HAGENSBORG WATER DISTRICT

WATER SYSTEM UPGRADE: TREATMENT OPTIONS

Prepared by:
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Prepared for:
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Executive Summary

Hagensborg is located on Highway #20, approximately 15 kilometers east of Bella Coola. Domestic water is delivered to the community through a system of 300mm diameter to 100mm diameter AC and PVC piping, originating from an intake on Snootli Creek. The source is surface water and currently no water treatment is provided.

The Hagensborg Water District operators and trustees realize they will be eventually be required to upgrade their water system to provide water treatment to levels as specified by Health Authorities. At the same time, they wish to accommodate the community opposition to chemical water treatment.

The population of Hagensborg was 386 in 2008 and the water system is therefore classified as a small water system under the BC Drinking Water Protection Act and BC Drinking Water Protection Regulation criteria.

Other considerations, in addition to water treatment, include a water storage reservoir which will be required with a treatment plant, and a dedicated raw water line to the fish hatchery. Additionally, replacement of the existing AC watermain (approximately 10km) should be undertaken before or in conjunction with central water treatment design and construction.

Considering these points, the Hagensborg Water District hired David Nairne and Associates to outline three treatment options.

The options are as follows:

Option 1 includes traditional treatment to Vancouver Coastal Health requirements including a chlorine residual and dechlorination at the point of entry to houses. Replacement of 10km of watermain/water services is included. The capital cost for this option ranges from 4.4 million dollars to 5.5 million dollars depending on reservoir construction and treatment plant construction.

Option 2 includes traditional treatment but not including a chlorine residual. A point of entry ultraviolet disinfection system will be required. This option will require approval from the Vancouver Coastal Health Authority; and, this option is only available to a small water system. Replacement of 10km of watermain/water services is included. The capital cost for this option ranges from 4.9 million dollars to 6.1 million dollars depending on reservoir construction and treatment plant construction.

Option 3 is a point of entry system for each house and includes filtration and UV disinfection to Health Authority specifications. This option will require approval from the Vancouver Coastal Health Authority; and, this option is only available to a small water system. Neither a water

storage reservoir nor a dedicated raw water line to the fish hatchery are required. Replacement of the remaining 10km of watermain/water services is not required to make this option feasible. The capital cost for this option is 1.5 million dollars without watermain/water services replacement, and 4.3 million dollars including watermain/water services replacement.

Estimated monthly maintenance costs per water service connection (per house), show options 1 at $9 per month, option 2 at $45 per month and option 2 at $38 per month. Life cycle costing over a 20 year period, shows option 3 to be lowest, option 1 as second lowest and option 2 to be highest.

The Hagensborg Water District consulted the community on June 2, 2009, during a community meeting, and again on June 25, 2009, during their AGM. The community preference formalized through a vote, is for option 3, the point of entry system.

Based on the outcomes of the community meeting and AGM, we recommend the Water District:

1. Reinforce Hagensborg's status as a small water system.
2. Lobby and obtain approval from the VCH for this option.
3. Complete any additional testing/monitoring which may be required.
4. Accurately determine number of buildings to be served by the system and determine flow rate required in order to size each UV unit. For example, a hotel may require a larger flow rate and therefore a larger UV than a single household – contact the supplier for assistance as required.
5. Accurately determine structural/plumbing/electrical changes through a building to building survey and prepare an accurate installation budget.
6. Prepare an updated total cost for this option.

Not required for option 3, but recommended for the integrity of the water system:

7. Complete all AC watermain replacement.
8. Complete all repairs to reduce system leakage.
9. Bring existing water meters online.

Background

Hagensborg is located on Highway #20, approximately 15 kilometers east of Bella Coola as shown in Figure 1 below.

Figure 1. Hagensborg Location Plan

The Hagensborg Water District serves the residents of the community through the Hagensborg water system.

The water system currently consists of untreated surface water from a creek intake/dam on Snootli Creek. The Water District operators and trustees realize they will be eventually be required to upgrade their water system to provide water treatment to levels as specified in the Guidelines For Canadian Drinking Water Quality, and operate their water system as specified in the B.C. Drinking Water Protection Act and the B.C. Drinking Water Protection Regulation, as administered by the Vancouver Coastal Health Authority.

To that end, the Hagensborg Water District have hired David Nairne and Associates to outline three treatment options that will ensure safe and potable water to their users while satisfying the Vancouver Coastal Health Authority (VCH) inspections.

The three options will include:

- Source surface water treatment including filtration, primary disinfection with UV, ozone or chlorine, secondary disinfection to provide a chlorine residual in the watermains,
- Source surface water treatment including filtration, primary disinfection with UV, secondary disinfection with UV at the point of entry into buildings,
- Point of Entry into buildings filtration and UV treatment.

Existing Hagensborg Water System Description

The water system currently consists of untreated surface water from a creek intake/concrete dam on Snootli Creek. The creek dam also provides water storage volume required by the community for domestic flows and fire flows.

A 300mm (12”) diameter intake and a 200mm (8”) diameter backup intake are cast into the dam. Aluminum screens for each intake- with approximately 1/8” diameter holes, provide filtration for leaves, sticks and debris. Gate valves provide isolation for each screen intake and provide screen overflow direction to waste, downstream of the dam.

From the intakes, a 300mm diameter PVC supply main run down to the firehall yard, near Highway#20. From there, the watermain splits and runs approximately 6km west towards Bella Coola, and approximately 6km east towards the original settlement of Hagensborg. Water meters are installed on each line, near the firehall, but are not in use.

Combinations of 200mm diameter PVC, 150mm diameter PVC, 150mm diameter AC and 100mm diameter AC pipe parallel the highway both east and west. Shorter distance lines of 150mm PVC, 150mm AC and 50mm PVC branch from the highway main to service buildings on side roads.
The water system provides service to approximately 207 buildings. The population served by this system was 386 in 2008 and is therefore classified as a small water system.

The following table shows elevations and distances recorded with a handheld GPS, and the calculated static water pressures available.

Table 1: Hagensborg Water Main Along Highway #20

	Elevation meters	Distance from intake km	Static pressure available kPa	Static pressure available psi
Creek Intake	105			
Fire Hall/Maintenance Yard	65	0.5	390	60
West				
1/2 way point	30	3.9	740	110
End of Line at Thorsen Ck	25	6.9	780	110
East				
Airport	35	2.7	690	100
End of Line	50	6.3	540	80

Sampling And Testing

The Hagensborg Water District regularly samples water from their water system in compliance with the VCH requirements. Testing results show the water is good quality including low mineralization, neutral pH, low organics and dissolved metals, low color, low turbidity and high UV transmittance. Results from a sample taken from the dam/intake site, in October, 2008, are attached in Appendix A.

The remainder of this paper references these testing results. Please note however, further testing and/or a pilot study may be necessary before a treatment process is finalized.

Domestic Usage Demands

In absence of actual flow volume data, MMCD design guidelines have been used to calculate the water demands of the community including Average Daily Demand (ADD) and Maximum Daily Demand (MDD).

Table 2:
Domestic Water Demand Calculation

Residential Population		390
Residential consumption (@ 600 l/c/d)	L/day/person	600
Residential consumption (@ 600 l/c/d)	L/day	234000
Institutional/Commercial/Industrial (24m3 x 1.5)	L/day	36000
Total Domestic Consumption	L/day L/sec	270,000 3.1
Leakage (assume 5%)	L/day L/sec	13,500 0.2
Avg Daily Demand, (ADD) (Domestic Consumption + Leakage)	L/day L/sec	283,500 3.3
Max. Daily Consumption (MDC) (2 x Domestic Consumption)	L/day L/sec	540,000 6.3
Max. Daily Demand (MDD) (MDC + Leakage)	L/day L/sec	553,500 6.4
Peak Hour Consumption (1.5 x MDC)	L/sec	9.38

ADD = approximately 4 litres/second (roundup)
MDD = approximately 7 litres/second (roundup)

Note that due to potential leakage (perhaps in the remaining old AC pipe), actual flows may be greater than calculated above. Therefore, before any central treatment is designed, the existing flow meters should be brought into service and demands confirmed. Gathering flow data for one year is good practice to establish summer versus winter usage.

Fire Flows and Storage

A storage reservoir is required to supply a volume of water needed to fight fires. Presently, the storage is provided by the creek/intake dam. The Fire Underwriters Survey recommends fire flows and durations based on fire hydrant coverage. Typically, a fire flow of 4000 litres per minute for a duration 90 minutes is specified for single family residences.

The Hagensborg Fire Department can determine the required flow rate and duration based on existing hydrants, existing residences, apartments, commercial, institutional and industrial buildings, and the reservoir can be sized accordingly.

Storage reservoir sizing is detailed in the following section: <u>Water Treatment Options.</u>

<u>Water Quality Standards</u>

Terminology

Water Quality Standards commonly refer to 3 log or 4 log reductions of waterborne viruses or bacteria. Based on logarithmic scales, a 3 log reduction means 99.9% removal of viruses or bacteria, while a 4 log reduction means 99.99% removal.

Turbidity is measured by Nephelometric Turbidity Units (NTU). The higher the number, the more turbid the water is.

The 4,3,2,1,0 standard refers to the Health Authorities goal of:
4 log reduction of viruses in drinking water,
3 log reduction of protozoa in drinking water,
2 treatment processes,
less than 1 NTU for turbidity,
zero coliform bacteria.

The Hagensborg Water District operates under the direction of the Vancouver Coastal Health Authority (VCH). The VCH, through the District Water Officer, applies and enforces the standards from the Guidelines for Canadian Drinking Water Quality, the B.C. Drinking Water Protection Act and the B.C. Drinking Water Protection Regulation.

Guidelines for Canadian Drinking Water Quality

The Guidelines for Canadian Drinking Water Quality provide parameters for acceptable levels of contaminants found in raw water:

- E.Coli: The maximum acceptable concentration (MAC) of Escherichia coli in drinking water is none detectable per 100ml.
- Total Coliforms: The MAC of total coliforms in water systems is none detectable per 100ml.
- Protozoa: Treatment should achieve at least a 3 log reduction/inactivation of cysts and oocysts
- Viruses: Treatment should achieve at least a 4 log reduction/inactivation of viruses.

- Turbidity: Waterworks systems that use a surface water source…filter the source water to…reduce turbidity levels…less than 0.1 NTU.

Additionally, guidelines for chemical, physical and radiological parameters are provided.

B.C. Drinking Water Protection Act and Drinking Water Protection Regulation

The Drinking Water Protection Act and Drinking Water Protection Regulation regulates water suppliers and defines water systems for the purposes ensuring drinking water is potable.

The Act imposes obligations on water suppliers. A Water Supplier must:

- Provide its water users with potable water,
- obtain a permit from the government before constructing or altering a water system,
- obtain a permit from the government before operating a water system,
- have operators who have been certified by the Environmental Operators Certification Program Society,
- develop and maintain an emergency plan,
- monitor its water on a regular basis,
- report any contamination or threat to the water system.

The following is reproduced from the B.C. Drinking Water Protection Act

> Part 1 - Introductory Provisions
> "potable water" means water provided by a domestic water system that
> (a) meets the standards prescribed by regulation, and
> (b) is safe to drink and fit for domestic purposes without further treatment;
> Part 2 - Drinking Water Supply
> Water supply systems must provide potable water
> 6. Subject to the regulations, a water supplier must provide, to the users served by its water supply system, drinking water from the water supply system that
> (a) is potable water, and
> (b) meets any additional requirements established by the regulations or by its operating permit.

The following is reproduced from the B.C. Drinking Water Protection Regulation

> "Act" means the Drinking Water Protection Act;
> "small system" means a water supply system that serves up to 500 individuals during any 24 hour period.
> 3. Domestic Water System
> 3.1 A small water system is exempt from Section 6 of the Act if:

(b) each recipient of the water from the system has a point of entry or point of use treatment system that makes the water potable.

5. Treatment

5(1) In this section:

"surface water" means water from a source which is open to the atmosphere and includes streams, lakes, rivers, creeks and springs.

5(2) For the purposes of section 6 (b) of the Act, drinking water from a water supply system must be disinfected by a water supplier if the water originates from

(a) surface water,

Vancouver Coastal Health Authority

The Vancouver Coastal Health Authority (VCH) interprets the Act and Regulations to best protect water systems in its jurisdiction. The following points are reproduced from Vancouver Coastal Health, Application for a Water Supply Construction Permit:

- The water supply should be obtained from a source that is likely to meet the Drinking Water Protection Act and the Guidelines for Canadian Drinking Water Quality,
- The source chosen should be one that is least subject to municipal and industrial contamination, and other types of contamination resulting from human activities within the watershed.
- Water supplies for drinking, culinary, and other domestic uses must be free of pathogenic organisms and their indicators and deleterious chemical substances including radioactive materials
- The water should have acceptable colour, odour and taste.
- Effective treatment should be provided whenever necessary to ensure safety and consistency
- Water sources for new waterworks systems or new sources for existing systems using surface water must be disinfected.
- The level of treatment and disinfection for surface supplies should ensure a minimum level of inactivation of 99.99% for viruses and bacteria and 99.9% for Giardia and Cryptosporidium cysts.
- Water after treatment and disinfection will have a minimum chlorine residual of 0.2 mg/L – with an acceptable range of .2mg/L to .4mg/L or a chloramine residual of 1 mg/L (maximum 3.0 mg/L) throughout the distribution system.
- Exceptions to the disinfection and/or other treatment requirements will be considered by the Drinking Water Officer following application from the water purveyor.

Discussion of Treatment Methods

Typical management for surface water sources includes a multi-barrier approach – from source to tap - to ensure safe water delivery to the user. The multi-barrier approach includes watershed protection and water treatment including primary and secondary disinfection.

Secondary disinfection provides residual protection against biological contamination in the water distribution system. In this discussion, we are focusing on the water treatment portion.

The typical treatment process for a small water system, which obtains surface water from a creek, includes:

1. filtration,
2. primary disinfection with chemical or UV methods and
3. secondary disinfection with chlorine to provide a residual in the water for distribution system protection.

Filtration

Filtration removes particles from the water supply including silt, natural organic matter, iron, manganese, and microorganisms. Filtration clarifies water and improves the effectiveness of disinfection. In some cases, coagulation and flocculation are required before filtration to remove suspended matter or colour in the water.

Cogulation and Floculation

Coagulation and flocculation are often required as a first step before filtration to assist in the removal of finely suspended particles in the water. Coagulation is the chemical destabilization of electrical forces keeping the particles apart, and flocculation is the aggregation of the particles into larger masses which can settle out of solution or be easily be filtered.

Slow Sand filtration

Slow sand filters are used in conjunction with other treatments to produce potable water from a surface water source. Slow sand filters are layers of coarse gravel over lain with coarse sand then fine sand on top to a depth of 1 to 2 meters in a typically concrete enclosure.

Water flows over and drains through the sand by gravity. A biofilm called a Schmutzdecke forms in the top, fine sand layer and consists of bacteria, fungi, protozoa, rotifera and insect larvae. The Schmutzdecke provides the treatment, effectively removing both particulate matter and some micro-organisms, while the sand provides the support for the Schmutzdecke.

The area of the filter is determined by the desired flow rate. A production of 100 – 200 litre/m2/hour can be expected. Hagensborg would need about 50 to 70 square meters of total surface – in two or more beds - for this method to supply the average day demand.

Slow sand filters are efficient, requiring no energy other than gravity flow, and work continuously, producing a constant slow flow rate. Maintenance includes backwashing and removing the top layer when the Schmutzdecke builds up thick enough to impair the movement of water through the sand.

Conventional Sand Filters

Conventional sand filters have a similar sand structure to slow sand filters, however are housed in smaller containers and operated with higher flow rate to produce up to 4800 litre/m2/hour. Filtration occurs throughout the full depth of the sand. Backwashing must be properly designed and performed at frequent intervals.

Multi-media filters

Multi –media filters are sand and gravel filters with fine to coarse material in reverse order of slow sand filters. Coarser and lighter material is on top while smaller and denser material is on the bottom. Solids are trapped throughout the bed, enabling the filter to hold far more before maintenance and backwashing are necessary which allows longer filter runs. These filters remove particles 10 – 15 microns in size and larger.

A typical multimedia filter is made up of light weight anthracite coal, heavier and smaller particles of calcined aluminum silicate or sand and heavier garnet on the bottom. During backwash, the media are completely mixed and lighter, coarse particles settle at the top and the finer and heavier particles remain at the bottom.

Flow rates are higher than conventional sand filters, up to 34000 litre/m2.hour. Therefore smaller size tanks and containers can be employed. Maintenance is minimal and the media does not need to be replaced.

Cartridge type filters

Cartridge filters are used in the treatment process after sand filters to remove particles and organisms to a one micron level. Cartridge filters meet the requirement for removal of 99.9% of Giardia and Cryptosporidium protozoa. These filters need to be replaced as part of maintenance. Replacement frequency will be determined by water condition and turbidity.

Membrane type filters: Reverse Osmosis, Nanofiltration and Ultrafiltration

Reverse Osmosis filters are polymer, semi permeable membranes. Water is driven through the membrane by pressure which removes organic and inorganic molecules down to a 0.01 micron level. Nano and Ultrafiltration are similar but with coarser pores. Membrane filters are expensive and operational costs are high for a small water system budget.

Disinfection

Primary disinfection occurs in the treatment process after filtration and is required to ensure the requirement of 99.99% removal of viruses and bacteria. Secondary disinfection is required by health authorities to ensure water distribution lines remain free of microbial regrowth. Common disinfection compounds and techniques include chlorine or chloramine, ozone and ultraviolet light.

Note that an exemption from filtration may be considered by the Health Authority in some cases, but the requirement for chemical disinfection and a chemical residual will be higher.

Chlorine And Chloramines

Chlorine

Chlorine can be added to the treatment process as a gas, liquid, pucks or generated onsite. Typically, for a small system, hypochlorite liquid (3% to 12% bleach) is dosed into the water according to the flowrate, pH and temperature of the water and the residual required. A contact time is required before the water reaches the first consumer. Contact times can be calculated from published CT tables and the delivery system designed thusly. Usually a storage reservoir or contact tank is required to provide the required contact time. Chlorine can be used as a primary and secondary disinfectant.

Disadvantages of chlorine, in addition to the safe handling procedures required, include the possible production of tri-halomethane (THM) byproducts, if water borne organics are present, which are considered carcinogens. THMs are produced when chlorine reacts with dissolved organic and inorganic carbon in the water. The VCH Authority requires a THM formation test if the Total Organic Carbon (TOC) in the water is greater than 2.5 mg/liter. However, as the results show from the October, 2008 sample, TOC is 0.93 mg/litre. Generally, organic removal is required in the treatment process before disinfection but is likely not required here due to the low TOC content.

Regardless, dechlorination of water and removal of any chlorination by-products at the point-of-use or point of entry into the home may be desirable. A common means of removing both chlorine and chlorine by-products from drinking water in the home is the use of activated carbon filters.

Chloramines

Chloramines are formed from the chemical combination of chlorine and ammonia. Chloramines are weak as a primary disinfectant but durable as a secondary disinfectant, therefore some municipalities specify chloramines as a residual. However, chloramines are highly toxic to fish and should not be used where treated water may runoff into streams.

Ozone

Ozone is a colourless gas at low concentrations and has a pungent odour associated with electrical sparks and thunder storms. Ozone is a strong oxidizer and is used as a primary disinfectant for water treatment. Ozone can be produced onsite from atmospheric oxygen in the reaction $3O_2 \rightarrow 2O_3$. The ozone molecule is unstable with a half life of 20 to 30 minutes in water.

Ozone is added to the treatment process through the use of an ozone generator and diffuser into the water stream. Contact times required are much less than chlorine and ozone has the capability of deactivating a wide range of pathogens. As well, ozone can oxidize minerals and metals in the water and improve the colour of water.

Disadvantages include some materials that may become more toxic or undesirable in an oxidized state such as bromide or some pesticides and organics. Filtration is required after ozonation due to oxidized particles settling out of solution. The capital cost is more and the operating costs are higher due to the ozone generator and pump.

Ozone can only be used as a primary disinfectant.

Ultra Violet Light

UV lamps used in water treatment look similar in design to standard fluorescent lamps but emit UV light through the ionization of mercury vapour, and produce light in the 200 – 300 nanometer range. The peak germicidal value for UV light happens at 265nm while a UV lamps produce about 90% of their energy at 253.7nm.

UV systems depend on clear water in order that pathogens cannot 'hide in the shadow' of turbidity in the water. UV Transmittance (UVT) is the amount of light that can be detected through the water at any point. A UVT of 70% or over is required for UV to be an effective disinfectant. In the October, 2008 sample, a UVT of 95% was recorded. Therefore, Snootli creek water is likely a good candidate for UV disinfection. However freshets and spring runoff are factors to be considered, and therefore, UVT sampling along with turbidity testing for a one year period is recommended.

A UV delivered dose is determined by the UVT of the source water, the intensity of the lamps, the flow rate and the time the water is in the light path. Dose is expressed as microwatt seconds per square centimeter.

Dose = uWsec/cm^2 = (microwatts X time)/cm^2

UV systems of NSF, Standard 55, Class A, include certified lamp units to 40,000 uWsec/cm^2 , which provides a 4 log reduction of viruses and 3 log reduction of protozoa when combined with 1 micron absolute filtration. Also available are ComCenter (data collection computer chips) to keeps a record of UV intensity of each of the units, alarm history and lamp hours.

Disadvantages of UV include reduced effectiveness as the lamp ages and reduced effectiveness in turbid water. Additionally, lamps sleeves can become stained from mineralization in the water which reduces the effectiveness. Advantages include chemical free water disinfection and less expense than ozone for capital and operating costs.

As with ozone, UV can only be used for primary disinfection.

Water Treatment Options For Hagensborg

Traditionally, a water treatment facility would be constructed near the source, before delivery to the first consumer. In this case, that would be likely close to the dam/intake or firehall site. The type and size of treatment would be dictated by community preferences and regulations governing the community. A typical water treatment/storage for Hagensborg is diagrammed in Figure 2.

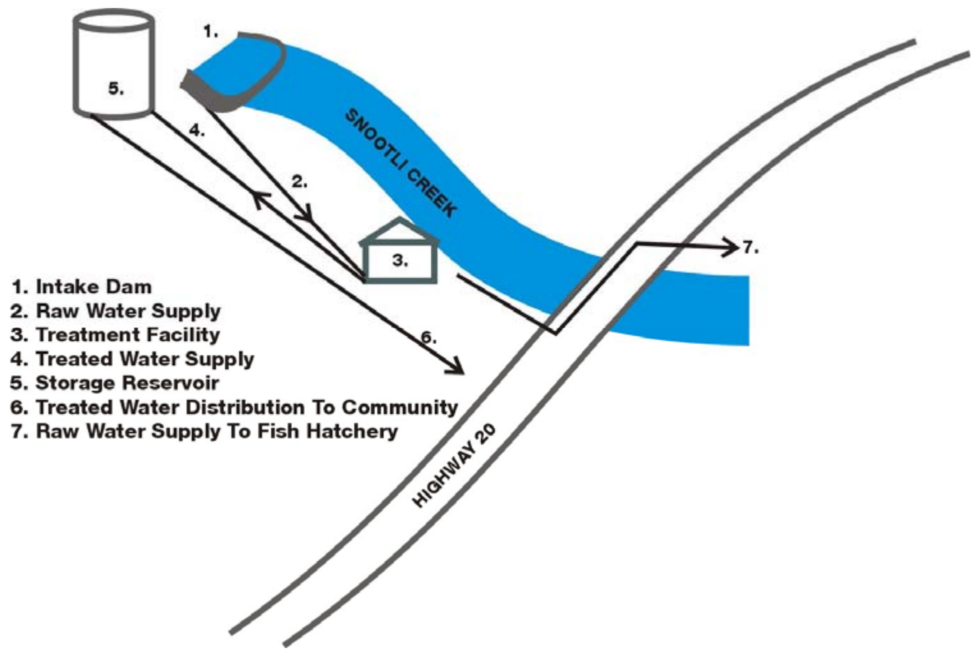

Figure 2. Typical Water Treatment/Storage Diagram

However, because this water system serves under 500 individuals in any 24 hour period, the Hagensborg water system can be classified as a small water system through the Water Protection Act, and a point of entry option may be permissible under the Vancouver Coastal Health Authority.

Therefore, three options are likely available to supply treated water:

1. Central water treatment at the source including filtration, primary disinfection with UV, ozone or chlorine, secondary disinfection to provide a chlorine residual in the watermains along with chlorine removal at the point of entry if desired,
2. Central water treatment at the source including filtration, primary disinfection with UV, secondary disinfection with UV at the point of entry into buildings,
3. Point of Entry into buildings: filtration and UV treatment to 4,3,2,1,0 objectives.

Other Considerations Before Treatment Implementation

Note that central water treatment will include revising piping and water storage requirements at or near the dam/intake or near the firehall site.

Replace Existing AC Watermain Piping, Reduce Leakage To Minimum

The Hagensborg Water District has begun replacement of the original watermains serving the community, which were installed 30 to 40 years ago. The original 100mm diameter and 150mm diameter AC watermain is being replaced by 200mm diameter PVC watermain. Some pipe replacement has occurred, but approximately 10 km of pipe still needs to be replaced.

Benefits of replacing the original pipe with PVC pipe include the following.

1. Depending on the condition of the AC pipe, properly installed PVC will offer less friction and greater domestic and fire flow velocities.
2. Larger diameter 200mm pipe offers greater fire flow volumes over 100mm and 150mm pipe.
3. Properly installed and tested PVC pipe offers leakage protection. In conversations with Hagensborg maintenance it is assumed there is at least some leakage in the existing system. Additionally, general experience indicates that AC pipe installed in the 1960's and 1970's will have moderate to significant leakage by this time, because of broken pipe, faulty service connections or faulty joints.
4. Properly installed and sealed PVC pipe offers contamination protection over AC pipe due to
    a. smaller chance of microbiological growth on pipe inverts or pipe joints,
    b. smaller chance groundwater cross contamination through broken pipe or faulty joints.

The community will want to complete watermain replacement before any central treatment is constructed due to the cost of treating water. Water main replacement costs are estimated in the following table.

Table 2a: Watermain Replacement Cost

Item	Quantity	Unit Price	Total
200 dia WM @ $200/m 10Km	10000	$200	$2,000,000
Fire Hydrants Assemblies@ $4500/ea 30ea	30	$4,500	$135,000
Gate Valves & Appurtances $1000/ea 50ea	50	$1,000	$50,000
Water Services @ $2000/ea 200ea	200	$2,000	$400,000
subtotal			$2,585,000
Engineering & Contingency 10%			$255,000
Total			**$2,840,000**

Note that the number of fire hydrants, gate valves and water services are estimates. Fire hydrants should be located near building clusters and gate valves should be located to isolate any part of the main line. After a detailed survey, these numbers may go up or down. Similarly, the number of water services is estimated knowing that some houses already have new connections.

Watermain replacement should be completed in time, regardless of the option chosen. However it should be completed before central treatment design and construction.

Existing Water Meters and Current Water Demands

As mentioned previously, the existing water meters should be brought into service to provide an accurate determination of daily demand through one year of data. System leakage can also be estimated. Central treatment and storage reservoir can be designed as per actual demand after system leakage repair.

Filter Backwash and Disposal

Treatment will include automatic backwash of multimedia filters with treated water from the storage reservoir. Therefore a disposal field of adequate capacity will need to be constructed near the plant. Sizing and location can be determined during design.

Water Storage Reservoir, Piping and Pumping

Fire Flows

Fire flows will need to be supplied by a water storage reservoir in the event central treatment is chosen, because, the water treatment plant will operate at a lower flow rate than required for fire flow. For a fire flow rate of 4000 litres per minute for 90 minutes, 360,000 litres of storage will be required. Also, as previously shown, the theoretical maximum day demand (regular community usage) is 7 litres per second (420 litres per minute), which is near where the treatment will operate.

Factors for sizing water storage reservoirs:

A: Fire Flow Storage (as above) = 360,000 litres

B: Equalization Storage: 25% of MDD (7 l/s X 24hrs) = 151,200 litres

C: Emergency Storage: 25% of A+B = 127,800 litres

The total required reservoir size will be A+B+C = 639,000 litres or 640m3

The Hagensborg Fire Department may determine a lower (or higher) fire flow is required; and, a lower or higher actual demand may be recorded once the water meters are on line, and then, the storage reservoir can be sized accordingly.

Water storage reservoirs can be constructed from concrete, as in Four Mile and Bella Coola Townsite, or above ground steel. Concrete has a longer life span than steel, but steel is less expensive to construct.

Bypass Option

A automatic bypass option around the treatment facility, to provide fireflows in an emergency, has been mentioned. However this option will introduce untreated, non potable water into the system. The VCH Application for a Waterworks Construction Permit, states, ‘Cross connection of watermains with any…source of non-potable water is prohibited." Therefore this option will not be explored further.

Contact Time

As previously mentioned, depending on the treatment process chosen, a contact time will be required and will be supplied by the reservoir.

Piping and Pumping

In order to provide the existing static pressures throughout the community, the storage reservoir should be sited at the same elevation as the intake/dam. The central treatment will be sited below the intake/dam and water will be pumped from a clear-well back up to the reservoir after treatment. Siting the reservoir lower than the existing intake/dam may be an option, or alternately, building another intake higher than existing may be an option, all of which need to be explored at the appropriate stage.

At this time, a clear-well, pump and piping are assumed.

Reservoir Capital Cost Estimates: Class D

The following cost estimates are extrapolated from recent northern reservoir construction. Class D costs are order of magnitude costs for preliminary consideration, and based on broad requirements, where little or no actual site information is known. Design engineering is included. Applicable taxes are not included at this stage.

Table 3: Reservoir Capital Cost Estimates

Concrete Reservoir & Clear-well Cost Estimate

	unit	amount	Unit price	Price
Siteworks, Structural, Mechanical	M3	640	$1,300	$832,000
Piping/Valves	M	500	$300	$150,000
Electrical/Controls/Clear-well	Ls	1	$150,000	$150,000
Design Engineering 7%				$78,000
			Total	**$1,210,000**

Steel Reservoir & Clear-well Cost Estimate

	unit	amount	unit price	Price
Siteworks, Structural, Mechanical	m3	640	$950	$608,000
Piping/Valves	m	500	$300	$150,000
Electrical/Controls/Clear-well	ls	1	$150,000	$150,000
Design Engineering 7%				$60,000
			Total	**$960,000**

Raw Water Delivery To Fish Hatchery

To keep the hatchery online if central treatment is chosen, a 150mm diameter, dedicated waterline can be installed, extending from above the central treatment site to the hatchery.

A length of 450 meters is assumed and the cost, (including tees, bends and connections), is calculated as below. A dedicated waterline will keep treated water away from the hatchery.

The value of the hatchery is a community decision. Additionally, some cost sharing may be forthcoming from the hatchery operators. A class D cost estimate is listed below.

Table 4: Dedicated Water Main to Hatchery Capital Cost

Piping/Valves, 150mm diameter	M	450	$150	$60,000
Design Engineering 15%				$9,000
			Total	**$69,000**

Small Water System Status

The Hagensborg Water District will want to reinforce their status as a small water system. A small water system is defined as a water system which serves 500 individuals in any 24 hour period. Considerations should include variable populations of schools and hotels as well as planned community growth.

Water Quality Testing and Monitoring

Further water quality testing will be required before treatment is finalized. As mentioned previously, Turbidity and UV Transmittance should be sampled for one year. In addition a water quality monitoring program for physical, chemical and bacteriological parameters will be required by the VCH as part of the operation permit.

Worksafe BC Considerations for Working With Chlorine

Worksafe BC specifies that workplaces where corrosive chemicals or other materials are used in a manner, concentration and quantity which present a risk of irreversible tissue damage to the eyes or skin, a tempered, continuous flow emergency eyewash or shower facility with a minimum duration of 15 minutes be available within 5 seconds from the hazard area.

Chlorine generation onsite may reduce the safety requirements, however confirmation with Worksafe BC will be required at the design stage.

Financing

A financing protocol has been developed by the Hagensborg Water District and includes cash reserves, grants and borrowing. Operation and maintenance costs will be borne by user rates. Adjustments are expected by The Water District as costs are refined at design and construction stages.

Option 1: Water Treatment At Source Including Chlorine Residual

Option 1 is a typical central treatment option. The proposed treatment train will include multimedia filtration rough filtering with coagulation/flocculation if required, cartridge filtration, UV disinfection, chlorine disinfection to provide a residual and dechlorination at the point of entry to each home. This option will meet the 4,3,2,1,0 objectives while ensuring non-chlorinated water for household use.

Plant Location

Locating the plant near the firehall provides easy site works, easy access and easy BC Hydro access, however locating the plant closer to the dam will lessen piping costs to and from the storage reservoir while increasing site work costs. At this stage, it is assumed the plant will be sited above the firehall site and main piping will be as described above in the reservoir location options.

Traditional Water Treatment – Masonry Brick Structure

As shown in table 5, the capital cost of a traditional masonry brick treatment structure (building), including site works, structural, mechanical, electrical, instrumentation and point of entry chlorine reduction will be approximately $1,230,000.

FilterCo: Proprietary Water Treatment – Steel Container Structure

FilterCo builds small water treatment plants that can be temporary or permanent, and can be moved to different sites as required. The plants meet all VCH requirements and can offer small water systems the flow required at less expense than traditional treatment structures. Systems are housed in a steel container (trailer) and require a minimum setup other than shipping, site work, outside piping and a hydro/tel connection.

FilterCo's option includes filtration, UV, a chlorine residual and POE chlorine reduction. Basic electronics to record UV intensity, alarm history and lamp hours are included, however additional controls and monitoring can be added if required. The capital cost for this option will be approximately $360,000. FilterCo's quote, notes and photos of existing systems are included in Appendix B

Table 5, on the following page shows Option 1 Class D capital costs with a traditional treatment structure compared to the steel container structure. Note that some tasks and costs are common to both structures.

Table 5: Option 1 Treatment Including Chlorine Residual		
Traditional Treatment Masonry Brick Structure		
Site works	$50,000	
Structural	$260,000	
Outside piping	$10,000	
Filtration/Mech/UV/Cl2	$210,000	
HVAC	$20,000	
Power/Electrical	$125,000	
Instrumentation/PLC	$50,000	
Electrical	$113,000	
BC Hydro/Tel	$5,000	
	sub total	$843,000
POE Cl2 reduction: $400 x 180 homes		$72,000
Contingency 20%		$180,000
Design Engineering 15%		$135,000
	Total	**$1,230,000**
Steel Container Structure		
Site works	$50,000	
FIlterCo Treatment	$118,200	
Shipping/Delivery	$3,500	
Outside piping	$10,000	
BC Hydro/Tel	$5,000	
Worksafe BC Requirements	$10,000	
	sub total	$196,700
POE Cl2 reduction: $400 x 180 homes		$72,000
Contingency 20%		$51,300
Design Engineering 15%		$40,000
	Total	**$360,000**

Option 2: Water Treatment At Source Without Chlorination Residual

This option includes the same treatment plant as option 1 except without a chlorine residual. An addition of UV at the POE will be required. No chemicals will be used in the water treatment system.

This option will reduce the cost of central treatment marginally but raise the cost at POE significantly compared to option 1. Note that a chlorine residual could easily be added to this option, which the VCH may find attractive.

This option will also require the agreement of the VCH. Capital class D estimates are shown in table 6, on the following page.

Table 6: Option 2 Treatment Without Chlorine Residual		
Traditional Treatment Masonry Brick Structure		
Site works	$50,000	
Structural	$260,000	
Outside piping	$10,000	
Filtration/Mech/UV/Cl2	$200,000	
HVAC	$20,000	
Power/Electrical	$125,000	
Instrumentation/PLC	$50,000	
Electrical	$113,000	
BC Hydro/Tel	$5,000	
	sub total	$833,000
POE UV: $1400 x 180 homes + $200 piping		$288,000
Contingency 20%		$219,000
Design Engineering 15%		$160,000
	Total	**$1,500,000**
Steel Container Structure		
Site works	$50,000	
FIlterCo Treatment	$115,000	
Shipping/Delivery	$3,500	
Outside piping	$10,000	
BC Hydro/Tel	$5,000	
Worksafe BC Requirements	$10,000	
	sub total	$193,500
POE UV: $1400 x 180 homes + $200 piping		$288,000
Contingency 20%		$68,500
Design Engineering 15%		$50,000
	Total	**$600,000**

Option 3: Point Of Entry Filtration and UV Disinfection

Option 3 includes Home Water Purifiers & Filters proposal to supply the Hagensborg Water District with a point of entry (POE) system that meets the 4,3,2,1,0 objectives for drinking water.

This option requires no changes to the water mains near the dam/intake or firehall site, no storage reservoir, no re-piping to accommodate the fish hatchery, no chemicals, and the treatment is independent of fireflows or current leakage in the system.

Option 3 includes essentially the same treatment process as in option 2, except the entire system is smaller and is a point of entry system for each building where potable water is supplied. This option is viable only for a small water system and will need agreement from the VCH.

The draft version of this report assumed the homeowner would be responsible for maintenance of their POE, however this final version identifies the Hagensborg Water District will maintain each POE.

Additionally, Home Water Purifiers & Filters have worked with the Hagensborg Water District to propose a system that fits the Hagensborg community, including access for Hagensborg maintenance personnel. At this time, a POE system installed on the property line or in the yard, adjacent to the home as required, in an insulated, protected, NEMA 4, enclosure is proposed. This approach offers the following advantages:

- Potable water delivered to the building.
- Easy access for maintenance.
- No access on private property required if POE installed at property line.
- All POE systems similar for maintenance tasks.

However, it is assumed cases will exist where the most practical place to install the POE will be inside the home, in the basement for example. A house by house survey will need to be undertaken to determine the most viable option per house.

Each POE requires 110 volt electrical power. POE systems adjacent or inside buildings can be easily connected. However POE on property lines can be connected directly to BC Hydro or connected to the house. The Water District have discussed this internally and proposed solutions apart from this report.

Home Water Purifiers & Filters propose to utilize a data logging system (COMM data collection) which records system operation, dosage and lamp. The data can easily be downloaded and provided to VCH as required to prove compliance. Additionally, the COMM centre can be located away from the filters and UV –where maintenance and inspectors can gain easy access regardless of location of the POE.

Home Water Purifiers & Filters proposal is attached in Appendix C.

System Description

1. Liquatec Multi-Gradient spun polypropylene, 1 micron filter traps majority of suspended particles and reduces turbidity. Complete with Pentek Filter Housings and brackets. Size approximately 8”X24”.
2. Harmsco Pleated polypropylene , micron absolute filter provides protozoa reduction to log 3 requirements and reduces turbidity to less than 0.1 NTU. Complete with Pentek Filter Housings and brackets. Size approximately 8”X24”.
3. Trojan UVMax Pro10, 20 or 30 UV Sterilizer, provides log 4 virus and bacteria inactivation. Complete with mounting and brackets. Size is approximately 4”X22”.
4. Trojan Emergency Solenoid Shutoff. Provides water system shut down in event of power outage to ensure nonpotable water does not reach the tap. Will likely be required by the VCH.
5. Trojan COMM Center provides data logging of system parameters including dosage, lamp history, alarm history and run-time history. Data can be downloaded to a computer and used to demonstrate system performance as may be required by the VCH.

The following cost estimate includes the quote from Home Water Purifiers & Filters, and includes class D estimates for installation. An estimate of $4000 for structural installation includes Home Water Purifiers & Filters estimate to provide an aluminum weatherproof enclosure, concrete slab, plumbing or electrical changes in the house, or other structural changes if the POE is installed inside the home. Note some homes will require minimal installation effort whilst others will require more attention. Additionally, this estimate includes UV protection at 10 gpm. Where a higher flow rate is desired, such as a hotel or community building, flow rates of 20 and 30 gpm can be provided at 30% to 90% additional cost per unit.

Also note that these systems can be installed by licensed carpenters, plumbers and electricians as long as major structural changes are not required to be designed or certified by a professional engineer.

Table 7: Option 3 Point Of Entry System
Home Water Purifiers & Filters: Suppliers

item	each home	total for 207 homes
Quoted System	$1,904	$394,128
Shipping/Delivery		$3,000
Computers/Data Collection		$3,000
Indoor Installation		
1) Plumbing	$500	$103,500
2) Structural	$4,000	$828,000
3) Electrical	$150	$31,050
	Sub total	$1,362,678
Contingency	10%	$137,322
	Total	**$1,500,000**

Total Capital Costs Summary For Options 1, 2 & 3

As previously shown, options 1 and 2 require watermain piping changes and a storage reservoir at or near the firehall or intake/dam site. Additionally, water delivery changes below the firehall will be required to provide a raw water supply to the hatchery.

Watermain replacement, as identified in Table 2a, is required prior to Option 1 or Option 2 construction. This cost is therefore included in Option 1 and Option 2. Option 3 does not require watermain replacement prior to POE construction.

In addition, repairs to the intake dam were identified subsequent to the draft report and priced at $15,000. This cost is included in all options.

The following tables compare total capital cost of the options.

Table 8: Option 1 Total Capital Cost
Treatment with Chlorine Residual/Dechlorination at POE

1. Concrete Reservoir/Concrete Treatment Building		
Dam Repairs		$15,000
10 km Watermain/Services Replacement		$2,840,000
Concrete Reservoir & Clear-well		$1,210,000
Dedicated WM to Hatchery		$69,000
Traditional Treatment Masonry Brick		$1,230,000
	subtotal	$5,364,000
Const Eng based on 6 months Construction		$180,000
	Total	**$5,544,000**
2. Steel Reservoir/FilterCo Steel Treatment Building		
Dam Repairs		$15,000
10 km Watermain/Services Replacement		$2,840,000
Steel Reservoir & Clear-well		$960,000
Dedicated WM to Hatchery		$69,000
FilterCo Treatment		$360,000
	subtotal	$4,244,000
Const Eng based on 6 months Construction		$180,000
	Total	**$4,424,000**

Table 9: Option 2 Total Capital Cost
Treatment NO Chlorine Residual/UV at POE

1. Concrete Reservoir/Concrete Treatment Building		
Dam Repairs		$15,000
10 km Watermain/Services Replacement		$2,840,000
Concrete Reservoir & Clear-well		$1,210,000
Dedicated WM to Hatchery		$69,000
Traditional Treatment Masonry Brick		$1,500,000
	subtotal	$5,634,000
POE: $1500 supply/install x 207 buildings		$310,500
Const Eng based on 6 months Construction		$180,000
	Total	**$6,124,500**
2. Steel Reservoir/FilterCo Steel Treatment Building		
Dam Repairs		$15,000
10 km Watermain/Services Replacement		$2,840,000
Steel Reservoir & Clear-well		$960,000
Dedicated WM to Hatchery		$69,000
FilterCo Treatment		$600,000
	subtotal	$4,484,000
POE: $1500 supply/install x 207 buildings		$310,500
Const Eng based on 6 months Construction		$180,000
	Total	**$4,974,500**

Table 10: Option 3 Total Capital Cost Point Of Entry System No Watermain Replacement	
Dam Repairs	$15,000
Reservoir & Clear-well	n/a
Dedicated WM to Hatchery	n/a
10 km Watermain/Services Replacement – Not Required This Stage	
Point Of Entry System/ 180 homes	$1,500,000
Total	**$1,515,000**

Table 10: Option 3 Total Capital Cost Point Of Entry System Includes Watermain Replacement	
10 km Watermain/Services Replacement	$2,840,000
Dam Repairs	$15,000
Reservoir & Clear-well	n/a
Dedicated WM to Hatchery	n/a
Point Of Entry System/ 207 homes	$1,500,000
Total	**$4,355,000**

Note that option 1 and option 2 assume a storage reservoir will be required for fire fighting. The costs for option 1 and option 2 can be reduced if the community decides no fire fighting storage is required (usually not considered - fire fighting storage is required). Similarly, option 1 and option 2 costs can be reduced marginally by the elimination of the dedicated water main to the hatchery.

Option 1 and Option 2 costs can be further reduced by elimination of the existing watermain replacement. This is not recommended as the cost for treatment plant construction and operation will increase due to increased water demand.

Option 3, Point Of Entry, has the least capital cost of the options and is attractive to the community because:

- no chemicals will be required,
- no chlorine residual will be in the watermains,
- no potential disruption of raw water delivery to the fish hatchery,
- no major construction projects involved including storage reservoir construction and water treatment facility construction.

Option 3 is only viable with a small water system status.

Option 1 is the standard storage and treatment regime for small communities which are not small water systems. A community plan with a vision of community growth may be valuable in

Hagensborg at this time. If a community assumes growth which will push it out of the small water system status, it may be prudent to plan for option 1.

Option 2 is central water treatment with point of entry UV and the most expensive of the options. This option includes no chlorine residual and may be acceptable to the VCH at this time, however, a chlorine residual could easily be added if community growth is planned. If a chlorine residual is added at a future date, installing a POE UV for each building at this time may not be cost effective.

As previously mentioned, option 1 and option 2 will also require the community to complete all AC watermain replacement to reduce all system leakage to a minimum, and bring the existing water meters online to accurately determine existing water usage over a one year period before the system is designed. Option 3 is also shown including watermain replacement if the community chooses that. Additionally, further water quality monitoring will be required before final design.

Operations and Maintenance Considerations For Options 1, 2 & 3

Option 1 and option 2 require a certified operator which usually includes salary implications for full time employees.

In this case, due to location and user base, we can assume option 1 and option 2 basic operations and maintenance costs to be delivered by current maintenance personnel. Note a basic contracted hourly rate has been assumed.

POE maintenance and inspection has been included with Option 2 and 3 using a contracted hourly rate of $40 and 6 hours maintenance per home per year. Replacement of POE UV and filters are included. Note that actual maintenance hours may be less, or more, and will depend on VCH requirements.

Daily inspections of a treatment plant/reservoirs are recommended, although automatic PLC can reduce this need. Detailed maintenance will need to be described at the design stage for treatment plants, and POE systems.

The following tables shows maintenance considerations for options 1, 2 and 3, and the new watermain. Note that option 2 is the most expensive system to maintain due to central treatment and POE UV.

Table 11 cont: Maintenance Considerations

Option 1 Maintenance **Task Description**	**Total Hours per Year**	**Contracted Hourly Costs @ $40/hr**	**Mat'l/Supplies Costs**
Daily Inspection/Meter Recording, 1/2 hr/weekday	130	$5,200	
Monthly Maintenance	48	$1,920	
Yearly/Cartridge Filter/2nd Year UV/Cl2	36	$1,440	$5,500
Pump Servicing and Miscellaneous Repair	36	$1,440	$2,000
BC Hydro Yearly			$1,200
Chemicals			$1,000
Miscellaneous			$1,580
Cl2 Reduction @POE by Home Owner			
Contingency			
	subtotals	$10,000	$11,280
TOTAL	**$21,280**		
O&M Monthly Cost Per Buildings (207)	**$9**		

Option 2 Maintenance **Task Description**	**Total Hours per Year**	**Contracted Hourly Costs @ $40/hr**	**Mat'l/Supplies Costs**
Daily Inspection/Meter Recording, 1/2 hr/day	130	$5,200	
Monthly Maintenance	48	$1,920	
Yearly/Cartridge Filter/2nd Year UV/Cl2	36	$1,440	$5,500
Pump Servicing and Miscellaneous Repair	36	$1,440	$1,000
BC Hydro Yearly			$1,200
POE Maintenance & Inspection Contract			
207 Homes @6hr/home/Year	1242	$49,680	
Filters Yearly @ $120 X 180 homes			$24,840
UV Yearly @$100 X 180 homes			$20,700
	subtotals	$59,680	$53,240
TOTAL	**$112,920**		
O&M Monthly Cost Per Buildings (207)	**$45**		

Option 3 Maintenance **Task Description**	**Total Hours per Year**	**Contracted Hourly Costs @ $40/hr**	**Mat'l/Supplies Costs**
POE Maintenance & Inspection Contract			
207 Homes @6hr/home/Year	1242	$49,680	
Filters Yearly @ $120 X 180 homes			$24,840
UV Yearly @$100 X 180 homes			$20,700
	subtotals	$49,680	$45,540
TOTAL	**$95,220**		
O&M Monthly Cost Per Buildings (207)	**$38**		

Table 11: Maintenance Considerations			
10 km Watermain/Water Services O&M		**Contracted**	
	Total Hours	**Hourly Costs**	**Mat'l/Supplies**
Task Description	**per Year**	**@ $40/hr**	**Costs**
Hydrant Flushing	30	$1,200	
Miscellaneous Repairs	40	$1,600	
			$2,000
	subtotals	$2,800	$2,200
TOTAL	**$5,000**		
O&M Monthly Cost Per Buildings (207)	**$2**		

Operations and Maintenance Life Cycle Cost

The following table show a life cycle analysis using the present value of O&M over a 20 year operation period plus the estimated capital cost as previously shown.

Assumptions included watermain replacement will take place prior to Option 1 or Option 2 construction. As watermain replacement is not required prior to option 3 construction, option 3 is shown with and without watermain replacement.

Two thirds funding of capital cost is assumed, leaving one third to be financed by the Hagensborg Water District for all options.

The lowest life cycle cost is option 3 without watermain replacement, while option 1 with proprietary treatment is the second lowest. Option 3 with watermain replacement is the third lowest life cycle cost. The highest life cycle cost is option 2.

Table 12
Hagensborg Water System Upgrades
Options Comparison
Life Cycle Cost Comparison Based on 20 Year Life Cycle

Option	Description	Capital Cost	Interest On Capital Cost *	Annual O&M cost **	O&M Present Value***	Life Cycle Cost	Pros	Cons
1	Central Treatment Concrete Treatment Building	$5,544,000	$1,108,800	$26,280	$391,000	$7,044,000	Traditional Treatment, Lowest Maintenance ost	Includes Chlorine
1	Central Treatment Steel Treatment Building - Filterco	$4,424,000	$884,800	$26,280	$391,000	$5,700,000	Traditional Treatment in Proprietary Package, Low Maintenance	Temp Steel Building May Need Replacement Before 20 yrs. Includes Chlorine
2	Central Treatment Concrete Building No Cl2, POE At Buildings	$6,124,500	$1,224,900	$117,920	$1,755,000	$9,104,000	Traditional Treatment, No Chlorine	High Capital and Maintenance Costs
2	Central Treatment Steel Building Filterco, No Cl2, POE At Buildings	$4,974,500	$994,900	$117,920	$1,755,000	$7,724,000	Traditional Treatment, No Chlorine	Steel Building Usually For Temporary Applications High Maintenance Costs
3	Point Of Entry System No Watermain Replacement	$1,515,000	$303,000	$100,220	$1,492,000	$3,310,000	Lowest Capital Cost, Lowest LCC, No Chlorine	Includes Water District Maintenance For 207 Buildings
3	Point Of Entry System Including Watermain Replacement	$4,355,000	$871,000	$100,220	$1,492,000	$6,718,000	2nd Lowest Capital Cost, No Chlorine	Includes Water District Maintenance For 207 Buildings

* interest rate=3%, based on Municipal Finance Authority of BC Amortization Schedules & 20 year term
** Includes 10+ Km watermain O&M
*** interest rate=3%
Life Cycle Cost includes Capital Cost + Interest + O&M Present Value

Community Meetings

The Hagensborg Water District held a community meeting on June 2, 2009, to present the draft version of this report, including the three treatment options. Although a formal vote was not conducted, overwhelming support for a non chemical option was voiced, along with a strong rejection of the use of chlorine.

Discussions during the meeting also included the requirement for the Hagensborg Water District to complete all maintenance tasks for option 3. The draft report incorrectly identified that the homeowner could complete, or assist, maintenance, thereby reducing costs. Additionally, the requirement to complete all watermain replacement before, or as part of, option 1 or option 2 construction was realized.

Subsequent, an updated cover letter was submitted including revised construction and maintenance costs. These costs were made available to the public during the Hagensborg Water District AGM on June 25.

During the AGM, a vote was conducted whereby the community preference option 3 was formalized.

Recommendations

Based on the outcomes of the community meeting and AGM, we recommend the Water District:

1. Reinforce Hagensborg's status as a small water system.
2. Lobby and obtain approval from the VCH for this option.
3. Complete any additional testing/monitoring which may be required.
4. Accurately determine number of buildings to be served by the system and determine flow rate required in order to size each UV unit. For example, a hotel may require a larger flow rate and therefore a larger UV than a single household – contact the supplier for assistance as required.
5. Accurately determine structural/plumbing/electrical changes through a building to building survey and prepare an accurate installation budget.
6. Prepare an updated total cost for this option.

Not required for option 3, but recommended for the integrity of the water system:

7. Complete all AC watermain replacement.
8. Complete all repairs to reduce system leakage.
9. Bring existing water meters online.