# SPECIAL INFRASTRUCTURE SERVICES COMMITTEE

## Wednesday, January 20, 2021

**Held Electronically in Accordance with Ministerial Order M192 and Transmitted via the SCRD Boardroom, 1975 Field Road, Sechelt, B.C.**

## AGENDA

---

**CALL TO ORDER 9:30 a.m.**

**AGENDA**

**1.** Adoption of Agenda

**PRESENTATIONS AND DELEGATIONS**

| | | |
|---|---|---|
| **2.** | Ineke M. Kalwij, Senior Hydrogeologist & Principal Engineer, Kalwij Water Dynamics Inc.<br>Regarding Groundwater Investigation | To Follow |
| **3.** | Wilbert Yang, Senior Waste Management Engineer, Tetra Tech Canada Inc.<br>Regarding Future Waste Disposal Options Analysis | To Follow |

**REPORTS**

| | | |
|---|---|---|
| **4.** | Results Groundwater Investigation Phase 2– Round 2 and Groundwater Investigation Phase 3 – Gray Creek<br>General Manager, Infrastructure Services / Manager, Capital Projects<br>**Regional Water (Voting – A, B, D, E, F and Sechelt)** | Annex A<br>pp 1 - 17 |
| **5.** | Future Waste Disposal Options Analysis Study – Results and Next Steps<br>General Manager, Infrastructure Services / Manager, Solid Waste Services<br>**Regional Solid Waste (Voting – All)** | Annex B<br>pp 18 - 78 |

**COMMUNICATIONS**

**NEW BUSINESS**

**IN CAMERA**

**ADJOURNMENT**

# SUNSHINE COAST REGIONAL DISTRICT STAFF REPORT

**TO:** Special Infrastructure Services Committee - January 20, 2021

**AUTHOR:** Remko Rosenboom – General Manager, Infrastructure Services

Stephen Misiurak, Manager Capital Projects

**SUBJECT:** **RESULTS GROUNDWATER INVESTIGATION PHASE 2– ROUND 2 AND GROUNDWATER INVESTIGATION PHASE 3 – GRAY CREEK RESULTS**

## RECOMMENDATION(S)

**THAT the report titled Results Groundwater Investigation Phase 2– Round 2 and Groundwater Investigation Phase 3 – Gray Creek be received;**

**AND THAT staff present a 2021 Round 1 Budget Proposal for a Groundwater Investigation Phase 3– Round 2 project, based on the recommended next steps in this report for the development of a well field at the explored Langdale and Maryanne West Park sites.**

**AND FURTHER THAT staff present at a 2021 Round 1 Budget Proposal for a Feasibility Study for surface water intake upgrades at Gray Creek based on Option 1 as described in this report.**

## BACKGROUND

The Comprehensive Regional Water Plan, approved in June 2013, identified several projects to increase the water supply for the Chapman Creek water supply system. One of those projects is the Groundwater Investigation project, which explores the potential development of production wells as an additional water supply source.

Phase 1 of this project was concluded in the spring 2017 and included a desktop feasibility study of the sites to develop production wells. The results of Phase 2 of the Groundwater Investigation project were presented to the Board in January 2019. During that phase, small diameter test wells were drilled at four sites selected during Phase 1. Subsequently, test pumps were temporarily installed to test productivity of the well, potential for impacts to other well owners and the environment, and to determine water quality. Based on the findings of this phase, the Board decided to advance the development of the Church Road Well Field, which is currently in final design and estimated to be completed in 2022.

In early 2020 the Board provided direction to staff to initiate a second round of drilling and testing of potential sites for production wells. The Board also provided direction to further explore the Gray Creek area for the feasibility of a production well given the known productive aquifer in this area. The test well drilled at this site during the Groundwater Investigation Phase 2 was unsuccessful in finding a good water supply.

In May 2018 the Board approved the Water Sourcing Policy – Framework and updated the policy objective for the water supply of the Chapman Water System:

> *The SCRD intends to supply sufficient water at Stage 2 levels throughout the year to communities dependent on water from the Chapman Creek System.*

*Emergency circumstances could result in increased Stage levels.*

*If, due to emergency circumstances, the water supply for Chapman Creek is completely unavailable, the SCRD strives to have adequate alternative water supply sources available to address all essential community water demands for at least one week.*

At the December 13, 2018 Planning and Community Development Committee meeting, the report titled 2018 Water Demand Analysis was received. This report presented an outlook of the annual shortfall in the amount of water to satisfy the water supply objective as outlined in the Water Sourcing Policy Framework. This shortfall is called the Water Supply Deficit.

The table presented below is taken from that report and presents the Water Supply Deficit (in Million cubic meters) for three levels of effectiveness of water conservation initiatives and a 2% average annual population growth within the area supplied by the Chapman Water System.

| **Effectiveness of water conservation initiatives (per capita, compared to 2010)** | **Water supply deficit (Million $m^3$)** | | |
|---|---|---|---|
| | **2025** | **2035** | **2050** |
| Service Area Population | 26,000 | 32,000 | 43,000 |
| 10% reduction | 2.01 | 2.83 | 4.35 |
| 20% reduction | 1.65 | 2.39 | 3.76 |
| 33% reduction | 1.22 | 1.82 | 2.98 |

Groundwater resources are generally considered to be less susceptible to impacts of climate change and in particular the short-term impacts of drier summers. The development of additional groundwater supply sources would also increase the overall resilience of the Chapman Creek Water System.

The purpose of this report is to present the outcome of the Groundwater Investigation Phase 2– Round 2 and the Groundwater Investigation Phase 3 – Gray Creek projects and to seek direction on the next steps.

## DISCUSSION

*Site Selection*

In the 2020 budget proposals for these projects, the following sites were identified:

- Gray Creek.
- Langdale (at BC Ferries Terminal, close to existing well).
- Harman Road.
- Elphinstone West or Chaster Creek.
- East Porpoise Bay.

The SCRD and the consultant retained for this project, (Kalwij Water Dynamics Inc.), assessed each of the sites and concluded that all five sites were indeed good sites to explore. The Elphinstone West or Chaster Creek area was narrowed down to the Maryanne West Park location.

For the East Porpoise Bay area, SCRD staff contacted BC Parks to explore the possibility to drill a test well within the BC Park located in this area. BC Parks indicated this would be in contravention of the *BC Parks Act*. Within the context of this project, obtaining a Park Use Permit for the drilling of a test well was not explored as the timelines for such process did not align with those of this project.

*Summary of Results*

The table below summarizes the key results of the Groundwater Investigation Phase 2 for each test well site locations.

| | **Maryanne West Park** | **Langdale** | **Gray Creek** | **Harman Road** |
|---|---|---|---|---|
| **Potential sustained productivity per well (litres per second)** | 19+ | 25+ | 6.3+ | N/A |
| **Potential for well field** | Yes | Yes | Yes | N/A |
| **Water Quality (poor, moderate, good)** | Good | Moderate or Good | Moderate or Good | N/A |
| **Risk of contamination or reduced yield (low, moderate, high)** | Moderate | Low | Low | N/A |
| **Risk for impacts to other wells (low, moderate, high)** | Low | Low | Low | N/A |
| **Risk for environmental impacts (low, moderate, high)** | Low | Low or Moderate | Low | N/A |
| **Regulatory complexity (3=lowest, 1=highest)** | 1 | 2 | 3 | N/A |
| **Ranking Development Costs (3=lowest, 1=highest)** | 2 | 1 | 3 | N/A |
| **Ranking Operational Costs (3=lowest, 1=highest)** | 2 | 1 or 2 | 3 | N/A |

*Maryanne West Park*

At this SCRD owned location, a productive test well was drilled with a good potential for the development of a well field consisting of at least two wells. The development of a well field may require an increase to the capacity of distribution system in the area. The water quality also satisfied all relevant guidelines and would only require chlorination.

This well is located within Aquifer 560, which is the same aquifer as the Church Road Well Field under development and the Town of Gibsons' wells. Recent discussions amongst the hydro-geotechnical experts of the Province of BC and the Town of Gibsons concluded that there is a lack of understanding of the magnitude and spatial distribution of the recharge of Aquifer 560. It is therefore anticipated substantial additional monitoring of the recharge towards the Maryanne West Park well site would be required before a Water Licence could be issued at this location.

*Langdale*

The test well site was located at the BC Ferries terminal in close proximity to the existing well that has been providing water to the Langdale community since 1971. The Langdale Water System is currently not connected to the Chapman Water System and the installation of water mains and a booster pump station would be required to connect both systems and to allow the water from the Langdale well site to flow into the Chapman Water System. The exact route of such connection would need to be confirmed.

The test well was drilled to a greater depth into the same aquifer as the existing well. The test well drilling, subsequent pump test and analysis confirmed that this site is very suitable to develop two production wells with a substantial combined yield. The existing Langdale well also has excess capacity that could be utilized to augment the water supply of the Chapman Water System. This excess amount will be confirmed in the upcoming months as part of the current redevelopment project for that well.

Additional monitoring of the water quality is required to confirm if treatment would be required to address elevated levels of manganese and iron in addition to chlorination.

Besides an agreement with BC Ferries on the development of one or two wells on their land, the establishment of an Environmental Flow Need for Langdale Creek and some additional aquifer monitoring is required in support of the Water Licence application.

*Harman Road*

This site was selected given the successful drilling of productive private wells that were tapped into both an unconfined and a bedrock aquifer in the area. The location of the test well selected was on the Ministry of Transportation and Infrastructure road dedication, as no agreement could be reached about the development on private land as originally intended.

The test well drilled at the Harman Road site was not successful in accessing an adequate supply of water in either the unconfined aquifer or the bedrock aquifer.

It should be noted that wells in bedrock aquifers are tapped into faults in the bedrock that are filled with water. As the location of those faults cannot be determined prior to drilling, drilling bedrock test wells has a relatively low likelihood of being successful. The fact that the Harman Road test well was not successful in hitting a productive bedrock fault does not necessarily mean that there is no potential for bedrock aquifer supply in the area.

*Gray Creek*

Initially a second test well in the Gray Creek area was targeted to be installed on the private property at the mouth of Gray Creek. Unfortunately, staff were not able to work out an agreement to do so as no agreement could be reached on the conditions of such an agreement. Alternatively, the SCRD received approval from the District of Sechelt to drill a test well on the road dedication owned by the District of Sechelt to the north of the private properties adjacent to the creek.

Due to the more substantial distance from the creek, the potential yield of a production well at this site is lower than anticipated. However, given that the site allows for the development of a small well field, the combined yield of these wells could account for a significant amount of the supply required for the Tuwanek and Sandy Hook neighborhoods. Therefore, there is value in this site being developed. Besides the basic connection to the water distribution system, no additional infrastructure upgrades would be required.

Additional monitoring of the PH would be required to confirm if additional water quality treatment, other than chlorination, would be required.

*Preliminary Cost Estimates*

The preliminary cost estimate to develop all three well sites is currently estimated at about $11,600,000. This includes drilling a total of five production sized wells, and Water Licence applications and detailed engineering design and construction for all three well sites. This cost estimate also includes 30% contingency and a 5% allocation for staff wages. The table below outlines the estimated costs for all components to develop well fields consisting of two wells at all three sites.

| **Description** | **Well Field Location** | | |
|---|---|---|---|
| | **Maryanne West Park** | **Langdale** | **Gray Creek** |
| **Construction Cost for Two Production Wells** *Construction, Hydrogeology, Engineering, Permitting, Additional Studies* | $ 0.92 M | $ 0.79 M | $ 0.68 M |
| **Infrastructure Costs** *Building, Mechanical, Electrical, Civil, Engineering, Permitting, Contingency* | $1.48 M | $ 1.40 M | $ 1.14 M |
| **Watermain Extension** *Tie-in to Existing Water System, Contingency* | $ 0.39 M | $ 1.59 M | $ 0.18 M |
| **Sub-Total Estimate** | **$ 2.79 M** | **$ 3.78 M** | **$ 2.00 M** |
| **30% Contingency** | $ 0.84 M | $ 1.13 M | $ 0.60 M |
| **Total Estimate** | **$ 3.63 M** | **$ 4.91 M** | **$ 2.61 M** |

It should be recognized that these are preliminary cost estimates and as such are based on the following assumptions and exclusions:

- Assumes Water Licences will be issued for all wells;
- Assumes no significant archaeological costs (beyond typical monitoring and reporting);
- Assumes land will be available for all test wells at minimal cost;
- Assumes no treatment required at Langdale and Gray Creek beyond chlorination;
- Excludes water modelling costs to assess potential for upgrades to distribution system;
- Excludes modifications to existing distribution system required to address new supply sources. This could include upsizing water mains or upgrades or new installations of valves and pumping stations.
- Includes an allowance of $25,000 related to developing and implementing a well monitoring program and associated assessments for Aquifer 560 in support of the Water License application for Maryanne West Park well(s);
- Includes an allowance of $25,000 related to developing and implementing a monitoring program to establish the Environmental Flow Requirements in support of a Water License application for the Gray Creek well(s); and,
- Excludes accounting for inflation and unknowns from work completed in the future (e.g. regulatory changes).

*Contribution towards Water Sourcing Policy*

The table below summarizes the impacts each well can have on the water supply deficit as well as the collective impact.

| | **Well Field Productivity* (L/s)** | **2025 ($m^3$)** | **2035 ($m^3$)** |
|---|---|---|---|
| Water Supply Deficit ($m^3$) | - | 2,010,000 | 2,830,000 |
| Church Rd Well Field Project** | 66 | 948,000 (47%) | 1,053,000 (37%) |
| Maryanne West Park | 38 | 502,000 (25%) | 541,000 (19%) |
| Langdale*** | 50 | 661,000 (33%) | 700,000 (25%) |
| Gray Creek | 13 | 172,000 (9%) | 207,000 (7%) |
| New Groundwater Total | | 2,224,000 (111%) | 2,427,000 (86%) |

*Assumes two production wells per site.
**Includes improvements from Soames Well and deductions from existing Granthams and Soames Water Systems demand.
***Does not include gains from existing Langdale Well recommissioning.

The net yield of wells over a six month drought scenario increases between 2025 and 2035 due to the nature of the Chapman Creek watershed. In the modeled watershed for the Water System Demand Analysis, May and June creek flows still benefit from the snowmelt and a water saturated ground. There is sufficient water in Chapman Creek to meet Environmental Flow Need (EFN) requirements and divert flow to the Chapman Creek Water Treatment Plant. Similarly in September and October, increases in dew and decreases in community water demand make the water supply deficit smaller in these months. This means that well flows are not fully utilized in these shoulder months.

From this table, one can infer that the new groundwater sources can address the water supply deficit of 2025.

For 2035, the following can be inferred:

- Using conservative estimates, these new groundwater sources cannot address the water supply deficit of 2035;
- An additional 36 litres per second of ground or surface sources is needed;
- Alternatively, a reduction in per capita demand of 12% could bridge the remaining deficit;
- A Raw Water Reservoir of 420,000$m^3$ would also be sufficient to bridge the remaining deficit.

One implication from increasing the diversity of sources of the Chapman Water System is the Chapman Creek Water Treatment Plant could operate below its minimum design flow. This could occur during extreme drought situations and after other water sources are commissioned prior to 2025. Chapman Creek Water Treatment Plant Modifications will be needed at the plant to enable it to operate below its design flow rate, while the Environmental Flow Need requirements for Chapman Creek would be maintained.

The other element of the Water Sourcing Policy is redundancy, should an emergency situation arise with the water supply from the Chapman Creek System. Anticipating that in such a situation, Stage 4 would be declared and a 50% reduction of the water use by the community would be achieved, the groundwater sources as outlined above and combined with Chaster Well would be sufficient to meet Stage 4 demand in 2025. This is not entirely the case for 2035.

*Recommended Next Steps*

Based on the assessment of the above summarized information, staff recommend the following next steps be undertaken:

<u>Maryanne West Park</u>

Given the potential for the Maryanne West Park site, staff recommend to confirm the development of this site and have identified 2 options for the scope of work to be completed in 2021. In the first option, this scope would include the development and implementation of a groundwater monitoring program, the drilling of one full size production well (10 inch) to confirm the potential yield and the preparation and submission of a Water Licence application. It is expected that it will take at least until 2023 or 2024 before the sustainable yield of one production well or a well field at this site can be confirmed and a final decision can be made on the development of this site. Once this is confirmed, it’s expected that the permitting, construction and commissioning of this well field will take until 2026 to complete.

The costs for this 2021 scope of work is approximately $661,500. If it would be confirmed to be feasible to develop a well field at this site then this is estimated to costs approximately $3,108,500. This will include the construction of a building to house the pumps and for the treatment equipment, water mains to connect the wells to the Chapman Water System, and various other civil works.

The alternative scope of work for 2021 would be to submit a Water licence application based on the currently available information on the potential of the site and some additional technical assessments and monitoring. This option postpones the drilling of a larger size well to confirm the actual potential for a well field at this location at a future project phase. As the application date of a Water Licence determines the seniority of a water right, the timely submission of such an application would at least secure the seniority position for a certain volume and flow of water. The actual yield of a larger size well at this location could then be established at a later date and if the yield is confirmed to exceed the applied for amount, a Water Licence for that additional amount can be applied for. The costs for this option is currently estimated at approximately $100,000, while the costs for the remainder of the well field development would cost approximately $3,531,500. Staff recommend this option given its lower required upfront expenditures for 2021, while concurrently securing the water rights for the potential development of a well field at this location.

<u>Langdale</u>

Based on the findings to date for the Langdale site, staff recommend the development of two new production wells and connection of the Langdale System to the Chapman Water System. It could be possible that the well field would be permitted, constructed and commissioned in 2024. For 2021 it’s recommended to initiate the following activities:

- assess the need for additional water treatment requirements;
- seek Land Use agreement with BC Ferries;
- drill and test two full size production wells (10 inch);
- complete the technical assessments in support of a Water Licence application and submit such an application; and
- develop preliminary and final design drawings and cost estimates for the well development and connection to the Chapman Water System.

The costs for the scope of work proposed to be initiated in 2021 is approximately $1,277,100. The construction of all the associated infrastructure in future years would cost approximately $3,824,900 This will include construction of a building to house the pumps and treatment equipment, along with significant lengths of new water transmission mains to connect the wells to the Chapman Water System, and various other civil works.

<u>Gray Creek</u>

Based on the findings to date, staff suggest to consider the development of two new production wells on the Gray Creek site. It could be possible that the well field could be permitted, constructed and commissioned in 2023. For 2021 this would require to initiate the following activities:

- assess the need for additional water treatment requirements;

- seek Land Use Agreement with the District of Sechelt and potentially neighbouring private land owner (access road);
- drill and test two full size production wells (10 inch);
- complete the technical assessments in support of a Water Licence application and submit such an application; and
- develop the preliminary and final design drawings and cost estimates.

It should be noted that the SCRD already has a Water Licence for the diversion of surface water upstream of the proposed well location. The current intake and treatment infrastructure is minimal in nature and would only support diversion during low flow situations with low turbidity levels in Gray Creek. Specific permission from Vancouver Health needs to be obtained annually prior to using the intake.

Over the years, the costs for upgrading this site to a fully developed intake location has been assessed and never considered financially feasible in the context of the cost to supply water from Chapman Creek. However, in the context of the cost of developing groundwater sources, this option should be considered. While a well field with a capacity of 13 l/s would cost approximately $2.7 M, upgrading the surface water intake and treatment is currently estimated to cost approximately $2.5 M and would provide about 27.8 l/s. Long-term creek flow monitoring should confirm if the surface water intake at Gray Creek would be able to provide such volume in a sustainable manner given the impacts of climate change on the Gray Creek watershed. Upgrading the surface water intake would only require a minor amendment to our existing Water Licence which would allow this upgraded supply source to be fully commissioned in 2024 or 2025. Upgrading the surface water intake instead of developing the well field would also further decrease the remaining Water Supply Deficit for 2035.

For the Gray Creek area the following options are developed for the Board's consideration for 2021:

1) Confirm technical, financial feasibility of upgrading the current surface water intake and treatment at Gray Creek by monitoring current and modeling future flow regimes for Gray Creek. Developing preliminary design and Class C cost estimates for the infrastructure upgrades. A cost estimate for this option is currently under development and expected to be in the range of $100,000 to $125,000.
2) Confirm the potential yield of a full size (10 inch) production well and developing preliminary design and Class C cost estimates for the infrastructure to be constructed. The cost for this option is estimated at approximately $575,000.
3) Proceed with the development of the well field until the development of final design drawings and cost estimates at a cost of approximately $1,000,000.
4) A combination of option 1 and 2.

Given the potential associated with upgrading the existing surface water intake, staff are recommending to proceed with option 1 for 2021. Based on the results of that project, the Board could still consider to initiate further work on the development of the well field in 2022.

Harman Road

For the Harman Road site, no next steps are recommended for 2021. Any further drilling in this area could be considered as part of a future test well drilling project. The future project could also include additional drilling into other bedrock aquifers and/or obtaining a Park Use Permit for the East Porpoise Bay area. Given the positive results of this test drilling program and the significant amount of work associated with the recommended next steps, staff do not recommend to initiate the next round of test drilling until 2022 at the earliest.

*Organizational and Intergovernmental Implications*

The requirement for any additional staffing time or resources to operate and maintain the proposed well fields and associated infrastructure can only be quantified once the detailed design and operating regimes of the infrastructure is complete. This information will be presented to the Board prior to the Board's final decision on the construction of these well fields.

*Financial Implications*

The following table presents a summary of the currently estimated costs of implementing the approach as recommended above.

| | Maryanne West Park | Langdale | Gray Creek | Total |
|---|---|---|---|---|
| **2021** | $100,000 | $1,277,100 | $125,000 | $1,502,100 |
| **2022-2026** | $3,531,500 | $3,824,900 | $2,400,000 | $9,856,400 |
| **Total** | $3,631,500 | $5,102,000 | $2,525,000 | $11,358,500 |

At 2021 Pre-budget Proposed Initiatives for a Groundwater Phase 3 - Round 2 Budget Proposal cost was presented. The costs for this project were estimated at $500,000 funded from [370] Regional Water Operating Reserves with the notice that the requested budget would be updated based on the presentation of the results included in this report.

As mentioned above, the costs for the recommended next steps for the Gray Creek, Langdale and Maryanne West Park sites are currently estimated at approximately $1,502,100. Based on the direction received from the Board, staff will confirm the cost estimates and proposed funding sources for the Board's consideration at 2021 Round 1 budget.

*Communication Strategy*

Information on this project will be shared broadly via local media, corporate newsletters, social media and the SCRD website. Additional information will be provided to property owners in the vicinity of the proposed well fields.

Staff will reach out to the *shíshálh* Nation and Sḵwx̱wú7mesh Nation to share the general findings of this project and next steps as directed by the Board.

## STRATEGIC PLAN AND RELATED POLICIES

This project reflects the set of values identified in the Strategic Plan, including the Strategy to *Plan For and Ensure Year-Round Water Availability Now and in the Future,* and the Strategy to *Develop Climate Adaptation Strategy* through the investigation of additional water sources in effort to expand and diversify water supply.

## CONCLUSION

Exploration for additional groundwater was completed in 2020 at Maryanne West Park, Langdale area, Gray Creek area, and Harman Road. Groundwater was found at all test well sites except for Harman Road. Each site with groundwater has the potential for two or more production wells.

Combined with existing sources, this project confirmed the potential to develop sufficient ground water supply sources to meet the community's demand until 2025 and almost until 2035 during a severe drought without escalating beyond Stage 2 of the water conservation regulations.

For the Maryanne West Park site, staff recommend pursuing the submission of a Water Licence application based on the currently available technical information for this site. A groundwater monitoring program is also recommended to develop a greater understanding of the aquifer.

For the Langdale site, staff recommend pursuing the next steps, including drilling two new productions wells, submission of a Water Licence application and completing the final engineering design.

For the Gray Creek site, staff recommend pausing on the development of groundwater. Recommended next steps focus instead on confirming the feasibility and costs of treating the surface water from Gray Creek. Some infrastructure already exists at Gray Creek and the SCRD already has a water licence.

Costs for the recommended next steps would be approximately $1,502,100.

**Attachments:**

Attachment A – Groundwater Investigation Project Summary

| Reviewed by: | | | |
|---|---|---|---|
| Manager | X - S. Walkey | Finance | |
| GM | | Legislative | |
| CAO | X-D. McKinley | Other | X- R. Shay<br>X- T. Rutley |

Kalwij Water Dynamics Inc.

**Sunshine Coast Regional District**
**Groundwater Investigation Phase 2, Part 2 and**
**Groundwater Investigation Phase 3 - Gray Creek**

**Date:** January 15, 2021

**To:** Remko Rosenboom, *General Manager Infrastructure Services* (SCRD)

**Copy:** Stephen Misiurak, P.Eng., *Manager Capital Project*, Trevor Rutley, *Infrastructure Capital Project Coordinator* (SCRD)

**From:** Ineke Kalwij, Ph.D., P.Eng., *Project Hydrogeological Engineer* (KWD)

**Project:** Groundwater Investigation Phase 2, Part 2 and Groundwater Investigation Phase 3 – Gray Creek.

**Subject:** Project Summary - Memorandum

# Project Summary

## 1. Background

The Sunshine Coast Regional District (SCRD) commenced a **Groundwater Investigation Program** in 2017 to determine the feasibility of groundwater development to meet the identified water supply deficit for the Chapman Water System (i.e.: 2 million $m^3$ of additional supply / storage by 2025). The development of the Church Road Well Field, scheduled for completion in late 2021, is expected to address approximately 45% of the water deficit. Additional groundwater supply sources are therefore required to make up the remaining shortfall.

Based on the foregoing, the SCRD issued a Request for Proposal on March 30, 2020, to conduct **Groundwater Investigation Phase 2, Part 2 and Groundwater Investigation Phase 3 – Gray Creek**. Kalwij Water Dynamics Inc. (KWD) was awarded the project to conduct the groundwater investigation study. KWD engaged Onsite Engineering Ltd. as the Civil Engineering Consultant, and Fyfe Well & Water Services as the Well Drilling Contractor.

In July 2020, KWD commenced with finalizing test well drilling locations in collaboration with SCRD staff, and following archaeological approval from the Sechelt First Nations (shíshálh Nation) and the Squamish Nation (Sḵwx̱wú7mesh Úxwumixw) for each of the sites, the test well drilling program proceeded at the following locations:

**Groundwater Investigation Phase 2, Part 2:**

1. Maryanne West Park - 1224 Chaster Road (adjacent to Cedar Grove Elementary School): **Test Well No. 1**
2. Langdale – BC Ferries Terminal property: **Test Well No. 2**
3. Harman Road, Ministry of Transportation and Infrastructure (MOTI) road-right-of-way: **Test Well No 4**

**Groundwater Investigation Phase 3 – Gray Creek**:

1. Gray Creek - District of Sechelt Road Dedication (**Test Well No 3**)

**Figure 1** (next page) shows the project sites.

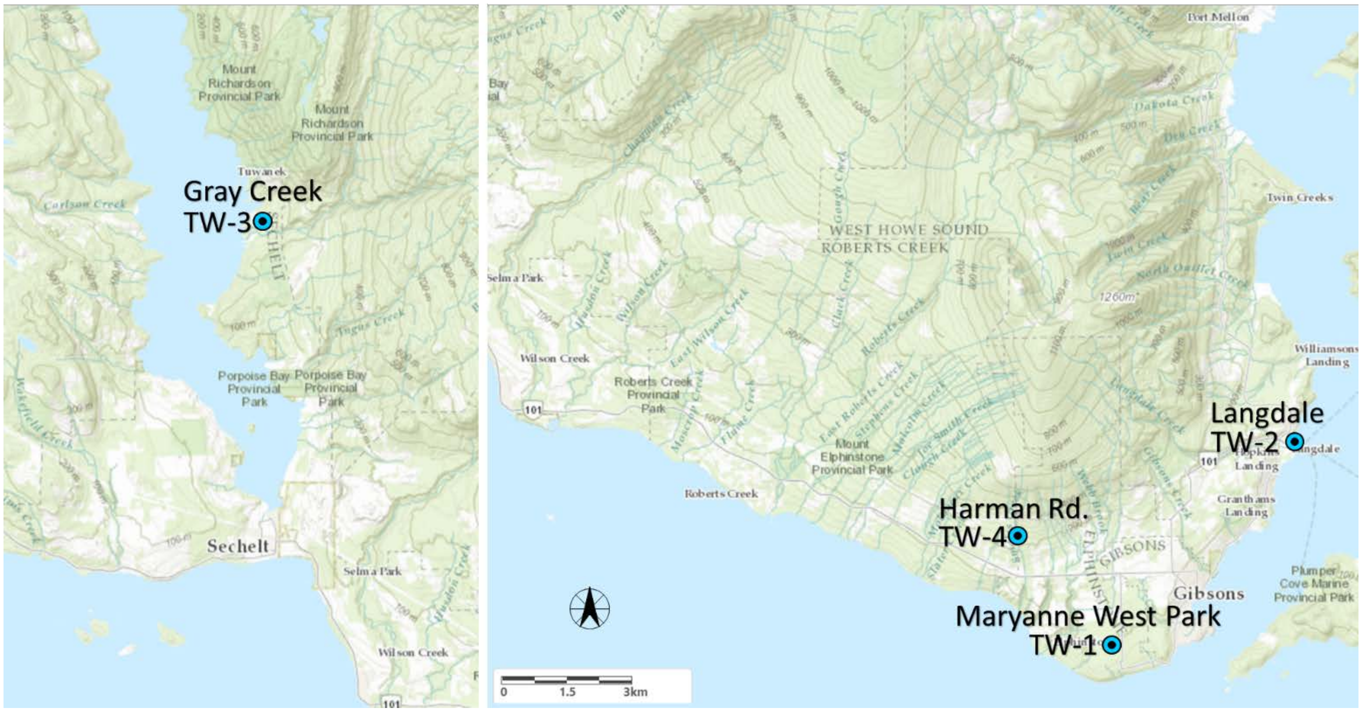



**Figure 1: Test Well Drilling Sites: Test Well No. 1 (TW-1) at Maryanne West Park, Test Well No. 2 (TW-2) at Langdale; Test Well No. 3 (TW-3) at Gray Creek; and Test Well No. 4 (TW-4) at Harman Rd.**

## 2. Implementation of the Field Work

The field work commenced on September 23, 2020, with the drilling of **Test Well No. 1** (**Maryanne West Park**) and was concluded on December 18, 2020 (**Test Well No. 4** on **Harman Road**). Broadly speaking, the field work entailed the drilling, construction, and development of the test wells, completing 48-hour duration continuous pumping tests (except for **Test Well no. 4**), in addition to hydrogeological field investigations (i.e.: recording borehole lithology based on soil samples retrieved during drilling; a grain size analysis was completed on selected aquifer soil samples in support of well screen selection). **Table 1** summarizes selected well and aquifer information for each test well. **Figure 2** (next page) shows project illustrations.

**Table 1. Well and Aquifer Information**

| Description | Units | Test Well No. 1 | Test Well No. 2 | Test Well No. 3 | Test Well No. 4 |
|---|---|---|---|---|---|
| | | Maryanne West Park | Langdale | Gray Creek | Harman Road |
| Civic Address | | 1224 Chaster Road | 1410 Sunshine Coast Hwy | District of Sechelt Road Dedication | Harman Road Right-of-Way |
| Construction / testing | | Sep 23 - Oct 23, 2020 | Oct 28 - Nov 13, 2020 | Nov. 26 - Dec. 11, 2020 | Dec.10 - 18, 2020 |
| Well ID No. | | 23761 | 23762 | 23763 | 23764 |
| Aquifer material | | sand and gravel | sand and gravel | sand and gravel | bedrock* |
| Depth to aquifer | m-bgs | 79 | 11 | 9.1 | Water bearing fractures @ 171 & 238 m-bgs (~ 0.95 L/s) |
| Aquifer thickness | m | 35 | 56 | 15 | |
| Completed well depth | m-bgs | 108 | 64 | 24 | 244 |
| Well screen interval | m-bgs | 104 - 108 | 60 - 64 | 18 - 24 | - |
| Static water level | m-bgs | 80 | 3.6 | 5.4 | 44 |

* The encountered water bearing sand and gravel aquifer at 38 m-bgs was only 1.5 m in thickness, producing about 1.6 L/s.


**Figure 2. The figures illustrate: (1) Drill rig used for drilling the test wells (air / dual rotary drilling technology); (2) an example of an aquifer soil sample retrieved during drilling; (3) section of a well screen; (4) well development in progress - compressed air is used to lift groundwater to surface.**

## 3. Key Findings

**Water Quantity (Production Well Capacity):**

Based on the results of the test well program, the estimated production well yield potential is presented in **Table 2**. Make note that higher well yields are anticipated for the proposed larger diameter production wells.

**Table 2. Water Quantity Results**

| Description | Well Field Location | | | |
|---|---|---|---|---|
| | Maryanne West Park<br>Test Well No. 1 | Langdale<br>Test Well No. 2 | Gray Creek<br>Test Well No. 3 | Harman Road<br>Test Well No. 4 |
| **Tested Well Pumping Rate** | 17.5 L/s | 22.0 L/s | 6.3 L/s | *not tested* |
| **Single Production Well Potential (* Includes a 30% Safety Factor)** | 19+ L/s * | 24+ L/s * | 6.3+ L/s * | Est. 1-2 L/s |
| **Potential for Multiple Production Wells (Well Field)** | yes | yes | yes | no |

**Water Quality:**

Results of the preliminary raw water quality analysis completed for water samples collected from **Test Wells Nos. 1, 2 and 3** suggest that for the analyzed constituents the water quality meets Canadian Drinking Water Guidelines for maximum acceptable concentrations. Only **Test Well No. 2** (**Langdale**) exceeded aesthetic objectives, i.e.: for iron and manganese concentrations. These are not considered health concerns; if these elevated concentrations persist with pumping, water treatment and /or blending with the existing water system supply may be required. The analysed water of **Test Well No. 3** (**Gray Creek**) reported a pH value of 6.76. Source waters with pH values consistently less than 7.0 may require treatment in order to raise the pH and enhance the effectiveness of chlorination.

**Source Protection:**

A preliminary assessment of groundwater at risk of containing pathogens (GARP) was completed for the test wells (Maryanne West Park, Langdale and Gray Creek sites), and all three sites were determined to be within 300 m of a probable enteric viral contaminant source (septic disposal fields) without a barrier (aquitard) to viral transport. Consequently, all three groundwater sources should be assumed to be at risk of containing pathogens. This risk is mitigated with chlorination as is currently the practice with all SCRD water sources.

**Stream-Aquifer Interaction:**

A preliminary assessment of the likelihood of hydraulic connection of the aquifers to nearby streams suggest that:

- **Maryanne West Park Site:** the aquifer is unlikely hydraulically connected to Chaster Creek.
- **Langdale Site:** the aquifer is unlikely directly hydraulically connected to Langdale Creek.
- **Gray Creek Site**: the aquifer is likely hydraulically connected to Gray Creek.

## 4. Outcome of the Multiple-Criteria Analysis

The **Multiple-Criteria Analysis Workshop**, held virtually on January 6, 2021, was attended by SCRD staff and KWD's project team members. Maryanne West Park, Langdale and Gray Creek test well sites were evaluated on the following criteria and sub-criteria:

- ✓ **Groundwater source**: *production well yield potential, water quality, and source protection.*
- ✓ ***Economic:*** *estimated costs for well construction, infrastructure, energy cost, estimated cost per litre per second, and possible water treatment cost assumption*.
- ✓ **Regulatory considerations and criteria that may affect groundwater licensing process:** *environmental flow need requirements, surface water - groundwater interaction, confirmed large groundwater users, anticipated ease of obtaining a groundwater licence*.
- ✓ **Practical & other considerations**: *land ownership, available space for building, well field development potential, resiliency, and local archaeology*.

The results are summarized in **Table 3**. The higher the score the better the site is for groundwater development. The scoring results suggest that, in essence, all three sites received over 70 percent of the total score available and thus are considered suitable for groundwater development advancement at this time.

**Table 3. Multiple-Criteria Analysis Results**

| Criteria (Weight) | Test Well No. 1 | Test Well No. 2 | Test Well No. 3 |
|---|---|---|---|
| | Maryanne West Park | Langdale | Gray Creek |
| 1. Groundwater Source (45%) | 1.24 | 1.13 | 0.79 |
| 2. Economic (30%) | 0.73 | 0.69 | 0.69 |
| 3. Regulatory Considerations (15%) | 0.23 | 0.41 | 0.45 |
| 4. Practical Considerations (10%) | 0.28 | 0.21 | 0.23 |
| **Total Score (out of 3.00)** | **2.47** | **2.44** | **2.15** |

## 5. Conclusions

Based on the results of the groundwater investigation program at **Maryanne West Park**, **Langdale**, and **Gray Creek** test well sites and the multiple-criteria analysis outcome, KWD concludes the following:

- ✓ Maryanne West Park, Langdale, and Gray Creek sites are suitable for production well development.
- ✓ All three sites a suitable for developing a well field with two or more production wells.
- ✓ All three sites have water quality that meets the maximum acceptable concentration for the tested water quality parameters. It is anticipated that only chlorination is required for all three test well sites.
- ✓ For all three sites pathogen risk can be mitigated with chlorination.

## 6. Recommendations

Based on the conclusions for the groundwater investigation program, KWD recommends the following:

- ✓ Proceed with the development of a well field comprising two production wells at the three test well sites: **Maryanne West Park**, **Langdale**, and **Gray Creek**; having a second production well not only increases well field production potential but also provides a mechanical backup and thus ensure well field resiliency and is more cost-efficient in terms of cost per litre per second.
- ✓ Consider the implementation of a long-term water and groundwater monitoring program as part of future aquifer and watershed management initiatives.
- ✓ Undertake all technical analyses and monitoring (including water level monitoring for Langdale Creek and Gray Creek) required for Water Licence applications and future effect monitoring.
- ✓ Begin the concurrent Water Licence application for each of the well site locations.

## 7. Estimated Costs for Well Field Development and Related Infrastructure

The estimated cost to develop two production wells at each site and to connect the well field to the Chapman Water System is as follow (**Table 4**):

**Table 4. Cost Estimates**

| Description | Well Field Location | | |
|---|---|---|---|
| | Maryanne West Park | Langdale [a] | Gray Creek [a] |
| Assumed Well Field Productivity (2 Wells) | 38 L/s | 48 L/s | 13 L/s |
| **Construction Cost for Two Production Wells** *Construction, Hydrogeology, Engineering, Permitting, Additional Studies* | $ 0.92 M | $ 0.79 M | $ 0.68 M |
| **Infrastructure Costs** *Building, Mechanical, Electrical, Civil, Engineering, Permitting, Contingency* | $1.48 M | $ 1.40 M | $ 1.14 M |
| **Watermain** *Tie-in to Existing Water System, Contingency* | $ 0.39 M | $ 1.59 M | $ 0.18 M |
| **Sub-Total Estimate** | **$ 2.79 M** | **$ 3.78 M** | **$ 2.01 M** |
| **30% Contingency** | $ 0.84 M | $ 1.13 M | $ 0.60 M |
| **Total Estimate** | **$ 3.63 M** | **$ 4.91 M** | **$ 2.61 M** |
| Cost per Litre per Second (based on Sub-Total) | $ 72 K | $ 78 K | $ 158 K |
| Energy Cost | $103 / 1000 $m^3$ | $66 / 1000 $m^3$ | $72 / 1000 $m^3$ |

[a] Possible additional water treatment requirements

## 8. Closure

This project summary was prepared as a precursor to the forthcoming technical report and will be part of SCRD's public record. KWD would like to thank the SCRD for the opportunity to lead and conduct Groundwater Investigation Phase 2, Part 2 and Groundwater Investigation Phase 3 – Gray Creek.

Respectfully submitted,

**Kalwij Water Dynamics Inc.**

PROFESSIONAL PROVINCE OF Dr. I. M. KALWIJ # 36260 BRITISH COLUMBIA ENGINEER

Jan. 15, 2021

Ineke Kalwij, Ph.D., P.Eng.

Project Manager and Hydrogeological Engineer
Direct: +1 (604) 615-4932
Email: ineke@kalwijwaterdynamics.com

**SUNSHINE COAST REGIONAL DISTRICT STAFF REPORT**

**TO:** Special Infrastructure Services Committee – January 20, 2021

**AUTHOR:** Remko Rosenboom, General Manager, Infrastructure Services
Robyn Cooper, Manager, Solid Waste Services

**SUBJECT:** **FUTURE WASTE DISPOSAL OPTIONS ANALYSIS STUDY – RESULTS AND NEXT STEPS**

## RECOMMENDATION(S)

**THAT the report titled Future Waste Disposal Options Analysis Study – Results and Next Steps be received;**

**AND THAT a Future Waste Disposal Options Analysis Study Part 3 - Detailed Analysis proceed with conducting a detailed analysis of the feasibility of siting a landfill and a waste export facility;**

**AND FURTHER THAT a 2021 Budget Proposal be prepared for a Future Waste Disposal Options Analysis Study – Next Steps including the parallel development of preliminary cost design, Class C estimates and other relevant technical analyses for a new landfill and a new transfer station (for waste export) as well as an associated public engagement process.**

## BACKGROUND

As per resolution 351/20 No. 2, staff initiated the Future Waste Disposal Options Analysis Study Part 1 and Part 2. This project will help direct the next steps for waste disposal beyond the lifespan of the Sechelt Landfill which as of November 29, 2019, had approximately six years of capacity remaining, until early 2026. An updated landfill life estimate will be available late Q1 2021.

Part 1 – Demand Analysis consisted of completing a demand analysis for future waste disposal. Whereas Part 2 - Feasibility consisted of a preliminary feasibility study of three options: siting a new landfill, waste export (barging off-coast for disposal elsewhere) and development of a waste to energy facility. As well, Part 2 allowed for the consultant to propose another option for consideration.

Part 3 - Detailed Analysis has not been initiated yet. Part 3 consists of conducting a more detailed analysis of one or possibly two of the options that resulted from Part 2 of the project. This third part is to advance work in 2021 ahead of an approval of a Budget Proposal for Future Waste Disposal Options Analysis Study – Next Steps, should the Board direct to do so.

The purpose of this report is to share the findings from Parts 1 and 2 of the project and to seek Board direction to proceed with Part 3.

## DISCUSSION

The Future Waste Disposal Options Analysis Study report was prepared by Tetra Tech Canada Inc. (Tetra Tech) and is included as Attachment A.

The report includes a multi-criteria analysis of four options. A summary of the options is presented below.

Option 1 - New Landfill: Siting a new landfill ranked highest in the multi-criteria analysis. A landfill was identified to have the lowest financial costs (preliminary costing), high social considerations with high job retention/creation and a high system resiliency of the SCRD maintaining control of disposal requirements and costs. Landfill ranked medium for environmental considerations due to high GHG emissions but low level of environmental risk to the community. However, although regulatory approval is possible, there is much pre-work and process prior to receiving such approvals.

Option 2 - Waste Export (third-party disposal): Waste Export ranked second highest in the multi-criteria analysis. Waste Export involves the construction of a transfer station and barging the waste off-cost for disposal at a third-party site, potentially located in Oregon or Washington. This option has medium ranked GHG emissions, low environmental risk with low to medium social considerations identified for system resiliency as the costs are variable with little SCRD control over those costs. The tipping fee costs are subject to market forces and exchange rates. However, regulatory approvals for waste export are expected with minimal hurdles.

Option 3 Waste to Energy: Waste to Energy ranked lowest in the multi-criteria analysis. Waste to Energy ranked lowest for financial considerations due to there being a high level of pre-approval investment and high future liabilities (high ongoing operational costs and decommissioning costs.) This option ranked low for GHG emissions, medium for environmental impacts, high for job creation and low for system resiliency due to likely limitation of acceptance of all waste created in SCRD. As well, it is not expected that regulatory approvals would easily be granted. The SCRD would be required to achieve a minimum of 70% diversion prior to the regulator even considering approval of this approach. The SCRD currently has approximately a 55% diversion rate.

Option 4 - Landfill Expansion: Expanding the current landfill ranked third of the four options in the multi-criteria analysis. A vertical expansion is the only potential landfill expansion option that would meet the regulatory requirements to remain within the existing waste footprint. There is no adjacent land to consider for a horizontal expansion. Landfill expansion was identified to have medium financial costs (preliminary costing), ranked lowest for environmental considerations due to the high GHGs and medium environmental impact. For social considerations, this option ranked lowest due to maintaining current levels of job creation and does not offer system resiliency but instead offers a short-term solution, if required, to plan and develop other options. Regulatory approvals are expected with minimal hurdles. However, this option has challenging engineering and operational implications.

*Options and Analysis*

Based on the findings in the Tetra Tech report, staff recommend that a Future Waste Disposal Options Analysis Study Part 3 - Detailed Analysis proceed with conducting a detailed analysis of siting a landfill and waste export. Staff also recommend advancing the analysis of these two options in tandem as opposed to sequentially.

Long term, a landfill is expected to be financially the most favourable. It also allows for SCRD control over the entire disposal process and associated costs. It is acknowledged that there are a lot of unknowns to be confirmed. A Part 3 – Detailed Analysis for siting a new landfill would include a detailed feasibility study of land acquisition, financial, technical, regulatory and operational considerations.

The desktop study assessed three potential locations for siting a landfill. Based on the assessments completed to date, staff recommend to focus Part 3 of this project on the development of a landfill in the area in Halfmoon Bay identified in the report. The former Halfmoon Bay Landfill is located in the vicinity of this area.

Based on the assessments completed to date, it can be concluded that waste export (third-party disposal) is considered the only feasible alternative if the development of a landfill is not successful. Given the anticipated remaining life of the Sechelt Landfill, staff recommend advancing the feasibility of this option. A Part 3 – Detailed Analysis for waste export would include identifying a preferred location for a transfer station as well as the detailed feasibility study of land acquisition, financial, technical, regulatory and operational considerations for such location. One of the locations that would be assessed for its potential to develop a transfer station would be the Hillside Industrial Park.

Staff recommend to discontinue advancing development of a waste to energy facility. The SCRD would need to achieve a minimum of 70% diversion before the Ministry of Environment and Climate Change Strategy would consider this as a viable disposal option for the SCRD. Based on the timelines to reach this diversion target and to initiate further feasibility of a waste to energy facility, a facility would not be operational prior to the Sechelt Landfill closing. Also, there are currently no partnership opportunities with other local governments who are already in the process of developing a waste to energy facility. As well, this option is cost prohibitive and the environmental considerations are great. For these reasons, this option is not considered viable.

Despite the potential to increase landfill life by four to five years, Staff recommend to discontinue advancing the landfill expansion due to the financial considerations as well as the engineering and operational requirements which are very challenging and may be prohibitive of an expansion.

The results from Part 3 are expected to be presented to the Board early Q2 2021.

*Organizational and Intergovernmental Implications*

All of the potential future waste disposal options will have significant impacts on the staff and the services provided by the SCRD Solid Waste Division.

All of these options will have implications for waste management services currently provided by all of the local governments on the Sunshine Coast.

*Financial Implications*

The approved budget for this project is $175,000 and includes Parts 1, 2 and 3. There is $50,000 of funds available to complete Part 3.

A Budget Proposal for a Future Waste Disposal Options Analysis Study – Next Steps is currently under development.

*Timeline for next steps*

It is anticipated that results from Part 3 will be presented to the Board in early Q2 2021.

Staff recommend that the 2021 Budget Proposal be prepared for a Future Waste Disposal Options Analysis Study – Next Steps includes the parallel development of preliminary cost design, Class C estimates and other relevant technical analyses for a new landfill and a new transfer station (for waste export) as well as an associated public engagement process. In Q2 2021 when staff present the results of Part 3 of the current project, staff will confirm the scope of this next project phase with the Board.

Parallel development of the two options is recommended in case siting a new landfill is not successful. As well, Class C estimates could also be used to apply for grants or to seek electoral approval for a long-term loan via AAP or assent vote process (referendum) if required.

*Communications Strategy*

Staff consider it to be very valuable to engage early on in the development of the long-term plan for the disposal of solid waste with the general public. Such process would allow for early information sharing and exchange. Staff are therefore recommending to initiate a public participation process in Q3 2021 as part of a next project phase. Subsequently, the Board could consider the input from this process at the same time it’s considering the costs and other technical considerations associated with both future waste disposal options.

## STRATEGIC PLAN AND RELATED POLICIES

One of the tactics in the 2019-2025 Strategic Plan is to “Undertake Solid Waste Management Demand Analysis and develop options for long-term solid waste management approach for garbage, recycling, organics”. This project directly supports that tactic.

## CONCLUSION

Based on the findings of the assessments completed to date, staff recommend undertaking more detailed feasibility studies for the development of a landfill in the Halfmoon Bay area and a transfer station at a location favorable for the export of waste. These assessments could be undertaken as ‘Part 3’ of the current project.

Based on the currently available information, staff are recommending that the next project phase would include the development of preliminary cost design, Class C estimates and other relevant technical analyses for a new landfill and a new transfer station (for waste export). Parallel to these activities, a public participation process is recommended to be initiated.

**Attachments:**

Attachment A – Tetra Tech Canada Inc. Future Waste Disposal Options Analysis Study report

| Reviewed by: | | | |
|---|---|---|---|
| Manager | | Finance | |
| GM | | Legislative | |
| CAO | X - D. McKinley | Other | |

Attachment A

# Sunshine Coast Regional District
# Future Waste Disposal Options Analysis Study

PRESENTED TO
**Sunshine Coast Regional District**

JANUARY 15, 2021
ISSUED FOR REVIEW
FILE: 704-SWM.SWOP04367-01

*This "Issued for Review" document is provided solely for the purpose of client review and presents our interim findings and recommendations to date. Our usable findings and recommendations are provided only through an "Issued for Use" document, which will be issued subsequent to this review. Final design should not be undertaken based on the interim recommendations made herein. Once our report is issued for use, the "Issued for Review" document should be either returned to Tetra Tech Canada Inc. (Tetra Tech) or destroyed.*

Tetra Tech Canada Inc.
Suite 1000 – 10th Floor, 885 Dunsmuir Street
Vancouver, BC V6C 1N5 CANADA
Tel 604.685.0275 Fax 604.684.6241

This page intentionally left blank.

# TABLE OF CONTENTS

## LIST OF TABLES IN TEXT



## LIST OF FIGURES IN TEXT



## APPENDIX SECTIONS

### TABLES

## FIGURES



## APPENDICES

## ACRONYMS & ABBREVIATIONS

| Acronyms/Abbreviations | Definition |
|---|---|
| CVRD | Cowichan Valley Regional District |
| EPA | Environmental Protection Agency (United States) |
| DOCP | Design, Operations and Closure Plan |
| GHG | Greenhouse Gas |
| MSW | Municipal Solid Waste |
| NPV | Net Present Value |
| PHTS | Pender Harbour Transfer Station |
| qRD | qathet Regional District |
| RDF | Refuse Derived Fuel |
| RMOW | Resort Municipality of Whistler |
| SCRD | Sunshine Coast Regional District |
| SSO | Source Separated Organics |
| SWMP | Solid Waste Management Plan |
| TPY | Tonnes Per Year |
| TS | Transfer Station |
| UAV | Unmanned Aerial Vehicle |
| WARM | Waste Reduction Model |
| WTE | Waste-to-Energy |

### LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of the Sunshine Coast Regional District and their agents. Tetra Tech Canada Inc. (Tetra Tech) does not accept any responsibility for the accuracy of any of the data, the analysis, or the recommendations contained or referenced in the report when the report is used or relied upon by any Party other than Sunshine Coast Regional District, or for any Project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user. Use of this document is subject to the Limitations on the Use of this Document attached in the Appendix or Contractual Terms and Conditions executed by both parties.

# 1.0 INTRODUCTION

Tetra Tech Canada Inc. (Tetra Tech) was retained by the Sunshine Coast Regional District (SCRD) to conduct an analysis of future waste disposal options for waste generated from the Sunshine Coast.

The Sechelt Landfill is expected to reach its capacity in the next five years and the disposal options analysis is intended to assist the SCRD in determining which solid waste management approach should be considered for solid waste generated in the future. Important considerations for this analysis include an understanding of future trends in the solid waste industry, market factors affecting tipping and shipping costs, and long-term risk factors including changes to environmental regulations and waste export regulations.

## 1.1 Background

Solid waste generated on the Sunshine Coast is currently delivered to one of two locations – the Pender Harbour Transfer Station and the Sechelt Landfill. The Pender Harbour Transfer Station receives waste from the northern portion of the Sunshine Coast which is then transferred to the Sechelt Landfill for burial. Waste from the remaining part of the Sunshine Coast is directly delivered to the Sechelt Landfill. Both facilities are operated by the SCRD.

In 2019, approximately 13,563 tonnes of waste was buried at the Sechelt Landfill, with approximately 1,279 of that tonnage originating from the Pender Harbour Transfer Station.

The strategic plan for the SCRD in their solid waste management plan (SWMP)[1] includes the following key themes:

- **Zero Waste:** To maximize the reduction of solid waste disposal and to encourage reuse, recycling and recovery of resources across the region.
- **Social and Environmental Sustainability:** To establish a state in which future needs of the present generation are met without compromising the ability of future generations to meet their own needs.
- **Financial Sustainability:** To maintain service obligations to the public and employees without increasing the debt or tax burden relative to the economy in which it operates.
- **Greenhouse Gas Reduction:** To reduce greenhouse gas (GHG) emissions in the region.

## 1.2 Project Objectives

The scope of work is divided into three parts: (Part 1) demand analysis, (Part 2) feasibility study, and (Part 3) detailed analysis. The demand analysis will estimate the quality and quantity of materials expected to be disposed over the next 30 years. The feasibility study has identified four options, as outlined in the RFP: (Option 1) siting a new landfill, (Option 2) disposal at a third-party facility, (Option 3) development of a waste to energy facility, and (Option 4) an alternative solution proposed by Tetra Tech. These options would be evaluated using multi-criteria analysis based on the information developed by Tetra Tech and evaluation criteria input from the SCRD.

At the direction of the SCRD Board of Directors, a detailed analysis will be completed for the preferred option(s) to confirm feasibility and further establish costs and plans for future waste disposal.

[1] AECOM Canada Ltd & SCRD Infrastructure Services Department. (2011). Solid Waste Management Plan – The Foundation for Zero Waste Plan – Final Draft. August 2011.

The objective of each component of the project is to answer the following key questions:

- **Demand Analysis:**
  - How much waste will be disposed in the SCRD from 2026 to 2056 (30 years after the landfill closes)?
  - How much airspace or processing capacity will be required?
  - How much waste will come from each sector?
  - How will the composition of waste change in the future?
  - How will waste quantities and composition change with new diversion programs being implemented?
- **Feasibility Study Option 1 - Landfill Siting:**
  - Are there suitable locations for siting a new landfill in the SCRD?
  - Would the regulators support siting a new landfill in the SCRD?
  - What are the expected capital and operating costs for a new landfill?
  - What are important considerations for siting landfills in British Columbia?
- **Feasibility Study Option 2 - Third-Party Disposal (Waste Export):**
  - What third-party facilities are available to accept waste from the SCRD?
  - What supporting facilities would the SCRD need to construct and operate to export waste to other facilities?
  - What are the long-term trends for waste export and tipping fees?
  - What are the capital and operating costs expected for third-party disposal of waste from the SCRD?
- **Feasibility Study Option 3 – Waste-to-Energy Facility:**
  - What are Waste-to-Energy facilities and what are their advantages and disadvantages?
  - What are the capital and operating costs expected for a new Waste-to-Energy Facility?
  - What municipalities or neighbouring regional districts could partner to support a Waste-to-Energy Facility?
  - Are reliable, market-proven technologies available to process the amount of waste available as feedstock?
- **Feasibility Study Option 4 - Alternative Solutions:**
  - What other options are available for waste disposal in the SCRD?

# 2.0 PART 1 – DEMAND ANALYSIS

The existing waste management systems and programs are presented below as background. Using SCRD data, a demand analysis of waste disposal was projected using trends in factors that will bear upon the current demand. These factors include population growth, current and planned diversion programs, and regulatory framework. Disposal tonnage and landfill airspace projections until 2056 were made to present an estimation of potential impacts on SWM infrastructure. The demand analysis included the following:

- Estimation of disposal rates between 2020 and 2056 based on current waste management practices, new waste diversion programs and trends that may further affect disposal rates; and,
- Predicted airspace requirements based on different disposal rate scenarios.

## 2.1 Solid Waste Management System

The SCRD is located within the traditional territories of the Sechelt and Squamish First Nations. SCRD's municipalities and electoral areas include: District of Sechelt, Town of Gibsons, Sechelt Indian Government District, Egmont/Pender Harbour, Halfmoon Bay, Roberts Creek, Elphinstone, and West Howe Sound. Figure 2-1 illustrates the boundaries of the SCRD and the communities within the boundary. Roughly 50% of the population lives between Gibsons and Sechelt, and most of the residents live within proximity to the highway corridor that runs between Gibsons and Earls Cove.

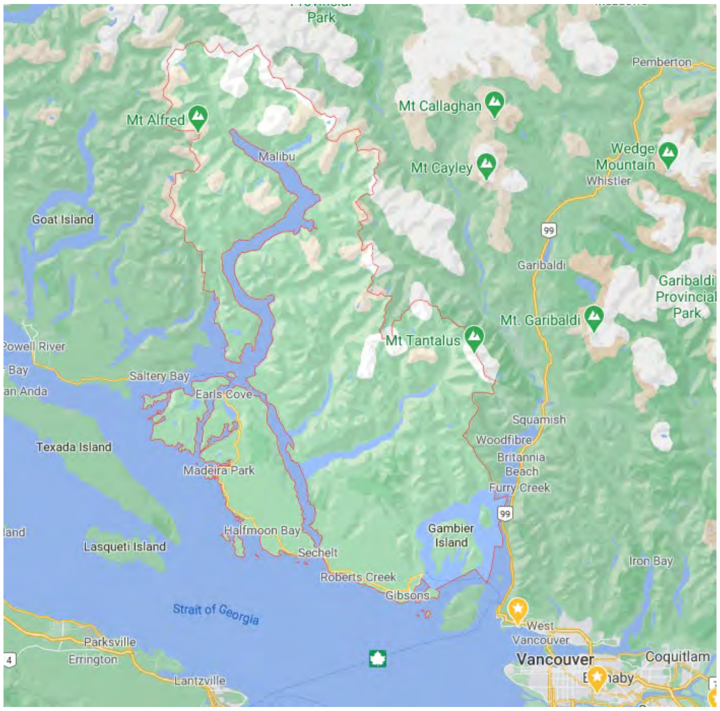



**Figure 2-1: SCRD Boundaries**

### 2.1.1 Programs and Infrastructure

Approximately 95% of the population have curbside collection services for garbage. Some residents have curbside recycling but the majority use recycling depots. There are three recycling depots operated by the SCRD via contracted services, one in Gibsons, one in Sechelt, and the other at Pender Harbour. The SCRD is responsible for four landfills, one active and three closed. Sechelt Landfill (pictured in Figure 2-2) is active and had approximately 143,800 m$^3$ of airspace remaining as of December 2018 according to the 2018 landfill Annual Report. According to the current Design, Operations and Closure Plan (DOCP)[2]. Pender Harbour Landfill was closed on July 20, 2015, and then began operation as a transfer station. The Pender Harbour Transfer Station (PHTS) services Electoral Area A, where residents and businesses can self-haul their waste. Waste is then transferred from the PHTS to the Sechelt Landfill for burial.

2 XCG Consulting Limited. (2017). Design, Operations, and Closure Plan: Sechelt Landfill, Sechelt, British Columbia. December 20, 2017.

Figure 2-2: Sechelt Landfill

In October 2020, the SCRD expanded its collection services to include green bin collection, for household food waste and food-soiled compostable paper. This was incorporated with a transition to an every-other-week garbage collection program to encourage residents to participate in the source separated organics (SSO) program. Presently, a permanent or pilot green bin program is available to many residents in municipalities and electoral areas. A green bin program is not in place for the Sechelt Indian Government or Electoral Area A. A pilot program is in place for the District of Sechelt. The collected SSO materials are taken to a private composting facility. This facility uses a GORE-cover system to compost yard waste, food scraps and fish waste.

### 2.1.2 Historical Tonnages

This section summarizes the historical tonnages (2011 to 2019) of material disposed and diverted in the SCRD. As of July 20, 2015, waste from PHTS was transferred to the Sechelt Landfill for burial. Table 2-1 presents the historical disposal and diversion tonnages in the SCRD[3,4]. Portrayed diversion statistics are not inclusive of green waste.

**Table 2-1: Historical Disposal and Diversion Tonnages in the SCRD**

| Year | Disposal | | | Diversion | | |
|---|---|---|---|---|---|---|
| | Pender Harbour TS | Sechelt Landfill | Total Buried Waste | Diversion at Landfill and Transfer Station | Curbside Recycling Collection | Depot Recycling |
| 2011 | 1,246 | 10,923 | **12,169** | 1,444 | 667 | 1,257 |
| 2012 | 1,155 | 10,524 | **11,679** | 2,438 | 701 | 1,510 |
| 2013 | 1,158 | 9,071 | **10,229** | 2,285 | 685 | 1,495 |
| 2014 | 1,338 | 10,447 | **11,785** | 2,244 | 642 | 1,367 |
| 2015 | 1,816 | 10,545 | **12,361** | 3,614 | 774 | 1,121 |
| 2016 | 1,183 | 11,493 | **12,677** | 4,427 | 1,107 | 1,179 |
| 2017 | 1,155 | 11,820 | **12,976** | 4,873 | 1,113 | 1,204 |
| 2018 | 1,197 | 11,697 | **12,894** | 4,560 | 1,050 | 1,234 |
| 2019 | 1,279 | 12,285 | **13,563** | 3,257 | 940 | 1,278 |

3 Sunshine Coast Regional District. (2020). Request for Proposal 2035008 Future Waste Disposal Options Analysis Study.
4 Sunshine Coast Regional District. (n.d.). Regional Diversion. Retrieved from https://www.scrd.ca/diversion

### 2.1.3 Waste Composition

In 2014 and 2015, the SCRD engaged Dillon Consulting Limited to conduct waste audits with the objective of providing quantitative data and a baseline of the region's waste composition. Table 2-2 is adapted from the results from the Dillon Waste Composition Report[5] and shows the municipal solid waste (MSW) and roll-off bin averages of major material categories in the SCRD waste stream.

The sampled roll-off bins were from the PHTS and the public drop-off area at the Sechelt Landfill. "Municipal Solid Waste" as defined is inclusive of the curbside garbage collection from the following sub-regions:

- District of Sechelt;
- Town of Gibsons;
- Sechelt Indian Government District;
- Electoral Area B;
- Electoral Area D & E (south of Hwy 101); and
- Electoral Area D & D (North of Hwy 101) and F.

**Table 2-2: 2014/2015 SCRD Waste Composition**

| Primary Material Category | Municipal Solid Waste | Roll-off Bins |
|---|---|---|
| Food Waste | 34% | 11% |
| Yard and Garden Waste | 1% | 2% |
| Pet Waste | 4% | 1% |
| Food Soiled Paper | 9% | 4% |
| **Total Organics** | **48%** | **17%** |
| Curbside and Depot Recyclables[6] | 23% | 16% |
| Other Stewardship Materials | 2% | 6% |
| **Total Recyclables** | **25%** | **22%** |
| **Residuals** | **27%** | **61%** |

Note that while pet waste is predominantly organic, it is not generally collected as part of a curbside SSO program. So, the total amount of organics that could potentially be collected as part of an SSO program is 44% of the MSW stream by weight.

5 Dillon Consulting Limited. (2014). Waste Composition Audit: Sunshine Coast Regional District. December 5, 2014.

6 Curbside and depot recyclables were classified in the Waste Composition study based on the program available from Recycle BC (then Multi-Material BC) in 2014 which did not include all materials that are currently accepted in the program.

### 2.1.4 Current Waste Management Summary

Table 2-3 summarizes key solid waste metrics in the SCRD based on the 2018 annual landfill report. The per capita diversion rate is calculated to be 56%[7].

**Table 2-3: SCRD Key Solid Waste Metrics (2018)**

| Description | Metric |
|---|---|
| **Population** | |
| SCRD Population | 30,398 |
| **Disposal and Diversion** | |
| Annual Disposal | 12,894 tonnes |
| Per Capita Waste Disposal | 424 kg/year |
| Annual Diversion | 16,368 |
| Diversion Rate | 56% |
| **Current Landfill Stats** | |
| Current Tipping Fee | $150/tonne |
| Landfill Disposal Capacity | 4-5 years |

## 2.2 Disposal Projections

The following estimates the amount of solid waste that would need to be disposed between 2026 and 2056 (30 years after the landfill reaches capacity) The demand analysis takes into consideration future population growth and potential waste diversion scenarios.

### 2.2.1 Population Projection

Population projections are based on the Government of British Columbia's regional district population estimates[8]. For the SCRD, it was determined that the average rate of population change between 2011-12 and 2018-19 was approximately +1.17% annually. Figure 2-3 illustrates the estimated population projection for the SCRD assuming an increase of 1.17% per year. The estimated populations in 2056 is 46,282.

7 Sunshine Coast Regional District. (n.d.). Regional Diversion. Retrieved from https://www.scrd.ca/diversion
8 Population estimate based on of BC states average population growth rate from 2011-2019

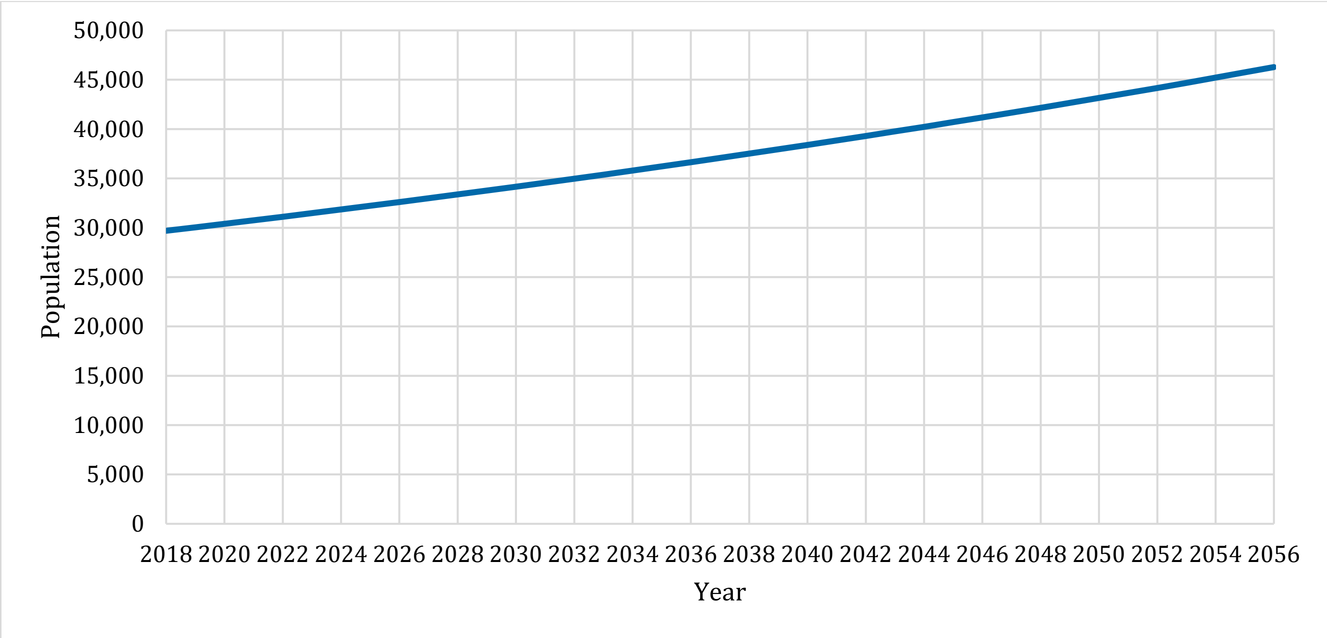



**Figure 2-3: SCRD Population Projection to 2056**

### 2.2.2 Waste Tonnage Projection

Over the timeframe of 2021 through 2056, it was determined that the annual waste generated in the SCRD will range from 13,833 to 20,892 tonnes per year. According to the SCRD, the Sechelt Landfill is expected to close in 2026. With the anticipated closure, the SCRD must seek new methods of which to manage its waste. Table 2-4 presents the SCRD tonnage and airspace waste requirements

**Table 2-4: Tonnage and Airspace Projections**

| Description | Value |
|---|---|
| Estimated Annual Tonnes (2026 – 2056) | 14,718– 20,892 tonnes |
| Annual Airspace Requirements (2026 – 2056) | 21,036– 31,656 $m^3$ |
| Estimated Tonnage after Landfill Closure (30-year horizon) | 550,000 tonnes |
| Estimated Airspace after Landfill Closure (30-year horizon) | 830,000 $m^3$ |

### 2.2.3 Potential Diversion Programs

As evident in the waste composition data discussed above, organics make up a significant portion of the waste disposed, an estimated 44% without considering pet waste (4%). Minimizing the amount of organics disposed in the Sechelt Landfill should reduce the amount of waste disposed, and ultimately extending the life of a landfill. The roll-out of the curbside SSO program in October 2020 should reduce the amount of waste disposed given high public participation rates.

Implementing additional diversion programs, such as ICI organics diversion or making the current diversion programs more stringent should decrease the demand for waste disposal.

## 2.3 Airspace Analysis

In this section the forecasted tonnages and airspace consumed for a landfill are presented. These projections are for the time period from 2026 (landfill closure) through to 2056 (30-year horizon). For these estimations, it is assumed that waste tonnages will increase in direct proportion to the population count of the SCRD. Over this time period, it is estimated that the SCRD will produce up to a total of 550,000 tonnes of waste. The projected annual tonnages are presented in Figure 2-4.

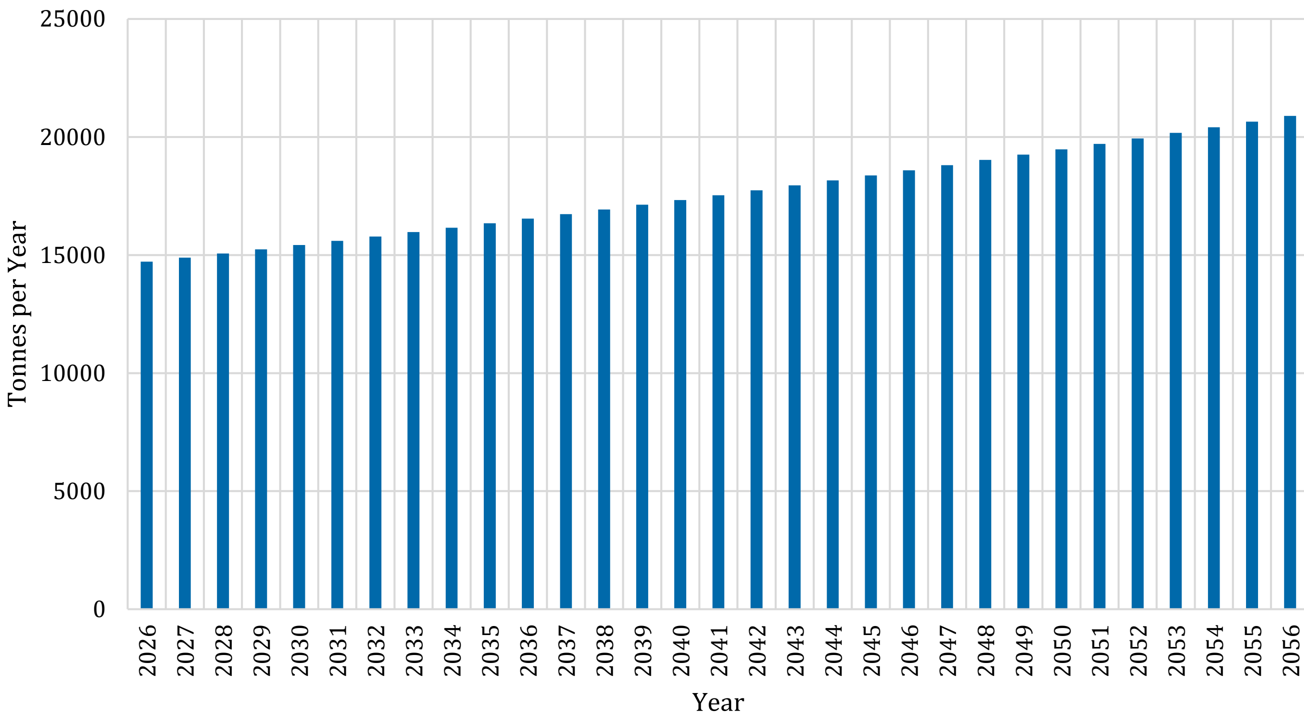



**Figure 2-4: Projected Waste Disposed per Year**

Based on the analysis above, the amount of MSW produced should increase from approximately 14,700 tonnes per year in 2026 to nearly 20,900 tonnes per year in 2056.

Figure 2-5 shows how the cumulative airspace would change from the baseline scenario if an optimistic organics diversion scenario was implemented. The pictured organics diversion scenario accounts for diversion in both the residential and ICI sectors. The air space analysis estimates that the SCRD will require a minimum of 830,000 cubic metres of total disposal capacity from 2026 to 2056.

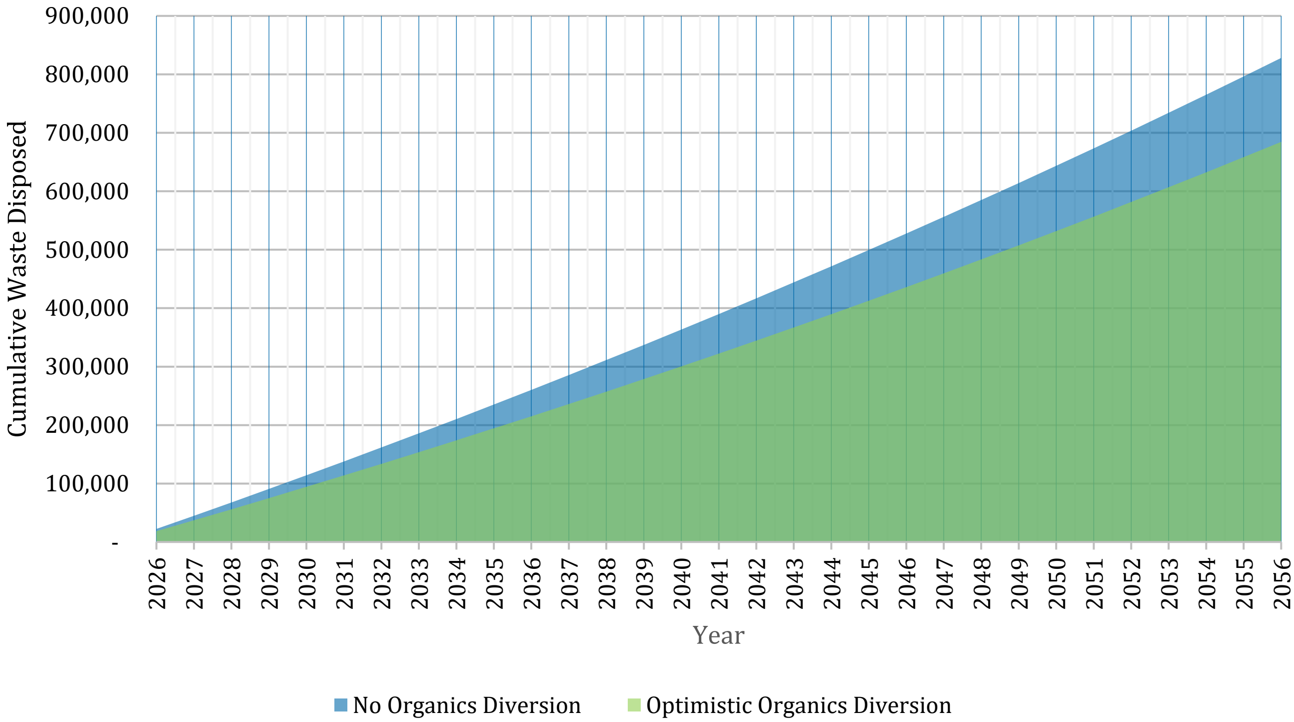



**Figure 2-5: Landfill Capacity over 30 Year horizon**

# 3.0 PART 2 – FEASIBILITY STUDY

This section examines the feasibility of the four options identified below.

Option 1 – Siting a New Landfill

Option 2 – Disposal at a Third-Party Facility

Option 3 – Development of a Waste-to-Energy Facility

Option 4 – Landfill Expansion

## 3.1 Option 1 – Siting a New Landfill

The objective of Option 1 is to identify whether there are any locations in the SCRD that, based on a desktop exercise, have characteristics that are potentially favourable for development of a Class II Landfill in accordance with the BC Landfill Criteria, and meet operational considerations including good road access and good access to utilities.

### 3.1.1 Overview

Tetra Tech initially considered the overall SCRD area. Based on the initial review and conversations with the SCRD, the study region was then narrowed down to three specific areas of interest (Figure 1). The areas of interest include the following:

1. Halfmoon Bay (Figure 2);
2. Mine Site near Egmont (Figure 3); and
3. Hillside North of Langdale (Figure 4).

### 3.1.2 Siting Criteria and Applied Constraints

The siting criteria outlined in the BC Landfill Criteria, as well as Tetra Tech's experience in siting landfills, were used to outline a series of conditions (constraints) that would range from unfavourable to favourable for the development of a landfill in a particular location. Some constraints are considered 'hard constraints' (for example, the presence of a river within 300 m) whereas some constraints are considered 'soft constraints' (for example proximity of a location to a major highway).

Tetra Tech used a GIS-based system of maps to evaluate various constraints to siting a landfill. The siting analysis was undertaken using a GIS-based review of information. This approach is advantageous because the procedures can be clearly documented, and the data is stored for future use, making it easy to repeat the analysis as required, or to refine the analysis during future more detailed investigation or application support. It also provides a degree of transparency to the process that can be of assistance in stakeholder discussions. Tetra Tech's preliminary evaluation of siting constraints was undertaken as a desktop review, with the focus of the review to narrow down potential locations for further evaluation through intrusive investigation.

The following constraints were considered for this preliminary siting evaluation and are summarized in Table 3-1 below.

- Water Features:
  - Water Supply: Landfill footprint must be > 300 m from water supply well or water supply intake and > 500 m from municipal or other high capacity water supply wells.
  - Surface Water: Landfill footprint must be > 100 m of surface water.
  - Floodplain: Landfill footprint must not fall within a floodplain.
  - Shorelines: Landfill footprint must be > 100 m of the sea level maximum high tide or seasonal high watermark of an inland lake shoreline.
  - Depth to Water Table: Landfill base must be > 1.5 m above 'groundwater' at all times. The separation distance must consider the hydrogeologic conditions at the site including the hydraulic capacity of the underlying soils.
- Biophysical:
  - Heritage/Archeological Sites: Landfill footprint is recommended to be >100 m from a heritage or archeological site. Landfill siting is subject to the requirements of the BC *Heritage Conservation Act*.

- Landfill Buffer Zone: Buffer zone between the landfill footprint and the landfill site boundary must be > 50 m, of which 30 m closest to the landfill site boundary must be reserved for natural or landscaped screening (berms and/or vegetative screens). Of the 20 m buffer closest to the landfill footprint, it can be used for access roads, surface water management (ditching), leachate management, landfill gas management and monitoring works, firebreaks, and other ancillary works as required.

- Gullies and Depressions: Landfill footprint must not be located in a gully or depression that acts as a point of water collection during rainfall events unless acceptable diversion works are provided such as ditching.

- Faults and Unstable Areas: Landfill footprint must be > 100 m of a geologically unstable area, this includes faults, areas underlain by weak soils or underground mine workings, areas prone to debris movement, among others.

- Environmental Sensitive Areas: Landfill footprint must be > 100 m of any environmentally sensitive areas such as parks, wildlife management areas, wetlands, bird sanctuaries, habitat of rare, threatened or endangered species, among others.

- Development and Utilities:

  - Land Use: Landfill footprint must be > 500 m of an existing or planned sensitive land use. This includes schools, residences, hotels, restaurants, among others. Land uses such as heavy industry, forestry operations, mining, railways are not considered sensitive land uses.

  - Airport: NAV Canada (or the local authority governing the Sechelt Airport) must assess and approve all proposals for land use near airports. The requirements are outlined by Transport Canada with the general rule of thumb requiring that a landfill footprint be > 8 km from any airport (due to the propensity for landfills to attract birds). The minimum separation may be reduced to 3.2 km if acceptable bird control measures are implemented.

### Table 3-1: Landfill Siting Constraints

| Criteria | Minimum Distance/Guideline |
|---|---|
| Water Supply | 300 m from a water supply well, 500 m from a high capacity water supply well |
| Surface Water | 100 m |
| Floodplain | Landfill footprint shall not be located in a floodplain |
| Shorelines | 100 m of the sea level maximum high tide or seasonal high-water mark |
| Depth to Water Table | 1.5 m above groundwater |
| Heritage/Archeological Sites | 100 m |
| Landfill Buffer Zone | 50 m |
| Gullies/Depressions | Landfill footprint shall not be located in a gully or area that acts as a point of water collection during rainfall events |
| Faults/Unstable Areas | 100 m |
| Environmental Sensitive Areas | 100 m |
| Land use | 500 m |
| Airports | 8 km or 3.2 km if bird control measures are implemented |

The spatial data in the figures above have been compiled from various sources including CanVec (2019), DataBC (2019), data provided by the SCRD (2020), the base imagery source is ESRI-Maxar (2013 to 2019) and Google Imagery.

### 3.1.3 Additional Evaluation Measures

Further to the mapping identified in Section 3.1.2, another important factor to consider is the topography of the area. Although it is not listed as one of the BC Landfill criteria, it is not recommended for the potential landfill to be constructed on sloped land exceeding an average 5 percent grade. SCRD provided Tetra Tech with LiDAR topography data for the Hillside site (included on Figure 4), however detailed topography data was not available for the other two areas of interest. The team's local knowledge and Google imagery was used to approximate whether the topography would be suitable in certain area, however this element would need to be further explored during the next phase of the project.

Site access is another important evaluation measure to consider. Given the SCRD's geography, not many areas potentially suitable for a landfill are currently accessible by road, and conversely, not many areas that are accessible by road are suitable for a landfill due to proximity to the general population.

Tetra Tech also reviewed the shíshálh /British Columbia Foundation Agreement (Foundation Agreement) provided by the SCRD, dated October 4, 2018 to assess whether any of the areas of interest presented below fall under the Foundation Agreement. None of the areas of interest were affected by this agreement.

### 3.1.4 Evaluation of Areas of Interest

The figures have been developed to document a number of the features that would influence the SCRD's ability to site a landfill. When looking at all figures, it is apparent that siting a new landfill within the SCRD will be challenging when considering the constraints discussed above and the topography of the area. It is important to consider all constraints, but to also use professional judgement and determine which constraints can be exempted. This would require additional work surrounding the approvals and permitting process and may also involve additional landfill engineering to ensure the site is suitably located and does not affect the integrity of the surrounding environment. All things considered, it is important to look at the big picture and long-term ramifications; there are many economic advantages to siting a new landfill in the area which would include eliminating SCRD's dependence on third parties, fluctuating markets, and ensuring SCRD is in full control of their waste management needs for the next 30 years (and beyond, depending on the size of the land acquired).

Based on the information provided, the evaluation of each of the areas of interest is as follows:

#### Area of Interest 1: Halfmoon Bay

The study area is shown on Figure 2 and is located approximately between 1 and 5 km northeast of Halfmoon Bay. This area was selected based on proximity to the current Sechelt Landfill (approximately 10 km away) and the distance from the existing Sunshine Coast Highway. The preferred potential location would be situated northeast of the utility corridor (running diagonally, parallel to the highway, shown as Crown Land) which would allow for a buffer from the highway. The construction of an access road to the landfill would be necessary, but the landfill site would be at an appropriate distance ensuring it is not visible from the highway.

At first glance, the spatial data compiled on Figure 2 eliminates any potential suitable areas for siting a landfill due to the entire area being designated as a sensitive ecosystem. However, it is apparent from the Google imagery that there are existing logging operations in the area, which would fall under industrial use. Considering the logging operations are ongoing, it can be assumed that the SCRD would need to work with the BC Ministry of Environment to explore options and determine which areas may be exempt from the constraint. Siting in this area would also allow the SCRD to take advantage of the existing logging roads making access to the potential site less costly.

Other prominent constraints shown on Figure 2 include the critical habitats for the marbled murrelet (a seabird) and the western painted turtle. Many of these habitats coincide with the existing waterbodies and therefore would not be considered as potential landfill locations, although that constraint could affect consideration as the receiving body for stormwater discharges from a future facility.

Based on this desktop review, it is recommended that this area of interest be pursued by the SCRD for the siting of a new landfill. Using the annual airspace requirements shown in Table 2-4 (assuming no diversion), an approximate landfill footprint was calculated and would provide the SCRD with a 30-year capacity. An outline of the approximate landfill size is shown on Figure 2 for perspective and includes three potential landfill locations. These proposed locations are in accordance with all constraints, with the exception of the sensitive ecosystem, and also allow for future lateral expansion which could further increase disposal capacity, over and above 30 years.

### Area of Interest 2: Mine Site near Egmont

The second area of interest is shown on Figure 3. It is the location of an active mine site operated by Lafarge. Tetra Tech sent a communication to Lafarge in an effort to have a high-level discussion related to the mining operations and the possibility of a proposed landfill in the vicinity, however no response has been received. Continued mining operations may be adjacent to some potential landfill sites which would need to be confirmed and evaluated in relation to potential ongoing consideration of a particular site.

As can be seen on Figure 3, there are seemingly many areas which comply with all constraints presented above, however there are several drawbacks to this location. It is believed the topography may not be suitable for a landfill in many cases (the topographical information for this area was not available), as well the distance from the current Sechelt Landfill is approximately 50 km. A second drawback is the proximity to the Skookumchuk Narrows, which is a provincial park and would be located directly across the potential landfill site. Although it is located outside of the buffer zone, the potential landfill may be visible due to its elevation which would be a visual nuisance. Lastly, the main concern is access. With no direct road access, waste would need to be barged in which is inconvenient and would greatly increase capital and long-term operational costs. Based on the desktop study, it is recommended that this location not be pursued as a potential landfill site.

### Area of Interest 3: Hillside North of Langdale

Hillside, the third area of interest, is shown on Figures 4 and 5. The site is located approximately 40 km from Sechelt and the current Sechelt Landfill. The area is easily accessible via the Port Mellon Highway. Similar to the first area of interest (Halfmoon Bay), the compiled data indicates that the area is designated as a sensitive ecosystem, however there are ongoing industrial operations throughout the area, and there was previous gravel mining in several areas. The area was also extensively logged. There are several water wells and water courses located within the area of interest, mainly located on the flatter areas closer to the shoreline. When considering the buffer zones for these constraints, the location of the landfill would be pushed up the slope. As its name suggests, this area of interest is located on a hill side, which is not the ideal topography for a landfill. LiDAR topographic information was provided to Tetra Tech by the SCRD and shown on Figure 5. Although capital costs would increase significantly, a stringent landfill design may allow for a landfill to be built in this area, however a thorough investigation would need to be completed prior to considering it. Significant design challenges would need to be considered including accounting for the risk of landslides and seismic stability, amount of rainfall and the complexity of designing the surface water management pond.

When compared to the other sites, the SCRD would benefit from cost savings related to land acquisition given that the SCRD already owns the Hillside site. Another advantage to consider for this location is that it is 'out of site' from the majority of the population and would be located in an area that is already designated for industrial use. Despite these advantages, siting a new landfill at this location includes too many risks due to the topography. Based on the desktop review, it is recommended that this location not be pursued as a potential landfill site.

This area may be of interest for a potential transfer station location.

### 3.1.5 Economic Evaluation

Tetra Tech completed a high-level economic evaluation for siting a new landfill within the SCRD. Siting a new landfill will vary greatly depending on many factors including location, distance to existing roads, ease of access, the complexity of the permitting and approval process required, level of stakeholder consultation necessary, as well as land acquisition costs. High-end and low-end values were included in the evaluation taking these variances into account. Tetra Tech assumed the new landfill would be accessible by road and would not require barging costs.

Tetra Tech sized the landfill assuming the estimated annual tonnes presented in Table 2-4 (baseline scenario, assuming no organics diversion) and would accommodate waste up to 2056. This does not include any further landfill lateral expansions. The estimated costs for siting a new landfill are presented in Table 3-2 below. The capital costs are divided by the total expected tonnage of material that will be managed between when the current landfill reaches capacity (2026) up to 2056. The operating costs are divided by the total expected tonnage of material that will be managed annually. A detailed breakdown of the costs is presented in Tables 1 through 4, included in the Appendices. The capital costs are presented as present-day values. The operating costs are presented as Net Present Value (NPV), assuming an inflation rate of 1.47% and a rate of return of 2.0%

**Table 3-2: Landfill Economic Estimate**

| Cost Category | Cost Sub-Category | New Landfill Costs | |
|---|---|---|---|
| | | Low-End | High-End |
| **Capital Costs** | Capital Costs | $9,569,860 | $13,545,544 |
| | **$/tonne** | **$17.51** | **$24.78** |
| **Operating Costs (2026-2056)** | Annual Operating Costs | $2,540,000 | $3,550,000 |
| | **$/tonne** | **$140** | **$195** |

It should be noted that although these costs presented herein include a' high-end value', costs associated with building a new landfill requiring a more complex design to account for topography or other barriers, have not been accounted for. These costs will vary greatly and will require a more detailed cost estimate, with costs increasing by approximately 30% to 50%.

It is also important to note that siting a new landfill is risky with no assurance of success. It is an iterative process that requires an upfront investment for site investigations, permitting and approvals and an updated solid waste management plan. Should the permitting process not be approved, the SCRD would need to reconsider an alternative site or disposal options.

It is suggested a site reconnaissance be undertaken to provide a preliminary evaluation of the specified area for the Area of Interest 1 – Halfmoon Bay. This reconnaissance would be used to get a general picture of the land, the topography, access, and to potentially identify features such as springs and small waterbodies that may not have been identified with the desktop review. This may be followed by a UAV (Unmanned Aerial Vehicle) survey in order to get a better idea of the topography and overall features. The reconnaissance and UAV survey can also be used to plan for a more detailed investigation, or if additional support in site selection is required. It should be noted that the BC Landfill Criteria do not include any geological requirements, however this is an element that needs to be investigated in order to provide a better idea for landfill engineering costs.

Should the option of siting a new landfill be approved for further study, up to three sites within the Halfmoon Bay area should be selected for intrusive investigation to verify the shallow geology, groundwater, and site conditions relative to the desktop analysis. This information would be used to assess the requirements for a detailed technical investigation and confirm the need to initiate an approval process for a new landfill. A preliminary investigation would include:

- Confirming access requirements for the site(s) (e.g., private land vs crown land, requirements for permits/ agreements, clearing requirements, etc.) and undertaking required steps to facilitate access;
- Planning for the fieldwork and coordination of safety requirements;
- Undertaking a geotechnical and hydrogeological drilling program to confirm the site's subsurface characteristics;
- Reviewing the results to confirm site suitability (i.e. red flag criteria will be developed to determine whether the investigation should be halted at the site) and adjust the program in real time; and
- Conducting a preliminary ground-truthing of various siting elements, such as proximity to roads, waterbodies, and adjacent land use.

Based on the results of the preliminary intrusive investigation, Tetra Tech would work with SCRD to select a preferred site for detailed investigation, undertake preliminary planning for an regulatory applications, and identify other potential work that may be required to confirm suitability of the selected site for development as a modern landfill.

## 3.2 Option 2 – Disposal at a Third-Party Facility

One option under consideration is construction of a transfer station to export waste out of the SCRD. Waste is currently being exported in several nearby communities, including the Resort Municipality of Whistler (RMOW), Cowichan Valley Regional District (CVRD) and qathet Regional District (qRD). Establishing a transfer station and a waste export arrangement typically involves four to five years of planning. Factors that affect the planning process include the following:

- **Siting and Zoning** – investigating suitable locations, identifying strategic locations, conducting impact assessments, ensuring appropriate zoning and undertaking a geotechnical analysis (foundation requirements).
- **Facility Design** – identifying facility requirements and capacity, operation requirements, structural considerations, site considerations, conceptual designs and cost estimates, budgeting for construction, detailed design, construction contract, facility construction and facility commissioning.
- **Exporting Arrangements** – processing procurement for disposal vendor, assessment of proposals, selection of a vendor, planning and acquisition of equipment for exporting arrangements and contract management.

**Figure 3-1: Modern Transfer station in the Regional District of Nanaimo**

Design and construction costs for a transfer station can range dramatically depending on the size of the facility, where it is located, how it is operated, etc. Designs can range from (A) a simple top loading arrangement that is performed outdoors, to (B) a top loading arrangement inside a temporary shelter (coverall building), to (C) a push pit design inside a building, and to (D) a modern facility with residential drop off services and a compactor. The estimated cost can range from $2 million for a simple design approach to $5.5 million for a modern approach. Based on feedback from SCRD staff, the transfer station design would likely include a modern facility with residential drop off capabilities. For the purpose of this evaluation, the estimated cost for a transfer station would be in the order of $5.5 million.

### 3.2.1 Key Considerations

- Long-term contract for export required, likely to the Roosevelt Regional Landfill (Rabanco) in Washington State or the Columbia Ridge Commercial Landfill in Oregon State, both in the United States (U.S.)
- Fluctuating U.S. dollar which can affect tipping fees and transportation costs.
- A location that is approved through the solid waste management plan and generally acceptable to the majority of the public and the SCRD board
- A sufficient area available for 30 years of service with appropriate buffers surrounding the facility
- A location conforming to local zoning bylaws
- Sufficient storage capacity for all waste materials generated in the SCRD
- Timing to design and build

### 3.2.2 Economic Evaluation

The potential transfer station is sized to accommodate the 2056 estimated waste stream. The cost considerations for a transfer station is summarized in Table 3-3. The capital costs are amortized over 30 years and divided by the average tonnage of material that will be managed between when the current landfill reaches capacity (2026 and 2056). The operating costs are divided by the forecasted annual tonnage of material that will be managed to determine the unit transfer station cost which is presented as a cost per tonne. All costs are depicted in NPV.

**Table 3-3: Transfer Station and Waste Export Economic Estimate**

| Cost Category | Cost Sub-Category | Transfer Station and Waste Export Costs | |
|---|---|---|---|
| | | Low-End | High-End |
| **Capital Costs** | Capital Costs | $2,081,482 | $5,522,790 |
| | **$/tonne** | **$3.81** | **$10.10** |
| **Operating Costs (2026-2056) Includes Transport and Disposal** | Annual Operating Costs | $3,734,977 | $6,194,596 |
| | **$/tonne** | **$205** | **$340** |
| **Unit Cost – Third Party Disposal** | **$/tonne** | **$208.81** | **$350.10** |

As presented in Table 3-3, the estimated cost to export that waste is anticipated to cost between $210 and $350 per tonne. This estimate accounts for costs from the transfer station to the out-of-region landfill and tipping fees for disposal of the waste. Estimates are based on reported costs from communities that currently export waste and information provided by waste haulers that currently offer this service. A large range in waste export operating costs per tonne are assumed to account for uncertainty due to the fluctuation in the Canada-US dollar exchange rate, and the various shipping and disposal tipping fee contracts that have been secured by the other BC municipalities who export their waste. The costs associated with property procurement are not included in these estimates, as they may fluctuate greatly dependent on facility size and location. Also, factors such as site preparation, grading, utility hookups, etc. are site specific and can range greatly in cost.

## 3.3 Option 3 – Development of a Waste-to-Energy Facility

This disposal options analysis provides an overview of four Waste-to-Energy (WTE) technologies and high-level cost estimates for the technology that could be implemented in the regional district and for a scenario if local governments were to collaborate and process their waste collectively.

### 3.3.1 Overview of WTE Technologies

Waste-to-Energy is a broad term that covers a variety of different technologies where waste is thermally converted to some form of energy, be it electricity, heat, pelletized fuel or liquid fuel. WTE technologies can reduce the amount of waste sent to landfills, though some residuals are typically generated and require disposal. The following four technologies were analyzed to determine their suitability for processing the SCRD's MSW:

- Hybrid Gasification;
- Mass Burn;
- Standard Gasification; and,
- Refuse Derived Fuel (RDF)

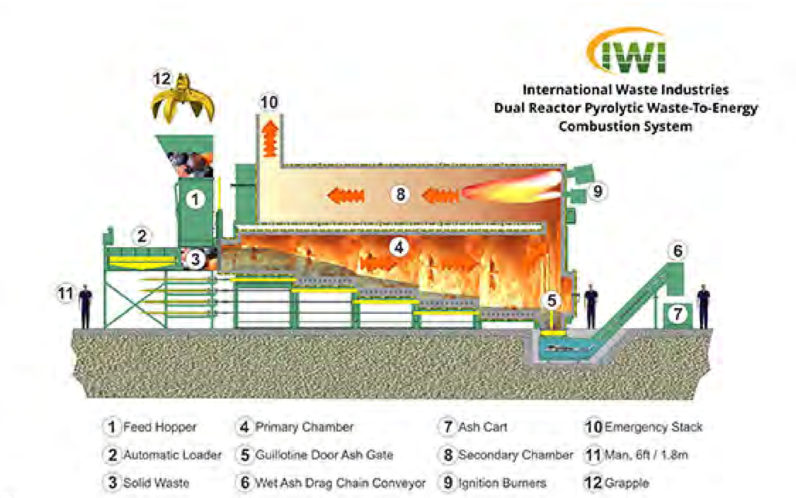



**Figure 3-2: Hybrid Gasification WTE System**

Detailed descriptions of each technology are provided in Appendix B.

#### 3.3.1.1 Comparison of WTE Technologies

Table 3-4 summarizes the system capacity, input, and output considerations related to the thermal technologies discussed.

### Table 3-4: Comparison of Technology Capacity, Feedstocks, and Suitability

| Technology Type | Scalability | Application of Technology | Typical Feedstock | Beneficial Outputs | Concerns | Suitability for SCRD |
|---|---|---|---|---|---|---|
| **Hybrid Gasification** | 1,000 to 150,000 tonnes per year | Most facilities are of a smaller scale (1,000 to 100,000 tonnes per year (tpy)) | Municipal solid waste<br>▪ Some pre-processing might be required | ▪ Heat can potentially be recovered | ▪ Potential air pollution concerns | ▪ Technically feasible but high capital and operation costs |
| **Mass Burn** | Greater than 150,000 tonnes per year | Commercially proven technology that works well for municipal waste stream | Municipal solid waste,<br>▪ No pre-processing required | ▪ Heat produces steam that can be used for industrial boilers or used in a turbine to produce electricity<br>▪ Metals can be recovered | ▪ Potential air pollution concerns<br>▪ Requires economies of scale | ▪ Insufficient amount of feedstock for the SCRD |
| **Gasification** | 25,000 to 300,000 tonnes per year | Few full-scale operational facilities (8,000 to 100,000 tpy) | Prefers high energy waste such as biomass or plastics<br>▪ Pre-processing required | ▪ Heat<br>▪ Electricity<br>▪ Hydrogen gas<br>▪ Renewable natural gas<br>▪ Methanol<br>▪ Ethanol | ▪ Potential air pollution concerns<br>▪ Not commercially proven<br>▪ High technical risk | ▪ Not commercially proven<br>▪ High capital and operating cost<br>▪ Technical risk |
| **RDF** | 5,000 to 300,000 tonnes per year | Few commercial scale facilities for municipal solid waste<br>Requires market for fuel produced | Municipal solid waste<br>▪ is processed to remove non-combustible components | ▪ RDF for cement kilns, pulp/paper mills, lumber kilns<br>▪ Recyclable metals | ▪ Need to secure end-markets<br>▪ Feedstock variance affects quality of the product | ▪ Feasible but end-product demand is not established.<br>▪ Private venture on Vancouver Island is considering constructing a facility but no timeline confirmed. |

### 3.3.2 Economic Evaluation

This section presents the economic evaluation of WTE in the SCRD. It shall be noted that property costs were not included.

#### 3.3.2.1 SCRD Waste-to-Energy

Hybrid Gasification is the most applicable WTE option for the SCRD due to the projected tonnages that the SCRD produces. The processing rate for this WTE option is 50 tonnes per day. High level capital costs were prepared based on projected waste tonnages and these costs take into consideration thermal combustion equipment, installation, site preparation and permitting. The facility operating costs were also estimated, and it takes into consideration labour, operation and maintenance, disposal costs for residuals for the ash and when the facility is down for maintenance and any potential revenues. While metals will be accumulated during pre-processing, it is assumed that any revenues will be negligible due to the need for transport out of the SCRD. The following table (Table 3-5) summarizes the expected capital and annual costs of a prospective WTE facility. Unit disposal costs are inclusive of capital costs and operating costs. All values are presented as NPV.

**Table 3-4: Hybrid Gasification Economic Estimate**

| Cost Category | Cost Sub-Category | Costs (2026 to 2056) |
|---|---|---|
| **Capital Costs** | Capital Costs | $29 M |
| | **$/tonne** | **$53** |
| **Operating Costs** | Annual Operating Costs | $3,300,000 |
| | **$/tonne** | **$186** |
| **Unit Disposal Cost** | **$/tonne** | **$239** |

#### 3.3.2.2 Hypothetical Collaboration Scenario - Waste-to-Energy

Estimated costs for a collaboration scenario was prepared to show how unit disposal costs would change if several communities worked together to dispose of their waste using a WTE approach. This scenario examines the benefits of economies of scale. Cost considerations for this scenario are exclusive of any property procurement required and conducted in the same manner as above. It was also assumed that the facility would not be located in the SCRD and waste would need to be transferred to another community.

The communities that were considered are currently exporting their MSW and are potential candidates who could consider more cost-effective disposal methods. These communities include qathet Regional District (qRD), Cowichan Valley Regional District (CVRD), and Resort Municipality of Whistler (RMOW) and their expected disposal rate would be approximately 73,000 tonnes per year combined. The collaboration WTE facility would be about four times larger than a SCRD only facility. Table 3-5 summarizes the estimated costs for a collaborative scenario.

**Table 3-5: Collaboration Scenario - Hybrid Gasification Economic Estimate**

| | Cost Sub-Category | Cost |
|---|---|---|
| **Capital Costs** | Capital Cost | $52 M |
| | **$/tonne** | **$22** |
| **Operating Costs** | Annual Operating Costs | $2.5 M |
| | **$/tonne** | **$160** |
| **Unit Disposal Cost**<br>*Plus Transfer Station (TS) Cost* | **$/tonne** | **$182 + (TS Cost)** |

As the WTE facility would be constructed outside of the SCRD, a transfer station would be required. The additional cost for a transfer station and transportation to the prospective facility are summarized in Table 3-6.

**Table 3-6: Transfer Station and Hauling Economic Estimate (WTE Option)**

| Cost Category | Cost Sub-Category | Transfer Station and Hauling Costs | |
|---|---|---|---|
| | | Low-End | High-End |
| **Capital Costs** | Capital Costs | $2,081,482 | $5,522,790 |
| | **$/tonne** | **$3.81** | **$10.10** |
| **Operating Costs (2026-2056)** | Annual Operating Costs | $1,639,746 | $1,821,940 |
| | **$/tonne** | **$90** | **$100** |
| **Transfer Station Cost** *WTE Option* | **$/tonne** | **$93.81** | **$110.10** |

With the additional cost for a transfer station and transport to another community, the unit disposal cost would be higher than if the SCRD were to build a WTE for their own community.

### 3.3.3 Additional Considerations for Waste-to-Energy Options

There are many other considerations regarding WTE facilities that go beyond financial implications. Some considerations that apply to all types of WTE facilities include:

- Having a disposal site for WTE residuals which includes bottom ash and residual management when the facility is down for maintenance;
- Ensuring that end-markets for products are secured;
- Feedstocks are sufficient to support consistent operation of a WTE facility; and,
- Air pollution controls are appropriately sized.

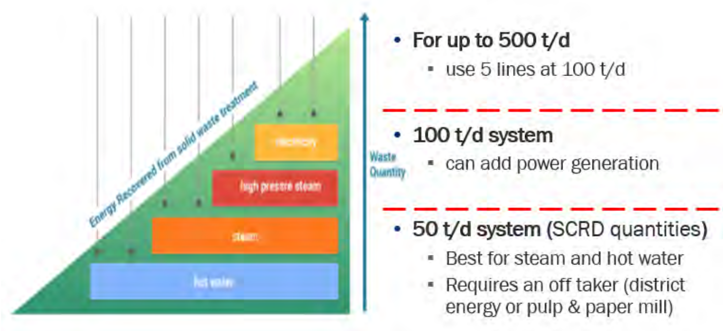
The following subsections discuss additional considerations that are unique to each introduced WTE technology.

#### 3.3.3.1 Residuals Management

The WTE option requires a residual management system for the ash that is produced and the waste that would need to be disposed when the WTE facility is down for maintenance. A hybrid gasification system is typically down for maintenance 10-15% of the time for annual maintenance. This is approximately 5 to 8 weeks per year when waste would need to be exported to a disposal facility. Furthermore, the ash from the combustion system would also need to be disposed of and this typically has a weight that is 20% -25% of the waste that is combusted.

#### 3.3.3.2 End Markets for Energy

The available energy that could be recovered from a SCRD WTE facility is limited because of the amount of waste available. Energy options available include hot water and steam. With these energy options, the facility would need to secure markets or end-users that could use the steam and hot water produced.




#### 3.3.3.3 Feedstock Management

It is important to manage the WTE facility in a manner so that waste can be fed into the combustion system in a consistent and continuous manner. When there is excessive waste being generated, waste will need to be stockpiled until the waste can be combusted. When there is low waste volumes entering the facility, the facility might need to shut down until a more consistent supply can be obtained. It is also very costly to restart the WTE facility as various types of fossil fuels are required to obtain the heat necessary to continuously fuel the fire.

#### 3.3.3.4 Air Pollution Controls

Emissions monitoring will be required to ensure air quality is not impacted. This is a requirement that will be expected to be conducted monthly and quarterly until it can be demonstrated that the facility is able to meet its emission limits.

#### 3.3.3.5 Provincial Waste Diversion Policies

The BC Ministry of Environment has a policy that states WTE options would not be entertained unless the community can demonstrate that it can achieve 70% diversion of its waste stream. Considering the SCRD is hovering around 55% diversion, more diversion measures would need to be implemented. This would also reduce the amount of waste that would be combusted.

## 3.4 Option 4 – Landfill Expansion

The Sechelt Landfill is nearing the end of its planned lifespan with its current capacity expected to be reached between late 2024 and late 2025. Depending on the long-term plan for waste disposal this leaves very little time to complete the regulatory, engineering, and construction work that may be required to prepare for the future of waste disposal from the SCRD. An expansion of the existing Sechelt Landfill could provide additional disposal capacity and time for the region to set up the systems required.

There are limited options to expand the landfill airspace available at the current Sechelt Landfill based on constraints identified by the SCRD including the requirement to maintain operations only within the existing waste footprint. It is understood that the ownership of land surrounding the Sechelt Landfill has been transferred to the shíshálh Nation and will be developed over the coming decades as mining operations are completed.

### 3.4.1 Overview

Two methods of landfill expansion were initially identified for consideration:

- **Vertical Landfill Expansion** would focus on increasing the height of the landfill to increase airspace. Vertical expansions have been completed recently at the Squamish Landfill and the Campbell River Landfill in British Columbia through addition of retaining wall structures to increase the volume of existing landfills.
- **Horizontal Landfill Expansion** would focus on increasing the footprint of the landfill to increase airspace. Horizontal expansions are common in landfill development where there is land available adjacent to the existing facility for purchase. Alternatively, landfills can often be expanded within their existing fence line by adjusting the location of supporting infrastructure including site entrances, drop-off areas, perimeter roads, and leachate and stormwater infrastructure.

The option of horizontal landfill expansion was eliminated at the preliminary phase of analysis based on the understanding that the SCRD cannot expand the existing Sechelt Landfill beyond its current fenceline and does not wish to remove or relocate the public drop-off area.

Vertical landfill expansion options are further evaluated in the following sections.

### 3.4.2 Landfill Vertical Expansion

Options for vertical expansion of the landfill are constrained by the existing landfill waste footprint and space available for construction. Tetra Tech reviewed topographical information of the existing landfill and adjacent lands to identify the area's most suitable for vertical expansion. Two options for vertical expansion were considered:

- Increasing the grade of existing side slopes; and
- Installing a mechanically stabilized earth structure to increase the depth of the landfill.

#### 3.4.2.1 Increasing Existing Side Slopes

Current side slopes at the Sechelt Landfill already meet the designed maximum 3 horizontal to 1 vertical specified in the site's Design, Operations, and Closure Plan (DOCP) (XCG 2017) in most areas. The designed side slopes were assessed to achieve an acceptable static factor of safety and displacement in a 1 in 475-year earthquake within acceptable limits. Based on the previous slope stability analysis and a walkover of the landfill Tetra Tech assessed that increasing side slopes would not offer substantial additional airspace.

#### 3.4.2.2 Mechanically Stabilized Earth Structure

Without "stepping out" the landfill's waste footprint there is very little additional airspace through a vertical expansion. Through discussion with SCRD staff, Tetra Tech identified that the only potential area for a reinforced berm structure is on the northeast edge of the landfill where there is potential for some adjustment to the existing perimeter road. Based on a high-level analysis up to 120,000 cubic metres of additional airspace, equivalent to approximately four to five years, could be developed through a vertical expansion of the Sechelt Landfill.

However, the north east area of the site is one of the only areas that already has existing final cover including vegetation which would need to be stripped to allow for berm construction and additional waste filling. The landfill cover would need to be rebuilt at the end of the landfill's life. Additionally, vertical expansion in this area would require the SCRD to relocate or substantially alter the existing landfill haul road which will impact several aspects of landfill operations and future maintenance costs. Due to significant challenges anticipated from changes to the existing haul road and workable top, the operational feasibility of a vertical expansion of the landfill is considered problematic at a maximum 120,000 cubic metres of additional airspace.

#### 3.4.2.3 Additional Considerations for Vertical Expansion

Vertical expansion of the Sechelt Landfill would require substantial engineering and site investigation to confirm suitability and design criteria. In particular, geotechnical analysis of the existing waste, underlying geology, and seismic potential would be required to ensure that the design offers a suitable factor of safety for future operations. The feasibility and location of a new or adjusted haul road would be investigated to minimize the impact on landfill operations throughout the construction period. The site's DOCP would be updated to reflect the new fill plan and required operating procedures for the site. As any landfill reaches its peak the working area on top of the waste footprint becomes more congested which tends to slow down operations and increase operating costs. Similar cost increases could be expected with a vertical expansion of the Sechelt Landfill.

The operational and cost implications of a vertical expansion of the Sechelt Landfill make this option very challenging. The close access to aggregate and soil materials for construction has been incorporated into cost considerations presented in Section 3.4.3.

### 3.4.3 Economic Evaluation

Tetra Tech completed a high-level economic evaluation for construction of a landfill vertical expansion. The ultimate cost of a vertical expansion is highly dependant on ultimate depth of waste the SCRD intends to achieve. No geotechnical assessment of the waste in place or the underlying geology has been completed to establish detailed design criteria for the expansion. High-end and low-end values were included in the evaluation to account for the potential cost variation.

Tetra Tech completed a high-level assessment of the airspace available with a vertical expansion based on the requirement of maintaining the existing waste footprint and not expanding the site's fenceline into adjacent properties on the west, south, and east sides of the site. The estimated costs for constructing a vertical expansion are presented in Table 3-7. The capital costs and operating costs are divided by the total expected tonnage of additional material to be disposed at the Sechelt Landfill due to a vertical expansion. A detailed breakdown of the costs is presented in Table 5, included in the Appendices.

**Table 3-7: Landfill Vertical Expansion Economic Estimate**

| Cost Category | Cost Sub-Category | Landfill Costs | |
|---|---|---|---|
| | | Low-End | High-End |
| **Capital Costs (2022)** | Capital Costs | $1,851,171 | $3,907,636 |
| | **$/tonne** | **$23.37** | **$49.34** |
| **Operating Costs (2026-2030)** | Annual Operating Costs | $2,790,000 | $3,800,000 |
| | **$/tonne** | **$181** | **$246** |

It should be noted that although these costs presented herein include a' high-end value', costs associated with constructing a vertical expansion requiring a more complex design to account for detailed operational or geotechnical requirements, have not been accounted for. These costs will vary greatly and will require a more detailed cost estimate, with costs increasing by up to 50%.

## 3.5 Economic Summary

A summary of the economic analyses for all the options considered is presented in Table 3-8. The economic evaluation is presented both in terms of total estimated cost (i.e. total capital cost plus total operating cost estimated over 30 years of operation) per tonne of waste managed as well as net present value (i.e. the cost when converted to present day dollars) per tonne of waste managed. The costs per tonne in Table 3-8 represent the total expenditures anticipated for each option, including future inflation, divided by the total tonnes disposed. The estimated cost per tonne is not equivalent to the cost per tonne that would be budgeted by the SCRD.

As summarized in Table 3-8, the lowest cost option for managing future solid waste disposal is siting and operating a new landfill within the SCRD. Other options are anticipated to incur higher costs due to relatively high capital or operating costs as presented in the previous sections.

### Table 3-8: Summary of Option Costs Per Tonne and Net Present Value Per Tonne

| Option | Estimated Cost Per Tonne[1] | | Net Present Value Per Tonne | |
|---|---|---|---|---|
| | Low-End | High-End | Low-End | High-End |
| Option 1 – New Landfill | $217 | $303 | $146 | $205 |
| Option 2 –Third-Party Disposal (Waste Export) | $285 | $476 | $188 | $315 |
| Option 3 – Waste-to-Energy | $399 | $469 | $278 | $325 |
| Option 4 – Landfill Expansion | $230 | $446 | $203 | $271 |

[1] Estimated Cost Per Tonne in Table 3-8 is calculated from total expenditures over the design horizon assuming 1.47% inflation per year. Previous sections present initial operating cost per tonne and are therefore not a direct comparison. The life of option 4 is limited to the few years in which waste can continue to be placed in the vertical expansion until that in turn reaches capacity.

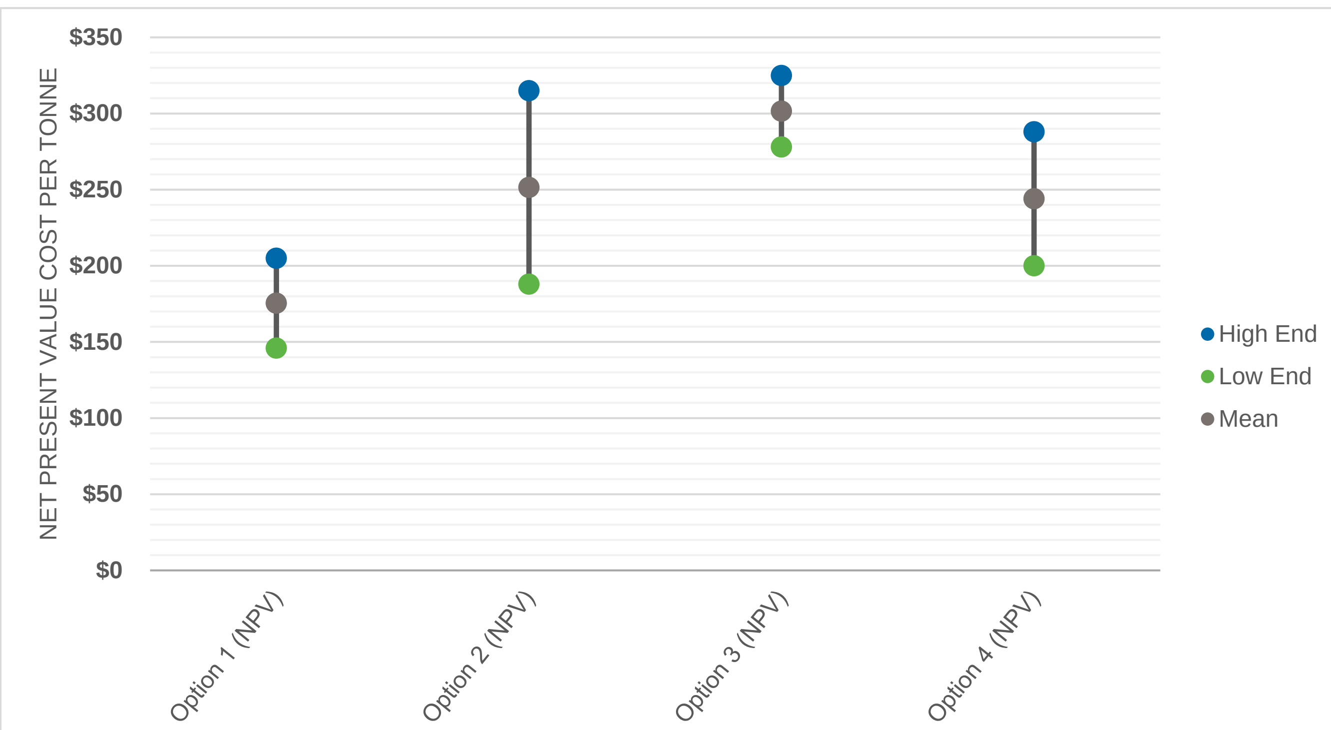



**Figure 3-3: Range of Cost of Each Option**

## 3.6 Multi-Criteria Analysis

The ranking proposed for each of the options available to the SCRD is based on a qualitative rating (i.e. low, medium and high) of the option's performance on each identified criterion. Table 3-9 describes the criteria used to select the preferred options and the preliminary relative weighting.

### Table 3-9: Waste Processing Criteria Descriptions

| Options Evaluate Criteria | Weighting | Criteria Description |
|---|---|---|
| **Environmental** | | |
| Greenhouse Gas Emissions | 2 | High-level GHG emissions calculation (using EPA tool) after waste is received at the gate (i.e. after collection or delivery) |
| Environmental Impact | 2 | Potential impacts to surface water, ground water, air quality, and litter |
| Regulatory Approval | 0 | Is the regulator anticipated to provide approval within the required timeframe? |
| **Social** | | |
| Job Creation | 1 | Number of long-term jobs created in the SCRD (> 6 months employment) |
| System Resiliency | 2 | Ability of the chosen system to manage all of the SCRD's waste stream over the next 30 years |
| **Economic** | | |
| Net Present Value Cost Per Tonne | 3 | Integrated capital and operating cost divided by the total tonnes of waste expected to be managed |
| Cost Risk | 2 | Amount of expenditure required prior to regulatory approval |
| Future Liabilities | 1 | Future cost considerations for the option selected |

Table 3-10 below provides an initial multi-criteria analysis ranking the priority of the waste disposal option using nominal value comparison. The Table identifies eight major considerations for the SCRD in determining the best long-terms option for waste disposal. The criteria were categorized into three pillars and weighting was applied based on Tetra Tech's industry experience

### Table 3-10: Waste Disposal Scenario Comparison

| Scenario | Environmental Considerations | | | Environmental Score (/9) | Social Considerations | | Social Score (/9) | Financial Considerations | | | Financial Score (/18) | Total Score (/60) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Criteria | **GHG Emissions**[1] (3 – Low GHGs, 1 – High GHGs) | **Environmental Impact** (3 – Low Environmental Risk, 1 – High Environmental Risk) | **Regulatory Approval Expected** (Yes, No) | | **Job Creation** (3 – High Job Creation, 1 – Low Job Creation | **System Resiliency** (3 – High System Resiliency, 1 – Low System Resiliency) | | **Net Present Value Cost Per Tonne** (3 – Lowest Cost Per Tonne, 1 – Highest Cost Per Tonne) | **Cost Risk** (3 – Low Level of Pre-Approval Investment, 1 – High Level of Pre-Approval Investment) | **Future Liabilities** (3 – No or low future costs to consider 1 – Future liabilities such as closure costs) | | |
| **Weighting** | 1 | 2 | 0 | | 1 | 2 | | 3 | 2 | 1 | | |
| **Option 1** – New Landfill | **1** (Up to 1300 tonnes CO2e per tonne landfilled). | **3** (New landfill built and operated to current standards poses a low level of environmental risk to the community.) | **Yes** (Regulatory approval contingent on identifying as suitable site and stakeholder/public consultation.) | 7 | **3** (Maintains or adds net new jobs to SCRD) | **3** (SCRD maintains control of disposal requirements and costs.) | ***9*** | **3** (Total cost $146 to $205 per tonne.) | **2** (Some design and feasibility work required prior to regulatory approvals.) | **2** (Some ongoing cost to maintain and close facility to contemporary standards.) | ***14*** | **30** |
| **Option 2** – Third-Party Disposal (Waste Export) | **2** (Up to 250 tonnes CO2e per tonne combusted assuming the receiving facility operates "aggressive" landfill gas collection.) | **3** (Receiving sites are large facilities built and operated to current standards including landfill gas collection.) | **Yes** (Few regulatory hurdles anticipated.) | 8 | **1** (Maintains or decreases jobs in SCRD) | **2** (Costs subject to market forces and exchange rate. Market is competitive enough to offer long-term certainty for waste disposal.) | ***5*** | **2** (Total cost from $188 to $315 per tonne.) | **3** (No regulatory approval required for waste export.) | **3** (Little additional environmental liability added.) | ***12*** | **28** |
| **Option 3** – Waste-to-Energy | **3** (Up to 150 tonnes CO2e per tonne combusted.) | **2** (New facility built and operated to current standards will manage potential emissions.) | **No** (The technology can be feasibly approved but environmental controls required may be cost prohibitive. SCRD must achieve 70% diversion before the regulator will approve use of waste to energy or incineration technology.) | 7 | **3** (Maintains or adds net new jobs to SCRD) | **1** (Efficiency of WTE technology may change as waste composition changes. WTE facilities under consideration may not be constructed or may not accept all of SCRD's MSW.) | ***5*** | **1** (Total cost from $278 to $325 per tonne.) | **1** (Significant work required prior to regulatory approvals. 70% diversion required prior to approval.) | **1** (Significant ongoing cost to maintain and decommission facility to contemporary standards.) | ***9*** | **18** |
| **Option 4** – Landfill Expansion | **1** (Up to 1300 tonnes CO2e per tonne landfilled). | **2** (Expanding an existing facility that was not constructed to current standards.) | **Yes** (Regulatory approval contingent on engineering design and risk.) | 5 | **2** (Maintains jobs in SCRD) | **1** (Expansion offers a short-term solution if required to plan and develop other options.) | ***4*** | 2 (Total cost from $203 to $271 per tonne). | **2** (Some design and feasibility work required prior to regulatory approvals.) | **3** (Little additional environmental liability added.) | ***13*** | **22** |

[1] GHG emissions calculated using the United States Environmental Protection Agency (USEPA) Waste Reduction Model (WARM) Version 15.1.

# 4.0 CONCLUSIONS

Based on the high-level assessment completed, siting a new landfill (Option 1) provides the SCRD with the benefit of maintaining control over their costs and management of environmental impacts, as well as, perhaps, the lowest cost per tonne among the options presented herein. Siting a new landfill is shown to offer superior performance in both social and financial considerations and performs well on environmental considerations compared to the other options considered. However, the process of siting a landfill also carries considerable risk of failure. Technical impediments to a site can be revealed late in the process, despite careful screening. The siting of a new landfill can also present challenges with public approval. Perhaps the greatest concern to SCRD with siting a new landfill would be schedule uncertainty and the question of whether the required regulatory and public approval process, as well as engineering, design and construction, be completed within the remaining timeframe

Option 2 – Third Party Disposal is the second highest ranked option according to the analysis. A third-party disposal site can offer some potential environmental advantages compared to small coastal landfills as new environmental protection technologies can be implemented at large facilities based on economies of scale and regulatory requirements. The large landfills in Washington and Oregon that currently import waste from Canada implement landfill gas collection, and environmental controls to meet their regulatory obligations. Importantly, using a third-party disposal facility offers the SCRD the least amount of control or influence on disposal costs and management of waste. Fluctuating exchange rates and market conditions at the time contracts are awarded have the potential to significantly impact the cost of waste disposal in the future.

Option 4 – Landfill expansion ranked third in the analysis. Vertical landfill expansion at the Sechelt Landfill is expected to be costly when considering the significant engineering and operations challenges while offering only a few years of additional airspace.

Option 3 – Waste-to-Energy are ranked forth in the analysis. The cost to construct and operate a waste to energy or incineration facility that meets environmental and regulatory performance criteria limits the feasibility of this option. Also, given the SCRD's current waste stream diversion rate of 55%, it would need to implement additional diversion measures in order to achieve the desired 70% diversion rate, as outlined in the BC Ministry of Environment WTE policy.

# 5.0 CLOSURE

We trust this document meets your present requirements. If you have any questions or comments, please contact the undersigned.

Respectfully submitted,
Tetra Tech Canada Inc.

FILE: 704-SWM.SWOP04367-01
FILE: 704-SWM.SWOP04367-01
FILE: 704-SWM.SWOP04367-01

Prepared by:
Zachary Lirenman, B.Sc.
Project Scientist
Solid Waste Management Practice
Direct Line: 778.945.5930
Zach.Lirenman@tetratech.com

FILE: 704-SWM.SWOP04367-01
FILE: 704-SWM.SWOP04367-01
FILE: 704-SWM.SWOP04367-01

Prepared by:
Lauren Quan, P.Eng.
Project Engineer
Solid Waste Management Practice
Direct Line: 204.954.6850
Lauren.Quan@tetratech.com

FILE: 704-SWM.SWOP04367-01
FILE: 704-SWM.SWOP04367-01
FILE: 704-SWM.SWOP04367-01

Prepared by:
Nancy Nikolakakis, P.Eng.
Project Engineer
Solid Waste Management Practice
Direct Line: 403.723.1536
Nancy.Nikolakakis@tetratech.com

FILE: 704-SWM.SWOP04367-01
FILE: 704-SWM.SWOP04367-01
FILE: 704-SWM.SWOP04367-01

Reviewed by:
Wilbert Yang, P.Eng.
Senior Planning Engineer
Solid Waste Management Practice
Direct Line: 604.608.8648
Wilbert.Yang@tetratech.com

FILE: 704-SWM.SWOP04367-01
FILE: 704-SWM.SWOP04367-01
FILE: 704-SWM.SWOP04367-01

Reviewed by:
Paul Evans, P.Eng., MBA
Project Engineer / Senior Consultant
Solid Waste Management Practice
Direct Line: 403.899.1477
Paul.Evans@tetratech.com

/sy

# REFERENCES

AECOM Canada Ltd & SCRD Infrastructure Services Department. (2011). Solid Waste Management Plan – The Foundation for Zero Waste Plan – Final Draft. August 2011.

British Columbia Ministry of Environment, Landfill Criteria for Municipal Solid Waste, Second Edition, June 2016.

Carey McIver & Associates Ltd. (2018). Sunshine Coast Regional District: Regional Organics Diversion Strategy. January 8, 2018.

Dillon Consulting Limited. (2014). Waste Composition Audit: Sunshine Coast Regional District. December 5, 2014.

Population estimate based off of British Columbia states average population growth rate from 2011-2019

Province of British Columbia, shíshálh /British Columbia Foundation Agreement, October 2018.

Sunshine Coast Regional District. (2020). Request for Proposal 2035008 Future Waste Disposal Options Analysis Study.

Sunshine Coast Regional District. (n.d.). Regional Diversion. Retrieved from https://www.scrd.ca/diversion

Sunshine Coast Regional District. (n.d.). Regional Diversion. Retrieved from https://www.scrd.ca/diversion

XCG Consulting Limited. (2017). Design, Operations, and Closure Plan: Sechelt Landfill, Sechelt, British Columbia. December 20, 2017.

XCG Consulting Limited. (2019). 2018 Annual Report: Sechelt Landfill, Sechelt, British Columbia. March 20, 2019.

# TABLES

## Table 1: Landfill Capital Costs Estimate

| Assumed Values: | | |
|---|---|---|
| Estimated Lifespan of New Landfill | 30 | 2026-2056 |
| Estimated Annual Tonnes (2026 - 2056) | 18,219 | Tonnes |
| Annual Airspace Requirements (2026 - 2056) | 27,605 | m3 |
| Total Landfill Footprint Area | 3.31 | Hectares |

| Capital Expenditures | Quantity | Units | Unit Cost | | Totals | |
|---|---|---|---|---|---|---|
| | | | Low End | High End | Low End | High End |
| Approvals, Permitting and Public Consultation | 1 | Event | $700,000 | $1,000,000 | $700,000 | $1,000,000 |
| Land Acquisition | 23 | Acre | $40,000 | $90,000 | $920,000 | $2,070,000 |
| | | | | **Subtotal - Landfill Siting** | **$1,620,000** | **$3,070,000** |
| Utilities (infrastructure, power, roads) | 1 | Event | $200,000 | $500,000 | $200,000 | $500,000 |
| Scale | 1 | Unit | $75,000 | $90,000 | $75,000 | $90,000 |
| Public Drop-Off | 1 | Unit | $400,000 | $600,000 | $400,000 | $600,000 |
| Buildings | 1 | Unit | $400,000 | $600,000 | $400,000 | $600,000 |
| Landfill Liner | 33,126 | m2 | $75 | $90 | $2,484,465 | $2,981,358 |
| Leachate Management System | 33,126 | m2 | $25 | $30 | $828,155 | $993,786 |
| Leachate Pumps | 1 | Unit | $250,000 | $300,000 | $250,000 | $300,000 |
| Leachate Treatment System | 1 | Unit | $3,000,000 | $4,000,000 | $3,000,000 | $4,000,000 |
| Stormwater Ditching | 908 | Linear Metre | $30 | $50 | $27,240 | $45,400 |
| Pond (Unlined) | 1 | Unit | $90,000 | $110,000 | $90,000 | $110,000 |
| Environmental Monitoring Wells | 15 | Unit | $7,000 | $10,000 | $105,000 | $150,000 |
| Environmental Management Plan | 1 | Unit | $15,000 | $15,000 | $15,000 | $15,000 |
| Design and Operations Plan | 1 | Unit | $75,000 | $90,000 | $75,000 | $90,000 |
| | | | | **Subtotal - Construction** | **$7,949,860** | **$10,475,544** |
| | | | | **Total Capital Expenditures** | **$9,569,860** | **$13,545,544** |
| | | | | **Capital Cost per Tonne Over the Lifespan of Landfill** | **$17.51** | **$24.78** |

**Notes:**
1. Unit rates and quantities costs are estimates based on Tetra Tech's recent construction and industry experience.
2. The estimated annual tonnes for 2025 to 2056 assumes no organics diversion will occur.
3. The total landfill footprint area was calculated based on the annual airspace requirements for 2026 to 2056, and assumed an average waste height of 25.0 m.

## Table 2: Landfill Operational Costs Estimate

| Assumed Values: | | |
|---|---|---|
| Estimated Lifespan of New Landfill | 30 | 2026-2056 |
| Estimated Annual Tonnes (2026 - 2056) | 18,219 | Tonnes |
| Annual Airspace Requirements (2026 - 2056) | 27,605 | m3 |
| Total Landfill Footprint Area | 3.31 | Hectares |

| Operational Expenditures | Quantity | Units | Unit Cost | | Totals | |
|---|---|---|---|---|---|---|
| | | | Low End | High End | Low End | High End |
| Annual Environmental Management | 1 | Annual | $40,000 | $50,000 | $40,000 | $50,000 |
| Operational and Maintenance Costs | 1 | Annual | $2,500,000 | $3,500,000 | $2,500,000 | $3,500,000 |
| | | | | | | |
| **Total Operational Expenditures** | | | | | **$2,540,000** | **$3,550,000** |
| **Operating Cost per Tonne** | | | | | **$139.41** | **$194.85** |

**Notes:**

1. Unit rates and quantities costs are estimates based on Tetra Tech's recent construction and industry experience.
2. The estimated annual tonnes for 2025 to 2056 assumes no organics diversion will occur.
3. The total landfill footprint area was calculated based on the annual airspace requirements for 2026 to 2056, and assumed an average waste height of 25.0 m.

## Table 3: Landfill Costs (Low End) - 30 Year Period

| Assumed Values: | | |
|---|---|---|
| Estimated Lifespan of New Landfill | 30 | 2026-2056 |
| Estimated Annual Tonnes (2026 - 2056) | 18,219 | Tonnes |
| Annual Airspace Requirements (2026 - 2056) | 27,605 | m3 |
| Total Landfill Footprint Area | 3.31 | Hectares |

| Operational Expenditures | Year<br>-3<br>2022 | Year<br>-2<br>2023 | Year<br>-1<br>2024 | Year<br>0<br>2025 | Year<br>1<br>2026 | Year<br>2<br>2027 | Year<br>3<br>2028 | Year<br>4<br>2029 | Year<br>5<br>2030 | Year<br>6<br>2031 | Year<br>7<br>2032 | Year<br>8<br>2033 | Year<br>9<br>2034 | Year<br>10<br>2035 | Year<br>11<br>2036 | Year<br>12<br>2037 | Year<br>13<br>2038 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Annual Environmental Management | 0% | 0% | 0% | 0% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| **Subtotal** | **$0** | **$0** | **$0** | **$0** | **$40,000** | **$40,000** | **$40,000** | **$40,000** | **$40,000** | **$40,000** | **$40,000** | **$40,000** | **$40,000** | **$40,000** | **$40,000** | **$40,000** | **$40,000** |
| Operational and Maintenance Costs | 0% | 0% | 0% | 0% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| **Subtotal** | **$0** | **$0** | **$0** | **$0** | **$2,500,000** | **$2,500,000** | **$2,500,000** | **$2,500,000** | **$2,500,000** | **$2,500,000** | **$2,500,000** | **$2,500,000** | **$2,500,000** | **$2,500,000** | **$2,500,000** | **$2,500,000** | **$2,500,000** |
| | | | | | | | | | | | | | | | | | |
| **Operations Annual Total** | **$0** | **$0** | **$0** | **$0** | **$2,540,000** | **$2,540,000** | **$2,540,000** | **$2,540,000** | **$2,540,000** | **$2,540,000** | **$2,540,000** | **$2,540,000** | **$2,540,000** | **$2,540,000** | **$2,540,000** | **$2,540,000** | **$2,540,000** |

| Operational Expenditures | Year<br>14<br>2039 | Year<br>15<br>2040 | Year<br>16<br>2041 | Year<br>17<br>2042 | Year<br>18<br>2043 | Year<br>19<br>2044 | Year<br>20<br>2045 | Year<br>21<br>2046 | Year<br>22<br>2047 | Year<br>23<br>2048 | Year<br>24<br>2049 | Year<br>25<br>2050 | Year<br>26<br>2051 | Year<br>27<br>2052 | Year<br>28<br>2053 | Year<br>29<br>2054 | Year<br>30<br>2055 | Year<br>31<br>2056 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Annual Environmental Management | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| **Subtotal** | **$40,000** | **$40,000** | **$40,000** | **$40,000** | **$40,000** | **$40,000** | **$40,000** | **$40,000** | **$40,000** | **$40,000** | **$40,000** | **$40,000** | **$40,000** | **$40,000** | **$40,000** | **$40,000** | **$40,000** | **$40,000** |
| Operational and Maintenance Costs | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| **Subtotal** | **$2,500,000** | **$2,500,000** | **$2,500,000** | **$2,500,000** | **$2,500,000** | **$2,500,000** | **$2,500,000** | **$2,500,000** | **$2,500,000** | **$2,500,000** | **$2,500,000** | **$2,500,000** | **$2,500,000** | **$2,500,000** | **$2,500,000** | **$2,500,000** | **$2,500,000** | **$2,500,000** |
| | | | | | | | | | | | | | | | | | | |
| **Operations Annual Total** | **$2,540,000** | **$2,540,000** | **$2,540,000** | **$2,540,000** | **$2,540,000** | **$2,540,000** | **$2,540,000** | **$2,540,000** | **$2,540,000** | **$2,540,000** | **$2,540,000** | **$2,540,000** | **$2,540,000** | **$2,540,000** | **$2,540,000** | **$2,540,000** | **$2,540,000** | **$2,540,000** |

| Capital Expenditures | | Year -3 (2022) | Year -2 (2023) | Year -1 (2024) | Year 0 (2025) | Year 1 (2026) | Year 2 (2027) | Year 3 (2028) | Year 4 (2029) | Year 5 (2030) | Year 6 (2031) | Year 7 (2032) | Year 8 (2033) | Year 9 (2034) | Year 10 (2035) | Year 11 (2036) | Year 12 (2037) | Year 13 (2038) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Landfill Siting | | 25% | 25% | 50% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| **Subtotal** | | **$405,000** | **$405,000** | **$810,000** | **$0** | **$0** | **$0** | **$0** | **$0** | **$0** | **$0** | **$0** | **$0** | **$0** | **$0** | **$0** | **$0** | **$0** |
| Landfill Construction | | 0% | 0% | 0% | 10% | 0% | 3% | 3% | 3% | 3% | 3% | 3% | 3% | 3% | 3% | 3% | 3% | 3% |
| **Subtotal** | | **$0** | **$0** | **$0** | **$794,986** | **$0** | **$238,496** | **$238,496** | **$238,496** | **$238,496** | **$238,496** | **$238,496** | **$238,496** | **$238,496** | **$238,496** | **$238,496** | **$238,496** | **$238,496** |
| | | | | | | | | | | | | | | | | | | |
| **Capital Annual Total** | | **$405,000** | **$405,000** | **$810,000** | **$794,986** | **$0** | **$238,496** | **$238,496** | **$238,496** | **$238,496** | **$238,496** | **$238,496** | **$238,496** | **$238,496** | **$238,496** | **$238,496** | **$238,496** | **$238,496** |
| | | | | | | | | | | | | | | | | | | |
| Assumed Inflation Rate | 1.470% | 1.01 | 1.03 | 1.04 | 1.06 | 1.08 | 1.09 | 1.11 | 1.12 | 1.14 | 1.16 | 1.17 | 1.19 | 1.21 | 1.23 | 1.24 | 1.26 | 1.28 |
| Inflated Values | | $410,954 | $416,995 | $846,249 | $842,772 | $2,732,260 | $3,032,744 | $3,077,325 | $3,122,562 | $3,168,463 | $3,215,040 | $3,262,301 | $3,310,257 | $3,358,917 | $3,408,294 | $3,458,395 | $3,509,234 | $3,560,820 |

| Capital Expenditures | Year 14 (2039) | Year 15 (2040) | Year 16 (2041) | Year 17 (2042) | Year 18 (2043) | Year 19 (2044) | Year 20 (2045) | Year 21 (2046) | Year 22 (2047) | Year 23 (2048) | Year 24 (2049) | Year 25 (2050) | Year 26 (2051) | Year 27 (2052) | Year 28 (2053) | Year 29 (2054) | Year 30 (2055) | Year 31 (2056) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Landfill Siting | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| **Subtotal** | **$0** | **$0** | **$0** | **$0** | **$0** | **$0** | **$0** | **$0** | **$0** | **$0** | **$0** | **$0** | **$0** | **$0** | **$0** | **$0** | **$0** | **$0** |
| Landfill Construction | 3% | 3% | 3% | 3% | 3% | 3% | 3% | 3% | 3% | 3% | 3% | 3% | 3% | 3% | 3% | 3% | 3% | 3% |
| **Subtotal** | **$238,496** | **$238,496** | **$238,496** | **$238,496** | **$238,496** | **$238,496** | **$238,496** | **$238,496** | **$238,496** | **$238,496** | **$238,496** | **$238,496** | **$238,496** | **$238,496** | **$238,496** | **$238,496** | **$238,496** | **$238,496** |
| | | | | | | | | | | | | | | | | | | |
| **Capital Annual Total** | **$238,496** | **$238,496** | **$238,496** | **$238,496** | **$238,496** | **$238,496** | **$238,496** | **$238,496** | **$238,496** | **$238,496** | **$238,496** | **$238,496** | **$238,496** | **$238,496** | **$238,496** | **$238,496** | **$238,496** | **$238,496** |
| | | | | | | | | | | | | | | | | | | |
| Assumed Inflation Rate | 1.30 | 1.32 | 1.34 | 1.36 | 1.38 | 1.40 | 1.42 | 1.44 | 1.46 | 1.48 | 1.50 | 1.53 | 1.55 | 1.57 | 1.60 | 1.62 | 1.64 | 1.67 |
| Inflated Values | $3,613,164 | $3,666,277 | $3,720,171 | $3,774,858 | $3,830,348 | $3,886,654 | $3,943,788 | $4,001,762 | $4,060,588 | $4,120,279 | $4,180,847 | $4,242,305 | $4,304,667 | $4,367,946 | $4,432,154 | $4,497,307 | $4,563,417 | $4,630,500 |

| | |
|---|---|
| Estimated Rate of Return | 2.00% |
| **Total Estimated Cost (Low End)** | **$118,570,612** |
| **Net Present Value (Low End)** | **$79,842,277** |

| | |
|---|---|
| **Total Estimated Costs per Tonne (Low End)** | **$217** |
| **Total Estimated NPV per Tonne (Low End)** | **$146** |

**Notes:**
1. The estimated annual tonnes for 2026 to 2056 assumes no organics diversion will occur.
2. The total landfill footprint area was calculated based on the annual airspace requirements for 2026 to 2056, and assumed an average waste height of 25.0 m.
3. The assumed inflation rate is based on Tetra Tech's industry experience.
4. The rate of return is based on the Bank of Canada long-term bond yield.

### Table 4: Landfill Costs (High End) - 30 Year Period

| Assumed Values: | | |
|---|---|---|
| Estimated Lifespan of New Landfill | 30 | 2026-2056 |
| Estimated Annual Tonnes (2026 - 2056) | 18,219 | Tonnes |
| Annual Airspace Requirements (2026 - 2056) | 27,605 | m3 |
| Total Landfill Footprint Area | 3.31 | Hectares |

| Operational Expenditures | | Year -3 2022 | Year -2 2023 | Year -1 2024 | Year 0 2025 | Year 1 2026 | Year 2 2027 | Year 3 2028 | Year 4 2029 | Year 5 2030 | Year 6 2031 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Annual Environmental Management | | 0% | 0% | 0% | 0% | 100% | 100% | 100% | 100% | 100% | 100% |
| **Subtotal** | | **$0** | **$0** | **$0** | **$0** | **$50,000** | **$50,000** | **$50,000** | **$50,000** | **$50,000** | **$50,000** |
| Operational and Maintenance Costs | | 0% | 0% | 0% | 0% | 100% | 100% | 100% | 100% | 100% | 100% |
| **Subtotal** | | **$0** | **$0** | **$0** | **$0** | **$3,500,000** | **$3,500,000** | **$3,500,000** | **$3,500,000** | **$3,500,000** | **$3,500,000** |
| | | | | | | | | | | | |
| **Operations Annual Total** | | **$0** | **$0** | **$0** | **$0** | **$3,550,000** | **$3,550,000** | **$3,550,000** | **$3,550,000** | **$3,550,000** | **$3,550,000** |
| **Capital Expenditures** | | | | | | | | | | | |
| Landfill Siting | | 25% | 25% | 50% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| **Subtotal** | | **$767,500** | **$767,500** | **$1,535,000** | **$0** | **$0** | **$0** | **$0** | **$0** | **$0** | **$0** |
| Landfill Construction | | 0% | 0% | 0% | 10% | 0% | 3% | 3% | 3% | 3% | 3% |
| **Subtotal** | | **$0** | **$0** | **$0** | **$1,047,554** | **$0** | **$314,266** | **$314,266** | **$314,266** | **$314,266** | **$314,266** |
| | | | | | | | | | | | |
| **Capital Annual Total** | | **$767,500** | **$767,500** | **$1,535,000** | **$1,047,554** | **$0** | **$314,266** | **$314,266** | **$314,266** | **$314,266** | **$314,266** |
| | | | | | | | | | | | |
| Assumed Inflation Rate | 1.470% | 1.01 | 1.03 | 1.04 | 1.06 | 1.08 | 1.09 | 1.11 | 1.12 | 1.14 | 1.16 |
| Inflated Values | | $778,782 | $790,230 | $1,603,693 | $1,110,522 | $3,818,710 | $4,217,868 | $4,279,871 | $4,342,785 | $4,406,624 | $4,471,401 |

| Operational Expenditures | Year 7 2032 | Year 8 2033 | Year 9 2034 | Year 10 2035 | Year 11 2036 | Year 12 2037 | Year 13 2038 | Year 14 2039 | Year 15 2040 | Year 16 2041 | Year 17 2042 | Year 18 2043 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Annual Environmental Management | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| **Subtotal** | **$50,000** | **$50,000** | **$50,000** | **$50,000** | **$50,000** | **$50,000** | **$50,000** | **$50,000** | **$50,000** | **$50,000** | **$50,000** | **$50,000** |
| Operational and Maintenance Costs | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| **Subtotal** | **$3,500,000** | **$3,500,000** | **$3,500,000** | **$3,500,000** | **$3,500,000** | **$3,500,000** | **$3,500,000** | **$3,500,000** | **$3,500,000** | **$3,500,000** | **$3,500,000** | **$3,500,000** |
| | | | | | | | | | | | | |
| **Operations Annual Total** | **$3,550,000** | **$3,550,000** | **$3,550,000** | **$3,550,000** | **$3,550,000** | **$3,550,000** | **$3,550,000** | **$3,550,000** | **$3,550,000** | **$3,550,000** | **$3,550,000** | **$3,550,000** |
| **Capital Expenditures** | | | | | | | | | | | | |
| Landfill Siting | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| **Subtotal** | **$0** | **$0** | **$0** | **$0** | **$0** | **$0** | **$0** | **$0** | **$0** | **$0** | **$0** | **$0** |
| Landfill Construction | 3% | 3% | 3% | 3% | 3% | 3% | 3% | 3% | 3% | 3% | 3% | 3% |
| **Subtotal** | **$314,266** | **$314,266** | **$314,266** | **$314,266** | **$314,266** | **$314,266** | **$314,266** | **$314,266** | **$314,266** | **$314,266** | **$314,266** | **$314,266** |
| | | | | | | | | | | | | |
| **Capital Annual Total** | **$314,266** | **$314,266** | **$314,266** | **$314,266** | **$314,266** | **$314,266** | **$314,266** | **$314,266** | **$314,266** | **$314,266** | **$314,266** | **$314,266** |
| | | | | | | | | | | | | |
| Assumed Inflation Rate | 1.17 | 1.19 | 1.21 | 1.23 | 1.24 | 1.26 | 1.28 | 1.30 | 1.32 | 1.34 | 1.36 | 1.38 |
| Inflated Values | $4,537,131 | $4,603,827 | $4,671,503 | $4,740,174 | $4,809,855 | $4,880,560 | $4,952,304 | $5,025,103 | $5,098,972 | $5,173,927 | $5,249,983 | $5,327,158 |

| Operational Expenditures | Year 19 2044 | Year 20 2045 | Year 21 2046 | Year 22 2047 | Year 23 2048 | Year 24 2049 | Year 25 2050 | Year 26 2051 | Year 27 2052 | Year 28 2053 | Year 29 2054 | Year 30 2055 | Year 31 2056 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Annual Environmental Management | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| **Subtotal** | **$50,000** | **$50,000** | **$50,000** | **$50,000** | **$50,000** | **$50,000** | **$50,000** | **$50,000** | **$50,000** | **$50,000** | **$50,000** | **$50,000** | **$50,000** |
| Operational and Maintenance Costs | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| **Subtotal** | **$3,500,000** | **$3,500,000** | **$3,500,000** | **$3,500,000** | **$3,500,000** | **$3,500,000** | **$3,500,000** | **$3,500,000** | **$3,500,000** | **$3,500,000** | **$3,500,000** | **$3,500,000** | **$3,500,000** |
| | | | | | | | | | | | | | |
| **Operations Annual Total** | **$3,550,000** | **$3,550,000** | **$3,550,000** | **$3,550,000** | **$3,550,000** | **$3,550,000** | **$3,550,000** | **$3,550,000** | **$3,550,000** | **$3,550,000** | **$3,550,000** | **$3,550,000** | **$3,550,000** |
| **Capital Expenditures** | | | | | | | | | | | | | |
| Landfill Siting | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| **Subtotal** | **$0** | **$0** | **$0** | **$0** | **$0** | **$0** | **$0** | **$0** | **$0** | **$0** | **$0** | **$0** | **$0** |
| Landfill Construction | 3% | 3% | 3% | 3% | 3% | 3% | 3% | 3% | 3% | 3% | 3% | 3% | 3% |
| **Subtotal** | **$314,266** | **$314,266** | **$314,266** | **$314,266** | **$314,266** | **$314,266** | **$314,266** | **$314,266** | **$314,266** | **$314,266** | **$314,266** | **$314,266** | **$314,266** |
| | | | | | | | | | | | | | |
| **Capital Annual Total** | **$314,266** | **$314,266** | **$314,266** | **$314,266** | **$314,266** | **$314,266** | **$314,266** | **$314,266** | **$314,266** | **$314,266** | **$314,266** | **$314,266** | **$314,266** |
| | | | | | | | | | | | | | |
| Assumed Inflation Rate | 1.40 | 1.42 | 1.44 | 1.46 | 1.48 | 1.50 | 1.53 | 1.55 | 1.57 | 1.60 | 1.62 | 1.64 | 1.67 |
| Inflated Values | $5,405,467 | $5,484,928 | $5,565,556 | $5,647,370 | $5,730,386 | $5,814,623 | $5,900,098 | $5,986,829 | $6,074,835 | $6,164,136 | $6,254,748 | $6,346,693 | $6,439,990 |

| | |
|---|---|
| Estimated Rate of Return | 2.00% |
| **Total Estimated Cost (High End)** | **$165,706,641** |
| **Net Present Value (High End)** | **$111,810,267** |

| | |
|---|---|
| **Total Estimated Costs per Tonne (High End)** | **$303** |
| **Total Estimated NPV per Tonne (High End)** | **$205** |

**Notes:**
1. The estimated annual tonnes for 2026 to 2056 assumes no organics diversion will occur.
2. The total landfill footprint area was calculated based on the annual airspace requirements for 2026 to 2056, and assumed an average waste height of 25.0 m.
3. The assumed inflation rate is based on Tetra Tech's industry experience.
4. The rate of return is based on the Bank of Canada long-term bond yield.

## Table 5: Landfill Capital Costs Estimate

| Assumed Values: | | |
|---|---|---|
| Estimated Lifespan of New Airspace | 5 | 2026-2056 |
| Estimated Annual Tonnes (2026 - 2036) | 15,432 | Tonnes |
| Annual Airspace Requirements (2026 - 2036) | 23,383 | $m^3$ |
| Estimated Additional Airspace Available | 120,000 | $m^3$ |

| | | | Unit Cost | | Totals | |
|---|---|---|---|---|---|---|
| **Capital Expenditures** | **Quantity** | **Units** | **Low End** | **High End** | **Low End** | **High End** |
| Stripping Final Cover | 11000 | Square Meter | $10 | $20 | $110,000 | $220,000 |
| General Excavation | 15,593 | Unit | $15 | $30 | $233,888 | $467,775 |
| Geogrid Supply and Install | 47817 | Square Meter | $4 | $6 | $191,268 | $286,902 |
| Engineered Fill Supply, Place, and Compact | 47,093 | Cubic Meter | $20 | $45 | $941,850 | $2,119,163 |
| Perimeter Road Construction | 315 | Linear Metre | $60 | $100 | $18,900 | $31,500 |
| Haul Road Reconstruction | 250 | Linear Metre | $150 | $250 | $37,500 | $62,500 |
| Stormwater Ditching Reconstruction | 315 | Linear Metre | $30 | $50 | $9,450 | $15,750 |
| Subdrain Construction | 315 | Linear Metre | 30 | 50 | $9,450 | $15,750 |
| Erosion Control Mat | 5103 | Square Meter | $10 | $30 | $51,030 | $153,090 |
| Hydroseeding | 5103 | Square Meter | $1 | $5 | $6,379 | $25,515 |
| Engineering, Tender, Close-Out (15%) | 315 | | | | $241,457 | $509,692 |
| | | | | **Total Capital Expenditures** | **$1,851,171** | **$3,907,636** |
| | | | | **Capital Cost per Tonne Over the Lifespan of Landfill Expansion** | **$23.37** | **$49.34** |

**Notes:**
1. Unit rates and quantities costs are estimates based on Tetra Tech's recent construction and industry experience.

## Table 6: Landfill Operational Costs Estimate - Year 1

| **Assumed Values:** | | |
|---|---|---|
| Estimated Lifespan of New Airspace | 5 | 2026-2056 |
| Estimated Annual Tonnes (2026 - 2036) | 15,432 | Tonnes |
| Annual Airspace Requirements (2026 - 2036) | 23,383 | m3 |
| Estimated Additional Airspace Available | 120,000 | m3 |

| | | | Unit Cost | | Totals | |
|---|---|---|---|---|---|---|
| **Operational Expenditures** | **Quantity** | **Units** | **Low End** | **High End** | **Low End** | **High End** |
| Annual Environmental Management | 1 | Annual | $40,000 | $50,000 | $40,000 | $50,000 |
| Operational and Maintenance Costs | 1 | Annual | $2,750,000 | $3,750,000 | $2,750,000 | $3,750,000 |
| | | | | | | |
| | | | | **Total Operational Expenditures** | **$2,790,000** | **$3,800,000** |
| | | | | **Total Operating Expenditure per Tonne** | **$181** | **$246** |

**Notes:**

1. Unit rates and quantities costs are estimates based on Tetra Tech's recent construction and industry experience.

## Table 7: Landfill Costs (Low End) - 8 Year Period

| Assumed Values: | | |
|---|---|---|
| Estimated Lifespan of New Airspace | 5 | 2026-2056 |
| Estimated Annual Tonnes (2026 - 2036) | 15,432 | Tonnes |
| Annual Airspace Requirements (2026 - 2036) | 23,383 | m3 |
| Estimated Additional Airspace Available | 120,000 | m3 |

| Operational Expenditures | | Year -3 2022 | Year -2 2023 | Year -1 2024 | Year 0 2025 | Year 1 2026 | Year 2 2027 | Year 3 2028 | Year 4 2029 | Year 5 2030 |
|---|---|---|---|---|---|---|---|---|---|---|
| Annual Environmental Management | | 0% | 0% | 0% | 0% | 100% | 100% | 100% | 100% | 100% |
| **Subtotal** | | **$0** | **$0** | **$0** | **$0** | **$40,000** | **$40,000** | **$40,000** | **$40,000** | **$40,000** |
| Operational and Maintenance Costs | | 0% | 10% | 10% | 10% | 100% | 100% | 100% | 100% | 100% |
| **Subtotal** | | **$0** | **$275,000** | **$275,000** | **$275,000** | **$2,750,000** | **$2,750,000** | **$2,750,000** | **$2,750,000** | **$2,750,000** |
| | | | | | | | | | | |
| **Capital Expenditures** | | | | | | | | | | |
| Vertical Expansion Construction | | **$1,851,171** | **$0** | **$0** | **$0** | **$0** | **$0** | **$0** | **$0** | **$0** |
| **Subtotal** | | **$1,851,171** | **$0** | **$0** | **$0** | **$0** | **$0** | **$0** | **$0** | **$0** |
| | | | | | | | | | | |
| **Annual Operation Total** | | **$1,851,171** | **$275,000** | **$275,000** | **$275,000** | **$2,790,000** | **$2,790,000** | **$2,790,000** | **$2,790,000** | **$2,790,000** |
| | | | | | | | | | | |
| Assumed Inflation Rate | 1.470% | 1.01 | 1.03 | 1.04 | 1.06 | 1.08 | 1.09 | 1.11 | 1.12 | 1.14 |
| Inflated Values | | $1,878,384 | $283,144 | $287,307 | $291,530 | $3,001,183 | $3,045,301 | $3,090,067 | $3,135,490 | $3,181,582 |

| | |
|---|---|
| Estimated Rate of Return | 2.00% |
| **Total Estimated Cost (Low End)** | **$18,193,988** |
| **Net Present Value (Low End)** | **$16,104,576** |

| | |
|---|---|
| **Total Estimated Costs per Tonne (Low End)** | **$230** |
| **Total Estimated NPV per Tonne (Low End)** | **$203** |

**Notes:**
1. The assumed rate of return and inflation rate are based on Tetra Tech's industry experience.

## Table 8: Landfill Costs (High End) - 8 Year Period

| Assumed Values: | | |
|---|---|---|
| Estimated Lifespan of New Airspace | 5 | 2026-2056 |
| Estimated Annual Tonnes (2026 - 2036) | 15,432 | Tonnes |
| Annual Airspace Requirements (2026 - 2036) | 23,383 | m3 |
| Estimated Additional Airspace Available | 120,000 | m3 |

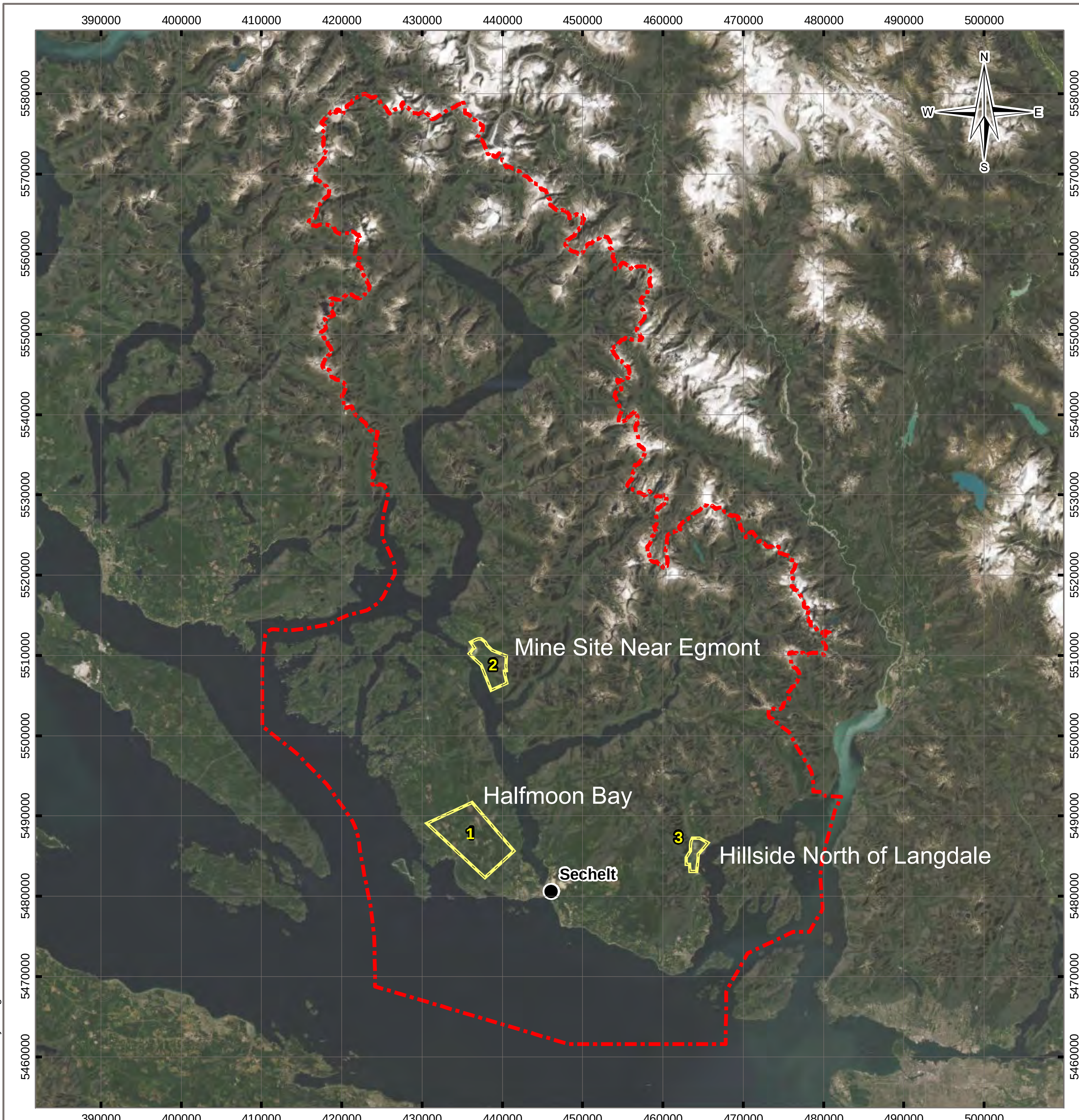
| Operational Expenditures | | Year -3 2022 | Year -2 2023 | Year -1 2024 | Year 0 2025 | Year 1 2026 | Year 2 2027 | Year 3 2028 | Year 4 2029 | Year 5 2030 |
|---|---|---|---|---|---|---|---|---|---|---|
| Annual Environmental Management | | 0% | 0% | 0% | 0% | 100% | 100% | 100% | 100% | 100% |
| | **Subtotal** | **$0** | **$0** | **$0** | **$0** | **$50,000** | **$50,000** | **$50,000** | **$50,000** | **$50,000** |
| Operational and Maintenance Costs | | 0% | 10% | 10% | 10% | 100% | 100% | 100% | 200% | 300% |
| | **Subtotal** | **$0** | **$375,000** | **$375,000** | **$375,000** | **$3,750,000** | **$3,750,000** | **$3,750,000** | **$7,500,000** | **$11,250,000** |
| **Capital Expenditures** | | | | | | | | | | |
| Vertical Expansion Construction | | **$3,907,636** | **$0** | **$0** | **$0** | **$0** | **$0** | **$0** | **$0** | **$0** |
| | **Subtotal** | **$3,907,636** | **$0** | **$0** | **$0** | **$0** | **$0** | **$0** | **$0** | **$0** |
| | | | | | | | | | | |
| | **Annual Total** | **$3,907,636** | **$375,000** | **$375,000** | **$375,000** | **$3,800,000** | **$3,800,000** | **$3,800,000** | **$7,550,000** | **$11,300,000** |
| | | | | | | | | | | |
| Assumed Inflation Rate | 1.470% | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Inflated Values | | $3,907,636 | $375,000 | $375,000 | $375,000 | $3,800,000 | $3,800,000 | $3,800,000 | $7,550,000 | $11,300,000 |

| | |
|---|---|
| Estimated Rate of Return | 2.00% |
| **Total Estimated Cost (High End)** | **$35,282,636** |
| **Net Present Value Costs (High End)** | **$21,459,316** |

| | |
|---|---|
| **Total Estimated Costs per Tonne (High End)** | **$446** |
| **Total Estimated Costs per Tonne (High End)** | **$271** |

**Notes:**
1. The assumed rate of return and inflation rate are based on Tetra Tech's industry experience.

# FIGURES




M:\SOLID_WASTE\SWOP04367-01\Maps\SWOP04367-01_FIG1.mxd modified 2021-01-07 by rhia.goo

## LEGEND

- Area of Interest
- Sunshine Coast Regional District

**NOTES**
Base imagery source:
ESRI-Maxar (various 2013-2019)

**FUTURE WASTE DISPOSAL OPTIONS ANALYSIS STUDY SUNSHINE COAST REGIONAL DISTRICT, BC**

**Landfill Siting Areas Of Interest**

| PROJECTION | DATUM | CLIENT |
|---|---|---|
| UTM Zone 10 | NAD83 | |

Scale: 1:700,000
10 5 0 10
Kilometres

**FILE NO.**
SWOP04367-01_FIG1.mxd

TETRA TECH

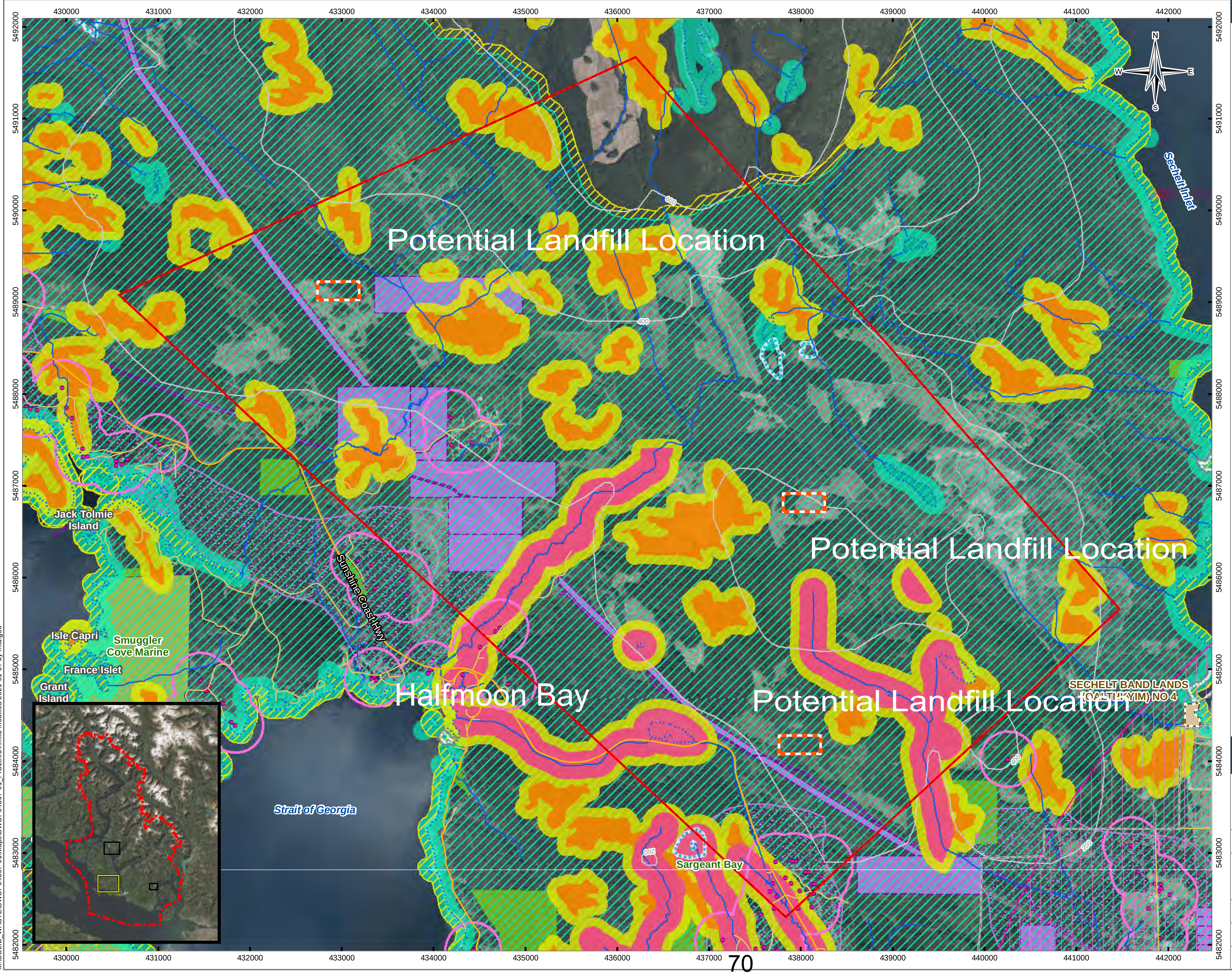
| OFFICE | DWN | CKD | APVD | REV |
|---|---|---|---|---|
| Tt-CAL | RG | SL | NN | 0 |

**DATE**
January 7, 2021

**PROJECT NO.**
SWM.SWOP04367-01

**Figure 1**

**STATUS**
ISSUED FOR REVIEW




## LEGEND

- Area of Interest
- Potential Landfill Location

**Water**
- Water Well
- Water Supply Well Buffer (300 m)
- Aquifer
- Stream
- Shoreline
- Surface Water and Shoreline Setback (100 m)

**Critical Habitat & Sensitive Ecosystem**
- Marbled Murrelet
- Western Painted Turtle Pacific Coast Population
- Critical Habitat Setback (100 m)
- Sensitive Ecosystem
- Sensitive Ecosystem Setback (100 m)
- Wetland

**Base Data**
- Major Road
- Local Road
- Elevation Contour (200 m)
- Airport Buffer (8 km)
- Aboriginal Land
- Land Use - Industrial Zoning
- Crown Land
- Parks

**NOTES**
Base data source:
Canvec (2019), DataBC (2019)
SCRD (downloaded 2020)
Base imagery source:
ESRI-Maxar (various 2013-2019)

**STATUS**
ISSUED FOR REVIEW

**FUTURE WASTE DISPOSAL OPTIONS ANALYSIS STUDY SUNSHINE COAST REGIONAL DISTRICT, BC**

## Area Of Interest 1 - Halfmoon Bay

| PROJECTION | DATUM | CLIENT |
|---|---|---|
| UTM Zone 10 | NAD83 | |

Scale: 1:40,000
300 150 0 300
Metres

**FILE NO.** SWOP04367-01_FIG2thru4.mxd

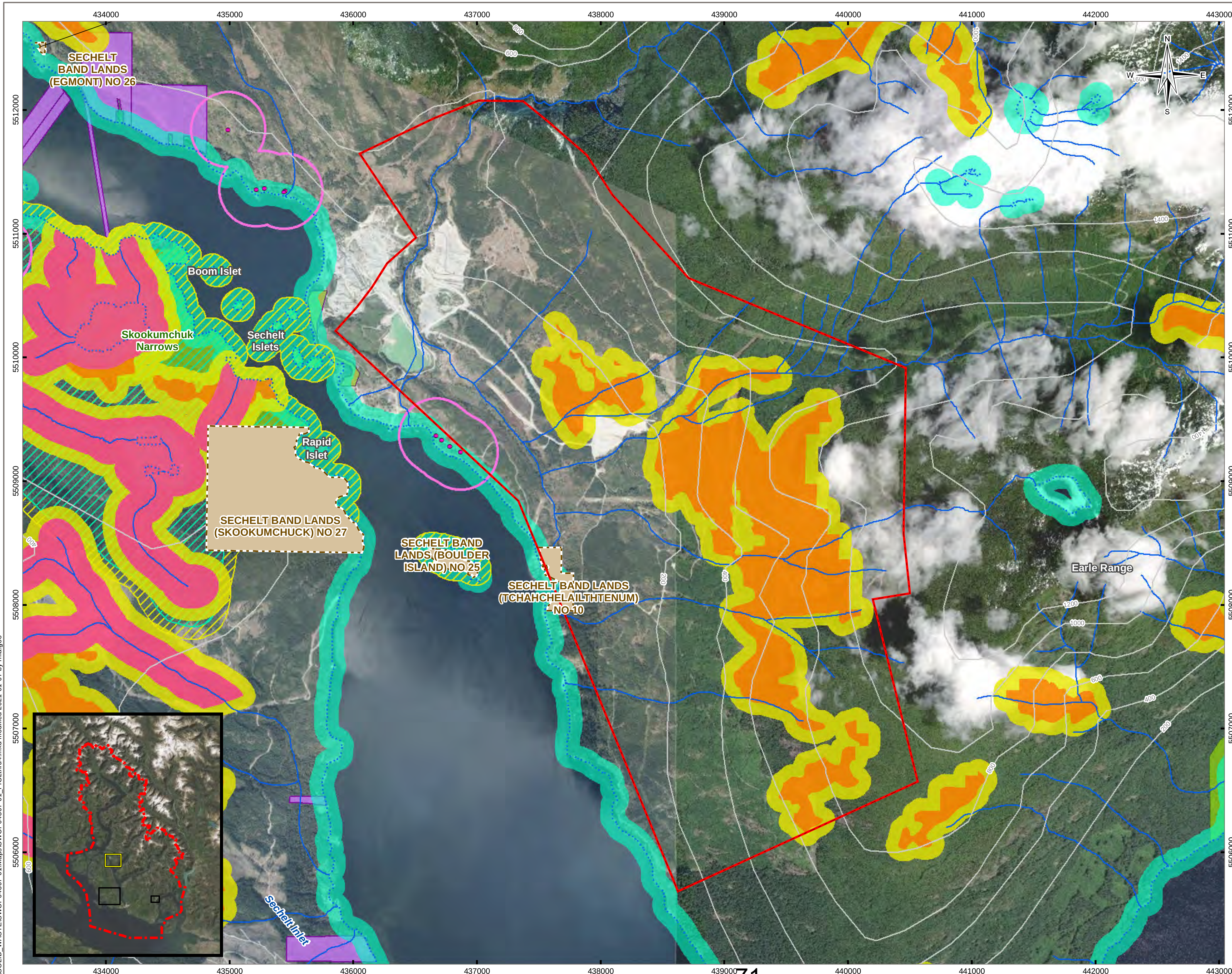
TETRA TECH

| OFFICE | DWN | CKD | APVD | REV |
|---|---|---|---|---|
| Tt-CAL | RG | SL | NN | 0 |

**DATE** January 7, 2021
**PROJECT NO.** SWM.SWOP04367-01

**Figure 2**

M:\SOLID_WASTE\SWOP04367-01\Maps\SWOP04367-01_FIG2thru4.mxd modified 2021-01-07 by rhia.goo




M:\SOLID_WASTE\SWOP04367-01\Maps\SWOP04367-01_FIG2thru4.mxd modified 2021-01-07 by rhia.goo

## LEGEND

Area of Interest

**Water**

Water Well

Water Supply Well Buffer (300 m)

Stream

Shoreline

Surface Water and Shoreline Setback (100 m)

**Critical Habitat & Sensitive Ecosystem**

Marbled Murrelet

Western Painted Turtle Pacific Coast Population

Critical Habitat Setback (100 m)

Sensitive Ecosystem

Sensitive Ecosystem Setback (100 m)

**Base Data**

Elevation Contour (200 m)

Aboriginal Land

Crown Land

Parks

**NOTES**
Base data source:
Canvec (2019), DataBC (2019)
SCRD (downloaded 2020)
Base imagery source:
ESRI-Maxar (various 2013-2019)

**STATUS**
ISSUED FOR REVIEW

**FUTURE WASTE DISPOSAL OPTIONS ANALYSIS STUDY SUNSHINE COAST REGIONAL DISTRICT, BC**

**Area Of Interest 2 - Mine Site Near Egmont**

| PROJECTION | DATUM | CLIENT |
|---|---|---|
| UTM Zone 10 | NAD83 | |

Scale: 1:30,000

300 150 0 300

Metres

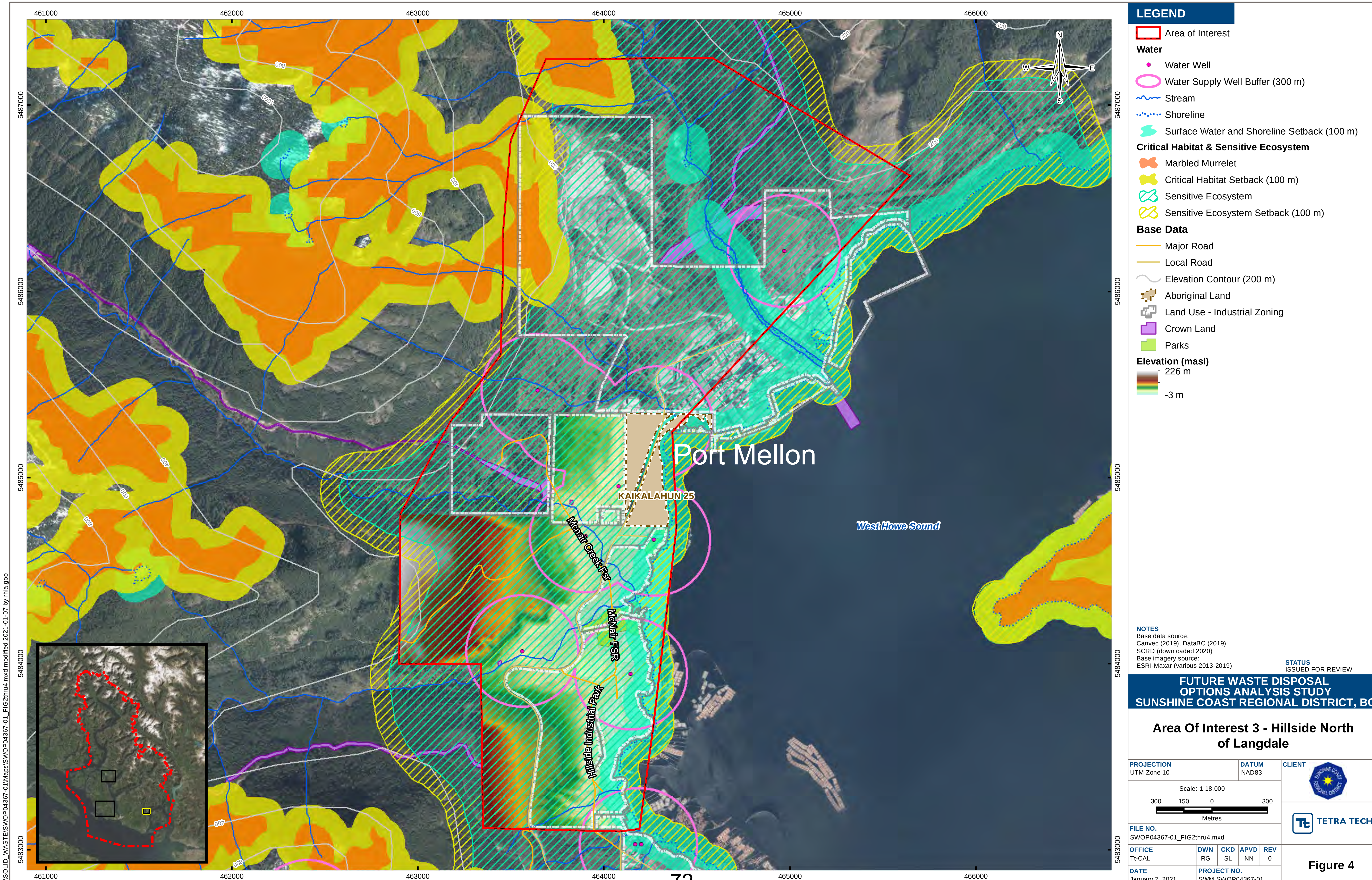
FILE NO.
SWOP04367-01_FIG2thru4.mxd

| OFFICE | DWN | CKD | APVD | REV |
|---|---|---|---|---|
| Tt-CAL | RG | SL | NN | 0 |

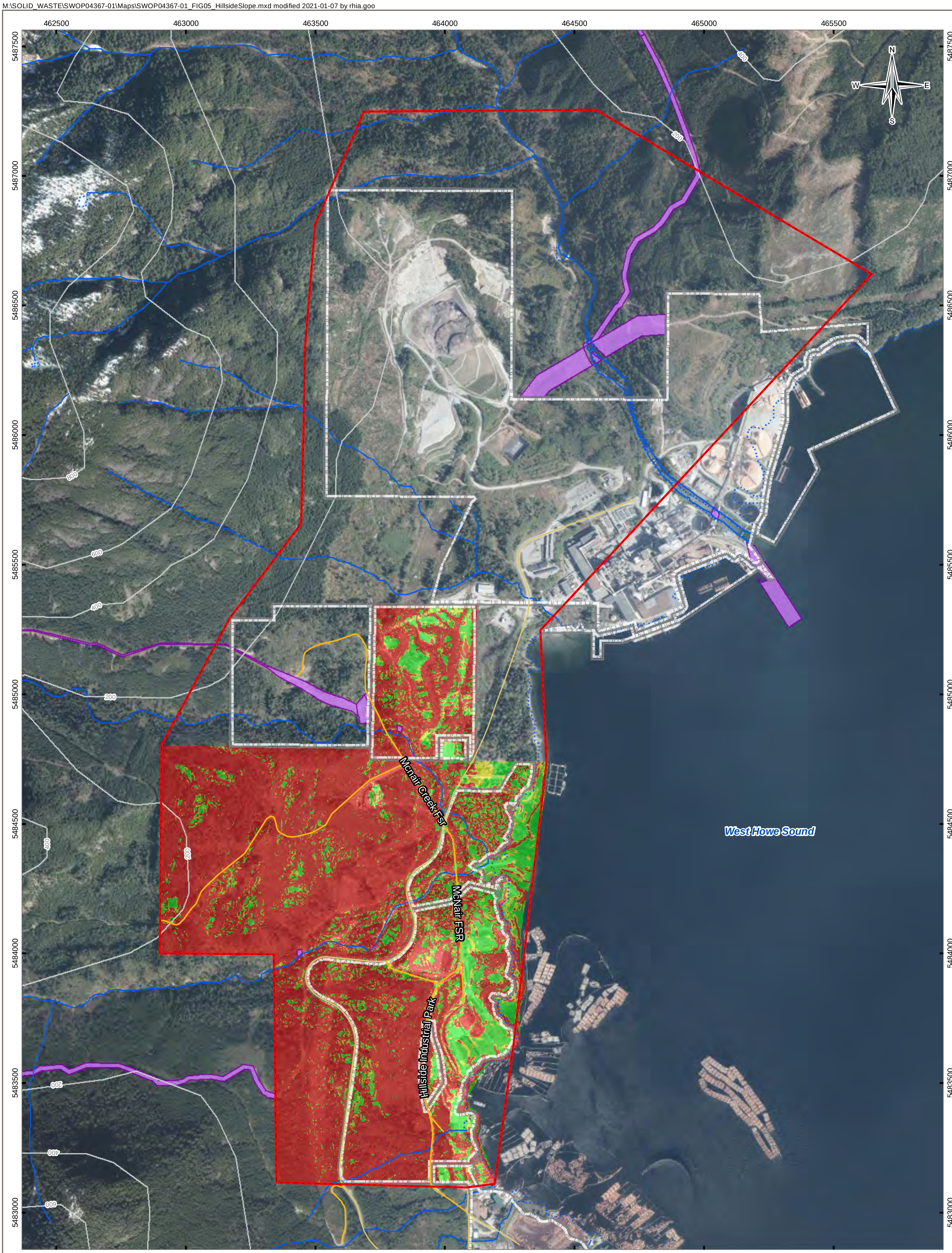
| DATE | PROJECT NO. |
|---|---|
| January 7, 2021 | SWM.SWOP04367-01 |

TETRA TECH

**Figure 3**


LEGEND
Area of Interest
Water
Water Well
Water Supply Well Buffer (300 m)
Stream
Shoreline
Surface Water and Shoreline Setback (100 m)
Critical Habitat & Sensitive Ecosystem
Marbled Murrelet
Critical Habitat Setback (100 m)
Sensitive Ecosystem
Sensitive Ecosystem Setback (100 m)
Base Data
Major Road
Local Road
Elevation Contour (200 m)
Aboriginal Land
Land Use - Industrial Zoning
Crown Land
Parks
Elevation (masl)
226 m
-3 m
Port Mellon
KAIKALAHUN 25
West Howe Sound
McNair Creek FSR
McNair FSR
Hillside Industrial Park
NOTES
Base data source:
Canvec (2019), DataBC (2019)
SCRD (downloaded 2020)
Base imagery source:
ESRI-Maxar (various 2013-2019)
STATUS
ISSUED FOR REVIEW
FUTURE WASTE DISPOSAL OPTIONS ANALYSIS STUDY
SUNSHINE COAST REGIONAL DISTRICT, BC
Area Of Interest 3 - Hillside North of Langdale
PROJECTION
UTM Zone 10
DATUM
NAD83
CLIENT
Scale: 1:18,000
300 150 0 300
Metres
TETRA TECH
FILE NO.
SWOP04367-01_FIG2thru4.mxd
OFFICE
Tt-CAL
DWN
RG
CKD
SL
APVD
NN
REV
0
DATE
January 7, 2021
PROJECT NO.
SWM.SWOP04367-01
Figure 4
M:\SOLID_WASTE\SWOP04367-01\Maps\SWOP04367-01_FIG2thru4.mxd modified 2021-01-07 by rhia.goo

M:\SOLID_WASTE\SWOP04367-01\Maps\SWOP04367-01_FIG05_HillsideSlope.mxd modified 2021-01-07 by rhia.goo




## LEGEND

Area of Interest

**Percent Slope**

- <5%
- 5-7.5%
- >7.5%

**Base Data**

- Major Road
- Local Road
- Elevation Contour (200 m)
- Stream
- Shoreline
- Land Use - Industrial Zoning
- Crown Land

**NOTES**
Base data source:
Canvec (2019), DataBC (2019)
SCRD (downloaded 2020)
Base imagery source:
ESRI-Maxar (various 2013-2019)

**FUTURE WASTE DISPOSAL OPTIONS ANALYSIS STUDY**
**SUNSHINE COAST REGIONAL DISTRICT, BC**

# Topography at Hillside North of Langdale

| PROJECTION | DATUM | CLIENT |
|---|---|---|
| UTM Zone 10 | NAD83 | |

Scale: 1:14,000
200 100 0 200
Metres

FILE NO.
SWOP04367-01_FIG05_HillsideSlope.mxd

| OFFICE | DWN | CKD | APVD | REV |
|---|---|---|---|---|
| Tt-CAL | RG | SL | NN | 0 |

| DATE | PROJECT NO. |
|---|---|
| January 7, 2021 | SWM.SWOP04367-01 |

TETRA TECH

**Figure 5**

STATUS
ISSUED FOR REVIEW

# APPENDIX A

## LIMITATIONS ON THE USE OF THIS DOCUMENT

# LIMITATIONS ON USE OF THIS DOCUMENT

## GEOENVIRONMENTAL

### 1.1 USE OF DOCUMENT AND OWNERSHIP

This document pertains to a specific site, a specific development, and a specific scope of work. The document may include plans, drawings, profiles and other supporting documents that collectively constitute the document (the "Professional Document").

The Professional Document is intended for the sole use of TETRA TECH's Client (the "Client") as specifically identified in the TETRA TECH Services Agreement or other Contractual Agreement entered into with the Client (either of which is termed the "Contract" herein). TETRA TECH does not accept any responsibility for the accuracy of any of the data, analyses, recommendations or other contents of the Professional Document when it is used or relied upon by any party other than the Client, unless authorized in writing by TETRA TECH.

Any unauthorized use of the Professional Document is at the sole risk of the user. TETRA TECH accepts no responsibility whatsoever for any loss or damage where such loss or damage is alleged to be or, is in fact, caused by the unauthorized use of the Professional Document.

Where TETRA TECH has expressly authorized the use of the Professional Document by a third party (an "Authorized Party"), consideration for such authorization is the Authorized Party's acceptance of these Limitations on Use of this Document as well as any limitations on liability contained in the Contract with the Client (all of which is collectively termed the "Limitations on Liability"). The Authorized Party should carefully review both these Limitations on Use of this Document and the Contract prior to making any use of the Professional Document. Any use made of the Professional Document by an Authorized Party constitutes the Authorized Party's express acceptance of, and agreement to, the Limitations on Liability.

The Professional Document and any other form or type of data or documents generated by TETRA TECH during the performance of the work are TETRA TECH's professional work product and shall remain the copyright property of TETRA TECH.

The Professional Document is subject to copyright and shall not be reproduced either wholly or in part without the prior, written permission of TETRA TECH. Additional copies of the Document, if required, may be obtained upon request.

### 1.2 ALTERNATIVE DOCUMENT FORMAT

Where TETRA TECH submits electronic file and/or hard copy versions of the Professional Document or any drawings or other project-related documents and deliverables (collectively termed TETRA TECH's "Instruments of Professional Service"), only the signed and/or sealed versions shall be considered final. The original signed and/or sealed electronic file and/or hard copy version archived by TETRA TECH shall be deemed to be the original. TETRA TECH will archive a protected digital copy of the original signed and/or sealed version for a period of 10 years.

Both electronic file and/or hard copy versions of TETRA TECH's Instruments of Professional Service shall not, under any circumstances, be altered by any party except TETRA TECH. TETRA TECH's Instruments of Professional Service will be used only and exactly as submitted by TETRA TECH.

Electronic files submitted by TETRA TECH have been prepared and submitted using specific software and hardware systems. TETRA TECH makes no representation about the compatibility of these files with the Client's current or future software and hardware systems.

### 1.3 STANDARD OF CARE

Services performed by TETRA TECH for the Professional Document have been conducted in accordance with the Contract, in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions in the jurisdiction in which the services are provided. Professional judgment has been applied in developing the conclusions and/or recommendations provided in this Professional Document. No warranty or guarantee, express or implied, is made concerning the test results, comments, recommendations, or any other portion of the Professional Document.

If any error or omission is detected by the Client or an Authorized Party, the error or omission must be immediately brought to the attention of TETRA TECH.

### 1.4 DISCLOSURE OF INFORMATION BY CLIENT

The Client acknowledges that it has fully cooperated with TETRA TECH with respect to the provision of all available information on the past, present, and proposed conditions on the site, including historical information respecting the use of the site. The Client further acknowledges that in order for TETRA TECH to properly provide the services contracted for in the Contract, TETRA TECH has relied upon the Client with respect to both the full disclosure and accuracy of any such information.

### 1.5 INFORMATION PROVIDED TO TETRA TECH BY OTHERS

During the performance of the work and the preparation of this Professional Document, TETRA TECH may have relied on information provided by persons other than the Client.

While TETRA TECH endeavours to verify the accuracy of such information, TETRA TECH accepts no responsibility for the accuracy or the reliability of such information even where inaccurate or unreliable information impacts any recommendations, design or other deliverables and causes the Client or an Authorized Party loss or damage.

### 1.6 GENERAL LIMITATIONS OF DOCUMENT

This Professional Document is based solely on the conditions presented and the data available to TETRA TECH at the time the data were collected in the field or gathered from available databases.

The Client, and any Authorized Party, acknowledges that the Professional Document is based on limited data and that the conclusions, opinions, and recommendations contained in the Professional Document are the result of the application of professional judgment to such limited data.

The Professional Document is not applicable to any other sites, nor should it be relied upon for types of development other than those to which it refers. Any variation from the site conditions present, or variation in assumed conditions which might form the basis of design or recommendations as outlined in this report, at or on the development proposed as of the date of the Professional Document requires a supplementary investigation and assessment.

TETRA TECH is neither qualified to, nor is it making, any recommendations with respect to the purchase, sale, investment or development of the property, the decisions on which are the sole responsibility of the Client.

### 1.7 NOTIFICATION OF AUTHORITIES

In certain instances, the discovery of hazardous substances or conditions and materials may require that regulatory agencies and other persons be informed and the client agrees that notification to such bodies or persons as required may be done by TETRA TECH in its reasonably exercised discretion.

# APPENDIX B

## WTE TECHNOLOGY DESCRIPTIONS

# 1.0 WASTE-TO-ENERGY TECHNOLOGIES

## 1.1 Hybrid Gasification

Hybrid gasification systems is typically suited for smaller waste quantities such as from the SCRD. For small communities, the technology vendor offers units as small as 50 tonnes per day that can be expanded in a modular fashion to provide systems up to 500 tonnes per day.

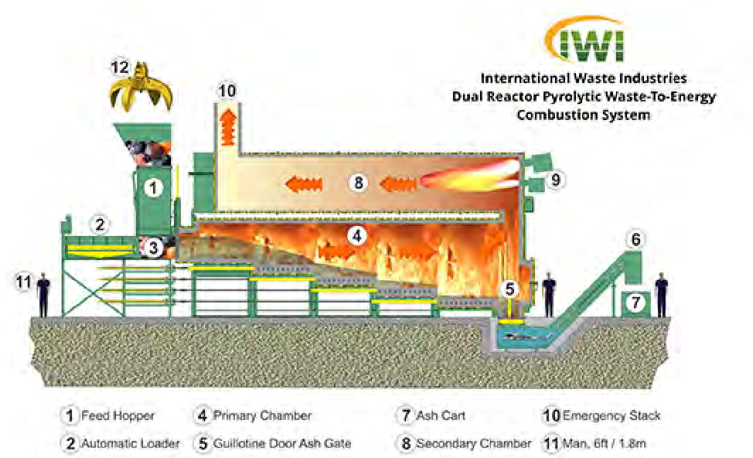



**Figure A: Hybrid Gasification System**

This type of thermal conversion technology produces a synthetic gas or 'syngas' that is created from heating of combustibles in an oxygen starved pre-burn chamber. This syngas is then directed and burned in a second combustion chamber. The syngas generated is more combustible than the solid carbon material (such as wood), thus improving overall combustion efficiency and generating a cleaner burn. Figure A shows the schematic of a hybrid gasification process.

This technology produces an ash that needs to be disposed in a landfill. Up to 25% of the amount of waste processed in this technology usually remains in the residual. These residuals are typically not hazardous if the feedstock is purely MSW. Opportunities to produce energy from the combustion process is limited as smaller facilities produce less heat that can be converted to energy.

## 1.2 Mass Burn Thermal Conversion

Waste to energy (WTE) thermal conversion is a straightforward and viable alternative to landfilling in certain cases, as waste materials are thermally converted to energy, that can then be used to generate heat and electricity. Conventional direct combustion, or thermal conversion, is the most prevalent technology for WTE in the industry, as there are hundreds of operating plants worldwide. With this technology, waste is generally burned as received with minimal pre-processing. This is commonly known as an incineration process. WTE facilities typically create energy in the form of high-pressure steam that can be used directly for industrial processes or to generate marketable electricity and/or district heating.

Mass burn technologies are the most common thermal conversion system for municipalities that receive more than 500 tonnes per day. For these facilities, waste is pushed into a waste bunker and manipulated using grapple cranes. The waste material is then loaded into a hopper where it is fed into the combustion chamber. The heat in the combustion chamber, fuel from the waste stream and oxygen which is injected into the chamber are the three elements that sustain the combustion process which produces significant amounts of thermal energy which is used to produce steam or hot water.

**Figure B: Mass Burn Facility**

Modern facilities typically achieve a waste volume reduction of more than 90%. By-products from the process typically include two forms of ash: bottom ash from the actual burning of the feedstock, and fly ash from the flue gas cleaning process. On a weight basis, this technology typically produces an ash residual that is approximately 20% of the waste processed. These ashes can be hazardous depending on the composition of feedstocks and require additional processes to safely dispose in a landfill.

Environmental concerns associated with mass burn thermal conversion include emissions that could impact air quality.

## 1.3 Gasification

Gasification is a partial combustion process in an oxygen-deficient atmosphere (i.e., the oxygen level is limited to convert the solid material). The resulting products are a carbon-rich ash and a syngas stream. The syngas is composed of various gases – hydrogen, carbon dioxide, and other trace gas. Gasification processes that use pure oxygen are able to obtain higher syngas energy content (300 to 380 British thermal units/standard cubic foot (Btu/scf)) as a result of the elimination of the nitrogen present in atmospheric air. While gasification is a more complex technology, it allows for the recovery of value products (i.e., syngas) which can be used to generate chemicals (fuels, alcohols, etc.). Catalytic conversion via the Fischer-Tropsch process and other methods can also be used to generate "drop-in" biofuels such as synthetic gasoline, renewable natural gas (RNG) and diesel. The syngas can also be used to drive gas engines and turbines to generate electricity that could be used internally or exported to a local electricity grid.

**Figure C: Gasification Plant**

The benefits of gasification are increased efficiency, greater variety of end products, and fewer back-end pollution control requirements. Commercially, gasification technologies have not proven to be economically and operationally comparable to traditional combustion processes such as mass burn because of its high complexity and high capital costs. Gasification technologies are typically 20-30% more expensive than mass burn technologies.

This technology is best suited to processing homogeneous materials that are pre-shredded and have a medium to high energy content such as biomass, plastics and shredded tires. However, there are still challenges that affect continuous and reliable operation of such a facility.

## 1.4 Refuse Derived Fuel

Refuse Derived Fuel (RDF) is an approach where waste is processed so that is can be used as a fuel to offset fossil fuel use. RDF is a suitable solid fuel replacement for fossil fuel and can be used in industrial boilers, the cement industry, or various heating purposes. Most RDFs are engineered to be co-fired with other fuels such as coal, diesel or natural gas. Although the energy content of RDF is generally 20% to 25% less than coal on a per tonne basis, it represents a means to decrease greenhouse gas emissions by partially substituting for fossil fuels.

RDF technology focuses on transforming the varied characteristics of garbage into a homogenous, predictable, carbon-rich feedstock. This includes creating a consistently sized material that has been processed through shredders and screens, removing non-combustible materials through the use of magnets and air density separators, and stabilizing the material for storage and transport through driers and the hydrolyzer. The end product is a combustible material that can be used in its raw fluffy form or compressed into a more compact pelletized form. Non-combustible materials (such as metal, glass, ceramics and other inert materials) are recycled or disposed of.