KERR WOOD LEIDAL
consulting engineers

Vancouver Island
201 - 3045 Douglas Street
Victoria, BC V8T 4N2
T 250 595 4223
F 250 595 4224

District of North Saanich Water System Master Plan

Final Report
October 2016
KWL Project No. 2148.003-300

Prepared for:

District of North Saanich

NORTH SAANICH

Figures

Tables

Appendices

Executive Summary

The District contracted KWL to develop a water master plan and a prioritized asset replacement and 30 year upgrading program based on system condition, and current and forecasted capacity issues. Water system capacity is measured as the system's ability to deliver acceptable fire-flows under maximum day demand conditions as well as acceptable pressures under peak hour summer demands.

A list of priorities and funding requirements for management of the water system through the next 30 years were developed.

SYSTEM CONDITION ASSESSMENT

The system is comprised of approximately 36% Asbestos Cement (AC) with an average age of 45 years and 60% PVC with an average age of 31 years and 4% Ductile Iron (DI) with an average age of 40 years.

The current main and service break frequency indicates the condition of the pipe network is quite good. The current reported main break frequency is 2 breaks per year and service break frequency is 5 breaks per year. Break rates will increase as the system ages and it is recommended that the District keep a database of watermain and service breaks to watch for signs of increased deterioration. It is also recommended that the District sample and test the remaining strength of older AC pipe as it is upgraded for capacity. This test data will also inform of the materials deterioration rate and estimated ultimate service life.

It is expected that the older AC and DI mains are in good condition and will not require renewal within the next 25 years, outside recommended capacity upgrades. PVC mains will also not require renewal within the next 25 years and are assumed to have a service life of 100+ years.

The District owns 34 PRV stations. A PRV station condition assessment was completed and revealed a handful of low priority maintenance projects. The assessment also found three stations with PRVs requiring rebuilds. Two of the rebuilds were completed at the time of inspection. The PRV stations were noted as being in good condition overall. The expected renewal frequency for PRV stations is between 60 and 80 years dependent on site conditions.

CAPACITY ASSESSMENT

Existing maximum day demand (MDD) is estimated at 175 L/s and future OCP MDD is estimated at 269 L/s. North Saanich is not expected to see significant population growth but future MDD could rise with a changing climate and farm market forces. The future MDD demand scenario assumes an additional 32 L/s in farm water use.

North Saanich's oldest AC water-mains were sized to the rural water standard of the day that considered fire-fighting capacity as secondary to the provision of safe drinking water. The District's system contains 100mm watermains and some long runs of un-looped 150mm pipe which cannot deliver 60 L/s; which is the recommended minimum fire flow for single family residentially zoned lands. Fire flow deficiencies are mostly constrained to older 100mm AC pipes which are expected to have a shorter lifespan than larger diameter AC. These mains are given top priority for capacity related replacements.

A high level review of the CRD's reservoirs found no existing or future deficiencies in storage volumes.

UPGRADES FUNDING

A hydraulic water model was developed that identified capacity constraints and determined recommended upgrades. A total of 20.53 km of water-main is recommended to be upgraded for capacity with an estimated cost of $13.26 million dollars. The majority of the proposed upgrades projects renew 1960s 100mm and 150mm AC pipe.

The District should plan for an annual PRV station renewal budget of $60,000 per year with renewals starting around 2020.

The Districts annual water infrastructure renewals funding budget of $488,300 should be used to complete the recommended water main upgrades and PRV station renewals within a 30 year period. The above funding requirements and renewals budget do not factor in inflation. It is recommended that the District's renewals funding budget be increased at the rate of inflation.

1. Introduction

1.1 Terms of Reference

In January 2014, the District of North Saanich (the District) contracted Kerr Wood Leidal Associates Limited (KWL) to build a water model for 2013 base demand, maximum day and assess the system capacity to deliver fire flows. A model calibration was completed in September 2014 along with inspection of all PRV stations to both assess condition and determine each PRVs set-point to assist in the model calibration. Following the initial model build and calibration, the District contracted KWL to develop a water master plan and a prioritized asset replacement and upgrading program. This plan was commissioned to address the objectives outlined in Section 1.3.

1.2 Background

Community and Growth Forecast

The District of North Saanich, at the top of the Saanich Peninsula, has the following defining characteristics:

- Large portions of the District are within the Agricultural Land Reserve and the community is focussed on retaining its largely rural agriculture feel.
- Bordered primarily by the ocean and having large forested parkland the community is committed to protecting both the land and marine ecosystems.
- North Saanich has large residential lots. The highest density areas have lots 30% larger than the average lot size in the District of Saanich and the more rural residential areas are comprised of acreages. With an aging demographic wanting to stay in North Saanich, the community recognizes a need for more seniors housing. Growth of industrial business has also added some pressure for higher density, more affordable housing choices, however this need is balanced with the communities desire to maintain its large lot character. It is assumed that Sidney will absorb much of the densification and more affordable housing growth pressures with densification in North Saanich happening in close proximity to Sidney and within a few carefully chosen and controlled developments.

Infrastructure

Development of the North Saanich's water system began in the early 1960's with approximately 37% of the total system built between 1963 and 1965. Approximately 19km of pipe was installed per year in this initial rapid growth period with 50% AC and 50% PVC. The next nineteen years saw a moderate development rate of 1.9km of pipe per year. System growth increased in the eleven year period from 1986 to 1996 with a growth rate of 5km per year. This 1986-1996 growth era represents 35% of the system and is mostly comprised of PVC pipe. From 1997 to present day North Saanich has not seen any significant development and the majority of the pipe installed in this timeframe, 0.4km on average per year, has been renewals.

Key Issues

The following are key issues that will be addressed by this plan:

- Rural areas of the system have insufficient fire flow capacity by today's standard which is due to 100mm AC watermains and long un-looped runs of 100-150mm mains.
- North Saanich water infrastructure is not yet requiring condition related renewals however a large portion of the system is comprised of 1960s AC pipe. Infrastructure renewal funding is the greatest challenge facing today's municipal governments and North Saanich will need to anticipate, through materials testing, and fund the eventual replacement of infrastructure installed in the initial rapid growth period of 1963-1965.
- It is not expected that population growth will create significant additional strain on the system however agricultural use could increase.

1.3 Study Objectives

The objectives of this plan are to:

- Use computational modelling to identify deficiencies of the water system in meeting level of service design criteria;
- Identify system improvements to remedy deficiencies;
- Develop a likely future growth scenario and determine how levels of service are met under these conditions;
- Recommend upgrades to address existing level of service deficiencies, and requirements to meet future demands;
- Review watermain and PRV station asset condition data and discuss renewals funding within the next 30 years; and
- Identify renewal/upgrade priorities and funding requirements for long term sustainable management of the water system (Class D cost estimates).

1.4 Abbreviations

The following abbreviations have been used throughout the report.

ADD	Average Day Demand
AC	Asbestos Cement
BDD	Base Day Demand (Typical Indoor Winter Water Usage)
ca	Capita (Person)
CI	Cast Iron Water Main
CRD	Capital Regional District
DI	Ductile Iron Water Main
GD	Geodetic Datum
FUS	Fire Underwriters Survey
ha	Hectare
HGL	Hydraulic Grade Line
HP	Horsepower
ICI	Industrial, Commercial and Institutional
ILI	Infrastructure Leakage Index
KWL	Kerr Wood Leidal Associates Ltd.
MDD	Maximum Day Demand
MF	Multifamily
ML	Megalitre (10^6 L)
PE	Population Equivalent
PHD	Peak Hour Demand
PRV	Pressure Reducing Valve
PRS	Pressure Reducing Station
SD	Seasonal Demand (Irrigation Demand on Max Day; BD+SD = MDD)
SF	Single Family
TWL	Top Water Level
UARL	Unavoidable Annual Real Losses
VAA	Victoria Airport Authority

2. Water Modelling

2.1 System Overview

The District of North Saanich is supplied with bulk water by the Capital Regional District (CRD). The bulk water typically originates from the Sooke Reservoir. From the Sooke Reservoir, the water travels to the various communities in Greater Victoria via a series of transmission mains. The Saanich Peninsula Water System, which includes portions of Saanich, Central Saanich, Victoria Airport Authority (VAA), Sidney, and the District of North Saanich, is supplied by CRD Transmission Main #4.

The existing District of North Saanich water system is shown in Figure 2-1. The District owned infrastructure ("the system") does not include reservoirs or pump stations which are all the responsibility of the CRD. The components of the CRD's Peninsula Water System which directly supply the District include:

- Transmission Main #4;
- Lowe Pump Station;
- Upper, Middle and Lower Dean Park Reservoirs;
- McTavish Reservoir;
- Deep Cove Pump Station; and
- Cloake Hill Reservoir.

The system is comprised of approximately 150 km of water main, thirteen pressure zones controlled by 34 District owned pressure reducing valve (PRV) stations, and five CRD operated PRV stations.

2.2 Data Sources

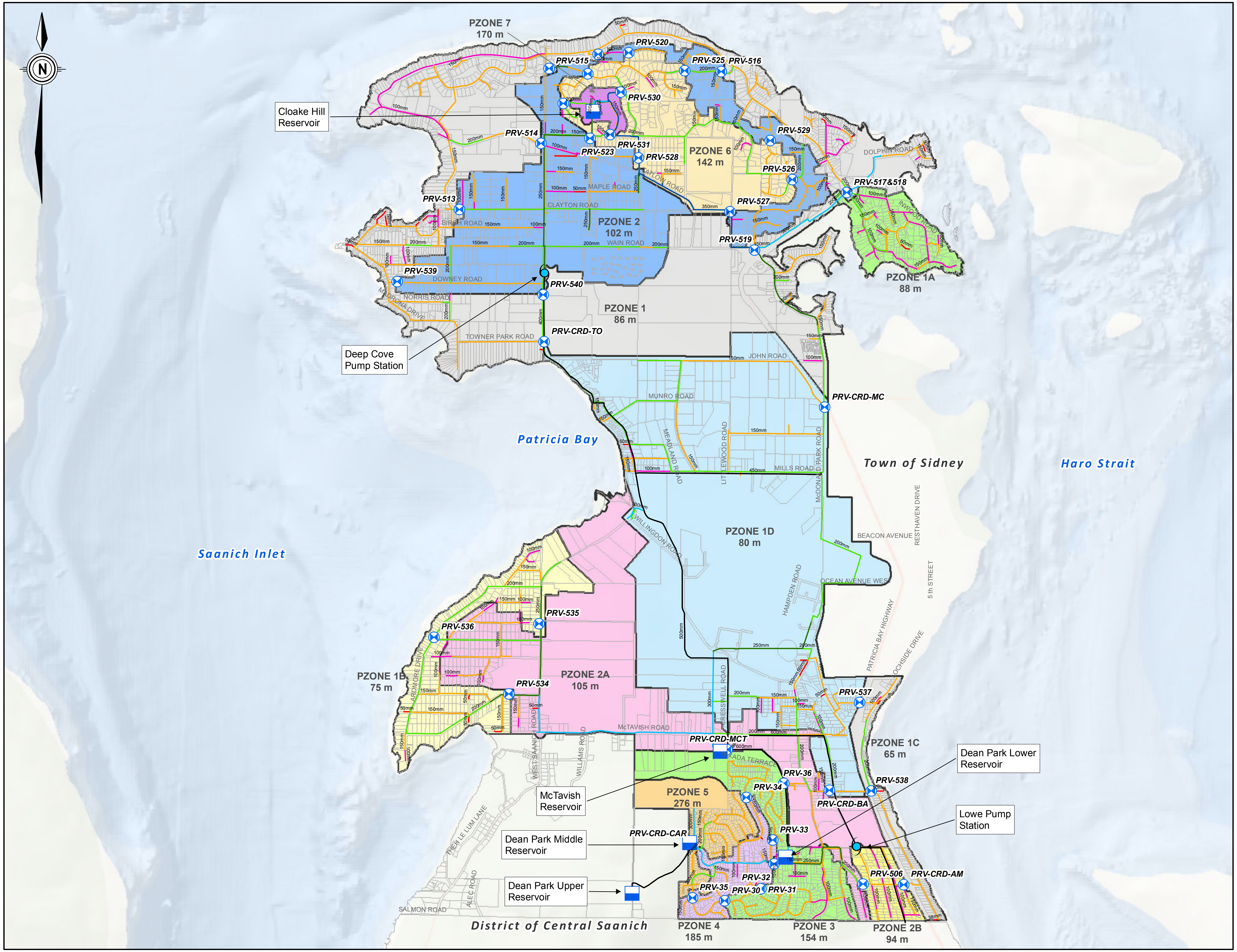
The water model was built using the sources of data described below:

District of North Saanich

- CAD file (DNS Watermap.dwg provided December 2013) – water system composite map, source of water main data and closed valve locations;
- GIS shapefiles (DNS Water.mdb provided November 2014) – source of water main install date information and used to verify material and diameters from CAD file;
- LiDAR elevation data file (flown October 2012) – used to determine elevations;
- 2013 Top 35 Service Meter Records (2013 Top 35 water users.xlsx) – annual water meter records for top 35 water users;
- North Saanich zoning data (DNS_Zoning_Complete.shp) – source of land use data; and
- PRV data table (PRV setpoints.pdf) – source of PRV station location, valve sizes and settings;

Capital Regional District

- SCADA records including flows, pressures and reservoir levels for July 1, 2013 to January 31, 2014 – used to determine max day demands and boundary conditions; and
- McTavish Reservoir Replacement Drawings (D-13026.00 As Recorded Drawings.pdf);



District of North Saanich
Water System Master Plan

Legend

- Pump Station
- Reservoir
- PRV Station
- CRD Supply Main

Water Main Diameter (mm)

- < 50
- 50 - 100
- 150
- 200
- 250
- 300
- 350
- > 350

Pressure Zone

- PZ 1 - 86 m HGL
- PZ 1A - 88 m HGL
- PZ 1B - 75 m HGL
- PZ 1C - 65 m HGL
- PZ 1D - 80 m HGL
- PZ 2 - 102 m HGL
- PZ 2A - 105 m HGL
- PZ 2B - 94 m HGL
- PZ 3 - 154 m HGL
- PZ 4 - 185 m HGL
- PZ 5 - 276 m HGL
- PZ 6 - 142 m HGL
- PZ 7 - 170 m HGL

Reference: GIS data from the District of North Saanich
Service Layer Credits: Esri, DeLorme, GEBCO, NOAA NGDC, and other contributors

KERR WOOD LEIDAL
consulting engineers

1,000 0 1,000
(m)

Project No.	Date
2148-010	October 2016

Water System Overview

Figure 2-1

Path: \\nasvictoria.victoria.kerrwoodleidal.org\Victoria\Projects\2000-2999\2100-2199\2148-003\430-GIS\MXD-Rpt\Water Master Plan Figures\2148003-DNS-Figure2_1_WaterSystem.mxd Date Saved: 05/11/2015 1:00:32 PM
Author: RSinnott

2.3 Water Model Components

2.3.1 Water Mains

The District's GIS, supplied in November 2014, was used to verify the pipe attributes populated in the initial water model build. The initial water model build was built from attributes in the DNS Watermap.dwg provided in 2013.

Material type was used to assign roughness coefficients (Hazen-Williams C-Factors). A summary of the water main materials, roughness coefficients and lengths for all the water mains included in the model (including CRD water mains) is provided in Table 2-1. Flow testing was completed in October 2014 to validate the roughness coefficients used in the model. Details of the flow testing results are described in Section 2.4.

Table 2-1: Water Main Summary

Material	Modelled Roughness Coefficient (C-Factor)	Length of Main in Model (m)$^{(1)}$	District Owned Mains (m)
Asbestos Cement (AC)	110	59,142	52,105
Concrete	110	3,057	0
Ductile Iron (DI)	120	9,038	5,575
Fibre Glass (FG)	100	2,314	0
Galvanized (GALV)	90	58	58
High Density Polyethylene (HDPE)	135	71	71
Polyethylene (PE)	135	1,390	1,390
Polyvinyl Chloride (PVC)	135	88,749	85,765
Steel	120	219	219
Unknown	100	4,483	4,483
TOTAL		**168,522**	**149,666**
Notes: (1) Length includes CRD mains			

2.3.2 PRV Stations

There are 34 District owned PRV stations and five CRD owned PRV stations. Diameter and set point data for the District owned PRVs were input using the PDF file "PRV setpoints.pdf" provided in December 2013.

The majority of the stations have a typical two valve arrangement; a smaller lead valve set to a higher pressure to provide domestic flows, and a larger lag valve to provide peak hour demands and fire flows when the system pressure is lowered. To improve model stability, all stations are modelled as one equivalent diameter valve with the lower pressure set point.

All pressure zones have multiple PRV feeds. It was important to determine the current operating point of each PRV to properly validate the model. Confirmation of PRV set-points as well as valve sizes and piping arrangement for District owned PRVs was completed through a condition assessment by District operations. More information on the model validation is included in Section 2.4. More information on the condition assessment is included in Section 3.2.

Information for the CRD PRV stations was collected through correspondence with CRD operators and SCADA records. The location and function of the CRD PRVs included in the model are described as follows:

- PRV-CRD-AM: Amity PRV, located at Amity Drive and Highway 17, supplies flow from Pressure Zone 2B to 1C;
- PRV-CRD-BA: Bazan Bay PRV, located at Bazan Bay Road and Manwaring Road, supplies flow from Pressure Zone 2A to 1D;
- PRV-CRD-CAR: Carmanah Terrace PRV, located at Dean Park Middle Reservoir, lowers pressure supplied from Dean Park Upper Reservoir (275.8 m TWL) to Pressure Zone 5;
- PRV-CRD-MC: McDonald PRV Station, located at McDonald Park Road and Highway 17, allows flow to go between Pressure Zones 1D and 1, normally closed;
- PRV-CRD-TO: Towner PRV Station, located at West Saanich Road and Towner Park Road, allows flow to go between Pressure Zones 1D and 1, normally closed;
- PRV-MCTAVISH-1: McTavish PRV located in a valve chamber adjacent to the McTavish Reservoir, supplies Pressure Zone 1D

A summary of the modelled PRV station data is included in Table 2-2.

Table 2-2: PRV Station Settings

Table 2-2: PRV Station Summary

PRV Station	Supplies Pressure Zone	From Pressure Zone	Valve 1 Diameter (mm)	Valve 1 Setting (HGL)	Valve 2 Diameter (mm)	Valve 2 Setting (HGL)	Modelled Equivalent Valve Diameter (mm)	Modelled Set Point (HGL)
513	1	2	50	84.5	150	78.9	158.1	78.9
514	1	2	75	83.2	150	77.6	167.7	77.6
515	1	2	50	85	150	78.6	158.1	78.6
516	1	6	50	89.5	100	83.8	111.8	83.8
517	1	2	100	83.4	200	77.8	223.6	77.8
519	1	2	64	89	150	84.1	163.1	84.1
521	1	2	50	90.1	100	84.4	111.8	84.4
539	1	2	64	89.1	100	84.2	118.7	84.2
540	1	2	64	88.7	100	82.3	118.7	82.3
520	2	6	50	110.5	100	104.8	111.8	104.8
523	2	6	50	97.9	150	91.5	158.1	91.5
524	2	6	50	101.6	100	96	111.8	96
525	2	6	50	108.9	100	103.3	111.8	103.3
526	2	6	50	92.2	100	86.6	111.8	86.6
527	2	6	100	97.7	300	90.6	316.2	90.6
528	2	6	100	102	200	97.8	223.6	97.8
529	2	6	50	104.2	150	98.6	158.1	98.6
30	3	4	50	145.1	100	150.7	111.8	145.1
31	3	4	50	152.8	100	147.2	111.8	147.2
32	3	4	50	149.1	100	142.8	111.8	142.8
33	3	4	50	155.2	100	151.7	111.8	151.7
34	3	5	50	152.8	100	146.4	111.8	146.4
35	4	5	50	184.3	100	179.4	111.8	179.4
530	6	7	100	140.8	250	134.5	269.3	134.5
531	6	7	100	142.1	300	136.4	316.2	136.4
532	6	7	75	141.5	150	136.6	167.7	136.6
518	1A	1	64	86.2	150	80.6	163.1	80.6
534	1B	2A	64	75.9	150	71	163.1	71
535	1B	2A	64	74.9	150	69.2	163.1	69.2
536	1B	2A	50	75.2	100	75.2	111.8	75.2
537	1C	1D	50	63.9	100	58.3	111.8	58.3
538	1C	1D	75	65.3	150	59.7	167.7	59.7
36	2A	3	50	107.4	100	100.4	111.8	100.4
506	2B	2A	50	94.9	100	89.3	111.8	89.3
CRD-AM	1C	2B	150	63.33			150	63.33
CRD-MC	1D & 1	1D & 1	150	78	200	78	NA	78
CRD-TO	1D & 1	1D & 1	200	77	200	77	NA	77
CRD-BA	1D	2A	150	77			150	77
CRD-CAR	5	DP-HIGH	75	?	150	200.72	168	200.72
CRD-MACTAVISH	Sidney / Bazan Bay	MacTavish	200	77.5	300	85.29	NA	77.5 / 85.29

2.3.3 Zone Boundaries (Closed Valves)

Closed valves which represent pressure zone boundaries were determined using the water system composite map and confirmed through correspondence with District staff.

2.3.4 Appurtenances

The remaining elements of the water distribution system which have no direct controlling effect on the operation of the system are not included in the water model (i.e. normally open valves, fire hydrants, etc.). The location of hydrants was used to assist in the assessment of available fire flows.

2.3.5 Boundary Conditions

There are five reservoirs owned and operated by the CRD that provide storage for the system. A summary of the CRD reservoir volumes is included in Table 2-3.

Table 2-3: CRD Reservoir Summary

Reservoir Name	Supplies Pressure Zone(s)	Reservoir Volume (ML)	Top Water Level Elevation (m)
Dean Park Lower	1B, 1C, 2A, 2B	4.23	110.5
Dean Park Middle	3, 4	2.68	189.5
Dean Park Upper	5	4.55	275.8
McTavish	1D	6.80	82.0
Cloake Hill	1, 1A, 2, 6, 7	4.49	170.6

Boundary conditions for the model were determined by analyzing SCADA information from the CRD and through correspondence with CRD operators.

Upstream boundary conditions determine the pressures available in the transmission mains supplying the system. For the North Saanich system the upstream boundary conditions are handled by setting initial levels for the CRD reservoirs and by modelling a portion of the CRD transmission system (Main #4). Reservoir level SCADA records for July 2013 to January 2014 from the CRD were reviewed to determine typical lower levels observed during high flow maximum day demand conditions. The setting of the PRV in the McTavish Reservoir Valve Chamber, supplies Pressure Zone 1D from CRD Main #4, was provided by the CRD through correspondence with the operators[1].

Upstream Boundary conditions are summarized in Table 2-4.

[1] Email correspondence with Tony Nakata, October 7, 2014.

Table 2-4: Upstream Boundary Condition Summary

Facility Name	Observed Range[2]	Modelled Setting
Dean Park Lower Reservoir	105.5 – 106.9 m HGL	106.1 m HGL
Dean Park Middle Reservoir	182.6 – 183.8 m HGL	180.5 m HGL
Dean Park Upper Reservoir	272.9 – 274.7 m HGL	272.3 m HGL
McTavish Reservoir	77.9 – 82 m HGL	80.5 m HGL
Cloake Hill Reservoir	154 – 170.4 m HGL	165.1 m HGL
McTavish Reservoir Valve Chamber PRV	n/a	85.3 m HGL

Downstream boundary conditions, demands of Sidney and the pump rate to Cloake Hill Reservoir through CRD transmission, are included for CRD Main #4 because flow through the transmission system will create head losses and reduce the pressure available to the system. Demands for the Town of Sidney were based on recent planning work completed by KWL and are summarized in Table 2-5.

Table 2-5: Downstream Boundary Condition Summary

Location	Existing MDD (L/s)	Future MDD (L/s)
Mills Road Sidney Supply	33.4	37.3
McTavish Reservoir Sidney Supply	33.4	37.3
CRD Deep Cove Pump Station to Cloake Hill Reservoir pumping rate.	100	100

2.3.6 Demands

Base day and seasonal demands for each lot were determined according to Section 4. Non-revenue water was equally distributed to each lot connected to the water distribution system. Each lot was given a demand and connected to the closest node in the system.

2.4 Model Validation

Hydrant flow tests were completed on August 28, 2014 to collect field data to validate the model results following the initial model build. A review of PRV set-points for District owned PRVs was completed through a condition assessment by District Staff in October and November 2014.

2.4.1 Hydrant Flow Testing

Validation testing involves taking a series of flow and pressure measurements in the field, calculating HGLs, and comparing values to results predicted in the model under the same flow conditions for each test location. To complete the field testing portion, a pressure transducer is placed on a hydrant (called the ‘residual’ hydrant) at a location of interest and a flow meter is placed on a hydrant (called the ‘flow’ hydrant) downstream or in close hydraulic proximity. The flow hydrant is then opened to create a large flow through the water main. The hydrant flow is measured and the pressure at the residual hydrant is recorded for the duration of the flow test. The pressure is also recorded before and after the hydrant is opened (called the ‘static’ pressure measurement).

[2] Observed range according to the SCADA records provided by the CRD for July 1, 2013 to January 31, 2014.

C-Factor testing follows a similar process as validation testing, but uses an additional pressure transducer to directly measure the friction losses on a section of water main (the friction loss is approximated as the difference in pressure between the two residual pressure loggers). The friction loss is then converted to a friction factor in a standard friction loss equation. Friction losses in the North Saanich model are calculated by the Hazen-Williams equation. In the Hazen-Williams equation, the coefficient "C" is inversely related to the friction loss slope, therefore the lower the C-Factor, the greater the friction loss.

Model validation and C-Factor flow testing was completed on August 28, 2014, by District of North Saanich and KWL staff. Ten test locations were selected as shown on Figure 2-2. The primary goal of the flow testing was to validate the water model. An additional logger was used to measure friction losses at six of the ten test locations.

The results of the C-Factor testing are shown in Table 2-6 below including a comparison C-Factor values for new pipes. The C-Factors used in the model (summarized in Table 2-1) compare well with the C-Factor values measured in the field.

Table 2-6: Flow Testing C-Factor Results

Test ID	Pipe Material and Diameter	Measured Hazen Williams C-Factor	"New" Pipe C-Factor
1	PVC, 200 mm dia.	127	150
2	AC, 150 mm dia.	123	140
4	PVC, 150 mm dia.	131	150
7A, 7B	PVC, 150 mm dia.	145, 143	150
8	PVC, 200 mm dia.	126	150
10	PVC, 200 mm dia.	136	150

The validation test results comparing the field measurements to pressure results predicted in the model are shown in Table 2-7 below.

2.4.2 Pressure Reducing Valve Setting Review

There are numerous PRV stations in the system and confirmation of PRV set points is an important step in model validation. Confirmation of PRV set-points as well as valve sizes and piping arrangement for District owned PRVs was completed through a condition assessment by District Staff in October and November 2014.

To determine the current set-points of each District owned PRV, the station was isolated from other PRVs in the zone, a demand was generated on a downstream hydrant, and each PRV was operated in isolation from others in the station. If the station had two valves, this process was repeated.

The settings were provided to KWL and were used to update the settings in the water model. The updated PRV settings are summarized in Table 2-2.

2.4.3 Validation Testing Results

KWL updated the model with the PRV set points collected by the District and then compared the pressure values collected in the field during the flow tests to the results collected by the model. The model validation results are summarized in Table 2-7.

Table 2-7: Model Validation Result Summary

Test ID	Location	Field Test Static HGL (m)	Field Test Residual HGL (m)	Model Static HGL (m)	Model Residual HGL (m)	Static Pressure Difference (m)	Residual Pressure Difference (m)
1	Wain Rd.	98.8	74.6	99.0	72.3	-0.2	2.3
2	Downey Rd.	99.6	66.7	98.1	68.4	1.5	-1.7
3	Kispiox Pl.	85.6	65.1	88.5	68.6	-2.9	**-3.5**
4	Cromarty Ave.	105.7	76.7	104.8	71.6	0.9	**5.1**
5	Cresswell Rd.	155.0	130.8	152.6	130.3	2.4	0.5
6	Amity Dr.	105.0	101.5	106.0	103.1	-1	-1.6
7A	Marina Way(1)	82.0	62.3	83.6	62.9	-1.6	-0.6
7B	Marina Way(2)	82.0	56.1	83.2	65.1	-1.2	**-9.0**
8	Tanger Rd.	144.5	121.5	141.8	115.3	2.7	**6.2**
9	Ravenscroft Pl.	85.6	69.9	85.9	62.2	-0.3	**7.7**
10	John Rd.	81.1	64.1	83.8	65.0	-2.7	-0.9

Notes:
(1) Bypass at CRD McDonald PRV Open
(2) Bypass at CRD McDonald PRV Closed

Static HGLs are heavily influenced by boundary conditions such as PRV set points and reservoir levels and are typically not greatly affected by friction losses because water main velocities are relatively low when hydrants are not flowing. The majority of the PRV stations in the system have two valves; a lead and a lag valve. The lead valves are usually smaller and have a higher set point than the lag valve. The lag valve is typically designed to be closed under normal daily flow conditions, but should open during high demand and fire flow conditions. For the sake of model stability, PRV stations with two valves were modelled as one equivalent valve, with the area of both valves summed and converted to an equivalent diameter.

For the purposes of model validation, the lead valve setting was assigned to the model for the static condition scenario, and the lag valve setting was assigned for flow condition scenario.

Residual HGLs are typically influenced primarily by friction losses. However, as some zones in the system have multiple PRVs supplying a relatively small area, modelled boundary conditions and using the lag PRV setting could play a role in residual HGL discrepancies as well (i.e. local lag valve does not open during a flow test in the field because the area is supplied by other stations).

American Water Works Association (AWWA) Manual M32, “Computer Modeling of Water Distribution Systems” provides guidance and best practices for water modelling and model validation. AWWA M32 recommends that hydraulic grade lines (HGL) predicted by the model be within 1.5 to 3 m of those recorded in the field.

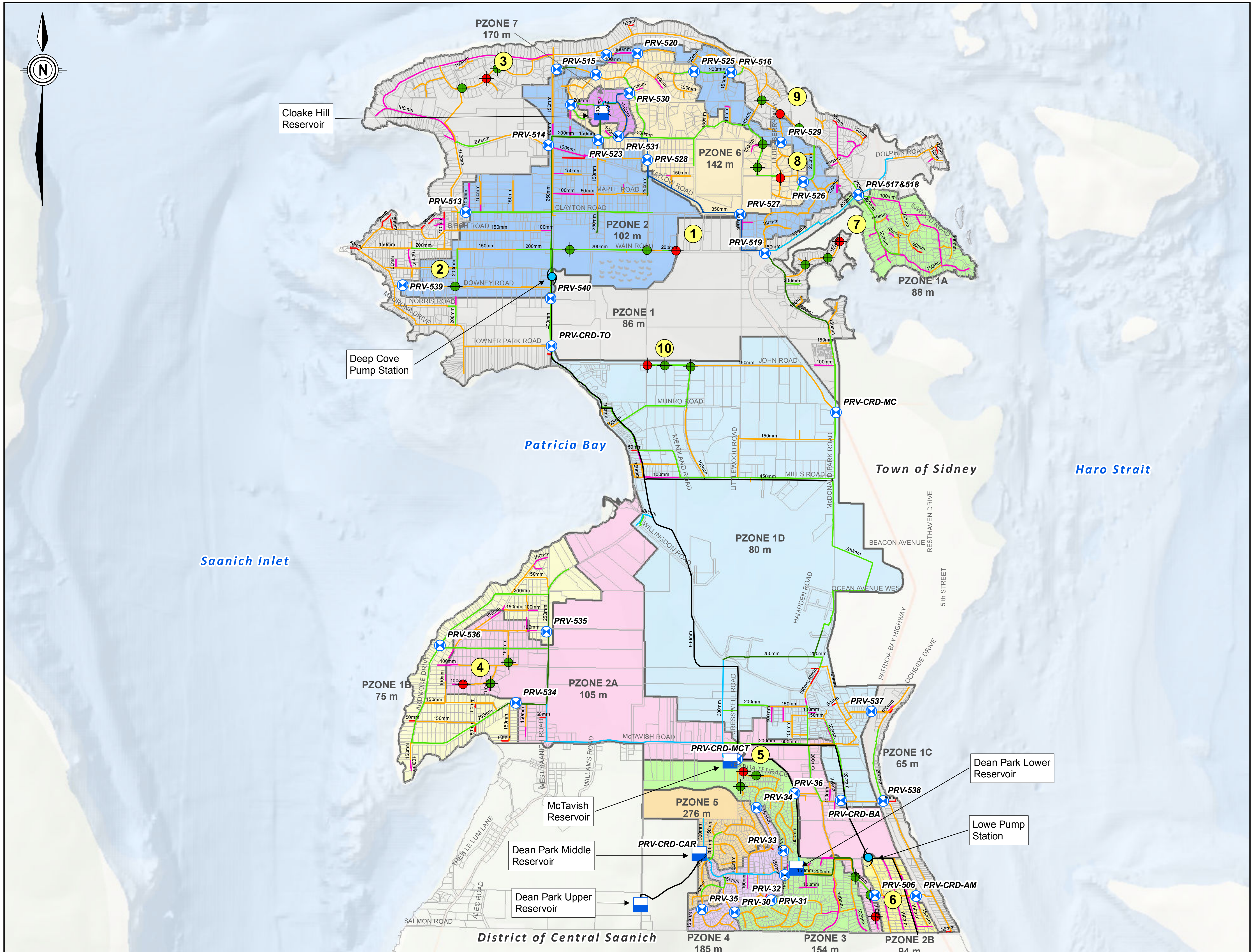
Results with a HGL difference greater than 3 m are highlighted in the table above. All tests are within the 3 m discrepancies for static pressure. Five tests have residual discrepancies greater than 3 m. Three of these discrepancies are conservative model results, one is a slight over-prediction of residual pressures at a -3.5m discrepancy and one is an over-prediction of residual pressures at a -9.0 m difference. The following is noted with regards to test 7B, the -9.0 m discrepancy:

- At the time of the test the system was being operated with the McDonald Park PRV that feeds from pressure zone 1D to pressure zone 1 fully open. McDonald PRV was opened at this time to take demand off the Cloake Hill reservoir which experienced a low level alarm.
- For Test 7B the McDonald PRV station was temporarily closed in an effort to run a test as the system is normally operated.
- Operations staff provided revised set-points for PRV 519 which had its setpoint reduced to allow pressure zone 1D to feed pressure zone 1 through the CRD Mcdonald PRV station. Operations did not mention changing set-points for the other PRVs in the surrounding area that feed pressure zone 1 from pressure zone 2. It is noted that other changes would likely have been required to allow flow through McDonald PRV station to zone 1.
- The above potential for missing details on how the zone was temporarily managed, is likely the reason for the discrepancies not only in Test 7B but also for Test 3 which also over-predicted residual pressures and Tests 8 & 9 which under-predicted residual pressures.

Other sources of error may include:

- PRVs not operating during the flow test – due to valve issues or clogged strainers;
- Changing boundary conditions during test – PRVs slowly opening during flows tests can impact measurements collected in the field;
- Discrepancies in the pipe network - Diameters or material types installed differs than those modelled; and
- Unaccounted for minor head losses – possible sources of head loss that have not been accounted for in the model include closed or partially closed valves.

The model validation exercise provided confidence in the model.



District of North Saanich
Water System Master Plan

Legend

- PRV Station
- Reservoir
- Pump Station
- CRD Supply Main

Flow Test Locations

- Flow Hydrant
- Residual Hydrant
- Flow Test ID

Water Main Diameter (mm)

- < 50
- 50 - 100
- 150
- 200
- 250
- 300
- 350
- > 350

Pressure Zone

PZ 1 - 86 m HGL	PZ 2B - 94 m HGL
PZ 1A - 88 m HGL	PZ 3 - 154 m HGL
PZ 1B - 75 m HGL	PZ 4 - 185 m HGL
PZ 1C - 65 m HGL	PZ 5 - 276 m HGL
PZ 1D - 80 m HGL	PZ 6 - 142 m HGL
PZ 2 - 102 m HGL	PZ 7 - 170 m HGL
PZ 2A - 105 m HGL	

Reference: GIS data from the District of North Saanich
Service Layer Credits: Esri, DeLorme, GEBCO, NOAA NGDC, and other contributors

KERR WOOD LEIDAL
consulting engineers

1,000 0 1,000
(m)

Project No.	Date
2148-010	October 2016

Model Validation Flow Test Locations

Figure 2-2

3. Condition Assessment

Understanding the actual economic life of underground assets is a complex but essential part of effective asset management. Collection of historical break data and pipe sampling and testing provide the best indicators of condition and calculation of replacement frequency or service life for a particular asset based on the costs of maintaining the asset versus replacement.

This section of the report reviews operations knowledge on main breaks, reviews materials and age and the systems overall condition. A field review of PRV stations was also completed by operations staff and a summary of this review is also provided.

3.1 Main and Service Break History and Life Expectancy

Main and Service Break History

The District does not have a formal database of main and service breaks. Senior operators with the District have stated that in the last 10 years there has been an average of 2 main breaks and 5 service repairs per year although the pipe material and diameter of the breaks is unknown. This equates to the following system wide benchmarks:

- 1.34 main breaks per 100km per year; and
- 1.1 service breaks per 1000 service connections given an approximate 4,500 services.

Both main and service break benchmarks are very low which indicates that the system's overall condition is very good. The District's main break frequency is approximately 10 times lower than the average reported in Canada and elsewhere.

PVC has the lowest break frequency of all pipe material types, accounts for 57% of the system, and likely assists in the overall low break frequency.

AC pipe is the second largest material type representing approximately 35% of the system. 65% of AC pipe is 45-55 years old (33,092m of the system). If 70% of all main breaks are associated with this older AC, the associated break frequency would be 4.2 breaks/100km/year. This theoretically calculated break frequency is low and it can therefore be inferred that the District's oldest AC mains are in good condition for their age.

Life Expectancy

The life expectancy of different materials types is a function of a number of factors such as ground conditions, water table, installation practices, loading conditions, and physical properties of the pipes design such as pressure class and wall thickness.

PVC pipe failures have typically been associated with manufacturing defects, poor installation practices and ground movement. Among municipalities that report break rates, PVC pipe 20 years and older have a very low break rate, around 1-3 breaks per 100 km per year, with a very low rise in break frequency with age. PVC began to be installed in the early 1960s so break data does not yet exist that would prove a definitive life expectancy. Some recent literature references low recorded break rates, low initial rates of rise in breaks, and the materials inert chemistry as reason to believe PVC will last past its design life of 100 years. The District won't likely need to renew much PVC infrastructure until sometime after AC renewals are complete. AC and DI renewals are therefore the focus of this master plans renewals budgeting discussion.

Asbestos Cement (AC) pipe life expectancy is a function of the rate of deterioration of the pipe wall resulting from chemical leaching of the cement material within the pipe, causing the pipe to soften and lose structural strength. The rate of internal and external pipe wall deterioration is a function of water chemistry and the surrounding soil environment and therefore service life will vary significantly from municipality to municipality and even within municipalities. A 2013 Water Research Foundation paper studied AC mains in 20 utilities in the United States and Canada and found that AC pipe subjected to aggressive water quality and soil environments ranged in condition from imminent failure to 50 years remaining life. The paper then states that in regions with less aggressive water quality and dry soil conditions, AC pipes might be expected to serve for another 100 to 150 years if not subject to active soil movement and premature failure[3]. The life expectancy of AC increases with wall thickness and therefore in practice has been seen to increase with pipe diameter as wall thickness increases as diameter increases for the same pressure class.

Much of the District's 100mm AC has reached 50 years of age however an increase in 100mm AC watermain breaks has not yet been noted by operations. This could be due to the District's pipes experiencing lower than average deterioration rates. Sample pipe sections from AC mains being replaced can be opportunistically collected and tested to quantify deterioration rates. This would involve phenolphthalein staining to quantify leaching of cementious material and mechanical testing to assess remaining pipe load capacity. It is noted that these test results would provide valuable information needed to confirm future funding levels.

The District has approximately 5.6km of ductile iron (DI) pipe. The life expectancy of DI is highly influenced by the surrounding soil environment and means of corrosion protection. In the absence of condition data the average life expectancy of DI is assumed to be 75 years.

3.2 PRV Condition Assessment

A condition assessment of PRV stations was completed by District staff in October and November, 2014. KWL provided an assessment form as well as a methodology for determining PRV set-points, required for validation of the model. Condition assessment reports are included in Appendix A.

PRV Condition Assessment Findings

The condition of the stations is generally good and all are expected to reach service life if regularly maintained.

Below is a complete list of work items identified through the condition assessment, organized by PRV station. Two stations, 35 and 514 had PRVs that were rebuilt at the time of inspection and Station 523 requires rebuilds of both PRVs. If not already completed, these rebuilds should be completed as soon as practical. The other work items detailed below have a lower urgency level and can be completed over a 3-5 year period. Work items are as follows:

Station # - Summary of Work

30 – Pipework and chamber needs paint.

31 –Risk of breaking pilot lines when entering and exiting due to proximity to ladder. Pipework and chamber need paint.

[3] Long Term Performance of Asbestos Cement Pipe, Water Research Foundation, Yafei Hu, Dunling Wang, and Rudaba Chowdhury, January 2013

32 – Leaking packing gland on isolation valve, 75mm pipe is galvanized.

35 – Pilot PRV on 100mm valve was rebuilt to restore service at time of inspection.

506 – Incoming pressure gauge was replaced during inspection. Hosebib bung leaking on high pressure side.

513 – Chamber and pipework need paint.

514 – Rebuilt 75mm PRV & pilot. Replaced speed control and restrictor.

515 – Pipework needs paint.

516 – Small diameter manhole opening and long distance to first rung of manhole. Chamber needs paint. Pipework needs paint.

520 – Chamber and pipework need paint.

521 – Replaced air valve and inlet pressure gauge at time of inspection. Chamber needs paint.

523 – Both 50mm and 150mm PRVs need to be rebuilt. Butterfly valves for sensors should be replaced with ball valves. Ladder should be relocated from centre of work area. Isolation valves packing glands leak when isolated. Chamber and pipework need paint.

524 – Pipework needs paint.

525 – Manhole needs to be grouted. Chamber and pipework need paint. 50mm pipework is galvanized.

526 – Isolation valves are leaking. Chamber and pipework need paint.

529 – Packing glands on isolation valves are leaking. Pipework rusty and needs paint. Chamber needs paint.

530 – Pipework and chamber need paint.

531 – 300mm isolation valve on outlet does not close completely. Pipework and chamber need paint.

532 – Pipework and chamber need paint.

534 – Outlet pressure gauge replaced at time of inspection.

In conversations following the condition assessment work, operations noted that Stations 525 and 516 should be given the highest priority for renewal. It is noted that our recommendations for system upgrades include the removal of Station 525 and rezoning of the discrete section of Zone 2 which it supplies to Zone 6. The small manhole opening and distance to the first ladder rung at Station 516 present a work place hazard.

PRV Life Expectancy and Renewals

The District owns 34 PRV stations. With an expected renewal frequency of between 60 and 80 years dependent on site conditions, the District will need to renew a station once every 2-3 years.

Given the generally good condition of the stations we do not foresee renewals occurring prior to 2020. The District should however continue to inspect PRV stations on a yearly basis and complete maintenance and renewals of components as necessary.

4. Demand Allocation

Existing and future demand scenarios were developed for the District of North Saanich. Water system demands are broken down into three components; base demand (BD), seasonal demand (SD) and non-revenue water (NRW), and are described as follows.

- Base demand (BD): Typical indoor water usage. Includes residential and Industrial Commercial Institutional (ICI) demands;
- Seasonal demand (SD): Irrigation demand. Includes residential and ICI demands;
- Non-revenue water (NRW): The volume of water lost between the system input volume (total source flow) and the total revenue water (metered water). NRW is distributed throughout the water system.

The maximum day demand (MDD) is the sum of BD, SD and NRW. The methodology used to determine and distribute the demands is summarized in the following sections.

4.1 Demand Allocation Methodology

The District provided the service water meter records for 2013. KWL reviewed the 35 records with the highest consumption and distributed these demands to the corresponding lots. Using the annual average day demand (ADD) data available from the meter records, the MDD was calculated based on the following assumptions.

- MDD = 2 x ADD – MMCD Design Guidelines, applied to most users;
- MDD = 4 x ADD – Applied to large agricultural users;
- MDD = 3 x ADD – Applied to BC Ferries; and
- BD = 0.7 x ADD – Applied to all users.

For the remaining lots, a land use map was developed using zoning data provided by the District of North Saanich. Unit rates from published sources and developed through previous KWL studies were used to assign residential population, population equivalence (PE) for ICI lots, base demand, and seasonal demand for each lot. The unit rates used for this study are summarized in the table below.

Table 4-1: Unit Rate Assumptions

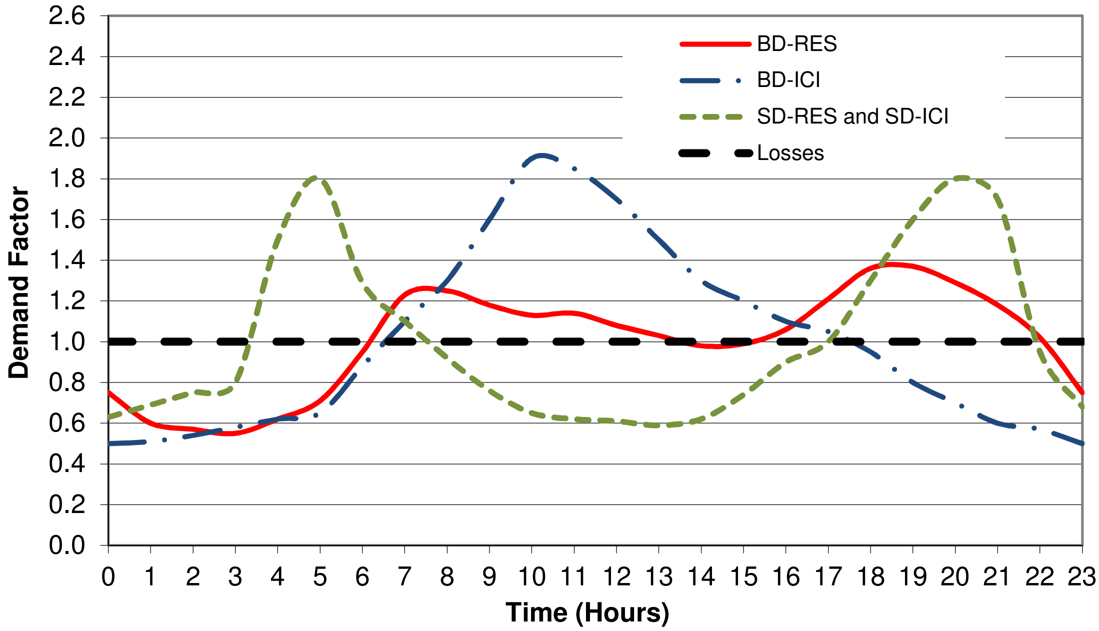
Demand Component		Reference
Population:		
Single Family Residential	2.6 ca/unit	2011 Census Data
Rural Agriculture	2.6 ca/unit	
Multi Family Townhouse	2.0 ca/unit	
Multi Family Apartment	1.4 ca/unit	
Population Equivalent:		
Industrial	90 ca/ha	MMCD Design Guidelines
Commercial	50 ca/ha	MMCD Design Guidelines
Institutional	90 ca/ha	MMCD Design Guidelines
Golf Course	10 ca/ha	Previous KWL Study
Base Demand:		
Per Capital Usage Rate	203 L/ca/day	Previous KWL Study – District of Saanich
Seasonal Demand:		
Single Family Residential Lot	1900 L/lot/day	Previous KWL Study
Rural Agriculture Lot	3800 L/lot/day	2 x Single Family Rate
Multi Family Lot Irrigated Area	20% of lot area	Previous KWL Study
Multi Family Lot Irrigation Rate	34,300 L/ha/day	Previous KWL Study – District of Saanich
ICI Lot	950 L/lot/day	½ of Single Family Rate

NRW was estimated by calculating the unavoidable annual real losses (UARL) for the system and assuming an infrastructure leakage index (ILI) of 1.5. The NRW was distributed equally to each lot connected to the water system.

4.2 Peaking Factors

Typical diurnal patterns were assigned to the various demand components to account for different usage throughout the day and are used to calculate peak hour demand. The diurnal patterns applied to the demands are shown in Figure 4-1.

Figure 4-1: Diurnal Water Demand Patterns



4.3 Existing Demands

Table 4-2 summarizes the demands assigned to the water model for the existing demand scenario.

For comparison, source flow data from the CRD for July 2013 to January 2014 was reviewed. The 2011 Census population was also compared to the population calculated using the rates from Table 4-1. The results of the comparison are provided in Table 4-2.

Table 4-2: Population and Demand Comparison

Parameter	Modelled	Comparison	Difference
District of North Saanich Residential Population	11,119	11,089 (1)	30
Max Day Demand (L/s)	175.2	174.3 (2)	0.9
Base Demand (L/s)	46.7	40.3 (3)	6.4

Notes:
(1) 2011 Census Population
(2) CRD Source Flow Data, July 24 and 25, 2013
(3) CRD Source Flow Data, December 2013 average

4.4 Future Demands

Areas with potential future development were identified through discussion with the District. Demands were calculated based on the number of lots or commercial area and the demand unit rates in Table 4-1.

Future demands for VAA are based on a previous planning study completed by KWL.

The existing agriculture demand for municipally supplied water was estimated at approximately 30 L/s by the water balance completed for the existing demand build. There are numerous competing factors which could either increase or decrease use of municipal water for agricultural irrigation in the future; these factors are summarized in Table 4-3.

Table 4-3: Influences on the Use of Municipal Water for Agricultural Irrigation

Increasing Usage	Decreasing Usage
Climate change (drought, heat)	High land values encourage alternate land uses (e.g. hobby farms)
"Local Food" movement increases food demand and cultivated area	An increase in municipal water rates discourages use for irrigation
Reduction in production in other farming areas due to climate (e.g. California drought) spurs local production	Increasing mechanization continues to make small farms less economically viable due to competition
Need for high quality water to reduce risk of contamination	Increases in irrigation efficiency (drip irrigation)
Need for high quality water for drip irrigation systems	Social shifts away from professional farming as a preferred career option
Reduced groundwater yield	
More water intensive farming practices associated with organic farming	

A review data on North Saanich Farms from 2006 and 2011 Statistics Canada information as well as the Draft Agriculture Plan for North Saanich (2010), indicates the following:

Existing Farm Land Overview:

- Total Agriculture Land Reservoir (ALR) Land = 1,407 ha
- ALR with agricultural potential = 1,055 ha
- Actively Farmed Land (2010) = 689 ha
- Agriculture potential land that has competing land-use = 269 ha
- Additional Land that could be farmed (2-3-4) = 97 ha
- Agriculture land that is active hay production = 286 ha (42% of the total)

Irrigated Land Overview:

- Total irrigated area (2006)= 257 ha
- Total irrigated area (2011) = 246 ha (4% decrease)
- Hay (2011) = 137 ha (20% increase from 115 ha in 2006 and 55% of the total irrigated land)
- Field Crops (2011) = 74 ha
- Fruit (2011) = 21 ha
- Other (2011) = 14 ha

It is estimated that the 30 L/s agricultural demand (municipal water), accounts for roughly 20% of the total agricultural demand with the remainder being supplied by private wells.

To develop future agriculture demands, the following assumptions were made:

- 75% of all lands being actively farmed for hay will be irrigated which is roughly a 60% increase from existing;
- Municipal water use will increase to 30% of the total Ag water use; and
- 20% increase in all other farm irrigation uses.

Based on the above assumptions, the resulting future irrigated agriculture areas are:

- Hay Irrigation Area (Future) = 217 Ha
- Other Irrigation Area (Future) = 131 Ha
- Total Irrigation Area (Future) = 348 Ha

Future municipal supplied irrigation is estimated to be 65 L/s, roughly double the existing estimate of agriculture demands.

The future development areas and additional future demands are summarized in Table 4-4.

Table 4-4: Future Demand Summary

Future Development	Number of Lots / Development Area (ha)	Additional Population or PE	Additional Base Demand (L/s)		Additional Seasonal Demand (L/s)		Total Additional MDD (L/s)
			Res	ICI	Res	ICI	
Residential							
East Saanich to McTavish Road	550 lots	1,375	3.2		9.7		12.9
McTavish Road West	470 lots	1,175	2.8		8.3		11.1
McDonald Park Road (Tseyum)	100 lots	250	0.6		1.8		2.4
Canoe Cove	100 lots	250	0.6		1.7		2.3
Birch / West Saanich	20 lots	50	0.1		0.3		0.4
Commercial							
Victoria Airport Authority		4,056		9.5		17.8	27.3
Sandown Park Race Track	4.05 ha	364		0.9		1.6	2.5
Birch / West Saanich	0.81 ha	73		0.2		0.3	0.5
Agricultural							
Additional Agriculture				32.4			32.4
Total Additional Future		7,593	7.3	43.0	21.8	19.7	91.8
Total Existing		13,287					175.2
Total Future		20,880					267

5. Design Criteria

Criteria from the Master Municipal Construction Document (MMCD) Design Guideline Manual were used to evaluate the system, and are summarized in the sections below.

5.1 System Pressure

The required system water pressures are summarized in the table below.

Table 5-1: Required System Pressure

Description	Required Pressure kPa (psi)
Minimum Pressure at Peak Hour Demand	300 kPa (44)
Maximum Allowable System Pressure	850 kPa (123)
Minimum Pressure Coinciding with Fire Flow and MDD	150 kPa (22)

5.2 Required Fire Flow

MMCD minimum fire flow values based on land use type were used and are provided in the table below.

Table 5-2: Required Fire Flow

Land Use Type	Required Fire Flow (L/s)	Required Duration (hr)	Storage Volume (ML)
Single Family Residential	60	1.4	0.3
Apartments, Townhouses	90	1.9	0.6
Commercial	150	2	1.1
Institutional	150	2	1.1
Industrial	225	2.9	2.3

Actual required fire flows should be determined for all new developments in accordance with the current edition of “Water Supply for Public Fire Protection – A Guide to Recommended Practice” published by the Fire Underwriters Survey (FUS).

Although some jurisdictions in Canada set lower minimum criteria for remote rural residential areas, the design calculations within these standards, when applied to an average North Saanich dwelling, will result in a required fire flow much greater than the minimum stated criteria. The BC Design Guidelines for Rural Residential Community Water Systems states that systems shall be designed to meet the FUS standard. The FUS standard references in the preface that “The minimum size water supply credited by FUS must be capable of delivering not less than 1000 L/min *(17 L/s)* for two hours…” however the FUS design calculation for a 1,500 square foot, wood frame, non-sprinklered home with maximum separation distances to other structures, computes to 60 L/s.

The District of Central Saanich’s 2013 Water Distribution Master Plan reviewed the difference between FUS calculated required fire flows and the MMCD guideline for typical residential and rural residential dwellings in Central Saanich. The FUS calculated values were found to be 80 L/s for both residential and rural residential dwellings compared to the MMCD value of 60 L/s. The District of Central Saanich used the higher 80 L/s value as their design criteria. Other local municipalities have done the same within their design standards.

Table 5-3 below provides a comparison of residential single family and multi-family required fire flow design criteria being applied by local municipalities.

Table 5-3: Comparison of Required Fire Flow for Residential Dwelling among Local Municipalities

Municipality	Required Fire Flow (L/s)	
	Single Family	Multi Family
MMCD	60	90
Central Saanich	80	140
Sidney	60	150-200
Saanich	60	200
Anmore	60	120
Belcarra	60	120
Burnaby	90	200
Coquitlam	60	120
Maple Ridge	60	120
North Vancouver City	60	90
Port Moody	60	150
Richmond	120	230
Abbotsford	75	120
City of Kelowna	60	90

The MMCD minimum fire flow values are applied as a basis for assessing the requirements for system upgrades within this master plan, however, required fire flows relating to new developments should be based on site specific FUS calculations for that development.

5.3 Hydrant Spacing

MMCD Design Guidelines indicate that hydrants should be located not more than 150 m apart, nor more than 90 m from a building, and in accordance with “Water Supply for Public Fire Protection – A Guide to Recommended Practice” published by the FUS. Additional hydrants may be needed where required fire flows are higher than 90 L/s.

5.4 Reservoir Storage Capacity

MMCD Design Guidelines indicate that the required reservoir capacity should be calculated by the following formula:

$$\text{Total Storage Volume} = A + B + C$$

Where:
$A = \text{Fire Storage (from FUS guide)}$
$B = \text{Equalization Storage (25\% of Maximum Day Demand)}$
$C = \text{Emergency Storage (25\% of } A + B\text{)}$

5.5 Unit Costs

Class D opinions of probable cost have been developed for each recommended project. The cost opinions have been assembled with no detailed site information and are based on the 2015 construction year. No allowance has been provided in these figures for escalation in subsequent years. The cost opinions in this report are indicative and have been prepared for long-term budgeting purposes only. Unit prices are based on recent costs for similar tasks; however, quantity take-offs are approximate and detailed assessment has not been completed. Land acquisition costs (if applicable) are not included.

Costs for water main construction reflect typical scope for a distribution main with road restoration. Costs for water main construction tasks were developed using the unit rates provided in Table 5-3.

Table 5-4: Water Main Unit Costs

Item	Unit Cost[1]
150 mm Diameter Water Main	$300/m
200 mm Diameter Water Main	$350/m
250 mm Diameter Water Main	$400/m
300 mm Diameter Water Main	$500/m
400 mm Diameter Water Main	$600/m
Service Connection	$2,000/each
Hydrant	$6,000/each
Tie-in	$5,000/each
PRV Station	$90,000/each
Note: 1 Unit costs do not include engineering, overhead / administration, contingency or taxes.	

The following allowances were added to the above unit rates to arrive at the total opinion of probable cost for each water main installation project:

- 15% engineering and construction management services;
- 10% overhead / administration; and
- 15% contingencies.

On average, for the density of service connections and the typical size of projects recommended for North Saanich, the above unit costs and allowances result in the following average unit costs:

- Distribution main upgraded to 150mm = $667/m;
- Distribution main upgraded to 200mm = $681/m;
- New 150mm for system looping = $494/m; and
- New 200mm for system looping = $549/m.

6. System Evaluation

6.1 Supply

The District's water system is supplied by the CRD owned and operated Saanich Peninsula Water System which includes CRD Main #4 and the Lowe and Deep Cove Pump Stations. A review of the supply capacity of the CRD transmission system and pump stations is outside of the scope of this report.

6.2 Available Reservoir Storage

The reservoirs in the District's system are owned and operated by the CRD but they have been included in the assessment to confirm that adequate storage is available and determine if the distribution system could be managed in a way that would assist in equalizing the demand on the reservoirs.

Table 6-1 lists each reservoir's future maximum day demands, balancing, emergency, and fire storage requirements relative to the MMCD Design Guidelines. Note that Sidney is also serviced by the McTavish Reservoir.

Table 6-1: Reservoir Volume Assessment (Future Demands)

Reservoir	Storage Volume (Ml)	Future MDD off Reservoir (L/s)	Design Fire Flow (L/s & Duration)	Fire Storage Volume (Ml)	Balancing Storage (25% MDD) (Ml)	Emergency Storage (25% of (Balancing Storage + Fire Storage)	TOTAL REQUIRED	Comments
Cloake Hill	4.5	98	150 L/s @ 2.0 Hrs	1.1	2.1	0.8	4.0	
McTavish	6.8	83	225 L/s @ 3.0 Hrs	2.4	1.8	1.1	5.3	Demand includes 33.4 L/s to Sidney.
Dean Park Upper	4.6	21	60 L/s @ 1.5 Hrs	0.3	0.4	0.2	1.0	
Dean Park Upper / Middle	7.2	44	150 L/s @ 2.0 Hrs	1.1	0.9	0.5	2.5	
Dean Park Total	11.5	108	150 L/s @ 2.0 Hrs	1.1	2.3	0.9	4.3	
Main #4 Demands		54					NA	Demand includes 33.4 L/s to Sidney at Mills Road and Zone 1D Demands at Mills Rd
TOTAL DEMAND (Including Sidney)		**343**						

All reservoirs provide sufficient storage for future demands based on the MMCD Design Guidelines.

Main #4 and reservoirs in Saanich supply a portion of Sidney demands and a portion of Zone 1D demands as well as the supply to Cloake Hill Reservoir via the Deep Cove Pump Station. These upstream reservoirs and large diameter mains are part of the CRDs strategy for storage. Analysis of the upstream demands, CRD pump stations and reservoir storage capacities is well outside the scope of this analysis.

The available storage in Cloake Hill is near but not exceeding the future demand. It is noted that the future demand on the Cloake Hill reservoir was modelled with the set-points of PRVs feeding Zone 1 were lowered to allow the CRDs McDonald Park and Towner PRV stations to supply approximately 10 L/s from Zone 1D to reduce demand on Cloake Hill Reservoir.

6.3 System Pressure Results

Figure 6-1 and Figure 6-2 show peak hour pressure with existing and future maximum day demands, respectively.

The largest change in peak hour pressures between existing and future scenarios is within Zone 2. This is due to assumed increases in agricultural demand in this area.

Modelling indicates that there are peak hour pressure deficiencies (i.e. pressures lower than 44 psi) at the following locations:

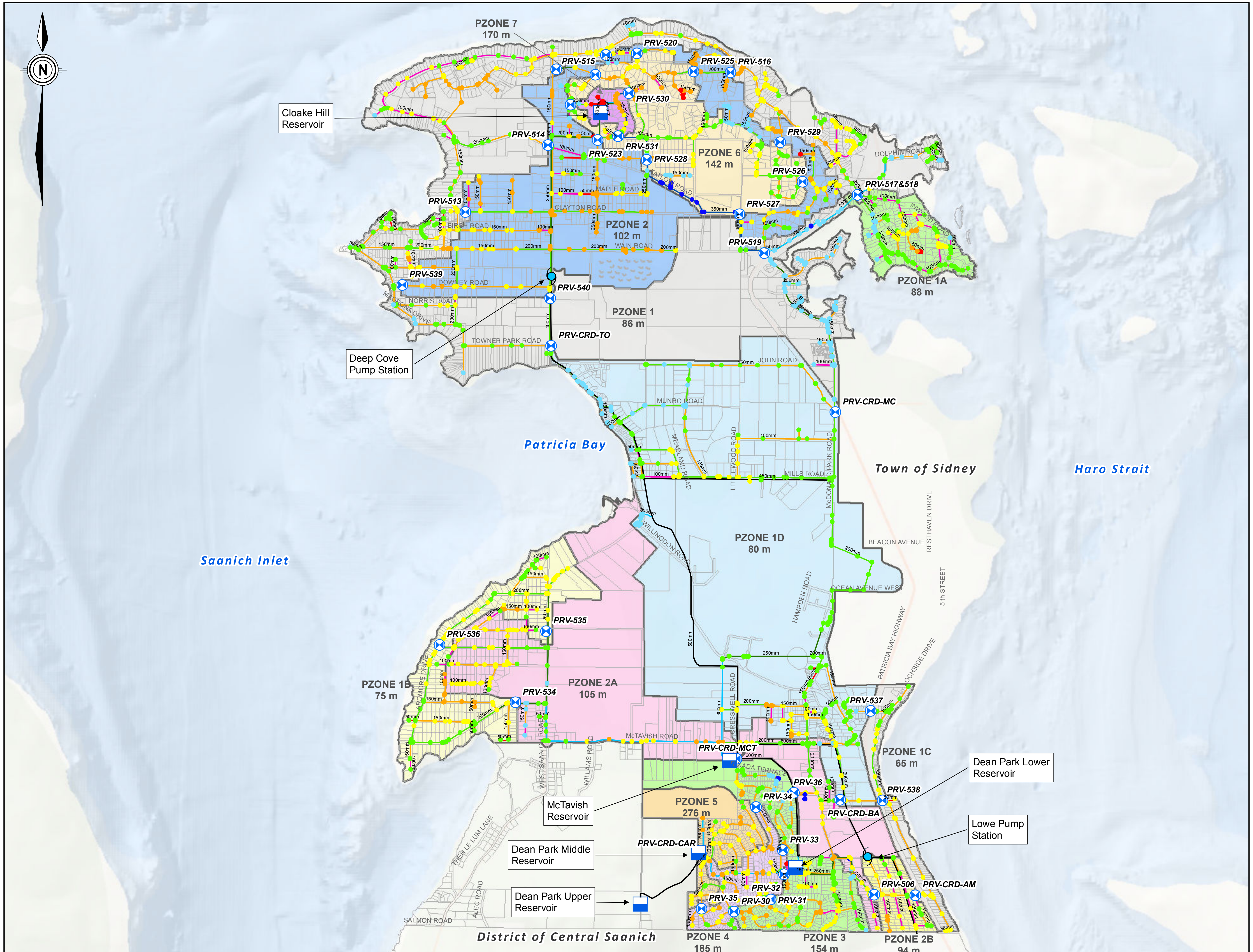
- Wain and Clayton Roads in Zone 2;
- Camas Drive in Zone 2;
- High point on Baxendale Road in Zone 2;
- High point on Rosborough Road in Zone 2;
- High point on Cromar Road in Zone 2.
- Top end of Honeysuckle Place in Zone 6;
- high point on Woodcreek Drive in Zone 1;
- Top end of Boas Road in Zone 1A;

6.4 Available Fire Flow Results

Figure 6-3 and 6-4 show the available fire flow with existing and future maximum day demands, respectively. Lots are colour coded to indicate the fire flow required based on the design criteria for each land use as shown in Table 5-2.

Fire flow deficiencies under both existing and future demand scenarios are primarily due to insufficiently sized 100mm mains and to a lesser extent a lack of system strength / looping.

District of North Saanich
Water System Master Plan



Legend

- PRV Station
- Reservoir
- Pump Station
- CRD Supply Main

Peak Hour Pressure (psi)

- < 44
- 44.1 - 60.0
- 60.1 - 80.0
- 80.1 - 100.0
- 100.1 - 123.0
- > 123

Water Main Diameter (mm)

< 50	250
50 - 100	300
150	350
200	> 350

Pressure Zone

PZ 1 - 86 m HGL	PZ 2B - 94 m HGL
PZ 1A - 88 m HGL	PZ 3 - 154 m HGL
PZ 1B - 75 m HGL	PZ 4 - 185 m HGL
PZ 1C - 65 m HGL	PZ 5 - 276 m HGL
PZ 1D - 80 m HGL	PZ 6 - 142 m HGL
PZ 2 - 102 m HGL	PZ 7 - 170 m HGL
PZ 2A - 105 m HGL	

Reference: GIS data from the District of North Saanich
Service Layer Credits: Esri, DeLorme, GEBCO, NOAA NGDC, and other contributors

KERR WOOD LEIDAL
consulting engineers

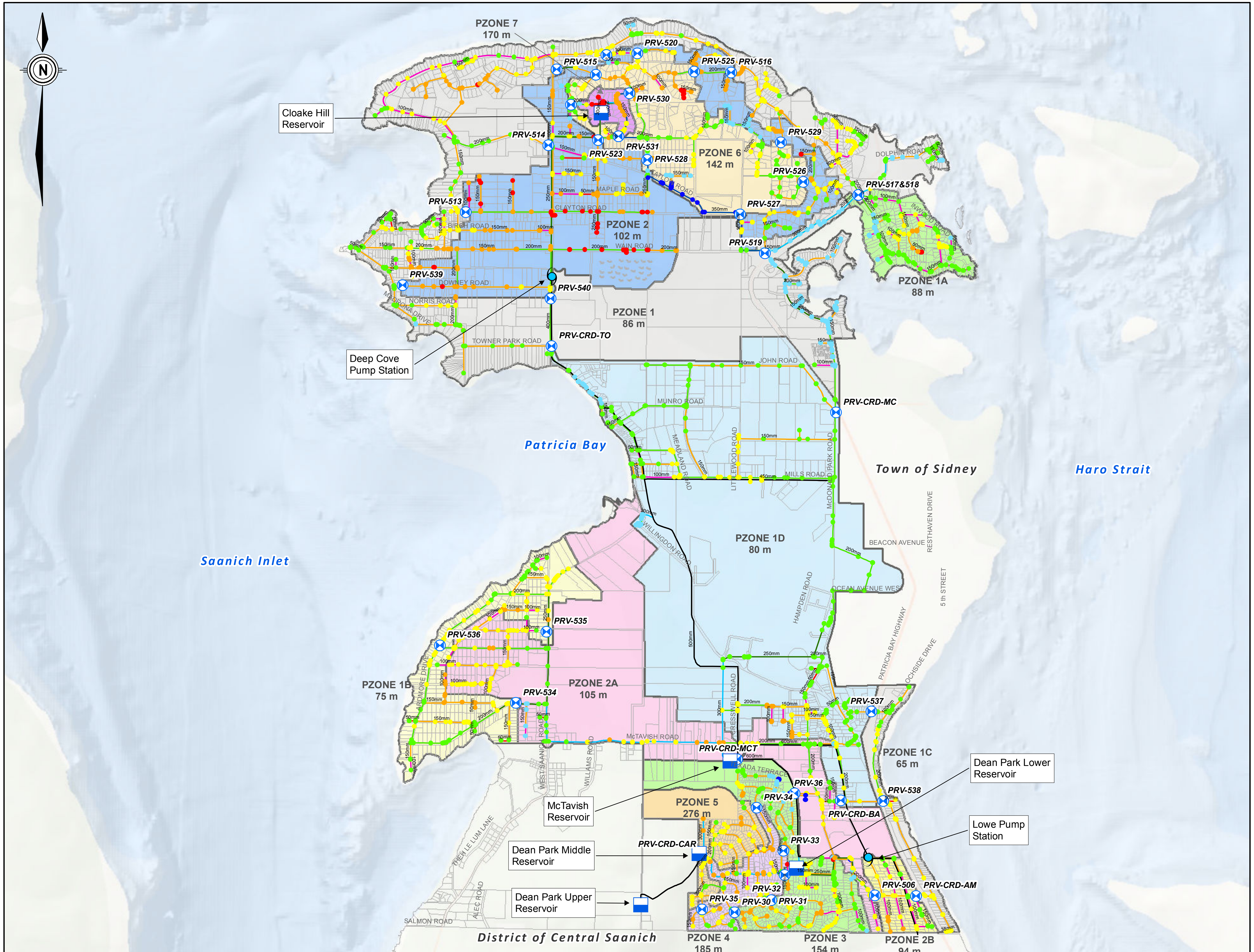
1,000 0 1,000
(m)

Project No.	Date
2148-010	October 2016

Existing Water System Existing Max Day Demand Peak Hour Pressure Model Results

Figure 6-1

Path: Q:\2100-2199\2148-003\430-GIS\MXD-Rpt\Water Master Plan Figures\2148003-DNS-Figure6_1_EX_PH_REV.mxd Date Saved: 05/11/2015 1:08:56 PM
Author: RSinnott



District of North Saanich
Water System Master Plan

Legend

Peak Hour Pressure (psi)

- < 44
- 44.1 - 60.0
- 60.1 - 80.0
- 80.1 - 100.0
- 100.1 - 123.0
- > 123
- PRV Station
- Reservoir
- Pump Station
- CRD Supply Main

Water Main Diameter (mm)

- < 50
- 50 - 100
- 150
- 200
- 250
- 300
- 350
- > 350

Pressure Zone

- PZ 1 - 86 m HGL
- PZ 1A - 88 m HGL
- PZ 1B - 75 m HGL
- PZ 1C - 65 m HGL
- PZ 1D - 80 m HGL
- PZ 2 - 102 m HGL
- PZ 2A - 105 m HGL
- PZ 2B - 94 m HGL
- PZ 3 - 154 m HGL
- PZ 4 - 185 m HGL
- PZ 5 - 276 m HGL
- PZ 6 - 142 m HGL
- PZ 7 - 170 m HGL

Reference: GIS data from the District of North Saanich
Service Layer Credits: Esri, DeLorme, GEBCO, NOAA NGDC, and other contributors

KERR WOOD LEIDAL
consulting engineers

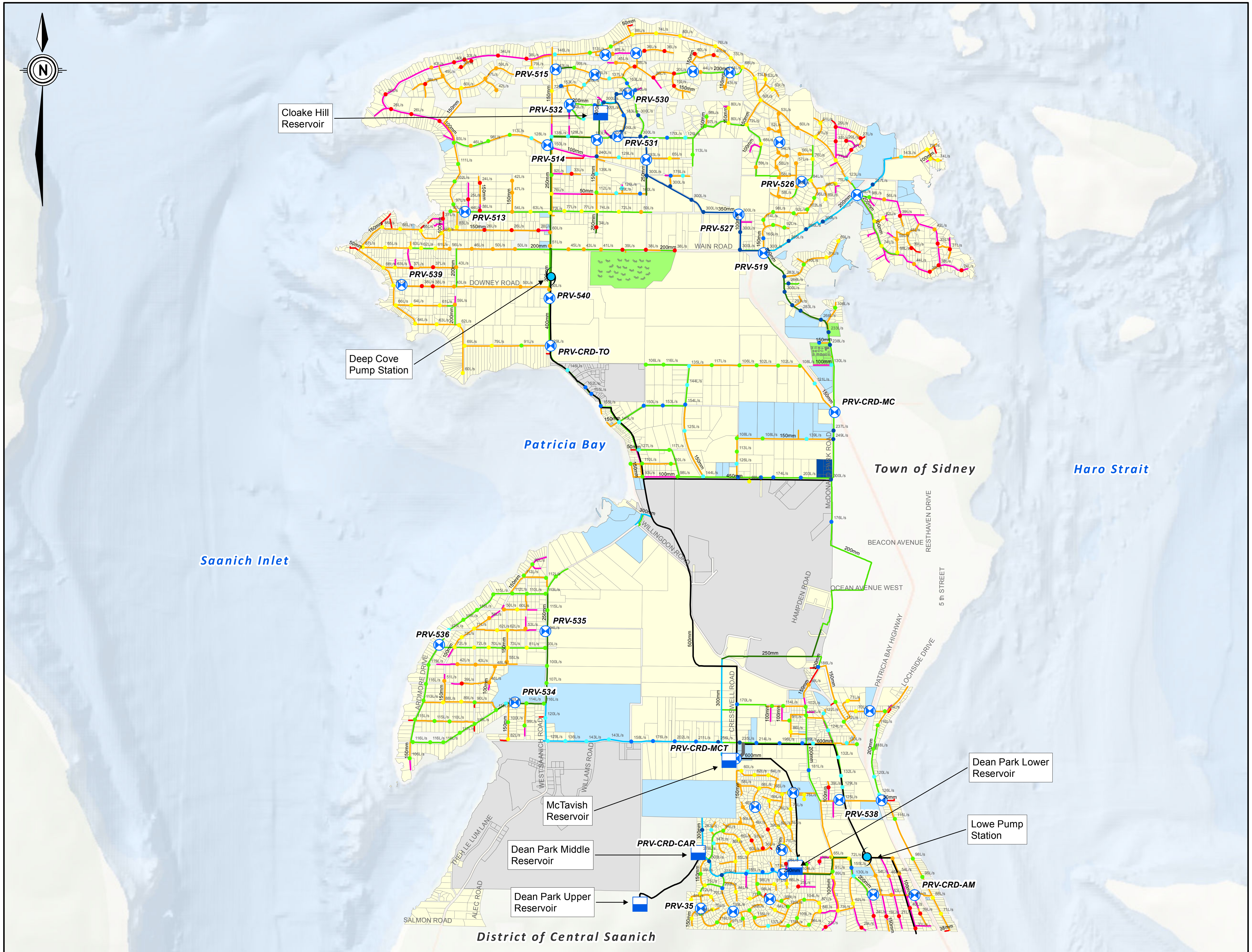
1,000 0 1,000
(m)

Project No.	Date
2148-010	October 2016

Existing Water System Future Max Day Demand Peak Hour Pressure Model Results

Figure 6-2

Path: Q:\2100-2199\2148-003\430-GIS\MXD-Rpt\Water Master Plan Figures\2148003-DNS-Figure6_2_FUT_PH.mxd Date Saved: 05/11/2015 1:37:01 PM
Author: RSinnott



District of North Saanich
Water System Master Plan

Legend

- PRV Station
- Reservoir
- Pump Station
- CRD Supply Main

Available Fire Flow (L/s)

- < 40
- 41 - 60
- 61 - 90
- 91 - 120
- 121 - 150
- 151 - 225
- > 225

Water Main Diameter (mm)

- < 50
- 50 - 100
- 150
- 200
- 250
- 300
- 350
- > 350

Lot Type (Required Fire Flow)

- Industrial (225 L/s)
- Commercial (150 L/s)
- Institutional (150 L/s)
- MF Res (90 L/s)
- Rural Agriculture (60 L/s)
- SF Res (60 L/s)
- Pauquachin FN
- Tseycum FN
- VAA

Reference: GIS data from the District of North Saanich
Service Layer Credits: Esri, DeLorme, GEBCO, NOAA NGDC, and other contributors

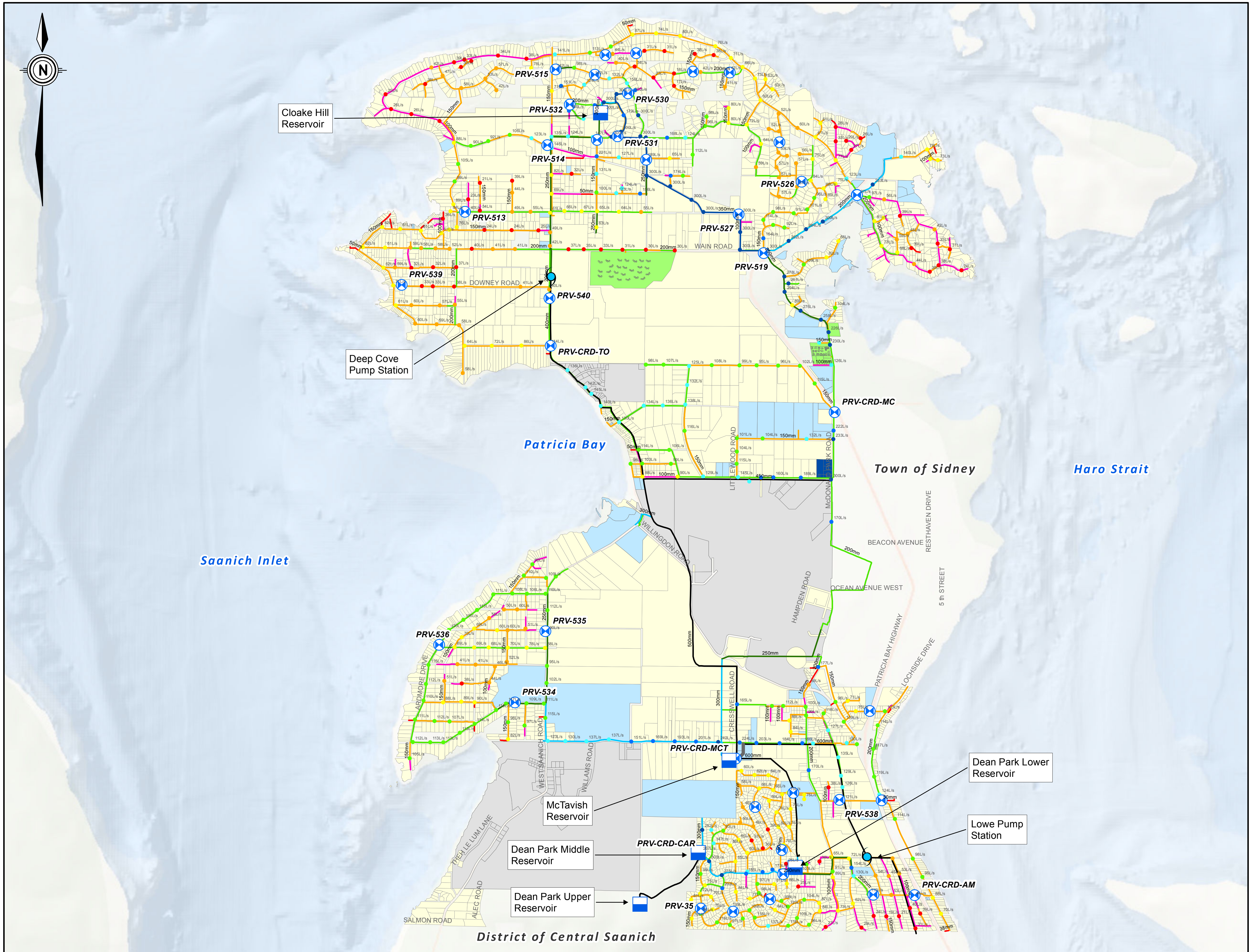
KERR WOOD LEIDAL
consulting engineers

1,000 0 1,000
(m)

Project No.	Date
2148-010	October 2016

Existing Water System
Existing Max Day Demand
Available Fire Flow
Model Results
Figure 6-3

Path: \\nasvictoria.victoria.kerrwoodleidal.org\Victoria\Projects\2000-2999\2100-2199\2148-003\430-GIS\MXD-Rpt\Water Master Plan Figures\2148003-DNS-Figure6_3_EX_FF_REV1.mxd Date Saved: 09/11/2015 12:43:57 PM
Author: RSinnott



District of North Saanich
Water System Master Plan

Legend

- PRV Station
- Reservoir
- Pump Station
- CRD Supply Main

Available Fire Flow (L/s)

- < 40
- 41 - 60
- 61 - 90
- 91 - 120
- 121 - 150
- 151 - 225
- > 225

Water Main Diameter (mm)

- < 50
- 50 - 100
- 150
- 200
- 250
- 300
- 350
- > 350

Lot Type (Required Fire Flow)

- Industrial (225 L/s)
- Commercial (150 L/s)
- Institutional (150 L/s)
- MF Res (90 L/s)
- Rural Agriculture (60 L/s)
- SF Res (60 L/s)
- Pauquachin FN
- Tseycum FN
- VAA

Reference: GIS data from the District of North Saanich
Service Layer Credits: Esri, DeLorme, GEBCO, NOAA NGDC, and other contributors

KERR WOOD LEIDAL
consulting engineers

1,000 0 1,000
(m)

Project No.	Date
2148-010	October 2016

Existing Water System Future Max Day Demand Available Fire Flow Model Results

Figure 6-4

Path: \\nasvictoria.victoria.kerrwoodleidal.org\Victoria\Projects\2000-2999\2100-2199\2148-003\430-GIS\MXD-Rpt\Water Master Plan Figures\2148003-DNS-Figure6_4_FUT_FF_REV2.mxd Date Saved: 30/06/2016 12:23:08 PM
Author: RSinnott

7. Recommended Water System Upgrades

Figure 7-1 shows recommended projects to address system deficiencies. All projects address future conditions but are also necessary to rectify existing fire flow deficiencies. Projects include:

- pipe upgrades (increases in diameter);
- new sections of pipe to increase looping and strengthen fire flows; and
- changes to zone boundaries and PRV settings.

This section of the report is divided into two sections as follows:

- Section 7.1 – description of pipe upgrade projects;
- Section 7.2 - changes to zone boundaries, PRV stations and set-points;

Figures 7-2 and 7-3 show peak hour pressures and available fire flows with the recommended projects under future demand conditions.

7.1 Recommended Projects List

Projects are identified on Figure 7-1 by project number and recommended sequential priority. Project numbering generally follows a North to South project numbering order.

Table 7-1 summarizes each project and includes:

- estimated project lengths,
- numbers of service connections, hydrants, and tie-ins;
- estimated Class D cost opinions and associated unit costs;
- a description of the project including the location, era and size of pipes being upgraded;
- purpose of the project; and
- a general priority rating based on era of existing pipe being replaced and severity of deficiencies rectified. Project priorities are rated with the following scale: Low, Low-Medium, Medium, Medium-High, and High.

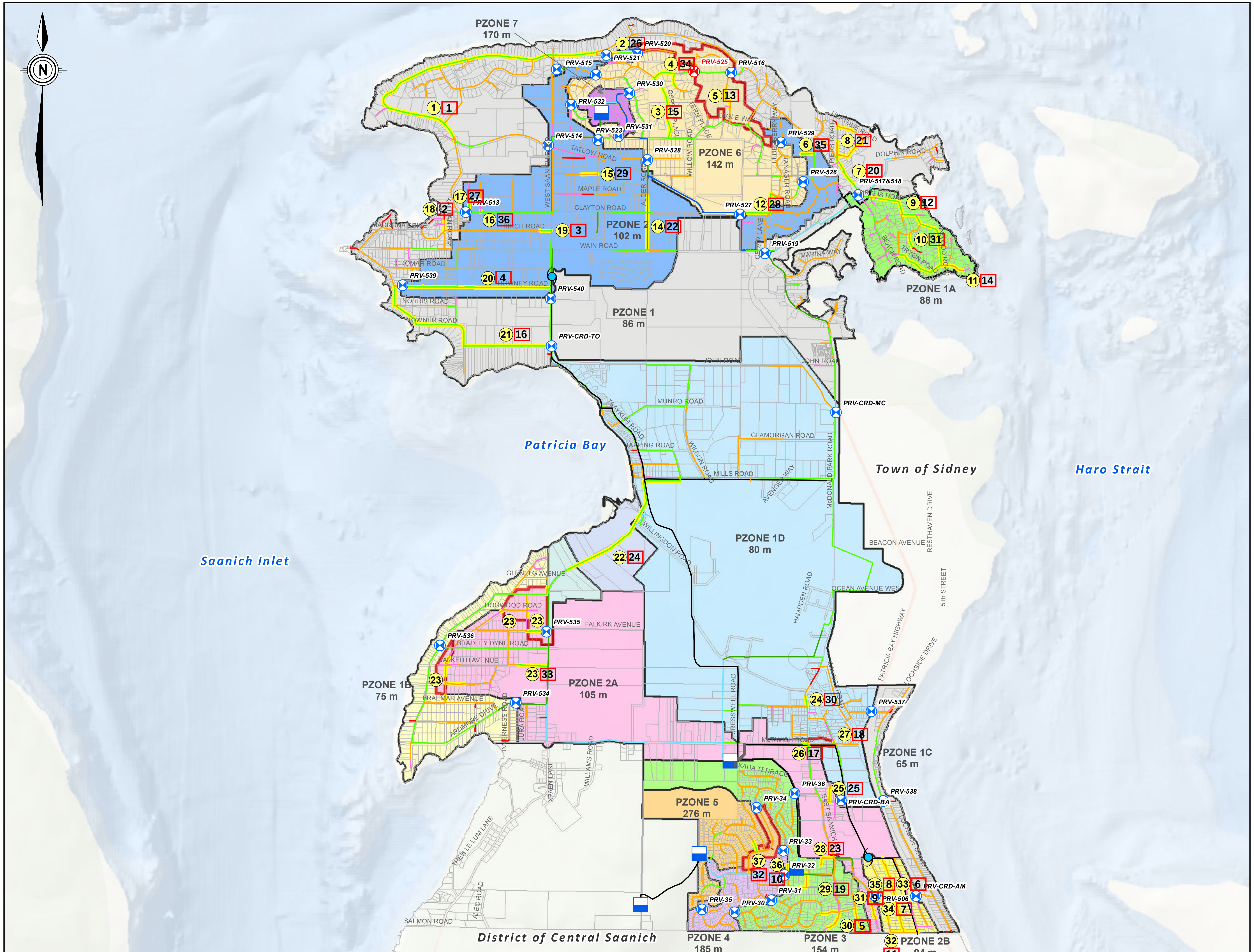
Cost opinions were derived using the methodology described in Section 5.5. The total cost for all pipe upgrades is $13.26 million dollars. The following is a summary of the project list:

- Total project length = 20.53km;
- Total renewals = 15.78km
- Total AC renewals = 12.67km;
- Total New Mains (Additional system looping) = 4.75km
- Project costs range from $2.43 million to $22,000.

Table 7-1: Recommended Pipe Upgrade Projects

Project #	Estimated Values: Length (m)	# Services	# Hydrants	# Tie-ins	TOTAL Cost	Average Unit Cost (Per Meter)	Description	Purpose	Priority
1	3,542	159	23	8	$ 2,430,000.00	$ 690	Replace early 1960s 100mm AC with 200mm PVC on Lands End Road and Chalet Road. Install new hydrants.	- Required for fireflow; - Increase number of hydrants; - Early 60s AC main replacement.	High
2	198	9	1	2	$ 145,000.00	$ 730	Upgrade section of 100mm pipe (1989 PVC) to 200mm PVC on Cloake Hill Road between PRV Stations 520 and 521.	- Required for fireflow.	Low
3	552	5	3	2	$ 324,000.00	$ 590	Install new 200mm PVC main to connect Sumac Drive from Hillgrove Rd at the South to Sumac Park at the North.	- Increase system looping in Zone 6; - Increase available fireflow and address fireflow deficiencies in Zone 6. - Install hydrants along Sumac Drive;	Medium
4	377	14	2		$ 241,000.00	$ 640	Upgrade 1987 150mm PVC to 200mm PVC on Oceanspray Drive from Sumac Drive to hydrant on Honeysuckle Place.	- Required for fireflow;	Low
5	248	0	0	2	$ 118,000.00	$ 480	Decommission PRV Station 525 (Oceanspray) to rezone discrete section of Zone 2 to Zone 6. Install new 150mm PVC main through park easement to connect Hawthorne Place and Hummingbird Place.	- Rezone to increase looping in Zone 6; - Increase available fireflow and address fireflow deficiencies in Zone 6.	Medium
6	137	6	1	1	$ 99,000.00	$ 720	Upgrade 1987 150mm PVC to 200mm PVC on Camas Drive.	- Required for fireflow;	Low
7	326	9	2	2	$ 216,000.00	$ 660	Upgrade 1964 150mm AC & PVC to 200mm PVC on Lands End Road North to Piers Road.	- Boosts fireflows in Zone 1; - Required for fireflow; - Early 60s AC main replacement.	Medium/ High
8	717	31	4	5	$ 460,000.00	$ 640	Upgrade 1970 & 1988 100mm AC to 150mm PVC on Piers Road and Neptune Road. 200mm PVC from Lands End Road to Piers/Neptune intersection.	- Required for fireflow;	Medium
9	1,866	113	12	2	$ 1,345,000.00	$ 720	Upgrade 1966 100mm AC to 200mm PVC on Curteis, Inwood and Tryon Roads. *See also KWL project number 13 which rezones Zone 1A to Zone 1.*	- Required for fireflow; - Increase number of hydrants; - 1966 AC main replacement.	High
10	153	5	1	2	$ 111,000.00	$ 730	Upgrade 1980 150mm PVC to 200 PVC on Boas Road between existing hydrant locations.	- Required for fireflow.	Low
11	256	12	1	1	$ 156,000.00	$ 610	Upgrade 1966 100mm AC to 150mm PVC on Tryon Road to hydrant (Section of Road to the Point).	- Required for fireflow; - 1966 AC main replacement.	Medium
12	654	0	0	2	$ 335,000.00	$ 510	Install new 200mm PVC main connecting Littlewood Road to Greenpark Drive through easement.	- Increase system looping in Zone 6; - Increase available fireflow and address fireflow deficiencies in Zone 6.	Low
13							PROJECT DELETED.		
14	587	0	3	3	$ 375,000.00	$ 640	Install new 250mm PVC main from Maple to Wain Road along Alder Road in right of way.	-New trunk feed into Zone 2 which increases looping / available fireflow.	Medium/ High
15	172	0	1	2	$ 95,000.00	$ 550	Install new 150mm PVC on Cypress Road to connect to Heather Road main.	- Increases system looping; - Increase available fireflow and address fireflow deficiencies in Zone 2.	Low
16	14	0	1	1	$ 22,000.00	$ 1,600	Connect hydrant on Baxendale and Clayton to 200mm on Clayton (This may already be the case).	- Required for fireflow.	Low
17	131	7	1	2	$ 106,000.00	$ 810	Upgrade 1988 100mm AC to 200mm PVC on Trillium Place from Clayton Road to hydrant.	- Required for fireflow.	Low
18	136	4	1	3	$ 98,000.00	$ 720	Upgrade 1963 100mm AC to 150mm PVC on Kalitan Road.	- Required for fireflow. - 1963 AC main replacement.	Medium/ High
19	121	6	1	2	$ 99,000.00	$ 820	Upgrade 1965 100mm AC to 200mm PVC on Birch Rd from West Saanich Road to hydrant.	- Required for fireflow. - 1965 AC main replacement.	High
20	1,627	41	10	3	$ 1,017,000.00	$ 630	Upgrade 1963 150mm AC to 200mm PVC on Downey Road.	- Required for fireflow. - 1963 AC main replacement.	High
21	2,176	82	14	4	$ 1,442,000.00	$ 660	Upgrade 1963 150mm AC to 200mm PVC on Towner Park Road, Towner Road and Madrona Road.	- Required for fireflow. - 1963 AC main replacement.	High
22	1,872	0	11	4	$ 1,032,000.00	$ 550	Install new 200mm PVC main on West Saanich Road as supply from Zone 2A (Dean Park Reservoir) to Zone 1D. Rezone PRV Station 535 to supply Zone 1D and install new 150mm PVC on West Saanich between Ardmore and Friszell for Zone 1B.	-New reservoir supply source (Dean Park) to Zone 1D and Zone 1 (through CRD PRVs); - New North / South supply main for Zone 1D. Increased redundancy.	Low
23	1,158	46	7	13	$ 804,000.00	$ 690	Install new pipe connections and upgrades in Ardmore to change Zone 2A and 1B boundaries.	- Increases system looping; - Increases available fireflow and addresses existing deficiencies.	Low
24	89	6	0	2	$ 74,000.00	$ 830	Upgrade 1970 100mm PVC to 200mm PVC on East Saanich Road North of Dickson Avenue.	- Required for fireflow.	Low
25	146	6	1	2	$ 101,000.00	$ 690	Upgrade 1970 100mm AC to 150mm PVC on Marshall Road.	- Required for fireflow.	Low
26	58	0	1	2	$ 47,000.00	$ 800	Rezone McTavish Rd from Zone 2A to Zone 1D.	- Increases looping in Zone 1D. - Improves available fireflow.	Medium
27	7	0	0	2	$ 17,000.00	$ 2,570	Connect 100mm and 200mm pipes on Mainwaring Road, North of McTavish.	- Increases looping in Zone 1D and improve water age.	Low
28	216	6	1	1	$ 123,000.00	$ 570	Upgrade 1975 100mm AC & PVC to 150mm PVC on Lowe Road.	- Required for fireflow.	Low / Medium
29	228	11	1	1	$ 142,000.00	$ 620	Upgrade 1970 100mm AC to 150mm PVC on Llwellyn Place.	- Required for fireflow; -1970 AC main replacement.	Medium
30	707	28	4	4	$ 437,000.00	$ 620	Upgrade 1960s 100mm AC TO 150mm PVC on Barrett Drive, East Saanich Road and Emard Terrace.	- Required for fireflow; -1960s AC main replacement.	High
31	255	11	1	2	$ 160,000.00	$ 630	Upgrade 1966 100mm AC to 150mm PVC on Moxon Terrace.	- Required for fireflow; -1966 AC main replacement.	Medium
32	359	0	0	3	$ 172,000.00	$ 480	Install new 150mm PVC along Central Saanich Boundary between Aldous Terrace and Bourne Terrace, also connecting Ebor Terrace.	- Required for fireflow.	Medium/ High
33	828	37	5	2	$ 507,000.00	$ 610	Upgrade 1963 & 1970 100mm AC to 150mm PVC on Ebor Terrace.	- Required for fireflow; -1963 AC main replacement.	High
34	290	13	1	1	$ 174,000.00	$ 600	Upgrade 1963 100mm AC to 150mm PVC on Aldous Terrace.	- Required for fireflow; -1963 AC main replacement.	High
35	90	4	0	1	$ 69,000.00	$ 770	Upgrade 1963 150mm AC to 250mm PVC on Amity Drive.	-Increase supply capacity to Zone 2B. - 1963 AC main replacement	High
36	100	6	1	1	$ 74,000.00	$ 740	Upgrade 100mm AC to 150mm PVC on Griggs Road.	- Required for fireflow.	High
37	119	5	1	2	$ 95,000.00	$ 800	Upgrade 150mm PVC to 200mm PVC on Portland Place.	- Required for fireflow.	Low
TOTALS	**20,513**	**682**	**117**	**92**	**$ 13,262,000.00**	**$ 650**			

District of North Saanich
Water System Master Plan



Legend

- Pump Station
- Reservoir
- PRV Station
- Decommissioned PRV Station
- Recommended Re-Zoning
- Recommended Water Main Upgrade
- KWL Project ID
- Potential Project Order (Priority)

Water Main Diameter (mm)

< 50	250
50 - 100	300
150	350
200	> 350

Pressure Zone

PZ 1 - 86 m HGL	PZ 2B - 94 m HGL
PZ 1A - 88 m HGL	PZ 3 - 154 m HGL
PZ 1B - 75 m HGL	PZ 4 - 185 m HGL
PZ 1C - 65 m HGL	PZ 5 - 276 m HGL
PZ 1D - 80 m HGL	PZ 6 - 142 m HGL
PZ 2 - 102 m HGL	PZ 7 - 170 m HGL
PZ 2A - 105 m HGL	

Reference: GIS data from the District of North Saanich
Service Layer Credits: Esri, DeLorme, GEBCO, NOAA NGDC, and other contributors

KERR WOOD LEIDAL
consulting engineers

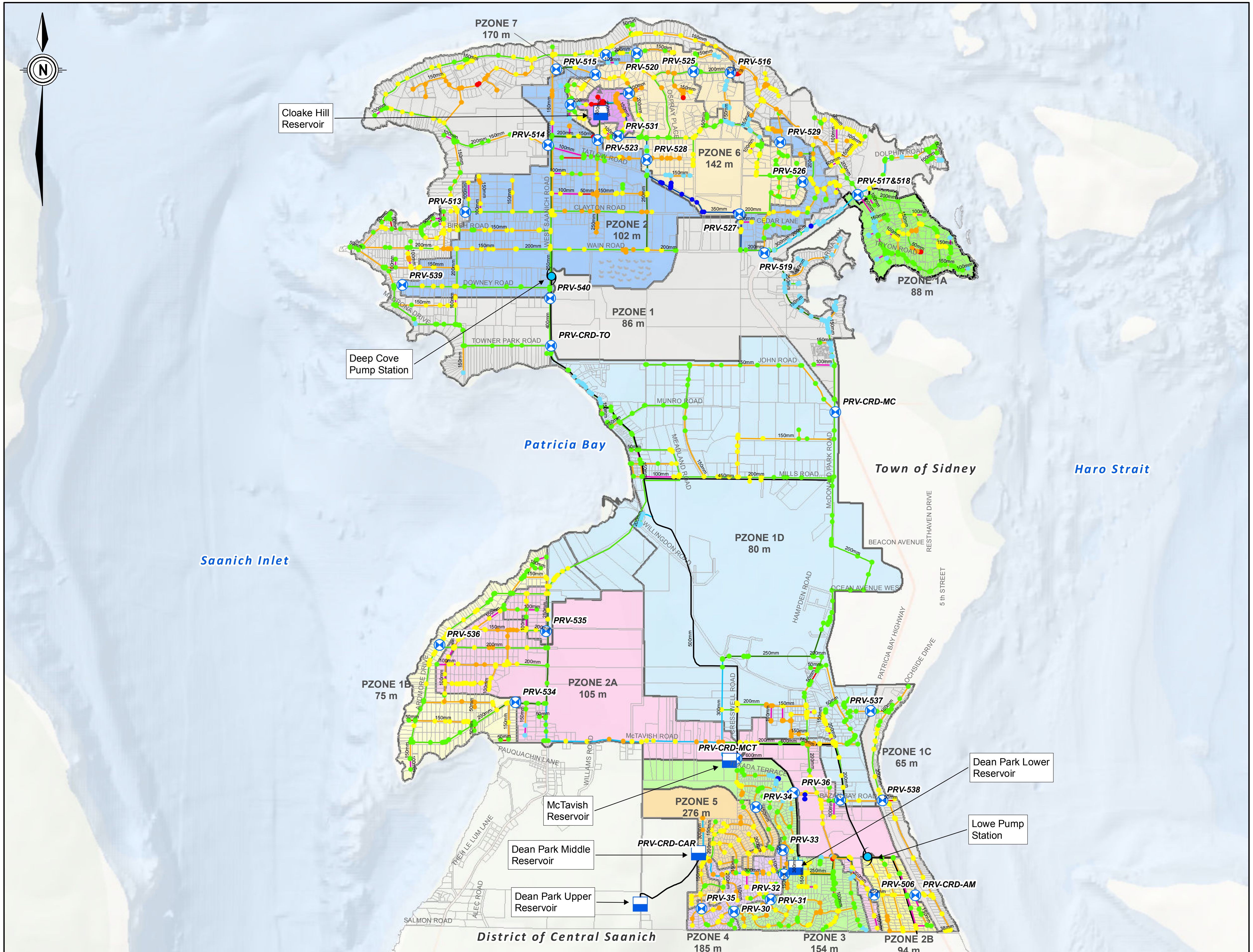
1,000 0 1,000
(m)

Project No.	Date
2148-010	October 2016

Recommended Upgrades

Figure 7-1

Path: Q:\2100-2199\2148-003\430-GIS\MXD-Rpt\Water Master Plan Figures\2148003-DNS-Figure7_1_REC_UP.mxd Date Saved: 05/11/2015 1:28:41 PM
Author: RSinnott



District of North Saanich
Water System Master Plan

Legend

- PRV Station
- Reservoir
- Pump Station
- CRD Supply Main

Peak Hour Pressure (psi)

- < 44
- 44.1 - 60.0
- 60.1 - 80.0
- 80.1 - 100.0
- 100.1 - 123.0
- > 123

Water Main Diameter (mm)

< 50	250
50 - 100	300
150	350
200	> 350

Pressure Zone

PZ 1 - 86 m HGL	PZ 2B - 94 m HGL
PZ 1A - 88 m HGL	PZ 3 - 154 m HGL
PZ 1B - 75 m HGL	PZ 4 - 185 m HGL
PZ 1C - 65 m HGL	PZ 5 - 276 m HGL
PZ 1D - 80 m HGL	PZ 6 - 142 m HGL
PZ 2 - 102 m HGL	PZ 7 - 170 m HGL
PZ 2A - 105 m HGL	

Reference: GIS data from the District of North Saanich
Service Layer Credits: Esri, DeLorme, GEBCO, NOAA NGDC, and other contributors

KERR WOOD LEIDAL
consulting engineers

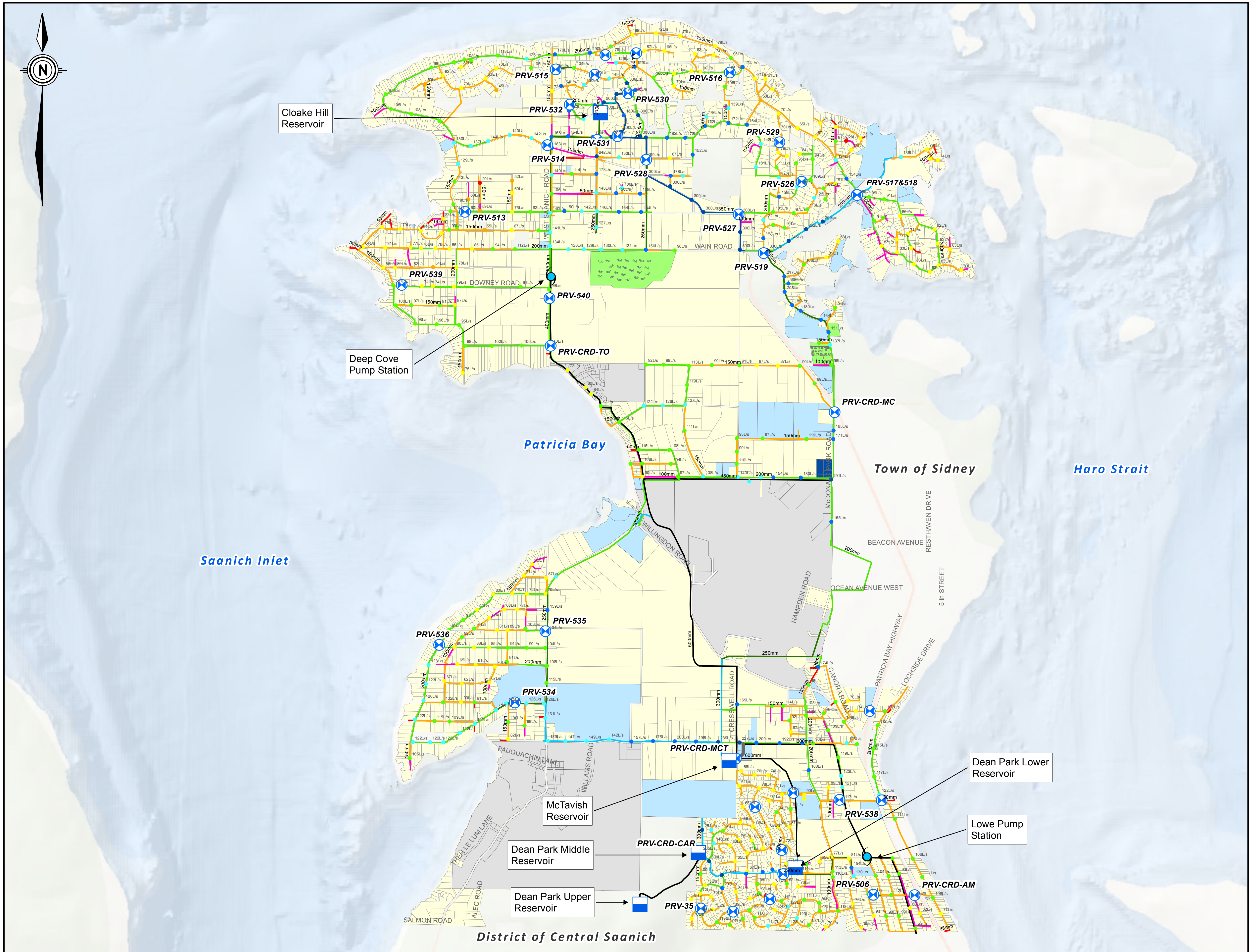
1,000 0 1,000
(m)

Project No.	Date
2148-010	October 2016

Recommended Upgrades Future Max Day Demand Peak Hour Pressure Model Results

Figure 7-2

Path: Q:\2100-2199\2148-003\430-GIS\MXD-Rpt\Water Master Plan Figures\2148003-DNS-Figure7_2_REC_PH.mxd Date Saved: 05/11/2015 1:26:14 PM
Author: RSinnott



District of North Saanich
Water System Master Plan

Legend

- Pump Station
- Reservoir
- PRV Station
- CRD Supply Main

Available Fire Flow (L/s)

- < 40
- 41 - 60
- 61 - 90
- 91 - 120
- 121 - 150
- 151 - 225
- > 225

Water Main Diameter (mm)

- < 50
- 50 - 100
- 150
- 200
- 250
- 300
- 350
- > 350

Lot Type (Required Fire Flow)

- Industrial (225 L/s)
- Commercial (150 L/s)
- Institutional (150 L/s)
- MF Res (90 L/s)
- Rural Agriculture (60 L/s)
- SF Res (60 L/s)
- Pauquachin FN
- Tseycum FN
- VAA

Reference: GIS data from the District of North Saanich
Service Layer Credits: Esri, DeLorme, GEBCO, NOAA NGDC, and other contributors

KERR WOOD LEIDAL
consulting engineers

1,000 0 1,000
(m)

Project No.	Date
2148-010	October 2016

Recommended Upgrades Future Max Day Demand Available Fire Flow Model Results

Figure 7-3

7.2 Zone Boundaries PRV Stations and Set-Points

Table 7-2 summarizes PRV set-point changes and revised zone boundaries. Zone boundary changes shown on Figure 7-1 include:

- Increased area serviced by Zone 2A in Ardmore, decreasing Zone 1B. This was done to increase system looping and boost fire flows. This involves new locations for closed boundary valves as well as new mains for looping and upgrades.
- Rezoning PRV Station 535 and the downstream section of West Saanich Road to Zone 1D. This was done to allow for a main extension on West Saanich to supply Zone 1D from Zone 2A which is serviced from Lower Dean Park Reservoir. This provides a secondary supply to Zone 1D and a second reservoir, increasing the service area of the Dean Park reservoirs. Consultation with the CRD should be done prior to making this operational change.
- Rezoning of main on McTavish Road between East Saanich Road and Mainwaring Road from Zone 2A to Zone 1D. This was done to increase system looping and boost fire flows in Zone 1D.
- Rezoning of Forest Park Drive from Dean Park Road to PRV Station 34 from Zone 4 to Zone 5. This was done to allow better system looping and boost fire flows in Zone 5.
- Decommissioning of PRV Station 525 to increase the service area of Zone 6. This was done to improve available fire flows and allow for additional system looping through Project KWL5.

Table 7-2: PRV Station Revised Valve Settings (Large PRV) and Zoning Changes

PRV Station	Pressure Zones				Hydraulic Grade Settings			NOTES
	To	From	Change To	ChangeFrom	Existing Modelled (m)	Revised Modelled (m)	Change (m)	
513	1	2			78.9	78	-0.9	Lowered Pressure in Zone 1 to allow Zone 1D to supply through CRD PRVs. Reduced demand on Cloake Hill Reservoir and reduced pumping costs (CRD).
514	1	2			77.6	78	0.4	
515	1	2			78.6	78.6		
516	1	6			83.8	79	-4.8	
517	1	2			77.8	78.5	0.7	
519	1	2			84.1	79	-5.1	
521	1	2			84.4	78.1	-6.3	
539	1	2			84.2	78	-6.2	
540	1	2			82.3	80	-2.3	
520	2	6			104.8	104.8		
523	2	6			91.5	97	5.5	Increased PRV setting to balance zone flows.
524	2	6			96	96		
525	2	6	6		103.3	NA	*	Abandon PRV Station as part of rezoning and strengthening of Zone 6.
526	2	6			86.6	92	5.4	Increased PRV setting to balance zone flows.
527	2	6			90.6	90.6		
528	2	6			97.8	97	-0.8	Decreased PRV setting to balance zone flows.
529	2	6			98.6	98.6		
30	3	4			145.1	145.1		
31	3	4			147.2	147.2		
32	3	4			142.8	142.8		
33	3	4			151.7	151.7		
34	3	4		5	146.4	146.4		Rezoned Forest Park Drive to Zone 5 to incease available fireflows.
35	4	5			179.4	179.4		
530	6	7			134.5	136.57	2.07	Increased PRV setting to balance zone flows.
531	6	7			136.4	136.4		
532	6	7			136.6	136.6		
518	1A	2	1		80.6	78.2	-2.4	Rezoned 1A as part of Zone 1 to increase supply capacity and available fireflows.
534	1B	2A			71	71		
535	1B	2A	1D		69.2	83	13.8	Rezoned to zone 1D providing supply from Zone 2A (Dean Park). This is paired with installation of a 200mm main on West Saanich Road. Boundary changes between Zone 1B and 2A to increase available fireflow.
536	1B	2A			75.2	75.2		
537	1C	1D			58.3	58.3		
538	1C	1D			59.7	59.7		
36	2A	3			100.4	100.4		
506	2B	2A			89.3	89.3		
CRD- Amity	1C	2B			63.33	63.33		
CRD-McDonald	1D & 1	1D & 1			78	84 / 78	6	Fully opened valve supplying Zone 1 from Zone 1D. Reduced demand on Cloake Hill Reservoir and reduced pumping costs (CRD).
CRD-Towner	1D & 1	1D & 1			77	84 / 77	7	
CRD- Bazan Bay	1D	2A			77	77		
CRD-Carmanah	5	Dean Park Upper			200.72	200.72		
CRD-MACTAVISH	Sidney / CRD Pump Station	MacTavish			77.5 / 85.29	77.5 / 85.29		

8. Water Master Plan

8.1 Project Prioritization Plan

Table 8-1, appended at the end of this section, provides the project list in a potential order subject to change as conceptual and detailed design is advanced.

8.2 Rate of Renewals

Figure 8-1 provides lengths of main by era of installation and material type. Only the top three material types, PVC, AC and DI are shown as they represent 97% of the total system.

The following is noted:

- 40% of the system was installed in the 1960's, an average age of 50 years. 57% or 33km of mains installed in the 1960's are AC.
- The average age of AC is 45 years and the average age of PVC is 31 years.
- Approximately 40% of the upgrades addressing fire flow deficiencies, 8.1km of pipe, replace 100mm AC pipe installed prior to 1965 (+50 year old 100mm AC).

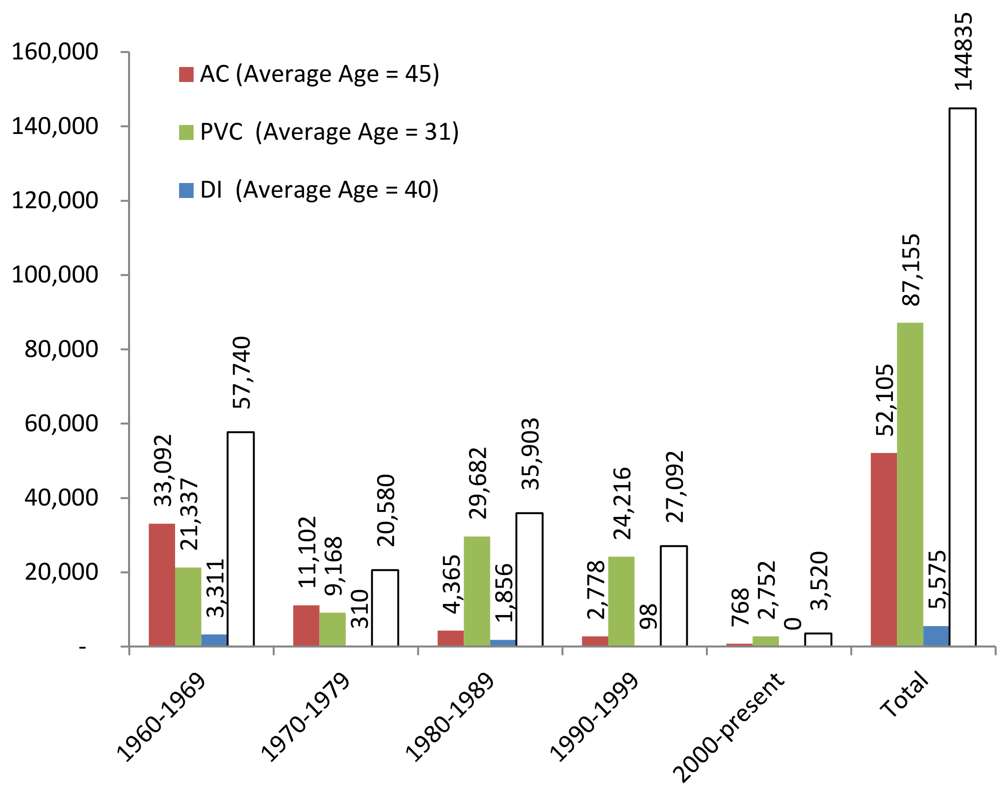


Figure 8-1: Length of Watermain by Pipe Materials and Installation Era

The following points are noted with regards to the timing and rate of renewals:

- At the current rate of funding for water infrastructure replacement, $488,300 annually, the upgrade replacements provided in this plan will take 30 years, assuming $60,000 will be needed annually, starting in 2020, for PRV station renewals.
- The total cost to replace AC and DI mains that do not require capacity upgrades is estimated at $30.6 million (in 2016 $). The current rate of replacement funding could see the renew of these AC and DI mains within 71 years or by 2117.
- Strength and pipe wall degradation testing of 100mm AC pipes being upgraded in the short term plan will inform the necessary budgeting for the short to medium term.
- Collecting historical break frequency data will also inform necessary funding levels moving forward.

The above discussion on renewals funding does not take into consideration the costs of regular maintenance.

Table 8-1: Potential Project Prioritization

Project Priority	Project #	Length (m)	Description	TOTAL Cost
1	1	3542	Replace early 1960s 100mm AC with 200mm PVC on Lands End Road and Chalet Road. Install new hydrants.	$ 2,430,000
2	18	136	Upgrade 1963 100mm AC to 150mm PVC on Kalitan Road.	$ 98,000
3	19	121	Upgrade 1965 100mm AC to 200mm PVC on Birch Rd from West Saanich Road to hydrant.	$ 99,000
4	20	1627	Upgrade 1963 150mm AC to 200mm PVC on Downey Road.	$ 1,017,000
5	30	707	Upgrade 1960s 100mm AC TO 150mm PVC on Barrett Drive, East Saanich Road and Emard Terrace.	$ 437,000
6	33	828	Upgrade 1963 & 1970 100mm AC to 150mm PVC on Ebor Terrace.	$ 507,000
7	34	290	Upgrade 1963 100mm AC to 150mm PVC on Aldous Terrace.	$ 174,000
8	35	90	Upgrade 1963 150mm AC to 250mm PVC on Amity Drive.	$ 69,000
9	31	255	Upgrade 1966 100mm AC to 150mm PVC on Moxon Terrace.	$ 160,000
10	36	100	Upgrade 100mm AC to 150mm PVC on Griggs Road.	$ 74,000
11	32	359	Install new 150mm PVC along Central Saanich Boundary between Aldous Terrace and Bourne Terrace, also connecting Ebor Terrace.	$ 172,000
12	9	1866	Upgrade 1966 100mm AC to 200mm PVC on Curteis, Inwood and Tryon Roads.	$ 1,345,000
13	5	248	Decommission PRV Station 525 (Oceanspray) to rezone discrete section of Zone 2 to Zone 6. Install new 150mm PVC main through park easement to connect Hawthorne Place and Hummingbird Place.	$ 118,000
14	11	256	Upgrade 1966 100mm AC to 150mm PVC on Tryon Road to hydrant (Section of Road to the Point).	$ 156,000
15	3	552	Install new 200mm PVC main to connect Sumac Drive from Hillgrove Rd at the South to Sumac Park at the North.	$ 324,000
16	21	2176	Upgrade 1963 150mm AC to 200mm PVC on Towner Park Road, Towner Road and Madrona Road.	$ 1,442,000
17	26	58	Rezone McTavish Rd from Zone 2A to Zone 1D.	$ 47,000
18	27	7	Connect 100mm and 200mm pipes on Mainwaring Road, North of McTavish.	$ 17,000
19	29	228	Upgrade 1970 100mm AC to 150mm PVC on Llwellyn Place.	$ 142,000
20	7	326	Upgrade 1964 150mm AC & PVC to 200mm PVC on Lands End Road North to Piers Road.	$ 216,000
21	8	717	Upgrade 1970 & 1988 100mm AC to 150mm PVC on Piers Road and Neptune Road. 200mm PVC from Lands End Road to Piers/Neptune intersection.	$ 460,000
22	14	587	Install new 250mm PVC main from Maple to Wain Road along Alder Road in right of way.	$ 375,000
23	28	216	Upgrade 1975 100mm AC & PVC to 150mm PVC on Lowe Road.	$ 123,000
24	22	1872	Install new 200mm PVC main on West Saanich Road as supply from Zone 2A (Dean Park Reservoir) to Zone 1D. Rezone PRV Station 535 to supply Zone 1D and install new 150mm PVC on West Saanich between Ardmore and Friszell for Zone 1B.	$ 1,032,000
25	25	146	Upgrade 1970 100mm AC to 150mm PVC on Marshall Road.	$ 101,000
26	2	198	Upgrade section of 100mm pipe (1989 PVC) to 200mm PVC on Cloake Hill Road between PRV Stations 520 and 521.	$ 145,000
27	17	131	Upgrade 1988 100mm AC to 200mm PVC on Trillium Place from Clayton Road to hydrant.	$ 106,000
28	12	654	Install new 200mm PVC main connecting Littlewood Road to Greenpark Drive through easement.	$ 335,000
29	15	172	Install new 150mm PVC on Cypress Road to connect to Heather Road main.	$ 95,000
30	24	89	Upgrade 1970 100mm PVC to 200mm PVC on East Saanich Road North of Dickson Avenue.	$ 74,000
31	10	153	Upgrade 1980 150mm PVC to 200 PVC on Boas Road between existing hydrant locations.	$ 111,000
32	37	119	Upgrade 150mm PVC to 200mm PVC on Portland Place.	$ 95,000
33	23	1158	Install new pipe connections and upgrades in Ardmore to change Zone 2A and 1B boundaries.	$ 804,000
34	4	377	Upgrade 1987 150mm PVC to 200mm PVC on Oceanspray Drive from Sumac Drive to hydrant on Honeysuckle Place.	$ 241,000
35	6	137	Upgrade 1987 150mm PVC to 200mm PVC on Camas Drive.	$ 99,000
36	16	14	Connect hydrant on Baxendale and Clayton to 200mm on Clayton (This may already be the case).	$ 22,000
			TOTAL	**$ 13,262,000**

9. Summary and Recommendations

9.1 Summary

In January 2014, the District of North Saanich (the District) contracted Kerr Wood Leidal Associates Limited (KWL) to build a water model for 2013 base demand, maximum day and assess the system capacity to deliver fire flows. A model calibration was completed in September 2014 along with inspection of all PRV stations to both assess condition and determine each PRVs set-point to assist in the model calibration. The District's GIS was used to verify and update the model in 2015. The model results are within acceptable agreement with field data.

Fire flow deficiencies under both existing and future demand scenarios are primarily due to insufficiently sized 100mm mains and to a lesser extent a lack of system strength through looping. The majority of 100mm mains are older AC becoming due for renewal.

Existing MDD is estimated at 175 L/s and future OCP MDD is estimated at 269 L/s. North Saanich is not expected to see significant population growth but future MDD could rise with a changing climate and farm market forces. The CRDs Sooke Lake water supply is very strong, and surrounding farm areas such as the Cowichan Valley have less resilient supply. The existing MDD demand includes 32.6 L/s in farm use. The future MDD demand scenario assumes an additional 32.4 L/s for farm use.

The current main and service break frequency indicates the condition of the pipe network is quite good. It is expected the older AC mains are in good condition for their age.

A PRV station condition assessment was completed and revealed a handful of low priority maintenance projects. The assessment also found three PRV stations with PRVs requiring rebuilds. Two of the rebuilds were completed at the time of inspection. Station 523 required rebuilds of both PRVs and this work may still be outstanding.

9.2 Recommendations

Upgrades to address existing and future fire flow deficiencies are recommended along with a prioritization plan. The total cost for all pipe upgrades is $13.26 million dollars. The following is a summary of the upgrade project list:

- Total project length = 20.53km;
- Total renewals = 15.78km
- Total AC renewals = 12.67km of which 8.1km is 100mm AC;
- Total New Mains (Additional system looping) = 4.75km

The District should plan for an annual PRV station renewal budget of $60,000 per year with renewals starting around 2020.

There is added risk and costs in managing assets as the system ages. Sample pipe sections from AC mains being replaced can be opportunistically collected and tested to quantify deterioration rates. It is noted that these test results would provide valuable information needed to confirm future funding levels.

9.3 Report Submission

Prepared by:

KERR WOOD LEIDAL ASSOCIATES LTD.

Ryan Lesyshen, M.Sc. P.Eng.
Project Manager

Reviewed by:

Eric Morris, M.A.Sc., P.Eng.
Technical Reviewer

Statement of Limitations

This document has been prepared by Kerr Wood Leidal Associates Ltd. (KWL) for the exclusive use and benefit of The Corporation of the District of North Saanich for the Water System Master Plan. No other party is entitled to rely on any of the conclusions, data, opinions, or any other information contained in this document.

This document represents KWL's best professional judgement based on the information available at the time of its completion and as appropriate for the project scope of work. Services performed in developing the content of this document have been conducted in a manner consistent with that level and skill ordinarily exercised by members of the engineering profession currently practising under similar conditions. No warranty, express or implied, is made.

Revision History

Revision #	Date	Status	Revision	Author
0	Oct 2, 2015	Draft		RYL/RS
1	Dec. 17, 2015	Revised Draft	Changes to the Executive Summary	RYL

2	July 6, 2016	Final	Changes to address final review of the Plan	RYL
3	October 3, 2016	Revised Final	Additional changes to address final review of the Plan	RYL

OQM | Organizational Quality Management Program