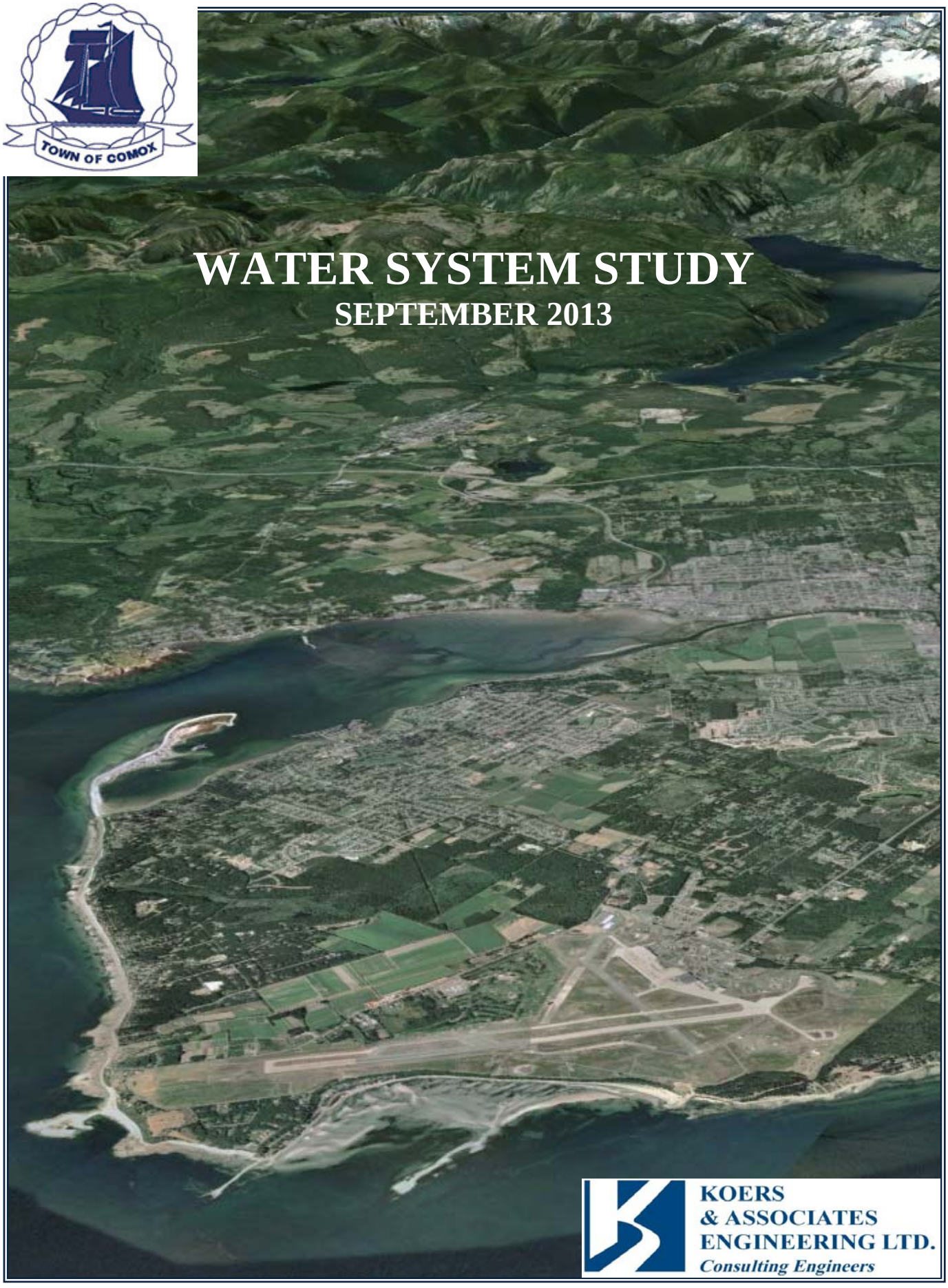

WATER SYSTEM STUDY

SEPTEMBER 2013

KOERS
& ASSOCIATES
ENGINEERING LTD.
Consulting Engineers

KOERS & ASSOCIATES ENGINEERING LTD.
Consulting Engineers

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www.koers-eng.com

September 20, 2013
1256 – Final Report

Town of Comox
1809 Beaufort Avenue
Comox, B.C. V9N 4B8

Attention: **Ms. Shelley Ashfield, PEng**
Municipal Engineer

Re: Town of Comox
Water System Study, September 2013

We are pleased to submit a three bound and a digital (pdf) copy of the "Town of Comox Water System Study, September 2013".

The report outlines the results of the computer network analysis of the water system and the improvements required to meet the pressure and flow requirements for a future population of 19,000 in accordance with the Official Community Plan build-out to Year 2031.

The majority of the upgrading projects identified in the 2003 study for the Town of Comox and the Comox Valley Water System have been implemented. Population growth has been slower than anticipated in the 2003 study. Per capita demands have been decreasing and the projected population rate of growth is lower than the 2003 study. As a result, the current system is able to accommodate the projected OCP build-out population. Upgrades are required to improve low operating pressures, meet the Town's minimum fire flow requirements, and to provide a much needed additional feed to the Town's 120 m high pressure zone distribution system east of Brooklyn Creek. Expansion of the storage capacity of the Comox Reservoir will be needed sometime between 2016 and 2026.

We thank you for the opportunity to be of service to the Town on this project. Please do not hesitate to contact us to discuss any matter in greater detail and we would be pleased to assist the Town in the implementation of the recommendations.

Yours truly,

KOERS & ASSOCIATES ENGINEERING LTD.

Chris Holmes, PEng
Project Engineer

Chris Downey, PEng
Project Manager

TOWN OF COMOX

WATER SYSTEM STUDY
SEPTEMBER 2013

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1 INTRODUCTION

1.1 AUTHORIZATION

In January, 2013, the Town of Comox authorized Koers & Associates Engineering Ltd. to complete a study of the Town's Water System. The study was to assess the ability of the Town's water system to meet the Official Community Plan growth projection needs to the build-out Year 2031. The study was to be carried out in accordance with Koers' proposal dated October 15, 2012.

1.2 BACKGROUND

The last study of the Town's water system was the "Town of Comox Water System - Water Study Updated, February 2003" by Koers & Associates Engineering Ltd. The study analysed the water distribution system and identified upgrades to meet projected service populations of 16,900-Year 2010 and 23,000-Year 2020.

While the Town's population has increased since 2003, reaching an estimated 13,504 in July 2012 as published by StatsBC (more than 1,800 additional people or a 16% increase over nine years), the rate of growth was slower than projected in the 2003 study. The Town recently updated its Official Community Plan (OCP), with a more moderate rate of growth to Year 2031, and has undertaken water conservation measures, resulting in a noticeable decrease in per capita water consumption.

Completed upgrades and expansions to the Town of Comox and Comox Valley water systems which affect the performance and capacity requirements of the Town's water supply and distribution system include:

Town of Comox

- Development of District Lot 144
- Town Boundary Expansions and Development
  - Aspen Road area
  - Knight Road area
  - Kye Bay and Lazo Road areas
  - Butchers Road area
- Lazo Road, Kye Bay Road and Knight Road Watermains
- Official Community Plan

Comox Valley Water System

- Crown Isle/Little River Reservoir
- 2nd East Courtenay Reservoir
- Dingwall Water Booster Pump Station
- Ryan Road Watermain Crossing
- Puntledge Road Water Control System Improvements
- Comox Reservoir Water Quality Improvements

The Official Community Plan was adopted in June 2011 to address land use needs and infrastructure requirements to Year 2031. One of its objectives is to reduce per capita water consumption by 40% from the 2008 baseline of 600 litres per capita per day (lpcd) to 360 lpcd.

The Town identified the need to update the 2003 water study to reflect the infrastructure changes that have occurred, and incorporate the new Official Community Plan to determine water infrastructure works required to meet projected demands to Year 2031.

1.3 STUDY OBJECTIVES

The key objectives of the study are:

- Update the water system computer model to reflect current conditions and analyse it to determine required upgrades to meet projected growth in accordance with the OCP to Year 2031 and to meet fire flow demands.

- Develop a timeline and cost estimates for required improvements to be used as part of a long-term capital plan and updating of the Town's Development Cost Charge Bylaw.

1.4 SCOPE OF WORK

To meet the study objectives, the following scope of work was adopted:

1. Collect and review available information including water system upgrades and expansions, boundary expansion areas, water use records, land use zoning and OCP documents, and historic and projected population data.

2. Use flow records to update per capita water demands for average day, maximum day and peak hour. Develop future per capita demands with and without the OCP water reduction objectives.

3. Determine flow requirements and water system design criteria.

4. Review and confirm population projections, per capita demands, and water system design criteria with Town staff.

5. Update the Comox Valley Water System (CVWS) WaterCAD computer model to include all new CVWS and Town of Comox water infrastructure.

6. Carry out system modelling for existing conditions and various demands. Identify system shortcomings and required works to rectify, if any.

7. Expand model to include demands in 10 years and at OCP build-out in 2031. Run model for various demands scenarios. Identify shortcomings. Re-run model several times each with varying infrastructure upgrades to identify necessary work.

8. Run extended time model over projected maximum 24 hour demand period to assess system's ability to refill reservoirs. Review storage volume requirements and determine if additional storage is required and year it would be necessary.

9. Prepare preliminary cost estimates for required improvements. Determine construction year for each improvement.

10. Present findings in a draft report complete with conclusions and recommendations to Town staff for review and comments. Report to include figures and a plan drawing showing the existing water system and proposed improvements.

11. Upon receipt of Town comments, finalize and present ten (10) bound copies and an electronic copy in pdf format.

1.5 ACKNOWLEDGEMENTS

Koers & Associates Engineering Ltd. acknowledges with thanks, the assistance provided by Shelley Ashfield, PEng, Municipal Engineer and Glenn Westendorp, Public Works Superintendent in the preparation of this report.

2 WATER SYSTEM

2.1 EXISTING SYSTEM

2.1.1 Supply, Treatment and Transmission Mains

The Town obtains it water from the Comox Valley Water System (CVWS) operated by the Comox Valley Regional District (CVRD). The CVWS also provides water to the City of Courtenay, Comox Indian Band, the Comox Valley Water Pollution Control Centre, and five CVRD Water Local Service Areas.

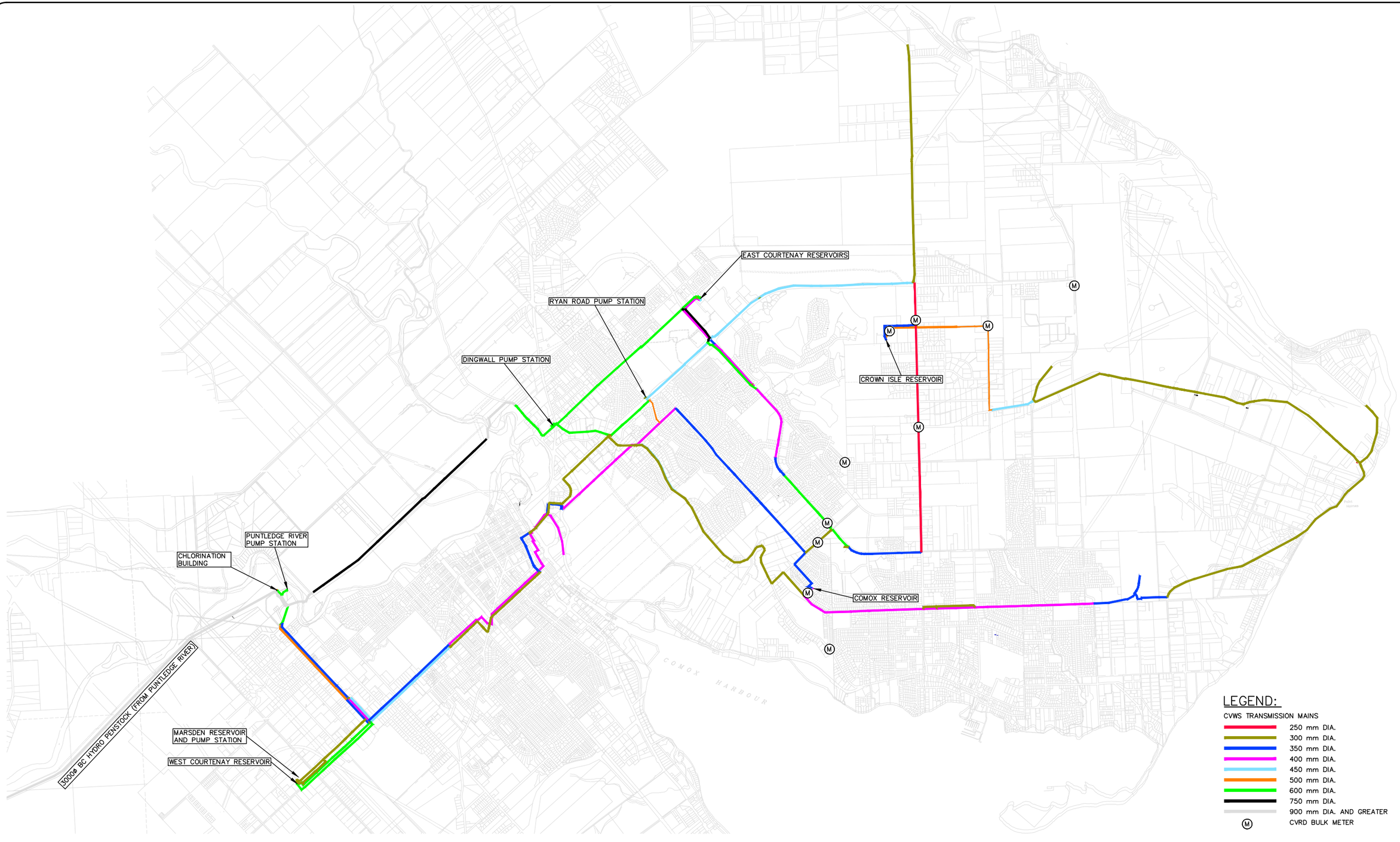
The CVWS operates under water licences for the withdrawal of water from the Puntledge River which is fed by Comox Lake. Under an agreement with BC Hydro, the CVWS withdraws water from a connection on BC Hydro's penstock which diverts water from the Puntledge River to generate power at their Puntledge River power station. The penstock creates a Hydraulic Grade Line (HGL) of 126 m which is able to service nearly all of the Comox Valley Water System customers by gravity. When the penstock is out of service, which is at least once a year for scheduled maintenance, the CVWS withdraws water directly from the Puntledge River via a CVWS pump station located adjacent to and downstream of the generating station.

Water withdrawn from the river passes through screens, located on the BC Hydro Penstock near the point of diversion and at the intake of the CVWS river pump station. It is then disinfected by gas chlorination at the CVWS chlorination building located near the BCHydro generating station. The treated water is conveyed to the nine service areas by transmission mains. It is metered as it enters a service area as well as when it leaving if it continues on to another service area. There are several transmission mains servicing the Town. They are; a 300 mm dia. main along Back Road, a 350 mm dia. main on Sheraton Road, a 600 mm dia. main on Lerwick Road, and a 450 mm dia. main on Ryan Road. At least 11 bulk meters are needed to measure and record the Town's water usage. The locations of the CVWS withdrawal points, treatment building, reservoirs, transmission mains, and bulk water meter locations for the Town are shown on Figure 1.

2.1.2 Distribution System

The Town owns and operates all water infrastructure within its boundaries with the exception of the CVWS transmission mains, bulk flow meters, and water storage reservoirs. These are operated and maintained by the CVRD. The Town owned and operated infrastructure consists of distribution mains, pressure reducing valve stations, gate valves, fire hydrants, air release valves, blow-off assemblies, drain assemblies, and individual service connections and individual water meters.

As shown on Figure 2, the Town has two pressure zones; an 89 meter and a 120 meter pressure zone. The minimum and maximum static pressures expected within each are shown in Table 1. The ground elevations and resulting pressures are derived from 1:5,000 scale topographical maps published by the provincial government with 2 meter contour intervals.



KOERS & ASSOCIATES ENGINEERING LTD.
Consulting Engineers

CLIENT	TOWN OF COMOX
PROJECT	2013 WATER STUDY

TITLE	COMOX VALLEY WATER SYSTEM WATER SUPPLY INFRASTRUCTURE
APPROVED	MB
DATE	MAY 2013
PROJECT No.	1256
SCALE	1:40000
DWG No.	FIGURE 1

File: H:\1013 Comox Town\1256 Water Study Update\03 Drawings\1256 FIG 1.dwg Plot Time: Sep 20, 2013 - 11:58am User: mbrook

T.W.L. 89m

89m

89m

89m

120m

120m

T.W.L. 89m

89m

89m

89m

LEGEND

- RESERVOIR TOP WATER LEVEL (TWL 89m)
- PRESSURE ZONE BOUNDARY
- TOWN OF COMOX BOUNDARY

KOERS & ASSOCIATES ENGINEERING LTD.
Consulting Engineers

CLIENT	TOWN OF COMOX
PROJECT	2013 WATER STUDY

TITLE	EXISTING PRESSURE ZONES
APPROVED	MB
DATE	MAY 2013
PROJECT No.	1256
SCALE	1:25000
DWG No.	FIGURE 2

3 DESIGN POPULATION & DEMANDS

3.1 HISTORIC & FUTURE POPULATION PROJECTION

The Official Community Plan (OCP) projects the Town population will reach approximately 19,000 by Year 2031. Based on the 2011 Census population of 13,627, the Town's population is projected to increase by more than 4,900 by Year 2031; a 39% increase. This equates to an annual compounded growth rate of 1.68%. Figure 3 presents the Town's Canada Census population counts from 1951 to 2011 with the OCP projected future annual population to Year 2031 based on the 1.68% annual compounded growth rate.

The OCP projected growth rate is similar, but slightly higher, to the projections in the 2008 Comox Valley Regional Growth Strategy (RGS). The RGS forecasts a valley wide rate of growth going from 1.6% in Year 2011 to 1.4% in Year 2021, followed by a gradual slowing to 1% by Year 2031. This includes the projected growth for the municipalities of: City of Courtenay, Town of Comox, and Village of Cumberland.

3.2 WATER DEMANDS

3.2.1 Design Criteria

In establishing the capacity of a water supply and distribution system, three levels of water demand are normally considered, in addition to fire flows. These are:

Average Day Demand	=	$\frac{\text{Total annual consumption}}{365 \text{ days}}$
Maximum Day Demand	=	Day with highest demand for the year
Peak Hour Demand	=	Highest flow rate maintained for one hour (generally occurring on maximum day of the year)

The system must also be capable of delivering fire flow demands during maximum day demands.

3.2.2 Current Demands

The Town of Comox monthly bulk water meter records for the previous six years (2007 to 2012) were obtained from the CVRD and reviewed for seasonal demand changes, maximum demand months, year over year trends, and to calculate annual average day and per capita day demands for each year and during the maximum month. This information is listed in Table 2 and presented graphically in Figure 4.

The highest and lowest recorded annual demands occurred in 2009 and 2011; respectively, while the highest and lowest recorded maximum month demands occurred in 2008 and 2011; respectively. Three of the maximum months occurred in July and the other three occurred in August.

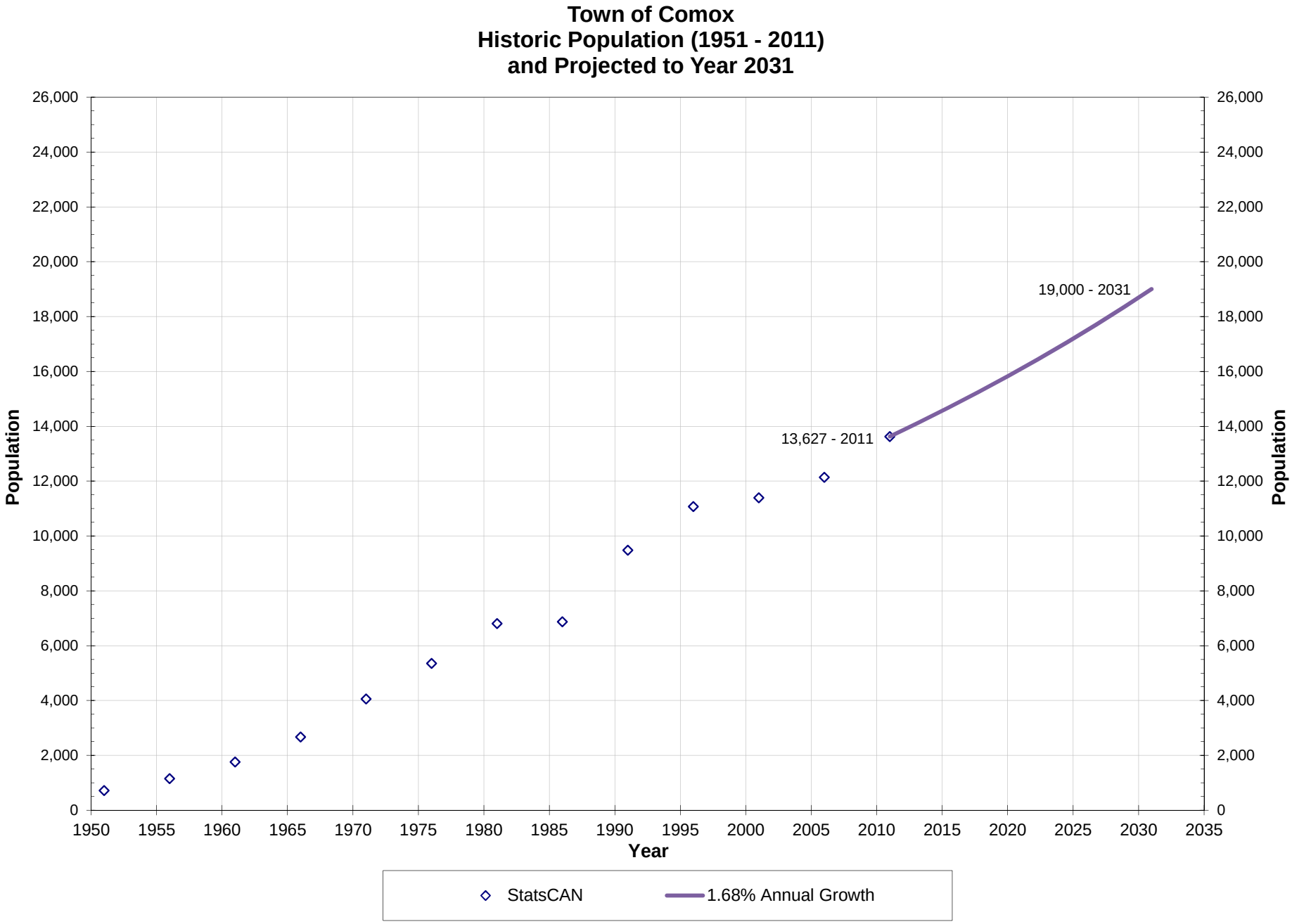

Town of Comox
Historic Population (1951 - 2011)
and Projected to Year 2031
Population
Year
19,000 - 2031
13,627 - 2011
StatsCAN
1.68% Annual Growth

FIGURE 3

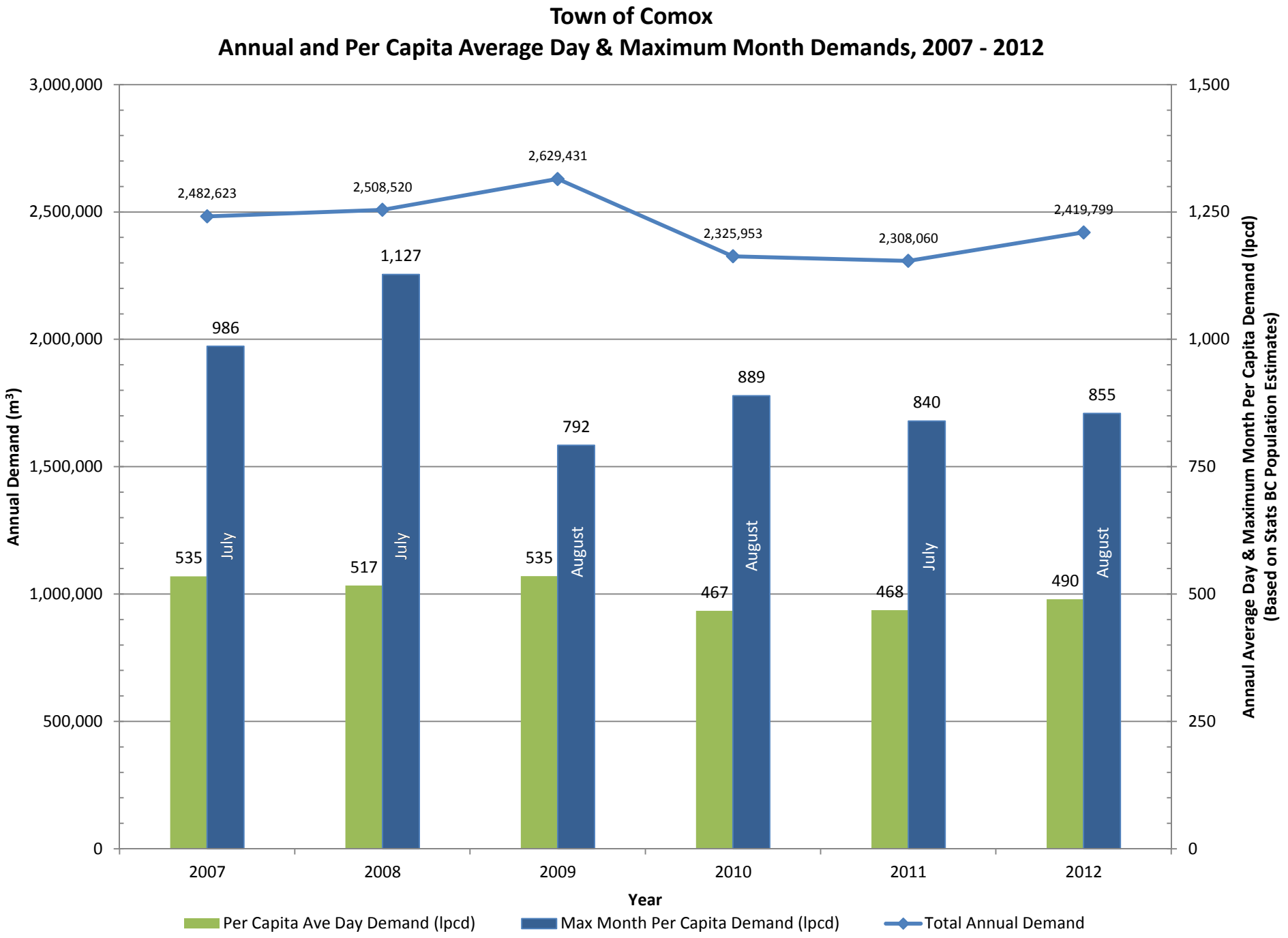

Town of Comox
Annual and Per Capita Average Day & Maximum Month Demands, 2007 - 2012
Annual Demand (m³)
Annaul Average Day & Maximum Month Per Capita Demand (lpcd)
(Based on Stats BC Population Estimates)
3,000,000
2,500,000
2,000,000
1,500,000
1,000,000
500,000
0
1,500
1,250
1,000
750
500
250
0
2,482,623
2,508,520
2,629,431
2,325,953
2,308,060
2,419,799
986
1,127
792
889
840
855
535
517
535
467
468
490
July
July
August
August
July
August
2007
2008
2009
2010
2011
2012
Year
Per Capita Ave Day Demand (lpcd)
Max Month Per Capita Demand (lpcd)
Total Annual Demand

FIGURE 4

Table 2
Annual and Maximum Month Demands, 2007 – 2012

Year	Stats BC Population Estimate	Annual Demand (m^3)	Average Day Demand (lpcd)	Maximum Month Demand	
				(m^3)	(lpcd)
2007	12,721	2,482,623	535	389,005	986
2008	13,265	2,508,520	517	**463,635**	**1,127**
2009	13,459	**2,629,431**	**535**	399,661	792
2010	13,638	2,325,953	467	385,159	889
2011	13,501	2,308,060	468	351,416	840
2012	13,504	2,419,799	490	376,021	855

The data shows an overall decline in annual demands after 2009 and in maximum month demands after 2008, with the exception of 2012 which saw an increase from the previous year, but still lower than the 2009 and 2008 peaks; respectively. It is noted that while the Town's population increased by more than 6%, the annual demand experienced a 2.5% decrease; resulting in a per capita average day demand decrease of 8.4% (535 to 490 lpcd). The maximum month demand experienced an overall 3.3% decrease.

The downward trend in per capita demand is believed to be a result of several factors, including public education and conservation programs:

- In 2007, the Comox Valley Water System Universal Metering Study Update was completed by Koers & Associates Engineering Ltd.
- In 2008, the provincial government launched a highly publicized campaign on sustainability which included the Living Water Smart program emphasizing water conservation. This program requires 50% of new municipal water needs to be acquired through conservation by Year 2020.
- In 2009, the CVRD Water Conservation Strategy Review Plan Study was completed by Koers & Associates Engineering Ltd.
- In 2010, the Town of Comox implemented a water conservation strategy which included a voluntary water meter installation program for residential property owners. In addition, a valley wide public education campaign along with a rebate program to replace high volume use toilets with "low flush" toilet, hand-out of shower and faucet aerators, and a rain barrel purchase program was carried out by the Comox Valley Regional District.
- In 2013, the CVRD introduced an irrigation rebate program for the installation of smart controllers to reduce water use by providing irrigation only when required according to weather and other environmental conditions.

Weather patterns also have an impact on demand. A review of rainfall records indicates a correlation between increasing water demands, peaking in July and August, with decreasing rainfall/warmer temperatures. Monthly rainfall data for 2007 to 2012 is presented in Table 3.

Monthly rainfall data recorded by Environment Canada at the Comox Airport revealed April, May and June of 2008 to be dryer than average but with a much wetter August (2.5

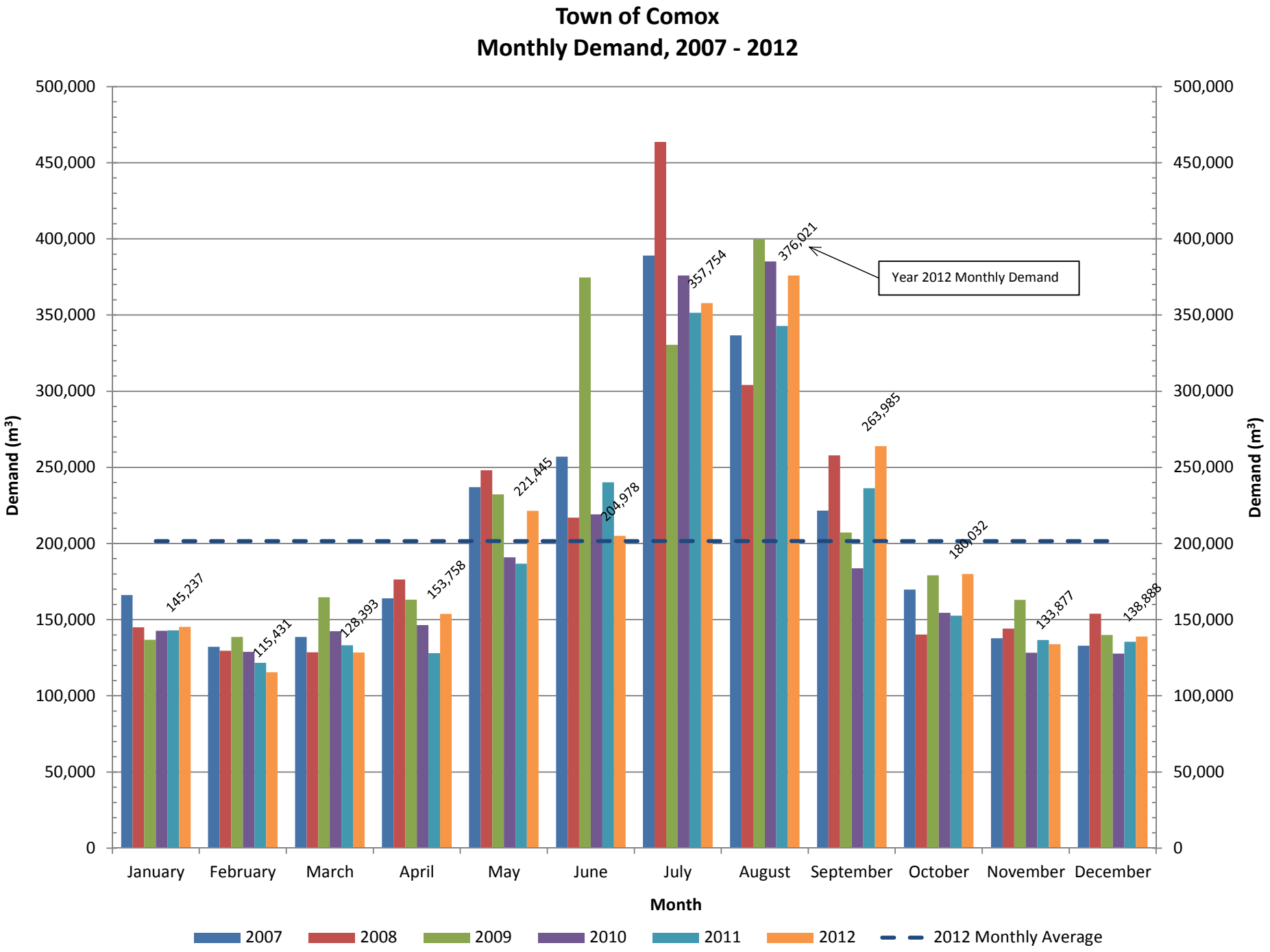

Town of Comox
Monthly Demand, 2007 - 2012
Demand (m³)
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
January
February
March
April
May
June
July
August
September
October
November
December
Month
145,237
115,431
128,393
153,758
221,445
204,978
357,754
376,021
263,985
180,032
133,877
138,888
Year 2012 Monthly Demand
2007
2008
2009
2010
2011
2012
2012 Monthly Average

FIGURE 5

times) followed by a much dryer September (2.9 times) compared to the 2007 to 2012 average. A graph of monthly demand (see Figure 5) shows August 2008 demand to be lower than the other five years.

Rainfall for May, June and July for 2009 and 2011 was slightly wetter than the average but in August, both years recorded less than 5 mm of rainfall. Figure 5 shows August 2009 demand was the highest of the six years. In 2010, May and August were wetter than average, while June was average. Less than 5 mm of rainfall was recorded for July 2010.

In 2012, May was dryer than average, followed by a wetter (1.7 times) June, followed by a three month dry period, where July recorded less than 15 mm of rainfall, and August and September recorded less than 10 mm of rainfall. Figure 5 shows September 2012 demand was the highest of the six years.

Table 3
Comox Airport Monthly Rainfall, 2007 - 2012

Month	Monthly Rainfall per Year (mm) *						Average (mm)
	2007	2008	2009	2010	2011	2012	
January	134	153	55	**241**	119	185	148
February	116	46	34	**133**	128	125	97
March	82	57	93	125	**200**	131	115
April	86	30	27	**97**	32	93	61
May	22	29	51	**75**	67	26	45
June	69	29	29	44	21	**77**	45
July	31	26	**51**	2	34	13	26
August	25	47	3	31	4	6	19
September	72	17	49	66	**85**	7	49
October	125	123	139	103	63	**178**	122
November	181	132	**371**	208	159	205	209
December	208	138	126	319	76	**281**	191
Total	1,150	827	1,030	1,445	987	1,327	1,128

* Highest monthly rainfall for the period is in **bold** text. Lowest monthly rainfall is underlined. Amounts under 15 mm are in red text.

3.2.3 Future Demands

The Town of Comox water system demand design criteria are listed in the Subdivision and Development Servicing Bylaw No. 1261, Schedule C.1 Subdivision and Development Specifications, Appendix F, Section 1 as follows: 635 litres per capita day (lpcd) for Average Day Demand; 2,100 lpcd for Maximum Day Demand; and 3,000 lpcd for Peak Hour Demand.

In the most recent water study for the Town (the 2003 Water Study Update), design demands were based on the Year 1998 when recorded demands were notably higher than other years, most likely in response to lower than average spring and summer rainfall and a very dry August and September; 7 mm and 3 mm of rainfall each month, respectively. These calculated design demands were: 1,720 lpcd for Maximum Day and 2,494 lpcd for Peak Hour; both lower than the Town's current design standards.

The 2012 Comox Valley Water System Study Update, prepared by Koers, observed a similar declining demand pattern between 2007 and 2012 as noted for the Town of

Comox. The CVWS design demands modeled for the study future conditions were: 560 lpcd for Average Day Demand; 1,300 lpcd for Maximum Day Demand; and 2,050 lpcd for Peak Hour Demand. Table 4 presents a comparison of the Town of Comox water design demands and those used in the CVWS study.

Table 4 – Per Capita Demands,
Town of Comox & Comox Valley Water System

Description	Town of Comox		Comox Valley Water System 2012 Study
	Design Standards	2003 Water Study	
Average Day Demand, lpcd	635	-	560
Maximum Day Demand, lpcd	2,100	1,720	1,300
Peak Hour Demand, lpcd	3,000	2,494	2,050

In the absence of maximum day or peak hour demands for the Town, a prudent approach is warranted for establishing design demands; balancing the acknowledgement of the recent implementation of the provincial and municipal water conservation measures with only a few years of data operating under them. For this study, it is proposed to use the per capita design demands presented in Table 5 based on the 2012 Comox Valley Water Study Update.

Table 5
Per Capita Design Demands

Description		Per Capita Demand
Average Day Demand	(ADD)	560 lpcd
Maximum Day Demand	(MDD)	1,300 lpcd
Peak Hour Demand	(PHD)	2,050 lpcd

Applying the per capita demands to the projected populations, the water demands in 5 year increments and Year 2031 are presented in Table 6.

Table 6
Design Demands

Year	Projected Population	Projected Demands		
		Average Day (l/s)	Maximum Day (l/s)	Peak Hour (l/s)
2013	14,088	91.3	212.0	334.3
2018	15,308	99.2	230.3	363.2
2023	16,635	107.8	250.3	394.7
2028	18,076	117.2	272.0	428.9
2031	19,000	123.2	285.9	450.8

3.2.4 Fire Flow Requirements

The ability to provide adequate fire flow is an important feature of a properly designed water distribution system. Fire flow requirements vary, depending on building design, floor area, number of stories, construction materials, if a fire sprinkler system is installed, fire break walls, and spacing from adjacent buildings (exposure).

The Town's design standards specify fire flow demands are to be calculated in accordance with the most recent version of the "Water Supply for Public Fire Protection" by the Fire Underwriters Survey (FUS), for existing and anticipated land use. In no case is it to be less than 75 l/s and it shall not exceed 300 l/s except in the case of an unusual risk. The FUS design duration for these flows range from 1.75 to 4 hours; respectively. The assumed minimum required fire flow for various land use are presented in Table 7. The flow duration is as per the FUS.

Table 7
Fire Flow Demands

Land Use	Assumed Minimum Required Fire Flow	
	Demand (L/s)	Duration (hrs)
Residential	75	1.75
Commercial	150	2
Institutional/Industrial	300	4

3.3 WATER CONSERVATION

In 2008, the provincial government launched the Living Water Smart program emphasizing water conservation. This program requires 50% of new municipal water needs to be acquired through conservation by Year 2020.

In 2010 the Town of Comox implemented a water conservation strategy which included a voluntary water meter installation program for residential property owners. Commercial, industrial, institutional, and multi-family properties are already metered. A valley wide public education campaign along with; a rebate program to replace high volume use toilets with "low flush" toilets; hand-out of shower and faucet aerators; and a rain barrel purchase program, was carried out by the Comox Valley Regional District in 2010 and 2011. The water demand data (Table 2 and Figure 4) indicates an overall decline in annual demands after 2009 and in maximum month demands after 2008; with the exception of 2012 which saw an increase from the previous year, but still lower than the 2009 and 2008 peaks; respectively. In 2013, the CVRD added a rebate program for the installation of smart irrigation controllers.

The purpose of the Town's Official Community Plan, adopted in June 2011, is to manage land use needs and infrastructure requirements for the next 20 years (to Year 2031). One of its objectives is to reduce per capita water consumption by 40% from the 2008 baseline of 600 litres per capita per day.

To date over 1,450 residential meters are installed, accounting for approximately 40% of all residential lots. Meters are installed on all new lots as part of the Town subdivision servicing requirements and on existing lots under the volunteer metering program when requested by residences.

A review of the residential metered demands records, indicates they account for 13% of the Town's monthly water demands in the winter and 22% in the summer.

The 2012 Comox Valley Water Study Update, notes the CVRD is anticipating reductions in per capita water consumption over the next thirty years, due to continued water conservation efforts as identified in their Water Efficiency Plan. These include: public education, rebates for the installation of low flow fixtures, leak detection and pressure reduction, water restrictions, and outdoor water efficiency rebates.

One of the most influential factors for reduced water demand at the point of use is the combination of universal metering and conservation pricing of water, where the use of water over certain quantity limits is priced higher per unit, generally identified as increasing block water rates.

4 WATER MODEL

4.1 COMPUTER PROGRAM

Modelling of the Town's water distribution system was carried out utilizing the computer software program WaterGems, an enhanced version of WaterCAD. This water distribution modelling and management software is in use throughout North America by engineering consultants, municipalities, and utility companies and is used by Koers because of its reliability, versatility, AutoCAD and GIS interface, and support by its creator Bentley Systems Inc.

WaterGems is a powerful, easy-to-use program to analyse, design, and optimize water distribution systems. The programs many features include; steady state and extended time modelling, multiple fire flow events modelling while evaluating flows and pressures across the entire system, peak hour pressure analyses, optimization of fixed and variable speed pumps and reservoir storage to minimize energy usage and cost, and automated model calibration. Other analyses features include; system leakage, water loss and unaccounted for water, reservoir mixing, and water-age. The modelling results are presented in tabular and graphical form.

4.2 MODEL UPDATE

4.2.1 Supply and Distribution System

The 2003WaterCAD water model was updated incorporating water supply and distribution system operational changes, upgrades and expansions since the 2003 water study. This includes upgrades to the CVWS water supply system and the Town of Comox distribution system noted previously in Section 1.2. Comox watermain extensions, replacements, and new subdivision main information was provided by Town staff. The existing water system is shown on drawing 1256-01 at the end of this report.

4.2.2 Pipe Friction Factors

A Hazen Williams friction factor was entered in the model for varying pipe materials, as listed in Table 8.

Table 8
Pipe Friction Factors

Pipe Material	Friction Factor, "C" (Hazen Williams formula)
High Density PolyEthylene, HDPE	145
PolyVinyl Chloride, PVC	140
Asbestos Cement, AC	130
Ductile Iron, DI	130
Steel with Coating, SC	130
Prestressed Concrete, PConc	120
Cast Iron, CI	110

The modeled friction factors are slightly less than those included in the Town design standards. This takes into account the reduction in capacity that occurs in the distribution system where fittings and service connection points are present and sliming on pipe walls

occurs with age. To better calibrate the friction factors, controlled field testing would be required during times of peak hour flows, where pressure losses in the various pipe types and sizes could be determined. Flow testing was not included in the scope of work for this study.

4.2.3 PRV Settings

The Town water distribution system contains two Pressure Reducing Valves (PRV's). Presently both are isolated and not in use, but when available, they can provide supplemental flow from the 120 m pressure zone to the 89 m pressure zone. These PRV's can become active under a large flow event, such as a major fire or a watermain break, or if either the Comox or Crown Isle reservoir were taken off-line for maintenance/upgrades.

The outlet pressure settings used in the model for the Town's two Pressure Reducing Valves (PRV's) were as follows:

Table 9 – Pressure Reducing Valve Settings

Location	Main PRV Dia. (mm)	Pipe Elevation (m)	Outlet Setting (psi)	HGL (m)
Pritchard Rd and Skeena Drive	200	34.3	62	77.9
Pritchard Rd and Cambridge Rd	150	46.8	50	82.1

The modelled settings are based on previous information provided to Koers. This should be confirmed to ensure the model results are consistent with the pressures in the surrounding areas.

4.2.4 Allocation of Demands

Water demands were distributed evenly throughout the model at nodal points (pipe intersections, end of mains and pipe diameter changes). The average day demand was used as the base. Maximum day and peak hours demands were modelled by multiplying each individual demand by the appropriate ratio (maximum day to average day, and peak hour to maximum day).

For the Year 2031 scenario, the future demands were added to the model to the various development permit areas in accordance with the Town's OCP. This permitted identifying improvements required to service the additional population growth where it is designated to occur. The demands for each area were calculated based on the land-use designation and the associated population density.

4.3 ANALYSIS CRITERIA

4.3.1 Reservoir Sizing

Water storage reservoirs are part of the CVWS and are operated and maintained by the CVRD. This includes the four reservoirs (Comox, Crown Isle and the two East Courtenay) which provide service to the Town of Comox. Reservoirs perform three functions:

- storage for fire fighting
- storage for emergencies (such as a watermain break)
- storage for equalization to manage hourly peaks in demand

The storage volume requirements were assessed in the "2012 Comox Valley Water Study Update" prepared by Koers & Associates Engineering Ltd. for the CVRD. They were calculated using the following, generally accepted, formula from the "Design Guideline Manual, 2005" from the Master Municipal Contract Document (MMCD) Association:

Storage Volume = A + B + C

Where:

A = Fire Storage	(from Fire Underwriters Survey Guide)
B = Equalization (Peaking) Storage	(25% of Maximum Day Demands)
C = Emergency Storage	(25% of A + B)

The requirement for Emergency Storage (C) can be reduced or eliminated based on several factors, including: water source dependability, reliability of the supply system (e.g. gravity vs pumped, duplication of mains and treatment, standby emergency power), multiple sources, more than one storage reservoir, and reservoir water circulation needs. Given the dependability of the CVWS supply source (the Puntledge River and Comox Lake), the reliability of the CVWS supply system (multiple mains), and the number and size of reservoirs in the CVWS, the emergency volume (C) was eliminated from the calculation.

4.3.2 Distribution System

The adequacy of the distribution system for various demand conditions is judged by the residual pressure available throughout the system and by the maximum velocity in the mains. The criteria applied to assess the Town's distribution system are as shown in Table 10.

Table 10
Distribution System Design Criteria

Under Peak Hour Demand Conditions		
Minimum residual pressure at property line	275 kPa	(40 psi)
Maximum velocity in mains	1.5 m/s (1)	
Under Fire Flow Demand Conditions (during Maximum Day Demands)		
Minimum residual pressure at hydrant	138 kPa	(20 psi)
Minimum residual pressure at property line	38 kPa	(5 psi)
Under Static Conditions		
Maximum service pressure – ideal	860 kPa	(125 psi)
Maximum service pressure – absolute	1,020 kPa	(150 psi)

(1) The Town of Comox design standards state velocity in supply mains should not normally exceed 3 m/s. The standards do not state a maximum velocity limit for distribution mains. The 3 m/s is considered too high for both supply and distribution mains, considering the potential transient pressure conditions, and hydraulic head losses. A maximum design velocity of 1.5 m /s is recommended.

5 SYSTEM ANALYSIS

5.1 DISTRIBUTION SYSTEM

The water system was evaluated under steady state conditions to determine the system pressures under peak hour conditions and during maximum day demands plus fire flows for existing and future conditions. The existing water system and pressure zones are shown on drawing 1256-01 located in the pocket at the end of this report.

Extended time modelling was also carried out during maximum day plus fire flow demands to assess the ability of the reservoirs to recover at the end of the day. The inability to full recover to top water levels would indicate a need to upgrade the CVWS supply mains feeding the reservoirs.

The modeling analyses are discussed below.

5.1.1 Peak Hour Pressures

Existing Conditions

The peak hour demand residual pressures for existing conditions are shown in Figure 6. The pressures are in keeping with the Town's design standards for a minimum of 275 kPa (40 psi) and a maximum 860 kPa (120 psi).

The lowest pressure during peak hour demand occurs in the Harbour Wood Park subdivision in West Comox, where a pressure of 331 kPa (48 psi) is calculated around Chestnut Avenue and Redwood Street. This is presently serviced by the 89 m HGL pressure zone.

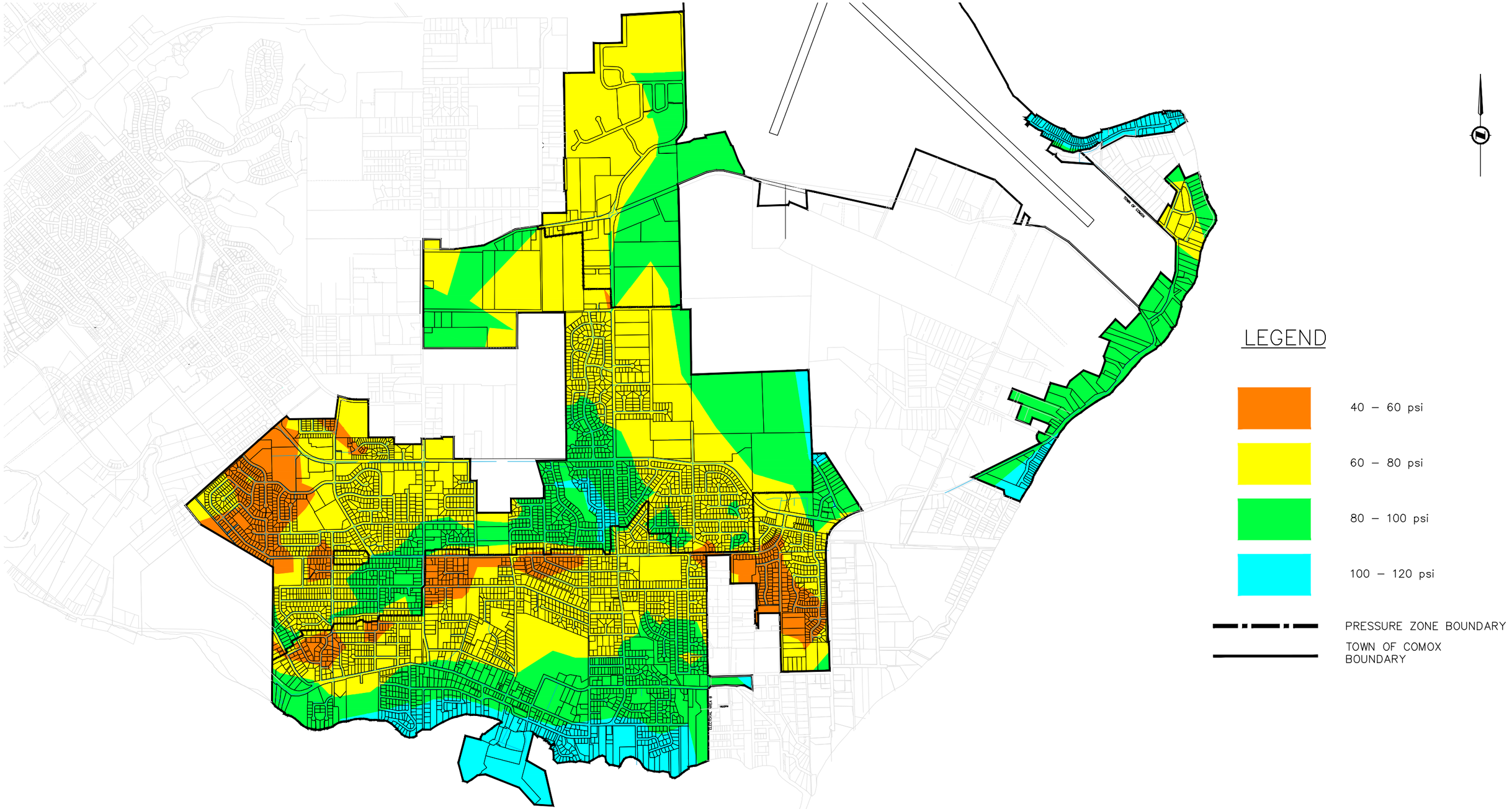
The highest pressures are along the waterfront of: the Comox Harbour, in Point Holmes and Kye Bay, as well as inland in the area of Salish Street and Somenos Drive near Brooklyn Creek at the boundary of the high and lower pressure zones.

Year 2031 Conditions

Build-out will bring increase demands which will result in a slight decrease in residual pressures due to friction losses in the mains, but all pressures will be in keeping with the Town's minimum and maximum design standards. The residual pressures during peak hour demand in Year 2031 are shown in Figure 7.

A pressure zone boundary adjustment is proposed in the area of Aitken St and Glacier View Drive area (Harbor Wood Park subdivision area) by expanding the service area of the 120 m HGL pressure zone. This can be achieved by opening and closing existing valves at the intersection of Aiken St and Downey Ave, Aiken St and Comox Ave, Chestnut Ave and Redwood Street, Comox Ave and Glacier View, and Glacier View Dr at Corker Ave. The locations of the valves to be open or closed are shown on Figure 8.

Properties along Noel Ave, between Aitken St and Aspen are presently serviced from the 400 mm diameter watermain connected to the 89 m HGL. Their service pressures will decrease to at or below the Town's minimum 275 kPa (40 psi) requirement. They should be switched over to the 120 m HGL by a watermain loop as shown on Figure 9.



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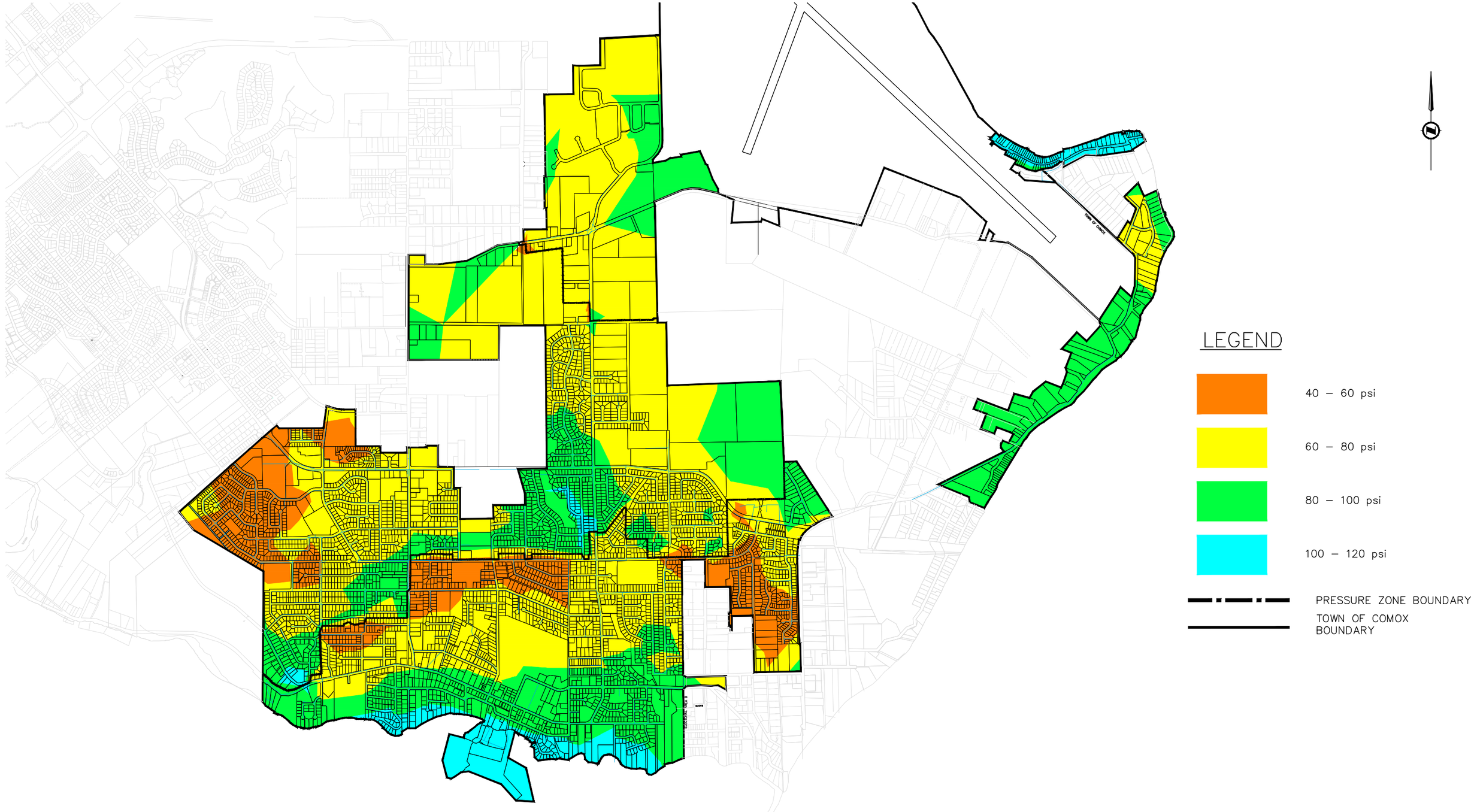
CLIENT	TOWN OF COMOX
PROJECT	2013 WATER STUDY

TITLE	EXISTING PEAK HOUR PRESSURES
APPROVED	MB
DATE	MAY 2013
PROJECT No.	1256
SCALE	1:25000
DWG No.	FIGURE 6

File: H:\1013 Comox Town\1256 Water Study Update\03 Drawings\1256-FIG 2, 6 TO 10.dwg Plot Time: Sep 20, 2013 – 11:56am User: mbrook



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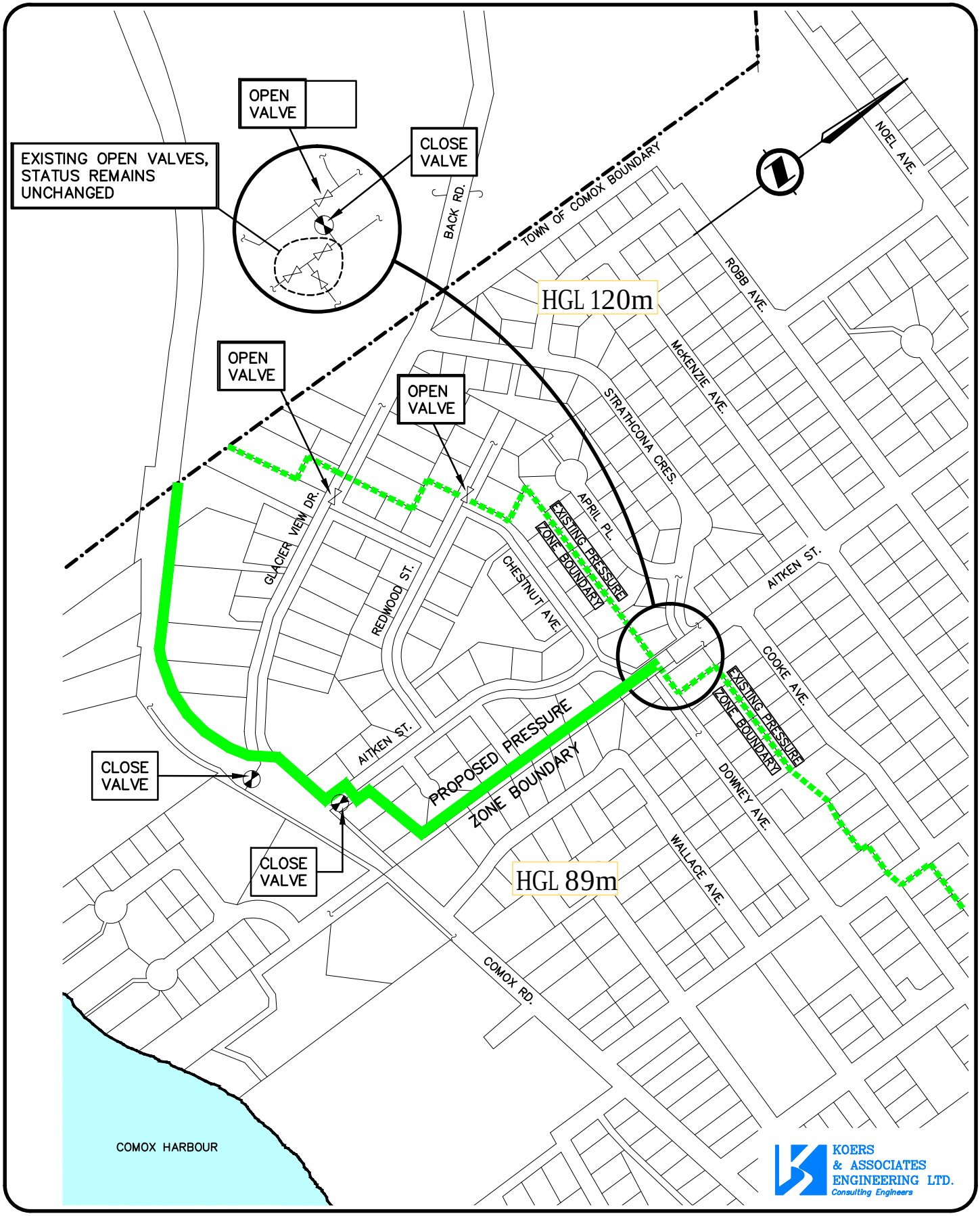
Consulting Engineers

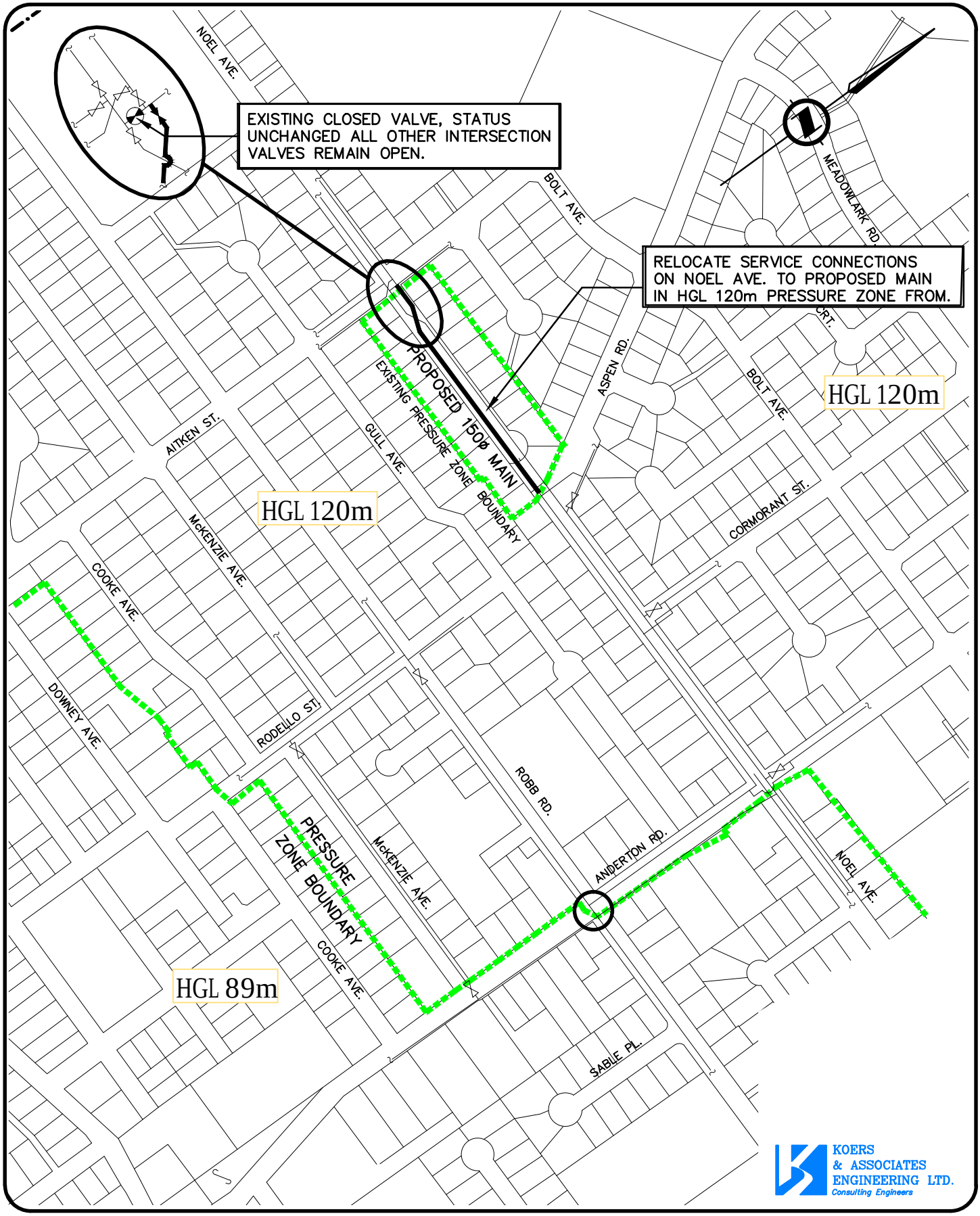
CLIENT	TOWN OF COMOX
PROJECT	2013 WATER STUDY

TITLE	YEAR 2031 PEAK HOUR PRESSURES (OCP BUILD OUT)
APPROVED	MB
DATE	MAY 2013
PROJECT No.	1256
SCALE	1:25000
DWG No.	FIGURE 7



CLIENT	TOWN OF COMOX
PROJECT	2013 WATER STUDY

TITLE	AITKEN ST & GLACIER VIEW DR AREA PRESSURE IMPROVEMENTS
APPROVED	
DATE	MAY 2013
JOB No.	1256
SCALE	1:5000
DWG No.	FIGURE 8



CLIENT	TOWN OF COMOX
PROJECT	2013 WATER STUDY

TITLE	NOEL AVE. AITKEN TO ASPEN PRESSURE IMPROVEMENTS
APPROVED	SCALE 1:5000
DATE MAY 2013	
JOB No. 1256	DWG No. FIGURE 9

5.1.2 Available Fire Flows

Existing Conditions

Figure 10 presents the available fire flows during maximum day demand for the current conditions. Adequate fire flows are available throughout the Town, with the exception of three 150 mm diameter dead end mains, all in residential areas. These areas are listed in Table 11. Other small diameter dead-end mains in the Town are not capable of delivering 75 L/s, but currently there is no hydrant at the ends.

Table 11 – Areas with Available Fire Flows Less than Design Standard

Location	Available Fire Flow (lps)	Required Fire Flow (lps)
Richardson Ave (central Comox)	61	75
East Centennial Ave (central Comox)	63	75
Coast View Dr (east Comox)	67	75

Upsizing or looping of the main, where possible, would resolve these issues, resulting in flows above the Town's minimum design standards. For Richardson Avenue, a 150 m long watermain loop is proposed from the north end of McLeod St to the south end of Douglas St, requiring an approximately 60 m long SRW along Robb Road Elementary School property. For East Centennial Avenue, upsizing 80 m of watermain along Stewart St and 340 m along East Centennial Avenue is proposed. For Coast View Drive, an 80 m long watermain loop along Torrence Road from Noel Ave to the north is proposed.

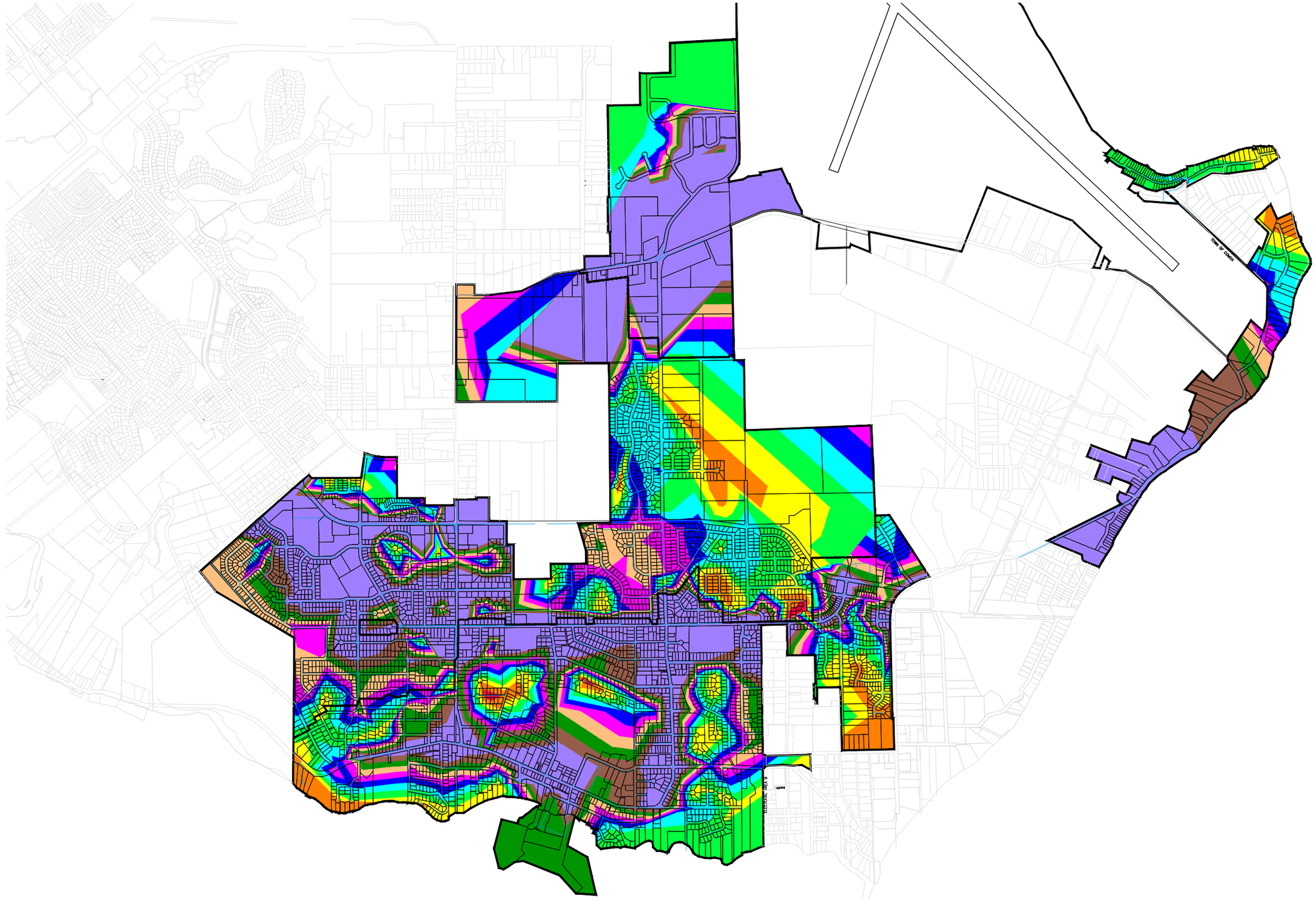
The fire flows available are based on the Pritchard and Skeena PRV being operational. It is presently isolated from the system, resulting in a reduction of available fire flows in the 89 m HGL pressure zone. The design upgrade of the station is presently underway, which will increase the use and accessibility of the station. It will become an above ground station, housed in a kiosk, eliminating the confined space entry issue of the existing below ground chamber. The pressure setting will be such that the PRV operates daily, instead of the current settings which cause it to function only during very large demands, such as a fire flow demand. A check valve will be installed, permitting the 89 m HGL pressure zone to feed the 120 m HGL pressure zone in the event the 120 m pressure zone feed is not available.

Year 2031 Conditions

Build-out will bring increased demands and watermain extensions. Where looped, the main extensions will improve available fire flows and improve water quality by avoiding dead end mains.

Available fire flows in northwest Comox in the Neptune Road/Aspen Road will decease slightly, but will be able to provide a minimum of 100 L/s. If mains were to be looped onto McDonald Road, available fire flows would increase. Fire flows in Butchers/Lazo Road area will decrease but would be above the Town's 75 L/s requirement for residential development. Flows in the Comox Marina, will decrease, but remain above 175 L/s.

The main supply to the Town's 120 m pressure zone east of Brooklyn Creek, is a single 250 mm diameter main along Guthrie Road. To strengthen the distribution system in this area, to improve water quality, and provide an alternate servicing main in the event of a break or need to service the Guthrie main, a supply from the north end into the area by



KOERS & ASSOCIATES ENGINEERING LTD.
Consulting Engineers

CLIENT	TOWN OF COMOX
PROJECT	2013 WATER STUDY

TITLE	EXISTING AVAILABLE FIRE FLOWS
APPROVED	MB
DATE	MAY 2013
PROJECT No.	1256
SCALE	1:25000
DWG No.	FIGURE 10

File: H:\1013 Comox Town\1256 Water Study Update\03 Drawings\1256-FIG 2, 6 TO 10.dwg Plot Time: Sep 20, 2013 - 11:56am User: mbrook

way of a new main constructed along Dryden Road between Anderton and Pritchard is proposed.

Available fire flows in Year 2031 is shown on Figure 11. These flows are based upon implementation on the system improvements shown on Figure 12.

5.2 RESERVOIR STORAGE

Storage volume requirements for the next 30 years (to Year 2041) were reviewed in the CVRD's "2012 Comox Valley Water Study Update" by Koers & Associates. The volume for each of the five CVWS reservoirs was calculated based on the sum of equalization storage plus fire flow requirements. Allowance for emergency storage was not included as per the rationale discussed previously in Section 4.2.1. The resulting storage requirements for the four reservoirs servicing the Town of Comox are presented in Table 12.

Table 12
CVWS Water Storage Requirements for Reservoirs Servicing the Town of Comox
(for Year 2041 design demands)

Reservoir	Storage Volume (m^3)				
	Equalization (Peaking)	Fire Flow	Year 2041 Requirement	Existing Available	Surplus / (Shortfall)
East Courtenay (2 reservoirs)	8,100	4,320 (1)	12,420	12,183	(237)
Comox	2,850	4,320 (1)	7,170	4,400	(2,770)
Crown Isle	1,470	1,645 (2)	3,125	4,000	885

(1) Based on a maximum 300 l/s demand, in accordance with City of Courtenay and Town of Comox design specifications, for a four hour duration.

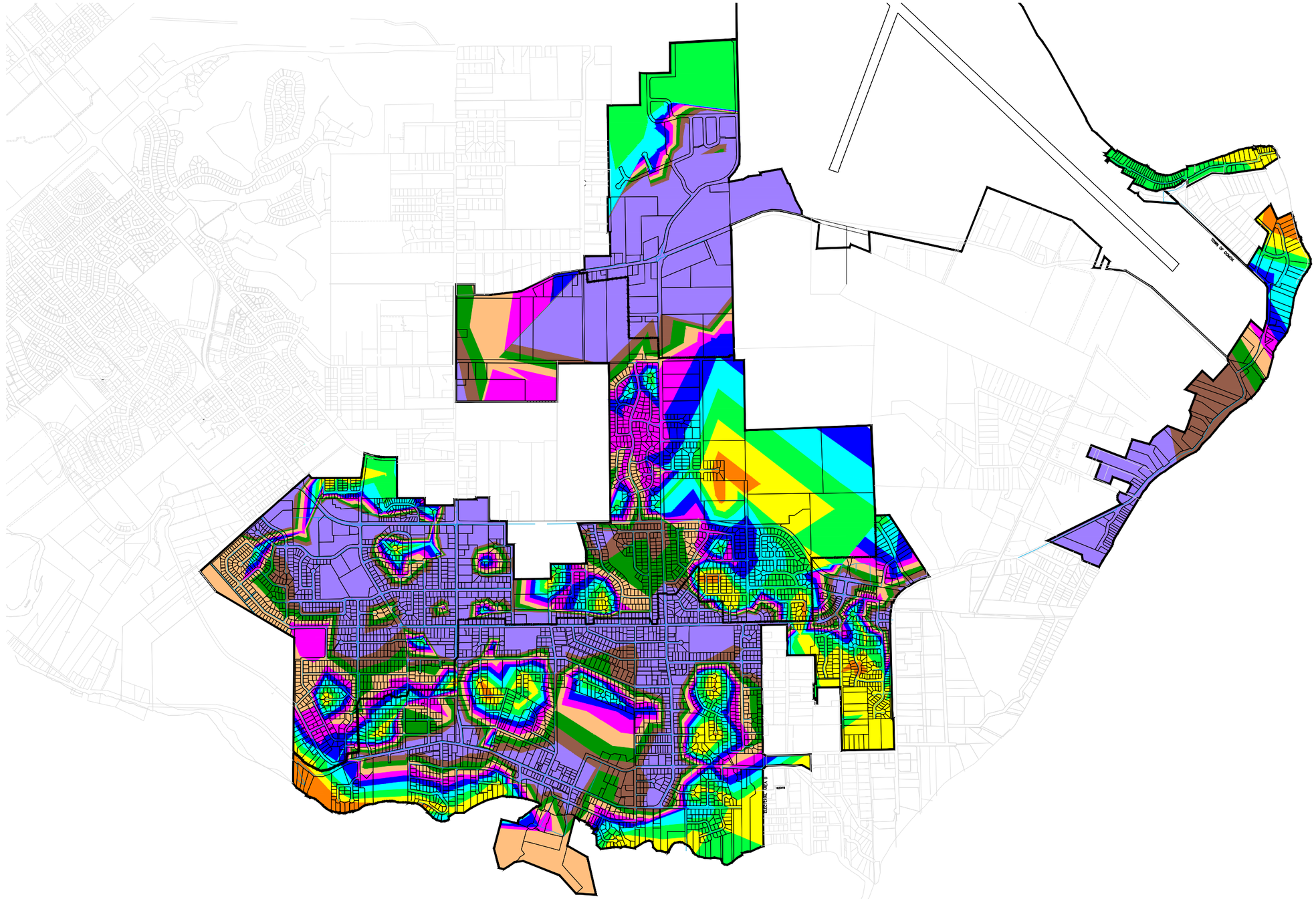
(2) Based on 183 l/s demand for a 2 ½ hour duration.

The duration of the fire flow is based on the design fire flow rate, in accordance with FUS guidelines.

The equalization (peaking storage) is calculated at 25% of Year 2041 maximum day demand for which the CVWS service population is projected to be 74,500; including 23,700 within the Town of Comox.

The analysis indicates additional storage will be required at all reservoirs to meet Year 2041 design demands, with the exception of the Crown Isle reservoir. The East Courtenay reservoirs can be considered adequate as the shortfalls are very small, equating to less than 2% of the total available storage volume.

Additional storage at the Comox Reservoir would be necessary as early as Year 2016 to meet the projected increasing demands from population growth. However, this can be delayed until Year 2026, given the surplus storage available in the Crown Isle reservoir and the ability of the East Courtenay reservoirs (120 m HGL) to supply the Comox Reservoir (89 m HGL) service area.



LEGEND

- < 75 lps
- 75–100 lps
- 100–125 lps
- 125–150 lps
- 150–175 lps
- 175–200 lps
- 200–225 lps
- 225–250 lps
- 250–275 lps
- 275–300 lps
- >300 lps
- PRESSURE ZONE BOUNDARY
- TOWN OF COMOX BOUNDARY

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CLIENT	TOWN OF COMOX
PROJECT	2013 WATER STUDY

TITLE	YEAR 2031 AVAILABLE FIRE FLOWS (OCP BUILD OUT)
APPROVED	MB
DATE	MAY 2013
PROJECT No.	1256
SCALE	1:25000
DWG No.	FIGURE 11

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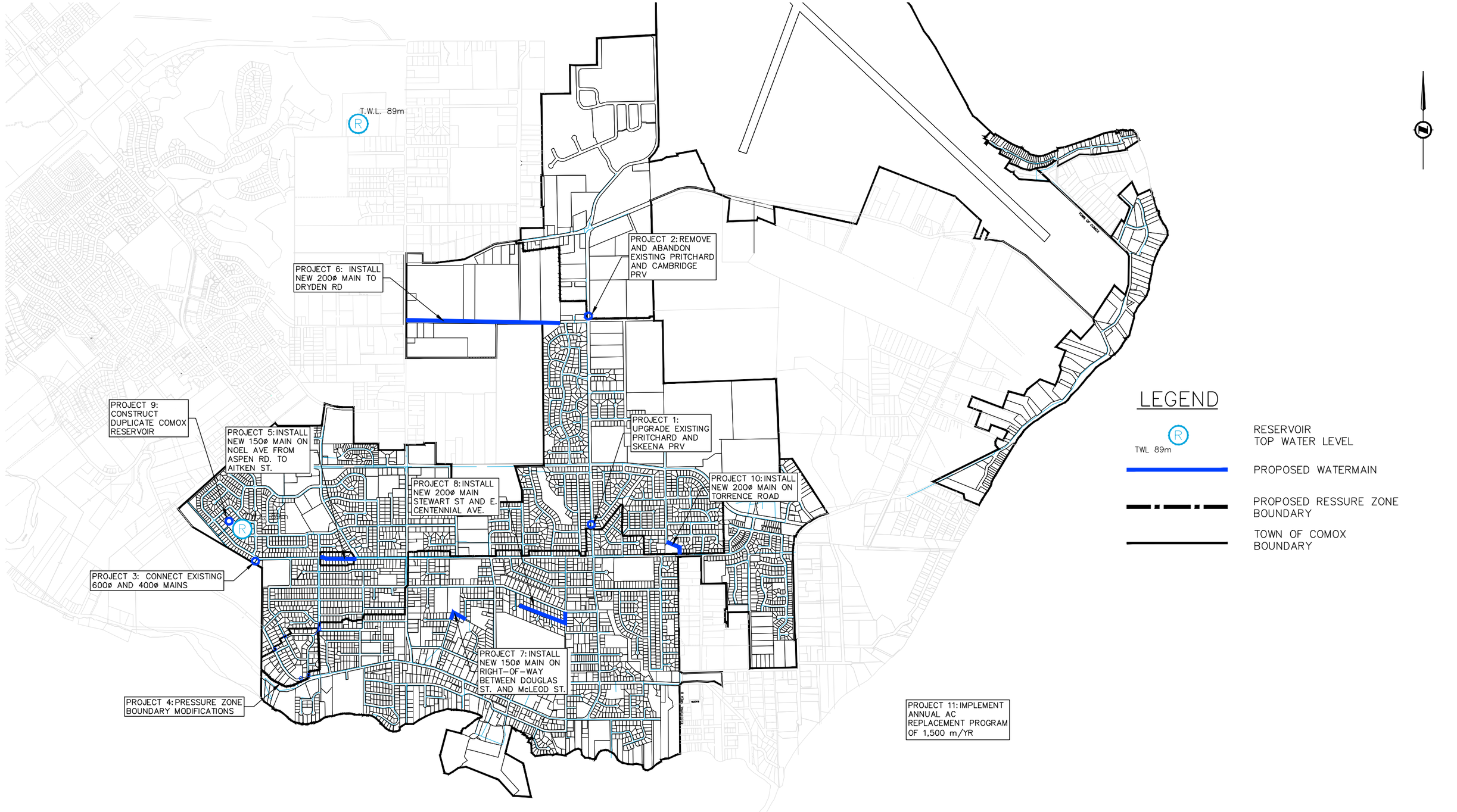

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CLIENT	TOWN OF COMOX
PROJECT	2013 WATER STUDY

TITLE	PROPOSED IMPROVEMENTS
APPROVED	MB
DATE	MAY 2013
PROJECT No.	1256
SCALE	1:25000
DWG No.	FIGURE 12

File: H:\1013 Comox Town\1256 Water Study Update\03 Drawings\1256-FIG 2, 6 TO 10.dwg Plot Time: Sep 20, 2013 - 11:56am User: mbrook

5.3 AC MAINS

There are approximately 99 kilometers of watermain in the Town, of which nearly one half (47 kilometers) are Asbestos Cement (AC) piping. The majority of these mains are more than 40 years old. The life span of AC mains ranges from 30 to 90 years, depending on many factors, such as water quality, type of soils, groundwater levels, pipe manufacturer, quality of installation, depth of bury, and traffic loading. The major problem experienced with AC pipe, other than wall fractures, is the leaching of the cement mortar binder out of the pipe. This can occur on the internal and the external surfaces, severely weakening the pipe strength. The rate of leaching depends on the aggressiveness of the groundwater and potable water in contact with the AC pipe. Leaching can be highly localized, and vary from pipe to pipe.

The remaining service life in an AC main can be estimated by a series of laboratory tests, requiring removal of a section of the watermain. Records of main and service connection repairs would aide in identifying known problem areas.

6 PROPOSED IMPROVEMENTS

Table 13 lists the recommended upgrading works, as discussed in Section 5 System Analysis, in order of priority to meet the existing and Year 2031 needs at build-out in accordance with the Official Community Plan when the Town's population is projected to reach 19,000. The project locations are shown on Figure 12.

The cost estimates are based on Class 'D' (feasibility study) estimates, made without preliminary design input. The estimates include a 30% general contingency allowance and a 30% allowance for legal, construction, financial, administration and engineering costs. The estimates are exclusive of GST.

Cost estimates are derived from our in-house construction cost data base for watermain construction projects in the mid-Vancouver Island/Comox Valley area. All costs are as of June 2013, when the ENR Construction Cost Index was 9542.

Table 13 – Proposed System Improvements

Priority	Project Year & Description	Cost Estimate Class 'D' (excluding GST)
1	2013 Pritchard & Skeena PRV (Upgrade)	$120,000
2	2013 Pritchard & Cambridge PRV (Abandon)	$25,000
3	2013 Watermain Tie-in, Tutor Dr Area, 600 mm dia.	$50,000
4	2013 120 m Pressure Zone Expansion – Aitken St and Glacier View Dr Area (opening and closing valves)	$2,000
5	2014 Watermain Loop – Noel Ave, Aitken St to Aspen Rd (220 m of 150 mm dia.)	$180,000
6	2014 Watermain Loop – Dryden Rd, Anderton Rd to Highwood Dr (880 m of 200 mm dia.)	$565,000
7	2015 Watermain Loop – McLeod St to Douglas St (155 m of 150 mm dia.)	$85,000
8	2016 Watermain Upgrade – Stewart St and East Centennial Ave (420 m of 200 mm dia.)	$335,000

Table 13 – Proposed System Improvements, Cont'd

Priority	Project Year & Description	Cost Estimate Class 'D' (excluding GST)
9	2016 to 2026 Comox Reservoir Duplication *(by CVRD)* (2,900 m^3)	$1,750,000
10	Watermain Loop – Torrence Rd, Noel Ave to 80 m north (80 m of 200 mm dia.)	(by development)
11	2013 - 2043 AC Watermain Annual Replacement Program	$1,200,000

A brief discussion of each project is presented below.

1. Pritchard & Skeena PRV Upgrade

The upgrading of this PRV station is presently underway. The below ground chamber will be replaced with an above ground kiosk to eliminate the confined space entry issues. The pressure settings will be set to allow the PRV to operate daily, as mechanical valves should be operated regularly. A check valve will be installed to permit water to flow from the 89 m HGL pressure zone into the 120 m HGL pressure zone in the event the feed from the 120 m HGL pressure zone is not available.

2. Pritchard & Cambridge PRV Abandon

The PRV is presently isolated from the system and not in use. The construction of the Crown Isle Reservoir and the Knight/Lazo roads watermain loop has replaced the need for this station. The station is to be abandoned, with the PRV removed with a pipe spool and the chamber backfilled. In its place, a fire hydrant should be installed between the two pressure zones with line valves on either side to allow for flushing of the dead-end mains. One of the line valves must be closed at all times.

3. Watermain Tie-in, Tutor Dr Area, 600 mm dia.

A 600 mm diameter watermain has been installed adjacent to a 400 mm diameter main along the reservoir access road and in a backyard SRW of the properties on the southside of Tutor Dr between the reservoir and Noel Ave. This main, constructed in the mid 2000's with the development of the DL144 subdivision, is part of the watermain twinning project CR-3 identified in the Town's 2003 Water Study Update. It is our understanding the main is presently connected to the 400 mm dia. main by a 50 mm service at either end. These should be upgraded to connect the 600 mm dia. to the 400 mm dia. Year 2031 modeling results show the remainder of the CR-3 project, extending the 600 mm dia. main to Aiken St and a 400 mm dia. extension from Aitken to Aspen (portion of CR-5), would not be needed until sometime beyond 2031. This is due to the lower actual and a lower projected future population growth compared to the 2003 study, and a reduction in per capita demands since completion of the 2003 study.

4. 120 m Pressure Zone Expansion – Aitken St and Glacier View Dr area

Open and Close existing valves. This project will improve low operating pressures in the Harbour Wood subdivision area, presently serviced by the Town's 89 m HGL pressure

zone. The expansion can be implemented as detailed on Figure 8. The cost estimate includes an allowance for notifying residences of the proposed pressure increase.

5. 120 m Pressure Zone Expansion – Noel Ave, Aitken St. to Aspen Rd.

230 m of 150 mm dia. This project will improve low operating pressures for the properties along Noel Ave between Aspen Rd and Aitken St that are presently serviced off of the 400 mm dia. main, which is part of the 89 m pressure zone. The new main would be a looping of the 120 m pressure zone system. The service connections for each property would be transferred over to the new main. The proposed looping is shown on Figure 9.

6. Watermain Loop – Dryden Road

880 m of 200 mm dia. This project is proposed in order to; strengthen the Town's distribution system, improve water quality, accommodate growth in NE Comox, and provide a much needed loop into the Town's 120 m pressure zone east of Brooklyn Creek. This area, east of Brooklyn Creek, is presently serviced from the south with the majority of the supply from the 250 mm diameter main along Guthrie Road.

7. Watermain Loop – McLeod St to Douglas

155 m of 150 mm dia. This project will increase fire flows along Richardson Avenue, from the calculated available 61 L/s, to the Town's minimum 75 L/s for residential development. This will require obtaining a right-of-way, approximately 60 m long, on Robb Road elementary school property. No specific allowance has been made in the cost estimate for securing a right-of-way.

8. Watermain Upgrade – Stewart St and East Centennial Ave

420 m of 200 mm dia. This project will increase fire flows along East Centennial Ave, from the calculated available 63 L/s, to the Town's minimum 75 L/s for residential development. The existing 150 mm dia. AC main is to be replace with 200 mm dia. consisting of 60 m along Stewart and 360 m along East Centennial Ave. New service connections would be installed from the main to the property line and hydrants and valves would be replaced.

9. Comox Reservoir Duplication *(By CVRD)*

2,900 m^3 addition by 2016 to 2026. Reservoirs are owned and maintained by the CVRD on behalf of the CVWS. The Expansion of storage capacity of the Comox Reservoir is the responsibility of the CVWS, of which the Town is a user. As such the Town will be responsible for contributing to the cost for the increase in storage. The additional storage is required as early as Year 2016, but can be delayed until Year 2026 given additional available storage in the Crown Isle Reservoir and the ability of the East Courtenay Reservoirs to provide flows to the Comox Reservoir service area. The cost estimate is based on construction of a new water storage reservoir adjacent to the existing reservoir and within the existing parcel of land.

10. Watermain Loop – Torrence Rd, Noel Ave to 80 m north

80 m of 200 mm dia. This project will increase fire flows in the Noel Ave/Torrence Road intersection area from the calculated available 67 L/s, to the Town's minimum 75 L/s for residential development. The extension will consist of approximately 80 m of 200 mm dia. main along Torrence Rd northward from Noel Ave connecting to the existing 200 mm dia. dead-ended main. It is understood this work will be completed with the development of the lot on the west side of Torrence Rd and North of Noel Avenue.

11. AC Main Annual Replacement Program

It is recommended the Town prepare an asbestos cement pipe annual renewal program to replace these watermains as they are aging and nearing the end of their design life. The Town has approximately 47 km of asbestos cement piping in the distribution system ranging in size from 100 mm to 300 mm dia. An annual allowance for the replacement of 1.5 kilometer per year has been made.

The cost estimate includes allowances for installation of a new main, tees, valves, hydrants; and service connections to property line backfilling with import trench backfill, repaving of the trench surface with 50 mm of asphalt, in place abandonment of the existing AC main, and removal of tees, valves and fittings.

7 CONCLUSIONS & RECOMMENDATIONS

7.1 CONCLUSIONS

Based on the findings of this study, the following conclusions are made:

1. The Town obtains it water from Comox Lake, which is conveyed to the Town's boundary by the Comox Valley Water System, of which the Town is one of nine service areas.

2. The Town's bulk water meters are ready monthly. Maximum day and peak hour data are not recorded.

3. The majority of the water projects from the 2003 Water Study Update have been implemented, and there have been a number of improvements to the Comox Valley Water System supply system over the past decade which benefit the Town.

4. The Town's Official Community Plan projects the population to reach approximately 19,000 by Year 2031; an increase of 4,900 people (39%) from the 2011 Census population count of 13,627.

5. The BC Living Water Smart program, launched in 2008, requires 50% of new municipal water needs to be acquired through conservation by Year 2020.

6. One of the Town's OCP objectives is to reduce per capita water consumption by 40% from the 2008 baseline of 600 litres per capita per day (lpcd).

7. A review of the estimated average day per capita demands since 2007 shows an overall decrease, with the last three years being under 500 lpcd.

8. The Town's average day, maximum day and peak hour demands are projected to increase to 123.2 l/s, 285.9 l/s and 450.8 l/s; respectively by Year 2031.

9. Pressure zone boundary adjustments can be made to improve service to residences in the Aitken St and Glacier View Dr area and along Noel Ave between Aitken and Aspen by moving them off of the 89 m HGL pressure zone and onto the 120 m HGL pressure zone.

10. The Town's minimum 75 L/s design fire flow requirement for residential development cannot be met in three areas, as noted in Table 11, without distribution pipe upgrades or looping.

11. The Town operates two pressure zones; 120 m HGL and 89 m HGL. There are two PRV linking them but both are isolated and not in use. The isolation of the Pritchard and Skeena PRV impacts on available fire flows in the 89 m HGL pressure zone. The upgrade of this PRV is presently underway. The Pritchard and Cambridge PRV is no longer required as a result of recent supply and distribution system upgrades.

12. Additional storage at the Comox Reservoir (to be constructed by the CVRD) is required by 2016 but can be delayed until 2026 because of available unallocated storage in the East Courtenay and Crown Isle reservoirs.

13. Nearly one half of the Town's watermains are Asbestos Cement. The majority are over 40 years old. The life span of AC mains ranges from 30 to 90 years.

7.2 RECOMMENDATIONS

Based on the conclusions listed in this report, it is recommended that:

1. The Town adopts the system improvement projects listed in Table 13.

2. Pressures improvements be carried out in the Aiken St and Glacier View Dr area by implementing project 4, and implementing project 5 to improve pressures to the Noel Ave residences between Aiken St and Aspen Rd.

3. If the Town's minimum fire flow design standard of 75 L/s is to be obtained for residential areas, projects 7, 8, and 10 be implemented. It is understood project 10 would be carried out by the developer of the vacant lot on the west side of Torrence Road.

4. The Town continues with the practice of examining water demands for new development, redevelopment, and future expansion areas, on a site specific basis as development proposals are received.

5. The Town continues advancing water conservation.

6. The Town develops an annual Asbestos Cement watermain replacement program. Laboratory testing of mains should be carried out to determine remaining service life and then used to establish the yearly replacement rate of the approximately 47 kms of mains.

7. The water study be updated every 5 to 7 years, subject to the rate of growth, to review capital project needs based on changes in water demands (per capita, maximum day, peak hour) resulting from population growth and conservation efforts.

8. The Town uses the proposed system improvement projects presented in this report and the development projections of the OCP to update the water Development Cost Charge (DCC) for the various land use categories in the DCC Bylaw.

APPENDIX A

1256 TECHNICAL MEMORANDUM NO. 1
Design Population , Design Water Demands, and Modeling Design Criteria

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1256 TECHNICAL MEMORANDUM NO.1

Town of Comox Water Study - DESIGN POPULATION, DESIGN WATER DEMANDS & MODELLING DESIGN CRITERIA

Issued: April 10, 2013

Previous Issue: None

1 OBJECTIVE

The objective of this technical memorandum is to define the design populations and water demands for the Town of Comox prior to completing the hydraulic computer modelling of the water system.

2 DESIGN POPULATION

The Town's Official Community Plan (OCP) projects the town population will reach approximately 19,000 by year 2031. Based on the 2011 Census population of 13,627, the population will increase by just over 4,900 by year 2031; a 35% increase. This equates to an annual compounded growth rate of 1.68%.

The OCP projected rate of growth is similar, but slightly higher, to the projections in the Comox Valley Regional Growth Strategy where the valley wide rate of growth is forecasted to go from 1.6% to 1.4% from year 2011 to year 2021, followed by a gradual slowing to 1% by year 2031. This valley wide rate of growth is for the Comox Valley Regional District including the municipalities of the City of Courtenay, the Town of Comox, and the Village of Cumberland.

Water modelling will be carried out based on the Town's OCP build-out design population of 19,000.

3 DESIGN WATER DEMANDS

3.1 Flow Records

Town of Comox monthly and annual water meter records for the previous six years were obtained from the Comox Valley Regional District and reviewed to determine average day and maximum month demands. A per capita demand, calculated by dividing the recorded water demand by the yearly population estimate published by Stats BC, is presented in Table 1.

Table 1
Water Demands, 2007 – 2012

Year	Stats BC Population Estimate	Annual Demand (m^3)	Ave. Day Demand (lpcd)	Max. Month Demand	
				(m^3)	(lpcd)
2007	12,721	2,482,623	535	389,005	986
2008	13,265	2,508,520	518	463,635	1,127
2009	13,459	2,629,431	535	399,661	792
2010	13,638	2,325,953	467	385,159	889
2011	13,501	2,308,060	468	351,416	840
2012	13,504	2,419,799	491	376,021	855

The highest annual demand occurred in 2009 while the highest monthly demand occurred in July 2008.

Daily readings to identify maximum day demands were not available at the time of this study and peak hour readings do not exist as they are not recorded by the flow meters.

3.2 Establishing Design Flows

In establishing the capacity of a water supply and distribution system, three levels of water demand are normally considered, in addition to fire flows. These are:

Average Day Demand = $\frac{\text{Total annual consumption.}}{\text{365 days}}$

Maximum Day Demand = Day with highest demand for the year.

Peak Hour Demand = Highest flow rate maintained for one hour (generally occurring on maximum day of the year).

The system must also be capable of providing water required for fire flow requirements during maximum day demands.

The Town of Comox Engineering Standards water system demand design requirements are: 635 litres per capita day (lpcd) for Average Day Demand; 2,100 lpcd for Maximum Day Demand; and 3,000 lpcd for Peak Hour Demand.

For the Town's most recent water study (year 2003), design water demands were based on year 1998 demands as spring and summer rainfall was notably lower than normal, resulting in high water demands. The design demands used were: 1,720 lpcd for Maximum Day; and 2,494 lpcd for Peak Hour; both are lower than the Town's design standards.

In the mid to late 2000's, the provincial government launched the Living Water Smart program emphasizing water conservation. This program requires 50% of new municipal water needs to be acquired through conservation by year 2020.

In 2010 the Town of Comox implemented a water conservation strategy which included a voluntary water meter installation program for residential property owners. In addition, a valley wide public education campaign along with a rebate program to replace high volume use toilets with "low flush" toilet, hand-out of shower and faucet aerators, and a rain barrel purchase program was carried out by the Comox Valley Regional District. The water demand data in Table 1, indicates a general overall decline in annual and maximum month demands since 2009 and 2008; respectively, with a slight increase in 2012.

The 2011 Comox Valley Water Study Update, prepared by Koers, also observed a decline in demand for the five year period of 2006 to 2010. The design demands used were: 560 lpcd for Average Day Demand; 1,300 lpcd for Maximum Day Demand; and 2,050 lpcd for Peak Hour Demand.

In the absence of maximum day or peak hour demands for the Town, a prudent approach is warranted for establishing design demands; balancing the acknowledgement of the recent implementation of the provincial and municipal water conservation measures with only a few years of data operating under them. For this study, it is proposed to use the per capita design demands presented in Table 2 and based on the 2011 Comox Valley Water Study Update.

Table 2
Proposed per Capita Design Demands

Description		Per Capita Demand
Average Day Demand	(ADD)	560 lpcd
Maximum Day Demand	(MDD)	1,300 lpcd
Peak Hour Demand	(PHD)	2,050 lpcd

Applying the per capita demands to the projected populations, water demands in 5 year increments, and year 2031 are presented in Table 3.

Table 3
Water Demand Projections

Year	Population	Demands		
		Average Day (l/s)	Maximum Day (l/s)	Peak Hour (l/s)
2013	14,088	91.3	212.0	334.3
2018	15,308	99.2	230.3	363.2
2023	16,635	107.8	250.3	394.7
2028	18,076	117.2	272.0	428.9
2031	19,000	123.2	285.9	450.8

3.2 Fire Flow Requirements

The ability to provide adequate fire flow is an important feature of a properly designed water distribution system. Fire flow requirements vary, depending on a building's floor area, number of stories, construction materials, if a fire sprinkler system is installed, and spacing from adjacent buildings (exposure).

The Town Engineering Standards specify a minimum of 75 l/s for residential areas to a maximum of 300 l/s. If developments require more than the maximum flow rate permitted to be withdrawn from the Town water system, they are required to provide the excess by other means, such as on-site storage.

4 MODELLING ANALYSIS CRITERIA

The following criteria is proposed to analyze the Town's water storage and distribution system utilizing the computer software program WaterGEMS:

Table 4 – Water Distribution System Design Criteria

Under Peak Hour Demand Conditions		
Minimum residual pressure at property line	275 kPa	(40 psi)
Under Fire Flow Demand Conditions (during Maximum Day Demands)		
Minimum residual pressure at hydrant	138 kPa	(20 psi)
Minimum residual pressure at property line [2]	38 kPa	(5 psi)
Under Static Conditions		
Maximum service pressure – ideal	860 kPa	(125 psi)
Maximum service pressure – absolute	1,020 kPa	(120 psi)
Pipe Friction Coefficients (Hazen Williams Formula, C Values)		
HDPE	145	
PolyVinyl Chloride (PVC) Pipe	140	
Asbestos Cement (AC) Pipe	130	
Ductile Iron	130	
Steel with Coating	130	
Prestressed Concrete	120	
Cast Iron	110	

The pipe friction factors are slightly less than those included in the Town Engineering Standards. This takes into account the reduction in capacity that occurs in the distribution systems, where fittings and service connection points are present and sliming on pipe walls occurs with age. To better calibrate the pipe friction factors, controlled field testing would be required during times of peak hour flows, where pressure losses in the various pipe types and sizes are determined. Flow testing was included as part of the scope of work for this study.

Technical Memorandum No. 1
Town of Comox Water Study – DESIGN POPULATION, DESIGN WATER DEMANDS & MODELLNG DESIGN CRITERIA

April 10, 2013

Please review and confirm if the Town is in agreement with the design parameters listed in this technical memorandum.

Yours truly,

KOERS & ASSOCIATES ENGINEERING LTD.

Mitchell Brook, P.Eng
Project Engineer

APPENDIX B

OFFICIAL COMMUNMITY PLAN MAPS

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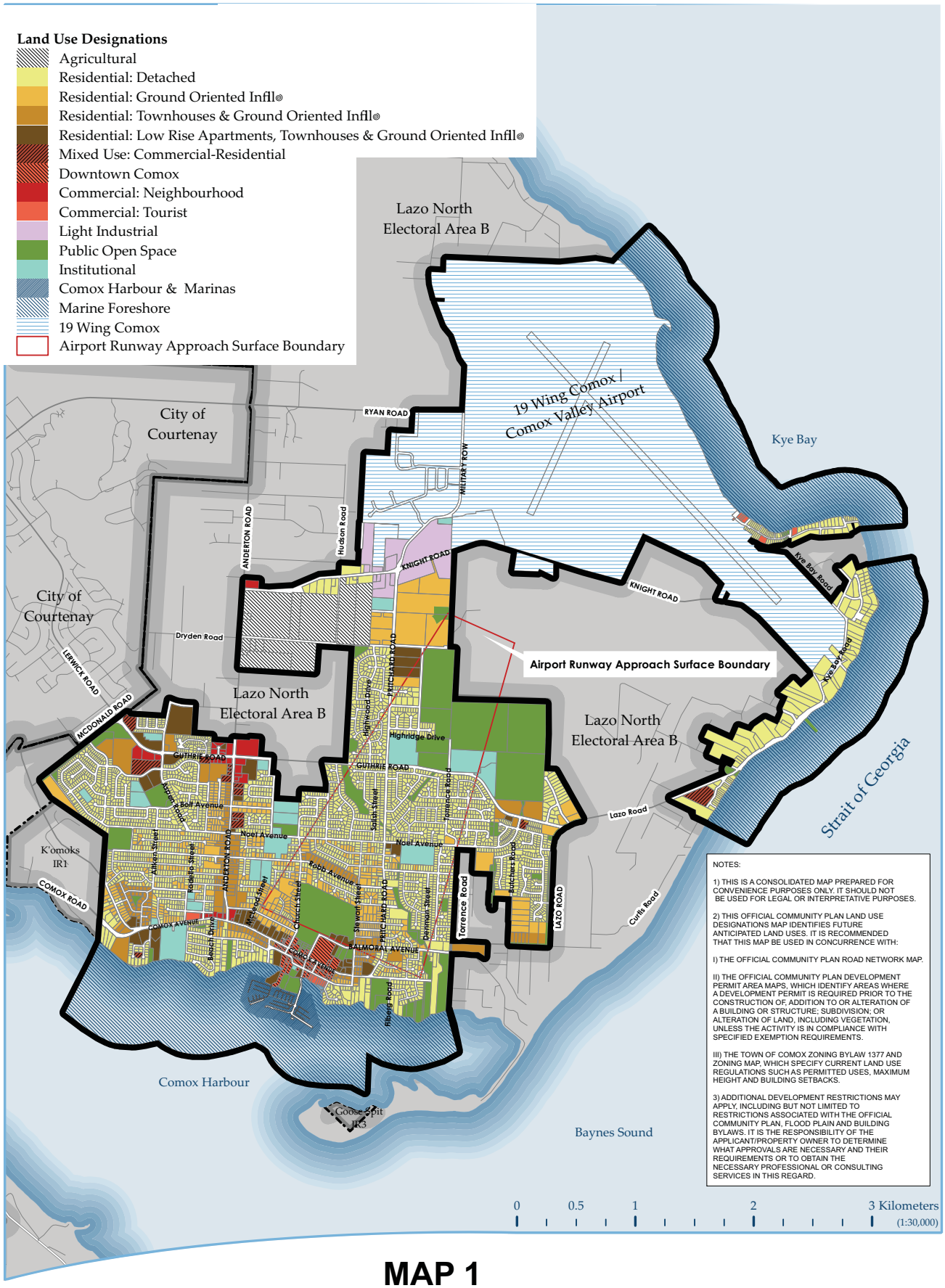
MAP 1 LAND USE DESIGNATIONS
MAP 2 RESIDENTIAL INFILL POTENTIAL



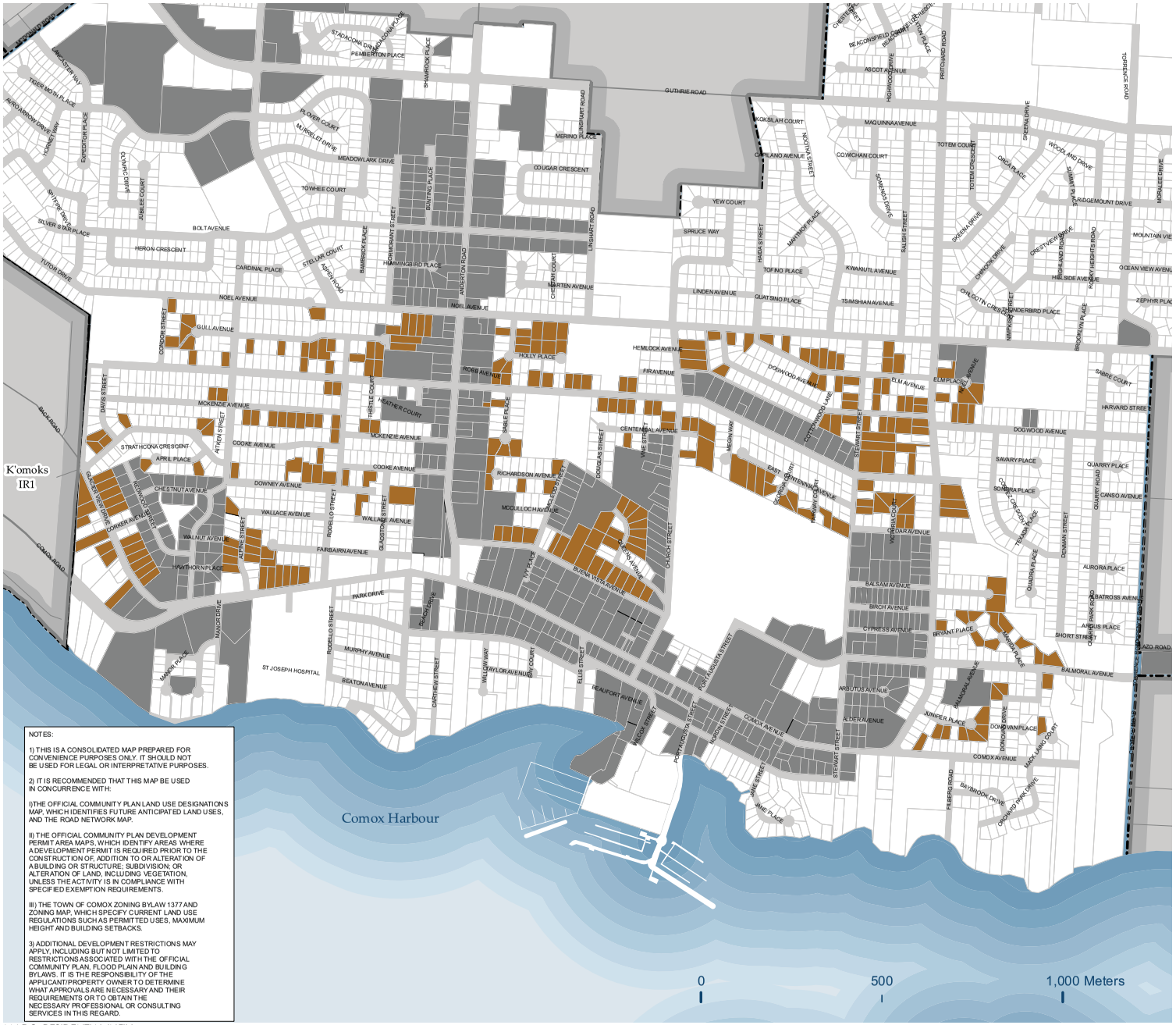
MAP 1
Land Use Designations

OFFICIAL COMMUNITY PLAN BYLAW 2011

ESTABLISHED JULY 20, 2011
BYLAW NO. 1685

TOWN OF COMOX

PLANNING DEPARTMENT



NOTES:

1) THIS IS A CONSOLIDATED MAP PREPARED FOR CONVENIENCE PURPOSES ONLY. IT SHOULD NOT BE USED FOR LEGAL OR INTERPRETATIVE PURPOSES.

2) IT IS RECOMMENDED THAT THIS MAP BE USED IN CONCURRENCE WITH:

I)THE OFFICIAL COMMUNITY PLAN LAND USE DESIGNATIONS MAP, WHICH IDENTIFIES FUTURE ANTICIPATED LAND USES, AND THE ROAD NETWORK MAP.

II) THE OFFICIAL COMMUNITY PLAN DEVELOPMENT PERMIT AREA MAPS, WHICH IDENTIFY AREAS WHERE A DEVELOPMENT PERMIT IS REQUIRED PRIOR TO THE CONSTRUCTION OF, ADDITION TO OR ALTERATION OF A BUILDING OR STRUCTURE; SUBDIVISION; OR ALTERATION OF LAND, INCLUDING VEGETATION, UNLESS THE ACTIVITY IS IN COMPLIANCE WITH SPECIFIED EXEMPTION REQUIREMENTS.

III) THE TOWN OF COMOX ZONING BYLAW 1377 AND ZONING MAP, WHICH SPECIFY CURRENT LAND USE REGULATIONS SUCH AS PERMITTED USES, MAXIMUM HEIGHT AND BUILDING SETBACKS.

3) ADDITIONAL DEVELOPMENT RESTRICTIONS MAY APPLY, INCLUDING BUT NOT LIMITED TO RESTRICTIONS ASSOCIATED WITH THE OFFICIAL COMMUNITY PLAN, FLOOD PLAIN AND BUILDING BYLAWS. IT IS THE RESPONSIBILITY OF THE APPLICANT/PROPERTY OWNER TO DETERMINE WHAT APPROVALS ARE NECESSARY AND THEIR REQUIREMENTS OR TO OBTAIN THE NECESSARY PROFESSIONAL OR CONSULTING SERVICES IN THIS REGARD.

MAP 2: RESIDENTIAL INFILL

MAP 2
Residential Infill Potential

Lot Analysis Category

Residential Infill Potential*
Designated for Mixed-Use or Multi-Family Development

*Criteria for Residential Infill Potential:
-Currently zoned R1.1, R1.2, or R1.3
-1000 sqm minimum area
-Within area bounded by Noel Ave, K'omoks IR1, Comox Ave, and Brooklyn Creek

OFFICIAL COMMUNITY PLAN BYLAW 2011

ESTABLISHED JULY 20, 2011
BYLAW 1685

TOWN OF COMOX

PLANNING DEPARTMENT