Okanagan Reservoir Lake Project

Prepared for: **Land and Water British Columbia Inc.**

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1.0 INTRODUCTION

There are numerous headwater reservoir lakes in the Okanagan Valley that have a multitude of uses. One of these uses is the lease of lakeshore properties administered by Land and Water British Columbia Inc. (LWBC). In the late 1980's, the Province of British Columbia considered the option of selling waterfront properties to the lessees throughout the province. There was considerable local opposition to the sale of these properties on the reservoir lakes at that time resulting in this option being discarded in the Okanagan. The opposition to the sale was the purported impact of the lease properties on water quality.

LWBC are presently considering the sale of 141 leased properties on 16 lakes for commercial and recreational purposes (see Figure 1). This consideration is to give the same opportunity to the Okanagan reservoir lake leaseholders as was previously given to the other leaseholders in the province. When this project was advertised, there was considerable concern and opposition from local governments, irrigation districts and some members of the public to the sales. One of the main issues of concern was the potential impact that the sale of these leases would have on the water quality of the lakes.

For these reasons, LWBC decided to initiate a study to determine if in fact, the sale of leases would have an immediate or future positive or negative impact on water quality in the headwater reservoir lakes. This study would encompass a number of scenarios as listed in the following Methods section.

2.0 METHODS

The methodologies chosen to answer the questions of impact were a combination of those outlined in the original LWBC Terms of Reference and others advanced by the authors. Considerable experience with these issues resulted in the authors opinions on how best to tackle this problem to come up with what was considered to be the best methods to answer the question. These methods are subsequently outlined in this Section.

2.1 Literature Review

An extensive literature review was conducted to collect available information on the numerous studies completed in the Okanagan Valley on the watersheds of interest.

Studies completed on water quality were collated and assessed and information collected from a number of sources including:

> Ministry of Water, Land and Air Protection, Ministry of Sustainable Resource Management, Interior Health, Regional Districts, Water Purveyors and Ministry of Forests

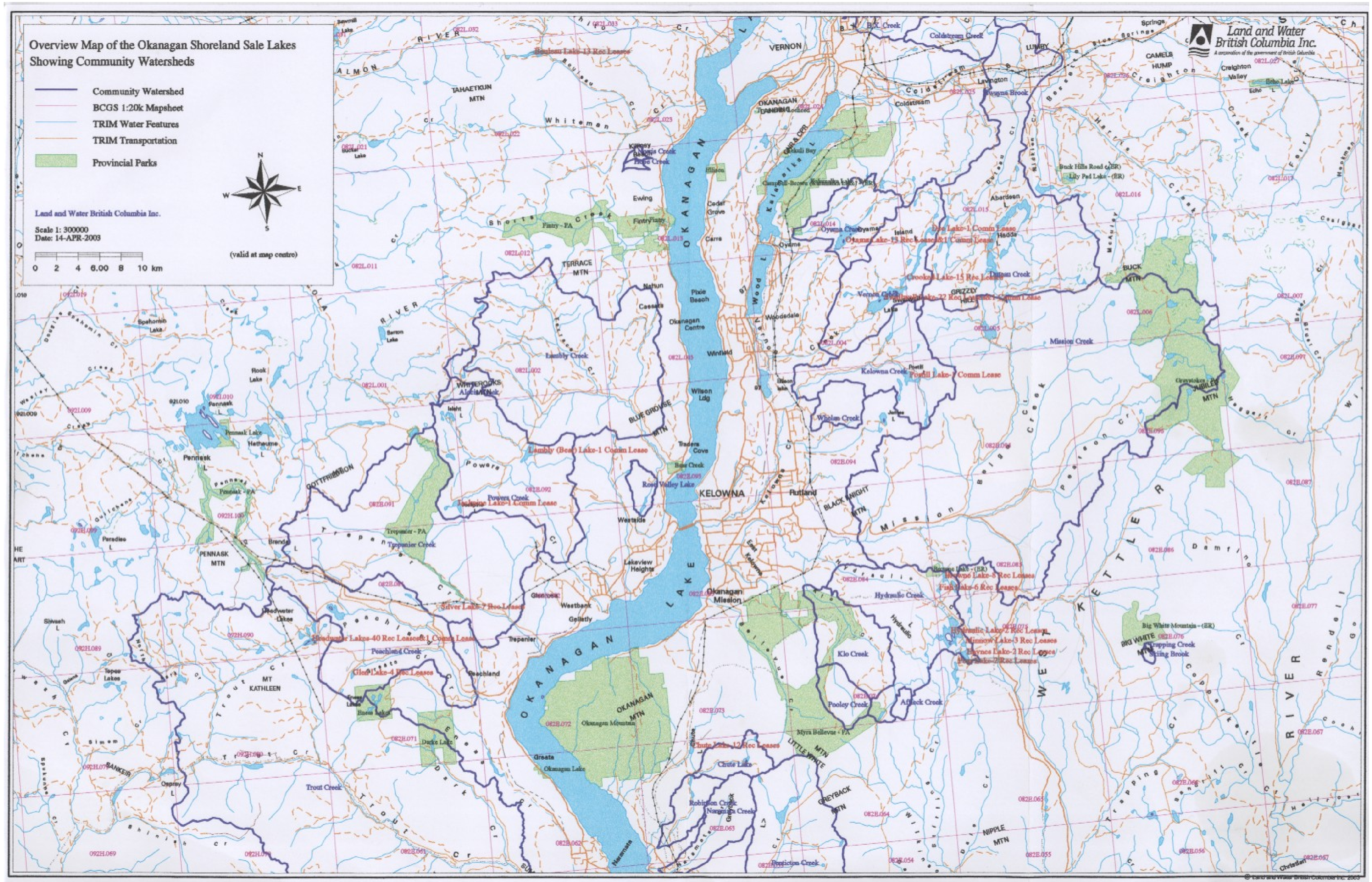

Figure 1. Map of study area, showing location of each lake.

In addition, numerous studies were completed through Forest Renewable British Columbia (FRBC) on such subjects as terrain and channel stability in selected community watersheds in the Okanagan region.

Information was collected on water licenses issued in the watersheds, zoning by-laws in the three Okanagan Regional Districts and any permits issued by Interior Health and/or MWLAP. Information on other activities such as grazing leases in the watershed was also collected.

2.2 Watershed Assessment

An assessment on the various impacts on water quality in the watersheds was completed based on the reviewed reports, interviews with selected individuals and field investigations by the authors.

2.3 Lease Site Investigations

A large portion of the study consisted of field investigations of all 141 lots. Based on our experience of the impacts of lake residences on water quality, it is our opinion the best way to assess the impacts is through on-site investigations of lease properties. This part of the program is based on work completed in the 1990's in concert with the Ministry of Health on Thompson Nicola Regional District lakes. This portion of the study required an on-site investigation of all lease properties from the standpoint of assessing the existing impact on water quality and the ability of the property to meet Interior Health conventional septic system requirements. This assessment consisted of such things as:

- Distance from water bodies to ensure minimum distances are available
- General assessment of slope
- General assessment of soil
- Depth to groundwater (if available) in area of existing or proposed septic field
- Adequacy of existing system relative to Interior Health requirements
- Present disposal methods
- Present use of the property

Much of the above required on-site assessment, but information was also obtained through Interior Health and MWLAP permit lists and the literature search to augment the field assessments.

2.4 Water Quality Monitoring

The ability to assess the impact of individual residential properties on existing lake water quality using normal sampling methodologies is limited. This is based on numerous studies conducted by the consultants on interior lakes over the last 30 years and scientific literature from British Columbia and other national and international jurisdictions.

One method used by MWLAP over the last two decades is the use of a fluorometer to attempt to pick up evidence of sewage inflow into lakes by scanning for whiteners and brighteners associated with use of soaps (*Petch, R. 1996*). This method is very expensive and requires sophisticated equipment. It is more efficient in areas of extensive development and only indicates the presence of sewage seepage and does not pinpoint exact sources. Another method is the injection of a dye into individual septic systems to determine whether sewage is entering the water body. This requires permission from several government agencies and the individual residential owner and is extremely time consuming in terms of man-hours.

The use of standard water quality parameters to determine whether individual septic systems are impacting local areas has not proven feasible. It is our opinion that water quality sampling of headwater lakes and watersheds would be useful to indicate existing water quality for use in future trend analysis. Therefore we used this scenario to conduct the following programs:

- sample each lake at fall overturn to determine lake trophic level. It would be preferable to do this during spring overturn but this would not be possible based on the contract period. The main parameters of interest are the nutrients. These data could be used to produce a ‘lake sensitivity rating’ for each lake to assist in determining the lake’s ability to assimilate additional nutrients (as per Cariboo Lake Management Strategy). The rating would determine the feasibility of using conventional septic system setbacks (Interior Health standards) or the need for more stringent requirements.
- sample inlet and outlet of each lake (where possible) to determine water quality entering and exiting the lake. Monitor each site in July, August and September for the following parameters: total and dissolved phosphorous, nitrate, nitrite, ammonia, total organic nitrogen, total Kjeldahl nitrogen, total nitrogen and fecal coliforms.

These data can be used to compare against any previous studies, as future baseline data, to set a sensitivity rating for each lake, and to assist in determining the range of activities that may be impacting water quality in the selected watersheds.

3.0 REGULATIONS, DISPOSAL METHODOLOGIES & DEVELOPMENT GUIDELINES

3.1 Existing Health Standards

At present, sewage disposal systems under 22.7 m^3/d come under the authority of the Health Act controlled by the various Health Authorities throughout the province. The types of sewage disposal systems are generally regulated by size of the discharge and availability of area for disposal. Generally speaking, sewage disposal is undertaken through the use of individual septic systems servicing individual domestic dwellings.

Sewage disposal permits are granted for individual domestic dwellings under the B.C. Sewage Disposal Regulation 411/85. This regulation is prescriptive in that the conditions to be met are specified in the “Permit to Construct”. Applications are made to the local Environmental Health Officer (EHO) through a standardized application form. Basic restrictions apply to the construction of the system and standard criteria are listed. The criteria relate to such things as pipe size and length, septic tank size, soil percolation rates and distance to watercourses. Methodology is outlined requiring standard methods to determine percolation rates and size of the field etc. Final decisions of the EHO can be appealed to the Environmental Appeal Board.

EHO’s make the final decision on whether a permit will be issued for the construction of a septic system. Generally speaking, if the system meets the requirements of criteria listed in the regulation, a permit will be issued. Through the appeal process, it has been determined that the authority of the EHO in making a decision is regulated by the Health Act. The Health Act does not take into account the potential for a system to cause pollution to adjacent waters, especially in terms of potential eutrophication. The intent of the Health Act is to prevent the failure of septic systems which would cause potential pathogenic contamination. Essentially, as long as the system operates efficiently and effluent does not surface, the EHO has no authority to consider other pollution effects. This was recently tested under an appeal where the EHO denied permission to a developer on a lake because of pollution concerns. His decision was successfully appealed because he went beyond the intent of the Sewage Disposal Regulation. The Environmental Appeal Board decided that the minimum setback of 30 meters was all that was required under Ministry regulation (*K. Christian, pers. comm*.).

3.2 New On-Site Treatment Methodologies

There are several new alternate disposal systems available for use where conventional systems are not allowed nor are feasible. The acceptability of these systems would be at the discretion of the local EHO and in some cases, a special permit to operate would be required.

3.2.1 Mound System

The most common alternate septic disposal system is the “mound” system. The absorption field is raised above the normal soil level by building the seepage system in a mound of soil with proper percolation characteristics. These systems are usually used where the percolation rate of the native soil is too fast or too slow. The mound allows the liquid to percolate through the introduced soil prior to entering the native soil. The design of the mound is based on the size of the septic system.

3.2.2 Single-Pass Sand Filters

This system pre-treats septic tank effluent by filtering it through sand before sending it to a standard or mound disposal field. Treatment mechanisms in a sand filter include physical filtering of solids, ion exchange, and decomposition of organic waste by soil-dwelling bacteria. Since wastewater leaves the sand filter as high quality effluent, the soil in the disposal field will be better able to accept it and the system will last longer.

3.2.3 Recirculating Media Filter

A re-circulating media filter (RMF) pre-treats septic tank effluent by filtering it through a medium of coarse sand gravel, peat or textile before sending it to the disposal field. The most common and reliable filter material is sand. Historically, this system was used for flows over 5000 gallons per day (gpd) but is now commonly used for small flow applications (less than 1200 gpd). This system is an attractive alternative because it requires less land and can handle high-strength waste.

Recirculation means cycling wastewater through a filter a number of times, allowing for continued filtering and increased bacterial decomposition. After the effluent has gone through the filter several times, a controlling mechanism sends the effluent to the disposal field for final polishing through the soil. This system allows for good removal of nitrogen and some removal of phosphorous, but does not remove fecal coliforms as effectively as single-pass or peat filters.

RMF's are much smaller than single-pass sand filters and are therefore, a better option for small lots. They do require regular maintenance and a maintenance contract is strongly recommended.

3.2.4 Peat Filters

A peat filter pre-treats septic tank effluent by filtering it through a two-foot thick layer of sphagnum peat before sending it to a conventional tile field. Peat filters remove high concentrations of both nitrogen and phosphorus, fecal coliforms, suspended solids and organic material.

There are two main types of peat filters: modules, and lined filters. Modules are manufactured plastic peat treatment cells. Lined peat filters are built on-site and usually lined with 30 mm PVC. A peat filter has three components: the peat, a pressure distribution system, and a drain. Wastewater from the septic tank is applied evenly over the peat surface by means of the pressure distribution system that allows for rapid infiltration. The effluent enters the drain, which is a liner or module that holds the effluent inside the filter. The drain collects the effluent and delivers it to the disposal field.

These systems require more maintenance than conventional septic systems. The peat media is expected to have a life expectancy of ten to fifteen years. Module peat filters are easier to maintain than lined peat filters because they are open to the surface.

3.2.5 Aerobic Treatment Units

An aerobic treatment system pre-treats household wastewater by adding air to break down organic matter, reduce pathogens, and transform nutrients. Compared to conventional septic tanks, these systems break down organic matter more efficiently, achieve greater decomposition of organic solids, and reduce the concentration of pathogens in the wastewater. There are numerous types of aerobic treatment systems available with different efficiencies and varying costs.

Aerobic treatment systems are much more complicated than conventional septic tanks. Because air is added to the tank, a highly oxygenated environment is created for the bacteria, which use organic matter as an energy source. In another stage, bacteria and solids settle out and the resulting cleaner effluent is distributed to the disposal field.

There are three basic types of aerobic treatment units: *suspended growth chamber*, *fixed-film reactor* and *sequencing batch reactor*. All three have a septic tank ahead of them that removes the large solids. Each type has its advantages and disadvantages. The *suspended growth chamber* is a simpler system but can have problems if the wastewater strength or quantity is changed. A *fixed-film reactor* is more expensive but produces a consistently high quality effluent. In the *sequencing batch reactor*, the bacteria settle out better but it has more moving parts with more potential for mechanical and electrical failure.

The value of these treatment systems is they produce a much better quality effluent than the standard septic tank, do not need much area, and can be used in sensitive areas that are not suitable for standard septic systems.

3.3 Lakeshore Guidelines

Lakeshore Management Guidelines are becoming increasingly more important throughout North America because of the settlement and usage of inland lakes. The Province of Ontario appears to be the first province in Canada that experienced the initial surge of lake colonization. Accordingly, the first attempts at controlling or regulating lakeshore development were initiated there in the early 1970's.

In British Columbia, guidelines have been instituted by a number of regional districts that can be used for development of most lakes in their regions (*e.g*. Regional District of Fraser Fort George, Peace River Regional District). Guidelines for development for specific lakes have also been produced by regional governments (Windermere Lake, Columbia Lake).

This section will review the pertinent guidelines that have been developed for various jurisdictions in British Columbia, as well as those in Wisconsin and Minnesota. Reference will also be made to the original work done in Ontario with a review of their system. Wisconsin and Minnesota were chosen from the United States because of the similarity between their lake systems and those in British Columbia. These excerpts are taken from a document entitled, *Lakeshore Management Policy Review,* produced for the Cariboo Regional District (*Lakeshore Env. Ltd., 2003*).

3.3.1 Regional District of Fraser Fort George (RDFFG)

The initial lakeshore guidelines in British Columbia were implemented by the RDFFG in 1978. Their purpose was to provide direction for development of lakeshore lands to developers, Regional District staff and board members, as well as other government agencies. Minor revisions were undertaken in 1980 and an additional revision was completed in 1994. The 1994 revision had two purposes: to direct lakeshore development to protect lakeshores from overuse and loss of desirable characteristics, and to provide information to lake users and property owners to protect the lake resource.

The 1980 guidelines focused on protecting aesthetic values, water quality, wildlife and fisheries habitat from destruction caused by over-development. The 1994 guidelines provided additional information to help protect the environment. They began to identify other values such as heritage or cultural values and recognized that management attention is needed in addition to guidelines to protect lakes.

The goal of the guidelines had three elements: to sustain environmental quality, to serve the interests of property owners, and to accommodate the needs of the general public. The specific objectives proposed were:

- preservation of water quality
- protection of foreshore and shoreland resources
- maintenance of recreational potential
- appropriate development
- integration of resource-based economic activities
- preservation of important or unique heritage and cultural features

The guidelines apply to all lands within 305 meters of the natural boundary of any lake. Lakes were classified according to their ability to accommodate additional development without significant adverse effects. Numerous criteria were utilized to determine the classification and included numerous ecological indicators as well as the amount of development already on the lake. Since there are many lakes in the District which lack the appropriate data, they were placed in the 'Natural Environment' category. This class was considered a "catch-all" group and as needed, these lakes would then be reassigned to one of the other five classes.

The lake classification system regulates whether development is permitted, maximum percent of perimeter development, minimum hectares/user units, minimum lot size, sewage disposal setbacks, and building setbacks.

The document outlines the steps required for proposed subdivision development. If a lake is classified, the document directs the steps that must be undertaken to meet the requirements of the particular classification. If a lake is unclassified, the proposed developer may be required to collect information to allow a classification to be set by the Regional District.

A large section of the report serves as an education source for lake users, especially residents. Detailed descriptions are given of each lake classification and the guidelines directed toward them. An Appendix gives the existing and proposed classification of numerous lakes in the region.

3.3.2 Peace River Regional District (PRRD)

The Peace River Regional District 'Lakeshore Development Guidelines' were completed in July, 2000. The Guidelines are a "policy document that has been prepared in response to growing pressures for development around lakeshore areas in the region".

The document was produced in order to:

- provide the public with important educational and background information on lakeshore ecological and development issues;
- provide developers with valuable conservation guidelines which can be used for construction projects in proximity to lakeshore areas, streams and ecologically sensitive areas; and
- provide the Board of the Peace River Regional District and Development Services Staff with development policies and conservation guidelines for specific lakes in the region, in order to assist in the decision-making process for future development proposals.

The document was designed to deal with private land situated within 300 metres of the natural boundary of lakes. Forty-one lakes in the District were chosen for specific analysis and development policies. The guidelines' goals and objectives were basically to develop a classification system that categorized the ability of each lake to accommodate future development activities. In addition, the developed guidelines would outline specific conditions for development proposals based on the lake classification. It was specified that the guidelines and policies were not to be considered regulations.

A section of the document outlined general guidelines that should be considered for all new development and subdivision proposals located within 300 metres of lakes in the District. It was suggested that these guidelines should be considered for all development next to any watercourse.

There were nine recommendations listed in the report to be considered by the Regional District. These included such things as the use of site-specific Development Permit areas, co-ordination with Ministry of Health to implement appropriate sewage setback requirements, implementation methodologies and public consultation.

3.3.3 Thompson Nicola Regional District (TNRD)

The TNRD initially set up a "Lakes Study – Policy Statement" in 1984. Lakes were evaluated on the basis of a number of factors including the following:

- physical characteristics (depth, area etc.)
- water quality
- unique features
- Canada Land Inventory ratings for waterfowl, ungulates and recreation
- shoreland ownership
- present land use

- access, and
- site factors (soils, slopes etc.)

The TNRD document is based directly on the guidelines set out in the RDFFG Lakeshore Guidelines.

Individual lakes were given a dominant classification but could also have one or more sub-dominant classifications. Each lake had a 'perceptual carrying capacity". Design principles were recommended for residential development along the lakes. These included recommendations for such things as cluster development rather than linear, use of natural exterior materials for buildings, development plans, storm water runoff collection and protection of the natural environment (*i.e.* trees, soils). Some general design principles were also recommended for commercial developments.

Management guidelines were set out for each lake classification. These included the format of future development including amount of perimeter development allowed, restrictions on motorboats, minimum sewage disposal setbacks, number of user units allowed, minimum cottage setbacks and minimum lot size.

This document was to be used by the TNRD Board of Directors to "assist in evaluating and making decisions on official plan, rezoning, development variance applications as well as Crown Land and highway subdivision referrals related to lakeshore development proposals".

Several recommendations were made that included continued liaison with provincial ministries to assist in classifying lakes, development of lake management plans for certain lakes, and protection and set-backs for feeder streams.

3.3.4 Lake Windermere

In response to local concerns, the District of Invermere prepared 'The Lake Windermere Management Strategy'. Presently, there are no regional government lakeshore development guidelines in use in the Kootenays. Lake Windermere is a highly developed lake with extensive summer use. The lake has valuable habitat for waterfowl, osprey, aquatic mammals and fish. It is used extensively for recreational power boating in the summer which conflicts with the habitat values and other recreational activities. The purpose of the study was to address the water quality, lake habitat, weed growth, upland development, public access, marinas and boat launches. A lake carrying capacity measure was used to determine the capacity of the lake to support additional development.

The study focused specifically on Lake Windermere and the foreshore. The strategy was prepared with a number of purposes (as listed above) including setting out roles and responsibilities and providing an action plan to ensure the management strategy recommendations were implemented.

Based on the results of the study, an Action Plan was produced that outlined numerous issues to be considered with recommendations on each issue. For example, a Carrying Capacity model was produced that estimated the ability of the lake to support recreational power boating and recommendations were made on the handling of sewage for existing and future development.

3.3.5 State of Wisconsin

In 1966, the State of Wisconsin enacted the Water Resources Act that required counties to adopt and administer shoreland zoning ordinances based on minimum state standards. These minimum standards were set for lot sizes, building setbacks, shoreland vegetation management and other shoreland related activities. The Shoreland Management Program assists local governments in the administration of shoreland zoning ordinances.

These standards apply only in unincorporated areas and are enforced by the counties. Nearly half of the counties have updated, or are in the process of updating their shoreland ordinances. The state government has decided that the existing standards may limit local innovation to protect shorelands and provide flexibility, rather than encourage it. Therefore, the Department of Natural Resources is launching a broad-based effort to update the existing standards.

The four major aspects of the existing code aim to:

- control the density of development
- create a protective buffer of vegetation along public waterways
- minimize disturbances to water resources
- protect wetlands that are located near lakes and streams by prohibiting draining and filling and limiting what can be done in those areas

In addition, Wisconsin has developed a lake classification system built on the principles of sensitivity to development or use and existing level of development or use. For an individual lake, certain physical factors such as surface area, average depth, stratification factor, flushing index etc. are taken into consideration. The sensitivity of the lake is calculated as ‘low sensitivity’, ‘medium sensitivity’ or ‘high sensitivity’ based on the above factors. Using these factors plus the existing amount of development per acre, the future amount of development is determined.

3.3.6 State of Minnesota

Minnesota’s Shoreland Management Act regulates all land within 1,000 feet (305m) of a lake and 300 feet (91.5m) of a river and the designated floodplain. Shoreland standards are adopted and administered by local governments and are commonly incorporated into their overall zoning controls. The primary agencies responsible for land use controls and zoning in Minnesota are local units of government such as counties, municipalities or townships. They have the authority to administer land use zoning controls for areas within their boundaries. These controls may identify a list of uses that are permissible or non-permissible for given areas or “zones”. They also may specify minimum design standards for newly created lots, onsite sewer systems and wells, subdivision plots, planned unit developments and construction in general.

There are state wide minimum standards that affect all lakes greater than 25 acres. These standards set guidelines for the use and development of shoreland property including: a sanitary code, minimum lot size, minimum water frontage, building setbacks, building heights, and subdivision regulations. Local units of government are required to adopt these, or stricter standards, into their zoning ordinance.

Lakes are also classified into three classes: Natural Environment, Recreational Development, and General Development. Natural Environment lakes are usually smaller than 150 acres, have less than 60 acres per mile of shoreline and have less than three dwellings per mile of shoreline. They are less than 15 feet deep, have shallow, swampy shorelines and some history of winterkill. Recreational Development lakes have between 60 and 225 acres of water per mile of shoreline, between 3 and 25 dwellings per mile of shoreline, and are more than 15 feet deep. General Development lakes have more than 225 acres of water per mile of shoreline, 25 dwellings per mile of shoreline and are more than 15 feet deep.

In Minnesota, there appears to be movement towards setting guidelines for individual lakes through public interest. Publications are available that assist the local areas in setting up a planning process to complete development guidelines for their particular lake.

3.3.7 Ontario

One of the first jurisdictions to consider lake management planning was the Province of Ontario. In the late 1970's, the Ministry of Natural Resources produced a lake planning document in response to a growing concern over the increased development of lakes within the province. The document was aimed at the development of Crown Land on lakes because it was believed the private sector could not sufficiently meet the need for cottage development. The lake planning process was incorporated into the overall land use planning of the Ministry.

Ontario's lake planning process was aimed at:

- producing a lake plan illustrating how to achieve an appropriate mix of land uses in order to fulfill the assigned role for the lake
- ensuring that these land uses impose a minimum level of strain on the lake environment

Therefore, the approach was to devise a plan for individual lakes rather than to set a standard for all lakes. The guidelines for writing the lake plan were very detailed and comprised nine different sections. These sections included such things as resource inventory and analysis, land tenure, capacity calculations, and public participation. The amount of information required both technically and through public participation and surveys, was very extensive (*Ontario Ministry of Natural Resources, undated*).

3.4 Okanagan Lakeshore Zoning

3.4.1 Okanagan-Similkameen Regional District

The Okanagan-Similkameen Regional District does not have specific lakeshore development guidelines. The two lake systems in this Regional District with lease properties are governed by separate by-laws with essentially the same regulations. The Headwater Lakes, Silver Lake and Glen Lake are governed by Bylaw 1725, a Rural Land Use Bylaw for Electoral Area 'H'. Chute Lake is governed by Bylaw 1566, Zoning Bylaw No. 1566 for Electoral Area 'E'.

Rural land Use Bylaw 1725 has a number of comments relative to development of properties on lakes. The Objectives (Section 2) from the Bylaw include reference to the following:

- Provide a variety of rural and recreational living experiences while maintaining the low density character and minimizing the impact on the environment;
- Provide the opportunity for a limited amount of new residential subdivision of parcels large enough to support individual on-site septic disposal systems and only where development will not have an adverse effect on the environment;
- Encourage the preservation and enhancement of the natural resources for: forestry, agriculture including, livestock grazing, fishery and wildlife habitat; extraction of minerals, placer and aggregate resources; as well as; recreational and tourism purposes having due regard for the visual landscape, surrounding land uses and the environment;
- Recognize the importance of the water resources, especially those used for potable water, to the viability of the planning area and to protect and where possible enhance these resources for future generations;
- Protect lands having significant recreational value and improve outdoor recreation opportunities while minimizing conflicts with adjacent land uses and natural resources;
- Encourage a limited amount of attractive and sensitively integrated commercial recreational and tourism development which is in keeping with the needs of residents and visitors alike;
- Identify, protect and enhance aquatic areas (watercourses, lakes, rivers, marshes, riparian areas), and terrestrial areas (significant grasslands, forests, cliffs and major steep slopes and valleys having slopes greater than 30%) as Environmentally Sensitive Areas (ESA's), to maintain the natural ecosystems, environmental quality, and aesthetic appeal of the area;

Under Section 6, General Regulations, Floodplain Regulations (6.1) govern properties near lakes in that they restrict construction within 7.5m of the natural boundary of the lake and 1.5m above the natural boundary of the lake. Exemptions are allowed for several uses and methodologies are available to achieve compliance.

Bylaw 1566 governs the Chute Lake area where development on lakes appears to be regulated only by the Floodplain Regulations (Section VII). These regulations mirror those found in Bylaw 1725 as described above.

3.4.2 Central Okanagan Regional District

Although the Central Okanagan Regional District (CORD) has a specific Foreshore Development Plan for Okanagan Lake, there are no specific foreshore development plans for the remainder of the lakes within the District (*K. Adsett, pers. comm*.). General rural zoning regulations under Official Community Plans (OCP's) govern development on lots regardless of whether they are next to lakes or some distance away.

There are a number of processes within the Regional District that are concerned with growth management and strategy (*CORD, 2003*). A paper entitled *'The Growth Management Strategy'* indicates the vision of the future and provides a general framework to guide development. Key issues within the strategy include water resources and environmental protection. The *'Environmental Protection Discussion Paper'* gives a detailed description of natural resources in CORD. The discussion paper provides for circulation of ideas and themes relating to regional environmental protection. It will generate policy and management review, and will guide future development and investment decisions. As stated in the paper, *'In order to effectively plan for and manage future growth and development, the communities of Kelowna, Lake Country and Peachland, the Regional District of Central Okanagan and provincial agencies are working in partnership to achieve common goals and vision of a Regional Growth Strategy. This Environmental Protection Discussion Paper is one of a series focusing on key issues applying to growth'.*

Although not specifically directed to lakeshore development, the paper does discuss water quality and environmental impacts from development.

3.5 Okanagan Shuswap Land Resource Management Plan (OSLRMP)

The OSLRMP is a provincial government plan that provides direction for the management of Crown land and the resources within the specified plan area (*OSLRMP, 2001*). As such, it encompasses the area that contains the reservoir lakes discussed in this document. The plan was developed by numerous public and government participants representing a wide range of interests. Of significance to this project, the plan recognizes the value of riparian management and its implications to the various water resources. The plan allows for the establishment of an 'Implementation and Monitoring Committee' (IMC) to provide on-going advice relating to the activities occurring in the plan area.

The proposal by LWBC was reviewed by the IMC in regards to the OSLRMP (*R. Pollard, pers. comm., 2003*). A document was subsequently produced by the IMC that indicated the areas where the objectives and strategies of the LRMP may be related to the proposal to dispose of Crown leased lots on the reservoir lakes (Appendix I). The strategies covered a wide range of issues from riparian integrity to considering public, agency and local government input to the proposal. Because of the large number of strategies listed, it is not possible to discuss them in this document. However, it is considered important that the listed strategies be reviewed prior to final decisions made on disposition of the leases.

4.0 RESULTS

4.1 Lease Site Investigations

As previously mentioned, LWBC have listed 141 lease lots to be tentatively sold. Field investigations were made on all sites to determine the existing impact on lake water quality and potential future impact assuming the lot services were upgraded to allow for permanent residence. Individual appraisal sheets were completed for each site. Based on these appraisals, an assessment of impact was written for each subdivision or grouping. The results are listed under the individual Irrigation or Regional Districts.

4.1.1 District of Lake Country

This district contained 50 recreational and 3 commercial leases on 4 lakes: Crooked, Dee, Oyama and Swalwell. Three of these lakes are interconnected in a north-south direction in the order of Dee, Crooked and Swalwell. As such, their water quality would be very similar.

Dee Lake has one commercial lease covering 19.95 hectares and encompasses the Dee Lake Wilderness Resort. The Resort has rustic cabins situated near the outlet channel that have no grey or black water services. The cabins and campground are serviced by a central shower building with a septic system located approximately 300 m from the channel. There are presently 10 new rental units being constructed along the south and east shore of the lake that are serviced by a central sewage collection system and discharged to dual septic fields approximately 200 m from the lake. This system is under a permit issued by Interior Health. Perimeter development on Dee Lake is calculated at 0.21 based on a lake perimeter of 3907m and the one commercial lease with an approximate perimeter of 828m. The perimeter development ratio is based on the amount of lakeshore development divided by the lakeshore length and is used to describe population density of the lake.

The present impact on the water quality from the operation is limited to silt run-off around the boat launch site and from the construction of the new cabins. Re-vegetation of the riparian between the cabins and the lake is in progress. Future construction of rental units is anticipated and must meet Health requirements. Proper operation of this resort should not cause impact to the water quality of Dee Lake and the outlet channel.

Crooked Lake is the fourth lake on the chain of lakes south of Dee Lake. As such, its water quality is dependent on the upstream lakes, Dee, Island and Deer. The lake has a surface area of 53ha and a perimeter development ratio of 0.08. Crooked Lake has 15 recreational leases on two lots (lots 2161 and 2162) covering a total area of 1.80 ha.

Lot 2162 contains five properties, all with areas of 0.12 ha and is located on the northwest side of the lake. The lake side property lines are approximately 30+ m from the high water mark of the lake. There is good mature overstory riparian, but some clearing of the understory has occurred. All of these properties are presently serviced by outhouses and appear to have no grey or black water discharges. There are presently minimal impacts to water quality from these properties. There is ample area on these properties to site future septic systems if that requirement becomes necessary.

Lot 2161 contains 10 properties, all 0.12 ha in size situated on the southwest side of the lake. There is considerable distance (30 – 45m) between the property boundaries and the high water mark of the lake. The riparian in this area is mostly undisturbed with mature overstory and good understory. All of the properties are serviced by outhouses with no evidence of grey or black water discharge. Presently, there is no impact to lake water quality from these properties and their maintenance of the riparian is a good example of proper lakeshore management. There is ample room to meet Health guidelines for proper septic disposal should these properties be upgraded.

Swalwell Lake is the last and most southerly lake of this chain of lakes and is the recipient of existing water quality from the upper lakes. It is situated at an elevation of 1370m and covers an area of approximately 225 ha. There are 22 recreational leases on the lake ranging in size from 0.07 - 0.23 ha and encompassing a total of 2.16 ha. There is also one commercial lease (Beaver Lake Resort) encompassing 7.8 ha. Perimeter development on the lake has a ratio of 0.06.

There are 18 lots (Blks. A – U) in Lot 3998 situated along the central western edge of the lake. These lots all have property boundaries set back a considerable distance from the high water mark (50 – 300m). Generally speaking, these lots have retained the virgin riparian areas with mature over- and understories and are relatively flat. The properties are serviced mostly by outhouses, but there may be several that are on septic systems. Power is generally supplied by solar panels or generators and many of the properties may be used year round for recreation. There is presently no impact to lake water quality from these residences. There is ample area to site proper septic systems on these properties to prevent impacts to water quality should future upgrading of the facilities occur. The condition of the riparian in this area is an excellent example of how to protect future lake water quality.

The remaining four recreational leases are situated on the south end of the lake just east of the resort. Three of the lots adjoin each other and the resort while the last lot is 0.5 km to the east on the other side of the lake outlet. This last lot has a rustic cabin on it and is serviced by an outhouse. The riparian over- and understory are mature with an access path to the lake. There is ample area for any future septic system and there are few present impacts to water quality.

Lot 3998, Blk. W has a rustic cabin with few facilities and is serviced by an outhouse. The riparian is mature and in good condition and no impacts to water quality are evident at this site.

Lots 1685 and 1733 are more developed and appear to be serviced by septic systems. These properties have poor riparians that have been cleared resulting in siltation problems. Improvements are needed to the riparian areas to alleviate impacts to water quality.

Beaver Lake Resort is situated on the south end of the lake and encompasses 7.8 ha. It is a fairly highly developed property with approximately 16 cabins, a lodge, a store and extensive campground. The Resort is serviced by 5 separate septic systems under permit to Interior Health. Most of the older cabins have only grey water discharges to dry wells. These will be diverted to septic fields in the future. The impact of the dry wells on lake water quality is presently unknown but will be eliminated with diversion to the septic system. The newer cabins have full facilities with discharges to septic systems. The campground encompasses Blk. Y and has a shower and sanitary services that are directed to a separate septic system. The resort is in discussion with LWBC to acquire some adjoining land to install a system capable of handling all wastes from the resort. There are little or no impacts from the services at the resort because of properly sited and permitted septic systems and retention of riparian areas. The only areas of impact would be silt runoff from the boat launch and the unknown impact from the dry wells.

Oyama Lake is a 360 ha, dystrophic lake situated at an elevation of 1360m and is supplied with water from Streak Lake. Oyama Creek drains the lake and enters the southeast end of Kalamalka Lake. The watershed is a listed community watershed under the Forest Practices Code and encompasses approximately 4223 ha. There are no listed water licenses for the lake, but there are 12 listed for the outlet stream, Oyama Creek. Perimeter development on the lake covers 760m and has a ratio of 0.05.

There are 13 recreational leases and one commercial lease (on two lots). Lot 2159 has six lots ranging in size from 0.09 to 0.12 ha. The properties are separated from the lakeshore by Crown Land with generally undisturbed mature riparian areas. The properties are generally flat with slopes less than 10%, except for one, which abuts an ephemeral stream. This property would require a proper assessment to determine whether suitable area is available for a future conventional septic system. The rest of the properties have suitable area for future septic systems if required. At present, these properties are serviced by outhouses and overall, based on the riparian and property characteristics, have no impact on water quality.

Lot 2160 has five properties ranging in size from 0.07 to 0.09 ha. Although there is no impact from these properties at present, based on existing development and riparian areas, 2 of the 5 have slope problems. One of these properties has no suitable area for a future septic system and would require a restrictive covenant to prevent future development if sold. The riparian areas are well maintained on these properties and there is ample distance from the property lines to the high water mark.

There are two isolated properties (Lots 2020 and 2035) situated on the lake. Lot 2020, at the south end is a large, flat lot adjoining the inlet creek. The lot is heavily forested and the building, serviced by an outhouse, is distant from the high water mark. Lot 2035 is south of the Resort on a flat, heavily forested knoll with no evidence of recent use. Neither of these properties affects water quality and there is ample area for future development of services.

Oyama Lake Resort is situated on two Lots and is open year round. Lot 1894 has a cottage and 4 un-serviced campsites. The cottage has power, water and a dry well disposal system. The lot is fairly flat and the riparian is in good condition. There is no impact from this lot and ample room exists for future septic system development. Lot 1893, the northern lot has the most extensive development with 8 cabins, a store/residence and 6 rustic campsites. There are several unpermitted septic systems servicing the residence, cabins and shower house (*pers. comm., resort owner*). The Lot is flat with ample area for conventional septic systems. Impacts on water quality from the Resort are minimal with some potential for siltation from frontage areas. This property requires proper permitting of their disposal systems through Interior Health.

4.1.2 Glenmore-Ellison Irrigation District

Postill Lake is a small 90 ha lake at an elevation of 1375m. It discharges into Kelowna Creek at its northwest end and is part of the Kelowna Creek Community Watershed which encompasses 7656.5ha. There are no registered water licenses on the lake but there are numerous ones on Kelowna Creek. This lake has considerable vertical drawdown. The perimeter development has a ratio of 0.03.

There is one commercial lease on Postill Lake that covers 3.16ha. This is a relatively small resort with 12 rental cabins and several tent sites. Five of the rental cabins are semi-waterfront with a service road between most of the cabins and the lake. The cabins are serviced by a new septic system with effluent pumped approximately 200m to a disposal field at the back of the property. The camping sites are located between the service road and the lake. They are serviced by outhouses that are 30+ m from the lakeshore and a shower house serviced by the septic system.

There is minimal impact on water quality from this operation with some siltation occurring near the launch site and swimming beach.

4.1.3 District of Peachland

Glen Lake is a small (10.8 ha) dystrophic lake and is part of the Peachland Community Watershed. There is one water license issued for 250 AF to the Municipality of Peachland for storage.

There are four recreational leases on the lake ranging in size from 0.16 to 0.78 ha. The perimeter development has a ratio of 0.12. Three of the four lots are lakefront with the fourth being a substantial distance from the lake and separated by the Forest Service Road. This lot, based on its distance and isolation from the lake, is not a concern to water quality in the lake. The buildings on the other three lots are rustic and range from 30 to 100m from the high water mark. Two of the three appear relatively unused and all three are unserviced except for outhouses. The riparian of all three is extensive and appears to be virtually untouched. There is presently no impact from these properties on the water quality of Glen Lake and future development should have no impact if disposal systems meet basic Health standards.

Silver Lake has an area of 11.5 ha, is at an elevation of 1075m and is part of the Peachland Community Watershed. There are 11 registered water licences on the lake of which eight are held by the Municipality of Peachland, one by the Silver Lake Forest Education Society and two by private individuals. There is an electric motor only restriction on this lake.

There are seven recreational leases ranging in size from 0.11 to 0.46 ha resulting in a perimeter development of 0.21. Five of the seven properties on Lots 2156 and 2157 (Blk's A & B) and Lot 2155 have good riparians and have little or no impact on lake water quality. There is ample area if future development requires septic systems. At present, these properties are serviced by outhouses.

The two properties on Lot 2158 are impacting local water quality through siltation, caused by clearing of the riparian understory. The buildings are situated fairly close to the high water mark. One of the properties has a large enough area in the back for a future septic system, while the other would require a proper assessment to see if sufficient area is available to site a system. Distance from the lake may not be sufficient to allow for a conventional system.

4.1.4 Southeast Irrigation District

The Southeast Irrigation District (SEID) has five lakes in two separate watersheds within its irrigation area that have lakeshore leases.

Hydraulic Creek is a designated Community Watershed under the *Forest Practices Code* and covers 9379 ha. Included in the watershed are four reservoir lakes that drain into Hydraulic Creek. Haynes Lake drains into Minnow Lake which drains into Hydraulic Lake and then Hydraulic Creek. Browne Lake drains into Fish Lake which discharges to Hydraulic Creek downstream of Hydraulic Lake.

Haynes Lake, the uppermost of this chain, is a 55 ha lake situated at an elevation of 1225m. Five water licenses are recorded for the lake, four are held by SEID and one by the Gang Ranch for stock watering. There are two residential leases on the northwest side of the lake comprising 0.47 ha resulting in a perimeter development ratio of 0.01. There is a small access road between the properties and the lake that is the front property line with a strip of Crown Land (approx. 10m) from the access road to the lakeshore. The riparian is comprised of mature overstory (pine and spruce) and sparse understory (willows, grasses) that appears to be natural to this area. The properties have no services (outhouses only) and have no impact on water quality. The back part of the properties have mature forests and have suitable area for septic systems if required.

Minnow Lake drains Haynes Lake, has an area of 16.8ha and is at an elevation of 1225m. There are no recorded water licenses on Minnow Lake. With three residential leases covering an area of 0.58ha, the lake has a perimeter development ratio of 0.05. Two of the properties are situated at the northwest side of the lake and have a small section of Crown Land between them and the high water mark of the lake. One of the properties is serviced by an outhouse and generator. It is quite flat and has ample area for a future septic system. The other property has an unlicensed septic system in the back of the property and an outhouse. The septic field is more than 30m from the high water mark of the lake. Impacts to water quality from these properties are limited to potential for minor siltation from cleared areas in front of the dwellings. Improved riparian understory would eliminate this problem.

The third lease is situated on the southeast end of the lake. There is a 10m Crown Land riparian between the front of the property and the high water mark of the lake. This riparian has mature overstory and a good understory of shrubs and small trees. The property is serviced by an outhouse and most of the property is heavily forested. There are no impacts to water quality from this property.

Hydraulic Lake is the last and largest lake in this chain covering an area of 260.6ha. There are no recorded water licenses on the lake but there are 16 on Hydraulic Creek, of which 14 are held by SEID. There are two residential leases situated at the north end of the lake adjacent to the resort covering 0.64ha. This results in a perimeter development ratio of 0.01. Both properties are flat and at a similar elevation to the high water mark of the lake. One of the properties has a septic system and is serviced by electricity. The property has no riparian understory with some mature conifers. The front and back of the property have extensive lawns. The main concern with this property would be the depth to groundwater and whether the septic system is properly sited.

The other property is mainly undeveloped and forested with a small, unserviced cabin. The main issue associated with this property would be the depth to the groundwater if future development would require a septic system.

The adjoining resort has a licensed sewage disposal system which may allow for the recreational properties to hook up for sewage disposal.

***Browne Lake**,* a 22.5 ha lake, situated at an elevation of 1280 m, has eight recreational leases on the west side of the lake covering a total of 0.88ha. The perimeter development ratio is 0.09. There are three recorded water licenses for storage allocated to SEID. A non-status access road separates these properties from the lake. A Crown Land riparian buffer (approx. 15m) separates the road from the lakeshore. The Crown Land riparian is heavily forested with a mature overstory and thick understory. The properties have unserviced cabins with outhouses and the back of the properties are heavily forested and quite flat. There is ample area at the back of the properties for future septic systems. There are no water quality impacts from any of these properties and the lake is well protected by the Crown Land riparian.

Fish Lake is a small, 13ha, lake that drains Browne Lake. It has six recreational leases and one recorded water license issued to SEID for storage. The leases are located on the west side and cover an area of 1.34ha and range in size from 0.17 – 0.24ha. The perimeter development ratio on the lake is 0.14. The cabins on the two properties on District Lot 504s are quite distant from the lakeshore (40 – 50m) with a riparian of mature conifers and sparse shrubs. The lots are flat and heavily treed in the back with ample area for future septic systems. There are no water quality impacts from these lots.

There are four properties on District Lot 503s with a small Crown Land riparian separating them from the lakeshore. Most of this riparian has good overstory and adequate understory, except on one property where the riparian has been cleared allowing for some siltation potential. The back of the properties are generally flat and heavily forested with ample area for septic systems. Water quality impacts are not evident, except for the previously mentioned siltation potential from one of the lots.

4.1.5 Westbank Irrigation District

There are two lakes in the Westbank Irrigation District that have commercial leases, Jackpine and Lambly. They are both part of the Powers Creek Community Watershed which covers an area of 13,596ha. There are numerous water licenses on Powers Creek, mostly held by the Westbank Irrigation District.

Jackpine Lake covers an area of 43ha at an elevation 1300m. It is fed by a small creek from Gladely Lake, however the dam on Gladely Lake was breached last year effectively removing about 4 acre feet of water storage for Jackpine Lake. There is one small commercial lease on Jackpine Lake covering 0.59ha. This translates into a perimeter development ratio of 0.02. There are only eight campsites at the resort and these are leased on an annual basis. They are serviced by outhouses and have no running water. The riparian condition at this resort is very good with narrow accesses to the lakeshore. There is ample area at the back of the property for a conventional septic disposal system. There is no impact from this resort on lake water quality.

Lambly (Bear) Lake is a fairly large reservoir of 82ha situated at an elevation of 1160m. At present, Lambly Lake is fed by Upper Lambly Creek, but plans are to divert water into this reservoir from other upland lakes (*Mould Eng., 2001*). Lambly Lake is the main storage reservoir for the Westbank Irrigation District with a storage capacity of approximately 3.5 million m^3. There are no registered water licenses on Lambly Lake, but there are numerous ones on Powers Creek below the lake. There is one commercial lease on the lake covering an area of 2.1ha with a perimeter development of 0.05.

The commercial lease is situated on the eastern shore of Lambly Lake. There are approximately eight cottages and two trailers to the south of the lodge/store and three new cottages to the north. There appears to be no area for general camping. The access road to the southern cottages passes between the cottages and the lake. There is approximately 2-3m of natural riparian between the lakeshore and the road and 10+m distance between the road and the cabins. The riparian is composed of some sparse natural vegetation, willows, poplars and grasses. All of the properties appear to be serviced by outhouses. The backs of the properties are heavily forested with varying slopes. The northern cottages are set back farther from the lakeshore between the access road and the lake. Impacts to water quality are restricted to some siltation from the access road and the properties.

4.1.6 Okanagan Similkameen Regional District

The Okanagan Similkameen Regional District has two lake systems containing 52 recreational leases and one commercial lease in two separate watersheds.

The Headwaters Lakes are within the Trout Creek Community Watershed which encompasses 71616 ha. Three of the four Headwaters Lakes (#1, #2 and #3) have leases while #4 has no leases. Lakes #2, #3, and #4 have outlets to Headwaters #1, the largest lake of the chain.

Headwaters Lake #1 has a surface area of 65.2 ha, is at an elevation of 1300m and drains into Trout Creek. There are no registered water licences on Lake #1 however, the outlet creek, Trout, has 35 licences of which 15 are held by the District of Summerland and the remainder by private individuals.

The only lease on the lake is a commercial lease, the Headwater Lake Resort encompassing an area of 4.3 ha. The Resort has 10 rustic cabins and 14 campsites. The campsites and cabins are serviced by two outhouses and a shower house with two showers. The shower house is serviced by a dry well as is the main residential house. Generally, the use of dry wells is not comparable to a proper septic system in terms of effluent treatment. Although in this case, the distance from the dry wells to the lakeshore is probably sufficient to allow for treatment of the effluent, it is recommended that a proper septic system be installed here to ensure no impact is occurring. The riparian contains mature overstory of Lodgepole Pine and Douglas-fir and sparse understory of grasses and shrubs. The overall impact from the operation is minimal with some siltation around the launch site and cleared areas by some cabins and campsites. The property has ample area to site conventional septic systems should future development occur.

Headwaters Lake #2 has an area of 22.8 ha and has no registered water licences. The lake is shallow with a maximum depth of 4m and a mean depth of 2.1m. There are 33 recreational leases on this lake covering a good portion of the shoreline. The leases are situated on seven lots with number of leases per lot ranging from one to eight.

Lot 2540 contains one lease and is situated at the south end of the lake and covers an area of 0.2 ha. This property has good riparian, the cabin is situated approximately 15m from the high water mark and is serviced by an outhouse. There is no impact from this property and ample area is available for a conventional septic system.

Lot 2548 has three developed properties ranging in size from 0.09 – 0.14ha. There is a Crown Land riparian strip of about 15 – 20m between the properties and the lake. Encroachment in the form of an access road has occurred on one of the properties although the remainder of the riparian has been maintained. This property has ample area for a septic system in back and may now be a permanent residence. The next property has retained the sparse riparian and has been highly developed with a water system and possible dry well disposal system. There is ample area in the back of the property for a septic system but the existing development would have to be rearranged to allow for a proper disposal field. The last property has been leveled with fill to allow for a flat building area. The property (Crown Land) slopes steeply to the lakeshore and the cabin is built right on the front property line. This property would require a Health inspection to determine whether sufficient area is available for a conventional septic system and whether there is sufficient distance from the high water mark.

Lot 2549 has eight properties varying from 0.08 – 0.12ha in size. There is approximately 10m of Crown Land riparian between the properties and the lakeshore. Generally speaking, the riparian is in good condition with a mature overstory of pine and fir and a sparse understory. Percolation test pits for septic disposal were noted on the properties. Six of the eight properties have ample area at the back of the properties for conventional disposal systems. One lot is surrounded on three sides by water and the cabin has been constructed on the property line close to the lake. This property may not have sufficient area to site a conventional disposal system due to distance constraints from the high water mark. The adjoining property may also have problems meeting the setback requirements from water for a conventional disposal system. The only impacts to water quality from the existing properties is minor siltation caused by clearing of native vegetation on the properties.

Lot 2678 has two properties, 0.12 and 0.14ha in size. Both properties have steep slopes to the lake and have problems associated with slope. One of the properties has been built up to allow for a flat area for construction of the cabin. Because of standing water to the north and steep slopes away from the cabin, there does not appear to be available area for a conventional septic system. This property may require specific restrictive covenants to limit development of services. The other property also has unique problems with the cabin having been built right next to the shoreline possibly in contravention of zoning regulations. The remainder of the property has good riparian with mature overstory and understory. Siltation problems are evident in cleared areas. There is potential for a septic system in the back of the property but pumping would be required. This property may require restrictive covenants should it be sold.

Lot 2679 contains eight properties ranging in size from 0.11 – 0.13ha. There is a Crown Land riparian strip of about 10m between the properties and the lake. Some of this riparian has been left in its natural state while some has been impacted by the owners. The riparian has mature overstory of pine and fir with varying thickness of understory shrubs and grasses. At present, the only impact to water quality is minor siltation caused by clearing of some of the riparian by several property owners. Conditions of sale should include retention and/or re-vegetation of the impacted riparian. The properties are large enough to handle future septic systems if required.

Lot 2680 has five leases having similar lot sizes of approximately 0.12ha. There is about 15m of Crown Land riparian between the lakeshore and the front property lines. On four of the five leases, this riparian has been left in its natural state. The cabins are generally 30 – 40m from the high water mark and are heavily forested. All of the properties have ample room for future conventional septic systems. On one of the properties, a large part of the Crown Land riparian has been removed resulting in potential siltation problems. This riparian needs to be re-vegetated as a condition of sale and left unused. Other than on this property, there are no water quality issues associated with the other properties.

Lot 2681 has four leases ranging in size from 0.12 to 0.14 ha. There is approximately 15m of Crown Land between the properties and the high water mark. The riparian on the Crown Land has generally been left intact except for some clearing on one of the properties. All of the properties are serviced by outhouses and ample area is available for future septic systems. There is little impact from these properties on lake water quality.

Headwaters Lake #3 has a surface area of 18.8ha and drains into Headwaters Lake #1. There are no registered water licenses on this lake, however, there is a dam and water is eventually released to Trout Creek which has a number of licenses.

There are seven recreational leases on three lots situated on the north end of the lake. Lot 2546 has four leases ranging in size from 0.12 to 0.18ha. The lots are quite large and there is a small riparian Crown Land between the property line and the lakeshore. The properties are heavily treed in the back and have fairly steep slopes. At present, the only water quality impact is some siltation caused by clearing of native vegetation. These properties would require a Health inspection if septic systems are installed in the future to determine whether slope is an issue.

Lot 2547 has two recreational leases of 0.09 and 0.07ha. The access road runs between the properties and the lake with a small Crown Land riparian next to the lake.

There are no water quality impacts from these lakes and area is available for future septic systems.

Lot 2544 has one property with a small Crown Land riparian strip next to the lake. There is no water quality impact from this property at present and ample area is available for a conventional disposal system.

Chute Lake is the second lake system in this Regional District. It has 12 recreational leases of which only ten will be made available for sale. Chute Lake is a small lake covering 35.7ha at an elevation of approximately 4000 ft. There are no recorded water licenses on the lake but there are 33 licenses on Chute Creek for domestic, irrigation, storage and stock watering. The largest are held by the Okanagan-Similkameen Regional District.

Only one of the lease properties (Lot 827^{s}) can be considered lakefront and the cabin on this property is around 50m from the lakeshore. The area between the cabin and the shore has mature over- and understory with the remainder of the property being heavily forested. There are no impacts to water quality from this property and there is ample room for placement of a conventional septic system in the future if needed.

Lots 769^{s} and 1054^{s} are both a long distance and downstream from the lake and have no impact on the lake water quality.

Lot 1053^{s} encompasses five properties and is situated on the southwest end of the lake. The lots are >50m from the lakeshore and separated from the shore by the Kettle Valley Right of Way, which contains a power line and a major Forest Service Road. The properties are serviced by outhouses and are fairly heavily forested. There is ample room for conventional septic systems. These properties are not impacting lake water quality.

4.2 Water Quality

4.2.1 Inlets/Outlets

Water quality samples were collected three times on a monthly basis at the inlets and outlets of each of the study lakes. In some instances, flow at the inlet and/or outlet was insufficient to collect a representative sample (Jackpine Lake inlet and outlet, Haynes Lake inlet, Postill Lake inlet, Silver Lake inlet and outlet, Dee Lake inlet). A summary of the tributary sampling program is given in Table 1.

The Browne Lake inlet was sampled on only one occasion because flow decreased to the point where representative sample collection was not possible. The Chute Lake tributaries were sampled on only one occasion due to access restrictions caused by the Okanagan Mountain fire.

Samples at all sites were analyzed for nutrients (total Kjeldahl nitrogen, total nitrogen, total organic nitrogen, ammonia nitrogen, nitrate, nitrite, total dissolved phosphorus and total phosphorus) as well as fecal coliforms. One exception was at the Silver Lake dock, where an initial sample was collected and analyzed for fecal coliforms only, due to the concerns of the Silver Lake Forestry Centre regarding potential water quality impacts on primary contact recreation.

Table 1. Summary of water quality samples collected in tributaries to the Okanagan reservoir lakes.

Site Descriptor	Location (Lat/Long)	Dates Sampled						
		23-Jul-03	24-Jul-03	05-Aug-03	19-Aug-03	21-Aug-03	22-Sep-03	30-Sep-03
Browne Lake Inlet	N49 48.827 W119 10.729		√					
Chute Lake Inlet	N49 41.958 W119 31.702		√					
Chute Lake Outlet	N49 41.401 W119 31.954		√					
Crooked Lake Outlet	N50 03.796 W119 12.441	√				√		√
Dee Lake Outlet	N50 06.401 W119 09.940	√				√		√
Fish Lake Inlet	N49 48.650 W119 11.517		√			√		√
Fish Lake Outlet	N49 47.941 W119 11.636		√			√		√
Haynes Lake Outlet	N49 45.400 W119 09.961		√			√		√
Headwater Lake 1 Outlet	N49 48.463 W120 01.175		√		√		√	
Headwater Lake 2 Outlet	N49 48.944 W120 00.198				√		√	
Headwater Lake 3 Outlet	N49 48.803 W120 00.574				√		√	
Headwater Lake 4 Outlet	N49 49.010 W120 00.566						√	
Hydraulic Lake Outlet	N49 47.048 W119 11.119		√			√		√
Lambly Lake Inlet	N49 57.351 W119 43.001			√	√		√	
Lambly Lake Outlet	N49 56.815 W119 42.868			√	√		√	
Oyama Lake Inlet	N50 05.968 W119 16.903	√				√		√
Oyama Lake Outlet	N50 07.355 W119 17.836	√				√		√
Postill Lake Outlet	N49 59.583 W119 12.765	√				√		√
Silver Lake at Dock	N49 49.737 W119 50.358		√					
Swalwell Lake Outlet	N50 02.500 W119 14.690	√				√		√

The results of the water quality analyses are given in Appendix II. Briefly, they can be summarized as follows:

Haynes Lake / Minnow Lake / Hydraulic Lake

As these lakes form an interconnected chain that does not vary in elevation, we expect the water quality to be very similar at the various inlets and outlets. This was generally the case, with nitrate concentrations consistently below the 0.02 mg/L detection limits and nitrite levels below the 0.005 mg/L detection limit. Ammonia concentrations were at or below the detection limit (0.005 mg/L) at both the Haynes Lake and Minnow Lake outlets. However, concentrations at the Hydraulic Lake outlet were slightly higher, ranging from 0.008 to 0.013 mg/L. Total Kjeldahl nitrogen, total organic nitrogen and total nitrogen were very similar over the course of the sampling program, ranging from about 0.28 mg/L in the earliest sample from the Haynes Lake outlet to 0.44 mg/L in the latest sample collected at the Hydraulic Lake outlet. Total dissolved phosphorus concentrations ranged from below detectable limits in most samples to a maximum of

0.008 mg/L in latest Minnow Lake outlet sample. Total phosphorus concentrations ranged from below detectable limits to a maximum of 0.022 mg/L in the Hydraulic Lake outlet. Fecal coliform concentrations were at or below detectable limits (< 1 CFU/100 mL) in all samples except the first one collected from the Haynes Lake outlet, when a concentration of 7 CFU/100 mL was found.

Browne Lake / Fish Lake

Water levels on Browne Lake are controlled by a small retaining wall, and the spill-over flows approximately 100 metres down a channel to Fish Lake. Therefore, the Fish Lake inlet and Browne Lake outlet can be considered the same. Water samples at the Fish Lake inlet were collected 1 metre downstream from the road crossing just upstream from Fish Lake. The Browne Lake inlet was sampled on only one occasion (in late July), as flow decreased to a trickle at this site and it was not possible to collect a representative sample.

Nitrite concentrations were consistently below detectable limits (< 0.005 mg/L) at all three sampling locations, and nitrate concentrations were also generally at or below detectable limits (< 0.02 mg/L). However, the September sample collected at the Fish Lake inlet had a concentration of 0.21 mg/L nitrate. Ammonia concentrations ranged from below detectable limits (< 0.005 mg/L) to a maximum of 0.023 mg/L at the Fish Lake inlet in August. Concentrations of the various nitrogen components (total Kjeldahl nitrogen, total organic nitrogen and total nitrogen) were similar at each site, and ranged from about 0.5 mg/L to 0.76 mg/L. Total dissolved phosphorus concentrations ranged from 0.006 mg/L at the Fish Lake outlet in August to 0.029 mg/L at the Fish Lake inlet in July. Concentrations of total phosphorus were slightly higher, with values ranging from 0.013 mg/L at the Fish Lake outlet in August to 0.041 mg/L at the Fish Lake inlet in September. Fecal coliform concentrations ranged from below detectable limits (< 1 CFU/100 mL) to a maximum of 5 CFU/100 mL at the Browne Lake inlet.

Oyama Lake

Nitrite concentrations were below detectable limits (< 0.005 mg/L) at both the inlet and outlet of Oyama Lake over the course of the summer. Nitrate concentrations ranged from below detectable limits (< 0.02 mg/L) at the inlet in September to a maximum of 0.04 mg/L at the inlet in July. Ammonia concentrations ranged from below detectable limits (< 0.005 mg/L) to a maximum of 0.027 mg/L at the inlet in July. Concentrations of the various nitrogen components (total Kjeldahl nitrogen, total organic nitrogen and total nitrogen) were similar at each site, and ranged from about 0.07 mg/L for total Kjeldahl nitrogen at the inlet in August to 0.35 mg/L for total nitrogen at the outlet in September. Total dissolved phosphorus concentrations ranged from below detectable limits (< 0.005 mg/L) at the outlet in August to 0.076 mg/L at the inlet in July. Concentrations of total phosphorus were slightly higher, with values ranging from 0.012 mg/L at the outlet in July to 0.1 mg/L at the inlet in August. Fecal coliform concentrations ranged from 8 CFU/100 mL at the inlet in September to a maximum of 190 CFU/100 mL at the outlet in September.

Dee Lake / Crooked Lake / Swalwell Lake

These lake form a chain much like Haynes / Minnow / Hydraulic lakes, with control structures at the outlet of Crooked Lake and Swalwell Lake. Water levels between Dee Lake, Island Lake, Deer Lake and Crooked Lake are the same, and as such we would expect very similar water quality between all of these lakes. Water from the spillway at Crooked Lake is the primary tributary to Swalwell Lake, so water quality in Swalwell is expected to be very similar to that in the upper lakes in the chain. The tributary to Dee Lake was dry throughout the summer, and no sample was collected at the Crooked Lake inlet due to difficult access. This site was not considered a high priority due to the fact that the lakes are contiguous and should have very similar water quality.

Nitrate and nitrite concentrations were consistently below detectable limits (< 0.02 mg/L and < 0.005 mg/L, respectively) at the outlet of all three study lakes. Ammonia concentrations ranged from below detectable limits (< 0.005 mg/L) at the Swalwell Lake outlet in September to 0.023 mg/L at the Dee Lake outlet in August. Concentrations of the various nitrogen components (total Kjeldahl nitrogen, total organic nitrogen and total nitrogen) were similar at each site, and ranged from about 0.31 mg/L for total organic nitrogen at the Swalwell Lake outlet in July to 0.62 mg/L for total nitrogen at the Dee Lake outlet in September. Total dissolved phosphorus concentrations ranged from below detectable limits (< 0.005 mg/L) to 0.01 mg/L. Concentrations of total phosphorus were slightly higher, with values ranging from below detectable limits (< 0.005 mg/L) to 0.023 mg/L at the Dee Lake outlet in September. Fecal coliform concentrations ranged from below detectable limits (< 1 CFU/100 mL) to a maximum of 9 CFU/100 mL at the Crooked Lake outlet in July.

Postill Lake

Samples were collected below the Postill Lake spillway. The tributaries to Postill Lake were dry throughout the summer.

Nitrate and nitrite concentrations were consistently below detectable limits (< 0.02 mg/L and < 0.005 mg/L, respectively) at the outlet. Ammonia concentrations ranged from below detectable limits (< 0.005 mg/L) in August to 0.016 mg/L in September. Concentrations of the various nitrogen components (total Kjeldahl nitrogen, total organic nitrogen and total nitrogen) were similar at each site, and ranged from 0.3 mg/L for each of the three constituents in August to 0.38 mg/L for total nitrogen in September. Total dissolved phosphorus concentrations were consistently below detectable limits (< 0.005 mg/L), while total phosphorus concentrations ranged from 0.008 mg/L in July to 0.024 mg/L in September. Fecal coliform concentrations were below detectable limits (< 1 CFU/100 mL) in both July and September, but increased to 10 CFU/100 mL in August.

Chute Lake

One sample was collected in July at both the inlet and outlet of Chute Lake. Samples were not collected in August or September due to access restrictions caused by the Okanagan Mountain fire. Concentrations of nitrate, nitrite and ammonia were at or below detection limits (< 0.02 mg/L, < 0.005 mg/L and < 0.005 mg/L, respectively) at both the inlet and outlet. Nitrogen concentrations ranged from 0.47 mg/L for total organic and total Kjeldahl nitrogen, to 0.74 mg/L for each of total organic, total Kjeldahl and total nitrogen. Phosphorus concentrations were higher at the inlet than at the outlet, with total dissolved vales of 0.039 mg/L at the inlet and 0.009 mg/L at the outlet, and total phosphorus concentrations of 0.075 mg/L at the inlet and 0.023 mg/L at the outlet. Fecal coliform concentrations were 1 CFU/100 mL at the inlet, and 41 CFU/100 mL at the outlet.

Lambly Lake

Samples were collected at both the inlet and outlet of Lambly Lake three times over the sampling period. Nitrate concentrations were at or below the detectable limit (< 0.02 mg/L) for most samples, with the exception of the inlet sample in July, which had a nitrate concentration of 0.1 mg/L. Nitrite concentrations ranged from below detectable limits (< 0.005 mg/L) to a maximum of 0.007 mg/L. Ammonia concentrations ranged from below detectable limits (< 0.005 mg/L) to 0.062 mg/L, in the outlet sample collected in July. Concentrations of nitrogen (total Kjeldahl nitrogen, total organic nitrogen and total nitrogen) were generally much lower at the inlet (concentrations ranging from 0.06 mg/L for total Kjeldahl to 0.17 mg/L for total nitrogen) than at the outlet (values ranging from 0.53 mg/L for total organic nitrogen to 0.76 mg/L for total nitrogen in July and August), although concentrations dropped considerably in September (0.19 mg/L for total Kjeldahl and total organic nitrogen, and 0.20 mg/L for total nitrogen). Total dissolved phosphorus concentrations ranged from below detectable limits (< 0.005 mg/L) in two of three samples at the outlet to 0.012 mg/L in the early inlet sample. Total phosphorus concentrations ranged from 0.006 mg/L in one each of the inlet and outlet sites to 0.025 mg/L in the mid-August outlet site. Fecal coliform concentrations were below detectable limits (< 1 CFU/100 mL) at the outlet, as well as in the September inlet sample. In the remaining two inlet samples, fecal coliform concentrations ranged from 9 CFU/100 mL to 19 CFU/100 mL.

Headwater Lakes

The four Headwater Lakes were sampled at their outlets. Headwater Lake #1 was sampled three times, Headwater lakes #2 and #3 were sampled twice each, and Headwater Lake #4 was sampled on one occasion.

Concentrations of nitrate and nitrite were consistently below detectable limits (< 0.02 mg/L and < 0.005 mg/L, respectively). Ammonia concentrations varied from below detectable limits (< 0.005 mg/L) to 0.012 mg/L at the Headwater Lake #4 outlet. Concentrations of nitrogen (total Kjeldahl nitrogen, total organic nitrogen and total nitrogen) were very consistent between the lakes and over the sampling period, ranging from 0.19 mg/L for total organic nitrogen in the September Headwater Lake # 2 outlet sample to 0.31 mg/L for each of the three types of nitrogen in the Headwater Lake #1 August sample. Total dissolved phosphorus concentrations were generally below detectable limits (< 0.005 mg/L) at all of the lakes, although the August Headwater #3 sample had a concentration of 0.014 mg/L. Total phosphorus concentrations ranged from below detectable limits (< 0.005 mg/L) to 0.016 mg/L in the September Headwater

Lake #1 outlet sample. Fecal coliform concentrations were generally at or below detectable limits (< 1 CFU/100 mL), with the exception of the first sample collected from the Headwater Lake #1 outlet. However, this sample was collected approximately 100 metres downstream of the outlet while the other samples were collected a few metres below the outlet. This lower sampling site was located in a stagnant slough, and is not likely a good representation of the quality of the lake discharge.

4.2.2 Lakes

Water samples were collected from each lake in early November. Samples were stratified, with one-third of the sample collected approximately 1 metre above the bottom of the lake, one-third collected from the centre of the water column, and one-third collected just below the surface of the lake. Samples were collected as near as possible to the deepest part of the lake (determined by bathymetric maps when available, and by depth-sounder when maps were not available). Samples were collected in November to ensure that summer stratification had been eliminated by cooling temperatures and fall winds, and before sufficient ice had formed to allow the lakes to become stratified again for winter. Water temperature, pH, conductivity and turbidity were measured in each component of the sample to give an indication of how well-mixed the water column was (Appendix III). Water samples were analyzed for the same nutrients as the summer tributary samples (total Kjeldahl nitrogen, total organic nitrogen, total nitrogen, total nitrate, total nitrite, dissolved ammonia, total dissolved phosphorus and total phosphorus). Detailed results are included as Appendix III, but are summarized briefly as follows:

Oyama Lake

Concentrations of nitrogen ranged from 0.31 mg/L for total organic nitrogen to 0.35 mg/L for total nitrogen. The nitrate concentration was 0.03 mg/L, while nitrite concentrations were below detectable limits (< 0.005 mg/L). The concentration of ammonia was 0.013 mg/L, the concentration of total dissolved phosphorus was 0.01 mg/L, and the concentration of total phosphorus was 0.018 mg/L.

Dee Lake

Concentrations of nitrogen ranged from below detectable limits (< 0.1 mg/L) for total organic nitrogen to 0.62 mg/L for total nitrogen. The nitrate concentration was 0.37 mg/L, while the concentration of nitrite was 0.075 mg/L. The concentration of ammonia was 0.243 mg/L, the concentration of total dissolved phosphorus was 0.02 mg/L, and the concentration of total phosphorus was 0.029 mg/L.

Crooked Lake

Concentrations of nitrogen ranged from 0.38 mg/L for total organic nitrogen to 0.49 mg/L for total nitrogen. The nitrate concentration was 0.05 mg/L, while nitrite concentrations were below detectable limits (< 0.005 mg/L). The concentration of ammonia was 0.061 mg/L, the concentration of total dissolved phosphorus was 0.011 mg/L, and the concentration of total phosphorus was 0.021 mg/L.

Swalwell Lake
Concentrations of nitrogen ranged from 0.31 mg/L for total organic nitrogen and total Kjeldahl nitrogen to 0.35 mg/L for total nitrogen. The nitrate concentration was 0.04 mg/L, while nitrite concentrations were below detectable limits (< 0.005 mg/L). The concentration of ammonia was 0.007 mg/L, the concentration of total dissolved phosphorus was 0.005 mg/L, and the concentration of total phosphorus was 0.03 mg/L.

Minnow Lake
Concentrations of nitrogen ranged from 0.39 mg/L for total organic nitrogen to 0.43 mg/L for total Kjeldahl nitrogen and total nitrogen. Concentrations of both nitrate and nitrite were below detectable limits (< 0.02 mg/L and < 0.005 mg/L, respectively), while the concentration of ammonia was 0.039 mg/L. The concentration of total dissolved phosphorus was 0.01 mg/L, and the concentration of total phosphorus was 0.014 mg/L.

Hydraulic Lake
Concentrations of nitrogen ranged from 0.33 mg/L for total nitrogen to 0.37 mg/L for total Kjeldahl nitrogen. Concentrations of both nitrate and nitrite were below detectable limits (< 0.02 mg/L and < 0.005 mg/L, respectively), while the concentration of ammonia was 0.021 mg/L. The concentration of total dissolved phosphorus was below detectable limits (< 0.005 mg/L), and the concentration of total phosphorus was 0.022 mg/L.

Postill Lake
Concentrations of nitrogen ranged from 0.39 mg/L for total organic nitrogen to 0.42 mg/L for total nitrogen. The concentration of nitrate was 0.02 mg/L, while that for nitrite was below detectable limits (< 0.005 mg/L). The concentration of ammonia was 0.007 mg/L, the concentration of total dissolved phosphorus was 0.014 mg/L, and the concentration of total phosphorus was 0.029 mg/L.

Browne Lake
Concentrations of nitrogen ranged from 0.57 mg/L for total organic nitrogen to 0.79 mg/L for total nitrogen. The concentration of nitrate was 0.04 mg/L, while that for nitrite was 0.006 mg/L. The concentration of ammonia was 0.172 mg/L, the concentration of total dissolved phosphorus was 0.038 mg/L, and the concentration of total phosphorus was 0.051 mg/L.

Fish Lake
Concentrations of nitrogen ranged from 0.53 mg/L for total organic nitrogen to 0.61 mg/L for total nitrogen. The concentration of nitrate was below detectable limits (< 0.02 mg/L), while the concentration of nitrite was 0.005 mg/L. The concentration of ammonia was 0.068 mg/L, the concentration of total dissolved phosphorus was 0.011 mg/L, and the concentration of total phosphorus was 0.018 mg/L.

Haynes Lake
Concentrations of nitrogen ranged from 0.35 mg/L for total organic nitrogen to 0.41 mg/L for both total Kjeldahl nitrogen and total nitrogen. The concentration of both

nitrate and nitrite were below detectable limits (< 0.02 mg/L and < 0.005 mg/L, respectively), while the concentration of ammonia was 0.06 mg/L. The concentration of total dissolved phosphorus was below detectable limits (< 0.005 mg/L), and the concentration of total phosphorus was 0.01 mg/L.

Lambly Lake

Concentrations of nitrogen ranged from 0.28 mg/L for total organic nitrogen to 0.29 mg/L for both total Kjeldahl nitrogen and total nitrogen. The concentration of both nitrate and nitrite were below detectable limits (< 0.02 mg/L and < 0.005 mg/L, respectively), while the concentration of ammonia was 0.012 mg/L. The concentration of total dissolved phosphorus was below detectable limits (< 0.005 mg/L), and the concentration of total phosphorus was 0.012 mg/L.

Jackpine Lake

Concentrations of nitrogen ranged from 0.45 mg/L for total organic nitrogen to 0.48 mg/L for total nitrogen. The concentration of nitrate was equal to the detectable limit (0.02 mg/L) while nitrite concentrations were below detectable limits (< 0.005 mg/L). The concentration of ammonia was 0.016 mg/L, the concentration of total dissolved phosphorus was 0.007 mg/L, and the concentration of total phosphorus was 0.012 mg/L.

Headwater Lakes #1 and #2

Concentrations of all nutrients were similar at these two lakes. Concentrations of nitrogen ranged from 0.18 mg/L for total organic nitrogen in Headwater Lake #2 to 0.26 mg/L for total nitrogen in Headwater Lake #1. The concentration of both nitrate and nitrite were below detectable limits(< 0.02 mg/L and < 0.005 mg/L, respectively) for both lakes, while the concentration of ammonia ranged from 0.013 mg/L in Headwater Lake #2 to 0.021 mg/L in Headwater Lake #1. The concentration of total dissolved phosphorus was below detectable limits (< 0.005 mg/L) in Headwater Lake #2 and only slightly higher in Headwater Lake #1 (0.007 mg/L), and the concentration of total phosphorus was 0.007 mg/L in both lakes.

Glen Lake

Concentrations of nitrogen ranged from 0.67 mg/L for total organic nitrogen to 0.75 mg/L for total nitrogen. The concentration of both nitrate and nitrite were below detectable limits (< 0.02 mg/L and < 0.005 mg/L, respectively), while the concentration of ammonia was 0.065 mg/L. The concentration of total dissolved phosphorus was below detectable limits (< 0.005 mg/L), and the concentration of total phosphorus was 0.007 mg/L.

Silver Lake

Concentrations of nitrogen ranged from 0.63 mg/L for total organic nitrogen to 0.71 mg/L for total nitrogen. The concentration of both nitrate and nitrite were below detectable limits (< 0.02 mg/L and < 0.005 mg/L, respectively), while the concentration of ammonia was 0.066 mg/L. The concentration of total dissolved phosphorus was 0.014 mg/L, and the concentration of total phosphorus was 0.017 mg/L.

Chute Lake

Concentrations of nitrogen ranged from 0.59 mg/L for total organic nitrogen to 0.65 mg/L for total nitrogen. The concentration of nitrate was 0.03 mg/L while nitrite concentrations were below the detectable limit (< 0.005 mg/L). The concentration of ammonia was 0.028 mg/L, the concentration of total dissolved phosphorus was 0.013 mg/L, and the concentration of total phosphorus was 0.022 mg/L.

4.3 Watershed Impacts

The watersheds associated with the headwaters lakes studied in this document have varied uses and many reports have been written concerning specific impacts. Since a number of these are officially designated as "Community Watersheds" (CWS) under the *Forest Practices Code,* protection of water quality for drinking water purposes has become paramount. Widespread uses for grazing, logging, and recreational use are still prevalent in the watersheds. Water quality monitoring has been undertaken in a number of the watersheds by different agencies. Water purveyors such as irrigation districts quite often monitor the water quality at their intakes while senior governments have sporadically monitored in the watersheds over the years to isolate water quality problems. Forestry companies have been required to do various slope and terrain stability studies relative to their logging plans.

4.3.1 Vernon Creek (District of Lake Country)

The Vernon Creek CWS contains the chain lakes, Dee, Island, Deer and Crooked which discharge into Swalwell. Several reports have been compiled on this watershed focussing on water quality and aspects associated with the Forest Practices Code. The reports discussed, among other things, impacts to water quality.

The area above the Swalwell chain is relatively flat and contains approximately 86% of the land area of the watershed. It is estimated, however, that the lower portion of the watershed (14%) accounts for the majority of sediment sources to the creek (*Summit, 1997*). Terrain stability of the upper watershed is generally very high compared to the area downstream of Swalwell Lake where numerous landslides have occurred (*Summit, 2000*).

Timber harvesting originally occurred in the lower part of the watershed but over the past forty years has advanced to the upper portions. Interior Watershed Assessment Procedures (IWAP's) were completed in 1995 and 1999 (*Ministry of Forests, 1995*; *Summit Env., 2000*). Although road density and length were higher in the upper watershed, and erodable roads and soils existed there, steeper slopes and more erodable soils occurred in the lower watershed. The roads in the upper watershed showed signs of eroding and although sediment was accumulating in the ditches, the flat terrain may prevent the movement into the water sources.

Cattle access to the creek channels throughout the watershed has caused erosion and sedimentation (*Einarson, 2002*). Riparian vegetation has been lost, resulting in the cattle having easier access to the tributaries, in turn resulting in increased sedimentation, nutrient loads and fecal coliform concentrations. Cattle leases have been issued for the Vernon Creek watershed allowing for the grazing of approximately 1400 cow/calf pairs over the summer. There is the potential for large nutrient and coliform bacteria inputs from this source to the tributaries and lakes in the watershed. Cattle were noted on the lakeshores during the study and local lakeshore residents noted that this was a common occurrence.

The Vernon Creek watershed is used extensively for recreational activities included such dispersed activities as angling, hiking, hunting, motorcycling, mountain biking, horseback riding, and snowmobiling. These activities occur year round throughout the watershed (*Einarson, 2002*). Potential impacts from these activities include physical disruption of stream banks and streambeds and improper disposal of human wastes.

Water quality data from the Vernon Cr. CWS was assessed and water quality objectives proposed to protect key drinking water parameters (*Einarson, 2002*). Generally speaking, water quality in the lower watershed was poorer than the upper area and impacts occurred below Swalwell Lake. Increases occurred in non-filterable residue caused by in-stream bank erosion or sloughed landslide material. Fecal bacteria concentrations increased downstream after runoff events and when cattle were observed in the vicinity when sampling indicated overland runoff of fecal material. There was evidence that increase in phosphorus levels was a result of cattle waste or runoff from nutrient rich soils.

4.3.2 Kelowna Creek (Glenmore-Ellison RD)

Kelowna Creek supplies water for drinking and irrigation purposes for the Glenmore-Ellison Irrigation District. The mainstem of Kelowna Creek flows through Postill Lake, one of three primary reservoir lakes supplying water to Kelowna Creek.

A study was completed on Kelowna Creek to determine the effects of recreation on the water quality of the creek in relation to other activities (*BWP Consulting, 2001*). The author defines the recreational activities as "*fishing in the various lakes, camping, hiking, boating, horseback riding, mountain biking and various motorized activities including all-terrain vehicles (ATV's), motorcycles and 4 x 4's*". Water quality samples for normal parameters were obtained at various sites along the creek. In addition, specialized ribosomal RNA analyses were also conducted to determine the origin of *E. coli* found in the samples.

The results showed that high levels of fecal and total coliforms were present throughout the Kelowna Creek watershed. The concentrations of all types of coliforms were lowest in the samples collected at the outlet of Postill Lake. Of the five fecal coliform samples taken from the outlet of Postill Lake only one was positive and that value was equal to the detectable limit (1 CFU/100 ml). The highest concentrations of coliforms were found at the mouth and the greatest increase occurred between the GEID intake and the mouth. This was thought to reflect the higher concentration of people and animals in this residential area.

The RNA analyses showed that cattle contributed 34% of *E. coli* to Kelowna Creek at the GEID intake, humans and domestic animals, 26% and wild animals 32%. The unknown portion was 8%. Humans contributed only 7.8% of the total contribution.

A report was completed on Kelowna Creek in 2001 assessing water quality and producing objectives for drinking water (*BWP Consulting, 2001*). The influences on water quality within the watershed include forest harvesting, forest roads, livestock grazing, recreation and wildlife.

Over the last 35 years, more clear cut harvesting has occurred in the upper watershed. Approximately 15% of the entire stream-length had been logged to the stream bank and 10% had an unstable channel, mostly within the lower portion of the watershed (*Dobson Eng., 1998*).

There is one grazing license for 900 head in the watershed from August 22 to October 30. Recreational activities are numerous including fishing, hunting and mostly day-use activities.

4.3.3 Trout Creek (Okanagan-Similkameen RD)

The Trout Creek Community Watershed drains an area of approximately 715 km^2 and supplies domestic and irrigation water. One of the main storage reservoirs on the system is the Headwaters Lakes complex which has numerous crown leases.

Uses of the watershed include numerous recreational activities, forest harvesting and agriculture/range use. Recreational activities include fishing, tubing, mountain biking, hiking, horseback riding, hunting, cross country skiing, snowmobiling and all terrain vehicle use. Agricultural use includes summer grazing in the upper watershed, commercial agricultural operations and hobby farms.

Assessment of water quality for the purposes of setting water quality objectives under the *Forest Practices Code* was undertaken (*Dean/Dobson Eng., 2001*). Although several sampling sites were established and monitored for a variety of parameters, there was little association with the parameters and watershed activities in the report. The presence of total and fecal coliforms in the samples suggested there was fecal contamination of Trout Creek by warm blooded animals. Some possible sources were considered to be domestic livestock, improper disposal of human wastes and wildlife. It was also mentioned that the production of THM's through chlorination resulted in concentrations above acceptable levels. Causes for this production were not known. Water quality guidelines were set for a variety of parameters to protect water quality for drinking water purposes.

A Level 1 Interior Watershed Assessment Procedure was completed in 1998 (*Dobson Eng., 1998*). This report concluded that the surface erosion hazard rating and riparian hazard rating were classified as moderate. Only a minor portion of the riparian area had been harvested. The landslide hazard rating was rated as low with only seven landslides identified in the area. Water quality in the watershed could be affected by sediment dispersed from the roads.

Based on the activities occurring in the Trout Creek watershed, potential impacts to water quality are in evidence and further monitoring is required to isolate and eliminate these sources. Existing data are not sufficient to isolate the impacts.

4.3.4 Powers Creek (Westbank Irrigation District)

The Powers Creek CWS covers an area of 139 km^2 and is used both as a drinking water and irrigation source by the Westbank Irrigation District. The watershed includes Jackpine and Lambly Lakes with Lambly being the main storage reservoir on the system. The system was originally used for agricultural water use and is now having difficulty providing satisfactory water quality for increased domestic use (*Mould Eng., 2001*).

Impacts on water quality in Powers Creek are of the non-point source type which includes forest harvesting, agriculture, recreation, mining and land ownership. The primary concern with respect to water quality in the watershed is the potential impact from forestry activities (*Mould Eng., 2001*). Proposed forest development above the H_{60} line may seriously impact the peak flows and sedimentation rates into the creek (*Dobson Eng. Ltd., 1998*). The Dobson report also concluded that the active logging roads in the watershed were only a minor source of sediment with the major contributing factor to surface erosion being collapsing wood culverts. Landslides provide a moderate amount of sediments to the stream with extensive riparian loss a potential sediment source. General recreation activities could influence water quality by physically disrupting stream banks and streambeds contributing to erosion and sedimentation. Residential development is limited and will have little impact on water quality (*Mould Eng., 2001*).

Water quality objectives were set for Powers Creek under the *Forest Practices Code* to protect water quality for drinking water quality (*Mould Eng., 2001*). Although general water quality was measured in that study, individual impacts were not specifically isolated. The report did conclude that forest harvesting and cattle ranging were the two major activities having the greatest impact on water quality within the Powers Creek watershed.

4.3.5 Hydraulic Creek/Mission Creek (Southeast Irrigation District)

Hydraulic Creek is a major tributary of Mission Creek and contains Browne, Fish, Haynes, Minnow and Hydraulic Lakes. It serves as a major source of domestic and irrigation water for SEIKID and is important from a fisheries perspective. The Hydraulic

Creek basin is considered an upland watershed with little anthropogenic activity other than forestry, cattle grazing and recreation.

Water quality objectives were set for the basin in 1990 because of concerns with the potential impact of increased logging on water quality (*Singleton, 1990*). Several water quality parameters were sampled at several sites on Hydraulic Creek in this study. The conclusions of the study were that logging activities appear to have a detrimental effect on water quality in the system and some water quality characteristics have increased considerably during periods of accelerated harvesting.

The objectives report was updated in 2001 through a study commissioned by FRBC in the Mission Creek Community Watershed (*BWP Consulting, 2001*). Forestry activities in the watershed have impacted water quality through landslides usually identified with roads. There is also a considerable portion of the stream length with unstable channels and a portion of the stream has been logged to the bank. Cattle grazing tenures are also present in the watershed allowing for approximately 325 head to be present from May to October. Mission Creek was also one of the most popular watersheds for recreational activities and included hiking, camping, fishing and boating.

The effects of general recreation activities on the water quality of Hydraulic and Mission Creeks was studied in 2001 (*BWP Consulting, 2001*). Maximum coliform concentrations were found in Mission Creek at the mouth, primarily due to increased densities of both humans and domestic animals in this reach of the creek. Lowest concentrations were found at the outlet of Hydraulic Lake. Also in that study, ribosomal RNA analysis of *E. coli* samples indicated that cattle accounted for 28% of the coliforms present in the stream, wildlife for 32% and humans and domestic animals for 28%. Humans alone accounted for approximately 15% of the fecal coliforms sampled.

5.0 DISCUSSION

5.1 Preamble

The issue of impacts from lakeshore development on water quality has become of great importance in many jurisdictions in North America. In the United States, major work has been done in Wisconsin and Minnesota because of increasing development and concerns about impacts on water quality. In Canada, issues have arisen in Ontario, Alberta and British Columbia as well as other provinces for the same reasons. As previously shown in Section 3.3, a number of jurisdictions have instituted specific lakeshore development guidelines to protect water quality of the lakes and the lifestyle quality for the residents.

Impacts to water quality of lakes can come from a number of diffuse sources. Generally speaking, in the Interior, the quality of lake water is directly dependent on the quality entering the lake from the contributing watershed. In the majority of instances, impacts to the lake watershed have the greatest impact to the specific lake. Many studies have been undertaken documenting the impact of land use activities on water quality. The majority of impact comes from land use activities such as forestry, agriculture and recreation. There are also specific instances where residential and commercial development around lakes has contributed to decreased water quality (*Grace, 1999; Urban Systems Ltd., 2001*).

The main concern with impact to water quality associated with residential and commercial development along lakeshores is the possibility of sewage effluent entering the lake. The main constituents of sewage effluent that can affect water quality are human pathogens and nutrients (nitrogen and phosphorus). Another impact associated with lakeshore development can be an increase in pollutants such as silt and petroleum products entering the water. This occurs where lakeshore properties have been denuded of vegetation and where large areas of imperious substrates are constructed such as parking areas. These allow for the transport of oil and gas products into the lake. Another impact associated with lakeshore development is the indirect effects that may arise due to increased boating and use of outboard motors. Studies have shown that emissions from outboard motors can impact aquatic life. Siltation problems can occur from increased wave action produced by motorized boats and indigenous waterfowl nests can be destroyed.

Generally speaking, in most instances, human pathogens have not been the major problem in lake studies, although the possibility still exists. In most cases, the addition of nutrients and silt have had the most impact on water quality. Addition of excessive nutrients to lake water can result in increased productivity which leads to undesirable side effects. These side effects are an increase or change in algae that can impact water clarity, taste and odour and fish species in the lake. Addition of silt can impact on fish spawning and rearing and smothering of aquatic vegetation.

The main reason for this study was to determine whether the existing leased lakeshore lots were having an impact on water quality. It was also of interest whether future problems could occur if the services were upgraded on the lots. A decision would then be made whether to sell the properties to the leaseholders. Determining impacts from lakeshore residences on water quality is not a simple process. It is not possible to sample water adjacent to properties and definitively link changes in water quality parameters to those lots. There are methods available to survey the water and pick up signatures that indicate sewage is entering a lake (*Petch, 1996*). These methods are very time consuming and expensive and can not be used as a definitive measure of impact.

It was decided that the best way to determine the impact of the existing leases on water quality was to individually assess each property to determine potential impact. In addition, water quality monitoring stations were set up on the lakes and tributaries to determine baseline water quality. Based on previous studies in the watersheds, an assessment was made on the activities that were affecting the water quality in those watersheds.

5.2 Assessment of Investigations

5.2.1 Property Site Investigations

The on-site investigation of the individual leases showed that the vast majority of these properties are having little or no impact on the water quality of the lakes. An overwhelming percentage of the cottages are serviced by outhouses. Most have no running water and therefore there are no disposal problems normally associated with development. Also, as shown in Section 4.0, in many instances there is Crown Land between the property line and the shoreline which allows for an undisturbed riparian buffer strip. It has been shown in countless studies that the best way to protect lake (or stream) water quality is to maintain a viable buffer strip. In most cases, this buffer strip has been left mostly untouched except for small access areas. In those instances where the lease property adjoins the shoreline, the majority have retained some of the buffer zone. In a minority of cases, the riparian had been totally or partially removed and minor impacts can occur through siltation.

The on-site investigations also looked at whether ample area was available to site standard septic systems if water became available to expand the services. In the vast majority of cases, there was ample property available to meet Interior Health standards for the construction of septic systems. If the properties were sold and services expanded, standard Health Branch inspections would be required to ensure proper facilities were constructed.

It is important to note that lakeshore properties can be developed without impacting the integrity of the lake water quality or lakeshore habitat. Proper lakeshore development has been an item of concern throughout North America and numerous methodologies have been advanced to ensure impacts do not occur. Appendix V lists available methodologies and specific literature references to ensure developments do not affect lake integrity.

5.2.2 Water Quality

As mentioned above, attributing changes in water quality parameters to specific developments or anthropogenic activities is difficult. As the water quality of the majority of the tributaries entering the lakes (representing water unaffected by lease developments) was very similar to that leaving the lake, it would appear that the lease properties are having a minimal effect on lake nutrient concentrations. Table 3 shows the Canadian Council of Ministers of the Environment (CCME) classification of each lake in terms of trophic status, based on total phosphorus concentrations at fall overturn. This classification scheme is similar to that presented by Nordin (1985), who cites a range of 0.001 – 0.01 mg/L total phosphorus at spring overturn as oligotrophic, 0.01 – 0.30 mg/L as mesotrophic and > 30 mg/L total phosphorus as eutrophic.

Table 2. Summary of lake productivity classifications, based on CCME phosphorus trigger ranges (National Guidelines and Standards Office, 2003).

Trophic Status – Total Phosphorus Concentrations (mg/L) at Overturn					
Ultra-oligotrophic (< 0.004 mg/L)	Oligotrophic (0.004 – 0.01 mg/L)	Mesotrophic (0.01 – 0.02 mg/L)	Meso-eutrophic (0.02 – 0.035 mg/L)	Eutrophic 0.035 – 0.1 mg/L)	Hyper-eutrophic (>0.1 mg/L)
	Headwater Lake #1	Oyama Lake	Dee Lake	Browne Lake	
	Headwater Lake #2	Minnow Lake	Crooked Lake		
		Fish Lake	Swalwell Lake		
		Haynes Lake	Hydraulic Lake		
		Lambly Lake	Postill Lake		
		Jackpine Lake	Chute Lake		
		Silver Lake			

Nordin (1985) also mentions the conflicts between trophic status and desired water uses. For example, mesotrophic to eutrophic lakes are desirable in terms of producing enough biomass to sustain a recreational fishery, but drinking-water reservoirs are generally preferred to be oligotrophic. As such, all of the lakes in this study (with the possible exception of Browne Lake) can be considered tolerable for both drinking water and fisheries uses. Phosphorus concentrations *per se* are not generally recognized as a drinking water parameter of concern. However, increases in phosphorus usually results in an increase in lake productivity or trophic state. This can then result in increases in such things as undesirable algae which can result in taste and odour problems. Therefore, from the standpoint of drinking water, it is desirable to ensure lake trophic status does not deteriorate.

5.2.3 Other Watershed Impacts

The watersheds under consideration in this report are large in area and can be considered multi-use watersheds. As such, they are subject to a number of activities that can impact water quality. Review of existing reports on these watersheds indicate that the impacts on water quality are mainly associated with major land use activities such as forestry. These watersheds are also used for grazing of cattle resulting in a potential for wastes to enter tributary streams and lakes. Evidence of this was noted on field trips where cattle were observed in and about streams and lakes in the watershed. The watersheds are also used in varying degrees for numerous recreational activities which include camping, fishing, hiking, hunting, ATVing and snowmobiling. Local cottage owners have stated a concern with the large number of campers utilizing unregulated camping areas with no services resulting in human wastes being left near lakes and streams. This appears to have been exacerbated by a decrease in services at the popular Forestry Recreation Sites found on most lakes. The possibility of the closure of these sites will present a major potential impact to water quality of streams and lakes in these watersheds.

A review of the available data and observation of activities in the watersheds leads the authors to believe that impacts to water quality from the existing lease properties are very minor in comparison to the other activities present in the affected watersheds.

6.0 CONCLUSIONS

- on-site inspections of all lease properties has shown that the properties are having little or no impact on water quality in the reservoir lakes;
- the majority of properties are serviced by outhouses; very few have conventional septic systems;
- the majority of properties have sufficient area to site conventional septic systems if required in the future;
- it is not known whether ancillary activities such as boating associated with the lease holders is having a detrimental effect on water quality;
- it appears, based on observation and published reports, that other activities in the watershed have a much greater chance of impacting water quality in the watersheds;
- the majority of lakes in this study can be considered mesotrophic based on their fall overturn total phosphorus concentrations.

7.0 RECOMMENDATIONS

If a decision is made to sell the leased properties to the leaseholders, the following recommendations are made to ensure that water quality in the reservoir lakes will not be impacted by this transaction:

- the two Regional Districts that contain the reservoir lakes establish, at the least, proper zoning conditions for lakeshore development to ensure impacts will not occur in the future if these properties are further developed
- the two Regional Districts consider establishing lakeshore development guidelines for all lakes and reservoirs within their boundaries based on the precedents set in other jurisdictions
- if general guidelines are not developed, the Regional Districts should ensure, at the least, that regulations governing proper riparian buffer zones be implemented on the reservoir lakes as published by senior government agencies
- LWBC ensure, prior to sale, that any existing encroachment onto Crown Land by the leaseholders be eliminated as a condition of sale
- LWBC and the Regional Districts should consider placing restrictive covenants on certain properties that may require special review prior to sale
- the Regional Districts consider applying to the proper legislative agency to restrict motor size and/or type and certain motor crafts for use on reservoir lakes to prevent impacts to water quality and the aquatic environment
- trend water quality monitoring as set up in this study be continued to ensure any impacts or potential deterioration is noted at an early stage to facilitate remedial action

- the use of dry wells for effluent treatment be not allowed on lakeshore properties
- LWBC should review the concerns of the Implementation and Monitoring Committee (IMC) of the Okanagan Shuswap LRMP as set forth in Appendix I.
- the Regional Districts should consider working in concert with groups such as the British Columbia Lake Stewardship Society (BCLSS) to set up water quality monitoring programs for the reservoir lakes

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Appendix I. Summary of Okanagan-Shuswap Land and Resource Management Plan

OKANAGAN-SHUSWAP LAND AND RESOURCE MANAGEMENT PLAN				
The following Okanagan-Shuswap LRMP objectives and strategies are related to the LWBC proposal to dispose of recreational Crown-leased lots on upland lakes and reservoirs in the Okanagan valley:				
Resource Section	**Objective**	**Strategy**	**LRMP Direction**	**Intent Statement**
Crown Land GMZ		1.2	Ensure that there is an opportunity for public comment on permits, licenses, and other applications that affect Crown land	i) Applies to all allocations under the Land Act; ii) The information collected is used to consider the impacts on other resources and Crown commitments.
Crown Land GMZ		1.3	When considering Land Act applications, strive to separate incompatible uses and combine compatible uses by directing specific uses to appropriate areas where practicable.	i) Provide a list of new Land Act applications to the Monitoring Committee; ii) This covers applications under the Land Act, waste management permits, water licenses, etc. (all non-FPC and MX Code related activities)
Crown Land GMZ		1.4i	Establish "reserves from application", or "designated use areas" under the Land Act that provide for a single or restricted use.	i) This is current management, and allows provincial agencies to apply under the Land Act for reserves or designations to ensure, at an operational level and site specific basis, that lands with important or unique resources or attributes are not alienated or tenured under the Land Act. Such Land Act designations do not preclude the taking of applications under the Forest Act, Mineral Tenure Act, or other acts.
Crown Land GMZ	2.0		Ensure that opportunities for Crown land dispositions and reserves are available in the future to meet a broad spectrum of conservation, settlement, economic development, and other societal needs.	i) Maintain options for future uses; ii) That dispositions consider both today's needs and future needs

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Resource Section	**Objective**	**Strategy**	**LRMP Direction**	**Intent Statement**
Crown Land GMZ		3.1	Where private ownership is deemed appropriate by BCAL, offer for sale isolated parcels registered in the Land Title Office and deemed surplus by provincial agencies. These parcels must also be appropriately zoned or designated within a local government land use plan.	
Crown Land GMZ		3.2	Encourage local governments to enter into protocol agreements with MELP and BCAL, respecting notification and review of such parcels by local government prior to the parcel being put up for sale.	
Crown Land GMZ		3.3	Give priority consideration to local government requests to acquire such land for infrastructure or other community purposes.	i) Recognizes the significance of local government needs for infrastructure and community purposes.
Crown Land GMZ		5.2	Consider public input, agency and local government comments when determining the type, configuration and conditions of Land Act designations, reserves and tenure.	

OKANAGAN-SHUSWAP LAND AND RESOURCE MANAGEMENT PLAN				
The following Okanagan-Shuswap LRMP objectives and strategies are related to the LWBC proposal to dispose of recreational Crown-leased lots on upland lakes and reservoirs in the Okanagan valley:				
Resource Section	**Objective**	**Strategy**	**LRMP Direction**	**Intent Statement**
Crown Land GMZ	6.0		Minimize impacts to foreshore and riparian areas, and particularly those that are undisturbed.	6.1. Lakefront developments and/or alterations should be consistent with local government foreshore plans approved by regulatory agencies; 6.2. Encourage partnership agreements between local governments, MELP, DOF, and BCAL that assist in local management of the foreshore (e.g. head leases); 6.3. Promote ongoing public education and reporting to prevent unauthorized construction, filling and other environmentally harmful activities in foreshore areas.
Fish and Aquatic Ecosystems GMZ	Issues		**Lake Foreshore Development:** Development pressures along lakeshores including expanding urbanization and increasing recreational development and access. This growth has led to modifications of the lakeshore including filling, dredging, removal of natural substrate in foreshore habitats, loss of riparian areas, altered run-off and water quality deterioration impacting spawning and rearing areas along foreshore critical for salmon and char.	At present, development along the foreshore is piecemeal and is assessed on a project by project basis. There is a need for foreshore planning to determine where and how development should occur to maintain productivity of the lake ecosystem, and to prevent the cumulative impacts of foreshore and upland developments on fish and fish habitat.
Fish and Aquatic Ecosystems GMZ	5.0		Reduce impacts of development activities on fish habitat.	The strategies apply to all development activities.

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Resource Section	**Objective**	**Strategy**	**LRMP Direction**	**Intent Statement**
Fish and Aquatic Ecosystems GMZ		7.2	Protect identified cold water sources that influence stream temperatures.	i) Cold water sources are sources of water that have measurable influence on the receiving water in the fish stream. They may be tributary streams or groundwater discharge; ii) These will be identified by "fish"agencies, as well as resource development proponents.; iii) Proponents only expected to identify these during normal fish/water inventory/ assessment projects; iv) Proponents to develop site specific management prescriptions to buffer against detrimental changes in the temperature regime of the cold water.
Fish and Aquatic Ecosystems GMZ	8.0		Restore the structural and functional integrity of stream riparian areas on private lands.	8.1. All levels of government that work with private landowners should encourage the use of stream riparian buffers where riparian integrity is compromised.
Fish and Aquatic Ecosystems GMZ		10.1	Address cumulative impacts of multiple land and water uses on both Crown and private land through watershed planning and stewardship.	
Fish and Aquatic Ecosystems GMZ		11.4	Manage the lakeshore management zone of Class B lakes consistent with the three DM's letter of August 28, 1997 until such time as revised management direction is provided by the Monitoring Committee.	Class B lake states that there is to be no clearcutting, no new roads, and there is to be a lakeshore management zone of 210 metres.

OKANAGAN-SHUSWAP LAND AND RESOURCE MANAGEMENT PLAN				
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Resource Section	**Objective**	**Strategy**	**LRMP Direction**	**Intent Statement**
Riparian and Wetlands GMZ		1.21	Avoid activities that degrade riparian areas (i.e. cause bank destabilization, siltation, vegetation removal)	i) This does not apply to timber harvesting or grazing activities approved under other strategies; iv) This is intended to guide non-forestry activities, as well as to reduce impacts to riparian vegetation in general.
Riparian and Wetlands GMZ	3.0		Retain, or where possible, restore or enhance Crown wetlands not located within the provincial forest.	iv) To address activities in and around riparian areas governed by the Land Title Act, Municipal Act, Highways Act v) To be implemented under the authority of the Land Act and the Water Act by BCAL and MELP, Water Management Branch
Water GMZ		1.1	Identify all watersheds that support water licenses, and prioritize those ones that require or would benefit from water management plans to make the most effectiveuse of the resource considering all values.	
Water GMZ		1.2	For the watersheds identified in strategy 1.1, MELP is to undertake and implement water management plans ona priority basis.	i) Management includes allocation or licensing decisions; ii) Management plans include plans to address conflicts among instream and consumptive uses, other resource plans, etc.
Water GMZ		2.8	Review storage opportunities where appropriate to supplement low flows or replace instream consumptive demand.	
Water GMZ	5.0		Manage for good water quality as indicated by levels of turbidity, temperature, sediments, and contaminants.	

OKANAGAN-SHUSWAP LAND AND RESOURCE MANAGEMENT PLAN				
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Resource Section	**Objective**	**Strategy**	**LRMP Direction**	**Intent Statement**
Water GMZ		5.2	Control non-point sources of water pollution and sedimentation through best land management practices	i) To provide water quality protection through improved land management practices; ii) It is achieved by following current regulations and referring to appropriate guidelines on how to achieve this strategy.
Water GMZ		5.4	Any resource use development activities in Class 1 and 2 "High Use Domestic Watersheds" may require professional on-site assessment prior to road building, or any other resource development activity which could significantly impact drainage patterns, to ensure sub-surface and surface drainage patterns are maintained.	
Water GMZ		5.17	Ensure that sewage treatment plants, recreational users, etc are not contributing harmful levels of parasites or harmful bacteria to the streams at any time.	
Water GMZ		5.19	Avoid degrading water quality and quantity where proposed developments have the potential to impact domestic water supplies outside of community watersheds.	This strategy recognizes the importance of watersheds that provide water for domestic consumption.
Water GMZ	6.0		Minimize risk to life and property from floods, erosion, mass wasting, and debris torrents.	

OKANAGAN-SHUSWAP LAND AND RESOURCE MANAGEMENT PLAN

The following Okanagan-Shuswap LRMP objectives and strategies are related to the LWBC proposal to dispose of recreational Crown-leased lots on upland lakes and reservoirs in the Okanagan valley:

Resource Section	Objective	Strategy	LRMP Direction	Intent Statement
Water GMZ		6.3	When alienating Crown land prone to flooding, minimize risk to life and property by applying appropriate restrictions on development/use.	i) Apply the MELP floodplain development control policy.
Community Crown Interface RMZ	1.0		Promote consistency among strategic level planning (LRMP), provincial agency operational planning, and local government plans in order to reduce conflict.	1.1. BCAL shall notify the affected regional districts and municipality of Crown lands being considered for disposition; 1.3. Government agencies and development proponents are to recognize, and coordinate with, local government foreshore plans where lakefront developments or alterations are proposed
Community Crown Interface RMZ	3.0		Ensure that operational plans, prescriptions and permits contain measures that will minimize as much as practicable any potential negative resource development impacts on adjacent communities.	3.1. Establish appropriate notification, streamlined referral, and/or feedback mechanisms to ensure that local government concerns are addressed; 3.2. Local governments should be notified in writing and provided with opportunities to comment on land and resource extraction proposals in the interface area; 3.3. Permitting agencies are to consider inclusion of mitigating conditions when approving permits if local government has concerns.
Community Crown Interface RMZ	4.0		Direct the disposition of Crown land for new residential, commercial and industrial development to areas designated within OCPs, rural land use bylaws, or regional growth strategies.	4.1. Land Act dispositions should be consistent with the regional district/municipal OCPs and/or RLUBs; 4.2. The ability to service the land and proposed development must be considered prior to disposition; 4.3. In areas where no local government land use plans exist, dispositions of Crown land under the Land Act shall include local governments in consideration of adequate servicing to the lands, as well as the social, economic, and environmental impacts of the proposal.

OKANAGAN-SHUSWAP LAND AND RESOURCE MANAGEMENT PLAN				
The following Okanagan-Shuswap LRMP objectives and strategies are related to the LWBC proposal to dispose of recreational Crown-leased lots on upland lakes and reservoirs in the Okanagan valley:				
Resource Section	**Objective**	**Strategy**	**LRMP Direction**	**Intent Statement**
Community Crown Interface RMZ	6.0		Ensure that the establishment of provincial reserves and designations for a single resource use do not arbitrarily preclude future expansion within the interface zone.	6.1. Within the interface zone, include local governments in the consultation process before establishing or revising boundaries for wildlife management areas, the Forest Land Reserve, the Agricultural Land Reserve, provincial parks, or other reserves.
Fish and Aquatic Ecosystems RMZ		1.2	Conduct a risk assessment prior to development in watersheds, or sub-drainages, containing, or upstream of, the above fisheries values as defined on the Fish RMZ map.	i) The risk assessment needsto be of sufficient detail in order for the professional to make determinations or predictions about the impacts of future development; such that managers can make informed decisions.
Fish and Aquatic Ecosystems RMZ	2.0		Maintain the productivity of the provincially important broodstock collection sites.	i) This objective justifies the rationale for the proposed RMZ; ii) The intent is that these areas will be managed differently than other areas.
Fish and Aquatic Ecosystems RMZ		3.4	Restrict removal of material and vegetation from the foreshore in order to maintain natural foreshore substrates.	
Fish and Aquatic Ecosystems RMZ		3.9	Retain a Crown shoreline strip or use covenants or restrictions to maintain shoreline vegetation and restrict development when alienating (i.e. selling or tenuring) Crown-owned shoreline and foreshore.	i) To maintain the riparian zone and protect fish habitat; ii) This is not intended to be an absolute barrier to lakeshore development; iii) In areas of important fish habitat, a strip that is greater then 15 metres may be required; iv) Decisions on the application of setbacks and covenants will need to be assessed on a site by site basis; v) In most cases the width of the strip will be a minimum of 15 metres.

OKANAGAN-SHUSWAP LAND AND RESOURCE MANAGEMENT PLAN

The following Okanagan-Shuswap LRMP objectives and strategies are related to the LWBC proposal to dispose of recreational Crown-leased lots on upland lakes and reservoirs in the Okanagan valley:

Resource Section	Objective	Strategy	LRMP Direction	Intent Statement
Fish and Aquatic Ecosystems RMZ		3.11	Avoid, wherever practicable, development within a 15 to 30 metre wide strip upslope of the high water mark (natural boundary).	i) Proposals within the setback must be assessed or planned by a qualified professional, who can also propose mitigation/compensation measures appropriate to alleviate potential impacts on fish or riparian values.
Fish and Aquatic Ecosystems RMZ		3.12	For the areas shown on the Large Lake Shoreline map avoid, wherever practicable, development within 100 metres upslope of the high water mark (natural boundary), and 50 metres out into the water	i) Proposals within the setback must be assessed or planned by a qualified professional; ii) A reserve of 'Notation of Interest' under the Land Act should be established over these areas to ensure they are not alienated; iii) Agencies develop assessment procedures at the operational level and on a site-specific basis; iv) Applies to Crown land developments other than forestry activities.
Community Watersheds RMZ	1.0		Maintain water quality in community watersheds to minimize, where practical, the measures that are required to treat water to meet minimum standards.	
Community Watersheds RMZ	3.0		Address water quality impacts related to physical access.	3.1. All roads, trails and other construction activity must be undertaken under appropriate regulations and standards; 3.2. Where required by SDM, develop access management plans to reduce water quality impacts; 3.3. Reduce access to and fording of streams that result in harmful impacts to water quality.
Community Watersheds RMZ	5.0		Maintain water quality in reservoirs and other lakes in community watersheds for which water is used for community use.	5.1. Limit access to the lakeshore and drawdown zone by motor vehicles and other mechanized means of transportation (e.g. mountain bikes); 5.2. Direct camping to designated recreation sites and tenured facilities

Appendix II. Results of water quality analyses for lake tributary monitoring.

	Oyama Lake Inlet	Oyama Lake Outlet	Dee Lake Outlet	Crooked Lake Outlet	Swalwell Lake Outlet	Postill Lake Outlet
Date and Time	23/07/2003 13:30	23/07/2003 14:30	23/07/2003 11:15	23/07/2003 11:40	23/07/2003 10:00	23/07/2003 16:15
Total Kjeldahl Nitrogen	0.09	0.31	0.48	0.46	0.32	0.34
Total Nitrogen	0.13	0.33	0.48	0.46	0.32	0.34
Total Organic Nitrogen	< 0.1	0.3	0.47	0.45	0.31	0.33
Ammonia Nitrogen	0.027	0.007	0.007	0.017	0.014	0.014
Nitrate Nitrogen Dissolved	0.04	0.02	< 0.02	< 0.02	< 0.02	< 0.02
Nitrate + Nitrite	0.04	0.02	< 0.02	< 0.02	< 0.02	< 0.02
Nitrite Nitrogen	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Phosphorus Total Dis.	0.076	0.007	< 0.005	0.005	0.011	< 0.005
Phosphorus Total	0.079	0.012	< 0.005	0.005	0.008	0.008
Fecal coliforms	16	19	4	9	< 1	< 1
Date and Time	21/08/2003 9:15	21/08/2003 9:40	21/08/2003 10:45	21/08/2003 11:10	21/08/2003 11:45	21/08/2003 12:40
Total Kjeldahl Nitrogen	0.07	0.29	0.51	0.49	0.32	0.3
Total Nitrogen	0.1	0.31	0.52	0.49	0.32	0.3
Total Organic Nitrogen	< 0.1	0.27	0.49	0.47	0.32	0.3
Ammonia Nitrogen	0.014	0.019	0.023	0.016	0.005	< 0.005
Nitrate Nitrogen Dissolved	0.03	0.02	< 0.02	< 0.02	< 0.02	< 0.02
Nitrate + Nitrite	0.03	0.02	< 0.02	< 0.02	< 0.02	< 0.02
Nitrite Nitrogen	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Phosphorus Total Dis.	0.076	< 0.005	0.01	0.006	< 0.005	< 0.005
Phosphorus Total	0.1	0.013	0.021	0.007	0.009	0.012
Fecal coliforms	22	120	6	4	< 1	10

*All data in mg/L, except fecal coliforms in CFU/100 mL

	Oyama Lake Inlet	Oyama Lake Outlet	Dee Lake Outlet	Crooked Lake Outlet	Swalwell Lake Outlet	Postill Lake Outlet
Date and Time	30/09/2003 10:15	30/09/2003 9:35	30/09/2003 11:40	30/09/2003 12:00	30/09/2003 12:25	30/09/2003 12:50
Total Kjeldahl Nitrogen	0.11	0.31	0.61	0.45	0.34	0.37
Total Nitrogen	0.13	0.35	0.62	0.45	0.34	0.38
Total Organic Nitrogen	0.1	0.31	0.59	0.44	0.34	0.36
Ammonia Nitrogen	0.005	< 0.005	0.021	0.005	< 0.005	0.016
Nitrate Nitrogen Dissolved	< 0.02	0.05	< 0.02	< 0.02	< 0.02	< 0.02
Nitrate + Nitrite	< 0.02	0.05	< 0.02	< 0.02	< 0.02	< 0.02
Nitrite Nitrogen	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Phosphorus Total Dis.	0.069	0.006	0.007	0.007	< 0.005	0.011
Phosphorus Total	0.078	0.015	0.023	0.018	0.01	0.024
Fecal coliforms	8	190	3	< 1	1	< 1

*All data in mg/L, except fecal coliforms in CFU/100 mL

	Haynes Lake Outlet	Hydraulic Lake Outlet	Browne Lake Inlet	Fish Lake Inlet	Fish Lake Outlet
Date and Time	24/07/2003 10:10	24/07/2003 9:25	24/07/2003 8:10	24/07/2003 7:00	24/07/2003 8:25
Total Kjeldahl Nitrogen	0.28	0.32	0.68	0.63	0.5
Total Nitrogen	0.3	0.33	0.68	0.65	0.52
Total Organic Nitrogen	0.28	0.31	0.67	0.62	0.5
Ammonia Nitrogen	< 0.005	0.013	0.009	0.013	< 0.005
Nitrate Nitrogen Dissolved	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Nitrate + Nitrite	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Nitrite Nitrogen	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Phosphorus Total Dis.	< 0.005	< 0.005	0.016	0.029	0.012
Phosphorus Total	0.024	0.022	0.016	0.029	0.019
Fecal coliforms	7	< 1	5	1	4

*All data in mg/L, except fecal coliforms in CFU/100 mL

	Haynes Lake Outlet	Minnow Lake Outlet	Hydraulic Lake Outlet	Fish Lake Inlet	Fish Lake Outlet
Date and Time	21/08/2003 14:35	21/08/2003 14:55	21/08/2003 15:50	21/08/2003 15:25	21/08/2003 15:15
Total Kjeldahl Nitrogen	0.34	0.34	0.32	0.68	0.56
Total Nitrogen	0.35	0.34	0.32	0.7	0.56
Total Organic Nitrogen	0.34	0.33	0.31	0.66	0.55
Ammonia Nitrogen	< 0.005	0.005	0.008	0.023	0.01
Nitrate Nitrogen Dissolved	< 0.02	< 0.02	< 0.02	0.02	< 0.02
Nitrate + Nitrite	< 0.02	< 0.02	< 0.02	0.02	< 0.02
Nitrite Nitrogen	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Phosphorus Total Dis.	< 0.005	< 0.005	0.005	0.014	0.006
Phosphorus Total	0.011	0.008	0.012	0.029	0.013
Fecal coliforms	1	< 1	< 1	3	1
Date and Time	30/09/2003 15:25	30/09/2003 15:40	30/09/2003 14:55	30/09/2003 14:30	30/09/2003 14:20
Total Kjeldahl Nitrogen	0.34	0.33	0.44	0.55	0.6
Total Nitrogen	0.35	0.34	0.44	0.76	0.6
Total Organic Nitrogen	0.34	0.33	0.43	0.55	0.6
Ammonia Nitrogen	< 0.005	< 0.005	0.008	< 0.005	0.005
Nitrate Nitrogen Dissolved	< 0.02	< 0.02	< 0.02	0.21	< 0.02
Nitrate + Nitrite	< 0.02	< 0.02	< 0.02	0.21	< 0.02
Nitrite Nitrogen	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Phosphorus Total Dis.	0.007	0.008	< 0.005	0.026	0.007
Phosphorus Total	< 0.005	< 0.005	0.016	0.041	0.018
Fecal coliforms	< 1	< 1	< 1	< 1	< 1

*All data in mg/L, except fecal coliforms in CFU/100 mL

	Chute Lake Inlet	Chute Lake Outlet	Lambly Lake Inlet	Lambly Lake Outlet	Headwater Lake #1 Outlet	Silver Lake at Dock
Date and Time	24/07/2003 0:40	24/07/2003 13:00	05/08/2003 10:45	05/08/2003 11:05	24/07/2003 16:15	24/07/2003 15:40
Total Kjeldahl Nitrogen	0.74	0.47	0.06	0.57	0.22	
Total Nitrogen	0.74	0.48	0.17	0.59	0.22	
Total Organic Nitrogen	0.74	0.47	< 0.1	0.53	0.22	
Ammonia Nitrogen	< 0.005	< 0.005	0.011	0.04	< 0.005	
Nitrate Nitrogen Dissolved	< 0.02	< 0.02	0.1	< 0.02	< 0.02	
Nitrate + Nitrite	< 0.02	< 0.02	0.11	0.02	< 0.02	
Nitrite Nitrogen	0.005	< 0.005	0.005	0.007	< 0.005	
Phosphorus Total Dis.	0.039	0.009	0.012	< 0.005	0.007	
Phosphorus Total	0.075	0.023	0.009	0.006	0.013	
Fecal coliforms	1	41	19	< 1	80	1

*All data in mg/L, except fecal coliforms in CFU/100 mL

		Lambly Lake Inlet		Lambly Lake Outlet		Headwater Lake #1 Outlet		Headwater Lake #2 Outlet		Headwater Lake #3 Outlet		Headwater Lake #4 Outlet
Date and Time		19/08/2003 9:20		19/08/2003 9:45		19/08/2003 15:00		19/08/2003 14:20		19/08/2003 14:30		
Total Kjeldahl Nitrogen		0.16		0.75		0.31		0.2		0.24		
Total Nitrogen		0.16		0.76		0.31		0.21		0.24		
Total Organic Nitrogen		0.16		0.69		0.31		0.2		0.24		
Ammonia Nitrogen	<	0.005		0.062	<	0.005	<	0.005	<	0.005		
Nitrate Nitrogen Dissolved	<	0.02	<	0.02	<	0.02	<	0.02	<	0.02		
Nitrate + Nitrite	<	0.02	<	0.02	<	0.02	<	0.02	<	0.02		
Nitrite Nitrogen	<	0.005	<	0.005	<	0.005	<	0.005	<	0.005		
Phosphorus Total Dis.		0.009		0.007	<	0.005	<	0.005		0.014		
Phosphorus Total		0.006		0.025		0.011		0.007		0.008		
Fecal coliforms		9	<	1	<	1		1	<	1		
Date and Time		22/09/2003 9:20		22/09/2003 9:45		22/09/2003 13:45		22/09/2003 14:15		22/09/2003 14:05		22/09/2003 13:55
Total Kjeldahl Nitrogen		0.06		0.19		0.29		0.2		0.28		0.26
Total Nitrogen		0.08		0.2		0.3		0.21		0.28		0.26
Total Organic Nitrogen	<	0.1		0.19		0.28		0.19		0.28		0.25
Ammonia Nitrogen	<	0.005	<	0.005		0.011		0.007	<	0.005		0.012
Nitrate Nitrogen Dissolved		0.02	<	0.02	<	0.02	<	0.02	<	0.02	<	0.02
Nitrate + Nitrite		0.02	<	0.02	<	0.02	<	0.02	<	0.02	<	0.02
Nitrite Nitrogen	<	0.005	<	0.005	<	0.005	<	0.005	<	0.005	<	0.005
Phosphorus Total Dis.		0.006	<	0.005	<	0.005	<	0.005	<	0.005	<	0.005
Phosphorus Total		0.008		0.007		0.016		0.005		0.006		0.01
Fecal coliforms	<	1	<	1	<	1	<	1	<	1	<	1

Appendix III. Summary of results of field measurements conducted during stratified lake sampling in November, 2003.

	Temperature (°C)	Specific conductivity (µS/cm)	Turbidity (NTU)	pH (pH units)
Lambly Lake				
0 m	5.0	77	0.73	7.45
3.5 m	4.8	77		7.38
6.5 m	4.8	77	1.38	7.35
Jackpine Lake				
0 m	1.9	65	1.17	7.63
3 m	2.8	68	1.38	7.75
5 m	2.8	60	1.50	7.54
Headwater Lake #1				
0 m	4.7	98	0.80	7.55
2.5 m	4.5	97	1.04	7.49
5 m	4.6	98	1.01	7.67
Headwater Lake #2				
0 m	3.5	98	0.32	7.87
1.5 m	3.4	99	0.46	8.03
3 m	3.5	99	0.57	7.93
Glen Lake				
0 m	5.1	248	0.27	8.07
4 m	5.0	248	0.09	8.09
8 m	5.1	249	0.00	8.07
Oyama Lake				
0 m	4.8	42	0.64	
9 m	4.4	42	0.92	
18 m	4.5	44	0.94	
Dee Lake				
0 m	3.8	60	0.89	
4.5 m	3.6	61	0.86	
9 m	3.6	60	0.64	
Crooked Lake				
0 m	3.9	58	0.68	
7 m	3.9	58	0.83	
14 m	3.7	59	1.57	
Swalwell Lake				
0 m	5.4	52	0.74	
10 m	5.2	52	0.74	
20 m	5.1	52	0.82	

	Temperature (°C)	Specific conductivity (µS/cm)	Turbidity (NTU)	pH (pH units)
Postill Lake				
0 m	3.0	37	1.74	
2 m	2.9	37	2.20	
4 m	2.9	37	2.01	
Browne Lake				
0 m	3.4	45	0.63	
3 m	3.4	46	0.38	
6 m	3.4	46	0.93	
Fish Lake				
0 m	3.1	64	0.57	
3 m	3.2	63	1.08	
6 m	3.2	63	0.94	
Haynes Lake				
0 m	4.8	42	0.49	
5.5 m	4.6	42	0.67	
11 m	4.3	42	0.92	
Minnow Lake				
0 m	3.2	41	0.42	
4 m	3.6	42	0.89	
8 m	3.7	42	0.62	
Hydraulic Lake				
0 m	2.8	32	1.05	
2.5 m	2.6	35	0.88	
5 m	2.8	32	0.32	
Silver Lake				
0 m	5.0	234	0.43	7.18
8 m	5.1	230	0.67	7.41
16 m	5.1	231	0.91	7.32
Chute Lake				
0 m	3.6	56	3.20	7.19
3 m	3.5	56	4.18	7.07
6 m	3.6	57	3.13	7.12

Appendix IV. Results of water quality analyses for stratified fall overturn lake monitoring.

	Minnow Lake	Hydraulic Lake	Postill Lake	Browne Lake	Fish Lake	Haynes Lake
Date and Time	03/11/2003 12:05	03/11/2003 12:50	02/11/2003 15:30	03/11/2003 9:40	03/11/2003 10:25	03/11/2003 11:30
Total Kjeldahl Nitrogen	0.43	0.37	0.4	0.74	0.6	0.41
Total Nitrogen	0.43	0.33	0.42	0.79	0.61	0.41
Total Organic Nitrogen	0.39	0.35	0.39	0.57	0.53	0.35
Ammonia Nitrogen	0.039	0.021	0.007	0.172	0.068	0.06
Nitrate Nitrogen Dissolved	< 0.02	< 0.02	0.02	0.04	< 0.02	< 0.02
Nitrate + Nitrite	< 0.02	< 0.02	0.02	0.05	< 0.02	< 0.02
Nitrite Nitrogen	< 0.005	< 0.005	< 0.005	0.006	0.005	< 0.005
Phosphorus Total Dis.	0.01	< 0.005	0.014	0.038	0.011	< 0.005
Phosphorus Total	0.014	0.022	0.029	0.051	0.018	0.01

	Oyama Lake	Dee Lake	Crooked Lake	Swalwell Lake	Lambly Lake	Jackpine Lake
Date and Time	02/11/2003 9:30	02/11/2003 11:55	02/11/2003 13:10	02/11/2003 14:15	01/11/2003 9:40	01/11/2003 10:55
Total Kjeldahl Nitrogen	0.32	0.18	0.44	0.31	0.29	0.46
Total Nitrogen	0.35	0.62	0.49	0.35	0.29	0.48
Total Organic Nitrogen	0.31	< 0.1	0.38	0.31	0.28	0.45
Ammonia Nitrogen	0.013	0.243	0.061	0.007	0.012	0.016
Nitrate Nitrogen Dissolved	0.03	0.37	0.05	0.04	< 0.02	0.02
Nitrate + Nitrite	0.03	0.44	0.05	0.04	< 0.02	0.02
Nitrite Nitrogen	< 0.005	0.075	< 0.005	< 0.005	< 0.005	< 0.005
Phosphorus Total Dis.	0.01	0.02	0.011	0.005	< 0.005	0.007
Phosphorus Total	0.018	0.029	0.021	0.03	0.012	0.012

	Headwater Lake #1	Headwater Lake #2	Glen Lake	Silver Lake	Chute Lake
Date and Time	01/11/2003 13:00	01/11/2003 13:40	01/11/2003 14:40	04/11/2003 11:50	04/11/2003 13:00
Total Kjeldahl Nitrogen	0.25	0.2	0.73	0.7	0.62
Total Nitrogen	0.26	0.2	0.75	0.71	0.65
Total Organic Nitrogen	0.23	0.18	0.67	0.63	0.59
Ammonia Nitrogen	0.021	0.013	0.065	0.066	0.028
Nitrate Nitrogen Dissolved	< 0.02	< 0.02	< 0.02	< 0.02	0.03
Nitrate + Nitrite	< 0.02	< 0.02	< 0.02	< 0.02	0.03
Nitrite Nitrogen	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Phosphorus Total Dissolved	0.007	< 0.005	< 0.005	0.014	0.013
Phosphorus Total	0.007	0.007	0.007	0.017	0.022

Appendix V. Suggested methodologies and references on protection of lake water quality for property development.

Methodologies:

- protection and maintenance of riparian buffers – one of the most important methodologies available to protect water quality and shoreline habitat is to ensure that buffer leave strips are required on all developments along lakeshores. A buffer strip of 15 meters is the recommended width, but variation could be allowed down to 5 meters in selected areas. There would be allowance for clearing of up to 25% of the strip to allow for a view, lake access, and the accommodation of the existing building setbacks.
- proper disposal of effluent – disposal of effluent from residences must meet minimum Interior Health standards. In certain instances, minimum standards may need to be upgraded based on individual inspections. Alternate or additive treatment methodologies are available for advanced treatment for individual lots.
- restrictions on motorized vessels – restrictions on motor size should be considered for selected lakes to minimize impacts to water quality.
- education program for lakeshore residents – education programs on protecting water quality should be made available to lakeshore owners. Numerous programs have been developed and made available to lakeshore owners throughout the province (see BCLSS).
- use of restrictive covenants where applicable – covenants should be considered on properties to ensure riparian strips are maintained and proper disposal methodologies are implemented.
- use of lakeshore development guidelines to control impacts – the use of lakeshore development guidelines have been successful in protecting water quality in other Regional Districts in British Columbia. The Okanagan Regional Districts may wish to consider implementing lakeshore development guidelines for lakes within their boundaries.

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