REVISION #2

Lund Water District
Water System Condition Assessment

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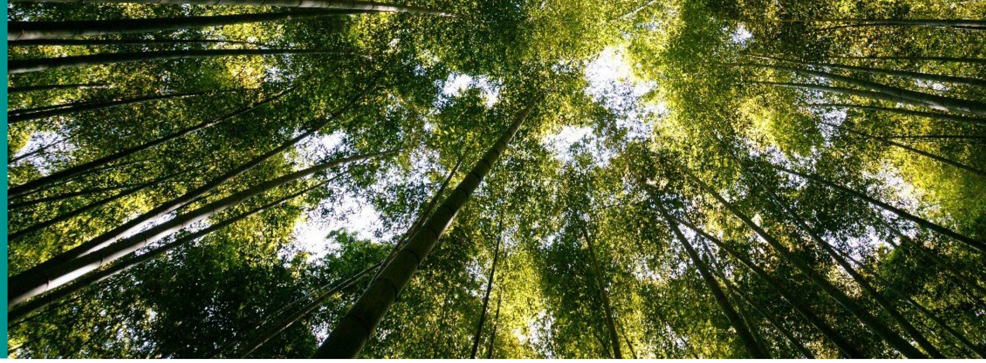


1. INTRODUCTION

McElhanney Consulting Services (McElhanney) has been retained by qathet Regional District (qathet) to review the Lund water system. The Lund water system is currently operated by the Lund Water District (LWD). The qathet Regional District is in discussions with Lund Water Improvement District and the Province of BC to potentially take over ownership and operation of the Lund water system.

The scope of this project is to review the existing Lund Water System assets to determine general condition, develop concepts for required upgrades to meet current regulations and standards, and to prepare class D cost estimates for the recommended scope of work.

1.1. DOCUMENT REVIEW

The following documents were reviewed or used as reference documents for preparation of this report:

- Lund Lake Dam – Seepage, Technical Memo, Tetra Tech, October 2017
- Lund Lake Dam Safety Review, EBA (Tetra Tech), January 2013
- Thulin Lake Dam Safety Review, EBA (Tetra Tech), January 2013
- Lund Water System Feasibility Study, Kerr Wood Leidal, April 2009
- Thulin Lake Dam Safety Audit, Cover Letter and Check List, October 2006
- Thulin (Second) Lake Dam Safety Audit (Lund Lake), Cover Letter and Check List, October 2006
- Thulin and Lund Lake Dam Safety Audit Forms, January 2004
- Thulin and Lund Lakes Water Source Study and Water Supply System Analysis, KPA Engineering Ltd., June 1995
- Water Licences – Thulin Lake, October 1974
- Various legal plans and land titles documents

1.2. SITE REVIEW

On November 19, 2018, John Sturdy, from McElhanney, visited Lund to complete a site review. Also on site were Mike Wall, Manager of Asset Management and Strategic Initiatives, and Caleb Allen, GIS/Survey Technician from qathet and Courtney Robertson, Operator for the Lund Water District.

2. EXISTING SYSTEM

2.1. OVERVIEW

The Lund water system consists of four primary components: supply system, pump stations and treatment, storage and distribution. Water is supplied from Thulin Lake. A supply main feeds water from the lake to the Thulin pump station and treatment facility. At this location, chlorine (12% sodium hypochlorite) is added to the water and the water is pumped into the distribution system. Primary storage for the system is in two above ground steel reservoirs located on a hill adjacent to the Thulin pump station. Level sensors in the reservoirs activate the pumps to maintain the working level in the reservoirs.

A second pump station is located on Larson Bay Road, which supplies a second reservoir located on Boars Nest Road. Level sensors in this reservoir control the pumps at the Larson Bay Road pump station. This section of the water system operates at a higher hydraulic grade line than the main system.

The distribution system consists of 100 mm and 150 mm mains. Most of the mains are believed to be PVC. There are many dead ends in the system and not many loops. This leads to challenges with water quality and flow capacity.

One segment of the distribution system is located under the harbour and is made of HDPE. It extends from behind the Lund Hotel to Finn Bay at the north end of town. Along the route, this segment of main feeds several water front properties, and Sevilla Island. Where this main comes ashore, it supplies a number of residences along, and above Finn Bay Road.

A third pump station is located on Finn Bay road, near where the submarine main comes ashore. This pump station feeds three polyethylene storage tanks, used only for fire protection. The tanks are located on the site of the former wood stave reservoir for this neighbourhood. These storage tanks feed one fire hydrant on Finn Bay Road, adjacent to the pump station. The pump station also provides domestic water to approximately 6 houses located on Alannah Road and Grouse Ridge Road. At least one of these properties uses a private booster pump to provide adequate water pressure to their residence.

2.2. SUPPLY

The water for the Lund water system is drawn from Thulin Lake. Thulin Lake is fed from Lund Lake which is in turn fed by Petri Lake. All lakes are fed from the surrounding hill sides. In the summer months, there is no flow over the dam from Lund Lake and therefore no surficial flow into Thulin Lake.

As the level of Thulin Lake does not drop significantly in the summer, there must be sub-surface flows into Thulin Lake from Lund Lake or other sources to recharge the lake in these months.

A detailed review of the water supply is not included in the scope of this study, however, a study of the Lund water system water source was prepared by KPA Engineering in 1995. This report concluded that the likely volume of water available was adequate for the current population but increasing the storage, by raising the dams, may be required as the community grows.

2.2.1. Dams

There are two dams owned by LWID, one for Lund Lake and one for Thulin Lake. The Lund Lake dam is an earth fill structure approximately 74 years old and the Thulin Lake dam is a concrete structure originally constructed almost 100 years ago. Tetra Tech/EBA conducted a safety review of both dams in 2012. In August 2017, they further reviewed the Lund Lake dam, particularly with respect to observed seepage through the dam. All reports are attached for reference.

Both dams have been determined by the Dam Safety Branch as having a High Downstream Consequence Classification. This is due to the downstream possibility of loss of life and high economic losses in the event of a dam failure.

The Tetra Tech report indicates that the Thulin Lake dam is considered stable under static and seismic conditions. The primary concern with the dam is the size of the spillway, which cannot contain the water under the inflow design flood. This will lead to overtopping of the dam. Our site review identified minor safety improvements for access onto the dam.

Little is known about the initial design and construction of the Lund Lake dam or the dam foundation. Analysis by Tetra Tech in 2012 determined that the dam does not meet standards under seismic conditions. The spillway is also undersized which will cause the dam to overtop during the inflow design flood. A pathway crosses the outflow stream just downstream of the dam. The culverts under the pathway are undersized causing the pathway to be overtopped during high flow events.

Leakage of water has been observed through the dam. This has the potential to lead to piping, which is the process where fine soil particles are eroded from the dam which can eventually lead to failure. The seepage is clear, which indicates that erosion is not likely taking place. There is a possibility that deterioration of a wooden flume or timber crib buried within the dam may be contributing to increased seepage through the dam.

In the short term, Tetra Tech recommends further investigation including coring the dam to better understand the dam construction and to determine if any wooden structures are buried within the dam. Once this investigation is complete, the scope of the future required works can be determined. It is likely that the dam will require either significant remediation or complete replacement.

2.2.2. Intake

The intake for the water system is located in Thulin Lake. It is a floating steel mesh screen. Recent inspection showed it to be partially plugged with algae but appeared otherwise to be in good condition.

2.2.3. Supply Main

The supply main from the intake to the pumphouse is a 250 mm steel and ductile iron main. There is a valve box near the dam which is poorly insulated and contains a main line valve which requires repair.

2.3. PUMP STATIONS AND TREATMENT

2.3.1. Thulin Pump Station

The Thulin pump station is a concrete block building. The original building was only approximately 3 m square. An addition approximately 3 m x 6 m has been added on. The pumps and chlorine injection equipment are located in the addition. The electrical equipment, chlorine analyzer and backup generator are in the original room.

The pump station has been recently upgraded. It contains two duty pumps each rated at 80 gal/min (6 l/s). There is also one smaller pump that can be operated off the available generator to provide water during a power failure. The pumps are controlled by level switches in the Thulin reservoirs. The electrical system in the building has been recently upgraded.

2.3.2. Treatment

Treatment consists of 12% sodium hypochlorite solution injected into the watermain when the pumps are running. The chlorine pump is controlled by a flow meter. The flow meter activates the pump and regulates the flow of chlorine to be injected based on the flow of water. A chlorine analyzer monitors the concentration of chlorine going into the system but requires regular maintenance to clean and calibrate the device, even with upstream filters, due to the water quality. There is only one primary chlorine injection pump, with no redundancy. There is a second chlorine pump that is smaller and can only safely pump a lower concentration of sodium hypochlorite. This pump is used during power failures when the smaller booster pump is in operation.

The chlorine storage tanks and injection system are located adjacent to the booster pumps in the same room in the building. Current code requires the storage of chlorine in a separate room in the building that is fully sealed off from the pump and electrical components.

Chlorine is delivered to the site in 210 l drums with four drums per pallet. These are stored in an old cube van body next to the pumphouse. A transfer pump is used to pump the chlorine from the drums into the tanks in the pumphouse. The storage room is well ventilated with a roll up door and a large screened opening.

2.3.3. Larson Bay Road Pump Station

The Larson Bay Road pump station pumps water to a higher-pressure zone fed by the Boars Nest Road reservoir. The building has been expanded, with the original room in the building containing most of the electrical panels and controls while the addition contains the mechanical equipment and pump starters. There are two 1 hp pumps rated at approximately 28 gal/min. They typically operate with one pump as the duty pump and one standby, alternating each time the pumps start. There is also a flow meter and pressure gauge.

The electrical panel is set up to allow for using a generator for emergency power. There is wireless communication between level sensors at the reservoir and the pump station to activate the pumps. The transmitter at the reservoir battery powered and charged with a solar panel. In the winter months, the battery regularly runs low and the transmitter fails. The system requires a better solar panel or connection to electrical supply.

This pump station appears to be in generally good condition.

2.3.4. Finn Bay Road Pump Station

This pump station was commissioned in 2016. It provides domestic water supply to a higher-pressure zone feeding the houses on Grouse Ridge Road and water to the Finn Bay reservoirs for fire prevention. The pump station is a simple configuration consisting of a single small pump and a single pressure tank. The pump boosts the water pressure from approximately 70 psi to 88 psi. A pressure switch in the pumphouse operates the pump when the pressure in the system drops. There is no provision for generator power during a power failure. A check valve should be installed between the pump and the pressure tank to prevent backflow through the system. A water meter would be beneficial to confirm water usage from the residential properties on Grouse Ridge Road.

2.4. STORAGE

There are three reservoir sites in the system.

2.4.1. Thulin Reservoirs

The Thulin reservoirs are the primary reservoirs for the Lund water system. The reservoirs are two adjacent steel tanks on a single concrete pad, located on a hill approximately 120 m south of the Thulin pump station. The tanks have a common wooden roof structure that includes a walkway connecting the tops of the tanks. A single access ladder leads to a small hatch between the tanks. The reservoirs combined store approximately 82 m^3 (18,000 Igal). The reservoirs were inspected in 2018 by Seaveyors Environmental and Marine Services Ltd. They identified numerous deficiencies with the tanks including:

- heavy corrosion and blistering of the interior walls
- failed exterior paint coating and extensive rust
- no cathodic protection
- large quantities of organic matter settled on the bottom of the tank including what appeared to be bird carcasses
- exterior valves are seized and unusable.

In addition, the tanks appear to have one common inlet and outlet structure, located on the bottom of the tank. This does not provide any mixing of water in the tank. Inadequate mixing can lead to thermal stratification, creation of stagnant areas and poor water quality with the potential for bacterial growth. There is also no interior ladder or visual level indicators. There is an overflow outlet in the tanks. The overflow pipe is reported to be located parallel to the supply main and terminates at the bank of Thulin Creek. Any overflow water will be chlorinated and would require treatment to remove any chlorine prior to discharge to the creek.

The issues of organics at the bottom of the reservoir and the dead zones with poor water quality will become most problematic during fire events where large volumes of water are drawn quickly from the tanks. This will cause the organic matter at the bottom of the tank and the poor quality water to be drawn into the distribution system, leading to potential contamination.

2.4.2. Boars Nest Road Reservoir

The Boars Nest Road reservoir is of similar design and construction to the two tanks at the Thulin reservoir site. The storage volume is approximately 41 m^3 (9000 Igal). The Seavayors report identified similar issues to those identified at the Thulin reservoirs. In addition to the issues identified above, the exterior coating on the tanks is a thicker membrane which is failing and peeling. There is concern that may be an asbestos containing coating. The report also identified potential seepage from the tank on the west side and extensive corrosion on the interior of the inlet/outlet pipe.

2.4.3. Finn Bay Reservoir

The Finn Bay reservoirs were constructed in 2016 to replace the former wood stave reservoir that was decommissioned in 2012. These new tanks are for fire protection only and do not supply any domestic water. The three new polyethylene tanks each hold 25.4 m^3 for a total of 76.2 m^3 (16,800 Igal). They are located on the concrete pad for the former wood stave tank. A header pipe made of sch 40 PVC supplies each of the tanks. Each tank has a float valve to allow water to refill the tank when water is used. An air gap and check valve are used to prevent back flow into the domestic system. Outlet pipes are also sch 40 PVC.

The tanks are supplied by a new 75 mm HDPE main from the Finn Bay Road pump station. This main also supplies domestic water to houses on Grouse Ridge Road. The outlet from the tanks join through a common PVC pipe header and connect to the older PVC pipe that formerly supplied the wood stave tank. This outlet pipe is only connected to one fire hydrant located on Finn Bay Road near the pumphouse. It is not connected to the domestic water distribution system.

There are two primary concerns with these tanks:

- Most of the inlet and outlet piping is uninsulated PVC. The polyethylene tanks are also uninsulated. There is no water movement in the pipes unless the fire hydrant is used. There is a risk of freezing, and if freezing occurs, the pipes are likely to crack.
- The PVC piping is exposed to the sun. Over time this piping will deteriorate and become more brittle with a higher risk of cracking and failing. PVC pipe should never be exposed to the sun for significant periods of time.

2.5. DISTRIBUTION

2.5.1. Mains

Land

There are approximately 5 km of watermain in the Lund water system. The supply main from Thulin Lake to the pumphouse is 250 mm. The distribution system is a combination of 150 mm and 100 mm mains. The mains are reported to be PVC.

There is a general understanding of the routing of the mains, but the exact location of mains is not well documented. Some of the mains are located on private property without any statutory right-of-way or easements. As the water system developed, mains were installed where it was cost effective and efficient. Approval from the land owner at the time may have been provided, but in most cases, there is nothing on the property title to allow for the trespass.

Sub-Marine

There is a sub-marine main that extends from the rear of the Lund Hotel under the harbour north towards Sevilla Island then comes ashore at the end of Finn Bay at the north end of Lund. The underwater main ties into distribution main on Finn Bay Road near the Finn Bay Road pumphouse. The underwater main is 100 mm HDPE. There are services from the main to waterfront houses along the harbour and a 100 mm connection to supply the houses on Sevilla Island. From Sevilla Island, a service extends underwater to service two additional waterfront houses north west of Sevilla Island. It is reported that connections to the main for services have been made using brass compression fittings. The location of the main is marked through the harbour with buoys to reduce the risk of boat anchors damaging the main.

2.5.2. Services

Most of the services appear to be typical services off the main to property line. There were a number of issues of concern observed:

- Where the mains are located on private property, there is no definition of which portion of the service belongs to the water district and which portion belongs to the property owner
- There were services identified that trespass across one private property to service an adjacent property with no easement in place.
- There is a booster pump on a service near the Finn Bay Road reservoir that may not be to code and may not be located on the property that it services.
- Services were observed on the surface of the ground with no frost protection.

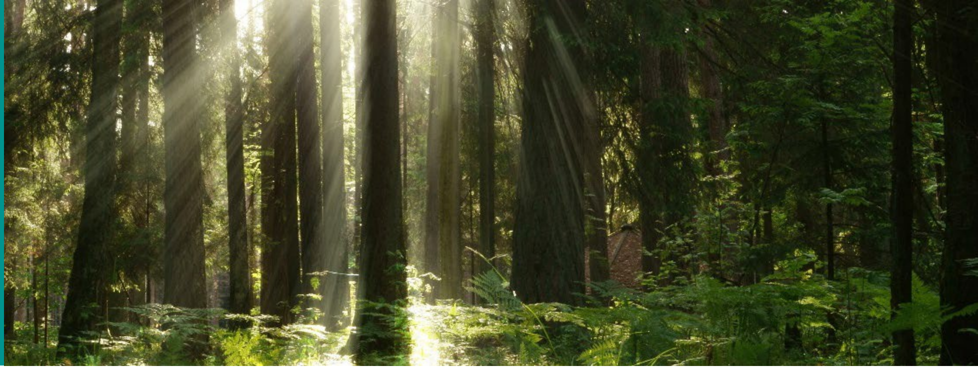
2.5.3. Appurtenances

Valves

There are very few line valves in the system. It is typical to have at least two line valves at each tee in the system. Very few tees have any valves. This makes maintenance very challenging. Large segments of the system must be shut down for any maintenance or main breaks. Some of the valves in the system are inoperable and must be replaced.

Hydrants and Standpipes

There are numerous hydrants and standpipes throughout the system. Typically, hydrants are located on 150 mm mains and standpipes are located on 100 mm mains. Spacing of the hydrants and standpipes appear to be reasonable. Additional water sampling stations should be installed at dead end mains. There is leakage at some of the standpipes which indicates that it is likely that several of the hydrants and stand pipes require maintenance.



3. SYSTEM DEMANDS & CAPACITY

3.1. EXISTING AND FUTURE DEMANDS

Water consumption in Lund over the past 8 years has been very consistent. In 2009 KWL calculated the Average Day Demand (ADD) to be 287 m^3/day. Data provided by LWD shows ADD between 2017 and 2014 to average 283 m^3/day with a high of 292 m^3/day. While some growth has occurred, removal of the wood stave reservoir reduced water loss. The combination has resulted in no significant increase in water demand.

There is potential for significant growth in Lund over time through densification and expansion of the water system. Many properties are currently large lots with one or two houses that have potential to be subdivided. While there is potential for growth, there are no significant drivers that are anticipated to drive growth quickly in the coming years.

At the same time, water conservation strategies continue to reduce the average day consumption per person in most communities. The qathet Regional District does have water conservation targets in place. In recent years, some communities have experienced a net reduction in ADD where water conservation has reduced consumption faster than growth has increased consumption. For Lund, it is reasonable to assume a net increase in water demand for design purposes of 2% per year.

With a current ADD or 283 m^3/day, or 3.28 l/s, the current MDD is 8.20 l/s and PHD is 13.11 l/s. In 10 years, at 2% annual increase, ADD will be 4.00 l/s, MDD 10.00 l/s and PHD 16.00 l/s. In 20 years, ADD will be 4.88 l/s, MDD 12.20 l/s and PHD 19.52 l/s.

The current water licence allows for withdrawal of 100,000 gal/day or 5.26 l/s. This is within the ADD projected for 20 years.

4. LAND TENURE ISSUES

There are significant land tenure issues throughout the Lund water system. Some segments of water main are located on private property with no right-of-way. For other segments the exact location must be determined to confirm if the main is within the road right-or-way or not.

Rights-of-way do exist for the Thulin Lake intake, supply main and reservoir. The SRW's are only 6 m wide, except around the dam and reservoir. The Thulin pump house may or may not be located within the SRW. Any new treatment facility and new reservoirs would need new rights-of-way.

It is impossible to be sure of all the land tenure issues because the exact location of the water main is not know in many areas. Based on the mapping available, there appears to be water mains on private property for the mains feeding into and out of the Scotch Place area. In addition, the main along the waterfront between Murray Road and the Lund Hotel is on private property. The main along Franzene Road is shown outside the road right-of-way, however, this may just be shown schematically.

The supply main under the harbour does not appear to have tenure from the Province of BC. This document would also have to cover services off the main and the services from Savilla Island to properties on shore. There are Rights-of-way on Savilla Island for BC Hydro which also contain the water mains. Each end of the underwater main crosses private property and there are no documents for rights-of-way on these properties either.

There other location where watermain is on private property is the supply main to the fire storage reservoir off Finn Bay Road. This main then continues across private properties to service the houses on Grouse Ridge Road. There also does not appear to be a right-of-way for the reservoir pad itself.

There are also some services which cross one private property to service another. These services should be documented and approved by LWD. Easements should be in place to permit a service to cross one property to service another. While technically these are issues for the property owners to resolve between themselves, it is in the interest of the LWD to know where these issues occur.

5. SYSTEM IMPROVEMENTS

5.1. OVERVIEW

The following sections describe upgrades or replacements to components of the water system based on field review and current design standards.

5.2. SUPPLY

5.2.1. Dams

The scope of work required for improvements to the two dams is not well understood at this point. Further investigations and reports are required to determine the required scope of work. At this time, it is assumed that only minor upgrades and improvements will be required for the Thulin Lake dam. The Lund Lake dam will likely require significant improvements or complete replacement. Costs have not yet been prepared by Tetra Tech for these options. The first step will be a detailed drilling and investigation program for the Lund Lake dam. A budget value of $1 million has been assumed for capital budgeting purposes.

5.2.2. Intake

The intake is generally in good condition according to recent inspection. The intake screen requires maintenance to remove organic growth.

5.2.3. Supply Main

The supply main is generally in good condition. A new line valve should be installed just downstream of Thulin Dam. The existing valve requires replacement.

5.3. PUMP STATIONS AND TREATMENT

5.3.1. Thulin Pump Station

The Thulin pump station is generally in good condition. The roof has leaks and requires replacement. There are also some gaps in the exterior cladding that allow access to rodents. The primary concern is the chlorine storage and injection equipment which is in the same room with the pumps and electrical equipment. This does not meet code and will lead to corrosion of the equipment. As part of the expanded treatment process, the chlorine injection equipment can be moved to the new treatment building.

The existing booster pumps are rated at 6 l/s. These pumps are typically designed for future Max Day Demand (MDD), which is 10 l/s in 10 years and 12.2 l/s in 20 years. The two pumps running together can likely meet the current MDD of 8.2 l/s, but each pump should be able to meet MDD independently. These pumps should be replaced with larger pumps to meet current MDD.

5.3.2. Treatment

Additional treatment beyond the current chlorination system is required based on the quality of the water supplied from Thulin Lake. Any treatment plant would have to be constructed upstream from the current pump station if the current pump station is to remain in operation. A more detailed study will be required to finalize the selection of the treatment process, but there are three likely options: Enhanced Slow Sand Filtration; Dissolved Air Floatation (DAF) with rapid sand filtration; and Membrane Filtration. Each option has advantages and disadvantages. With all options, the waste from the treatment plant will be transported to the sewage treatment plant for disposal. Waste water can likely be pumped from the treatment plant to the Emil Road sewage pump station. From there it is pumped to the sewage treatment plan.

Slow Sand Filtration is the simplest system to operate and does not required chemicals for injection. The process operates by gravity and uses a coarser pre-filter to remove larger constituents then slowly filters the water through fine grained sand. As a result, it has the lowest operating costs. The disadvantage of this system is the size of the treatment plant required. KWL estimated the size of the plant required at 120 m^2 (1,300 ft^2). The limited area available near the Thulin pump station may make this option not viable.

In DAF plants, water is initially mixed with a coagulant, then fine air bubbles float the particles to the surface where they are skimmed off. The clarified water then passes through a rapid sand filter. DAF plants are much smaller than Slow Sand Filtration. KWL estimate the required size for a DAF plant to be 20 m^2 (215 ft^2). Our experience indicates that a building closer to 45 m^2 (485 ft^2) is required to accommodate the DAF plant plus all the chemicals, pumps, tanks, controls and disinfection equipment. A building of this size would be much easier to accommodate near the existing pumphouse.

With Membrane Filtration, similar to DAF, a coagulant is mixed with the water then the water is pushed through a very fine membrane using high pressure. The waste water is either recycled through the system again or disposed of. This system likely produces the highest quality water, but also has the highest operating costs and is the most complex to operate.

With all options, treated water would be disinfected using Ultra Violet light then a small amount of chlorine would be injected for residual in the system.

Membrane Filtration has the highest capital and operating costs. As there are most cost effective solutions, this option is discounted. Typically, Slow Sand Filtration has a higher capital cost and lower operating cost than DAF resulting in a lower life cycle cost.

For the purposes of this study, we will assume the use of a Slow Sand Filtration plant because it has the higher capital cost of the two viable options. Whichever option is selected at detailed design, backup power should be included as a component to the design.

5.3.3. Larson Bay Road Pump Station

The Larson Bay Road pump station has recently been upgraded and does not require any significant further improvements. The pumps should be checked to confirm that the most efficient pump has been selected. This should as part of the design of the new reservoir and pipes downstream of the pumphouse. It is likely that different pumps will be selected. A permanent backup generator system should also be constructed.

5.3.4. Finn Bay Road Pump Station

This pump station is new and was designed as a relatively simple single pump and pressure tank system. A check valve should be installed downstream of the pump and a flow meter installed to confirm water consumption. There is only one pump in the station. In the short term, a spare pump should be kept on site for replacement should this pump fail. The pump station should be redesigned to allow for a second pump with alternating operation and installation of a backup generator for use during power failures. The required pressure tank size should be calculated and compared to the existing tank to confirm if an additional tank is required.

There is still at least one house on this system using a private booster pump to further increase the pressure to their house. A review should be done of the pump selected to see if an alternate pump can be selected to eliminate all private booster pumps. Any increase in system pressure from the pumphouse may require installation of a pressure reducing valve on houses lower in the system.

5.4. STORAGE

The Seaveyors reservoir inspection report, April 2018, concluded that both the Thulin and Boars Nest Road reservoirs were in poor shape and should be replaced. Their inspection confirmed that the coating has failed on the interior and exterior of the tanks, the design of the single inlet and outlet creates stagnant water in the tanks, some of the valves have failed, and the roof design has, in the past, allowed birds to enter the tanks. Calculations have also showed that the tanks are undersized. Rather than add additional tanks, we recommend replacement of both tanks.

5.4.1. Thulin Reservoirs

The required storage for a water distribution reservoir is calculated by summing three components: Balancing Storage, Fire Storage; and Emergency Storage.

Balancing storage is 25% of the MDD. Assuming MDD of 8.2 l/s, balancing storage is 177 m^3.

For fire storage, we have assumed a house size of 1,300 ft^2 and an exposure distance of over 30 m. Based on Table 6 in the BC Design Guidelines for Rural Residential Community Water Systems, volume of storage required is 120 m^3.

Emergency storage is 25% of balancing storage plus fire storage, or 75 m^3. Total storage required is 370 m^3 or 83,000 Igal. This compares to the current reservoirs which have a capacity of approximately 82 m^3 or 18,000 Igal.

Access to the site is very challenging. The existing road access is very steep and overgrown. Improvements to the access road will be required. As noted above, additional area for SRW will be required to construct the new larger reservoirs, while keeping the old reservoirs in service until the new tanks are completed.

5.4.2. Boars Nest Road Reservoir

There are approximately 25 services from the Boars Nest Road Reservoir. Assuming 2.5 people per residence and a MDD per person (for an unmetered service) of 900 l/capita/day, the total MDD for this neighbourhood is 56 m^3. Balancing storage would then be 14 m3. If we assume the same fire storage and that all the emergency storage for the community is located at the Thulin reservoir, then the new Boars Nest Road reservoir should be a total of 134 m^3. This compares to 41 m^3 currently on site. Like Thulin, construction of a new reservoir, while keeping the existing reservoirs in service until the new tanks are in service will require additional SRW.

5.4.3. Finn Bay Road Reservoir

The Finn Bay Road reservoir is only for fire protection and only services one fire hydrant. The three tanks provide a total of 76 m3 of fire storage. This is equivalent to 20 minutes of fire protection at 60 l/s.

This reservoir is new, but some work is required to protect the exposed pipes from sun and frost. Land tenure issues also need to be resolved at this site.

5.5. DISTRIBUTION

5.5.1. Mains

Land

While developing a computer model of the water system was not within the scope of work, knowledge of the system a review of previous reports has provided a good indication of upgrades and extensions to the system that would be suitable at this time. The primary location for improvements is along Highway 101 between Finn Bay Road and Larson road. This new section of main will improve flow to Larson Road and allow two segments of main around Scotch Place to be abandoned that are located on private property. This main could be extended south along Highway 101 past Larson Road to service additional properties that are currently services by a long service pipe through private property.

Another segment recommended for upgrade is the 100 mm main on Larson Road, above the pump station. Upsizing this main to 150 mm will improve fire flow.

In addition, the main along Finn Bay Road should be extended along Finn Bay Road to tie into the main fed by the underwater main. This will create a loop to the north end of the system which will increase fire flow and resiliency. This will also provide service to Lund Park, where the new community centre is planned and allow for future development as supported by the OCP to lands within the service area of the LWD but are not currently serviced.

In the future, this main could be extended further up Finn Bay Road to service Mead Road and Norlund Road. It is not recommended at this time as there is little demand along the route, which may cause the water to become stagnant in the main.

Modeling the system may identify other segments of main that are under sized for fire flow. Modeling should be done as part of the detailed design.

In all cases where new water mains are constructed within existing roadway rights-of-way, priority will be given to an alignment for the proposed pipe which can, for little additional cost, provide additional space within the corridor for multimodal transportation. This could include sidewalks, bike lanes, or multi-use pathways.

Sub-Marine

The underwater main is undersized to provide fire flow to Finn Bay Road, but construction of new main along Finn Bay

Road will resolve this issue. In general, this main appears to be functioning well. There have been issues with leaks at some of the service connections and there are concerns that the compression fittings used underwater will deteriorate over time. As noted above, tenure for this main and services must be obtained from the Province.

5.5.2. Appurtenances

It is recommended that two new valves be installed at every tee in the system to allow for easier isolation.

A review of hydrant and standpipe spacing is not within the scope of this report, however it appears that spacing is mostly adequate. An allowance for three additional hydrants and repairs to some of the existing hydrants has been included.

6. COSTESTIMATE

6.1. CAPITAL COSTS

The following table summarizes the Class D cost estimates for the scope of work anticipated.

Table 1: Capital Cost Summary

ITEM	QUANTITY	UNITS	UNIT COSTS	TOTAL COST
Mobilization/ Demobilization, Insurance, Bonding and Overhead	1	LS	$800,000	$800,000
Dam Upgrades (allowance)	1	LS	$1,000,000	$1,000,000
Intake and Supply Main	1	LS	$30,000	$30,000
Water Treatment Plant	1	LS	$4,000,000	$4,000,000
Pump Stations (Thulin, Larson & Finn Bay)	1	LS	$100,000	$100,000
Reservoirs (Thulin and Boars Nest)	1	LS	$1,500,000	$1,500,000
Watermain – 150 mm	1800	M	$800	$1,440,000
Watermain – 200 mm	1000	M	$1,000	$1,000,000
Valves	30	EA	$4,000	$120,000
Fire Hydrants and Standpipes	1	LS	$50,000	$50,000
Water meters / backflow prevention	80	EA	$2,000	$160,000
Legal Survey and Legal fees	1	LS	$250,000	$250,000
Land Acquisition for SRW's	1	LS	$500,000	$500,000
Miscellaneous	1	LS	$50,000	$50,000
Sub-Total				**$11,000,000**
Engineering – 15%				$1,700,000
Project Management – 10%				$1,100,000
Contingency – 30%				$3,300,000
Total				**$ 17,100,000**

7. COST RECOVERY

Utility fees can be recovered in a number of ways. The two primary methods are trough user fees and parcel tax. User fees can be a combination of fixed rates, such as fixed annual fee or annual fee based on meter size, zoning or lot size, and variable rates based on consumption. The goal is to allocate the costs of the utility fairly amongst the landowners and users of the system. The choice of cost recover strategy depends on many factors in the community.

Parcel taxes can be charged to a property within a utility service area regardless of whether they are connected and using the system or not. This is a method to charge a fee to those who have access to the utility but choose not to connect to the service available. There is little value in using a parcel tax if all properties that can connect and use the utility are connected. If this is the case, cost would be allocated in the same way by an annual user fee. These fees are paid by the property owner.

Fixed annual fees are similar to parcel taxes, except that they are only paid by those properties that are connected to the system. These fees can vary depending on land use (residential, commercial, institutional) or by the size of service provided. How these fees are calculated can be based on what is considered to be most fair for any given community.

Variable rates ae based on consumption. These fees only apply where consumption is metered. Included in the scope of work costed in this report is installation of water meters for all services. Fees based on consumption are considered fair for the user fee components at each user pays for the portion of the water that they consume. One drawback for the utility using consumption fees is that budgets are based on an assumed annual consumption. If less water is consumed in a year than planned, less revenue is collected yet most costs to operate the utility are fixed and do not depend on the volume of water consumed.

Ultimately, a combination of parcel tax, fixed annual fee (perhaps based on meter size or zoning) and user fee would be most suitable. The use of a parcel tax ensures that properties within the service area that can connect to the system, but choose not to, pay a portion of the costs of the system. Fixed annual fees ensure a known revenue stream to the utility. Consumption fees allocate costs fairly by usage and encourage water conservation.

Further study is required to determine the most appropriate allocation of costs once the utility is fully metered.

Utility fees for a number of similar water systems within the Capital Regional District have been reviewed. These systems include Beddis, Sticks Allison, Fulford, and Highlands/Fernwood. All the systems use a parcel tax and an annual user charge. Two of the four are metered and also charge a fee based on consumption. Estimated total annual costs per single family service for all fees range from $1,465 to $2,030.

The two systems most comparable to Lund are Beddis and Fulford. Each has approximately 100 services and use a lake for a water source with Dissolved Air Floatation for the water treatment system. Total annual fees for 2019 per single family residence is approximately $1,850 for Beddis and $2,030 for Fulford.

APPENDIX A
REFERENCE REPORTS