Comox Valley
REGIONAL DISTRICT

Staff Report

DATE: March 5, 2020

FILE: 5330-20/CVSS LWMP

TO: Chair and Members
Comox Valley Sewage Commission

Supported by Russell Dyson
Chief Administrative Officer

R. Dyson

FROM: Russell Dyson
Chief Administrative Officer

RE: **Comox Valley Sewerage Service Liquid Waste Management Plan - Recommended Conveyance Short List**

Purpose

The purpose of this report is to recommend to the Comox Valley Sewage Commission (CVSC) the Comox Valley Sewerage Service Liquid Waste Management Plan (LWMP) short list of options for conveyance of wastewater from the major pump stations to the Comox Valley Water Pollution Control Center (CVWPCC).

Recommendation from the Chief Administrative Officer:

THAT the Comox Valley Sewage Commission approve the Comox Valley Sewerage Service Liquid Waste Management Plan conveyance short list of options as presented in the report dated March 5, 2020, for detailed study and subsequent evaluation to select a preferred conveyance option.

Executive Summary

- At their March 12, 2019 meeting the CVSC approved the long lists of conveyance, treatment and resource recovery options for conceptual study.
- Following approval of the long list, the Comox Valley Regional District's (CVRD) technical consultants, WSP, completed a conceptual study of conveyance options, with review by CVRD staff prior to circulation to committee members.
- On March 21, the Technical Advisory Committee (TAC) reviewed the studies and evaluated and scored the goals in the technical and affordability categories.
- On March 22, the joint TAC and Public Advisory Committee (PAC) reviewed the studies and the TAC scoring of the technical and affordability categories. The TACPAC then evaluated and scored the categories of local economic benefits, environmental benefits and social benefits, with the intention of selecting the three highest scoring options for the shortlist.
- From this process, the highest scoring options were:
    - 3C – Gravity tunnel from Comox to the CVWPCC, score 71.0 (out of 100).
    - 3B – Forcemain tunnel through Lazo Hill, score 64.0.
    - 3A – Forcemain tunnel through Comox Hill and Lazo Hill, score 62.9.
    - 2A – Overland forcemain, score 62.4.
    - 4A – Northside forcemain concept, score 47.3.
    - The other five options all scored 41 or less.
- The members of the TAC and PAC reached consensus that since the all the tunnel based options have very similar routes, technical components and technical risks, they be studied together as one shortlist option – the "optimal tunnelling option".
- It was agreed by consensus that Option 2A, conventional forcemain, would also be carried forward to the shortlist, as it scored so close to the tunneled forcemain options.

- It was agreed by a majority vote that Option 4A also be included on the shortlist, to provide three distinctly different options for detailed study. The dissenting views were based upon the significantly lower scoring for 4A compared to the 3 series and 2A options.
- The final shortlist of options recommended by the TACPAC on March 22 for detailed study were:
  - 3 Optimal Tunneling Concept;
  - 2A – Overland Forcemain; and
  - 4A – North side Forcemain Concept.
- Since that time, there have been extensive discussions with the K'ómoks First Nation (KFN) about these options, as they relate to crossing of Indian Reserve No. 1 (IR1). As a result of this consultation, a memorandum of understanding (MOU) between the CVRD and KFN regarding sewer has been approved by both parties, and the KFN now supports proceeding to the next phase in conveyance consultation.
- With the KFN approval and further technical development of the options, two changes have occurred:
  - Option 3, the Optimal Tunneling Concept, has been found to be suitable for a two-phase implementation; and
  - Option 4A is not recommended for further study, as it involves significantly higher costs and no discernable benefits compared to Options 2 and 3.
- Therefore, the final short list of options recommended for detailed evaluation is:
  1. Conventional Overland Forcemain (previously 2A);
  2. Optimal Tunnelling Concept (previously 3); and
  3. Optimal Tunneling Concept in two phases.
- Should the sewage commission approve the recommended shortlist, staff will initiate the next phase of LWMP consultation, and begin negotiation with the KFN towards a sewer Community Benefits Agreement (CBA). In the event the shortlist is not approved staff will update the KFN accordingly.
- Once the CBA has been approved by the CVRD and KFN, staff will bring forward recommendations for a preferred conveyance solution and a path forward for authorizing the required borrowing – either through the LWMP or a separate electoral assent process.

Prepared by:	Concurrence:	Concurrence:
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Background

Conveyance Options Development and Evaluation Process

The LWMP process is centred around developing a broad range of options for the issues at hand, then progressively studying and narrowing them down from a long list to a short list, and eventually selecting a preferred option. The process is laid out as follows, and this report summarizes the results of steps three and four.

1. *Develop* conceptual options;
2. *Screen Out* the non-viable options to derive the official long list for conceptual study. This evaluation is focused on eliminating options that are obviously technically or economically non-feasible;
3. *Conceptual Study*. Includes technical descriptions of construction and operations, conceptual layout and Class D cost estimates for comparison purposes;
4. *Evaluate* the long list option to select short list options for detailed study. This evaluation is focused on selecting the most promising options;
5. *Detailed Study*. Refinements of the technical descriptions, preliminary layouts, construction and operation strategies and quantity estimating. Preparation of Class C capital cost estimates, operating cost estimates to get the life cycle cost and financial modelling of subsequent residential tax burdens;
6. *Evaluate* to select preferred option(s). This evaluation is about selecting the best option. For conveyance and treatment, there will be one preferred option. For resource recovery, the decision is primarily about economic viability, which may lead to no option being selected, or multiple options being selected, or simply recommendations for further or future study.

Conceptual Study of the Long List

After finalizing the long list at TACPAC Meeting No. 5, the technical consultants began the conceptual study. After confirmation of the long list by the CVSC at the March 12, 2019 meeting, the studies were finalized and circulated to the TACPAC members as part of the agenda for TACPAC Meeting No. 6.

For each option series and the subsequent variants, the study considered:

- The conceptual alignments for the pipe and tunnel components;
- The hydraulic profile; and
- The sizing requirements to handle peak flows for a 100 per cent increase in population, deemed to be in 50 years.

From this, the physical components of the system, pipeline and pump station requirements (capacity and pressure) were determined. Many of the options used the same components, (e.g. an upgrade to Courtenay Pump Station for moderate pressure increase) and the components were tabulated to make a "shopping list" for which options required which components. The capital cost of the components were individually estimated, and the cost for each option was determined by adding up the cost of the relevant components. In this way, there is the greatest possible consistency of technical and cost modelling assumptions between the options.

The study also provided the technical consultants assessments of the major advantages and disadvantages for each option, and the considerations for:

- Technical;
- Environmental;
- Archaeological;
- Operational; and
- Cost.

A 40 per cent contingency was then applied to the cost estimates, consistent with a Class D estimate. In recognition of the greater risk of technical issues with tunneling, and subsequent cost issues, the tunneled components had their contingency increased to 60 per cent.

Operating cost estimates were determined using the estimated labor and power electricity requirements of the pump stations. Electricity costs were based on current BC Hydro rates using both the peak demand (kW) and energy (kWh) charges for large commercial customers.

The costs were modelled using a net present value approach. Asset management (the future replacement of the various components) was included, assuming industry standard is that pump stations have a life of 25 years and pipes and tunnels have a life of 60 years. Future costs were inflated at three per cent annually for labor, 3.02 per cent for construction, and five per cent for electricity. All costs were then discounted at 3.05 per cent, the current BC Municipal Finance Authority rate, to produce a net present value at 30, 50 and 100 years.

Evaluation of the Conveyance Long List Options

The primary tool for evaluating the options is goal based evaluation system as approved by the CVSC on February 25, 2019. This matrix is presented below in Table No. 1.

Table No. 1: Evaluation System for Conveyance Options

Category	Goal	Description, Comment	Scored by	Weight %
Technical	Resilience to external factors.	Includes climate change, natural disasters and seasonal impact.	TAC	15%
	Resilience to internal factors.	Operational simplicity and reliability, minimize risk of failure.	TAC	15%
	Long term solution.	Provides asset life, and possibly capacity, beyond the minimum planning horizon.	TAC	10%
	Flexibility to accommodate future changes.	Technical consultants to elaborate.	TAC	5%
Technical Total				**45%**
Affordability	Minimize lifecycle cost.	Net present value of capital, operational and replacement cost period is to the planning horizon.	CVRD	14%
	Long term value.	Provides asset life and capacity beyond the design planning horizon.	TAC	4%
Affordability Total				**18%**
Economic Benefits	Benefits to local economy.	Primarily during construction.	TACPAC	2%
Economic Total				**2%**
Environmental Benefits	Minimize risk of impacts to sensitive environment.	Example action - remove forcemain from estuary, but must also consider risks/impact of new location.	TACPAC	12%
	Mitigate climate change impacts (Energy, and greenhouse gasses (GHG)).	Most energy reductions reduce GHG's, but not all GHG reductions reduce energy.	TACPAC	6%
Environmental Total				**18%**
Social Benefit	Minimize noise, odour and visual impacts in operation.		TACPAC	10%
	Minimize community disruption during construction.		TACPAC	3%
	Maximize community and recreational amenity value.	Best example is recreational trails above a pipeline, but there might be other opportunities.	TACPAC	4%
Social Total				**17%**
Grand Total				**100%**

The implementation of the evaluation system was as follows:

1. The TAC held a special meeting on March 21, 2019 scoring the four goals in the technical category and the “long term value” goal in the affordability category.
2. CVRD staff did the scoring for the “lifecycle cost” goal, based on the 50 year net present values calculated by the technical consultants, and presented this to the TAC on March 21, 2019.
3. The results for the technical and affordability categories were presented to the TACPAC at Meeting No. 6 on March 22, 2019. The detailed scoring of these goals is presented in Appendix D.

4. At this same meeting, the joint TACPAC scored the categories of economic, environmental and social benefits. The detailed scoring of these goals is presented in Appendix D.
5. After all the scoring had been completed by the TACPAC, the summarized results for all options were calculated and presented. A running tally of progress scores for the options was not presented during the evaluation. This was to help avoid potential bias in favor of certain options that might be winning or losing.
6. The TACPAC discussed the final results and voted on the options to be carried forward as the short list. The detailed results and scoring logic are attached in Schedule A.

Discussion of the Results

There were some surprising and consistent themes that emerged from the scoring. The main ones being:

- The relative rankings based on cost and net present value were not particularly sensitive to the input assumptions. At the TAC meeting, a sensitivity analysis was done by varying some parameters such as the energy costs, pump run hours per day and the discount rate. While this changed the actual cost numbers, in each case the relative rankings of the options did not change, with the same four options always being the top scorers.
- There was some surprise at the cost of the estuary options, with the pipe installation cost being double that of overland forcemain. The technical consultants explained that the productivity is limited by the tides, with the effective work window being as low as four hours, all equipment having to be removed before high tide. Additionally, to work in both low tide periods in a day would often mean work at night, with associated complications. Overall, this is considered "marine construction", and previous projects have borne out the increased costs. The other expected benefit of low operational costs from lower pumping head requirements did not really materialize. In avoiding the Willemar bluffs and going overland, there is a significant elevation head to overcome, the same as for all the overland and tunneled options (series 2 and 3).
- The options with an in-line pump station scored poorly on technical, energy and GHG evaluations. This was not a surprise, as in-line pump stations are avoided for just these reasons, but the degree of the cost penalty was surprising. All the energy used to pump the water the first time is lost when the water reaches the wet well of the inline pump station, where it is pumped again.
- The decentralized treatment option scored the lowest in most categories. The massive additional cost of building and operating a second treatment plant did not come close to making up for the minor benefits in conveyance of effluent instead of raw sewage. It did win the "flexibility to accommodate future changes" category, but this also does not make up for the many disadvantages of a second plant.
- The overland forcemain (2A) and tunneled forcemain (3A and 3B) options were very close in scoring. These are all very similar options, with similar alignments and the main difference is the tunnel ones trade a higher initial cost for lower operating costs. It should be noted that all the tunneled options still include 7 to 7.7km of new overland forcemain, compared to 8.8km for 2A. So they are really overland forcemains with tunnels through the high points, they are not an "all tunnel" option.
- The benefit scoring (local economic, environmental and social) for the top five ranked options was remarkably similar, as summarized in Table No. 2 below:

Table No. 2: Benefit Scoring Summary for Top Five Ranked Options

Category	Weight %	1A	1B	1C	2A	2B	3A	3B	3C	4A	4B	5
Technical & Affordability	63	30.6	29.9	20.5	43.5	26.6	44.9	45.2	52.5	29.4	18.6	-16.8
Economic, Enviro & Social Benefits	37	10.0	10.0	5.7	18.9	14.4	18.0	18.7	18.5	18.0	14.1	2.6
Total	100	40.7	39.9	26.1	62.4	40.9	62.9	64.0	71.0	47.3	32.7	-14.2

Selecting the Short List

In seeing the final results, there was some surprise at how close the scoring was for the second to fourth ranked options of 3B, 3A and 2A, being within two points of each other. For the evaluation system, and the level of detail in the modelling, it has been considered that if two options are within ten points, they are effectively tied.

In discussion on this, it was suggested by CVRD staff that is was inadvisable to select all three tunneling options as the short list since they are all subject to the same technical and cost risk of tunneling. It was suggested that the three tunnelling options be considered and studied as one option, since the technical and cost components are very similar, as are the risk factors associated with tunneling. The TACPAC was in consensus with this suggestion.

It was further agreed by consensus that Option 2A, the conventional forcemain, would also be carried forward to the shortlist, as it scored so close to the tunneled forcemain options, thus becoming the second ranked option on the short list.

It was agreed by a majority vote of the TACPAC, that Option 4A also be included on the shortlist to provide three distinctly different options for detailed study. The dissenting views were based upon the significantly lower scoring for 4A compared to the 3 series and 2A options, that this option should only be studied if all of 3 and 2A where ruled out on some technical basis.

The final shortlist of options recommended by the TACPAC to the CVSC for detailed study were:

- 3 Series – Tunneling Options 3A, 3B and 3C;
- 2A – Overland Forcemain; and
- 4A – Northside Forcemain concept.

In the final analysis, all the options that had one or more of the major undesirable components, including an estuary pipe, an inline pump station, or a second treatment plant, lost out in the evaluation across all the categories. The shortlist represents the remaining options that avoided these components. The conceptual study and quantitative evaluation system provided an objective measure of both the cost and relative undesirability of incorporating these components.

Public Feedback

Public feedback was not part of this evaluation process, but had previously been sought on the composition of the long list and reported to the CVSC at March 12, 2019. The feedback at that time, in terms of options, is summarized as:

- Avoid a raw sewage pipe in the estuary (Option 1 and 6);
- Opposition of the Comox No. 2 Pump Station (effectively inline pump station concepts of Option 1A and 2B);

- General favoring of Option 3 (tunnels) and Option 4 (north side); and
- Some support for Option 5 (decentralized treatment).

The selected shortlist of 2A, 3 series and 4A Options is in line with the public's most favored options.

Consultations with K'ómoks First Nation

From March 2019 to February 2020, CVRD staff have engaged in discussions with the KFN to better understand the impacts of conveyance routing, as all three options under consideration cross through IR1.

As a result of this consultation, a memorandum of understanding (MOU) between the CVRD and KFN regarding sewer has been approved by both parties. The MOU recognizes the existing sewer line through IR1 was expropriated without adequate consultation and commits both parties to negotiate a community benefits agreement (CBA). The CBA will provide compensation for the existing sewer line through IR1 and mitigate future construction impacts in archaeologically sensitive areas in KFN IR1 and the estuary foreshore. Under the statutory right of way agreement with the KFN, once decommissioned the existing force main through IR1 will have to be removed at the CVRD's expense.

Details will be released publicly following the negotiation of a CBA with KFN, which is underway now. Selection of a preferred conveyance solution will occur once the CBA is approved by the CVRD and KFN.

Revised Conveyance Options

Over the past year, in parallel with the KFN consultation, staff have been working extensively with WSP, the LWMP technical consultants. Key outcomes from this work include selection of the optimal tunneling solution, which makes use of horizontal directional drilling to significantly reduce the cost of tunneling through the two heights of land, and development of a phased approach for implementation of the optimal tunneling solution.

The phased approach consists of installing the new forcemain and tunnel from central Comox to the CVWPCC first, and a later phase to construct a new forcemain from Courtenay to central Comox. This approach allows for the earliest possible decommissioning of the Willemar Bluffs section, while making use of the expected 15 to 20 year remaining service life of the existing estuary section of forcemain, thereby spreading out the capital costs of the project over a much longer timeframe. The comparison of works for the complete and phased approach is shown in Table No. 3 below.

Table No. 3: Comparison of Works for Option No. 3 with Phasing Concept

Items	Option 3, as Single Project	Option 3, Phase 1	Option 3, Phase 2
Upgrade Jane Place Pump Station	Y	Y	-
Upgrade Courtenay Pump Station	Y	Y	-
Forcemain from Courtenay Pump Station to Central Comox, including tunnel through Comox Hill	Y	N	Y
Forcemain connection Marina Park to Beaufort Avenue	-	Temporary	Decommissioned
Forcemain connection Jane Place to Beaufort Avenue	Y	Y	-
Forcemain from Central Comox to Lazo Hill	Y	Y	-
Tunnel through Lazo Hill and connection to CVWPCC	Y	Y	-

Option 4A, the Northside concept, is recommended for removal from the LWMP conveyance shortlist as it incurs much higher costs and delivers no benefits over Options 2A, and 3, for the following reasons:

- Lowest scored option carried forward in the shortlist;
- Approximately $20 M, 40 per cent higher capital costs;
- Significantly higher lifecycle costs due to pumping wastewater to impractically high elevation;
- Higher Courtenay Pump Station operational risks from much higher pumping pressures; and
- No possibility of project phasing.

Accordingly, the final shortlist of options recommended to the CVSC for consideration are:

1. Overland forcemain (previously option 2A);
2. Optimal tunneling concept (previously option 3); and
3. Optimal tunneling concept with two phase implementation.

Timeline

The proposed timeline for the completion of the conveyance component is (dates to be confirmed):

Date	Activity
March 2020	Completion of detailed studies.
Early April 2020	TACPAC Meeting No. 10, evaluation and ranking, preliminary selection of preferred option.
Mid-April	Public facilitated session No. 4 to review preliminary selection of preferred conveyance option.
May 2020	TACPAC Meeting No. 11, final evaluation and recommendation of preferred option.
June 2020	Recommend preferred conveyance option and assent process at CVSC meeting.
Fall 2020	Completion of Stage 2 LWMP report, for approval by CVSC and submission to BC Ministry of Environment.

The LWMP process for treatment and resource recovery components will resume at TACPAC Meeting No. 9, March 4, 2020 and continue in the fall of 2020.

Analysis/Options
The short list of conveyance options outlined in this report are the result of the intentional process of first setting the goals, then developing the options, and using the goals to evaluate the options.

The changes since the TACPAC Meeting No. 6 are the result of addressing details that could not be resolved at that time, and are in line with the original TACPAC recommendations. However, the CVSC can choose to add or delete an option to the short list, as appropriate.

Staff recommend that the short list be adopted as presented.

If the CVSC contemplates a change then this suggests that something has been either missed in the evaluation process, or that the CVSC is making the change based on other factors. If this is the case then the CVSC is requested to clearly identify any areas for reconsideration, and the reasons for doing so, for communication back to the TACPAC.

Financial Factors
The importance of minimizing the financial burden of additional sewer infrastructure on the community has been a priority during the LWMP process. Development of a phased approach for inclusion on the LWMP conveyance shortlist was driven by the opportunity to spread out the capital cost burden on the sewer users over a longer period of time, thereby minimizing the financial impact on rate payers. Additionally, the financial component of the evaluation of long list options included a focus on full lifecycle analysis to ensure that the impacts of operating, maintenance and replacement costs were factored into the decision making process.

Legal Factors
None at this stage

Regional Growth Strategy Implications
The short list of options represents the implementation of the goals and evaluation system as related to conveyance. The idea is to have the options achieve as many of the goals as possible, including affordability. These shortlisted options have the potential to action some of the same goals within the Regional Growth Strategy (RGS) and Sustainability Strategy.

RGS Goals

Goal 2. Ecosystems, natural areas and parks: Protect, steward and enhance the natural environment and ecological connections and systems.

Goal 5. Infrastructure: Provide affordable, effective and efficient services and infrastructure that conserves land, water and energy resources.

Goal 8. Climate change: Minimize regional greenhouse gas emissions and plan for adaptation.

RGS Objectives

5-D. Encourage sewage management approaches and technologies that respond to public health needs and maximize existing infrastructure.

5D-2. New development will replace and/or upgrade aging sewer infrastructure or provide cash-in-lieu contributions for such upgrades through Development Cost Charges or similar financial contributions.

Note that Development Cost Charges were not considered as part of the financial modelling for evaluating the long list, but will be included in the detailed modelling for the evaluation of the short list and selection of the preferred option.

Sustainability Strategy Implications

As part of the development of the goals for the three components, comparisons were made to the Comox Valley Sustainability Strategy, which contains numerous goals directly related to wastewater and many others indirectly related (e.g. resource recovery). As with the overall intent of the strategy, these targets are for things to be achieved by 2050, which is at the end of the design horizon for this LWMP. However, by being aware of these aspirational targets and goals at the start of the LWMP process, appropriate emphasis can and has been placed on them, and many of the long list options action some of these goals.

Sustainability Strategy 2050 Targets

Climate	80 per cent reduction in greenhouse gases from 2007 levels.
Energy	50 per cent decrease in per capita energy use and/or will not increase energy use from current levels.
Water	All wastewater treatment in the Comox Valley will be advanced or reuse level.

Sustainability Strategy Goals & Objectives

2.2.2.	Existing local government buildings and facilities are retrofitted to achieve a 25-30 per cent improvement in energy and water efficiency.
3.5.	Liquid waste is handled to minimize negative impacts and to turn wastes into resources.
3.5.1(a).	Consider amending approach to Sewer Master Plan to make it a comprehensive LWMP that addresses all aspects of sustainable wastewater management. Ensure any update to sewer/liquid waste management plans are aligned with sustainability objectives and targets.

The conveyance component alone is limited in the number sustainability goals that it can action. These are primarily about environmental protection and minimizing GHGs by minimizing energy use.

Citizen/Public Relations

Public engagement is a cornerstone of the LWMP process, and indeed is written into the Environmental Management Act.

The philosophy adopted for this LWMP is that each major decision contemplated by the TACPAC will be taken out to the public for input. The input from the public is then brought back to the TACPAC for review and consideration in their decisions and recommendations to the CVSC. The CVSC makes the final decisions based on recommendations from the TACPAC.

This decision by the CVSC on the conveyance short list will be communicated to the public and TACPAC as part of the ongoing public engagement process.

The next interactive public engagement on conveyance will be in early June, after the detailed study, evaluation and ranking of the shortlisted options. The public feedback will be considered in the final selection of the preferred conveyance option.

Attachments: Schedule A - Detailed Evaluation Results

Appendix A – Conveyance Options Conceptual Study (WSP)
Appendix B – TAC 6A Meeting Minutes (March 21, 2019)
Appendix C – TACPAC 6 Meeting Minutes (March 22, 2019)

Colour scale - green boxes = best, yellow/orange = intermediate, pink = worst

Summary of Results

Category	Goal	Weight %	1A	1B	1C	2A	2B	3A	3B	3C	4A	4B	5
Technical	Resilience to External Factors	15%	6.0	4.5	3.0	10.5	9.0	13.5	12.0	15.0	9.0	7.5	0.0
	Resilience to Internal Factors	15%	6.0	6.0	3.0	9.0	3.0	10.5	10.5	12.0	6.0	3.0	0.0
	Long Term Solution	10%	5.0	5.0	4.0	5.0	4.0	6.0	6.0	6.0	5.0	4.0	4.0
	Flexibility to accommodate future changes	5%	1.0	1.0	0.0	3.0	2.0	2.0	2.5	4.0	2.0	2.5	5.0
Technical Total		***45%***	***18.0***	***16.5***	***10.0***	***27.5***	***18.0***	***32.0***	***31.0***	***37.0***	***22.0***	***17.0***	***9.0***
Affordability	Minimize Lifecycle Cost	14%	10.6	11.4	8.9	14.0	7.0	10.5	11.8	13.1	5.4	0.0	-27.4
	Long term Value	4%	2.0	2.0	1.6	2.0	1.6	2.4	2.4	2.4	2.0	1.6	1.6
Affordability Total		***18%***	***12.6***	***13.4***	***10.5***	***16.0***	***8.6***	***12.9***	***14.2***	***15.5***	***7.4***	***1.6***	***-25.8***
Economic Benefits	Benefits to local economy	2%	1.2	1.6	1.6	2.0	2.0	1.2	1.4	1.3	2.0	2.0	1.8
Local Economic Benefit Total		***2%***	***1.2***	***1.6***	***1.6***	***2.0***	***2.0***	***1.2***	***1.4***	***1.3***	***2.0***	***2.0***	***1.8***
Environment Benefits	Minimize risk of impacts to sensitive environment	12%	-1.3	-1.8	-5.3	6.3	2.8	6.7	6.7	6.6	6.4	4.6	1.6
	Mitigate climate change impacts (Energy and GHG's)	6%	3.6	2.8	2.8	2.6	2.2	3.3	3.3	3.1	1.3	0.5	0.0
Environmental Benefit Total		***18%***	***2.2***	***1.0***	***-2.6***	***8.9***	***5.1***	***10.0***	***10.0***	***9.6***	***7.7***	***5.1***	***1.6***
Social Benefit	Minimize noise, odour and visual impacts in operation	10%	7.3	7.2	6.4	6.5	5.8	6.7	6.7	6.6	6.1	4.8	-0.6
	Minimize community disruption during construction	3%	-0.8	0.0	0.0	0.9	0.9	-0.5	0.0	0.3	1.1	0.9	-1.3
	Maximize community and recreational amenity value	4%	0.0	0.2	0.2	0.7	0.7	0.6	0.6	0.6	1.1	1.3	1.1
Social Benefit Total		***17%***	***6.6***	***7.4***	***6.6***	***8.1***	***7.3***	***6.7***	***7.3***	***7.6***	***8.3***	***7.0***	***-0.8***
Grand Total		**100%**	**40.7**	**39.9**	**26.1**	**62.4**	**40.9**	**62.9**	**64.0**	**71.0**	**47.3**	**32.7**	**-14.2**

Detailed Evaluation of Results

Category	Technical											
Item	**Analysis**	**1A**	**1B**	**1C**	**2A**	**2B**	**3A**	**3B**	**3C**	**4A**	**4B**	**5**
Major Components (construction and operation)	km of estuary pipe	6.5	5.0	6.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	km of overland forcemain	0.6	2.3	2.2	8.8	8.2	7.1	7.2	7.7	13.2	15.7	13.2
	km of tunnel	0.6	0.0	0.0	0.0	0.0	1.7	1.1	1.1	0.0	0.0	0.0
	Tunnel shafts	3	0	0	0	0	5	3	3	0	0	0
	Total large pump stations	2	2	3	2	3	2	2	2	2	3	2
	Total WWTP's	1	1	1	1	1	1	1	1	1	1	2
Construction Impacts	Avoid estuary	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y
	Avoid new pump station site	N	N	N	N	N	N	N	?	N	N	N
	Avoid road disturbance in central Comox	Y	Y	Y	N	N	N	N	N	N	N	N
	Avoid road disturbance in Lazo Hill	Y	N	N	N	N	Y	Y	Y	Y	N	N
	Avoid additional WWTP site	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N
	Avoid new KFN pump station	Y	Y	Y	Y	Y	Y	Y	Y	N	N	N
Operational Impacts	Avoid 3rd large pump station	Y	Y	N	Y	N	Y	Y	Y	Y	N	Y
	Avoid critical failure point (overflow risk)	Y	Y	N	Y	N	Y	Y	Y	Y	Y	Y
	Avoid additional WWTP	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N

Evaluation by TAC												
Goal	**Description**	**1A**	**1B**	**1C**	**2A**	**2B**	**3A**	**3B**	**3C**	**4A**	**4B**	**5**
Resilience to External Factors	Includes climate change, natural disasters, seasonal impact	**2**	**1.5**	**1**	**3.5**	**3**	**4.5**	**4**	**5**	**3**	**2.5**	**0**
Scoring Logic	**Full marks for gravity tunnel as it is most resistant to earthquakes, score zero for second WWTP, as it is vulnerable to almost everything. Deductions for longer forcemains (earthquake risk) and -2 for Estuary options (sea level rise), -1 for in-line pump station (any disturbance will have consequences magnified). No specific seasonal impacts identified for any option.**											
Weight	15%	**6**	**4.5**	**3**	**10.5**	**9**	**13.5**	**12**	**15**	**9**	**7.5**	**0**
Resilience to Internal Factors	Operational simplicity and reliability, minimize risk of failure	**2**	**2**	**1**	**3**	**1**	**3.5**	**3.5**	**4**	**2**	**1**	**0**
Scoring Logic	**Gravity tunnels scores best, but not full marks as it still involves pump stations and forcemains. Zero for second WWTP, as adds great complexity, -2 for Inline pump stations for risk factor, -1 for long forcemains.**											
Weight	15%	**6.0**	**6.0**	**3.0**	**9.0**	**3.0**	**10.5**	**10.5**	**12.0**	**6.0**	**3.0**	**0.0**
Long Term Solution	Provides asset life, and possibly capacity, beyond the minimum planning horizon.	**2.5**	**2.5**	**2**	**2.5**	**2**	**3**	**3**	**3**	**2.5**	**2**	**2**
Scoring Logic	**Options are all very close, as all the pipe/tunnel components have a 60 year design life, so score all at 2.5. The tunnels have the ability to be re-lined so add 0.5 points. - 0.5 points for the in-line pump stations as it is an additional short-life component (pump stations are 25 years)**											
Weight	10%	**5.0**	**5.0**	**4.0**	**5.0**	**4.0**	**6.0**	**6.0**	**6.0**	**5.0**	**4.0**	**4.0**

Flexibility to accommodate future changes	Technical Consultants to elaborate	**1**	**1**	**0**	**3**	**2**	**2**	**2.5**	**4**	**2**	**2.5**	**5**
Scoring Logic	**Second WWTP provides the greatest flexibility, as future load growth is split. Estuary pipelines provide the least. -1 for in-line pump stations. Gravity tunnel has the ability to tie in HMCS Quadra and parts of the Jane catchment directly to tunnel, so scores an extra point.**											
Weight	5%	**1**	**1.0**	**0.0**	**3.0**	**2.0**	**2.0**	**2.5**	**4.0**	**2.0**	**2.5**	**5.0**
Total Technical Category	45%	**18.0**	**16.5**	**10.0**	**27.5**	**18.0**	**32.0**	**31.0**	**37.0**	**22.0**	**17.0**	**9.0**

Category	Affordability											
Goal	**Description**	**1A**	**1B**	**1C**	**2A**	**2B**	**3A**	**3B**	**3C**	**4A**	**4B**	**5**
	Capital Only ($M)	80	57	65	45	59	80	69	66	69	84	174
	50 Year NPV (Capital + O&M) ($m)	122	118	131	105	141	123	116	109	149	176	**316**
Minimize Lifecycle Cost	Net present value of capital, operational and replacement cost, period is to the planning horizon	3.8	4.1	3.2	5.0	2.5	3.8	4.2	4.7	1.9	0.0	-9.8
Scoring Logic	**Lowest 50yr NPV =5, Opt 4B 50yr NPV=0, pro-rate other options, allow Opt 5 to go negative as it is off the chart compared to other options**											
Weight	**14%**	**11**	**11**	**9**	**14**	**7**	**11**	**12**	**13**	**5**	**0**	**-27**
Long term Value	Provides asset life and capacity beyond the design planning horizon	2.5	2.5	2.0	2.5	2.0	3.0	3.0	3.0	2.5	2.0	2.0
Scoring Logic	**Use same values as for technical criteria of long term solution**											
Weight	**4%**	**2.0**	**2.0**	**1.6**	**2.0**	**1.6**	**2.4**	**2.4**	**2.4**	**2.0**	**1.6**	**1.6**
Total Affordability	**18%**	**12.6**	**13.4**	**10.5**	**16.0**	**8.6**	**12.9**	**14.2**	**15.5**	**7.4**	**1.6**	**(25.8)**

Category	Local Economic Benefits											
		1A	1B	1C	2A	2B	3A	3B	3C	4A	4B	5
	Spending components ($M)											
	Overland Forcemain	$1	$7	$7	$28	$33	$28	$29	$24	$33	$44	$33
	Estuary Forcemain	$38	$33	$38	$0	$0	$0	$0	$0	$0	$0	$0
	Pump Stations	$17	$17	$19	$17	$26	$17	$17	$14	$36	$40	$36
	New WWTP	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$105
	Tunneling	$24	$0	$0	$0	$0	$35	$24	$28	$0	$0	$0
	Total $	$80	$57	$65	$45	$59	$80	$69	$66	$69	$84	$174
	Local %											
Overland FM	**75%**	$1	$5	$5	$21	$25	$21	$22	$18	$25	$33	$25
Estuary FM	**50%**	$19	$16	$19	$0	$0	$0	$0	$0	$0	$0	$0
Pump Stations	**65%**	$11	$11	$13	$11	$17	$11	$11	$9	$23	$26	$23
New WWTP	**60%**	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$63
Tunneling	**10%**	$2	$0	$0	$0	$0	$4	$2	$3	$0	$0	$0
	Local $ $M)	$33	$33	$37	$32	$41	$35	$35	$30	$48	$59	$111
	Local %	42%	58%	57%	71%	71%	44%	50%	45%	70%	70%	64%
Goal	**Description**											
Economic Benefits	Benefits to local economy	2.9	4.0	4.0	5.0	5.0	3.1	3.5	3.2	4.9	4.9	4.5
Scoring Logic	**Highest Local % = 5 , zero local % = 0, pro-rate remaining options**											
Weight	**2%**	**1.2**	**1.6**	**1.6**	**2.0**	**2.0**	**1.2**	**1.4**	**1.3**	**2.0**	**2.0**	**1.8**
Total Economic Benefit Category	**2%**	**1.2**	**1.6**	**1.6**	**2.0**	**2.0**	**1.2**	**1.4**	**1.3**	**2.0**	**2.0**	**1.8**

Note 1. The initial % spending on the various components as presented by the project coordinator was adjusted after discussions with the TACPAC. It was noted that even though components like forcemain might be awarded to a local contractor, some of the money leaves for external costs (e.g. pipe). Conversely, tunneling will go to a national or international contractor, but some of the money will still be spent locally.
Note 2 The initial ranking as presented by the project coordinator was based on local $, not local %. After reviewing the results, it was obvious for Option 5 that this measure was giving benefit for "local spending on a wasteful project" , and the TACPAC requested using local % instead

Category	Environment -Minimize Impacts											
Item	**Analysis**	**1A**	**1B**	**1C**	**2A**	**2B**	**3A**	**3B**	**3C**	**4A**	**4B**	**5**
Visible components (construction and operation)	km of estuary pipe	6.5	5.0	6.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	km of overland forcemain	0.6	2.3	2.2	8.8	8.2	7.1	7.2	7.7	13.2	15.7	13.2
	tunnel shafts	3	0	0	0	0	5	3	3	0	0	0
	Total large pump stations	2	2	3	2	3	2	2	2	2	3	2
	Total WWTP's	1	1	1	1	1	1	1	1	1	1	2
Construction Impacts	Avoid estuary	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y
	Avoid new pump station site	N	N	N	N	N	N	N	?	N	N	N
	Avoid road disturbance in central Comox	Y	Y	Y	N	N	N	N	N	N	N	N
	Avoid dike road	N	N	N	N	N	N	N	N	Y	Y	Y
	Avoid road disturbance in Lazo Hill	Y	N	N	N	N	Y	Y	Y	Y	N	N
	Avoid additional WWTP site	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N
	Avoid new KFN pump station	Y	Y	Y	Y	Y	Y	Y	Y	N	N	N
Operational Impacts	Avoid 3rd large pump station	Y	Y	N	Y	N	Y	Y	Y	Y	N	Y
	Avoid critical failure point (overflow risk)	Y	Y	N	Y	N	Y	Y	Y	Y	Y	Y
	Avoid additional WWTP	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N
	response time to a failure											

Goal	Description	1A	1B	1C	2A	2B	3A	3B	3C	4A	4B	5
Minimize risk of impacts to sensitive environment	Example action - remove forcemain from estuary, but must also consider risks/impact of new location	-0.6	-0.7	-2.2	2.6	1.2	2.8	2.8	2.7	2.7	1.9	0.7
Scoring Logic	**All options start with 5 points, then;**											
	if Pipe in Estuary (environmental and archaeological damage during construction)	-4										
	(add)if running along Dike rd	-0.5										
	Per large Pump Station (overflow risk)	-0.5										
	per km of WW forcemain	-0.1										
	If critical failure point	-1										
	if new wwtp (overflow risk)	-2										
	other?											
Weight	12%	-1.3	-1.8	-5.3	6.3	2.8	6.7	6.7	6.6	6.4	4.6	1.6

Category	**Environment -GHG's**											
		1A	1B	1C	2A	2B	3A	3B	3C	4A	4B	5
	GHG tons CO2e for Construction +50yr operating (from WSP)	4755	6397	6370	6737	7410	5299	5287	5722	9258	10859	11829
Goal	**Description**											
Environment	Mitigate climate change impacts (energy and GHG's)	3.0	2.3	2.3	2.2	1.9	2.8	2.8	2.6	1.1	0.4	0.0
Scoring Logic	**Zero GHG = 5, highest GHG option = 0, pro-rate other options**											
Weight	6%	3.6	2.8	2.8	2.6	2.2	3.3	3.3	3.1	1.3	0.5	0.0
Total Environment Category	**18%**	**2.2**	**1.0**	**-2.6**	**8.9**	**5.1**	**10.0**	**10.0**	**9.6**	**7.7**	**5.1**	**1.6**
Note 1. The GHG footprint for Option 5 is for the conveyance portion only and does not include the WWTP itself.												

Category	Social - Construction											
		1A	1B	1C	2A	2B	3A	3B	3C	4A	4B	5
Components Visible in Construction	km of estuary pipe	6.5	5.0	6.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	km of overland forcemain	0.6	2.3	2.2	8.8	8.2	7.1	7.2	7.7	13.2	15.7	13.2
	Tunnel shafts	3	0	0	0	0	5	3	3	0	0	0
	Pump Station Rebuilds	2	2	2	2	2	2	2	2	2	3	2
	New Pump Station sites	1	1	1	1	1	1	1	0	1	1	1
	Total WWTP's	1	1	1	1	1	1	1	1	1	1	2
Construction Impacts	Avoid estuary	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y
	Avoid new pump station site	N	N	N	N	N	N	N	N	N	N	N
	Avoid road disturbance along Dike rd. and KFN	N	N	N	N	N	N	N	N	Y	Y	N
	Avoid road disturbance in central Comox	Y	Y	Y	N	N	N	N	N	N	N	N
	Avoid road disturbance in Lazo Hill	Y	N	N	N	N	Y	Y	Y	Y	N	N
	Avoid additional wwtp site	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N
	Avoid new KFN pump station	Y	Y	Y	Y	Y	Y	Y	Y	N	N	N
Goal	**Description**	**1A**	**1B**	**1C**	**2A**	**2B**	**3A**	**3B**	**3C**	**4A**	**4B**	**5**
	Minimize community disruption during construction	-1.3	0.1	0.1	1.4	1.5	-0.9	0.1	0.5	1.9	1.5	-2.1
Scoring Logic	**All options start with 5 points, then;**											
-3	if in estuary (archaeological damage, visual, noise, night work, and traffic during construction)											
-0.1	Per pump station rebuild											
-0.5	Per new pump station site											
-0.1	Per km of overland forcemain											
-1	Additional disruption if doing FM along dike road through KFN											
-1	Additional disruption if doing FM in central Comox											
-0.5	Per tunnel shaft											
-0.1	if new KFN pump station											
-3	if new WWTP											
Weight	3%	-0.8	0.0	0.0	0.9	0.9	-0.5	0.0	0.3	1.1	0.9	-1.3

Category	Social - Operation											
Category	**Goal**	**1A**	**1B**	**1C**	**2A**	**2B**	**3A**	**3B**	**3C**	**4A**	**4B**	**5**
Visible Components in Operation	km of estuary pipe	6.5	5.0	6.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	km of overland forcemain	0.6	2.3	2.2	8.8	8.2	7.1	7.2	7.7	13.2	15.7	13.2
	Total Large Pump Stations	2	2	3	2	3	2	2	2	2	3	2
	Total Small Pump Stations	3	3	2	3	2	3	3	2	3	2	3
	New WWTP's	0	0	0	0	0	0	0	0	0	0	1
	FM -gravity transition	0	0	0	0	0	0	0	1	0	1	0
Goal	**Description**											
	Minimize noise, odour and visual impacts in operation	3.7	3.6	3.2	3.3	2.9	3.3	3.3	3.3	3.0	2.4	-0.3
Scoring Logic	**All options start with 5 points, then;**											
-0.5	Per large pump station											
-0.1	Per small pump station											
-0.05	per km of conveyance											
-4	Per new WWTP											
-0.1	per FM -gravity transition											
Weight	10%	7.3	7.2	6.4	6.5	5.8	6.7	6.7	6.6	6.1	4.8	-0.6

Category	Social - Amenity											
Category	**Goal**	**1A**	**1B**	**1C**	**2A**	**2B**	**3A**	**3B**	**3C**	**4A**	**4B**	**5**
Visible Components in Operation	km of estuary pipe	6.5	5.0	6.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	km of overland forcemain	0.6	2.3	2.2	8.8	8.2	7.1	7.2	7.7	13.2	15.7	13.2
	Total Large Pump Stations	2	2	3	2	3	2	2	2	2	3	2
	Total Small Pimp Stations	3	3	2	3	2	3	3	2	3	2	3
	New WWTP's	0	0	0	0	0	0	0	0	0	0	1
Amenity Value	km of bike lane	0.6	2.3	2.2	8.8	8.2	7.1	7.2	7.7	13.2	15.7	13.2
	km of separate recreational trail	0	0	0	0	0	0	0	0	0	0	0
Goal	**Description**											
Maximize community and recreational amenity value	Best example is recreational trails above a pipeline, but there might be other opportunities	0.1	0.2	0.2	0.9	0.8	0.7	0.7	0.8	1.3	1.6	1.3
Scoring Logic	**All options start with zero points, then;**											
0.1	Per km of bike lane											
0.2	Per km of recreational trail											
Weight	4%	0.0	0.2	0.2	0.7	0.7	0.6	0.6	0.6	1.1	1.3	1.1
Total Social Category	**17%**	**6.6**	**7.4**	**6.6**	**8.1**	**7.3**	**6.7**	**7.3**	**7.6**	**8.3**	**7.0**	**-0.8**

Note 1. For the overland forcemains, it is assumed that when the road is re-laid, it would be painted with a bike lane. There were no specific opportunities for dedicated recreational trails identified, though there might be during the detailed study phase. No other recreational amenity value was recognized for any option, though this might change in the detailed design stage.

Appendix A

COMOX VALLEY REGIONAL DISTRICT

LIQUID WASTE MANAGEMENT PLAN

STAGE 1 – CONVEYANCE LONG LIST STUDY

MARCH 15, 2019

LIQUID WASTE MANAGEMENT PLAN

STAGE 1
CONVEYANCE LONG LIST STUDY

COMOX VALLEY REGIONAL DISTRICT

REV 1

PROJECT NO.: 18P-00276-00
DATE: MARCH 15, 2019

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10 CONVEYANCE OPTIONS

10.1 OVERVIEW

10.1.1 EXISTING INFRASTRUCTURE CAPACITY AND CONDITION

The existing large diameter sanitary system on the south side of the Comox Valley Sewerage System (CVSS) consists of three pump stations, namely Courtenay, Jane Place Pump Stations (PS) and K'omox First Nation Pump Station. Courtenay PS (CPS) is located on Comox Road, near the Highway 19A bridge that crosses the Puntledge River and services Courtenay. Jane Place PS (JPS) is located in Jane Place, near the Comox Valley Marina, and it services the south area of Comox. The K'omox FN pump station is relatively small and connects directly into the forcemain. A combined gravity and pressurized system serves the north sections of the CVSS. This system consists of various gravity trunks including the Hudson and Greenwood trunks, and the Canadian Forces Base (CFB) pump station and the associated alignment to convey the sewage to the treatment plant. Figure 10-1 presents the existing CVSS infrastructure.

Currently, sewage is conveyed from the Courtenay PS in a 750 mm ø reinforced concrete pipe (Hyperscon) eastward along Comox Road and Bayside Road before routing into the foreshore, where sewage from JPS ties directly into and the diameter increases to 860 mm ø. The force main makes a turn northward at Goose Pit by crossing Hawkins Road and continues in the foreshore along Willmar Bluffs to the Comox Valley Water Pollution Control Centre (CVWPCC).

In 2002, the Comox Valley Regional District (CVRD) discovered significant sections of the forcemain in the foreshore were exposed without the protective cover material due to changes in soil deposition patterns and erosion. This was confirmed by Northwest Hydraulic Consultants Ltd. (NHC) in 2003, which was again reaffirmed in a 2016 study, *Risk Analysis of CVRD Force main on Balmoral Beach*, NHC, 2016. A risk analysis of the forcemain along the Bluffs was prepared by NHC in 2016. It was concluded that risk of forcemain failure exists along the beach and estimated a minimum 24-hour response time is required to fix any major failures to the forcemain. The study recommended that the affected portion of the forcemain to be relocated off-the-beach. The existing forcemain has an estimated 12 years remaining in the design life. A forcemain re-alignment study was performed in 2005 to assess various options for re-routing the forcemain, allowing the section along Willemar Bluffs to be decommissioned. This LWMP process is intended to further develop and select a preferred alignment.

Figure 10-1: Existing Force Main Alignment

Courtenay PS has a wet well and dry well configuration with 3 service and 1 standby 200 HP pumps. The lead-lag-pumps-off elevation in the wet well is -4.25 m. Jane PS has a wet well configuration with 2 service and 1 standby 77 HP pumps. The lead-lag-pump off elevation in the wet well is -3.25 m. Both pump stations are currently pumping sewage to the CVWPCC that has an inlet invert elevation at 8 m. Currently, sewage is conveyed at 0 m elevation as the force main travels along the foreshore. The hydraulics of the existing systems are presented in Table 10-1.

Table 10-1: Hydraulics of Existing System

Parameter	Courtenay PS	Jane Place PS
Static Head to CVWPCC (m)	17	15
Line Losses (m)	12	7
Total Head (m)	29	22

The achievable pumping capacities at either of the pump stations declines with the flowrate of the other pump station. Such that Courtenay PS is only able to achieve 380 L/s when JPS is operating at Peak Wet Weather Flow (PWWF), and JPS is only able to achieve 120 L/s when Courtenay PS is operating at PWWF. Figure 10-2 was derived from the 2013 AECOM report, demonstrating the operating rate range between the two pump stations.

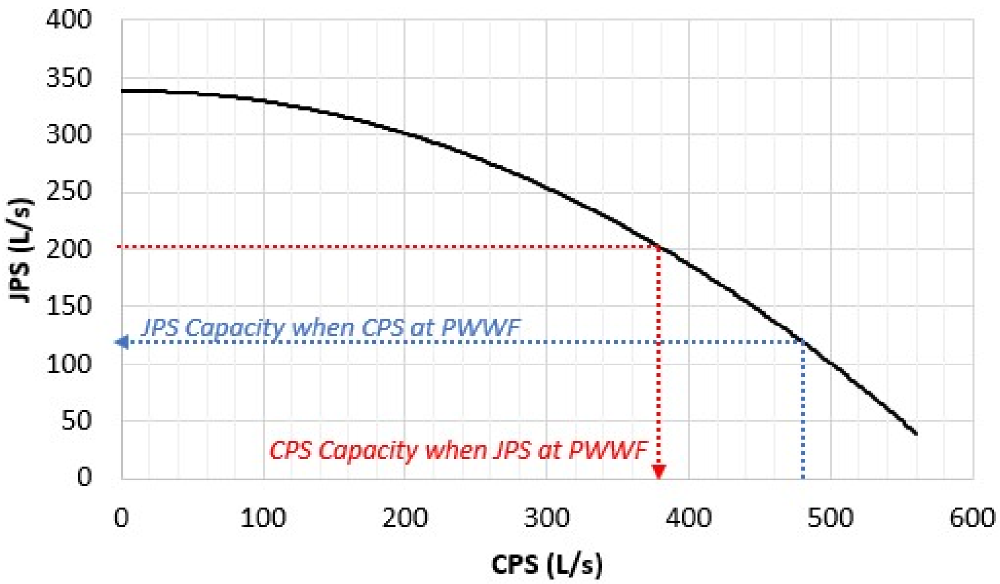


Figure 10-2: Existing System Performance

Given the current flow restrictions at either pump stations, upgrades to both pump stations are imminent in the near future to ensure management of the sanitary flows.

10.1.2 OPTIONS BOUNDARIES AND LIMITING FACTORS

The LWMP Stage 1 and Stage 2 studies are limited to the existing sewage conveyance systems between Courtenay, Comox and the CVWPCC. Consideration for future sewage from Area A's South Sewer project is not in this report but is addressed elsewhere. Furthermore, the current and future sewage that flows into the CFB Pump station via the Hudson and Greenwood trunk mains is not directly included in this evaluation. It is indirectly addressed through population growth off-sets where future loads to the foreshore system are adjusted to address sewage loads directed to through the CFB pump station.

10.2 STAGE 1 LWMP CONVEYANCE OPTIONS

The work team developed a preliminary long-list of options which could feasibly be used to convey sewerage from Courtenay, K'ómoks First Nation, and Comox to the CVWPCC. Options which were considered technically viable were carried forward to the Technical and Public Advisory Committees (TAC and PAC, respectively) for review and consideration. The option of a deep water marine alignment between the Courtenay PS and the CVWPCC was eliminated from further study by the team due to unacceptable fundamental technical and environmental issues. The remaining options were categorized as conveyance alignments and concepts and are described below:

1. Estuary Alignments – These alignments all include a section of forcemain in the estuary, specifically the inter-tidal zone. The objective of these options is to only eliminate the section of forcemain along Willmar Bluffs while minimizing impact of construction in the heavily populated and built-out sections of the CVRD.
2. Overland Alignments – These alignments are entirely overland and would generally follow existing road right-of-ways and be installed using traditional cut and cover trenching methods. These options minimize the need for construction in the estuary and allow for more conventional proven overland construction methods.
3. Tunnel Alignments – As a variation to overland options these alignments would incorporate a significant tunnelled section of pipe to off-set the hydraulic pressures necessary to overcome the natural topography between the CPS, JPS, and the CVWPCC.
4. North Side Concept – This option is a broad consideration for a conveyance system that includes an alignment which follows roads North of Comox Road between the CPS pump station and the CVWPCC, and a separate alignment conveying sanitary sewer directly from JPS to the CVWPCC.
5. Decentralized Treatment Concept – This option is a broad consideration which explores the idea that a portion of the sewage could be treated at a location at a wastewater treatment plant other than the CVWPCC rather than pumping the sewage to a common location. The effluent from this new wastewater treatment plant would then need to be conveyed to the location of the existing outfall at the CVWPCC.

The level of detail noted below is intended to broadly outline the above alignment and conveyance concepts. As such, detailed routings and facility locations are not included or discussed. Critical factors noted in the reviews include:

- General location and size of critical infrastructure such as pipes, pump stations, and treatment facilities;
- Technical challenges such as hydraulics, servicing capacity, and risks of construction and installation;
- Environmental considerations such as habitat impact, ecosystem impacts and proximity to known sensitive habitat;
- Archaeological considerations such as proximity to known sites;
- Operations and maintenance considerations including ability to isolate the system, shutdown operations, undertake repairs, flexibility, and complete spill management activities;
- Marine construction costs are carried at approximately double the terrestrial construction. This is based on historic comparison pricing along with the basis that working times are governed by tides which impact efficiency. Furthermore, excavation in the tidal zone is inefficient as the trench side slopes must be flatter due to sloughing of the saturated sands/mud soils;
- Land acquisition is not included in any price;
- Potential to expand the system to address future capacity; and
- Relative capital and operational costs.

With respect to cost estimates, the following is the basis of costing. Cost estimates are Class 'D' which can be defined as follows:

"A preliminary estimate which, due to little or no site information, indicates the approximate magnitude of cost of the proposed project, based on the client's broad requirements. This overall cost estimate may be derived from lump sum or unit costs for a similar project. It may be used in developing long term capital plans and for preliminary discussion of proposed capital projects." - EGBC Cost Estimate Definitions.

Furthermore, the following assumptions and criteria are incorporated into the cost estimates.

- Capital costs are based on the following:
  - Similar infrastructure installed in other communities, where available; and
  - Cost curves and project holistic unit rates.
- Operating costs are based on:
  - Estimated annual average power consumption for major equipment only;
  - Estimated relative labour effort between options; and
  - Asset renewal requirements.

The costs presented in this report do not include GST. These costs are only for the purpose of options comparison and discussion and are not suitable for budgeting. Detailed industry quotes, building sizing, layouts and such are not included or considered for this level of costing.

10.2.1 ESTUARY ALIGNMENTS

OPTION 1A – ESTUARY WITH LAZO HILL TUNNEL	
Description:	The forcemain from CPS would continue directly to the CVWPCC along the estuary and across the peninsula, such that there is no in-line pump station; however, a tunnel through the Lazo Road hill would be used to reduce the required pressures in the system. Pending the tunnel elevation, a new pump station may be required in the general vicinity of the existing JPS. Detailed financial modelling of the tunnel length verses the pumping costs would need to be undertaken to optimize this option. In order to evaluate this option a tunnel elevation which does not result in a major pump station upgrade at CPS or JPS has been assumed. The existing JPS would be repurposed as a small subdivision pump station.
Advantages	» Subject to tunnel elevation, there may be potentially limited changes to existing pump stations hydraulics. » Maximizes useful life of estuary foreshore forcemain » Avoids construction of a forcemain through Comox. » Avoids the construction of additional large pump stations.
Disadvantages	» Involves work along and in the estuary, including environmentally and archaeologically sensitive areas. » Elevated maintenance and risk management needs due to proximity to marine environment. » Elevated construction and operational risk associated with a tunnel.
Technical Consideration	The system would be installed and operated very similar to the existing CVRD forcemain configuration. Required pumping head and pressure to convey sewage would be provided by separate pumping stations which would function nearly independently of each other. Any operational issues at any one station would be isolated in that collection zone. The hydraulic pressures can be reduced by tunnelling through the Lazo Road hill. The estimated system hydraulic operating pressure would be in the order of 40 to 50 meters. A significant technical challenge of this project is the inherent nature of the risks involved in tunnelling. As a result, a higher front-end effort may be required to map the geotechnical conditions along and around the proposed tunnelled alignment. Due to the uncertainty and risks surrounding tunnelling, a higher contingency would need to be accounted for during construction.
Environmental Considerations	Marsh habitat within the estuary area is recognized as major habitat for numerous water bird species. The estuary constitutes large intact salt marsh communities which have been noted as significant due to the increasing rarity on the east coast of Vancouver Island.
Archaeological Considerations	Significant sections of the pipe alignment would follow through existing archaeological sites, such as DkSf-4 and DkSf-44, however any estuary alignments should be assumed to encounter archeological sites.
Operational Considerations	Maintenance and repair of any inter-tidal section of pipe would be limited by tidal conditions. Furthermore, the ability to detect and control any leakage or sewage spilled due to a line break would be significantly limited and potentially improbable. As such the design of the system would have to recognize the risks associated with a failure and a higher material strength would have to be used to off-set this risk. Present day material standards for this application would utilize a continuously fused HDPE pipe retained below the seabed using concrete weights. As HDPE is susceptible to punctures due to boat anchors, additional concrete armouring would likely be required to protect the pipe from external damage. This configuration would add

significant costs to the project due to the relatively large diameter (~1,000 mm) and the resulting weight and size of a concrete collars. Furthermore, this protective armour would further limit any access to allow repair work to be completed in the future.

Subject to the methods used to install the tunnel section, repairs to any damaged section of pipe would not be possible as the system cannot be shut down or excavated to undertake repair work. A critical consideration during the tunnel design would be the choice of material used and if a carrier pipe arrangement is to be employed. The more cost-effective solution would utilize the same pipe to line the micro-tunnel as the fluid carrying pipe. However, this arrangement would not provide any indication of leakage or opportunity to repair the carrier pipe. An alternative arrangement is to utilize a separate casing and carrier pipe. This would result in a casing pipe with a diameter approximately 200 mm larger than the carrier pipe. This arrangement would provide containment should the carrier pipe leak and would permit replacement of the carrier pipe should alternative methods be available to temporarily convey the sewage around the tunnel during repairs.

Operational flexibility is provided by the independence of each of the pump stations. Future twinning of the alignment would be at elevated ri sks in the estuary as work would be completed in intertidal zones, similar to the initial construction. Future twinning of the tunnelled section would be at elevated risks as it would be installed parallel to the first tunnel section.

Infrastructure Elements

Description	Capital Cost	Investment Year	Renewal Frequency	Renewal %	Total Power (kW)	Labour hrs/day
New Courtenay - Moderate Pressure Increase	$10,500,000	2020	25	40%	625	3
Downgrade Jane	$2,362,500	2020	25	40%	25	0
New Jane - Moderate Pressure Increase	$3,850,000	2020	25	40%	250	3
Forcemain Tunnel through Lazo hill	$23,587,200	2020	60	100%	0	0
Estuary Courtenay to Lazo Hill	$38,133,480	2030	60	100%	0	0
Jane to forcemain	$1,108,800	2030	60	100%	0	0
Total Capital Cost	$79,541,980					

Cost Considerations

This option has an initial capital expenditure of around $80M which can be spread over a 10 year period as all components are not required simultaneously. , the majority of which accounts for the cost of the linear conveyance infrastructure between the CPS and the CVWPCC, particularly as construction must be partially completed in the foreshore conditions, leading to significantly higher construction costs.

Power requirements are low as the forcemain is maintained at a lower elevation. There are advantages based on operating cost for this option as it sustains a relatively low elevation throughout the length of the alignment.

Figures

Alignment is provided on Figure 10-3. Profile is provided on Figure 10-6.

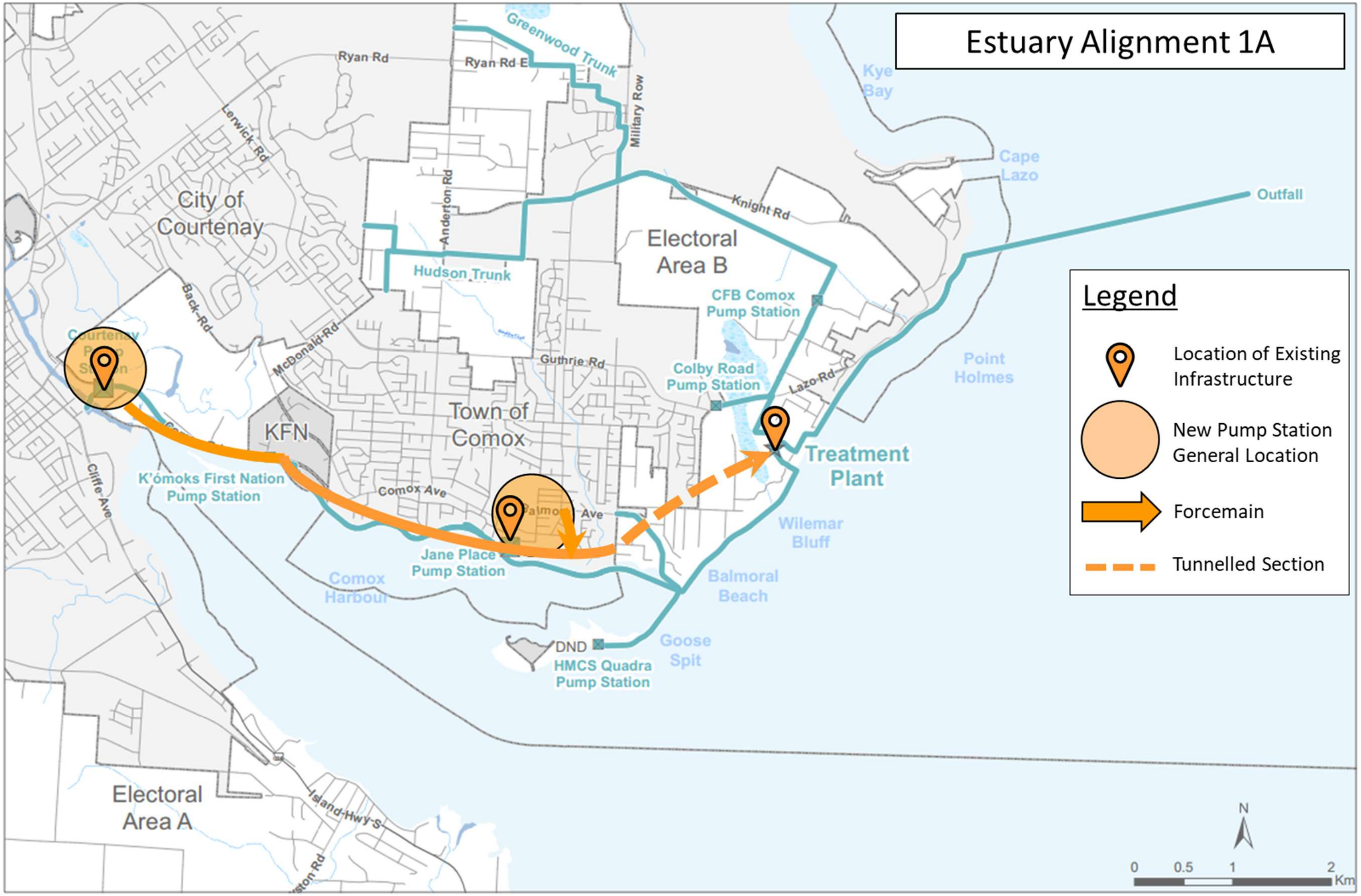


Figure 10-3: Estuary Alignment 1A

OPTION 1B – ESTUARY WITH LAZO HILL OVERLAND ROUTE	
Description:	The forcemain from CPS would continue directly to the CVWPCC in the estuary such that there is no in-line pump station. In order to overcome the Lazo Road hill, the CPS would be upgraded to provide sufficient forcemain pressure to overcome the height of land. As a result, the existing JPS would not be able to cope with this higher hydraulic requirement and therefore a new high head pump station would be required in the general vicinity of the existing JPS. This new facility would convey raw sewage into the forcemain between CPS and the CVWPCC. The existing JPS would be repurposed as a small subdivision pump station to convey sewage from the small catchments remaining outside of the service area of the new pump station.
Advantages	» Minimizes construction of a forcemain through Comox. » Only involves 2 large pump stations (JPS repurposed as local facility only).
Disadvantages	» Involves work along and in the estuary, including environmentally and archaeologically sensitive areas. » Elevated maintenance and risk management needed due to proximity to the marine environment.
Technical Consideration	The system would be installed and operated very similar to the existing CVRD forcemain configuration. Required pumping head and pressure to move sewage would be provided by separate pumping stations which would function nearly independently of each other. Any operational issues at any one station would be isolated in that collection zone. The required discharge pressures from the CPS would be in the order of 60 to 70 meters and be in excess of typical sanitary pumps. This would limit the available options for pumps or require a high pressure sanitary pump station configuration, specifically using two lower head pumps in direct series to achieve the necessary discharge pressures. The existing Jane Place property would not be large enough to accommodate a new pump station and as such a new property would be required to facilitate this new station. The existing JPS would still be required, albeit for a lower pumping capacity as it would only service the properties which would not gravity drain to the new pump station.
Environmental Considerations	Marsh habitat within the estuary area is recognized as major habitat for numerous water bird species. The estuary constitutes large intact salt marsh communities which have been noted as significant due to the increasing rarity on the east coast of Vancouver Island.
Archaeological Considerations	Significant sections of the pipe alignment would follow through existing archaeological sites, such as DkSf-4 and DkSf-44, however any estuary alignments should be assumed to encounter archeological sites.
Operational Considerations	Maintenance and repair of any inter-tidal section of pipe would be limited by tidal conditions. Furthermore, the ability to detect and control any leakage or sewage spilled due to a line break would be significantly limited and potentially improbable. As such the design of the system would have to recognize the risks associated with a failure and a higher material strength would have to be used to off-set this risk. Present day material standards for this application would utilize a continuously fused HDPE pipe retained below the seabed using concrete weights. As HDPE is susceptible to punctures due to boat anchors, additional concrete armouring would likely be required to protect the pipe from external damage. This configuration would add significant costs to the project due to the relatively large diameter (~1,000 mm) and the resulting weight and size of a concrete collars. Furthermore, this protective armour would further limit any access to allow repair work to be completed in the future.

The selection of a new property for the JPS provides an opportunity to consider future sea-level changes and increased resilience of this station to climate change.

Operational flexibility is provided by the independence of each of the pump stations. Future twinning of the alignment would be at elevated risks in the estuary as work would be completed in intertidal zones, similar to the initial construction. Excavation and installation of a twinned section of pipe in the overland portion would not be a significant challenge.

Infrastructure Elements

Description	Capital Cost	Investment Year	Renewal Frequency	Renewal %	Total Power (kW)	Labour hrs/day
New Courtenay - Moderate Pressure Increase	$10,500,000	2020	25	40%	1125	3
Downgrade Jane	$2,362,500	2020	25	40%	25	0
New Jane - Moderate Pressure Increase	$3,850,000	2020	25	40%	425	3
Overland Lazo Hill to CVWPCC	$5,913,600	2020	60	100%	0	0
Estuary Courtenay to Jane	$32,728,080	2020	60	100%	0	0
Jane to forcemain	$1,108,800	2020	60	100%	0	0
Old Jane to New Jane	$51,744	2020	60	100%	0	0
Total Capital Cost	$56,514,724					

Cost Considerations

This option has a capital cost of around $57M, a significant part of which accounts for the cost of the linear conveyance infrastructure between the CPS and the CVWPCC, particularly as construction must be partially completed in the foreshore conditions, leading to higher construction costs. There is also a need for the construction of a new moderate-pressure CPS and a new moderate-pressure JPS. This option requires the downgrading of the JPS and continued asset maintenance for a total of three pump stations, however the downgraded JPS will require minimal maintenance efforts.

Compared to alignment 1A, there are no advantages based on operating cost for this option as it has a higher pumping head requirement since the conveyance system needs to overcome the height of land at Lazo hill.

Figures

Alignment is provided on Figure 10-4. Profile is provided on Figure 10-6.

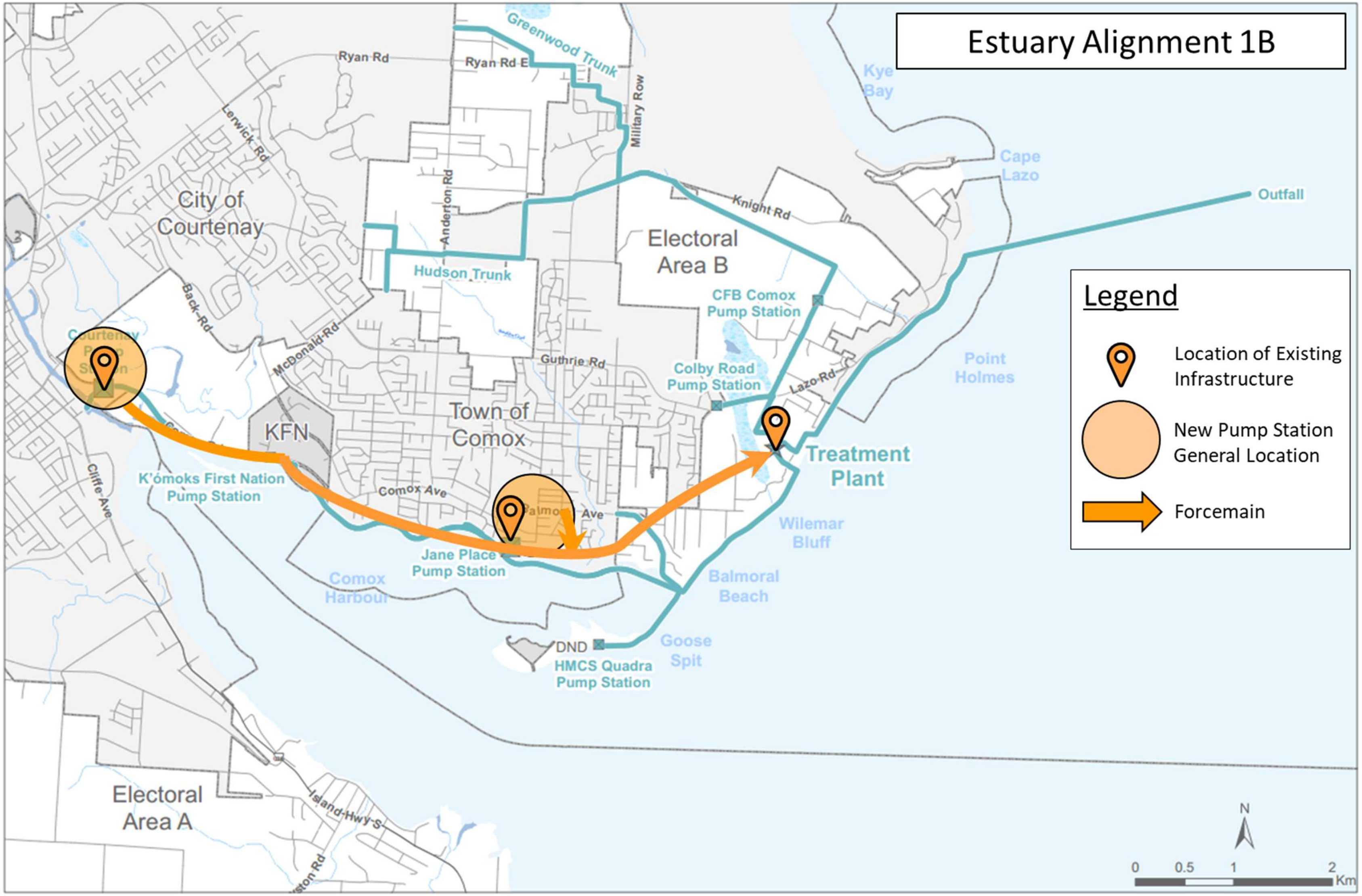


Figure 10-4: Estuary Alignment 1B

OPTION 1C – ESTUARY WITH A NEW IN-LINE PUMP STATION	
Description:	This option includes the construction of a new pump station facility located between Comox and the Lazo Road hill, at the Beech Street property. This would be an inline facility which receives raw sewage from the CPS/JPS discharge forcemain. The new pump station would pump the sewage over the Lazo Road hill and the sewage would flow to the CVWPCC. The JPS would tie-in to the CPS discharge forcemain at a location upstream of the new pump station. The elevation of the new pump station would have to be low enough to permit the JPS to pressures at the forcemain connection.
Advantages	» Minimize hydraulic changes to existing CPS and JPS. » Maximize useful life of existing foreshore forcemain. » Avoids construction of a forcemain through Comox.
Disadvantages	» Pump stations in series and single point of complete failure of sewage conveyance system. » Involves operation and maintenance of 3 large pump station. » Involves work along and potentially in the estuary, including environmentally and archaeologically sensitive areas. » Elevated maintenance and risk management needs due to proximity to marine environment.
Technical Consideration	Unlike the existing CVRD pump station configuration, this station would be in-line with existing pump stations and all sewage would pass through this facility. Total capacity of this station would be the combined flow from CPS and JPS. To address the operational risks with this single point of operation, a very high level of system redundancy and operational flexibility would be required. This could include balancing storage or double redundancy on major systems such as power supply and piping systems. This arrangement limits the need to change the existing system pressure as the new station would be located to accommodate the existing CPS and JPS hydraulic operations. The discharge pressure required from this station would need to overcome the Lazo road hill of approximately 50m.
Environmental Considerations	Marsh habitat within the estuary area is recognized as major habitat for numerous water bird species. The estuary constitutes large intact salt marsh communities which has been noted as significant due to the increasing rarity on the east coast of Vancouver Island.
Archaeological Considerations	Significant section of the pipe alignment would follow through existing archaeological sites, such as DkSf-4 and DkSf-44.
Operational Considerations	Maintenance and repair of any inter-tidal section of pipe would be limited to tidal conditions. Furthermore, isolation and collection of leaking sewage would not be possible in intertidal zones. Repair and restoration of any damaged sections of pipe in the overland portions would be completed following common practices and could be completed quickly, with limited long-term impacts and completed using readily available local resources. Operation of the entire CVRD sewage system would be contingent on the operation of this new pump station. Overflows at this location would not be permitted and the provision of balancing storage would be strongly encouraged to provide an opportunity for maintenance activities or emergency responses to any faults.

Infrastructure Elements

Description	Capital Cost	Investment Year	Renewal Frequency	Renewal %	Total Power (kW)	Labour hrs/day
Upgrade Courtenay (Capacity and AM driven)	$4,200,000	2020	25	40%	375	3
Upgrade Jane (Capacity and AM driven)	$3,150,000	2020	25	40%	150	3
New In-line Pump Station	$12,040,000	2020	25	40%	1075	3
Overland Lazo Hill to CVWPCC	$5,913,600	2020	60	100%	0	0
Estuary Courtenay to Lazo Hill	$38,133,480	2030	60	100%	0	0
Jane to forcemain	$1,108,800	2030	60	100%	0	0
Total Capital Cost	$64,545,880					

Cost Considerations	This option has a moderate initial capital expenditure of around $65M, a significant part of which accounts for the cost of the linear conveyance infrastructure between the CPS and the CVWPCC, particularly as construction must partially be completed in the foreshore conditions, leading to significantly higher construction costs. There is also a need for the construction of a new in-line pump station west of the Lazo Road hill with sufficient capacity to convey all of Courtenay and Comox's sewage. This option requires the continued asset maintenance for a total of three pump stations. Similar to option 1B, and compared to alignment 1A, there are no advantages based on operating cost for this option as it has a higher pumping head requirement since the conveyance system needs to overcome the height of land at Lazo Road hill.
Figures	Alignment is provided on Figure 10-5. Profile is provided on Figure 10-6.

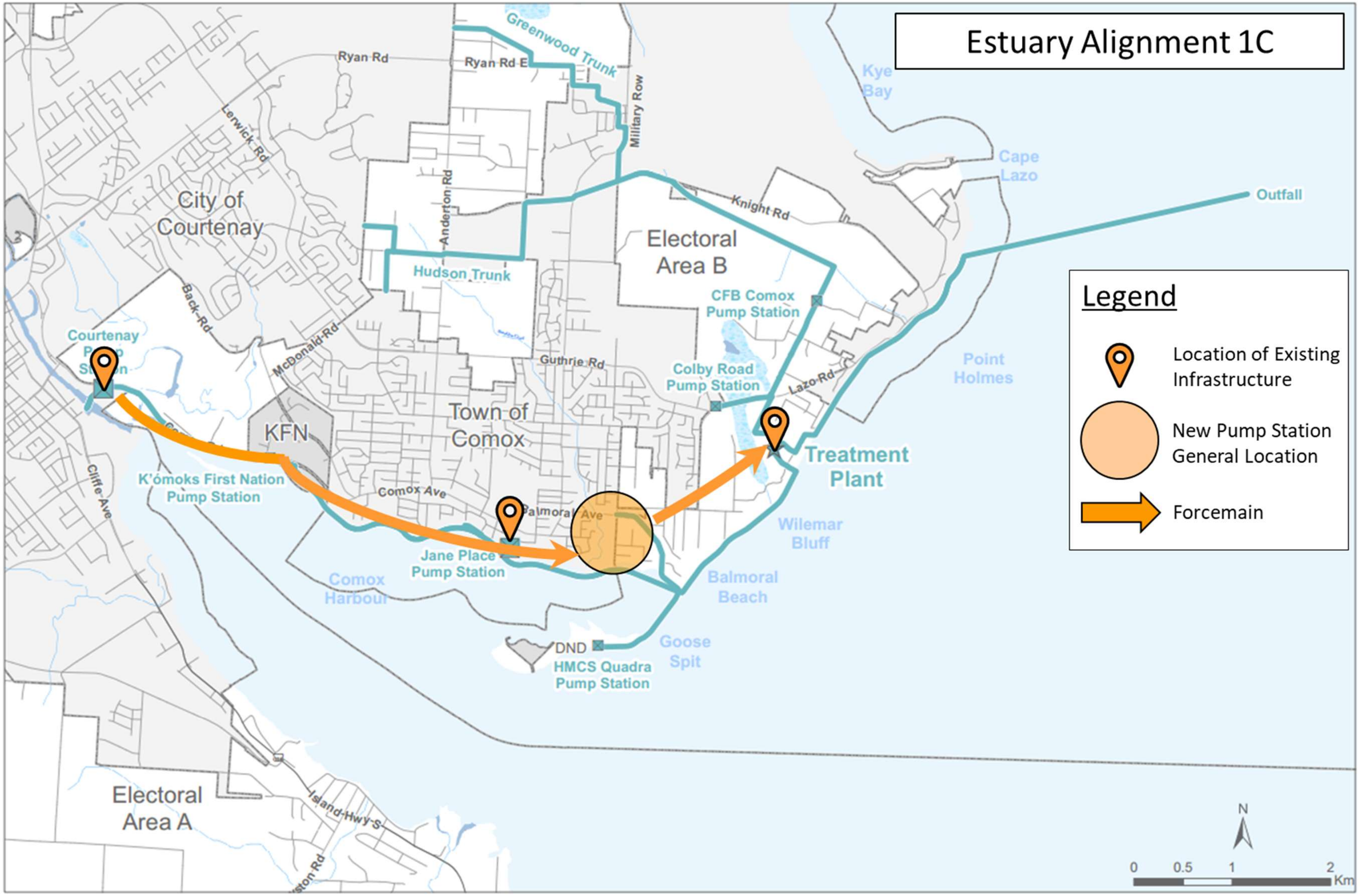
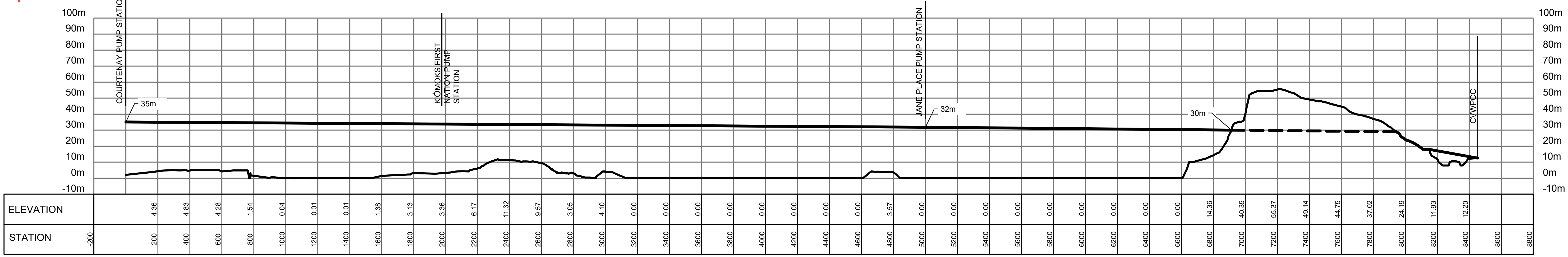
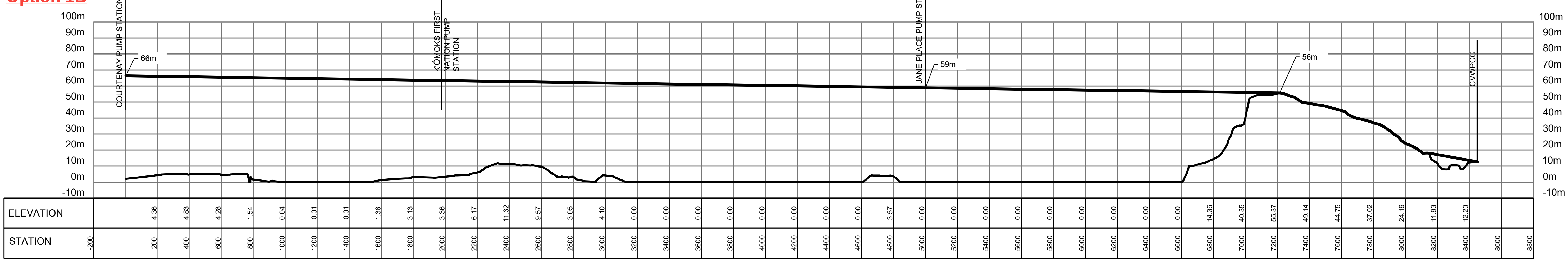


Figure 10-5: Estuary Alignment 1C

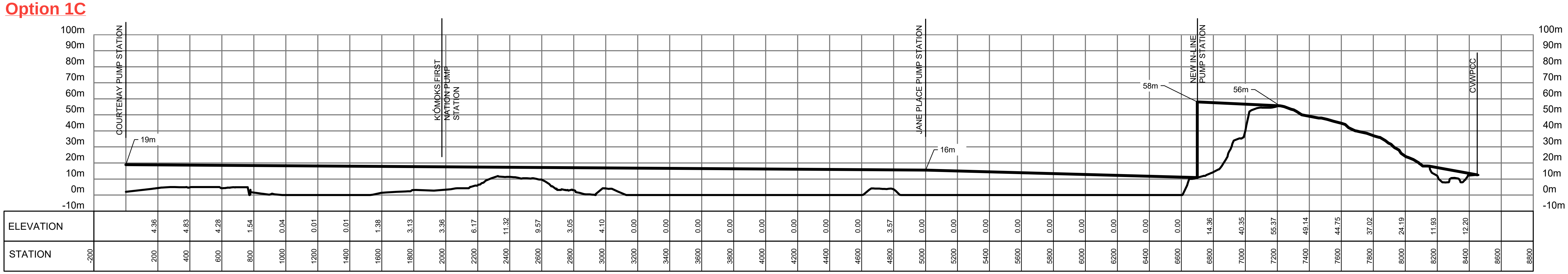
Option 1A



Option 1B



Option 1C



OPTION 1
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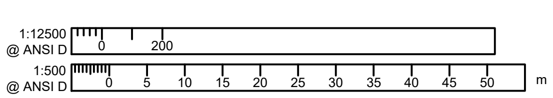

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Figure 10-6: Option 1 Hydraulic Profiles

10.2.2 OVERLAND ALIGNMENTS

OPTION 2A – OVERLAND FORCEMAIN	
Description:	This alignment would involve installation of a new forcemain overland from the CPS towards the CVWPCC. This forcemain would pass over the Comox Road hill. Due to the change in discharge pressure, a significant upgrade or rebuild would be required at the CPS. The forcemain from CPS would continue directly to the CVWPCC such that there is no in-line pump station. In order to overcome both the Comox Road hill and the Lazo Road hill, the CPS would be upgraded to meet the necessary hydraulic pressure. As a result, the existing JPS would not be able to cope with this higher hydraulic requirement and therefore a new higher head pump station would be required in the general vicinity of the existing JPS. This new facility would convey raw sewage into the forcemain between CPS and the CVWPCC. The existing JPS would be repurposed as a small subdivision pump station to convey sewage from the small catchments remaining outside of the service area of the new pump station.
Advantages	» No pipe in the estuary mitigating environmental and archaeological risks. » All pipe and structures would be on-land to maximize maintenance accessibility. » Only involves 2 large pump stations (JPS repurposed as local facility only).
Disadvantages	» Significant hydraulic changes to the CPS and JPS. » Construction of new conveyance system through an area with significant existing infrastructure and high traffic.
Technical Consideration	The system would operate similar to the existing CVRD sewage system where a single forcemain conveys sewage directly to the CVWPCC. The two pump stations would operate independently of each other. The most significant variation from the existing system is that the forcemain would follow the natural topography of the land and therefore the pump station would need to be relatively high pressure in order to overcome the existing hills. As the flow rate through these stations is reasonably high, there are options available to provide the necessary discharge pressures, however the selection of options becomes reduced at these pressures, which are estimated to be in the order of 60 to 70 m of pressure. The overland forcemain would be installed using standard cut-and-cover installation methods with the general intention of following existing roadways. This approach is very common and as such, reasonably well established. Additional complexities would involve relocating existing utilities and restoration of surface roadways, sidewalks, and similar features. Due to the nature of sanitary systems, the depth of excavation would be set to be below the existing water systems.
Environmental Considerations	Overland portions routed along existing roadways would have limited environmental impacts. Areas with significant adjacent trees could be potentially damaged due to root damage.
Archaeological Considerations	The intention would be to remain within existing areas of disturbance, so no unique archaeological impacts are likely.

Operational Considerations	Maintenance of the higher head pump station would be similar to that of the existing facilities, however there is a reduced selection of pump options. In addition, a typical higher head sewage pump operates at reduced efficiency compared to lower head pumps. Maintenance and repair on the overland forcemain would be completed using well established repair methods based on open excavation. Should a pipe failure occur, standard methods of isolation and pumping off-site using a vacuum truck would be employed.

Infrastructure Elements

Description	Capital Cost	Investment Year	Renewal Frequency	Renewal %	Total Power (kW)	Labour hrs/day
New Courtenay - Moderate Pressure Increase	$10,500,000	2020	25	40%	1050	3
Downgrade Jane	$2,362,500	2020	25	40%	25	0
New Jane - Moderate Pressure Increase	$3,850,000	2020	25	40%	425	3
Overland Courtenay to Jane (New or Existing)	$16,493,400	2020	60	100%	0	0
Overland Jane to Lazo Hill	$4,851,000	2020	60	100%	0	0
Overland Lazo Hill to CVWPCC	$5,913,600	2020	60	100%	0	0
Jane to forcemain	$1,108,800	2020	60	100%	0	0
Total Capital Cost	$45,079,300					

Cost Considerations	This option has a relatively low initial capital expenditure at $45M, as construction of the linear conveyance infrastructure is mostly completed overland in already-disturbed areas, leading to lower construction costs. There is need for the construction or re-construction of two new pump stations. This option requires the continued asset maintenance for a total of three pump stations, however the downgraded JPS will require minimal maintenance efforts. There is no operating cost advantage to this option as it requires pumping of the raw sewage over the heights of land at both Comox Road and Lazo Road hills, resulting in significant financial operating costs.
Figures	Alignment is provided on Figure 10-7. Profile is provided on Figure 10-9.

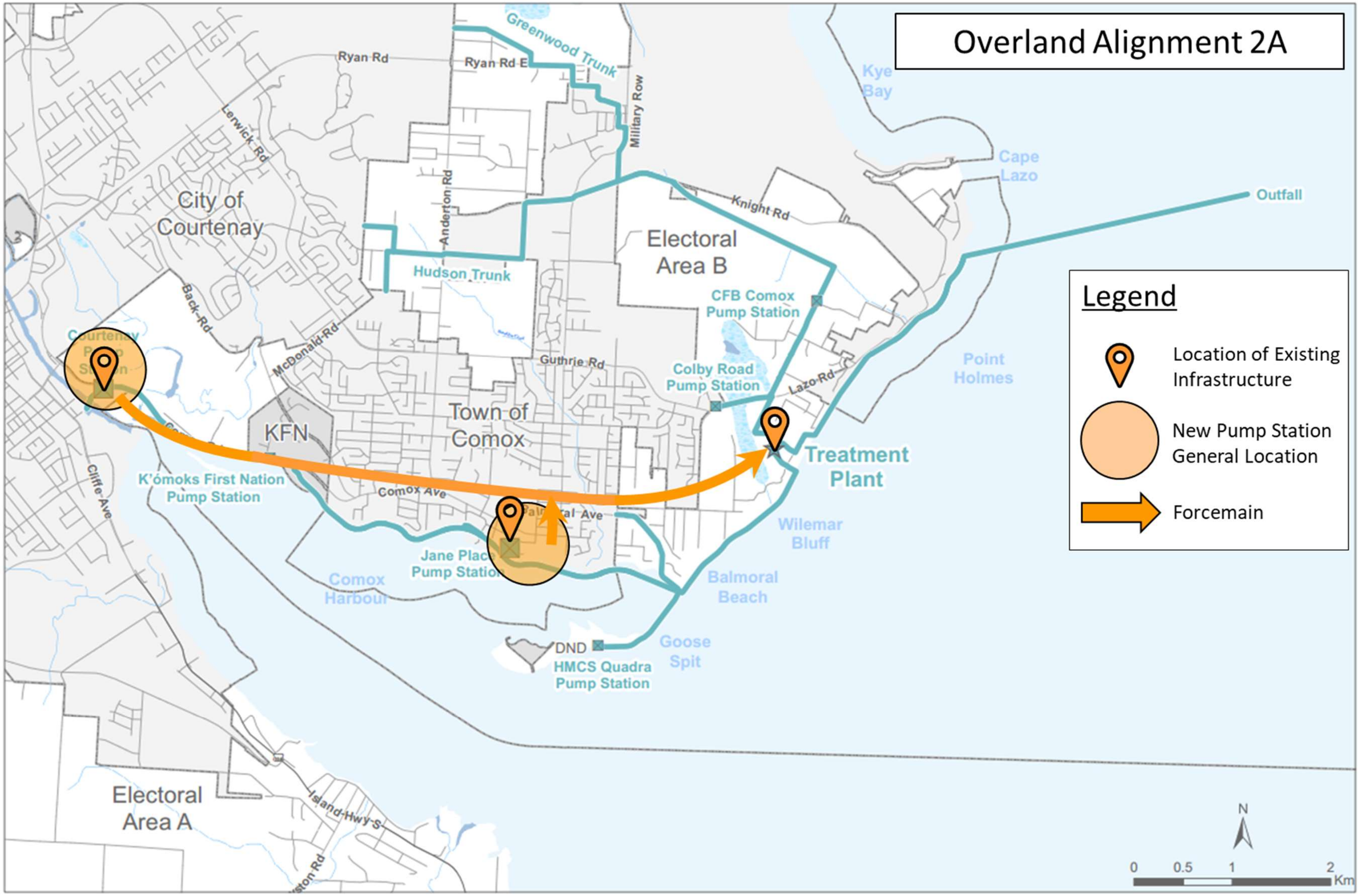


Figure 10-7: Overland Alignment 2A

OPTION 2B – OVERLAND FORCEMAIN WITH IN-LINE PUMP STATION	
Description:	This alignment would involve installation of a new forcemain overland from CPS towards a new in-line pump station. The forcemain from CPS would convey raw sewage over the Comox Road hill and down into a new pump station, connected in series, between the JPS and Lazo Road heights of land, at the Beech Street property. The elevation of the new pump station would need to be at an elevation to suit the existing discharge pressures from the JPS. From the new pump station, the raw sewage would be conveyed over the Lazo Road hill to the CVWPCC.
Advantages	» No pipe in the estuary mitigating environmental and archaeological risks. » All pipe and structures would be on-land to maximize maintenance accessibility. » Minimize hydraulic changes to existing JPS.
Disadvantages	» Pump in series and single point of complete failure of sewage conveyance system. » Involves operation and maintenance of 3 large pump station, one of high criticality. » Significant hydraulic changes to the CPS. » Construction of new conveyance system through an area with significant existing infrastructure and high traffic.
Technical Consideration	Unlike the existing CVRD pump station configuration this new system would include an in-line pump station where all sewage would pass. Total capacity of this station would be the combined flow from CPS and JPS. To address the operational risks with this single point of operation a very high level of system redundancy and operational flexibility would be required. This could include balancing storage or double redundancy on major systems such as power supply and piping systems. This arrangement limits the need to change the existing JPS pressure as the new station would be located to accommodate the existing JPS hydraulic operations. The discharge pressure required from this station would need to overcome the Lazo road hill. The overland forcemain would be installed using standard cut-and-cover installation methods with the general intention of following existing roadways. This approach is very common and as such, reasonably well established. Additional complexities would involve relocating existing utilities and restoration of surface roadways, sidewalks and similar features. Due to the nature of sanitary systems the depth of excavation would be set to be below the existing water systems.
Environmental Considerations	Overland portions routed along existing roadways would have limited environmental impacts. Areas with significant adjacent trees could be potentially damaged due to root damage.
Archaeological Considerations	The intention would be to remain with existing areas of disturbance, so no unique archaeological impacts are likely.
Operational Considerations	Maintenance of the higher head pump station would be similar to that of the existing facilities, however there is a reduced selection of pump options. In addition, a typical higher head sewage pump operates at reduced efficiency compared to lower head pumps. Operation of the entire CVRD sewage system would be contingent on the operation of this new pump station. Overflows at this location would not be permitted and the provision of balancing storage would be strongly encouraged to provide an opportunity for maintenance activities or emergency responses to any faults.

Maintenance and repair on the overland forcemain would be completed using well established repair methods based on open excavation. Should a pipe failure occur standard methods of isolation and pumping off-site using a vacuum truck would be employed.

Infrastructure Elements

Description	Capital Cost	Investment Year	Renewal Frequency	Renewal %	Total Power (kW)	Labour hrs/day
New Courtenay - Moderate Pressure Increase	$10,500,000	2025	25	40%	750	3
Upgrade Jane (Capacity and AM driven)	$3,150,000	2020	25	40%	300	3
New In-line Pump Station	$12,040,000	2020	25	40%	1075	3
Overland Courtenay to Lazo Hill	$26,999,280	2030	60	100%	0	0
Overland Lazo Hill to CVWPCC	$5,913,600	2020	60	100%	0	0
Total Capital Cost	$58,602,880					

Cost Considerations

This option has moderate initial capital expenditure of $59M, as construction of the linear conveyance infrastructure is mostly completed overland in already-disturbed areas, leading to lower construction costs. There is need for the construction of a new CPS and a new in-line pump station west of the Lazo Road hill. This option requires the continued asset maintenance for a total of three pump stations.

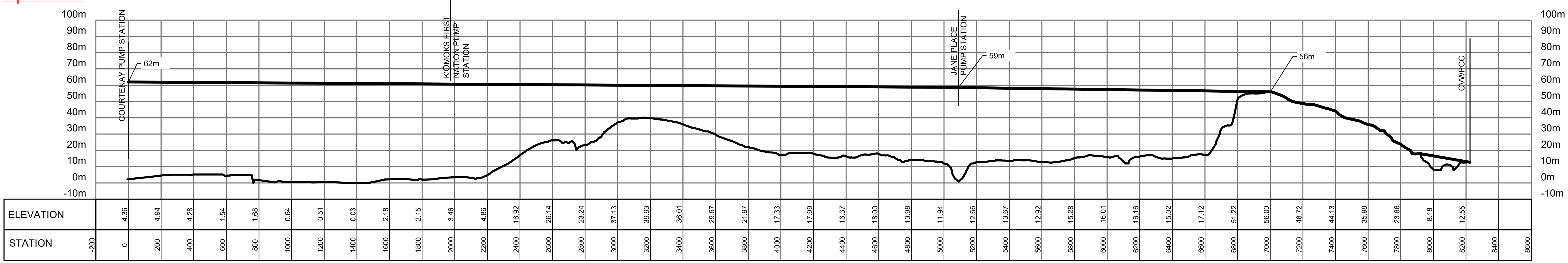
There are operating cost disadvantages to this option as it requires pumping of the raw sewage over the height of land at Comox Road hill, breaking head at the location of the new in-line pump station, and again pumping over the height of land at the Lazo Road hill, resulting in significant financial operating costs.

Figures

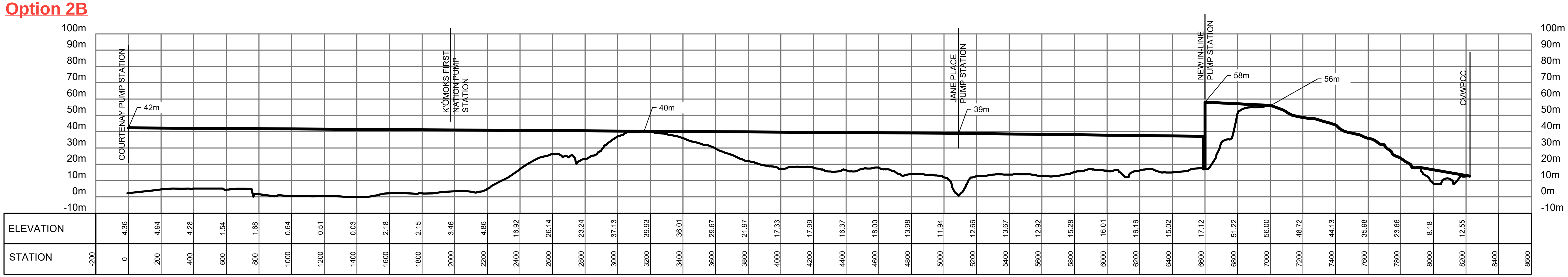
Alignment is provided on Figure 10-8. Profile is provided on Figure 10-9.

Figure 10-8: Overland Alignment 2B

Option 2A



Option 2B



OPTION 2
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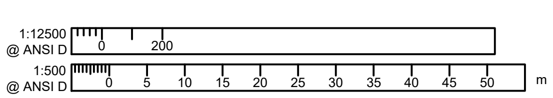

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Figure 10-9: Option 2 Hydraulic Profiles

10.2.3 TUNNELLING ALIGNMENTS

OPTION 3A – TUNNEL THROUGH COMOX RD HILL AND LAZO RD HILL	
Description:	This alignment would involve installation of a combination of new forcemains installed using open cut methods and micro-tunnel methods in order to minimize pumping requirements. The primary areas where tunnelling would be appropriate are under the Comox Rd. and Lazo Rd hills. Sewage would be pumped from the CPS to an elevation where a tunnel would be constructed through the Comox Road hill. The forcemain would transition to an open cut installation through Comox and back to a tunnel to pass under the Lazo Road hill and down to the CVWPCC. The JPS could connect to the forcemain. To avoid major modifications to the JPS the tunnel elevations would have to be selected to suit the existing hydraulics of the JPS. The tunnel through the Comox Road hill would be around a 30-meter elevation and be in the 800 to 1,000 m length. To pass through the Lazo Road hill, while maintain an elevation suitable to limit upgrades at the JPS it is likely that 1,200 to 1,500 m tunnel would be required. This would necessitate an intermediate shaft and add cost and complexity to the project as this has the potential to penetrate the groundwater in the area. Following construction this shaft would be removed. Alternative routing would need to be explored to evaluate options to avoid this shaft. The overland forcemain would be installed using standard cut-and-cover installation methods with the general intention of following existing roadways. This approach is very common and as such, reasonably well established. Additional complexities would involve relocating existing utilities and restoration of surface roadways, sidewalks, and similar features. Due to the nature of sanitary systems the depth of excavation would be set to be below the existing water systems.
Advantages	» No pipe in the estuary mitigating environmental and archaeological risks. » All overland pipes and structures will maximize maintenance accessibility. » Alleviates some of the high head requirements as compared to other overland options.
Disadvantages	» Construction of new conveyance system through an area with significant existing infrastructure. » High risk tunnel installation and a potential construction shaft located along the Lazo Road hill section. » Limited maintenance accessibility for the tunnelled sections of alignment.
Technical Consideration	This system would operate similar to the existing configuration where a single forcemain connects the CPS with the CVWPCC and the JPS connects into the forcemain. To avoid significant changes to the existing pump stations a micro-tunnel would be used to pass through the two heights of land. The length of the micro-tunnel would be limited to 800 to 1,000 m between access shafts. Tunnel sections would need to be reviewed for the financial benefit of installing a twinned system during initial construction. Risks to future expansion and tunnelling adjacent a critical forcemain would need to be factored into the decision making during preliminary design. The design of the tunnel forcemain would likely utilize materials not commonly used in Western Canada for sewage infrastructure as the pipe would have to be designed for the installation conditions and the exposure to sewage.

Environmental Considerations	Overland portions routed along existing roadways would have limited environmental impacts. Areas where there are significant adjacent trees could be potentially damaged due to root damage. The deeper tunnel options would likely involve dewatering during installation and construction which may temporarily impact local groundwater wells.
Archaeological Considerations	The intention would be to remain with existing areas of disturbance so no unique archaeological impacts are likely.
Operational Considerations	Maintenance of the pump stations would be similar to that of the existing facilities. Maintenance and repair on the overland forcemain would be completed using well established repair methods based on open excavation. Should a pipe failure occur standard methods of isolation and pumping off-site using a vacuum truck would be employed. There would be no opportunity to undertake maintenance on the tunnel section of pipe and any damage would require a cured-in-place repair technology. This repair cannot be completed while the system is in operation and therefore would necessitate a significant by-pass design to permit the tunnel to be taken off-line.

Infrastructure Elements

Description	Capital Cost	Investment Year	Renewal Frequency	Renewal %	Total Power (kW)	Labour hrs/day
New Courtenay - Moderate Pressure Increase	$10,500,000	2020	25	40%	625	3
Downgrade Jane	$2,362,500	2020	25	40%	25	0
New Jane - Moderate Pressure Increase	$3,850,000	2020	25	40%	250	3
Forcemain Tunnel through Lazo hill	$23,587,200	2020	60	100%	0	0
Forcemain Tunnel through Comox hill	$11,734,800	2020	60	100%	0	0
Overland from Comox hill to Lazo hill	$10,977,120	2020	60	100%	0	0
Jane to forcemain	$1,108,800	2020	60	100%	0	0
Overland Courtenay to CVWPCC (Excl. Tunnel Sections)	$15,846,600	2020	60	100%	0	0
Total Capital Cost	$79,967,020					

Cost Considerations	This option has moderate initial capital expenditure of $80M, as construction of tunnelled sections caries additional cost compared to open-cut installation of linear infrastructure. However, the remainder of the alignment construction is mostly completed overland in already-disturbed areas. This option requires the continued asset maintenance for a total of the two existing CPS and JPS. There are significant advantages based on operating cost for this option as it sustains a relatively low elevation by tunnelling through the heights of land at the Comox Road and Lazo Road hills.
Figures	Alignment is provided on Figure 10-10. Profile is provided on Figure 10-13.

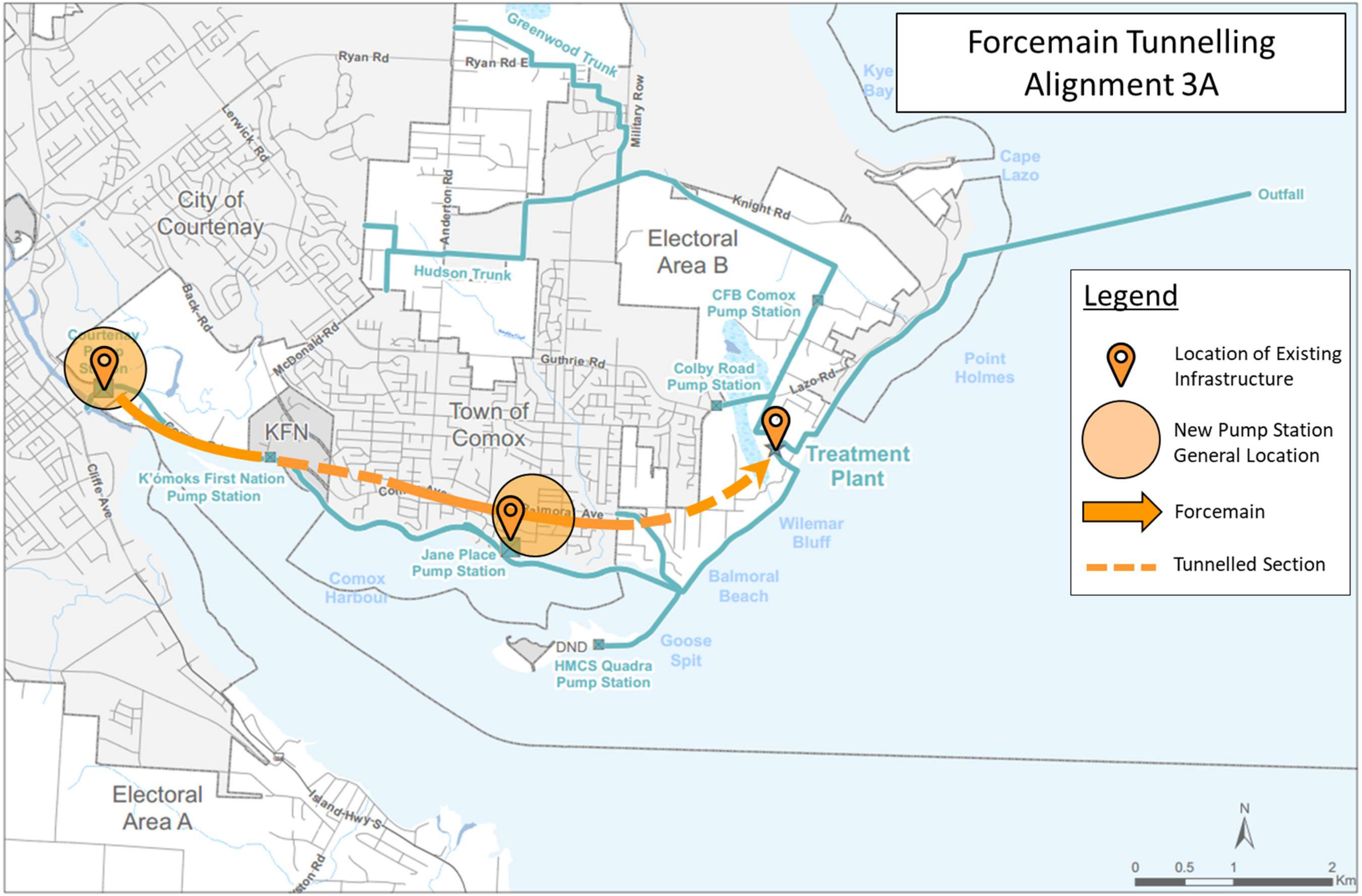


Figure 10-10: Forcemain Tunnelling Alignment 3A

OPTION 3B – TUNNEL THROUGH LAZO RD HILL

Description:	A new open cut forcemain would be installed from CPS and would continue directly to the CVWPCC with a tunnel through the Lazo Road Hill. The existing JPS would likely not be able to cope with this higher hydraulic requirement and therefore a new high head pump station would be required in the general vicinity of the existing JPS. This new facility would convey raw sewage into the forcemain between CPS and the CVWPCC. The existing JPS would be repurposed as a small subdivision pump station. If the tunnel elevation is sufficiently low, the existing JPS would be suitable. Assuming a new JPS the tunnel through Lazo Road hill would be approximately 800 to 1,000 m long. The overland forcemain would be installed using standard cut-and-cover installation methods with the general intention of following existing roadways. This approach is very common and as such, reasonably well established. Additional complexities would involve relocating existing utilities and restoration of surface roadways, sidewalks and similar features. Due to the nature of sanitary systems the depth of excavation would be set to be below the existing water systems.
Advantages	» No pipe in the estuary mitigating environmental and archaeological risks. » All pipe and structures on-land to maximize maintenance accessibility. » Alleviates some of the high head requirements as compared to other overland options.
Disadvantages	» Construction of new conveyance system through an area with significant existing infrastructure. » Higher upgrade requirements at the CPS and JPS.
Technical Consideration	This system would operate similar to the existing configuration where a single forcemain connects the CPS with the CVWPCC and the JPS connects into the forcemain. As the flow rate through these stations is reasonably high there are options available to provide the necessary discharge pressures, however the selection of options becomes reduced at these pressures, which are estimated to be in the order of 50 to 60 m of pressure. Tunnel sections would need to be reviewed for the financial benefit of installing a twinned system during construction. Risks to future expansion and tunnelling adjacent a critical forcemain would need to be factored into the decision making at the project on-ste. The design of the tunnel forcemain would likely utilize materials not commonly used in Western Canada for sewage infrastructure as the pipe would have to be designed for the installation conditions and the exposure to sewage.
Environmental Considerations	Overland portions routed along existing roadways would have limited environmental impacts. Areas where there are significant adjacent trees could be potentially damaged due to root damage. The deeper tunnel options would likely involve dewatering during installation/construction which may temporarily impact local groundwater wells.
Archaeological Considerations	The intention would be to remain with existing areas of disturbance so no unique archaeological impacts are likely.

Operational Considerations	Maintenance of the higher head pump station would be similar to that of the existing facilities, however there is a reduced selection of pump options. In addition, a typical higher head sewage pump operates at reduced efficiency compared to lower head pumps. Maintenance and repair on the overland forcemain would be completed using well established repair methods based on open excavation. Should a pipe failure occur standard methods of isolation and pumping off-site using a vacuum truck would be employed. There would be no opportunity to undertake maintenance on the tunnel section of pipe and any damage would require a cured-in-place repair technology. This repair cannot be completed while the system is in operation and therefore would necessitate a significant by-pass design to permit the tunnel to be taken off-line.

Infrastructure Elements

Description	Capital Cost	Ivestment Year	Renewal Frequency	Renewal %	Total Power (kW)	Labour hrs/day
New Courtenay - Moderate Pressure Increase	$10,500,000	2020	25	40%	750	3
Downgrade Jane	$2,362,500	2020	25	40%	25	0
New Jane - Moderate Pressure Increase	$3,850,000	2020	25	40%	275	3
Forcemain Tunnel through Lazo hill	$23,587,200	2020	60	100%	0	0
Overland Courtenay to Lazo Hill	$26,999,280	2020	60	100%	0	0
Old Jane to New Jane	$51,744	2020	60	100%	0	0
Overland Lazo Tunnel to CVWPCC	$1,617,000	2020	60	100%	0	0
Total Capital Cost	$68,967,724					

Cost Considerations	This option has moderate initial capital expenditure of $69M, as construction of tunnelled sections caries additional cost as compared to open-cut installation of linear infrastructure. However, the remainder of the alignment construction is mostly completed overland in already-disturbed areas. This option requires the downgrading of the JPS and continued asset maintenance for a total of three pump stations, however the downgraded JPS will require minimal maintenance efforts. There are advantages based on operating cost for this option compared to overland options as it sustains a lower elevation by tunnelling through the height of land at the Lazo Road hills.
Figures	Alignment is provided on Figure 11. Profile is provided on Figure 10-13.

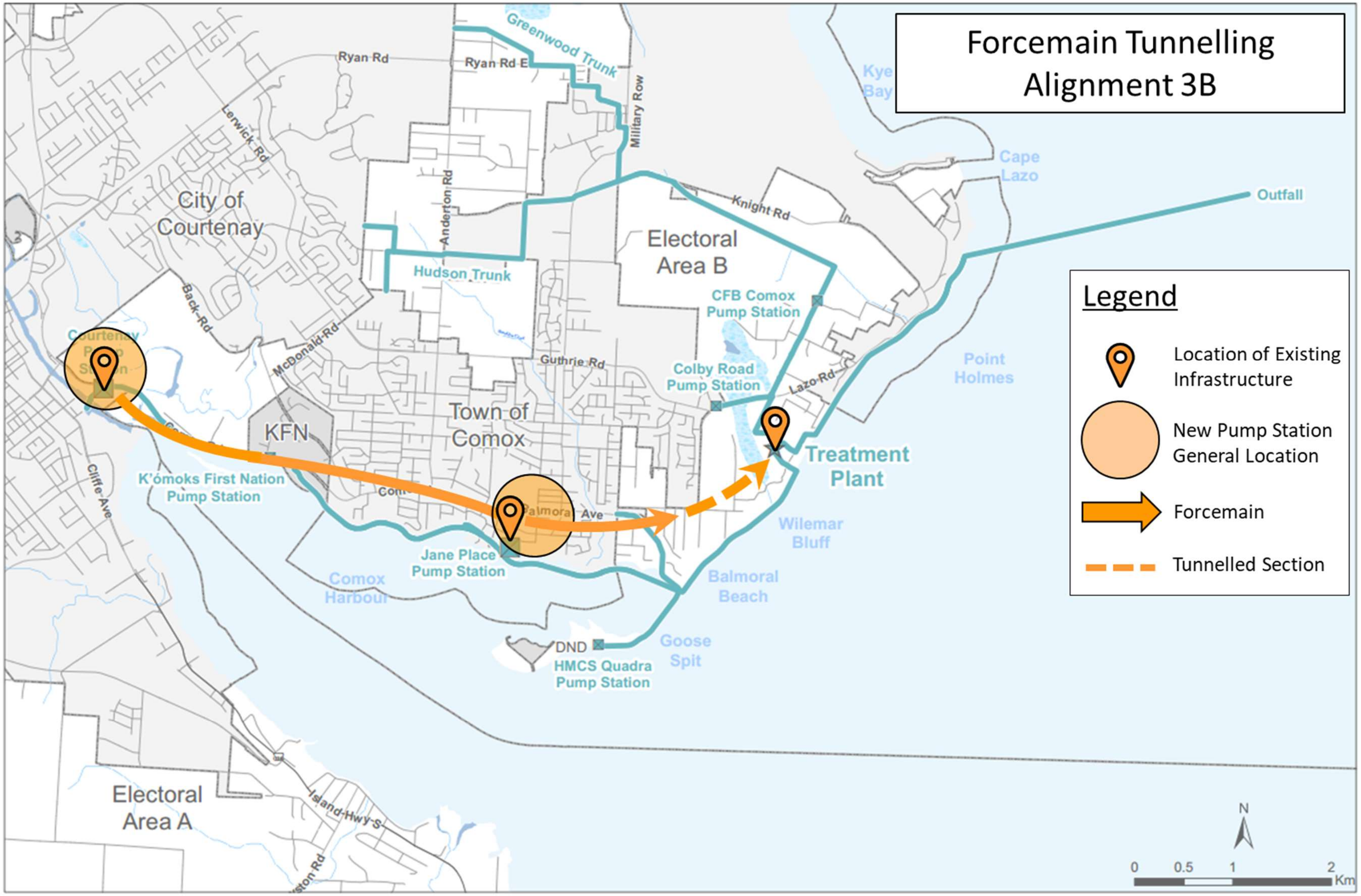


Figure 10-11: Forcemain Tunnelling Alignment 3B

OPTION 3C – GRAVITY TUNNEL FROM COMOX TO THE CVWPCC	
Description:	A new open cut forcemain would be installed from CPS and would continue directly to the CVWPCC such that there is no in-line pump station. To reduce pressures a gravity sewer main tunnel would be used to pass through the Lazo Road height of land. Depending on the tunnel elevation the existing JPS may not require replacement to a high head pump station. The alignment options for the gravity sewer main would be restricted to those which accommodate the required slope. The JPS would connect to the gravity sewer main through a new forcemain. The tie-in location would be governed by the gravity sewer main alignment. In order to maintain the existing JPS hydraulic conditions a tunnel length of around 2,300 m would be required. It is likely that this would necessitate 2 access shafts during construction. Each shaft would be in the order of 15 m and 25 m deep. Detailed analysis during preliminary design would be required to determine the benefit of a minor hydraulic upgrade at the JPS as compared to a tunnel of around 1,500 m with only one access shaft. The overland forcemain would be installed using standard cut-and-cover installation methods with the general intention of following existing roadways. This approach is very common and as such, reasonably well established. Additional complexities would involve relocating existing utilities and restoration of surface roadways, sidewalks and similar features. Due to the nature of sanitary systems the depth of excavation would be set to be below the existing water systems.
Advantages	» No pipe in the estuary mitigating environmental and archaeological risks. » All pipe and structures on-land to maximize maintenance accessibility. » Alleviates some of the high head requirements for the CPS and most of the high head requirements for the JPS as compared to other overland options. » Part of the JPS catchment and the HMCS Quadra outlet could potentially be tied directly into the gravity tunnel.
Disadvantages	» Construction of new conveyance system through an area with significant existing infrastructure. » Gravity sewer main alignment must follow a specific slope which is dependent on the topography. » Gravity sewer mains are nominally larger diameter as compared to forcemains for the same flow.
Technical Consideration	This system would operate similar to the existing configuration where a single forcemain connects the CPS with the CVWPCC and the JPS connects into the forcemain. Significant upgrades to the CPS would be required to overcome the hydraulic pressure of the Comox Road Hill. Between Comox and the Lazo Road Hill the forcemain would transition to a gravity sewer which would connect to the CVWPCC. Design of the gravity sewer would require a minimum slope which can be relatively low due to the large diameter of the pipe, potentially as low as 0.5%. The elevation of the CVWPCC is approximately 12 meters and therefore a 2,300-m gravity sewer would require a tunnel elevation of around 24 meters. Subject to pump selection review, it is possible that the JPS could be upgraded to meet this new discharge pressure within the existing site. The design of the tunnel gravity sewer would likely utilize materials not commonly used in Western Canada for sewage infrastructure as the pipe would have to be designed for the installation conditions and the exposure to sewage.

Environmental Considerations	Overland portions routed along existing roadways would have limited environmental impacts. Areas where there are significant adjacent trees could be potentially damaged due to root damage. The deeper tunnel options would likely involve dewatering during installation/construction which may temporarily impact local groundwater wells.
Archaeological Considerations	The intention would be to remain with existing areas of disturbance, so no unique archaeological impacts are likely.
Operational Considerations	Maintenance of the higher head pump station would be similar to that of the existing facilities, however there is a reduced selection of pump options. In addition, a typical higher head sewage pump operates at reduced efficiency compared to lower head pumps. Maintenance and repair on the overland forcemain would be completed using well established repair methods based on open excavation. Should a pipe failure occur standard methods of isolation and pumping off-site using a vacuum truck would be employed. The gravity tunnel pipe could potentially be repaired using cured-in-place technologies which would utilize robotic tooling to inspect and prepare repair patches. As the gravity pipe has storage capacity very short-term shutdowns could be accommodated in low flow seasons.

Infrastructure Elements

Description	Capital Cost	Investment Year	Renewal Frequency	Renewal %	Total Power (kW)	Labour hrs/day
New Courtenay - Moderate Pressure Increase	$10,500,000	2020	25	40%	750	3
Upgrade Jane (Capacity and AM driven)	$3,150,000	2020	25	40%	275	3
Gravity Tunnel through Lazo hill	$27,800,640	2020	60	100%	0	0
Overland Courtenay to Jane (New or Existing)	$16,493,400	2020	60	100%	0	0
Overland Jane to Lazo Hill	$4,851,000	2020	60	100%	0	0
Jane to forcemain	$1,108,800	2020	60	100%	0	0
Overland Lazo Tunnel to CVWPCC	$1,617,000	2020	60	100%	0	0
Total Capital Cost	$65,520,840					

Cost Considerations	This option has moderate initial capital expenditure of $66M, as construction of tunnelled sections caries additional cost compared to open-cut installation of linear infrastructure. However, the remainder of the alignment construction is mostly completed overland in already-disturbed areas. This option requires the continued asset maintenance for the two existing CPS and JPS. There are advantages based on operating cost for this option as it sustains a relatively low elevation by tunnelling through the height of land at the Lazo Road hills.
Figures	Alignment is provided on Figure 12. Profile is provided on Figure 10-13.

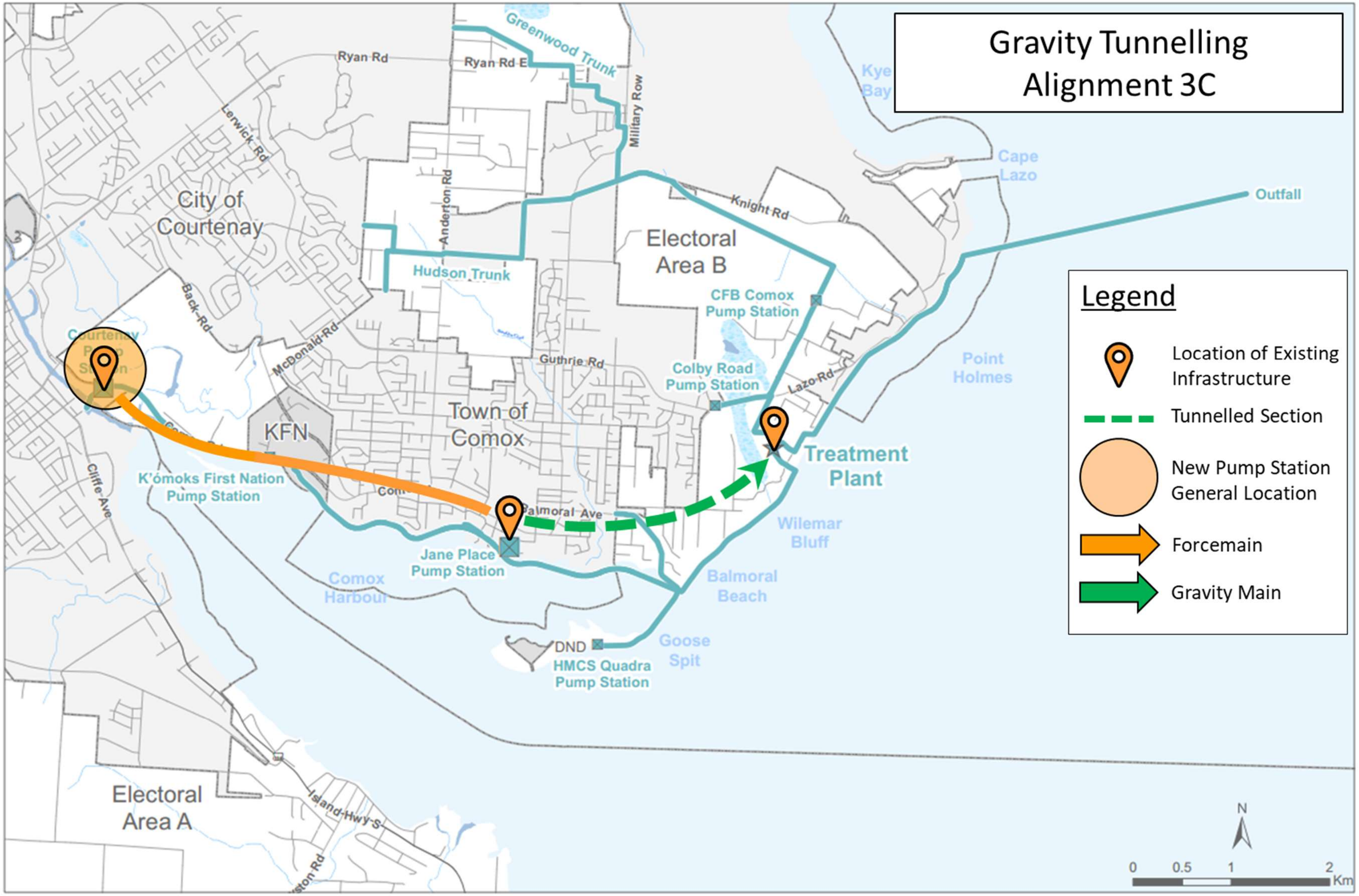
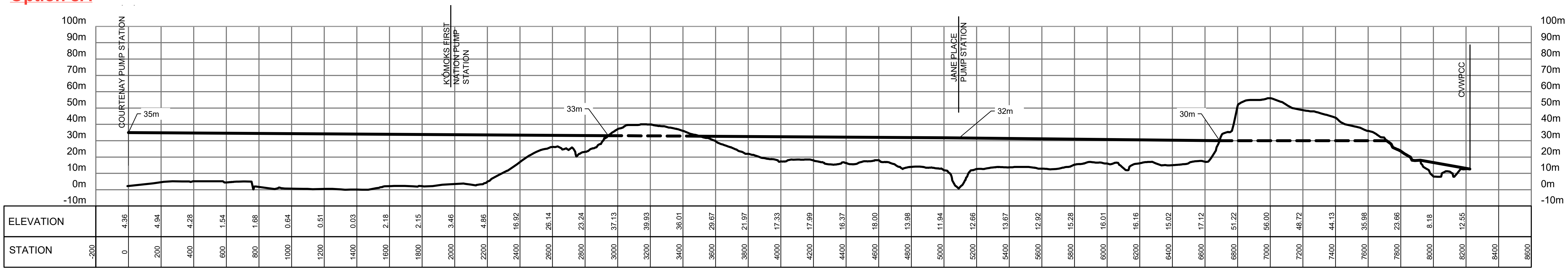
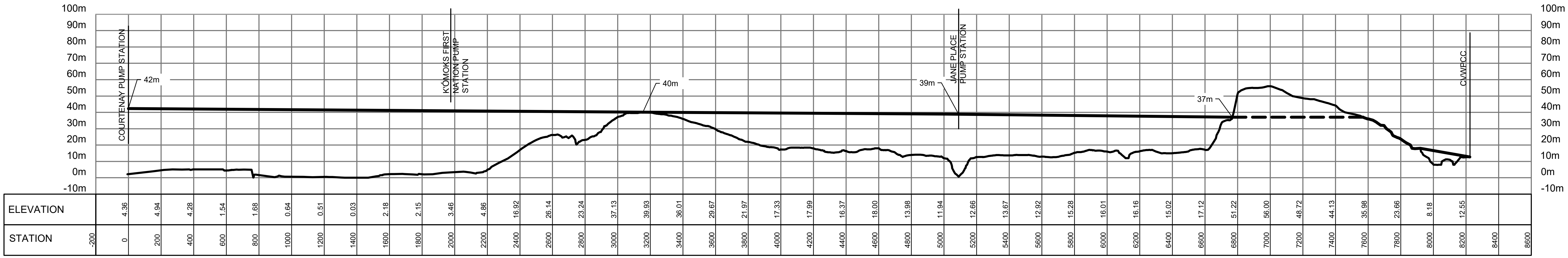


Figure 10-12: Gravity Tunnelling Alignment 3C

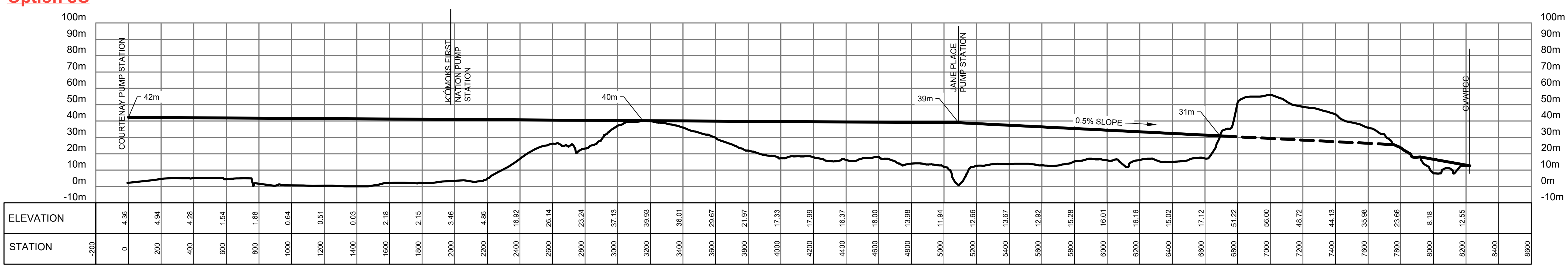
Option 3A



Option 3B



Option 3C



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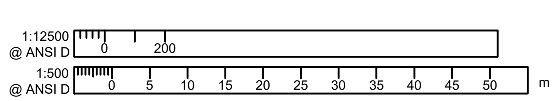

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Figure 10-13: Option 3 Hydraulic Profiles

10.2.4 NORTH SIDE CONCEPTS

OPTION 4A – NORTH SIDE FORCEMAIN CONCEPT	
Description:	In this concept, raw sewage would be pumped from the location of the existing CPS along the north side of the Comox to the CVWPCC. Sewage from the JPS would be conveyed to this north side forcemain at a location west of the Lazo Road hill. A joint forcemain would convey the combined flows from the CPS and JPS to the CVWPCC. CPS would potentially be required to pump sewage to the CVWPCC over the highest elevation of Glacier View Drive hill (El. 73 m) in a forcemain. JPS would be required to pump sewage to the new forcemain between Courtenay and the CVWPCC which would have a hydraulic grade of around 50 to 60 m. The combined forcemain would continue to the CVWPCC along existing roadways or right-of-ways. This option would trigger a high head upgrade at both the CPS and JPS, leading to the requirement for a rebuild of both pump stations. The overland forcemain would be installed using standard cut-and-cover installation methods with the general intention of following existing roadways. This approach is very common and as such, reasonably well established. Additional complexities would involve relocating existing utilities and restoration of surface roadways, sidewalks and similar features. Due to the nature of sanitary systems the depth of excavation would be set to be below the existing water systems.
Advantages	» Only involves 2 large pump stations (JPS repurposed as local facility only) » Pump Stations operating in parallels as opposed to in series, minimizing need for a sophisticated control system. » Avoids construction in the downtown core area, limiting construction impact to areas with less infrastructure development as compared to the downtown core. » No pipe in the estuary mitigating environmental and archaeological risks. » All pipe and structures on-land to maximize maintenance accessibility.
Disadvantages	» Construction for the linear assets required along two separate alignments within the CVSS, increasing construction disturbance. » Operating two partially separate high pressure forcemain networks. » The North Side of Glacier View Drive is at a significant higher elevation than that of the South Side (73 m vs 39 m).
Technical Consideration	The system would operate as two independent systems. The Courtenay pump station would be a high head pump station, in the order of 80 to 100 m pressure, and would likely require a two stage pump configuration which utilizes two standard sewage pumps configured immediately in-line with each other. This approach to sewage conveyance is relatively unique in this market, but not unheard-of. A new right-of-way would be required through the ALR and up to existing roadways. It is unlikely that this system could transition to a gravity system as there is a high point at near the crossing of Prichard Rd. The forcemain from the JPS could be routed up Prithcard Rd to intersect with the Courtenay forcemain or be routed directly to the CVWPCC, with the short alignment likely a connection to the forcemain from Courtenay. Either way the JPS would require a significant upgrade to increase the discharge pressure to around 50 to 60 m hydraulic pressure.

Environmental Considerations	Overland portions routed along existing roadways would have limited environmental impacts. Areas where there are significant adjacent trees could be potentially damaged due to root damage.
Archaeological Considerations	The intention would be to remain with existing areas of disturbance, so no unique archaeological impacts are likely.
Operational Considerations	Maintenance of the higher head pump station would be similar to that of the existing facilities, however there is a reduced selection of pump options. In addition, a typical higher head sewage pump operates at reduced efficiency compared to lower head pumps. Although there would only be 2 pump stations in the system, the Courtenay facility would effectively be two stations in one. Pumps and electrical equipment would be provided in duplicate as two pumps would be operating in-series to meet the operational pressures. As such, the number of pumps and associated equipment in the system would increase from the existing. Maintenance and repair on the overland forcemain would be completed using well established repair methods based on open excavation. Should a pipe failure occur standard methods of isolation and pumping off-site using a vacuum truck would be employed. A benefit of this arrangement is the opportunity to route the new infrastructure along roadways which are not as constrained by traffic and existing infrastructure as would be expected within the higher density areas of Comox.

Infrastructure Elements

Description	Capital Cost	Investment Year	Renewal Frequency	Renewal %	Total Power (kW)	Labour hrs/day
New Courtenay - High Pressure Increase	$29,400,000	2020	25	40%	1250	3
Downgrade Jane	$2,362,500	2020	25	40%	25	0
New Jane - Moderate Pressure Increase	$3,850,000	2020	25	40%	425	3
Overland Jane to connect to FM (Long Distance to North)	$4,804,800	2020	60	100%	0	0
Overland Forcemain North from Courtenay to CVWPCC	$27,489,000	2020	60	100%	0	0
Old Jane to New Jane	$51,744	2020	60	100%	0	0
KFN Pump Station and FM to Courtenay	$616,000	2020	60	100%	0	0
Total Capital Cost	$68,574,044					

Cost Considerations	This option has a moderate initial capital expenditure of $69M as it includes an overall alignment from the CPS to the CVPWCC on the north side, and another alignment from the JPS to the above forcemain. There is also a need for the construction of a new high-pressure CPS and a new moderate-pressure JPS. This option requires the downgrading of the JPS and continued asset maintenance for a total of three pump stations, however the downgraded JPS will require minimal maintenance efforts. There is no operating cost advantage to this option as is requires pumping a significant portion of the Courtenay sewage over the height of land, resulting in significant financial operating costs.
Figures	Concept alignment is provided on Figure 14. Profile is provided on Figure 10-15.

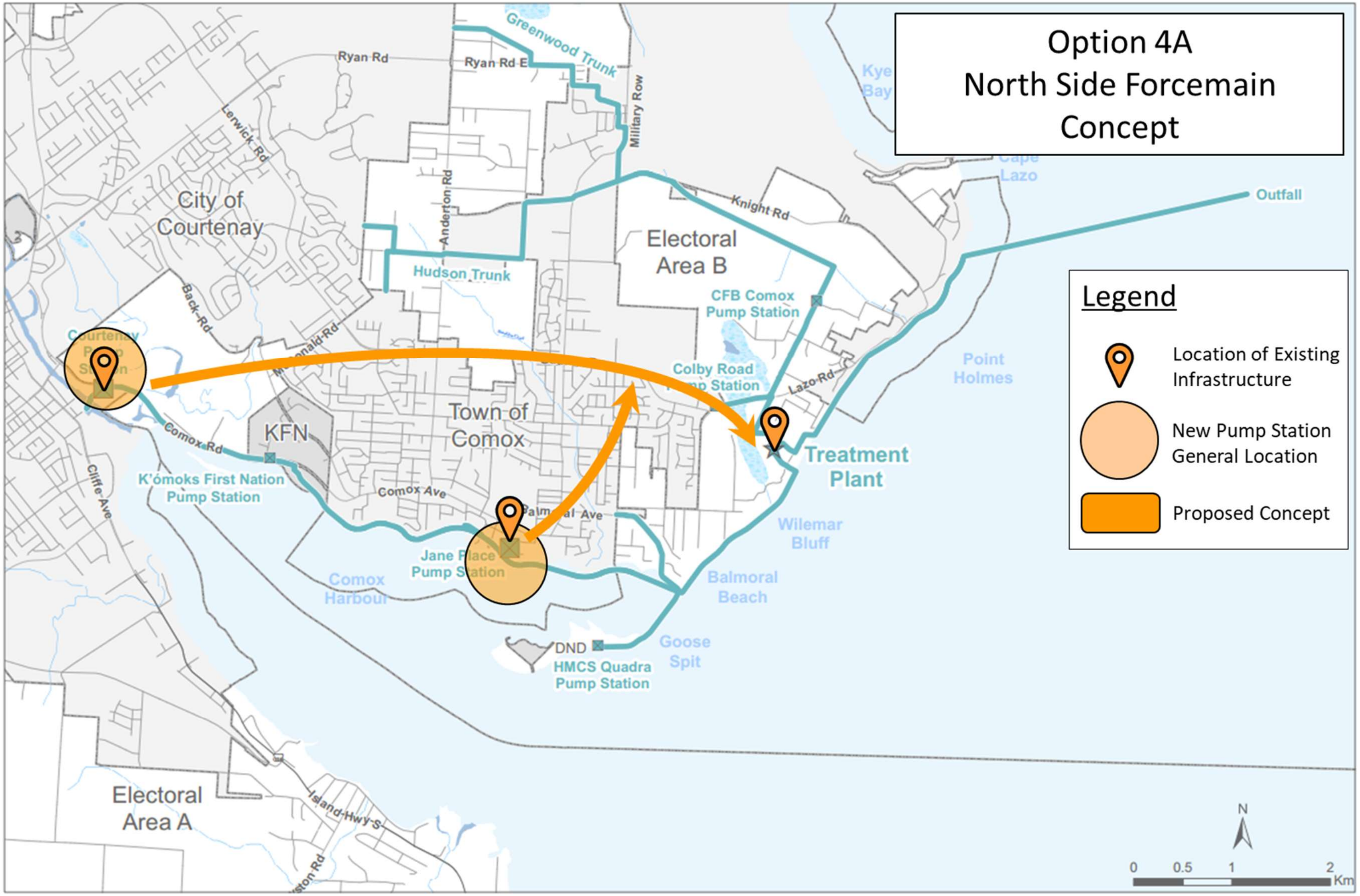
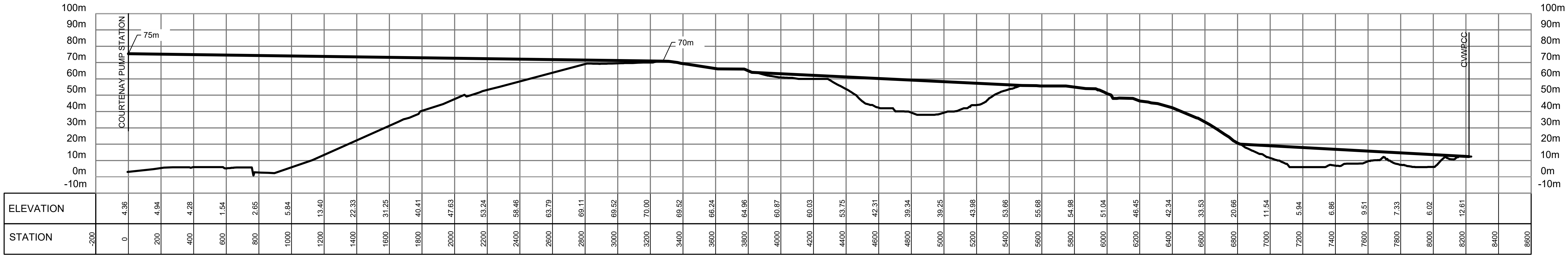
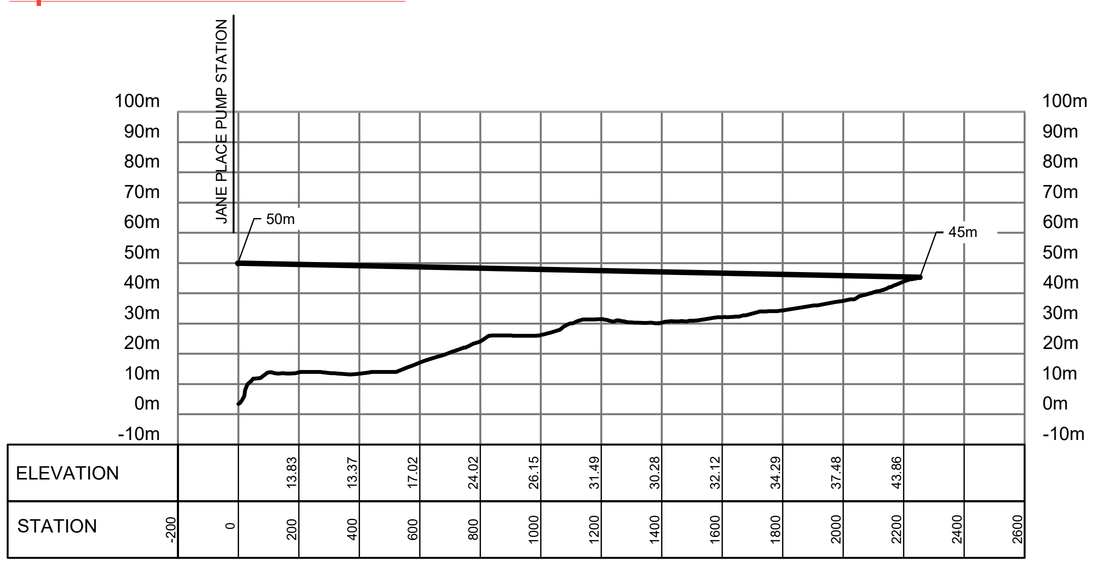


Figure 10-14: North Side Forcemain Concept 4A

Option 4A - North Section



Option 4A - South Section



OPTION 4A
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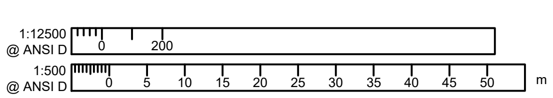

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Figure 10-15: Option 4A Hydraulic Profiles

OPTION 4B – NORTH SIDE GRAVITY CONCEPT	
Description:	In this concept, raw sewage would be pumped from the location of the existing CPS along the north side of the Comox to an alignment parallel with the Hudson Gravity Sewer System. Sewage would gravity flow along this route to the existing CFB pump station. As the CFB pump station does not have adequate capacity to accommodate the CPS flows a new significantly larger facility would be required at this location. From the CFB pump station the sewage would be conveyed to the CVWPCC. CPS would be required to pump sewage to the CVWPCC over the highest elevation of Glacier View Dr hill (El. 73 m) to reach the height of land where it can gravity flow to the CFB pump station. JPS would be required to pump sewage directly to the CVWPCC over Lazo Hill which would have a hydraulic grade of around 50 to 60 m. This option would trigger a high head upgrade at both the CPS and a moderate head upgrade at the JPS, leading to the requirement for a rebuild of both pump stations. The overland forcemain would be installed using standard cut-and-cover installation methods with the general intention of following existing roadways. This approach is very common and as such, reasonable well established. Additional complexities would involve relocating existing utilities and restoration of surface roadways, sidewalks and similar features. Due to the nature of sanitary systems the depth of excavation would be set to be below the existing water systems.
Advantages	» Pump Stations operating independently from each other. » Avoids construction in the downtown core area, limiting construction impact to areas with less infrastructure development as compared to the downtown core. » No pipe in the estuary mitigating environmental and archaeological risks. » All pipe and structures on-land to maximize maintenance accessibility.
Disadvantages	» Construction for the linear assets required along two separate alignments within the CVSS, increasing construction disturbance. » Operating two partially separate high pressure forcemain networks. » The North Side of Glacier View Drive is at a significant higher elevation than that of the South Side (73 m vs 39 m). » A very long conveyance upgrade is required. » Requires a significant upgrade to the CFB pump station and results in 3 large pump stations in the conveyance. CFB is in-line with CPS pump station and would be a significant point of failure.
Technical Consideration	The CPS and JPS system would operate as two independent systems. The Courtenay pump station would be a high head pump station, in the order of 80 to 100 m pressure, and would likely require a two stage pump configuration which utilizes two standard sewage pumps configured immediately in-line with each other. This approach to sewage conveyance is relatively unique in this market, but not unheard-of. A new right-of-way would be required through the ALR and up to existing roadways. It is unlikely that this system could transition to a gravity system as there is a high point at near the crossing of Prichard Rd. The CPS would pump to the CFB pump station which would be in-series and as such would be a risk should the CFB pump station be off-line as it would restrict flow from CPS and the existing Hudson/Greenwood gravity collection system. The forcemain from the JPS could be routed directly to the CVWPCC over Lazo Hill The JPS would require a significant upgrade to increase the discharge pressure to around 50 to 60 m hydraulic pressure.

Environmental Considerations	Overland portions routed along existing roadways would have limited environmental impacts. Areas where there are significant adjacent trees could be potentially damaged due to root damage.
Archaeological Considerations	The intention would be to remain with existing areas of disturbance, so no unique archaeological impacts are likely.
Operational Considerations	Maintenance of the higher head pump station would be similar to that of the existing facilities, however there is a reduced selection of pump options. In addition, a typical higher head sewage pump operates at reduced efficiency compared to lower head pumps. Although there would only be 2 pump stations in the system, the Courtenay facility would effectively be two stations in one. Pumps and electrical equipment would be provided in duplicate as two pumps would be operating in-series to meet the operational pressures. As such, the number of pumps and associated equipment in the system would increase from the existing. Maintenance and repair on the overland forcemain would be completed using well established repair methods based on open excavation. Should a pipe failure occur standard methods of isolation and pumping off-site using a vacuum truck would be employed. A benefit of this arrangement is the opportunity to route the new infrastructure along roadways which are not as constrained by traffic and existing infrastructure as would be expected within the higher density areas of Comox.

Infrastructure Elements

Description	Capital Cost	Investment Year	Renewal Frequency	Renewal %	Total Power (kW)	Labour hrs/day
New Courtenay - High Pressure Increase	$29,400,000	2020	25	40%	1250	3
Downgrade Jane	$2,362,500	2020	25	40%	25	0
New Jane - Moderate Pressure Increase	$3,850,000	2020	25	40%	425	3
Overland Jane to connect to FM (Long Distance to North)	$4,804,800	2020	60	100%	0	0
Overland Gravity North from Courtenay to CVWPCC	$38,962,000	2020	60	100%	0	0
Old Jane to New Jane	$51,744	2020	60	100%	0	0
KFN Pump Station and FM to Courtenay	$616,000	2020	25	40%	25	0
New CFB Pump Station	$3,920,000	2020	25	40%	225	2
Total Capital Cost	$83,967,044					

Cost Considerations	This option has a significant initial capital expenditure of $84M as it follows the longest conveyance route between the CPS and the CVWPCC. In addition, it requires the CFB Pump station to be upgraded to pass the CPS flows, resulting in a 3rd large pump station. The Hudson and Greenwood collection system is not sized to accommodate all the Courtenay flows and therefore would need to be twinned. There is no operating cost advantage to this option as is requires pumping a significant portion of the Courtenay sewage over the height of land, resulting in significant financial operating costs. Furthermore, all the CPS flows are re-pumped at the CFB pump station.
Figures	Concept alignment is provided on Figure 16. Profile is provided on Figure 10-17.

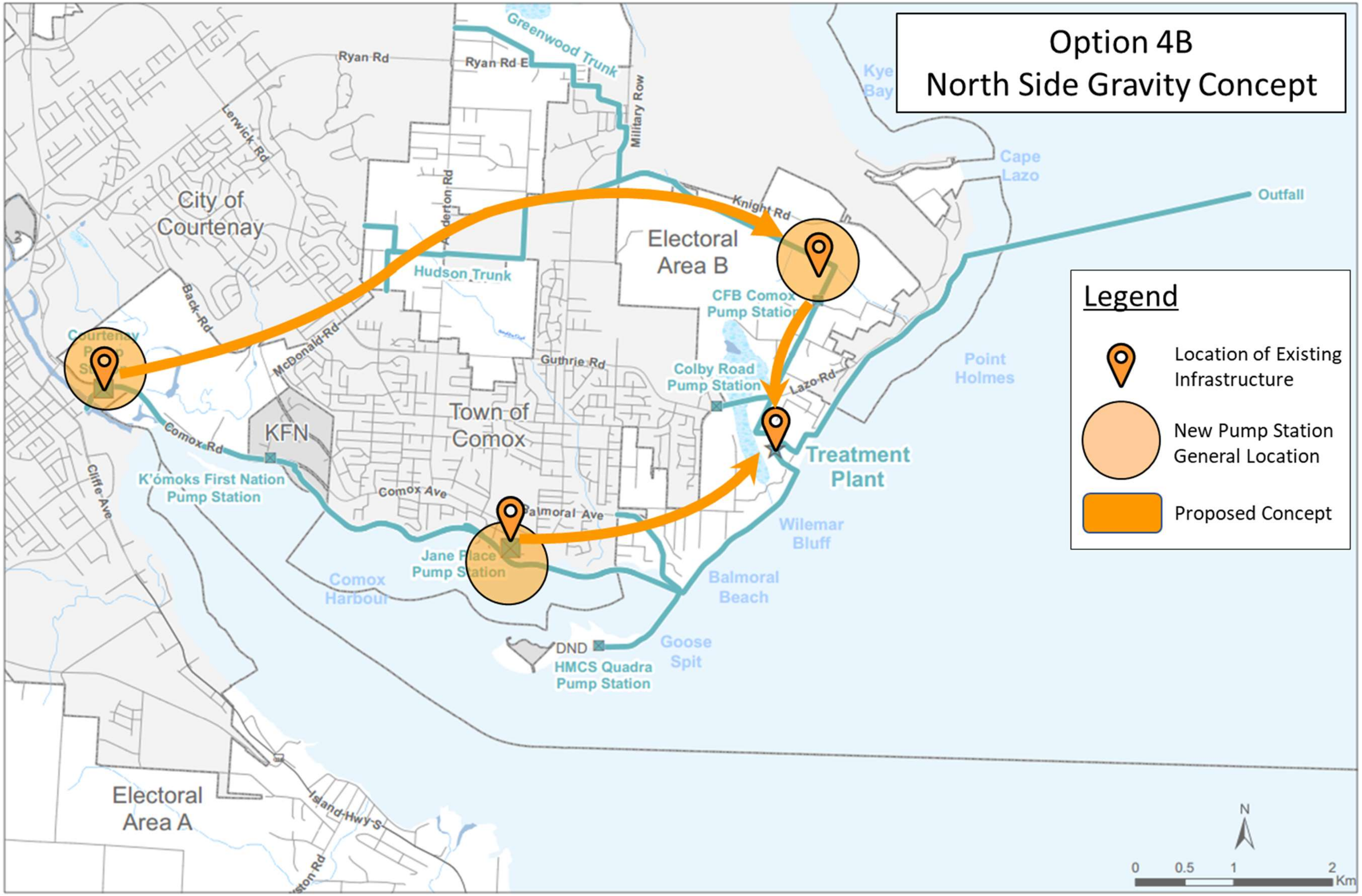
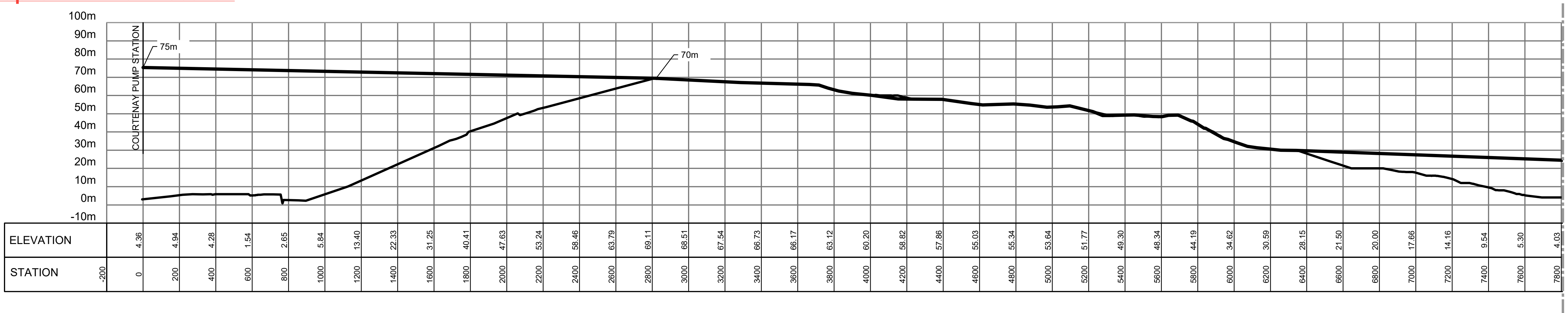
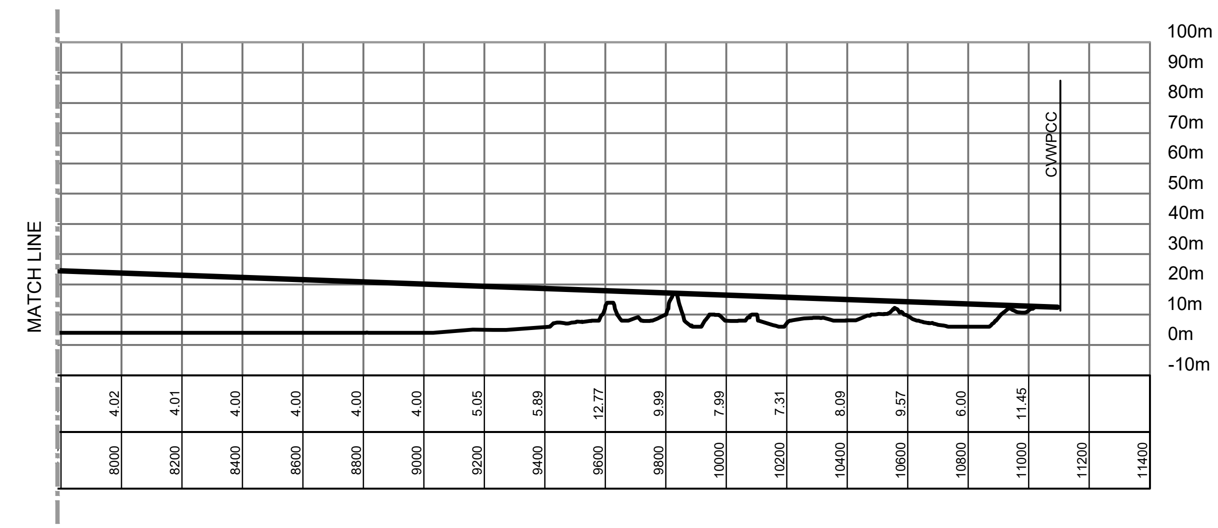


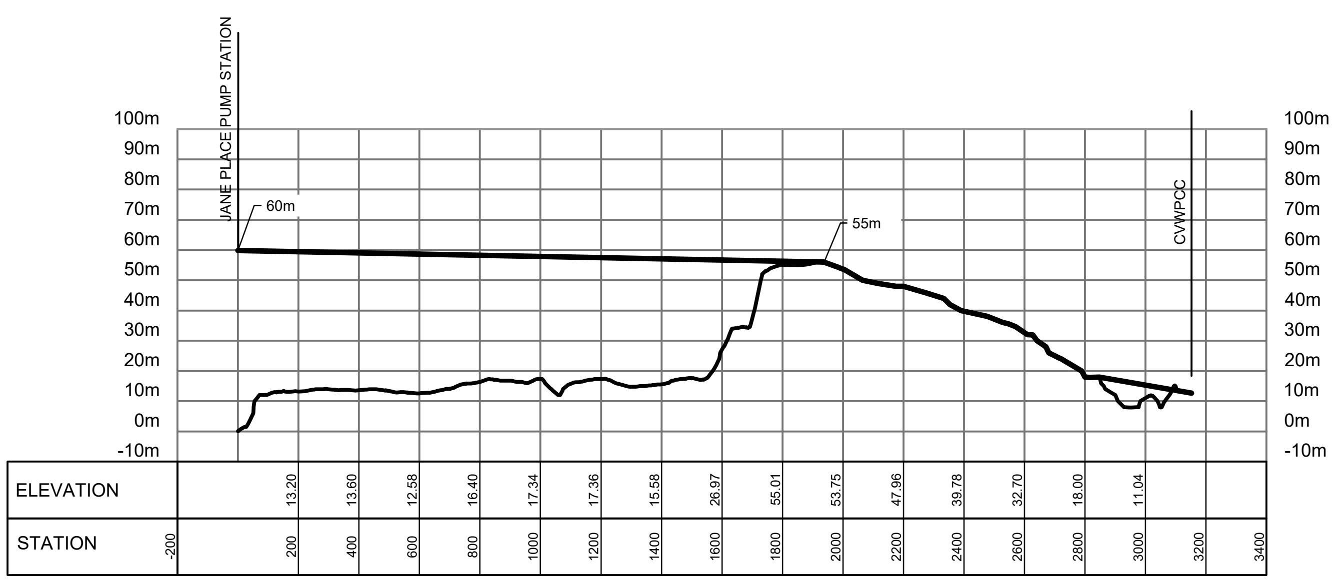
Figure 10-16: North Side Gravity Concept 4B

Option 4B - North Section





Option 4B - South Section



OPTION 4B

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PROFILE BETWEEN CH: -200.00 AND 3400.00

1:12500(H) 1:1250(V) AT A1

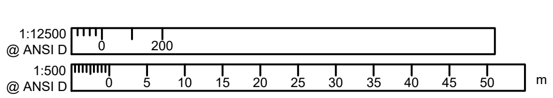

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Figure 10-17: Option 4B Hydraulic Profiles

10.2.5 DECENTRALIZED TREATMENT CONCEPT

OPTION 5 – DECENTRALIZED TREATMENT

Description:	In this option, an additional wastewater treatment plant would be constructed in close proximity to the location of the existing Courtenay PS to treat the sewage collected and currently conveyed by the Courtenay PS. Due to the location of the outfall, the effluent of a decentralized wastewater treatment plant would have to be conveyed to the location of the existing outfall for discharge. Alignments for the conveyance of the effluent discharge are similar to those discussed within Options 1, 2, 3 and 4, and include estuary, overland, tunnelled, and north side alignments. The sewage collected at the JPS will be conveyed to the existing CVWPCC for treatment using an overland or tunnelled option. Overland options would still require a new pump station for the JPS, and subject to the length and depth of the tunnelled option a new pump station in Comox maybe required.
Advantages	» Eliminates the need for conveyance of Courtenay's raw sewage through the CVSS to the CVWPCC » Alleviate capacity-driven upgrade requirements at the CVWPCC.
Disadvantages	» Requires the need for conveyance of the decentralized Wastewater Treatment Plant (WWTP) effluent to the outfall using a new pumping and conveyance system. » Significant operational burden with two wastewater treatment plants. » Significant cost associated with the construction of a new wastewater treatment plant, and maintenance and operation of two plants. » Still requires conveyance of raw sewage overland from Comox.
Technical Consideration	Even following treatment of the sewage, the effluent would need to be discharged to the existing outfall as it is not an option to discharge treated effluent within the embayed waters around Comox. As a result, an effluent pipe would have to be routed from the CPS to the CVWPCC. This effluent would be a unique fluid (i.e.: not potable water, storm water or sewage) and as such could not be integrated with any existing system in the Comox area. Once the effluent is at the CVWPCC site it would by-pass the treatment plant and combine with the CVWPCC effluent. By removing a major portion of the sewage from the existing CVWPCC the existing plant would likely be rendered oversized and could result in a reduction in treatment efficiency and performance. Locating a new treatment plant in the general area of the CPS would be a significant challenge as this would have a very large footprint and need to be designed to address all future sewage flows in the catchment area. Once the effluent has been treated a high pressure effluent pump station would be required to convey the effluent. The ground elevation at a potential WWTP site would potentially be exposed to sea-level rise and storm surges.

Environmental Considerations	Overland portions routed along existing roadways would have limited environmental impacts. Areas where there are significant adjacent trees could be potentially damaged due to root damage. Depending on the exact location, new WWTP would result in a loss of land around the ALR and the associated habitat in the area.
Archaeological Considerations	Depending on the exact location of the new WWTP, and the alignment associated with the effluent conveyance, there can moderate to high potential of encountering known or unknown archeological sites in this general area. Construction of new infrastructure along existing areas of disturbance will minimize risk of archaeological impacts.
Operational Considerations	Operation of a second CVWPCC would be required and would not be suitable for overlap of many operational resources. Staff would be required at both sites and treatment systems would be duplicated, resulting a loss of efficiency associated with system maintenance. Solids handling and disposal would have to occur at two locations, rather than at one centralized site. There would be limited reduction in overall power requirements as a pump station is still required to convey treated effluent to the CVWPCC. A minor increase in pump efficiency would be achieved as a pump suitable for treated effluent will be more efficient than a raw sewage pump.

Infrastructure Elements

Description	Capital Cost	Investment Year	Renewal Frequency	Renewal %	Total Power (kW)	Labour hrs/day
New Courtenay - High Pressure Increase	$29,400,000	2020	25	40%	900	3
Downgrade Jane	$2,362,500	2020	25	40%	25	0
New Jane - Moderate Pressure Increase	$3,850,000	2020	25	40%	425	3
Overland Jane to connect to FM (Long Distance to North)	$4,804,800	2020	60	100%	0	0
Overland Forcemain North from Courtenay to CVWPCC	$27,489,000	2020	60	100%	0	0
New Courtenay WWTP	$105,000,000	2020	100	100%	2000	24
Old Jane to New Jane	$51,744	2020	60	100%	0	0
KFN Pump Station and FM to Courtenay	$616,000	2020	60	100%	0	0
Total Capital Cost	$173,574,044					

Note that Total Power for the New Courtenay WWTP is not necessarily representative of the expected total power required for the facility. The value of 2000 kW has been used such that it accounts for a number of various Operations and Maintenance cost categories that are not built into the cost model and are difficult to individually account for.

Cost Considerations	This option has a significant initial capital expenditure of $174M, approximately double the average capital cost for all other options considered. This cost is driven by the need for construction of an additional WWTP in Courtenay. There is no operating cost advantage to this option as is requires the operation of an additional WWTP, including additional power requirements and labor. Also, depending on the alignment for the effluent conveyance (assumed a North side alignment similar to 4A in this case), the high pumping head requirement for conveyance of effluent can result in significant financial operating costs.
Figures	Concept alignment is provided on Figure 18. Profiles are not provided as the alignment will follow a combination of the alignments presented under one of options 1,2, 3, or 4.

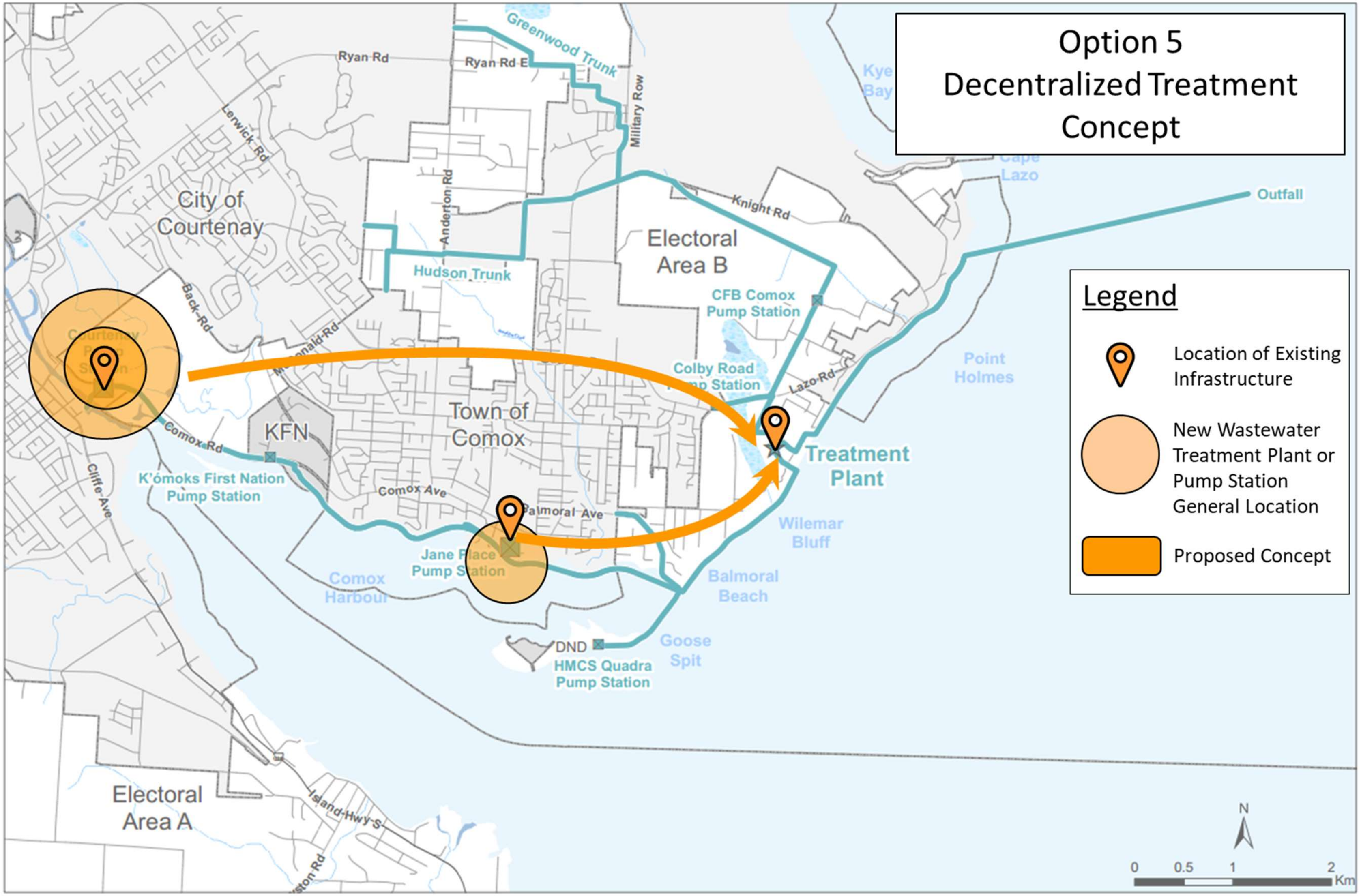

Figure 10-18: Decentralized Treatment Concept 5

10.2.6 OPTIONS FINANCIAL SUMMARY

Table 10-2 shows the summary of the infrastructure components that are applicable to each of the alignment and concept options presented in this section, as well as the approximate capital cost associated with each item. The costs presented in this report do not include GST. These costs are only for the purpose of options comparison and discussion and are not suitable for budgeting.

Table 10-2: Infrastructure Components' Capital Cost

Description	Class 'D' Cost 2019$	Alignments and Conveyance Concepts										
	40% Contingency	1A	1B	1C	2A	2B	3A	3B	3C	4A	4B	5
Upgrade Courtenay (Capacity and AM driven)	$ 4,200,000			•								
New Courtenay - Moderate Pressure Increase	$ 10,500,000	•	•		•	•	•	•	•			
New Courtenay - High Pressure Increase	$ 29,400,000									•	•	•
Upgrade Jane (Capacity and AM driven)	$ 3,150,000			•		•			•			
New Jane - Moderate Pressure Increase	$ 3,850,000	•	•		•		•	•		•	•	•
Downgrade Jane	$ 2,363,000	•	•		•		•	•		•	•	•
New In-line Pump Station	$ 12,040,000			•		•						
Forcemain Tunnel through Lazo hill	$ 23,587,000	•					•	•				
Forcemain Tunnel through Comox hill	$ 11,735,000						•					
Gravity Tunnel through Lazo hill	$ 27,801,000								•			
Overland from Comox hill to Lazo hill	$ 10,977,000						•					
Overland Courtenay to Lazo Hill	$ 26,999,000					•		•				
Overland Courtenay to Jane (New or Existing)	$ 16,493,000				•				•			
Overland Jane to Lazo Hill	$ 4,851,000				•				•			
Overland Jane to connect to FM (Long Distance to North)	$ 4,805,000									•	•	•
Overland Lazo Hill to CVWPCC	$ 5,914,000		•	•	•	•						
Overland Forcemain North from Courtenay to CVWPCC	$ 27,489,000									•		•
Overland Gravity North from Courtenay to CVWPCC	$ 38,962,000										•	
Estuary Courtenay to Jane	$ 32,728,000		•									
Estuary Courtenay to Lazo Hill	$ 38,133,000	•		•								
New Courtenay WWTP	$ 105,000,000											•
Jane to forcemain	$ 1,109,000	•	•	•	•		•		•			
Old Jane to New Jane	$ 52,000		•					•		•	•	•
Overland Courtenay to CVWPCC (Excl. Tunnel Sections)	$ 15,847,000						•					
Overland Lazo Tunnel to CVWPCC	$ 1,617,000							•	•			
KFN Pump Station and FM to Courtenay	$ 616,000									•	•	•
New CFB Pump Station	$ 3,920,000										•	

Table 10-4 on the following page shows the 30, 50, and 100-year Net Present value (NPV) for all alignments options and conveyance concepts discussed in this report. The NPV is representative of the capital cost, asset management cost, and operations and maintenance costs (inclusive of power and labour). The parameters used in calculating the NPV are shown in Table 10-3.

Table 10-3: NPV Calculations Parameters

Parameter	Value	Unit
15-yr Municipal Finance Authority (MFA) Long-Term Lending Rate	3.05	%
15-yr Engineering News-Record (ENR) Construction Index	3.02	%
Starting Power Cost	11.21	$/kW-hr
Power Rate Increase	5	%
Operating hrs/day	12	hr
Variable Rate	0.055	$/kW-hr
Labour Rate	100,000	$/yr
Labour Inflation	3	%

Table 10-4: Options Net Present Value

Option ID	Options Description	Initial Capital Cost	30-Year			50-Year			100-Year		
			Capital	O&M	Total	Capital	O&M	Total	Capital	O&M	Total
1A	Estuary With Lazo Hill Tunnel	$ 79.5	$ 86.1	$ 14.9	$ 100.9	$ 92.7	$ 29.4	$ 122.1	$ 167.4	$ 97.4	$ 264.8
1B	Estuary with Lazo Hill Overland Route	$ 56.5	$ 63.2	$ 24.3	$ 87.5	$ 69.8	$ 48.5	$ 118.3	$ 121.9	$ 164.9	$ 286.8
1C	Estuary with a New In-Line Pump Station	$ 64.5	$ 72.1	$ 25.8	$ 97.9	$ 79.8	$ 51.1	$ 130.9	$ 139.2	$ 171.1	$ 310.3
2A	Overland Forcemain	$ 45.1	$ 51.7	$ 23.3	$ 75.0	$ 58.4	$ 46.4	$ 104.8	$ 99.3	$ 157.4	$ 256.7
2B	Overland Forcemain with In-Line Pump Station	$ 58.6	$ 68.7	$ 33.1	$ 101.8	$ 74.7	$ 66.0	$ 140.7	$ 127.1	$ 223.5	$ 350.6
3A	Tunnel Through Comox Hill and Lazo Hill	$ 80.0	$ 86.6	$ 14.9	$ 101.5	$ 93.2	$ 29.4	$ 122.6	$ 168.4	$ 97.4	$ 265.8
3B	Tunnel Through Lazo Hill	$ 69.0	$ 75.6	$ 17.0	$ 92.6	$ 82.2	$ 33.6	$ 115.8	$ 146.6	$ 112.4	$ 259.0
3C	Gravity Tunnel From Comox to the CVWPCC	$ 65.5	$ 70.9	$ 16.6	$ 87.6	$ 76.4	$ 32.9	$ 109.3	$ 138.0	$ 109.9	$ 247.9
4A	North Side Forcemain Concept	$ 68.6	$ 82.7	$ 26.0	$ 108.8	$ 96.8	$ 52.1	$ 148.9	$ 157.0	$ 177.4	$ 334.4
4B	North Side Gravity Concept	$ 84.0	$ 99.9	$ 30.3	$ 130.2	$ 115.8	$ 60.4	$ 176.2	$ 190.2	$ 204.8	$ 395.0
5	Decentralized Treatment Concept	$ 173.6	$ 187.7	$ 58.3	$ 246.0	$ 201.8	$ 114.0	$ 315.8	$ 364.0	$ 371.9	$ 735.9

For ease of comparison, the following colour gradient has been used in Table 10-4. The highest cost in each column is shown in red (right of the color gradient), and the lowest cost in each column is shown in green (left of the colour gradient), with the in-between values shown in the respective colour along the gradient.

Minutes of the meeting of the Liquid Waste Management Plan (LWMP) Technical Advisory Committee (TAC) Meeting #6A held on Thursday, March 21, 2019 at the Comox Valley Regional District (CVRD) Boardroom, commencing at 9:00am.

PRESENT:		
	P. Nash, LWMP Project Coordinator	
	K. La Rose, Senior Manager of Water/Wastewater	CVRD
	M. Imrie, Manager of Wastewater Services	CVRD
	A.Idris, Engineering Analyst	CVRD
	W. Bayless	WSP
	C. McColl, K'ómoks First Nation	PAC/TAC
	R. O'Grady, City of Courtenay Engineering	TAC
	S. Ashfield, Town of Comox Engineering	TAC
	G. Bonekamp, Department of National Defence	TAC

ITEM	DESCRIPTION	OWNER
6A.1	Call to Order Meeting was called to order at 9:00am	Kris La Rose
6A.2	Purpose of Meeting • Kris explained that the purpose of this meeting is to have an in- depth discussion and evaluation of the technical aspects of the options. The results will be presented and explained to the TACPAC the next day, prior to the TACPAC scoring the remaining categories.	Kris La Rose

6A.3	Conveyance Long List Options
	• Walt gave a presentation and review of conceptual studies of conveyance options.
	• Explanation of:
	  o Major assumptions.
	  o The workings of the cost model.
	  o GHG estimations.
	  o Local content.
	• A sensitivity analysis was performed by changing some of the model parameters and observing the resulting differences in capital and short and long term operating costs. Parameters varied included:
	  o Energy prices.
	  o Energy consumption (by changing pump running hours).
	  o Unit costs for estuary work.
	  o Discount rate.
	• It was noted that the same four options, 2A, 3A, 3B and 3C, seemed to stay at the top of the NPV rankings in all cases, though the order within the top for might change.
		Walt Bayless

ITEM	DESCRIPTION	OWNER
6A.4	Evaluation of Technical Criteria A live spreadsheet of the evaluation system was used and the TAC members progressively scored each goal for all the options and then moved on to the next goal. Scoring was done by first comparing the major components of the various options, number of pump stations, lengths of pipe, etc. and some of the operational attributes that go with them. For each evaluation goal, there was a discussion on the major pros and cons of the options as they relate to the goal in question, putting some plus and minus values to the attributes, and then creating a scoring logic to get the scores from zero to five. It was noted that this was still a subjective process and the logic is still a guide. The final scores agreed upon did not always fit formulaically with the scoring logic. The scoring tables and the scoring logic are attached as Schedule A, and the final scoring is summarized below. (Color scale - green boxes = best; yellow/orange = intermediate; pink = worst)	Paul Nash

Goal	Resilience to External Factors	Resilience to Internal Factors	Long Term Solution	Flexibility to accommodate future changes	*Total*
Weight %	**15%**	**15%**	**10%**	**5%**	***45%***
Opt. 1A	6.0	6.0	5.0	1.0	***18.0***
1B	4.5	6.0	5.0	1.0	***16.5***
1C	3.0	3.0	4.0	0.0	***10.0***
2A	10.5	9.0	5.0	3.0	***27.5***
2B	9.0	3.0	4.0	2.0	***18.0***
3A	13.5	10.5	6.0	2.0	***32.0***
3B	12.0	10.5	6.0	2.5	***31.0***
3C	15.0	12.0	6.0	4.0	***37.0***
4A	9.0	6.0	5.0	2.0	***22.0***
4B	7.5	3.0	4.0	2.5	***17.0***
5	0.0	0.0	4.0	5.0	***9.0***

The major findings from the technical evaluation were:

- The estuary options are most vulnerable to climate change and sea level rise. Even though they are installed in the intertidal zone, a sufficient sea level rise would make them permanently submerged which would make repairs and future twinning very difficult.
- The inline pump stations were very undesirable from an operational point of view.
- The tunnel options are operationally desirable as they result in lower pumping pressures and avoid the need for a third pump station.
- The north side concepts as presented, were undesirable primarily because of the very high pumping head at the Courtenay Pump Station.

ITEM	DESCRIPTION	OWNER
	• The decentralized treatment concept was very undesirable and created a large increase in operational complexity. It was acknowledged that it also created the greatest increase in future flexibility. • There was little separating the options for long term value as all the linear components have a 60 year design life. There is the possibility to reline a tunnel. The pump stations have a 25 year life, and options involving a third pump station were score slightly lower for this reason.	
6A.5	Evaluation of Affordability Criteria The minimize lifecycle cost criteria was scored based on the 50 year net present value for all of the options. The 30 year period was deemed to be too short, and the 100 year period was felt to be too long. There was some discussion that a 60 year period would be ideal, as it coincided with the design life of the components, and this was suggested for the detailed study stage. It was initially intended to score the lowest cost option as five and the highest as zero, and pro-rate the remainder. However, the decentralised treatment option, at more than twice the cost of any other, compresses all the other scores such that there is little to separate them. The approach proposed by the project coordinator was to score the second highest cost option (4B) as zero, pro-rate all the others, and allow the decentralized option to go to a negative score, and this approach was agreed upon by the TAC. The second affordability criteria of long term value was scored using the same scores as derived for the technical goal of long term solution. The final scoring for the affordability category is summarized below.	Paul Nash

Goal	Minimize Lifecycle Cost	Long term Value	Total
Weight %	**14%**	**4%**	**18%**
Opt. 1A	10.6	2.0	**12.6**
1B	11.4	2.0	**13.4**
1C	8.9	1.6	**10.5**
2A	14.0	2.0	**16.0**
2B	7.0	1.6	**8.6**
3A	10.5	2.4	**12.9**
3B	11.8	2.4	**14.2**
3C	13.1	2.4	**15.5**
4A	5.4	2.0	**7.4**
4B	0.0	1.6	**1.6**
5	-27.4	1.6	**-25.8**

ITEM	DESCRIPTION	OWNER
6A.6	Round Table and Issues for Discussion at TACPAC Meeting The general consensus of the main outcomes was: • Some surprise at how poorly the estuary options fared on the cost modelling. It was not expected that estuary construction would be as expensive as it is, and the estuary options still required medium pressure pumping upgrades. • No surprise that the options with an inline pump station fared poorly on the technical evaluation, as they make any option more complex to operate and heighten the risks and consequences of a failure. • No surprise that the decentralized treatment option came out the lowest ranking as it is a very complex solution to a conveyance problem. • The tunnel options look good on paper, but more information is needed to assess geotechnical risk, and on the legal issues about underground rights of way. Overall it was felt that the TAC session had been very worthwhile and all members were supportive of doing the same again for evaluation of the shortlisted options. There were no specific issues raised for consideration at the TACPAC meeting.	
6A.7	Adjournment The meeting adjourned at 12:00 pm	

Attachments:
Schedule A –Detailed Evaluation Results for Technical and Affordability Categories.

SCHEDULE A: EVALUATION RESULTS

EVALUATION SYSTEM DESCRIPTION

Category	Goal	Description, Comment	Scored by	Weight %
Technical	Resilience to External Factors	Includes climate change, natural disasters, seasonal impact	TAC	15%
	Resilience to Internal Factors	Operational simplicity and reliability, minimize risk of failure	TAC	15%
	Long Term Solution	Provides asset life, and possibly capacity, beyond the minimum planning horizon.	TAC	10%
	Flexibility to accommodate future changes	Technical Consultants to elaborate	TAC	5%
Technical Total				**45%**
Affordability	Minimize Lifecycle Cost	Net present value of capital, operational and replacement cost, period is to the planning horizon	CVRD	14%
	Long term Value	Provides asset life and capacity beyond the design planning horizon	TAC	4%
Affordability Total				**18%**
Grand Total				**63%**

Evaluation Results for Conveyance Options, Technical and Affordability Categories
(Color scale: green boxes = best; yellow/orange = intermediate; pink = worst)

Category	Goal	Weight %	1A	1B	1C	2A	2B	3A	3B	3C	4A	4B	5
Technical	Resilience to External Factors	15%	6.0	4.5	3.0	10.5	9.0	13.5	12.0	15.0	9.0	7.5	0.0
	Resilience to Internal Factors	15%	6.0	6.0	3.0	9.0	3.0	10.5	10.5	12.0	6.0	3.0	0.0
	Long Term Solution	10%	5.0	5.0	4.0	5.0	4.0	6.0	6.0	6.0	5.0	4.0	4.0
	Flexibility to accommodate future changes	5%	1.0	1.0	0.0	3.0	2.0	2.0	2.5	4.0	2.0	2.5	5.0
Technical Total		***45%***	***18.0***	***16.5***	***10.0***	***27.5***	***18.0***	***32.0***	***31.0***	***37.0***	***22.0***	***17.0***	***9.0***
Affordability	Minimize Lifecycle Cost	14%	10.6	11.4	8.9	14.0	7.0	10.5	11.8	13.1	5.4	0.0	-27.4
	Long term Value	4%	2.0	2.0	1.6	2.0	1.6	2.4	2.4	2.4	2.0	1.6	1.6
Affordability Total		***18%***	***12.6***	***13.4***	***10.5***	***16.0***	***8.6***	***12.9***	***14.2***	***15.5***	***7.4***	***1.6***	***-25.8***
Grand Total		**63%**	**30.6**	**29.9**	**20.5**	**43.5**	**26.6**	**44.9**	**45.2**	**52.5**	**29.4**	**18.6**	**-16.8**

Category	Technical											
Item	**Analysis**	**1A**	**1B**	**1C**	**2A**	**2B**	**3A**	**3B**	**3C**	**4A**	**4B**	**5**
Major Components (Construction and Operation)	km of estuary pipe	6.5	5.0	6.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	km of overland forcemain	0.6	2.3	2.2	8.8	8.2	7.1	7.2	7.7	13.2	15.7	13.2
	km of tunnel	0.6	0.0	0.0	0.0	0.0	1.7	1.1	1.1	0.0	0.0	0.0
	Tunnel shafts	3	0	0	0	0	5	3	3	0	0	0
	Total large pump stations	2	2	3	2	3	2	2	2	2	3	2
	Total WWTP's	1	1	1	1	1	1	1	1	1	1	2
Construction Impacts	Avoid estuary	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y
	Avoid new pump station site	N	N	N	N	N	N	N	?	N	N	N
	Avoid road disturbance in central Comox	Y	Y	Y	N	N	N	N	N	N	N	N
	Avoid road disturbance in Lazo Hill	Y	N	N	N	N	Y	Y	Y	Y	N	N
	Avoid additional WWTP site	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N
	Avoid new KFN pump station	Y	Y	Y	Y	Y	Y	Y	Y	N	N	N
Operational Impacts	Avoid third large pump station	Y	Y	N	Y	N	Y	Y	Y	Y	N	Y
	Avoid critical failure point (overflow risk)	Y	Y	N	Y	N	Y	Y	Y	Y	Y	Y
	Avoid additional WWTP	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N

Evaluation by TAC												
Goal	**Description**	**1A**	**1B**	**1C**	**2A**	**2B**	**3A**	**3B**	**3C**	**4A**	**4B**	**5**
Resilience to External Factors	Includes climate change, natural disasters, seasonal impact	2	1.5	1	3.5	3	4.5	4	5	3	2.5	0
Scoring Logic	**Full marks for gravity tunnel as it is most resistant to earthquakes, score zero for second WWTP, as it is vulnerable to almost everything. Deductions for longer forcemains (earthquake risk) and -2 for Estuary options (sea level rise), -1 for in-line pump station (any disturbance will have consequences magnified). No specific seasonal impacts identified for any option.**											
Weight	15%	6	4.5	3	10.5	9	13.5	12	15	9	7.5	0
Resilience to Internal Factors	Operational simplicity and reliability, minimise risk of failure	2	2	1	3	1	3.5	3.5	4	2	1	0
Scoring Logic	**Gravity tunnels scores best, but not full marks as it still involves pump stations and forcemains. Zero for second WWTP, as adds great complexity, -2 for Inline pump stations for risk factor, -1 for long forcemains.**											
Weight	15%	6.0	6.0	3.0	9.0	3.0	10.5	10.5	12.0	6.0	3.0	0.0
Long Term Solution	Provides asset life, and possibly capacity, beyond the minimum planning horizon.	2.5	2.5	2	2.5	2	3	3	3	2.5	2	2
Scoring Logic	**Options are all very close, as all the pipe/tunnel components have a 60 year design life, so score all at 2.5. The tunnels have the ability to be re-lined so add 0.5 points. - 0.5 points for the in-line pump stations as it is an additional short-life component (pump stations are 25 years)**											
Weight	10%	5.0	5.0	4.0	5.0	4.0	6.0	6.0	6.0	5.0	4.0	4.0

Flexibility to accommodate future changes	Technical Consultants to elaborate	1	1	0	3	2	2	2.5	4	2	2.5	5
Scoring Logic	**Second WWTP provides the greatest flexibility, as future load growth is split. Estuary pipelines provide the least. -1 for in-line pump stations. Gravity tunnel has the ability to tie in HMCS Quadra and parts of the Jane catchment directly to tunnel, so scores an extra point.**											
Weight	5%	1	1.0	0.0	3.0	2.0	2.0	2.5	4.0	2.0	2.5	5.0
Total Technical Category	45%	18.0	16.5	10.0	27.5	18.0	32.0	31.0	37.0	22.0	17.0	9.0

Category	Affordability											
Goal	**Description**	**1A**	**1B**	**1C**	**2A**	**2B**	**3A**	**3B**	**3C**	**4A**	**4B**	**5**
	Capital Only ($M)	80	57	65	45	59	80	69	66	69	84	174
	50 Year NPV (Capital + O&M) ($m)	122	118	131	105	141	123	116	109	149	176	**316**
Minimize Lifecycle Cost	Net present value of capital, operational and replacement cost, period is to the planning horizon	3.8	4.1	3.2	5.0	2.5	3.8	4.2	4.7	1.9	0.0	-9.8
Scoring Logic	**Lowest 50yr NPV =5, Opt 4B 50yr NPV=0, pro-rate other options, allow Opt 5 to go negative as it is off the chart compared to other options**											
Weight	**14%**	**11**	**11**	**9**	**14**	**7**	**11**	**12**	**13**	**5**	**0**	**-27**
Long term Value	Provides asset life and capacity beyond the design planning horizon	2.5	2.5	2.0	2.5	2.0	3.0	3.0	3.0	2.5	2.0	2.0
Scoring Logic	**Use same values as for technical criteria of long term solution**											
Weight	**4%**	**2.0**	**2.0**	**1.6**	**2.0**	**1.6**	**2.4**	**2.4**	**2.4**	**2.0**	**1.6**	**1.6**
Total Affordability	**18%**	**12.6**	**13.4**	**10.5**	**16.0**	**8.6**	**12.9**	**14.2**	**15.5**	**7.4**	**1.6**	**(25.8)**

Comox Valley
REGIONAL DISTRICT

Minutes of the meeting of the Liquid Waste Management Plan (LWMP) Joint Technical and Public Advisory Committees (TACPAC) Meeting #6 held on Friday, March 22, 2019 at the Comox Valley Regional District (CVRD) Boardroom, commencing at 9:00am.

PRESENT:

A. Habkirk, Chair and Facilitator	
P. Nash, LWMP Project Coordinator	
K. La Rose, Senior Manager of Water/Wastewater	CVRD
M. Imrie, Manager of Wastewater Services	CVRD
C. Wile, Manager of External Relations	CVRD
J. Boguski, Branch Assistant – Engineering Services	CVRD
A.Idris, Engineering Analyst	CVRD
W. Bayless	WSP
M. Swift, Town of Comox Councillor	PAC
W. Cole-Hamilton, City of Courtenay Councillor	PAC
A. Hamir, Lazo North – Electoral Area B Director	PAC
C. McColl, K'ómoks First Nation	PAC/TAC
T. Ennis, Comox Valley Conservation Partnership	PAC
S. Wood, Comox Business Improvement Association	PAC
S. Carey, Courtenay Resident Representative	PAC
T. Servizi, Courtenay Resident Representative	PAC
K. Niemi, Courtenay Resident Representative	PAC
K. vanVelzen, Comox Resident Representative	PAC
D. Jacquest, Comox Resident Representative	PAC
R. Craig, Comox Resident Representative	PAC
J. Steel, Area B Resident Representative	PAC
M. Lang, Area B Resident Representative	PAC
R. O'Grady, City of Courtenay Engineering	TAC
S. Ashfield, Town of Comox Engineering	TAC
G. Bonekamp, Department of National Defence Engineering	TAC
L. Aitken, Area B Representative Alternate (Observer)	
D. Hillian, City of Courtenay Councillor (Observer)	

ITEM	DESCRIPTION	OWNER
6.1	Call to Order • The meeting was called to order at 9:05am	Allison Habkirk
6.2	Review of Minutes of Meeting # 5 • The motion by R. O'Grady, seconded by D. Jacquest that was defeated was not noted in meeting #5 minutes – M. Lang • It was inaccurately stated in the minutes that A. Hamir put forward a motion that the minutes of meeting #4 be adopted. – K. vanVelzen MOTION: That the minutes of meeting #5 be adopted – A. Hamir SECONDED: W. Cole-Hamilton CARRIED	Allison Habkirk

ITEM	DESCRIPTION	OWNER
6.3	Review of LWMP Process Changes • We have decided to prioritize and identify a preferred solution for the conveyance component of this LWMP process due to its urgent nature and come back to shortlisting treatment and resource recovery options later. • This is not breaking the conveyance piece off of the LWMP process, it is just addressing the conveyance options first to allow for more in depth analysis of the options. • We plan to short list the treatment and resource recovery long list options in TACPAC meeting #8, after selecting a preferred solution for conveyance if time allows. • CVRD Senior Management met with K'ómoks First Nation (KFN) Chief and Council on February 20 to consult and present long list of options for conveyance, treatment and resource recovery components of the LWMP. • The KFN Chief and Council voiced their strong opposition to all of the estuary alignment option due to archaeological and environmental concerns. • The Chief and Council also voiced their support for treatment options that include UV disinfection. • We recognize the importance of engaging with the KFN and obtaining their support in order to move forward with any of these options because the entire plan area falls within the KFN's unseeded territory. • The CVRD is going to meet with the KFN Chief and Council on March 27. We will touch base again with Committee members if plans change or KFN does not support any of the options.	Kris La Rose
6.4	Long List Options – Conveyance • From our experience, construction costs in the intertidal zone are twice as much as construction in terrestrial zone because inefficiencies due to tidal cycles, stringent regulations, nature of construction on wet sand and requirement for specialized equipment. • 40 per cent contingency is carried in the Class D cost estimates to account for unknowns at this stage. • An extra 20 per cent contingency is being carried for the tunneling options to account for inherent risk of cost overruns with tunnels. • Asset replacement cost is considered as part of the life cycle costs (60 years for 100 per cent pipe replacement, 25 years for replacement of 40 per cent for structures) • Annual inflation rates are considered: 3 per cent for labour, 3.02 per cent for construction (figures from the *Engineering News Record* (ENR)) and 5 per cent increase in power demand and energy costs. • What is the proximity of tunnel to water wells that could affect the ground water supply? – M. Lang o Don't know the exact answer to that but the interference with well water supply depends on the size and depth of the tunnel relative to the size of the aquifer. However, any	Walt Bayless

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<tr><th>ITEM</th><th>DESCRIPTION</th><th>OWNER</th></tr>
<tr><td></td><td>impacts are likely to be temporary during the construction period. – W. Bayless
• Truck traffic across the 17th Street Bridge could be significant, especially if it coincides with the upgrading project of the 5th Street Bridge. This would be worth consideration as a social aspect. – W. Cole-Hamilton
• The 3.02 per cent construction inflation rate from ENR seems low, was this an average over a long time? – W. Cole-Hamilton
  o Yes, there is a significant uncertainty on the inflation/interest rates but changes in rates won't make a difference in terms of the relative cost of the 'buckets' of the options. – W. Bayless
  o Also, the ENR is a North American index and therefore local variabilities may come into play, especially on the island. – P. Nash</td><td></td></tr>
<tr><td>6.5</td><td>Review of TAC Score of Technical Criteria
• Was there a consideration for ease of recovery after a disaster? – K. Niemi
  o The ease/complexity of recovery was factored in the operational considerations. – W. Bayless
• Compared to previous processes I was involved in, it was a good surprise and reassuring to see that the sensitivity analysis resulted in a consistent shift of the option groups/buckets. – R. O'Grady</td><td>Paul Nash</td></tr>
<tr><td>6.6</td><td>TACPAC Evaluation of Long List Options – Conveyance
• Do any of these options affect the septicity of the sewer? Is there a measure to control odour for these options? – J. Steel
  o In general, the longer the route, the more septic the wastewater becomes. There are way to mitigate odour such as adding Ferrous Chloride (FeCl2) in the collection laterals and conveyance mains. However, these are not silver bullets but odour issues can be addressed. – W. Bayless
  o We have hydrogen sulfide (H2S) concentration at the headworks of about 5 parts per million (ppm) and occasionally that rises to 20 ppm for a short time. Adding FeCl2 works but it does not eliminate septicity. – M. Imrie
  o It is appropriate to consider the septicity for options that take the longest path of conveyance to the treatment plant.- K. La Rose
• To what extent does the geology affect the tunneling options? – T. Ennis
  o Our analysis was primarily based off of the available well data on Lazo hill, which mostly show sandy composition. However, a more detailed analysis would be exercised in the detailed study of the short listed options. – W. Bayless
• I would prefer evaluating economic benefits based on percentage of cost that stays in the local economy rather than absolute values. – W. Cole-Hamilton (supported by the majority of TACPAC members)</td><td></td></tr>
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	• Access/time required to get to the damaged sections and the environmental damage that may occur in the meantime should be considered in the environmental category.
	• Where are the archaeological sensitivities considered? – W. Bayless
	    o The TAC suggested that archaeological factors should be evaluated as part of both environmental and social benefits factors. – K. La Rose
	• It is important to keep in mind that in addition to the estuary and foreshore, inland areas such as the Comox Road. are known archaeological sites. – T. Ennis
	• Was the land acquisition cost for the treatment plant of Option 5 considered?
	    o There was no particular consideration related to any of the options such as those that include a new pump station or a new treatment plant.- K. La Rose
	• What is the extent of the "general vicinity" noted for replacing the Jane Place Pump Station?
	    o From a technical perspective, the objective of this new pump station is to use the existing gravity collection system to capture flows. However, locating the pump station and the boundary of the study area is beyond what I can speak to. – W. Bayless
	    o We have a circle around the general area for potential pump station placement. At this point, the intent is not to have an inline pump station outside Comox.
	• Has there been a consideration for the fact that Area 'B' residents do not have the benefit of using the wastewater system but would experience the same disruption as the municipalities? And therefore the level of social impact would be different depending on whether those impacted benefit from the system?
	    o All the septic systems in the valley discharge in the CVWPCC and therefore residents of Area 'B' and the other local areas are beneficiaries of the system. Also, the main trigger of this LWMP process is to mitigate the risk of a catastrophic failure of the section of the forcemain along the Willemar Bluffs, which would be in the interest of the entire community to solve. – D. Jacques
	    o We are focussed on identifying a solution to the problems related to conveyance in this LWMP process. Topics related to the governance of the sewer system and participation to the service is out of the scope of this LWMP process. – P. Nash
	• Siting of tunnel shafts, pump stations should be explored in further detail for the short listed options. – S. Ashfield
	
	MOTION: That conveyance short list include Option 2A, Option 3A, B and C, and Option 4A. – M. Lang
	SECONDED – T. Servizi	

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<tr><td></td><td>D. Jacques and R. Craig oppose the motion to include Option 4A in the short list because it scored significantly lower than the other options. MOTION CARRIED – TACPAC consensus on forwarding Option 2A and Option 3A, B and C. Opposition from some members on Option 4A due to its weighting score being so close to other options. Does the results from this LWMP process make the work currently underway at the treatment plant redundant? – A. Hamir
Some work has been delayed until after the LWMP process is complete (such as adding additional clarifier). However, the equalization tanks and work related to odour control are going ahead independent of the LWMP process. – K. La Rose</td><td></td></tr>
<tr><td>6.7</td><td>LWMP Schedule Update
May 30 is the start of the FCM Conference and therefore members who are elected officials cannot attend TACPAC 7 as it is currently scheduled. – M. Swift</td><td></td></tr>
<tr><td>6.8</td><td>Preview of TACPAC #7</td><td></td></tr>
<tr><td>6.9</td><td>Meeting Adjourned</td><td></td></tr>
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