2006 WATER QUALITY REPORT

Salmon Arm

WATER QUALITY REPORT 2006

Contents **Page**

Over the next 20 years, the average supply of worldwide water per person is expected to drop by a third.

Leah Symington, University of Wisconsin.

1.0 BACKGROUND

The City currently operates and maintains a public water distribution system under the regulations of the Drinking Water Protection Act and Regulations passed May 16, 2003 (http://www.qp.gov.bc.ca/statreg/stat/D/01009_01.htm) by the Province of BC and the Guidelines for Canadian Drinking Water Quality, 2006 edition (http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/doc_sup-appui/sum_guide-res_recom/index_e.html).

The Interior Health Authority (IHA) have advised the City that "Under the legislation, the province has increased the basic expectations around assessing water systems, certifying operators and suppliers, and monitoring and reporting on water quality. The legislation gives provincial drinking water officers (i.e. Interior Health Authority) increased powers to protect water sources from contamination by a drinking-water health hazard. In addition, the drinking-water officers will oversee a source-to-tap assessment of every drinking-water system in the province to address all potential risks to human health."

These provincial health officials will ensure water quality is maintained through operating permits developed specifically for each water system. The permits specify monitoring requirements for all substances of concern in a particular water system. In addition, the regulations require all water system operators to be certified under the "Environmental Operators Certification Program."

The City was issued (May 15, 2005) a revised Operating Permit from Interior Health Authority. The new permit incorporated changes in the standards and reporting requirements necessary to meet the Drinking Water Protection Act & Regulation standards. The upcoming changes in the City's Operating requirements were identified in previous correspondence between Interior Health and the City. These include:

- A study to determine options to meet the minimum treatment/disinfections standards of:
  - 4 log (99.99%) inactivation of viruses
  - 3 log (99.9%) inactivation of Giardia
  - 2 log (99%) inactivation of Cryptosporidium

- ◦ Less than 1 NTU turbidity, and
- ◦ The use of two or more disinfection technologies acceptable to the Health Authority and develop a work/installation plan to implement the chosen option.

- Continuous monitoring of the water disinfection process.
- An audit of our Bacteriological monitoring program.
- An updating of the Emergency Response Plan.
- A documented yearly maintenance program for the next five years.
- Development and implementation of a Cross Connection Control
- program.
- Implementation of a monthly and yearly reporting system.

The City of Salmon Arm, in an effort to meet these requirements, had a study completed by Stantec Consulting Ltd. in 2005 to identify appropriate treatment options for the City (http://salmonarm.fileprosite.com/contentengine/Link.asp?ID=2183). The recommendation made by this study is to use a rapid sand filtration process followed by UV disinfection and chlorination for the Shuswap Lake supply. For East Canoe Creek the recommendation is for UV disinfection followed by chlorination and automatic valving to prevent turbidity exceeding 1.0 NTU. A Pilot Study to confirm the suitability of the proposed process was completed in the spring of 2006 (Appendix 7). The City of Salmon Arm is currently in the detailed design phase for construction of the treatment facility for the Shuswap Lake supply.

The City has also updated the Emergency Response Plan (See Appendix 8), revised its Bacteriological Monitoring Program (See Appendix 3), and initiated staff training in Cross Connection Control. The City will continue to do further work in these areas in 2007.

2.0 WATER SYSTEM OVERVIEW

The municipal water system consists of two main raw water sources, chlorine treatment systems for the source waters and an extensive water pumping, distribution, and storage system. Our water supply is via three (3) sources, East Canoe Creek at Metford Dam, Shuswap Lake at Canoe Beach and a minor water supply from Rumball Creek

About 2 million tons of waste is dumped every day into rivers, lakes and streams One liter of wastewater pollutes about eight liters of freshwater.

Jessica McNichol, UN World Water Assessment Program for irrigation at the Mt. Ida Cemetery (Figure 1). Water treatment of the source waters (except Rumball Creek) is by primary disinfection with chlorine. The distribution system includes approximately 205.2 km of watermain varying in diameter from 100 mm to 1000 mm. It also includes seven (7) different pressure zones, thirteen (13) reservoirs, one dam and five pump stations.

Shuswap Lake is at a nominal elevation of about 346 m (1135 ft.) Geodetic Survey of Canada (GSC) datum while the Metford Dam intake on East Canoe Creek is at elevation 567 m (1860 ft.) GSC. The Utilities Division attempts to maximize the supply of water from East Canoe Creek so that pumping into the system from Shuswap Lake and the associated costs are minimized. The flow of water from East Canoe Creek into the water system is by gravity.

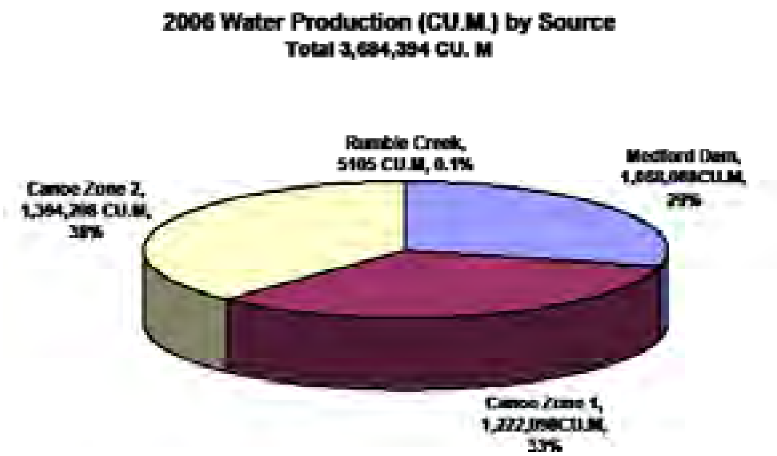


Figure 1 - Water Source Distribution

Periodic problems are experienced with East Canoe Creek, such as:

- turbidity levels that exceed the Interior Health Maximum Allowable Concentration. High turbidity levels are typically associated with higher creek flows during the spring snowmelt and extended high rainfall events in the watershed;
- peak summer water demands that exceed the low natural summer flows in the creek; and
- intermittent high coliform counts, which cause the shutdown of the Metford Dam intake and required the use of Shuswap Lake as the sole water source.

The distribution system is segregated into seven (7) pressure zones. The storage reservoir in the highest pressure zone (Zone 5) is at elevation 615 m (2020 ft.) GSC above sea level. Water has to be pumped over 269 m (885 ft.) in elevation from Shuswap Lake to the storage reservoir at the highest elevation.

3.0 MONITORING PROGRAM

Drinking water quality is a function of source water quality, water treatment, and water quality changes after treatment. As a result, monitoring of drinking water quality consists of three components: source (raw) water monitoring, monitoring after treatment, and monitoring in the distribution system.

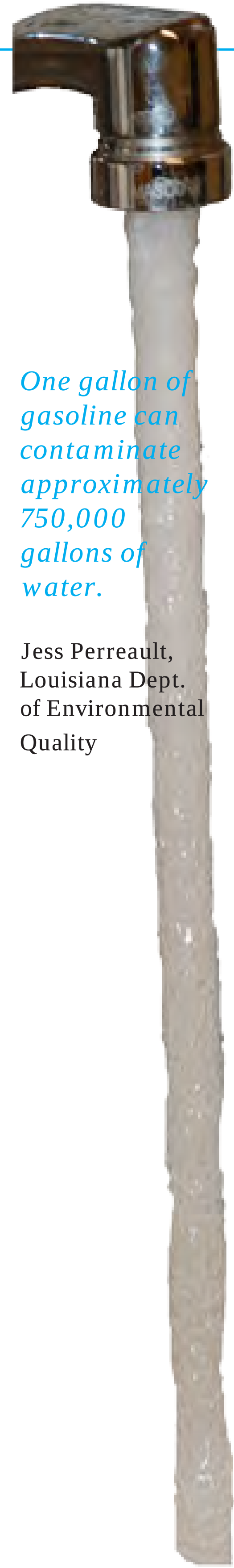
4.0 TESTING PARAMETERS

The City of Salmon Arm, as a purveyor of drinking water to a service population of approximately 14,500, is required to test at least 14 samples per month as outlined in the Guidelines for Canadian Drinking Water Quality, Sixth Edition. Our water distribution network is approximately 205.2 kilometres in length.

To adequately represent all areas within our network, Interior Health has approved a program to test 18 samples per month (we sample nine sites on a bi-weekly basis, see Appendix 3). The water is regularly tested for its microbiological characteristics, specifically total coliforms, faecal coliforms, turbidity and pH.

At the time of sampling, the Water Utility Operator also checks the water temperature and chlorine residual to ensure the water continuously has disinfection capability. As it is not economically feasible to test for all pathogens in drinking water, the microbiological guidelines are based on these indicator tests.

A Maximum Acceptable Concentration (MAC) level has been



One gallon of gasoline can contaminate approximately 750,000 gallons of water.

Jess Perreault, Louisiana Dept. of Environmental Quality

Of the total world's freshwater supply, 30.8% is groundwater, including soil moisture, swamp water and permafrost.

Environment Canada, A Primer on Fresh Water

established by Health Canada for microbiological criteria. Each MAC has been designed to safeguard human health, assuming a lifelong consumption of drinking water containing the substances at the maximum concentration level.

Aesthetic Objectives (AOs) apply to characteristics of drinking water that can affect its acceptance by consumers. These would include items such as taste, odour, and appearance. However, there are constituents that could pose a health risk in some individuals (i.e. compromised immunity, etc.) if the allowable AOs are exceeded.

4.1 Test Parameters

Total Coliforms

The presence of total coliforms in the water system is an indicator that the system is experiencing regrowth of bacteria, infiltration of contaminates has occurred, or that it has not been properly treated at the source. The MAC for total coliforms is 10 per 100 ml (see Section 11.0, Pg. 23). If the sample tests are shown to exceed the MAC, it is re-sampled to confirm the original result. If the second test result is above the MAC, the affected main is isolated, monitored, flushed, and tested again. The response to another unacceptable test result is to take the main out of service, chlorinate, flush, retest it, and keep it out of service until acceptable results are obtained.

Faecal coliforms

Faecal coliforms in drinking water may indicate the presence of faecal contamination. Escherichia coli, one species in the faecal coliform group and the one best known because of its link to the death of seven people and illness of over 2000 others in Walkerton, Ontario, in 2000, is a definite indicator of the presence of faeces in the distribution system. The MAC for faecal coliform is 0 per 100 ml.

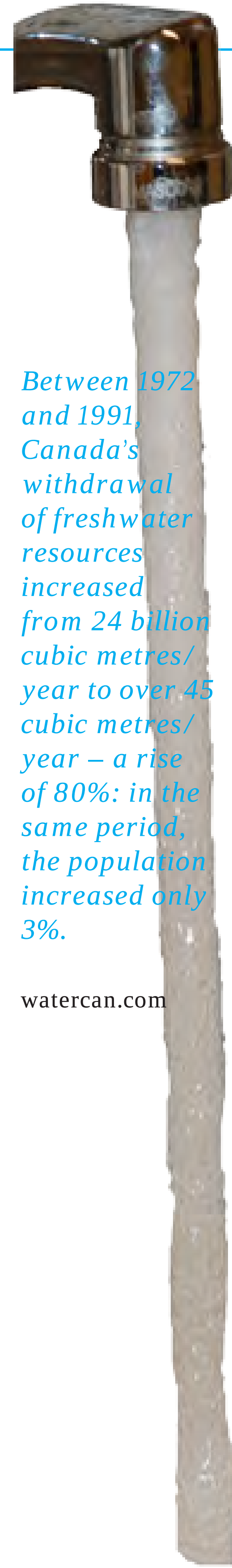
An unacceptable MAC test for faecal coliform triggers an immediate Boil Water Order by the Medical Health Officer which remains in effect until the problem is isolated, identified, resolved, and acceptable test results are obtained.

Heterotrophic Plate Count

The general bacterial population is estimated by means of a background colony count referred to as a heterotrophic plate count (HPC). Although not a significant health concern on its own, the presence of a background bacterial growth indicates that pathogenic bacteria could thrive in the system should they be able to enter it. Also, excessively high HPCs can hinder the detection of coliforms. The MAC for HPCs is 500 colonies per millilitre. If a test result indicates more than 500, the water is re-sampled and tested. Further test results indicating HPCs above 500 require the watermains to be flushed and monitored until a decreasing trend is observed.

Turbidity

Turbidity measurements relate to the optical properties of water. Poor turbidity is caused by suspended matter such as clay, silt, finely divided organic and inorganic matter, soluble coloured organic compounds, plankton, and other microscopic organisms. Excessive turbidity not only detracts from the appearance and taste of water, it can also serve as a source of nutrients for waterborne bacteria. As our supply source is surficial, and therefore subject to changes in quality due to weather changes, the water is sometimes discoloured and may taste different when it rains heavily after a long dry spell. Excessively high turbidity can also have a negative effect on disinfection techniques. The unit of measurement is the nephelometric turbidity unit (NTU). The MAC for water at the source is one NTU and the AO within the system has been set at less than five (5) NTU (Canadian Drinking Water Guideline) at the point of consumption. The Metford Dam intake is automatically shut off when the turbidity level reaches one (1) NTU. The system is monitored and flushed, when unacceptably high turbidity test results are recorded. Turbidity is continuously measured at both water supply sources (see Figure 2).



Between 1972 and 1991, Canada's withdrawal of freshwater resources increased from 24 billion cubic metres/ year to over 45 cubic metres/ year – a rise of 80%: in the same period, the population increased only 3%.

watercan.com

Today, around 3800 cubic kilometers of fresh water is withdrawn annually from the worlds lakes, rivers and aquifers. This is twice the volume extracted 50 years ago.

Environment Canada

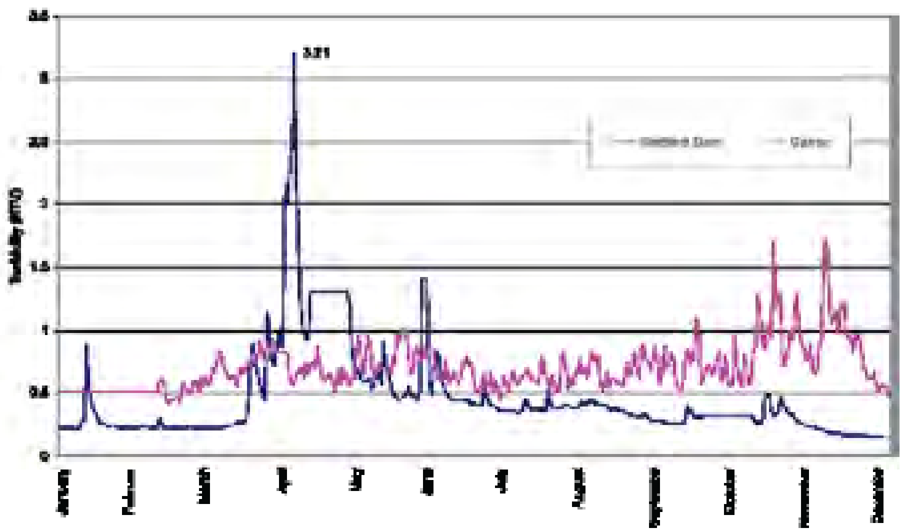


Figure 2 – Average Turbidity : 2006

Chemical Analysis

The Utilities Division takes samples on a yearly basis from both sources for a chemical analysis of common minerals and other chemical parameters (such as hardness). Results are checked against the Guidelines for Canadian Drinking Water Quality (see Appendix 1). In 2006, no tests have shown any parameters outside the maximum values recommended in the guidelines.

5.0 TESTING PROGRAM

Water at the nine sampling sites is tested and sampled every second week (18 samples per month) by our Water Utility Operator (see Appendix 4). Samples are tested on-site for temperature and chlorine residual, and the results are recorded. Samples are taken in accordance with the 20th Edition of Standard Methods for the Examination of Water and Wastewater, placed in a sterile bottle, sealed, identified by location with time of day noted, placed in a cooler, and delivered to a certified laboratory for testing (Caro Environmental Services in Kelowna). The water is tested for total coliform, and faecal coliform counts. All results are returned to Interior Health. If there is a positive test result, the local Health Office contacts the Director of Operations. Depending on the location and type of positive test result, the City will institute one or more of the following:

a. further testing to confirm the previous test results;
b. main flushing to remove stagnant water;
c. disinfection, if it appears to have contamination from an outside source; and
d. Boil Water Advisory, if there is a health risk to users.

Supplementary to the Interior Health requirement for the bi-weekly testing of water within the distribution system, the City has instituted a weekly testing program of 17 additional sites that are tested for temperature and chlorine residual. These sites are located in key locations on the extremities of the system known to have low flow or stagnant water conditions. This ensures that no biological re-growth is occurring within the system. Where either of these parameters reaches the set limits, flushing to refresh the water supply is instituted.

The health of our water system and public trust in it are things the City takes seriously. Our Utilities Division staff work closely with Interior Health so that a program is in place that ensures our citizens are provided with safe and healthy drinking water.

A dripping water tap wastes an average of 40 kilowatt hours of electricity/month. This is the equivalent of running a colour television 8 hours a day for about 31 days.

Katie Shelton,
First Science

Did you know?

The average five-minute shower takes between 15 to 25 gallons of water.

An automatic dishwasher uses approximately 9 to 12 gallons of water while hand washing dishes can use up to 20 gallons.

Each person uses about 100 gallons of water a day at home.

6.0 WATER DISTRIBUTION SYSTEM DETAILS

Figure 3 - Salmon Arm Water Utility Operator sampling water

The public water system services an area of approximately 7,290 hectares (see Appendix 2) of which 969 hectares includes Band Lands. The City distributes water in pipes made of a variety of materials. The first watermains were made of wood. These wooden mains have since been replaced with cast iron, ductile iron, PVC, polyethylene, steel, asbestos cement and some copper piping. The oldest mains still operating in the Salmon Arm water system inventory are cast iron pipes.

6.1 Watermains

Cast Iron Watermains
Approximately 0.3%, or 0.6 kilometres, of our watermain inventory is made of cast iron pipe. The majority of this pipe material was installed prior to 1978. The service life expectancy of cast iron pipe is between 50 and 100 years, depending on the soil type.

Ductile Iron Watermains
Approximately 9.5%, or 19.5 kilometres, of our water system is made

of ductile iron pipe. Ductile iron is still used in some applications in Salmon Arm. The service life expectancy of ductile iron pipe can be up to 100 years.

PVC Watermains

Approximately 39.24%, or 80.5 kilometres, of our water system is made of PVC pipe. Most of this pipe material has been installed since 1979. Although the service life of PVC pipe is not yet known, it is anticipated that it is 70 years or greater.

Asbestos Cement Watermains

Approximately 49.4%, or 101.3 kilometres, of our watermain inventory is made of Asbestos Cement water pipe. Most of this pipe material was installed prior to 1978. The life expectancy of Asbestos Cement pipe is between 50 and 60 years, depending on water quality, soil type and installation conditions. The remaining service life of existing Asbestos Cement pipe is estimated at 1 to 50 years.

The asbestos fibres in the pipe do not pose a health risk in this form. The fibres are entirely encased in a cement jacket where they pose no problem to human health. The Utilities Department crew employ special techniques to cut the pipe to ensure that the fibres cannot become airborne during the cutting process.

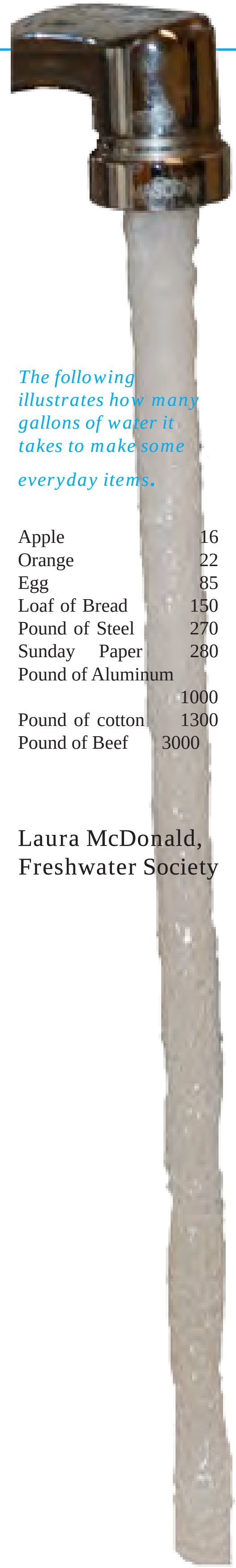
High Density Polyethylene Watermains (HDPE)

Approximately 0.4% or 0.8 kilometres of our water system is made of Polyethylene pipe. Up until now it has only been used in small diameters for water services or distribution to small numbers of houses. The upgraded intake pipe from Shuswap Lake to the Canoe Pump Station is a 1000mm diameter High Density Polyethylene pipe in 2003.

6.2 Other Components

Water Pumping Stations

The municipal water system includes 14 water storage facilities and seven pumping stations. Normally, if there is a major pumping station or storage facility failure, water service to a large area of the community could be discontinued or adversely affected until repaired. With our gravity feed from Metford Dam, water can be cascaded



The following illustrates how many gallons of water it takes to make some everyday items.

Apple	16
Orange	22
Egg	85
Loaf of Bread	150
Pound of Steel	270
Sunday Paper	280
Pound of Aluminum	1000
Pound of cotton	1300
Pound of Beef	3000

Laura McDonald,
Freshwater Society

Did you know ?

About 70% of the earth is covered in water.

3% of the water on earth is freshwater and only 1% is available for human consumption.

Nearly 70% of the earths fresh water exists in the form of glaciers and permanent snow cover.

Only 0.3% of total global fresh water is stored in lakes and rivers.

down through all the zones, with the exception of Zone 5. The pump stations house a combined total of 15 pumps with a service life of approximately 40 to 50 years for each pump.

Figure 5 - Zone 1 Pumping Station at Canoe Beach

Water Services

Salmon Arm has 5299 connections supplying water from the main to the property line. As with the watermains, these pipes age and require replacement. If a service connection were to fail, water service to the affected home or business would be discontinued until repaired. Whenever possible, service connections older than 25 years are replaced by the developers in accordance with the Subdivision and Development Servicing Bylaw. Service pipe may also be replaced when the watermain is being upgraded as part of the Capital Expenditure Program.

Of the 5299 service pipes, approximately 90% are copper pipe. Based on a study by the Seattle Water Department, the average service life for copper service pipes installed in Seattle is 40 to 50 years. The corrosive nature of some soils will likely decrease the average service life of some connections.

The remaining 10% of service pipes are made of galvanized iron, cast iron, asbestos cement, ductile iron, PVC or polyethylene pipe. The older industrial service pipes are made of asbestos cement and cast iron pipe, while the newer industrial service pipes are made of ductile iron, PVC or polyethylene.

System Control – "SCADA" (Supervisory **C**ontrol **A**nd **D**ata **A**cquisition**)**

Maintaining reservoir water levels, operating pumps, monitoring quality control equipment and maintaining a historical data file of the water systems operations is made easier by a comprehensive software program employed by the Utilities Department. Connected by telephone lines and/or radio links, the SCADA software is able to monitor sensors at all the reservoirs and pump stations. Interpreting the data received, it then automatically turns pumps on and off to keep the system flowing smoothly. When trouble is detected within the system the software issues alarms and notifies Water Utilities Department staff.

Water Storage Facilities

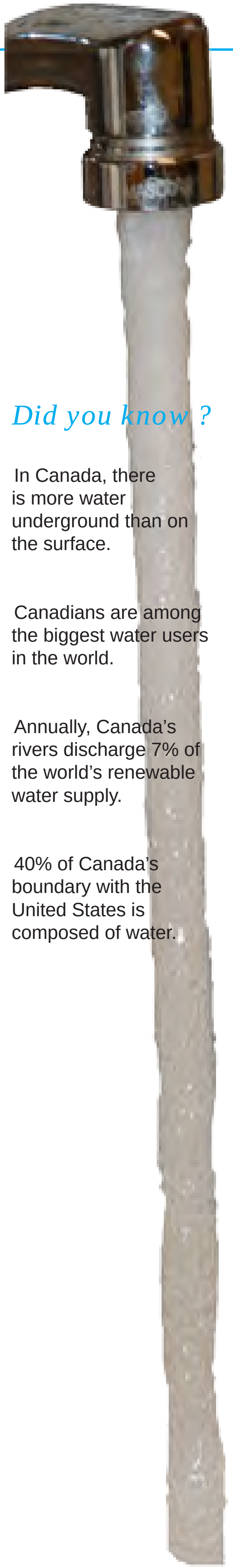
The City has thirteen (13) enclosed reservoirs and one (1) dam storing water for seven (7) pressure zones within the system. Each reservoir is sized to balance daily water consumption, as well as provide an emergency water supply for fire protection. The 13 reservoirs have a total storage capacity of 15,500 m^3 (3,410,300 gallons). In addition, the Metford Dam on East Canoe Creek has storage for 8200 m^3 (1,800,000 gallons).

Fire Hydrants

Salmon Arm has approximately 677 City and 125 private fire hydrants. Approximately 90% of the hydrant inventory is the older style, slide-gate hydrant and the remainder are the newer compression style hydrants.

Air Valves

Turbulence created in the water as it flows through the system causes some of the dissolved air in the water to collect as bubbles in the pipes. These air bubbles collect at the high points in the system and restrict water flow. We have approximately 181 air valves installed in below-ground chambers that automatically bleed air from the pressurized



Did you know ?

In Canada, there is more water underground than on the surface.

Canadians are among the biggest water users in the world.

Annually, Canada's rivers discharge 7% of the world's renewable water supply.

40% of Canada's boundary with the United States is composed of water.

piping system. If an air valve failed, negative pressures could allow groundwater to infiltrate and contaminate the water system. Air valves receive regular maintenance as required and are replaced at the end of their service life, which is approximately 20 years.

Flow Control (Gate) Valves
We have approximately 1878 flow control valves attached to the underground water pipe network. The valves are primarily used to control the direction of water flow and to isolate areas of the network for inspection or repair. The expected service life of a flow control valve is 40 to 50 years.

Pressure-Reducing Valve Stations
The maximum design water pressure for piping within the municipal water system is 1034 kPa (150 psi). We have five pressure reducing valve stations containing one Pressure-reducing valve (PRV) each. Pressure reducing valves are used to control the pressure in the water system by creating head losses that prevent pressures from exceeding the design maximum. The failure of a PRV could disrupt flows and mainline pressures to a large area of the community.

The Utilities Department currently overhauls the PRV stations every year in an effort to extend their service life. Most individual premises also have secondary PRV's as fluctuating pressures can place excessive stress on internal plumbing systems and fixtures.

• ***Figure 6 – Zone 4 Pump/Pressure Reducing Station on 30th Street NE***

Water Meters

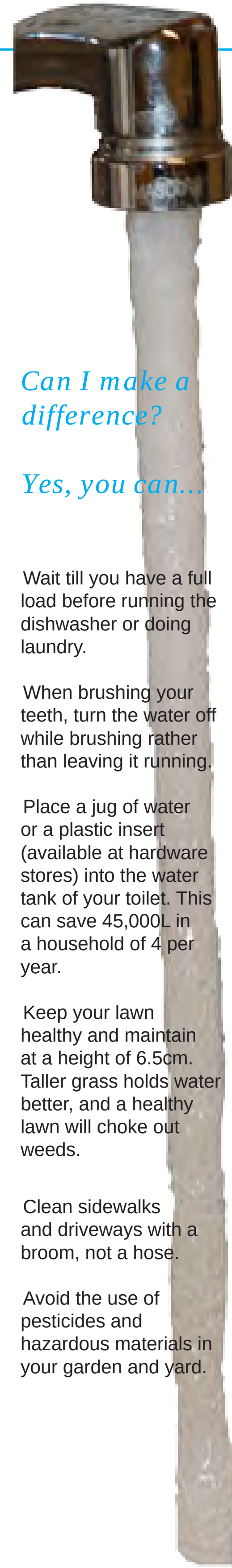
The City currently meters approximately 1409 water services or only about 26.5% of all water connections to homes or businesses. As a water meter ages, its mechanisms tend to underestimate the water passing through it and consequently users may be undercharged for the actual water use. The normal service life of a water meter is approximately 15 years.

6.3 Water System Value

The total value of our primary water distribution system, as detailed in Figure 7 below, is approximately $55,800,000. We budgeted $1.472 million in 2006 or approximately 2.6%, on water infrastructure replacement. The replacement program is designed to address some of these previously discussed replacement components and other general deficiencies within the system on a priority basis. However; a thorough and comprehensive maintenance program also helps to extend the life expectancy of a majority of these water infrastructure elements.

System Components	Quantity in Use in Salmon Arm	Approximate Replacement Cost
Watermains	205.2 km	$42,850,600
Reservoirs/Tanks	13 Reservoirs/1Dam	$7,600,000
Pumping Stations	7	$5,700,000
System Control	1	$400,000
Total		$56,550,600

Figure 7 - Infrastructure replacement value



Can I make a difference?

Yes, you can...

Wait till you have a full load before running the dishwasher or doing laundry.

When brushing your teeth, turn the water off while brushing rather than leaving it running.

Place a jug of water or a plastic insert (available at hardware stores) into the water tank of your toilet. This can save 45,000L in a household of 4 per year.

Keep your lawn healthy and maintain at a height of 6.5cm. Taller grass holds water better, and a healthy lawn will choke out weeds.

Clean sidewalks and driveways with a broom, not a hose.

Avoid the use of pesticides and hazardous materials in your garden and yard.

Did you know ?

Up to 60% of the human body is water.

The brain is composed of 70% water.

Blood is 82% water.

The lungs are nearly 90% water.

7.0 SYSTEM MAINTENANCE

Maintenance of the Salmon Arm water system involves four key programs:

1. Valves;
2. Watermains;
3. Hydrants; and,
4. Reservoirs.

As replacement of the entire distribution grid is not affordable, system maintenance becomes a critical component in the management of the water infrastructure. The total Operation and Maintenance Expenditures in 2006 for the water system was $1.204 million.

7.1 Annual Maintenance Program

Valve Maintenance

Valves are interspersed along watermains and can be shut or opened to alter the flow of water or to isolate a portion of the water system for repair or maintenance. These valves can be inadvertently buried or left closed causing maintenance challenges by restricting water flow through the main. In response to these problems, Utilities Department staff began a valve exercising program. A City crew tries to inspect each valve annually, exposing buried valves, making repairs, and exercising every valve by turning it first to a closed position then back to open.

Watermains

Watermain maintenance involves both the upgrading of aging watermains and ensuring that existing watermains are operating effectively.

Watermain Upgrading

In addition to repairing watermains that break, aging watermains must be replaced. An ongoing replacement/preventative measures program is in place, targeting areas with older piping materials in susceptible condition and areas identified with inadequate fire flow. Future development is also factored into the overall plan.

Capital Watermain Projects for 2006 were:

1. 4th Avenue SE (Homely Reservoir), from 10th Street SE to 6th Street SE, watermain upgrade of 840m watermain to 300mm diameter PVC and install 100m of new 200mm diameter watermain to increase the water supply to Homely Reservoir.
2. 1st Avenue SE (5th to 6th Street SE) watermain upgrade, replace 86m of deteriorated watermain with 200mm PVC. This works was done in conjunction with active development in the area to take advantage of cost savings for the City.
3. 2nd Street SE (Okanagan Avenue to 2nd Avenue SE), upgrade 200m of watermain to 200mm in conjunction with road improvements.
4. 2nd Avenue NE (Ross Street to 6th Street SE), install 150m of 200mm diameter watermain. This improvement was done in conjunction with road improvement works.
5. 8th Avenue NE and 6th Avenue NE (Hudson Street to 7th Street NE), upgrade 194m of watermain to 200mm PVC.
6. Upgrade of 75m of watermain to 200mm PVC from 4th Street NE eastward along the north property line of Penkert's Bakery.
7. 40th Street NE (20th Avenue SE to Auto Road SE), installation of 558m of 200mm diameter watermain.
8. A water loss survey was conducted to identify areas/zones that should be closely inspected for leaks.
9. Detailed design of the Shuswap Lake water treatment plant recommendation made by the Stantec Consulting Ltd.

Watermain Flushing

As water travels from the watersheds, it collects organic particles and transports them to the water system. As these particles travel to areas of the water system with lower flow velocities they settle out. Accumulated debris and stagnant water inhibit flow through mains, cause dirty water and potentially create a favourable environment for bacterial growth. In response to these concerns, the Utilities Department initiated a watermain flushing program for identified problem areas. Each main is flushed annually during daytime hours. When flushing, a hydrant is opened and the water stream is used to expel the contents of the main. There are approximately 17 locations throughout the municipality referred to as "high maintenance areas" where water demand is low or where watermains terminate in a dead

Did you know ?

A rat can last longer without water than a camel.

All porcupines float.

Every time Beethoven sat down to write music, he poured ice water over his head.

end. These areas are flushed as required, sometimes as often as every month during the summer.

Figure 8 – Utilities Department operator flushing watermain as part of regular maintenance

We also flush mains within 24 hours of receiving test results from the Interior Health that indicate bacteria levels outside the accepted provincial standard which are based on the “Guidelines for Canadian Drinking Water Quality”.

Hydrant Maintenance

Historically, fire hydrants were only serviced when requested by the Fire Department. To ensure proper fire protection, Salmon Arm implemented a fire hydrant maintenance program. The program requires staff to check the pressure on each hydrant before it is serviced and dismantles each hydrant, renewing worn parts as necessary. The hydrant is then lubricated and reassembled. All hydrants get an overhaul every other year.

Reservoir Maintenance

Debris can accumulate in reservoirs and bacteria and algae can grow on the walls. Each year, the Utilities Department staff cleans and services two different reservoirs. The program involves decommissioning the reservoir, draining it, removing any sediment, repairing leaks, and disinfection.

The reservoir is then refilled, chlorinated and tested for water quality. This program requires approximately two days to complete before the reservoir can be brought back into service.

Figure 9 - Metford Dam (March 23, 2007)

8.0 WATERMAIN BREAKS

Most water utilities frequently experience minor disruptions. Pipes break, valves stick, hydrants leak and power outages occur. Although these are not anticipated, the problems experienced can usually be corrected with minimal disruption, and regular service can be quickly restored.

In 2006, our staff responded to and repaired 5 watermain breaks, one of which resulted in damage to a public road. (Note: service connection or hydrant lead breaks are not included in this total).

Procedures for Watermain Repairs or Tie-ins

Watermains are disinfected whenever they are exposed to the

There is the same amount of water on earth today as there was when the earth was formed.

Katie Dixon, US Environmental Protection Agency atmosphere. To prevent a possible introduction of contamination, City crews try to maintain positive pressure in the system. This practice makes it more difficult to complete repairs and it may appear as though water is being wasted when conducting them, but it is a necessary safeguard to protect the integrity of the system.

Repairs or tie-ins with no groundwater entry
These repairs are typically the result of electrolysis holes, cracks, or splits, and are repaired using repair clamps. Provided the watermain maintains positive pressure until City crews have excavated below the invert of the pipe, it is assumed that no contaminant can enter the system. The repair clamps and other materials required to complete the repairs are cleaned with a 6% chlorine solution. Upon completion of the repairs, the main is flushed and put back into service.

Repairs or tie-ins with groundwater entry
On occasion, watermain breaks have occurred where it is impossible to maintain positive pressure or to pump all groundwater below the invert of the watermain before throttling it down or shutting it off. In this case, disinfection, flushing, and residual testing procedures are followed prior to recommissioning the watermain.

The City adheres to the procedures set out in the American Water Works Association (AWWA) Standard C651-92 regarding watermain chlorination. This requires that the main is completely isolated, that it is disinfected with a chlorine concentration of 200 milligrams per litre (mg/L) for a retention time of 2 hours, and that after two hours the chlorine residual level is a minimum of 100 mg/L.

If this condition is not met, the main must be re-chlorinated using the same standard. After a successful result, the watermain is flushed continuously until the chlorine residual is less than one milligram per litre. When the desired residual level is achieved, the watermain is returned to service.

New Watermains
Disinfection of a new watermain is completed in accordance with AWWA C651, Continuous Feed Method which requires initial disinfection with a chlorine concentration of 25 mg/L for a retention time of 24 hours. At the end of the disinfection period, the chlorine

Many Canadians lose more water from leaky taps than they need for cooking and drinking.

watercan.com

residual level is a minimum of 10 mg/L. If this condition is not met, the main must be re-chlorinated using the same standard. After a successful result, the watermain is flushed continuously until the chlorine residual is less than 1 mg/L. When the desired residual level is achieved it is allowed to sit for 24 hours before test samples are sent to a certified laboratory for coliform tests. If the bacterial tests are clean, then the main is ready for connection to the system. If the samples are not clean, the whole process is repeated

9.0 NOTIFICATION PROTOCOL

Normally, breaks or disruption to water service are caused by conditions that can be repaired and reinstated quickly, directly by City forces without risk to the public health. Sometimes however, situations arise that require extra care to guarantee that the integrity of our water infrastructure has not been compromised. The Utilities Department endeavours to keep the Medical Health Officer apprised of any extraordinary situations that may adversely impact the City's water system.

10.0 WATER CONSUMPTION

Our community still has an above average per capita water use amongst Canadian municipalities. Some possible causes of this excessively high per capita consumption may include undetected system leaks, illegal connections, high residential summer irrigation demand, and inaccurate metering. The City commissioned a Water Use Efficiency Study and appointed a committee to review the findings and make recommendations to Council on the need for and the form of any water conservation measures. In 2003 the Water Use Efficiency Committee brought forward a Water Conservation policy which Council adopted (see Appendix 6). Sustainable Shuswap continues to assist with the management of this Program.

The policy sets water consumption targets and called for a detailed study that has been ongoing for the past number of years. Initial activities involved numerous education and voluntary compliance programs aimed at informing the residents of the need and benefit to the community if we change our water consumption habits to reduce wasting water. Further objectives of the study include possible

Did you know ?

The value of the in-ground assets of Canadian municipal water supply and wastewater systems totals over $100 billion.

About 82% of Canadians (1994 data) are served by wastewater treatment plants, compared with 75% Americans, 86.5% Germans, and 99% Swedes.

Less than 3% of the water produced at a large municipal water treatment plant is used for drinking purposes; during the summer, about half of all treated water is sprayed onto lawns and gardens.

implementation of regulatory measures including full water metering to achieve targeted water consumption goals, soil profiling and consumption by user.

Public education and residential user audits (in 2005) are believed to have contributed to a peak day production and average day production reduction of 14% and 12% respectively (goal was 20% and 14%). Unfortunately, 2006 saw an increased production of 6.4%. This may be attributed to increased development pressure as well as warmer than usual temperatures and lower than usual precipitation for the year.

In an effort to identify and quantify production loss within the system, the City had a Leak Detection Study completed by IKEN Services Ltd. (October, 2006). The study was conducted on two zones, an older zone (zone 1- Canoe) and a relatively new zone (zone 5 – 2020). The results indicate that Zone 1 has a considerable recoverable loss, which in part, is likely due to leakage, and would benefit from a more detailed assessment. Although Zone 5 did show a potential recoverable loss, it was not outside of what would generally be accepted as normal loss. It is anticipated that further leak detection works will be completed by the City in the coming years. It is evident that leakage within the system combined with actual consumption (as well as unauthorized use) creates somewhat skewed municipal water consumption data. Regardless of potential losses in the system, production data can be used to illustrate consumption trends and is therefore useful in identifying areas where conservation measures can be implemented.

Figure 10 compares the total monthly water consumption from 2004 to 2006 with local weather data for the same period. See Appendix 5 for further total consumption data.

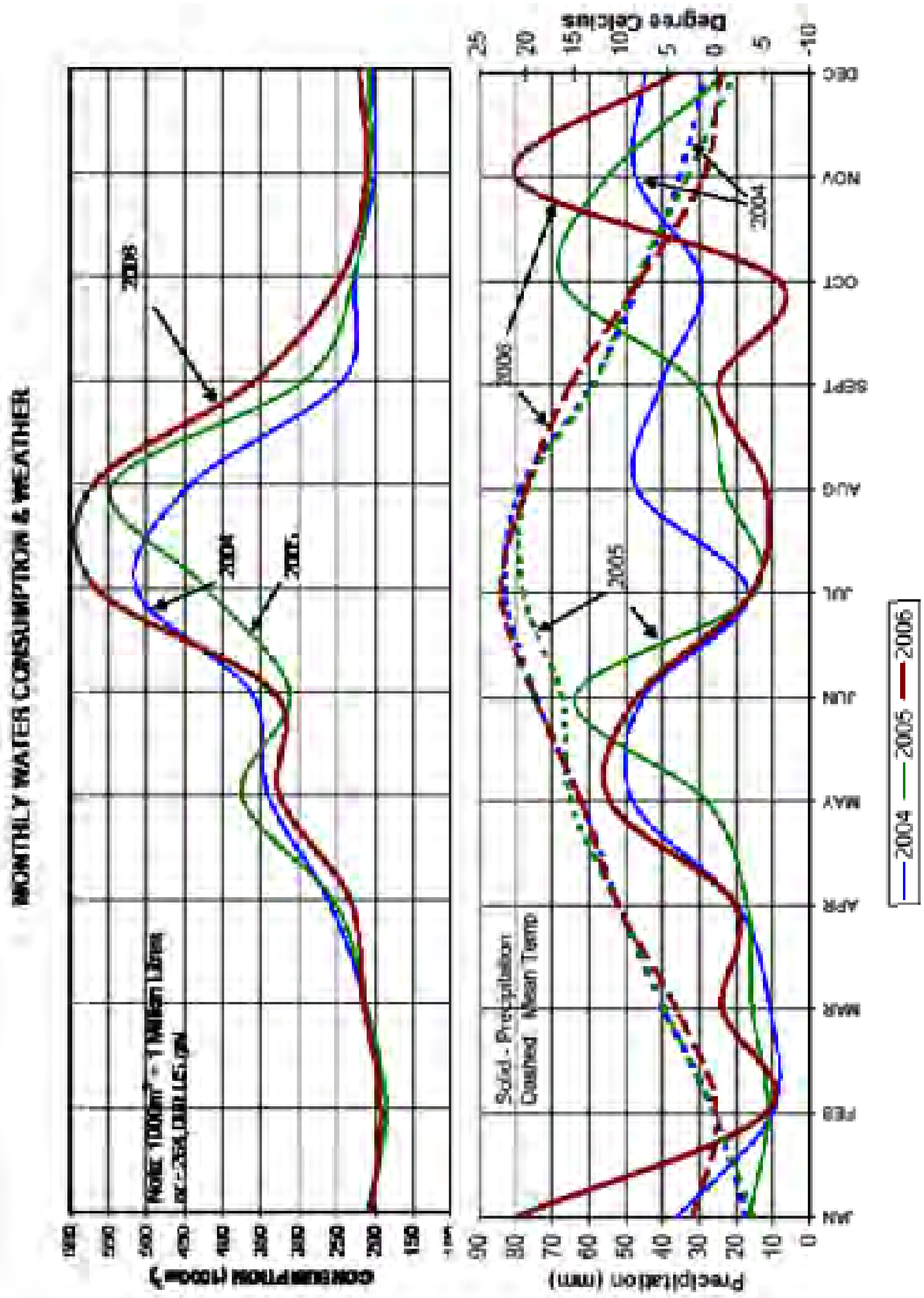


Figure 10 See Appendix 5

11.0 TEST RESULTS

The Guidelines for Canadian Drinking Water Quality, Sixth Edition and the British Columbia Safe Drinking Water Regulation have established the following microbiological criteria:

- No sample should contain more than ten total coliform organisms per 100 ml, none of which should be faecal coliforms;
- No two consecutive samples from the same site should show the presence of coliform organisms; and
- At least 90% of the samples must have zero total coliforms per 100 ml.

Of the 87 treated water samples analysed for microbiological criteria in 2006, zero faecal coliforms were detected and all sites indicated less than one for the presence of total coliforms.

12.0 2006 CHALLENGES TO DRINKING WATER QUALITY

There were no contamination incidents within the distribution system during the 2006 operating year. However, we did have four short periods where the source water on East Canoe Creek was showing high turbidity (above 1NTU). One of these turbidity events resulted in a public Water Quality Advisory Notice on December 4 that was lifted December 20.The East Canoe intake was shut down briefly during each event until turbidity levels dropped back to a normal range (below 1 NTU). Also, the SCADA system was down for one day (April 27) due to an electrical storm. The system was operated manually with out incident until the issue was resolved.

13.0 CONCLUSION

The City of Salmon Arm has made a lot of progress in the implementation of BC's Drinking Water Protection Act and Regulations. While there is still some work to do, construction of the Shuswap Lake water treatment plant and adding UV treatment at Medford Dam, City staff continue to work hard to maximize the safety and reliability of the water we deliver to our customers.

APPENDIX 1

CITY OF SALMON ARM
SOURCE WATER CHEMICAL ANALYSIS
TEST RESULTS

WATER QUALITY REPORT
SHUSWAP LAKE INTAKE AT CANOE PUMP STATION

	pH (units)	Conductivity at 25 deg C (umhos/cm	Dissolved Solids (Total) mg/L	Suspended Solids mg/L	Hardness (Total) mg/L as CaCO3	Nitrate mg/L as N	Nitrite mg/L as N	Fluoride mg/L	Total Coliform (Colonies/100mL)	Fecal Coliform (Colonies/100mL)	Aluminum Total) mg/l	Antimony (Total) mg/l	Arsenic (Total) mg/L	Barium (Total) mg/L	Boron (Total) mg/L	Cadmium (Total) mg/L	Calcium (Total) mg/L	Chloride mg/L	Chromium (Total) mg/L	Copper (Total) mg/L	Iron (Total) mg/L	Lead (Total) mg/L	Magnesium (Total) mg/L	Manganese (Total) mg/L	Mercury (Total) mg/L	Molybdenum (Total) mg/l	Potassium (Total) mg/l	Selenium (Total) mg/L	Sodium (Total) mg/L	Sulphate mg/L	Uranium (Total) mg/l	Zinc (Total) mg/L	Heterotrophic Plate Count (colonies/100mL)
01-Dec-94	6.51	120	58	2.5	46	0.1	0.1		3				<0.005	0.033	0.14	<0.002	14.3	0.8	<0.005	0.021	0.17	<0.005	2.5	<0.01	<0.0001			<0.005		8.9		0.04	
05-Dec-95	6.7	110	76	<1	37.5	0.06	0.06	<0.05	4	<1			<0.005	0.007	0.16	<0.001	11.9	<2	<0.005	0.004	1.6	<0.005	1.9	<0.005	<0.0001			<0.005	<1	8.2		0.01	
29-Mar-96	7.11	120	80	1	45.7	0.07	0.07	0.06	<1	<1			0.02	<0.002	<0.05	<0.002	14	<2.0	0.006	0.003	<0.01	<0.01	2.6	0.02	<0.0001			<0.01	2.2	7.2		0.01	
15-Jan-97	7.63	140	<5	100	60	<0.05	<0.05	<0.05	<1	<1			<0.005	0.092	<0.05	<0.001	17.9	<2	<0.005	0.005	0.06	<0.01	3.3	0.01	<0.0001			<0.005	3	8.4		0.01	
04-Feb-98	7.11	130	70	9	61	<0.05	<0.05	0.05	14	<1			<0.02	0.11	<0.05	0.001	18.8	<2	<0.005	0.028	0.16	<0.01	3.4	<0.01	<0.0001			<0.005	4	<5		<0.01	56
15-Dec-98	7.4	130	74	2	55.4	0.08	0.08	0.1	6	<1			<0.02	0.011	<0.01	<0.0005	17.7	1	<0.001	0.007	<0.003	<0.005	2.72	<0.0005	<0.0001			<0.01	2.23	8		0.002	12
08-Mar-99	7.59	130	94		48.7	0.102	<0.003	0.1	0	0			<0.001	<0.08	<0.01	<0.0005	15.4	1	<0.004	<0.005	<0.01	<0.01	2.9	<0.005	<0.05			<0.01	2.02	9		<0.002	
13-Jan-00	7.9	119	75	<1	57	0.11	<0.01	0.1	8	0			<0.01	0.01	<0.1	<0.0002	18	1.1	<0.01	<0.01	<0.03	<0.001	3	0.006	<0.00005			<0.0005	2.24	8.7		0.006	15
18-Jan-01	7.2	192	81	<1	60	0.11	<0.01	<0.1	0	0			<0.01	0.01	<0.1	<0.0002	19.3		<0.01	<0.01	<0.03	<0.001	2.8	<0.005	<0.00005			<0.001	2.12	8.3		0.008	12
09-Jan-02	7.6	111	67	<1	53	0.09	<0.01	<0.10	0	0			0.0002	0.01	<0.1	<0.0002	16.6	0.95	<0.01	<0.01	<0.03	<0.001	2.7	<0.005	<0.00005			<0.0005	2.03	7.6		0.007	26
14-Jan-03	7.3	119	58	<1	46	0.09	<0.01	<0.10	0	0			0.0002	<0.01	<0.1	<0.0002	14.5	1.1	<0.01	<0.01	0.03	<0.001	2.5	0.007	<0.00005			<0.001	2	7.5		<0.005	14
13-Jun-03	7.6	115	75	2	52	0.07	<0.01	0.1	0	0			<0.001	<0.02	<0.01	<0.0002	16.5	1.25	<0.002	<0.01	0.08	<0.001	2.6	0.003	<0.0002			<0.001	2	8		<0.05	
13-Jan-04	7.5	110	68	<1	48	0.09	<0.01	0.15	0	0	0.01	<0.0005	<0.001	<0.02	<0.01	<0.0002	15.3	0.9	<0.002	<0.01	<0.03	0.002	2.28	0.003	<0.0002	<0.03	1.01	<0.001	<2	6.8	0.00037	<0.05	60
19-Jan-05	**7.3**	**108**	**63**	**2**	**49**	**0.09**	**<0.01**	**0.1**	**0**	**0**	**0.05**	**<0.0005**	**<0.001**	**<0.02**	**<0.10**	**<0.002**	**15**	**0.9**	**<0.002**	**<0.01**	**0.124**	**<0.001**	**2.5**	**0.021**	**<0.0002**	**<0.03**	**1.0**	**<0.001**	**<2**	**7.1**	**0.0004**	**<0.05**	**8**
20 Sept 05 `	**7.0**	**107**	**73**	**2**	**47**	**0.11**	**<0.01**	**0.15**	**2**	**0**	**0.04**	**<0.0005**	**<0.001**	**<0.02**	**<0.1**	**<0.0002**	**15**	**1.00**	**<0.002**	**<0.01**	**0.10**	**<0.001**	**2.3**	**0.019**	**<0.0002**	**<0.03**	**1.0**	**<0.001**	**<2**	**6.5**	**0.0004**	**<0.05**	**43**
30-Mar-06	**7.3**	**128**	**73**	**<1**	**51**	**0.07**	**<0.01**	**0.15**	**0**	**0**	**0.04**	**<0.0005**	**<0.001**	**<0.02**	**<0.1**	**<0.0002**	**16**	**1.20**	**<0.002**	**<0.01**	**0.08**	**<0.001**	**2.7**	**0.017**	**<0.0002**	**<0.03**	**1.1**	**<0.001**	**3**	**9.1**	**0.0005**	**<0.05**	**10**
19-Jun-06	**7.0**	**118**	**72**		**50**	**0.12**	**<0.01**	**0.1**	**17**	**0**	**0.07**	**<0.0005**	**<0.001**	**<0.02**	**<0.1**	**<0.0002**	**16**	**1.15**	**<0.002**	**<0.01**	**0.14**	**<0.001**	**2.4**	**0.026**	**<0.0002**	**<0.03**	**1.0**	**<0.001**	**<2**	**7.6**	**0.0004**	**<0.05**	**490**
CDWG : Canadian Drinking Water Quality Guidelines																																	
CDWG*1		**-**				**10.0**	**1.0**	**1.5**	**	**			**0.025**	**1.0**	**5.0**	**0.005**	**-**		**0.05**		**0.3**	**0.01**	**-**		**0.001**			**0.01**			**<0.02**		**500**
CDWG*2	**6.5-8.5**		**<500**		**<500**													**<250**		**<1.0**				**0.05**					**<200**	**<500**		**<0.05**	

CDWG*1 Maximum acceptable concentration

CDWG*2 Aesthetic concentration

** Microbiological Characteristics:
For total coliform the maximum acceptable concentration is 0 colonies/100mL. However, due to uneven distribution in water:
1) No sample should contain more than 10 total coliform organisms per 100 mL none of which should be fecal coliforms.
2) No consecutive samples from the same site should show any coliforms
3) If any coliforms are detected, or if there are more than 200 background colonies on a toal coliform membrane filter per 100 100 mL, the site should be resampled, and if results confirmed, cause should be determined and remediation undertaken.

Notes: Hardness: 80-100 as CaCO3 preferred
>200 as CaCO3 poor but tolerated
>500 as CaCO3 normally unaccepted

Aluminum - No health guideline "operational guidance values" for water treatment

WATER QUALITY REPORT
METFORD DAM INTAKE

	pH (units)	Conductivity at 25 deg C (umhos/cm)	Dissolved Solids (Total) mg/L	Suspended Solids mg/L	Hardness (Total) mg/L as CaCO3	Nitrate mg/L as N	Nitrite mg/L as N	Fluoride mg/L	Total Coliform (Colonies/100mL)	Fecal Coliform (Colonies/100mL)	Aluminum Total) mg/l	Antimony (Total) mg/l	Arsenic (Total) mg/L	Barium (Total) mg/L	Boron (Total) mg/L	Cadmium (Total) mg/L	Calcium (Total) mg/L
01-Dec-94	7.8	400	190	1.2	204	<0.05	<0.05		2				<0.005	0.044	0.16	<0.002	65.1
05-Dec-95	7.66	360	130	<1	161	<0.03	<0.03	0.06	<1	<1			<0.0050	0.022	0.17	<0.001	55.1
29-Mar-96	Note: Resampled Shuswap Lake Source Only																
15-Jan-97	8.08	370	200	<1	220	<0.05	<0.05	<0.05	<1	<1			<0.005	0.11	<0.05	<0.001	72.9
04-Feb-98	7.31	410	250	<1	240	<0.05	<0.05	0.13	12	<1			<0.02	0.13	<0.05	0.001	79.7
15-Dec-98	7.32	580	380	2	267.5	0.28	0.28	0.3	40	<1			<0.02	0.0509	<0.01	<0.0005	87
08-Mar-99	8.08	445	273		192	<0.003	<0.003	0.2	0	0			<0.001	0.08	<0.01	<0.0005	61
13-Jan-00	8.4	380	241	<1	226	0.01	<0.01	0.2	7	0			<0.01	0.03	<0.1	<0.0002	75.6
18-Jan-01	7.9	390	267	<1	241	0.05	<0.01	0.2	1	0			<0.01	0.03	<0.1	<0.0002	77.3
09-Jan-02	8.2	358	214	<1	184	<0.01	<0.01	<0.10	4	0			<0.0001	0.02	<0.1	<0.0002	60
14-Jan-03	8.1	409	232	<1	219	0.02	<0.01	<0.10	10	2			<0.0001	0.03	<0.1	<0.0002	68.6
13-Jan-04	7.9	396	254	<1	216	0.05	<0.01	0.25	1	1	<0.01	<0.0005	<0.001	0.03	<0.1	<0.0002	69.4
19-Jan-05	**7.8**	**371**	**228**	**<1**	**203**	**0.03**	**<0.01**	**0.2**	**7**	**0**	**<0.01**	**<0.0005**	**<0.001**	**0.03**	**<0.1**	**<0.0002**	**68**
20-Sep-05	**8.0**	**352**	**233**	**<1**	**182**	**0.00**	**<0.01**	**0.20**	**3**	**2**	**<0.01**	**<0.0005**	**<0.001**	**0.03**	**<0.1**	**<0.0002**	**60**
30-Mar-06	**8.0**	**393**	**247**	**<1**	**196**	**<0.01**	**<0.01**	**0.15**	**0**	**0**	**<0.01**	**<0.0005**	**<0.001**	**0.03**	**<0.1**	**<0.0002**	**65**
19-Jun-06	**7.9**	**349**	**215**		**177**	**0.02**	**<0.01**	**0.20**	**26***		**<0.01**	**<0.0005**	**<0.001**	**0.03**	**<0.1**	**<0.0002**	**62**
CDWG : Canadian Drinking Water Quality Guidelines																	
CDWG*1		**-**				**10.0**	**1.0**	**1.5**	**	**			**0.025**	**1.0**	**5.0**	**0.005**	**-**
CDWG*2	**6.5-8.5**		**<500**		**<500**												

	Chloride mg/L	Chromium (Total) mg/L	Copper (Total) mg/L	Iron (Total) mg/L	Lead (Total) mg/L	Magnesium (Total) mg/L	Manganese (Total) mg/L	Mercury (Total) mg/L	Molybdenum (Total) mg/l	Potassium (Total) mg/l	Selenium (Total) mg/L	Sodium (Total) mg/L	Sulphate mg/L	Uranium (Total) mg/l	Zinc (Total) mg/L	Heterotrophic Plate Count (colonies/100mL)
01-Dec-94	<0.05	<0.005	0.003	0.03	<0.005	10.1	<0.01	<0.0001			<0.005		28.3		<0.01	
05-Dec-95	<2	<0.005	<0.002	0.07	<0.005	5.6	<0.005	<0.0001			<0.005	<1	17		<0.01	
29-Mar-96																
15-Jan-97	<2	<0.005	0.004	0.03	<0.01	8.6	<0.01	<0.0001			<0.005	2	17.1		<0.01	
04-Feb-98	<2	0.008	0.034	0.19	<0.01	10.9	<0.01	<0.0001			<0.005	4	28		<0.01	32
15-Dec-98	26	<0.001	0.011	0.098	<0.005	12.2	0.0173	<0.0001			<0.01	10.8	33		0.013	
08-Mar-99	<0.50	<0.004	<0.005	<0.01	<0.001	10.2	<0.005	<0.05			<0.01	2.78	37		<0.002	
13-Jan-00	0.6	<0.01	<0.01	<0.03	<0.001	9.1	<0.005	<0.00005			<0.0005	2.16	20		<0.005	19
18-Jan-01	0.6	<0.01	<0.01	<0.03	<0.001	11.7	<0.005	<0.00005			<0.001	2.92	33		<0.005	44
09-Jan-02	0.5	<0.01	<0.01	<0.03	<0.001	8.3	<0.005	<0.00005			<0.0005	2.26	16.3		<0.005	68
14-Jan-03	0.6	<0.01	<0.01	<0.03	<0.001	11.7	<0.005	<0.00005			<0.001	3	31		<0.005	49
13-Jan-04	0.45	<0.002	<0.01	<0.03	<0.001	10.3	0.003	<0.0002	<0.03	1.59	<0.001	2.8	31	0.00102	<0.05	200
19-Jan-05	**0.5**	**<0.002**	**<0.01**	**<0.03**	**<0.001**	**8.5**	**<0.002**	**<0.0002**	**<0.03**	**1.3**	**<0.001**	**2.2**	**18.2**	**0.00080**	**<0.05**	**200**
20-Sep-05	**0.50**	**<0.002**	**<0.01**	**0.00**	**<0.001**	**7.9**	**<0.002**	**<0.0002**	**<0.03**	**1.5**	**<0.001**	**2**	**22**	**0.00070**	**<0.05**	**34**
30-Mar-06	**0.50**	**<0.002**	**<0.01**	**<0.03**	**<0.001**	**8.1**	**<0.002**	**<0.0002**	**<0.03**	**1.5**	**<0.001**	**3**	**25**	**0.00090**	**<0.05**	**70**
19-Jun-06	**0.50**	**<0.002**	**<0.01**	**<0.03**	**<0.001**	**5.4**	**<0.002**	**<0.0002**	**<0.03**	**1.3**	**<0.001**	**<2**	**13**	**0.00060**	**<0.05**	**750**
CDWG : Canadian Drinking Water Quality Guidelines																
CDWG*1		**0.05**		**0.3**	**0.01**	**-**		**0.001**			**0.01**			**<0.02**		**500**
CDWG*2	**<250**		**<1.0**				**0.05**					**<200**	**<500**		**<.05**	

CDWG*1 Maximum acceptable concentration

CDWG*2 Aesthetic concentration

** Microbiological Characteristics:
For total coliform the maximum acceptable concentration is 0 colonies/100mL. However, due to uneven distribution in water:
1) No sample should contain more than 10 total coliform organisms per 100 mL none of which should be fecal coliforms.
2) No consecutive samples from the same site should show any coliforms
3) If any coliforms are detected, or if there are more than 200 background colonies on a toal coliform membrane filter per 100 100 mL, the site should be resampled, and if results confirmed, cause should be determined and remediation undertaken.

* 19 June 06 - Total Coliform - 26 colonies/100 mL with unidentified bacterial background greater than 200 colonies/100 mL

Notes: Hardness: 80-100 as CaCO3 preferred
>200 as CaCO3 poor but tolerated
>500 as CaCO3 normally unaccepted

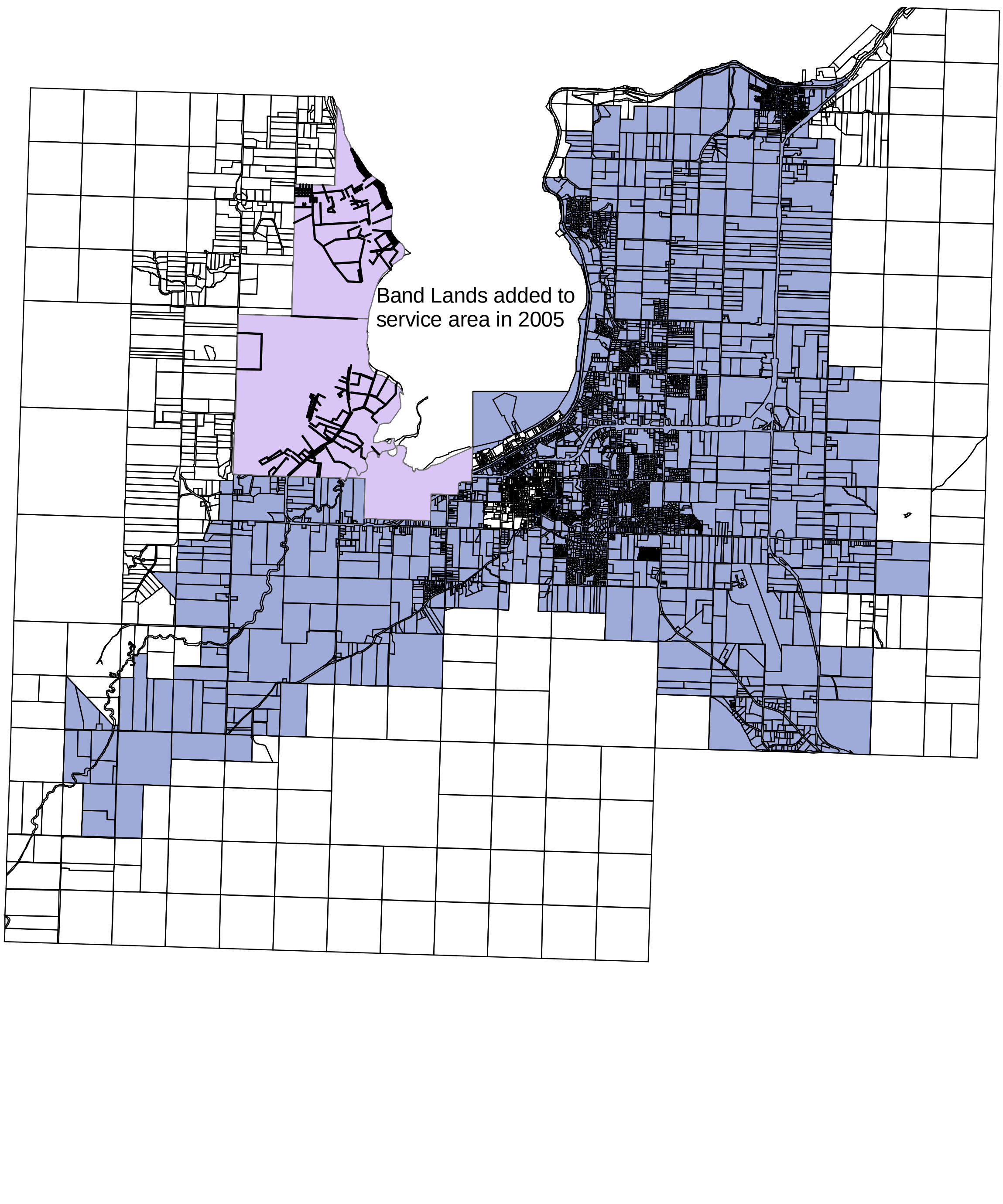
Aluminum - No health guideline "operational guidance values" for water treatment are 0.10 or 0.20 mg/l depending on treatment type.

APPENDIX 2

CITY OF SALMON ARM
WATER SERVICE AREA

3

CITY OF SALMON ARM
WATER SERVICE AREA



APPENDIX 3

INTERIOR HEALTH AUTHORITY
CITY OF SALMON ARM
WATER SAMPLE SCHEDULE

DISTRICT OF SALMON ARM
OPERATIONS DEPARTMENT
WATER UTILITY
WATER SAMPLE SITES & LOCATIONS

	Water Sample Site Name	Street Location
1.	Canoe Fire Hall	6600 – 50 Street NE
2.	Mt Ida School	7381 – 50 Avenue SW
3.	Homely Reservoir	851 – 10 Avenue SE
4.	Zone 3 Reservoir	4921 – 30 Street NE
5.	Country Kitchen	5270 Auto Road SE
6.	TCH East	4940 - 50 Street NE [TCH]
7.	IR #3 Reservoir	251 Gleneden Road NW
8.	IR #6 Reservoir	2540 – 50 Street NW
9.	DSA Gravel Pit* [alternate]	6641 – 10 Avenue SE

WATER SAMPLE SCHEDULE

Week 1 & 3	Canoe Fire Hall Country Kitchen Mt Ida School IR #6 Reservoir
Week 2 & 4	Homely Reservoir IR #3 Reservoir Zone 3 Reservoir TCH East DSA Gravel Pit* [alternate]

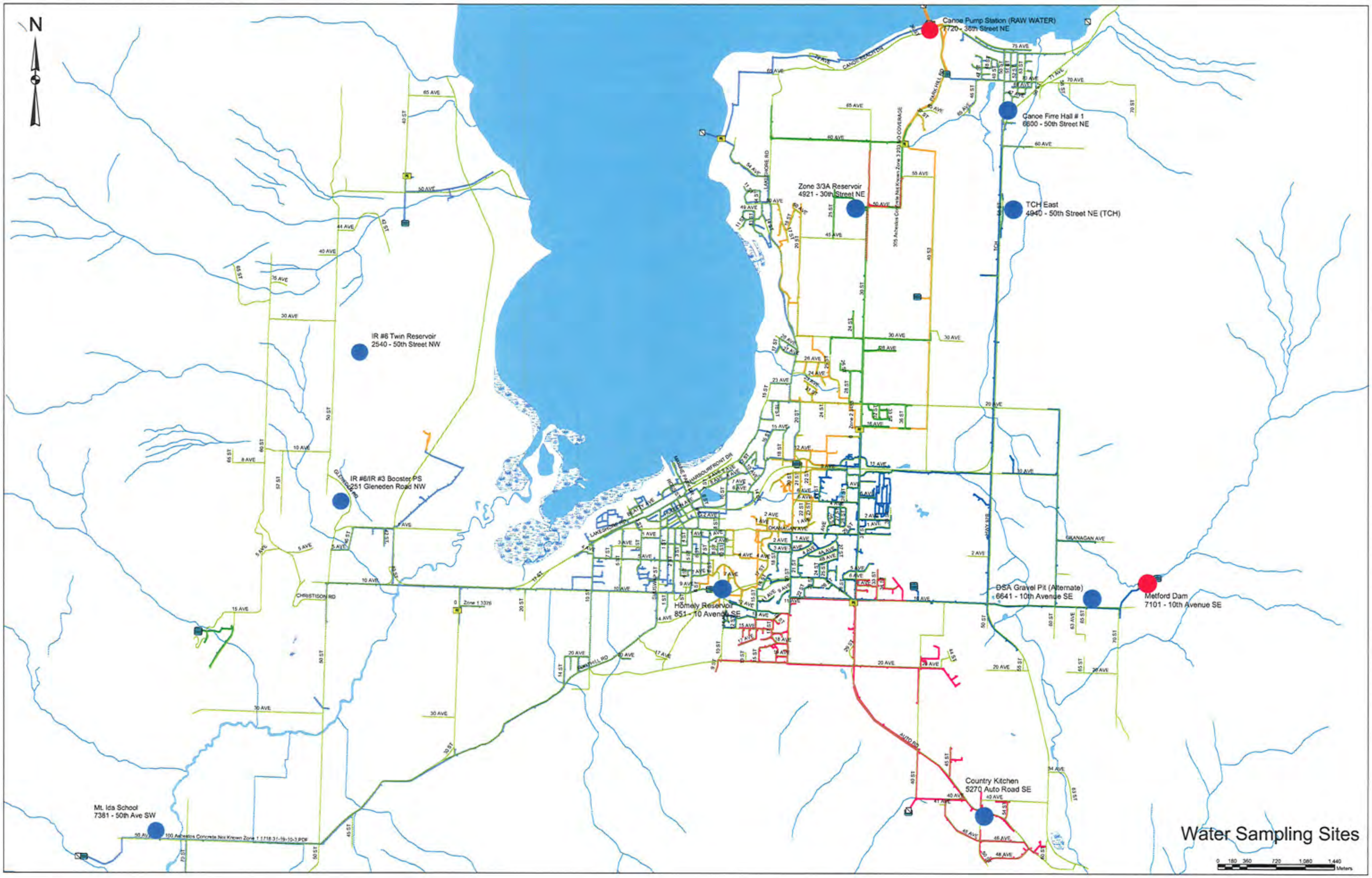
*DSA Gravel Pit is an alternate site for water samples when Metford Dam is not in use.

OTHER BACTERIOLOGICAL SAMPLING/TESTING:

	Raw Water Sample Sites	Street Location	Sample Schedule
1.	Canoe Pump Stn [Raw]	7720 – 36 Street NE	Week 1 & 3
2.	Metford Dam [Raw]	7101 – 10 Avenue SE	Week 2 & 4

Canoe Beach [Swimming]

- May and September [Twice a month from the three alternating sites as listed below]
- June, July & August [Once a week 2 samples from the three alternating sights between Canoe Beach Wharf, Canoe Beach in front of the Pump Stn and Canoe Beach East].


Water Sampling Sites
N
Canoe Pump Station (RAW WATER)
7720 - 36th Street NE
Canoe Firre Hall # 1
6600 - 50th Street NE
TCH East
4940 - 50th Street NE (TCH)
Zone 3/3A Reservoir
4921 - 30th Street NE
IR #6 Twin Reservoir
2540 - 50th Street NW
IR #6/IR #3 Booster PS
251 Gleneden Road NW
Hornely Reservoir
851 - 10 Avenue SE
DSA Gravel Pit (Alternate)
6641 - 10th Avenue SE
Metford Dam
7101 - 10th Avenue SE
Country Kitchen
5270 Auto Road SE
Mt. Ida School
7381 - 50th Ave SW
0 180 360 720 1,080 1,440
Meters

Salmon Arm

APPENDIX 4

INTERIOR HEALTH AUTHORITY
CITY OF SALMON ARM WATER SYSTEM
BIOLOGICAL MONITORING REPORTS

City of Salmon Arm - Reporting Database
From: Jan 01 2006 To: Dec 31 2006

CARO Environmental Services
Coliform Testing - Part 1

Thursday, April 19, 2007

DATE		Canoe Pump Stn RAW			Metford Dam RAW			Canoe Wharf RAW			Canoe Beach RAW			Canoe Beach East RAW			Canoe Firehall			Mt. Ida School			Homely Reservoir			Zone 3 Reservoir		
		Total	Faecal	Over	Total	Faecal	Over	Total	Faecal	Over	Total	Faecal	Over	Total	Faecal	Over	Total	Faecal	Over	Total	Faecal	Over	Total	Faecal	Over	Total	Faecal	Over
Jan 3	T	15	0	2													0	0	0	0	0	0						
Jan 9	M				47	0	>200																0	0	0	0	0	0
Jan 11	W				33	0	71																					
Jan 16	M	10	0	7													0	0	0	0	0	0						
Jan 23	M				0	0	26																0	0	0	0	0	0
Feb 6	M	16	0	0													0	0	0	0	0	0						
Feb 13	M				2	0	11																0	0	0	0	0	0
Feb 20	M	2	0	6													0	0	0	0	0	0						
Feb 27	M				11	0	12																0	0	0	0	0	0
Mar 6	M	2	0	11													0	0	0	0	0	0						
Mar 13	M				2	1	0																0	0	0	0	0	0
Mar 20	M	2	0	5													0	0	0	0	0	0						
Mar 27	M				7	0	3																0	0	0	0	0	0
Apr 3	M	1	0	3													0	0	0	0	0	0						
Apr 10	M				23	0	20																0	0	0	0	0	0
Apr 18	T	1	0														0	0		0	0							
Apr 24	M				1	0																	0	0		0	0	
May 1	M	0	0														0	0		0	0							
May 8	M				2	0		12	12		24	24											0	0		0	0	
May 15	M	0	0														0	0		0	0							
May 23	T				11 est	1					20 est	59 est		330 es	240 es								0	0		0	0	
May 24	W																						0	0		0	0	
May 25	T										OG	25		70 Est	19													
Jun 5	M							100 es	4		40 est	16					0	0		0	0							
Jun 12	M				38 est	3					54 est	1		26 est	2								0	0		0	0	
Jun 19	M	1	0					43 est	1					90 est	1		0	0		0	0							
Jun 26	M	450 es	41		12 est	1								28 est	6								0	0		0	0	
Jul 4	T	2	0								12 est	1		13	7		0	0		0	0							
Jul 10	M				40 est	24					11 est	1		41 est	5								0	0		0	0	
Jul 17	M	2 est	0								22 est	15		9 est	1		0	0		0	0							
Jul 25	T				48 est	41					6 est	4		12 est	10								0	0		0	0	
Jul 27	T				33 est	6																						
Aug 14	M				120 es	2																	0	0		0	0	
Aug 16	W										00 est	4		110 es	2													
Aug 21	M	2 est	1								30	5		7	7		0	0		0	0							
Aug 28	M				65 est	0																	0	0		0	0	
Sep 5	T	0	0								5 est	3		5 est	3		0	0		0	0							

City of Salmon Arm - Reporting Database
From: Jan 01 2006 To: Dec 31 2006

CARO Environmental Services
Coliform Testing - Part 1

Thursday, April 19, 2007

DATE		Canoe Pump Stn RAW			Metford Dam RAW			Canoe Wharf RAW			Canoe Beach RAW			Canoe Beach East RAW			Canoe Firehall			Mt. Ida School			Homely Reservoir			Zone 3 Reservoir		
		Total	Faecal	Over	Total	Faecal	Over	Total	Faecal	Over	Total	Faecal	Over	Total	Faecal	Over	Total	Faecal	Over	Total	Faecal	Over	Total	Faecal	Over	Total	Faecal	Over
Sep 6	W																											
Sep 11	M				30 est	3																	0	0		0	0	
Sep 18	M	0	0														0	0		0	0							
Sep 25	M				87 est	10					110	25		150 es	25								0	0		0	0	
Oct 2	M	3	0														0	0		0	0							
Oct 12	T				27	1																	0	0		0	0	
Oct 16	M	1	0														0	0		0	0							
Oct 23	M				30	0																	0	0		0	0	
Oct 30	M				14	0																						
Nov 6	M	2	0														0	0		0	0							
Nov 9	T																											
Nov 14	T				20	1																	0	0		0	0	
Nov 20	M	5	0														0	0		0	0							
Nov 27	M				2	0																	0	0		0	0	
Dec 4	M	2	0														0	0		0	0							
Dec 11	M				35	30																	0	0		0	0	
Dec 18	M	0	0														0	0		0	0							

City of Salmon Arm - Reporting Database

From: Jan 01 2006 To: Dec 31 2006

CARO Environmental Services

E.Coli and Coliform Testing - Part 1

DATE		Canoe Pump Stn RAW			Metford Dam RAW			Canoe Wharf RAW			Canoe Beach RAW			Canoe Beach East RAW			Canoe Firehall			Mt. Ida School			Homely Reservoir			Zone 3 Reservoir		
		Total	E.Colil	Over	Total	E.Colil	Over	Total	E.Colil	Over	Total	E.Coli	Over	Total	E.Coli	Over	Total	E.Coli	Over	Total	E.Colil	Over	Total	E.Colil	Over	Total	E.Colil	Over
Jan 3	T	15	0	2													0	0	0	0	0	0						
Jan 9	M				47	0	>200																0	0	0	0	0	0
Jan 11	W				33	0	71																					
Jan 16	M	10	0	7													0	0	0	0	0	0						
Jan 23	M				0	0	26																0	0	0	0	0	0
Feb 6	M	16	0	0													0	0	0	0	0	0						
Feb 13	M				2	0	11																0	0	0	0	0	0
Feb 20	M	2	0	6													0	0	0	0	0	0						
Feb 27	M				11	0	12																0	0	0	0	0	0
Mar 6	M	2	0	11													0	0	0	0	0	0						
Mar 13	M				2	1	0																0	0	0	0	0	0
Mar 20	M	2	0	5													0	0	0	0	0	0						
Mar 27	M				7	0	3																0	0	0	0	0	0
Apr 3	M	1	0	3													0	0	0	0	0	0						
Apr 10	M				23	0	20																0	0	0	0	0	0
Apr 18	T	1	0														0	0		0	0							
Apr 24	M				1	0																	0	0		0	0	
May 1	M	0	0														0	0		0	0							
May 8	M				2	0		12	12		24	24											0	0		0	0	
May 15	M	0	0														0	0		0	0							
May 23	T				11 est	1					20 est	59 est		330 est	240 est								0	0		0	0	
May 24	W																						0	0		0	0	
May 25	T										OG	25		70 Est	19													
May 28	S				27	11																	0	0		0	0	
Jun 5	M							100 est	4		40 est	16					0	0		0	0							
Jun 12	M				38 est	3					54 est	1		26 est	2								0	0		0	0	
Jun 19	M	1	0					43 est	1					90 est	1		0	0		0	0							
Jun 26	M	450 est	41		12 est	1								28 est	6								0	0		0	0	
Jul 4	T	2	0								12 est	1		13	7		0	0		0	0							
Jul 10	M				40 est	24					11 est	1		41 est	5								0	0		0	0	
Jul 17	M	2 est	0								22 est	15		9 est	1		0	0		0	0							
Jul 25	T				48 est	41					6 est	4		12 est	10								0	0		0	0	
Jul 27	T				33 est	6																						
Aug 14	M				120 est	2																	0	0		0	0	
Aug 16	W										00 est	4		110 est	2													
Aug 21	M	2 est	1								30	5		7	7		0	0		0	0							
Aug 28	M				65 est	0																	0	0		0	0	

Started with E-coli testing at Caro Environmental

City of Salmon Arm - Reporting Database

From: Jan 01 2006 To: Dec 31 2006

CARO Environmental Services
E.Coli and Coliform Testing - Part 1

DATE		Canoe Pump Stn RAW			Metford Dam RAW			Canoe Wharf RAW			Canoe Beach RAW			Canoe Beach East RAW			Canoe Firehall			Mt. Ida School			Homely Reservoir			Zone 3 Reservoir		
		Total	E.Colil	Over	Total	E.Colil	Over	Total	E.Colil	Over	Total	E.Coli	Over	Total	E.Coli	Over	Total	E.Coli	Over	Total	E.Colil	Over	Total	E.Colil	Over	Total	E.Colil	Over
Sep 5	T	0	0								5 est	3		5 est	3		0	0		0	0							
Sep 6	W																											
Sep 11	M				30 est	3																	0	0		0	0	
Sep 18	M	0	0														0	0		0	0							
Sep 25	M				87 est	10					110	25		150 est	25								0	0		0	0	
Oct 2	M	3	0														0	0		0	0							
Oct 12	T				27	1																	0	0		0	0	
Oct 16	M	1	0														0	0		0	0							
Oct 23	M				30	0																	0	0		0	0	
Oct 30	M				14	0																						
Nov 6	M	2	0														0	0		0	0							
Nov 9	T																											
Nov 14	T				20	1																	0	0		0	0	
Nov 20	M	5	0														0	0		0	0							
Nov 27	M				2	0																	0	0		0	0	
Dec 4	M	2	0														0	0		0	0							
Dec 11	M				35	30																	0	0		0	0	
Dec 18	M	0	0														0	0		0	0							

APPENDIX 5

DAILY WATER CONSUMPTION 2001 TO 2006

City of Salmon Arm
Daily Water Consumption
2001 to 2006

January						
	2001	**2002**	**2003**	**2004**	**2005**	**2006**
01-Jan	**8,684**	**8,989**	5,632	5,655	6,010	5,966
02-Jan	7,353	6,571	6,484	7,633	6,463	7,329
03-Jan	7,145	6,701	6,467	5,673	6,856	7,216
04-Jan	8,089	6,908	6,965	6,754	5,972	6,738
05-Jan	8,112	6,537	5,461	7,360	6,812	6,141
06-Jan	8,569	7,069	**7,509**	**8,194**	6,428	7,105
07-Jan	8,026	6,950	5,568	7,624	6,255	7,002
08-Jan	7,280	6,294	7,013	7,378	6,735	5,862
09-Jan	6,850	6,651	7,004	6,928	6,214	6,736
10-Jan	7,093	6,686	5,922	8,030	6,392	7,016
11-Jan	7,066	6,704	6,618	6,915	6,800	6,214
12-Jan	7,024	5,854	5,996	7,267	6,200	7,077
13-Jan	7,480	7,400	6,837	5,996	7,013	7,056
14-Jan	7,196	6,187	6,865	6,866	7,114	6,416
15-Jan	7,186	8,590	6,308	6,625	7,169	6,395
16-Jan	7,218	7,970	6,025	7,474	6,677	6,830
17-Jan	6,868	5,998	6,561	6,525	6,798	6,472
18-Jan	7,074	6,723	6,116	6,519	6,269	5,960
19-Jan	7,900	7,082	6,409	6,857	7,129	6,451
20-Jan	6,437	7,082	6,431	6,907	6,655	6,033
21-Jan	7,390	7,082	7,090	6,527	6,216	5,240
22-Jan	7,183	7,082	6,348	6,728	6,539	**7,724**
23-Jan	7,231	7,082	6,209	6,752	6,860	5,865
24-Jan	7,349	8,315	6,157	6,609	6,801	6,457
25-Jan	7,444	6,014	6,927	6,195	6,764	6,360
26-Jan	7,127	6,631	6,620	7,083	6,061	6,760
27-Jan	7,360	6,184	6,310	2,933	**7,966**	6,393
28-Jan	7,145	7,613	6,010	6,475	6,200	6,374
29-Jan	7,140	6,795	6,670	6,933	7,083	6,563
30-Jan	6,841	6,691	7,064	6,198	6,099	7,529
31-Jan	7,073	6,392	5,697	6,243	7,668	7,070
TOTAL	**227,934**	**214,827**	**199,292**	**207,855**	**206,220**	**204,346**
Max Day	**8,684**	**8,989**	**7,509**	**8,194**	**7,966**	**7,724**
Min Day	**6,437**	**5,854**	**5,461**	**2,933**	**5,972**	**5,240**
Median	**7,196**	**6,723**	**6,431**	**6,754**	**6,677**	**6,472**
Average	**7,353**	**6,930**	**6,429**	**6,705**	**6,652**	**6,592**

City of Salmon Arm
Daily Water Consumption
2001 to 2006

February						
	2001	**2002**	**2003**	**2004**	**2005**	**2006**
01-Feb	7,033	7,329	**7,101**	7,325	6,372	7,214
02-Feb	7,499	6,870	5,850	6,497	6,863	7,253
03-Feb	7,082	6,620	6,762	6,384	6,536	6,858
04-Feb	7,044	7,272	6,529	7,248	5,693	7,220
05-Feb	7,229	6,723	6,027	6,410	7,489	6,833
06-Feb	**9,443**	6,550	6,686	6,813	5,652	7,514
07-Feb	7,427	6,824	6,010	6,379	7,111	7,177
08-Feb	8,025	6,919	6,657	7,131	4,443	6,835
09-Feb	6,447	6,824	6,431	7,182	**9,479**	7,278
10-Feb	7,572	6,846	6,280	6,686	5,882	6,933
11-Feb	5,071	7,387	6,820	6,493	6,443	6,652
12-Feb	7,314	6,318	6,281	6,958	6,756	7,073
13-Feb	7,244	6,811	6,795	7,021	6,141	7,218
14-Feb	6,943	6,728	5,552	6,351	7,130	6,882
15-Feb	6,819	6,379	6,746	6,748	6,973	5,978
16-Feb	7,665	6,970	6,318	7,092	5,884	6,775
17-Feb	6,864	7,469	6,930	6,841	6,549	6,734
18-Feb	7,355	6,374	5,983	7,045	6,792	**8,032**
19-Feb	7,393	6,739	6,412	6,490	7,240	6,935
20-Feb	7,815	**7,493**	6,790	5,718	6,943	6,349
21-Feb	7,292	5,827	6,338	6,606	6,282	6,647
22-Feb	7,064	7,253	6,392	7,001	6,430	6,698
23-Feb	7,063	6,301	6,361	7,101	6,824	6,088
24-Feb	7,232	6,631	6,298	7,234	6,734	6,931
25-Feb	7,268	6,675	6,809	**8,342**	6,469	6,612
26-Feb	6,759	6,544	5,952	6,572	6,691	7,092
27-Feb	6,595	6,581	6,508	6,992	6,759	7,328
28-Feb	7,055	6,534	6,607	6,776	7,152	5,387
29-Feb				7,226		
Total	**201,615**	**189,791**	**180,223**	**198,664**	**185,709**	**192,526**
Max Day	**9,443**	**7,493**	**7,101**	**8,342**	**9,479**	**8,032**
Median	**7,231**	**6,734**	**6,422**	**6,841**	**6,712**	**6,907**
Average	**7,201**	**6,778**	**6,437**	**6,850**	**6,632**	**6,876**

City of Salmon Arm
Daily Water Consumption
2001 to 2006

March						
	2001	**2002**	**2003**	**2004**	**2005**	**2006**
01-Mar	6,849	7,077	6,330	6,594	5,873	6,576
02-Mar	7,202	5,862	6,425	7,185	7,508	6,576
03-Mar	7,452	7,147	6,268	6,021	7,695	6,911
04-Mar	7,086	6,528	6,728	7,490	7,320	6,825
05-Mar	7,599	5,868	5,662	6,743	6,021	7,154
06-Mar	7,919	6,801	6,693	7,043	6,845	6,292
07-Mar	6,693	6,045	6,850	6,412	7,182	7,589
08-Mar	7,478	7,245	6,076	6,615	6,681	6,483
09-Mar	6,944	5,985	6,432	6,897	7,119	7,618
10-Mar	7,067	6,544	**7,492**	6,724	6,148	6,928
11-Mar	7,036	6,696	5,711	6,845	6,391	6,835
12-Mar	7,550	6,396	7,076	6,127	6,153	6,721
13-Mar	7,364	7,168	5,608	7,077	7,763	6,682
14-Mar	7,186	5,773	6,929	6,470	6,075	5,904
15-Mar	6,733	6,663	6,344	6,193	7,378	**8,494**
16-Mar	7,104	6,546	6,368	7,484	6,216	6,751
17-Mar	6,923	6,268	6,734	6,272	7,489	6,068
18-Mar	7,927	6,472	6,152	7,292	6,168	7,201
19-Mar	6,902	6,665	6,922	6,337	6,296	7,257
20-Mar	7,436	6,458	6,831	6,959	6,229	5,781
21-Mar	7,424	6,880	6,031	**7,681**	7,292	7,227
22-Mar	7,228	6,887	6,321	6,831	7,323	6,608
23-Mar	7,023	6,164	6,344	7,465	7,299	6,470
24-Mar	6,849	**7,339**	7,116	6,464	7,197	6,996
25-Mar	7,357	6,246	6,353	7,188	6,184	7,061
26-Mar	**8,308**	6,889	6,445	7,031	6,869	7,001
27-Mar	7,307	6,061	7,113	6,483	6,295	6,847
28-Mar	7,417	7,008	5,999	7,507	**7,868**	7,290
29-Mar	6,351	6,518	6,917	7,300	7,249	7,442
30-Mar	8,018	6,451	7,171	7,463	7,126	7,216
31-Mar	6,496	6,087	6,757	7,037	6,136	7,271
TOTAL	**224,225**	**202,736**	**202,197**	**213,226**	**211,386**	**214,073**
Max Day	**8,308**	**7,339**	**7,492**	**7,681**	**7,868**	**8,494**
Median	**7,202**	**6,528**	**6,432**	**6,897**	**6,869**	**6,911**
Average	**7,233**	**6,540**	**6,522**	**6,878**	**6,819**	**6,906**

City of Salmon Arm
Daily Water Consumption
2001 to 2006

April						
	2001	**2002**	**2003**	**2004**	**2005**	**2006**
01-Apr	7,256	7,262	7,595	7,572	7,434	7,003
02-Apr	7,365	6,679	5,996	6,967	6,919	7,052
03-Apr	6,240	6,958	6,692	7,625	7,198	7,191
04-Apr	7,392	7,001	6,791	8,424	7,077	6,713
05-Apr	6,816	6,417	6,767	8,016	7,404	7,530
06-Apr	7,298	7,242	6,932	8,838	6,865	7,301
07-Apr	7,297	7,088	7,179	9,772	7,911	7,111
08-Apr	7,919	7,716	7,487	8,439	7,224	7,900
09-Apr	7,775	6,286	6,905	8,611	7,978	7,406
10-Apr	7,722	6,968	7,395	9,085	8,657	7,629
11-Apr	7,642	6,519	7,612	8,964	7,062	7,664
12-Apr	7,351	7,752	6,704	10,396	7,669	7,220
13-Apr	6,585	6,001	**8,001**	9,287	6,939	7,415
14-Apr	7,433	6,781	6,786	6,894	7,945	7,567
15-Apr	7,554	6,661	6,378	7,832	7,032	6,902
16-Apr	8,555	6,906	6,526	7,736	7,044	7,179
17-Apr	6,994	7,253	7,182	6,865	7,838	6,872
18-Apr	8,104	6,848	6,811	8,241	7,735	7,567
19-Apr	7,366	6,501	6,908	8,036	7,303	7,927
20-Apr	8,619	7,806	7,043	7,605	9,070	8,436
21-Apr	7,965	7,657	7,940	7,673	9,059	7,213
22-Apr	8,618	7,029	7,892	9,010	9,584	7,773
23-Apr	8,620	6,688	7,633	8,351	9,571	8,496
24-Apr	8,159	6,602	7,657	9,047	10,661	8,336
25-Apr	8,925	7,509	6,777	10,739	10,955	**9,688**
26-Apr	**9,972**	7,355	6,948	9,586	10,809	7,755
27-Apr	9,689	8,067	6,860	8,717	10,396	9,506
28-Apr	8,182	**10,072**	7,820	10,177	**11,710**	8,807
29-Apr	8,062	9,996	7,573	**11,733**	11,078	8,132
30-Apr	7,617	9,353	7,217	11,177	10,990	9,646
TOTAL	**235,091**	**218,969**	**214,003**	**261,414**	**255,116**	**232,937**
Max Day	**9,972**	**10,072**	**8,001**	**11,733**	**11,710**	**9,688**
Median	**7,682**	**7,015**	**6,995**	**8,525**	**7,874**	**7,567**
Average	**7,836**	**7,299**	**7,133**	**8,714**	**8,504**	**7,765**

City of Salmon Arm
Daily Water Consumption
2001 to 2006

May						
	2001	**2002**	**2003**	**2004**	**2005**	**2006**
01-May	8,437	**12,012**	9,378	12,368	12,208	7,215
02-May	8,113	10,505	7,584	12,265	12,010	9,161
03-May	7,070	9,914	7,600	11,344	11,013	9,406
04-May	8,326	8,620	7,411	11,382	11,083	10,089
05-May	7,669	8,531	7,137	10,003	11,392	9,750
06-May	9,115	7,235	6,925	10,281	10,996	10,134
07-May	8,338	8,092	8,354	11,812	12,825	9,071
08-May	8,610	7,774	7,561	11,241	11,509	9,273
09-May	9,091	8,728	7,639	9,463	11,962	11,577
10-May	10,129	9,568	8,625	10,499	13,410	10,518
11-May	10,062	10,537	8,262	9,857	16,563	9,438
12-May	10,878	11,308	6,583	9,310	15,357	9,094
13-May	12,930	11,592	8,960	10,571	13,092	10,715
14-May	9,305	7,884	10,584	10,610	12,675	12,626
15-May	8,619	10,496	12,180	11,737	12,143	12,674
16-May	8,655	9,862	11,230	13,836	9,545	15,061
17-May	7,703	9,139	8,497	12,844	9,140	14,842
18-May	9,083	9,092	8,583	15,191	9,857	**15,970**
19-May	8,977	10,026	10,193	**15,535**	8,723	14,971
20-May	9,525	9,345	9,609	14,872	8,743	11,118
21-May	12,673	8,028	10,465	13,168	8,984	10,368
22-May	14,318	7,641	8,733	9,599	9,040	9,583
23-May	15,376	7,430	9,330	9,052	9,950	10,053
24-May	14,000	7,356	11,256	10,175	10,468	9,699
25-May	**16,724**	7,191	8,763	10,297	12,293	8,118
26-May	16,466	7,911	8,305	9,367	12,651	9,168
27-May	9,712	5,959	15,041	8,940	15,241	9,227
28-May	10,619	8,114	19,675	9,590	16,677	8,637
29-May	9,117	9,930	**22,776**	8,618	**18,154**	8,210
30-May	10,300	10,124	21,389	8,800	13,926	9,438
31-May	12,254	8,870	9,166	7,494	13,254	10,133
TOTAL	**322,191**	**278,814**	**317,793**	**340,119**	**374,882**	**325,335**
Max Day	**16,724**	**12,012**	**22,776**	**15,535**	**18,154**	**15,970**
Median	**9,305**	**8,870**	**8,763**	**10,499**	**12,010**	**9,750**
Average	**10,393**	**8,994**	**10,251**	**10,972**	**12,093**	**10,495**

City of Salmon Arm
Daily Water Consumption
2001 to 2006

June						
	2001	**2002**	**2003**	**2004**	**2005**	**2006**
01-Jun	10,986	8,702	8,925	8,658	11,142	8,955
02-Jun	9,369	10,868	10,279	9,002	10,420	8,598
03-Jun	8,568	11,824	11,207	10,486	12,284	8,076
04-Jun	5,012	12,431	13,379	12,367	13,759	9,080
05-Jun	13,923	11,831	14,519	10,942	**13,873**	9,237
06-Jun	9,519	9,729	15,318	8,704	10,935	10,746
07-Jun	9,012	8,254	**16,645**	9,159	9,409	11,875
08-Jun	9,911	8,078	15,987	10,759	9,354	9,350
09-Jun	9,122	8,726	9,684	12,116	9,993	9,814
10-Jun	8,339	11,056	10,123	9,872	11,546	9,386
11-Jun	7,812	13,409	9,939	8,781	12,196	9,453
12-Jun	7,920	14,789	11,113	8,381	9,802	9,493
13-Jun	8,016	16,263	9,674	9,110	9,818	10,037
14-Jun	7,971	17,524	9,637	8,598	10,124	8,789
15-Jun	7,996	16,651	10,161	8,420	9,379	8,485
16-Jun	8,240	15,247	11,663	10,659	11,110	10,029
17-Jun	8,414	14,671	15,740	11,421	10,731	8,760
18-Jun	9,585	9,896	14,026	12,657	8,471	8,292
19-Jun	13,061	10,207	12,378	14,645	8,898	9,180
20-Jun	12,537	11,420	9,579	14,477	10,032	8,602
21-Jun	13,810	14,878	8,973	13,317	10,795	9,899
22-Jun	14,262	16,376	7,178	17,521	10,049	9,424
23-Jun	**14,820**	16,857	9,275	**18,088**	9,296	11,492
24-Jun	13,781	17,784	9,501	18,082	9,442	12,963
25-Jun	13,600	17,927	9,852	17,539	9,067	15,560
26-Jun	12,550	**19,923**	11,367	15,423	8,637	13,746
27-Jun	10,686	16,471	11,906	11,345	13,379	17,924
28-Jun	9,115	11,038	13,960	11,398	8,629	18,488
29-Jun	11,848	11,362	13,370	15,335	10,675	**18,804**
30-Jun	13,098	9,877	10,657	15,649	9,121	18,446
TOTAL	**312,883**	**394,066**	**346,014**	**362,909**	**312,365**	**332,978**
Max Day	**14,820**	**19,923**	**16,645**	**18,088**	**13,873**	**18,804**
Median	**9,552**	**12,131**	**10,885**	**11,371**	**10,041**	**9,473**
Average	**10,429**	**13,136**	**11,534**	**12,097**	**10,412**	**11,099**

City of Salmon Arm
Daily Water Consumption
2001 to 2006

July						
	2001	**2002**	**2003**	**2004**	**2005**	**2006**
01-Jul	13,262	11,716	13,763	14,611	10,472	19,379
02-Jul	15,653	13,693	11,156	13,770	10,105	18,944
03-Jul	17,706	15,596	12,174	15,271	9,777	18,033
04-Jul	18,625	13,644	11,812	15,357	8,961	18,736
05-Jul	18,937	11,774	11,878	15,152	12,737	14,361
06-Jul	18,937	14,373	14,307	13,311	10,340	12,307
07-Jul	17,799	17,561	12,177	13,456	10,285	14,775
08-Jul	17,131	11,915	14,628	11,909	10,276	17,231
09-Jul	20,931	13,355	15,975	13,612	10,923	16,738
10-Jul	20,684	17,383	16,960	13,199	11,544	12,540
11-Jul	**22,283**	19,017	17,564	10,790	10,425	16,403
12-Jul	19,739	20,084	17,863	10,593	13,724	14,449
13-Jul	17,900	16,721	17,014	15,231	12,752	14,556
14-Jul	17,830	15,256	14,396	15,577	13,469	17,571
15-Jul	13,719	19,290	18,287	16,750	12,998	18,291
16-Jul	10,778	19,889	19,711	17,691	10,402	18,607
17-Jul	9,826	20,785	19,704	19,475	11,316	16,376
18-Jul	9,168	19,953	18,615	19,398	12,955	20,417
19-Jul	8,914	21,180	19,560	15,198	17,010	20,142
20-Jul	9,322	19,664	18,201	16,943	16,001	20,081
21-Jul	9,766	20,118	16,515	17,142	17,397	21,086
22-Jul	11,019	23,080	21,364	17,142	14,717	22,005
23-Jul	8,108	21,892	22,452	19,213	12,698	19,834
24-Jul	10,971	**23,915**	22,350	20,398	15,557	**23,578**
25-Jul	12,055	22,937	21,141	19,758	13,355	21,668
26-Jul	15,689	23,172	21,974	16,960	17,916	21,799
27-Jul	15,161	21,220	21,080	20,787	17,809	21,529
28-Jul	12,719	19,824	17,643	21,045	18,644	21,251
29-Jul	10,838	19,869	22,009	21,177	**19,497**	21,284
30-Jul	11,338	17,643	**22,731**	21,007	19,170	17,645
31-Jul	11,142	13,677	21,600	**21,593**	18,818	13,484
TOTAL	447,952	560,195	546,602	513,513	422,050	565,097
Max Day	**22,283**	**23,915**	**22,731**	**21,593**	**19,497**	**23,578**
Median	**13,719**	**19,290**	**17,863**	**16,750**	**12,955**	**18,607**
Average	**14,450**	**18,071**	**17,632**	**16,565**	**13,615**	**18,229**

City of Salmon Arm
Daily Water Consumption
2001 to 2006

August						
	2001	**2002**	**2003**	**2004**	**2005**	**2006**
01-Aug	12,554	15,562	21,800	19,752	15,477	20,343
02-Aug	13,000	14,551	**21,855**	17,705	20,868	19,544
03-Aug	13,000	14,887	19,723	**19,957**	20,748	19,180
04-Aug	13,500	12,411	16,458	17,571	19,620	18,356
05-Aug	13,000	13,275	20,706	11,368	20,440	19,236
06-Aug	12,000	13,532	20,431	12,379	21,282	19,669
07-Aug	12,500	16,574	19,013	10,863	21,674	17,549
08-Aug	12,000	17,682	19,663	13,027	17,377	20,344
09-Aug	12,000	17,895	19,785	10,956	22,001	19,825
10-Aug	12,000	16,259	18,792	17,382	21,593	14,018
11-Aug	12,000	18,067	12,886	17,581	19,348	13,905
12-Aug	11,000	19,079	18,272	17,506	**22,256**	15,524
13-Aug	12,437	20,049	19,118	19,373	20,684	17,027
14-Aug	12,353	**20,309**	18,461	19,717	20,487	14,938
15-Aug	12,609	18,260	19,141	18,013	18,300	19,877
16-Aug	17,043	17,573	19,336	14,700	18,963	19,797
17-Aug	**17,727**	16,031	18,588	17,694	13,385	18,364
18-Aug	15,706	16,692	15,075	18,542	14,968	19,146
19-Aug	15,690	18,295	18,931	17,664	16,361	19,460
20-Aug	15,520	17,435	19,699	17,758	17,014	19,049
21-Aug	13,204	18,533	18,309	15,171	17,964	16,210
22-Aug	10,673	18,585	18,369	10,871	14,503	19,779
23-Aug	9,780	19,776	17,830	10,211	14,963	18,018
24-Aug	10,090	18,426	16,602	11,083	14,881	18,374
25-Aug	9,850	18,162	12,999	9,132	15,932	17,589
26-Aug	11,504	17,103	16,540	9,348	17,332	19,440
27-Aug	12,302	18,529	17,694	9,436	16,287	20,137
28-Aug	13,111	18,155	16,983	10,019	16,675	16,902
29-Aug	13,979	18,137	16,976	8,695	11,086	**22,169**
30-Aug	13,550	17,732	17,539	8,244	9,672	17,212
31-Aug	13,838	16,534	16,215	9,584	11,959	17,858
TOTAL	**399,517**	**534,089**	**563,789**	**441299**	**544098**	**568837**
Max Day	**17,727**	**20,309**	**21,855**	**19,957**	**22,256**	**22,169**
Median	**12,554**	**17,732**	**18,461**	**14,700**	**17,377**	**19,049**
Average	**12,888**	**17,229**	**18,187**	**14,235**	**17,552**	**18,350**

City of Salmon Arm
Daily Water Consumption
2001 to 2006

September						
	2001	**2002**	**2003**	**2004**	**2005**	**2006**
01-Sep	10,437	11,586	14,158	**9,967**	9,706	17,455
02-Sep	11,586	11,852	16,628	8,716	11,571	17,017
03-Sep	**14,593**	11,611	**18,291**	8,204	12,178	16,003
04-Sep	11,730	11,906	15,992	7,851	9,636	14,754
05-Sep	12,871	12,356	15,898	8,333	10,045	**17,810**
06-Sep	10,618	11,827	16,679	8,457	12,040	17,131
07-Sep	10,492	12,301	14,791	8,628	**12,185**	16,238
08-Sep	10,493	12,198	9,741	8,297	11,512	16,115
09-Sep	10,802	11,252	13,159	8,506	10,285	13,733
10-Sep	12,693	12,673	12,518	7,850	9,516	12,694
11-Sep	11,517	13,332	11,197	8,547	10,270	11,569
12-Sep	11,442	**14,028**	9,788	7,824	8,898	14,857
13-Sep	12,252	13,937	11,073	8,583	10,582	12,452
14-Sep	13,189	12,781	10,194	7,817	9,165	9,772
15-Sep	11,436	12,900	7,745	8,490	8,899	10,008
16-Sep	13,827	11,403	9,507	8,067	8,703	9,519
17-Sep	13,378	11,097	9,107	6,618	9,425	9,705
18-Sep	12,450	11,984	8,742	8,237	9,844	9,375
19-Sep	11,506	10,711	7,637	6,838	8,636	9,992
20-Sep	10,191	10,552	9,411	7,795	9,397	9,321
21-Sep	8,753	10,323	7,971	8,280	9,619	8,905
22-Sep	9,167	11,608	8,343	7,486	7,677	9,372
23-Sep	10,832	11,569	8,254	7,726	9,008	8,551
24-Sep	10,059	12,263	8,979	7,901	9,339	9,672
25-Sep	9,518	11,271	9,200	7,753	9,455	8,924
26-Sep	8,477	9,983	8,943	8,182	9,767	9,818
27-Sep	8,230	10,686	9,771	7,853	9,690	8,959
28-Sep	8,126	10,006	9,477	7,725	8,833	9,058
29-Sep	8,106	9,054	8,845	8,080	8,846	9,539
30-Sep	8,953	9,487	9,510	8,073	8,172	8,627
TOTAL	327,724	348,537	331,549	242,683	292,900	356,944
Max Day	**14,593**	**14,028**	**18,291**	**9,967**	**12,185**	**17,810**
Median	**10,817**	**11,610**	**9,625**	**8,077**	**9,567**	**9,905**
Average	**10,924**	**11,618**	**11,052**	**8,089**	**9,763**	**11,898**

City of Salmon Arm
Daily Water Consumption
2001 to 2006

October						
	2001	**2002**	**2003**	**2004**	**2005**	**2006**
01-Oct	8,007	8,134	9,825	7,870	7,796	**9,955**
02-Oct	**8,829**	8,869	9,793	**8,395**	7,873	8,548
03-Oct	8,530	8,306	8,774	7,334	8,085	9,410
04-Oct	7,857	8,787	**10,094**	7,621	7,536	8,425
05-Oct	8,446	7,848	9,444	8,390	7,882	9,421
06-Oct	7,766	**8,971**	8,112	7,530	7,687	8,552
07-Oct	7,733	8,359	8,687	8,129	7,870	7,777
08-Oct	7,851	8,409	7,331	7,901	7,472	8,994
09-Oct	7,554	7,309	8,432	8,071	7,437	9,121
10-Oct	7,995	7,655	7,579	6,467	7,561	7,821
11-Oct	6,813	7,130	7,381	7,914	8,280	8,184
12-Oct	6,430	8,500	6,984	7,142	7,477	8,957
13-Oct	7,861	6,591	6,689	7,391	6,717	7,520
14-Oct	6,911	8,161	7,981	7,651	**8,408**	8,568
15-Oct	7,437	7,979	6,651	7,358	7,281	7,896
16-Oct	7,075	7,588	6,901	6,553	7,651	7,481
17-Oct	6,562	7,605	6,886	7,367	7,082	7,591
18-Oct	6,844	7,408	6,318	6,833	6,209	7,581
19-Oct	6,632	7,471	6,543	7,308	7,368	6,594
20-Oct	6,631	7,014	7,508	6,241	7,757	7,748
21-Oct	7,016	6,768	6,099	7,232	7,311	7,035
22-Oct	6,642	7,940	6,833	7,061	6,714	6,362
23-Oct	6,065	7,509	6,690	6,989	7,295	7,416
24-Oct	7,141	6,881	6,399	6,129	7,218	7,392
25-Oct	6,123	7,297	7,918	7,450	7,531	7,207
26-Oct	6,472	6,620	6,793	6,756	6,706	6,588
27-Oct	6,237	6,942	6,172	6,651	7,292	7,721
28-Oct	5,537	6,844	5,330	6,688	7,492	6,556
29-Oct	6,093	7,059	8,297	6,823	7,071	7,224
30-Oct	7,459	6,529	7,076	7,021	5,491	7,451
31-Oct	6,581	6,617	7,012	7,519	6,688	7,246
TOTAL	**221,129**	**235,098**	**232,530**	**225,785**	**228,237**	**244,340**
Max Day	**8,829**	**8,971**	**10,094**	**8,395**	**8,408**	**9,955**
Median	**7,016**	**7,509**	**7,076**	**7,334**	**7,472**	**7,721**
Average	**7,133**	**7,584**	**7,501**	**7,283**	**7,362**	**7,882**

City of Salmon Arm
Daily Water Consumption
2001 to 2006

November						
	2001	**2002**	**2003**	**2004**	**2005**	**2006**
01-Nov	6,159	6,616	6,044	6,587	6,357	6,971
02-Nov	6,103	6,783	6,341	6,901	7,399	6,953
03-Nov	6,729	6,545	6,878	7,140	6,131	7,618
04-Nov	6,803	**7,092**	6,390	6,483	7,016	6,133
05-Nov	6,657	6,203	6,831	6,468	6,846	7,302
06-Nov	6,369	6,608	6,480	7,123	7,111	7,499
07-Nov	7,357	6,945	6,293	6,495	**8,193**	6,877
08-Nov	6,734	6,402	6,116	6,826	7,510	7,006
09-Nov	6,659	6,489	5,978	7,016	6,750	8,121
10-Nov	7,179	6,605	6,543	6,276	5,914	6,536
11-Nov	5,833	6,461	6,709	6,249	8,139	6,491
12-Nov	6,426	6,811	6,572	7,203	6,479	7,130
13-Nov	7,134	6,558	6,972	5,992	6,515	7,100
14-Nov	5,929	7,059	6,395	6,685	7,419	6,877
15-Nov	6,245	6,265	6,170	6,632	6,495	7,039
16-Nov	6,702	6,394	6,045	7,083	7,080	6,518
17-Nov	6,307	6,806	6,489	6,624	7,303	7,224
18-Nov	5,977	6,939	**7,247**	6,638	5,814	6,753
19-Nov	7,647	6,608	6,886	6,865	6,728	6,691
20-Nov	7,568	6,491	6,261	7,143	6,611	7,291
21-Nov	5,753	6,929	6,534	6,874	7,755	7,686
22-Nov	6,108	6,302	5,342	6,061	6,010	6,451
23-Nov	5,994	6,074	6,537	6,914	7,858	6,822
24-Nov	0	6,360	7,219	7,020	6,136	7,559
25-Nov	**9,122**	6,231	6,254	6,657	7,039	7,101
26-Nov	6,244	6,968	7,117	6,439	6,597	6,510
27-Nov	6,240	6,681	6,595	6,453	6,867	7,081
28-Nov	7,400	6,341	6,607	6,556	6,476	6,859
29-Nov	6,139	6,862	6,768	**7,242**	7,907	**8,453**
30-Nov	6,782	6,066	6,679	5,999	6,750	6,160
TOTAL	**192,298**	**197,494**	**195,291**	**200,641**	**207,205**	**210,812**
Max Day	**9,122**	**7,092**	**7,247**	**7,242**	**8,193**	**8,453**
Median	**6,397**	**6,582**	**6,535**	**6,648**	**6,798**	**6,989**
Average	**6,410**	**6,583**	**6,510**	**6,688**	**6,907**	**7,027**

City of Salmon Arm
Daily Water Consumption
2001 to 2006

December						
	2001	**2002**	**2003**	**2004**	**2005**	**2006**
01-Dec	5,573	6,625	6,883	6,548	6,894	7,030
02-Dec	7,224	6,864	6,443	6,627	5,985	7,467
03-Dec	6,461	5,767	6,462	6,229	7,198	7,666
04-Dec	3,143	6,160	6,471	6,505	6,662	6,709
05-Dec	6,528	7,239	6,528	6,470	6,810	7,562
06-Dec	5,058	6,151	5,670	6,598	6,907	7,336
07-Dec	**8,345**	5,874	6,214	5,698	7,052	6,442
08-Dec	6,691	6,502	**7,604**	7,593	7,269	6,803
09-Dec	6,291	6,246	6,113	6,080	6,244	6,614
10-Dec	6,515	6,536	6,729	6,127	6,715	7,437
11-Dec	6,344	6,277	6,486	6,260	6,035	7,510
12-Dec	6,451	6,890	6,348	6,836	**7,713**	6,935
13-Dec	6,053	6,622	5,509	7,283	5,889	7,258
14-Dec	6,427	5,473	6,645	6,585	7,430	6,479
15-Dec	6,187	6,265	7,079	7,377	6,319	6,918
16-Dec	6,800	6,771	6,679	6,276	5,649	6,896
17-Dec	6,711	6,743	6,517	7,185	7,248	7,571
18-Dec	6,998	6,745	6,749	6,156	7,126	6,780
19-Dec	0	6,054	6,407	6,534	6,187	7,657
20-Dec	8,046	6,459	6,393	6,697	6,891	6,437
21-Dec	6,435	7,162	6,791	6,280	6,542	**8,031**
22-Dec	6,543	5,722	6,752	6,454	6,769	6,277
23-Dec	5,194	7,518	7,360	**7,662**	7,012	7,788
24-Dec	6,829	6,133	6,614	6,584	6,810	7,313
25-Dec	5,842	6,303	6,091	5,967	6,183	6,839
26-Dec	5,594	6,005	6,005	5,996	6,411	7,029
27-Dec	7,454	6,324	6,829	6,571	7,379	6,988
28-Dec	6,015	6,723	6,473	6,390	6,149	6,780
29-Dec	6,451	6,525	7,403	6,412	6,379	7,762
30-Dec	7,309	5,402	6,839	6,777	7,012	6,681
31-Dec	7,170	**7,548**	6,515	6,734	7,119	7,752
TOTAL	**192,681**	**199,627**	**203,600**	**203,488**	**207,986**	**220,745**
Max Day	**8,345**	**7,548**	**7,604**	**7,662**	**7,713**	**8,031**
Median	**6,451**	**6,459**	**6,517**	**6,534**	**6,810**	**7,029**
Average	**6,216**	**6,440**	**6,568**	**6,564**	**6,709**	**7,121**
Average/day	9,055	9,792	9,679	9,347	9,447	10,052

APPENDIX 6

WATER CONSERVATION POLICY

TOPIC: To establish City water reduction goals and a water use efficiency program

PURPOSE:

1. to effectively defer the need for water & sewage system capacity improvements and the resultant other associated infrastructure costs;
2. to reduce operating / maintenance (o & m) costs;
3. to establish a more fair and equitable water rates structure;
4. to contribute directly or indirectly to the reduction of impact on the environment;
5. to have in place a City water conservation strategy so as to qualify for senior government funding programs.

POLICY (GOALS) Goals: Years 2003, 2004, 2005, 2006 and 2007

1. Develop and deliver a public awareness & education program for VOLUNTARY water use efficiencies to achieve
   a. a reduction of PEAK daily use by 20% (Factor of 1:5)
   b. a reduction of AVERAGE daily use by 14% (Factor of 1:7)

   There shall be a report back to Council in 2006 / 2007.

POLICY (IMPLEMENTATION) Implementation Strategy – Goals

1. Formalize the rationale in support of deferral of infrastructure and related costs in relation to peak daily demand.
2. Formalize the rationale in support of reduction in average daily demand.
3. Approach the goals on three fronts:
   a. Public use (leakage & public land sprinkling).
   b. Business use: water audits and/or inventory of use.
   c. Residential use: conservation by education.
4. Review the water user fee rates (i.e. metered vs non-metered).
5. Review commercial, industrial, institutional and multi-family metered accounts to ensure consistency.
6. Adopt a Bylaw requiring "ultra-low" flush toilets.
7. Develop a Water Efficiency Program using internal resources (staff) and external resources (consultant or others), funded through the Water Management budget; such program to include, at minimum, the following elements:

a. Water efficiency theme, logo, or slogan for purposes of branding and imaging of objectives.
b. Education materials for multi-media communication purposes, such materials to clearly present the goals, rationale and strategies being pursued in the interests of conservation.
c. Establish media partnerships, as appropriate, with newspaper, radio, television and internet services for short and long-term use of multi-media communication with water users.
d. Establish business partnerships, as appropriate, with suppliers, service businesses and others to facilitate and encourage more efficient water management in and around the home and business.
e. As appropriate from year to year, engage the resources of third party agencies to supplement the primary efforts of the City in public education.

8. Amend Bylaw No. 1274 to effectively convert permissible outdoor sprinkling from the current "alternate odd/even days" which results in potential 50% peak daily demand to a "three-day cycle" which results in a potential 33% peak daily demand.
9. Develop and implement an evaluation process to monitor the success of the Water Efficiency Program, the results of which shall be made public at intervals as part of the public education process.
10. Assess, identify and develop maintenance practices to reduce / eliminate water distribution system leakage.
11. Develop and implement a "cross-connection" control program.
12. Residential Lawn – Profiling – continue with program (limited version).
13. Automated underground irrigation systems – documentation, audit and public education.

Prepared by: Director of Operations	Date: March 15, 2003
Approved by Council	Date: March 24, 2003
Amended:	Date: December 11, 2006

APPENDIX 7

STANTEC APPENDIX A PILOT STUDY

City of Salmon Arm
Water Treatment Plant

Pilot Scale Study

Prepared for

City of Salmon Arm

Prepared by

Stantec Consulting Ltd.
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November 2006

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Table of Contents

APPENDIX A

Pilot-Scale Study

The goal of the pilot-scale tests was to determine design criteria for the main treatment processes selected for the Shuswap Lake WTP; coagulation, flocculation and direct filtration. The following design criteria were selected, based on pilot testing:

- Chemical doses (i.e., coagulant, coagulant aid and filter aid)
- Flocculation time
- Filter design (i.e., media type and configuration)
- Filtration rate and backwash strategy
- Design UVT for UV disinfection

A.1 Methodology

The pilot-scale test started with a bench-scale screening test. Different coagulant and coagulant aid doses were tested, using a jar test apparatus. Based on these results, initial doses were selected and used at the pilot-scale. During pilot-scale testing, the doses were adjusted to maximize turbidity removal.

A.1.1 Jar Tests

A standard jar test apparatus with 2-liter jars was used to identify the optimal chemical dose range to be used during the pilot-scale study. This type of equipment has been calibrated in order to control mixing energy (i.e., velocity gradient [G]), and relate it to rotational speed of the stirrer. Once this relationship is known, the flocculation mixing energy can be controlled at the bench-scale and then extrapolated to full-scale. The mixing conditions selected were in the order of those anticipated at the full-scale water treatment plant. **Table A.1** shows the mixing conditions used in this study. No settling period was allowed for prior to filtration, to simulate direct filtration.

Table A.1
Jar Test Mixing Conditions

Parameter	Flash Mixing	Flocculation	
		Stage 1	Stage 2
RPM	300	75	42
Time (min)[1]	1	10	10
G (sec^{-1})[2]	300	60	30
G x t	1.8×10^4	3.6×10^4	1.8×10^3

[1] A test was also performed where the flocculation time was 15 instead of 20 minutes
[2] G values are given at 10°C for a 2 liter square breaker, using a Phipps and Bird apparatus

Two different coagulants were tested; alum ($Al_2(SO_4)_3.14H_2O$), and polyaluminum chloride (PACl). PACl is an hydrolyzed form of alum, and its composition is proprietary. Different vendors will have different products. Isopac (Klearwater, Lions Bay, BC) was used in this set of tests. Isofloc 222 (Kleartech, Lions Bay, BC), a cationic polymer was used as flocculation aid. A summary of coagulant dose ranges is shown in **Table A.2**. Filter aid was not tested at bench-scale. Concentrations of Hydrofloc 502 (Klearwater, Lions Bay, BC), ranging from 0.01 to 0.03 mg/L were tested at pilot-scale.

Table A.2
Coagulant and Coagulant Aid Dose Ranges

Coagulant / Coag. Aid	Dose Range Tested (mg/l)
Alum[1]	10 - 20
PACl[2]	6 - 18
Isofloc 222[2]	1.0 – 2.0

[1] Dose reported as dry product (48% alum solution)
[2] Dose reported as product supplied

The goal of the jar tests was to identify the concentration of alum and PACl to use during pilot-scale testing. Because the DBPs formed in the distribution are within the project goals, the major objective was to reduce turbidity. During these screening tests, all analytical work was done on-site. **Table A.3** shows the parameters measured during jar testing

Table A.3
Monitoring Plan

Parameter	Sampling Point		
	Raw	Flocculated	Filtered[1]
pH[2]	√	√	
Temperature	√	√	
Alkalinity	√	√	
Turbidity	√		√
Colour (True / Apparent)[3]	√		√
UV-254[4]	√		√

[1] Filtration performed with Whatman No. 1 filter paper (Fisher Scientific)
[2] pH probe was calibrated every day, with buffers 4, 7 and 10
[3] True colour samples were filtered through a 0.45 µm filter prior to measurement

A.1.2 Pilot-Scale Experimental Set Up

Terasen Water was retained to install and commission all pilot-scale equipment. The equipment was located at the Canoe Beach Zone 1 Pump Station. **Figure A.1** shows photos of the pilot-scale testing location.

Figure A.1
Pilot-Scale Equipment at the Canoe Beach Pump Station

Table A.4 shows the different coagulation/flocculation conditions tested during the pilot-scale study, at different filtration rates (i.e., 10, 15 and 18 m/h). Alum and PACL were tested at different concentrations. Two flocculation times (15 and 20 minutes) were evaluated. **Table A.5** shows the different media filter configurations evaluated during this study.

Table A.4
Pilot-Scale Test Matrix

Test Scenarios	Filter Rate (m/h)	Coagulant		Coag. Aid (mg/L)	Filter Aid (mg/L)	Floc Time (min)
		Type	Dose (mg/L)			
1	18	PACl	4	1.75	0.022	20
2	15	PACl	12	1.75	0.019	15
3	15	PACl	4	1.75	0.019	15
4	10	PACl	4	1.75	0.021	15
5	18	Alum	6	1.75	0.022	15
6	15	Alum	6	1.75	0.020	15

Table A.5
Filter Configurations

Filter Column	Media Type	Media Depth (m)	Media Size* (mm)
1	Sand Anthracite	0.3 0.7	0.5 1.1-12
2	Sand Anthracite	0.3 1.7	0.65 – 0.75 1.35-1.45
3	Anthracite	1.7	1.35 – 1.45

*UC<1.4 for both media

During this study, samples were collected to evaluate system performance with regards to turbidity removal, UVT increase, and DBP formation decrease. Filter performance was also evaluated through particle counts analysis. **Table A.6** shows the parameters that were monitored as well as monitoring frequency.

Limited sampling was done at the filtration rate of 10 m/h. This test was only conducted to confirm filter run length at a lower filtration rate.

Table A.6
Parameters Monitored During Pilot-Scale Testing

Parameter	Monitoring	Location[1]	Frequency
Temperature (^oC)	On-Site	Raw, CE, FE	Daily
pH (-)	On-Site	Raw, CE, FE	Daily
Turbidity (NTU)	On-Site	Raw, CE, FE	Continuously
Particle counts (#/mL)	On-Site	Raw, FE	Continuously[2]
Alkalinity ($mgCaCO_3/L$)	On-Site/Lab[3]	Raw, CE	1x/Month
Hardness ($mgCaCO_3/L$)	Lab	Raw, CE	1x/Month
UV absorbance (cm^{-1})	Lab	Raw, CE, FE	2x/Week
DOC (mg/L)	Lab	Raw, CE, FE	2x/Week
TOC (mg/L)	Lab	Raw, FE	2x/Week
Metals ($\mu g/L$)	Lab	Raw, FE	1x/Month
TTHM-FP[4] ($\mu g/L$)	Lab	Raw, FE	1x/Week[4]
HAA5-FP[4] ($\mu g/L$)	Lab	Raw, FE	1x/Week[4]

1 CE – Coagulation/Flocculation Effluent; FE – Filter Effluent
2 On one filter effluent, only
3 Limited number of samples will be confirmed by a local lab
4 FP – Formation potential

A.1.3 Disinfection Byproducts Formation Potential Tests

Tests were carried to assess the TTHM and HAA5 formation potential. Formation potential tests are conservative evaluations of DBP formation, as they are incubated head-space free and do not account for pipe wall reactions and/or DBP volatilization in the distribution system. In the distribution system, chlorine will also react with the pipe walls, and formed DBPs will volatilize contributing to lower overall concentration of these compounds in the water. Three different DBP formation potential scenarios were evaluated in this study, ranging from the worst-case scenario (ultimate formation potential), to a more realistic scenario (where DBP were incubated only for 72 hours at the lowest temperature processed by the laboratory, 20^oC). **Table A.7** shows the conditions under which DBP formation potential tests were carried.

Table A.7
DBP-FP Test Conditions

Test Condition	No. Tests[1] (-)	Temperature (°C)	pH (-)	Test Time (day)	Cl_2 Residual (mg/L)
1	2	25	7	7	1.0 - 1.5
2	1	20	7	7	1.0 - 1.5
3	1	20	7	3	0.5 - 1.0

1 HAA5 were only measured for selected tests

A.1.4 Backwash Water Treatment Bench-Scale Testing

Different tests were performed with the filter backwash water, to evaluate its settling potential and supernatant characteristics. Tests were run with and without coagulant and polymer addition. Two sets of tests were conducted. In the first one, only qualitative and turbidity information were collected. These tests were conducted with alum and PACl (**Table A.8**). After a rapid mix step (for approximately one minute, using the jar test apparatus), the samples were allowed to settle for 30 minutes. Isofloc 222 concentration was kept at 1.5 mg/L. Control samples (without any chemical addition) were settled up to 70 minutes.

Table A.8
Backwash Water Treatment Test Conditions

Test No.	Alum / PACl (mg/L)	Isofloc 222 (mg/L)	Max. Settling Time (min)
1	0, 10, 25, 45	1.5	30*
2	0 and 40	1.5	120

* Information was collected at 0, 5, 15, 25 and 30 minutes

A similar treatment approach was adopted during the second set of tests. One sample was processed without chemical addition. The second sampled was treated with 25 mg/L of alum and 1.5 mg/L of Isofloc 222. After rapid mix (when chemicals were added), the samples were allowed to settle for 120 minutes. After settling, the supernatant was collected and analyzed for pH, temperature, dissolved oxygen (DO), 5-day biological oxygen demand (BOD_5), total suspended solids (TSS), total metals and total organic carbon (TOC).

A.2 Results

A.2.1 Jar Tests

The raw water quality measured during bench-scale testing is summarized in **Table A.9**. **Figures A.2 and A.3** show the turbidity removal obtained with different concentrations of alum and PACl. In addition, **Figure A.3** also shows the impact of coagulant dose on turbidity removal. The jar tests were optimized to remove turbidity. Historically, the DBPs measured in the distribution system have been considerable less than the GCDWQ limits. Therefore, no organics removal optimization was required.

Table A.9
Raw Water Quality During Jar Testing

Parameter	Shuswap Lake	GCDWQ[1]
pH (-)	7.1 ± 0.1	6.5 - 8.5[2]
Temperature (^oC)	8.4 ± 1.1	-
Alkalinity ($mgCaCO_3/L$)	47 ± 0.25	-
Turbidity (NTU)	0.75 ± 0.12	1[3]
Apparent Colour (PtCo units)	6.5 ± 1.7	-
True Colour (PtCo units)	1.0 ± 1.2	15[2]
UVA-254 (cm^{-1})	92 ± 1.1	-

[1] GCDWQ – Guidelines for Canadian Drinking Water Quality
[2] Aesthetic Objective
[3] Long-Term Goal is 0.1 NTU

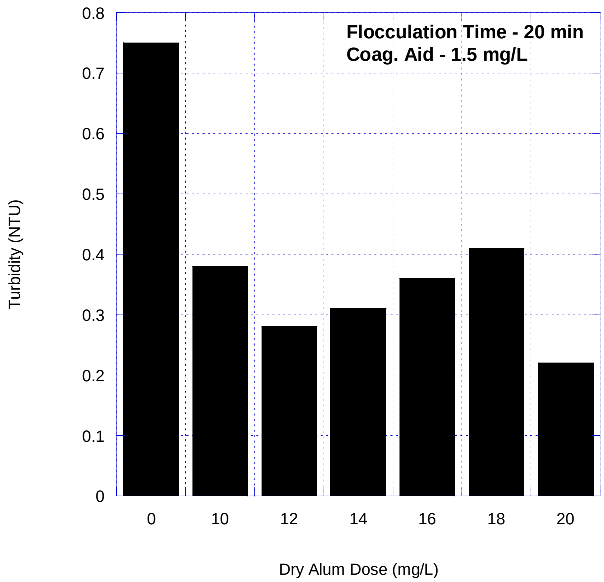


Figure A.2
Impact of Alum Dose on Turbidity

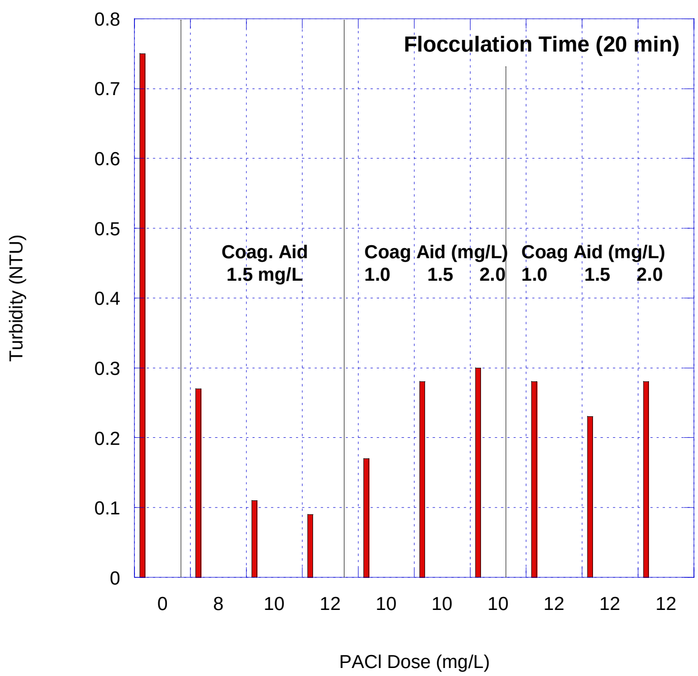


Figure A.3
Impact of PACl, and Coagulant Dose on Turbidity

Because direct filtration relies on the formation of pinpoint flocs to ensure that the filters perform efficiently, doses were evaluated based on filtered turbidity, floc size and water filterability (measured through visual observation). For the tests run with PACl, no visible floc was observed with a concentration of 6 mg/L. Conversely, the flocs formed were too large when doses above 12 mg/L were used. These samples were not processed as the goal of the bench-scale effort was to identify chemical dose ranges to use at pilot-scale. Based on the results obtained, the following doses were used:

- Alum – 16 mg/L (as dry product);
- PACl – 12 mg/L (as neat product);
- Coagulant aid polymer (Isofloc 222) – 1.75 mg/L (as neat product).

Based on the performance of full-scale plants located in the Okanagan region, the filter aid polymer dose range was set between 0.01 and 0.03 mg/L.

A.2.2 Pilot-Scale Study

The pilot-scale study was conducted during a period of 10 weeks, from late April to July of 2006. As mentioned previously (**Table A.4**), different conditions were tested during this period. In order to measure system performance, grab samples were collected at specific times, corresponding to different coagulation and filtration regimes. Raw water quality measured for the these samples is shown in **Table A.10**. The turbidity was monitored continuously, and varied between 0.3 and 1.0 NTU. The highest values were obtained between the last week of May and the first week of June.

Table A.11 summarizes the data obtained during the pilot study. Five locations were sampled; raw water, flocculated water and filter effluents. DBP tests were performed, selectively, on Filters 2 and 3 effluents.

In addition to showing the different parameters sampled, **Table A.11** also shows filter cycle lengths (F.C.), unit filter rate volume (UFRV), and headloss (ΔP). The filter cycle was defined as the period in which the turbidity measured in the filter effluent remained under 0.1 NTU. The UFRV was calculated as the volume of water treated per filter unit area, for a given filter run.

Table A.10
Average Raw Water Quality During Pilot-Scale Testing

Parameter	Shuswap Lake	GCDWQ[1]
pH (-)	7.6 ± 0.2	6.5 - 8.5[2]
Temperature (^oC)	5.7 ± 0.5	-
Alkalinity ($mgCaCO_3/L$)	45 ± 1.5	-
Turbidity (NTU)	0.63 ± 0.1	1[3]
True Colour (PtCo units)	<5	15[2]
DOC (mg/L)	1.8 ±0.2	-
TOC (mg/L)	2.5 ± 0.5	-
UVT (%)	90 ± 0.9	-
Iron (mg/L)	<0.005	0.1[2]
Manganese (mg/L)	0.002	-
Calcium (mg/L)	15	-
TTHM (µg/L)[4] • #1 • #2 • #3	 104 ± 2.1 75 62	 100
HAA5 (µg/L) • #1 • #2 • #3	 91 ± 14 - 73	 80[5]

1 GCDWQ – Guidelines for Canadian Drinking Water Quality
2 Aesthetic objective
3 Long-term goal is 0.1 NTU
4 Test conditions specified in Table A.7
5 Proposed limit

Table A.11
Direct Filtration Process Performance

ID	F.R.	F.T.	Coag		C.A.D.	F.A.D.	Raw Water									Flocculated Water				
	(m/h)	(min)	Type (-)	Dose (mg/L)	(mg/L)	(mg/L)	Turb (NTU)	Temp (°C)	pH (-)	Alk (mg/L)	TOC (mg/L)	DOC (mg/L)	UVT (%)	TTHM (μg/L)	HHA5 (μg/L)	Temp (°C)	pH (-)	Alk (mg/L)	DOC (mg/L)	UVT (%)
1	15	20	PACl	12	1.75	0.02	0.5	5	8	44	2	1.6	90	-	-	5.6	7.6	41	1.3	95
2	15	20	PACl	12	1.75	0.02	0.54	5.1	8	-	2.3	1.9	88	106	101	5.4	7.5	-	1.5	-
3	15	15	PACl	4	1.75	0.02	0.79	6.3	7.5	46	3.4	2.0	88	-	-	6.3	7.5	42	1.5	89
4	15	15	PACl	4	1.75	0.02	0.87	6.6	7.4	46	2.1	2.0	90	-	-	7.0	7.4	42	-	-
5	15	15	Alum	6	1.75	0.02	0.65	5.8	7.5	44	3.3	1.5	90	103	81	6.6	7.5	42	1.3	90
6	15	15	Alum	6	1.75	0.02	0.69	5.7	7.5	-	2.1	1.9	90	-	-	5.8	7.6	-	-	-
7	18	15	Alum	6	1.75	0.02	0.51	5.6	7.6	45	2.4	2	90	-	-	5.7	7.7	41	1.6	92
8	18	15	PACl	4	1.75	0.02	0.51	5.6	7.6	46	2.3	1.8	90	75.2[2]	-	5.7	7.7	46	1.7	94
9	18	15	PACl	4	1.75	0.02	0.59	6.0	7.6	42	2.3	1.7	90			6.4	7.7	39	-	-
10	18	18	Alum	6	1.75	0.02	0.66	6	7.7	48	2.1	1.8	90	62.1[3]	73[3]	6.2	7.6	45	-	-

Table A.11
Direct Filtration Process Performance (Cont.)

ID	F.R.	Coag	Filter No. 1 Effluent							Filter No. 2 Effluent									Filter No. 3 Effluent							
	(m/h)	Dose (mg/L)	F.C. (h)	UFRV (m^3/m^2)	ΔP (in)	Turb (NTU)	TOC (mg/L)	DOC (mg/L)	UVT (%)	F.C. (h)	UFRV (m^3/m^2)	ΔP (in)	Turb (NTU)	TOC (mg/L)	DOC (mg/L)	UVT (%)	TTHM (μg/L)	HHA5 (μg/L)	F.C. (h)	UFRV (m^3/m^2)	ΔP (in)	Turb (NTU)	TOC (mg/L)	DOC (mg/L)	UVT (%)	TTHM (μg/L)
1	15	12	-	-	-	0.08	2.5	1.3	95	12	180	50	0.04	-	1.1	95	-	-	12	180	7	0.08	-	1.2	95	-
2	15	12	8	120	52	0.09	1.7	1.2	97	16	240	30	0.04	1.7	1.1	97	73	64	7	105	16	0.06	3.5	1.3	96	-
3	15	4	21	315	73	0.05	2.3	1.8	94	21	315	47	0.04	1.6	1.5	94	-	-	29	435	36	0.04	3.2	1.5	90	-
4	15	4	11	165	70	0.06	1.7	1.6	95	22	330	80	0.04	1.4	1.4	95	-	-	44[1]	660	65	0.04	1.6	1.3	95	-
5	15	6	19	285	67	0.06	1.4	1.4	94	21[1]	315	72	0.06	2.4	1.2	94	70	56	20[1]	315	67	0.06	1.5	1.3	95	70
6	15	6	7	105	37	0.08	1.6	1.5	94	11	165	35	0.08	1.5	1.5	94	-	-	4	60	16	0.1	1.6	1.6	94	-
7	18	6	11	198	41	0.08	1.7	1.7	94	11	198	28	0.07	1.8	1.5	94	-	-	9	162	12	0.08	1.6	1.6	94	-
8	18	4	32	576	50	0.07	1.9	1.6	93	48	864	20	0.06	1.9	1.5	93	54.3[2]	-	41	738	26	0.07	1.8	1.5	93	45.6[2]
9	18	4	19	342	37	0.07	-	-	-	48*	864	32	0.05	1.7	1.4	94	-	-	39	702	23	0.07	1.8	1.4	94	-
10	18	6	22	396	20.5	0.05	-	-	-	44	792	56.7	0.04	1.9	1.5	94	37.7[3]	39[3]	44	792	44.5	0.03	1.5	1.5	95	42.4[3]

[1] Forced Backwash; [2] DBP Formation Potential tested at 20°C, during 7 days; [3] DBP Formation Potential tested at 20°C, during 3 days.

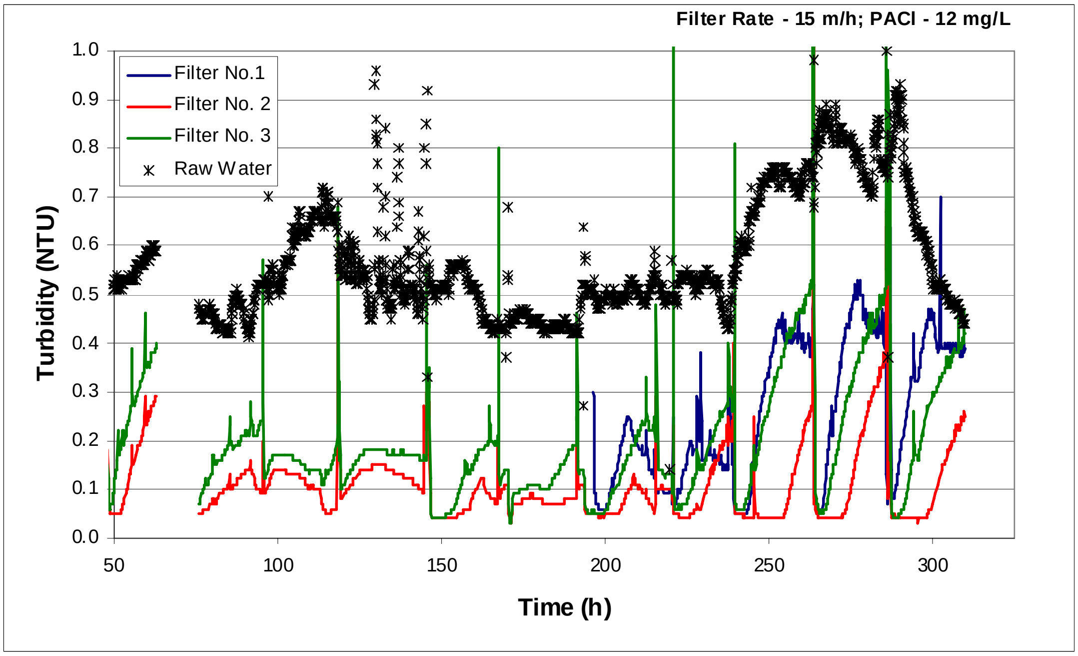
Table A.12 shows the overall performance (removal of TOC, DOC, and DBP precursors) obtained for the different filters tested. The increase in UVT was relatively constant for all test conditions and filter designs, and corresponded to 4.8 ± 1.65 percent.

Table A.12
Filter Performance Indicators

Test No.	Percent Removal (%)								
	Filter No. 1		Filter No. 2				Filter No. 3		
	TOC	DOC	TOC	DOC	TTHM	HAA5	TOC	DOC	TTHM
1	-	19	-	31	-	-	-	25	-
2	26	37	26	42	31	36.6	-	32	-
3	32	10	-	25	-	-	-	25	-
4	19	20	33	30	-	-	24	35	-
5	58[1]	6.7	27	20	31	30.9	54[1]	13	32
6	24	21	27	21	-	-	24	16	-
7	29	15	25	25	-	-	33	20	-
8	17	11	17	17	28	-	22	17	40
9	-	-	26	18	-	-	22	18	-
10	-	-	9.5	17	39	39	29	17	32
Ave	25	17	26	24	33	36	26	22	34
St Dev	5.8	9.4	4.8	8.1	4.8	4.2	4.5	7.2	4.3

1 This value was not accounted in the average

Figures A.4 through A.8 show the on-line turbidity and pressure data measured for the two different PACl doses (4 and 12 mg/L). **Figures A.4 and A.6** show several filter cycles, while **Figures A.7 and A.8** focus on the impact of PACl concentration in one filter run. These figures show the impact of filter type and coagulant dose addition on effluent turbidity removal and pressure increase. The rema ining data can be found at the end of the appendix. In addition to on line turbidity monitoring, two particle counters were also installed. One particle counter monitored the raw water while the other monitored one of the filters (Filters No. 2 and 3 were monitored, at different times during the project). **Figure A.5** shows particle counts data, for a representative set of samples.



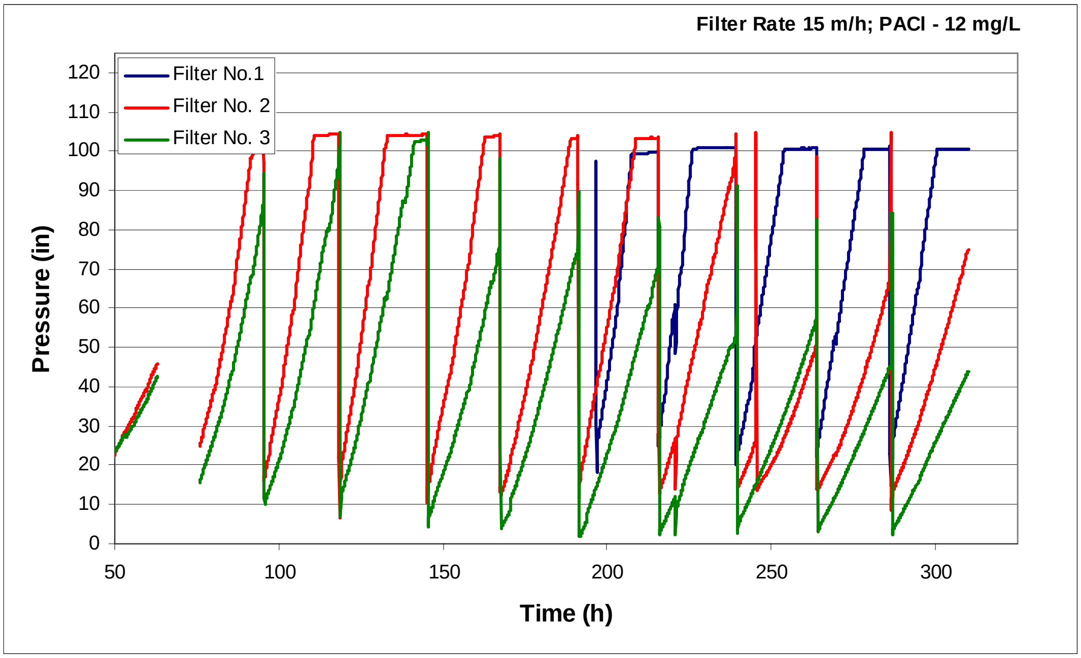


Figure A.4 – Turbidity and pressure data measured at a filter rate of 15 m/h and a PACl dose of 12 mg/L (Flocculation time: 20 minutes)

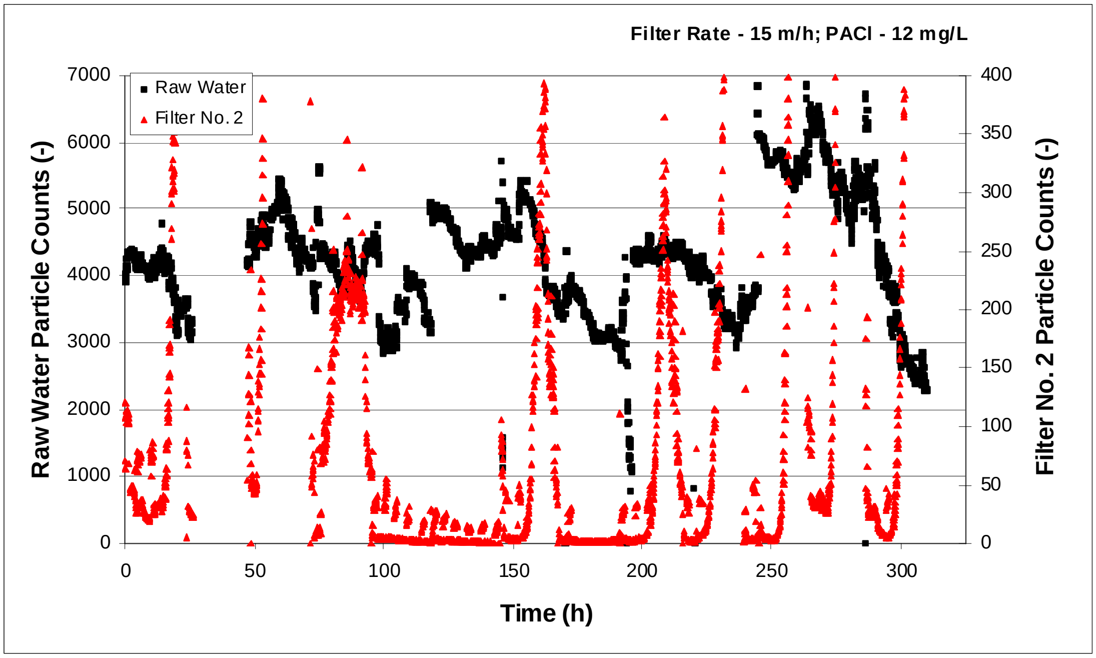
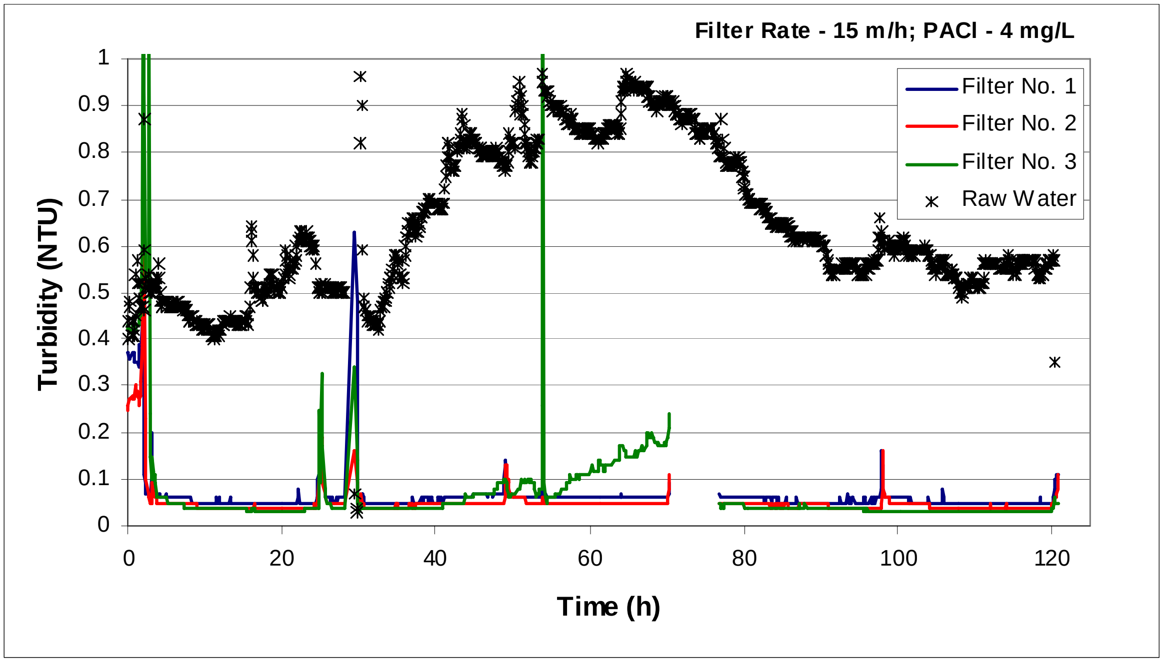


Figure A.5 – Particle counts removal measured for filter number 2, at a filter rate of 15 m/h and a PACl dose of 12 mg/L (Flocculation time: 20 minutes).



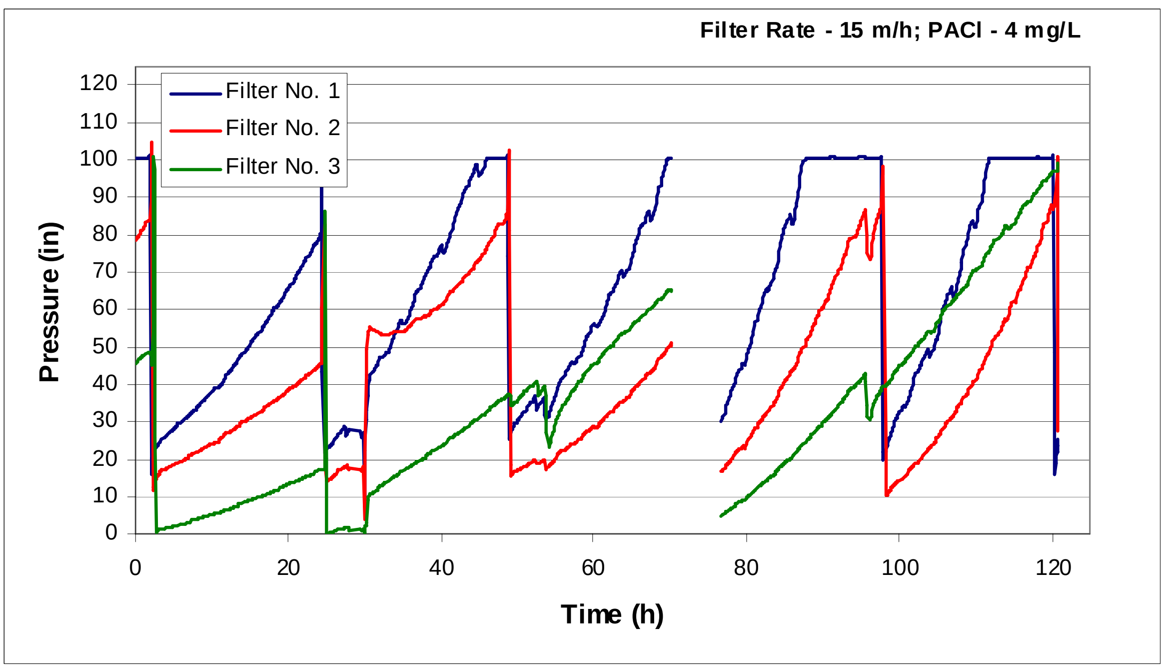
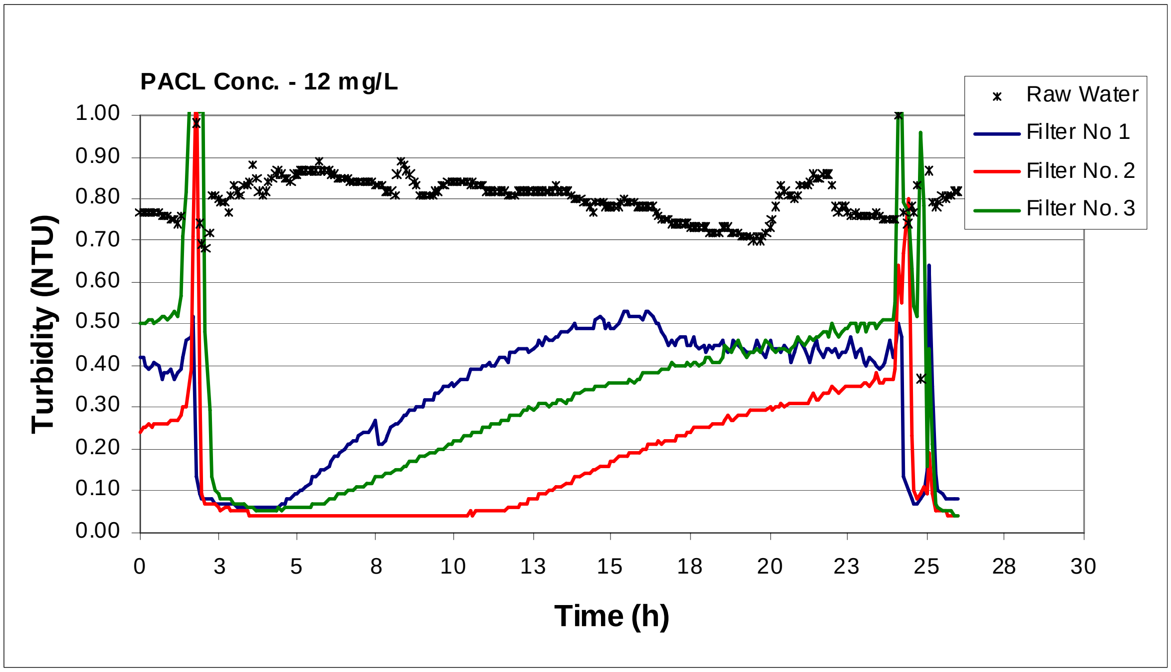


Figure A.6 - Turbidity and pressure data measured at a filter rate of 15 m/h and a PACl dose of 4 mg/L (Flocculation time: 15 minutes).



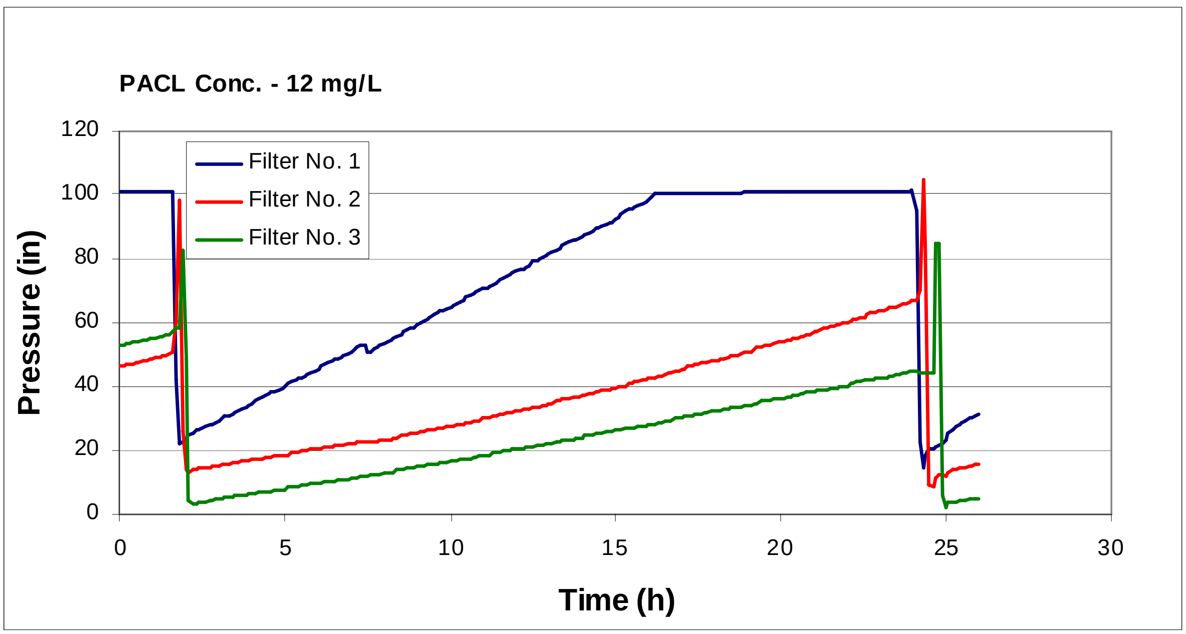
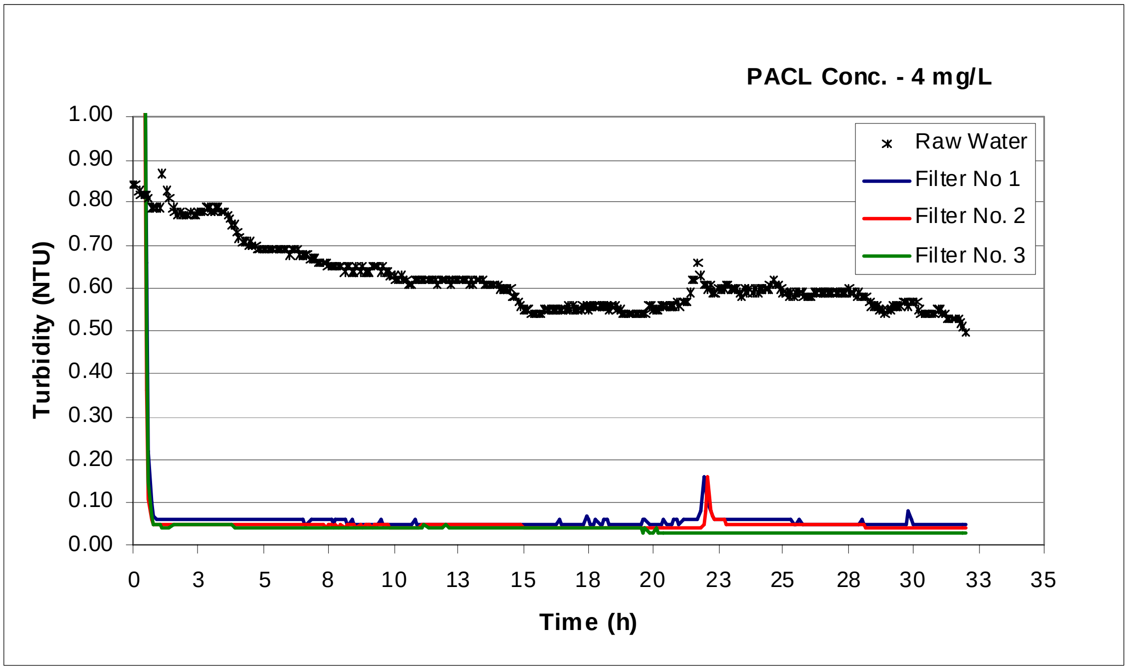


Figure A.7 – Filter cycle turbidity and pressured monitored at a filter rate of 15 m/h and a PACl dose of 12 mg/L (Flocculation time: 15 minutes).



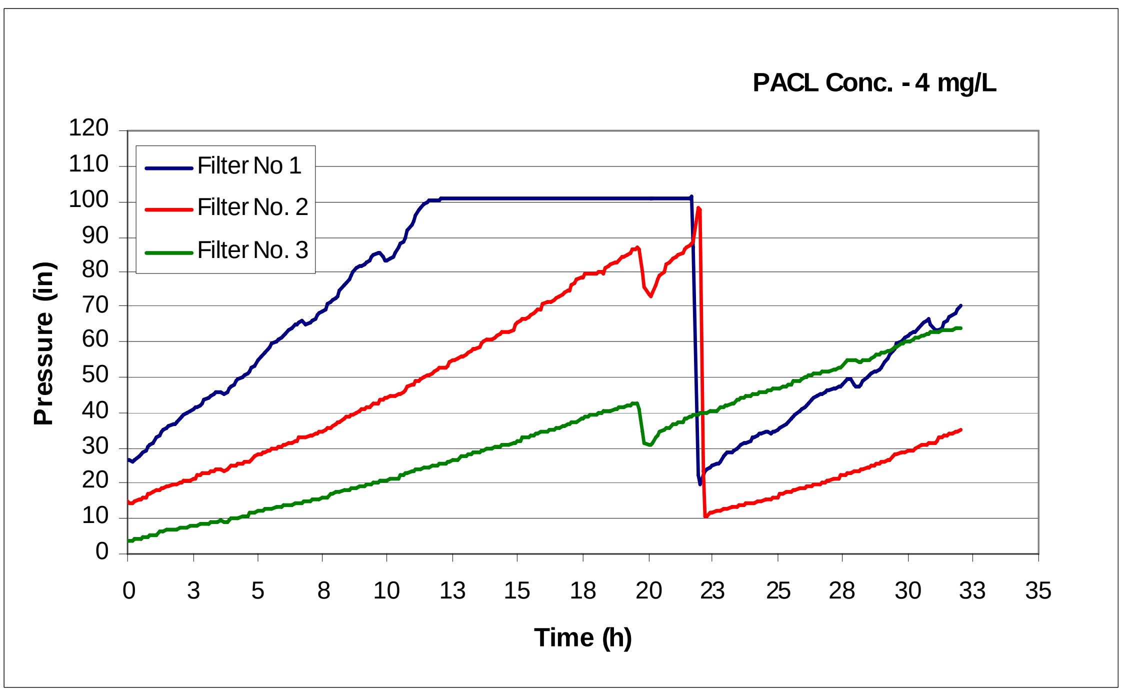


Figure A.8 - Filter cycle cycle turbidity and pressured monitored at a filter rate of 15 m/h and a PACl dose of 4 mg/L (Flocculation time: 15 minutes).

A.2.3 Backwash Water Treatment

One of the options being considered regarding disposal of the filter backwash water include disposal back into Shuswap Lake. This option would first allow for the suspended solids to settle, after which the supernatant would be returned to Shuswap Lake. As detailed in Section 8.1.4, settleability tests were performed with backwash water collected from the pilot plant (Filters No. 2 and 3). PACl and alum were added to backwash water at concentrations of 10, 25 and 40 mg/L (from left to right; jars 1-3 PACl and jars 4-6 alum), while coagulant aid was kept at 1.5 mg/L. **Figures A.9** shows the samples at time zero, prior to any chemical addition. **Figures A.10 and A.11** show the samples after 15 and 25 minutes of settling time. The turbidity monitored for the supernatant was lower than 0.3 NTU for all samples.

Table A.13 shows the results obtained for the test number 3 (see **Table A.8**). Backwash water was allowed to settle with and without coagulant and coagulant aid addition. A dose of 25 mg/L of alum and 1.5 mg/L of Isofloc 222 were added to backwash water and compared to the sample without chemical addition. For each scenario, two samples were collected; the first in the beginning of the backwash cycle, and the second corresponding to a composite of samples collected throughout the backwash cycle. The first set of samples corresponded to the worst-case scenario, while the second intended to more accurately portray the effluent generated throughout the backwashing process.

Figure A.9 – Backwash water samples at the start of the settleability tests.

Figure A.10 – Backwash water samples after 15 minutes of settling time (From the left; PACl 10, 25 and 40 mg/L, and 0, 25 and 40 mg/L of alum). Control test (with no chemical addition) was performed in the beaker shown.

Figure A.11– Backwash water samples after 25 minutes of settling time (From the left; PACl 10, 25 and 40 mg/L, and 0, 25 and 40 mg/L of alum). Control test (with no chemical addition) was performed in the beaker shown.

Table A.13
Backwash Water Supernatant Quality Data

Parameters	No Alum Addition		With Alum Addition	
	Initial	Composite	Initial	Composite
Temperature (^{o}C)	14.8	15.5	14.7	15.4
pH (-)	7.6	7.7	7.2	7.1
Alkalinity (mg$CaCO_3$/L)	41	43	31	31
Hardness (mg$CaCO_3$/L)	47	53	53	46
TOC (mg/L)	3.1	3.6	2.2	2.5
BOD_5 (mg/L)	4.5	5.1	4.2	3.6
D.O. (mg/L)	4.8	4.9	4.9	5.0
TSS (mg/L)	<10	<10	<10	<10
Turbidity (NTU)	1.9	1.5	1.5	1.4
Aluminum (mg/L)	0.54	0.67	0.83	1.21
Copper (mg/L)	0.002	0.003	0.002	0.002
Iron (mg/L)	<0.05	<0.05	<0.05	<0.05
Phosphorus (mg/L)	<0.15	<0.15	<0.15	<0.15

A.3 Discussion and Recommendations

During start-up, coagulant and coagulant aid were dosed as determined during bench-scale testing. As testing progressed different optimal doses were identified. These corresponded to 25 percent of the doses initially determined, approximately 4 mg/L for PACl and 6 mg/L for alum. The lower doses resulted in equally filtered turbidity but considerably higher filter production (assessed through the UFRV). **Figures A.4 and A.6** show the impact of PACl dose on filter runs (including pressure and turbidity data). Even though the raw water turbidity was slightly higher when the higher coagulant dose was being tested, the good results obtained with the lower dose were observed throughout the testing program. The effluent water turbidity remained below 0.1 NTU and the headlosses were considerably less than with the higher dose. For these reasons, alum and PACl concentrations of about 6 and 4 mg/L were used, instead of the 16 and 12 mg/L initially predicted.

It appears as if a slightly larger organics removal was obtained at the higher dose. This is to be expected, based on literature data. However, historically DBPs have been well within the regulated limits. Therefore, coagulant dosed was optimized to remove turbidity and maximize filter runs.

Both coagulants performed well and should therefore be selected based on price (product and delivery), supplier availability, and operational concerns. Considering alum and PACl prices for 2008 at \$275/mT and \$700/mT, coagulant costs would be approximately \$7,000 and \$7,500, respectively (at average flow).

Two flocculation times were tested, 15 and 20 minutes, with no measurable impact on process performance. The lowest flocculation was adopted throughout the testing period. In general, good DOC removal was obtained during coagulation / flocculation (ranging from 5 to 25 percent), attesting to the efficiency of the process.

Table A.12 shows organics and DBP precursors removals for the three filters tested. Filters 2 and 3 performed slightly better than filter 1. However, TOC (which ultimately contributes to DBP formation) removal was very similar for all three media configurations tested (approximately 25 percent). As mentioned previously, coagulant addition was optimized for turbidity, not organics removal. Nevertheless, a reduction in total THM (TTHM) and HAA5 of approximately 35 percent was obtained. The tests performed at a temperature of 20 ^{o}C and incubated for 72 hours, yielded 38 and 39 μg/L of TTHM and HAA5, respectively. These concentrations are less than half of the regulated limits. Because the test temperature is significantly higher than that of the distribution system (which is around 10 - 15 ^{o}C), less DBP formation will likely be obtained.

Generally, higher headlosses were obtained with filter 1, followed by filters 2 and 3. These results were expected, based on media types. Filter 1 is a dual media with small effective size sand and anthracite, filter 2 is a dual coarse effective size sand / anthracite media, and filter 3 is a coarse effective size anthracite media. Average pressure increases for filters 1, 2 and 3 were 3.7, 2.0 and 1.2 inches/h, respectively.

Overall, throughout testing, filter 2 appeared more robust in dealing with process upsets, when compared to filter 3, likely due to the extra sand layer. However, less headloss was obtained for filter 3. Therefore, filter selection should take in consideration filtered water quality and available headloss throughout the plant. Due to the discrepancy between water demand in the winter and summer months, the filters will be operating at much lower filtration rates than the design rate. Additionally, the design rate will be considerably less than the 18 m/h tested. During pilot testing, a test was conducted with a filter rate of 10 m/h. Filters 2 and 3 run for 120 hours without requiring backwashing. Filter 1 required backwashing after approximately 70 hours of operation.

For all filters an increase in UVT of 4.8 percent was obtained. Based on the historical water quality data provided by the CSA, the 1, 25, 95 and 99 UVT percentile are 80, 84, 91 and 92 percent. Assuming a 5 increase in UVT due to the direct filtration process UVT values would vary between 85 and 97 percent. An evaluation of UV disinfection systems should be made where the worst-case scenario is addressed within reasonable capital and O&M costs.

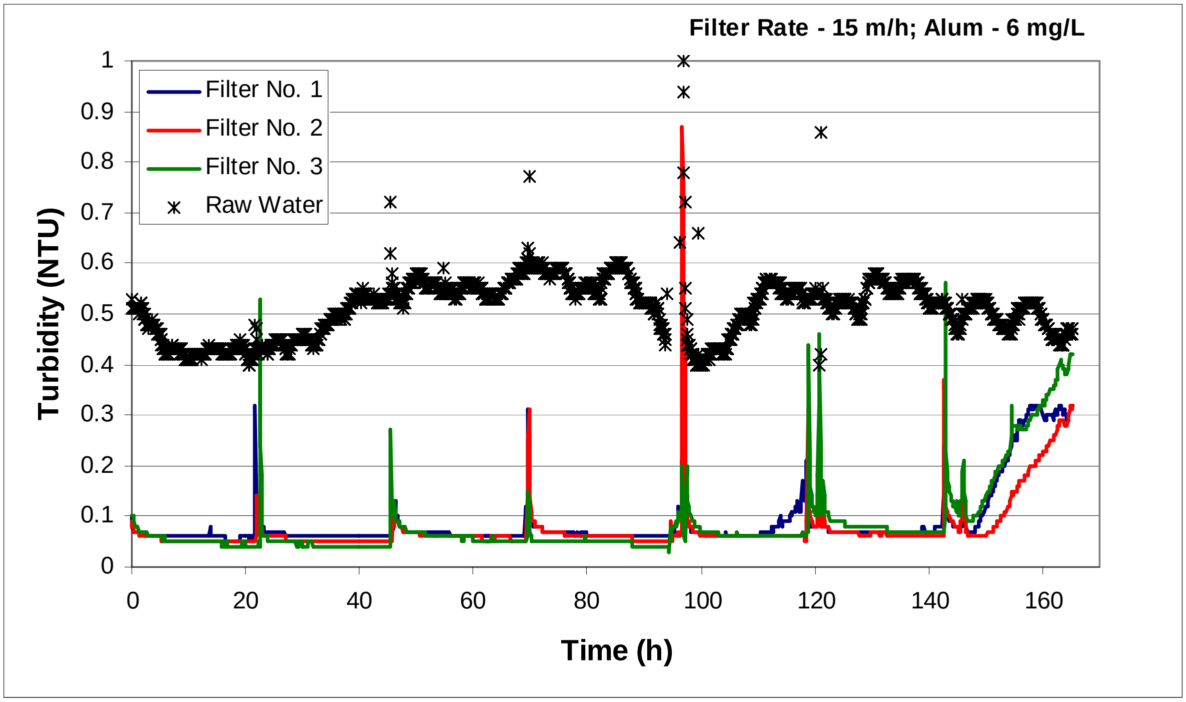
Although the particle counters were installed as recommended by the manufacturer, the flow was not held constant throughout the study. The flow measured through the particle counters varied daily. This does not allow for an accurate estimate of the number of total particulates present in the filter effluents. However, it was possible to observe a significant decline in the number of total particulates, when compared to the raw water. **Figure A.5** shows an example of filter efficiency with regards to particle removal. The direct filtration process resulted in a decrease of particle in the filter effluent, that was independent of the level of particulate measured in the raw water. Although it is not possible to specify with accuracy the exact number of particulates obtained in the filtered water, it is fair to say that particle counts were reduced by approximately 50 to 100 fold.

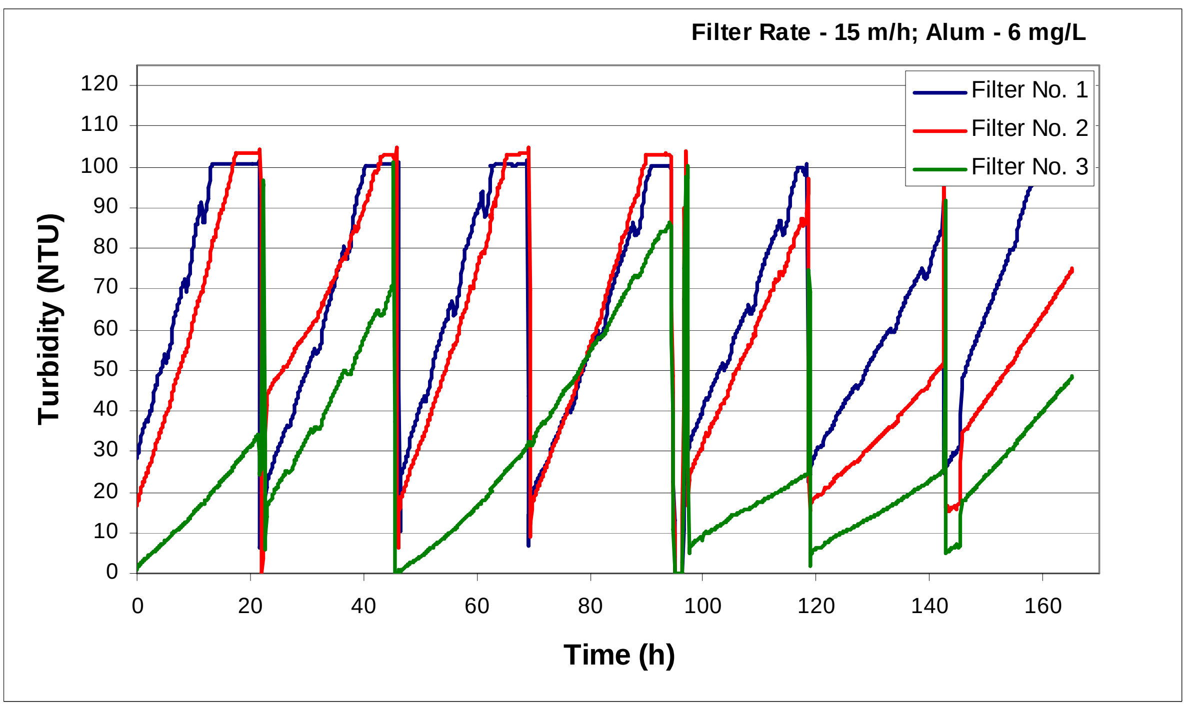
With regards to backwash water treatment, based on the summary tests performed, upon settling the water will likely be suitable discharge into Shuswap Lake. General water quality parameters evaluated showed low organic matter, BOD_5 and particulate matter present in the supernatant. Issues that require further investigation are the impact of temperature on the receiving water body.

Based on the results obtained, the following is a summary of findings and recommendations:

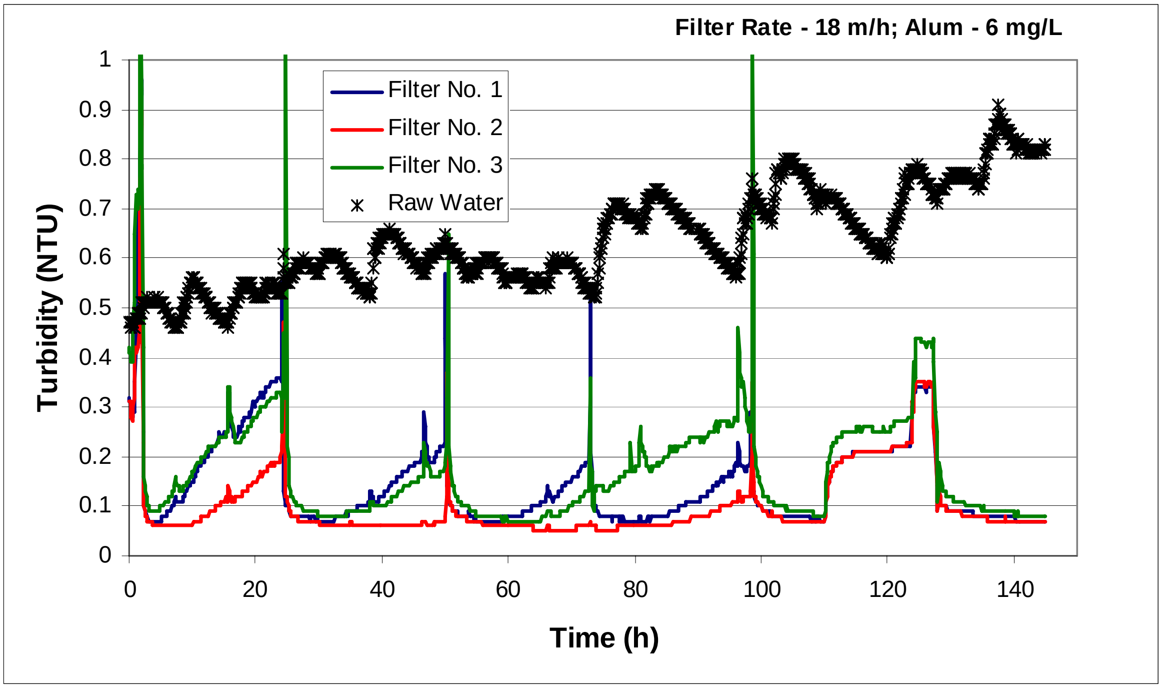
- Both alum and PACl performed well. Selection should be done based on price, supplier availability and operational issues.
- Optimal coagulant doses for turbidity removal were in found to be in the range of 6 mg/L of alum (as dry weight) and 4 mg/L if PACl. Doses will likely required adjustment as the raw water quality may change.
- Optimal coagulation aid polymer concentration was determined to range between 1.5 and 2.0 mg/L.
- A flocculation time of 15 minutes yielded good pin floc, and turbidity and organics removal (including DBP precursors).
- Optimal filter aid polymer concentration was determined to range between 0.015 and 0.03 mg/L
- Filters 2 and 3 showed better overall performance than filter 1, and should be considered during pre-design. Filter 1 showed higher filter headlosses due to the tighter media used.
- Filter rates up to 18 m/h were tested successfully on a continuous basis.
- A filtered water UVT ranging between 85 and 96 percent should be considered during pre-design for Shuswap Lake source, and 80 percent for East Canoe Creek.

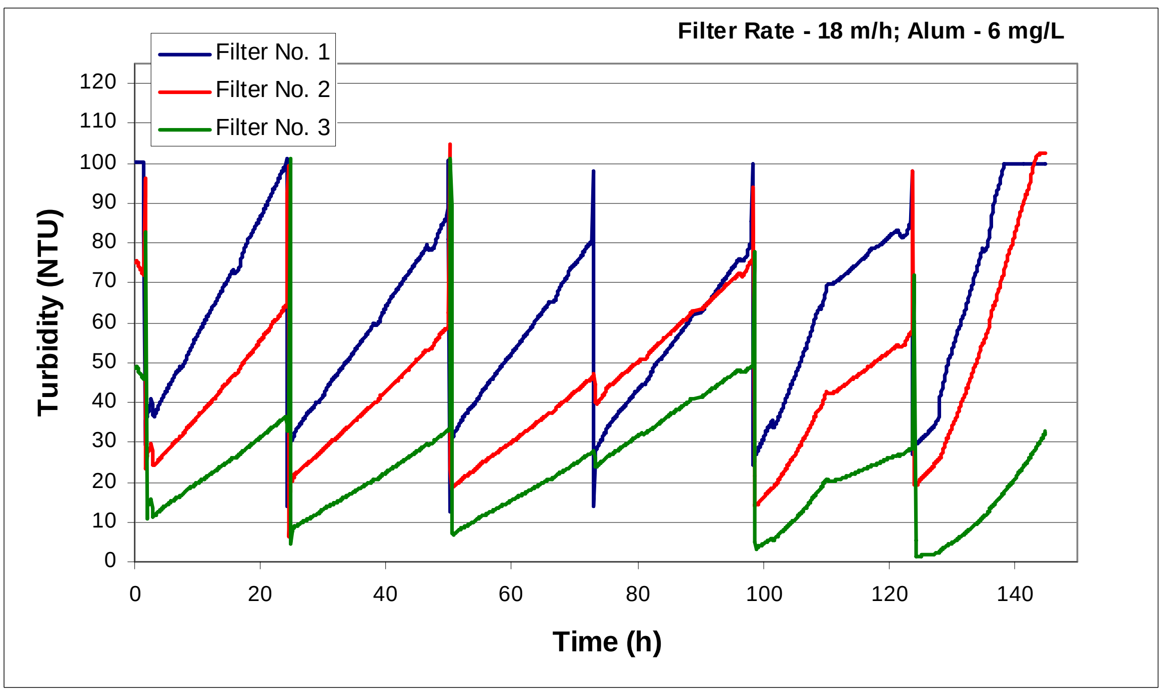
Additional Pilot-Scale Test Results



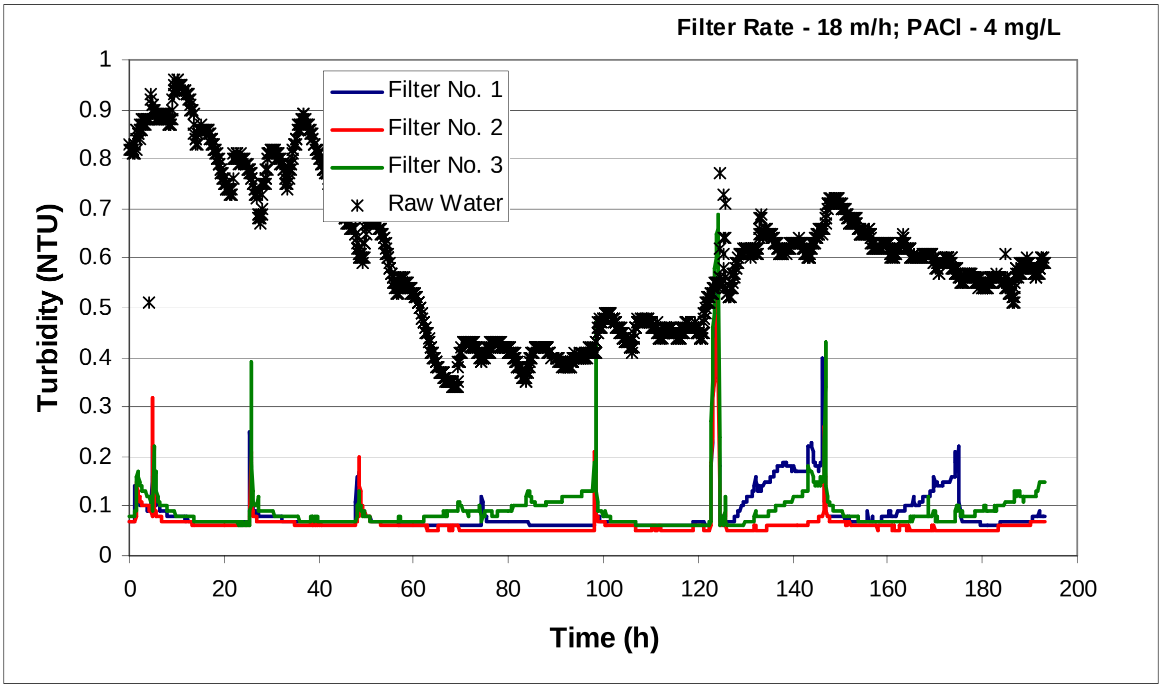


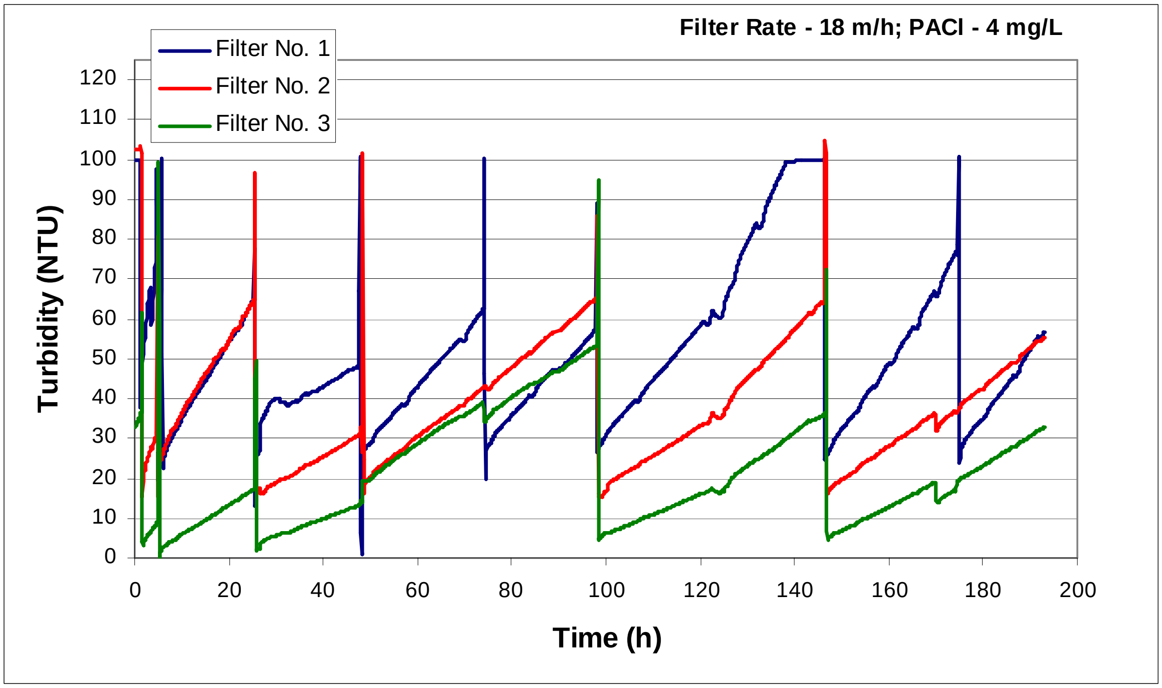
Turbidity and pressure data measured at a filter rate of 15 m/h and a alum dose of 6 mg/L (Flocculation time: 15 minutes).



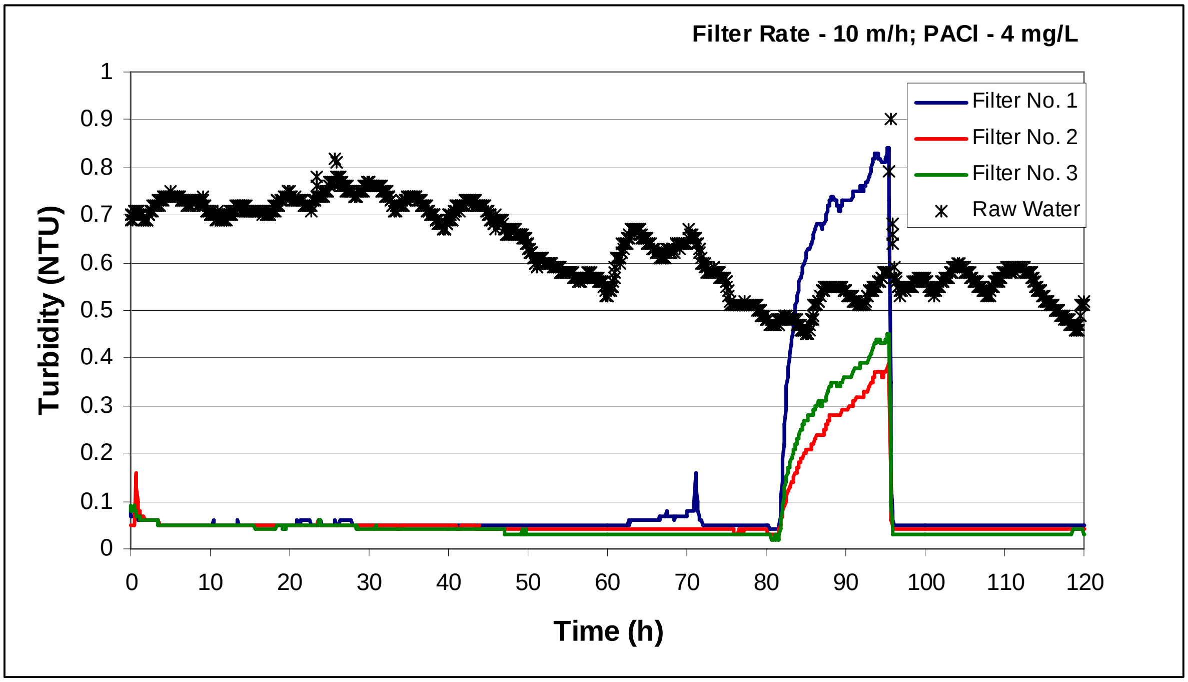


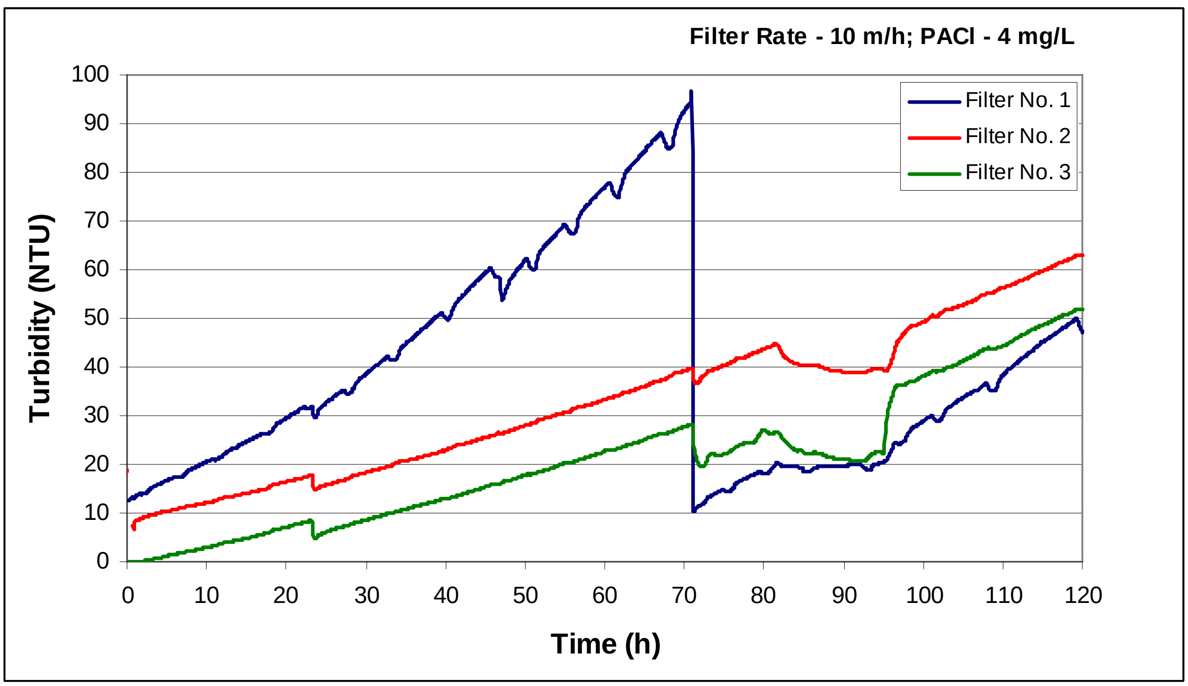
Turbidity and pressure data measured at a filter rate of 18 m/h and an alum dose of 6 mg/L (Flocculation time: 15 minutes).





Turbidity and pressure data measured at a filter rate of 18 m/h and a PACl dose of 4 mg/L (Flocculation time: 15 minutes).





Turbidity and pressure data measured at a filter rate of 10 m/h and a PACl dose of 4 mg/L (Flocculation time: 15 minutes).

APPENDIX 8

WATER EMERGENCY RESPONSE PLAN

City of Salmon Arm

EMERGENCY RESPONSE PLAN

Emergency Response Plan

PREFACE

The purpose of an Emergency Response Plan (ERP) is to provide a reference guide for the City of Salmon Arm to use in the event of an emergency. Emergencies may be an incident which presents a threat to the health of people drawing water from the system or a disruption to the City's normal fire protection capabilities.

The ERP is divided into three sections:

Part I - Action Plans

The following possible emergency scenarios are listed with recommended responses and procedures provided:

1. Contamination of Source
2. Loss of Source
3. Chlorinator Failure
4. Backflow Contamination
5. Broken Watermain
6. Pressure Reducing Valve (PRV) Failure
7. Pump failure

Part II – Contact List

A contact list is provided which identifies key personnel and agencies that may need to be notified.

Part III – System Inventory

Description of the major components of the water system is provided along with mapping to assist the City in identifying the location of the problem in relation to the overall system.

Appendix I

Water user notification templates notices that describe the situation and the effect of the emergency.

Appendix II

Water systems maps

- Section maps of the City water infrastructure which can help locate applicable infrastructure throughout the City limits

PART I - ACTION PLANS

1. CONTAMINATION OF SOURCE

ACTIONS REQUIRED:

1) Shut down source

2) Assess nature and cause of problem

3) Contact Local Health Officer

4) Notify users of water contamination. In case of bacteriological contamination, issue a boil water order. In case of chemical or toxic substance, advise accordingly.

   - **Issue a mail out to all City of Salmon Arm homes immediately (see notification templates)**
   - **In particular ensure at risk users i.e. hospitals, nursing homes are contacted directly**

5) Make direct calls and notification to users and alert local media requesting public service announcements

6) Post notice on all public water taps and fountains (shut off if possible)

7) Contact government agencies and emergency personnel:
   - Ministry of Environment
   - Fire Department
   - Provincial Emergency Preparedness Program

8) Arrange for alternate drinking water source if necessary

9) Once problem is rectified, initiate water flushing and disinfection program in distribution system to remove contaminate

10) Retest source, report to Health Inspector

11) When safe to do so and permission in writing has been received from the Ministry of Health turn water source back on

12) Cancel all boil water notices, advertise water is safe again

13) When appropriate determine if contamination can be prevented in the future. If so include capital works or operational changes required in annual budget for consideration

CONTACTS

- City Staff (Utility personnel, Managers)
- Local Health Authority
- Refer to contact list as necessary

USEFUL RESOURCES

- City maps
- Applicable operational procedures
- Water notices
- Contact list

2. LOSS OF SOURCE

ACTIONS REQUIRED:

1. Identify lost source

2. Assess nature and cause of problem

3. Notify users of water shortage and the need for conservation (if deemed necessary)

4. Notify Health Unit & Health office if possible contamination has occurred (see contamination of source response)

5. Arrange for alternate drinking water source if necessary

6. Correct loss of source problem

7. Put back into service

8. Inform effected users operations back to normal

CONTACTS

- City Engineer
- City Staff (Utility personnel, Managers)
- Local Health Authority
- Fire Department
- Provincial Emergency Preparedness Program
- Ministry of Environment
- Refer to contact list as necessary

USEFUL RESOURCES

- City maps
- Applicable operational procedures
- Water notices
- Contact list

3. CHLORINATOR FAILURE

ACTIONS REQUIRED:

1. Assess nature and cause of problem

2. Contact Local Health Officer

3. Arrange for other disinfection procedures (shut off source and use alternate source only) if possible

4. Notify users of water disinfection failure. Issue a boil water order.

    - **Produce and issue a mail out to all City of Salmon Arm homes immediately (see notification templates)**
    - **In particular ensure at risk users i.e. hospitals, nursing homes are contacted directly**

5. Make direct calls and notification to users and alert local media requesting public service announcements

6. Post notice on all public water taps and fountains (shut off if possible)

7. Arrange for alternate drinking water source if necessary

8. Arrange for chlorine failure repairs

9. Contact chlorinator manufacturer for advice on repairs to chlorinator if required

10. Once problem is rectified, initiate water flushing and disinfection program in distribution system to remove contaminate if required

11. Test source, report to Health Inspector

12. When safe to do so and permission in writing has been received from the Ministry of Health turn water source back on

CONTACTS

- City Engineer
- City Staff (Utility personnel, Managers)
- Local Health Authority
- Fire Department
- Refer to contact list as necessary

USEFUL RESOURCES

- City maps
- Chlorinators manufacture's specifications
- Applicable operational procedures
- Water notices
- Contact list

4. BACKFLOW CONTAMINATION

ACTIONS REQUIRED:

1. Assess nature and cause of backflow contamination problem

2. Contact Local Health Officer

3. Isolate area if possible

4. Arrange for alternate drinking water source if necessary

5. Notify users of potential water contamination. In case of bacteriological contamination, issue a boil water order. In case of chemical or toxic substance, advise accordingly.

6. Make direct calls and notification to users and alert local media requesting public service announcements

7. Make corrections to fix or eliminate the problem

8. Once problem is rectified, initiate water flushing and disinfection program in distribution system to remove contaminate if required

9. When safe to do so and permission in writing has been received from the Ministry of Health turn water source back on

CONTACTS

- City Engineer
- City Staff (Utility personnel, Managers)
- Local Health Authority
- Fire Department
- Refer to contact list as necessary

USEFUL RESOURCES

- City maps
- Applicable operational procedures
- Water notices
- Contact list

5. BROKEN WATERMAIN

ACTIONS REQUIRED:

1. Isolate break at nearest valves

2. Repair break as quickly as possible

3. Determine zone of influence
   (a) If break is limited to a specific area, inform affected users of temporary loss of service or pressure reductions while repairs are being completed
   (b) If break causes disruption to overall system, inform all users to reduce consumption

4. Try to maintain positive pressure throughout the distribution system

5. Contact government agencies and emergency personnel if break deemed serious enough to cause a health hazard:
   - Local Health Officer
   - Fire Department
   - City Engineer

6. Arrange for alternate drinking water source if necessary

7. Once repair is completed, initiate water flushing and disinfection program in affected mains if positive pressure was not maintained during repair

8. Reinstate main operation and contact effected users

CONTACTS

- City Staff (Utility personnel, Managers)
- Local Health Authority
- Fire Department
- Refer to contact list as necessary

USEFUL RESOURCES

- City maps
- Applicable operational procedures
- Water notices
- Contact list

6. PRESSURE REDUCING VALVE (PRV) FAILURE

ACTIONS REQUIRED:

1. Assess nature and cause of problem

2. Contact PRV supplier and City Engineer for assistance

3. Determine zone of influence. With a large PRV failure, the small PRV may become the primary source of water supply to some users and pressure reductions may occur at peak demand conditions. Notify affected users to reduce water consumption.

4. Contact the Fire Department to let them know fire flows have been reduced

5. If large PRV needs to be removed for servicing, install a spool piece for manual operation during fire flow conditions

6. Once corrected contact affected users and the Fire Department to let them know the PRV is back in service

CONTACTS

- City Engineer
- City Staff (Utility personnel, Managers)
- Fire Department
- Refer to contact list as necessary

USEFUL RESOURCES

- City maps
- PRV manufacture's specifications
- Applicable operational procedures
- Water notices
- Contact list

7. PUMP FAILURE

ACTIONS REQUIRED:

1. Turn on Metford Dam source (if Canoe source pumps fail) if not already on

2. Assess nature and cause of pump problem (if pump located at reservoir re-route water if possible). If unable to correct contact appropriate supplier/consultant for assistance.

3. Contact BC Hydro if power failure is cause of pump failure

4. Notify users of water shortage and the need for conservation (if demand is higher than Metford can supply). In addition contact the Fire Department that fire flows may be reduced

5. Once pump failure is corrected put back into service

6. Contact all effected users and inform them pump is back on line

CONTACTS

- City Engineer
- City Staff (Utility personnel, Managers)
- Fire Department
- Local Health Authority (if deemed necessary)
- Refer to contact list as necessary

USEFUL RESOURCES

- City maps
- PRV manufacture's specifications
- Applicable operational procedures
- Water notices
- Contact list

PART II – CONTACT LIST

CITY OF SALMON ARM
WATERWORKS EMERGENCY RESPONSE PLAN

In the order listed, contact the following:

MANAGEMENT PERSONNEL

		Office	Home	Cell
Utilities Foreman	Gerry Rasmuson	803-4085	832-9568	517-7950
[**in the absence of the Utilities Foreman**]				
Mgr of Public Works, Utilities & Parks	John Rosenberg	803-4088		517-0259
Public Works/Parks Foreman	Jerry Robertson	803-4086	832-8361	517-7938
City Engineer				
Director of Engineering & Public Works	Dale McTaggart	803-4016	835-8399	
Chief Administrative Officer	Carl Bannister	803-4033	833-0571	

Once contacted, Management personnel will assess the situation and if the incident is of a nature that requires a City response team, Management will contact waterworks personnel on the following call out list:

WATERWORKS PERSONNEL

	Home		Home
Gerry Rasmuson	832-9568		
Roger Parkes	832-5154	John Rosenberg	517-0259
Larry Smith	832-9406	Jerry Robertson	832-8361
Mike Davie	832-5528	Dale McTaggart	835-8399

The responding personnel will make their own assessment of the situation and, only if safe to do so and after notifying Management of the status, may take the necessary steps to correct the situation.

If contamination of the water system is suspected, in addition to Management personnel, the following must be contacted:

		Office	Cell
Medical Health Officer	Brian Gregory	833-4109	804-9497
Chief Medical Health Officer	Dan Ferguson	851-7350	319-4739
Medical Health Officer	Dr Peter Riben	377-7944	1-866-851-7311

Depending on the situation the following agencies may have to be contacted:

	Office	Emergency
RCMP	832-6044	911
Ministry of Environment		1-800-663-3456
Fire Department	803-4060	911
Provincial Emergency Program [PEP]	832-8194	832-2424
Shuswap Lake General Hospital	833-3600	
Ambulance	832-4691	911

Organization	Name	Telephone	Cell	Home	Fax
CITY OF SALMON ARM					
• Director of Engineering & Public Works	Dale McTaggart	803-4016		835-8399	803-4041
• Chief Administrative Officer	Carl Bannister	803-4033		833-0571	803-4042
• Mgr Public Works, Utilities& Parks	John Rosenberg	803-4088	517-0259	833-1013	803-4092
• Utilities Foreman	Gerry Rasmuson	803-4085	517-7950	832-9568	803-4092
• City Engineer					
INTERIOR HEALTH OFFICIALS					
• Public Health Inspector	Brian Gregory	833-4100		804-0320	832-1714
• Public Health Inspector	Anita Ely	833-4100		833-0314	832-1714
• Public Health Inspector	Courtenay Zimmerman	833-4100	804-5760		832-1714
• Senior Drink Water Inspector	Robert Rippin	1-250-851-7340			851-7341
• Senior Public Health Inspector	Bob Fleming	1-250-851-7340			
• Regional Public Health Inspector	Kristina Dingman	1-250-851-7340			
• Medical Health Officer	Dr Paul Hasselback	1-250-862-4092			
• Public Health Emergency [24 hr]		1-866-851-7311			
PROVINCIAL EMERGENCY PROGRAM		832-2424			
HOSPITALS					
• Salmon Arm		833-3600			
• Vernon		1-250-545-2211			
CSA FIRE DEPARTMENT					
• Emergency		911			
• Non Emergency [Central Dispatch]		803-4066			
• Fire Chief	Brad Shirley	803-4064			803-4068
REGIONAL FIRE DEPARTMENT					
• Emergency		911			
• Non-Emergency [Central Dispatch]		803-4066			832-4065
SALMON ARM RCMP		911			832-6842
LOCAL MEDIA					
• Radio	CKXR	832-2161			
• Television	CHBC-TV	1-250-762-4535			
• Newspaper	SA Observer	832-2131			
	Lakeshore News	832-9461			

Organization	Name	Telephone	Cell	Home	Fax
EQUIPMENT SUPPLIERS/MFG					
Chlorination system	Chem Aid Services	1-604-536-0223			
	AC Ind Instrument	1-604-985-9856			
PVR Stations	Mearles Machine	1-250-763-0109			
	Terasen	1-800-500-8855			
	Wolsely Waterworks	1-866-546-2977			
LOCAL CONTRACTORS					
• Excavator – Win & Chris Excavating	Win Johnson	832-4678	833-2465		
• Plumber – Turner Plumbing	Brian Turner	832-3769	804-9253		
• Electrician – Inskip Electric	Bruce Inskip	832-8132	833-2774		
TESTING AGENCIES					
Environmental Monitoring Water Quality Testing	Eco Tech Laboratory Ltd – Kamloops	1-250-573-5700			573-4557
	CARO Environmental Services – Kelowna	1-250-765-9646			765-3893

PART III – SYSTEM INVENTORY

Water Source

The City water system consists of two (2) main raw water sources, treatment systems for the source waters and an extensive water pumping, distribution, and storage system. Our water supply is via two (2) sources, East Canoe Creek at Metford Dam and Shuswap Lake at Canoe Beach. Water treatment of the source waters is by primary disinfection with chlorine.

Shuswap Lake is at a nominal elevation of about 346 m (1135 ft.) while the Metford Dam intake on East Canoe Creek is at elevation 567 m (1860 ft.). The Utilities Department attempts to maximize the supply of water from East Canoe Creek so that pumping into the system from Shuswap Lake and the associated costs are minimized. The flow of water from East Canoe Creek into the water system is by gravity.

Distribution System

The public water system services an area of approximately 6,322 hectares (see Appendix 2). The City distributes water in pipes made of a variety of materials. The first watermains were made of wood. These wooden mains have since been replaced with cast iron, ductile iron, PVC, polyethylene, steel, asbestos cement, spun concrete and some copper piping. The oldest mains still operating in the Salmon Arm water system inventory are cast iron pipes.

The distribution system includes approximately 196 km of watermain varying in diameter from 100mm to 600mm. It also includes six different pressure zones, ten reservoirs, one dam and four pump stations. There was a major expansion in the northwest sector of the City to service the Adams Lake Band Reserve, Neskonlith Band Reserve and some lands in the Gleneden area. This extension adds three (3) reservoirs, one (1) pump station and 5600 meters of 300mm diameter watermain to the water system.

Pressure Zones

The distribution system is segregated into six (6) pressure zones. The storage reservoir in the highest pressure zone is at elevation 615 m (2020 ft.). Water has to be pumped over 269 m (885 ft.) in elevation from Shuswap Lake to the storage reservoir at the highest elevation.

*Telephone & name updates done May 2007

Acknowledgements

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