APPENDIX

B

IMPACTS AND COSTS OF SOUTH REGION SERVICE AREA

MEMO

TO: Kris La Rose, P.Eng.; Zoe Berkey, EIT; CVRD

FROM: Negin Tousi, EIT, Carol Campbell, P.Eng., Aline Bennett, P.Eng., Al Gibb, P.Eng., WSP

SUBJECT: South Region Service Area Impacts on CVSS Conveyance and Wastewater Infrastructure

DATE: January 9, 2019

BACKGROUND

The CVRD operates and maintains the sewerage system for the Comox Valley Sewerage Service (CVSS) for the City of Courtenay and the Town of Comox, and for the K'ómoks First Nation and the Department of National Defence by contracts with each. The conveyance system primarily consists of two pump stations and one common forcemain which together pump sewage to the Comox Valley Water Pollution Control Centre (CVWPCC), located in Electoral Area 'B' near the Willemar Bluffs. The Courtenay Pump Station (CPS), located on Comox Road, near the Highway 19A bridge that crosses the Courtenay River, and the Jane Place Pump Station (JPS), located at Jane Place near the Comox Valley Marina, are the two main pump stations which pump into this forcemain. Sewage is conveyed across the Courtenay River from areas of Courtenay on the west side of the river via a siphon under the river to the CPS. The Greenwood and Hudson Trunk service areas to the north of the Town of Comox and DND, and convey sewage flows to the CVWPCC via the CFB Pump Station. The system is shown in Figure 1.

Electoral Area 'A', also know as the South Region of the CVRD, is located to the south of the City of Courtenay, and does not have a centralized sewage collection system and uses privately owned onsite septic systems for wastewater management. There is interest in a future connection of the South Region to the existing CVRD sewerage area.

This memo summarizes population and sewage flow estimates for the South Region based on the previous work and more recent information regarding planned development, and assesses the impacts of conveyance of the South Region flows to CVRD's wastewater conveyance and treatment systems. Infrastructure capacity requirements to convey and treat flows from the South Region are assessed and the cost impacts evaluated. The impacts of the planned K'ómoks First Nation development, as well as the entire South Region are evaluated.

Development projections in the area are varied and changing, with multiple residential development projects proposed, which creates uncertainty in future build-out populations. High, medium, and low growth scenarios are presented to show the potential range of future service population over the next 50 years.

Figure 1 - Comox Valley Sewer Service Area (A)

CURRENTLY DEVELOPED AREAS

The developed area for the South Region currently includes Royston and Gartley, collectively known as Royston, and Kilmarnock and Union Bay, collectively known as Union Bay, (See Figure 2, part of the CVRD's Electoral Area 'A').

It is assumed that the development will be limited in these areas to maintain their existing density. There is no available data for the current population, and, therefore, the population was estimated based on the existing number of dwellings and an assumed population density of 2.1 people per dwelling taken from the more recent 2016 Census for the CVRD's Area 'A'. As of 2019, the estimated population of the South Region is approximately 2,756 people as shown in Table 1.

Table 1 - Existing Population

	ROYSTON		UNION BAY		TOTAL
	Royston	Gartley	Kilmarnock	Union Bay	
# of dwellings	459(1)	173(1)	276(1)	381(1)	
2017 population	964	363	580	800	2,707
2018 population (2)	973	367	585	807	2,732
2019 population (2)	982	370	590	815	2,756

(1) Data obtained from the CVRD South Regional Sewer Service Map.
(2) Annual percentage growth rate of 0.91% from the 2016 Census for the CVRD for Area 'A' was used.

FUTURE DEVELOPMENTS

The projections include the impact of KFN development on the fee simple and treaty settlement lands (including on the old Sage Hills property), and Union Bay Estates (see Figure 2). According to the information supplied by the CVRD, the proposed developments are either in the planning and/or design/construction phase. The Union Bay Estates will be developed in phases and the construction is due to commence in 2020. Development of KFN lands has not commenced yet.

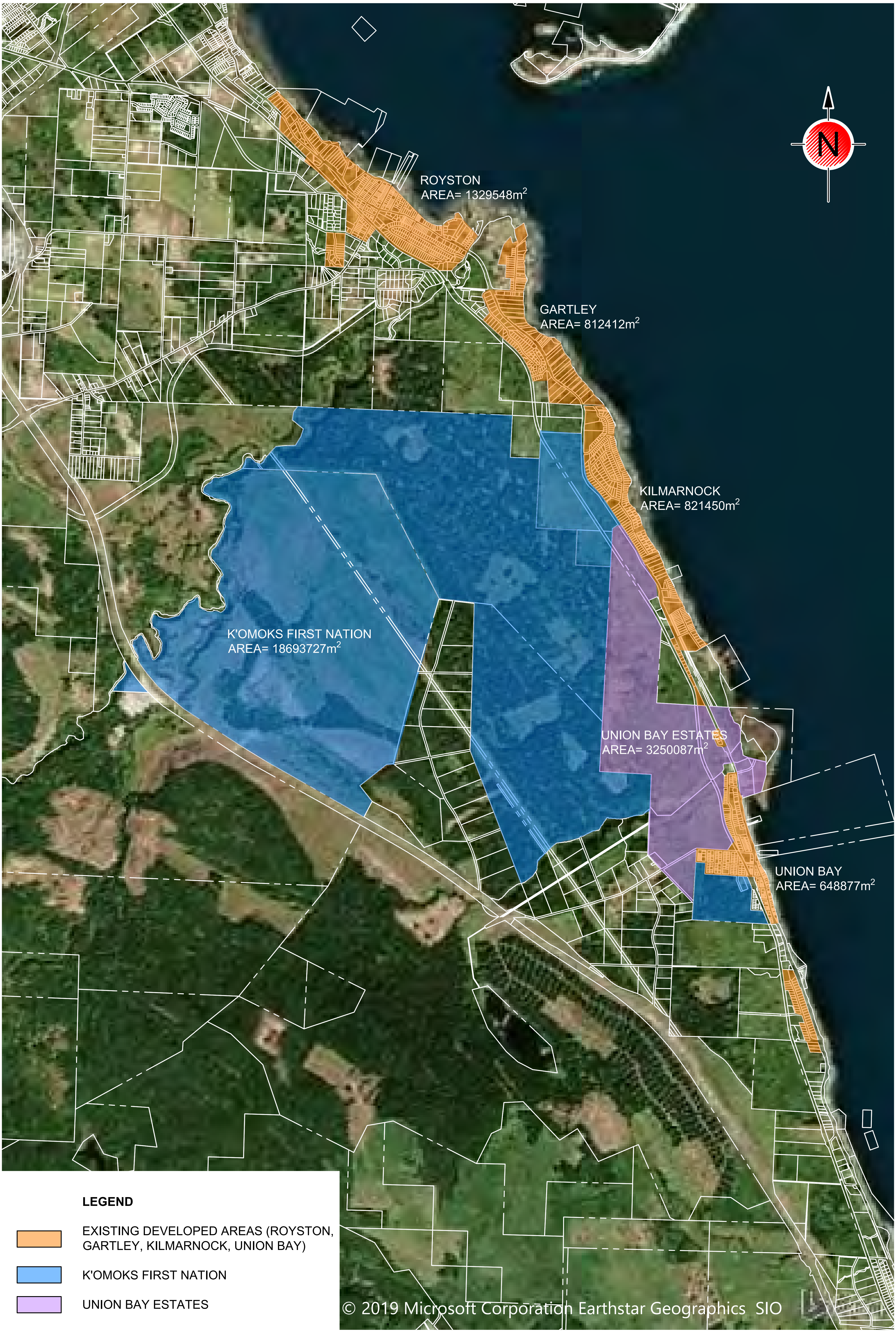

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FIGURE 2

SOUTH REGIONAL FUTURE SEWER AREA

POPULATION GROWTH SCENARIOS

HIGH GROWTH SCENARIO

For the high growth scenario, the projected rate of population growth over the next 50 years was estimated based on the estimated ultimate number of people that will occupy each development at build-out. For this scenario, the population is projected to increase from 2,756 to 26,056 in 50 years, which corresponds to an overall average annual growth rate of 4.5%.

BASIS OF POPULATION PROJECTIONS

CURRENTLY DEVELOPED AREAS

The change in the currently developed areas is expected to remain low. Based on the projected growth rates from various sources summarized in Table 2 below, that projects a decline in the population growth rate, it was assumed that the growth rate will remain at 0.91% according to the 2016 Census for the CVRD, Area 'A' data for the currently developed area.

Table 2 - CVRD Population Growth Rates

PROJECTED POPULATION GROWTH RATES

CVRD Regional Growth Strategy, 2010 – Area 'A'					
Year	2011-2021			2022-2030	
% change	1.40 %			1.00 % or less	
CVRD Official Community Plan, 2014 – Area 'A'					
Year	2021			2031	
% change	No growth			No growth	
BC Stats Population Projections					
Year	2019-2027	2028-2031	2032-2034	2035-2038	2039-2041
% change	1.20 %	1.10 %	1.00 %	0.90 %	0.80 %

UNION BAY ESTATES

According to the McElhanney *Kensington Union Bay Estates Sanitary Master Plan 2019*, Union Bay Estates has a build-out population of approximately 7,000 people that is expected to be reached by 2050. A population of 1,068 people by 2030, corresponding to a growth rate of 107 persons per year, was projected for Phase 1. Phase 2 development will take place from 2030 to 2040 and will double the population in the area. The final development phase, over the following 10 years to 2050, will further add approximately 5,000 people corresponding to 231 units per year at 2.1 persons per unit. It was assumed once a full build-out was reached in 2050, the growth will stagnate.

Although Union Bay Estates is installing some initial treatment capacity locally, the analysis assumes that this is a temporary solution and that all Union Bay Estates flows would eventually be sent to the CVSS.

KFN

The build-out population for the KFN developments is estimated at 16,270 people as indicated in the 2018 *KFN Development Preliminary Water Model Review* by Koers & Associates. It was assumed that approximately 325 people, corresponding to 155 units at 2.1 persons per unit, will be added annually over 50 years, from 2025 to 2075.

POPULATION PROJECTION

These assumptions were applied to the high growth population projection. The population change in 5-year increments from 2020 to 2070 is shown in Table 3.

Table 3 – Population Projection - South Region High Growth Scenario

YEAR	EXISTING(1)	UNION BAY ESTATES(2)	KFN(3)	TOTAL
2019	2,756	-	-	2,756
Projected				
2020	2,781	97	-	2,878
2025	2,910	582	319	3,811
2030	3,045	1,067	1,914	6,026
2035	3,186	1,607	3,509	8,302
2040	3,334	2,147	5,104	10,585
2045	3,488	4,577	6,699	14,764
2050	3,650	7,007	8,294	18,951
2055	3,819	7,007	9,889	20,715
2060	3,996	7,007	11,484	22,487
2065	4,181	7,007	13,079	24,267
2070	4,375	7,007	14,674	26,056

(1) Annual percentage growth rate of 0.91% from the 2016 census for the CVRD for Area ‘A’ was used.
(2) Annual growth rates obtained from the McElhanney 2019 report: 97 people (46 units/year) for Phase 1 (2020-2030); 108 people (51 units/year) for Phase 2 (2030-2040); 486 people (231 units/year) for Phase 3 (2040-2050); assumes 0.0% growth rate from 2050 to 2070.
(3) Assumes an annual growth rate of 319 people (152 units/year) to reach a build-out population of 16,270 in 2075.

MEDIUM GROWTH SCENARIO

In the medium growth scenario, the population is projected to increase from 2,756 to 10,702 people by 2070, which is an addition of 7,946 people over 50 years, corresponding to an overall average annual growth rate of 2.7%.

BASIS OF POPULATION PROJECTION

CURRENTLY DEVELOPED AREAS

Population growth of the currently developed area is expected to remain low. A growth rate of 0.5%, taken from the 2017 *Royston Water Source Study* by Koers & Associates, was used for the medium growth scenario.

UNION BAY ESTATES

The medium growth scenario assumes that the Union Bay Estates Development Phase 1 and 2 are completed 5 years later than planned, in 2035 and 2045, respectively. A population of 1,097 people by 2035, corresponding to a growth rate of 67 persons per year, was projected for Phase 1. Development of Phase 2 (from 2035 to 2045) was projectws to increase to 72 persons per year or 34 units at 2.1 persons per unit. For the final development phase, over the following 25 years to 2070, development was assumed to drop back down to 67 persons per year.

KFN

The medium growth scenario assumes that the development of KFN lands will be similar to the Union Bay Estates Phase 3 growth rate, adding 38 units annually (at 2.1 persons per unit) compared to 152 units per year (one quarter the rate) as assumed in the high growth scenario, resulting in a build-out of 3,680 people or 1752 units, by 2070.

POPULATION PROJECTION

The population change in 5-year increments from 2020 to 2070 is shown in Table 4 below.

Table 4 – Population Projections - South Region Medium Growth Scenario

YEAR	EXISTING[(1)]	UNION BAY ESTATES[(2)]	KFN[(3)]	TOTAL
2019	2,756	-	-	2,756
Projected				
2020	2,770	67		2,837
2025	2,840	402	80	3,322
2030	2,912	737	480	4,129
2035	2,985	1,097	880	4,962
2040	3,061	1,457	1,280	5,798
2045	3,138	1,792	1,680	6,610
2050	3,217	2,127	2,080	7,424
2055	3,299	2,462	2,480	8,241
2060	3,382	2,797	2,880	9,059
2065	3,467	3,132	3,280	9,879
2070	3,555	3,467	3,680	10,702

(1) Assumes an annual percentage growth rate of 0.5%.
(2) Assumes an annual growth rate of 67 people (32 units/year) for Phase 1 (2020-2035); 72 people (34 units/year) for Phase 2 (2035-2045); 67 people (32 units/year) for Phase 3 (2045-2070).
(3) Assumes an annual growth rate of 80 people (38 units/year) to reach a quarter of the build-out population in 2075.

LOW GROWTH SCENARIO

The population is projected to increase from 2,756 to 6,735 people by 2070, corresponding to an overall average annual growth rate of 1.8%.

BASIS OF POPULATION PROJECTION

CURRENTLY DEVELOPED AREAS

The population growth rate for of the currently developed area of 0.25% is assumed for the low growth scenario.

UNION BAY ESTATES

For the Union Bay Estates, an annual growth rate of approximately 34 to 36 people corresponding to 16 to 17 units (at 2.1 persons/unit) is assumed, half that of the medium growth scenario. The same growth rate, 34 people per year, was assumed for Phase 3.

KFN

A similar growth rate was applied to the KFN development. It was assumed that only one eighth of the build-out population will occur by 2075 adding 40 people per year which equates to 19 units annually.

POPULATION PROJECTION

The population change for the low growth scenario in 5-year increments from 2020 to 2070 is shown in Table 5 below.

Table 5 – Population Projections - South Shore Low Growth Scenario

YEAR	EXISTING(1)	UNION BAY ESTATES(2)	KFN(3)	TOTAL
2019	2,756	-	-	2,756
Projected				
2020	2,763	34	-	2,797
2025	2,798	204	40	3,042
2030	2,833	374	240	3,447
2035	2,869	544	440	3,853
2040	2,905	724	640	4,269
2045	2,941	904	840	4,685
2050	2,978	1,084	1,040	5,102
2055	3,016	1,254	1,240	5,510
2060	3,054	1,424	1,440	5,918
2065	3,092	1,594	1,640	6,326
2070	3,131	1,764	1,840	6,735

(1) Assumes an annual percentage growth rate of 0.25%.
(2) Assumes an annual growth rate of 34 people (16 units/year) for Phase 1 (2020-2035); 36 people (17 units/year) for Phase 2 (2035-2050); 34 people (16 units/year) for Phase 3 (2050-2070).
(3) Assumes an annual growth rate of 40 people (19 units/year) to reach an eight of the build-out population in 2075.

SUMMARY

Three population projections have been developed for different potential growth scenarios in the South Region, and are summarized below in Table 6 and Figure 3. The projections range from a 50-year population of 6,735 to 26,056 in 2070, and depend significantly on the rate of development in the Union Bay Estates and KFN developments.

Table 6 - Summary of Population Projection Scenarios – All (Current + KFN + Union Bay Estates)

YEAR	LOW GROWTH	MEDIUM GROWTH	HIGH GROWTH
	1.8% average growth rate	2.7% average growth rate	4.5% average growth rate
2019	2,756	2,756	2,756
2020	2,797	2,837	2,878
2025	3,042	3,322	3,811
2030	3,447	4,129	6,026
2035	3,853	4,962	8,302
2040	4,269	5,798	10,585
2045	4,685	6,610	14,764
2050	5,102	7,424	18,951
2055	5,510	8,241	20,715
2060	5,918	9,059	22,487
2065	6,326	9,879	24,267
2070	6,735	10,702	26,056

The population projections for different potential growth scenarios for KFN only are summarized below in Table 7. The projections range from a 50-year population of 1,840 to 14,674 in 2070.

Table 7 - Summary of Population Projection Scenarios – KFN Only

YEAR	LOW GROWTH	MEDIUM GROWTH	HIGH GROWTH
2025	40	80	319
2030	240	480	1,914
2035	440	880	3,509
2040	640	1,280	5,104
2045	840	1,680	6,699
2050	1,040	2,080	8,294
2055	1,240	2,480	9,889
2060	1,440	2,880	11,484
2065	1,640	3,280	13,079
2070	1,840	3,680	14,674

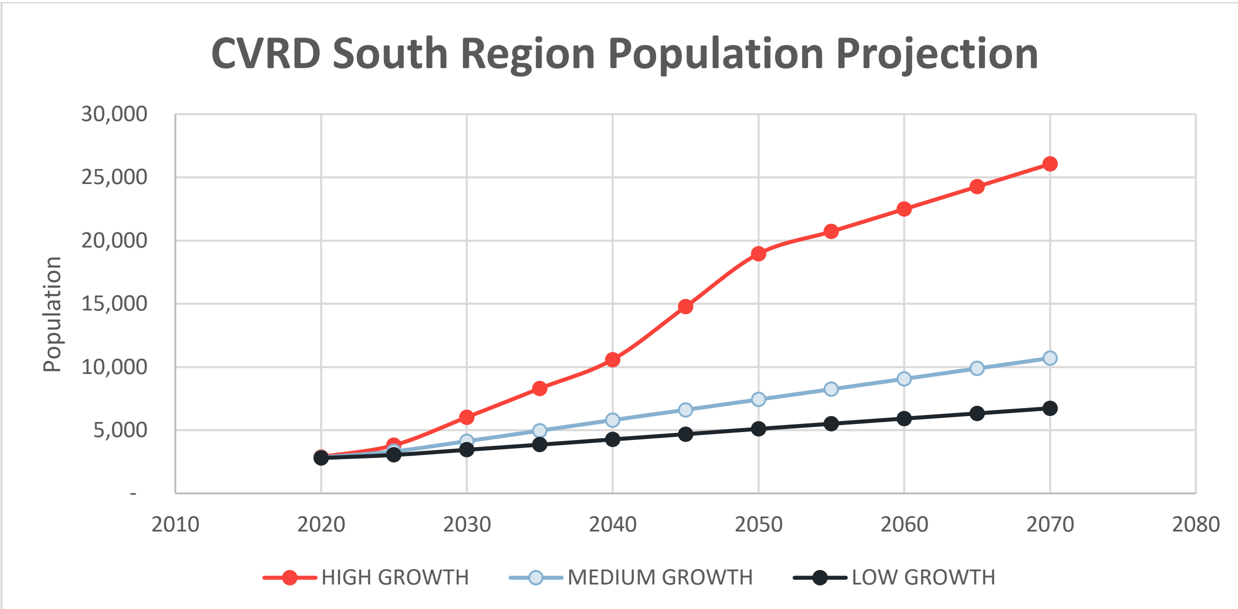

Figure 3 - South Region High, Medium and Low Growth Population Projections

FLOW PROJECTIONS

Several studies[1,2,3] have been conducted to estimate future wastewater flows for the South Region. A daily flow rate of 240 liters per capita (L/c/d) was used in the reviewed studies to estimate the Average Dry Weather Flow (ADWF). For the purpose of this study, it was assumed that the same design criteria would apply. All Peak Dry Weather Flows (PDWF) and Peak Wet Weather Flows (PWWF) were developed using methodology consistent with the Stage 2 conveyance assessment and using peaking factors and inflow and infiltration (I&I) rates from the 2014 MMCD Guidelines.

The peaking factors (PF) for PDWF were calculated using the following formula[4]:

$$PF = 3.2/P^{0.105}$$

Where P = Population (in thousands, rounded to the nearest thousand)

The peaking factors were calculated for the total population of the South Region and the City of Courtenay. A portion of the City of Courtenay flows are diverted directly to the CVPCC via the Hudson Trunk, estimated to be 5% of the City of Courtenay flows, and are anticipated to be in the near future via the construction of the Greenwood Trunk, estimated to 15% of City of Courtenay flows. Population estimates for determining flows through the foreshore system have been reduced by 20% to account for these diversions. Table 8 shows the total population and peaking factors for each of the growth scenarios.

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[1] Kensington Union Bay Estates Sanitary Master Plan by McElhanney (2019)
[2] South Region Water Reclamation Facility Schematic Design Repot (Draft) by AE (2016)
[3] South Region Sewage Collection, Treatment and Discharge Study by AE (2011)
[4] MMCD Design Guidelines (2014)

Table 8 - Peaking Factors

YEAR	POPULATION				LOW GROWTH		MED GROWTH		HIGH GROWTH	
	South Sewer			Courtenay[(1)]	Combined Pop	PF	Combined Pop	PF	Combined Pop	PF
	Low	Med	High							
2020	2,797	2,837	2,878	22,970	25,768	2.3	25,808	2.3	25,849	2.3
2030	3,447	4,129	6,026	26,442	29,890	2.2	30,571	2.2	32,469	2.2
2040	4,269	5,798	10,585	30,207	34,476	2.2	36,005	2.2	40,792	2.2
2050	5,102	7,424	18,951	34,508	39,610	2.1	41,932	2.2	53,459	2.1
2060	5,918	9,059	22,487	39,422	45,339	2.1	48,480	2.1	61,909	2.1
(1) Excludes population serviced by Hudson/Greenwood where flows are diverted to the CVWPCC via the CFB Pump Station.										

Peak Wet Weather Flows (PWWF) were calculated to account for the anticipated I&I in the South Region. Since the South Region will be a newly developed area (compared to the existing service area), it is anticipated that I&I rates will be lower. The I&I for the South Region is calculated using an area-based I&I rate of 0.06 L/s/ha[5]. Table 9 shows the total areas associated with each of the anticipated developments in the South Region (Refer to Figure 2 for geographical reference).

Table 9 - South Region Development Areas

DEVELOPMENT	AREA (HA)
Royston	133
Gartley	81
Kilmarnock	82
K'omoks First Nation	1,869
Union Bay Estates	325
Union Bay Area	65
Total Area	**2,556**

As shown on Figure 2, the majority of the K'ómoks First Nation land is currently green field and completely undeveloped. The KFN proposed development area accounts for approximately two thirds of all the proposed development areas in the South Region and would therefore account for a significant amount of I&I if the entire area is developed. Therefore, the KFN area to be developed was adjusted to represent an area that would yield the same population density in design year 2060 compared to the rest of the South Region developments. Table 10 shows the Population Density Equivalent Adjusted Area for the K'ómoks First Nation lands for each growth scenario.

[5] MMCD Design Guidelines (2014)

Table 10 - KFN Development Population Density Equivalent Adjusted Area

	LOW GROWTH	MED GROWTH	HIGH GROWTH
South Sewer Pop Density Excl KFN (2060), Person/ha	6.52	12.73	16.03
KFN Pop Density Eq Adjusted Area (2060), ha	221	226	716

The projected wastewater flows for the South Region are calculated based on the above assumptions and are shown in Table 11.

Table 11 - Projected South Region Flow Rates for Low, Medium, and High Population Growth Scenarios

YEAR	LOW GROWTH			MEDIUM GROWTH			HIGH GROWTH		
	ADWF (L/S)	PDWF (L/S)	PWWF (L/S)	ADWF (L/S)	PDWF (L/S)	PWWF (L/S)	ADWF (L/S)	PDWF (L/S)	PWWF (L/S)
2020	8	18	100	8	18	101	8	18	130
2030	10	21	104	11	26	108	17	37	149
2040	12	26	109	16	35	118	29	64	176
2050	14	31	113	21	45	127	53	111	223
2060	16	35	118	25	54	136	62	130	242

The projected wastewater flows for the KFN calculated based on the above assumptions are shown in Table 12.

Table 12 - Projected KFN (in South Region) Flow Rates for Low, Medium, and High Population Growth Scenarios

YEAR	LOW GROWTH			MEDIUM GROWTH			HIGH GROWTH		
	ADWF (L/S)	PDWF (L/S)	PWWF (L/S)	ADWF (L/S)	PDWF (L/S)	PWWF (L/S)	ADWF (L/S)	PDWF (L/S)	PWWF (L/S)
2020	-	-		-	-		-	-	
2030	1	2	84	1	3	86	5	12	124
2040	2	4	87	4	8	91	14	31	143
2050	3	6	89	6	13	96	23	50	162
2060	4	9	91	8	17	100	32	68	180

CONVEYANCE SYSTEM IMPACTS

The conveyance system infrastructure that would be impacted by South Region flows are the following:

- The siphon under the Courtenay River will convey added South Region flows;
- CPS will pump added South Region flows; and
- The forcemain from CPS to the CVWPCC will convey added South Region flows;
- JPS required pumping discharge head will be increased when JPS and CPS are pumping concurrently.

As the design life of pipes are typically longer than for pump stations, the following design horizons were used to assess impacts of South Region addition to the existing Foreshore Conveyance System:

— Forcemain: 2060 Design Horizon
— Pump Stations: 2040 Design Horizon

FLOW IMPACTS

Only the impacts on the existing Foreshore Conveyance System within the CVSS are assessed, as the Hudson/Greenwood/CFB Conveyance System will not be impacted. Table 13 summarizes the estimated PWWF for the existing foreshore conveyance system, as determined for the Stage 2 LWMP assessment[6], and for the South Region for low, medium and high growth scenarios. Table 14 summarizes the estimated PWWF for the existing foreshore conveyance system with existing and KFN flows only

Table 13 – Peak Wet Weather Flows for the Foreshore Conveyance System

YEAR	PWWF (L/S)						
	CVSS[(1)]	South Region (Low Growth)	South Region (Med Growth)	South Region (High Growth)	Total (Low Growth)	Total (Med Growth)	Total (High Growth)
2020	685	100	101	130	786	786	816
2030	702	104	108	149	806	811	852
2040	720	109	118	176	829	838	896
2050	740	113	127	223	854	868	964
2060	763	118	136	242	881	900	1,005
(1) Scenario assumed is that 50% of future flows will be diverted to the Greenwood or Hudson Trunk Sewers and will not be conveyed through the Foreshore Conveyance System							

Table 14 – Peak Wet Weather Flows for the Foreshore Conveyance System - KFN only

YEAR	PWWF (L/S)						
	CVSS[(1)]	KFN (Low Growth)	KFN (Med Growth)	KFN (High Growth)	Total (Low Growth)	Total (Med Growth)	Total (High Growth)
2020	685	-	-	-	685	685	685
2030	702	84	86	124	786	788	826
2040	720	87	91	143	807	811	864
2050	740	89	96	162	829	836	902
2060	763	91	100	180	854	863	943
(1) Scenario assumed is that 50% of future flows will be diverted to the Greenwood or Hudson Trunk Sewers and will not be conveyed through the Foreshore Conveyance System							

As shown in Table 13 with the South Region flows added to the CVSS flows, the 2060 PWWF increases by:

— 15% for the low growth scenario
— 18% for the medium growth scenario, and
— 32% for the high growth scenario.

[6] CVRD LWMP Stage 2 – Conveyance Options Assessment – DRAFT #1, October 28, 2019

As shown in Table 14, with the KFN flows added to the CVSS flows, the 2060 PWWF increases by:

- 12% for the low growth scenario
- 13% for the medium growth scenario; and
- 24% for the high growth scenario.

SIPHON IMPACTS

A siphon conveys wastewater under the Courtenay River to the CPS, and consists of a concrete inlet structure at the end of 21st St., two PVC pipes (600 mm ø and 350 mm ø), and an outlet structure. According to McElhanney's 2011 report, *CVRD Sanitary Sewer System Master Plan Update – Final Master Plan*, the combined capacity of the two pipes is 670 L/s with no surcharge, and 760 L/s with 0.4 m surcharge in the inlet chamber. There is a third 250 mm ø pipe in the arrangement which can be used if increasing flows require it.

Our review of the siphon estimated the capacity to be 535 L/s with no surcharge and 716 L/s with 0.4 m surcharge. If the third pipe is brought into service, the capacity increases to 620 L/s with no surcharge, and to 850 L/s with 0.4 m surcharge.

Estimated Peak Wet Weather Flows for the Year 2060 passing through the siphon and pumped by CPS (which excludes Comox flows pumped by JPS) are shown in Table 15. Comparing these flows against the siphon capacity, the siphon is able to convey flows across the river for all growth scenarios, with all three siphon pipes in service to the year 2060, if allowed to surcharge.

Table 15 – 2060 Courtenay and South Region Peak Weather Flows

	LOW GROWTH	MED GROWTH	HIGH GROWTH
Courtenay Flows	520 L/s	520 L/s	520 L/s
Courtenay + South Region Flows (incl. KFN)	637 L/s	656 L/s	761 L/s
Courtenay + KFN flows only	611 L/s	619 L/s	698 L/s

FORCEMAIN IMPACTS

Currently, sewage is conveyed from CPS in a 750 mm ø reinforced concrete cylinder pipe (Hyprescon) eastward along Comox Road and Bayside Road before routing into the foreshore, where sewage from JPS pumps directly into the common forcemain, at which point the diameter increases to 860 mm. The forcemain turns northward at Goose Spit and continues in the foreshore to the CVWPCC.

The impacts of the additional South Region flows are accounted for in two separate sections:

- First Section: Forcemain from CPS to the JPS tie-in (start of common forcemain)
- Second Section: Common forcemain from the JPS tie-in to the CVWPCC

The methodology used to assess the required pipe size for the Foreshore Conveyance System with and without the addition of the South Region Flows is based on limiting the maximum velocity to 2.0 m/s in the forcemain, the most conservative value from maximum allowable velocity values used by Lower Mainland municipalities as shown in Table 16 for comparison.

Table 16 –Maximum Forcemain Velocities for Various Municipalities

MUNICIPALITY	MAXIMUM VELOCITY (M/S)
Burnaby	2.0
Coquitlam	3.5
Kamloops	2.5
North Vancouver	3.0
Surrey	5.0
Port Moody	3.5
Port Coquitlam	3.5

For the medium growth scenario, the addition of the South Region flows would require that the theoretical size of the forcemain from CPS to JPS tie-in be increased from 600 mm ø to 650 mm ø (1 pipe size larger) to maintain the pipe velocity below 2 m/s. For the section from the JPS tie-in to CVWPCC, the addition of the South Region flows would require that the design criteria for the size of the forcemain be increased from 700 mm ø to 750 mm ø (1 pipe size larger).

However, note that the existing forcemain sizes of 750 mm ø and 860 mm ø are already larger than the estimated minimum pipe sizes required to convey the additional South Region flows. The existing 750 mm ø forcemain can convey flows of up to 885 L/s and the existing 860 mm ø pipe can convey flows of up to 1,160 L/s based on this criterion. Table 17 shows the velocities in the forcemain for the medium and high growth scenarios. Therefore, for both the medium and high growth scenarios, the "trigger" date for upgrading the forcemain size to accommodate the South Region flows will be beyond the year 2060.

When the forcemain is replaced to relocate it out of the foreshore in the near to medium future, the incremental size increase (and therefore cost premium) to accommodate the South Region flows will be marginally larger, as allowable flow velocity is inversely proportional to the square of the pipe diameter, and therefore the pipe size increase required is minimal (1 to 2 pipe sizes). Sizing of the replacement sections of the existing forcemain would be based on estimated capacity at the end of the replacement pipe's expected service life.

In summary, to the year 2060, the existing Foreshore Conveyance System can accommodate the South Region and CVSS flows for all growth scenarios, based on a maximum velocity of 2 m/s.

Table 17 – Estimated Forcemain Velocities for Medium and High Growth Scenarios

YEAR	MEDIUM GROWTH		HIGH GROWTH	
	750 mm ø from CPS to JPS	860 mm ø from JPS to CVWPCC	750 mm ø from CPS to JPS	860 mm ø from JPS to CVWPCC
2020	1.30	0.99	1.37	1.04
2030	1.34	1.02	1.43	1.09
2040	1.39	1.05	1.52	1.15
2050	1.43	1.09	1.65	1.26
2060	1.48	1.13	1.72	1.31

PUMP STATIONS IMPACTS

The CPS pumps the flows from the South Region to the CVWPCC. CPS currently has 2 service and 1 standby 200 HP (149 kW) pumps, and is now at capacity when pumping at the same time that JPS is pumping. The pumping capacity will need to be increased when the forcemain is replaced and relocated out of the foreshore, due to the higher head requirements. The section of the forcemain from JPS to CVWPCC is planned for relocation and replacement in the short-term due to erosion of the forcemain cover near the Willemar Bluffs. Replacement of the section from CPS to JPS may be replaced at the same time, or in a future phase.

There are two alignment options for the relocated forcemain as identified in the Stage 2 Conveyance assessment:

1. Overland, whereby the forcemain will be installed using conventional cut and cover methods, and
2. Trenchless, where portions of the forcemain will be installed utilizing trenchless methods, thus reducing the required pump discharge head requirement.

JPS will be impacted only when pumping together with CPS. CPS will also be impacted when JPS is simultaneously pumping. These impacts are not accounted for in the following evaluation and can only be determined through a more detailed hydraulic analysis. However, this requirement will incrementally increase power requirements for all scenarios, and this increment is not expected to be significantly larger when South Region flows are contributed.

The capacity requirements were estimated to upgrade the CPS to the year 2040, based on the following assumptions:

- Pump station pumping alone (head requirements will be higher if pumping together with JPS)
- 50% of of the projected flows from City of Courtenay growth will be directed to the Hudson/Greenwood trunk sewers

Medium Growth Scenario Impacts

Table 18 summarizes the flow, head and peak power requirements for CPS for both alignment options for CVSS, CVSS + South Region, and CVSS + KFN flows, for the 2040 medium growth scenario.

Table 18 – Estimated Peak Power for CPS with and without South Region Flows – 2040 Medium Growth

SCENARIO	FLOW (L/S)	PUMPING HEAD (M)		PEAK POWER (KW)	
		Option 1 – Cut & Cover	Option 2 - Trenchless	Option 1 – Cut & Cover	Option 2 - Trenchless
CVSS Flows only	494	66.0	32.0	575	275
CVSS + South Region flows	613	66.0	32.0	700	350
CVSS + KFN Flows only	585	66.0	32.0	675	325
Assumptions: Power factor = 0.9 Efficiency = 0.65					

If the South Region flows are directed to CPS, the 2040 peak power requirement at CPS increase from 575 kW to 700 kW, or by 22%, for Option 1, and from 275 kW to 350 kW, or by 27%, for Option 2. Costs have been estimated using cost curves based on peak power, and therefore are proportional to peak power. Incremental costs are summarized in Table 19.

Table 19 – Estimated Cost for CPS with and without South Region Flows – 2040 Medium Growth

SCENARIO	ESTIMATED CAPITAL COST	
	Option 1 – Cut & Cover	Option 2 - Trenchless
CVSS Flows only	$11.59 M	$4.62 M
CVSS + South Region flows	$14.11 M	$5.88 M
CVSS + KFN Flows only	$13.61 M	$5.46 M
Incremental Cost Premium to Convey South Region flows	$2.52 M	$1.26 M
Incremental Cost Premium to Convey KFN flows	$2.02 M	$0.84 M

High Growth Scenario

For the high growth scenario, the power and cost estimates are summarized in Table 20 and Table 21:

Table 20 – Estimated Peak Power for CPS with and without South Region Flows – 2040 High Growth

SCENARIO	FLOW (L/S)	PUMPING HEAD (M)		PEAK POWER (KW)	
		Option 1 – Cut & Cover	Option 2 - Trenchless	Option 1 – Cut & Cover	Option 2 - Trenchless
CVSS Flows only	494	66.0	32.0	575	275
CVSS + South Region flows	670	66.0	32.0	775	375
CVSS + KFN Flows only	637	66.0	32.0	725	350
Assumptions: Power factor = 0.9 Efficiency = 0.65					

Table 21 – Estimated Cost for CPS with and without South Region Flows – 2040 High Growth (Class D)

SCENARIO	ESTIMATED CAPITAL COST	
	Option 1 – Cut & Cover	Option 2 - Trenchless
CVSS Flows only	$11.59 M	$4.62 M
CVSS + South Region flows	$15.62 M	$6.30 M
Courtenay Pump Station, including KFN Flows only	$14.62 M	$5.88 M
Incremental Cost Premium to Convey South Region flows	$4.03 M	$1.68 M
Incremental Cost Premium to Convey KFN flows	$3.02 M	$1.26 M

Low Growth Scenario

For the low growth scenario, the estimates are summarized in Table 22 and Table 23:

Table 22 – Estimated Peak Power for CPS with and without South Region Flows – 2040 Low Growth

SCENARIO	FLOW (L/S)	PUMPING HEAD (M)		PEAK POWER (KW)	
		Option 1 – Cut & Cover	Option 2 - Trenchless	Option 1 – Cut & Cover	Option 2 - Trenchless
CVSS Flows only	494	66.0	32.0	575	275
CVSS + South Region flows	603	66.0	32.0	700	350
CVSS + KFN Flows only	581	66.0	32.0	675	325
Assumptions: Power factor = 0.9 Efficiency = 0.65					

Table 23 – Estimated Cost for CPS with and without South Region Flows – 2040 Low Growth (Class D)

SCENARIO	ESTIMATED CAPITAL COST	
	Option 1 – Cut & Cover	Option 2 - Trenchless
CVSS Flows only	$11.59 M	$4.62 M
CVSS + South Region flows	$14.11 M	$5.88 M
Courtenay Pump Station, including KFN Flows only	$13.61 M	$5.46 M
Incremental Cost Premium to Convey South Region flows	$2.52 M	$1.26 M
Incremental Cost Premium to Convey KFN flows	$2.02 M	$0.84 M

CONVEYANCE SYSTEM IMPACTS SUMMARY

For the medium growth scenario to 2040, adding the South Region flows increases the power requirement and capital costs of the Courtenay Pump Station Upgrade by about 22% for Option 1 (Cut & Cover) and by about 27% for Option 2 (Trenchless) , for both Stage 2 LWMP conveyance options as shown in Table 24. For the high growth scenario, this increases to 35% for both options, and for the low growth scenario, it decreases to about 22% for Option 1 (Cut & Cover) and 27% for Option 2 (Trenchless).

Table 24 – Summary of CPS Impacts for Medium Growth Scenario.

SCENARIO	OPTION 1 – CUT & COVER		OPTION 2 - TRENCHLESS	
	Estimated Power Requirement	Estimated Capital Costs (Class D)	Estimated Power Requirement	Estimated Capital Costs (Class D)
CVSS Flows only	575	$11.59 M	275	$4.62 M
CVSS + South Region flows	700	$14.11 M	350	$5.88 M
CVSS + KFN Flows only	675	$13.61 M	325	$5.46 M

WASTEWATER TREATMENT PLANT IMPACTS

The Stage 2 LWMP Wastewater Treatment Plant Capacity Assessment and cost estimate were developed based on a 2040 design horizon for a population of 60,448 for the current CVSS which includes the City of Courtenay, the Town of Comox, and CFB Comox.

Adding the projected population, assuming the medium growth projection, of the South Region to the plant service area adds an estimated 5,798 people by 2040, an additional 1,382 m^3/d (16 L/s) Average Dry Weather Flow, and 118 L/s Peak Wet Weather Flow to the plant load.

The capacity assessment and estimates developed for the 2040 upgrade are based on a population increase of approximately 15,200 people. Adding 5,798 people to the plant by 2040 timeframe increases biological capacity requirements by roughly 38% from the 2040 expansion requirements as shown in Table 25.

Table 25: Flow and Load Capacity Increase Requirements with Addition of South Region

	2020 CVSS	2040 CVSS	2040 EXPANSION REQUIRED	2040 SOUTH REGION (2)	2040 PROJECTION WITH SOUTH REGION (2)	2040 EXPANSION % INCREASE REQUIRED WITH SOUTH REGION	2040 TOTAL PLANT CAPACITY % INCREASE WITH SOUTH REGION
	a	b	c= b - a	d	e = b + d	f = d / c	g = d / b
Population	45,259 (1)	60,448 (1)	15,189	5,798	66,246	38%	10%
Average Dry Weather Flow (ADWF) m^3/d	12,885	17,210	4,324	1,382	18,592	32%	8%
Maximum Day Flow (MDF), m^3/d	37,547	50,148	12,601	3,024	53,172	24%	6%
Peak Wet Weather Flow (PWWF), L/s	576	769	193	118	887	61%	15%
Average BOD5, kg/d	3,621	4,836	1,215	462	5,298	38%	10%
Average TSS, kg/d	4,526	6,045	1,519	577	6,622	38%	10%

(1) From WSP Stage 2 Wastewater Treatment Level Assessments, November 2019
(2) Assuming the medium growth projection

Considered from a different perspective, plans are currently in place to upgrade the CVWPCC to meet 2040 capacity requirements for the CVSS service area (not including South Region). This will provide for additional capacity for approximately 15,200 additional people.

If the South Region is connected and growth occurs at the low, medium, or high growth rates assumed, capacity of the new plant expansion is reached between 2030 and 2035 as shown in Table 26. In other words, another upgrade could be required at the plant anywhere from 10 to 15 years after the initial plant expansion, or 5 to 10 years earlier than without the South Region Flows.

Table 26: Relative increase in population compared to 2020 Population

YEAR	CVSS POPULATION	LOW GROWTH		MEDIUM GROWTH		HIGH GROWTH	
		Population Projection	Increase relative to 2020 CVSS pop	Population Projection	Increase relative to 2020 CVSS pop	Population Projection	Increase relative to 2020 CVSS pop
2020	45,259	2,797	2,797	2,837	2,837	2,878	2,878
2025	49,138	3,042	6,921	3,322	7,201	3,811	7,690
2030	53,018	3,447	11,206	4,129	11,888	6,026	13,785
2035	56,733	3,853	15,327	4,962	16,436	8,302	19,776
2040	60,448	4,269	19,458	5,798	20,987	10,585	25,774
Capacity is consumed within		12-15 years		11-14 years		10-13 years	

There is a significant amount of uncertainty regarding the pace at which development may actually occur, and when these populations may materialize. Given the uncertainty of these projections, it is prudent to ensure that the next plant upgrade is planned so that unit processes can be easily expanded if needed.

For hydraulic components of the plant that are not easily expandable (such as headworks influent channels for example), it is recommended to take a conservative approach during the next upgrade.

From a regulatory perspective, the plant currently exceeds its maximum daily flow allowance of 18,500 m^3/d outlined in Permit PE-5856 and so must go through the process of either registering under the Municipal Wastewater Regulation or applying for an Operational Certificate through the Liquid Waste Management Planning Process. Both processes require new environmental impact studies, receiving environment monitoring and dilution modelling be completed to assess the impact of the discharge on the receiving environment. These studies use projected flow and loading information as inputs to the studies. If the addition of the South Region is projected to occur within the near future, it may be worthwhile to include these flows and loads in the assessment of the impacts on the receiving environment at this point, instead of going through the process again in 10 to 15 years. Dilution modelling has not been completed with the inclusion of the South Region flows, however, the additional flows and loads are not expected to drive additional treatment requirements because the predicted 2040 dilution is currently well above minimum dilution requirements

Similarly, the Liquid Waste Management Plan defines the service area for the CVWPCC. Changing the service area is considered a 'major change' under the Guidelines and may require that the Liquid Waste Management Plan be re-opened and the committees be reformed to approve the change in plant service area. If the South Region service area is to be included in the future, it may be worthwhile to incorporate that into the LWMP during the current process.

OUTFALL IMPACTS

The outfall is currently approaching its capacity limits and a new outfall is planned for early 2030's. The upgraded outfall should be designed for a 40 plus year design horizon. Using 2060 as the design year, for the purposes of this assessment, and the variation in potential population increase with the addition of the South Region, there is a population increase anywhere from 6% to 24% beyond the 2060 CVSS projections. The outfall would be designed based on the peak wet weather flows. The current projected 2060 peak wet weather flows are in the order of 1,000 L/s. Adding the South Region would add between 120 - 240 L/s of peak wet weather flows by 2060 depending on growth in the region. Assuming a gravity flow option is preferred to a pumping option, it may be required to go to a larger pipe size than what would be required for the CVSS PWWF flows.

Current outfall replacement cost estimates are in the order of $22M-$25M in 2019 $CAD for the CVSS flows only, which assumes a 54" pipe. This can accommodate flows of up to approximately 1,010 L/s by gravity. Beyond this, the pipe would need to be upsized to accommodate the additional flows and maintain gravity flow, and there is an estimated 30% cost premium to increase to a larger pipe diameter (from 54" to 63" HDPE pipe), as construction costs are closely scaled to the pipe costs (per communication with GreatPacific).

From a regulatory perspective, predicted minimum dilutions for the 2060 Maximum Day Flow (not including the South Region) were well above minimum regulatory limits. Dilution modelling has not been completed with the South Region flows included, but it is anticipated that the additional flows would be within required dilution limits.

SUMMARY

CONVEYANCE SYSTEM IMPACTS

Table 27 summarizes the impacts on the conveyance system components of the Comox Valley Sewerage Service (CVSS) system with the addition of the South Region Flows, and for the addition of K'ómoks First Nation (KFN) flows only. The impacted infrastructure includes the Courtenay Pump Station (CPS), the siphon under the Courtenay River and the Foreshore Forcemain.

Table 27 – Conveyance System Impacts (Courtenay Pump Station and Forcemain)

	CVSS ONLY	CVSS+SOUTH REGION (INCLUDES KFN)		CVSS + KFN ONLY	
		MEDIUM GROWTH	RANGE	MEDIUM GROWTH	RANGE
Design Population (CPS)					
- 2040	30,207	36,005	34K to 41K	31,487	31K to 35K
- To 2060	39,422	48,480	45K to 62K	42,302	42K to 51K
PWWF					
- 2040	720 L/s	838 L/s	829 L/s to 896 L/s	811 L/s	807 L/s to 864 L/s

	CVSS ONLY	CVSS+SOUTH REGION (INCLUDES KFN)		CVSS + KFN ONLY	
		MEDIUM GROWTH	RANGE	MEDIUM GROWTH	RANGE
- 2060	763 L/s	900 L/s	881 L/s to 1,005 L/s	863 L/s	854 L/s to 943 L/s
CPS Peak Power - Option 1	575 kW	700 kW	700 to 775 kW	675 kW	675 kW to 725 kW
CPS Peak Power - Option 2	275 kW	350 kW	350 to 375 kW	325 kW	325 to 350 kW
CPS Upgrade Cost - Option 1	$11.59M	$14.11 M	$14.11 M to $15.62 M	$13.61 M	$13.61 M to $14.62 M
CPS Upgrade Cost - Option 2	$4.62 M	$5.88 M	$5.88 M to $6.30 M	$5.46 M	$5.46 M to $5.88 M
Costs are Class D estimates in 2019 $ CAD.					

FORCEMAIN

The existing forcemain sizes of 750 mm ø and 860 mm ø are larger than the minimum pipe sizes required to convey the additional South Region flows. The existing 750 mm ø forcemain section can convey flows of up to 885 L/s and the existing 860 mm ø pipe can convey flows of up to 1160 L/s based on limiting the velocity to 2 m/s. Therefore, to the year 2060, the existing size of the Foreshore Conveyance System has the capacity to accommodate the South Region and CVSS flows for all growth scenarios.

PUMP STATIONS

For the medium growth scenario to 2040, adding the South Region flows increases the power requirement and capital costs of the Courtenay Pump Station Upgrade by about 22% for Option 1 (Cut & Cover) and by about 27% for Option 2 (Trenchless), for both Stage 2 LWMP conveyance options. For the high growth scenario, this increases to 35% for both options, and for the low growth scenario, it decreases to about 22% for Option 1 (Cut & Cover) and 27% for Option 2 (Trenchless). This results in an incremental cost of $2.52 M for Option 1 (cut and cover) and $1.26 M for Option 2 (trenchless).

SIPHON

The capacity of the siphon is estimated to be 620 L/s with no surcharge, and to 850 L/s with 0.4 m surcharge with the all three siphon pipes in service. Therefore, the siphon is able to convey flows across the river for all growth scenarios, to the year 2060, if allowed to surcharge.

WASTEWATER TREATMENT PLANT IMPACTS

The Stage 2 LWMP Wastewater Treatment Plant Capacity Assessment and cost estimate were developed based on a 2040 design horizon for a population of 60,448 for the current CVSS. Adding the projected population of the South Region to the plant service area adds an estimated 5,798 people by 2040, an additional 1,382 m^3/d (16 L/s) Average Dry Weather Flow, and 118 L/s Peak Wet Weather Flow to the plant load, assuming the medium growth projection. Adding 5,798 people to the plant by 2040 timeframe increases the biological capacity requirement for the 2040 expansion by roughly 38%. This equates to an overall 2040 plant capacity increase of 10%.

If the South Region is connected and growth occurs at the low, medium, or high growth rates assumed, capacity of the new plant expansion is reached between 2030 and 2035 as shown in Table 26. In other words, another upgrade could be required at the plant anywhere from 10 to 15 years after the initial plant expansion, or 5 to 10 years earlier than without the South Region Flows.

From a regulatory perspective, the plant currently exceeds its maximum daily flow allowance of 18,500 m^3/d outlined in Permit PE-5856, and so must go through the process of either registering under the Municipal Wastewater Regulation or applying for an Operational Certificate through the Liquid Waste Management Planning Process. If the addition of the South Region is projected to occur within the near future, it may be worthwhile to include these flows and loads in the assessment of the impacts on the receiving environment at this point, instead of going through the process again in 10 to 15 years.

Similarly, the Liquid Waste Management Plan defines the service area. If the South Region service area is to be potentially included in the future, it may be worthwhile to incorporate that into the LWMP during the current process; this will avoid a major LWMP amendment to accommodate new service areas in the future.

OUTFALL

The current projected 2060 peak wet weather flows are in the order of 1000 L/s. Adding the South Region would add between 120 L/s - 240 L/s of peak wet weather flows by 2060 depending on growth in the region. Current outfall replacement cost estimates are in the order of $22M-$25M in 2019 $CAD for the CVSS flows only, which assumes a 54" pipe diameter. This can accommodate flows of up to 1,010 L/s by gravity. Beyond this, the pipe would need to be upsized to a 63" pipe to accommodate the additional flows and maintain gravity flow, and there is an estimated 30% cost premium to increase to the larger pipe diameter (assuming HDPE pipe), as construction costs are closely scaled to the pipe costs.

From a regulatory perspective, predicted minimum dilutions for the 2060 Maximum Day Flow (not including the South Region) were well within regulatory limits. Dilution modelling has not been completed for the South Region flows; however, the additional flows and loads are not expected to drive additional treatment requirements because the predicted 2040 dilution is currently well above minimum dilution requirements.

MEMO

TO: Kris La Rose, P.Eng.; Zoe Berkey, EIT; CVRD

FROM: Stephanie Wong, EIT, Carmen Peters, EIT, Carol Campbell, P.Eng.,
cc: Aline Bennett, P.Eng., Al Gibb, P.Eng., WSP

SUBJECT: **CVRD LWMP – South Region Forcemain Cost Estimate – FINAL**

DATE: **February 5, 2020**

BACKGROUND

The Comox Valley Regional District (CVRD) retained WSP Group Canada Ltd. (WSP) to complete a combined Stage 1 and Stage 2 Liquid Waste Management Plan (LWMP). As a supplement to this plan, WSP has been requested to prepare a desktop review and evaluation of two concepts and associated cost estimates for a forcemain to connect the South Region to the Comox Valley Sanitary System (CVSS).

Two sanitary servicing concepts have previously been investigated by Associated Engineering Ltd. (Associated Engineering) in 2016 and McElhanney Consulting Services Ltd. (McElhanney) in 2018. Associated Engineering considered sanitary servicing concepts of properties along Highway 19A, between Union Bay and Royston, including gravity collection systems with sanitary sewers between 150 and 375 mm in diameter, and pump stations with associated forcemains between 100 to 250 mm in diameter. McElhanney prepared a concept and cost estimate for a 375 mm forcemain along Highway 19A, between a proposed pump station at Royston Road and Marine Drive in Royston and the Courtenay River Siphon in Courtenay.

CVRD is now investigating installation of a forcemain following Highway 19A between Argyle Road and the Courtenay River Siphon. Additionally, CVRD wishes to consider the feasibility of an alternate alignment to the CVSS via an estuary crossing from Royston to Jane Place Pump Station (Jane Place PS) in Comox.

This memo provides a conceptual overview, assessment, and cost estimates of each of the routing options. The assessment also considers social and environmental impacts of the options.

Additionally, CVRD has requested that an estimate for the cost to extend the forcemain along Highway 19A from Argyle Road to Union Bay, near the boat launch, be included in this review.

CONCEPT DESCRIPTION

CONCEPT 1 – HIGHWAY 19A

Concept 1 consists of a 375 mm forcemain routed along Highway 19A to connect a pump station at Argyle Road, between Union Bay and Royston, to the Courtenay River Siphon in Courtenay. The siphon discharges into the Courtenay Pump Station for pumping to the CVPCC. Highway

210 – 889 Harbourside Drive
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wsp.com

19A is a provincial secondary highway that serves as an alternate route to Highway 19 and connects several communities on the east coast of Vancouver Island. Refer to **Figure 1** for the proposed alignment.

The 10,340 m long forcemain route has been divided into three main sections as follows:

Section 1: Argyle Road to Marriot Road (boulevard)

- The forcemain alignment is assumed to be in the shoulder on the west side of the highway to avoid the existing watermain located on the east side of the highway, reduce traffic impacts, and minimize road reconstruction costs. The majority of the highway consists of two-lane highway with narrow shoulders and ditches on both sides of the highway, limiting the available construction workspace and laydown area.
- There are overhead hydro/telecom poles along the majority of the alignment. Provisions must be made to maintain safe working clearances from the overhead poles while maintaining required clearances from the watermain alignment.
- At Trent River, the forcemain crossing is assumed to be constructed via Horizontal Directional Drilling (HDD). The crossing is approximately 40 m long.

Section 2: Marriot Road to Anfield Road (rural highway)

- Construction is assumed to continue in the roadway on the west side to avoid the existing watermain(s) on the east side of the highway. Similar to Section 1, the majority of this section consists of two-lane highway with narrow shoulders and ditches on both sides of the highway, limiting the available construction workspace and laydown area.
- There is an existing 200 mm sanitary gravity main on the west side of the road between Marriot Road and Millard Road, and an existing 150 mm forcemain on the west side of the road between Millard Road and Anfield Road.
- Similar to Section 1, there are hydro/telecom poles along the majority of the alignment. Provisions must be made to maintain safe working clearances from the overhead poles while maintaining required clearances from existing utilities.

Section 3: Anfield Road to Courtenay River Siphon at 20th Street (urban)

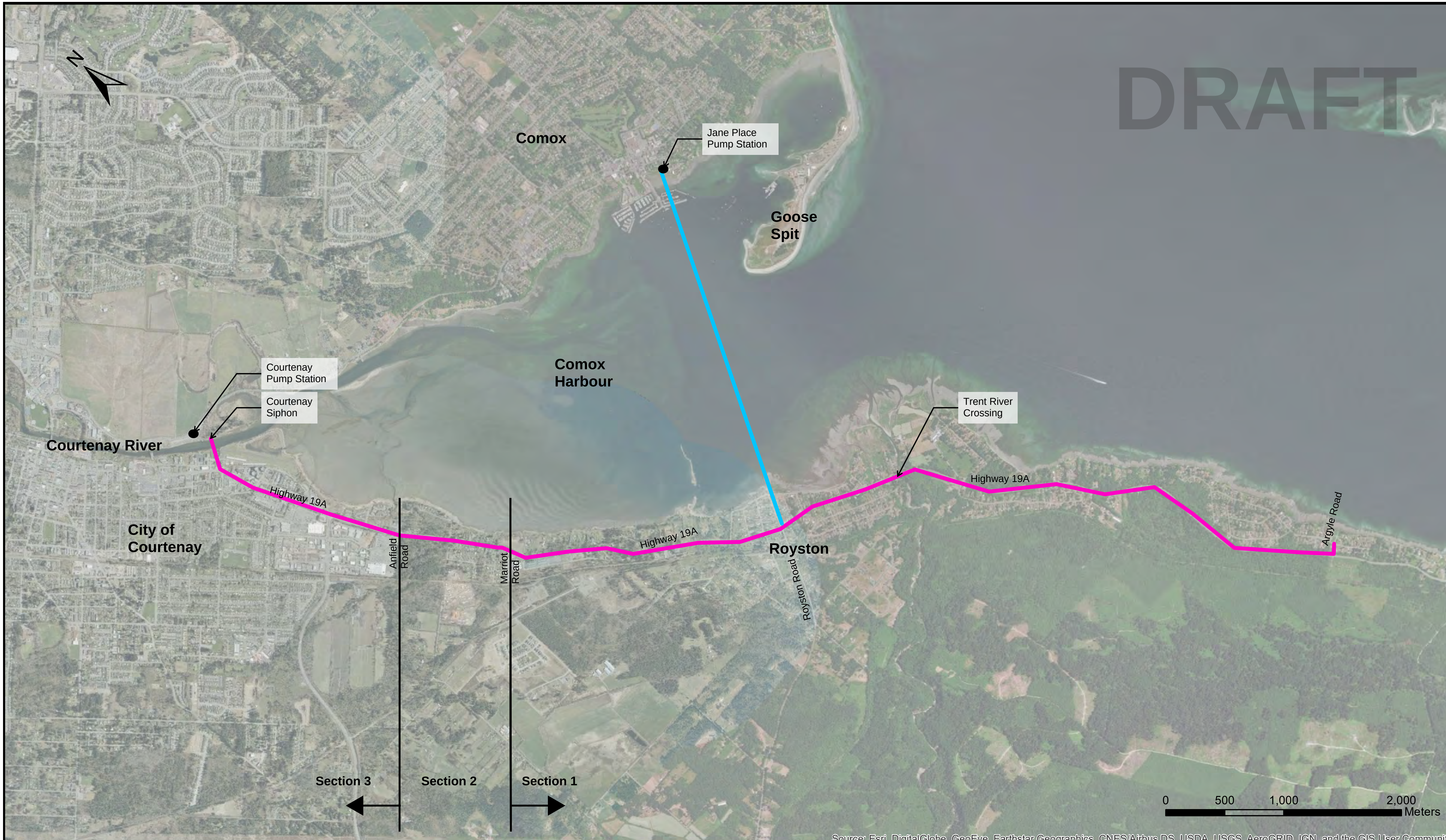
Construction assumed to be in the roadway to minimize conflicts with existing utilities.

Pump Station Upgrades

Concept 1 will require upgrading Courtenay Pump Station to pump the South Region flows to the CVPCC. The impact of these flows on the Courtenay Pump Station's pumping capacity and the associated cost were estimated in WSP's Memo ***South Region Service Area Impacts on CVSS Conveyance and Wastewater*** of January 9, 2020. Two options were considered, as outlined in WSP's memo ***CVRD Liquid Waste Management Plan Stage 2 – Conveyance Options Assessment – DRAFT #1 of October 28, 2019***. One option assumes the pump station will be pumping to a forcemain installed over land using cut and cover methods, and the second option assumes the forcemain will be partially installed using trenchless methods at a lower elevation. It was assumed that the pump station would be upgraded with larger pumps while retaining the existing wet well structure.

CONCEPT 2 – ESTUARY CROSSING

Concept 2 is a marine crossing across the estuary between Royston and the Jane Place Pump Station. A direct alignment would be approximately 2900 m in length and would pass through the Comox Harbour and discharge into the Jane Place Pump Station. Refer to **Figure 1** for the proposed alignment.



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COMOX VALLEY REGIONAL DISTRICT
SOUTH REGION FORCEMAIN COST ESTIMATE

Legend
- Concept 1 - Highway 19A
- Concept 2 - Estuary Crossing

Figure
FIGURE 1

Project No:
18P-00276-00

Last Revision Date
JAN 2020

The harbour is heavily utilized by boats travelling to and from the Comox Valley Marina and anchoring in the harbour. As such, laying a pipe along the bottom of the harbour presents risks related to the potential for boat anchors to catch on and damage the forcemain. Additionally, tidal currents may cause movement of the pipe if not secured. Due to the risks associated with laying the pipe on the estuary floor, options to install the pipe below ground have been reviewed.

Pump Station Upgrades

Concept 2 will require upgrading the Jane Place Pump Station to pump the South Region flows to the CVPCC. The impact of these flows on the station's pumping capacity and the associated cost are estimated for this assessment, in order to compare the cost of the two concepts. It is assumed that the pump station would be upgraded with larger pumps while retaining the existing wet well structure. Our initial review indicates this is possible, however, this would need to be confirmed with a more detailed hydraulics analysis, especially if the forcemain is to be installed using traditional cut and cover methods.

TRENCHLESS CONSTRUCTION

Three trenchless construction methods have previously been reviewed in the preparation of the Liquid Waste Management Plan for crossings of Comox Road Hill and Lazo Road Hill:

- Shield Tunnelling;
- Slurry Microtunnelling; and
- Horizontal directional drilling (HDD).

Shield tunnelling is not suitable for this estuary crossing application as it is not designed to work below the water table and is typically used to install larger diameter pipes (> 2.2 m). Microtunnelling is also not applicable in this application as sections are typically only installed in 600 m lengths, thus requiring multiple intermediate jacking stations which is not feasible for a 2900 m waterbody crossing. Additionally, microtunnelling is not typically used for installation of HDPE pipe.

The HDD construction method is likely to be the only trenchless method that could be considered. HDD consists of three steps: drill a pilot hole, ream the pilot hole to the required diameter, and pull the carrier pipe through in a continuous string. Surface pits are required at the pilot end and the exit to maintain a fluid-filled borehole for stability. This method is suitable for use with HDPE piping, has a high level of control, and can be used above and below the water table. However, the length of the crossing exceeds the typical maximum installation length for HDD of approximately 1500 m. This would require construction of an "island" within the estuary for an intermediary exit point and installation of the pipe in two sections. The feasibility and constructability of such an "island" would need to be investigated more thoroughly if this option were to be pursued further.

Staging areas on either side of the estuary would be required to accommodate the drilling rig, other machinery, and construction laydown. The Royston side may have sufficient area for laydown, but the Jane Place PS site is very constrained as it is located in between residential houses.

Additionally, the HDD method typically requires the new carrier pipe to be pulled through in a continuous string and so sufficient space to layout and assemble the pipe would be required. Assuming the pipe could be installed in two sections as above, the two continuous pipe lengths (nearly 1500 m each) would need to be assembled on land and likely floated out into the harbour to be pulled through the pilot hole via the constructed "island".

Geotechnical investigations would also be required to determine the existing soil conditions and confirm their suitability for HDD construction.

Given the complexities of an HDD crossing, this is not likely to be considered a feasible option. Social and environmental considerations of this option have been included in the Construction Impacts section of this memo for comparison purposes, however a cost estimate has not been prepared.

DREDGING

An alternative option would be to dredge a trench across the estuary and install the forcemain within the dredged trench. For shorter crossings, the pipe could be assembled on land and then pulled across the river, however due to the length of this crossing the pipe would likely need to be partially assembled in sections on land and fully assembled underwater.

There would also be a significant amount of dredged material created with this method. To avoid damage by boat anchors, the pipe should be buried to a depth of between 3 m and 4 m. Assuming a 3.5 m deep trench, nearly 152,250 m^3 of material would need to be excavated. Some of this excavated material could likely be used for cover, however a significant portion of it would likely need to be disposed of.

CONSTRUCTION IMPACTS

CONCEPT 1 – HIGHWAY 19A

SOCIAL

Highway 19A is a provincial highway. As such, forcemain construction would require permits and approvals from regulatory bodies such as the BC Ministry of Transportation and Infrastructure (MoTI). Furthermore, construction of the forcemain along Sections 1 and 2 of Highway 19A would have a significant impact on traffic as the highway is the primary connection between several communities along the east coast of Vancouver Island. At least one lane of traffic should be maintained at all times for the duration of construction to allow vehicle traffic to continue to use the highway. The highway also provides direct access to residential properties and small communities on both sides of the highway. Construction in the area will need to consider maintaining access to the properties. Local residents may also experience temporary disturbances arising from construction in the area.

Construction of Section 3 of the forcemain through the urban area of Courtenay could have an impact on the local businesses and residents along Highway 19A. The forcemain alignment also traverses several arterial intersections, which will have an added impact on traffic on the Courtney region. Such impacts can be reduced through effective traffic management.

A potential benefit of this concept is the opportunity to incorporate improvements along the highway shoulder for active transportation in conjunction with the forcemain installation along Highway 19A.

ENVIRONMENTAL

There are ditches on one or both sides of the highway along the majority of Sections 1 and 2. An environmental assessment would need to be completed to classify these ditches in accordance with local bylaws and Provincial and Federal regulations. This would then dictate what type of permitting and/or approvals would be required, as well as any restrictions on the time of year during which construction could occur. Additionally, sections of the proposed alignment pass through forested areas that may provide habitat to various wildlife species.

The river crossing at Trent River will include construction in or around the river and may also require the provision of environmental protection measures, permitting and approvals under environmental regulations. An environmental specialist should be consulted as part of the river crossing design.

While a detailed review of approval and permitting requirements should be undertaken if this concept option is selected, the following are examples of typical Provincial and Federal regulations and regulatory bodies under which consultation and permits and/or approvals may be required:

- Fisheries Act
- Water Sustainability Act
- Riparian Areas Protection Regulation
- Migratory Bird Convention Act
- Wildlife Act
- Fisheries and Oceans Canada
- Forests, Lands, Natural Resource Operations & Rural Development
- Comox Valley Regional District
- City of Courtenay

An archaeological assessment of the alignment should also be undertaken as part of the project.

CONCEPT 2 – ESTUARY CROSSING

SOCIAL

Construction would also have a large impact on local residents, especially in the areas of the Jane Place PS and the Royston Road / Marine Drive area in Royston. Local residents in these areas would be subject to long periods of construction disturbance including noise, vibrations, construction vehicle traffic, dust and mud. The project may also have a negative overall public perception from the idea of conveying raw wastewater across the estuary, which could present difficulties in obtaining public buy in to the project.

Additionally, both construction options presented would impact boating traffic in and out of the harbour and boats anchored in the marina area. The Comox Harbour and Marina are heavily used by both pleasure crafts and Commercial Fishing Fleets throughout the year.

Upgrades to the Jane Place Pump Station to accommodate the additional flows would also impact residents near the pump station as the site is very constrained and surrounded by residential properties.

ENVIRONMENTAL

Both methods discussed for construction of the estuary crossing would require environmental permitting and approvals. Similar to Concept 1, a detailed review of approval and permitting requirements should be undertaken if either option in this concept is to be pursued further. The requirements discussed in this memo are a high-level overview of only some of the issues that are likely to be encountered with the proposed methodology.

Extensive approvals and permitting would be required for the dredging method under the Fisheries Act as dredging will likely result in harmful alteration, disruption or destruction (HADD) of fish habitat which is prohibited under the Fisheries Act unless the project receives authorization. If the HDD method were to be used and construction of an intermediary "island" required, similar permitting under the Fisheries Act, through Fisheries and Oceans Canada, would likely apply. Work would also be required to take place within the low-risk fisheries protection window under both options.

There is also a risk of a "frac-out" with the HDD method where the drilling fluid seeps out of the excavation if weak ground conditions are present. This seepage could contaminate the surrounding area, however there are approaches that can be taken to minimize this risk such as installing a surface casing at susceptible points. This would be an additional consideration that would likely need to be addressed in the permitting process.

Approvals under the Canadian Navigable Waters Act and an environmental assessment would likely also be required for both construction options.

Construction works in both methods would also take place near the shore which could invoke additional permits and/or approvals under regulations and regulatory bodies, in addition to the aforementioned Fisheries Act and Canadian Navigable Waters Act, such as:

- Water Sustainability Act
- Riparian Areas Protection Regulation
- Migratory Bird Convention Act
- Wildlife Act
- Forests, Lands, Natural Resource Operations & Rural Development
- Comox Valley Regional District
- Town of Comox

An archaeological assessment of areas impacted by the crossing should also be undertaken as part of the project.

COST ESTIMATE

Class D cost estimates (+/-40% accuracy) were prepared for the two concepts for comparison purposes and are summarized in Table 1. The estimates include the Highway 19A forcemain extension and estuary crossing and exclude the cost of constructing pump stations and local collection systems in the South Region, as these costs are comparable for both concepts. Costs to upgrade Courtenay Pump Station, required for Concept 1, and to upgrade Jane Place Pump Station, required for Concept 2, are presented in Table 2.

The cost estimates include a 15% allowance for engineering and a 40% contingency. All costs are in 2020 dollars.

A summary of the cost estimates is presented in Table 1 below and discussed in further detail in the sections below.

Table 1: Cost Estimate Summary[1]

CONCEPT	ESTIMATED CONSTRUCTION COST	CONTINGENCY (40%)	ENGINEERING (15%)	TOTAL ESTIMATED COST
Concept 1 – Highway 19A	$9,100,000	$3,640,000	$1,911,000	$14,700,000
Concept 2 – Estuary Crossing	$15,164,000	$6,065,000	$3,184,348	$24,413,000
Extension – Argyle Road to Union Bay	$2,900,000	$1,160,000	$435,000	$4,500,000

Note:
[1] Cost estimates are Class D (+/- 40% accuracy) in 2020 dollars (CAD).

The following table summarizes the estimated cost to upgrade Courtenay Pump Station (for Concept 1) or at Jane Place Pump Station (for Concept 2) to pump South Region flows. These estimates are based on work completed and summarized in the January 9, 2020 memo ***South Region Service Area Impacts on CVSS Conveyance and Wastewater Infrastructure***, by WSP for the medium growth scenario.

Table 2 – Pump Station System Impacts – Medium Growth Scenario

	CONCEPT 1 (COURTENAY PUMP STATION)		CONCEPT 2 (JANE PLACE PUMP STATION)	
	CVSS only	CVSS + South Region	CVSS only	CVSS + South Region
2040 PWWF	494 L/s	613 L/s	226 L/s	344 L/s
PS Peak Power - Option 1 (Cut & Cover)	575 kW	700 kW	250 kW	375 kW
PS Peak Power - Option 2 (Trenchless)	275 kW	350 kW	125 kW	175 kW
PS Upgrade Cost - Option 1 (Cut & Cover)	$11.59M	$14.11 M	$5.04 M	$7.56 M
PS Upgrade Cost - Option 2 (Trenchless)	$4.62 M	$5.88 M	$2.1 M	$2.94 M

For Concept 1, adding the South Region flows to Courtenay Pump Station increases the power requirement and capital costs of the Courtenay Pump Station Upgrade by about 22% for the Stage 2 LWMP Option 1 (cut & cover) and by about 27% for the Stage 2 LWMP Option 2 (Trenchless). This results in an incremental cost of $2.52 M for Option 1 (cut and cover) and $1.26 M for Option 2 (trenchless).

For Concept 2, adding the South Region flows increases the power requirement and capital costs of the Jane Place Pump Station Upgrade by about 50% for Stage 2 LWMP Option 1 (cut & cover) and by about 40% for Stage 2 LWMP Option 2 (trenchless). This results in an incremental cost of $2.52 M for Option 1 (cut and cover) and $0.84 M for Option 2 (trenchless).

CONCEPT 1 – HIGHWAY 19A

The following assumptions were made in preparing the Concept 1 estimate:

- Forcemain is 375 mm diameter HDPE DR17.
- No allowance has been made for excavation of rock.
- All pipe installation is assumed to be cut and cover, unless otherwise specified.
- Forcemain depths are assumed to be between 1.0 to 2.0 metres depth.
- All backfill is assumed to be imported material.
- Pigging stations are required every 500 metres.
- Air release valve assemblies will be provided at high points (total of 7), blowdowns at low points (total of 3).
- Underground utilities along Sections 1 and 2 are assumed to be limited to the watermain parallel to the proposed forcemain and intermittent crossing laterals.
- The existing road width is assumed to be sufficient along Sections 1 and 2 to maintain a safe working clearance from the existing hydro poles during excavation while maintaining required clearances from existing utilities. Provisions to construct near the hydro poles is limited to the cost of coordination and permitting with BC Hydro; no allowance has been provided for relocating or temporarily supporting hydro poles.
- Construction of Section 3, between Anfield Road and 20^{th} Street, is anticipated to require higher installation costs due to a greater number of crossing and parallel utilities, increased traffic management requirements, and higher surface restoration requirements.
- The Trent River crossing is assumed to be constructed via HDD.
- Allowances have been provided for environmental protection plan and monitoring, groundwater management and bypass pumping, and sediment and erosion control. However, no detailed studies have been completed indicating that specific environmental protection, groundwater management, or sediment and erosion control are required.

The Highway 19A forcemain alignment and associated cost estimate should be considered concept level prepared for comparative purposes only. Should the CVRD choose to proceed with this forcemain alignment, there may be opportunities to improve the forcemain alignment and refine the costs. Possible considerations include:

- Re-use of native backfill, if native backfill gradation is suitable.
- Routing the section of the forcemain alignment in the City of Courtenay (Section 3) to follow the Courtenay Riverway Walk or various bike paths. This will reduce impact to vehicular traffic and reduce road restoration costs. However, the social implications of disturbing a well-used pedestrian and cycling path should also be considered.

COST ESTIMATE

Table 3: Concept 1 Cost Estimate[1]

ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT COST	PRICE
1	Forcemain- Argyle Road & Highway 19A to Courtenay River Siphon				
1.1	Forcemain[2]				
	Section 1 - 375 mm HDPE DR17, boulevard	lm	7400	$575	$4,255,000
	Section 2 - 375 mm HDPE DR17, roadway (rural highway)	lm	1060	$8715	$758,000
	Section 3 - 375 mm HDPE DR17, roadway (urban)	lm	1880	$1,110	$2,087,000
1.2	Appurtenances and Tie-Ins				
	1200 mm Manhole	each	2	$7,000	$14,000
	Air release valve assembly[3]	each	7	$19,000	$133,000
	Pigging station assembly[3]	each	21	$15,000	$315,000
	Blowdown assembly[3]	each	3	$17,000	$51,000
	Tie-in to existing manhole (MH 1-004 at river siphon)	LS	1	$15,000	$15,000
1.3	Roadworks and Restoration				
	Trent River crossing[4]	LS	1	$500,000	$500,000
	Driveway restoration, residential	each	52	$1,100	$57,000
	Highway 19A crossings (75mm asphalt restoration)	each	2	$11,000	$22,000
	Road crossings, south of Marriot Rd (50mm asphalt restoration)	each	7	$3,000	$21,000
Subtotal Item 1					**$8,200,000**
2	General				
2.1	Mobilization and demobilization	LS	1	$120,000	$120,000
2.2	Health and safety	LS	1	$120,000	$120,000
2.3	Environmental protection plan and monitoring	LS	1	$120,000	$120,000

ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT COST	PRICE
2.4	Allowance for water management and bypass pumping	LS	1	$250,000	$250,000
2.5	Sediment and Erosion Control	LS	1	$120,000	$120,000
2.6	Coordination with Hydro	LS	1	$150,000	$150,000
Subtotal Item 2					**$900,000**
Subtotal All Items					**$9,100,000**
Contingency (40% of Subtotal)					$3,640,000
Engineering (15% of Subtotal + Contingency)					$1,911,000
TOTAL					**$14,700,000**

Notes:
[1] Class D cost estimate in 2020 dollars (CAD). Subtotals and totals are rounded to the nearest $100,000.
[2] Complete with fittings & thrust blocks, trench excavation, bedding, backfill, and surface restoration. Assume 1-2 m deep.
[3] Complete with underground chamber.
[4] Assume HDD river crossing.

CONCEPT 2 – ESTUARY CROSSING

The following assumptions have been made in preparing the Concept 2 cost estimate:

- Forcemain is 375 mm diameter HDPE DR17.
- All pipe installation is assumed to be via dredging and partially assembled underwater.
- Trench depth assumed to be 3.5 m along the entire crossing length.
- Side slopes of the dredged trench assumed to be 4H:1V.
- Disposal costs for dredged material are not included.
- Dredged material removal rate of 900 tonnes/day assumed.
- Installation rate of 15 m per day.
- Installation cost includes a large crew and diver(s).
- General requirements (such as mobilization and demobilization, permitting, etc.) assumed to be 10% of the total construction cost.

COST ESTIMATE

Table 4: Concept 2 Cost Estimate[1]

ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL
1.1	375 mm HDPE Forcemain	m	2,900	$550	$1,595,000
1.2	Dredging[2]	tonnes	289,275	$25	$7,232,000
1.3	Installation	days	190	$26,000	$4,940,000
1.4	Tie-ins to forcemain	LS	1	$20,000	$20,000
1.5	General requirements	each	1	10%	$1,377,000
Subtotal					**$15,200,000**
Contingency (40% of Subtotal)					$6,080,000
Engineering (15% of Subtotal + Contingency)					$3,192,000
TOTAL					**$24,500,000**

Notes:
[1] Class D cost estimate in 2020 dollars (CAD). Subtotals and totals are rounded to the nearest $100,000.
[2] 4H:1V trench side slopes and 3.5 m deep trench along length of crossing.

UNION BAY EXTENSION

The extension from Argyle Road to Union Bay, near the boat launch, would involve construction of an additional 3,600 m of forcemain and an HDD crossing at Hart Creek. The forcemain would be aligned within the shoulder on the west side of the highway in the same manner as Section 1 of the Courtenay to Argyle Road alignment.

There is an elevated hydro transformer platform on the west side of the highway approximately 1310 m north of the Union Bay boat launch. It is assumed that the forcemain would cross to the east side of the highway for a section approximately 200 m in length at this point to avoid construction adjacent to the platform.

Approximately 1,790 m of the 3,600 m section of highway used for this alignment is two lane (one lane each direction). There is a section of four lane highway (two lanes each direction) for approximately 1,020 m south of Clover Road, and three lane highway before and after this section. These four and three lane sections allow for at least one lane per travel direction to remain largely unimpacted during construction.

The same assumptions used in the “Concept 1 – Highway 19A” cost estimate have been used for the Union Bay extension.

COST ESTIMATE

Table 5: Argyle Road to Union Bay Extension Cost Estimate[1]

ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL
Forcemain Extension: Argyle Road to Union Bay					
1.1	Forcemain[2]				
	375 mm HDPE DR17, boulevard[2]	lm	3400	$575	$1,955,000
	375 mm HDPE DR17, roadway (rural highway)[2]	lm	200	$715	$143,000
1.2	Appurtenances and Tie ins				
	Air valve assembly[3]	each	1	$19,000	$19,000
	Pigging station assembly[3]	each	7	$15,000	$105,000
	Blowdown assembly[3]	each	1	$17,000	$17,000
	Hart Creek Crossing[4]	LS	1	$250,000	$250,000
1.3	Roadworks and Restoration				
	Driveway restoration, residential	each	16	$1,100	$18,000
	Highway 19A crossings (75mm asphalt restoration)	each	2	$11,000	$22,000
	Road crossings (50mm asphalt restoration)	each	8	$3,000	$24,000
Subtotal Item 1					**$2,600,000**
2	General				
2.1	Mobilization and demobilization	LS	1	$42,000	$42,000
2.2	Health and Safety	LS	1	$42,000	$42,000
2.3	Environmental protection plan and monitoring	LS	1	$42,000	$42,000
2.4	Allowance for water management and bypass pumping	LS	1	$88,000	$88,000
2.5	Sediment and erosion control	LS	1	$42,000	$42,000
2.6	Coordination with Hydro	LS	1	$52,000	$52,000
Subtotal Item 2					**$300,000**

ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL
Subtotal All Items					**$2,900,000**
Contingency (40% of Subtotal)					$1,160,000
Engineering (15% of Subtotal + Contingency)					$435,000
TOTAL					**$4,500,000**

Notes:
[1] Class D cost estimate in 2020 dollars (CAD). Subtotals and totals are rounded to the nearest $100,000.
[2] Complete with fittings & thrust blocks, trench excavation, bedding, backfill, and surface restoration. Assume 1-2 m deep.
[3] Complete with underground chamber.
[4] Assumed HDD creek crossing (approx. 20 m crossing length).

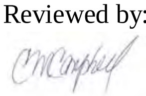
SUMMARY

A desktop review and assessment of two concepts for installation of a forcemain to connect the South Region to the CVSS have been undertaken. Concept 1 involves constructing a forcemain along Highway 19A between the Courtenay River Siphon and Argyle Road, while Concept 2 involves an estuary crossing between the Jane Street Pump Station in Comox and the Royston area. Installation methods for Concept 2 are limited to HDD or dredging due to the length of the estuary crossing, heavy boat traffic across the proposed estuary crossing, and existing ground conditions. Additionally, a cost estimate for extending the Concept 1 forcemain along Highway 19A from Argyle Road to Union Bay has also been completed.

The estimated cost of Concept 1 and Concept 2 is $14.7M and $24.5M, respectively, excluding the incremental cost to upgrade Courtenay Pump Station (Concept 1) and Jane Place Pump Station (Concept 2). The estimated cost of the 3,600 m Union Bay extension is $4.5M. The incremental cost for pump station upgrades to accommodate South Region flows for both concepts is estimated to be $2.52M of Conveyance Option 1 – cut and cover installation of the replacement CVSS forcemain, and $1.26M for Concept 1 and $0.84 for Concept 2, for Conveyance Option 2 – trenchless installation.

Although both Concept 1 and Concept 2 have permitting and approval requirements, Concept 1 is anticipated to be significantly less complex, with lower risk of delays and restrictions that will impede construction. Both concepts will have social impacts during construction, with Concept 1 primarily impacting residents and traffic along the Highway 19A forcemain alignment, and Concept 2 primarily impacting boating traffic in the harbour area. The environmental risks of Concept 1 are also of lower consequence and more easily mitigated; environmental risks from Concept 2 may include risk of disruption or destruction of fish habitat and contamination from drilling fluid through “frac-out”.

Reviewed by:



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