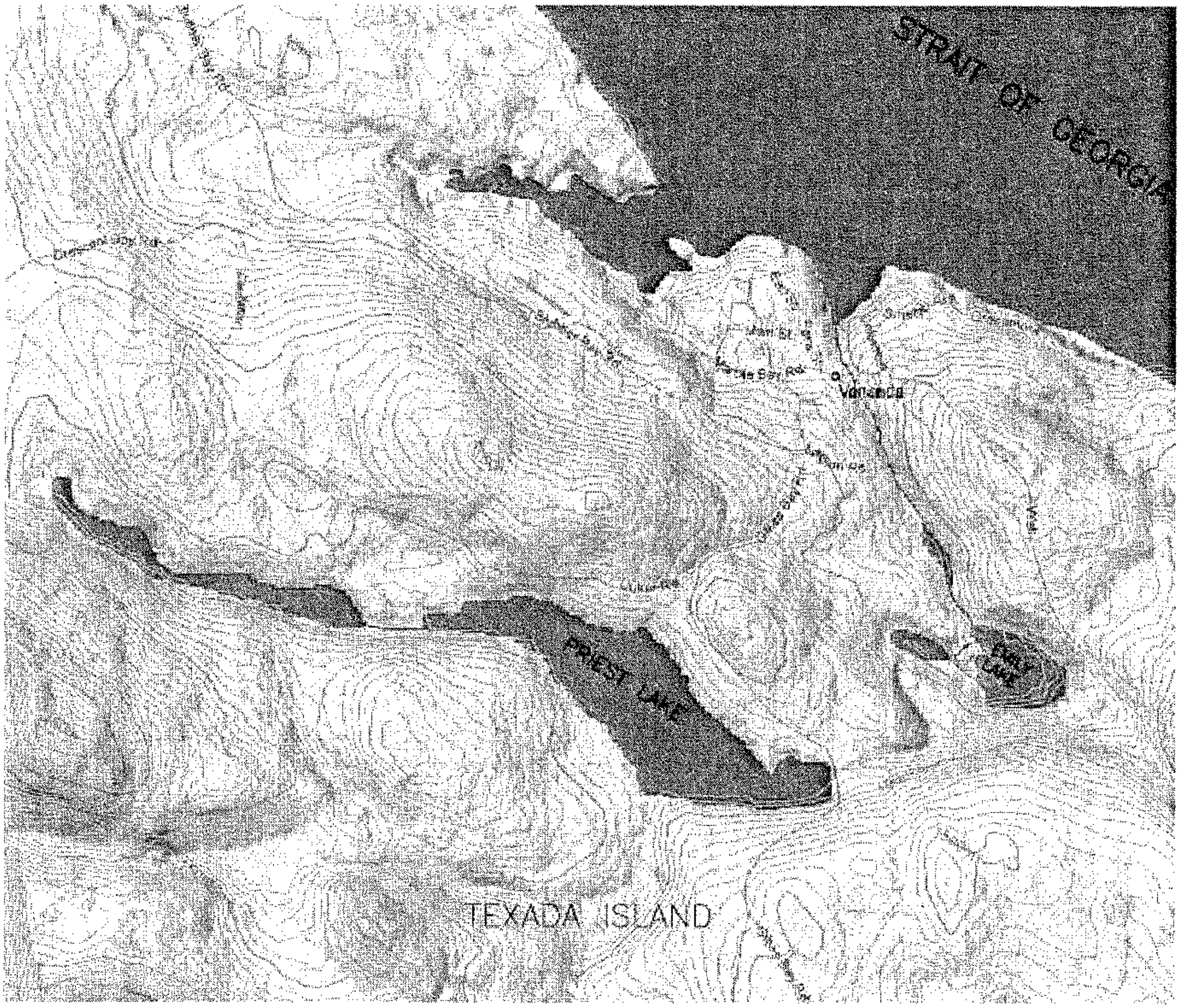
VAN ANDA IMPROVEMENT DISTRICT

WATER SYSTEM

ASSESSMENT STUDY REPORT



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CONTENTS

EXECUTIVE SUMMARY

The Van Anda water supply currently services approximately 220 lots and a population of 600 people. The present system is relatively simple and cost effective both in terms of operation and management, but pressure from various sources is being applied to improve reliability primarily with respect to the quality of water, and to improve the capabilities of the system to provide fire protection for the full serviced community. This report seeks to provide the Van Anda Improvement District (VAID) with the background information, assessments and direction needed to achieve these objectives. The study progresses through hazard and risk assessments for the major system elements beginning with the source waters, the water intake, treatment and distribution systems, provides a brief overview of management and financial elements of the organization, and then outlines major elements of a capital works program, including order-of-magnitude costs and suggested implementation priorities.

In relation to source water (Priest Lake) protection, the assessments identified that "high" to "very high" levels of risk were associated with the presence of the following hazards within the watershed.

- Wildlife
- Roads
- Residences with septic systems near the lake
- Forest harvesting
- Graveyard
- Natural gas pipeline
- Limestone quarry

More generally, heavy precipitation with associated runoff events, and wildfires were also identified as potential sources of contaminants in Priest Lake.

The recommended mitigation measures to address these higher level risks were to:

1. Install a chlorine analyser; *(An item included in the capital works plan)*
2. Inspect septic systems on the north side of Priest Lake; *(Inspections have been conducted and will continue)*
3. Apply water treatment processes capable of effectively inactivating *Giardia*, *Cryptosporidium*, and other pathogens; *(An item included in the capital works plan)*
4. Develop an emergency response plan that includes responses associated with source water; *(The existing plan is to be updated)*
5. Initiate an integrated watershed management planning and protection process;

6. Continue source water quality monitoring program, adding tests for dissolved organic carbon (TOC, DOC) and phosphorus;
7. Redraw Priest Lake community watershed boundary based on air photo interpretation.

Priest Lake as a source is more than adequate in terms of the availability of water. In terms of meeting Canadian Drinking Water Quality guidelines (CDWQ), water quality in the past has been generally good, but on occasion the established limits for colour, turbidity and coliform densities have been exceeded. Natural organic constituents and algae typical of lake-captured waters vary seasonally and at times have adversely impacted water quality in terms of colour, turbidity, trihalomethane formation potential (THM-FP), and taste and odours levels. THM concentrations based on the limited water quality data available, are typically higher than the 100 μg/L CWDQ guideline.

The study identified modifications to the intake system and construction of additional treatment works as potential mitigation measures. The capital works plan highlights the associated surveys and sampling programs as "Priority 1" items.

In relation to reliable treatment and supply, the assessments identified the highest levels of risk to be associated with failure of the chemical feed pump and extended power outages. Appropriate mitigation measures are installation of the standby chemical feed pump together with a chlorine residual analyzer with associated automatic control and alarm systems.

Assurance that the quality of the product water consistently meets the CDWQ guidelines requires installation of new treatment processes and modification of the existing chlorine disinfection system. Filtration is the most reliable solution, but typically would be considered part of the longer-term capital works program because of the high costs. In the meantime, modifications can be made to the disinfection process to reduce THM-FP and to increase system reliability. UV radiation, combined with chloramination or mixed oxidants (MIOX) are potential means of increasing inactivation of *Giardia* and *Cryposporidium* and reducing THM levels in the finished waters. Treatment reliability can be greatly improved by installation of an on-line chlorine analyser and turbidity meter along with provisions for standby power and a control system that automatically notifies operators in the event of alarm conditions.

The assessments identified the highest levels of risk in relation to the water distribution system are associated water quality deterioration in dead-end areas of the piping network, and in portions of the system that would experience excessively low pressures under fire flow demand conditions. Another "very high" risk hazard is failure of the existing reservoir. Major modifications to the distribution system are required to address these high risk items.

The existing distribution system has very limited capacity to provide fire protection and this level of service will require major upgrading of the piping network and storage facilities. Replacement of more than 75% of the piping network and four times the current volume of system storage are required in capacity upgrading. Proposed storage upgrades include replacement of the existing tank with a reservoir twice the size and construction of a second reservoir at the top end of Wall Street. The high costs again suggest that this construction will need to phased-in over an extended period. More complete documentation of the existing works and use of a hydraulic model are recommended elements of the associated planning and design process.

Lack of accurate flow data and system drawings are obstacles in assessing the performance and operating the water treatment and distribution systems as well as in planning for future expansion and upgrading. Installation of at least one system flowmeter and the metering of all service connections are recommended.

The report outlines a capital works plan that divides the required investigations and upgrades into three priority levels for phasing within an implementation program. Projected costs of upgrading the water supply and distribution system are in the order of $4.5 M.

The primary recommendations arising from this assessment and planning study are that VAID:

1. Adopt and implement a phased capital works program to address the noted potential hazards and system deficiencies, and that program should be similar to the one presented in Section 7.
2. Implement metering and a rate structure that reflects the true cost of water and provides appropriate capital reserves.

3. For demands beyond the reasonable scope of self-financed works and studies, pursue funding assistance from senior governments. Currently that avenue is through the Powell River Regional District.

1.0 INTRODUCTION

1.1 Background

The Van Anda Improvement District (VAID) provides potable water to a community of approximately 600 persons through a distribution network supplying 220 service connections. The VAID seeks to upgrade this water system and under the Local Government Infrastructure Planning Grant program commissioned McElhanney Consulting Services Ltd. (McElhanney) to conduct a system assessment and to assist in preparation of a capital works plan. The VAID approved a proposal for the work that McElhanney submitted October 28, 2005.

The VAID seeks through implementation of an appropriate capital works plan to achieve objectives of the provincial Drinking Water Protection Regulation (B.C. Reg. 200/2003) and the standards that the Vancouver Coastal Health Authority (VCHA) has adopted in enforcing this regulation.

1.2 Scope of Work

The scope of work as outlined in the proposal includes:

- An assessment of the existing infrastructure and overall system
- A feasibility study to determine the most cost-effective means to remedy deficiencies
- A capital works plan that provides estimated budgets and timelines.

Assessments of the Van Anda system generally follow methods set out in the **Comprehensive Drinking Water Source To Tap Assessment Guideline** but are more limited due to the budgetary constraints of the project.

2.0 SOURCE WATERS

Van Anda has one water source; Priest Lake. An assessment of opportunities for a second water source is not included within the scope of the current study.

2.1 Source Water Assessment

2.1.1 Source Area And Potential Contaminant Sources

Priest Lake has a surface area 42[1] ha and a watershed size approximately 1,131 ha. Other specifics are summarized in the following table:

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[1] Alluvia Environmental Services, June 23, 2004 – Van Anda Improvement District Drinking Water Source Assessment Report (Draft)

Watershed Code	905-126000-61600
Waterbody Identifier	00307JERV
FPC Community Watershed #	TEX.003
Water License #s	C047520, C023365, C017599
Annual Withdrawal Limit	73 Million Gallons
Point of Diversion #	PD45676
Location	49°44'48"N, 124°33'55"W

In July 2007, VAID personnel used the Source-to-Tap Screening Tool (Appendix A) to identify "Potential Contaminant Sources within 50 m of Intake" and noted the following items in relation to this watershed area.

- Accumulation of natural debris, algae or other material;
- Pipeline, road, railway or hydro transmission line crossing stream or close to stream;
- Recreational activities including boat launch, float plane use, hunting;
- Septic systems;
- Wildlife.

Under "Potential Contaminant Sources in Contributing Watershed" the following items were noted:

- Forestry-related activities;
- Major highway, railway, pipeline, hydro transmission lines
- Mining or oil/gas exploration and/or extraction
- Recreational activities;
- Wildlife, and
- Natural contaminant sources (landslides, exposed sediments, bogs).

Alluvia Environmental Services (AES) completed an earlier drinking water source assessment study and report for the Vancouver Coast Health Authority in 2004. That report identified the same drinking water hazards in Priest Lake watershed and assessed the risk levels as summarized below;

Hazard	Risk Level
Wildlife	Very High
Roads	Very High
Residences with septic systems near the lake	High
Forest harvesting	High
Graveyard	High

Natural gas pipeline	High
Limestone quarry	High[2]
Recreation	Moderate
Small-scale mining	Low

That report made the following recommendations for improving source water quality and minimizing the risk of waterborne illness:

8. Install a chlorine analyser;
9. Inspect septic systems on the north side of Priest Lake;
10. Apply water treatment capable of effectively inactivating *Giardia*, *Cryptosporidium*, and other pathogens;
11. Develop an emergency response plan that includes responses associated with source water;
12. Initiate an integrated watershed management planning and protection process;
13. Continue source water quality monitoring program, adding tests for dissolved organic carbon (TOC, DOC) and phosphorus;
14. Redraw Priest Lake community watershed boundary based on air photo interpretation.

McElhanney in reviewing the list of potential drinking water hazards, added heavy precipitation with associated runoff events, and wildfires as potential sources of contaminants in Priest Lake Watershed. Source protection and treatment are water system barriers applicable to these additions. The above AES recommendations encompass measures that would address these additional hazards appropriately. For example, Recommendation 5, preparation of the integrated watershed plan, would include applicable source protection measures such as appropriate public education and signage, and implementation of best management practices (BMPs) in relation to any construction activity occurring within the watershed. Applicable BMPs in this case include measures for sediment control and for spill prevention and containment. Any filtration process capable of meeting Recommendation 3 would also address any risks to drinking water quality associated with the high intensity rainfall events and wildfires.

Formulation of a capital works program warrants a review of any additional background information and any new data compiled since the 2004 drinking water source risk assessment study. A discussion of the findings follows.

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[2] AES identified the risk as "moderate". The "high" risk level is at the request of the VCHA and based on subsequently recorded water quality data November 22, 2007 for a culvert downstream of the quarry. (Appendix B).

2.1.2 Source Water Quality

Since January 2004, the bacteriological quality of the source water has been routinely monitored, and various Coliforms including Fecal Coliform have been found in virtually all samples. The chemical quality of the source water has been analysed more than a dozen times over the last fifteen years and the most frequent analyses have occurred since January 2004. The data reveals no apparent trends in the quality changes. Occasionally, Kirk Creek and Quarry Creek waters entering Priest Lake are sampled and analysed as well (Appendix B). Nitrate concentrations increased to 7.5 mg/L in the latest water sample from Quarry Creek. If higher concentrations were found to be a trend, this would warrant an investigation into the specific source and potential mitigation measures.

Given the source is surface water, seasonal water quality variability is to be expected but the data are limited and show few marked changes. Quality variability can be natural and arise with changes in the climatic conditions and in the life cycle stages of aquatic vegetation. Other more subtle seasonal changes may occur as a result of human activities within boundaries of the watershed. Nitrate levels are an example where changes are observed. Higher groundwater levels and larger inflow contributions to Priest Lake likely account at least to some degree for the slightly higher levels during wet weather periods (0.8 mg/L as opposed to 0.3 mg/L during dry weather periods). Nitrate contributions from the quarry operations warrant further investigation as previously noted. Such an investigation should also note changes in the boundaries of the watershed associated with quarrying operations since surveys for the current mapping were completed.

Organic carbon is another critical parameter of source water quality in relation to selection of appropriate water treatment processes. Organic carbon (TOC and DOC) concentrations in the source water are one of the determinant factors in the trihalomethane (THM) levels in the product water after chlorination. Since 2004, OC levels in the source waters, and THMs in the disinfected waters have been sampled and analysed once yearly. In all cases source water TOC concentrations have been more than double the 2.5 mg/L. that VCHA has set as the threshold value for analysis of Tannins and Lignins and for conducting the Trihalomethane Formation Potential (THM-FP) test.

Total THMs include bromoform, bromodichloromethane, chloroform and chlorodibromomethane. Health Canada classifies bromodichloromethane as a "probable" carcinogen and chloroform as a "possible" carcinogen. The industry recognizes that some people who drink water containing THMs in excess of the current standard over many years, may experience problems with their liver, kidneys, or central nervous systems, and may have an increased risk of getting cancer.

THMs concentrations in the treated water have exceeded the maximum acceptable concentrations of 100 µg/L as set out in the "Guidelines for Canadian Drinking Water Quality" (CDWQ). Four of five samples have exceeded this level with an average value of 159 µg/L and a maximum of 260 µg/L.

Chlorine dosage rate is another determinant factor in THM production. The operating data show chlorine dosage levels progressively increased from concentrations of 2 ppm in 2004 to 4 ppm in 2006. The only THM concentration below the 100 µg/L guideline was recorded in 2004 and was associated with the lower chlorine dosage levels. Seasonal TOC, chlorine demand and THM levels could be expected to change but available data are too limited to identify any pattern of this sort.

Coliforms including E. coli and Fecal Coliform are regularly found in the source waters, and on the rare occasions when the disinfection system has failed to operate as intended, boil water advisories have been required.

Samples of treated water as compared to source water are more routinely assessed for microbiological quality. Maximum acceptable concentrations as set out in the CDWQ for total and faecal coliforms (Appendix B) are exceeded on occasion. Coliform densities 1 cfu/100 mL or greater occur in approximately 6% of the samples. One in 300 samples have Fecal Coliform at densities 1 cfu/100 mL or greater, and E.coli are observed at these same densities once in 600 samples.

Turbidity levels have been routinely recorded since March 2005. This limited record shows the CDWQ guideline of 1 NTU exceeded infrequently.

2.1.3 Source Water Quantities

Consumption levels and lake withdrawals to date have not been monitored except in relation to the recorded hours the intake pump operates and metered services which are limited to the hotel, Lafarge, Arnold's, the Boat Club and the Legion. Based on the theoretical capacity of the intake pump being 87 m^3/hour (400 USgpm), water consumption has been in the order of 240,000 m^3/year (≈ 73% of the maximum volume allowed under the current water license). Metered consumption is in the order of

6,700 m^3/year, approximately 3% of the total supply. In these figures the implicit consumption rate is 1.1 m^3 per day per capita on an average day basis, and 6.4 m^3/day/ dwelling as the maximum day demand (MDD). These rates are exceptionally high when compared to the MMCD design guidelines of 0.6 m^3/c/day as the average day demand, and 1.2 m^3/c/d as MDD. Pump operation as the basis for consumption estimates is of questionable value. The correlations between the operating hours of the intake pump and the Wall Street booster pump are poor and operating hours dropped noticeably when the intake pumping unit was replaced suggesting that operation of the earlier unit was off the published pump curve. Installation of a flowmeter given these findings is recommended as a priority item.

The depth of Priest Lake is nominally 10 m at the location of the intake, and the water surface elevation can be expected to fluctuate over a range of 0.7 m during the course of the operating year. These fluctuations impact the capacities of the intake structure and the intake pumps to supply water to the distribution reservoir. The intake opening is a 200 mm diameter pipe reported to be positioned 3 m above lake-bottom and 2.5 m below water surface. The variance in depth of 1.5 m is noted and it warrants further field investigation and documentation.

2.2 Condition, Suitability and Security of the Water Source

Priest Lake as a source is more than adequate in terms of the availability of water. In terms of meeting CDWQ guidelines, water quality in the past has been generally good, but on occasion the established limits for colour, turbidity and coliform densities have been exceeded. Natural organic constituents and algae typical of lake-captured waters vary seasonally and at times have adversely impacted water quality in terms of colour, turbidity, and taste and odours levels.

The presence of wildlife and human activities in the Priest Lake watershed poses risks of source waters contamination, as noted in the AES 2004 report. Full treatment of the source water is warranted given the "very high" level of risk associated with these hazards. The VCHA latest inspection report (March 15, 2007) emphasises the need to meet the 4,3,3,<1 treatment standard. Under this standard, treatment achieves a 4-log reduction for viable viruses and bacteria, 3-log reductions for Giardia and Cryptosporidium cycts, and maintains turbidity levels < 1 NTU in the product water.

THM production levels exceeding 100 μg/L is confirmed in the sample analyses to date and reflects the source water quality and current disinfection methods. The VCHA inspection report emphasises the need for a treatment process that addresses this hazard. These treatment options are discussed in greater detail in the following section of this report.

The suitability of Priest Lake as a source of water for VAID is undeniable in the absence of a proven groundwater source alternative.

The possibilities of adverse impacts on water quality through activities in the watershed, forest fires, contaminant spills, vandalism etc limit the security available with a surface water supply. Source protection programs and water treatment are drinking water barriers particularly relevant to surface water sources such as Priest Lake.

The water supply intake, which is located in a deep portion of the lake, has no surface structure associated with it. This design provides additional security but the ability to withdraw water from different levels in the water column to optimize quality is lost. In the absence of a water treatment plant, a design review of the water intake is warranted.

Source water is conveyed through a 200 mm diameter pipe to the intake pump-well located on the shores of Priest Lake. When lake levels are low, the available suction head limits the pumping capacity to the reservoir. We assess the associated risk of low water levels severely restricting pumping to a point that water supply is jeopardized as "very high" based on the Risk Assessment Tables provided in Appendix C. The hazard is rated "Level A", >90% probability of occurrence in the next 10 years; and the consequence Level 4, "major", given the supply system would be significantly compromised and operations abnormal if existing at all. Mitigation options to remove this limitation and increase the integrity of supply include any of the following:

- Deepen the pump-well.
- Increase the size of the intake pipe, if the intake structure is to be replaced, and
- Replace the pump, if additional treatment facilities are to be incorporated into the water supply system.

2.3 Monitoring and Reporting Programs

Operating personnel currently monitor the quantity of available source water by recording water surface levels of Priest Lake from a staff gauge. The staff gauge is located near the intake pump well, and the readings are recorded at least monthly.

Water extraction is monitored through daily hour-meter reading that track operation of the intake pumps. As noted in 2.1.3, the accuracy of a water consumption record on pump hours is questionable.

Since March 2005, operating personnel have monitored the quality of source water through turbidity readings that are recorded in the daily journal. As previously noted, samples from Priest Lake, Kirk Creek and Quarry Creek are periodically collected and analysed for the standard list of physical and chemical water quality parameters. Samples from Priest Lake more recently have been collected twice annually. Certified laboratories complete the analyses and reports and processing is through the VCHA.

The sample sets collected for analyses of bacteriological quality typically include Priest Lake. Sampling frequency is once every two weeks.

Tannins and lignins should be added to the list of source water quality parameters to be monitored, together with DOC[3] and THM-FP. Otherwise, the monitoring and reporting of water quality at current levels and frequencies are appropriate for the foreseeable future.

3.0 WATER TREATMENT

3.1 Condition, Suitability and Security of the Treatment System

The suitability of the existing treatment system is assessed taking into consideration the hazards and risk levels associated with both the source waters and current facilities. The following discussion provides first, a description of the existing treatment system and then addresses identified deficiencies.

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[3] Vancouver Coastal Health Authority, June 27, 2006; Application for a Water supply System Construction Permit – Guidelines and Application page 9 of 10.

The treatment system consists of an intake pump that extracts water from Priest Lake, a chemical feed system that introduces sodium hypochlorite into the water for disinfection purposes, and a distribution reservoir that provides contact time for disinfection. The pump monitoring and control facilities and the chlorination equipment are housed in a locked, wood fabricated, shed.

The chlorine disinfection process consists of using commercial grade (12%) sodium hypochlorite, a solution tank, a chemical-feed pump and an injector located in the watermain between the intake pump and the distribution reservoir. Dosage is set manually based on operator-measured chlorine residuals. Operation of the chemical-feed pump is interlocked with the starting and stopping of the intake pump that in turn operates in response to float level switches located in the distribution reservoir and activated by changes in water levels. The following tables show the identified hazards and assessed risk levels associated with each.

3.1.1 Hazard Identification and Risk Characterization

Hazard No.	Drinking Water Hazard	Possible Effects	Existing Preventative Measures	Associated Barrier(s)
3-1	Intake pump fails	Reservoir level drops and water pressure in the community falls	Daily inspections Installed standby pump	Water System Maintenance
3-2	Chemical feed pump fails	Source water not disinfected enters the distribution system	Daily inspections Second chemical feed pump on the shelf Manual collection of samples and analysis of chlorine residuals	Water System Maintenance
3-3	Reservoir out of service	Loss of chlorine contact time Pressure in the distribution system increases up to the shut-off head of the intake pump	Apparently no by-pass provisions	Water System Maintenance
3-4	Float switches in the reservoir fail	Pump fails to start and the amount of water stored in the reservoir is depleted. Pump fails to stop and the reservoir overflows.	Daily inspections	Water System Maintenance
3-5	Power outage	Intake pump and the disinfection system stop operation. Reservoir level drops and water pressure in the community falls	None identified	Water System Maintenance

RISK CHARACTERIZATION TABLE

Hazard No.	*Drinking water hazard*	*Likelihood level*	*Consequence level*	*Risk level*	*Assumptions/Comments*
3-1	Intake pump fails	C	3	High	Once the pump failure is detected, the standby pump can be quickly placed into operation. An automated alarm system would reduce response time. Motor overload will shut the pump off and the chlorination system will stop. If pump failure did not result in motor overload, the disinfection system would continue to operate and water in the reservoir supply line would be overdosed. Monitoring pump status and performance levels offer some warning of pending failure.
3-2	Chemical feed pump fails	A	3	Very high	Failures not related to power outages have happened in the past and as a result, boil-water advisories were required. Installation of the standby pump and automatic controls to alternate pump operation is an appropriate mitigation measure. Chlorine residual analyzer, with data logger and alarm system are required to address the system deficiency identified by VCHA.
3-3	Reservoir out of service	C	3	High	Loss of reservoir means at least temporary loss of water service. All flow control is through manually operated isolation valves. This reservoir is near the end of its service life and will be replaced in the foreseeable future. A hydro-pneumatic tank would be required for the intake pumps to operate on a closed system.
3-4	Float switches in the reservoir fail	C	3	High	Appropriate mitigation measure would be installation of redundant float switches for HH and LL alarms and for standby over-ride control for the intake pumps.
3-5	Power outage	A	3	Very High	Consequence level is dependant upon timing and duration. Portable standby generator is an option with appropriate wiring upgrades.

In relation to the source water quality, AES source water assessment report and VCHA inspection reports identify the following deficiencies with the current disinfection system.

1. *Giardia* and *Cryposporidium* in the source waters remain "very high" risks and the VCHA continues to highlight this factor as a ***critical*** inadequacy that requires follow-up.[4]
2. Organic carbon concentrations in the raw water and associated THM production above the CDWQ 100 μg/L guideline remain high. The corresponding risk level remains "very high" and the VCHA continues to highlight this issue as a ***critical*** inadequacy of the present system that requires follow-up.
3. Turbidity levels infrequently exceed CDWWQ guidelines. Under these circumstances, associated concerns remain with respect to high chlorine dosage levels, THM productions and the effectiveness levels of the disinfection process. These associated risks areassessed as unacceptably "high" and VCHA continues to highlight this factor as a ***critical*** inadequacy that requires follow-up.

Source water solutions fall into two categories; source protection and water treatment. In the case of VAID, the greatest potential for improvement is with treatment. The options range from an upgrade of the lake intake and from there to incorporating filtration and alternative disinfection methods into the treatment processes. Section 7, Capital Works Plan, provides a discussion of treatment and upgrading options.

The more significant deficiencies in relation to the present treatment system components and operation the VCHA highlight in their inspection reports and are identified in the previously risk level assessments. The possibility of source water that has not been disinfected entering the distribution system is the major concern. This condition occurs only when the chlorination system fails due to reasons other than power outage. Failure of the chemical feed pump and an extended power outage are the highest risk levels identified.

An extended power outage is the next limitation of major concern in relation to the present treatment facilities. Access for a portable industrial generator which could readily meet the power requirements of the intake pump (7.4 kW) and the chemical feed pump (45 W) is a reasonable mitigation measure.

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[4] March 15, 2007 Inspection Report

3.2 Monitoring and Reporting Program

Current reporting is limited to daily entries of pump hours. Turbidity levels and additions to the chlorine solution tank are recorded typically every other day. Lake levels and summaries of pump hours and chlorine additions are made monthly.

Accurate flow data are required for capital works planning and budgeting for the cost of operations. A flowmeter in the area of the lake intake and treatment works is essential for these and other purposes such as control of chemical feed pumps, etc.

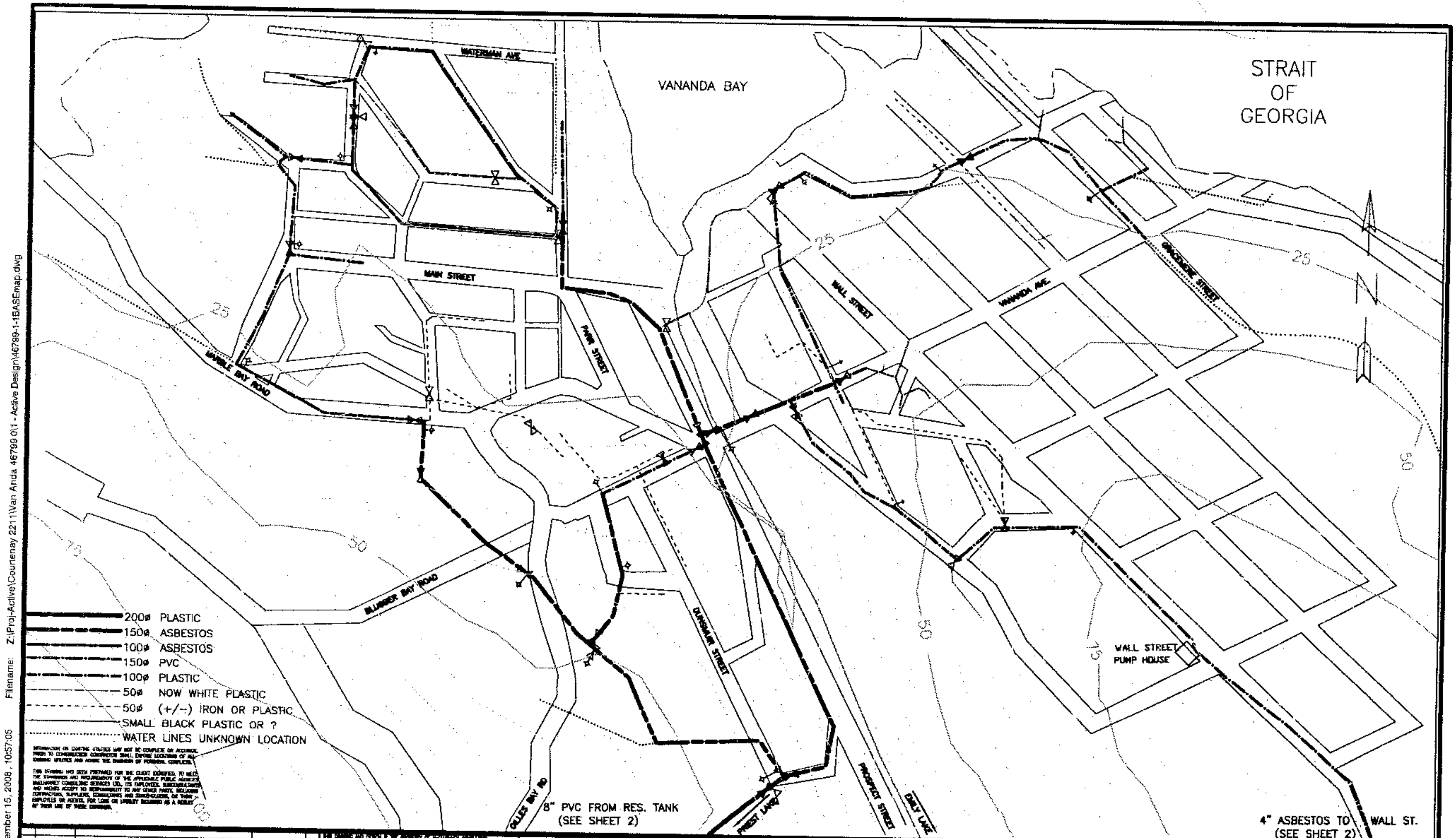
Lack of a chlorine analyser is a disinfection-related deficiency that VCHA has identified. The critical function of the chemical pump suggests additional system redundancy and provisions for alarm autodialing are reasonable mitigation measures. The associated alarm contacts would be pump status, solution tank low-level, and once installed low and high level set-points for the chlorine analyser.

A self contained, automated monitor capable of continuously recording turbidity levels would raise the level of protection and assist Operations. The turbidity readings and associated alarms would alert Operations of changes in raw water quality that warrant their intervention. With the present system, changes in the watershed and failure of some nature in the intake system are broad-category causes of changes in water quality. If a filtration process was incorporated into the system, treatment performance would be added to this list of potential causes.

4.0 DISTRIBUTION SYSTEM

4.1 System Description

The system as outlined in Figures 1 and 2, consists of the distribution reservoir (Approximate elevation of 110 m, 1976 wood-stave construction, 204 m^3), and a water transmission main (200mm diameter PVC) supplying a piping network that ranges in elevation from 5m to 80m above sea level. The following table summarizes piping and isolation valves of the distribution system, and the system includes the Wall Street booster pumping station and 21 hydrants as well.



No.	Date	Revision	Dr.
A	12/12/08	REPORT FIGURE	ACA

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VAN ANDA IMPROVEMENT DISTRICT
VAN ANDA, TEXADA ISLAND

WATER SUPPLY SYSTEM

FIGURE 1

TEXADA ISLAND, BC

2211-46799-1
MCSL Project No. 2211-46799-1
Drawing No. 46799-1-1
Sheet 1 of 2

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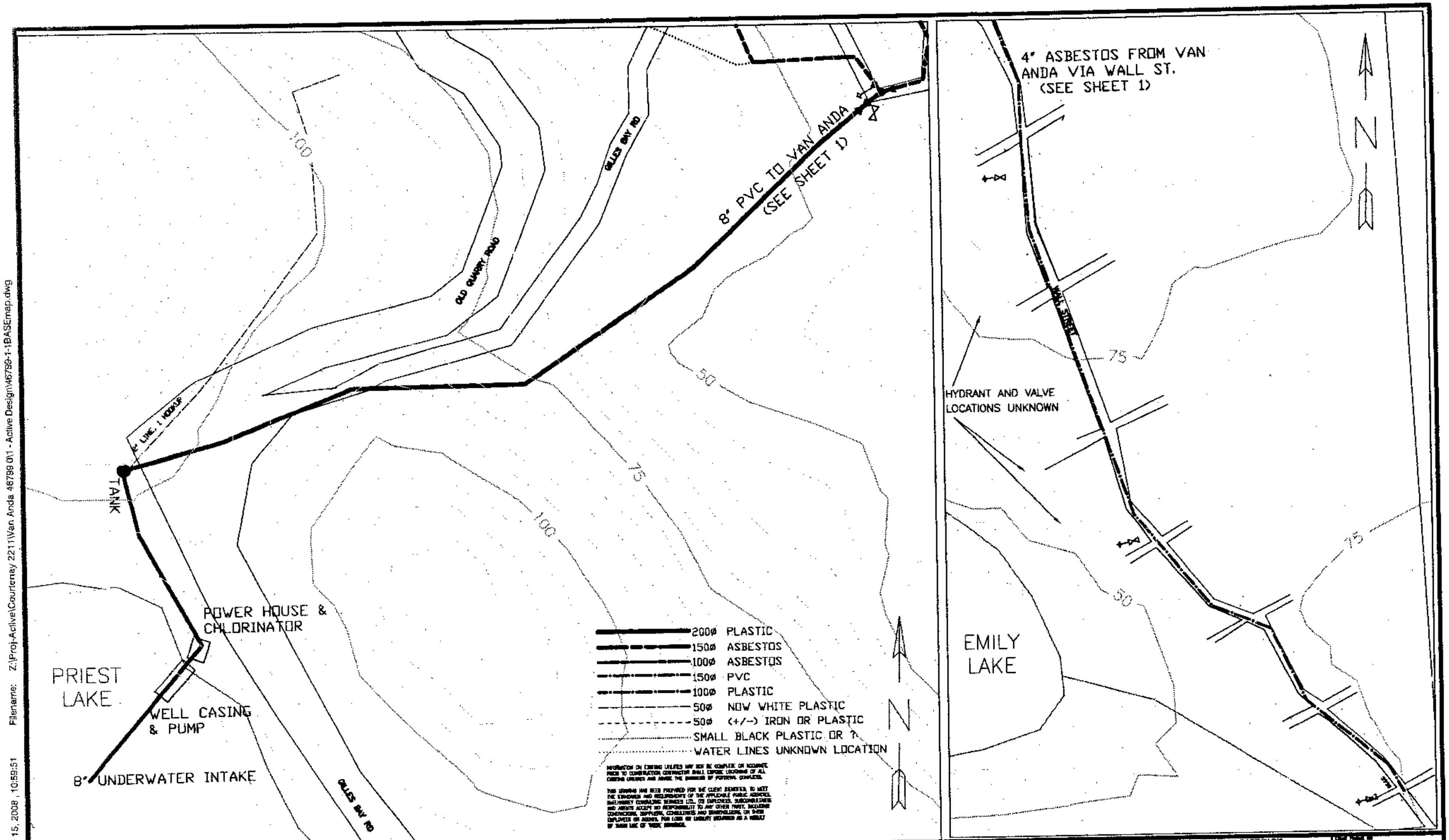

INFORMATION ON EXISTING UTILITIES MAY NOT BE COMPLETE OR ACCURATE. PRIOR TO CONSTRUCTION CONTRACTOR SHALL EXPOSE LOCATIONS OF ALL EXISTING UTILITIES AND ADVISE THE ENGINEER OF POTENTIAL CONFLICTS.

No.	Date	Revision	Dr.
A	12/12/08	REPORT FIGURE	ADA

THIS DRAWING AND DESIGN ARE A BORROWED COMPILATION OF TWO SOURCES:

1) WATER SUPPLY DRAWING DATED JULY 1999 AND CURRENT TO THE BEST KNOWLEDGE OF ONE J.G. COOK.
2) AN UNSCALED UNREFERENCED TOPOGRAPHICAL DRAWING SUPPLIED BY—

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Date: SEPT 26/2007
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VAN ANDA IMPROVEMENT DISTRICT
VAN ANDA, TEXADA ISLAND

WATER SUPPLY SYSTEM

FIGURE 2
VAN ANDA
TEXADA ISLAND, BC

Client Project No.
2211-46799-1
MCSL Project No. 2211-46799-1
Drawing No.
46799-1-1
Sheet 2 of 2

Diameter (mm)	Material	Length (m)	Valves	Comments
200	Plastic (PVC/HDPE)	1,400	2	Water transmission main
200	Plastic (PVC/HDPE)			Intake line
150	Ductile Iron	250	1C; 1G	Supply line to reservoir
150	Asbestos Cement	1,500	6	
150	PVC	None indicated on the Sept 2006 colour-coded map		
100	Ductile iron	5	2C; 1G	Discharge line – intake pump
100	Asbestos Cement	900	5	
100	Plastic (PVC/HDPE)	3,900	10	
50	PVC (white plastic)	950		
50	Iron or plastic	1,400		
Small	HDPE	750		
Unknown	Unknown	1,450		

4.1.1 Hazard Identification

Hazard No.	Drinking Water Hazard	Possible Effects	Existing Preventative Measures	Associated Barrier(s)
4-1	Failure of the aging reservoir	Loss of supply	Inspections, repairs	System maintenance
4-2	Dead ends	Poor water quality; low hydraulic capacity and no redundancy in supply	Line flushing program	System maintenance
4-3	Failure of the single water transmission main	Loss of supply and storage inaccessible	None identified	System maintenance Emergency response planning
4-4	Back-flow/cross-connections	Contaminated water entry under certain pressure conditions	None identified	System maintenance Emergency response planning
4-5	Wall Street booster pump failure	Low water supply capacity in the Emily Lake area	Inspections, repairs	System maintenance Emergency response planning
4-6	Fire flows	Risk contaminated water entry at low line pressure locations	Hydrant testing and characterization	Emergency response planning
4-7	Leaks	Contaminated water entry at low line pressure locations High pumping and treatment costs	Surface inspections	System maintenance

The following table shows the risk levels judged to be associated with each of these drinking water hazards.

4.1.2 Risk Characterization

Hazard No.	*Drinking water hazard*	*Likelihood level*	*Consequence level*	*Risk level*	*Assumptions/Comments*
4-1	Failure of the aging reservoir	C	4	Very High	Loss of reservoir means at least temporary loss of water service. All flow control is through manually operated isolation valves. This reservoir is near the end of its service life and will be replaced in the foreseeable future. A hydro-pneumatic tank would be required for the intake pumps to operate on a closed system.
4-2	Dead ends	A	3	Very high	Number of dead-ends is large. The number limits the hydraulic capacity of the piping network. The number requires higher chlorine dosage levels to maintain chlorine residuals. Higher chlorine dosage is associated with higher THM levels.
4-3	Failure of the single water transmission main	C	4	Very High	Loss of transmission main means loss of supply, storage and a rapid loss in line pressures. A second reservoir located at the south end of Wall Street could supply the distribution network for a period in the event a portion of the transmission main was lost.
4-4	Back-flow/cross-connections	D	4	High	Back-flow and cross-connection programs will identify medium and high risk locations and provide guidance in defining and implementing back-flow prevention measures.
4-5	Wall Street booster pump failure	B	2	High	Standby pump available on the shelf. Hydro-pneumatic tanks with little storage capacity. Unacceptably low line pressures with hydrant operation (ie: no fire protection in the Emily Lake area). Short-term -portable standby generator. Longer-term Wall Street reservoir and large water mains..
4-6	Fire flows	A	3	Very High	Supply system capacity is inadequate to meet fire flows without dropping line pressures below acceptable levels within areas of the serviced community. Computer simulation modeling can be used to identify the more vulnerable areas.
4-7	Leaks	A	2	High	The amount of unaccounted for water based on pump hours is large. The risks of contaminant entry under fire flow conditions could be high. Exacerbates treatment costs; further investigations are recommended.

Risk levels previously identified highlight the more significant deficiencies of the distribution system, while the VCHA inspection reports identify no violations specific to this portion of the system.

Loss of storage with failure of the reservoir is of greater consequence than loss of its role in the treatment process. Given the very high level of risk, replacement must be included in the capital works plan and in the meantime, operations and maintenance needs to focus on ensuring the integrity and reliability of the reservoir and on contingency planning for an event where it is not available.

Service to the households and other properties in the community is limited by the hydraulic capacity of the distribution network. The area that can currently be serviced with fire flows without creating low pressure conditions posing significant contaminant risks in other areas in the system, is relatively small. VAID wishes to expand the capacity of the distribution system to meet fire protection for the full community[5]. A water model is the most effective way to clearly define the distribution system upgrades required to meet this objective.

This capacity issue can be addressed in two ways; by increasing capacity and by decreasing water demand. Recommended measures in relation to capacity expansion are:

1. Use of larger sized distribution lines
2. Elimination of the dead-ends
3. Construct a second reservoir on Wall Street in the area of Emily Lake.

Water demand defines the capacity requirements and impacts capital and operating costs of treatment and pumping facilities. Recommended measures to reduce water demand are to:

1. Meter all service connections, and
2. Investigate and eliminate water loss.

A metering system enables auditing of water use and losses and is a tool to curb disproportionately high water usage, and to educate residents of the merits of water conservation.

A cross-connection program is currently not in place. Best management practices include implementation of a program that includes a cross-connection control by-law, requirements for

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[5] Email from the Secretary of VAID, Heidi Gable, to Dan Hooper on November 14, 2008.

installation and testing of backflow prevention devices and provisions for public education. The program would require installation of backflow prevention devices in new residences, at institutional, commercial and industrial facilities.

5.0 SYSTEM MANAGEMENT

Four general areas are evaluated in the assessment of system management, based on the Comprehensive Drinking Water Source to Tap Assessment Guideline:

1. Water supply management standards and practices.
2. Water supply system operation and maintenance procedures and practices.
3. Documentation and reporting practices.
4. Emergency response and contingency planning practices.

This recommended procedure is comprehensive and exceeds the scope of the current study. The following tables, however, provide an overview of the related issues and are included to promote on-going discussion. They also provide a structure in which to relay general impressions gained through our cursory review the issues.

Assessment Area	Status	Comments
Management Standards and Practices		
Structure and processes	Working	Expect changes with expanded treatment facilities and additional control programs (metering, back-flow prevention, etc)
Standards and policies	Evolving	The level of service is evolving and the objective includes full fire protection.
Compliance with regulatory requirements	Working	Expect changes with expanded treatment facilities and additional control programs (metering, back-flow prevention, etc)
Staffing and training	Working	
Financial planning and administration	Adequate	
Operation and Maintenance Procedures and Practices	**Status**	**Comments**
Compliance with the operating permit	No	Quality issues with treated water (THMs)
Adequacy of standards, procedures and practices	Working	Standardization of water line materials and locations recommended. Upgrading of control and alarm systems recommended
Testing, inspection and maintenance schedules	Working	No reported problems
System monitoring processes	Inadequate	Boil-water advisories have been the result of

		undetected chemical feed pump failure.
Backflow prevention/cross-connection control program	No	Identify service connections with potential elevated risk levels (institutional, industrial, recreational properties)
Documentation and Reporting Practices		
Daily logs	Inadequate	Planning, design and cost allocations are hampered with the lack of accurate consumption data.
Accurate drawings of water line locations	No	Potential contributing cause of accidental line damage arising from construction, loading conditions, etc. Lead to inaccuracies in analyses and modelling of the system.
Complaint reports	File exists	Valuable in identifying seasonal patterns, setting flushing schedules and formulating upgrading plans.
Emergency Response and Contingency Planning Practices		
Plan on file	Yes	VCHA requires that plan be updated (Inspection report March 15, 2007)

6.0 FINANCIAL CAPACITY AND GOVERNANCE

Three general areas are evaluated in the assessment of financial capacity and governance:

1. Governance and accountability structures.
2. Financial capacity.
3. Risk to provision of safe drinking water imposed by community growth and development.

Further, the assessment is to describe the influence that these three elements have on the physical production of safe drinking water.

Similar to the note in the introduction of Section 5, the recommended guideline procedures exceed the scope of the current study, but the following table highlights the nature of assessment issues and general impressions gained through our cursory review and correspondence with VAID.

Assessment Area	Status	Comments
Governance and Accountability Structures		
One person responsible	No	Board of Trustees has overall responsibility
Assigned positions	Several	Chairman, Trustees, Administrator, Certified Water Operator
Sufficient personnel	Yes	
Technical/operations assistance		Dan Glover; specialized inspectors, electricians
Engineering advice		McElhanney
Financial advice		Duke & Company
Insurance		Aon Reed Stenhouse
Legal Council		
Financial Management & Capacity		
Capital works plan	In progress	Refer to Section 7 for an initial plan
Financial plan	Yes	Operations are to an approved annual budget
Adequate renewal plan	No	Ref: InfraGuide Best Practices on Developing a Water Distribution System Renewal Plan
Water rate structure	Needs revision	Inadequate to meet present and projected futures needs
Adequate liability insurance coverage	Yes	General liability insurance with Aon Reed Stenhouse
Methods of accessing funds	Severely limited	Parcel taxes; water tolls, connection fees
Community Growth and Development		
Involvement in land-use decision	Several avenues	Regional District Official Community Plan; Ministry of Transportation and Infrastructure, Watershed Protection Bylaw
Specific development pressures	Pressure to expand the service boundary	Gyrafalcon properties has an application for inclusion and for land-use re-zoning (resource to rural)
Growth management issues		Growth increase capacity expansion requirements but at the same time expands the tax base and provides opportunities for development cost charges
Risks that growth pose to safe supply of water		Exacerbates limitations of the distribution system if capacity expansion is delayed
Overview		
Are best management practices achievable?	Yes with financial assistance	Treatment and distribution upgrades for this community represent major costs hurdles.

7.0 CAPITAL WORKS PLAN

7.1 Review of Options

7.1.1 Source Water Options

Quality changes within Priest Lake with depth and the present intake structure draws water from a single inlet port 3 - 7 m below water surface. An additional 5 m of depth exists beyond the extent of the present intake piping, and a structure that enables withdrawals over the full range of water depths is possible. Opportunities to reduce TOC/DOC, turbidity and colour levels are of particular interest. New intake works should be investigated in light of these possibilities recognizing that product water quality closely matches that of the source water. A sampling program should be implemented as the initial step.

7.1.2 Treatment Options

Additions to the treatment processes are required to reduce source water *Giardia* and *Cryptosporidium* densities and turbidity, and to remove organic precursors to THM production. Current risk levels can be reduced somewhat with the intake upgrading noted above and with potential changes in the disinfection process but some form of filtration would be needed to fully meet the CDWQ guidelines and standards set by the VCHA. Filtration provides a physical barrier to passage of *Giardia* and *Cryptosporidium*. Filtration reduces THM concerns in two ways; first by removing precursors from the treated water and secondly by lowering the chlorine demand and associated dosage to maintain the required residual.

Filtration options are numerous but the slow sand filter (SSF) is likely to be most appropriate for VAID. A number of communities including Gillies Bay are assessing SSF systems. The operations and maintenance of this type of system are not overly complex and this option involves the least amount of chemical handling and pumping. The system can be installed with minimum amounts of proprietary equipment and this lowers capital costs. SSF systems relatively large size provides an advantage with respect to stable reliable performance, but the extra land requirement can be a major disadvantage in some instances.

Incorporation of filtration into the existing water supply system would result in significant changes in the hydraulic conditions and would require new pumping systems.

In summer 2006 McElhanney prepared a capital cost comparison of different filtration options for Gillies Bay Improvement District. The numbers of lots in the serviced communities are comparable; 208 for GBID versus 220 for VAID, but a comparison of the two sets of flow data does raise questions regarding the accuracy of the VAID records. The estimated GBID capital costs for filtration systems are representative for purposes of this study.

Treatment Process	**System**	**Capital Cost**
Conventional slow sand filter (SSF)	Custom designed open cast-in-place tanks	$ 650,000
SSF pre-fabricated tank system	Blue Futures Filters Inc	$ 900,000
Membrane filtration package plant	Memcor Membrane Filtration XP-24	$ 1,050,000
Conventional sedimentation filtration (CSF) package plant	Trident HSC-750	$ 1,250,000
Proprietary SSF package plant	MSFilter	$ 1,350,000

Capital and operating and maintenance costs of filtration are major expenditures, and implementation as early as possible of related data gathering and background activities is recommended.

1. Obtain more accurate water consumption data,
2. Implement water conservation measures such as metered services, and
3. Conduct pilot testing to optimize treatment process design and to ensure cost-effectiveness.

Disinfection alternatives to the present chlorination system warrant consideration. With a combination of disinfection methods, greater effectiveness in the inactivation of *Giardia* and *Cryposporidium* and potentially lower production of THMs are potentially available. Ozone, UV radiation, chloramination and mixed oxidants (MIOX) are potential means of increasing inactivation of *Giardia* and *Cryposporidium* and reducing THM levels in the finished waters. Some form of chlorination, however, would still be required to ensure that acceptable chlorine residual levels are maintained in the distribution system.

Chlorine alone is not effective in the inactivation of *Cryptosporidium* , but the addition of any of the options noted above would address this inadequacy. UV radiation could readily be accommodated within the present system, but it alone would not address the THM issue. Ozone on the other hand is widely used as a pre-treatment step in filtration and through oxidation of precursors would reduce THM levels in the finished waters. In this case, it would be part of a longer-term solution. In relation to shorter-term solutions, chloramination and some technical literature suggest mixed oxidants (MIOX) also address both inactivation of *Giardia* and *Cryposporidium* and THM levels.

As components are added the level of complexity and cost of the disinfection system increases. As stand-alone projects that address both micro-organism inactivation and THM levels, chloramination and mixed oxidants are likely the most cost-effective approaches. Chloramination involves additional chemical (ammonia) handling but at this stage appears to provide the most certain solution. The addition of ammonia increases the handling of hazardous materials and with it the level of risk to operations personnel. Fisheries concerns would increase with use of ammonia in the area of Priest Lake.

Performance levels achieved with mixed oxidant systems is reported to depend on raw water quality to a significant degree. A system like MIOX, however, avoids the handling of hazardous materials entirely but it has higher capital and energy costs. Jar or pilot tests would be required to confirm effectiveness on the source waters. Estimated capital costs of these two disinfection options range from $70,000 for $105,000.

7.2 Distribution System

7.2.1 Level of Service

As previously noted, the service level that the VAID seeks to provide the community includes fire protection. Fire flows have a direct impact on the required storage capacity and the hydraulic capacity of the pipe network.

7.2.2 Storage

The present storage capacity of 204 m^3 is much less than the calculated 800 m^3 required based on MMCD design guidelines for a residential communities, and providing a 15% growth allowance in the design. The storage volume consists of fire storage (430 m^3) equalization storage (210 m^3) and

Emergency Storage (160 m^3). Two reservoirs each providing half this capacity have a total capital cost in the order of $500,000.

7.2.3 Water Transmission Mains

A single water transmission line services the community and one means to address security of supply and areas of low pressure and flow would a second transmission main linking the reservoir of main transmission line to Wall Street on the south east limits of the system. The length of this link would depend on the properties available for right-of-ways and could range from 1 to 2.5 kilometres. Based on a 200 mm diameter watermain, capital costs excluding land acquisition would be in the order of $250,000 to $400,000.

A second reservoir located at the top end of Wall Street is another option for improving security of supply and providing additional fire protection. The second reservoir is VAID's preference option.

7.2.4 Distribution Network

VCHA recommends watermains normally be 100 mm diameter or larger and looped. Watermains designed to accommodate fire flows are typically larger. Standard size pipe typically is 200mm diameter. Pipes 150 mm in diameter are limited to short interconnecting streets and short dead-ends not over 100 m long. Pipes 100 mm in diameter are used for delivering domestic supply only and not serving hydrants. The majority of Van Anda's watermains (≈ 37%, 4,600 m) are 50 mm diameter or smaller.

Replacement costs in the order of $1.65 M would apply in the Van Anda water distribution system meeting the above standards.

Pipe Size (mm Ø)	Size Upgrading (m)	New Lines (m)	$
200		3,050	590,000
150		1,280	220,000
100	4,600	950	840,000
		Total Cost	$1,650,000

7.2.5 Metering of Service Connections

A number of options exist with respect to the type of meter, and the installation and reading procedures. Positive displacement and multi-jet meters are typically used on residential water services. Installation can be by supplier, contractor or by community forces, and reading can be done manually or with a touch probe. Estimated capital costs for 220 lots range from $85,000 to $110,000 based on these various options.

7.3 Capital Works Plan

ITEM	STUDIES/MODIFICATIONS	PRIORITY	COSTS (Order of Magnitude)
Source protection	Undertake watershed boundary survey and investigate runoff quality and quantity investigations in the area of the quarry operations	1	5,000
Intake structure	Conduct a water column sampling program	1	5,000
	Make longer, deeper and with multiple ports	2	$30,000
Intake pumps	Add control & alarm system	1	10,000
	Add standby power receptacle	1	5,000
Turbidity meter	Install in-line with data logger/recorder	1	10,000
Flowmeter	New addition to system	1	10,000
Disinfection	Add control & alarm system	1	10,000
	Add chlorine residual analyser	1	10,000
	Conduct MIOX trials	2	5,000
	Add UV	3	30,000
Filtration	Conduct pilot program	2	10,000
	Proceed with design and construction	3	700,000
Storage	Add an emergency by-pass system	1	25,000
	Replace existing reservoir	2	250,000
	Install 2nd reservoir on Wall St.	2	250,000
Water transmission main	Extend to the proposed Wall St reservoir.	2	590,000
Distribution system upgrades for full fire protection	Replace piping sized under 100mm Ø; minimize dead-ends	3	1,060,000

Service connection meters	Implement bylaw provisions & accounting system	1	0
	Installation	1	110,000
		Sub-total:	$3,125,000
		Engineering (15%)	$468,750
		Contingencies (25%)	$898,438
		Total	$4,492,188

Taxes and land acquisition are not included in the above estimates.

8.0 CONCLUSIONS AND RECOMMENDATIONS

8.1 Conclusions

The existing works are cost effective and easy to operate and maintain. There are, however, potential hazards to be addressed, namely:

- Source water *Giardia* and *Cryposporidium* contamination with no treatment process that effective inactivation of these micro-organisms;
- High THM levels in the disinfected water due to relatively high TOC levels in the source waters and chlorine demand;
- Water of unacceptable bacteriologic quality in the distribution system because of an undetected failure of the disinfection system and the presence of numerous dead-ends.
- Contaminant entry coinciding with low-line pressures created in supplying fire flows. The capacity of the existing distribution system is limited to the extent that fire protection can be safely provided to a relatively small portion of the community.
- Accidental damage to the distribution system because line locations are not accurately documented or marked in the field.

Service levels and existing system components do not meet VCHA standards in several areas.

- THM concentrations are frequently higher than 100 μg/L.
- Treatment is inadequate to address *Giardia* and *Cryposporidium* contamination,
- Storage capacity is inadequate to meet balancing and emergency requirements and makes no provision for fire demand, and
- Small line sizes and numerous dead-ends severely limit the capacity of the distribution system in meeting VAID service level objectives and provincial standards.

The projected costs of upgrading the water supply and distribution system are in the order of $4.5 M, and this figure includes metering as a water conservation measure.

Resources available to VAID with respect to system management, financial capacity and governance are very limited and are typical of small improvement districts. The demands on the community and staff to fund and manage water treatment and distribution systems are increasing dramatically. The ability to respond effectively requires a phased implementation plan and VAID continued management may be dependant on access to funding programs of senior governments. Currently that avenue is through the Powell River Regional District.

8.2 Recommendations

4. Adopt and implement a phased capital works program similar to the one presented in Section 7 to address the noted potential hazards and system deficiencies.
5. Implement metering and a rate structure that reflects the true cost of water and provides appropriate capital reserves.
6. For demands beyond the reasonable scope of self-financed works and studies, pursue funding assistance from senior governments.

Report prepared by:

Dan Hooper, P.Eng.

G. D. HOOPER

12/5/08

APPENDIX A

Drinking Water
Source-to-Tap
Screening Tool

BRITISH
COLUMBIA

Ministry of Health Services
Ministry of Water, Land and Air Protection
2004

Contacting B.C.'s Health Authorities

Northern Health Authority Suite 300 - 299 Victoria Street Prince George, B.C. V2L 5B8 Phone: (250) 565-2649 Fax: (250) 565-2640 www: http://www.northernhealth.ca	**Interior Health Authority** 2180 Ethel Street Kelowna, B.C. V1Y 3A1 Phone: (250) 862-4200 Fax: (250) 862-4201 www: http://www.interiorhealth.ca
Vancouver Island Health Authority 1952 Bay Street Victoria, B.C. V8R 1J8 Phone: (250) 370-8699 Fax: (250) 370-8750 www: http://www.viha.ca/	**Vancouver Coastal Health Authority** Suite 200, 520 W 6th Ave Vancouver, B.C. V5Z 4H5 Phone: Toll Free 1-866-884-0888 Local (604) 736-2033_ Fax: (604) 874-7661 www: http://www.vancoastalhealth.ca/
Fraser Health Authority 300 - 10233 153rd Street Surrey, B.C. V3R 0Z7 Phone: (604) 587-4600 Fax: (604) 587-4666 www: http://www.fraserhealth.ca	**Provincial Health Services Authority** 700-1380 Burrard St Vancouver, B.C. V6Z 2H3 Phone: (604) 675-7400 Fax: (604) 708-2700 www:http://www.phsa.ca/default.htm

A. WATER SUPPLY SYSTEM CONTACT INFORMATION

1. **On what date was this assessment completed?**

   ______________________ *Date completed (dd/mm/yy)*

2. **What is the name of the water supply system for this assessment?**
   The name referred to in this question is the name that appears on the Operating Permit, or usual name of the water supply system (Wickham Improvement District, Marge's Trailer Court)

   ____ *Name of water supply system*

3. **What is the location of this water supply system? (e.g. Chilliwack, Fulford Harbour)**

   ______________________ *Location name*

4. **What type of governance structure do you have for your water supply system: *(Check appropriate box)***

   ☐ *Regional District*
   ☐ *Municipality*
   ☐ *Improvement District*
   ☐ *Water Users Community*
   ☐ *Private Water Utility*
   ☐ *Other (specify)* ______________________

5. **What is the name and address of the owner of this water supply system?**
   The owner may be the governance structure listed in Question 4, a corporation, strata or an individual (Wickham Improvement District, IntraTourist Inc., Marge Bellows)

   Legal name of owner ____
   Street: ____
   City: ______________________ Postal Code: ______________________
   Phone #: ______________________ Cell phone #: ______________________
   Fax #: ______________________ Pager #: ______________________
   E-mail address: ____

6. **Who are the contact person(s) for the governance structure?**

   Manager/Administrator - same as above ☐ or:

   Name: ____
   Street: ____
   City: ______________________ Postal Code: ______________________
   Phone #: ______________________ Cell phone #: ______________________
   Fax #: ______________________ Pager #: ______________________
   E-mail address: ____

Operator - same as above ☐ or:

Name: ____________________

Street: ____________________

City: ____________________ Postal Code: ____________________

Phone #: ____________________ Cell phone #: ____________________

Fax #: ____________________ Pager #: ____________________

E-mail address: ____________________

7. **Who completed this assessment?**

(Please indicate below the name, the agency the phone number and email address of the person who completed this assessment).

Name of person who completed assessment	*Agency or employer of person who completed the assessment*	*Phone Number and Email of person who completed assessment*

A.1 *Administration and Management of the Water Supply System*

8. **Do you have an engineering assessment (e.g. engineering report and capital works plan) in place for your water supply system that was completed within the last 5 years?**

   1. *Yes*
   2. [✓ *No*]
   3. *Unsure*

9. **Do you have an up-to-date financial plan (e.g. operating budget and capital expenditure program) for your water supply system that covers a period of more than one year?**

   1. *Yes*
   2. [✓ *No*]
   3. *Unsure*

10. **Do you have liability insurance for your water supply system?**

   1. [✓ *Yes*]
   2. *No*
   3. *Unsure*

11. **Do you have an opportunity to participate in land-use decisions, such as subdivision or zoning approvals that impact your water supply system?**

   1. [✓ *Yes*]
   2. *No*
   3. *Unsure*

A.2 Description of the Water supply system

12. **What is the approximate population size served by this water supply system?** *(Put number in blank)*
If the population varies seasonally, list the population served in each season.

660 *Approximate number of people served, OR*

______ ______ ______ ______ *Approximate number served per season*

13. **How many connections does this system have?**
A connection means the service line or pipe by which a residential, commercial or industrial customer or other water user obtains water from the supplier's distribution system.

220 *Number of connections*

14. **Does this water supply system provide water for any of the following facilities?** *(Circle ALL that apply)*

1. *Hospital*
2. [✓ *School*]
3. *Continuing care home*
4. *Retirement home*
5. *Child/adult care*
6. [✓ *Camps/campsites*]
7. [✓ *Restaurants*]
8. *Special needs facility*

15. **Does this water supply system currently have an operating permit issued by the local health authority?**

1. [✓ *Yes*]
2. *No*
3. *Unsure*

16. **Before undertaking new construction or modifying the water supply system, do you obtain a construction permit from the local health authority?**

1. *Yes*
2. [✓ *No*]
3. *Unsure*

17. **Is there an approved Emergency Response Plan for this water supply system?**

1. [✓ *Yes*]
2. *No*
3. *Unsure*

18. **Has this water supply system ever experienced water supply problems due to drought?**

1. *Yes*
2. [✓ *No*]
3. *Unsure*

19. **Does this water supply system have a drought management plan?**

1. *Yes*
2. [✓ *No*]
3. *Unsure*

20. **Is this water supply system currently on a boil water advisory?**

1. *Yes* *If "yes", explain:* ____________________
2. [✓ *No*]
3. *Unsure*

21. Has this water supply system ever had a boil water advisory?

1 [✓ *Yes*] *Details:* Chlorinator problems.
2 *No*
3 *Unsure*

22. Are all components of this water supply system infrastructure (i.e., intake, pump house, treatment plant, reservoirs, including storage tanks) protected from tampering or unauthorized access?

1. [✓ *Yes*]
2. *No*
3. *Unsure*

23. Are the water system facilities alarmed for situations that might affect drinking water safety (hydro failure, high or low chlorine residual, etc.) and the operator automatically alerted so that the operator can respond quickly?

1. *Yes*
2. [✓ *No*]
3. *Unsure*

A.3 Operator Certification and Facility Classification

The Environmental Operators Certification Program is a program for the classification of water and wastewater treatment systems or facilities and certification of facility operators.

A facility is classified based on its level of complexity. The complexity of a facility or system is assessed and ranked from Small System, usually the smallest and/or least complex to Class I through Class IV, the most complex. Facility classification provides and indication of the degree of knowledge and training that will be required of an operator of that facility.

Individuals can receive water operator certification as Small Water or Wastewater System, Level I, Level II, Level III, or Level IV operators paralleling the facility classification.

Details of the EOCP criteria can be found at http://www.eocp.org/ under the program guide section.

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24. Is your water supply system classified by the Environmental Operator Certification Program (EOCP)?

1. [✓ *Yes*] *If "yes" what is the Classification Level of your water supply system (Check box that applies)*
☒ Small Water System, or
Treatment ☐ Class I ☐ Class II ☐ Class III ☐ Class IV
Distribution ☐ Class I ☐ Class II ☐ Class III ☐ Class IV
2. *No*
3. *Unsure*

25. Is the operator(s) of this water supply system currently certified by the Environmental Operator Certification Program?

1. [✓ *Yes*] *If "yes" what is the Certification Level of the most senior operator (Check box that applies)*
☒ Small Water System, or
Treatment ☐ Level I ☐ Level II ☐ Level III ☐ Level IV
Distribution ☐ Level I ☐ Level II ☐ Level III ☐ Level IV
2. *No*
3. *Unsure*

26. Are you having difficulty finding people with the appropriate level of certification to operate your water supply system?

1. *Yes*
2. [✓ *No*]
3. *Unsure*

27. Please use this space to add comments relevant to this section for further information or clarification.

B.2 *Surface Water Sources (including Springs)*

Complete the following chart with information about each surface water source used by the system. If the system has more than three sources, copy this page and complete the chart for all remaining sources. If the system has a spring, complete this chart.

If the system also has groundwater sources, please complete the chart for Groundwater Sources.

Surface Source Description	**Source __**	**Source __**	**Source __**
51. What is the name of the surface water source *(e.g. Twenty-one Mile Creek, Wheelbarrow Springs)*	Priest Lake		
52. Describe the intake location of the surface water source: *(i.e. On east bank of Cleanwater Creek, 1 km upstream of highway, distance from shore, depth below surface, fixed, floating)*	center of lake 8' below surface		
53. GPS (Geographic Positioning System) coordinates (if available):			
54. Which of the following best describes this surface water source: [✓ 1.] *Primary (used year-round, or most of the year)* 2. *Secondary (used part of the year)* 3. *Back-up or Emergency*			
55. Is there a written watershed protection plan for this surface water source that considers drinking water? 1. [✓ *Yes*] 2. *No* 3. *Unsure*			
56. Do you know the approximate boundary of the contributing watershed (determined by the height of land or topographic boundary upstream of the intake) for this surface water source? 1. [✓ *Yes*] *If Yes, what is the approximate area of the watershed (in km²)* 1131 ha 2. *No* 3. *Unsure*			

Potential Contaminant Sources within 50 m of Intake	**Source __**	**Source __**	**Source __**
57. Look at the area within 50 m (160 ft) above the intake. Do you see or know of any of the following activities, or natural conditions, occurring in that area? Answer: Write number in the boxes below each well	1. Yes 2. No 3. Unsure	1. Yes 2. No 3. Unsure	1. Yes 2. No 3. Unsure
a) Accumulation of natural debris, algae or other material	1		
b) Major bank erosion or instability	2		
c) Pipeline, road, railway or hydro transmission line crossing stream, or close to stream	1		
d) Chemical storage (household or agricultural, including pesticides)	2		
e) Fuel storage (above ground or underground)	2		
f) Landfill, refuse storage or contaminated site	2		
g) Livestock	2		
h) Manure storage or application	2		
i) Municipal, industrial, or stormwater discharges, or agricultural drainage entering the source (stream, lake, reservoir) above the intake	2		
j) Recreation activities (legal or by trespass), including boat launch, float plane use, hunting.	1		
k) Septic systems, (including your own or those on nearby properties)	1		
l) Wildlife (deer, bear, beaver, ducks, geese, cougars, etc.)	1		
m) Other (specify)			

Potential Contaminant Sources in Contributing Watershed	**Source __**	**Source __**	**Source __**
58. Do you see or know of any of the following activities, or natural conditions, occurring within the contributing watershed (or equivalent source area for springs) upstream of the intake? Answer: Write number in the boxes below each well	1. Yes 2. No 3. Unsure	1. Yes 2. No 3. Unsure	1. Yes 2. No 3. Unsure
a) Commercial/industrial chemical storage	2		
b) Commercial/industrial fuel storage (above ground or underground)	2		
c) Forestry-related activities, including silviculture (tree planting)	1		
d) High density residential (i.e. subdivision) areas	2		
e) Intensive agriculture (e.g. commercial vegetable growing, nurseries, orchards, feed lots)	2		
f) Landfill, refuse storage or contaminated sites	2		
g) Livestock	2		
h) Major highway, railway, pipeline, hydro transmission lines	1		
i) Mining or oil/gas exploration and/or extraction	1		
j) Major municipal, commercial or industrial facilities or activities such as sewage treatment plant, refinery, factory, service station etc.	2		
k) Municipal, industrial, or stormwater discharges, or agricultural drainage entering the source (stream, lake, reservoir) above the intake	2		
l) Recreation activities (legal or by trespass)	1 Some		
m) Wildlife (deer, bear, beaver, ducks, geese, cougars, etc.)	1		
n) Natural contaminant sources (landslides, exposed sediments, bogs)	1		
o) Other (specify)			

Source Water Quality	**Source __**	**Source __**	**Source __**
Physical/Chemical parameters: TOC,turbidity, pH, colour, nitrate, nitrite, metals, arsenic, fluoride, trihalomethanes (THM) *Microbiological parameters total and fecal coliforms, heterotrophic plate counts, E. coli*			
59. Has the surface water ever been tested at the source, before any treatment, for 1. *Physical/Chemical parameters* 2. *Microbiological water quality* [✓ 3. *Both*] 4. *None*			
60. Is the surface water tested regularly at the source, before any treatment? 1. *Yes* *If yes, please specify (a) Physical/Chemical parameters, [✓ (b)] Microbiological water quality or (c) both* 2. *No* 3. *Unsure*			
61. Who does the regular testing? 1. *Water supply system owner or operator (supplier)* [✓ 2. *Health Authority (Environmental Health Officer)*] 3. *Other (specify)*			
62. Have you ever had any source water quality test results exceed the maximum acceptable concentration as stated in the "Guidelines for Canadian Drinking Water Quality" that could impact health such as: fecal colifoms, E. coli, nitrate-nitrogen, arsenic, turbidity (DO NOT include aesthetic parameters such s iron, manganese, or hardness [✓ 1. *Yes*] 2. *No* 3. *Unsure*			

C. TREATMENT OF WATER SOURCE

63. **If you have more than one source, are the sources combined prior to treatment?**
    1. *Yes*
    2. *No*
    3. *Unsure*

64. **If you answered "no" to the previous question, is each source treated individually?**
    1. *Yes*
    2. *No*
    3. *Unsure*

65. **If some sources are not treated, please list them by name:**

Source Name(s) ______________________________

Source Treatment	**Source __**	**Source __**	**Source __**
66. Is the source water disinfected with chlorine? 1. [✓ *Yes*] 2. *No* 3. *Unsure*			
67. Is the source water disinfected by an alternative method (not chlorine)? 1. *Yes* 2. [✓ *No*] 3. *Unsure*			
68. Is the source water treated by filtration? 1. *Yes* 2. [✓ *No*] 3. *Unsure*			
69. If the source water is treated by filtration, is it effective in removing disease-causing organisms (i.e., giardia, cryptosporidium) and their carriers (turbidity) 1. *Yes* *(If yes) please describe* 2. *No* 3. *Unsure*			
70. Is the source water treated by other methods to remove disease-causing organisms (i.e., *giardia, cryptosporidium)* and their carriers *(turbidity)?* 1. *Yes* *(If yes) please describe method* 2. [✓ *No*] 3. *Unsure*			

71. Is the source water treated for other reasons, such as iron or manganese removal, arsenic etc.? 1. Yes *(If yes) please describe* 2. [✓ *No*] 3. *Unsure*			

72. **Do you check, maintain and record treatment operations?**
    1. [✓ *Yes*] *(If yes) please describe (i.e. how often?)* daily
    2. *No*
    3. *Unsure*

73. **Do you have operating manuals for all equipment and operating instructions for all treatment processes?**
    1. [✓ *Yes*]
    2. *No*
    3. *Unsure*

74. **Please use this space to add comments relative to this section for further information or clarification.**

D. WATER STORAGE

This section refers to facilities used for storing water prior to distribution to the customer. The term "finished water" refers to water ready for consumption.

75. **Are there any tanks used to store finished water?**
    1. [✓ *Yes*]
    2. *No* *(If no), please go to Section E. Distribution System*
    3. *Unsure*

76. **Are the storage tanks covered?**
    1. [✓ *Yes*]
    2. *No*
    3. *Unsure*

77. **Are all openings, such as vent pipes, overflows and drains screened or valved to protect against the entrance of small animals, and pests?**
    1. [✓ *Yes*]
    2. *No*
    3. *Unsure*

78. **Do the storage tanks include design features that encourage adequate daily water turnover, water circulation and reduce stagnation and chlorine decay?**
    1. [✓ *Yes*]
    2. *No*
    3. *Unsure*

79. **Are finished water samples taken from the water storage tank?**
    1. [✓ *Yes*]
    2. *No*
    3. *Unsure*

80. **Are storage tanks cleaned periodically?**
    1. [✓ *Yes*] *(If yes) please describe (i.e. frequency)* 2 years
    2. *No*

3. *Unsure*

81. Please use this space to add comments relative to this section for further information or clarification.

E. DISTRIBUTION

82. Is there a distribution system flushing program in place?

1. [✓ *Yes*]
2. *No*
3. *Unsure*

83. Do you have a routine leak detection and repair program?

1. [✓ *Yes*]
2. *No*
3. *Unsure*

84. Are you aware of any areas in your distribution system where there is no measurable (less than 0.2 mg/L total or less than 0.1 mg/L free) chlorine residual?

1. *Yes*
2. [✓ *No*]
3. *Unsure*
4. *Do not use chlorine*

85. Are routine operation and maintenance checks, such as exercising the valves, performed on the distribution system and recorded?

1. [✓ *Yes*] during flushing
2. *No*
3. *Unsure*

> **Cross-Connection**
>
> Any actual or potential connection between the potable drinking water supply system and any source or system containing non-potable water or other substances. An example is the piping between a public water supply system or consumer's potable water system and an auxiliary water system, cooling system, or irrigation system
>
> Cross connection control program may include a cross-connection control by-law, requirements for installation and testing of backflow prevention devices, establishment of a residential backflow protection program where an appropriate backflow device is installed at every new residence, survey of commercial and industrial facilities for potential cross-connections, public education.

86. Is there a written cross connection control program in place?

1. *Yes*
2. [✓ *No*]
3. *Unsure*

87. Is there a cross-connection control by-law in your community or for your water supply system?

1. *Yes* *(If yes) Is the by-law enforced?* ______________________________
2. [✓ *No*]
3. *Unsure*

88. Please use this space to add comments relative to this section for further information or clarification.

F. TAP WATER QUALITY

89. Are you aware of any health risks that have been identified by the environmental health officer or other water quality professional for your water supply system?

1. *Yes*
2. [✓ *No*]
3. *Unsure*

90. Is the tap water tested regularly for parameters that impact health (such as total and fecal colifoms, E. coli, nitrate-nitrogen, arsenic, turbidity NOT for aesthetic traits like iron, manganese, or hardness)?

1. [✓ *Yes*]
2. *No*
3. *Unsure*

91. Who does the regular testing?

1. *Water supply system owner or operator*
2. [✓ *Health Authority (Environmental Health Officer)*]
Other (specify) ________________________________

92. Are you notified promptly about potential health risks after the water samples are tested?

1. [✓ *Yes*]
2. *No*
3. *Unsure*

93. Who interprets the laboratory results to identify and advise you about potential health risks?

1. *Water supply system owner or operator*
2. [✓ *Health Authority (Environmental Health Officer*]
3. *Water quality professional (lab staff, consultants)*
4. *Other (specify)* ________________________________

94. Do you usually know what corrective action is required when you are notified of potential health risks?

1. [✓ *Yes*]
2. *No*
3. *Unsure*

95. Have you ever had any water quality results exceed the maximum acceptable concentration as stated in the "Guidelines for Canadian Drinking Water Quality" that could impact health: fecal colifoms, E. coli, nitrate-nitrogen, arsenic, turbidity; NOT aesthetic traits like iron, manganese, or hardness?

1. [✓ *Yes (If yes) please describe*] fecal coliform
2. *No*
3. *Unsure*

96. Have you ever had any water quality results where disinfection by-products, such as trihalomethanes (THMs) exceed the standard contained in the "Guidelines of Canadian Drinking Water Quality"?

1. *Yes (If yes) please describe?* ________________________________
2. [✓ *No*]
3. *Unsure*

97. Please use this space to add comments relative to this section for further information or clarification.

G. NEXT STEPS

I agree that the responses to the questions in the Screening Tool are true to the best of my knowledge.

Water Supply System Owner or Delegate *Date* July 19/07

I have read this competed Screening Tool and discussed the contents with the water supply system owner or delegate.

Drinking Water Officer *Date*

Action Required	Date Assigned	Date By Which Action Must Be Complete

APPENDIX B
VAN ANDA WATER SUPPLY
Seasonal Water Quality

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Colour, True	Col. unit	15	26			15	15	15	7.5		<2.5	13.25	
Turbidity	NTU	38.9	0.7			0.62	0.9	1.8	0.55			0.61	
Carbon, Organic	mg/L	8.3				4.85			6.0		5.1	5.7	
THM - FP	µg/L	141				262					183	161	
Alkalinity to pH 4.5	mg CaCO3 / L		70			87	71.7	86				85.65	
Chloride (Cl)	mg/L		3.9			3.6	3.52	4.3				6.95	
Fluoride (F)	mg/L		0.09			0.06	0.05	0.05				0.09	
Sulphate (SO4)	mg/L		22.8			24	18.69	22.8				37.25	
Nitrogen, Nitrate as N	mg/L		1			0.46	0.19	< 0.1			0.032	0.628	
Nitrogen, Nitrite as N	mg/L		<0.05			< 0.005	<0.006	< 0.05			0.004	0.011	
pH	pH Units		7.75			8.12	7.81	8.27				7.58	
Residue, Filterable (TDS)	mg/L		110			120	127	124				161.5	
Hardness	mg $CaCO_3$ / L		96.9			110	90.4	107				122	
Aluminum (Al)	mg/L		0.034			0.01	0.21	< 0.005				0.00305	
Antimony (Sb)	mg/L		0.0009			0.0013		0.0009				0.001025	
Arsenic (As)	mg/L		0.0005			0.0007	<0.01	0.0007				0.00065	
Barium (Ba)	mg/L		0.005			0.005	0.0048	0.006				0.005847	
Boron (B)	mg/L		0.008			0.007	0.027	0.01				0.013333	
Cadmium (Cd)	mg/L		< 0.00001			< 0.00001	< 0.0006	< 0.00001				0.00002	
Calcium (Ca)	mg/L						33					23.1	
Chromium (Cr)	mg/L		0.001			0.001	< 0.0009	0.0006				<0.005	
Copper (Cu)	mg/L		0.013			0.003	0.009	0.021				0.014	
Iron (Fe)	mg/L					<0.03	0.028	0.17				0.011	
Lead (Pb)	mg/L		0.0006			0.0001	0.003	0.0003				0.0001	
Magnesium (Mg)	mg/L						1.95					1.3	
Manganese (Mn)	mg/L		0.009			< 0.005	0.006	0.032				0.012	
Potassium (K)	mg/L						< 0.4					0.25	
Selenium (Se)	mg/L						< 0.004					< 0.05	
Sodium (Na)	mg/L		3.4			3.4	3	3.8				5.6	
Zinc (Zn)	mg/L		0.009			0.006	0.0357	0.003				0.005	
Uranium (U)	mg/L		0.005			0.0054	< 0.06	0.0043				0.003975	
Mercury	mg/L						< 0.0001						

Source: Laboratory analyses for 13 samples collected since 1992, 12 since 2000.

APPENDIX B
PRIEST LAKE TRIBUTARIES

	Units	Quarry Creek 22-Nov-07	Quarry 290103 20-Feb-04	Kirk 290103 20-Feb-04	Kirk Ck 400458 8-Aug-05
Colour, True	Col. unit		6	30	46
Turbidity	NTU		2	0.8	1.2
Alkalinity to pH 4.5	mg CaCO3 / L		134	78	202
Chloride (Cl)	mg/L		4	3.3	5
Fluoride (F)	mg/L		0.37	0.13	0.12
Sulphate (SO4)	mg/L		82.7	20.7	22
Bromide (Br)	mg/L				
Nitrogen, Nitrate as N	mg/L	7.51	3.7	1.1	0.07
Nitrogen, Nitrite as N	mg/L	<0.002	<0.05	<0.05	< 0.005
Phosphorus, Ortho as P	mg/L				
pH	pH Units	8.04	8.05	7.81	8.08
Residue, Filterable (TDS)	mg/L		262	113	230
Hardness, Total - calc.	mg CaCO3 / L	384	233	100	208
ICP Extractable					
Aluminum (Al)	mg/L	< 0.05	0.026	0.059	< 0.005
Antimony (Sb)	mg/L	< 0.05	0.0064	0.0012	0.0004
Arsenic (As)	mg/L	< 0.05	0.0029	0.0006	0.0014
Barium (Ba)	mg/L	0.028	0.014	0.005	0.011
Berylium (Be)	mg/L	< 0.001			
Boron (B)	mg/L	0.06	0.023	0.011	0.017
Cadmium (Cd)	mg/L	< 0.005	0.00007	< 0.00001	0.00001
Calcium (Ca)	mg/L	144			
Chromium (Cr)	mg/L	< 0.005	0.0014	0.0012	0.0006
Cobalt (Co)	mg/L	< 0.005			
Copper (Cu)	mg/L	< 0.005	0.01	0.009	< 0.001
Iron (Fe)	mg/L	< 0.005	0.06	0.04	0.11
Lead (Pb)	mg/L	< 0.05	0.0001	< 0.0001	< 0.0001
Magnesium (Mg)	mg/L	5.4			
Manganese (Mn)	mg/L	< 0.001	< 0.005	< 0.005	0.056
Molybdenum (Mo)	mg/L	0.08			
Nickel (Ni)	mg/L	< 0.02			
Phosphorus (P)	mg/L	0.8			
Potassium (K)	mg/L	0.9			
Selenium (Se)	mg/L	< 0.05			
Silicon (Si)	mg/L	1.97			
Silver (Ag)	mg/L	< 0.01			
Sodium (Na)	mg/L	3.1	2.8	3	5.5
Strontium (Sr)	mg/L	0.879			
Sulfur (S)	mg/L	78			
Tin (Sn)	mg/L	0.08			
Titanium (Ti)	mg/L	< 0.002			
Vanadium (V)	mg/L	0.03			
Zinc (Zn)	mg/L	0.025	0.006	0.001	< 0.001
ICPMS Extractable					
Aluminum (Al)	ug/L	2.1			
Antimony (Sb)	ug/L	14.3			
Arsenic (As)	ug/L	10.1			
Barium (Ba)	ug/L	27.4			
Berylium (Be)	ug/L	< 0.002			
Bismuth (Bi)	ug/L	< 0.02			
Boron (B)	ug/L				
Cadmium (Cd)	ug/L	0.02			
Chromium (Cr)	ug/L	1.1			
Cobalt (Co)	ug/L	0.141			
Copper (Cu)	ug/L	0.30			
Lead (Pb)	ug/L	< 0.01			
Lithium (Li)	ug/L	4.13			
Magnesium (Mg)	ug/L				
Manganese (Mn)	ug/L	0.517			
Molybdenum (Mo)	ug/L	83.2			
Nickel (Ni)	ug/L	4.19			
Selenium (Se)	ug/L	9.3			
Silver (Ag)	ug/L	< 0.02			
Strontium (Sr)	ug/L	891			
Thallium (Tl)	ug/L	0.200			
Tin (Sn)	ug/L	< 0.01			
Uranium (U)	ug/L	67	0.0335	0.0063	0.0087
Vanadium (V)	ug/L	33.8			
Zinc (Zn)	ug/L	2.8			

APPENDIX C - RISK ASSESSMENT TERMINOLOGY

TABLE 7-1. Qualitative Measures of **Likelihood**
(after NHMRC/ARMCANZ, 2001: Berry and Failing, 2003)

Level	Descriptor	Description	Probability of Occurrence in Next 10 Years
A	Almost certain	Is expected to occur in most circumstances	>90%
B	Likely	Will probably occur in most circumstances	71-90%
C	Possible	Will probably occur at some time	31-70%
D	Unlikely	Could occur at some time	10-30%
E	Rare	May only occur in exceptional circumstances	<10%

TABLE 7-2. Qualitative Measures of **Consequence**
(after NHMRC/ARMCANZ, 2001)

Level	Descriptor	Description
1	Insignificant	Insignificant impact, no illness, little disruption to normal operation, little or no increase on normal operating costs
2	Minor	Minor impact for small population, mild illness moderately likely, some manageable operation disruption, small increase in operating costs.
3	Moderate	Minor impact for large population, mild to moderate illness, significant modification to normal operation but manageable, increase in operating costs, increase in monitoring.
4	Major	Major impact for small population, severe illness probable, systems significantly compromised and abnormal operations if at all, high level of monitoring required
5	Catastrophic	Major impact for large population, severe illness probable, complete failure of systems

TABLE 7-3 Qualitative **Risk** Analysis Matrix

Likelihood	Consequences				
	1 Insignificant	2 Minor	3 Moderate	4 Major	5 Catastrophic
A (almost certain)	Moderate	High	Very High	Very High	Very High
B (likely)	Moderate	High	High	Very High	Very High
C (possible)	Low	Moderate	High	Very High	Very High
D (unlikely)	Low	Low	Moderate	High	Very High
E (rare)	Low	Low	Moderate	High	High