



QUALICUM BAY HORNE LAKE WATERWORKS DISTRICT

WATER SYSTEM EVALUATION

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EXECUTIVE SUMMARY

This Water System Evaluation was commissioned to review previous reports and data, estimate future growth, provide existing system analysis, update the Capital Works Plan, update the Capital Expenditure Cost Bylaw and recommend further studies and steps to be taken to ensure the system will satisfy a growing population.

The last comprehensive study on the water distribution system was undertaken in 1990 by Willis Cunliffe Tait & Company Ltd, although smaller water supply reports have been undertaken up to November 2003.

The ground water supply appears to be sufficient to provide water to a larger population. There is currently no water treatment provided for the water supply. Historic water samples indicate no health concerns however; there are aesthetic issues with high Iron and Manganese at the source.

The existing steel bolted reservoirs have sufficient storage for Maximum Day Demands for existing and future populations. Currently, the existing storage facility has no capacity for Commercial and Industrial fire protection however; there is capacity for storage of residential fire flows.

The distribution system has been constructed in stages over the years. The older areas have smaller diameter pipes (100mm to 150mm diameter) and are constructed of Asbestos Cement (AC) pipe. Upgrades have been completed over the years replacing portions of the AC pipe with newer larger diameter Polyvinyl Chloride (PVC) pipe. However, the majority of the system still consists of smaller diameter AC piping. Newer developments have been installing PVC pipe and Fire Hydrants to current engineering standards. The level of fire protection for residential and commercial buildings is poor in the majority of the District. An upgrade programme has been identified in order to provide continued domestic demand and if required, to achieve residential fire protection in most areas of the Waterworks District. Further study is needed to identify fire protection requirements for larger commercial development.

This report includes cost estimates to implement the recommendations and a Capital Expenditure breakdown. The total value of Capital Works that would serve existing customers is \$3,399,500. The total value of Capital Works that would serve Future Development is \$1,765,150. The current Capital Expenditure Charge (CEC) is \$2,250 per single family residential unit. The recommended CEC for a single family residential unit is \$5,150.

This report presents a program to upgrade the water distribution system over the next 10 to 20 years, and a Capital Work program is outlined to ensure the continued reliable supply of water to the Qualicum Bay Horne Lake Waterworks District.

1 INTRODUCTION

The Qualicum Bay Horne Lake Waterworks District (the District) retained McElhanney Consulting Services Ltd (McElhanney) to undertake this study to determine the condition of the existing water system and to plan for future improvements. This report presents the following information:

- review of previous reports and data;
- overview of the existing system;
- analysis of current water consumption;
- projection of future demand
- analysis of existing system to meet current and projected need;
- recommended improvements; and,
- capital expenditure program

1.1 BACKGROUND

Qualicum Bay is a seaside community located on the east coast of Vancouver Island approximately 60 km north of Nanaimo, BC and 50 km south of Courtenay, BC. This unincorporated community lies within the Regional District of Nanaimo and forms part of Electoral Area “H”.

The Qualicum Bay Horne Lake Waterworks District was incorporated under the Water Act in 1968 and is an Improvement District as defined under the Local Government Act. The District’s Letters patent define a mandate to acquire, maintain, and operate works for water supply and distribution and all matters incidental. The District’s mandate does not include fire protection and therefore provision of fire flows is not a requirement. A copy of the original Letters Patent with subsequent amendments to adjust the District’s boundaries are included as Appendix A.

The District borders the Bowser Waterworks District to the North and the Little Qualicum Waterworks District to the south. The water system serves approximately 430 residential connections, 40 commercial customers, and the Qualicum First Nation. Refer to Appendix D Drawing No. 1 for details.

1.2 PREVIOUS REPORTS

The following is a list of known studies or reports that have been prepared directly for the District or relate to the system in general:

- Water System Upgrading, Willis Cunliffe Tait & Company Ltd, October 1990 (WCT 1990);
- Qualicum Bay to Deep Bay Phase 1 – Hydrogeological Study, Thurber Environmental Consultants Ltd, November 2003 (Thurber 2003);

- Reservoir Site Geotechnical Assessment, Lewkowich Geotechnical Engineering Ltd, January 2008 (Lewkowich 2008).
- Summary of Kalicum’s 1990 drilling program, prepared by District Staff.

2 EXISTING SYSTEM

2.1 WATER SUPPLY

The Nile Creek was developed as the District’s original water source in 1968. A groundwater supply was developed in the early 1990’s based on recommendations provided in WCT 1990. The Nile Creek inlet and associated works are now abandoned.

Water supply is currently provided by three (3) wells located on the west side of Horne Lake Road, 160 metres south of Olympic Road. These wells tap the Quadra Sands Aquifer and provide high yield and good quality water. Security fencing is installed around the reservoirs and well field. In addition, each well head is protected with an individual pump control building. Water from these wells is pumped to three (3) storage facilities.

Information on well capacity was provided by the District and is summarized in Table 2.1:

Description & Location	Year	Well Record Yield (L/s)	Thurber Study Yield (L/s)	Kalicum Drilling Yield (L/s)
Well #1 17m west of Horne Lake Rd	1993	n/a	21	n/a
Well #2 30m west of Horne Lake Rd	1994	30.28	21	n/a
Well #3 43m west of Horne Lake Rd	2006	8.45	n/a	30.30

Well # 3 was remediated by Kalicum Drilling Ltd in October 2010. Pump testing showed that Well #3 is close enough to be influenced by the operation of Well #1, and the rated well capacities presented in Table 2.1 will drop when more than one well is being pumped. A summary of the Kalicum Drilling program was prepared by the District and stated that “The Water Board can safely say that our wells produce 525 gallons per minute (33 L/s)”.

All three wells are in general use, with one well in operation at any given time. Pumps are controlled manually to alternate well operation. Water consumption is measured by flow meters at each well head and by individual meters on each service connection. An analysis of these records is presented in Section 3 – Water Demand. We have assumed a combined safe yield from all three wells of 33 L/s.

2.2 WATER TREATMENT

Water samples are taken from various locations throughout the distribution system every two weeks and are tested for Bacteriological Indicators. Results are consistently good and the District does not provide chlorine residual disinfection of the distribution system. A test of the Chemical and Physical parameters was last performed in 2010 during the remediation of Well #3. Those test results noted that the source water has a high iron and manganese content; considered an aesthetic concern. The District has adopted a regular flushing and cleaning program to control the accumulation of metals that may impact water quality.

All three wells are advanced to the Quadra Sands Aquifer and Thurber 2003 found that “generally the water from the Quadra Sands Aquifer is currently of high quality and is suitable for human consumption without treatment”. Source water is potable; however the high iron and manganese content is an on-going concern and has been the cause for some complaint from individual rate payers.

2.3 WATER STORAGE

The following three reservoirs are located at the well field:

- two above-ground bolted steel tanks with a volume of 500,000 litres (110,000 lgal) each; and,
- one ground level concrete tank with a volume of 230,000 litres (50,000 lgal).

Both steel reservoirs are in regular use. The concrete reservoir is cycled regularly and kept for emergency storage only, as well as used by the Bow Horn Bay Volunteer Fire Department to fill their trucks. The concrete reservoir predates the steel tanks and the steel tanks were built 8 metres higher to provide an additional 75 Kpa (11 psi) of system pressure. We have assumed an effective, operational storage capacity of 1 million litres (220,000 lgal).

The future storage requirements for the system are outlined in Section 4.2 Water Storage.

2.4 WATER DISTRIBUTION SYSTEM

The Qualicum Bay-Horne Lake Water System was constructed in phases over a period of more than 4 decades. The original lines were built in the late 1960's with 100 mm and 150 mm (4 and 6 inch) diameter Asbestos Cement pipe. Newer subdivision works typically incorporate 150mm and 200mm diameter Polyvinyl Chloride piping. The current water system has approximately 17,550 metres of distribution main that includes the following pipe materials:

- Asbestos Cement (AC) – 11,960 metres (75%);
- Polyvinyl Chloride (PVC) – 3,400 metres (21%);
- Ductile Iron (DI) – 300 metres – (<2%); and,
- High-Density Polyethylene (HDPE) – 320 metres (2%).

Asbestos Cement pipe was in common use prior to the introduction of Polyvinyl Chloride in the mid 1970's. Since that time many communities have experienced problems with deterioration and the eventual failure of their AC pipe system. Asbestos Cement pipe failures tend to be caused by degradation of the pipe material, and/or poor pipe bedding. These problems result from a combination of the following factors:

- Failures are most prevalent in districts that use a surface water supply that tends to be slightly more acidic than ground water. This 'soft' water attacks the cement and reduces pipe strength.
- AC pipe is a brittle material that is prone to cracking when subjected to uneven loads caused by trench settlement, slope movement or vehicle loads.
- Insufficient bedding during installation may result in point loads against the outside of the pipe that result in high stress and pipe failure.

Many communities in BC have adopted an AC pipe replacement program to spread the cost of upgrades over time. The warrant for action is assessed on a case by case basis depending on factors specific to the community.

The District's water distribution system is generally linear in nature with two long dead-end branches that run north and south along Highway 19A. Linear systems exhibit the following two principal weaknesses:

- no redundancy; and,
- high headloss.

This lack of redundancy has a negative impact on system reliability; watermain breaks in an un-looped system may cause a large number of customers to be cut off from service for an extended period of time. Network analysis has shown that small diameter lines restrict the capacity of the system to provide Fire Flows, and in some cases lines would need to be upgraded to meet the insurance industry's recommended guidelines.

2.5 PREVIOUSLY IDENTIFIED CAPITAL PROJECTS

The previous 1990 water study, WCT 1990, recommended a series of projects to address water quality concerns. All of those recommendations were addressed by development of a new ground water source. No other projects were identified. Three water wells have since been installed and there are no outstanding capital projects from that report.

3 WATER DEMAND

3.1 HISTORICAL WATER USE

All three wells are fitted with a meter located in the pump house. Flows are recorded daily and logged by District staff. Meter results for the years 2005 to 2011 were analyzed to determine existing water consumption patterns. Some data gaps were noted, however, data for the high consumption summer months was nearly complete. Refer to Appendix “B” for a summary of meter records.

Flow records were entered into a spreadsheet for analysis and daily values were entered for each month. A summary of monthly consumption from 2005 to 2011 is presented in Figure 3.1.

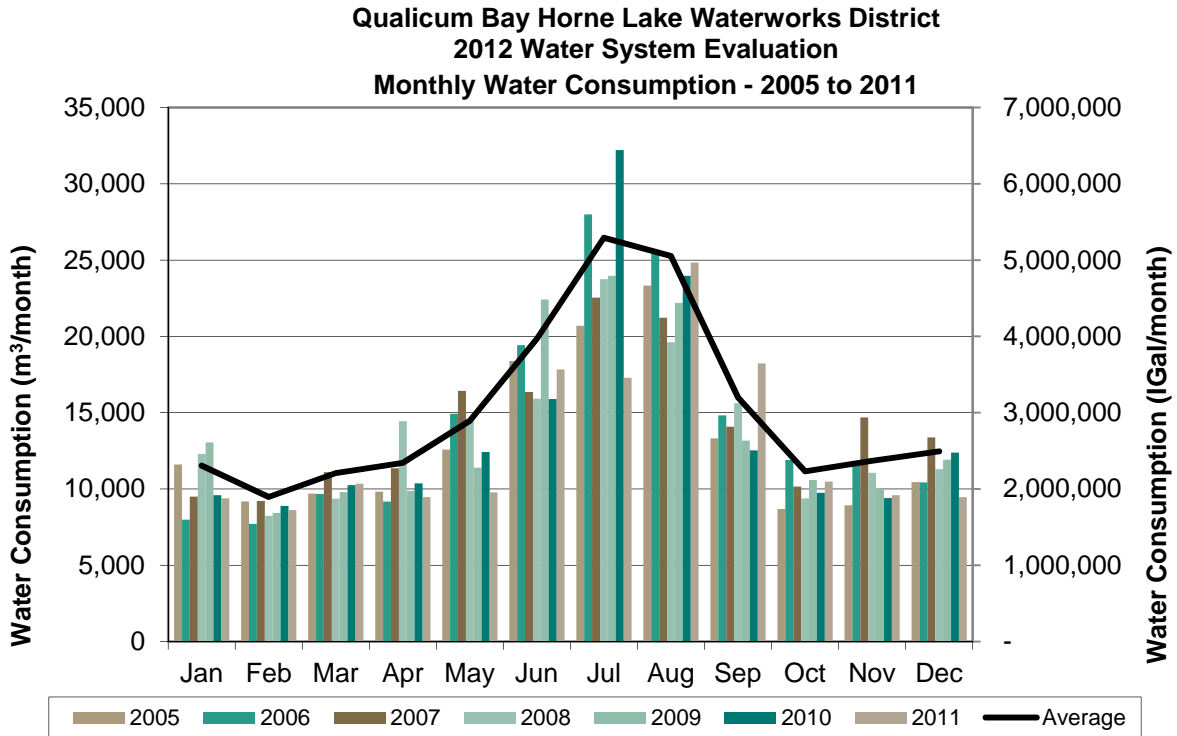


Figure 3.1 2005 to 2011 Water Consumption

Water consumption is lowest from October to April each year, while consumption rates are highest in June, July and August. Summertime water consumption is typically 2.5 times greater than wintertime consumption.

3.2 EXISTING POPULATION

The serviced population for the District is estimated to be 750 persons based on 430 households and an average household population of 1.74 persons. Population density is calculated based on statistics from the 2011 Census for both Qualicum Bay and Deep Bay/Bowser as presented in Table 3.1.

TABLE 3.1: POPULATION & NUMBER OF DWELLINGS			
Area	Qualicum Bay	Deep Bay / Bowser	Qualicum Bay Horne Lake District
	<i>2011 Census Data</i>	<i>2011 Census Data</i>	<i>Calculated</i>
Population	334	1613	750
Total Private Dwellings	187	956	430
Population per Dwelling	1.79	1.69	1.74

3.3 CONSUMPTION BY SECTOR

Residential users consume the majority of the water in the District, followed by commercial, industrial and then Qualicum First Nations. A summary of consumption by each sector is presented in Figure 3.2.

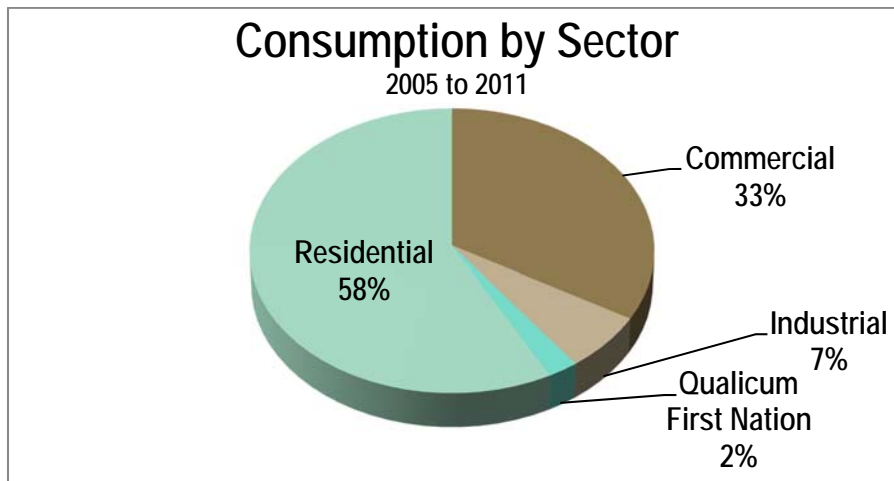


Figure 3.2 Consumption by Sector

3.4 SYSTEM LOSSES

System losses were calculated by comparing meter readings at the well head with meter readings at lot services for the period 2009 to 2011. A summary of that comparison is presented in Table 3.2.

Year	Individual Meters m ³	Well Reading m ³	Losses m ³	Percent Loss
2009	151,000	171,000	20,000	12%
2010	157,000	170,000	13,000	8%
2011	152,000	161,000	9,000	6%
Average	153,000	167,000	14,000	8%

System losses are typically caused by a combination of leakage and un-metered flow. Un-metered flow can result from firefighting, line flushing, pipe breaks or a variety of other causes. These readings indicate an average loss of 8% over a three year period. This loss is within the normal expected range for a system of this size. These results indicate a relatively “tight” distribution system with no significant leakage concerns.

3.5 SYSTEM DEMAND RATES

Water Demand for the system was calculated using available data. Calculated rates are presented in Table 3.3.

Demand	Description	Demand Rate L/s	Daily Demand per Capita L/cap/day	Ratio to ADD
Average Day Demand ADD	Average rate of consumption in a given year. Based on well meter data for 2005 to 2011.	5.3	610	1.0
Maximum Day Demand MDD	Consumption for the single highest demand day of the year (September 9, 2011). MDD provides an indicator of the required well supply rate.	14.8	1710	2.8
Peak Hour Demand PHD	Consumption for the single highest demand hour per year. PHD is used to identify reservoir requirements.	*21.2	*2450	*4.0

*Calculated values based on typical ratios to ADD for similar communities.

Table 3.4 provides a comparison of the District’s water system demand rates to a range of standards from other municipal water systems on Vancouver Island.

TABLE 3.4: COMPARISON OF WATER SYSTEM DEMAND RATES			
Standard	Average Day Demand L/c/day	Max Day Demand L/c/day	Peak Hour Demand L/c/day
City of Nanaimo	455	1135	1820
Capital Regional District	545	1363	1908
Master Municipal Construction Documents (MMCD)	600	1200	1800
Qualicum Bay Horne Lake District	610	1710	2450
City of Campbell River	635	2100	3000

Demand rates for the District are in the range of rates for other jurisdictions. We note that the City of Campbell River does not meter individual service connections and communities with un-metered connections typically have higher rates of consumption.

3.6 PROJECTED WATER DEMANDS

3.6.1 Maximum Future Population

The design population is calculated by multiplying population density (expressed as persons per dwelling unit or ppdu) and the number of services. Future domestic water demand is calculated based on the growth potential for the entire District service area. The population at “Build-out” is estimated based on the maximum allowable subdivision density as listed in the Regional District of Nanaimo’s Official Community Plan (Bylaw No. 1335).

There are currently 18 zones within the District and calculation of the Build-out population based on current zoning is presented in Table 3.5.

TABLE 3.5: MAXIMUM FUTURE POPULATION ESTIMATE

Description	Zoning	Area	Min. Lot Size	Max. Residential Dwellings	Maximum Future Population <i>At 1.74 persons/dwelling</i>
		Ha	Ha		
Horne Lake Development	CD32Z	1.1	-	19	33
Qualicum Bay Seniors	CD41F	1.9	-	25 (assumed)	44
Crown and Anchor Campground	CD42	1.7	-	1	2
Commercial 1	CM1B	0.6	0.05 (residential)	12	21
Commercial 2	CM2M	0.3	0.1 (Office)	3	5
Commercial 4	CM4M	0.5	0.2	2	3
Commercial 5	CM5Z	27.5	0.16 (Retail)	200 (assumed)	348
Industrial 1	IN1M	5.7	0.5	-	
Industrial 2	IN2D	2.2	0.6	-	
Public Use 1	PU1M	10.6	0.1 (Public Utility)	-	
Public Use 6	PU6Z	46.1	-	-	
Recreation 1	RC1Z	3.2	1	-	
Resource Management 1	RM1V	187.2	0.5 (Aquaculture)	-	
Residential 1	RS1N	2.7	0.16	16	28
Residential 2	RS2M	145.1	0.2	725	1262
Residential 3	RS3M	3.5	0.2	17	30
Residential 6	RS6D	2.3	2	1	2
Rural 1	RU1Z	504.6	8	63	110
TOTAL					1888 persons

3.6.2 Projected Population Growth

Table 3.6 provides a calculation of the recent historical population growth rate for Qualicum Bay and Deep Bay/Bowser based on statistics available from the Census of Canada website (<http://www12.statcan.gc.ca>).

Area	Description	Year		
		2001	2006	2011
Qualicum Bay & Deep Bay/Bowser	Population	1682	1882	1947
	Annual Growth Rate	-	2.3%	0.7%
Average Annual Growth Rate – 2001 to 2011:				1.5%

Based on the RDN Regional Growth Strategy, historical growth rates and economic conditions, we have assumed the projected population growth rate of 2.0% per annum. The maximum “build out” population will be reached in approximately 47 years, or in the year 2059. Additional growth and water demands could arise from changes to the zoning bylaws or through boundary extension, however, analysis of that potential is beyond the scope of this study.

3.6.3 Projected Water Demand

Projected domestic water demand for the next 20 years is presented in Table 3.7 and is based on the current zoning, rates of consumption, peaking factors and projected growth rate.

Years		0	5	10	15	20
Year		2012	2017	2022	2027	2032
Population		750	828	914	1009	1114
ADD	L/day	460,000	510,000	560,000	620,000	680,000
	lgal/day	100,000	110,000	120,000	140,000	150,000
MDD	L/day	1,280,000	1,420,000	1,560,000	1,730,000	1,890,000
	lgal/day	280,000	310,000	330,000	390,000	420,000
PHD	L/day	1,840,000	2,040,000	2,240,000	2,480,000	2,720,000
	lgal/day	400,000	440,000	480,000	560,000	600,000

3.7 DESIGN STANDARDS

Design criteria used for analyzing and comparing the various water system components are provided in a number of standards and guideline documents. With reference to these standards and guideline documents, we used the following design criteria for the Qualicum Bay-Horne Lake Waterworks System.

Water Supply

The total developed groundwater capacity, or “safe yield” of the wells should equal or exceed the design Maximum Day Demand. The groundwater sources need to sustain this rate of flow continuously for 100 days in the summer, during which the aquifer would not be recharged by precipitation and without utilizing more than 70% of the available drawdown below the lowest seasonal static groundwater table. (Reference Design Guidelines for Rural Residential Community Water Systems).

Water Treatment

Where there are problems with the potability of the source or aesthetic concerns, the provision of treatment may be a condition of source approval. (Reference Design Guidelines for Rural Residential Community Water Systems).

Water Storage

Provide storage for fire protection, balancing, and emergency use. Balancing Storage should not be less than 25% of the Maximum Day Demand. Also Emergency Storage should not be less than 25% of Fire Storage plus Balancing Storage. (Reference Design Guidelines for Rural Residential Community Water System.)

Distribution System

Water distribution systems are sized to supply peak water consumption. The critical design criteria are typically based on either:

1. Maximum Day Demand plus Fire Flow or;
2. Peak Hour Flow.

MDD plus Fire Flow is found to be the more stringent requirement for smaller water systems and has been included as a design case for this study.

System Pressure

The working pressure at peak hourly flow should range between 275 kPa (40 psi) and 700 kPa (100 psi). (Reference Design Guidelines for Rural Residential Community Water Systems).

A minimum residual water pressure of 140 kPa (20 psi) in the watermains is required during fire flows. (Reference Water Supply for Public Fire Protection, FUS).

Hydrant Spacing

The distribution system includes a series of standpipes and fire hydrants. Recommendation for hydrant spacing is provided by the following standards:

- The Master Municipal Construction Document Association's publication *Design Guideline Manual* (MMCD) recommends that hydrants should be located in general at street intersections and no more than 150 m apart nor more than 90 m from a building
- The Fire Underwriters Survey publication *Water Supply for Public Fire Protection – A Guide to Recommended Practice* (FUS) recommends the maximum spacing of hydrants in commercial, industrial, institutional and multi-family residential areas to be 90m; in single family residential areas 180 metres is recommended.
- *Design Guidelines for Rural Residential Community Water Systems* recommends a hydrant spacing of not more than 300 meters.

3.8 FIRE FLOWS

The District's Letters Patent does not include fire protection, however the distribution system is equipped with fire hydrants and the volunteer fire department relies on the system to provide fire flows.

That said, we recommend that all new water system components including supply, storage and distribution mains that are identified in this study be sized to provide a level of fire protection.

Fire flow requirements are typically calculated in accordance with the latest edition of the "Water Supply for Public Fire Protection", published by the Fire Underwriters Survey (FUS). FUS fire flows vary widely depending on building size, construction, exposure and occupancy.

As a guide, typical minimum fire flows have been referenced from the Master Municipal Construction Documents Association (MMCD) and generally conform to that of the FUS. MMCD requirements are summarized in Table 3.8.

TABLE 3.8: FIRE - FLOW DEMANDS & FIRE STORAGE REQUIREMENTS

Type of Development <i>(without sprinkler systems)</i>	Minimum Fire Flow L/s	Required Fire Flow Duration hours	Required Fire Storage L (lgal)
Single Family Residential	60	1.4	300,000 (70,000)
Apartments, Townhouses	90	1.9	620,000 (140,000)
Commercial	150	2.0	1,080,000 (240,000)
Institutional	150	2.0	1,080,000 (240,000)
Industrial	225	2.9	2,350,000 (520,000)

4 SYSTEM ANALYSIS

4.1 WATER SUPPLY

The existing well field has a combined safe yield of 33 litres per second (2.85 million litres per day). Current MDD is 1.28 million litres per day and the projected MDD for year 2032 is 1.89 million litres per day. We are not aware of any issues with seasonal variation in well capacity or pump drawdown that would cause concern. We conclude that the current well supply has adequate capacity to handle projected growth to year 2032.

4.2 WATER STORAGE

Storage facilities are typically sized to provide fire, balancing and emergency storage based on the following formula:

$$\text{TOTAL STORAGE VOLUME} = A + B + C$$

Where,

- A = Required Fire Storage *per Fire Underwriters Survey Guide*
- B = Equalization Storage *25% of Maximum Day Demand*
- C = Emergency Storage *25% of A+B*

Projected storage requirements for domestic flows plus fire protection for single family residential development is presented in Table 4.1.

TABLE 4.1: STORAGE REQUIREMENTS FOR DOMESTIC FLOWS PLUS FIRE PROTECTION FOR SINGLE FAMILY RESIDENTIAL

Year	Fire Flow	MDD	Total Storage Volume
2012	300,000 litres	1,280,000 litres	775,000 litres
2017	300,000 litres	1,420,000 litres	818,750 litres
2022	300,000 litres	1,560,000 litres	862,500 litres
2027	300,000 litres	1,730,000 litres	915,625 litres
2032	300,000 litres	1,890,000 litres	965,625 litres

Existing reservoirs provide sufficient storage for both domestic flows and single family residential fire flows for now and 20 years in the future. Additional storage would be required to meet FUS requirements for commercial, institutional, and industrial developments.

4.3 EXISTING DISTRIBUTION SYSTEM

A computer model of the Qualicum Bay – Horne Lake Water System was created by McElhanney to assess the capacity of a distribution system to meet delivery requirements. The water model was developed using WaterCAD™ software and provides a mathematical representation of the distribution system.

Model inputs define the physical characteristics of the system and the anticipated flows. The distribution system is modeled as a network of pipes interconnected at nodes. Pipes in the model are assigned the physical characteristics of pipes in the field (length, diameter and roughness), the nodes define the points of connection between the lines and define the water demand in the system (both domestic and fire flows).

Model outputs include the flow and head loss along each line and the pressure at each node. Pipes and nodes are shown on the drawing in Appendix D.

4.3.1 Model Calibration

The computer model was calibrated using flow and pressure data from two sets of hydrant tests:

- Tests conducted by the Bow Horn Bay Fire Department, September 8, 2010; and
- Tests conducted by McElhanney, March 4, 2012

Pipe length and pipe diameter was based on available records, and the model was calibrated by adjusting pipe roughness until flow and pressure outputs matched field test data. Pipe roughness generally fell within reasonable, and commonly referenced values, however anomalies were identified in the following two areas:

- Leon, Marshall & Dunsmuir Roads, and
- Highway 19A, between Lions Way and Charlton Drive.

Calibration results indicate higher-than-expected headloss in these two areas. Inordinate headloss may be caused by factors other than pipe roughness that include, but are not be limited to the following:

- Obstructions;
- Debris in the pipes;
- Damaged pipe;
- Constrictions from pipe repairs;
- Partially closed valve(s); and or,
- Inaccurate system mapping of piping components.

Additional investigation is recommended to verify the nature and severity of headloss in these cases.

Refer to Appendix C for a summary of the model calibration.

4.3.2 *Current System Performance*

The model was used to assess the capacity of the current system to meet three different demand scenarios. Results were compared to the criteria previously identified.

Demand Scenario 1 – Current System with Current Peak Hour Flow

The results of the existing domestic Peak Hour Demand (PHD) analysis indicate the residual pressures in the system are above the 275 kPa (40 psi) minimum. There are four areas with pressure less than 400 kPa (60 psi):

1. Linx Road (west end)
2. Cochrane Road (south end),
3. Horne Lake Road (south of railway), and
4. Dunsmuir Road (most southerly node).

Demand Scenario 2 – Current System with Year 2032 Peak Hour Flow

The projected PHD in Year 2032 (20yrs) is estimated to be 2,720,000 L/day or 31.5 L/s, representing a 47% increase over existing demands. The 20-Year PHD analysis provides residual pressures that are similar to current operation. Pressure is maintained above the 275 kPa (40 psi) minimum and the same four areas have pressure less than 400 kPa (60 psi).

Demand Scenario 3 – Current System with Year 2032 Maximum Day Demand and Residential Fire Demand

Simulations were conducted to assess the system with the existing service population to determine available fire flows. A fire flow of 60 L/s for single family residential development was used. The existing storage and distribution system cannot supply this fire flow to the extremities of the service area. In general, fire flow is not available at 60 L/s throughout the district. The available fire flow is less than 30 L/s for areas north of Qualicum First Nation and on the Island Highway south of Daft Road.

4.3.3 Modelling Summary

In summary, the existing system can meet Peak Hour Demand with satisfactory pressure under current and Year 2032 conditions. System improvements are required to meet minimum firefighting standards.

4.4 PROPOSED DISTRIBUTION SYSTEM IMPROVEMENTS

The computer model was used to assess two different system improvement scenarios as follows:

Improvement Scenario 1 – Retain Existing Layout and Increase Pipe Sizes

The model was revised by replacing existing small diameter AC lines with larger diameter PVC lines to reduce headloss within the system and thereby increase system capacity to satisfy Year 2032 Maximum Day Demand plus a residential Fire Demand of 60 l/s. The following system improvements were identified:

- Replace the existing 200 mm diameter line on Horn Lake Road from the rail road track south of Berkshire Road to Huson Road with a 300 mm diameter main. Total length of main replacement is 350 metres;
- Replace the existing 100 mm and 150 mm diameter AC lines on Leon, Kenmuir, Huson and Highway 19A with 250 mm diameter main to create a continuous loop. Total length of main replacement is 850 metres;
- Replace the existing 150 mm diameter line on Highway 19a from Kenmuir Road south to Van Isle Road with a 200 mm diameter main. Total length of main replacement is 1,100 metres; and,

- Replace the existing 150 mm diameter line on Highway 19A from Huson Road north to Charlton Road with a 250 mm diameter main. Total length of main replacement is 4,200 metres.

Improvement Scenario 2 – Construct a Watermain on Bradshaw Road and Increase Pipe Sizes

The model was revised by adding a main along Bradshaw Road from Dunsmuir Road to Highway 19A at Goodyear Road. Installation of this new line will create a loop to service adjacent properties, provide redundancy and improve capacity to the south end of the District.

The north end of the system is currently serviced by a single 150 mm diameter AC main that is 4,200 metres long. This long, small diameter line introduces high headloss under fire flow conditions and offers no redundancy. Options for a second line to service the north end of the District and create a loop in the distribution system are limited. The E&N rail right of way offers a contiguous alignment, however construction of a line along this corridor would provide limited benefit to adjacent properties.

We have assumed that the north end of the system will continue to be serviced by a single line along Highway 19A and the following system improvements were identified:

- Install a new 200 mm diameter line on Bradshaw Road from Dunsmuir Road to Highway 19A. Total length of new main construction is 1,700 metres.
- Replace the existing 200 mm diameter line on Horn Lake Road from the rail road track south of Berkshire Road to Huson Road with a 300 mm diameter main. Total length of main replacement is 350 metres;
- Replace the existing 100 mm and 150 mm diameter AC lines on Leon, Kenmuir, Huson and Highway 19A with 200 mm diameter mains to create a continuous loop. Total length of main replacement is 850 metres;
- Replace the existing 150 mm diameter line on Highway 19A from Huson Road north to Charlton Road with a 200 mm diameter main. Total length of main replacement is 4,200 metres.

Watermain system improvements identified under Scenario 1 and Scenario 2 include replacement of several kilometers of small diameter AC line. As discussed previously, a number of waterworks jurisdictions have adopted AC watermain replacement programs. Capacity upgrades should be coordinated with an AC main replacement program that identifies priority projects based on both pipe condition and system capacity.

A second option to improve flows and provide additional security to the north end of the water system would be to construct a reservoir at the north end of the system to balance pressures and allow fire flows to be fed from two directions. Identification of an appropriate location and associated cost estimates were considered beyond the scope of this current study.

We understand that the north end of the Qualicum Bay, Horne Lake Waterworks District has a connection to the Bowser Waterworks District via a watermain that crosses the Nile River along Highway 19A. This connection is provided with a normally closed valve that can be opened to provide flow in either direction in case of emergency. Consideration should be given to replacing this manually operated valve with a control valve that will open automatically under low pressure flow conditions.

5 CONCLUSIONS

A summary of conclusions is presented below:

1. Source water is potable without disinfection , but has high iron and manganese content;
2. The District should plan for AC watermain replacement and adopt a program that includes the installation of larger replacement mains to improve system capacity;
3. Average daily water consumption is 610 litres per capita per day. This consumption is within the range of other jurisdictions;
4. Summertime water consumption is 2.5 times greater than wintertime consumption;
5. The system currently serves approximately 750 people. That service population is projected to grow to 1114 by Year 2032. The ultimate build-out population within the District based on the current Official Community Plan in 1888 people;
6. System loss is calculated at 8% indicating a “tight” distribution system. At this point leakage is not a concern;
7. The current well supply has adequate capacity to handle projected growth to Year 2032;
8. The existing reservoirs provide adequate storage capacity to service the Year 2032 population with fire storage for single family residential development;
9. Additional investigation is required to find the cause of high system head losses in the vicinity of Leon, Marshal and Dunsmuir Roads, and on Highway 19A between Lions Way and Charlton Road;
10. The existing distribution system can deliver Peak Hour Flows with satisfactory system pressures for both the current population and the projected Year 2032 population;
11. The existing distribution system cannot deliver a fire flow of 60 l/s plus current Maximum Day Demand throughout the service area;
12. Capacity upgrades should be co-ordinated with an AC watermain replacement program that identifies priority projects based on both pipe condition and system capacity.

6 RECOMMENDATIONS

Based on our review of the existing information provided and computer modelling, we recommend the following system improvements. Each project has been assigned a schedule of priority focused on strengthening the system to improve domestic water supply and improve residential fire flows.

1. Project #1 – Watermain Investigation (Priority 1-5 years)

Investigate the following areas to identify the nature of high head losses inferred by hydrant flow test results:

- a. Leon, Marshall & Dunsmuir Roads, and
- b. Along the Island Highway, between Lions Way and Charlton Drive.

2. Project #2 – AC Watermain Condition Assessment (Priority 1-5 years)

In the late 1960's over 7km of AC watermain was installed. This watermain is approaching approximately 40 years old. All systems deteriorate with age and use, however performance may not be affected until deterioration is well advanced. As such, we recommend the District undertake a condition assessment of the AC pipe to identify areas that need pipe replacement.

3. Project #3 – AC Watermain Replacement Program (Priority 1-30 years)

Based on the findings from the AC watermain condition assessment, we recommend the District implement an AC watermain replacement program to address the aging infrastructure. Due to the large amount of old AC pipe in use, planning should be undertaken to replace the critical portions of the main on a yearly basis to avoid a large capital costs.

Replacement in the following areas will also improve residential fire protection:

Project #3a – Leon Road / Kenmuir Road WM Upgrade (250mm) (Priority 1-5 years)

Upgrade approximately 850m of the 100mm diameter mains on Leon Road and Kenmuir Road. This will improve supply to the south end of the system and strengthen system looping by increasing the second feed line to the Island Highway.

Project #3b – Island Highway Watermain Upgrade (250mm) (Priority 5-10 years)

This portion of watermain was installed in the late 1960's and is the primary distribution piping to the north end of the District. Replacing the 150mm diameter piping with 250mm diameter will provide firefighting capacity to the northern end of the District.

4. Project #4 – Bradshaw Road Watermain (200mm) (Priority 10-15 years)

Construction of the Bradshaw main will improve supply to the south end of the system and increase system redundancy by providing a second feed line to compliment the 150mm on the Island Highway. In addition, there have been requests from residents in the Bradshaw Road area to connect to the District system. Expanded service to that area may require a boundary extension.

5. Project #5 – Horne Lake Road Watermain Upgrade (300mm) (Priority 1-5 years)

A single 200mm AC line delivers water to system from the rail road track south of Berkshire Road to Huson Road. To increase hydraulic capacity this 250m long portion of line needs to be upgraded to 300mm.

Refer to Drawing No. 4 in Appendix D for proposed project locations. Project costs are included in Appendix E.

7 CAPITAL EXPENDITURE PROGRAM

The Local Government Act provides a Local Waterworks District with several methods to fund a Capital Works project. In general these funding options are developed to fund two different types of projects:

- Type "A" - Projects required to serve existing customers; and,
- Type "B" - Projects required to serve future development.

These funding methods are described as follows:

7.1 FUNDING FOR PROJECTS THAT SERVE EXISTING CUSTOMERS

Renewal Reserve Fund

Renewal Reserve Funds allow a Local District to put money aside to finance the cost of renewing capital infrastructure. This saving mechanism can reduce or eliminate the amount of borrowing required to construct future works. Renewal Reserve Funds can be formally established with a bylaw passed by the Board of Trustees and registered with the Inspector of Municipalities. Funding sources typically include the following:

- Operating surpluses;
- Budgeted annual contributions;
- Miscellaneous revenue items;
- Sale of assets;

Short Term Borrowing

The Board of Trustees is authorized to pass borrowing bylaws as required to meet approved expenditures. Short term borrowing is typically used to fund unexpected costs and to provide interim financing for capital projects. Temporary borrowing bylaws are registered with the Inspector of Municipalities and are secured by the toll and taxing powers of the Waterworks District.

Long Term Borrowing

The Local Government Act allows a Waterworks District to borrow money by issue and sale of notes, bonds debentures and other securities. In practice this method of borrowing is arranged through the Municipal Finance Authority and is guaranteed by the Province. Long term borrowing bylaws and associated documents are prepared by the Ministry of Community, Sport and Cultural Development.

7.2 FUNDING FOR PROJECTS THAT SERVE FUTURE DEVELOPMENT

Capital Expenditure Charges

The ability of a Waterworks District to serve future development may be restricted by the system's capacity to meet that additional demand. Upgrades to the system that are required to meet this increase in demand, but are not tied to a single specific development project are typically funded through a Capital Expenditure Charge (CEC) Fund.

The Qualicum Bay Horne Lake Waterworks District has a CEC bylaw and collects CEC funds from new customers when they receive service. This funding method has been used in the past to construct capital works projects that are identified in the District's CEC bylaw. This study includes information to update the list of projects covered by the District's CEC bylaw to reflect water consumption rates, current construction costs and projected future growth. A copy of the District's current CEC bylaw is included in Appendix A.

Subdivision Regulation Bylaw

Subdivision applications made to the Ministry of Transportation are referred to the Waterworks District for review and comment. The District's position to support an application is typically based on capacity available in the existing system and the ability to service newly created lots. The cost of servicing new development is typically allocated to the applicant and not existing users.

Waterworks Districts are empowered to pass bylaws that define servicing standards to be met with new construction and the Approving Officer must not approve a subdivision until services meet those standards. Servicing Standards typically apply to development as well as subdivision and are subject to the following limitations:

- Standards can only apply to works that are included in the Letters Patent (waterworks in the case of the Qualicum Bay Horne Lake Waterworks District).
- The landowner is 100% responsible for the cost of works required to meet standards that are built on his property and on highway adjacent to his property.

Latecomer Charges

In certain cases the developer is required to oversize works that are constructed on his property or within adjacent road right of way, or he may be required to construct works that extend beyond his property to serve his development. When excess or extended services also benefit adjacent properties, then the developer has a right to request that the Waterworks District pass a Latecomer's Bylaw that allows him to recoup his additional costs.

Table 7.1 provides a summary of the cost estimates with pro-rated allocation between Type A (Serve Existing Customers) and Type B (Serve Future Development).

TABLE 7.1: COST ESTIMATE APPROPRIATION		
Project Description	Type "A" <i>Serve Existing Customers</i>	Type "B" <i>Serve Future Development</i>
Project #1 – Watermain Investigation	\$ 6,900.00	
Project #2 – AC Watermain Condition Assessment	\$ 29,900.00	
Project #3 – AC Watermain Replacement Program	\$1,513,400.00	\$ 514,550.00
Project #3a – Leon Road / Kenmuir Road WM	\$ 252,600.00	\$ 85,900.00
Project #3b – Island Highway Watermain Upgrade	\$ 1,472,600.00	\$ 501,000.00
Project #4 – Bradshaw Road Watermain		\$ 621,500.00
Project #5 – Horne Lake Road Watermain Upgrade	\$ 124,100.00	\$ 42,200.00
TOTAL	\$ 3,399,500.00	\$1,765,150.00

Table 7.2 below provides a detailed 5yr Capital Plan breakdown for the initial recommended works.

TABLE 7.2: 5 YEAR CAPITAL PLAN					
Project	2014	2015	2016	2017	2018
Project #1 – Watermain Investigation	\$ 6,900.00				
Project #2 – AC Watermain Condition Assessment	\$ 29,900.00				
Project #3 – AC Watermain Replacement Program (30yr timeframe)			\$67,600.00	\$67,600.00	\$67,600.00
Project #3a – Leon Road / Kenmuir Road Watermain			\$45,000.00	\$293,388.00	
Project #5 – Horne Lake Road Watermain Upgrade	\$22,000.00	\$144,300.00			
TOTAL	\$58,800.00	\$144,300.00	\$112,600.00	\$360,988.00	\$67,600.00

The 5yr Capital Plan can be revised to suit the availability of funds.

7.3 PROPOSED CAPITAL EXPENDITURE CHARGES

Proposed Capital Expenditure Charges (CEC) has been prepared to suit each development type as defined in By-law No. 64. A copy of that bylaw has been included in the Appendix A.

The existing CEC rate schedule is presented in Table 7.3.

TABLE 7.3: EXISTING CEC RATE SCHEDULE		
General Rate Schedule	Basis of Assessment	Charge
Single Family Residential	Lot	\$2,250.00
Multiple Unit (Apartment, Condo, Motels)	Unit	\$1,200.00
Mobile Home Parks (or Trailer Courts)	Unit Pad	\$1,200.00

The proposed CEC fees are based on the following assumptions:

- 20 year projection for all projects with the exception of Project # 3 – AC Watermain Replacement Program which utilizes a 30 year timeframe;
- Project # 7 – Bradshaw Road Watermain will be constructed under the subdivision bylaw requirements, a latecomers agreements or negotiated terms of boundary extension.

The following population projections have been used:

20YR		30YR	
Population 2012 =	750 persons	Population 2012 =	750 persons
Population 2032 =	<u>1114 persons</u>	Population 2042 =	<u>1358 persons</u>
Population Increase =	364 persons	Population Increase =	608 persons

The proposed CEC's are calculated as follows:

Total Project Costs for CEC's = Total Type "B" Projects *minus* Bradshaw Road Watermain
= \$1,765,150.00 - \$621,500.00 = \$1,143,650.00

20YR CEC Portion = Total CEC's *minus* AC Watermain Replacement Program
= (\$1,143,650.00 - \$514,550.00) / 364 persons = \$1,728.29

30YR CEC Portion = Total CEC's for AC Watermain Replacement Program
= \$514,550.00 / 608 persons = \$846.29

Total CEC per person = \$1,728.29 + \$846.29 = **\$2,574.58 per person.**

Please note that existing CEC reserve monies have not been included in the above calculation. The total CEC per person could be reduced if reserve CEC funds are available.

TABLE 7.4: PROPOSED CEC RATE SCHEDULE

General Rate Schedule	Basis of Assessment	Persons Per Unit	Charge
Single Family Residential	Lot	2.0	\$5,150.00
Multiple Unit (Apartment, Condo, Motels)	Unit	1.5	\$3,862.00
Mobile Home Parks (or Trailer Courts)	Unit Pad	1.5	\$3,862.00

The current bylaw does not account for proposed commercial or industrial developments. The District may consider updating the bylaw to reflect those zoning conditions and potential CEC's.

Table 7.5 provides a comparison of the proposed residential CEC charge with Charges for similar municipal water systems on Vancouver Island.

TABLE 7.5: COMPARISON OF RESIDENTIAL WATER CHARGES

Location	CEC	DCC
City of Port Alberni		\$2,159.43
District of Lantzville		\$3,893.51
Bower Waterworks District	\$4,367.00	
Qualicum Bay Horne Lake Waterworks	\$5,150.00	
Deep Bay Improvement District	\$6,500.00	
City of Parksville		\$6,997.14
Village of Cumberland		\$8,605.00
District of Tofino		\$9,640.00

8 CLOSURE

It has been a pleasure to work with the Qualicum Bay Horne Lake Water District. We trust this document meets your requirements. If you have any further inquiries, please do not hesitate to contact the undersigned at your earliest convenience.

Yours very truly,
McElhanney Consulting Services Ltd.

Written By,

Reviewed By,

D.Tunncliffe, P.Eng.
Project Engineer

C.Pogson, P.Eng.
Division Manager, Engineering

APPENDIX A – LETTERS PATENT / CEC BYLAW

Qualicum Bay-Horne Lake Waterworks District

LETTERS PATENT

[L.s.] GEORGE R. PEARKES,
Lieutenant-Governor.

CANADA:

PROVINCE OF BRITISH COLUMBIA

ELIZABETH the SECOND, by the Grace of God, of the United Kingdom, Canada and Her other Realms and Territories, Queen, Head of the Commonwealth, Defender of the Faith.

To all to whom these presents shall come—
Greeting.

Ray Williston,
*Minister of
Lands, Forests,
and Water
Resources.*

WHEREAS by section 53 of the *Water Act* it is provided that the Lieutenant-Governor in Council may incorporate a tract of land and the owners thereof into an improvement district:

And whereas the Lieutenant-Governor in Council has, by Order in Council made pursuant to the said Act, been pleased to order that the tract of land hereinafter described and the owners thereof be incorporated into an improvement district under the said Act, and has made further provision to the tenor and effect hereinafter appearing:

Now know ye that by these presents We do hereby order and proclaim:—

1. The tract of land within Newcastle Land District and Victoria Land Registration District more particularly described as Lot 50 of Lot 81, Plan 1967; Lot 2 of Lot 16, Plan 2164, except Plans 10527 and 14687; Lots 1 to 6, inclusive, of Lot 16, Plan 10527; Lots 1, 2, and 3 of Lot 16, Plan 14687; Lots 1 to 4, inclusive, of Lot 16, Plan 15105; Lot A of Lot 16, Plan 14715; Lot 1 of Lot 16, Plan 12755; that part of Lot 16 as shown on Plan 885R, except Plans 12186 and 12759; Lots 1, 2, and 3 of Lot 16, Plan 12186; Lots A, B, and C of Lot 16, Plan 12759; Lots 1 to 6, inclusive, of Lot 16, Plan 13336; Lot A of Lot 16, Plan 11435; Lots 1 to 25, inclusive, of Lot 16, Plan 13312; Lot A of Lot 16, Plan 13467; Lots 19, 20, 21, and 22; Lot 33, except Lot 9, Plan 2459; Qualicum Indian Reserve, together with all adjacent road allowances, except throughout the Esquimalt and Nanaimo Railway right-of-way, and all subdivisions thereof and all owners of land therein are incorporated into an improvement district under the *Water Act* and subject to the provisions thereof and to the conditions hereinafter contained.

2. The improvement district shall be known as "Qualicum Bay-Horne Lake Waterworks District."

3. The objects of the improvement district shall be the acquisition, maintenance, and operation of works for waterworks purpose and all matters incidental thereto.

4. There shall be five Trustees of the improvement district.

5. The persons qualified to vote at the first election of Trustees shall be Canadian citizens who are twenty-one years of age or older and are entitled to be registered as voters under the *Provincial Elections Act* and are owners of land in the tract of land hereinbefore described, and the persons qualified to be candidates at the election shall be the persons qualified as aforesaid to vote and their wives and husbands.

6. Mr. Walter Joseph Morton, R.R. 1, Qualicum, B.C., shall be Returning Officer for the first election of Trustees. He shall call a general meeting of the persons who are qualified as aforesaid to vote and shall, at least fourteen days before the date of the meeting, post at three conspicuous places within the area hereinbefore described and publish in a newspaper circulating in the said area a notice signed by him giving the date, time, and place of holding the meeting. The Returning Officer shall be chairman of the meeting, and subject to the provisions of clause 5 shall have power to determine whether or not any person who desires to vote is qualified to do so. He shall have power to determine the procedure to be followed at the meeting and the method of taking the votes. Each qualified voter shall be entitled to cast one vote for each of five candidates. The Returning Officer shall declare the result of the election and shall notify the Comptroller of Water Rights of the said result.

7. The candidate elected as Trustee for whom the greatest number of votes is cast at the general meeting called pursuant to clause 6 hereof shall hold office until the annual general meeting of 1971, the candidates elected for whom the second and third greatest numbers of votes are cast shall hold office until the annual general meeting of 1970, and the candidates elected for whom the fourth and fifth greatest numbers of votes are cast shall hold office until the annual general meeting of 1969, but should there be nominated no more than five candidates for the office of Trustee, or should any two or more candidates receive an equal number of votes, then the Returning Officer shall have power to and shall declare which of the candidates are elected and which shall hold office until the next, the second, and the third succeeding annual general meetings respectively.

8. All subsequent elections of Trustees shall be held at the annual general meetings of the improvement district, and it shall be the duty of the Trustees to call a general meeting to be held between January 1st and May 1st in each year for the following purposes:—

- (a) To receive from the Trustees a report on the condition of the works and a statement of the financial condition of the improvement district;
- (b) To discuss with the Trustees any matter relating to the works or finances of the improvement district;
- (c) To fix the remuneration of the Trustees for the ensuing year;
- (d) To elect a Trustee or Trustees to succeed those whose terms of office expire coincident with the holding of such annual general meeting, and to elect a Trustee or Trustees to fill any other vacancy or vacancies that has or have occurred or is or are about to occur among the Trustees;
- (e) To choose the auditor for the ensuing year.

A special general meeting may be called by the Trustees at any time for the purpose of electing a Trustee or Trustees to fill any vacancy or vacancies among the Trustees, or for the purpose of discussing with the owners any matter or matters which in the opinion of the Trustees should be brought up at a general meeting.

At least fourteen days' notice of every general meeting shall be given by notices posted at three conspicuous places within the district and published in a newspaper circulating in the district.

The secretary shall enter in a book provided by the Trustees for this purpose minutes of all matters brought before the meeting and the action taken thereon. At any general meeting every person shall be qualified to vote who is a Canadian citizen and is twenty-one years old or older and is an owner of land in the improvement district, or the authorized agent of any board or corporation that is an owner of such land, or legal representative of any owner of such land who has died, become insolvent or insane, and is entitled to be registered as a voter under the *Provincial Elections Act*. Every person qualified as aforesaid to vote and the wife or husband of any such person shall be qualified to be a candidate for Trustee of the improvement district. In the event of the right of any person to vote at any general meeting being challenged, the chairman shall have authority to determine whether or not such person is entitled to vote, and the chairman may require such person to make and file with him a statutory declaration showing that the declarant is qualified as aforesaid to vote at such general meeting. Forthwith after the holding of a general meeting the Trustees shall file with the Comptroller of Water Rights a true copy of the minutes of such meeting

(OVER)

and copies of all auditor's reports and financial statements presented or discussed at the meeting.

9. All words and phrases given special meaning in section 2 of the *Water Act* shall, where used herein, be ascribed the meaning given them in the said section, unless the context otherwise requires.

In testimony whereof, We have caused these Our Letters to be made Patent and the Great Seal of Our said Province to be hereunto affixed.

Witness, Major-General the Honourable George Randolph Pearkes, V.C., P.C., C.C., C.B., D.S.O., M.C., C.D., Lieutenant-Governor of Our said Prov-

ince, in Our City of Victoria, this seventh day of May, in the year of our Lord one thousand nine hundred and sixty-eight, and in the seventeenth year of Our Reign.

By Command.

W. D. BLACK,
Provincial Secretary.

Reprinted from B.C. Gazette—Part II, May 16, 1968.

Printed by A. SUTTON, Printer to the Queen's Most Excellent Majesty
in right of the Province of British Columbia.
1968

Qualicum Bay-Horne Lake Waterworks District

LETTERS PATENT

[L.S.]

H. P. BELL-IRVING
Lieutenant Governor

CANADA:

PROVINCE OF BRITISH COLUMBIA

ELIZABETH the SECOND, by the Grace of God, of the United Kingdom, Canada and Her Other Realms and Territories, Queen, Head of the Commonwealth, Defender of the Faith

To all to whom these presents shall come—
Greeting

W. N. Vander Zalm
*Minister of
Municipal Affairs*

WHEREAS, the Qualicum Bay-Horne Lake Waterworks District is an improvement district

incorporated under the *Water Act* by Letters Patent issued on May 7, 1968:

And whereas it is provided by section 825 of the *Municipal Act* that the Lieutenant Governor in Council may at any time amend the Letters Patent of any improvement district in any respect:

And whereas the Board of Trustees of the Qualicum Bay-Horne Lake Waterworks District has requested that the number of Trustees of the district be increased to 7 from 5:

Now know ye that by these presents We do order and proclaim that on, from and after the date of these supplementary Letters Patent the number of Trustees of Qualicum Bay-Horne Lake Waterworks District shall be 7:

And that the Letters Patent dated May 7, 1968, providing for the incorporation of the Qualicum Bay-Horne Lake Waterworks District be amended by striking out section 4 in its entirety and substituting the following therefore:

"4. There shall be 7 Trustees of the improvement district. The first terms of office of the 2 additional Trustees, which increases from the number of 5 to 7, shall be determined as follows: The candidate receiving the largest number of votes at a general meeting called for this purpose shall hold office until the annual general meeting of

1983 and the candidate receiving the second largest number of votes shall hold office until the annual general meeting of 1982."

And that the Letters Patent of the Qualicum Bay-Horne Lake Waterworks District be deemed to be amended so as to conform to the premises as and from the date of these supplementary Letters Patent.

In testimony whereof, We have caused these Our Letters to be made Patent and the Great Seal of Our said Province to be hereunto affixed.

Witness, the Honourable Henry P. Bell-Irving, Lieutenant Governor of Our said Province of British Columbia, in Our City of Victoria, in Our said Province, this ninth day of April in the year of our Lord one thousand nine hundred and eighty-one, and in the thirtieth year of Our Reign.

By Command.

[L.S.] EVAN WOLFE
*Provincial Secretary and Minister
of Government Services*

Reprinted from *The British Columbia Gazette*, May 7, 1981.

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Victoria, 1981

Qualicum Bay-Horne Lake Waterworks District

LETTERS PATENT

[L.S.]

H. P. BELL-IRVING
Lieutenant Governor

CANADA:

PROVINCE OF BRITISH COLUMBIA

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W. N. Vander Zalm
*Minister of
Municipal Affairs*

WHEREAS the Qualicum Bay-Horne Lake Waterworks District is an improvement district

incorporated under the *Water Act* by Letters Patent issued on May 7, 1968:

And whereas it is provided by section 825 of the *Municipal Act* that the Lieutenant Governor in Council may at any time amend the Letters Patent of any improvement district in any respect:

And whereas the Board of Trustees of Qualicum Bay-Horne Lake Waterworks District has requested that the boundaries of the district be amended to include all and singular those parcels or tracts of land situate, lying and being as follows:

Firstly—Commencing at the northeast corner of Lot 1 of Lots 31 and 90, Newcastle District, Registered Plan 28488 on file in the Land Title Office, Victoria; thence southerly along the easterly boundary of said Lot 1, Plan 28488 and continuing southerly along the southerly prolongation thereof to the point of intersection with the southwesterly limit of the Esquimalt and Nanaimo Railway Company's right of way, as constructed on the ground; thence northwesterly along said southwesterly limit to the point of intersection with the northerly boundary of Lot 31; thence easterly along the northerly boundary of Lots 31 and 90 to the point of intersection with the northerly prolongation of the easterly boundary of Lot 1 of Lots 31 and 90, Plan 28488; thence southerly along said prolongation to the aforesaid northeast corner of Lot 1 of Lots 31 and 90, Plan 28488, being the point of commencement.

Secondly—Commencing at the northwest corner of Lot 10 of Lot 31, Newcastle District, Registered Plan 21871 on file in the Land Title Office, Victoria; thence easterly along the northerly boundary of said Lot 10, Plan 21871, to the southwest corner of Lot 11 of Lot 31, Plan 21871; thence northerly along the westerly boundaries of Lots 11, 12, 13 and 14 of Lot 31, Plan

21871, to the northwest corner of said Lot 14, Plan 21871; thence easterly along the northerly boundary of Lot 14 of Lot 31, Plan 21871, to the northeast corner thereof; thence N.12°46'12"W. for a distance of 10.373 metres; thence N.88°07'26"W. for a distance of 244.241 metres; thence S.41°44'E. for a distance of 162.549 metres; thence S.82°57'05"E. for a distance of 84.333 metres to the aforesaid northwest corner of Lot 10 of Lot 31, Plan 21871, being the point of commencement:

Now know ye that by these presents We do order and proclaim that the boundaries of the Qualicum Bay-Horne Lake Waterworks District be amended as hereinbefore described and that on, from and after the date of these supplementary Letters Patent the boundaries of the Qualicum Bay-Horne Lake Waterworks District be defined as follows: Commencing at the northeast corner of Lot 16, Newcastle District, being a point on the natural high-water mark of Vancouver Island on the northeasterly shore thereof; thence in a general northwesterly direction along said natural high-water mark to the most northerly corner of Lot A of Lots 22 and 85, Registered Plan 26426 on file in the Land Title Office, Victoria; thence southwesterly along the northwesterly boundary of said Lot A, Plan 26426, to the most westerly corner thereof; thence southwesterly in a straight line to the most easterly corner of Lot 21 of Lot 22, Registered Plan 23173; thence southwesterly along the southeasterly boundary of said Lot 21, Plan 23173 and continuing southwesterly along the southwesterly prolongation thereof to the point of intersection with the northeasterly boundary of Lot 5 of Lot 22, Registered Plan 12132; thence northwesterly, southwesterly and westerly along the northeasterly, northwesterly and northerly boundaries of said Lot 5, Plan 12132, to the northwest corner thereof; thence west to the point of intersection with the easterly boundary of Lot 57 of Lot 85, Registered Plan 2018; thence southerly along the easterly boundary of said Lot 57, Plan 2018, to the point of intersection with the northeasterly limit of the Esquimalt and Nanaimo Railway Company's right of way, as constructed on the ground; thence southeasterly along said northeasterly limit to the point of intersection with the westerly boundary of Lot 22; thence southerly and easterly along the westerly and southerly boundaries of Lot 22 to the northwest corner of Lot 21; thence southerly and easterly along the westerly and southerly boundaries of Lot 21 to the northwest corner of Lot 33; thence southerly along the westerly boundary of said Lot 33 to the point of intersection

with the aforesaid northeasterly limit of Esquimalt and Nanaimo Railway Company's right of way; thence southeasterly along said northeasterly limit to the point of intersection with the southerly boundary of Lot 33; thence easterly along the southerly boundary of said Lot 33 to the most southerly southeast corner thereof; thence southerly and easterly along the westerly and southerly boundaries of Lot 20 to the southeast corner thereof; thence southerly and easterly along the westerly and southerly boundaries of Qualicum Indian Reserve to the northwest corner of Lot 19; thence southerly along the westerly boundary of said Lot 19 to the southwest corner thereof; thence westerly along the northerly boundaries of Lots 90 and 31 to the point of intersection with the southwesterly limit of the Esquimalt and Nanaimo Railway Company's right of way, as constructed on the ground; thence southeasterly along the said southwesterly limit of the Esquimalt and Nanaimo Railway Company's right of way to the point of intersection with the westerly boundary of Lot 90; thence southerly along the westerly boundary of Lot 90 to the southeast corner of Lot 7 of Lot 31, Registered Plan 21871; thence westerly along the southerly boundary of said Lot 7, Plan 21871, to the southwest corner thereof; thence westerly in a straight line to the most easterly corner of Lot 8 of Lot 31, Plan 21871; thence southwesterly and northwesterly along the southeasterly and southwesterly boundaries of said Lot 8, Plan 21871, to the most westerly corner thereof; thence southwesterly and northwesterly along the southeasterly and southwesterly boundaries of Lot 9 of Lot 31, Plan 21871, to the most westerly corner thereof; thence northerly and easterly along the westerly and northerly boundaries of Lot 10 of Lot 31, Plan 21871, to the southwest corner of Lot 11 of Lot 31, Plan 21871; thence northerly along the westerly boundaries of Lots 11, 12, 13 and 14 of Lot 31, Plan 21871, to the northwest corner of said Lot 14, Plan 21871; thence easterly along the northerly boundary of Lot 14 of Lot 31, Plan 21871, to the northeast corner thereof; thence N.12°46'12"W. for a distance of 10.373 metres; thence N.88°07'26"W. for a distance of 244.241 metres; thence S.41°44'E. for a distance of 310.169 metres; thence southeasterly on a radius of 634.786 metres for a distance of 105.722 metres; thence easterly in a straight line to the southwest corner of Lot 4 of Lot 90, Registered Plan 1874; thence easterly along the southerly boundary of said Lot 4, Plan 1874, to the most easterly southeast corner thereof; thence northerly along the easterly bound-

ary of Lot 4 of Lot 90, Plan 1874, to the northeast corner thereof; thence easterly and northerly along the southerly and westerly boundaries of Lot 19 to the point of intersection with the southwesterly limit of Island Highway as shown on Registered Plan 13312; thence southeasterly along said southwesterly limit to the most northerly corner of Amended Lot 1 of Lot 16, Plan 13312; thence southerly along the westerly boundary of said Amended Lot 1, Plan 13312, to the southwest corner thereof; thence southeasterly along the southwesterly boundaries of Amended Lots 1 and 2 and Lots 4 to 18, inclusive, of Lot 16, Plan 13312, to the southeast corner of said Lot 18, Plan 13312; thence northeasterly along the southeasterly boundary of Lot 18 of Lot 16, Plan 13312, to the most easterly corner thereof; thence southeasterly along the southwesterly limit of Island Highway as shown on Plan 13312 to the most northerly corner of Lot 19 of Lot 16, Plan 13312; thence southwesterly along the northwesterly boundary of said Lot 19, Plan 13312, to the most westerly corner thereof; thence southerly along the westerly boundaries of Lots 19 to 25, inclusive, of Lot 16, Plan 13312, to the southwest corner of said Lot 25, Plan 13312; thence easterly along the southerly boundary of Lot 25 of Lot 16, Plan 13312, to the southeast corner thereof; thence southerly in a straight line to the

northeast corner of Lot 1 of Lot 16, Registered Plan 23494; thence westerly and southerly along the northerly and westerly boundaries of said Lot 1, Plan 23494, to the southwest corner thereof; thence southerly, easterly and northerly along the westerly, southerly and easterly boundaries of Lot A of Lot 16, Registered Plan 13467, to the northeast corner thereof; thence northerly, southeasterly and southerly along the westerly, northeasterly and easterly boundaries of Lot 1 to Lot 16, Registered Plan 2164, to the southeast corner thereof; thence southwesterly in a straight line to the northeast corner of Lot 49 of Lot 81, Registered Plan 1967; thence southerly along the easterly boundary of said Lot 49, Plan 1967, to the southeast corner thereof; thence southerly in a straight line to the most northerly corner of Lot 36 of Lot 81, Plan 1967; thence northeasterly in a straight line to the northwest corner of Lot 35 of Lot 81, Plan 1967; thence easterly along the northerly boundary of said Lot 35, Plan 1967, to the point of intersection with the southerly prolongation of the westerly boundary of Lot 4 of Lot 81, Registered Plan 7071; thence northerly along said prolongation and continuing northerly along the westerly boundary of said Lot 4, Plan 7071, to the northeast corner thereof; thence northerly in a straight line to the most southerly corner of Lot 2 of Lot 81, Registered Plan 8426; thence north-

westerly along the southwesterly boundaries of Lots 2 and 1 of Lot 81, Plan 8426, to the southwest corner of said Lot 1, Plan 8426; thence northwesterly in a straight line to the most southerly corner of Lot 52 of Lot 81, Plan 1967; thence northwesterly and northerly along the southwesterly and westerly boundaries of said Lot 52, Plan 1967, to the aforesaid northeast corner of Lot 16, being the point of commencement:

And that the Letters Patent of the Qualicum Bay-Horne Lake Waterworks District be deemed to be amended so as to conform to the premises as and from the date of these supplementary Letters Patent.

In testimony whereof, We have caused these Our Letters to be made Patent and the Great Seal of Our said Province to be hereunto affixed.

Witness, the Honourable Henry P. Bell-Irving, Lieutenant Governor of Our said Province of British Columbia, in Our City of Victoria, in Our said Province, this twelfth day of March in the year of our Lord one thousand nine hundred and eighty-one, and in the thirtieth year of Our Reign.

By Command.

[L.S.] EVAN WOLFE
Provincial Secretary and Minister
of Government Services

Reprinted from *The British Columbia Gazette*, May 7, 1981.

Qualicum Bay-Horne Lake Waterworks District

LETTERS PATENT

[L.S.] R. G. Rogers, *Lieutenant Governor*. Canada: Province of British Columbia. Elizabeth the Second, by the Grace of God, of the United Kingdom, Canada and Her Other Realms and Territories, Queen, Head of the Commonwealth, Defender of the Faith. To all to whom these presents shall come—Greeting. W. S. Ritchie, *Minister of Municipal Affairs*.

Whereas the **Qualicum Bay-Horne Lake Waterworks District** is an improvement district incorporated by Letters Patent issued on May 7, 1968:

And whereas it is provided in section 825 of the *Municipal Act* that the Lieutenant Governor in Council may at any time amend the Letters Patent of any improvement district in any respect:

And whereas the Board of Trustees of the Qualicum Bay-Horne Lake Waterworks District has requested that the boundaries of the district be amended to exclude all and singular those parcels or tracts of land situate, lying and being as follows: Commencing at the most northerly corner of Lot A of Lots 22 and 85, Newcastle District, Registered Plan 26426 on file in the Land Title Office, Victoria, being a point on the natural high-water mark of Vancouver Island, on the northeasterly shore thereof; thence southwesterly along the northwesterly boundary of said Lot A, Plan 26426, to the most westerly corner thereof; thence southwesterly in a straight line to the most easterly corner of Lot 21 of Lot 22, Registered Plan 23173; thence southwesterly along the southeasterly boundary of said Lot 21, Plan 23173 and continuing southwesterly along the southwesterly prolongation thereof to the point of intersection with the northeasterly boundary of Lot 5 of Lot 22, Registered Plan 12132; thence northwesterly, southwesterly and westerly along the northeasterly, northwesterly and northerly boundaries of said Lot 5, Plan 12132, to the northwest corner thereof; thence west to the point of intersection with the easterly boundary of Lot 57 of Lot 85, Registered Plan 2018; thence southerly along the easterly boundary of said Lot 57, Plan 2018, to the point of intersection with the westerly prolongation of the southerly boundary of Lot 1 of Lot 22, Registered Plan 17597; thence easterly along said prolongation and continuing easterly along the southerly boundary of said Lot 1, Plan 17597, to the most easterly southeast corner thereof; thence east to the point of intersection with the northeasterly limit of Highway 19, Island Highway, as constructed on the ground; thence in a general northwesterly direction along said northeasterly limit to

the southwest corner of the remainder of Lot 1 of Lot 22, Registered Plan 12132; thence easterly along the southerly boundary of the said remainder of Lot 1, Plan 12132, to the southeast corner thereof, being a point on the natural high-water mark of Vancouver Island, on the northeasterly shore thereof; thence in a general northwesterly direction along said natural high-water mark to the aforesaid most northerly corner of Lot A of Lots 22 and 85, Registered Plan 26426, being the point of commencement:

Now know ye that by these presents We do order and proclaim that the boundaries of the Qualicum Bay-Horne Lake Waterworks District be amended as hereinbefore described and that on, from and after the date of these supplementary Letters Patent the boundaries of the Qualicum Bay-Horne Lake Waterworks District be defined as follows: Commencing at the northeast corner of Lot 16, Newcastle District, being a point on the natural high-water mark on Vancouver Island, on the northeasterly shore thereof; thence in a general northwesterly direction along said natural high-water mark to the southeast corner of the remainder of Lot 1 of Lot 22, Registered Plan 12132 on file in the Land Title Office, Victoria; thence westerly along the southerly boundary of said remainder of Lot 1, Plan 12132, to the southwest corner thereof, being a point on the northeasterly limit of Highway 19, Island Highway, as constructed on the ground; thence in a general southeasterly direction along said northeasterly limit to a point which lies due east of the most easterly southeast corner of Lot 1 of Lot 22, Registered Plan 17597; thence west to said most easterly southeast corner; thence westerly along the southerly boundary of Lot 1 of Lot 22, Plan 17597 and continuing westerly along the westerly prolongation thereof to the point of intersection with the easterly boundary of Lot 57 of Lot 85, Registered Plan 2018; thence southerly along the easterly boundary of said Lot 57, Plan 2018, to the point of intersection with the northeasterly limit of the Esquimalt & Nanaimo Railway Company's right of way, as constructed on the ground; thence southeasterly along said northeasterly limit to the point of intersection with the westerly boundary of Lot 22; thence southerly and easterly along the westerly and southerly boundaries of Lot 22 to the northwest corner of Lot 21; thence southerly and easterly along the westerly and southerly boundaries of Lot 21 to the northwest corner of Lot 33; thence southerly along the westerly boundary of said Lot 33 to the point of intersection with the aforesaid northeasterly limit of Esquimalt & Nanaimo

Railway Company's right of way; thence southeasterly along said northeasterly limit to the point of intersection with the southerly boundary of Lot 33; thence easterly along the southerly boundary of said Lot 33 to the northwest corner of Lot 1 of Lot 32, Registered Plan 30108; thence southerly and easterly along the westerly and southerly boundaries of said Lot 1, Plan 30108, to the southeast corner thereof; thence southerly and easterly along the westerly and southerly boundaries of Lot 20 to the southeast corner thereof; thence southerly and easterly along the westerly and southerly boundaries of Qualicum Indian Reserve to the northwest corner of Lot 19; thence southerly along the westerly boundary of said Lot 19 to the southwest corner thereof; thence westerly along the northerly boundaries of Lots 90 and 31 to the point of intersection with the southwesterly limit of the Esquimalt & Nanaimo Railway Company's right of way, as constructed on the ground; thence southeasterly along said southwesterly limit of the Esquimalt & Nanaimo Railway Company's right of way to the point of intersection with the westerly boundary of Lot 90; thence southerly along the westerly boundary of Lot 90 to the southeast corner of Lot 7 of Lot 31, Registered Plan 21871; thence westerly along the southerly boundary of said Lot 7, Plan 21871, to the southwest corner thereof; thence westerly in a straight line to the most easterly corner of Lot 8 of Lot 31, Plan 21871; thence southwesterly and northwesterly along the southwesterly and southwesterly boundaries of said Lot 8, Plan 21871, to the most westerly corner thereof; thence southwesterly and northwesterly along the southeasterly and southwesterly boundaries of Lot 9 of Lot 31, Plan 21871, to the most westerly corner thereof; thence northerly and easterly along the westerly and northerly boundaries of Lot 10 of Lot 31, Plan 21871, to the southwest corner of Lot 11 of Lot 31, Plan 21871; thence northerly along the westerly boundaries of Lots 11, 12, 13 and 14 of Lot 31, Plan 21871, to the northwest corner of said Lot 14, Plan 21871; thence easterly along the northerly boundary of Lot 14 of Lot 31, Plan 21871, to the northeast corner thereof; thence N.12°46'12"W. for a distance of 10.373 metres; thence N.88°07'26"W. for a distance of 244.241 metres; thence S.41°44'E. for a distance of 310.169 metres; thence southeasterly on a radius of 634.786 metres for a distance of 105.722 metres; thence easterly in a straight line to the southwest corner of Lot 4 of Lot 90, Registered Plan 1874; thence easterly along the southerly boundary of said Lot 4, Plan

1874, to the most easterly southeast corner thereof; thence northerly along the easterly boundary of Lot 4 of Lot 90, Plan 1874, to the northeast corner thereof; thence easterly and northerly along the southerly and westerly boundaries of Lot 19 to the point of intersection with the southwesterly limit of Island Highway as shown on Registered Plan 13312; thence southeasterly along said southwesterly limit to the most northerly corner of Amended Lot 1 of Lot 16, Plan 13312; thence southerly along the westerly boundary of said Amended Lot 1, Plan 13312, to the southwest corner thereof; thence southeasterly along the southwesterly boundaries of Amended Lots 1 and 2 and Lots 4 to 18, inclusive, of Lot 16, Plan 13312, to the southeast corner of said Lot 18, Plan 13312; thence northeasterly along the southeasterly boundary of Lot 18 of Lot 16, Plan 13312, to the most easterly corner thereof; thence southeasterly along the southwesterly limit of Island Highway as shown on Plan 13312 to the most northerly corner of Lot 19 of Lot 16, Plan 13312; thence southwesterly along the northwesterly boundary of said Lot 19, Plan 13312, to the most westerly corner thereof; thence southerly along the westerly boundaries of Lots 19 to 25, inclusive, of Lot 16, Plan 13312, to the southwest corner of said Lot 25, Plan 13312; thence easterly along the southerly boundary of Lot 25 of Lot 16,

Plan 13312, to the southeast corner thereof; thence southerly in a straight line to the northeast corner of Lot 1 of Lot 16, Registered Plan 23494; thence westerly and southerly along the northerly and westerly boundaries of said Lot 1, Plan 23494, to the southwest corner thereof; thence southerly, easterly and northerly along the westerly, southerly and easterly boundaries of Lot A of Lot 16, Registered Plan 13467, to the northeast corner thereof; thence northerly, southeasterly and southerly along the westerly, northeasterly and easterly boundaries of Lot 1 of Lot 16, Registered Plan 2164, to the southeast corner thereof; thence southwesterly in a straight line to the northeast corner of Lot 49 of Lot 81, Registered Plan 1967; thence southerly along the easterly boundary of said Lot 49, Plan 1967, to the southeast corner thereof; thence southerly in a straight line to the most northerly corner of Lot 36 of Lot 81, Plan 1967; thence northeasterly in a straight line to the northwest corner of Lot 35 of Lot 81, Plan 1967; thence easterly along the northerly boundary of said Lot 35, Plan 1967, to the point of intersection with the southerly prolongation of the westerly boundary of Lot 4 of Lot 81, Registered Plan 7071; thence northerly along said prolongation and continuing northerly along the westerly boundary of said Lot 4, Plan 7071, to the northeast corner thereof; thence northerly in a straight

line to the most southerly corner of Lot 2 of Lot 81, Registered Plan 8426; thence northwesterly along the southwesterly boundaries of Lots 2 and 1 of Lot 81, Plan 8426, to the southwest corner of said Lot 1, Plan 8426; thence northwesterly in a straight line to the most southerly corner of Lot 52 of Lot 81, Plan 1967; thence northwesterly and northerly along the southwesterly and westerly boundaries of said Lot 52, Plan 1967, to the aforesaid northeast corner of Lot 16, being the point of commencement:

And that the Letters Patent of the Qualicum Bay-Horne Lake Waterworks District be amended so as to conform to the premises as and from the date of these supplementary Letters Patent.

In testimony whereof, We have caused these Our Letters to be made Patent and the Great Seal of Our said Province to be hereunto affixed.

Witness, the Honourable Robert G. Rogers, Lieutenant Governor of Our said Province of British Columbia, in Our City of Victoria, in Our said Province, this ninth day of December in the year of our Lord one thousand nine hundred and eighty-three, and in the thirty-second year of Our Reign.

By Command.

[L.S.] J. R. Chabot, *Provincial Secretary and Minister of Government Services.*

Reprinted from *The British Columbia Gazette*, January 19, 1984.

Qualicum Bay-Horne Lake Waterworks District

LETTERS PATENT

[L. S.] David C. Lam, *Lieutenant Governor*. Canada: Province of British Columbia. Elizabeth the Second, by the Grace of God, of the United Kingdom, Canada, and Her Other Realms and Territories, Queen, Head of the Commonwealth, Defender of the Faith. To all to whom these presents shall come — Greeting. Lyall Hanson, *Minister of Municipal Affairs, Recreation and Culture*.

Whereas the Qualicum Bay-Horne Lake Waterworks District is an improvement district incorporated by Letters Patent issued on the 7th day of May, 1968:

And whereas it is provided in section 825 of the *Municipal Act* that the Lieutenant Governor in Council may at any time amend the Letters Patent of any improvement district in any respect:

And whereas the Board of Trustees of the **Qualicum Bay-Horne Lake Waterworks District** has requested that the boundary of the district be amended to include all and singular those parcels or tracts of land situate, lying and being as follows:

Commencing at the southeast corner of Lot 1 of Lot 32, Newcastle District, Registered Plan 30108, on file in the Land Title Office, Victoria; thence westerly and northerly along the southerly and westerly boundaries of said Lot 1, Plan 30108 to the northwest corner thereof; thence northerly along the northerly prolongation of the westerly boundary of Lot 1 of Lot 32, Plan 30108 to the point of intersection with the southerly boundary of Lot 33; thence westerly along the southerly boundary of said Lot 33, to the point of intersection with the northeasterly limit of Esquimalt & Nanaimo Railway Company's right of way as shown on Registered Plan 45846; thence southeasterly along said Esquimalt & Nanaimo Railway Company's right of way to the most westerly corner of Lot A of Lot 32, Plan 45846; thence southeasterly along the southwesterly boundaries of said Lot A, Plan 45846 and Lot 1 of Lot 32, Registered Plan 47847 to the most southerly corner of said Lot 1, Plan 47847; thence southeasterly along the northeasterly limit of Esquimalt & Nanaimo Railway Company's right of way as shown on Plan 47847 to the point of intersection with the easterly boundary of Lot 32; thence northerly along the easterly boundary of said Lot 32 to the point of intersection with the easterly prolongation of the southerly boundary of Lot 1 of Lot 32, Plan 30108; thence westerly along said prolongation to the aforesaid southeast corner of Lot 1 of Lot 32, Plan 30108, being the point of commencement.

Now know ye that by these presents We do order and proclaim that the boundary of

the Qualicum Bay-Horne Lake Waterworks District be amended as hereinbefore described and that on, from and after the date of these Supplementary Letters Patent the boundary of the **Qualicum Bay-Horne Lake Waterworks District** be defined as follows:

Commencing at the northeast corner of Lot 16, Newcastle District, being a point on the natural high-water mark on Vancouver Island, on the northeasterly shore thereof; thence in a general northwesterly direction along said natural high-water mark to the southeast corner of the Remainder of Lot 1 of Lot 22, Registered Plan 12132, on file in the Land Title Office, Victoria; thence westerly along the southerly boundary of said Remainder of Lot 1, Plan 12132 to the southwest corner thereof, being a point on the northeasterly limit of Highway 19, Island Highway, as constructed on the ground; thence in a general southeasterly direction along said northeasterly limit of Highway 19, to a point which lies due east of the most easterly southeast corner of Lot 1 of Lot 22, Registered Plan 17597; thence west to said most easterly southeast corner; thence westerly along the southerly boundary of Lot 1 of Lot 22, Plan 17597 and continuing westerly along the westerly prolongation thereof to the point of intersection with the easterly boundary of Lot 57 of Lot 85, Registered Plan 2018; thence southerly along the easterly boundary of said Lot 57, Plan 2018, to the point of intersection with the northeasterly limit of the Esquimalt & Nanaimo Railway Company's right of way, as constructed on the ground; thence southeasterly along said northeasterly limit to the point of intersection with the westerly boundary of Lot 22; thence southerly and easterly along the westerly and southerly boundaries of Lot 22 to the northwest corner of Lot 21; thence southerly and easterly along the westerly and southerly boundaries of Lot 21 to the northwest corner of Lot 33; thence southerly along the westerly boundary of said Lot 33 to the point of intersection with the aforesaid northeasterly limit of Esquimalt & Nanaimo Railway Company's right of way; thence southeasterly along said northeasterly limit to the most westerly corner of Lot A of Lot 32, Plan 45846; thence southeasterly along the southwesterly boundaries of said Lot A, Plan 45846 and Lot 1 of Lot 32, Registered Plan 47847, to the most southerly corner of said Lot 1, Plan 47847; thence southeasterly along the northeasterly limit of Esquimalt & Nanaimo Railway Company's right of way as shown on Plan 47847 to the point of intersection with the westerly boundary of Lot 20; thence southerly and easterly along the westerly and southerly boundaries of Lot 20

to the southeast corner thereof; thence southerly and easterly along the westerly and southerly boundaries of Qualicum Indian Reserve to the northwest corner of Lot 19; thence southerly along the westerly boundary of said Lot 19 to the southwest corner thereof; thence westerly along the northerly boundaries of Lots 90 and 31 to the point of intersection with the northeasterly limit of the Esquimalt & Nanaimo Railway Company's right of way, as constructed on the ground; thence southeasterly along said northeasterly limit of the Esquimalt & Nanaimo Railway Company's right of way to the point of intersection with the westerly boundary of Lot 90; thence southerly along the westerly boundary of said Lot 90 to the southeast corner of Lot 7 of Lot 31, Registered Plan 21871; thence westerly along the southerly boundary of said Lot 7, Plan 21871, to the southwest corner thereof; thence westerly in a straight line to the most easterly corner of Lot 8 of Lot 31, Plan 21871; thence southwesterly and northwesterly along the southeasterly and southwesterly boundaries of said Lot 8, Plan 21871, to the most westerly corner thereof; thence southwesterly and northwesterly along the southeasterly and southwesterly boundaries of Lot 9 of Lot 31, Plan 21871, to the most westerly corner thereof; thence northerly and easterly along the westerly and northerly boundaries of Lot 10 of Lot 31, Plan 21871, to the southwest corner of Lot 11 of Lot 31, Plan 21871; thence northerly along the westerly boundaries of Lots 11, 12, 13 and 14 of Lot 31, Plan 21871, to the northwest corner of said Lot 14, Plan 21871; thence easterly along the northerly boundary of Lot 14 of Lot 31, Plan 21871, to the northeast corner thereof; thence N.12°46'12"W. for a distance of 10.373 metres; thence N.88°07'26"W. for a distance of 244.241 metres; thence S.41°44'E. for a distance of 310.169 metres; thence southeasterly on a radius of 634.786 metres for a distance of 105.722 metres; thence easterly in a straight line to the southwest corner of Lot 4 of Lot 90, Registered Plan 1874; thence easterly along the southerly boundary of said Lot 4, Plan 1874, to the most easterly southeast corner thereof; thence northerly along the easterly boundary of Lot 4 of Lot 90, Plan 1874, to the northeast corner thereof; thence easterly and northerly along the southerly and westerly boundaries of Lot 19 to the point of intersection with the southwesterly limit of Island Highway as shown on Registered Plan 13312; thence southeasterly along said southwesterly limit to the most northerly corner of Amended Lot 1 of Lot 16, Plan 13312; thence southerly along the westerly boundary of said Amended Lot 1, Plan

13312, to the southwest corner thereof; thence southeasterly along the southwesterly boundaries of Amended Lots 1 and 2 and Lots 4 to 18, inclusive, of Lot 16, Plan 13312, to the southeast corner of said Lot 18, Plan 13312; thence northeasterly along the southeasterly boundary of Lot 18 of Lot 16, Plan 13312, to the most easterly corner thereof; thence southeasterly along the southwesterly limit of Highway 19, Island Highway as shown on Plan 13312 to the most northerly corner of Lot 19 of Lot 16, Plan 13312; thence southwesterly along the northwesterly boundary of said Lot 19, Plan 13312, to the most westerly corner thereof; thence southerly along the westerly boundaries of Lots 19 to 25, inclusive, of Lot 16, Plan 13312, to the southwest corner of said Lot 25, Plan 13312; thence easterly along the southerly boundary of Lot 25 of Lot 16, Plan 13312, to the southeast corner thereof; thence southerly in a straight line to the northeast corner of Lot 1 of Lot 16, Registered Plan 23494; thence westerly and southerly along the northerly and westerly boundaries of said Lot 1, Plan 23494, to the southwest corner thereof; thence southerly, easterly and northerly along the westerly, southerly and easterly boundaries of Lot A

of Lot 16, Registered Plan 13467, to the northeast corner thereof; thence northerly, southeasterly and southerly along the westerly, northeasterly and easterly boundaries of Lot 1 of Lot 16, Registered Plan 2164, to the southeast corner thereof; thence southwesterly in a straight line to the northeast corner of Lot 49 of Lot 81, Registered Plan 1967; thence southerly along the easterly boundary of said Lot 49, Plan 1967, to the southeast corner thereof; thence southerly in a straight line to the most northerly corner of Lot 36 of Lot 81, Plan 1967; thence northeasterly in a straight line to the northwest corner of Lot 35 of Lot 81, Plan 1967; thence easterly along the northerly boundary of said Lot 35, Plan 1967, to the point of intersection with the southerly prolongation of the westerly boundary of Lot 4 of Lot 81, Registered Plan 7071; thence northerly along said prolongation and continuing northerly along the westerly boundary of said Lot 4, Plan 7071, to the northwest corner thereof; thence northerly in a straight line to the most southerly corner of Lot 2 of Lot 81, Registered Plan 8426; thence northwesterly along the southwesterly boundaries of Lots 2 and 1 of Lot 81, Plan 8426, to the southwest corner of said Lot 1, Plan 8426;

thence northwesterly in a straight line to the most southerly corner of Lot 52 of Lot 81, Plan 1967; thence northwesterly and northerly along the southwesterly and westerly boundaries of said Lot 52, Plan 1967, to the aforesaid northeast corner of Lot 16, being the point of commencement.

And that the Letters Patent of the Qualicum Bay-Horne Lake Waterworks District be deemed to be amended so as to conform to the premises as and from the date of these Supplementary Letters Patent.

In testimony whereof, We have caused these Our Letters to be made Patent and the Great Seal of Our said Province to be hereunto affixed.

Witness, the Honourable David C. Lam, Lieutenant Governor of Our said Province of British Columbia, in Our City of Victoria, in Our said Province, this nineteenth day of April, in the year of Our Lord one thousand nine hundred and ninety and in the thirtieth year of Our Reign.

By Command,

[L.S.] Howard Dirks, *Provincial Secretary*.

Reprinted from *The British Columbia Gazette*, June 14, 1990.

Qualicum Bay-Horne Lake Waterworks District

LETTERS PATENT

[L.S.] Allan McEachern, *Administrator*. Canada: Province of British Columbia. Elizabeth the Second, by the Grace of God, of the United Kingdom, Canada, and Her Other Realms and Territories, Queen, Head of the Commonwealth, Defender of the Faith. To all to whom these presents shall come — Greeting. Robin Blencoe, *Minister of Municipal Affairs, Recreation and Housing*.

Whereas the Qualicum Bay-Horne Lake Waterworks District is an improvement district incorporated by Letters Patent issued on the 7th day of May, 1968:

And whereas it is provided in section 825 of the *Municipal Act* that the Lieutenant Governor in Council may at any time amend the Letters Patent of any improvement district in any respect:

And whereas the Board of Trustees of the Qualicum Bay-Horne Lake Waterworks District has requested that the boundary of the district be amended to include all and singular those parcels or tracts of land situate, lying and being as follows:

Commencing at the southeast corner of Lot 1 of Lot 16, Newcastle Land District, Registered Plan 2164, on file in the Land Title Office, Victoria; thence southwesterly in a straight line to the northeast corner of Lot 49 of Lot 81, Registered Plan 1967; thence westerly along the northerly boundaries of Lots 49 and 47 of Lot 81, Plan 1967 to the northwest corner of said Lot 48, Plan 1967; thence westerly in a straight line to the northeast corner of Lot 47 of Lot 81, Plan 1967; thence westerly along the northerly boundary of said Lot 47, Plan 1967 to the northwest corner thereof; thence westerly in a straight line to the northeast corner of Lot 46 of Lot 81, Plan 1967; thence westerly along the northerly boundary of said Lot 46, Plan 1967 to the northwest corner thereof; thence northerly along the westerly boundaries of Lots 81 and 16 to the point of intersection with the southwesterly limit of Highway Number 19, Island Highway, as shown on Registered Plan 13312; thence southeasterly along said southwesterly limit of Highway Number 19 to the most northerly corner of Amended Lot 1 of Lot 16, Plan 13312; thence southerly along the westerly boundary of said Amended Lot 1, Plan 13312, to the southwest corner thereof; thence southeasterly along the southwesterly boundaries of Amended Lots 1 and 3 and Lots 4 to 18, inclusive, of Lot 16, Plan 13312, to the southeast corner of said Lot 18, Plan

13312; thence northeasterly along the southeasterly boundary of Lot 18 of Lot 16, Plan 13312, to the most easterly corner thereof; thence southeasterly along the southwesterly limit of Highway Number 19, Island Highway as shown on Plan 13312 to the most northerly corner of Lot 19 of Lot 16, Plan 13312; thence southwesterly along the northwesterly boundary of said Lot 19, Plan 13312, to the most westerly corner thereof; thence southerly along the westerly boundaries of Lots 19 to 25, inclusive, of Lot 16, Plan 13312, to the southwest corner of said Lot 25, Plan 13312; thence easterly along the southerly boundary of Lot 25 of Lot 16, Plan 13312, to the southeast corner thereof; thence southerly in a straight line to the northeast corner of Lot 1 of Lot 16, Registered Plan 23494; thence westerly and southerly along the northerly and westerly boundaries of said Lot 1, Plan 23494 to the southwest corner thereof; thence southerly, easterly and northerly along the westerly, southerly and easterly boundaries of Lot A of Lot 16, Registered Plan 13467 to the northeast corner thereof; thence northerly, southeasterly and southerly along the westerly, northeasterly and easterly boundaries of Lot 1 of Lot 16, Plan 2164, to the aforesaid southeast corner thereof, being the point of commencement.

Now know ye that by these presents We do order and proclaim that the boundary of the **Qualicum Bay-Horne Lake Waterworks District** be amended as hereinbefore described and that on, from and after the date of these Supplementary Letters Patent the boundary of the Qualicum Bay-Horne Lake Waterworks District be defined as follows:

Commencing at the northeast corner of Lot 16, Newcastle Land District, being a point on the natural high-water mark of the Strait of Georgia, on the southwesterly shore thereof; thence in a general northwesterly direction along said natural high-water mark to the southeast corner of the Remainder of Lot 1 of Lot 22, Registered Plan 12132, on file in the Land Title Office, Victoria; thence westerly along the southerly boundary of said Remainder of Lot 1, Plan 12132 to the southwest corner thereof, being a point on the northeasterly limit of Highway Number 19, Island Highway, as constructed on the ground; thence in a general southeasterly direction along said northeasterly limit of Highway Number 19, to a point which lies due east of the most

easterly southeast corner of Lot 1 of Lot 22, Registered Plan 17597; thence west to said most easterly southeast corner of Lot 1 of Lot 22, Plan 17597; thence westerly along the southerly boundary of said Lot 1, Plan 17597 and continuing westerly along the westerly prolongation thereof to the point of intersection with the easterly boundary of Lot 57 of Lot 85, Registered Plan 2018; thence southerly along the easterly boundary of said Lot 57, Plan 2018, to the point of intersection with the northeasterly limit of the Esquimalt and Nanaimo Railway Company's right of way, as constructed on the ground; thence southeasterly along said northeasterly limit of the Esquimalt and Nanaimo Railway Company's right of way to the point of intersection with the westerly boundary of Lot 22; thence southerly and easterly along the westerly and southerly boundaries of Lot 22 to the northwest corner of Lot 21; thence southerly and easterly along the westerly and southerly boundaries of Lot 21 to the northwest corner of Lot 33; thence southerly along the westerly boundary of said Lot 33 to the point of intersection with the aforesaid northeasterly limit of the Esquimalt and Nanaimo Railway Company's right of way as constructed on the ground; thence southeasterly along said northeasterly limit of the Esquimalt and Nanaimo Railway Company's right of way to the most westerly corner of Lot A of Lot 32, Registered Plan 45846; thence southeasterly along the southwesterly boundaries of said Lot A, Plan 45846 and Lot 1 of Lot 32, Registered Plan 47847, to the most southerly corner of said Lot 1, Plan 47847; thence southeasterly along the northeasterly limit of Esquimalt and Nanaimo Railway Company's right of way as shown on Plan 47847 to the point of intersection with the westerly boundary of Lot 20; thence southerly and easterly along the westerly and southerly boundaries of Lot 20 to the southeast corner thereof; thence southerly and easterly along the westerly and southerly boundaries of Qualicum Indian Reserve to the northwest corner of Lot 19; thence southerly along the westerly boundary of said Lot 19 to the southwest corner thereof; thence westerly along the northerly boundaries of Lots 90 and 31 to the point of intersection with the northeasterly limit of the Esquimalt and Nanaimo Railway Company's right of way, as constructed on the ground; thence southeasterly along said northeasterly limit of the Esquimalt and Nanaimo Railway Company's right of way

to the point of intersection with the westerly boundary of Lot 90; thence southerly along the westerly boundary of said Lot 90 to the southeast corner of Lot 7 of Lot 31, Registered Plan 21871; thence westerly along the southerly boundary of said Lot 7, Plan 21871, to the southwest corner thereof; thence westerly in a straight line to the most easterly corner of Lot 8 of Lot 31, Plan 21871; thence southwesterly and northwesterly along the southeasterly and southwesterly boundaries of said Lot 8, Plan 21871, to the most westerly corner thereof; thence southwesterly and northwesterly along the southeasterly and southwesterly boundaries of Lot 9 of Lot 31, Plan 21871, to the most westerly corner thereof; thence northerly and easterly along the westerly and northerly boundaries of Lot 10 of Lot 31, Plan 21871, to the southwest corner of Lot 11 of Lot 31, Plan 21871; thence northerly along the westerly boundaries of Lots 11, 12, 13 and 14 of Lot 31, Plan 21871, to the northwest corner of said Lot 14, Plan 21871; thence easterly along the northerly boundary of Lot 14 of Lot 31, Plan 21871, to the northeast corner thereof; thence North 12°46'12" West for a distance of 10.373 metres; thence North 88°07'26" West for a distance of 244.241 metres; thence South 41°44' East for a distance of 310.169 metres; thence southeasterly on a radius of 634.786 metres for a distance of 105.722 metres; thence easterly in a straight line to the southwest corner of Lot 4 of Lot 90, Registered Plan 1874;

thence easterly along the southerly boundary of said Lot 4, Plan 1874, to the most easterly southeast corner thereof; thence northerly along the easterly boundary of Lot 4 of Lot 90, Plan 1874 to the northeast corner thereof; thence easterly along the southerly boundary of Lot 19 to the southeast corner thereof; thence southerly along the westerly boundaries of Lots 16 and 81 to the northwest corner of Lot 46 of Lot 81, Registered Plan 1967; thence easterly along the northerly boundary of said Lot 46, Plan 1967 to the northeast corner thereof; thence easterly in a straight line to the northwest corner of Lot 47 of Lot 81, Plan 1967; thence easterly along the northerly boundary of said Lot 47, Plan 1967 to the northeast corner thereof; thence easterly in a straight line to the northwest corner of Lot 48 of Lot 81, Plan 1967; thence easterly along the northerly boundaries of Lots 48 and 49 of Lot 81, Plan 1967 to the northeast corner of said Lot 49, Plan 1967; thence southerly along the easterly boundary of Lot 49 of Lot 81, Plan 1967, to the southeast corner thereof; thence southerly in a straight line to the most northerly corner of Lot 36 of Lot 81, Plan 1967; thence northeasterly in a straight line to the northwest corner of Lot 35 of Lot 81, Plan 1967; thence easterly along the northerly boundary of said Lot 35, Plan 1967 to the point of intersection with the southerly prolongation of the westerly boundary of Lot 4 of Lot 81, Registered Plan 7071; thence northerly along said prolongation and continuing

northerly along the westerly boundary of Lot 4 of Lot 81, Plan 7071 to the northwest corner thereof; thence northerly in a straight line to the most southerly corner of Lot 2 of Lot 81, Registered Plan 8426; thence northwesterly along the southwesterly boundaries of Lots 2 and 1 of Lot 81, Plan 8426, to the southwest corner of said Lot 1, Plan 8426; thence northwesterly in a straight line to the most southerly corner of Lot 52 of Lot 81, Plan 1967; thence northwesterly and northerly along the southwesterly and westerly boundaries of said Lot 52, Plan 1967, to the aforesaid northeast corner of Lot 16, being the point of commencement.

And that the Letters Patent of the Qualicum Bay-Horne Lake Waterworks District be deemed to be amended so as to conform to the premises as and from the date of these Supplementary Letters Patent.

In testimony whereof, We have caused these Our Letters to be made Patent and the Great Seal of Our said Province to be hereunto affixed.

Witness, the Honourable Allan McEachern, Administrator of Our said Province of British Columbia, in Our City of Victoria, in Our said Province, this 23rd day of July, in the year of Our Lord one thousand nine hundred and ninety-three and in the forty-second year of Our Reign.

By Command.

[L.S.] Colin Gabelmann, *Attorney General*.

Reprinted from *The British Columbia Gazette*, October 28, 1993.

Qualicum Bay - Horne Lake Waterworks District
Bylaw No. 64

A bylaw to fix a charge for Capital Expenditures on:

New parcels of land within the District created by a sub-division from this day forward.

Each and every separate unit of Domestic, Commercial or Public accommodation which forms part of an Apartment Building, or a Condominium Building, or a Shopping Centre and Office Building complex or any other type of building constructed so as to provide separate units of accommodation for Domestic, Commercial or Public use.

Each and every space built or provided for the accommodation of Mobile Homes, Camper Trucks, Trailers, and/or any type of articulated vehicle in Mobile Home Parks, or in Trailer Courts or in any other type of construction or provision.

Whereas:

It is considered that due to the future and continuing development of land within the District, it will be necessary at a future date for the District to enlarge mains, renew pipelines, close loops, increase the capacity of storage tanks and install additional pumps, or to otherwise augment the system to ensure an adequate supply of potable water within the District; and

Whereas:

It is considered that the cost of the said enlarging of mains renewing of pipelines, closing of loops, increasing storage capacity, installing additional pumps, or otherwise augmenting the system, shall be borne by persons developing land and/or property within the District.

THE TRUSTEES of the QUALICUM BAY - HORNE LAKE WATERWORKS DISTRICT ENACT as follows:

In addition to the provisions of Bylaw No. 2, "Subdivision Water Regulations By-law 1968" or any amendments thereto, every subdivider shall pay a capital charge of Two Thousand Two Hundred and Fifty Dollars (\$2250.00) per lot resulting from his subdivision prior to it being approved by the Trustees of the District except that one Lot in each parcel of land being subdivided and on which the District has levied Waterworks Taxes will be exempt from the said charge.

That a charge for capital expenditure of One Thousand Two Hundred Dollars (\$1200.00) per each unit of accommodation built singly or involving Apartment, Condominiums, Motels or any other multiple unit construction is hereby fixed and made payable to the District by each and every owner of an Apartment, Condominium, Motel or any other multiple unit construction.

(a) The said charge for capital expenditures be payable to the District in the

prescribed form to have each single unit or Apartment Condominium, Motel or any other multiple unit construction supplied with water from the Waterworks of the District; and it is provided that such application shall contain a statement of the number of units built or provided for at the time of the application, and it is further provided that a similar Annual statement shall state the total number to date of units of space built or provided for and that the One Thousand Two Hundred Dollars (\$1200.00) charge for capital expenditures shall be payable to the District for every unit of space built or provided for.

That a charge for Capital Expenditure of One Thousand Two Hundred Dollars (\$1200.00) per each Unit Pad space built or provided for in Mobile Home Parks Trailer Courts, it hereby fixed and made payable to the District by each and every owner of a Mobile Home Park, or a Trailer Court or a combination Mobile Home Park and Trailer Court within the District.

- (a) That the said charges for Capital Expenditures be payable to the District at the same time as the Application is made to the District in the prescribed form, to have the Mobile Home Park or Trailer Court or combination Mobile Home Park and Trailer Court supplied with water from the Waterworks of the District, and it is provided that such Application shall contain a statement of the number of unit pad spaces built or provided for at the time of the Application, and it is further provided that a similar Annual statement shall state the total number, to date, of unit pad spaces built or provided for, and that the charge of One Thousand Two Hundred Dollars (\$1200.00) for Capital Expenditure shall be payable to the District for every unit pad space built or provided for.

That water will not be supplied by the District:

- (a) to any subdivisions as in Clause 1.
- (b) to a unit built involving Apartment, Condominiums, Motels or any other multiple Unit construction as in Clause 2.
- (c) to any unit pad space built or provided for in a Mobile Home Park or Trailer Court as in Clause 3 or any combination of the aforementioned until the charge for Capital Expenditure has been paid to the District as provided for in Clause 1, 2, and 3.

All sums of money collected under this Bylaw shall be deposited in a special Trust Account, separate from all other funds of the District, and deposits in such special Trust Account plus all interest or earnings hereon shall be disbursed only by a Resolution of the Trustees of the District which has been given the written approval

APPENDIX B – SUMMARY OF METER RECORDS

Summary of Well Meter Records

Total (Wells #1, #2, #3)

Year	2011	January	February	March	April	May	June	July	August	September	October	November	December
Date													
1	81,000	92,000	194,450	54,500	75,000	105,500	-	190,000	281,300	77,500	62,400	72,700	
2	86,300	57,200	64,600	74,000	80,500	115,300	-	187,850	155,200	78,000	67,000	63,400	
3	56,600	66,900	64,500	74,300	80,300	118,000	-	166,900	139,800	76,800	59,700	69,400	
4	81,100	68,800	70,700	54,300	58,900	119,500	-	182,300	158,700	72,500	59,200	66,000	
5	72,300	56,200	79,000	83,800	82,800	120,000	209,800	196,400	193,400	76,300	65,000	67,000	
6	59,700	70,700	61,700	54,800	63,300	100,516	144,900	195,000	192,600	73,600	64,000	70,000	
7	77,600	68,400	77,500	75,800	75,400	147,500	205,700	194,000	195,900	66,300	67,900	45,600	
8	71,600	57,600	56,000	75,100	67,200	163,300	152,400	196,000	200,100	60,000	60,600	79,600	
9	75,400	79,400	64,580	79,600	87,000	148,200	162,000	184,000	200,900	61,000	62,600	51,800	
10	63,100	59,700	56,000	60,800	172,700	168,100	164,200	182,500	197,000	67,700	65,700	74,000	
11	60,500	43,500	54,800	61,500	-	151,500	163,200	163,900	193,356	58,400	132,000	74,000	
12	61,000	65,600	66,500	74,500	-	196,000	152,700	193,600	167,200	151,600	113,400	96,200	
13	60,600	63,300	49,200	63,200	-	142,000	139,100	180,000	165,700	149,200	67,000	62,300	
14	55,600	72,200	67,800	88,000	-	126,500	101,000	183,500	101,100	67,900	68,100	62,000	
15	61,000	45,400	53,400	76,200	-	114,500	92,900	187,100	115,000	54,800	55,600	71,500	
16	61,400	89,300	63,500	62,300	-	113,500	131,600	172,000	115,100	53,500	91,800	73,800	
17	69,400	45,600	71,400	77,000	-	127,600	98,600	142,230	135,500	56,100	66,700	62,800	
18	63,100	65,600	82,400	78,300	-	148,000	81,900	158,900	135,500	113,900	78,900	62,900	
19	46,000	75,300	57,500	59,000	89,700	86,300	141,500	146,200	98,600	77,500	70,000	65,800	
20	58,300	48,000	53,100	80,900	128,200	143,900	103,100	182,600	80,000	78,300	71,000	60,100	
21	69,000	82,500	85,200	65,700	132,300	133,300	111,800	245,800	96,650	52,200	71,800	56,500	
22	68,000	53,900	75,300	91,400	104,700	188,800	100,100	120,200	96,650	70,700	74,600	73,000	
23	62,700	75,300	55,000	91,400	110,000	134,300	143,200	136,100	83,100	68,000	50,800	71,540	
24	61,900	70,100	78,300	54,200	75,900	119,800	155,133	168,000	76,000	73,700	74,900	60,000	
25	57,800	61,800	52,800	54,200	105,100	125,000	167,967	139,500	77,000	86,000	63,100	59,000	
26	95,800	62,500	80,100	63,400	114,500	128,000	151,200	167,200	71,300	59,000	73,000	58,000	
27	43,900	106,900	128,600	63,400	83,700	125,400	162,400	157,000	73,200	64,000	64,900	58,900	
28	83,400	90,900	63,300	48,100	85,000	111,300	183,100	165,000	75,300	72,300	76,900	76,300	
29	68,000	-	74,900	73,600	84,000	110,739	192,550	271,700	68,100	66,000	48,200	78,100	
30	67,500	-	75,400	70,000	82,600	90,100	190,000	138,000	71,400	63,000	62,500	67,500	
31	65,300	-	97,600	-	111,900	-	-	169,600	-	60,700	-	72,000	
	2,064,900	1,894,600	2,275,130	2,083,300	2,150,700	3,922,455	3,802,050	5,463,080	4,010,656	2,306,500	2,109,300	2,081,740	

Year	2009	January	February	March	April	May	June	July	August	September	October	November	December
Date													
1	128,500	74,400	103,000	6,700	-	173,400	192,400	231,700	152,600	74,100	78,850	87,900	
2	108,000	70,700	72,500	65,400	-	216,400	202,800	238,300	122,700	89,200	42,700	131,100	
3	108,400	60,400	54,900	57,800	-	178,000	192,600	244,900	-	108,600	62,400	128,300	
4	121,600	26,300	68,800	63,800	90,900	173,300	194,900	205,900	149,250	73,200	72,700	135,300	
5	122,500	111,900	61,700	60,200	70,200	199,300	202,300	179,300	107,800	89,987	77,700	87,450	
6	110,600	56,100	57,300	68,100	74,200	176,900	-	192,200	96,200	98,900	63,700	87,450	
7	112,200	65,300	63,300	71,200	72,200	180,900	96,600	186,700	93,700	56,190	-	57,700	
8	112,200	60,900	57,100	67,700	70,800	183,800	80,300	186,000	102,000	75,000	140,700	87,500	
9	113,700	68,500	60,300	66,300	74,400	182,600	91,800	146,500	91,100	89,800	66,200	95,700	
10	105,700	62,700	62,500	64,900	89,100	201,800	91,400	164,900	92,600	72,100	81,700	83,700	
11	108,500	62,500	58,400	73,700	81,800	177,100	124,900	116,500	90,700	80,000	88,800	99,100	
12	113,400	64,700	77,600	69,200	71,500	184,700	143,100	117,200	77,800	80,000	51,300	-	
13	101,600	62,300	81,200	69,400	72,100	189,200	164,400	126,600	103,000	80,000	66,700	220,600	
14	86,400	55,200	81,000	74,300	74,700	187,900	126,100	105,200	88,200	106,600	85,600	66,000	
15	78,100	61,000	83,500	72,800	72,300	228,800	172,400	107,000	71,600	67,100	85,600	76,200	
16	68,000	87,800	93,000	71,000	81,400	168,800	145,400	130,400	110,990	66,000	65,900	80,900	
17	67,400	85,800	94,300	67,700	-	106,300	174,900	145,200	76,600	69,900	71,000	77,250	
18	87,300	86,300	69,700	74,500	-	125,300	182,400	149,200	90,800	69,900	72,500	80,950	
19	84,600	71,200	57,700	72,800	95,400	147,600	189,700	166,300	108,700	62,600	71,300	84,400	
20	76,200	63,800	69,100	83,000	88,100	150,200	185,500	139,100	58,000	74,200	68,700	71,050	
21	79,600	64,800	62,100	78,200	85,700	148,800	179,900	110,000	98,000	72,800	83,850	71,050	
22	69,300	65,700	64,500	78,200	103,600	164,000	207,000	173,100	88,300	60,800	83,850	78,800	
23	83,300	70,600	74,300	74,200	101,200	184,600	178,900	170,100	67,400	65,900	66,000	68,500	
24	67,100	65,300	69,400	82,700	147,700	154,900	196,000	162,500	102,100	71,400	76,500	74,700	
25	67,400	67,900	65,400	76,500	139,200	96,700	231,500	132,700	215,700	71,400	75,300	74,100	
26	87,800	43,100	61,500	81,800	101,700	105,000	175,800	113,400	89,259	68,500	82,200	74,100	
27	9,500	-	61,300	97,300	105,600	132,700	220,000	131,900	95,600	65,500	99,200	68,267	
28	110,000	118,600	65,700	92,800	134,900	113,900	227,800	135,800	79,400	61,700	76,650	68,267	
29	100,200	-	62,900	83,800	105,500	123,400	227,800	137,400	101,000	62,700	76,650	68,267	
30	90,500	-	71,100	106,000	152,400	173,500	227,800	169,100	74,700	67,000	53,900	65,800	
31	91,000	-	68,700	-	151,300	-	246,000	167,100	-	78,850	-	70,600	
	2,870,600	1,853,800	2,153,800	2,172,000	2,507,900	4,929,800	5,272,400	4,882,200	2,895,799	2,329,927	2,188,150	2,621,001	

Year	2008	January	February	March	April	May	June	July	August	September	October	November	December
Date													
1	94,000	83,100	57,500	70,943	118,433	186,383	185,600	103,100	124,400	71,100	57,100	89,000	
2	86,500	66,600	51,500	83,285	75,825	142,177	178,600	80,800	122,000	76,200	68,150	84,500	
3	89,400	57,300	59,800	107,167	67,352	127,650	184,500	108,500	105,000	72,100	68,150	80,900	
4	89,300	67,500	59,600	82,711	82,225	78,200	142,000	137,500	109,800	63,900	61,500	84,700	
5	85,700	61,900	58,300	74,067	91,979	81,300	136,200	163,500	108,700	74,800	57,100	83,800	
6	9,300	57,200	58,300	71,192	79,700	67,300	113,200	163,300	127,200	75,300	60,600	80,700	
7	97,000	63,900	60,600	60,765	96,100	88,100	155,100	181,000	118,700	78,800	61,900	89,500	
8	106,435	63,794	69,637	111,637	70,100	91,200	161,200	169,300	143,600	74,600	59,400	92,000	
9	99,921	61,341	64,194	101,081	97,400	99,200	166,000	172,000	125,600	80,500	63,500	90,900	
10	98,317	66,159	71,255	116,681	91,200	69,800	184,100	142,300	117,800	81,500	67,900	89,000	
11	100,739	63,358	69,960	111,370	90,600	78,800	154,700	161,600	129,600	68,000	176,100	88,900	
12	105,425	67,793	68,945	88,400	87,900	94,700	169,800	185,600	130,300	69,300	86,700	85,100	
13	98,651	68,216	63,963	83,200	83,900	113,399	187,700	141,700	126,100	69,600	63,800	80,700	
14	103,577	58,208	70,060	77,900	69,700	119,067	178,700	185,400	118,500	71,100	87,000	-	
15	103,051	61,938	66,742	144,665	70,000	140,673	187,200	219,500	137,100	62,700	63,300	-	
16	88,600	64,826	82,950	146,512	79,800	160,229	195,100	191,600	106,400	48,300	62,800	89,200	
17	87,500	52,700	61,277	118,950	120,700	154,979	198,400	172,400	105,200	62,000	74,900	90,300	
18	87,800	62,200	77,635	147,033	177,505	95,200	169,900	164,300	95,400	61,400	141,100	-	
19	89,200	65,400	58,400	74,600	168,500	115,700	195,700	149,900	196,500	58,400	84,200	-	
20	96,000	66,700	62,700	83,800	106,916	95,300	167,100	128,800	182,100	81,100	78,800	104,600	
21	96,800	60,600	56,500	80,300	93,704	110,500	177,900	102,100	120,000	51,500	77,300	109,800	
22	78,500	55,100	75,000	165,171	120,479	150,400	220,900	95,900	175,100	62,000	88,200	123,700	
23	65,800	65,200	62,900	150,810	107,682	148,200	174,700	116,700	75,500	57,400	88,300	-	
24	58,300	67,600	70,818	141,959	120,346	124,400	188,500	84,700	74,200	57,400	141,300	-	
25	86,400	54,000	75,436	153,647	142,700	130,900	214,700	103,000	86,300	42,400	100,700	-	
26	78,300	56,100	71,622	104,823	149,300	142,600	147,400	178,000	73,300	65,100	73,700	114,700	
27	83,000	60,000	70,273	105,170	103,500	120,400	134,200	105,000	70,600	67,800	75,600	157,400	
28	82,400	53,900	69,382	89,744	100,900	-	183,600	107,400	71,800	74,300	83,400	148,800	
29	91,300	60,400	79,392	130,497	99,600	173,900	146,200	78,500	79,100	63,800	78,200	145,500	
30	83,400	-	71,582	120,007	112,400	200,200	106,300	105,000	80,900	61,800	82,300	140,600	
31	84,700	-	64,174	-	114,300	-	118,200	117,400	-	60,400	-	140,600	
	2,705,316	1,813,033	2,060,397	3,178,087	3,190,746	3,500,857	5,223,400	4,315,800	3,436,800	2,064,600	2,433,000	2,484,900	

Year	2007	January	February	March	April	May	June	July	August	September	October	November	December
Date													
1	72,000	74,912	81,020	92,729	121,760	157,854	107,200	194,693	118,300	83,029	70,608	106,160	
2	69,000	70,889	85,368	90,448	142,048	167,225	120,500	216,093	123,000	87,592	67,000	107,510	
3	63,800	70,390	89,671	90,245	109,300	188,819	125,200	195,424	95,600	81,906	95,487	117,002	
4	65,100	67,277	85,922	79,613	124,992	126,000	127,500	202,571	94,300	80,694	85,259	74,510	
5	65,800	79,050	86,208	87,373	90,500	111,900	152,700	204,141	97,000	80,834	85,654	134,313	
6	60,700	79,752	88,840	85,329	90,800	124,900	164,000	190,679	104,000	76,829	129,516	90,403	
7	67,100	67,284	93,222	96,602	95,200	86,400	168,800	207,084	89,800	77,421	128,537	94,569	
8	67,600	61,100	77,700	80,900	152,820	94,600	140,100	167,448	100,100	83,300	122,132	69,300	
9	57,100	62,000	79,400	75,700	124,623	104,200	188,100	188,783	103,400	88,801	140,063	90,700	
10	69,900	56,700	72,200	79,200	143,790	94,300	192,939	152,324	124,900	84,933	83,200	76,200	
11	60,500	68,800	69,900	64,900	130,561	98,000	226,806	158,938	133,200	84,932	88,200	87,000	
12	66,600	68,800	76,000	70,400	105,200	113,326	236,223	151,668	127,200	81,376	85,200	81,200	
13	74,900	68,100	74,500	67,100	99,000	117,526	246,280	142,613	118,400	69,020	93,572	79,000	
14	67,400	68,600	74,900	72,900	110,500	122,735	213,517	162,482	113,000	69,758	152,464	87,000	
15	78,000	74,200	74,500	70,900	156,232	133,275	197,874	186,528	133,100	73,413	113,533	81,900	
16	72,000	73,300	76,000	71,600	140,478	137,101	165,979	179,800	110,900	66,700	138,709	89,200	
17	64,700	66,900	76,800	65,500	92,700	153,760	212,008	128,500	91,100	60,400	87,600	92,900	
18	68,800	77,500	78,400	98,500	118,000	91,908	161,677	114,200	98,500	56,000	85,400	98,700	
19	69,900	80,100	72,200	78,200	93,700	115,238	155,277	101,500	85,500	59,900	101,100	88,700	
20	66,800	98,800	73,500	166,156	82,000	146,491	117,924	97,200	102,700	49,000	150,211	90,100	
21	61,300	74,100	71,300	69,900	88,300	136,300	113,558	108,200	119,939	59,800	135,396	92,500	
22	90,800	61,800	73,700	80,800	101,400	122,100	105,771	103,800	100,462	61,200	151,320	88,000	
23	58,000	78,600	73,800	69,200	99,100	111,300	115,755	123,300	92,349	61,300	132,412	91,900	
24	63,900	83,600	69,900	160,265	92,300	109,000	-	137,000	101,358	53,400	112,694	97,342	
25	69,800	76,500	80,000	203,034	110,500	85,900	148,659	144,900	96,671	59,000	111,678	103,643	
26	63,300	76,100	88,600	113,367	102,200	112,800	162,932	129,200	79,767	56,700	126,414	101,260	
27	64,000	71,400	70,600	116,396	123,100	99,700	174,326	120,900	91,454	57,900	87,892	99,597	
28	67,000	71,500	78,000	-	112,900	133,600	180,480	101,600	86,012	56,500	91,827	84,900	
29	71,400	-	73,000	-	151,490	100,400	159,829	107,900	83,003	60,600	92,612	94,200	
30	64,100	-	100,800	-	157,880	100,700	182,214	127,500	83,026	71,700	84,703	85,700	
31	66,900	-	76,300	-	150,681	-	193,624	120,800	-	140,950	-	166,900	
	2,088,200	2,028,054	2,442,251	2,497,307	3,614,055	3,597,358	4,957,752	4,667,769	3,098,041	2,234,888	3,230,397	2,942,309	

Year	2006	January	February	March	April	May	June	July	August	September	October	November	December
Date													
1	63,900	58,300	65,100	61,800	73,800	110,600	201,700	211,310	132,870	80,000	68,192	96,453	
2	56,700	55,300	59,800	61,200	79,700	93,800	215,800	233,005	151,345	85,000	134,164	99,596	
3	59,700	65,500	65,500	68,100	78,200	68,600	245,600	217,266	176,082	85,600	139,627	84,100	
4	53,900	55,700	54,300	54,900	126,100	96,800	266,933	213,388	180,849	84,700	81,300	93,400	
5	58,000	56,300	65,200	66,300	94,300	116,700	233,986	220,780	195,234	81,400	72,300	89,500	
6	53,100	70,200	68,800	52,100	81,800	134,600	199,191	238,748	156,816	79,200	61,300	86,600	
7	58,900	50,800	54,200	54,800	76,200	152,600	203,385	229,314	142,635	79,800	90,829	88,900	
8	52,900	61,100	60,200	60,900	89,200	143,600	207,030	217,562	133,600	69,300	83,359	67,200	
9	69,300	56,000	67,300	67,200	104,700	95,300	203,820	111,900	115,900	88,300	94,984	-	
10	53,600	53,900	62,100	73,100	82,400	92,200	225,170	136,100	94,500	80,900	72,300	68,200	
11	51,800	69,500	62,200	86,100	100,000	128,800	241,722	172,451	115,500	60,700	65,200	71,000	
12	55,100	60,900	69,600	103,100	97,100	136,600	193,257	191,958	102,500	62,700	63,700	70,300	
13	56,100	65,600	66,400	85,700	90,000	118,200	97,300	197,225	116,400	80,200	68,500	100,242	
14	53,000	66,300	64,500	55,000	134,200	119,300	107,900	219,472	95,600	74,700	110,215	74,546	
15	59,500	52,100	66,000	70,000	132,200	99,500	105,400	197,636	104,500	85,371	73,209	66,600	
16	58,300	58,400	67,000	78,700	133,300	100,800	159,600	169,400	106,300	87,288	64,233	76,300	
17	43,500	55,000	-	73,600	160,800	121,300	182,700	191,762	107,800	82,340	102,548	67,300	
18	53,300	62,000	-	60,900	150,100	147,800	171,300	177,500	94,500	76,534	71,100	75,700	
19	54,600	66,800	66,500	58,900	140,400	141,200	210,200	164,100	76,700	76,798	71,700	64,800	
20	63,400	67,700	69,100	60,500	138,800	148,500	161,100	174,600	73,300	72,815	74,660	69,400	
21	50,700	55,100	100,900	54,600	149,400	140,200	238,100	183,200	78,500	79,471	100,926	78,600	
22	59,600	66,200	110,000	66,500	139,500	179,300	255,900	171,200	73,100	71,021	112,044	57,200	
23	61,500	65,700	123,300	67,500	89,400	170,300	223,900	160,300	79,000	86,758	109,643	68,100	
24	53,600	70,800	108,700	76,400	73,600	192,800	261,000	172,000	76,000	101,659	96,175	77,100	
25	53,500	55,000	65,900	63,800	82,400	182,800	221,500	198,200	84,900	101,373	76,700	69,400	
26	54,900	61,200	62,800	67,200	74,200	211,400	186,500	156,600	78,500	100,025	69,900	71,600	
27	59,900	54,600	78,000	62,100	62,200	220,700	220,900	166,900	83,100	183,584	77,900	68,000	
28	54,300	60,900	107,900	71,000	99,800	202,000	190,100	177,500	75,300	61,900	108,790	90,600	
29	65,800	-	84,500	66,600	113,100	208,300	165,700	153,100	80,700	68,300	77,855	66,900	
30	61,000	-	66,400	68,800	119,000	199,900	174,000	126,400	80,000	69,600	92,422	73,200	
31	52,800	-	66,800	-	119,100	-	186,400	94,100	-	119,588	-	62,900	
	1,756,200	1,696,900	2,129,000	2,017,400	3,285,000	4,274,500	6,157,094	5,644,977	3,262,031	2,616,925	2,585,775	2,293,737	

Year	2005	January	February	March	April	May	June	July	August	September	October	November	December
Date													
1	67,200	83,600	69,300	64,900	82,300	93,800	164,200	152,900	98,600	66,200	60,100	67,100	
2	61,800	69,700	56,900	62,800	74,800	115,000	169,300	176,300	124,100	72,000	63,500	72,400	
3	67,500	72,700	61,300	68,000	80,900	103,800	145,300	178,800	142,500	62,700	58,700	72,300	
4	63,100	66,400	61,100	69,900	69,100	118,500	138,900	213,300	105,900	66,000	53,600	79,300	
5	61,800	67,200	67,200	68,500	64,500	127,600	124,700	210,700	100,400	66,400	57,000	85,200	
6	61,600	66,800	57,100	62,100	87,000	112,200	138,400	208,800	116,000	60,300	61,000	83,100	
7	73,300	76,700	69,300	62,400	91,800	131,200	130,000	196,500	95,400	59,000	59,300	72,400	
8	71,800	71,300	68,700	65,300	81,600	85,200	113,900	210,500	112,400	70,600	60,800	75,300	
9	77,400	67,400	76,500	65,500	96,300	74,800	101,500	200,200	109,200	65,100	67,200	71,400	
10	71,500	73,400	60,500	68,300	85,900	111,500	105,600	198,200	96,300	60,400	58,900	72,100	
11	74,400	67,600	67,800	67,300	90,700	97,600	110,000	186,300	116,800	66,300	61,200	77,400	
12	89,500	79,100	66,400	66,900	99,100	85,200	89,200	177,900	124,500	64,900	51,400	78,000	
13	95,100	75,000	70,500	66,600	106,100	85,000	94,400	192,000	120,300	66,600	61,100	77,200	
14	94,600	75,700	71,000	61,900	97,200	90,900	124,800	198,500	120,800	62,300	62,200	69,000	
15	102,400	69,300	74,400	56,900	88,000	101,000	124,300	202,900	97,000	74,600	58,200	77,500	
16	111,500	73,200	65,900	66,400	82,500	139,700	93,100	189,000	85,600	48,300	59,600	68,800	
17	65,100	69,000	60,900	67,700	80,900	158,800	128,300	134,000	82,400	60,900	53,900	71,300	
18	103,100	78,300	69,200	75,600	78,600	129,500	167,800	134,100	101,300	58,000	48,900	78,600	
19	88,700	69,000	73,600	73,200	78,900	143,400	153,200	128,100	84,300	58,600	64,000	80,400	
20	96,700	82,600	82,300	64,800	78,800	178,400	169,500	136,300	84,100	60,300	65,700	78,500	
21	105,700	81,000	75,100	61,700	68,700	177,500	168,300	149,300	85,800	59,800	77,900	73,400	
22	84,900	74,700	73,800	85,900	80,400	165,700	165,500	110,500	77,400	59,200	77,500	81,350	
23	90,600	67,900	67,900	81,700	88,500	169,800	156,700	157,600	83,300	60,300	71,600	81,350	
24	88,600	73,200	73,400	81,800	78,800	196,500	181,400	160,300	85,400	60,400	72,400	67,100	
25	107,300	71,900	67,900	84,900	73,600	168,700	183,500	178,300	70,400	60,000	78,400	72,900	
26	79,000	66,500	77,300	88,700	88,300	209,800	192,500	158,100	94,800	55,600	77,700	72,300	
27	85,900	61,700	65,300	82,300	107,200	179,900	191,400	136,600	88,700	53,000	76,800	67,800	
28	74,700	68,400	74,700	89,000	118,500	183,300	205,500	130,300	81,000	55,000	78,200	74,000	
29	72,900	-	74,400	87,500	135,900	170,000	178,400	115,000	60,600	60,100	82,600	86,800	
30	82,500	-	67,300	91,900	132,300	140,400	164,300	107,800	83,500	59,200	86,200	59,900	
31	81,700	-	67,000	-	99,600	-	177,600	103,400	-	60,700	-	54,900	
	2,551,900	2,019,300	2,134,000	2,160,400	2,766,800	4,044,700	4,551,500	5,132,500	2,928,800	1,912,800	1,965,600	2,299,100	

APPENDIX C –SUMMARY OF MODEL CALIBRATION

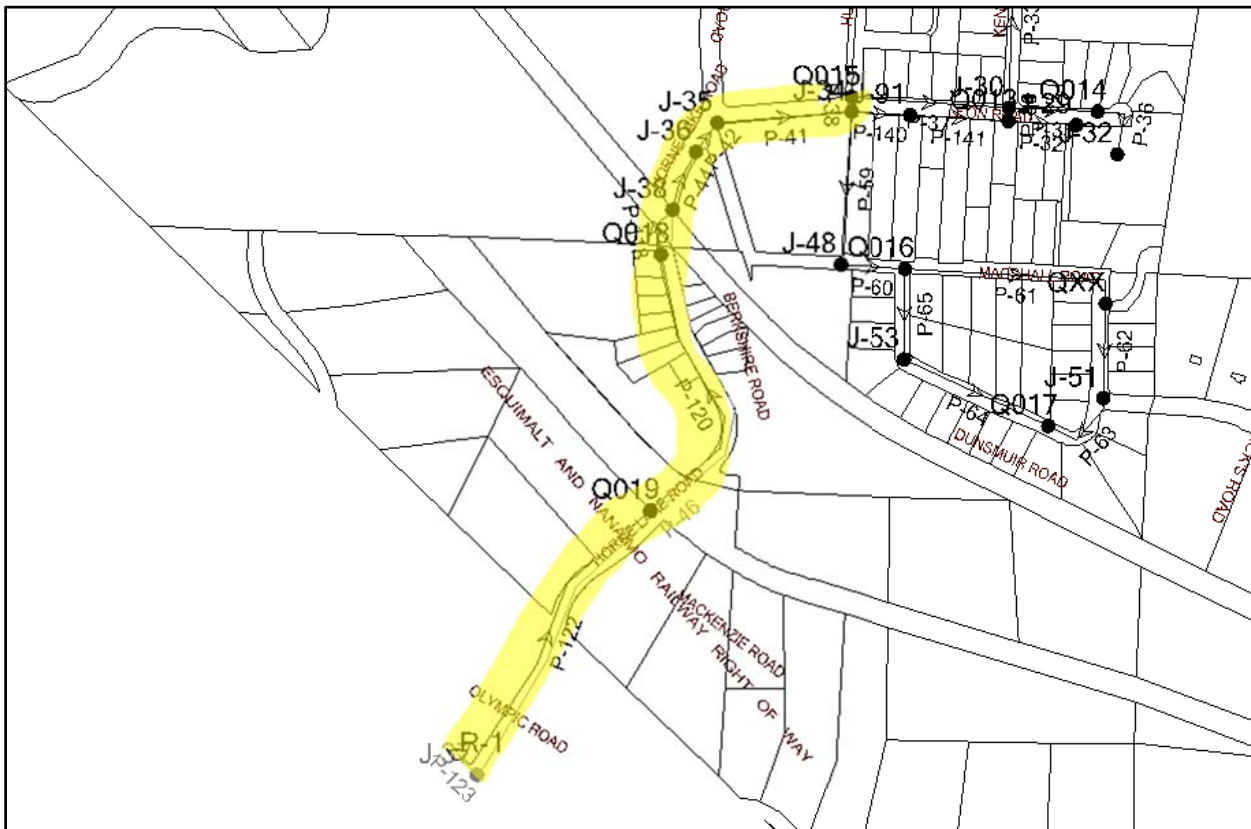
MODEL CALIBRATION FOR QUALICUM BAY HORNE LAKE WATER SYSTEM

Calibration references Bow Horn Bay Fire Department Data: "Qualicum Bay Water Works Hydrants by Hydrant Number (with Valve Locations) updated 2010-09-08"

ALL Calibrations assume:

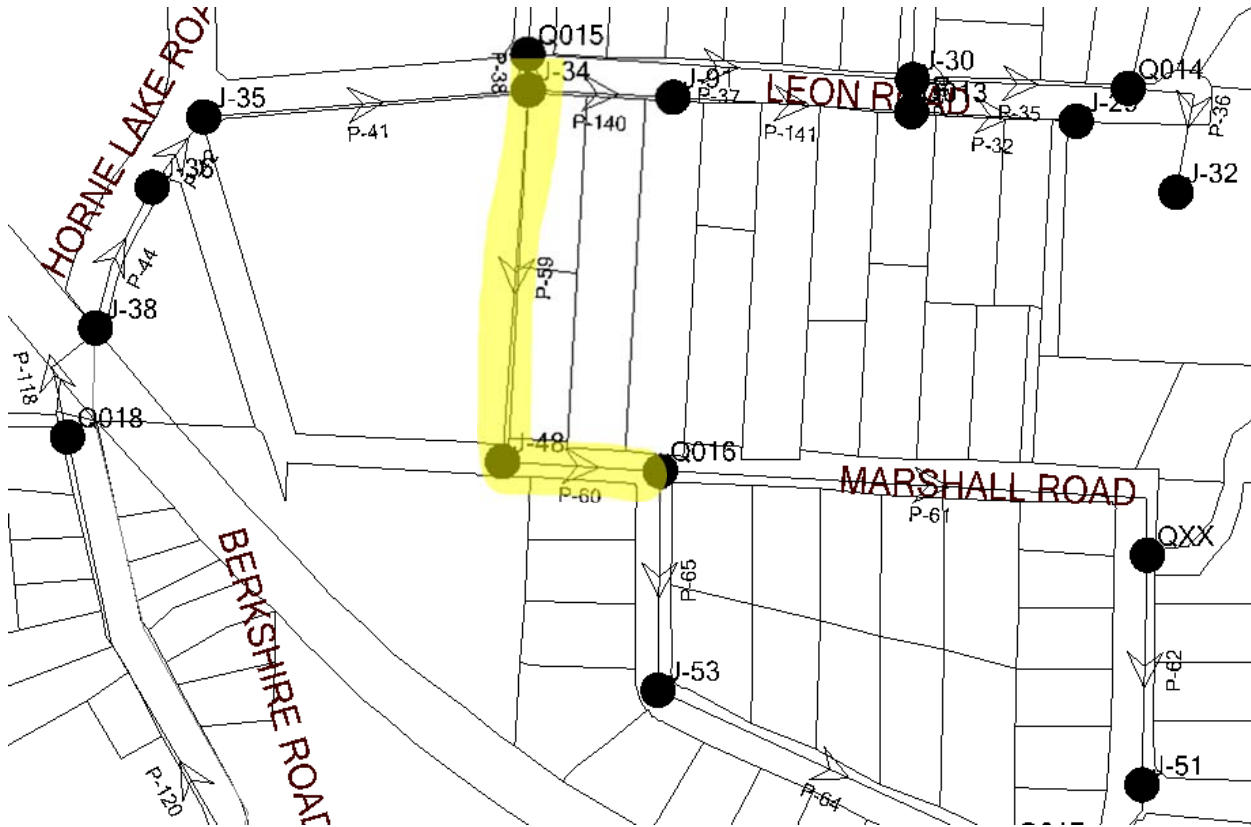
- AC pipe coming down from Reservoirs on Horne Lake Road are NOT active.
- Average Day Demands (ADD)
- Adjust Roughness (C factor) only
- No demand adjustments

CALIBRATION 1



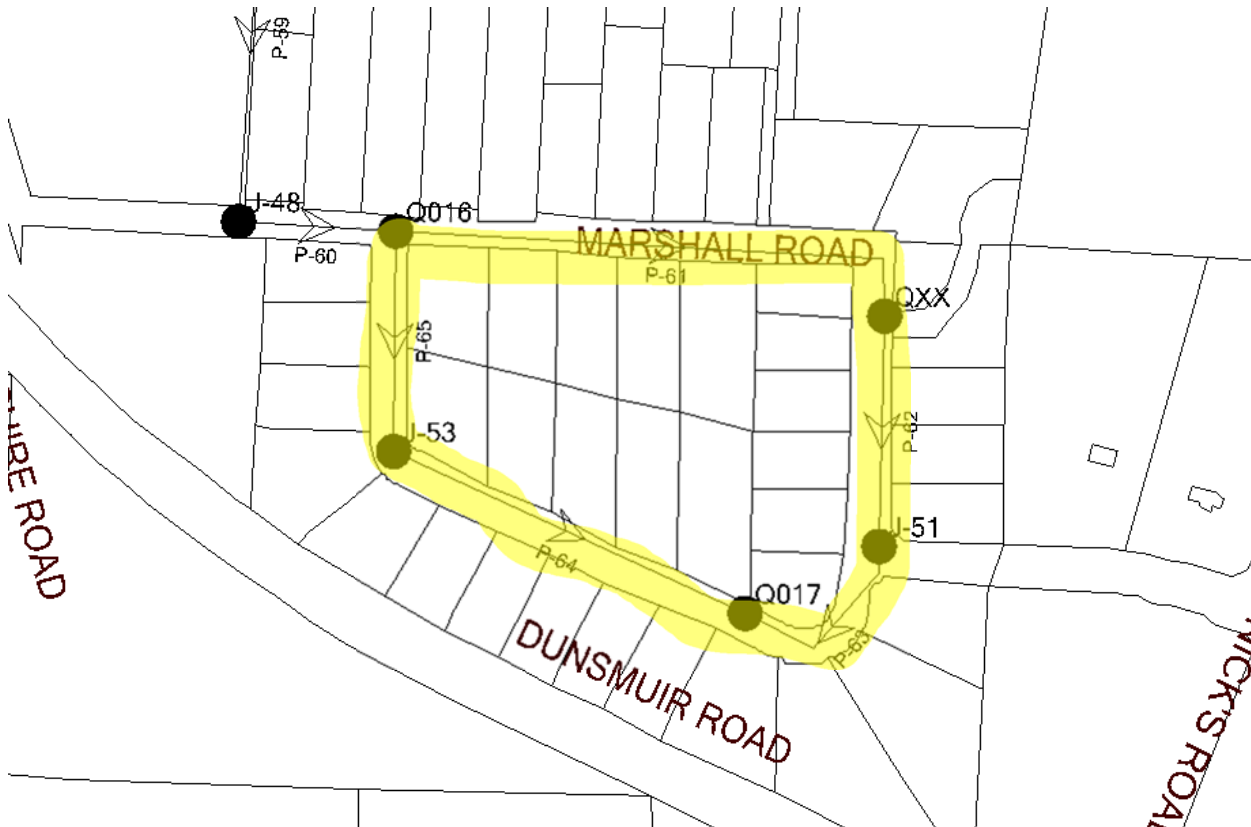
Adjusted pipe roughness for PVC to 140 (typical) and AC to 120 (typical), indicating expected friction losses. Observed hydraulic grades compare well to simulated grades.

CALIBRATION 2



Adjusted pipe roughness for AC to 100; a low value indicating significant friction losses in this area. Observed hydraulic grades compare well to simulated grades.

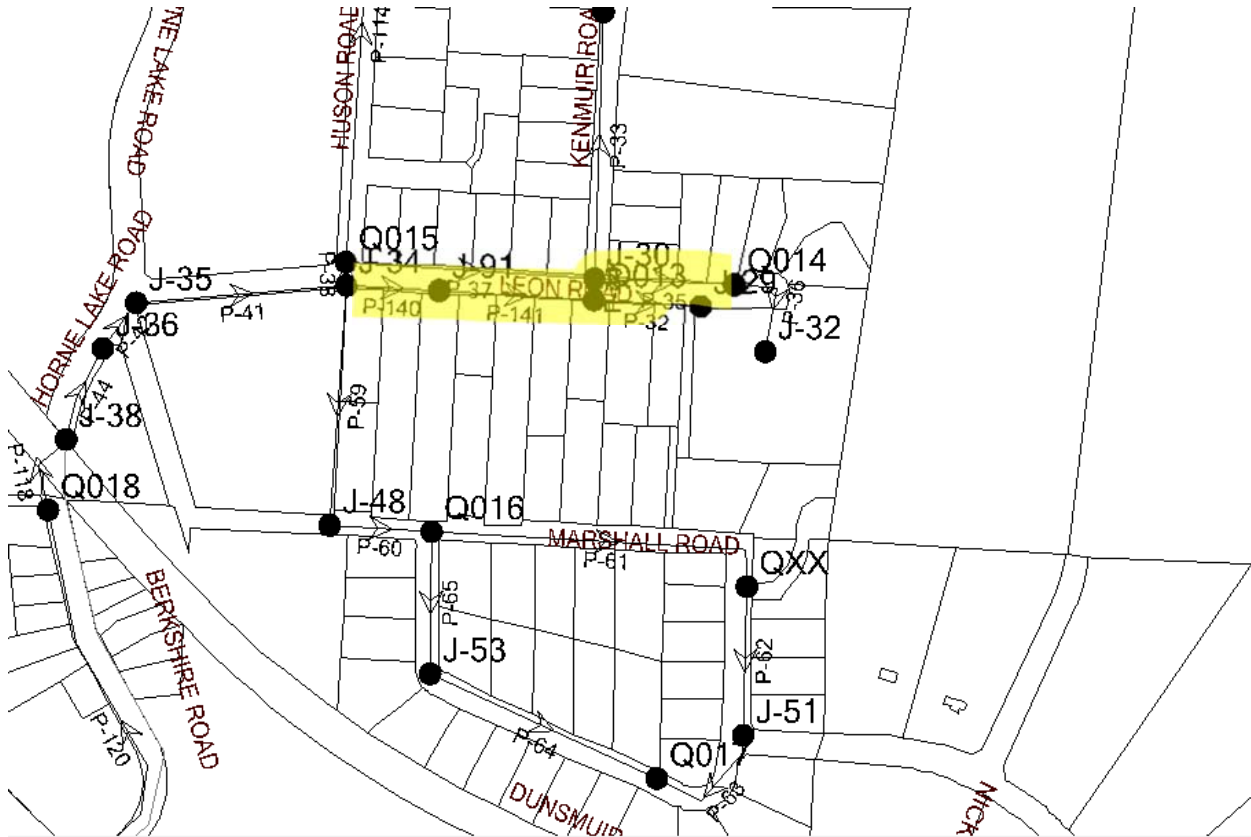
CALIBRATION 3



Adjusted pipe roughness for AC to 75 (minimum value used); very low values indicating major friction losses in this area.

Considerable variance from observed hydraulic grades (30m) to simulated grades (52m).

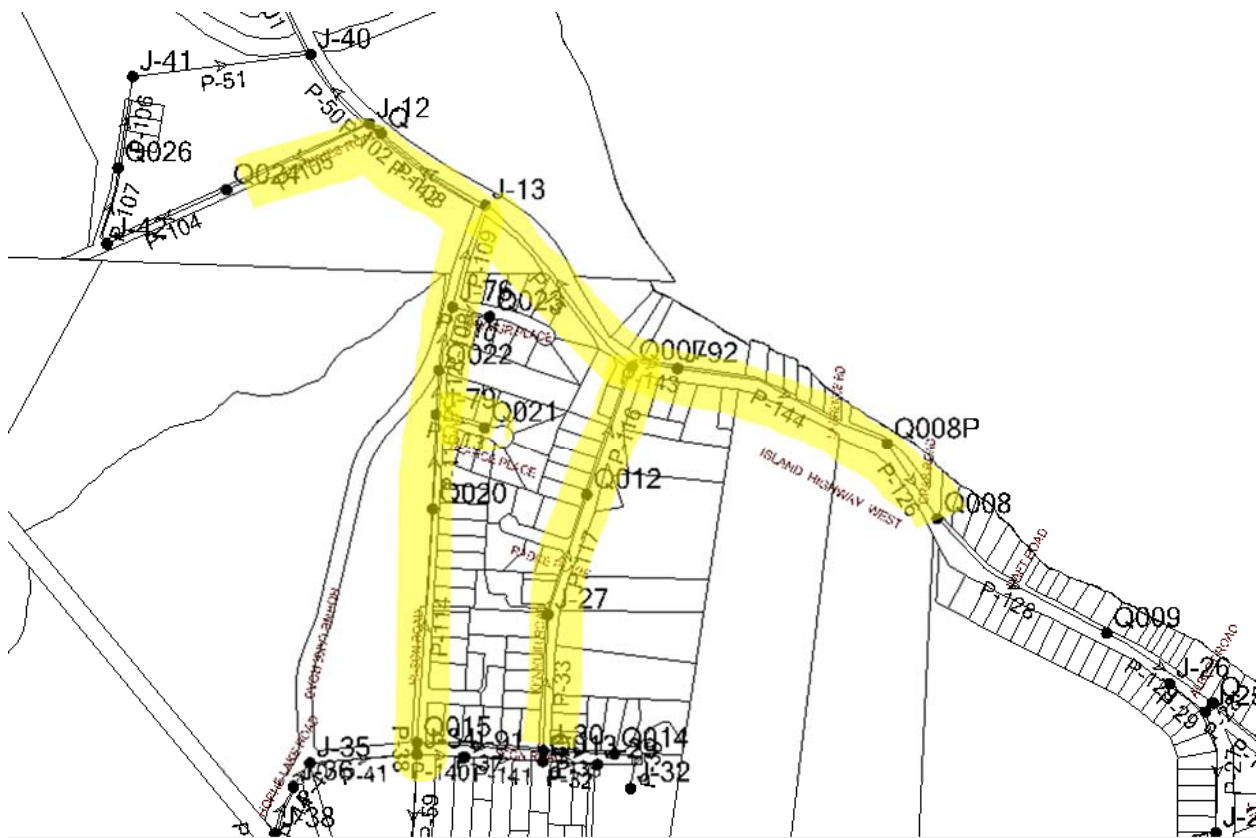
CALIBRATION 4



Adjusted pipe roughness for AC to 80 (very low) and to 100 for PVC (very low), indicating major friction losses in this area.

Observed hydraulic grades compare well to simulated grades.

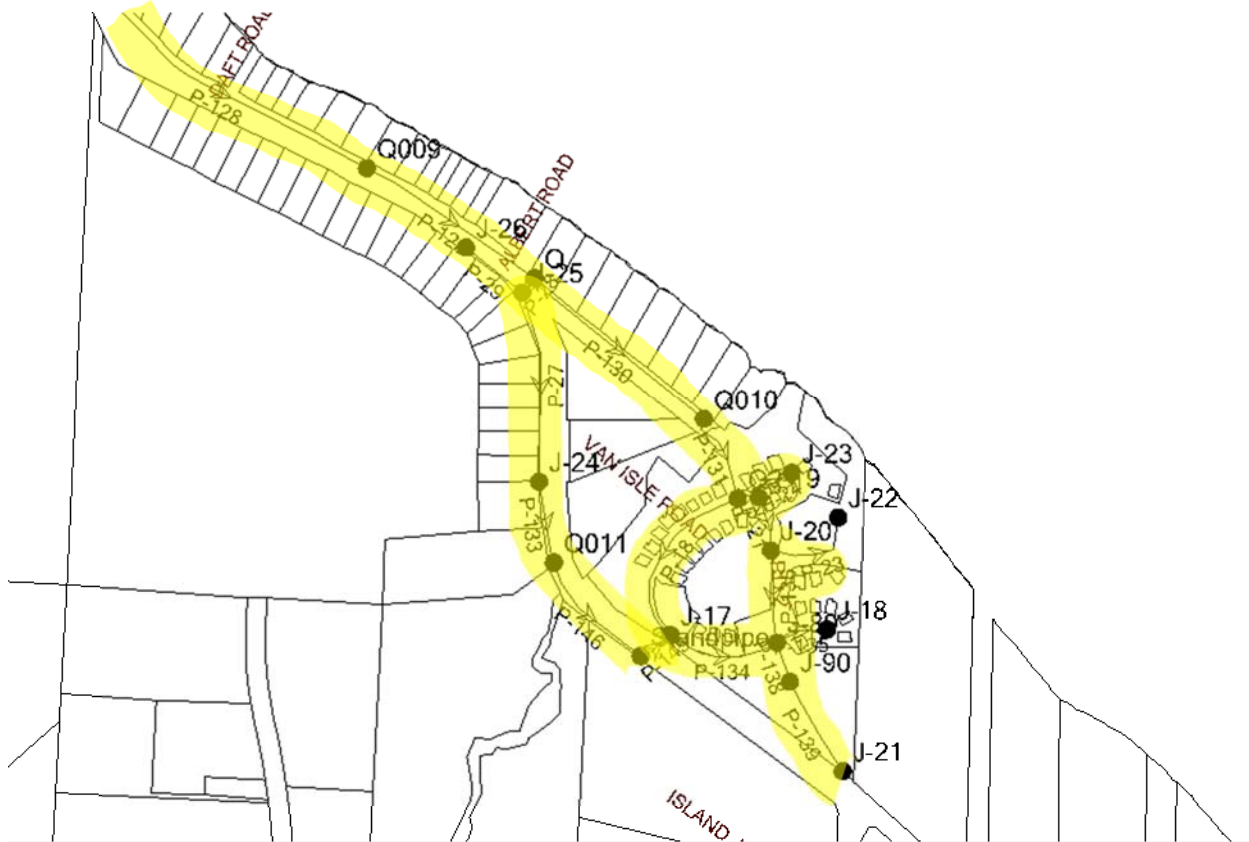
CALIBRATION 5



Adjusted pipe roughness for AC to 130 (high) and to 150 for PVC (high), indicating low friction losses in this area.

Observed hydraulic grades compare well to simulated grades with the exception of Q024 on Fisheries Road entering Qualicum Bay First Nations: 30m observed vs. 20m simulated.

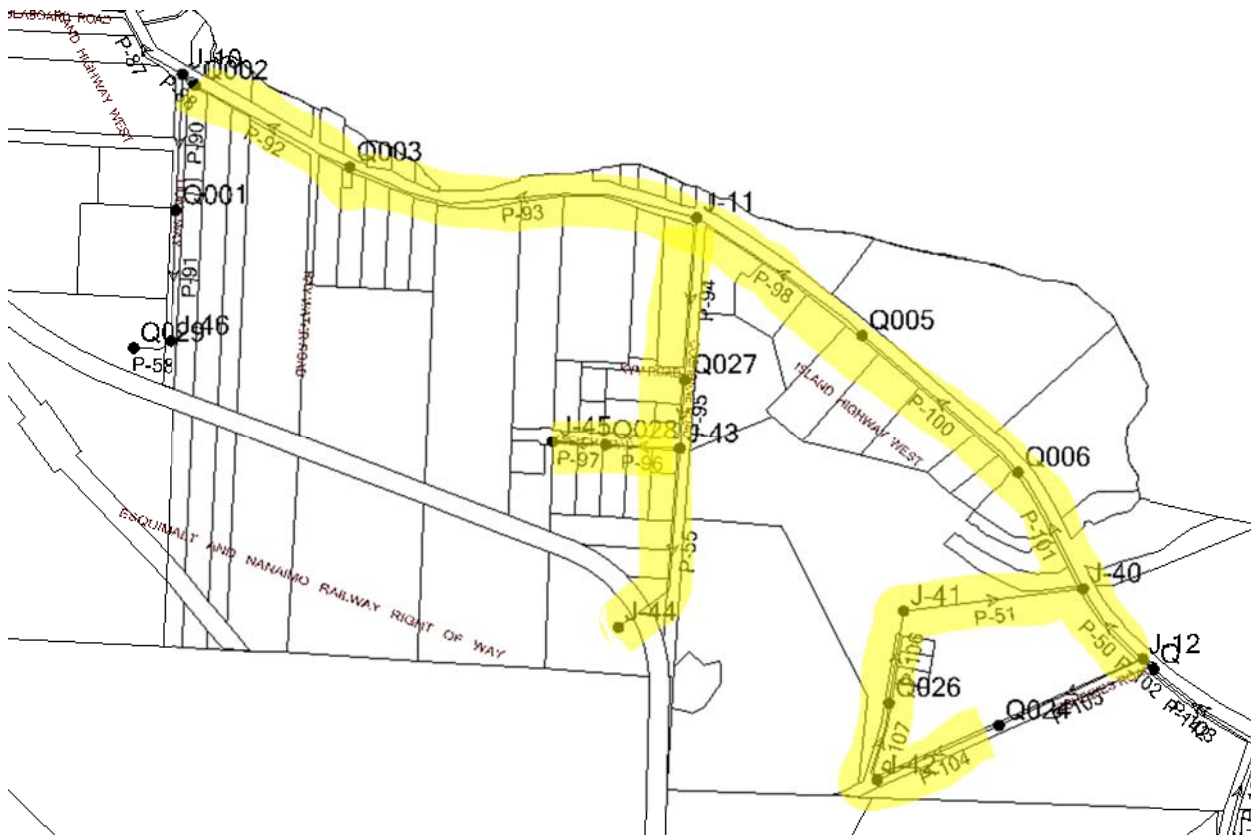
CALIBRATION 6



Adjusted pipe roughness for AC to 120 (typical) and to 140 for PVC (typical), indicating expected friction losses in this area.

Observed hydraulic grades compare well to simulated grades.

CALIBRATION 7



Adjusted pipe roughness for AC to 140 (high) and to 150 for PVC (max), indicating lower than expected friction losses in this area.

Observed hydraulic grades compare well most cases to simulated grades. In other cases, there is significant variation (observed/simulated): Q026 (26m/14m), Q005 (17m/5m), Q002 (8m/33m).

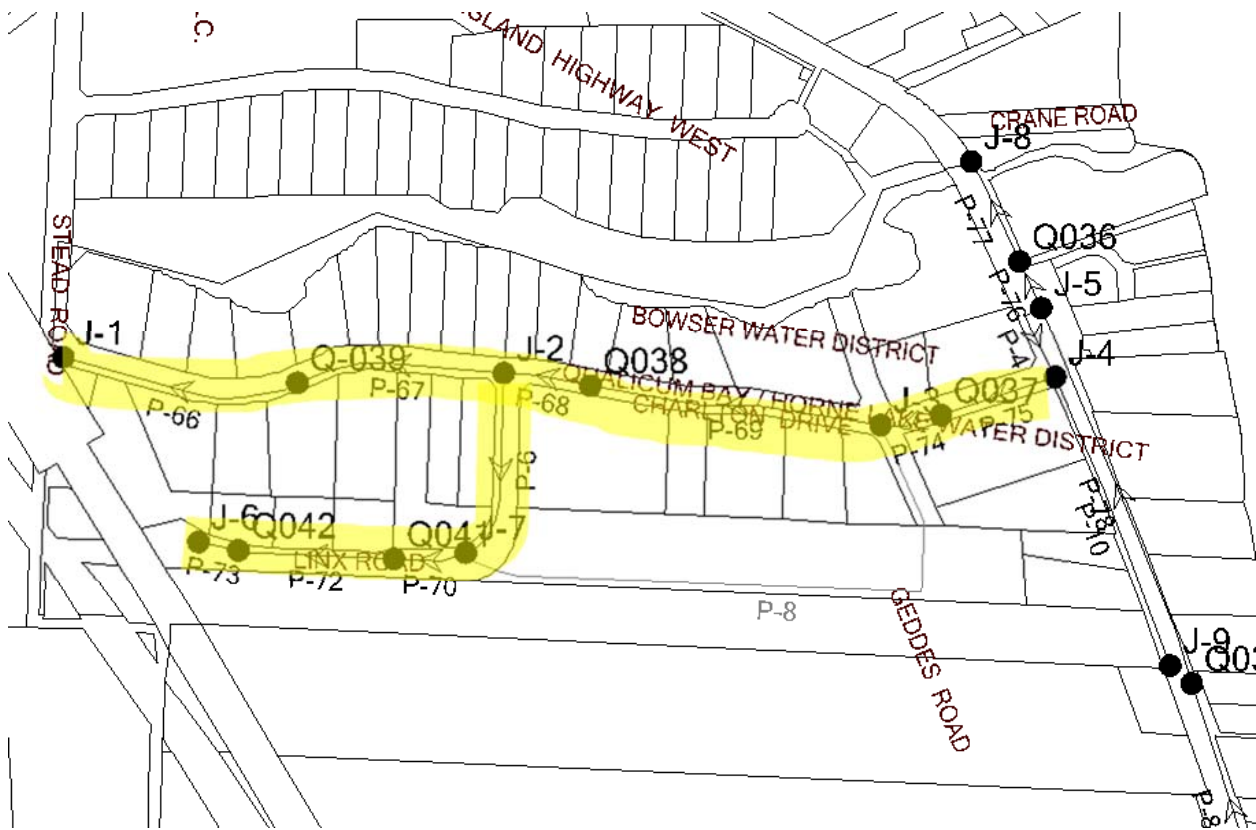
CALIBRATION 8



Adjusted pipe roughness for AC to 100 (low), indicating **significant friction losses in this area.**

Observed hydraulic grades compare well in a few cases to simulated grades. In most cases, there is significant variation (observed/simulated): Q030 (9m/27m), Q031 (8m/21m), Q033 (10m/19m), Q035 (16m/28m), Q036 (9m/-8m).

CALIBRATION 9



Adjusted pipe roughness for AC to 140 (high) and to 150 for PVC (max), indicating lower than expected friction losses in this area.

There is significant variation between observed and simulated hydraulic grades: Q037 (8m/23m), Q038 (25,-8m).

APPENDIX D – SYSTEM DRAWINGS

APPENDIX E – PROJECT COST ESTIMATES

CAPITAL EXPENDITURES

PROJECT # 1 - WATERMAIN INVESTIGATION

ITEM	QTY	UNITS	RATE	COST
Conduct Hydrant & Pressure Tests	1	LS	\$ 1,000	\$ 1,000
Monitor Reservoir & Water Meter	1	LS	\$ 800	\$ 800
Analyze in Water Model	1	LS	\$ 1,500	\$ 1,500
Reporting	1	LS	\$ 1,500	\$ 1,500
Sub Total				\$ 4,800
25% Contingency				\$ 1,200
TOTAL				\$ 6,000
15% Engineering				\$ 900
TOTAL				\$ 6,900

PROJECT # 2 - AC WATERMAIN CONDITION ASSESSMENT

ITEM	QTY	UNITS	RATE	COST
Collect Sample throughout system	15	ea	\$ 800	\$ 12,000
Laboratory Testing	15	ea	\$ 350	\$ 5,250
Reporting	1	LS	\$ 3,500	\$ 3,500
Sub Total				\$ 20,750
25% Contingency				\$ 5,188
TOTAL				\$ 25,938
15% Engineering				\$ 3,891
TOTAL				\$ 29,828

PROJECT # 3 - AC WATERMAIN REPLACEMENT PROGRAM

ITEM	QTY	UNITS	RATE	COST
200mm Main	11,962	m	\$ 180	\$ 2,153,160
200mm Gate Valve	120	ea	\$ 1,600	\$ 192,000
Fire Hydrant Assemblies	90	ea	\$ 3,000	\$ 270,000
Air Release Valve	15	ea	\$ 3,000	\$ 45,000
Shoulder Gravel	340	cu.m.	\$ 65	\$ 22,100
Asphalt Paving	6,460	s.q.m	\$ 70	\$ 452,200
Sub Total				\$ 3,134,460
25% Contingency				\$ 783,615
TOTAL				\$ 3,918,075
15% Engineering				\$ 587,711
TOTAL				\$ 4,505,786
Less Project # 3a				\$ (338,388)
Less Project # 3b				\$ (1,973,256)
Less Project # 5				\$ (166,247)
TOTAL				\$ 2,027,896

PROJECT # 3a - LEON & KENMUIR ROAD WATERMAIN UPGRADE (250mm)

ITEM	QTY	UNITS	RATE	COST
Remove Existing Main	200	m	\$ 11	\$ 2,200
250mm Main	850	m	\$ 210	\$ 178,500
250mm Gate Valve	8	ea	\$ 1,900	\$ 15,200
Fire Hydrant Assemblies	6	ea	\$ 3,000	\$ 18,000
Tie to Existing Main	3	ea	\$ 2,100	\$ 6,300
Shoulder Gravel	80	cu.m.	\$ 65	\$ 5,200
Asphalt Paving	50	s.q.m	\$ 70	\$ 3,500
Traffic Control	1	LS	\$ 6,500	\$ 6,500
Sub Total				\$ 235,400
25% Contingency				\$ 58,850
Sub Total				\$ 294,250
15% Engineering				\$ 44,138
TOTAL				\$ 338,388

PROJECT # 3b - ISLAND HIGHWAY WATERMAIN UPGRADE (250mm)

ITEM	QTY	UNITS	RATE	COST
Remove Existing Main	1000	m	\$ 11	\$ 11,000
250mm Main	4200	m	\$ 210	\$ 882,000
250mm Gate Valve	40	ea	\$ 1,900	\$ 76,000
Creek Crossing (Big Qualicum River)	1	LS	\$ 25,000	\$ 25,000
Fire Hydrant Assemblies	30	ea	\$ 3,000	\$ 90,000
Tie to Existing Main	7	ea	\$ 2,100	\$ 14,700
Shoulder Gravel	2500	cu.m.	\$ 65	\$ 162,500
Asphalt Paving	1500	s.q.m	\$ 70	\$ 105,000
Traffic Control	1	LS	\$ 6,500	\$ 6,500
Sub Total				\$ 1,372,700
25% Contingency				\$ 343,175
Sub Total				\$ 1,715,875
15% Engineering				\$ 257,381
TOTAL				\$ 1,973,256

PROJECT #4 - BRADSHAW ROAD WATERMAIN (200mm)

ITEM	QTY	UNITS	RATE	COST
200mm Main	1700	m	\$ 180	\$ 306,000
200mm Gate Valve	20	ea	\$ 1,600	\$ 32,000
Fire Hydrant Assemblies	12	ea	\$ 3,000	\$ 36,000
Air Release Valve	4	ea	\$ 2,500	\$ 10,000
Tie to Existing Main	2	ea	\$ 2,100	\$ 4,200
Shoulder Gravel	340	cu.m.	\$ 65	\$ 22,100
Asphalt Paving	100	s.q.m	\$ 70	\$ 7,000
Traffic Control	1	LS	\$ 15,000	\$ 15,000
Sub Total				\$ 432,300
25% Contingency				\$ 108,075
Sub Total				\$ 540,375
15% Engineering				\$ 81,056
TOTAL				\$ 621,431

PROJECT #5 - HORNE LAKE ROAD WATERMAIN UPGRADE (300mm)

ITEM	QTY	UNITS	RATE	COST
Remove Existing Main	350	m	\$ 11	\$ 3,850
300mm Main	350	m	\$ 250	\$ 87,500
300mm Gate Valve	3	ea	\$ 2,300	\$ 6,900
Tie to Existing Main	2	ea	\$ 2,100	\$ 4,200
Shoulder Gravel	80	cu.m.	\$ 65	\$ 5,200
Asphalt Paving	50	s.q.m	\$ 70	\$ 3,500
Traffic Control	1	LS	\$ 4,500	\$ 4,500
Sub Total				\$ 115,650
25% Contingency				\$ 28,913
Sub Total				\$ 144,563
15% Engineering				\$ 21,684
TOTAL				\$ 166,247