 1987 levels and are now exceeding water quality objectives set for the Similkameen River, both upstream and downstream of the discharge.

The Ashnola River flows into the Similkameen River from outside the Study Area. Ministry of Environment monitoring data was reviewed to determine if this river has an impact on the Similkameen River. The monitoring data was collected from 1990 to 1992 and indicates that there are no impacts from the parameters analyzed.

Table 5.6 - MOE Monitoring Data for Similkameen River near Keremeos

Parameter	Objective	0500692 1987 (n=3,7)	0500693 1987 (n=5)	0500692 1993 (n=4,5)	0500693 1993 (n=4,5)
Enterococci	<3/100 mL (np)	---	---	47/100 mL np	40/100 mL np
F. Coli.	<10/100 mL (np)	0 - 20/100 mL	0 - 2/100 mL	75/100mL np	2 - 20/100mL
E. Coli.	<10/100 mL (np)	---	---	110/100mL np	80/100mL np
Suspended Solids	max. increase 10 mg/L or 10%	---	---	<4 - 39	<4 - 31
Turbidity (NTU)	max. increase 1 - 5 NTU or 10%	---	---	0.3 - 5.9	0.3 - 7.0
WAD-CN	<0.005 mg/L av, 0.01 mg/L max.	---	---	<0.005	<0.005
SAD-CN + thiocyan. (as CN)	0.2 mg/L max.	---	---	<0.039	<0.061
Cyanate (as CN)	0.45 mg/L max.	---	---	<0.05	<0.05
Ammonia	<1.09 mg/L av., 5.68 mg/L max.	<0.005 - 0.007	<0.005 - 0.007	<0.005 - 0.008	<0.005 - 0.005
pH (pH units)	6.5 - 8.5	7.4 - 8.2	7.3 - 8.3	7.8 - 8.1	7.8 - 8.1
Dissolved Oxygen	8 mg/L July - Mar. 11 mg/L Apr. - June	---	---	10 - 11	9.5 - 11.2
Arsenic - T	0.05 mg/L max.	---	---	<0.001 - 0.002	<0.001 - 0.003
Aluminum - D	<0.05 mg/L av., 0.10 mg/L max. or 20 % inc.	---	---	<0.02 - 0.05	<0.02 - 0.04
Chromium - T	<0.002 mg/L av., 0.02 mg/L max. or 20 % inc.	---	---	<0.002	0.003 av. 0.006 max.
Copper - T	<0.002 mg/L av, 0.006 mg/L max. or 20 % inc.	---	---	0.002 av. 0.004 max.	0.002 av. 0.004 max.
Iron - T	0.3 mg/L max. or 20 % inc.	---	---	0.07 - 0.83	0.06 - 0.91
Lead - T	0.004 mg/L av., 0.03 mg/L max. or 20 % inc.	---	---	<0.003	<0.003
Manganese - T	0.05 mg/L max. or 20 % inc.	---	---	0.003 - 0.034	0.003 - 0.037
Mercury-T (μg/L)	<0.02 μg/L av., 0.1 μg/L max.	---	---	<0.005 - 0.008	<0.005 - 0.008
Molybdenum - T	<0.01 mg/L av., 0.05 mg/L max.	---	---	<0.004	<0.004
Nickel - T	0.025 mg/L max. or 20% inc.	---	---	<0.01	<0.01
Uranium - T	<0.01 mg/L av., 0.1 mg/L max. or 20 % inc	---	---	0.0003-0.0008	0.0003-0.0004
Zinc - T	<0.01 mg/L av., 0.03 mg/L max. or 20 % inc.	---	---	0.01 av. 0.02 max.	0.01 av. 0.02 max.

n = number of sampling events, np = ninetieth percentile.
D = dissolved metals, T = total metals.
All results reported in mg/L (ppm), except where noted.

5.3 KEREMEOS CREEK WATERSHED

Keremeos Creek flows approximately 40 kilometers and drains approximately 350 km^2 from the Apex region south until it converges with the Similkameen River at the Town of Cawston, as shown in Figures 5.2 and 5.3. There are several tributaries to Keremeos Creek which include: South Keremeos Creek, Marsel Creek, Cedar Creek, Olalla Creek and Shuttle Creek. Designated water uses proposed for Keremeos Creek include drinking water, irrigation and habitat for rainbow trout and other species of fish.

Water quality objectives are currently being developed by the Ministry of Environment to protect aquatic life, wildlife, irrigation and drinking water supplies (Dean et al, 1995). There are sewage disposal permits to land along the Keremeos Creek Valley granted by Ministry of Health, as well as a sewage treatment plant for the Apex Ski Area.

The main reference for this section is the draft Water Quality Assessment and Objectives for Keremeos Creek Watershed - Okanagan Area prepared by Environmental Protection Branch, Ministry of Environment, Penticton (Dean and Jensen, 1995). All water quality data, water use and discharge information for the Keremeos Creek Watershed is summarized from this document. *All of the water quality data presented in Dean and Jensen, 1995, was reviewed, however only data which presents the current or latest state of water quality or data which indicates trends in the water quality has been summarized in this report.*

The Ministry of Environment has collected water quality data from established monitoring stations for selected parameters from 1994 to 1995. These stations are shown in Figures 5.2 and 5.3. The monitoring data was collected during base flow conditions. This data will be used to propose water quality objectives and assess future water quality. Only Keremeos Creek and tributaries for which water quality data are available have been included in this section.

5.3.1 Upper Keremeos Creek

This section of Keremeos Creek is in the Apex area above Green Mountain Road starting at the base of Mount Riordan and Beaconsfield Mountain. There are sewage discharges to land, ranching, development activity at Apex Resort and gravel pit operations along this portion of the watershed. Water quality objectives are being developed for the creek to include: major anions, total and suspended solids, pH, dissolved oxygen, ammonia, metals and microbiological indicators. Designated water uses for this section include: irrigation and livestock watering, drinking water and the protection of wildlife and aquatic life.

There are approximately 30 septic discharge to land permits issued by the Ministry of Health and one effluent permit to land for the sewage treatment plant at the Apex Ski Area. There is also a sand pit operated by Ministry of Transportation and Highways used to stockpile sand and salt to sand the roads in winter.

Upper Keremeos Creek has a significant number (10) of monitoring stations as shown on Figure 5.3. This is to collect water quality data and monitor for potential impacts from development at Apex Ski Area.

Table 5.7 summarizes water quality data from stations E221386 and E221385 which are upstream and stations E221389 and E221338 downstream of the of Apex Resort. All parameters were below the proposed water quality objectives except for one F. coli. result at station E221389. The data shows an increase between upstream and downstream locations in the levels for: specific conductivity, nitrites/nitrates, phosphates, chloride, fecal coliform, alkalinity and total dissolved solids. Water quality data for the other monitoring stations are summarized in Dean and Jensen, 1995.

Table 5.7 - MOE Monitoring Data for Upper Keremeos Creek, 1994 - 1995

Parameter	Proposed Objective	E221386 (n=1-4)	E221385 (n=1-4)	E221389 (n=1-9)	E221338 (n=1-7))
Color (TCU)	NA	5 av.	5 av.	5 av.	5 av.
pH (pH units)	6.5 - 8.5	6.8 - 7.6	6.5 - 7.5	7.1 - 7.7	7.2 - 7.8
Suspended Solids	10 mg/L	<4 av.	<4 av.	<4 av.	0 av.
Sp.Cond. (µS/cm)	NA	97 av.	84 av.	156 av.	168 av.
Turbidity (NTU)	1 NTU increase	0.2 - 0.4	0.2 - 0.3	0.3 - 0.6	0.2 - 0.5
Total Diss. Solids	NA	94	69 av.	126	139 av.
Alkalinity (T4.5)	NA	23.1	25.4	39.1	49.25 av.
Kjeldahl Nit. - T	NA	0.05 av.	<0.04 - 0.06	<0.04 - 0.12	0.05 - 0.07
F. Coli. (CFU)	<10 CFU/100mL	0	0 - 1	0 - 12	0 - 8
Chloride - D	100 mg/L	<0.5 - 1.1	2.7 - 5.8	13.4 - 27	10.6 - 14.1
Ammonia - D	~1 mg/L for total *	<0.005 - 0.01	<0.005 av.	<0.005 - 0.006	<0.005 av.
NO_2/NO_3 - D	10 mg/L for NO_3	0.07 av.	0.04 av.	0.25 av.	0.155 av.
Nitrite - D	~0.6 mg/L max., ~0.2 mg/L 30 day av. **	0.02 av.	<0.005 av.	<0.005 - 0.009	0.012
Phosphate - D	NA	<0.003 av.	<0.003 av.	<0.003 - 0.005	0.006 av.
Phosphate - T	NA	<0.003 av.	<0.003 av.	<0.003 - 0.005	0.005 av.
Sulphate - D	NA	18.6	---	8.9	12

All results reported in mg/L (ppm), except where noted.
n = number of sampling events, NA = not applicable.
D = dissolved, T = total.
* = dependent on temperature.
** = dependent on chloride concentrations.

There is significant monitoring for potential impacts from development at the Apex Ski Area. Three issues of water quality in upper Keremeos Creek have arisen from these developments: impacts of sewage treatment plant, siltation during spring runoff and impacts from salting roads.

The Ministry of Environment fecal coliform data indicates that there are no microbiological impacts from the sewage treatment plant operated by Apex Ski Resort under permit PE-06017. Golder Associates (October 25, 1995) performed a hydrogeological investigation and impact assessment of the sewage treatment plant at Apex Ski Resort. The data collected is comparable to the Ministry of Environment data. The investigation report indicates that the sewage treatment plant is not impacting the water quality of the groundwater or Keremeos Creek, however further sampling should be conducted to monitor for potential impacts.

Spring runoff around Apex Ski Resort caused siltation in upper Keremeos Creek in the spring of 1995 (Dean and Jensen, draft 1995). Ministry of Environment, Water Management Branch issued an order to Apex Ski Resort to eliminate siltation of Keremeos Creek and produce a drainage and erosion control plan. Golder Associates produced a drainage, erosion and sediment control plan and implemented actions to control siltation in upper Keremeos Creek for Apex Ski Resort (October 3, 1995). The work to control siltation is to be performed over 1995 and 1996 with maintenance of control systems to be on-going.

There is also an increase of chloride levels in the north fork of Keremeos Creek, presumably from runoff of salted roads and the operation of a gravel stockpile. The stockpile is operated to sand the roads in the Apex area with a gravel/salt mixture during the winter. The levels do not exceed the proposed water quality objectives for the protection of irrigation and drinking water uses. The chloride levels decrease to near background levels where Keremeos Creek meets Highway 3A. Ministry of Transportation and Highways are currently investigating mitigative measures to prevent the leaching of the salt stockpile. The Ministry has also built a settling pond to remove siltation from the road runoff prior to entering Upper Keremeos Creek.

5.3.2 South Keremeos Creek and Marsel Creek

This fork of the Keremeos Creek starts on the south side of Beaconsfield Mountain and flows between Apex and Dividend Mountains. This fork converges with Keremeos Creek three kilometers north of Highway 3A. There are rainbow trout and other species of fish in the mouth and lower sections of the creek. There are five licenses for livestock watering from springs located near the headwaters. The designated water uses for this section of the creek are protection of aquatic life, wildlife and livestock watering.

Marsel Creek has its headwaters at the west end of Yellow Lake. The creek has intermittent flows and flows south west until it converges with Keremeos Creek at Highway 3A.

The Ministry of Environment has collected water quality data from a station on South Keremeos Creek just upstream of the confluence with Keremeos Creek. The data was collected in 1994 and 1995 during base flow conditions for South Keremeos Creek. The data for Marsel Creek was collected in January, 1995 during base flow conditions and again during freshet. Table 5.8 summarizes water quality data collected at station E221391 and Marsel Creek at Green Mountain Road at base flow conditions only. The water monitoring stations are shown in Figure 5.2.

The data for the two creeks is comparable with the data collected at stations E221389 and E221338 upstream on Upper Keremeos Creek with exception of the following parameters on Marsel Creek: specific conductance, Kjeldahl nitrogen, chloride and total and dissolved phosphorus. These parameters are at significantly higher levels although they represent only one sampling event.

Samples from these stations were also analyzed for trace metals. There are no proposed water quality objectives for metals due to the lack of current potential impacts from metals for this area. The results indicate that the water is suitable for protection of aquatic life with respect to metals.

Table 5.8 - MOE Monitoring Data for South Keremeos and Marsel Creeks

Parameter	E221391 (n=5-7)	Marsel Creek (n=1)
Color (TCU)	5 av.	---
pH (pH units)	7.3 - 7.9	8.3
Suspended Solids	<4 av. (n=4)	---
Sp.Cond. (μS/cm)	138 av. (n=2)	741
Turbidity (NTU)	0.2 - 0.5	---
Total Diss. Solids	96 - 150	---
Alkalinity (T4.5)	53.8 av.	---
Kjeldahl Nit. - T	<0.04 - 0.13	0.29
F. Coli. (CFU)	0 - 1	2
Chloride - D	4.76 av.	72.8
Ammonia - D	<0.005	<0.005
NO_2/NO_3 - D	0.02 - 0.17	0.11
Nitrite - D	<0.005 - 0.02	<0.005
Phosphate - D	<0.003	0.114
Phosphate - T	<0.003 - 0.01	0.122
Sulphate - D	12 (n=1)	---

All results reported in mg/L (ppm), except where noted.
n = number of sampling events.
D = dissolved, T = total.

5.3.3 Cedar Creek and Olalla Creek

Cedar Creek is a tributary to and converges with Keremeos Creek just north of Olalla. The creek flows for approximately seven kilometers through hills to the west of the Keremeos Creek Valley. The creek has water licenses for irrigation and domestic water. The lower reaches are habitat for rainbow and brook trout. The designated water uses proposed for Cedar Creek are for aquatic life, wildlife, drinking water, livestock and irrigation.

Olalla Creek also flows from the hills to the west for approximately eight kilometers and converges with Keremeos Creek in Olalla. Olalla Creek has water licenses for irrigation and domestic water. The designated water uses proposed for Olalla Creek are for aquatic life, drinking water and irrigation.

The Ministry of Environment has collected monitoring data from stations located just upstream of the confluence of the creeks with Keremeos Creek to collect water quality data and monitor potential impacts from the creeks. The stations E221525 and E221526 are shown in Figure 5.2. Water quality data was collected from the stations for 1994 and 1995 during base flow conditions.

The water quality data is summarized in Table 5.9. The data indicate that the water entering Keremeos Creek from Cedar and Olalla Creeks meets all objectives for Keremeos Creek and is of generally high quality for the analyzed parameters. The creeks do not represent an impact to Keremeos Creek when this water quality data is compared to data collected from stations E221339 and E211340 on Keremeos Creek. The data for these stations is presented in Table 5.10.

Table 5.9 - MOE Monitoring Data for Cedar and Olalla Creeks

Parameter	E221525 (n=1,2)	E221526 (n=1,2)
pH (pH units)	7.7	8.2
Sp.Cond. (μS/cm)	281	288
Turbidity (NTU)	<0.1	0.1
F. Coli. (CFU)	0	0 - 2
Chloride - D	0.6 av.	<0.5 - 2.9
Ammonia - D	<0.005	0.01
NO_2/NO_3 - D	<0.02 av.	<0.02 av.
Nitrite - D	<0.005 av.	<0.005 av.
Phosphate - T	<0.003 av.	0.005 av.

All results reported in mg/L (ppm), except where noted.
n = number of sampling events.
D = dissolved, T = total.

5.3.4 Lower Keremeos Creek

This section of Keremeos Creek flows approximately 26 kilometers from its confluence with Marsel Creek until it reaches the Similkameen River at Cawston. The designated water uses proposed for this section of the creek are for drinking water, livestock, irrigation, wildlife and the protection of aquatic life. The creek provides habitat for rainbow and brook trout and other species of fish. The creek has water licenses for domestic water, livestock watering and irrigation.

Water quality objectives are being developed for the creek which include: nutrients, solids, pH, dissolved oxygen and microbiological indicators. The Ministry of Environment has collected water quality data from several monitoring stations (E221339, E211340, E221341 and 0500757) on the lower section of Keremeos Creek shown in Figure 5.2.

Water quality data is summarized in Table 5.10 for four monitoring stations on Keremeos Creek. The data indicate that the water quality meets the proposed objectives with exception of fecal coliform which exceed objectives at Olalla and remain above objectives at the confluence with the Similkameen River. Also, phosphorus and nitrogen levels increase along the length of the creek. There are approximately 1900 cattle along Keremeos Creek, of which approximately 400 have access to the creek. The data in Table 5.10 is an indication of the effects of the ranching activity.

Table 5.10 - MOE Monitoring Data for Lower Keremeos Creek

Parameter	Proposed Objective	E221339 (n=2-7)	E221340 (n=4-8)	E221341 (n=2-6)	0500757 (n=5-13)
Color (TCU)	NA	5 av.	5 av.	23 av.	15.83 av.
pH (pH units)	6.5 - 8.5	7.8 - 8.0	7.9 - 8.1	7.4 - 8.2	7.2 - 8.4
Suspended Solids	10 mg/L max. increase	<4 av.	<4 av.	<4 - 8	---
Sp.Cond. (μS/cm)	NA	253.7 av.	330 av.	342 av.	293 av.
Turbidity (NTU)	5 NTU increase	0.1 - 0.5	0.3 - 0.4	0.3 - 2.3	0.2 - 4.2
Total Diss. Solids	500 mg/L	170 av.	250 av.	251 av.	---
Alkalinity (T4.5)	NA	87.2 av.	138 av.	138 av.	119 av.
Hardness	NA	121 (n=1)	181 av.	170 (n=1)	167 av.
Kjeldahl Nit. - T	NA	<0.04 - 0.13	0.08 - 0.19	0.07 - 5.74	0.04 - 6.51
F. Coli. (CFU)	<10 CFU/100mL	0 -1	1- 62 (13 av.)	26 - 1300 (244 av.)	2- 140 (31 av.)
Chloride - D	100 mg/L	5.6 av.	4.8 av.	5.13 av.	5.09 av.
Ammonia - D	~1 mg/L for total *	<0.005 av.	0.01 av.	0.92 av.	0.35 av.
NO_2/NO_3 - D	10 mg/L	0.07 av.	0.42 av.	0.49 av.	0.36 av.
Nitrite - D	~0.18 mg/L max., ~0.06 mg/L 30 day av.**	<0.005 - 0.009	<0.005 - 0.04	0.02 - 0.06	0.01 - 0.04
Phos. - D	NA	0.005 av.	0.003 - 0.01	<0.003 - 0.46	<0.003 - 0.35
Phos. - T	NA	0.006 av.	0.003 - 0.01	0.003 - 0.56	<0.003 - 0.46
Sulphate - D	NA	31.7 (n=1)	41.4 (n=1)	40.1 (n=1)	38.3 av.

All results reported in mg/L (ppm), except where noted.
n = number of sampling events, NA = not applicable.
D = dissolved, T = total.
* = dependent on temperature.
** = dependent on chloride concentrations.

5.4 SHINGLE CREEK WATERSHED

This watershed consists of Shingle Creek and Shatford Creek and their tributaries. This watershed drains approximately 300 km^2 (Section 4.4) of land west of Penticton and is part of the Okanagan Basin. These creeks are habitat for rainbow and brook trout and other species of fish. The water uses of these creeks include irrigation, livestock watering, domestic supply and the protection of aquatic life and wildlife. There are no water quality objectives for the creeks however, the water quality should be protected for the above water uses. There are septic discharges to land, road construction and maintenance and ranching and agricultural activities in this watershed.

5.4.1 Shingle Creek

Shingle Creek flows from its headwaters in the hills west of Penticton to where it converges with the Okanagan River between Lake Okanagan and Skaha Lake. There are domestic sewage discharge to land permits issued by the Ministry of Health adjacent to the creek.

The Ministry of Environment has collected water quality data at stations along the creek as shown in Figure 5.4. There has been a substantial amount of water quality data collected by the Ministry of Environment at station 0500066, at the mouth of Shingle Creek between 1972 and 1990. This was to monitor local domestic water use. This part of Shingle Creek is no longer used as a domestic water source however, it is not known if the Penticton Band still uses the water for drinking. Station 0500066 was also established to track long term trends and also for agriculture and forestry studies (J. Bryan, MOE - Penticton, pers. comm.). The data is summarized in Table 5.11 for stations 0500858, 0500857 and 0500066. The data for 0500857 and 00858 are for nutrients and was collected during 1980 and 1981. The data for station 0500066 is averaged for the period from 1972 to 1982 and for the period from 1985 to 1990. This water quality data can be used as baseline water quality to assess and monitor present and future water quality. The data for station 0500066 indicate high suspended solids, turbidity, phosphate and f. coliform levels although there are no objectives set for this creek.

Table 5.11 - MOE Monitoring Data for Shingle Creek

Parameter	0500858 1980 - 1981 (n=26 - 30)	0500857 1980 - 1981 (n=55 - 60)	0500066 1972 - 1982 ($n \leq 111$)	0500066 1985 - 1990 ($n \leq 125$)
Color (TCU)	---	---	5 - 40 (13 av.)	---
pH (pH units)	---	---	7.2 - 9 (8.1 av.)	7.5 - 8.8
Suspended Solids	---	---	58 av.	341 av.
Sp.Cond. (μS/cm)	---	---	279 av.	246 av.
Turbidity (NTU)	---	---	0.6 - 12 (2.5 av.)	0.3 - 80 (18 av.)
Total Diss. Solids	---	---	169 av.	96 (n=1)*
Alkalinity (T4.5)	---	---	137 av.	---
Kjeldahl Nit. - T	---	---	0.05 -0.51	0.13 - 2.14
F. Coli. (MPN)	---	---	2 - 170 (45 av.)	---
Chloride - D	---	---	2.4 av.	---
Ammonia - D	0.008 av.	0.014 av.	0.015 av.	0.011 av.
NO_2/NO_3 - D	0.045 av.	0.21 av.	0.07 av.	0.052 av.
Nit. Org. - T	0.29 av.	0.29 av.	---	---
Phos. - D	0.014 av.	0.039 av	0.008 - 0.065	0.004 - 0.045
Phos. - T	0.471 av.	0.386 av.	0.008 - 8.7	0.007 - 1. 8
Sulphate - D	---	---	14.6 av.	---

All results reported in mg/L (ppm), except where noted.
n = number of sampling events.
D = dissolved, T = total. * = 1.0 μm pore size filter (usually 0.45 μm).

5.4.2 Shatford Creek

Shatford Creek has its headwaters in the Seven Peaks area and flows to the east until it converges with Shingle Creek west of Penticton. There are domestic sewage discharge to land permits issued by the Ministry of Health adjacent to the creek.

The Ministry of Environment has collected water quality data from three stations, 0500859, 0500860 and 0500861, along the creek as shown in Figure 5.4.

Table 5.12 summarizes water quality data for the three stations. The data for stations 0500859 and 0500860 are for nutrients and was collected during 1980 and 1981. The water quality data for station 0500861 is summarized for the period from 1980 to 1981 and for the period from 1994 to 1995. This water quality data can also be used as baseline water quality to assess and monitor present and future water quality. The data for these stations indicate there are no impacts for the parameters analyzed.

Table 5.12 - MOE Monitoring Data for Shatford Creek

Parameter	0500859 1980 - 1981 (n=28 - 31)	0500860 1980 - 1981 (n=25 - 28)	0500861 1980 - 1981 (n=25 - 28)	0500861 1994 - 1995 (n=1 - 10)
Color (TCU)	---	---	---	5 av.
pH (pH units)	---	---	---	6.8 - 7.8
Suspended Solids	---	---	---	6
Sp.Cond. (μS/cm)	---	---	---	150 av.
Turbidity (NTU)	---	---	---	<0.1 - 0.3
Total Diss. Solids	---	---	---	83 av.
Alkalinity (T4.5)	---	---	---	35 av.
Hardness	---	---	---	---
Kjeldahl Nit. - T	---	---	---	0.07 - 0.11
F. Coli. (CFU/cL)	---	---	---	0 - 4
Chloride - D	---	---	---	4.95 av.
Ammonia - D	0.01 av.	0.009 av.	0.009 av.	---
NO_2/NO_3 - D	0.1 av.	0.09 av.	0.09 av.	0.02 - 0.03
Nitrite - D	---	---	---	0.005 - 0.007
Nit. Org. - T	0.26 av.	0.86 av.	0.85	---
Phos. - D	0.02 av.	0.02 av.	0.02 av.	<0.003 av.
Phos. - T	0.99 av.	0.67 av.	0.67 av.	<0.003 - 0.004
Sulphate - D	---	---	---	6.9

All results reported in mg/L (ppm), except where noted.
n = number of sampling events.
D = dissolved, T = total.

5.5 GROUNDWATER QUALITY

There are numerous groundwater wells in the Study Area. The uses of the wells is for drinking water, livestock watering and irrigation. The Ministry of Environment Groundwater Section in Victoria maintain a file of all well logs submitted to them. Three wells in the Study Area are used as observation wells by the Ministry of Environment, Groundwater Section. These wells are in the Village of Keremeos. There are static water levels recorded for these wells and water chemistry for two of the wells. There is limited water chemistry for other wells on file with the Ministry of Environment, Groundwater Section. Please contact Groundwater Section, Victoria, for the location and water chemistry of the wells.

There are numerous wells along the Similkameen River, Keremeos Creek, Shingle Creek and in the Apex Region. There is a significant amount of water chemistry data for all the wells drilled in the Study Area kept by the persons who installed the wells.

The effluent of the Keremeos Sewage Treatment Plant (STP) is monitored for suspended solids, biological oxygen demand and daily flow prior to being discharged to the ground. The monitoring results indicate that the STP has been in compliance with the permitted levels except daily flow ($350m^3$/day) was exceeded in May/June, 1995. The groundwater is also monitored for ammonia, phosphorus and chloride, although there are no permit levels. This data is kept on file with the Ministry of Environment - Penticton.

Table 5.13 summarizes the groundwater quality for two of the Ministry of Environment, Groundwater Section observation wells (#75 and #76) in the Village of Keremeos.

Table 5.13 - MOE Monitoring Data for Keremeos Observation Wells

Parameter	Observation Well #75 1991	Observation Well #76 1994
pH (pH units)	8.4	8.0
Sp.Cond. (µS/cm)	156	228
Total Diss. Solids	90*	178
Alkalinity (T4.5)	85	104
Hardness	58.9	124
Kjeldahl Nit. - T	0.34	<0.04
Chloride - D	1.0	3.5
Ammonia - D	0.011	<0.005
NO_2/NO_3 - D	<0.02	0.56
Nitrite - D	<0.005	<0.005
Nit. Org. - T	0.33	<0.04
Phos. - D	<0.003	0.004
Phos. - T	0.016	0.006
Sulphate - D	<1.0	19

All results reported in mg/L (ppm), except where noted.
n = number of sampling events.
D = dissolved, T = total. * = 1.0 µm pore size filter (usually 0.45 µm).

Groundwater quality in the Apex Ski Area is monitored for impacts from the sewage treatment plant (STP) as required in their operating permit # PE-06017. Golder Associates (October 25, 1995). collected groundwater samples from two monitoring wells around the sewage treatment plant. The results are presented in Table 5.14. The data for BH-1 is background. The data for BH-4 is downstream of the sewage treatment plant but may be outside the effluent plume. In the report, it is recommended that wells BH-3 and BH-5 be used to further monitor for impacts as these wells are directly downstream of the sewage discharge. In the Golder Associates hydrogeological investigation, it is reported that the water samples from BH-1 and BH-4 are representative of the shallow aquifer around the sewage treatment plant. The domestic drinking water in Apex Ski Area is taken from reservoirs, fed by Keremeos Creek and a groundwater well, both located upstream from the sewage treatment plant.

Table 5.14 - Monitoring Data for Apex Ski Area STP

Parameter	BH-1 1995 (n=3,4)	BH-4 1995 (n=3,4)
pH (pH units)	7.4 - 7.8	6.3 - 6.5
Sp.Cond. (µS/cm)	150 av.	169 av.
Chloride - D	0.5 - 1.1	10.7 - 17.2
Kjeldahl Nit. - T	0.08 - 0.78	0.005 - 0.007
Ammonia - D	0.032 - 0.073	<0.005
Nitrate- D	<0.005	0.083 - 0.133
Nitrite - D	0.001 - 0.002	0.001 - 0.004
Nitrogen - T	0.08 - 0.78	0.14 - 0.19
Phos. - D	0.004 - 0.057	0.001 - 0.013
Phos. - T	0.066 - 4.39	0.003 - 0.013

All results reported in mg/L (ppm), except where noted.
n = number of sampling events.
D = dissolved, T = total.

Groundwater in Hedley is used for drinking water and irrigation. Groundwater around Hedley is monitored by Candorado Mines to fulfill the requirements of their operating permit (PA-7893). It is also monitored by the Ministry of Environment. Data was collected and analyzed Candorado Mines bi-weekly from January to June, 1994 for monitoring wells 88-1, 88-3, P3 and Hedley town water. The Ministry of Environment also collected some data from these sites. Groundwater monitoring wells 88-1, 88-3 and P3 are located downstream of the leaching area for Candorado Mines operations and upstream of the Similkameen River. Groundwater data for these wells monitors potential impacts on the Similkameen River. The Hedley town well is also monitored. This well supplies Hedley with drinking water and is located on Hedley Creek upstream of Candorado Mines operations. Groundwater data for this well monitors for impacts from the scouring of tailing piles by Hedley Creek.

The monitoring data is summarized in Table 5.15. The data meets all drinking water criteria for the parameters analyzed.

Table 5.15 - Monitoring Data for Hedley Area Groundwater Wells

Parameter	Well 88-1 (n=13)	Well 88-3 (n=15)	Well P3 (n=14)	Hedley Town Water (n=2)
Arsenic - D	0.017 (n=3)	0.0057 (n=3)	0.019 (n=3)	---
Chloride -D	3.7	1.9	1.4	1.1
Zinc - D	<0.005 - 0.03	<0.005 - 0.067	<0.005 - 0.11	0.01 (n=1)
Nickel - D	<0.001 - 0.002	<0.001 - 0.0025	<0.001 - 0.03	0.002 (n=1)
Lead - D	<0.001	<0.001	<0.001 - 0.022	<0.001
Iron - D	<0.003 - 0.115	<0.003 - 0.018	<0.003 - 0.02	<0.001
Copper - D	<0.001 - 0.005	<0.001 - 0.008	0.002 - 0.03	0.055
Cobalt - D	<0.001 - 0.002	<0.001 - 0.002	<0.001 - 0.002	<0.001
CN (SAD) - T	<0.005 - 0.06	<0.005 - 0.195	<0.005 - 0.035	<0.005
Thiocyanate - T	<0.025	<0.025 - 0.9	<0.025 - 0.5	<0.025

All results reported in mg/L (ppm), except where noted.
These results are ranges, for exact numbers contact Ministry of Environment Penticton.
n = number of sampling events.
D = dissolved, T = total.

5.6 TRENDS IN WATER QUALITY

The following water quality trends are evident from the monitoring data collected by the Ministry of Environment and Homestake Mines. All of these trends can be associated with human activities.

There has been an increase in the level of sulphates, nitrates and total dissolved solids in Nickel Plate Mine Creek, Red Top Gulch Creek and Cahill Creek from background levels due to the operations on Nickel Plate Mine. Figures 5.5 and 5.6 show some of these trends in Red Top Gulch Creek and Cahill Creek. In some instances the water quality objectives established by the Ministry of Environment for these parameters are being exceeded. Homestake Mines has taken mitigative measures to reduce these impacts. This can be seen from the reduction of these parameters in Cahill Creek due to diverting Nickel Plate Mine Creek into the tailings pond.

Figure 5.5 Average Annual Sulphate Levels in Red Top Gulch

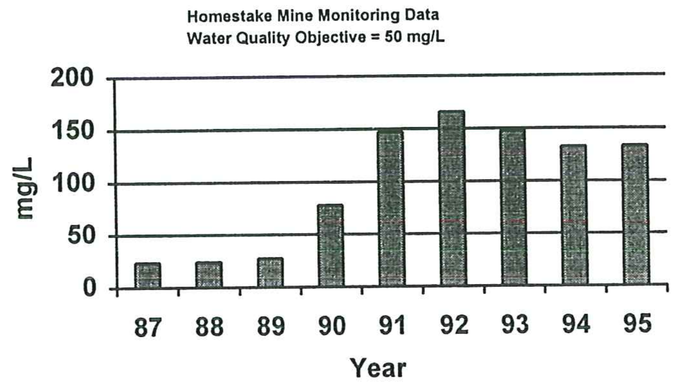
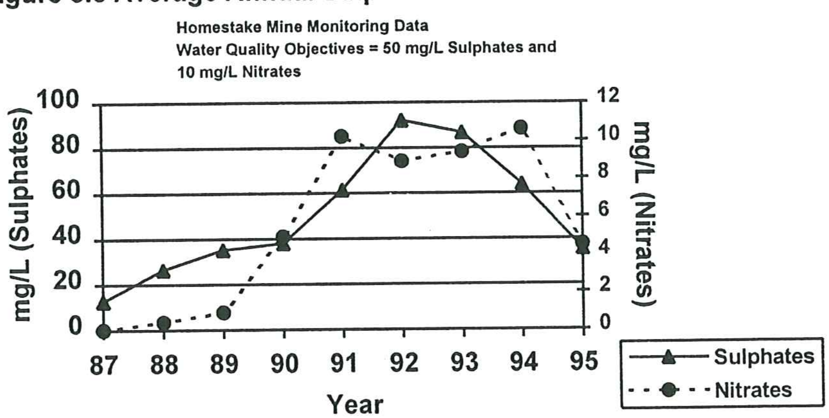
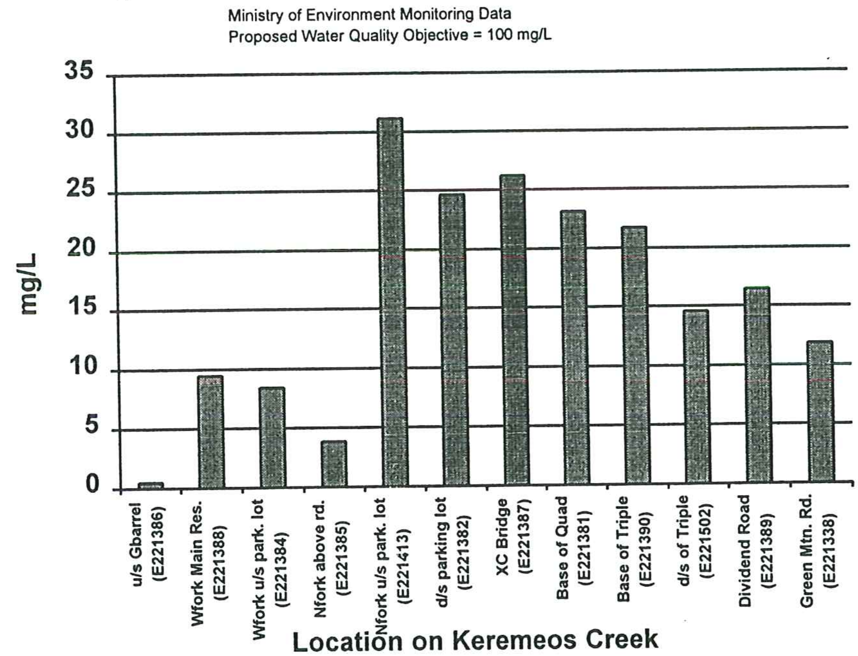


Figure 5.6 Average Annual Sulphate and Nitrates Levels in Cahill Creek



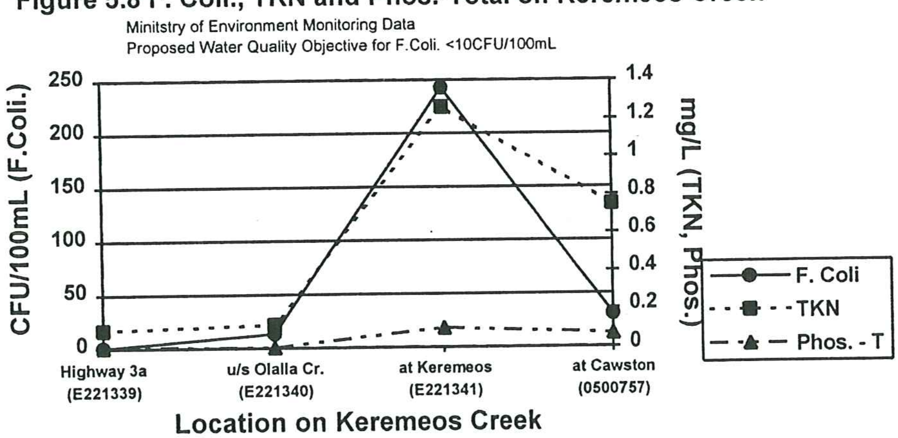
There is an increase in the levels of chloride in Upper Keremeos Creek (Apex Ski Area) from background levels from previous storage practices of salt or utilization thereof, which is shown in Figure 5.7. The levels of chlorides has not exceeded water use criteria and is attenuated downstream.

Figure 5.7 Chloride Levels in Upper Keremeos Creek



There is an increase in the levels of fecal coliform, phosphorus and nitrogen in Lower Keremeos Creek from upstream levels due to agricultural activities. These trends are shown in Figure 5.8. There needs to be further study on the sources of these impacts to develop mitigative measures.

Figure 5.8 F. Coli., TKN and Phos.-Total on Keremeos Creek



Fecal coliform, nitrogen (TKN) and phosphate levels in Similkameen River around Keremeos are elevated above background levels due to agricultural and/or possibly a failed septic system (there is currently no evidence of a failed septic system).

5.7 DATA GAPS

During the course of this study, certain areas and issues lacked sufficient information to develop a clear understanding of the dynamics of the biophysical systems and human impacts on those systems. Below is a list of these information gaps or where limited data is available:

There is no water quality data for the Marron Creek Watershed or lakes in the Study Area.

Groundwater quality data is not consolidated in one location within one government agency. Also, there is not a lot of groundwater quality data available, much of the information is kept with the users of the groundwater. This limits the ability of this study to comment on the current groundwater quality over the entire Study Area.

There is limited recent water quality data on Shingle and Shatford Creeks. If the area, is developed or logged, the need to collect more baseline data to monitor the effects of these potential activities should be determined.

5.8 OVERALL CONCLUSIONS AND RECOMMENDATIONS

Overall, there is a significant amount of water quality monitoring data available for the area. Some of the data was collected to monitor potential impacts from specific sources and some was collected as part of the Ministry of Environment initiative to determine ambient water quality of provincial waterbodies. The monitoring data collected by Homestake Mines has been adequate to monitor water quality in the area. The monitoring program of Apex Resort sewage treatment plant has indicated that no impacts have occurred to Keremeos Creek.

The water in the Seven Peaks Study Area is generally of good quality. There are two areas, the lower Similkameen River and lower Keremeos Creek which consistently exceed water quality objectives for fecal coliform. These and recent increases in phosphorus, nitrates and chloride appear to be attributable to human activities throughout the study area.

The levels of sulphates, nitrates and total dissolved solids in water bodies surrounding Nickel Plate Mine needs to be carefully monitored to mitigate impacts on the Similkameen River. The mine is due to cease operations in 1996. The reclamation plan includes measures to mitigate impacts on water quality in Cahill Creek and its tributaries. Homestake Mines is currently developing treatment methods to mitigate impacts after closure.

There are presently no impacts from Candorado Mines operations indicated by the current monitoring program, however the amount of analytical monitoring data included in this study was limited.

We recommend the following:

- Continue monitoring for potential impacts from Nickel Plate Mine and Candorado Mines operations.
- Adopt water quality objectives and implement monitoring activities developed in Water Quality Assessment and Objectives for Keremeos Creek Watershed Okanagan Area - when the report becomes final.
- Develop Water Quality Assessment and Objectives for Shingle Creek Watershed.
- Continue monitoring for microbiological indicators and nutrients in lower Keremeos Creek and for microbiological indicators in the Similkameen River to determine sources of these impacts and as sources are identified develop mitigative measures.
- Increase the frequency of monitoring Keremeos Creek during spring runoff for impacts from surface runoff to determine if implemented control measures at Apex Resort are effective.

SECTION 6.0

FISHERIES RESOURCES

Reid Crowther

SECTION 6.0
FISHERIES RESOURCES

6.1 INTRODUCTION

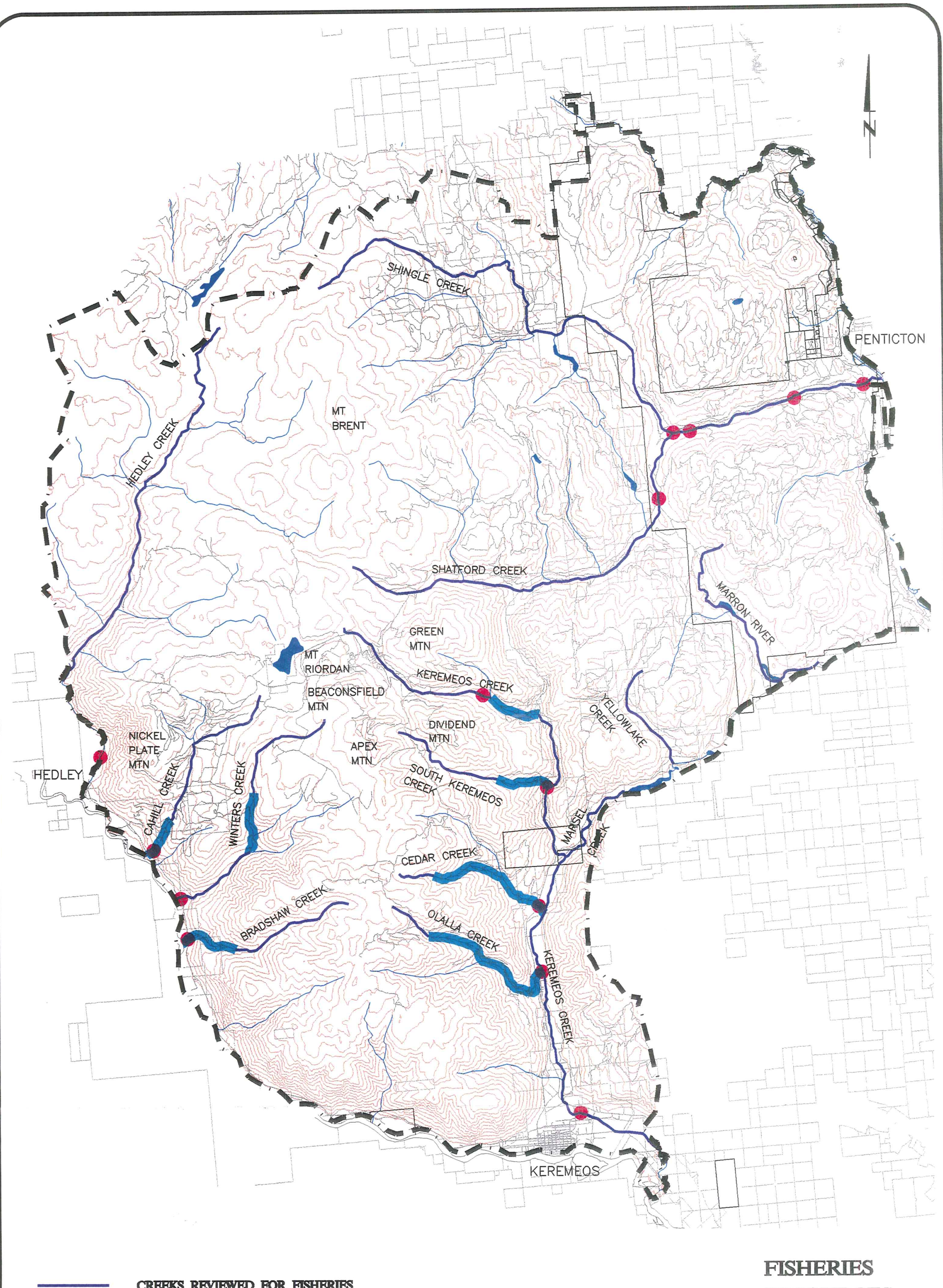
6.1.1 The Study Area

The study area for the fisheries investigation was limited to four lakes, ten creeks and the Similkameen River (Figure 6.1). These water bodies were chosen as they are the dominant ones in the Seven Peaks area in terms of the fisheries resource. Data were not available for Red Top Gulch, Sheep Creek, Marsel Creek and the Marron River. These water bodies were considered for study as part of the fisheries section. Other smaller creeks which were not investigated are still important in the overall fisheries analysis from a standpoint of supplementing flow to the larger creeks, providing habitat for aquatic plants and insects and providing areas of refuge or spawning. The waterbodies which were investigated, provide an overview of the fisheries in the Seven Peaks area.

The fisheries resource includes those animals important for the sport fishing industry (i.e. rainbow trout) and those which are not considered sport fish (i.e. sculpins). Typically, there are more population data for sport fish as BC Environment maintains stocking records, creel surveys, lake surveys and controls the fish catch quotas. Information on the non-sport fish populations comes mainly from scientific investigations.

Out of the 19 waterbodies considered in the Seven Peaks fisheries study, 17 are contained within the Similkameen Fisheries Management Unit. These include Ford, Nickel Plate, Twin and Yellow Lakes; Similkameen and Marron Rivers; and Hedley, Cahill, Red Dog Gulch, Bradshaw, Winters, Keremeos, South Keremeos, Ollala, Cedar, Yellow Lake and Marsel Creeks.

The most recent management plan for the Similkameen unit was developed by BC Environment in 1984. Shatford and Shingle Creeks are contained in the Okanagan Fisheries Management Unit.



CREEKS REVIEWED FOR FISHERIES

CREEK SLOPE GREATER THAN 15%

ELECTROFISHING SITE

FISHERIES RESOURCES

FIGURE 6.1

SCALE: 1:150,000

Reid Crowther

6.1.2 The Similkameen Fishery in a Regional Context

As outlined in the 1984 management plan, all Similkameen lakes are classed as small but appear to be some of the most productive lakes in the region. This unit was estimated in 1984 to produce 25% of the total regional fisheries production. The Similkameen unit is characterized as a small lake fishery; 85% of angling activity and 90% of the catches occur in lakes. In 1980, this unit supported 22% of the regional effort, second to the Okanagan unit. In terms of catch, the Similkameen unit supported 21% of the sportfish catch. The Similkameen unit success rate was estimated to be 1.9 fish per angler day. The provincial target for catch success is 2 fish per angler day. In terms of the Regional trout stocking program the Similkameen unit received 37% of the total. In general, the 1984 regional rainbow trout harvest was thought to represent 90% of the harvestable surplus, suggesting that the capacity to increase the harvest on small lakes in the region is very limited. Rainbow trout represented 93.4% of the species catch for the Similkameen and 79% of the catch for the Okanagan.

The Ministry of Environment publishes fishing regulations for the entire Province which are based on information regarding fish populations, population trends and fishing pressure. The Seven Peaks study area is contained in Region 8 (Okanagan). The daily catch quotas in this region for 1994-96 are as follows:

- Trout/char: 6, but only 1 over 50 cm and 4 from streams (only 2 over 30 cm);
- Kokanee: 10 (none from streams). Lake Okanagan catch prohibited;
- Whitefish: 15 (all species combined);
- Bass (Largemouth and smallmouth combined): 4;
- Burbot: 10;
- Yellow perch: 20;
- Walleye: 8;
- Crayfish: 25;
- No fishing in any stream (spring closure from April 1 to June 30); with the following exceptions within the Seven Peaks Study Area: Similkameen River and Tulameen River.

A review of historical fishing regulations to 1976 revealed the following notable changes to the daily catch quotas:

1982 - Kokanee quota was reduced to 15 from 25;
1985 - The trout/char quota was reduced to 6 from 8, a 25% reduction;
1987 - The Kokanee quota was reduced to 10 from 15.

The Kokanee quota was reduced by 60% between 1981 to 1987.

6.1.3 Lakes

The highest productivity lakes in the region occur at elevations typically below 1300m (BC Environment 1984). Lakes at higher elevations are cooler, contain lower standing crops of plankton and bottom fauna as well as smaller fish. The lower temperatures result in slow fish growth. Of the four lakes studied, only Nickel Plate Lake is located above 1300 m.

<u>Ford Lake</u>

Ford Lake (elev. 884m) is situated along Green Mountain Road, midway between Highway 3 and the Apex mountain turnoff. The lake is approximately 100m long and 50m wide. There are no records of depth measurements. Drainage is to the South Keremeos Creek, Keremeos Creek, Similkameen River and Okanagan River.

The lake is considered to be manageable by BC Environment. There is no active fisheries enhancement and nothing is planned. Natural stocking occurs via Keremeos Creek (BC Environment 1995).

Since 1993 there have been a number of complaints from local anglers regarding no trespassing signs erected by a nearby property owner. The Ministry of Environment intervened and will post signs indicating the location of public access to the lake (S. <u>MATHEWS</u>, 1994).

Nickel Plate Lake

Nickel Plate Lake (elev. 1860m) is situated 5 km west of Apex ski resort on Corona Mines Road. The lake has an area of 81 Ha, with a maximum depth of 26m. The mean lake depth is 10 m. There are three inlets and one outlet to the lake. Drainage is into Nickel Plate Creek which joins Hedley Creek then Similkameen River and Okanagan River. There is a dam on Nickel Plate Lake providing storage for licensed downstream water users. Nickel Plate Lake contains a rainbow trout population supported by natural production and an annual stocking program.

A small lake colloquially known as Secret 1 (elev. 1907m) is slightly to the east of Nickel Plate Lake. It has a maximum depth of 5.7m and a mean depth of 4.5 m. Another small unnamed lake is located immediately south east of Secret Lake. There is no inventory information available from this lake other than reports that it contains a small naturally reproducing rainbow trout population.

The current stocking plan is for 5,000 marked rainbow trout fingerlings to be released annually. The management plan recommends that the stocking program take into account the development of the fishery in the lake and the amount of natural reproduction. In a 1981 study, approximately 6% of the lake's population were found to be hatchery reared fish (Wilther 1989).

In a more recent study, the hatchery fish contribution to the fishable population was again found to be very low (<10%) and as a result, the stocking rate was reduced from its historical level of 10,000 fingerlings annual to 5,000 fingerlings beginning in 1995. The majority of natural production is known to occur in the two inlets at the north end of the lake.

Nickel Plate Lake was first stocked in 1952 with rainbow trout. In conjunction with the fish stocking program, Gammarus sp. (aquatic copepod) and aquatic plants were also introduced. Natural lake level fluctuations (1.5 - 2.0 m) were likely responsible for freezing the plants during the winter. This resulted in an unsuccessful aquatic plant transplant (Withler, 1989). There is currently no fisheries enhancement on Nickel Plate lake nor is anything planned.

In Secret 1 there is no natural spawning. Rainbow trout are known to exist in the lake and there are plans for stocking 500 fingerlings annually. The management plan for this lake is to maintain a walking trail into the lake. The Ministry of Environment reports on this lake indicate that in some years the fish do well while others say they are either killed during the winter or are fished out in the fall. Rainbow trout from 0.25 kg to 0.45 kg (0.5 lb. to 1 lb.) were reported caught in the summer of 1979 and large fish were reported caught in the spring of 1980. Presumably they were from the 1979 stocking efforts (BC Environment, 1995).

Twin Lakes

Twin Lakes also known as Horn Lake and Nipit Lake are located 11 miles from Okanagan Falls. Horn Lake is the north east lake, with an area of between 33 - 40 Ha and a maximum depth of 30 m. It was first stocked in 1944 with eastern brook trout. The lake is now stocked with both rainbow trout and eastern brook trout. The management plan for the lake is to increase public access and to maintain the fishery for moderate sized rainbow trout (BC Environment, 1995). There is no public access to Nipit Lake; therefore, it is not stocked and is considered an unmanageable lake.

Yellow Lake

Yellow Lake (elev. 762m) is located 25 km from Penticton. Access is via Highway 97 past Kaleden onto Highway 3A west. The lake has an area of 31 Ha, a maximum depth of 36m with a mean depth of 17m. The structure at the outlet of the lake controls flows into Marsel Creek. There is a dam at the west end of the lake which provides storage for conservation purposes only. The water license is held by BC Environment, Fisheries Branch, Penticton.

The lake was first stocked in 1939 with rainbow trout. The management objective for the lake is to maintain heavy use for 0.45 kg (1 lb.) rainbow trout in the summer and eastern brook trout in the winter. Yellow Lake is currently under fisheries enhancement by means of a lake aeration project (BC Environment, 1995). Yellow Lake has the highest fisheries use in all of the lakes of the Similkameen unit. In 1984 it accounted for approximately 10% of the fishing effort in the entire unit.

6.1.4 Rivers

Similkameen River

The Similkameen River flows in a south-east direction through the study area. The region of the river in the study area is between the towns of Hedley and Cawston. It is generally a meandering river with a large floodplain which accommodates severe flow fluctuations during spring freshet. Lowest flows occur in the fall and early winter.
The Similkameen River contains a large resident population of rainbow trout in addition to a variety of other fish species. See Section 6.3.2 for a listing of fish species for all rivers within the Seven Peaks study area.

Marron River

The Marron River flows for approximately 16 km through the Penticton Indian Reserve ultimately entering a small lake near the south end of Skaha Lake. Marron Lake and Aeneas Lake are contained within the Marron River's drainage.

6.1.5 Creeks

The creeks in the Similkameen Drainage are typically fast flowing through steep terrain. Several creeks have intermittent flow which is usually during spring freshet or after storm events. The majority of creek mouths will contain many of the fish species listed for the Similkameen River. The extent of fish species distribution upstream of the mouth is limited by water availability, accessibility and habitat preference for individual fish species.

Slopes greater than 15-20% are believed to act as natural barriers to fish migration (US Army Corps of Engineers, 1991 and S. Mathews, pers. comm.). In conjunction with cold water temperatures these creeks have a low productivity which results in smaller sized fish. With the exception of Shatford and Shingle creeks, the creeks in the study area ultimately flow into the Similkameen River. Their value as a fishery becomes important indirectly as their flows augment the flow in the Similkameen River. Also, these areas may provide spawning and/or refuge areas for fish.

Hedley Creek

Hedley Creek is one of the larger creeks in the study area. It flows for 24 km in a southerly direction from its headwaters west of Nickel Plate Mine, through the town of Hedley and into the Similkameen River. Hedley Creek may provide refuge and/or spawning habitat for rainbow trout of the Similkameen River. Limits to habitat are low summer flows and development impacts caused by mining and flood protection works to the lower reaches (BC Environment, 1994)

Cahill Creek

Cahill Creek is 10 km long from its headwaters at Nickel Plate Lake to the Similkameen River. An area of steep terrain (15-20 % slope) exists from the north side of highway 3 for approximately 1.8 km which provides a restriction to fish migration up Cahill creek.

Red Top Gulch Creek

Red Top Gulch is one of the minor creeks in the area (2.5 km). It likely flows only seasonally and is very steep (30% slope).

Bradshaw Creek

Bradshaw Creek flows in a south west direction for approximately 8 km. The creek enters the Similkameen River approximately 8 km south east of the town of Hedley. It also has seasonal flow only.

Winters Creek

Winters creek flows for approximately 15 km from its headwaters, south east of Apex ski resort to where it meets the Similkameen River approximately 7 km downstream of the town of Hedley. A 3 km section of steep terrain of the creek exists approximately 3 km upstream from highway 3. Winters creek headwaters is in the location of the proposed Garnet quarry.

Keremeos and South Keremeos Creeks

Keremeos Creek drains the area south of the Apex ski resort and flows in a south east direction, through the towns of Ollala, Keremeos and Cawston and into the Similkameen River. The total length of the creek is approximately 30 km. The creek is impacted by low summer flows and development impacts from ranching and residential subdivisions in the lower reaches (BC Environment, 1994). Keremeos Creek is considered one of the most important small tributaries of the Similkameen River in terms of trout production. It contains a large resident population of eastern brook trout and rainbow trout and is also considered an important spawning and rearing area for Similkameen River rainbow trout.

The South Keremeos Creek joins Keremeos Creek approximately 8.5 km north of the town of Ollala.

Ollala Creek

Ollala Creek flows in a south easterly direction for 10 km to where it meets the Keremeos Creek in the town of Ollala. A steep section, of approximately 5 km, exists upstream from where it enters Keremeos Creek.

Cedar Creek

Cedar Creek flows for 7 km from its headwaters to where it enters Keremeos Creek approximately 4.5 km north of the town of Ollala. A steep section of terrain exists from its confluence with Keremeos Creek for approximately 5 km.

Marsel Creek

Marsel Creek drains Yellow Lake. The creek flows to the south west for 4.5 km to where it joins Keremeos Creek. Flow to this creek is controlled by an outlet dam on Yellow Lake. Flow is supplemented by ground water seepages.

Yellow Lake Creek

Yellow Lake Creek flows for 7 km before entering Toy Lake. Toy Lake flows to Yellow Lake via a culvert under Highway 3A.

Shatford Creek

Shatford Creek is in the Okanagan drainage basin. Shatford Creek flows from its headwaters, on the north west side of Green Mountain, approximately 2 km north east of the Apex ski resort to its confluence with Shingle Creek. It is approximately 17 km long.

Shingle Creek

Shingle Creek is in the Okanagan drainage basin. Shingle Creek flows from its headwaters, north east of Penticton in a south easterly direction for approximately 20 km and enters the Okanagan River at Penticton. Shingle Creek flows alongside of Green Mountain Road which crosses it 4 times.

6.2 FISH OF THE SOUTHERN INTERIOR OF BRITISH COLUMBIA

6.2.1 Common Species

Approximately 10,000 years ago, during the Pleistocene ice age, British Columbia was virtually covered by thick sheets of ice. When the ice retreated, fish advanced up the newly created rivers and lakes. Due to the glacial history, the fish fauna of BC is made of almost entirely of recent immigrants from the Pacific Ocean or from the Mississippi, Yukon and Columbia River systems (McPhail and Carveth, 1992).

The complex pattern of deglaciation that followed the Pleistocene era created a number of unique evolutionary opportunities. Some populations of fish were left stranded in periglacial lakes, while others were left to colonize new habitats free from predators or competition. Some species were isolated from others through the process of isostatic rebound which created waterfall barriers. Under these conditions, some groups, such as the sticklebacks have demonstrated a remarkable ability to speciate in a very short period of time (McPhail and Carveth, 1992).

The Seven Peaks area is contained with in the Columbia drainage system. The Columbia and its tributaries contain one of the most distinctive fish faunas in North America (Cannings, 1993). In B.C. the Columbia system contains 43 species of fish (Table 6.1). There are 27 species considered to be native and probably survived glaciation somewhere within the Columbia system. Of the 27 native species, 9 are considered to be endemic, that is, they evolved within the system. No other drainage system in B.C. contains this number of endemic species and it is these endemics that set the B.C. freshwater fish fauna apart from that in the rest of Canada. There are 15 species (37 percent) that have been introduced to this system. This is a higher proportion of introduced species than in any other river system in B.C. The majority of introduced fish are found in the lower Columbia and Okanagan drainages (McPhail and Carveth, 1992). The following list of fish are those that have been introduced into the Columbia River system:

brook trout	goldfish	black crappie
brown trout	tench	largemouth bass
lake trout	brown catfish	smallmouth bass
broad whitefish	black catfish	yellow perch
carp	pumpkinseed	walleye

The rivers draining the Interior Plateau contain fish species similar to the rivers of the lower Columbia system and its tributaries. There are falls and rapids on these rivers which that act as barriers to migration of fish. An example of this is Okanagan Falls (Okanagan River) where 22 native species occur below this barrier but only 15 species occur above it. Similkameen Falls is another barrier to migrating fish. Only 2 native species (rainbow trout and longnose dace) occur above the falls. Barriers prevent the upstream dispersal of species as well as isolating upstream and downstream gene pools. This is responsible for the phenomenon of divergence. In at least one case, the upstream and down stream forms of the largescale sucker are morphologically different from each other (McPhail and Carveth, 1992).

6.2.2 Rare or Endangered Species

Freshwater fish in British Columbia have limited dispersal opportunities and consequently are restricted in distribution. In fact, 36 out of a total 103 taxa are considered rare enough to be tracked by the British Columbia Conservation Data Center (CDC) which performs an on-going, computer assisted ecological inventory. The CDC focuses on the individual components of natural diversity, compiling and collecting information on the status and distribution of rare or endangered species, common species and natural communities.

In the Seven Peaks Area there are 3 species registered with the CDC: Umatilla dace, Mottled sculpin and the Chiselmouth (Cannings, 1993). Considerable research on dace and sculpins in the Similkameen drainage has been completed by Alex Pedden of the Royal Victoria Museum.

Umatilla Dace

Umatilla Dace (*Rhinichthys umatilla*) - was first considered a hybrid of *R. osculus* and *R. falcatus*. There may be different *R. umatilla* in different rivers. The Similkameen populations appear to be the same as those in Oregon (Cannings, 1993).

R. umatilla is a riverine species which prefers the cover of large cobbles and boulders where the current is fast enough to prevent siltation. This species is absent from cold tributaries in the mountains. In regions where *R.umatilla* is sympatric with *R. falcatus* in B.C., it is more numerous and prefers stronger current. Other dominant, potential competitors are *R. cataractae and Cottus* sp.(Carl, Clemons and Lindsay, 1967).

R. umatilla are regionally endemic and does not appear to be very threatened, however, the Otter Creek population has suffered habitat loss due to hydroelectric development and is under stress.

Mottled Sculpin

Mottled Sculpin (*Cottus bairdi*) may be considered a multi-species conglomerate. In B.C., only the Flathead River populations may be true *C. bairdi*. Its range is restricted to a portion of the Columbia River drainage and its tributaries, including a number of localities in the Similkameen drainage (Carl, Clemons and Lindsay, 1967). In B.C. it is found in flowing waters ranging in size from small creeks to large rivers and mountain lakes. In the Similkameen drainage, the species is also common in the smaller tributaries.

This species has restricted distribution and is likely a disjunct of the western population. It is an undescribed subspecies in Oregon and is considered a taxon of "special concern". It is possibly threatened by coal mining in the Flathead Valley and by hydroelectric developments in the Similkameen and Columbia Rivers.

Chiselmouth

Chiselmouth was unknown in B.C. until its discovery in Skaha Lake in 1950 (Carl, Clemons and Lindsay, 1967). Chiselmouth (*Acrocheilus alutaceus*) is currently known from scattered locations throughout BC, Washington and Oregon, including the Okanagan basin (Okanagan River and south Okanagan Lakes) and the Similkameen drainage. In BC, the Chiselmouth is found in a variety of relatively warm water bodies such as small creeks, backwaters of large rivers and lakes.

Although its range is somewhat confined and its distribution spotty, this species is found in numerous localities and a variety of water body types. There are no serious threats although there is a perceived threat from future hydroelectric developments.

6.3 FISH OF THE SEVEN PEAKS STUDY AREA

6.3.1 Ford Lake

The Ministry of Environment management summary for Ford Lake indicates that the only known species of fish present is the brook trout. There is a report that a yellow perch was captured in 1988. The lake was first stocked in 1982 with brook trout, however it is currently not being stocked.

Nickel Plate Lake

Nickel Plate Lake has had four surveys in the last 40 years. Rainbow trout were the only species captured (Withler, 1989). The data are presented below.

Date	Ave. length (cm)	Range (cm)	Count	Average weight (g)	Capture Method
Aug. 1950	30.4	14.6 - 58.5	57	403	gillnet
June 1980	28.5	20.9 - 44.5	30	?	gillnet
June 1981	32.2	20.3 - 51.7	27	?	gillnet
June 1989	26.6	18.0 - 41.0	?	243	angling (creel census)

The 1994 Ministry of Environment stocking records show that 10,000 rainbow trout fingerlings (ave. weight 2.0 g) were released into the lake.

Twin (Horn) Lake

The Ministry of Environment 1994 Stocking records show that 2,000 rainbow trout yearlings (ave. weight 12.8 g) and 2,000 brook trout fingerlings (ave. weight 3.4 g) were released into the lake.

Stocking records review from 1985 to 1994 indicates that a total of 34,650 rainbow trout (average weight 9.6 g) including 2,650 brood stock and 26,000 brook trout (average weight 4.3 g) were stocked in Yellow Lake.

Yellow Lake

Yellow Lake is considered to be unable to produce a natural population because of absence of suitable spawning habitat. The species known to exist in Yellow Lake are rainbow and brook trout and are present only due to stocking efforts. A survey by the Ministry of Environment in 1988-89 revealed the following information.

- Average daily boat count ranged between 4 - 10.
- Stocking rate 350 -450 yearlings per ha
- Length at capture:
- Rainbow trout 27.0 - 29.0 cm
- Brook trout 20.0 - 25.0 cm

1994 Stocking records show that 25,000 rainbow trout yearlings (ave. weight 12.8 g) and 15,000 brook trout fingerlings (ave. weight 3.4 g) were released into the lake. Stocking records review from 1985 to 1994 indicates that a total of 260,000 rainbow trout (average weight 9.4 g) including 5,000 brood stock and 150,000 brook trout (average weight 3.9 g) were stocked in Yellow Lake.

6.3.2 Rivers

Similkameen River

A 1984 report by IEC Beak gives reference to the following species known to exist in the Similkameen River upstream of the Enloe Dam (Washington State):

- Rainbow trout (*Oncorhynchus nerka*)
- Mountain whitefish (*Prosopium williamsoni*)
- Black crappie (*Pomoxis nigromaculatus*)
- Northern squawfish (*Ptychocheilus oregonensis*)
- Peamouth chub (*Mylocheilus caurinus*)
- Northern mountain sucker (*Catastomus platyrhynchus*)
- Redside shiner (*Richardsonius balteatus*)
- Bridgelip sucker (*Catastomus columbianus*)

- Longnosed dace (*Rhinichthys cataractae*)
- Sculpins (*Cottus spp.*)

The Similkameen River represents an important sport fishery in this area. The highest densities of rainbow trout in the mainstream Similkameen River, below Similkameen Falls were found between Keremeos and Princeton (IEC Beak 1984). The estimated rainbow trout population for 1984 was 42,600. This represents 30% of the population for the entire system. The most fished area of the river occurs between Bromely Rock Park and Stemwinder (5 km upstream of Hedley). Approximately 75% of the fishing effort occurs in this area (S. Mathews, pers. comm.).

A survey of the Similkameen River for the Fisheries Branch of BC Environment was carried out between July 7 to September 2, 1994 (Johnston, 1994). The sample locations are shown on Figure 6.1 The survey was carried out at elevations below 1,000 m. The data for the Similkameen River Sub-basin which flows through the Seven Peaks study area are presented in Table 6.2. The sample locations for the Similkameen River are all upstream of the study area boundaries, however, they have been included in this report as the fish populations are likely to be the same.

The Ministry of Environment 1994 stocking records show that 1,000 rainbow trout (catchable average weight 217.4 g) were released near Princeton, (BC Environment, 1994).

Marron River

There is no available information on fish species and population characteristics for Marron River. A wide variety of fish are expected to be in the Marron River due to the species found in the two lakes along its drainage.

6.3.3 Creeks

As previously mentioned, an intensive (presence/absence) electrofishing survey was undertaken by Ron Johnson for the Fisheries Branch of BC Environment from July 7 to September 2, 1994. The survey was carried out at elevations below 1000 m in the Seven Peaks Area and the results are presented in Table 6.3.

6.4 TRENDS IN POPULATION CHARACTERISTICS

6.4.1 Trends in Population Characteristics

The information available on Nickel Plate Lake suggests that there is very little difference between the size of fish caught in surveys conducted in 1950, 1980, 1981 and 1989. The average length of fish throughout these surveys was 30.4, 28.5, 32.2 and 26.6 cms respectively with ranges between 14.6 - 58.5, 20.9 - 44.5, 20.3 - 51.7 and 18.0 - 41.0 cms, respectively.

Recent studies by the Ministry of Environment on Nickel Plate Lake have shown that current stocking rate (to 1995) was too high considering the large amount of natural production. As a result, stocking rate was reduced to 5,000 (a 50% reduction from former years). Monitoring of the trout population and the fishery will continue to determine if further stocking decreases are warranted.

1993 MOE 1984 IEC Beak

A 1993 Ministry of Environment inventory of a section of the Similkameen River between Similkameen Falls and Princeton indicates that the rainbow trout population was approximately 200 fish per km. The 1984 IEC Beak report on the same stretch of river indicated rainbow trout populations of 260 fish per km. A difference of 60 fish per km (1984 vs 1993 study) is not significant considering the assessment technique (snorkel floats) and the level of accuracy it provides. In addition, the Similkameen River rainbow trout catch statistics for the Hedley to Princeton Reach for 1984 was 840 animals. This was prior to 1989 stocking efforts. During 1989, the catch had increased to 4,130 for the same reach. This shows that, by these accounts, the rainbow trout population has increased in this part of the Similkameen River since the start of the stocking program. It should be noted that in the last 20 years the quota has been reduced from 8 to 4 (wild trout release in one section) and the gear

census 1984, 8?

requirements changed from "wide open" to bait ban from April 1 to October 31 and the use of single barbless hooks.

Although outside the study area, the 1993 State of the Environment Report for British Columbia stated that the fish populations in Okanagan Lake and its tributaries have seriously declined in the past two decades. A variety of factors may have contributed to this decrease including; water shortages, overfishing, habitat deterioration, disease, competition, predation and natural population fluctuations. These factors affecting the Okanagan Lake system may also be applicable to the Similkameen River system.

There are no other data available to assess trends and changes that may be occurring in the Similakameen River system within the study area. This is a significant gap in the data base.

6.5 DATA GAPS

The 1984 Similkameen Fisheries Management Unit plan has not been updated and may not represent current fish stock levels. The numbers (of fish) used in this report have been based on a small number of sample data and are not likely to be representative of the conditions in the whole river system (S. Matthews, pers. comm.).

There is insufficient information on the levels of natural fish production for some of the lakes to draw conclusions and make recommendation on allowable catch quotas and for general fisheries resource management requirements.

There is insufficient data available on fish population and habitat characteristics of the rivers and creeks in the Seven Peaks Study Area.

There is insufficient data on species compositions, habitat conditions and locations of stock to understand the trends and changes that are occurring to the fisheries resource in the study area. This has resulted in insufficient quantifiable information to develop management plans. A planned electrofishing program for 1995 was canceled due to Ministry of Environment budget constraints.

6.6 CONCLUSIONS AND RECOMMENDATIONS

6.6.1 Water Bodies

The water bodies considered in this report may be used to generalize the entire study area. Typically, the creeks are steep and cold and have low productivity. This low level of production is naturally occurring and not due to human activities. The Similkameen River and the lakes in the study area are by far the most important water bodies in terms of fish production and maintenance of the sport fishery. According to the Ministry of Environment the lakes in this region are currently near their maximum potential for productivity. There is not much room for increased fish production in the creeks but there is potential for increasing angler utilization (S. Matthews, pers. comm.).

The smaller creeks in the study area are important in terms of providing flow to the Similkameen River and maintaining lake water levels. The degradation of the water quality or decrease in flow volumes in the smaller water bodies can impact on the larger water bodies.

Calculations of the possible changes to Nickel Plate/Hedley Creek and Keremeos Creek indicate minimal changes to water flows from the Apex Resort water license application. Habitat index calculations for both creeks remained unchanged after the predicted changes to water flows were calculated. Therefore, the movement of 160 ac-ft from the Hedley watershed to the Keremeos watershed should have minimal impacts to aquatic life within Nickel Plate/Hedley Creek and Keremeos Creek (Wildstone, 1995).
In regard to Nickel Plate Lake, additional use of water will result in a reduction of 2.75% of the littoral zone. Although this percentage is not directly proportional to the production of aquatic life, it is suggested that a minimal impact to aquatic life will result from the annual withdrawal of 160 ac-ft from Nickel Plate Lake (Wildstone, 1995).

The Similkameen Management Unit is based on a small rainbow trout fishery which is heavily dependent upon annual stocking. Overall fish production in the unit will not improve as the lakes are currently at or near maximum productivity. Although the unit contains the second-largest number of lakes in the region, their total surface area only represents 3% due to their small sizes (BC Environment, 1984).

6.6.2 Fisheries Resources

From the results of the 1994 electrofishing program, the five most common species captured from the Similkameen and Southern Okanagan watersheds were:

Similkameen System:

Species	% of waterbodies with confirmed presence
Rainbow trout	68
Mottled sculpin	21
Longnose dace	17
Torrent sculpin	15
Brook trout	11

most common species

South Okanagan System:

Species	% of waterbodies with confirmed presence
Rainbow trout	51
Longnose dace	19
Brook trout	11
Redside shiner	11
Prickly sculpin	8

Only six fish species have been confirmed in the Similkameen River and only four species confirmed in the creeks in the study area. The most abundant species was rainbow trout, which occurred in all water bodies, the second and third most common species were the brook trout and mottled sculpin respectively. They were confirmed in three of the ten water bodies studied.

6.6.3. Impacts

The sources of possible impact on fisheries by human activities are:

- Future road construction or existing road maintenance and improvements can cause degradation of the water quality of the creeks. In steep areas, such as the Seven Peaks region, erosion control is extremely important. Management and construction procedures such as the Forest Practices Code are in place to mitigate this issue. Forest Renewal BC projects can be used to assess watersheds to determine what rehabilitation may be required.

- Leachate from mine tailings can be toxic to aquatic life due to cyanide, sediments and high metals content. Sedimentation caused by erosion can smother fish eggs and benthic organisms when it settles out on the creek bed. The following mines are known (or proposed) to exist in the study area:

  Nickel Plate Mine
  Candorado Mine
  Garnet Quarry (proposed)

- Continued urbanization through developments such as the Apex Ski Resort or municipal growth in Hedley, Olalla, Keremeos and Cawston can have significant impacts on water quality and thereby affect the fisheries resource. Urbanization can impact on water quality during and after construction through sedimentation, septic wastewater discharges, pesticide and fertilizer usage and changes to storm water discharge rates. Urbanization can also impact fisheries and other aquatic resources by reducing flows in the creeks due to increased water usage (both licensed and unauthorized).

- Ranching and other agricultural land uses can adversely impact the fisheries through increased water usage for irrigation; by increasing sedimentation and runoff from fields; and by the addition of potentially toxic compounds found in pesticides and fertilizers. Historically runoff from intensive agricultural areas has resulted in contamination of creeks and rivers by agricultural chemicals. Water requirements for agricultural irrigation are increasing throughout the region. In addition, impacts from cattle can cause loss of riparian vegetation and destabilizing stream banks.

- Wetlands have declined (in area) by 85% in the Southern Interior of the province and this is certainly true of the lower Keremeos Creek system. The buffering system that protects the integrity of the aquatic system is in decline. This decline represents a significant vulnerability to the aquatic system as wetlands and swamps provide a natural system for cleansing runoff before it enters the creeks and rivers.

6.6.4 Recommendations

It is recommended that research be carried out to better understand the characteristics of the rare and endangered fish species of the study area. In particular this would include inventories, distribution characteristics, genetic and taxonomic relationships between isolated populations, habitat requirements and in particular the impacts from hydroelectric development. In particular Otter Creek should be surveyed to assess the status of Umatilla dace and the deeper water habitats of the Columbia River system. Also further inventories are needed to delineate more clearly Chiselmouth's curious distribution in B.C. (Cannings 1993). There also needs to be better protection of exemplary habitat, such as that in the Similkameen River at Keremeos (Clemons 1993).

In order to properly update the Similkameen Fisheries Management Unit plan it is recommended that representative field data on species and population characteristics be collected from the significant creeks in the study area flowing into the Similkameen River as soon as possible.

It is recommended that fish productivities in the lakes of the study area be assessed to assist in establishing restocking requirements, fish catch quotas and to also assist in overall resource management requirements.

It is recommended that fisheries surveys be carried out on a regular basis in the Similkameen River, Hedley, Cahill, Winters, Keremeos, South Keremeos, Olalla, Cedar, Shatford and Shingle Creeks to develop reliable information at specific locations on species and population characteristics, and on general habitat requirements throughout the entire region.

It is recommended that information on the changes in population characteristics and species dynamics be entered into the Ministry of Environment, Lands and parks GIS at locations which can be used to indicate the overall sustainability of this resource in the Seven Peaks Area.

SECTION 7.0

VEGETATION

Reid Crowther

SECTION 7.0
VEGETATION

7.1 BIOGEOCLIMATIC ZONES & NATURAL DISTURBANCE POTENTIAL

The study area contains five biogeoclimatic zones (Figure 7-1). Their distribution clearly shows the north-south trend of physiographic features through the study area. The two main zones are the interior Douglas fir (IDF), which lies at mid to low elevation, and the Englemann spruce/subalpine fir zone (ESSF), which occupies the higher mountain range on the west side of the study area. The IDF zone covers 40,312 ha or 39 percent of the study area. The ESSF zone covers 23,942 ha (23 percent). Between the two main zones is a narrow band of montane spruce (MS) at mid elevation. It is a highly disaggregated zone, with some 65 identified parcels covering 17,932 ha (17 percent of the study area). In the lowest elevations are narrow bands of ponderosa pine zone (PP); and near Penticton, beside the larger lakes and in stream valleys on the east side of the study area is bunch grass zone (BG). These cover 13,622 ha (13 percent) and 7,226 ha (7 percent) respectively.

Over three-quarters (77 percent) of the study area is classed as very dry. Over half (54 percent) of this is further classed as hot. These very dry hot areas are subzones and variants of the lower elevation Douglas Fir, Ponderosa Pine and Bunchgrass zones. At mid elevation, highly disaggregated areas (some 90 patches) of IDF are classified as dry and cool, and the MS is classified as dry and mild or very dry and cool. The ESSF zone is subclassified as very dry and cold, with several large islands at the highest elevation classed very dry cold parkland.

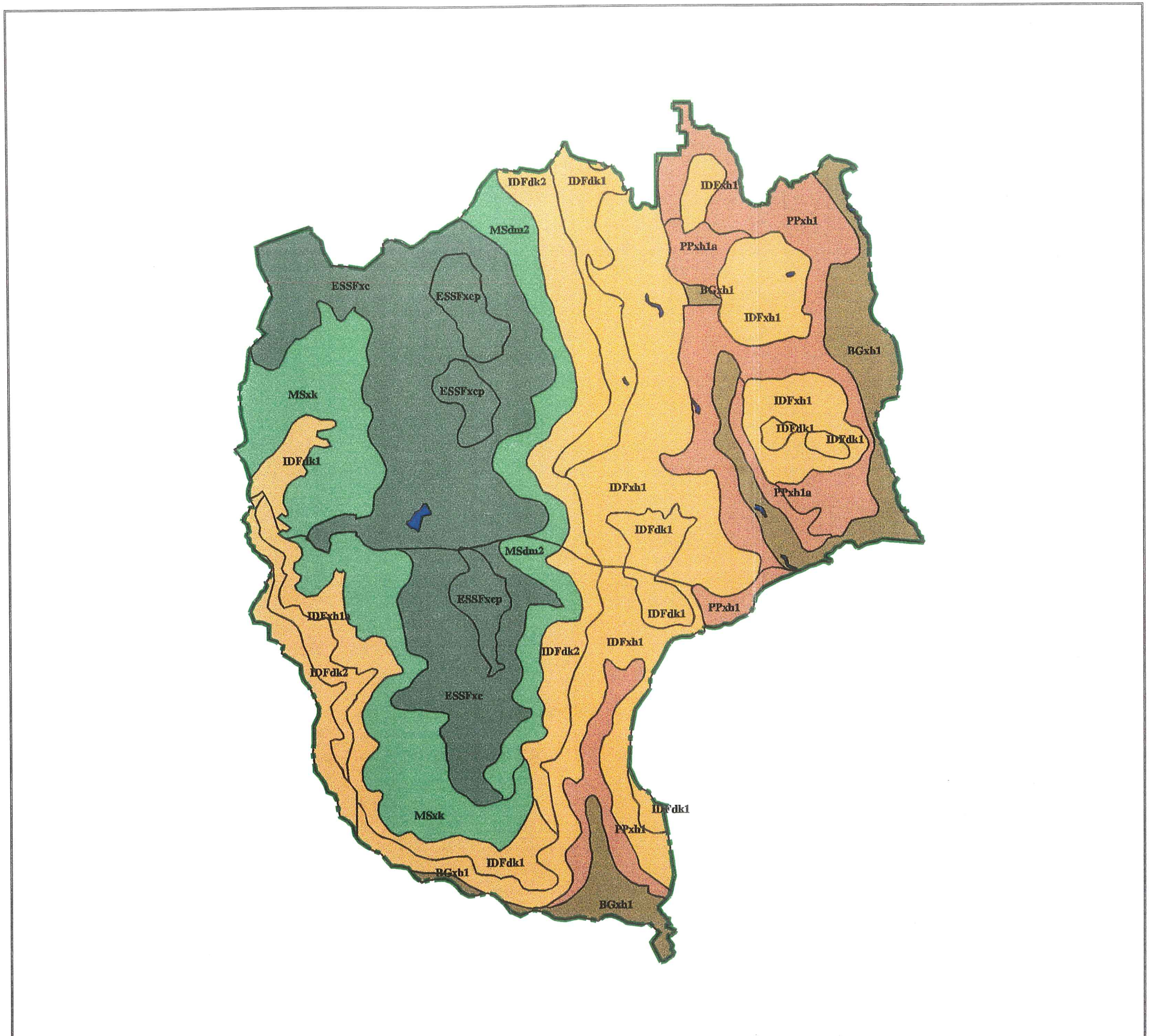
It is apparent that the study area contains much hot dry lower elevation terrain, with consequent limitations to plant growth. There is little standing water, and streamflow decreases in summer (see Hydrology section).

As part of the Forests Practices Code the BC government has developed a classification of natural disturbance potential based largely on the biogeoclimatic

FIGURE 7-1

7 PEAKS STUDY AREA

Biogeoclimatic Units



LEGEND

- Bunch Grass
- Englemann Spruce/Subalpine Fir
- Interior Douglas Fir
- Montane Spruce
- Ponderosa Pine
- Lakes

- Study Area Boundary
- BEC Unit Boundary

0 1.25 2.5 3.75 MILES

0 2 4 6 KILOMETERS

SOUTHERN INTERIOR REGION GIS, 1996

Map Scale 1:220 000

Projection Albers Equal Area, NAD83

classification (BC Government, 1995). The study area, as classed by natural disturbance regimes, is indicated in Figure 7-2.

The large area that includes the east side of the study area and lower elevation on the southwest side is considered to be an ecosystem with frequent stand-maintaining events (NTD4), in this area, fire. This area actually consists of some 166 parcels totalling 61,160 ha (59 percent of the study area). It consists of grassland, shrubland and forested areas that have historically been maintained by frequent, but likely low-intensity fires. These fires would have removed the accumulating forest floor fuel and thinned young trees, thus maintaining an open forest structure.

In recent years fire suppression has no doubt allowed fuel to accumulate on the forest floor, and vegetation has been modified by cattle grazing and by the planting of non-native forage species. Natural biodiversity has likely decreased in this area.

The higher elevation area, equivalent to the montane spruce and Engelmann spruce BGC zones, is considered to be an ecosystem with frequent stand-initiating events (NTD3). This area includes 38,465 ha or 37 percent of the study area. In this area the events can be forest fires and also bark beetle depredation. The long term result can be a mosaic of even age stands where the fires or beetle damage removed small to very large areas of forest. These areas could contain undamaged, hence older, patches of forest. Fires have been estimated to occur approximately every 150 years (Biodiversity Guidebook, 1995) in this type of habitat. Other estimates are 175-275 years in Montane Spruce and 200-300 years in the ESSF zone (Parminter, 1992).

Within the NTD3 area are two high elevation areas classed as natural disturbance type 5, alpine tundra and subalpine parkland. In this study area these two cover types include forested areas below the alpine treeline and also non-forested high alpine areas. These areas typically have short growing seasons and low soil moisture, although microclimatic areas can be very productive for sedges, grasses, forbs, and deciduous shrubs. Due to low fertility and short growing season, these areas can be damaged by grazing cattle.

7.2 FOREST COVER

Several sources of land cover mapping provide forestry information. One source that provides an overview of the study area, baseline thematic mapping, is shown in Figure 7-3. This mapping combines LandSat imagery, 1:250,000 NTS, TRIM data, and other sources of information. Of the fourteen land use types identified and coded by BC Environment staff, Old Forest is defined as 140 year or older and greater than 6 m in height. Only areas of 50 ha or more are typically identified. The Young Forest classification includes forests less than 140 year and over 6 m in height. This mapping identified 28,575 ha of Old Forest (28 percent of the total study area) and 45,887 ha (44 percent) as Young Forest.

Forest cover types and age classes were obtained from BC Forests forest cover mapping. Commercially valuable forested lands accounted for two-thirds of the study area (69,131 ha). The remainder was classified as non-forested (4297 ha, 4.2 percent) or non-productive (30,294 ha, 29 percent). Non-forested land is capable of supporting commercial forests; non-productive land cannot support commercial forestry but may have other valuable uses.

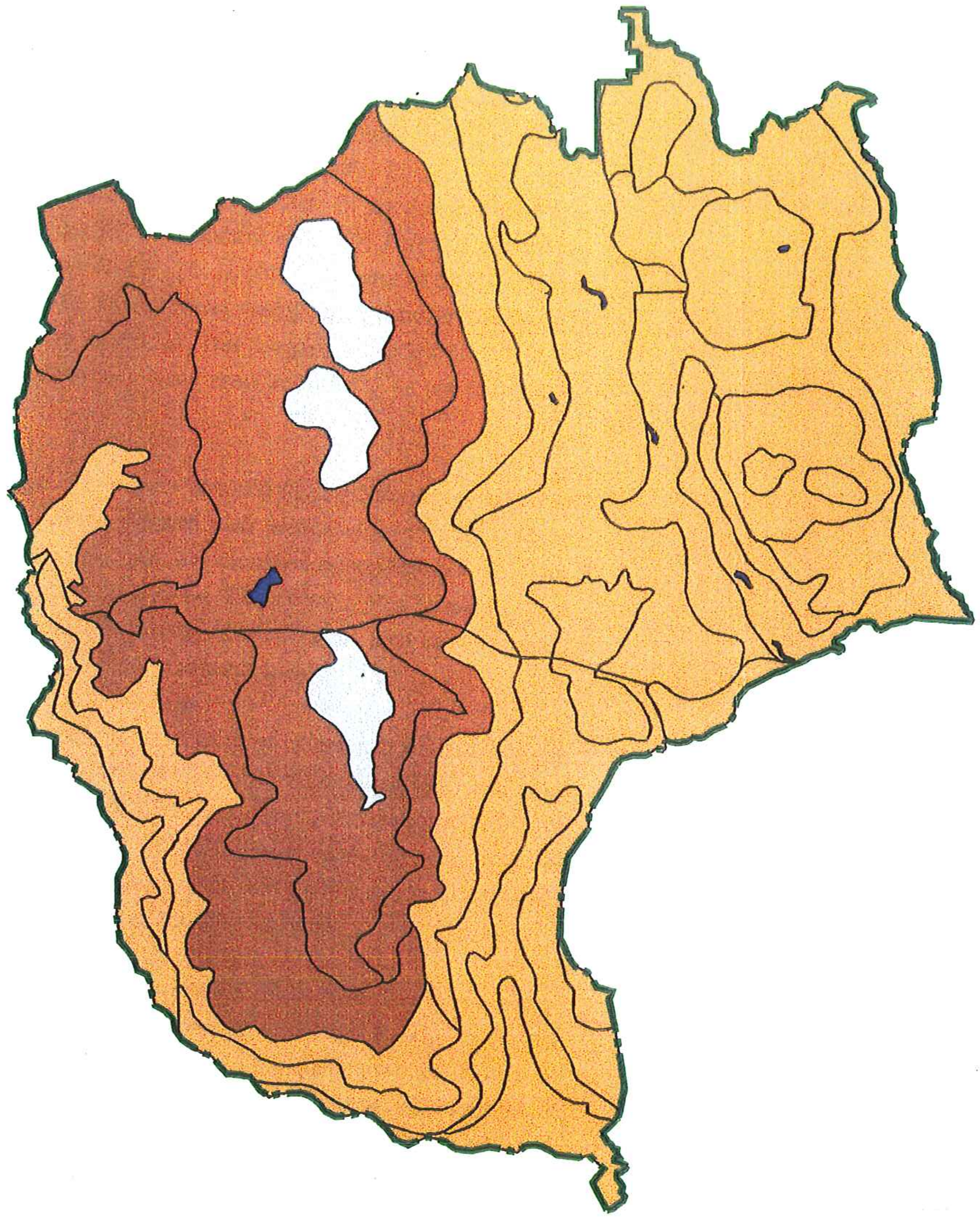
Tree species are shown in Figure 7-4. The most common tree species in the study area are Douglas fir, largely in the lower elevations, and lodgepole pine, at higher elevations to the west and north. Each species covers some 27,000 ha and constitutes nearly 40 percent of the forested land. Spruce, including Engelmann spruce, and Ponderosa pine are the next most common species, each covering about 7,000 ha (10 percent of the forested land).

Ponderosa pine, firs and other species are found on the remaining ten percent of forested land. Ponderosa pine occurs, sometimes in large stands, in the dry lowlands on the east side of the study area. In the high elevations, balsam fir and subalpine fir are found. These are usually in small stands, but subalpine fir occurs in a very large stand in the northwest part of the study area. Very small areas of black cottonwood and trembling aspen occur in lower elevations on the east side of the study area, and a very few areas of birch and whitebark pine occur also.

FIGURE 7-2

7 PEAKS STUDY AREA

Natural Disturbance Regimes



LEGEND

Natural Disturbance Types

- NDT3 - Ecosystems with Freguent Stand Initiating Events
- NDT4 - Ecosystems with Frequent Stand Maintaining Events
- NDT5 - Alpine Tundra and Sub-alpine Parkland
- Lakes

0 1.25 2.5 3.75 MILES

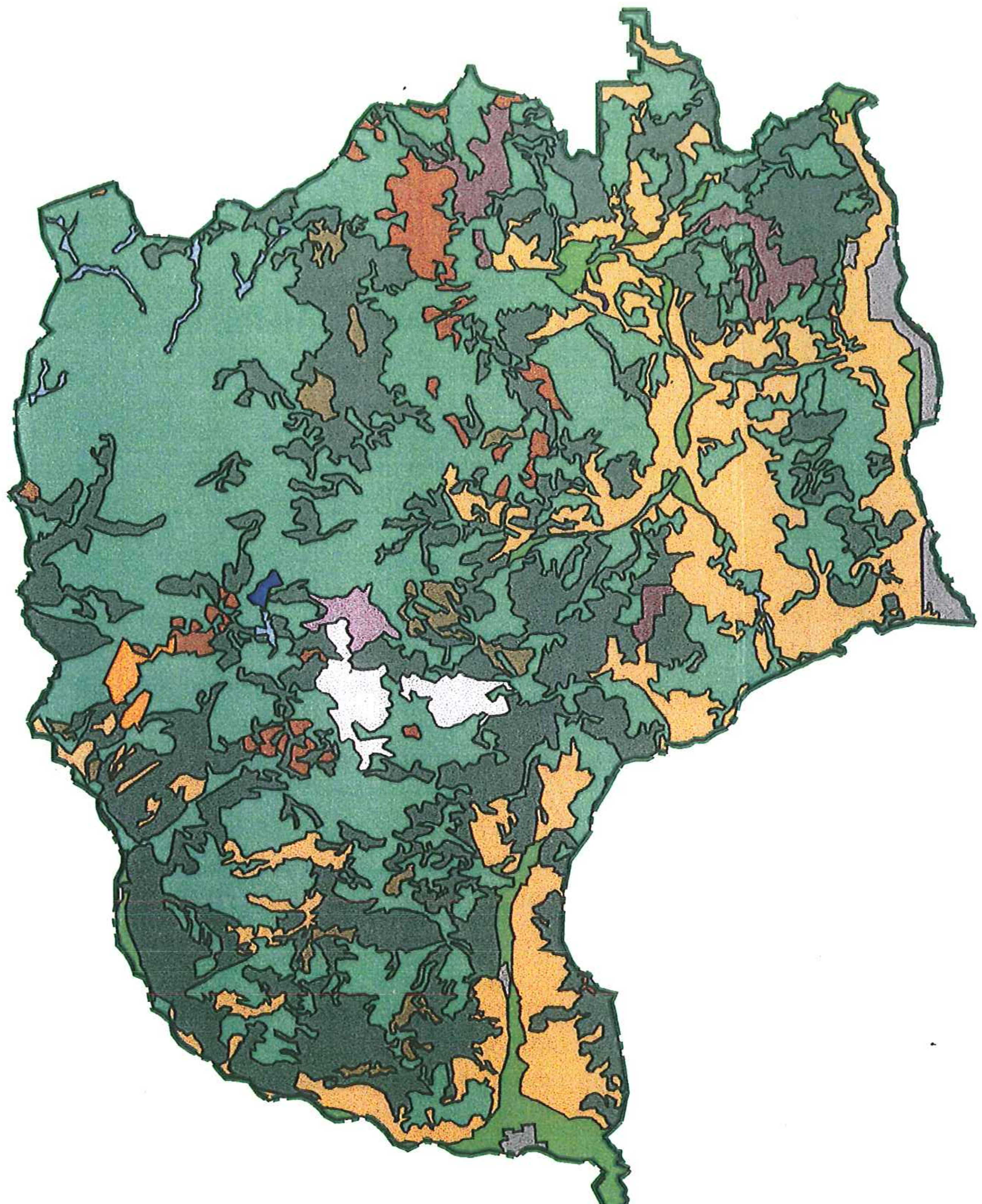
0 2 4 6 KILOMETERS

Prepared by MINISTRY OF ENVIRONMENT

SOUTHERN INTERIOR REGION GIS, 1996

Map Scale 1:220 000

Projection Albers Equal Area, NAD83



7 PEAKS STUDY AREA

Baseline Thematic Map

LEGEND

- Alpine
- Subalpine Avalanche Chutes
- Barren Surface
- Old Forest
- Young Forest
- Recently Logged
- Selectively Logged
- Mining
- Agriculture
- Rangeland
- Recreation Activities
- Urban
- Wetlands
- Fresh Water
- Study Area Boundary
- BTM Unit Boundary

FIGURE 7-3

0 1.25 2.5 3.75 MILES

0 2 4 6 KILOMETERS

Prepared by MINISTRY OF ENVIRONMENT

SOUTHERN INTERIOR REGION GIS, 1996

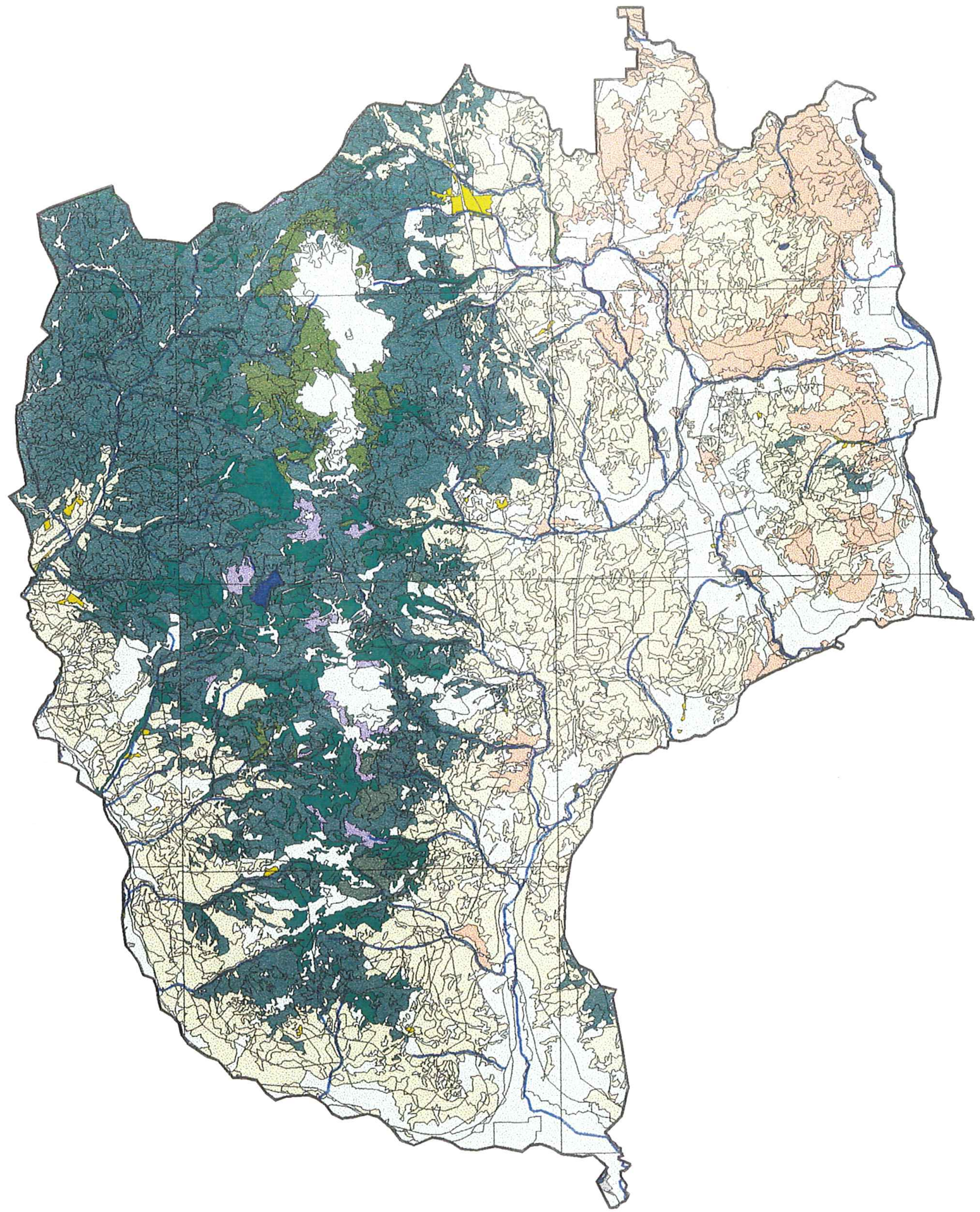
Map Scale 1:220 000

Projection Albers Equal Area, NAD83

FIGURE 7-4

7 PEAKS STUDY AREA

Forest Cover Species Distribution



LEGEND

- Balsam poplar Cottonwood
- Aspen
- True Fir
- Alpine Fir
- Common Paper Birch
- Douglas Fir
- Whitebark Pine
- Lodgepole Pine
- Ponderosa Pine
- Spruce
- Engelmann Spruce

0 1.25 2.5 3.75 MILES

0 2 4 6 KILOMETERS

Prepared by MINISTRY OF ENVIRONMENT
SOUTHERN INTERIOR REGION GIS, 1996

Map Scale 1:220 000

Projection Albers Equal Area, NAD83

Source: MOF Forest Cover 1:20,000

The forest age class map (Figure 7-5) indicates a diverse mix of stand ages throughout the study area, including the eastern stand-maintaining area and the higher elevation stand initiating area. There are many more and larger areas with no forest cover in the dryer low elevation areas, and there appear to be larger stands in the 120 to 250 year age groups. In the higher elevation stand initiating area there appear to be smaller stands in the 141-250 year class, and more small stands in the 21-40, 41-60 and 81-100 year classes.

Nearly one-quarter of the forested land consists of trees in the 141 to 250 year age class. The majority of them are Douglas fir, followed distantly by spruce and Ponderosa pine.

The oldest trees in the study area (over 250 years) are spruce, (including Engelmann spruce), Douglas fir and lodgepole pine. These occur in a very few small areas and constitute less than a third of a percent of forest cover.

7.3 FIRE HISTORY

A fire history of the study area would be somewhat useful to understand the process of forest development, the stand- initiating disturbances and concerns about accumulating fuels on the forest floor. Such an analysis would require considerable effort to review air photos and recorded history and carry out field reconnaissance.

Baseline thematic map analysis typically identifies areas burned within the past 20 years, or forests with less than 16 percent cover. Such analysis did not identify any burned areas in the study area.

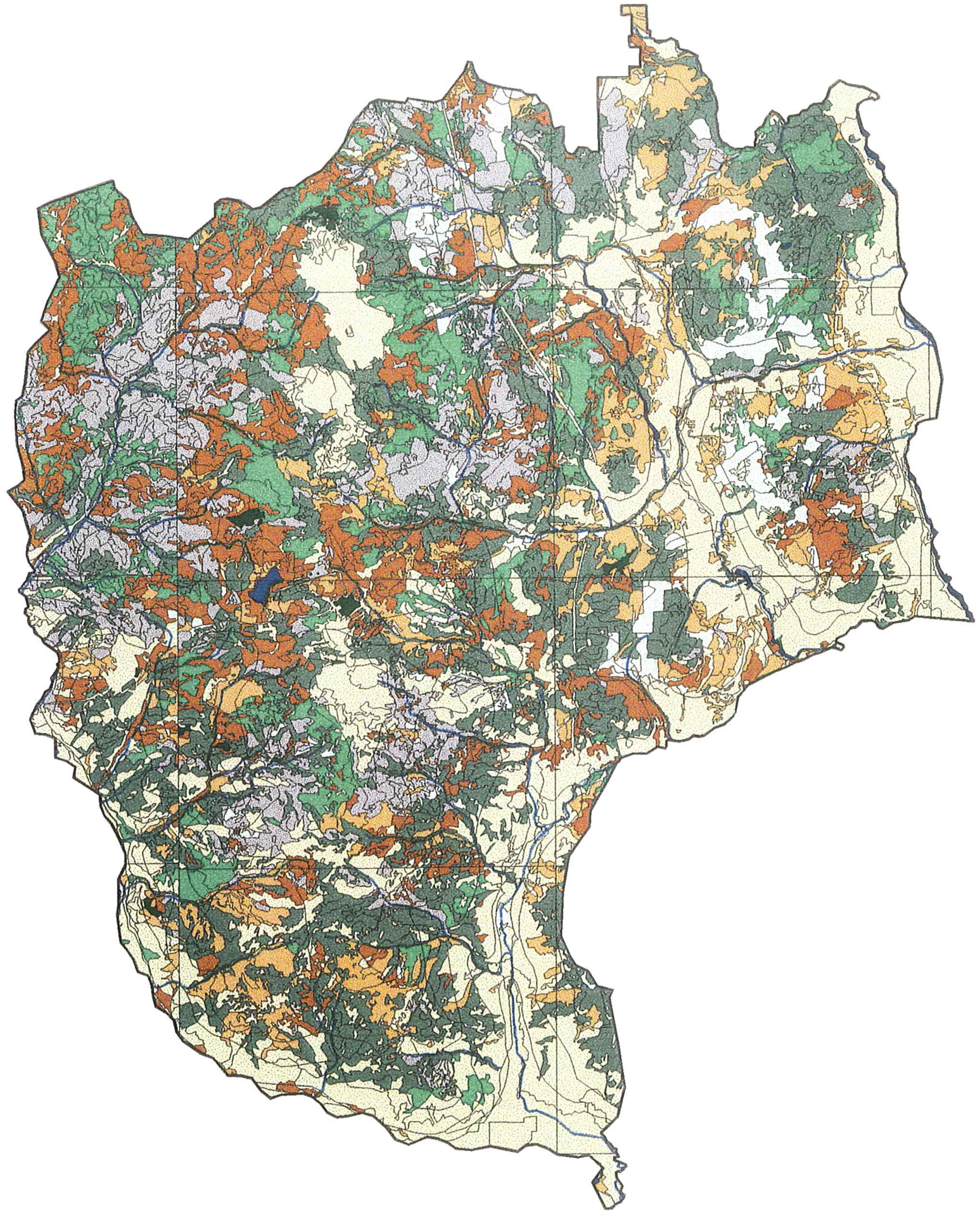
Forest cover analysis identified 25 plots totalling nearly 800 ha that were classified as non-productive burn. This classification amounts to nearly three percent of the study area. Most of the plots were in the Engelmann Spruce/Subalpine Fir zone.

7.4 RIPARIAN, SHRUBLAND AND UNDERSTOREY VEGETATION

FIGURE 7-5

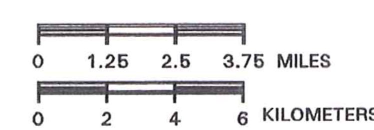
7 PEAKS STUDY AREA

Forest Cover Seral Distribution



LEGEND

- Non forested stands (NC, NCBR, NSR, NTA)
- Non productive Land Areas (Basic Class)
- Forested stands with a projected age less than 80 years
- Forested stands with a projected age between 81-100 years
- Forested stands with a projected age between 101-120 years
- Forested stands with a projected age between 121-140 years
- Forested stands with a projected age between 141-250 years
- Forested stands with a projected age greater than 250 years
- Lakes/Rivers



Prepared by MINISTRY OF ENVIRONMENT
SOUTHERN INTERIOR REGION GIS, 1996

Map Scale 1:220 000

Projection Albers Equal Area, NAD83

Source: MOF Forest Cover 1:20,000

Although there are no specific studies describing wetlands, shoreline vegetation, or any understorey vegetation of the study area, some general information can be found.

The Baseline Thematic map identified 16,566 ha of Rangeland (some 16 percent of the study area). This classification can include unimproved pasture and grasslands with scattered shrubs up to 6 m in height and less than 35 percent forest cover. Sparse forest stands and their understorey shrubs can be included. Consequently, it appears that a large amount of the study area could contain riparian and understorey vegetation of significance to wildlife and fish habitat, rare and endangered species, soil protection and many other values, but without better analysis, this classification is not well understood.

Other BTM land use classifications may involve considerable vegetation cover also such as Recreational Activities and perhaps Wetlands.

The forest cover classification included Non-forested areas, defined as not presently forested but having the capability to produce commercial forests. These areas consisted of some "non-commercial brush" and mostly "not satisfactorily restocked" lands. It is likely that much of this land is in a very early seral stage and provides a shrub type habitat. Over 4,000 ha, or 4 percent of the study area, was so classified.

Forest classification also includes a Non-productive category, describing lands that are incapable of supporting commercial forests. Subclassifications that could describe riparian and shrubland type habitats were "clearing" (2287 ha), "meadow" (132 ha), "non-productive brush" (159 ha), "non-productive burn" (798 ha), and "swamp" (471 ha). Other classifications that may include some land of value to wildlife, fisheries recreation and other such uses were "nonproductive" (5453 ha), "open range" (14,415 ha), and "rock" (1588 ha).

A few incidental observations were noted during stream surveys for fish populations and habitats (S. Matthews, BC Environment, pers. comm. 1995) but the information is not mappable and could not contribute to an understanding of wildlife habitats or other land uses.

7.5 RARE AND ENDANGERED SPECIES

The BC Conservation Data Centre prepared a list of rare and endangered species for the study area. As of 26 May 1995, 30 plant species were listed at 45 locations as having rare and endangered status. (Status definitions are provided in Appendix B). Twenty-four of these locations (53 percent) were given a provincial code of 1 or 2 (critically imperiled because of extreme rarity, imperiled because of rarity) and a red listing. Seventeen of them (38 percent) had a provincial code of 2 to 3 (imperiled because of rarity, rare or uncommon) and a blue designation. The remaining four species locations were given a yellow designation. These locations are shown on Figure 7-6.

Many of the observations of these species were made as part of general surveys of the South Okanagan region and it is unclear how extensively the specific study area was included.

7.6 FORESTRY OPERATIONS

Several sources of data indicated recent forestry operations in the study area. A general overview is provided by the baseline thematic mapping. The Recently Logged classification includes areas that have been logged in the last 20 years, or older if tree cover is less than 40 percent and under 6 m in height. Selectively Logged areas must be clearly identified on the source photography.

Figure 7-3 and its associated database identified 29 Recently Logged areas totalling 2,278 ha (2.2 percent of the study area) and four Selectively Logged areas covering 1,597 ha (1.6 percent).

Forestry operator licenses are held by Gorman Brothers, Weyerhaeuser and BC Forests Small Business Forest Enterprise Program (Figure 7-7). Detailed information and maps of past and proposed harvest areas and restocked areas were obtained for the Penticton Forest District. In the Merritt Forest District, immediately west of the Seven Peaks study area, Crown Land is in Weyerhaeuser's operating area.

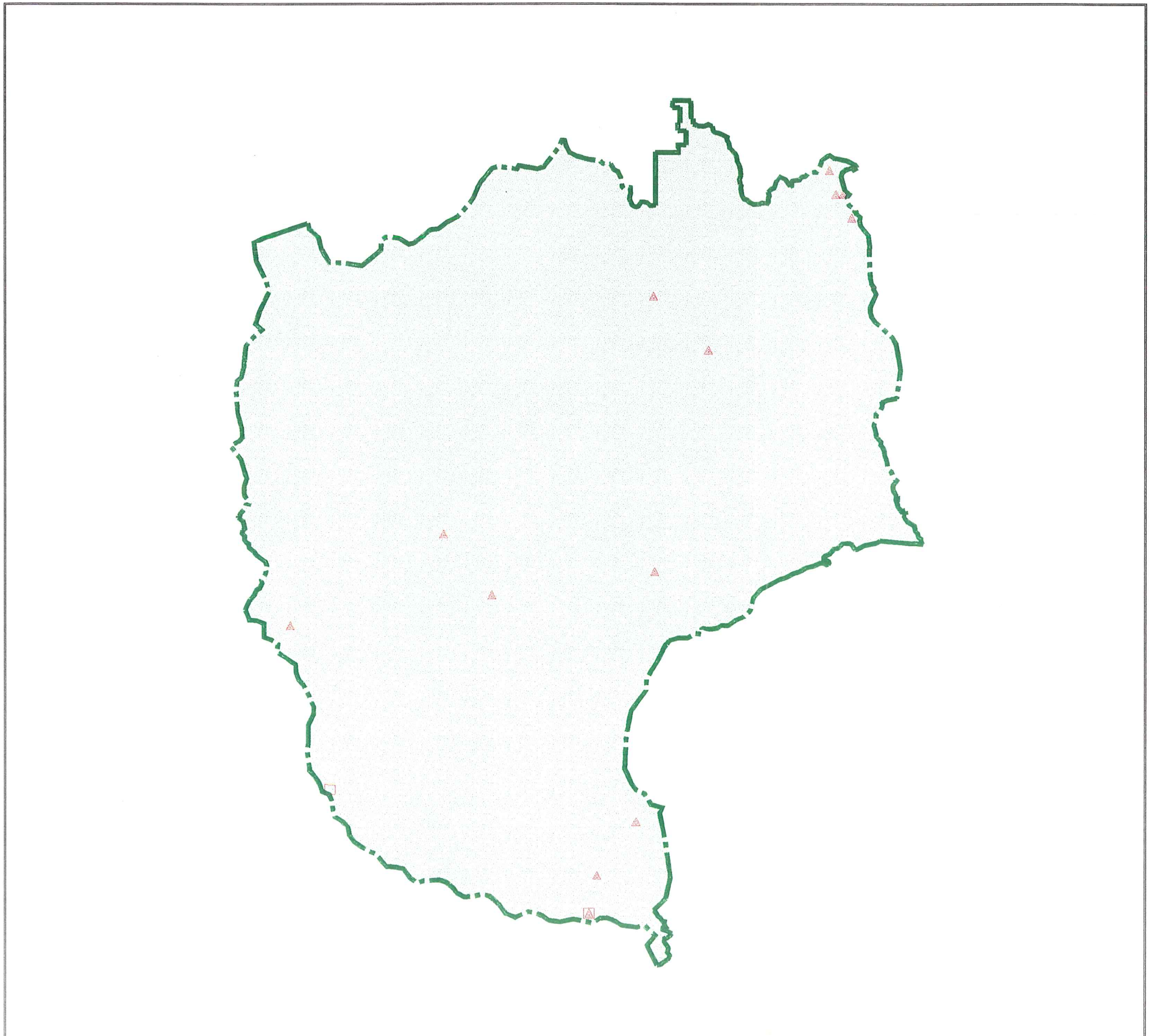
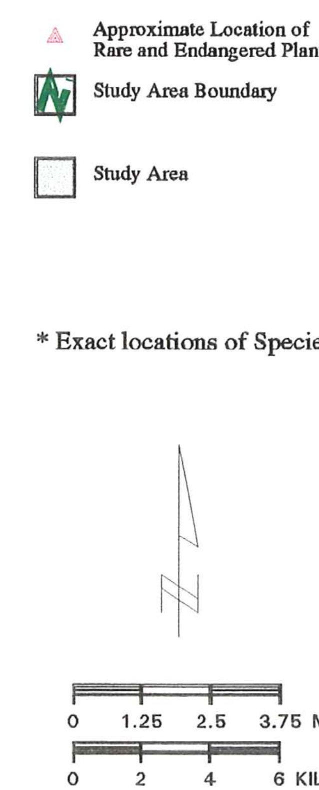


FIGURE 7-6

7 PEAKS STUDY AREA

Rare & Endangered Plant Species

* Exact locations of Species not shown



Prepared by MINISTRY OF ENVIRONMENT
SOUTHERN INTERIOR REGION GIS, 1996

Map Scale 1:220 000

Projection Albers Equal Area, NAD83

Source: Conservation Data Centre

Because of road access problems, forest companies indicated that forestry activity in the study area has been less than expected in recent years. Weyerhaeuser harvest activity in 1994 was limited to three small cut blocks immediately west of Nickel Plate Lake. Harvest blocks are scheduled for the next five years in five general locations: south of Nickel Plate Lake, west of Winters Creek, northeast of Nickel Plate Lake, upper Shatford Creek area, and in the Hedley Creek drainage. Only four of the blocks have reached the approval stage; others are in initial, advanced and silviculture prescription stages. Two areas of reforestation have been identified. Some roads were under construction as of late 1995.

Weyerhaeuser has provided detailed information regarding the volumes of timber, road construction and harvest methods proposed.

The BC Forests Small Business Forest Enterprise Program operates as a forest company. They have not had any recent harvest operations in their one license area north of Yellow Lake. In 1994 they carried out single tree removal on Weyerhaeuser lands north of Shatford Creek in order to remove pine beetle damaged trees. They do not have plans for additional harvests in the near future.

7.7 SUGGESTED TREND DATA AND STANDARDS

The only information available that allows trends to be measured is that on forest cover maps. These show existing forest characteristics and also forestry activities by date. However, in the past five or so years, there has been almost no forest harvesting in the study area and trends or cumulative harvest statistics are not relevant. There is expected to be more harvesting and reforestation in the next five years, and these can be monitored.

The following vegetation information would be useful to monitor in the future. This information could be provided at present by analysis of biogeoclimatic zones, landsat thematic mapper, forest cover maps (currently in the GIS) and from forest company plans.

- Past forest harvesting (ha, date, percent, cumulative percent);

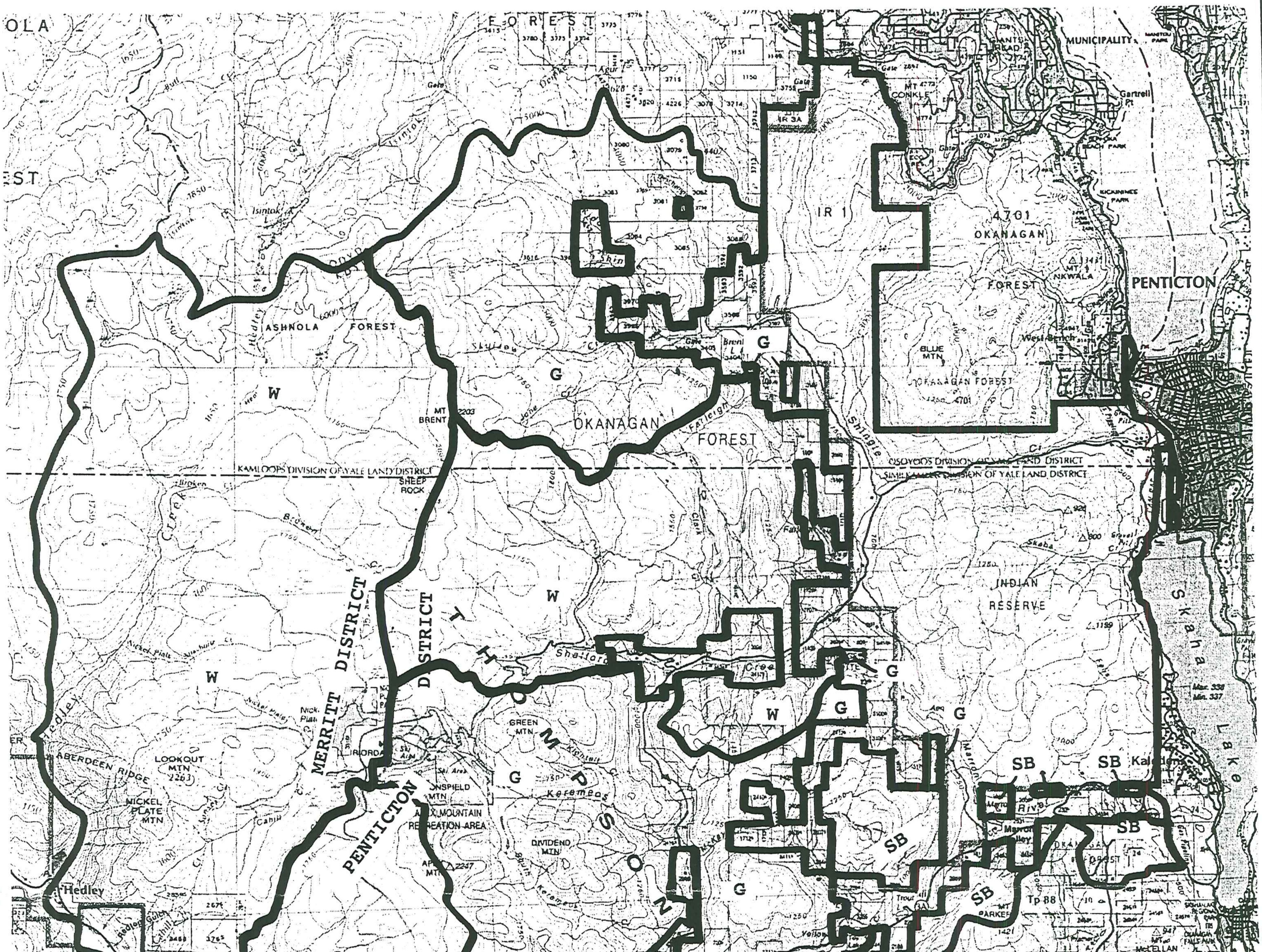


FIGURE 7-7

FORFEST LICENSEE OPERATOR AREAS

SEVEN PEAKS
ENVIRONMENTAL
BASELINE AUDIT

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- Forest harvest projections (ha, date, percent, cum percent);
- Reforestation activity (ha, date, success);
- Logging road construction (length, area, locations, reclamation);
- Forest burns (ha, date);

Under the Forest Practices Code recommendations and standards have been published (and more are being developed) to guide and regulate forestry operations in order to maintain ecosystem integrity as much as possible. For example, forests can be managed in ways that promote rather than reduce biodiversity (BC Government, 1995). These ways include awareness of the physical and biological sensitivity of the area; planning at a forest ecosystem network scale (FEN); controls on cut block size, location, pattern and distribution in the forested area; improved road construction and decommissioning techniques; retention of wildlife trees and snags, singly and in groups; leaving woody debris in the forest; and other management methods.

These forestry standards are intended to control over-harvesting and environmental degradation. The above listed indices can provide monitoring of forest uses.

7.8 DATA GAPS AT PRESENT

The following information would be useful for a better understanding of the vegetation cover in the study area:

- Information on understorey and wetlands vegetation;
- Studies of the impact of fire suppression and grazing on the NDT4 area.

7.9 CONCLUSIONS AND RECOMMENDATIONS

7.9.1 Conclusions

There is an abundance of forest vegetation data available, due to the forest cover maps. This information will allow a variety of analyses to be performed using the GIS.

There is a recent list of rare and endangered plant species for the study area, but it is not clear how extensively the area has been surveyed. It is likely that detailed surveys were carried out along accessible routes and much of the study area has been examined only superficially.

Non-commercial plant species, such as riparian vegetation, grassland, shrubland and understorey species, have been little documented. It is in these areas that native species can be impacted by grazing, competition with non-native species, and other land uses. Plant biodiversity can diminish quickly, and with it the wildlife species that depend on the habitat.

7.9.2 Recommendations

The lack of information on wetland and understorey vegetation is serious from the perspective of understanding many land uses, existing and potential. Surveys and mapping of these communities is recommended.

The stand natural disturbance types could be analyzed by age classes and by sub-areas to see if stand maintenance and stand initiating have occurred as predicted. This study could contribute to an understanding the of effects of cattle grazing, fire suppression and bark beetle control on the natural development of various forest types.

SECTION 8

WILDLIFE

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SECTION 8.0
WILDLIFE

8.1 GENERAL INFORMATION

Wildlife data are collected by Wildlife Management Units. The study area lies in parts of WMU's 8-7, 8-8 and 8-2 (Figure 8-1) and makes up a small proportion of each unit. As a result, harvest data for each unit apply only generally to the study area.

There is much general information on the wildlife and habitats of the Okanagan region. It is apparent from this information that the area contains very rare and highly sensitive species and habitats. In particular, the shrub-grasslands in this hot dry region contribute only about .06 percent of the provincial land area. Only about 12 percent of the grasslands are crown land and much of the remaining area, particularly on the valley floors, has been disturbed by developments, cattle grazing and the introduction of non-native plants (B.C. Environment publication, nd).

Other general publications such as "Rare Invertebrates of the South Okanagan", "Spotted Bat", "Antelope-brush Ecosystems", and "A National Treasure, Natural Areas of the South Okanagan and Lower Similkameen Valleys" (B.C. Environment publications, nd), make strong cases for the rarity and fragility of the dryland ecosystem in parts of the study area.

A series of handbooks has been prepared that describe the habitats and species requirements of amphibians, reptiles, selected birds and mammals of the southern interior ecoprovince (B.C. Environment, 1988). This area extends from Abbotsford to Trail and from the US border north to Clinton and Clearwater, thus encompassing a much larger area than the present study area. This information is very useful for defining habitats of various species and for understanding their requirements. However, it does not describe or identify specific locations or habitats within the study area.

FIGURE 8-1

7 PEAKS STUDY AREA

WILDLIFE MANAGEMENT UNIT AREAS
(approx.)

LEGEND

- Study Area
- Lakes and Rivers
- Study Area Boundary
- Roads

0 1.25 2.5 3.75 MILES

0 2 4 6 KILOMETERS

Prepared by MINISTRY OF ENVIRONMENT
SOUTHERN INTERIOR REGION GIS, 1996

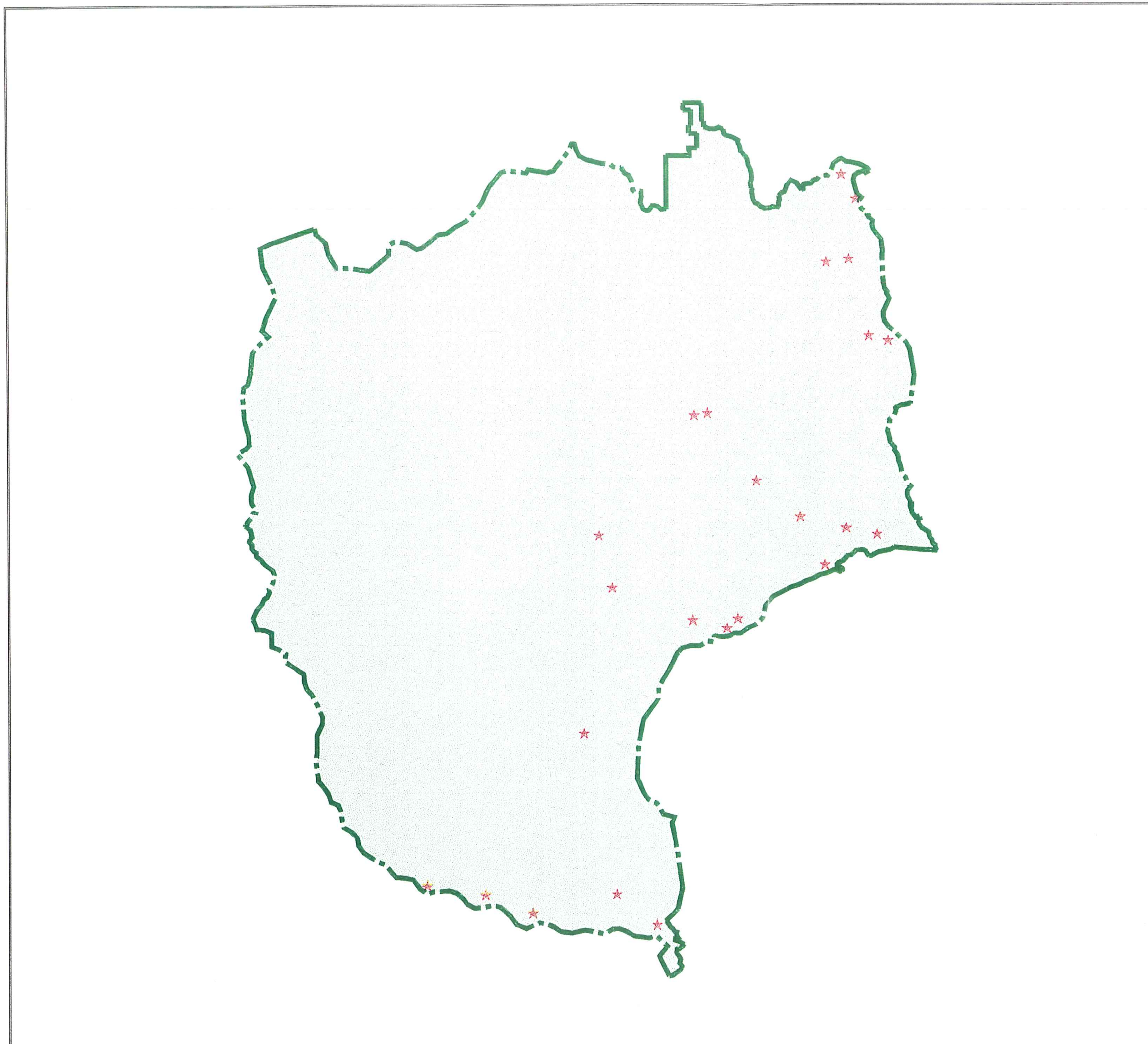
Map Scale 1:220 000

Projection Albers Equal Area, NAD83

FIGURE 8-13

7 PEAKS STUDY AREA

Rare & Endangered Animal Species



Approximate Location of Rare and Endangered Animals

Study Area Boundary

Study Area

* Exact locations of Species not shown

0 1.25 2.5 3.75 MILES

0 2 4 6 KILOMETERS

Prepared by MINISTRY OF ENVIRONMENT SOUTHERN INTERIOR REGION GIS, 1996

Map Scale 1:220 000

Projection Albers Equal Area, NAD83

Source: Conservation Data Centre

Apart from this general information there appear to have beenno specific surveys of wildlife in the study area, not even for game animals such as deer, moose or mountain goats. Perhaps the most quoted source of data for vegetation, wildlife and other natural resources in the study area is Karasiuk (1990). It was subsequently used as the basis for the Wild Stone Resources report (1995) of wildlife impacts by the Apex Mountain Resort. Karasiuk's study, however, was based on airphoto and literature review, interviews and only three days of field reconnaissance that covered nearly all natural resource topics. It is apparent that little detailed field work has been done in the study area.

8.2 WILDLIFE HARVESTS

Some trappers operate in the three wildlife management units but information on exact numbers and trapline locations is not readily available. Figure 8-2 indicates that there has been considerable variation in fur harvest over the last decade, particularly in units 8-2 and 8-7. Unit 8-8 has produced more furs than have the other two units. The fluctuation is likely due to fur prices rather than changes in animal populations. There does not appear to have been an overall trend in harvest in the three management units.

The primary species trapped in the three areas are red squirrels and weasels. The more valuable marten and beaver have been taken, but in much smaller numbers. Based on average prices for 1993-94, the harvest from the three WMU's was $8,037.

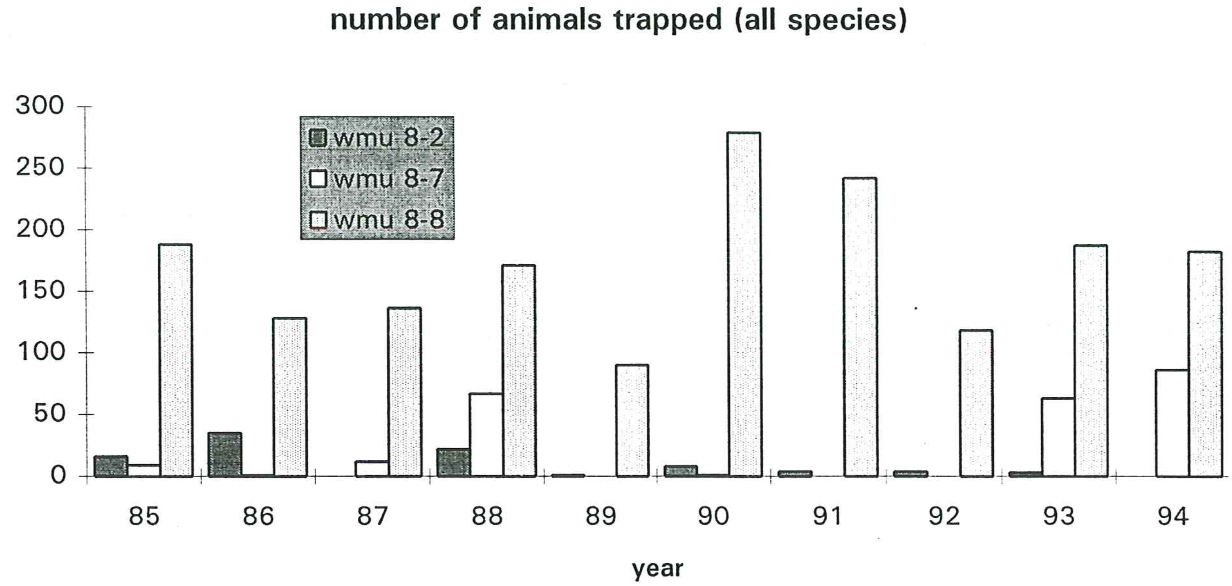


Figure 8-2 Fur harvest in WMU 8-2, 8-7 and 8-8

Numbers of hunters, and their success-rate, are monitored by means of random surveys. For moose, black bear and white-tail deer, 50 percent of hunters are polled. For mule deer, 22 percent are polled, and for other species, which have fewer hunters, 100 percent of the hunters receive a questionnaire. A large return, in the order of 70 to 80 percent, is received, and follow-up surveys of non-respondents has indicated little respondent bias. The conclusion is that good data on numbers and success-rates are obtained.

Species including caribou, grizzly bear, mountain sheep and goats and cougar receive compulsory inspection, so all legally killed animals are counted. The total number of these hunters, however, is learned from questionnaires.

The following tables include both resident and non-resident hunters. In this study area the number of non-resident hunters is relatively low. The number of hunters licensed in the three wildlife management units appears to have remained relatively steady for the last two decades. In unit 8-2 (Figure 8-3) the numbers have been relatively low for all species except for deer hunters. The Figures show mule and white-tail deer hunters since 1987; earlier no species distinction was made and data were not provided.

In unit 8-7 (Figure 8-4) moose hunting and also elk hunting has been popular (although only three elk were harvested in the period of recording). Black bear hunting remained low but steady. In unit 8-8 (Figure 8-5) mule deer hunting attracted the most hunters, with white-tail deer and moose next in popularity. As in unit 8-7, black bear hunting remained steady.

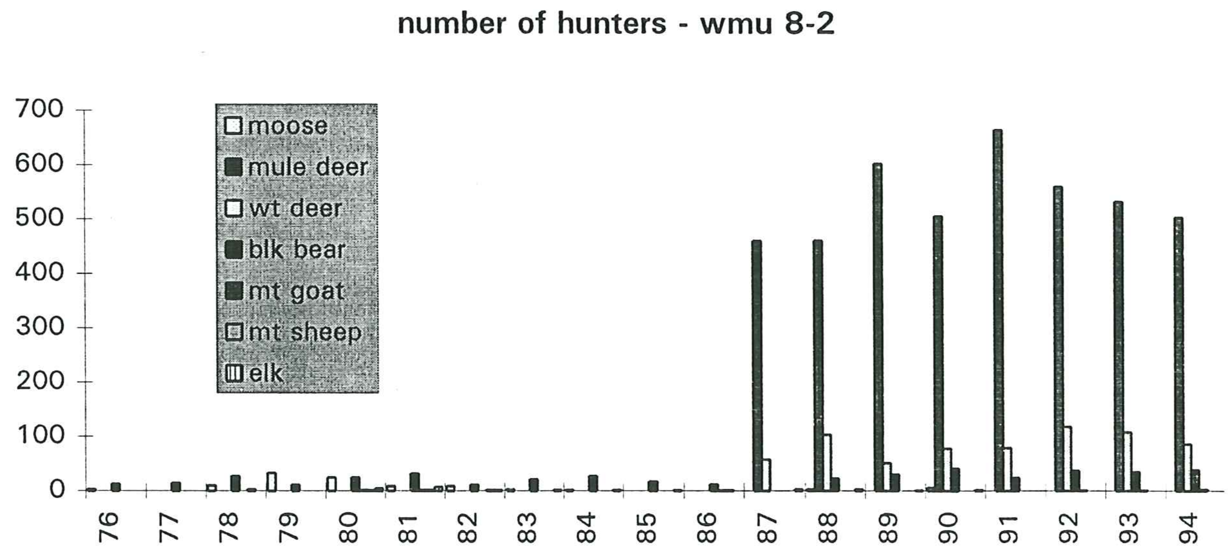


Figure 8-3. Numbers of hunters in WMU 8-2

The kill per hunter data (Figures 8-6, -7, and -8) provide a very rough measure of population densities in the management units. In unit 8-2 in the late 1970's and early 1980's from one-quarter to one-half of the hunters obtained a moose. Since that time none has been taken. Mule deer were taken consistently by about one-half the hunters (since 1987). In the late 1970's and early 80's black bears were harvested by a large proportion of hunters. Since then the harvest success-rate has been steady but lower. A small number of hunters have sought mountain sheep in unit 8-2. One animal was taken in 1981.

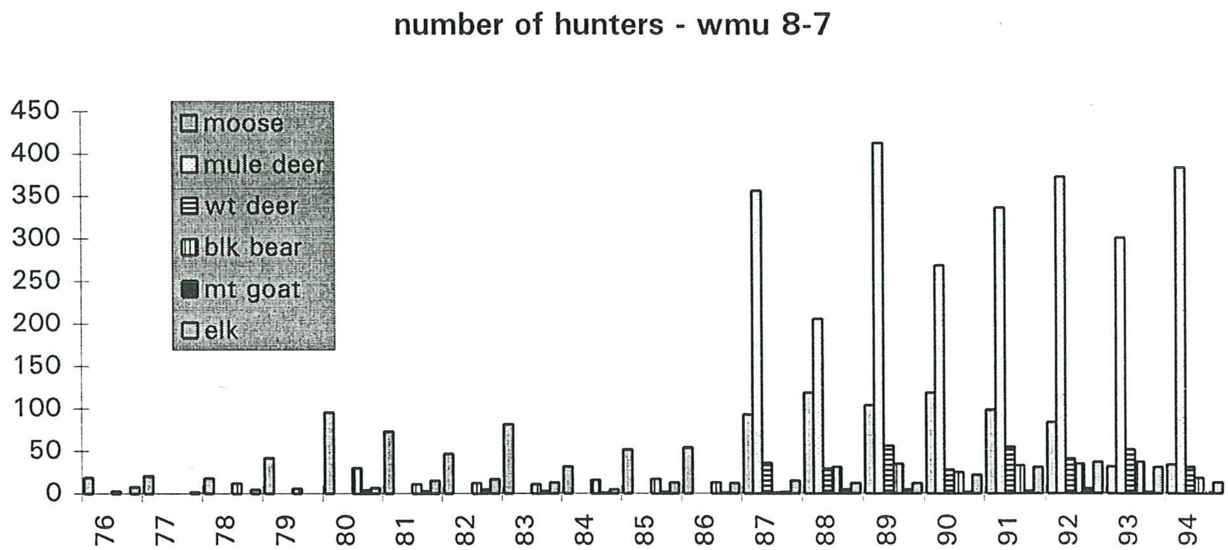


Figure 8-4. Number of hunters in WMU 8-7.

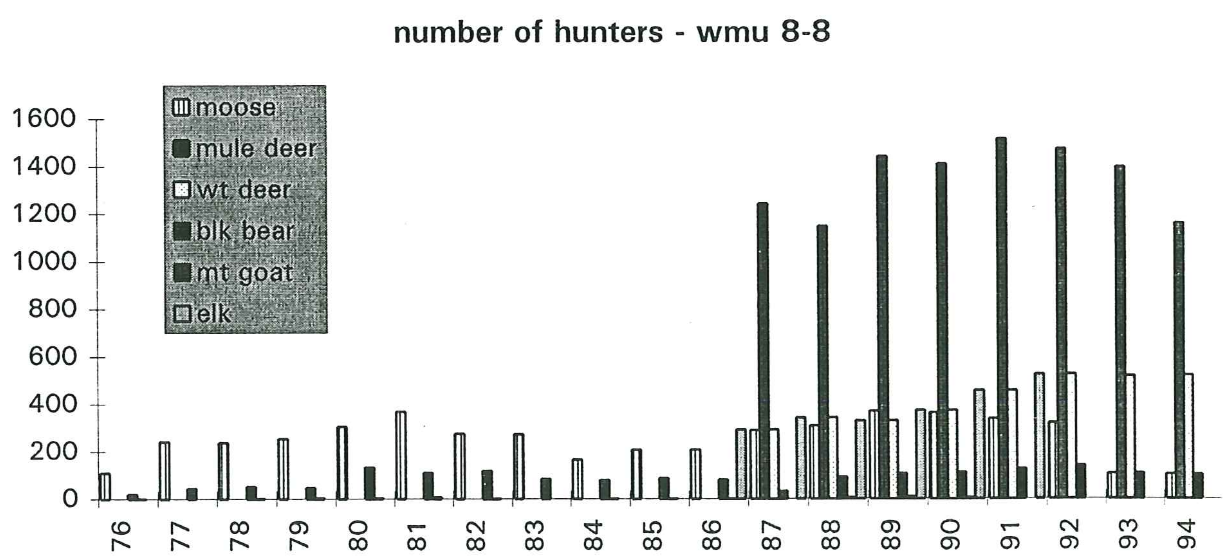


Figure 8-5. Numbers of hunters in WMU 8-8.

In unit 8-7 a small proportion (usually less than one-quarter) of hunters take moose each year. Mule deer have been consistently taken by nearly one-half the hunters. The number of bear hunters did not change much in the early 1980's but the harvest was very low. Since then bear populations may have increased, and the harvest rate has increased to about one-third of hunters in some years.

Figure 8-4 indicates the success rate of goat hunters is very high, sometimes two and three animals per hunter. This calculation is incorrect, according to Wildlife Branch. The number of goats harvested is known accurately through inspection, but due to the sampling method and the very small number of goat hunters, their numbers are often incorrectly calculated.

In unit 8-8 the hunter success-rate for moose trended downward during the early 1980's and again during the early 1990's. Mule deer have been taken consistently by about one-third of hunters and white-tail deer by about one hunter in 15. Bear harvest success was high in the late 1970's and through the 1980's. It has been somewhat more variable in the 1990's but is still relatively high, with a fifth to a tenth of hunters being successful.

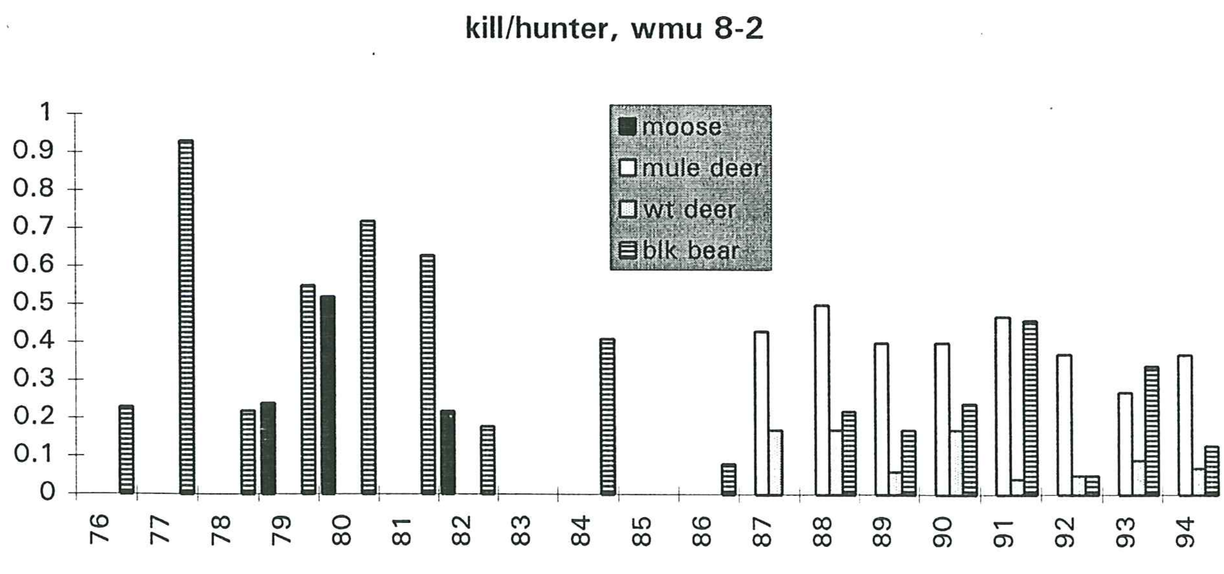


Figure 8-6. Harvest success-rate in WMU

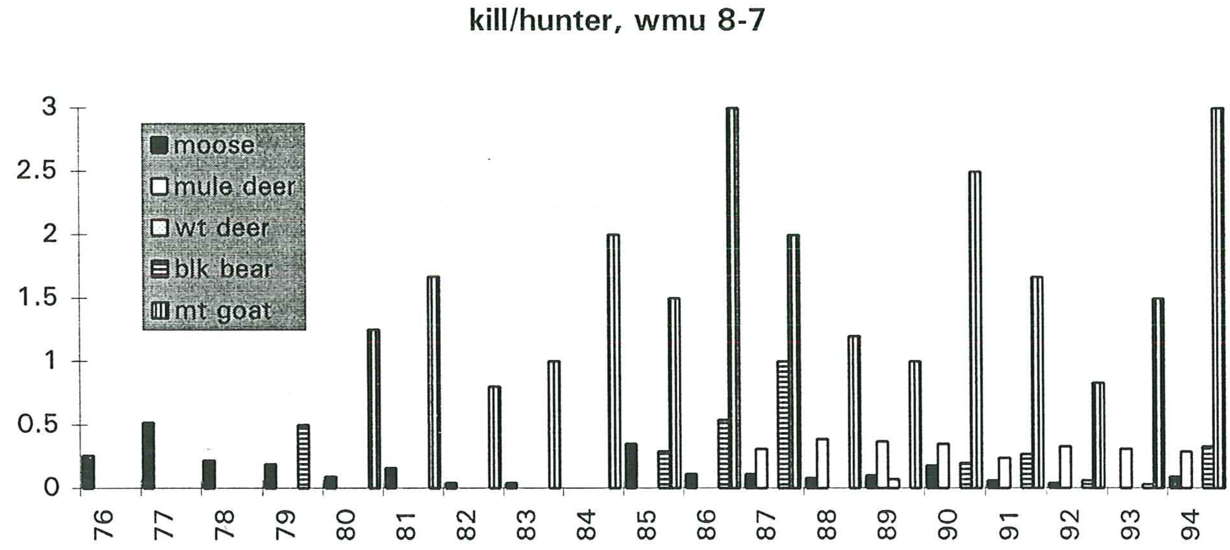


Figure 8-7. Harvest success-rate in WMU 8-7.

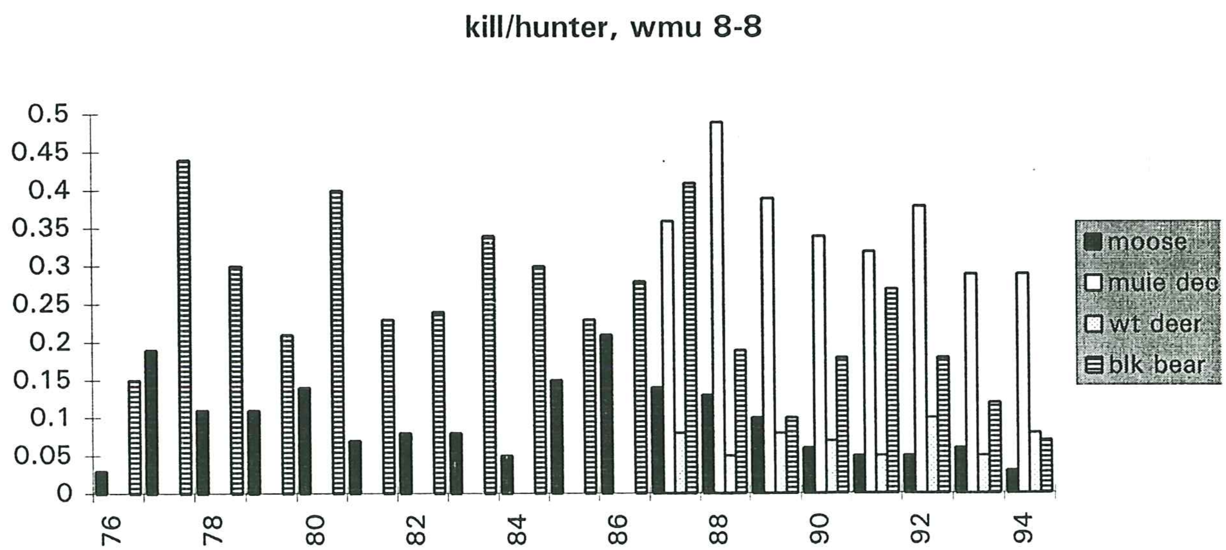


Figure 8-8. Harvest success-rate in WMU 8-8.

8.3 BIOPHYSICAL HABITAT MAPPING

B.C. Environment has recently prepared a biophysical land classification for part of the study area. This classification is based on biogeoclimatic units and terrain parameters. It allows a prediction of the type of vegetation cover that would occur, and the quality and expanse of specific wildlife habitats to be expected. This map is still in preliminary development by Wildlife Branch and was not available as of March 1996. It is expected that analysis of this map will provide statistics on areas and percents of various habitat types. Forest cover maps provided by Weyerhaeuser and Gormans Bros. delineated wildlife corridors and forest ecosystem network areas (FEN's) that were to be protected from disturbance.

Forest cover mapping identified a total area of over 19,000 ha (18.7 percent of the study area) as having high environmental sensitivity. These areas cannot provide sustained timber production due to some sensitive aspect or to their value for some other resource. The main issues of concern were unstable soils and inadequate forest regeneration, either singly or in combination. Recreational uses also contributed to the rating of some lands. Only one 2.9 ha plot was given a high sensitivity rating due to wildlife. Many other plots of land were given a low sensitivity rating due to wildlife, and only one of these, a 4 ha plot in a Ponderosa pine unit, was identified as having specific wildlife values, in this case deer.

The Baseline thematic map (Figure 7-3) identified wetlands over 15 ha. These included swamps, marshes and fens but excluded any areas used for hay cutting or grazing. Ten such locations were listed, totalling 500 ha in area.

The study area contains eight lakes with a total area of 153 ha (.2 percent of the study area). Nickel Plate Lake is the largest, at 77 ha. Brent Lake is 22 ha, and others are smaller.

8.4 WILDLIFE-VEHICLE COLLISION DATA

Highway maintenance workers report dead animals on provincial highways. Data include highway section and kilometer reference, month and species, but caution in using the data is required for a number of reasons. Only dead animals on or very close to the highway are included. Often the highway segment and kilometer reference are suspect and the exact location of the accident is not known; in the following the kilometers are not used. More rarely, the animal species is incorrect. In the following statistics a recorded caribou has been changed to a more probable elk. In addition, BC Transportation and Highways staff estimate there are up to five dead animals missed for every one reported.

Data is available for 1979 to 1994 for segments of Highways 97, 3 and 3A. No data are collected on Green Mountain Road or other secondary roads. The following graphs indicate the total numbers of animals killed by year and highway section, and also on a per kilometer basis. Dead animals (in order of occurrence) included deer (no species given), coyote, bear, moose, bobcat, porcupine, elk, sheep, beaver and horned owl. Because animals other than deer occurred very infrequently, they have been aggregated in the following graphs (Figures 8-9, -10, -11, and -12).

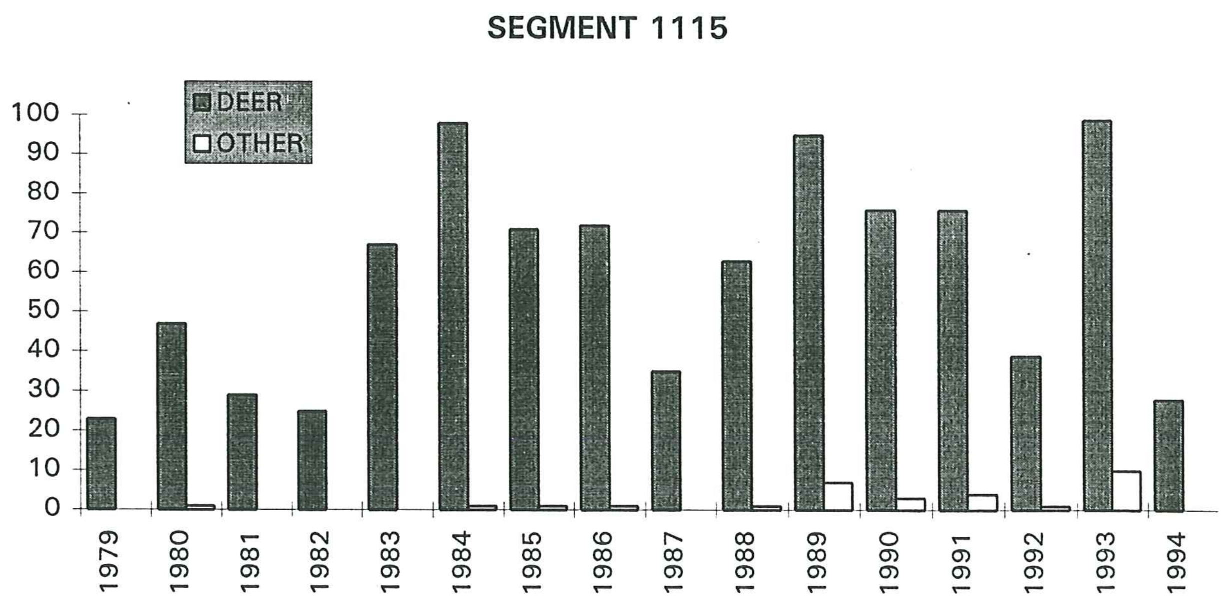


Figure 8-9. Road kills on 16 km of Highway 97 from Kaleden Junction to Sage Mesa Drive.

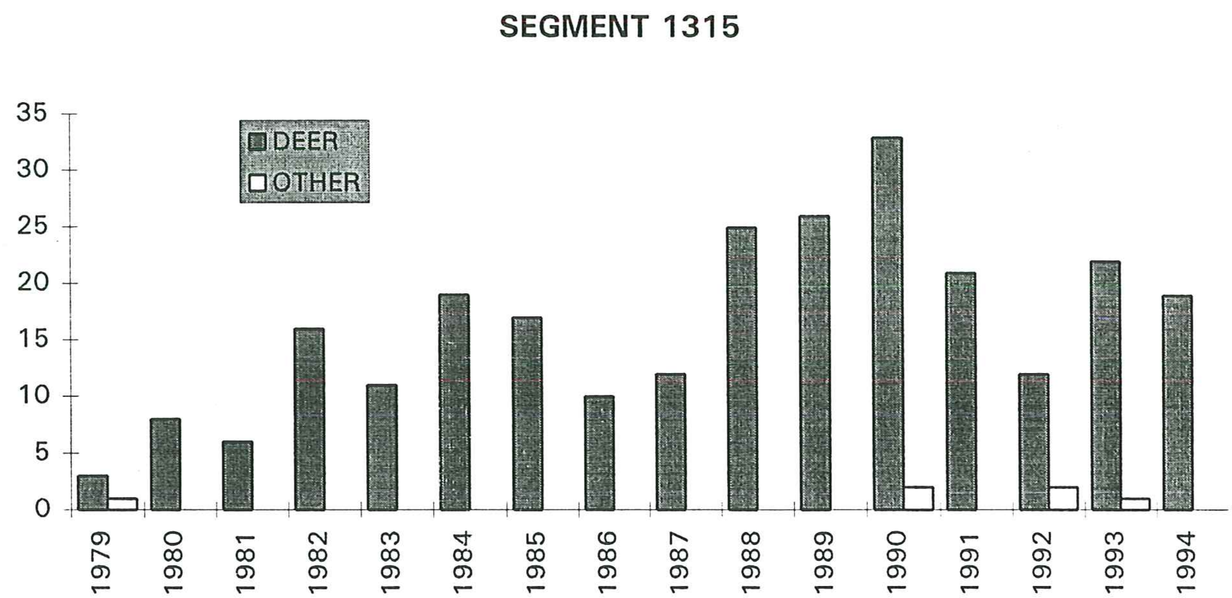


Figure 8-10. Road kills on 31.7 km of Highway 3A from Keremeos to Kaleden Junction.

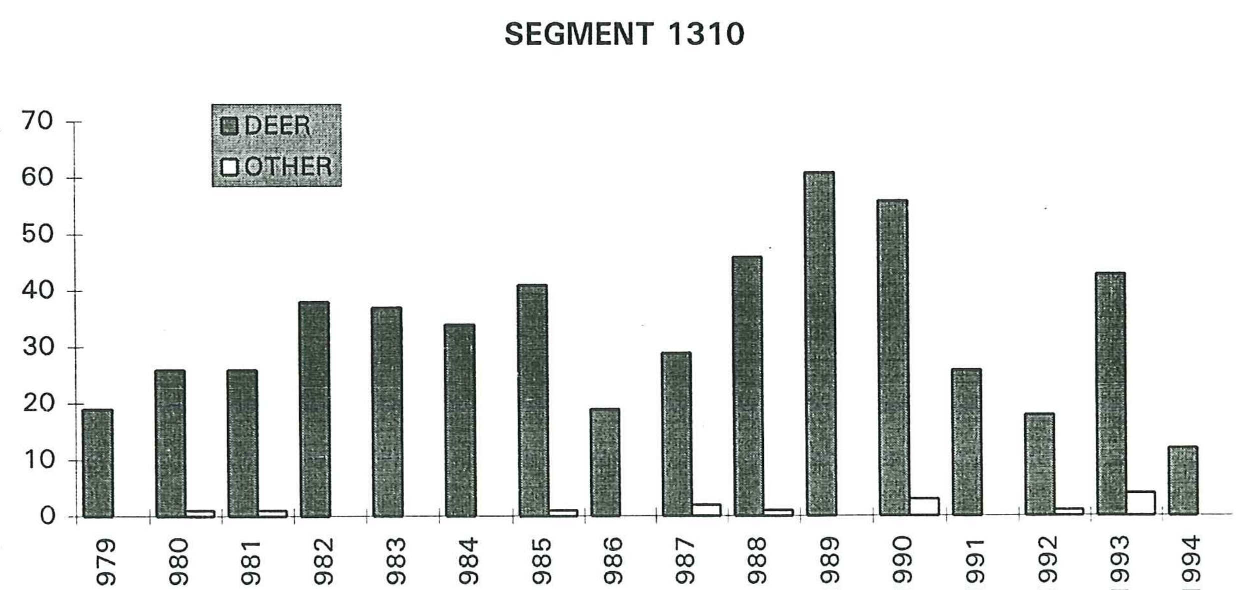


Figure 8-11. Road kills on 30.3 km of Highway 3 from Keremeos to Hedley.

Given the inadequacies of the data, perhaps the most valid observation is that a very large number of deer are killed on the highways. The short section of Highway 97 through Penticton accounted for a reported 60 to 100 animals in most years. If an additional five are missed for each reported, up to 600 deer per year may be killed on this short and urbanized stretch of highway. Highway 3 and 3A had fewer collisions.

The data may indicate rough annual population levels of deer, or perhaps climatic conditions that cause animals to seek lower elevations near the roads in some winters. The years 1988 to 1991 had relatively more deer accidents on the three roads. Years 1981 to 1985 also indicated a slight increase in deer accidents.

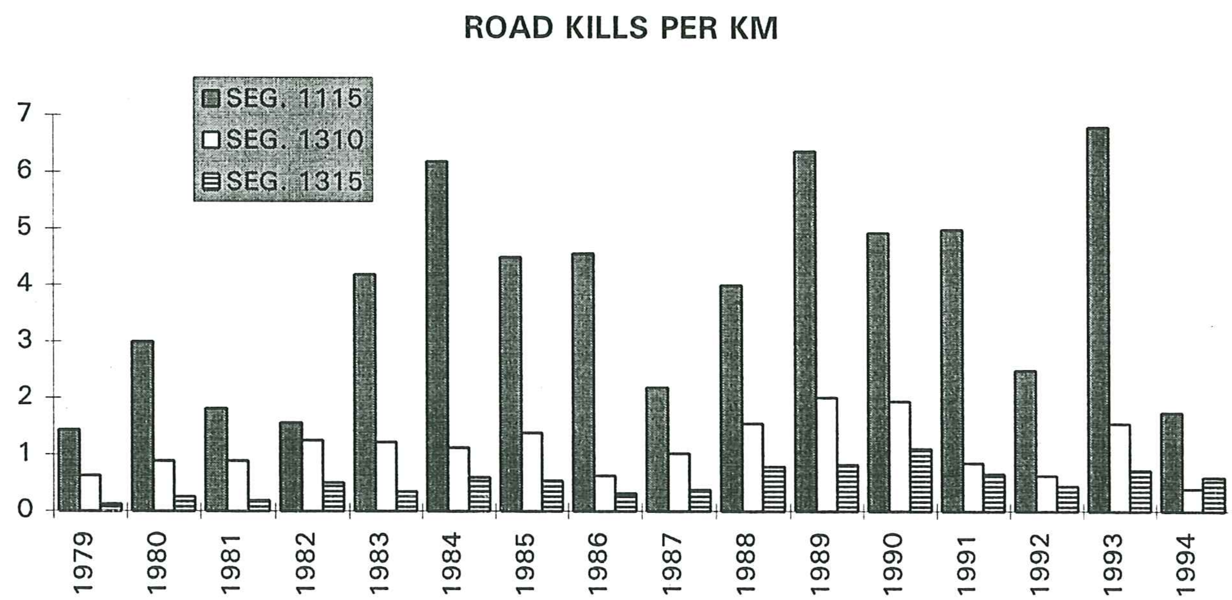


Figure 8-12. Number ot fofal road kills per kilometer of highway segment.

It is apparent that highway 97 has many more animal collisions than do the other two segments on Highways 3 and 3a. This could be due to natural migration patterns of animals, higher volume or faster traffic, types of vehicles, reporting methods, or a combination of factors.

8.5 RARE AND ENDANGERED SPECIES

An estimated 31 percent of all threatened or endangered wildlife species occur in the South Okanagan and Lower Similkameen valleys (B.C. Government, nd).

The Conservation Data Centre lists two fish species, one amphibian, four reptiles, three birds and two mammals with provincial ranks of S1, S2 or S3, equivalent to a Red or Blue listing. These vertebrates have been identified at 35 locations in the study area (Figure 8-13). Note that exact locations are not provided for some species, here reptiles, for conservation reasons. Ranks and listings are defined in the Appendix.

While the CDC does not yet list invertebrates (but is in the process of developing this database), a general publication of BC Environment (1995) makes clear the incredible number and diversity of insects, spiders, molluscs, worms and other small species that exist in the south Okanagan region. At present some 20,000 to 25,000 species are known, likely half of the true number. About 23 invertebrates are known only from the south Okanagan, and 75 are not found elsewhere in Canada. The few and very small protected areas will not be sufficient to protect these, and other as yet unknown, species.

As with the rare and endangered plant species, most of the animal species have been identified during surveys of the larger south Okanagan region and it is unclear how thoroughly the Seven Peaks study area has been surveyed.

8.6 SPECIFIC STUDIES

A wildlife assessment of the existing and proposed development at the Apex Resort was recently completed (Wild Stone Resources Ltd. 1995). It provided a fairly comprehensive description of the ecosystem within the resort area, including a review of the species to be expected near the resort, and potential impacts of the recreation complex to the habitats and species. It did not provide new data such as field surveys or population counts but relied on forest cover maps, air photos and interviews with regional biologists, local trappers and others.

This study listed significant elements in forest cover that contribute to wildlife habitat, such as large trees, variation in tree size and spacing, numbers of dead standing and fallen trees, multiple canopy layers, canopy gaps, and decadence in trees. Due to the small scale of available maps and the lack of specific field surveys, the Wild Stone study concluded they could not assess these elements on the Apex Resort site.

The conclusions of the Wild Stone report were circumscribed due to lack of field data on wildlife populations and habitats, and in some cases lack of mapping or other information regarding possible developments, but in general some wildlife habitat is expected to be lost or radically changed due to clearing of forests and understorey for recreation and residential uses. A concern was expressed that an increase in summer use of the area by tourists and recreationalists would impact native animal species more than the present winter-only use. An increase in horse-back riding, hiking, mountain bike riding and snowmobiling would have minimal impact on animal populations.

Recommendations were to improve the database since so little information was available regarding actual characteristics of forest stands, population surveys of plants or animals, and the effects of cattle grazing on animal populations and their habitats. Without this information it was difficult to evaluate the impacts of the existing and proposed recreation developments. Karasiuk (1990) similarly concluded there was little original information or surveys on wildlife species or habitats in the Apex Mountain Recreation area or Provincial Park. A list of 53 bird species known for the Apex-Nickel Plate study area was provided, over 20 of which breed there. None is considered threatened.

A generalized map of moose and mule deer habitats was provided. This map showed areas of timberline vegetation and alpine meadow above 1950 ft southeast of Nickel Plate Lake, areas of wetland habitat (sedge meadow and willow) immediately north and south of Nickel Plate Lake, and three areas considered of moderate importance to moose and mule deer: adjacent to the east side of Nickel Plate Lake, near the Potholes lakes, and near Rock Oven Hill.

The above habitat map was based on air photo interpretation and brief field reconnaissance; this study did not provide any new survey data.

The study concluded there were no critical nesting, brood-rearing, staging or overwintering areas for birds in the Apex study area. Nickel Plate Lake was considered poor habitat for waterfowl and shorebirds. Low populations of furbearers exist and traplines were operated in adjacent areas. The area was considered of low importance as habitat for ungulates. There may be small populations of mule deer during late spring, summer and fall, and very small populations of moose all year.

8.7 SUGGESTED TREND DATA AND STANDARDS

Because there is so little baseline information available for the study area no trends can be clearly documented. There is however much indirect information to suggest that trends of great concern are occurring. These relate specifically to changes in the area and quality of dryland wildlife habitats.

Following analysis of the recent biophysical mapping, specific measures of these habitats can be selected for monitoring and perhaps for protection. Useful indices to monitor may be the following (depending on the capability of the biophysical maps):

- numbers and areas of critical wildlife habitat clusters;
- numbers and areas of various other wildlife habitats;
- numbers and areas of wetlands, by sub-classifications;
- ratios of critical wildlife classifications to regional and provincial values;
- analysis of ownership, zoning, and existing or potential land uses on the critical habitat classifications.
- areas of each habitat type that are protected from disturbances; percents of total protected and total land base.

8.8 DATA GAPS AT PRESENT

The following specific information is lacking or very inadequate at present:

- game animal surveys, population estimates, migration information;
- studies of specific non-game species or habitats in the study area;

- specific habitat descriptions and mapping;
- rare and endangered species in the specific Seven Peaks study area have likely been minimally surveyed;
- biophysical habitat mapping, when completed, will be for a small part of the study area;
- impact of grazing on wildlife habitats and populations.

8.9 CONCLUSIONS

The biophysical mapping, when completed and analyzed, will do much to improve knowledge of a variety of game and non-game habitats. This mapping will cover only a small part of the study area. There will remain a remarkable lack of information about animal populations in the study area.

The effects of cattle grazing on native animals and wildlife habitats in general has not been studied here. It is likely that the effects are significant in some locations and for some wildlife species.

8.10 RECOMMENDATIONS

Game animal population surveys are needed to understand the effects of hunting pressure in the study area and to monitor changes in habitat quality.

The overall database must be greatly improved before land use analysis and monitoring can be begun.

SECTION 9.0

AGRICULTURE

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SECTION 9.0
AGRICULTURE

9.1 INTRODUCTION

Although the study area is largely forested at higher elevations and lowland valleys areas are prone to high temperatures and low precipitation, there are some valuable agricultural areas and some land is protected as Agriculture Land Reserve. This land is considered valuable for agricultural purposes and is legislatively.

Two soil reports have been completed for the agricultural areas in the study area. One is relatively old (1949), and the second is more recent (1986). They are available from Maps BC Approximate locations of farmed lands in the study area were provided by BC Agriculture staff but no information is available regarding the number of farms in the area or their size or type of production.

Agricultural lands were identified on the Baseline thematic map (Figure 7-3). Analysis of the data indicated 18 areas totaling 2824 ha that were defined as land used for production but undefined as to crop. These agricultural lands account for less than three percent of the study area.

In addition to the crop land, the Baseline thematic classification identified rangelands, defined as pastures, grasslands, and shrublands with less than 35 percent shrub cover less than 6 m high. Sparse forests with a xeric understorey were included in this classification. These areas may be used for cattle grazing or other purposes in the study area. There were 32 areas of rangeland, totaling 16,566 ha (16 percent of the entire study area).

Grazing of cattle and sheep in this area has occurred for at least 100 years. Presently cattle grazing on Crown land is regulated by BC Forests. Eight main grazing permitted areas exist in the study area and there may also be several smaller holdings along the periphery of the study area (Figure 9-2). The eight areas totalled over 74,000 ha or 72 percent of the study area. Within each tenure a number of areas or pastures have been identified on which ranchers are required to

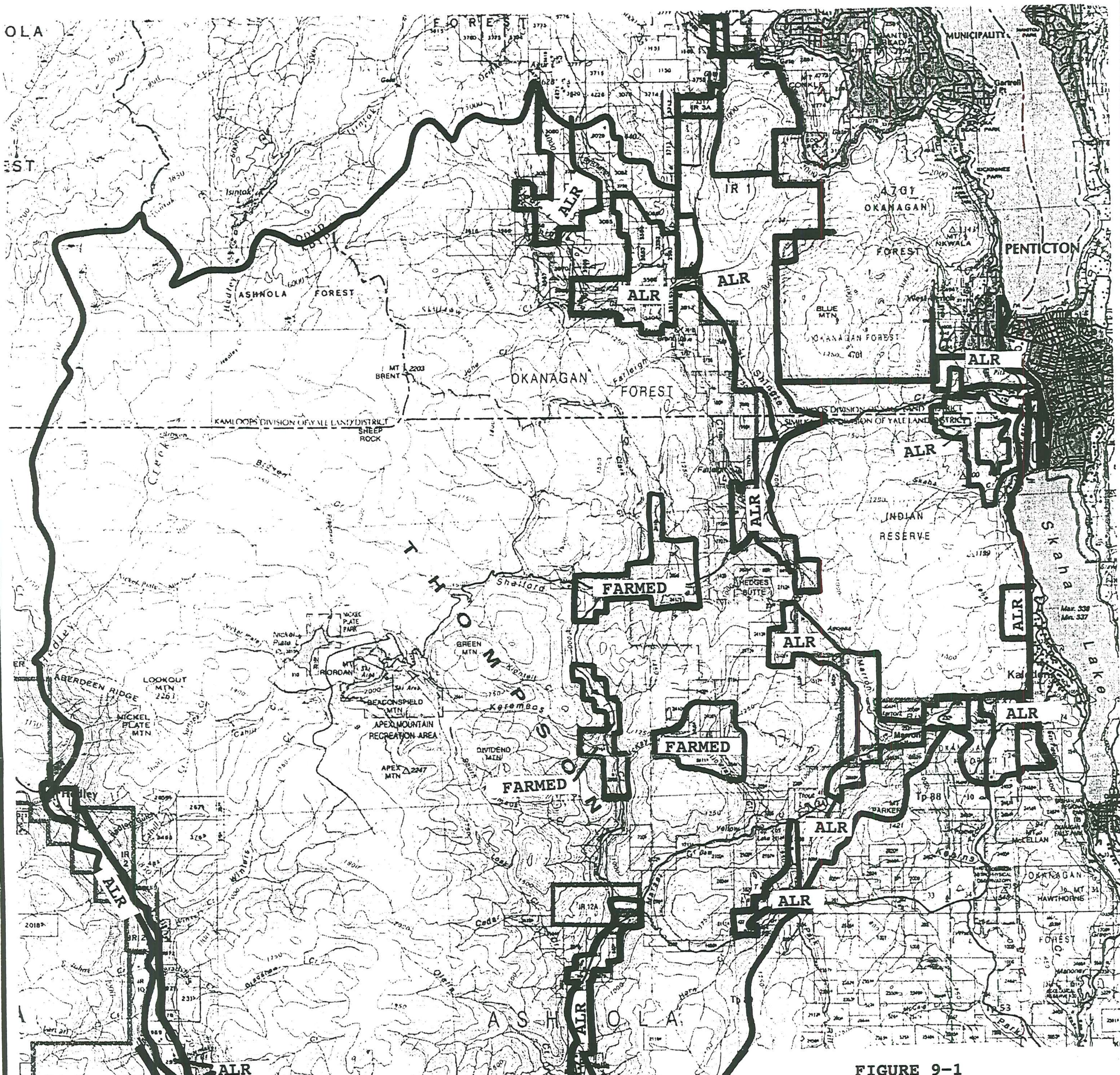


FIGURE 9-1

AGRICULTURAL LAND RESERVE AND APPROX. FARMED AREAS

SEVEN PEAKS ENVIRONMENTAL BASELINE AUDIT

35565-02

Reid Crowther

rotate cattle during the summer. The grazing period of the current permits extends from 7 April through 30 November, varying somewhat with the tenure.

Use of each tenure is defined in terms of maximum permitted animal-months, ranging in the study area from 130 to 4206. The study area has a maximum total of 9,292 animal-months allocated to it. This number is not exact since some pastures have limitations such as even-year use only. According to BC Agriculture and Forestry staff, most licensees stock to within 10 percent of their permitted level, and most would like to increase their herd size. One licensee has requested non-use approval at present (1995-96).

Cattle appear to have access to water courses and lakes in the study area, and they share food and space with native animals. There is a fairly large literature on the effects of cattle grazing on natural areas and their effects on streams and lakes and on existing native animals. BC Environment, through the Agricultural Code of Practice, provides legislation to control agricultural wastes entering water bodies. The Forest Practices Code and the recently updated Range Act also provide legislation and guidelines for range and riparian management.

BC Environment Water Management Branch has monitored water quality in the Similkameen River and some tributaries (Swain, 1990). They listed designated water uses as drinking water, aquatic life, wildlife, recreation, livestock and irrigation. Other local streams were similar, with some variation depending on specific uses. They concluded that agricultural runoff, both wastes and fertilizers, did not contribute a significant load to the river system, but they are proposing more detailed non-point source analyses in the future.

To date there have been no specific conflicts between cattle grazing and other resources uses.

9.2 SUGGESTED TREND DATA AND STANDARDS

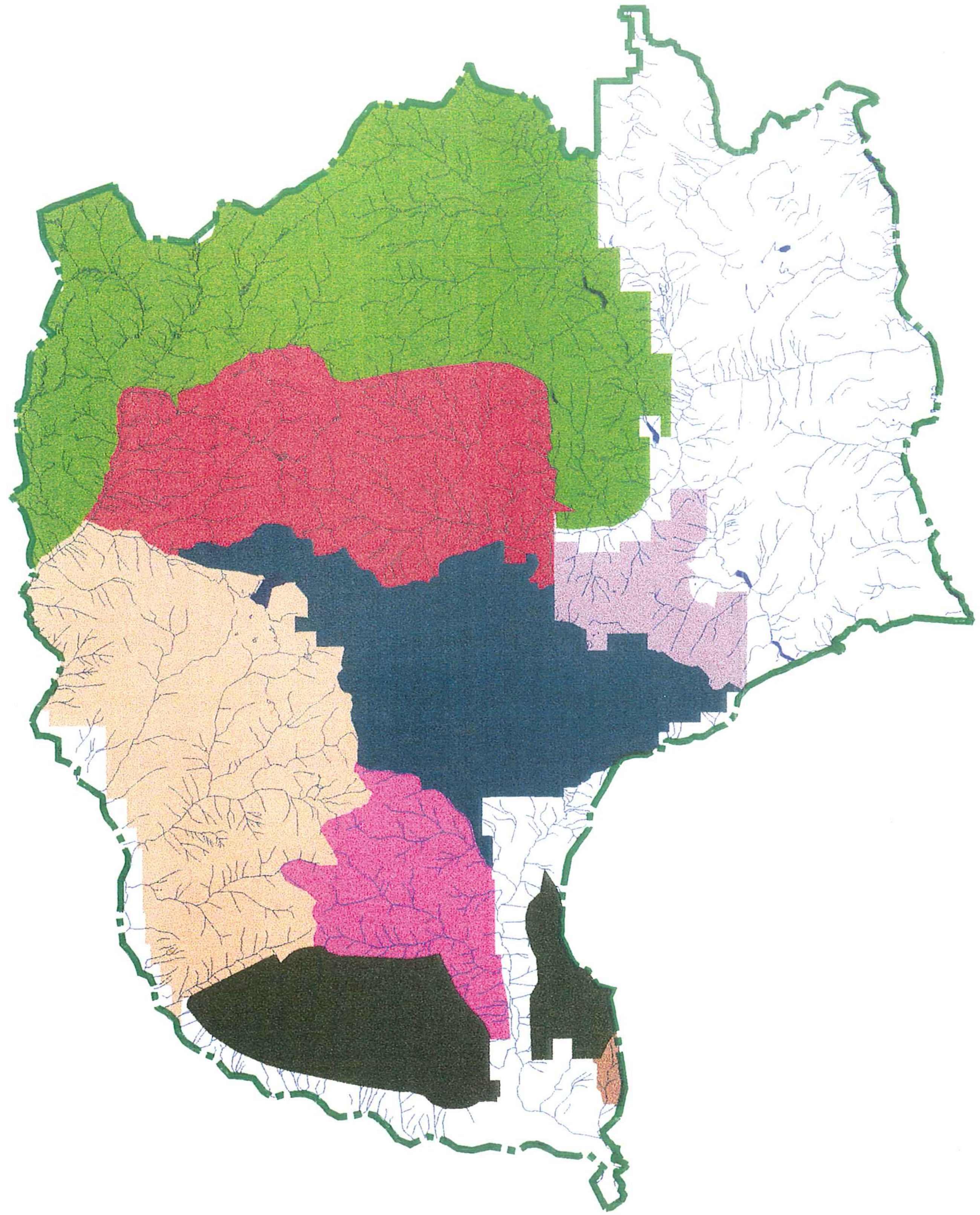
The following measures would be useful to monitor agricultural land uses in the study area:

1. locations and numbers of cattle on grazing permit areas;

FIGURE 9-2

7 PEAKS STUDY AREA

Grazing Licences



LEGEND

- Bobtail Ranch
- Carter
- Clifton
- Lewis
- Manders/Felker
- Sanders
- T-6 Ranch
- Wabnegger
- Unlicened Area
- Lakes and Rivers
- Study Area Boundary

0 1.25 2.5 3.75 MILES

0 2 4 6 KILOMETERS

Prepared by MINISTRY OF ENVIRONMENT
SOUTHERN INTERIOR REGION GIS, 1996

Map Scale 1:220 000

Projection Albers Equal Area, NAD83

Source: MOF Forest Cover 1:20,000

Source: TERRAIN RESOURCE INVENTORY MAPPING (T.R.I.M.)

2. land uses on Agriculture Land Reserve;
3. location, areas, type and extent of farming and ranching activities;
4. area of farm land under irrigation, if any, and volumes of water used.

9.3 CONCLUSIONS

Little is known about the quality of soils for agriculture in the study area, nor of the types of farms or their productivity.

9.4 CONCLUSIONS

There is little information available regarding the extent of agricultural activities in the study area except for cattle grazing on crown land, which is closely regulated.

9.5 RECOMMENDATIONS

Better information should be collected on the amount of farmland being used for various types of production, and the methods of farming.

SECTION 10.0

RECREATION

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SECTION 10.0
RECREATION

The study area contains a small Provincial Park, a Provincial Recreation Area and a commercial ski hill complex. Trails have been developed in some areas, and there are proposals and opportunities for other recreational facilities. The following describes the significant recreational features.

In overview, the Baseline thematic map (Figure 7-3) indicated one 415 ha area of recreational land. Specific types of recreation uses or facilities cannot be defined at this level of analysis.

10.1 NICKEL PLATE LAKE PROVINCIAL PARK AND APEX MOUNTAIN PROVINCIAL RECREATION AREA

The park was established in 1938 and is now a Class A park (managed by B.C. Parks rather than by a board of citizens). It is 105 ha, borders on the northeast shore of Nickel Plate Lake, and has no facilities or structures, not even privies. Land uses such as grazing, forestry or mineral development are not allowed in the park.

The recreation area is also under the jurisdiction of B.C. Parks. It was established in 1961 and includes 575 ha of Crown land. A number of permitted uses exist, including mining (in some parts) and various recreational developments. Apex Mountain Resorts Ltd. (formerly Apex Alpine Recreations 1988 Ltd.) has a 50 year agreement to operate a ski resort.

Except for the commercial ski resort, use rates of recreation facilities in the area of Nickel Plate Lake Park and Apex Recreation Area are not monitored. Use rates were studied by Karasiuk in 1990 and 1991 by means of public meetings and surveys. The major winter uses were downhill skiing, followed distantly by cross-country skiing. Summer activities were hiking, enjoying peace and quiet, sightseeing and exploring, fishing and cycling. These activities were focused on Nickel Plate Lake, Beaconsfield Mountain - Apex ski hill, Mount Riordan, Apex Mountain itself, Apex village, and the Powerline Trial.

10.2 APEX MOUNTAIN RESORTS LTD

The Apex resort was started in 1960 with one ski run. A master plan was completed in 1979 and revised in 1981 and 1991. Development since then has largely followed the master plan.

There are now eight ski lifts. The 1994 skier capacity was about 2500 per day. There are 1166 beds for accommodation.

Water is provided by two wells (40,000 and 60,000 gallons/day) and Keremeos Creek (up to 65,000 g/day winter and 15,000 g/day summer). Water was withdrawn from Keremeos Creek for snow making but that licence has expired. Apex may also withdraw 224,000 g/day for water works and about 450,000 g/day for snowmaking from Nickel Plate Lake.

A secondary sewage treatment plant (aerated lagoon system) is presently operating at 20 percent capacity. It discharges to two infiltration basins. Waste water, ground water and Keremeos Creek water quality monitoring is carried out.

The master plan proposed a goal of 3540 skiers/day and on-site accommodation of 2500 beds. Water supply of 40 g/min. would be required. The secondary sewage treatment plant (aerated lagoon and ground disposal system) are adequate for future developments. The existing electric supply from a sub-station at Hedley is considered adequate.

The master plan appears to have overestimated the rate of increase of skiers to the resort (Figure 10-1). For example, the actual number of skiers in 1993 was some 27 percent less than forecast. This and other analyses have suggested modest grow th and investment opportunities in the area. The resort is attempting to develop year-round activities to augment skiing revenue.

Figure 10-1. Projected and actual numbers of skiers per year at Apex Mountain Resorts Ltd. (source: Apex Alpine Resort, nd; Price Waterhouse, 1994).

10.3 TRAILS AND CAMPGROUNDS

Systems of backcountry trails have been developed by Apex Resort, jointly by B.C. Forests and Penticton Outdoor Club, and by the Nickel Plate Cross Country Ski Club (for the 1990 B.C. Winter Games). The Outdoor Club trails are ungroomed and basic; the Ski Club trails are maintained to competition standards.

A Nordic Centre day-use lodge was also built and is managed by the Nickel Plate Nordic Cross-Country Ski Club. B.C. Forests has jurisdiction over non-commercial recreation facilities and initiatives on Crown lands. The Forests Ministry does not have any campsites in the study area.

Nickel Plate Winter Trails Working Group has developed a draft Trails Management Plan, including maps of existing and proposed trails. The management plan was designed in part to accommodate increased demand and in part to reduce conflict between cross-country skiers and snowmobilers. This plan was under the initiative of B.C. Forests and the working group included members of local recreation clubs, commercial operators and B.C. government staff. The Plan was expected to be implemented by November 1995.

A rough estimate of cross-country ski activity indicated between 1000 and 6000 people used the trails between 10 February and 11 April 1990 (Karasiuk, 1990). This was based on 59 samples giving an average of 17.4 vehicles per day parked at trail head parking lots.

10.4 RESIDENTIAL DEVELOPMENT

Apex Village had about 60 cabins and chalets in 1990. By 1995 there were 152 single family lots approved and 116 of them constructed. Four condominiums and a hotel have also been constructed. These are located in small subdivisions near Apex Mountain Resorts, just outside the Provincial Recreation Area. In 1990 an estimated 100 people stayed year round at the Village.

10.5 ALTITUDE TRAINING INSTITUTE

A proposed private development, the Altitude Training Institute of Canada, has not yet materialized. It was to be developed at Apex Mountain Resorts and owned by the South Okanagan Sport Development Association, an non-profit society. It would provide high altitude athletic endurance training.

10.6 OTHER RECREATION FEATURES

The RA (resource area) designation of the Regional District zoning system (Figure 11-4, following section) allows various commercial recreation uses, and several proposals have been made for golf courses in the study area. The locations and present status of these proposals is not known.

The abandoned buildings and mine shafts of the Mascot gold mines near Hedley are being developed as a tourist attraction by B.C. Heritage Branch. They plan to open the site to visitors in August 1996. At present, most traffic is expected to be from Penticton, via the Homestake Mine. Once the mine has closed, which is expected sometime in 1996, parking lots can be expanded on mine property.

A private firm is considering constructing an aerial tramway to the Mascot gold mine site from Hedley. According to Heritage Branch staff, Upper Similkameen Band members are supportive of the development and could be involved in providing transportation or other services. Volumes of traffic to the site cannot be predicted at this time.

10.7 SUGGESTED TREND DATA AND STANDARDS

The following trends could be monitored to better understand changes in recreational land uses in the study area:

- areas of land used by various recreational activities, by date;
- numbers of vehicles/day (or per month, depending on use rate) to each recreational feature;

- areas of land used by recreational activities that fall into various wildlife habitat, biogeoclimatic zone, or sensitive habitat classifications;

- employment in recreational activities;

- standards or guidelines for various recreational activities (such as hiking, horse trail use, horse grazing) have been developed in other areas to avoid environmental degradation. It is unlikely that the Seven Peaks area has experienced sufficiently high levels of use to cause damage, but recreational activities should be monitored. If erosion, soil compaction, over-grazing or other forms of environmental damage are observed, specific guidelines for the area should be developed.

10.8 DATA GAPS AT PRESENT

The main lack of information are:

- inadequate use-rate data for most recreational facilities in the study area;

- no traffic data for users of recreational facilities.

10.9 CONCLUSIONS

Given present recreational use rates, there is likely sufficient information to monitor activities and impacts to the environment.

10.10 RECOMMENDATIONS

Environmental impact assessments should be carried out for any proposed recreational developments or expansions to existing ones.

SECTION 11.0

COMMUNITY ACTIVITIES & INFRASTRUCTURE

Reid Crowther

SECTION 11.0
COMMUNITY ACTIVITIES AND INFRASTRUCTURE

11.1 ABORIGINAL ISSUES

Figure 11-1 shows the location of the Indian Reserves inside and adjacent to the present study area. The original reserves included the "cut-off" lands and totalled 21,543 ha (about 20.9 percent of the study area). The cut-off lands were removed from the reserves during the 1920's and 1940's. This reduced the reserve area by 5,839 ha, to nearly 15,704 ha, 15.2 percent of the study area.

Two reports are available regarding Native land uses in the study area. One, completed in 1993, cited studies showing the study area is within the territory traditionally used by the Okanagan people (Bastion Group, 1993). These people apparently maintained villages in the valleys and established summer camps at higher elevations to gather food, find valuable rocks for projectiles, and for hunting.

This relatively short survey concluded there was no direct evidence Natives had used Mt. Riordan in the area of the proposed Crystal Peak garnet mine, but there was much indirect evidence that Native people had historically used resources in the general area.

A second report included detailed interviews with Native people (Van den Berg and Associates, 1994). These people identified sites on Mt. Riordan near the proposed garnet mine as being or having been important hunting and gathering locations and campsites (Figure 11-2). Locations on Mt. Riordan were also identified by the Native people "as important to them for sacred purposes associated with vision quests and other forms of spiritual training".

11.2 PROTECTED AREA STRATEGY DESIGNATION

Part of the study area had been considered as an Approved Study Area (ASA) by the Protected Area Strategy Group. This status would require an "enhanced

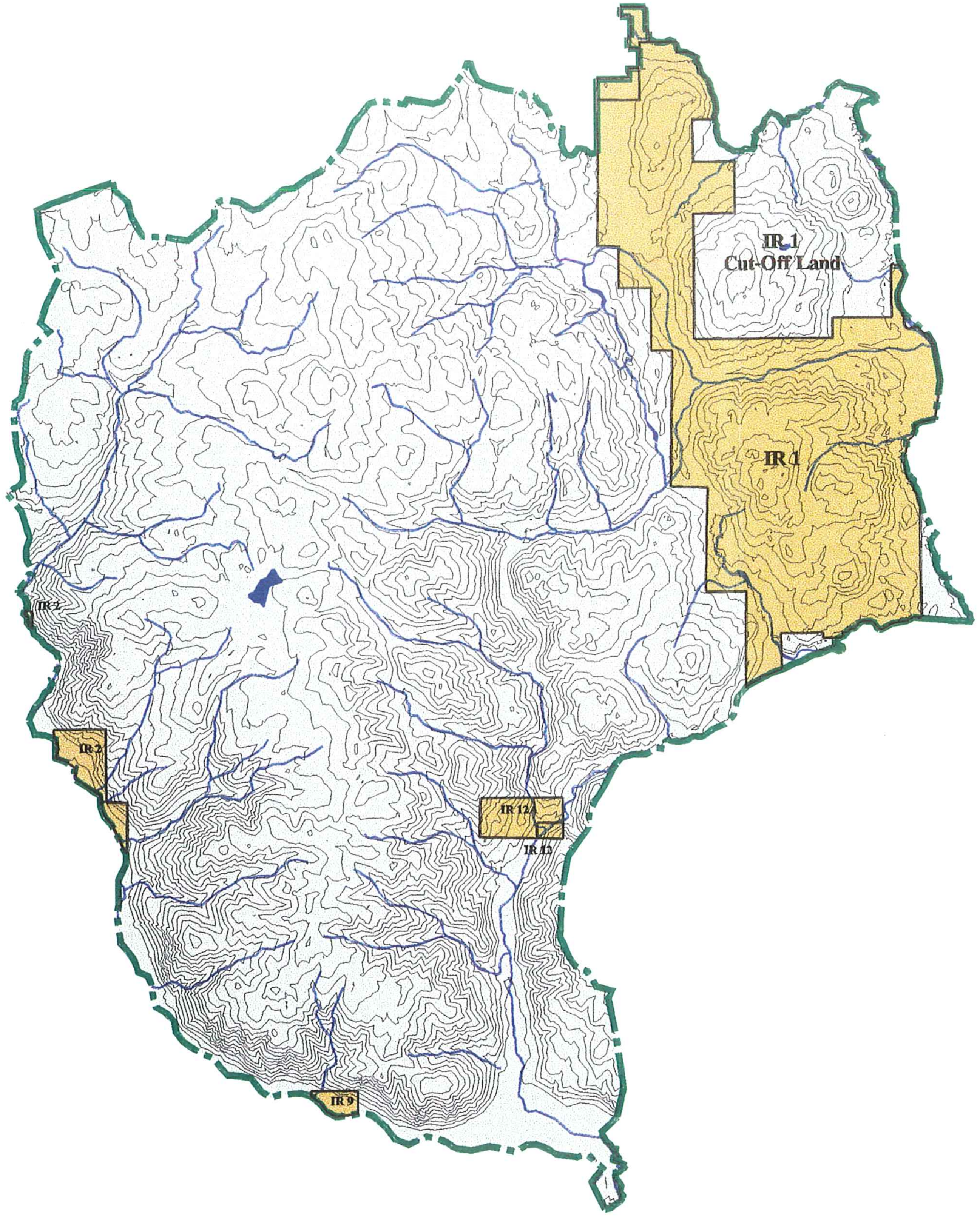


FIGURE 11-1

7 PEAKS STUDY AREA

Indian Reserves

LEGEND

- Study Area
- Lakes and Rivers
- Present Day First Nation Reserve
- Study Area Boundary
- Contour Lines
- First Nation Reserve

0 1.25 2.5 3.75 MILES

0 2 4 6 KILOMETERS

Prepared by MINISTRY OF ENVIRONMENT SOUTHERN INTERIOR REGION GIS, 1996

Map Scale 1:220 000

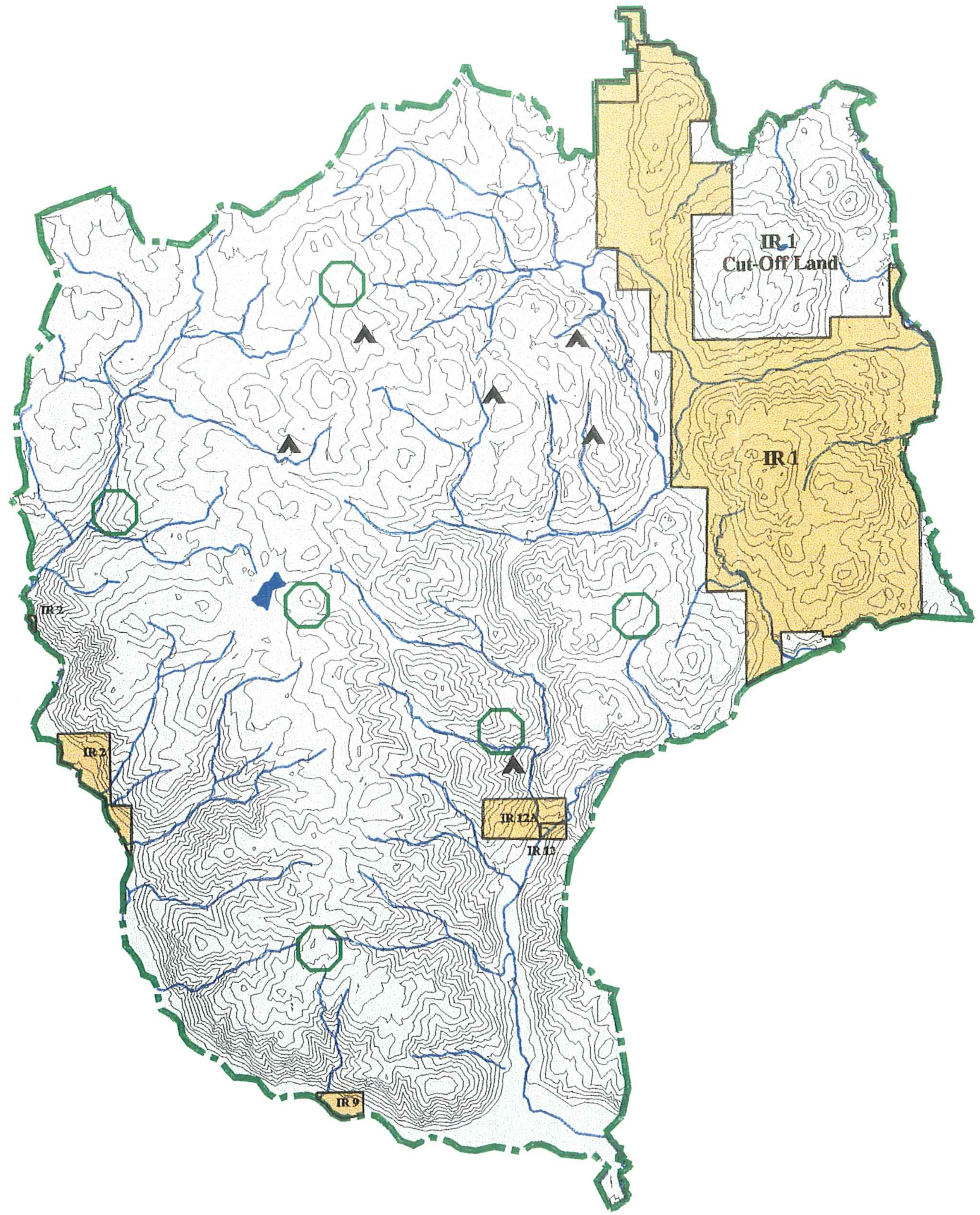
Projection Albers Equal Area, NAD83

Source: TERRAIN RESOURCE INVENTORY MAPPING (T.R.I.M.)

FIGURE 11-2

7 PEAKS STUDY AREA

Aboriginal Hunting, Gathering and Campsite Areas



LEGEND

- Study Area
- Lakes and Rivers
- First Nation Reserve
- Study Area Boundary
- Contour Lines
- First Nation Reserve
- Approximate location of Campsites
- Approximate location of Hunting and Gathering Areas

0 1.25 2.5 3.75 MILES

0 2 4 6 KILOMETERS

Prepared by MINISTRY OF ENVIRONMENT SOUTHERN INTERIOR REGION GIS, 1996

Map Scale 1:220 000

Projection Albers Equal Area, NAD83

Source: TERRAIN RESOURCE INVENTORY MAPPING (T.R.I.M.)

Source: Vanden Berg & Associates, 1994

referral process" for any proposed development or land use, and would provide stringent guidelines to protect the area.

The areas defined as Brent Mountain ASA and Brent Extension and Apex Mountain Addition were initially considered because of their conservation, recreation and cultural heritage characteristics. Specifically they were given a Medium-high Conservation rating due to:

- Mid-Elevation Forests To Alpine (Idfdk1, Msxk, Msdm2, Essfxc, And Essfxcp);
- Scattered Old Growth In A Mosaic Of Age Classes;
- A Dry Alpine Environment With Little Disturbance;
- Extensive Wetlands Along Stream Channels And At High Elevation;
- Habitat For White-Tailed Ptarmigan, Red Crossbill, Clark's Nutcracker, Golden Eagle, Marten, Fisher, Hoary Marmot;
- Krummholz Subalpine Parkland, Subalpine And Alpine Meadows And Rock Outcrop Habitats;
- The Only Alpine Proposed For Protection In The Ecosection;
- Would Enhance The Conservation Viability Of Nickel Plate Provincial Park.

They were given a Very High Recreation rating due to:

- Settings Represented Rolling Subalpine/Alpine And Forested Plateaux;
- Back-Country Hiking Through Open Rolling Subalpine And Alpine;
- Provide A Pocket Wilderness For The Okanagan Population;
- Use And Appreciation Of Nature;
- Horseback Riding, Photography, Hunting;
- Panoramic Views, Particularly Towards Cathedral Park And Snowy Alpine.

They were given a Low Cultural Heritage rating due to:

- Themes Represented;
- Probable Traditional Use; Hunting.

The proposed areas were perceived to have the following weaknesses:

- Predominantly Young Age Class Forests At Lower Elevations;
- Unit Does Not Extend To The Valley Bottom;
- Mountain Pine Beetle In And Around The Area.

Later the Apex Addition was removed from consideration, but the Brent ASA and most of the Brent Extension continue to be protected and have an overall Protected Area Strategy rating of High. This land, covering some 11,534 ha, 11 percent of the study area, is shown in Figure 11-3.

11.3 COMMUNITY LAND USES AND REGIONAL DISTRICT ZONING

The Baseline thematic map (Figure 7-3) indicated seven areas of urban development totalling 1,158 ha or 1.1 percent of the study area. These included the town of Keremeos, communities along Highway 3A, residential developments west of Penticton, and the rural subdivisions near Apex Mountain Recreation Area. Typically only areas 15 ha or larger are mapped, so smaller residential areas may exist as well.

The Regional District of Okanagan-Similkameen has responsibility for zoning in the study area, as shown in Figure 11-4. This information is also available as CAD files. The area falls within five major zoning areas and Rural Land Use Bylaws. These are RLUB 1033 in the north. It is zoned mostly Resource Area, with some Farmland. RLUB 100 lies immediately south and is all zoned Forestry-Grazing.

RLUB 984 is the most complex area, extending along the Shatford Creek valley from near Penticton west to include the Apex Mountain Recreation Area. It includes Park, Resource Area, several residential categories, Agriculture, Mixed Use and Large Holding zones. One area designated Rural Resort is located at the junction of Green Mountain Road and Apex Mountain Road.

RLUB 1034 extends south from the Shatford Creek area to Indian Reserve 12A and east to the study area boundary. It is largely zoned Resource Area, with small areas of Agriculture, Large Holdings, Residential and Commercial zones.

FIGURE 11-3

7 PEAKS STUDY AREA

ROPOSED PROTECTED AREA

LEGEND

- Study Area
- Lakes and Rivers
- Proposed Protected Area
- Study Area Boundary
- Contour Lines
- Proposed Protected Area Boundary

0 1.25 2.5 3.75 MILES

0 2 4 6 KILOMETERS

Prepared by MINISTRY OF ENVIRONMENT
SOUTHERN INTERIOR REGION GIS, 1996

Map Scale 1:220 000

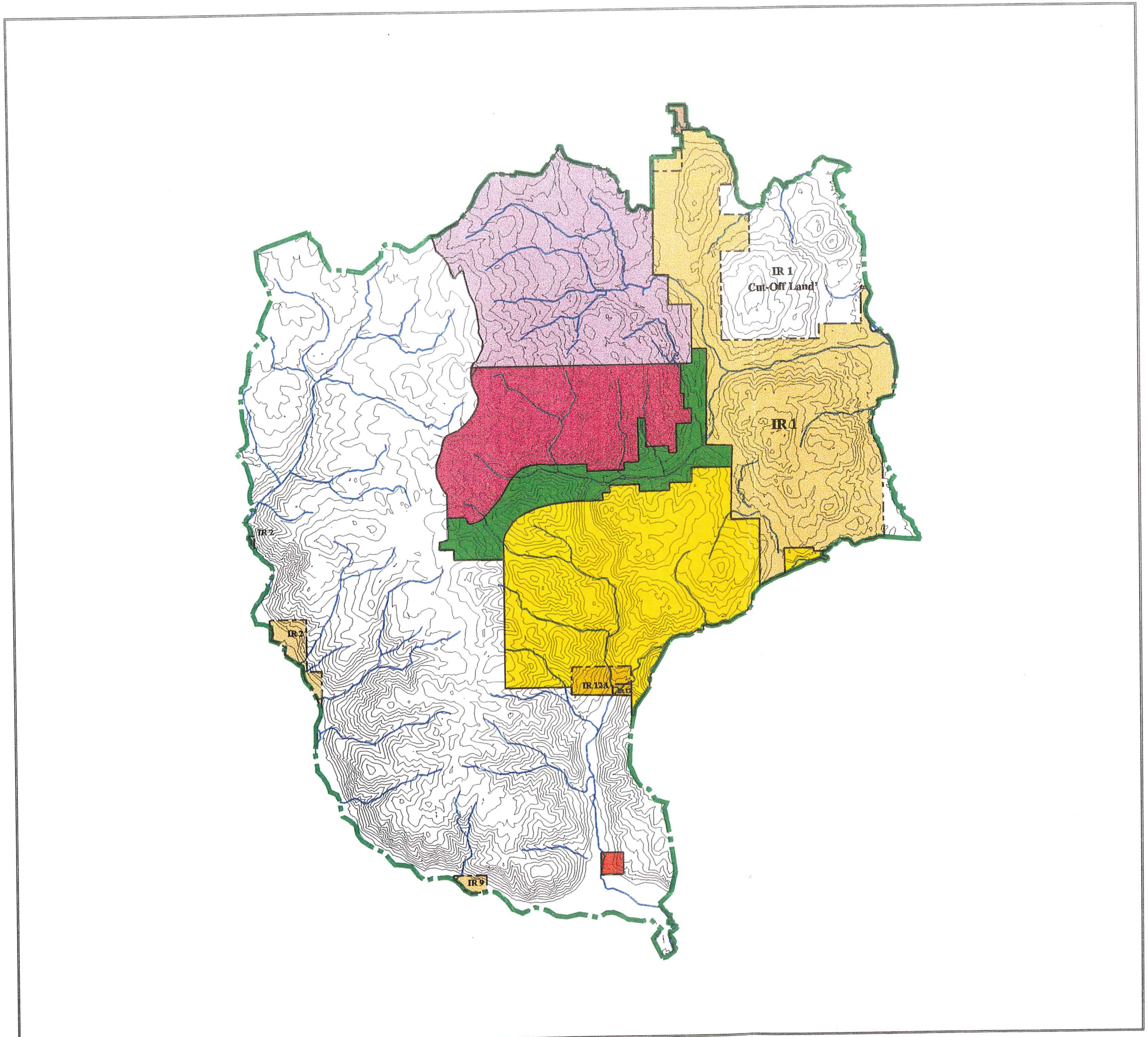
Projection Albers Equal Area, NAD83

Source: TERRAIN RESOURCE INVENTORY MAPPING (T.R.I.M.)

FIGURE 11-4

7 PEAKS STUDY AREA

Regional District Zoning Area



LEGEND

- First Nation Reserve
- Regional Land Use By-Law 1033
- Zoning By-Law #100 (All Forestry Grazing)
- Regional Land Use By-Law 984
- Regional Land Use By-Law 1034
- Zoned Forestry Grazing
- Study Area Boundary
- Zoning By-Law Boundary
- First Nation Reserve

0 1.25 2.5 3.75 MILES

0 2 4 6 KILOMETERS

Prepared by B.C. MINISTRY OF ENVIRONMENT SOUTHERN INTERIOR REGION GIS, 1996

Map Scale 1:220 000

Projection Albers Equal Area, NAD83

Source: REGIONAL DISTRICT OF OKANAGAN - SIMILKAMEEN

Source: TERRAIN RESOURCE INVENTORY MAPPING (T.R.I.M.)

The large area on the west side of the study area, corresponding to Electoral Area G, has no zoning except for a small area designated Forestry-Grazing.

Resource Area zoning allows forestry, agriculture, residential development, parks, golf courses and mining.

The distinction between Farmland and Agriculture zones is somewhat unclear, since each may include Agricultural Land Reserve that has its own restrictions. The Agriculture zoning may allow more uses than Farmland designation, such as residential, parks, public recreation reserves, golf courses, and gravel extraction.

Large Holdings designation allows residential development and most agricultural activities.

Mixed Use zoning allows residential development, commercial buildings such as hotels, commercial recreation facilities, retail stores, gas stations and other developments.

The one Rural Resort zoning appears to be a special case that allows residential and multi-residential development, agriculture, specified recreational facilities and a ski lift.

11.4 UTILITIES AND OTHER INFRASTRUCTURE

There are several major road rights-of-way and many logging and other secondary roads in the study area, but few other utility corridors. Roads are under provincial jurisdiction. Although the volume of traffic through Indian Reserves to the ski resort has been a source of contention, there exists only one brief traffic count session for any of the roads to the resort. On 30 November 1994 a traffic counter was operated at the junction of Green Mt. Rd and Apex Rd for 12 hours. A total of 499 vehicles were counted.

A main hydro transmission line runs north through the study area just east of Indian Reserve 12a. Electric power to Apex Mountain Resort is via a power line from Hedley.

Apex Mountain Resort has several wells and a domestic water distribution system and a secondary sewage treatment system with lagoon. Nearby residences can use the water and sewer connections. Some of them have their own wells or surface water sources and septic systems.

11.5 SUGGESTED TREND DATA AND STANDARDS

The following information should be monitored in order to develop trends in land use and activity;

- Traffic Counts;
- Origin-Destination Data Of Traffic Into The Study Area;
- Location And Number Of Residences; Water And Sewage Facilities;
- Locations Of Residential Developments And Potential Developments (Given Existing Zoning), Which Could Result In Fragmented And Scattered Communities With Consequent High Infrastructure Costs;
- Population Growth In The Study Area.

11.6 DATA GAPS AT PRESENT

The main data gap is the very weak traffic volume data into the study area.

11.7 CONCLUSIONS

The present zoning appears to allow a wide variety of land uses throughout the study area. This could result in uncontrolled developments, dispersed residential developments with consequent high costs for provision of infrastructure and services.

11.8 RECOMMENDATIONS

With exception of traffic data, there appears to be adequate information about the study area.

SECTION 12.0

MONITORING CHANGE

Reid Crowther

SECTION 12.0
MONITORING CHANGE

The following comments provide some initial ideas for monitoring environmental conditions of the Seven Peaks area to assess cumulative changes. It identifies several parameters that could be monitored and entered into the Ministry of Environment's GIS in order to measure the changes that are occurring in the Seven Peaks area. These parameters can also be used to identify and describe tends and changes occurring within specific natural resource populations. The intent is to provide a mechanism to provide information regarding the sustainable use of the Seven Peaks area.

The environmental parameters that appear to be suitable for the Seven Peaks area are described under three broad headings as follows: biodiversity; clean and safe air, land and water; and sustainability.

12.1 BIODIVERSITY

Under biodiversity the environmental conditions that could be monitored in the Seven Peaks area include the protected area strategy, species at risk, wildlife populations and key habitats. Comprehensive wildlife population inventories have not been completed at this time and therefore would have to be completed as a priority if they are to be used to monitor change in the future.

Protected Area Strategy

One of the primary tools to ensure that biodiversity is maintained throughout B.C. is the Protected Area Strategy which has goals to protect 12% of the unique features and essential ecosystems in the province, and to promote sustainable use of the natural environment. Overall, insufficient unique wildlife habitat is protected in the Southern Interior ecoprovince to protect the large number of rare and endangered species. This includes the Seven Peaks area. The amount of protected area in the Southern Interior ecoprovince is in the order of 2% and in the Seven Peaks area it is less than 1%. Bunchgrass land typical of this dryland region contribute only about 0.06% of the provincial land area and approximately 7% of the Seven Peaks area. Throughout the entire province a very small amount is crown land. The remainder has been disturbed by developments, ranching and the introduction of non-native plant species. A small amount is contained within Nickel Plate Lake provincial park and the Apex Mountain Recreation Area.

There is a long way to go in protecting the unique features and sensitive ecosystems and thus biodiversity in this area. More consideration should be given to the establishment of wildlife areas, ecological reserves and wilderness reserves in the Seven Peaks area. Although not completely documented, there are significant concerns regarding loss of dryland habitat in this area.

Species At Risk

In concept, this is a measure of the percentage/number of species at risk (rare and endangered) in relation to the total number of species in the area. This parameter may be better measured at the ecoprovince level rather than on the smaller scale of the Seven Peaks area. Protection of species requires protection of appropriate habitat.

Presently 58% of the threatened and endangered species and 14% of the vulnerable species in B.C. are found in the Southern Interior ecoprovince. The greatest pressures are on those species that require valley bottom habitat, the lands which receive the greatest pressure from agriculture and urbanization. For example, wet lands which are essential for many species comprise only 15% of their original area and have clearly diminished in the lower Keremeos Creek area.

The valley bottoms comprise about 1% of the southern Interior ecoprovince and most of the wildlife species being managed rely on this habitat for survival.

Key Habitats

One way to measure wilderness or key habitats is by the ratio of roads (by area) there are in a specific area to the total area. In essence this implies that the more roads there are the less wilderness there will be. All access and other vehicle routes are included in this analysis. It includes asphalted, gravel, forestry and dirt roads. This data could be made available now but would require the cooperation of, in particular, the recreation, forest, mining and exploration companies.

Due to road access problems in recent years forestry activities in the Seven Peaks area has been voluntarily restricted pending negotiations between the Indian Bands and the Province. These negotiations appear to have reached a point of resolution whereby the forest companies believe that they can now increase harvesting rates for the area in the next five years. If this occurs it is going to result in changing habitats for existing wildlife and will likely impact key habitats such as valley bottoms and wetlands.

There is an opportunity to require the recreation, mining and forest companies to monitor road development as a function of the Seven Peaks area as a means to better manage potential impacts on key habitats and biodiversity.

12.2 CLEAN AND SAFE AIR, LAND AND WATER

The environmental conditions that could be measured under this category include water quality, contamination of land by chemical compounds that remain for long periods such as dioxins and a number of air quality parameters such as urban air quality, climate change and ozone thickness. Due to the low development in the

Seven Peaks area the only condition of relevance is a water quality index for surface water bodies and groundwater aquifers.

Water Quality Index

The water quality index is a measure of the number of surface water bodies with excellent, good, fair and poor water quality. Based on existing water quality objectives and monitoring requirements this parameter can be easily monitored. There may have to be more regular water quality analysis done on the Shatford and Shingle Creeks to fulfill the requirements for an index to be representative of the Seven Peaks area.

The present study has suggested that overall water quality is good throughout the Seven Peaks area, however, there are a number of locations where specific parameters are of concern. For example Nickel Plate Mine Creek, Red Top Gulch, and Cahill Creek have elevated levels of sulphates, nitrates and total dissolved solids due to operations at Nickel Plate Mine which have exceeded the water quality objectives established for these creeks. Also high fecal coliform counts, and elevated phosphorus and nitrogen are found in Lower Keremeos Creek; Upper Keremeos Creek experiences elevated levels of chloride probably due to road salting activities; and the Similkameen River near the Town of Keremeos has elevated levels of fecal coliforms due to agricultural runoff. Although these latter conditions do not exceed water quality objectives (for Upper Keremeos Creek and Similkameen River) they do represent increases over background levels and indicate changes are occurring. In addition, there are potential erosion problems in the Upper Keremeos Creek below the Apex Mountain Resort where ski hill development has resulted in silts entering the creek in the past.

Groundwater Quality

Groundwater quality can be measured by the number of contaminated wells as a percentage of the total number of wells in the Seven Peaks area. This would require annual testing of wells and central analysis of the data. The primary concerns would be from chemical contamination such as fuels and from nitrates and phosphates from fertilizers.

The municipal wells are required to be monitored monthly. Ranchers and farmers could be required to monitor their wells annually during a specified time to enable this criteria to be implemented. We believe that new legislation would be required to implement this program but feel that it is one of the primary parameters that needs to be monitored to assess cumulative effects.

12.3 SUSTAINABILITY

The environmental conditions that can be monitored to assess sustainability include water use, sustainable transportation, energy production, land use and compliance with environmental regulations. Water use is regulated and could be used to monitor sustainability, the amount of the land base under development can be tracked and use to monitor sustainability, and compliance with government regulations is currently monitored and can be used to monitor sustainability.

Water Use

A measure of the amount of water used per capita per day provides an international standard for measuring sustainability. Some data on water use is currently available from the ski resort and Nickel Plate Mine which could be used to monitor this parameter in the Seven Peaks area.

Surface water use is currently regulated through water withdrawal licenses that provide a maximum limit on the amount that can be used per license. It is well known that most licenses are under-used most years. Also the hydrological summary concluded that there is little capacity for additional storage within the Seven Peaks area. Licensed water use in the area appears to be at or close to its limit and therefore it represents an ideal parameter to indicate development pressure.

However, more accurate data on actual water use would provide a better analysis of potential growth capacity and thus sustainability than the current data. The current data does provide a baseline measurement of water use licenses against which future use or demands can be compared.

Land Use

This parameter is measured by establishing a baseline percentage of the area of the major land uses to the total area and monitoring the changes with time. This data is known but not included in the Ministry of Environment's GIS at this time. The data has been collected during this study and is available for input into the GIS.

Compliance with Environmental Regulations

This parameter requires a calculation of the percentage of licensed facilities not in compliance with government regulations every six months. This information is currently published by the Ministry of Environment. It includes municipal facilities (sewage treatment plants and landfills), industrial facilities (mines and forestry) and recreational facilities such as Apex ski resort.

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APPENDIX A

APPENDIX A

RARE AND ENDANGERERED FISHES OF THE SEVEN PEAKS AREA

Rare or Endangered Species

With the exception of trouts and salmons, most British Columbians are unaware of the remainder of the native species of fish in their province. In comparison with other vertebrates, most of the rare animal species are fish.

Freshwater fish in British Columbia are very limited in the dispersal opportunities and are very restricted in distribution. In fact, 36 out of a total 103 taxa are considered rare enough globally or provincially to be tracked by the British Columbia Conservation Data Center (CDC) (Cannings 1993).

The BC CDC performs an on-going, computer assisted ecological inventory. It focuses on the individual components of natural diversity, compiling and collecting information onthe status and distribution of rare or endangered species, common species and natural communities. Species are ranked on global and provincial levels.
The CDC uses a standardized methodology employed in similar centers in over 70 jurisdictions in Canada, the United States and Latin America.

The status of the species is ranked on a scale of one to five. The rank is based primarily on the number of extant occurrences of the species but other factors such as abundance, range, protection and threats are considered. To facilitate species ranking, each of the preceding factors is given a letter rank from "A" to "D" for each species where "A" indicates the greatest peril and "D" is the least. The global (G) rank is based on the status of the species throughout it's entire range whereas the provincial (S) rank is based solely on it's status within BC.

Summary of Conservation Data Center Ranking System
1 - Critically imperiled because of extreme rarity (5 or fewer occurrences or very few remaining individuals) or because of some factor(s) making it especially vulnerable to extirpation or extinction.

2 - Imperiled because of rarity (typically 6-20 extant occurrences or few remaining individuals) or because of some factor(s) making it vulnerable to expiration or extinction.

3 - Rare or uncommon (typically 21-100 occurrences): may be susceptible to largescale disturbances: e.g. may have lost extensive peripheral populations.

4 - Frequent to common (greater than 100 occurrences); apparently secure but may have a restricted distribution; or there may be perceived future threats.

5 - Common to very common; demonstrably secure and essentially ineradicable under present conditions.

X - Apparently extinct or extirpated, without expectation that it will be rediscovered.

Summary of Conservation Data Center Ranking Factors

Known occurrences: A = 0 - 5
B = 6 - 20
C = 21 - 100
D = >100

Abundance: A = fewer than 1,000 individuals
B = 1,000 - 3,000 individuals
C = 3,000 - 10,000 individuals
D = over 10,000 individuals

Range : A = global: narrow endemic (usually less than 260 square km)
B = global: regional endemic (260 to 26,000 square miles)
provincial: narrow range, less than 10% of territory
C = global: moderately widespread, or widespread with spotty distribution
D = global: widespread (greater than 2,600,000 square km)

Trend A = declining rapidly
B = declining
C = stable
D = increasing

There are presently 3 species registered with the BC CDC from the Seven Peaks study area, Umatilla dace, Mottled sculpin and the Chiselmouth. A summary of each of the species is presented below.

Umatilla Dace

Umatilla Dace (*Rhinichthys umatilla*) - First described by Gilbert and Evermann in 1896 from samples taken out of the Columbia River at Umatilla, Oregon. This species was first considered a hybrid of *R. osculus* and *R. falcatus*. There may be different *R. Umatilla* in different rivers. The Similkameen populations appear to be the same as those in Oregon.
R. umatilla is a riverine species which prefers the cover of large cobbles and boulders where the current is fast enough to prevent siltation. This species is absent from cold tributaries in the mountains. In regions where *R.umatilla* is sympatric with *R.falcatus* in B.C., it is more numerous and prefers stronger current. Other dominant, potential competitors are *R. cataractae* and *Cottus spp.*

Global Ranking

Rank G4?
Known Occurrences: C
Abundance: D
Range: B - Regional endemic
Trend: B? - Probably has declined because of loss of habitat to hydroelectric developments
Protected occurrences: C
Threats: C
Fragility: C

Comments: Regional endemic; extensive habitat loss to hydroelectric reservoirs

Provincial Ranking

Rank: S2
Known occurrences: C - 18 known sites; probably a few more exist.
Abundance: C? - Sampling is difficult in large rivers; needs further inventory
Range: A - Restricted to Similkameen (including Otter Creek) and Lower Columbia, Kootenay and Slocan Rivers and the Kettle River below Cascade Falls.
Trend: B? - Otter Creek population has declined in recent years. In the Columbia system, the effects of dams are unknown.
Protected occurences: A
Threats: C - Except for the Otter Creek population, the species does not appear to be very threatened.

Comments: Restricted to a number of localities in only five rivers; one population in decline.

Future Needs

Research: Genetic and taxonomic relationships among various isolated populations needs to be elucidated.
Inventory: Otter Creek should be surveyed to assess the status of this species there. If possible, deeper water habitats of the Columbia system should be searched to determine the status of adult Umatilla dace.
Protection: Exemplary habitat, such as that in the Similkameen River at Keremeos, should be protected.

Mottled Sculpin

Mottled Sculpin (*Cottus bairdi*) may be considered a multi-species conglomerate. In BC, only the Flathead River populations may be true *C. bairdi*. It's range is restricted to a portion of the Columbia River drainage and it's tributaries, including the Similkameen River. In BC it is found in flowing waters ranging in size from small creeks to large rivers and montane lakes. In the Similkameen drainage, the species is also common in the smaller tributaries.

Global Ranking

Rank: G5
Known occurrence: D
Abundance: D
Range: D
Trend: D?
Protected occurences: D
Threats: D?
Fragility: D?

Comments: A widespread species; western populations disjunct. An undescribed subspecies in Oregon is considered a taxon of "special concern".

Provincial Ranking

Rank S3
Known occurences: C - 31 known occurences; there are probable a number more but certainly fewer than 100.
Abundance: C - Can be abundant but fewer than 320 stream km.
Range: A - Known only for the portions of the extreme southern interior: the Similkameen system, the Kettle River below Cascade Falls, a small portion of the Columbia River and the Flathead drainage.
Trend: C
Protected occurences: A
Threats: C - Possibly threatened by coal mining in the Flathead valley and by hydroelectric developments in the Similkameen and Columbia Rivers.

Comments: Restricted distribution; possible threats of hydroelectric developments and coal mining.

Future Needs
Research: The taxonomic relationships of the various British Columbia populations have yet to be clarified.

Chiselmouth
Chiselmouth (*Acrocheilus alutaceus*) is known from scattered locations throughout BC, Washington and Oregon, including the Okanagan basin (Okanagan River and south Okanagan Lakes) and the Similkameen drainage. In BC, the chiselmouth is found in a

variety of relatively warm water bodies such as small creeks, backwaters of large rivers and lakes.

Global Ranking

Rank: G5
Known occurences: D
Abundance: D
Range: C
Trend: C
Protected occurences: U
Threats: C
Fragility: D

Comments: Although it's range is somewhat confined and it's distribution spotty, this species is found in numerous localities and a variety of water body types. There are no serious threats.

Provincial Ranking

Rank: S3
Known occurences: C - 18 known occurences, probably more than 30.
Abundance: D
Range: B - It's spotty distribution makes it difficult to calculate the true "extent' of the range.
Trend: C - No evidence of a decline.
Protected occurences: A
Threats: C - Not known from reservoirs in BC; perhaps threatened by future hydroelectric developments.

Comments: Has a small, spotty, relictual type of distribution in the province but no obvious threats.

Future Needs
Research: The biology of this species is still poorly known.
Inventory: Further inventories are needed to delineate more clearly this species' curious distribution in BC. In particular, the distribution of chiselmouths in the West Road River drainage as well as the upper Columbia system needs to be investigated further. The population reported from the Nicola Lake should be verified.

APPENDIX B

APPENDIX B

PLANTS AND ANIMALS

Conservation Data Centre Ranking Definitions

Each "element" (for example, a species) on the Conservation Data Centre's list is ranked using the system developed over the past 20 years by The Nature Conservancy. Each element is ranked at two levels: global (G) and provincial, or "subnational" (S). The global rank is based on the status of the element throughout its entire range whereas the provincial rank is based solely on its status within British Columbia. The global rank is established by a biologist assigned to that element by The Nature Conservancy; the provincial rank cannot exceed the global rank.

The status of an element is indicated on a scale of one to five; the score is based primarily on the number of extant occurrences of the element, but other factors such as abundance, range, protection, and threats are also considered if the information is available. Generally speaking, the Conservation Data Centre will track only those species with ranks of 1-3. In addition to the ranks 1-5, there are several letter ranks; all are defined below.

1 = Critically imperiled because of extreme rarity (5 or fewer extant occurrences or very few remaining individuals) or because of some factor(s) making it especially vulnerable to extirpation or extinction.

2 = Imperiled because of rarity (typically 6-20 extant occurrences or few remaining individuals) or because of some factor(s) making it vulnerable to extirpation or extinction.

3 = Rare or uncommon (typically 21-100 occurrences); may be susceptible to large-scale disturbances; e.g. may have lost extensive peripheral populations.

4 = Frequent to common (greater than 100 occurrences); apparently secure but may have a restricted distribution; or there may be perceived future threats.

5 = Common to very common; demonstrably secure and essentially ineradicable under present conditions.

H = Historical occurrence; usually not verified in the last 40 years, but with the expectation that it someday may be rediscovered.

X = Apparently extinct or extirpated, without the expectation that it will be rediscovered.

U = Status uncertain, often because of low search effort or cryptic nature of the element; uncertainty spans a range of 4 or 5 ranks.

R = Reported from the province, but without persuasive documentation for either accepting or rejecting the report.

RF = Reported in error, but this error has persisted in the literature.

? = Limited information is available or the number of extant occurrences is estimated.

A = An element (usually an animal) that is considered accidental or casual in province; a species that does not appear on an annual basis.

E = An exotic or introduced species to the province.

Z = Occurs in the province but as a diffuse, usually moving population; difficult or impossible to map static occurrences.

In addition to the above ranks, there are four letter qualifiers sometimes used in conjunction with them:

T = Designates a rank associated with a subspecies.

B = Breeding; the associated rank refers to breeding occurrences of mobile animals.

N = Non-breeding; the associated rank refers to non-breeding occurrences of mobile animals.

Q = Taxonomic validity of the element is not clear or in question.

RED AND BLUE AND YELLOW LISTED SPECIES

The following are the definitions of Red List and Blue list as the Conservation Data Centre applies them to wildlife species.

RED LIST: Includes any indigenous species or subspecies (taxa) considered to be Extirpated, Endangered, or Threatened in British Columbia. Extirpated taxa no longer exist in the wild in British Columbia, but do occur elsewhere. Endangered taxa are facing imminent extirpation or extinction. Threatened taxa are likely to become endangered if limiting factors are not reversed. Red-listed taxa include those that have been, or are being, evaluated for these designations.

BLUE LIST: Includes any indigenous species or subspecies (taxa) considered to be Vulnerable in British Columbia. Vulnerable taxa are of special concern because of characteristics that make them particularly sensitive to human activities or natural events. Blue-listed species are at risk, but are not Endangered or Threatened.

YELLOW LIST: All other wildlife species are considered Yellow listed.

The following rankings and lists are used by CDC for animals, plants and communities. The main distinctions are that there are no S3S4 rankings for communities; in plants there are no S1S2 and no S2? rankings. The S1? used only for plants puts them on the Blue List.

Animals:

S1 S1S2 S2 S2? = RED

S2S3 S3 S3? S3S4 = BLUE

Communities:

S1 S1S2 S2 S2? = RED

S2S3 S3 S3? = BLUE

Plants:

S1 S2 = RED

S1? S2S3 = BLUE