Technical Memorandum No. 4

Draft

REGIONAL DISTRICT OF KITIMAT-STIKINE

Lakelse Lake Provincial Park Campground Wastewater Treatment Options

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1 Introduction

The purpose of this investigation was to determine whether there are any economic or technical reasons for the Lakelse Lake Furlong Bay Provincial Park Campground and beach complex to connect to a potential new RDKS-initiated eastside Lakelse Lake subdivision wastewater treatment system. This comparison is to be based on three options: septic tank and ground disposal, stand-alone secondary treatment with effluent ground disposal and joint-treatment with an RDKS Lakelse Lake "1st Avenue" community treatment system.

The level of detail of this comparison is based on conceptual designs and therefore the cost estimates should only be used for comparison of options rather than the setting of final budgets.

2 The Current Situation

At present, the Park has 156 unserviced campsites. To provide toilet and toilet and shower services to Park users, the Park is equipped with the following:

- Three toilet-shower buildings with flush toilets and showers in the campground (two in the north/paved side of the campground and one in the south/gravel side) to serve the campers.
- Nine panabode-style pit (non-water flush) toilets with sealed pump-out tanks.
- One toilet-change house building near the beach to serve the "day users".
- One trailer/camper sani-dump station.

These facilities are shown in Figure 1 with the three toilet-shower buildings designated A, B and C. The pit toilets have been given letter-number designations, e.g. A3, B1, C2, etc. for use in the collection/treatment scenarios. The toilet-change house has no specific designation but is the facility located nearest to the beach.

Toilet-shower buildings A and B are both four-unit toilet and shower buildings. They are equipped with septic tanks. Effluent from these septic tanks is pumped through a 100 mm diameter force main to a septic field located to the south of the Park Facility Operator's (PFO's) building. This disposal field has 540 lineal metres of disposal lines according to Park staff (John Howard – personal communication).

Building C is a four-unit toilet and shower building. It has its own septic tank and disposal field located behind the building. There are seven disposal field lines with a total of 210 lineal metres and three inspection boxes.

The nine pit toilets are currently used as back-ups to the toilet-shower buildings. According to Park Staff (Ben Sabal – personal communication) most campers prefer to use the toilet-shower buildings instead of the pit toilets. The concentrated wastewater (“blackwater”) collected in the sealed tanks under these pit toilets is removed only annually by a mobile septage hauler pump truck. The concentrated wastewater is then disposed of at the Thornhill landfill septage pits.

The ten-unit toilet-change house at the Furlong Bay Day Use area has six urinals, three toilets and two foot showers (John Howard – personal communication). The building is equipped with a septic tank and the effluent from this tank is pumped to the disposal field south of the PFO Service yard, i.e. it shares the same disposal field as used by the A and B toilet-shower buildings.

The sani-dump station has a large holding tank. The tank is large enough for the current level of usage. The tank contents are pumped out and hauled away for off-site disposal once a season.

3 Wastewater Generation Estimates

Each wastewater source-type in the Park has its own wastewater generation rate. Since there is no water or wastewater flow data available, the basis for the estimation of these flows is the Provincial guidelines for design of the septic system, i.e. the “Sewerage System Standard Practice Manual” (SSSPM), issued by the Ministry of Health in June 2005 and available at:

http://www.healthservices.gov.bc.ca/protect/bcsr_spm.pdf.

Based on available Park information in Figure 1, there are 156 campsites in the campground. Based on the SSSPM guidelines, the wastewater generation rate could be anywhere in the 180 L/campsite/day to 365 L/campsite/day range depending on level of occupancy and level of water use (SSSPM Table 4.2). However, based on the proportion of toilet and shower buildings to pit toilet-only buildings, the 180 L/campsite/day is likely the most reasonable value to use. The design condition is assumed to be with the campground completely full, i.e. a long weekend with good (sunny) weather.

The beach area is served by a toilet-change house building. The numbers of day users of the beach area is difficult to determine with accuracy. For the purposes of this study a range of 500 to 1000 persons will be examined. In all cases, the per person flow will be held at 40 L/person/day (SSSPM Table 4.2).

According to Parks information, the sani-dump is used between 300 to 400 times per season with volumes in the 90 L to 140 L/discharge basis. Even at the extreme, this would be about 56,000 L per season or an average of about 622 L/day (0.622 m^3/day) over a 90 day “season”. This is a relatively low flow volume and is well within the level of accuracy of the other two flow components. As a result, the sani-dump flow will not specifically be added to the other two flows. Currently, the sani-dump collection tank is pumped out once per season with the contents hauled off-site for disposal.

On the basis of the above, an estimate of the design wastewater flow for a fully-occupied campground with an additional 1000 beach day-users was developed. This estimate is shown in Table 1.

Table 1
Estimated Design Wastewater Flows

Wastewater Flow Source	No. of Units	Flow per Unit	Flow per Source (L/day)
Campsites serviced by toilet-shower buildings "A" and "B"	75 campsites	180 L campsite	13,500
Beach day use toilet-shower building	1000 day users	40 L per users	40,000
Sub-total			53,500
Campsites Serviced by toilet-shower building "C"	81 campsites	180	14,580
Total for campsites and day use			68,080
Design Flow			70,000

As may be seen in Table 1, 156 campsites at 180 L/campsite per day plus 1000 beach users at 40 L/person per day results in an estimated daily flow of about 68,080 L/day or about 68 m^3/day. On this basis, 70 m^3/day will be used for conceptual design purposes.

Based on the above flow estimate, it should be noted that the maximum wastewater flow that is permitted under a single Ministry of Health permit is 22.7 m^3/day per permit. As a result, the permit jurisdiction would fall to the Ministry of Environment (MoE). Furthermore, the MoE no longer issues permits but instead they issue either Operational Certificates (OCs) under LWMPs or Municipal Sewage Regulation (MSR) registrations.

4 Wastewater Treatment Options

4.1 Septic Treatment and Disposal

Septic treatment and ground disposal is currently the main method of wastewater treatment and disposal at the Park. The septic tank is used as a settling and flotation device in which the heavy solids settle as "septage sludge" and the lighter fraction (typically congealed oils and greases) floats to the surface as "scum". The middle fraction, i.e. the liquid fraction is discharged to the ground via perforated pipes that are buried in gravel-filled trenches. The rate at which the wastewater can be discharged to ground is dictated by the soil conditions, i.e. the percolation rate as measured in minutes for a water level in a test hole to drop 2.54 cm (1 inch). This results in the selection of a unit infiltration rate, i.e. L/m^2/day and, by calculation the infiltration area requirements.

For the septic tank and disposal field option, there are two sub-options. These include the following:

- A new version of the status quo system, i.e. two septic systems with the beach toilet-change house and the "A" and "B" toilet-shower buildings all on one septic system and the "C" toilet-shower building on a second separate system.

- One large septic system that combines all of the wastewater.

These options are discussed in the following sections. As stated above, 70 m^3/day has been used as the assumed total design flow. In all cases, the existing pit toilets and sani-dump station would continue to be operated with annual pump outs and off-site disposal.

4.1.1 The "Status Quo" Two-system Septic Tank Option

For this option, there would be two systems. One would serve the toilet-change house and the "A" and "B" toilet-shower buildings for a total of about 54 m^3/day according to Table 1. The second system would serve toilet-shower building "C" with a flow of about 15 m^3/day according to Table 1.

Based on Table 8-1 in the SSSPM guidelines, regarding septic tank volume requirements, the larger 54 m^3/day system might be best split into two tanks, each based on 27 m^3/day, with the volume of the tanks in this size range based on the equation:

Volume = 15000 L + 1.34 x the average daily flow.

Using information in Section 8.1.2 of the SSSPM, this would result in two tanks, each with a working volume measured from the inside bottom of the tank to the invert of the outlet of about 52000 L (52 m^3), as shown in Table 2.

In addition to the two septic tanks, each system would require a flow distribution box and a disposal field. Assuming a percolation rate of from between 5 and 15 minutes, the estimated surficial wastewater loading rate would be of 29 L/m^2/day based on SSSPM Table 5-3. Based on 27000 L/day/septic tank, this results in a disposal trench area requirement of about 931 m^2 per system that, at a trench width of 0.3 m, equates to a trench length requirement of about 3100 m. This would be thirty-two (32), 100 m trenches which, at a spacing of 1.80 m, results in a overall disposal field area of about 5800 m^2 per tank, as shown in Table 2. To bring the overall disposal field area down, wider trench widths of 0.6 m and 0.9 m were tested. As shown in Table 2, the best combination of minimum overall disposal field area and minimum trench length is with 0.9 m wide trenches spaced 2.7 m centre to centre, yielding eleven (11) 100 m long trenches and an overall disposal field area of about 3000 m^2 per each of the two septic tanks. This is a significant area. In addition, equal areas should be set aside for future disposal fields to replace these ones if/when they clog.

The details for the smaller second system, at 15000 L/day, are shown in Table 3. From SSSPM Section 8.1.2, the working volume of the single tank would be 35100 L. With the estimated surficial wastewater loading rate would be of 29 L/m^2/day based on SSSPM Table 5-3, the 15000 L/day flow would require at least 517 m^2 of trench area. As shown in Table 3, the best combination of minimum overall disposal field area and minimum trench length is with 0.9 m wide trenches spaced 2.7 m centre to centre for an overall disposal field area of about 1620 m2 with six 100 m long disposal trenches. This does not include areas set aside for a future disposal field.

4.1.2 The Single Septic System Option

For this option, as per Table 1, the design flow would be about 70 m^3 or 70000 L per day. Based on MSR redundancy needs, it would likely be best to split this flow into two separate 35000 L systems. Based on SSSPM Section 8.1.2, that the working volume of the tanks in this size range would be based on the equation:

Volume = 15000 L + 1.34 x the average daily flow.

This would result in two tanks, each with a working volume measured from the inside bottom of the tank to the invert of the outlet of about 62000 L (62 m^3), as shown in Table 4.

In addition to the two septic tanks, each system would require a flow distribution box and a disposal field. Assuming a percolation rate of from between 5 and 15 minutes, the estimated surficial wastewater loading rate would be of 29 L/m^2/day based on SSSPM Table 5-3. Based on a flow of 35000 L/day/septic tank, this results in a disposal trench area requirement of about 1207 m^2 per system, as shown in Table 4. At a trench width of 0.3 m, equates to a trench length requirement of about 4025 m. This would be forty-one (41), 100 m trenches which, at a spacing of 1.80 m, results in a overall disposal field area of about 7400 m^2 per tank, as shown in Table 4. To bring the overall disposal field area down, wider trench widths of 0.6 m and 0.9 m were tested and, as shown in Table 4. The best combination of minimum overall disposal field area and minimum trench length was with 0.9 m wide trenches spaced 2.7 m centre to centre, yielding fourteen 100 m trenches and an overall disposal field area of about 3800 m^2 per each of the two septic tanks. This is a significant area. In addition, equal areas should be set aside for future disposal fields to replace these ones if/when they clog.

4.1.3 Costing of the Two Septic System Options

The two septic system options have been costed in Tables 5 and 6, respectively, for the two smaller systems and the single large system options, respectively.

For the two system option, it is assumed that the toilet-changing building and the "A" and "B" toilet-shower buildings would be equipped with grinder pumps instead of the existing septic tanks. Force mains from the grinder pumps would be used to convey the wastewater to the twin septic tanks and disposal fields located in the area near the Park Facility Operator building shown on Figure 1. Based on the flows the larger system would use separate primary and secondary septic tanks for each of the two disposal fields required. The smaller system for the C" toilet-shower building would use only one two-chamber tank and disposal field located adjacent to the building, much as in the current situation.

In the case of the single septic system, the "A", "B" and "C" toilet-shower buildings and the Day-use toilet-changing building would all be equipped with grinder pumps and forcemains to convey their wastewaters to the location of the single septic system (assumed to be behind the Park Facility operations complex). The system would use separate primary and secondary septic tanks for each of the two disposal fields.

Based on the above and the unit lengths and prices shown in Tables 5 and 6, it may be seen that the cost of the two alternatives is similar, i.e. in the $710,000 for the two-system alternative and $780,000 for the single system. While typically larger systems exhibit economies of scale, the fact that the two-system alternative has fewer grinder pumps and less force main is likely the reason that of the two septic tank alternatives, the two-system alternative is the less expensive one.

These costs will be compared to the other two options: a stand-alone secondary treatment system or incorporation with a potential RDKS-instigated "1st Avenue" treatment system.

4.2 The Stand-alone Treatment System

The stand-alone treatment system could be anything from a facultative lagoon to an aerated lagoon to a mechanical treatment plant of various forms. Disposal would be to ground, via a rapid infiltration basin. Because the flows from a single treatment system would be greater than 22.7 m^3/day, the regulator would be the Ministry of Environment (MoE) under the Municipal Sewage Regulation (MSR) registration process or an Operation Certificate (OC) under the Liquid Waste Management Plan (LWMP) process. In either case, since disposal will be to ground, the guidelines that are being used for this alternative comparison exercise are those from the Ministry of Health, as discussed above.

4.2.1 Lagoon System

The two lagoon options are classified as "Type 2" treatment under the SSSPM guidelines and, as such, would be expected to produce effluents less than 45 mg/L BOD (and 60 mg/L total suspended solids (TSS) under the MSR guidelines). Assuming a wastewater flow of 70 m^3/day, an annual rainfall of 1200 mm, 30 day minimum hydraulic retention time in the aeration cell(s) and 60 day storage prior to discharge, a twin train lagoon system would require an area of approximately 120 m x 140 m (1.68 ha.), not including the rapid infiltration (RI) basins. At a percolation rate of 5 to 15 minutes per 2.54 cm, from Table 5-3 in SSSPM, the disposal area required for the rapid infiltration basin would be based on 59 L/m^2/day (up from 29 L/m^2/day with the septic tank effluent). Based on the 59 L/m^2/day infiltration rate, at 70 m^3/day, the required infiltration area would have to be at least 1190 m^2. With the provision of a second RI basin, the overall area requirement would be in the order of 2 ha. This area would have to be provided within the park boundary. For the purposes of this exercise, this location has been assumed to be 500 m from the Park Operations Facility.

The sizing of the aeration, storage/settling ponds and rapid infiltration basin is shown in Tables 7, 8 and 9, respectively. The estimated cost for such a lagoon and infiltration basin system is shown in Table 10 at approximately $1.97 million. This is significantly more than either of septic tank options discussed above.

4.2.2 Stand-alone Mechanical Wastewater Treatment Plant

There are several types of stand-alone mechanical wastewater treatment plants that could be used in this situation. One of the most innovative processes that can produce the highest quality effluent is a membrane bioreactor (MBR). In this case, the aerobic suspended growth bacteria that are used to treat the wastewater are separated from the bulk of the aerated mixed liquor by a membrane process, i.e. a physical barrier that all restricts total suspended solids (TSS) and most bacteria and viruses. The effluent quality from these plants is compatible with reclaimed water use, i.e. the water could conceivably be used for irrigation water and/or toilet-flushing purposes.

The effluent quality from the MBR would make it a "Type 3" treatment plant according to the SSSPM guidelines and, as such, at a 5 to 15 minute percolation rate, the effluent disposal loading criteria would be 88 L/m^2/day (up from 59 L/m^2/day for the Type 2 effluent) according to SSSPM Table 5.3.

Such systems are available as turnkey package plants from Vancouver area wastewater treatment equipment suppliers. Recently, one such MBR treatment plant for 65.3 m^3/day was constructed in Richmond, BC for a diamond mine in Ontario. The unit was done on a shipping skid for approximately $812,000 not including installation at the mine. Since this is effectively the size of what the Park would need, it has been used as a component of the cost in Table 11.

The size of the required site for this MBR treatment facility would be in the order of 0.5 ha. because the treatment plant is very compact and the two associated rapid infiltration basins are relatively small.

From Table 11, it may be seen that the total cost of this high quality effluent treatment plant and infiltration basin system would be approximately $2.06 million. This is much higher than the septic tank options but comparable to the lagoon option.

4.3 Combining With a "1st Avenue" Wastewater Treatment System

The third general option for treatment of the wastewater of the Furlong Bay campground and beach portion of the Provincial Park would be combining the wastewater with that from potential a "1st Avenue" collection and treatment system. This option was previously investigated in the Stage 2 Liquid Waste Management Plant (LWMP) Technical Memorandum No. 1 (TM1) "Investigation of Communal Wastewater Treatment for Lakelse Lake East", June 2005.

In TM1 of Stage 2, there were five options presented. Two of them, Options 3 and 5 included the Furlong Bay campground and beach portion of the Provincial Park. Option 2 which included 1st Avenue South and 1st Avenue North, but not the Park had an estimated average daily flow (at build-out) of 420 m^3/day and an treatment plant area requirement of 1.3 ha. Cost was estimated at $3.60 million for the treatment plant and rapid infiltration basin.

Option 3, which was Option 2 plus the Furlong Bay portion of the Park, had an estimated flow of 600 m^3/day (i.e. at that time, the Park was thought at that time to have the potential to generate 180 m^3/day based on 600 persons at 300 L/capita/day). On this basis, the treatment plant and rapid infiltration basin would need 1.6 ha and would cost approximately $4.40 million, i.e. the extra cost to accommodate the assumed Park flows would be approximately $800,000, not including the additional Park-related infrastructure costs, i.e. the internal collection and pumping system and the force main to the new treatment plant.

Based on this more recent round of estimating the Park wastewater flows, the flows from the Park would be substantially less than the 180 m^3/day assumed in TM 1. One this basis, Option 4 from TM1 with a flow of about 690 m^3/day (compared to Option 3 with a flow of 600 m^3/day) would be a better cost comparison. On this basis the estimated incremental cost difference between Option 3 and Option 4 would be about $350,000, i.e. $4.732 million for Option 4 versus $4.382 million for Option 3 plus the additional Park-related internal infrastructure costs. However, to be fair, in this analysis, the Park should pay a proportional amount of total plant cost, e.g. about 13% of the $4.732 million, or about $618,000, not just the incremental cost.

The internal Park infrastructure costs would be the same as for the centralized standalone treatment facility except the forcemain to the treatment location would be assumed to be 1000 m as per TM 1, instead of the 500 m discussed in Section 4.2.2 above. On this basis, as shown in Table 12, the total estimated cost of Option 5 would be approximately $1.27 million which is greater than the septic tank options but substantially less than the stand-alone treatment options.

The above comparison is based on an ultimate Lakelse Lake East build-out scenario. However, if the Park was to share a portion of, say, a five year horizon treatment plant cost, although it would constitute a higher percentage of the total flow, the plant cost would be lower because the flows would be lower. At present, there approximately 248 lots in the Lakelse Lake East study area. It has been estimated that the build rate would be approximately 10 lots per year. As a result, in five years there would be 298 lots. At an occupancy rate of 3 persons per lot (on average) and a per capita wastewater flow of 370 L/day, this would equate to an average daily flow of about 330 m^3/day. With the addition of the Park flow this would be 400 m^3/day, i.e. the Park would constitute 17.5% of the total flow to the plant. Based on the same cost model as used in TM1, a 400 m^3/day treatment plant would cost approximately $3.52 million with the Park's 17.5% representing about $616,000. This effectively the same as the value in Table 12 using the ultimate build-out costs, showing that owing Park's share of the treatment plant is consistent regardless of the method of calculation used.

5 Summary and Conclusions

Five options to collect and treat the wastewater from the Furlong Bay campground and beach portion of Lakelse Lake Provincial Park have been presented and evaluated. These options include the following:

- Two separate septic systems.
- One large centralized septic system.
- A lagoon-type treatment system with rapid infiltration basin effluent disposal.
- A stand-alone membrane bioreactor (MBR) treatment system with rapid infiltration basin effluent disposal.
- Combining the treatment of the collected wastewater with a potential RDKS "1st Avenue" wastewater treatment plant.

The estimated costs of these five option is presented in Table 13. As may be seen, the cost of the two septic system options are the two lowest cost alternatives. The combined "1st Avenue" and Park treatment plant is the next least expensive. The lagoon treatment is the second most expensive and the stand-alone MBR option is the most expensive option.

On the basis of these results, the Park should likely continue to be serviced by septic systems unless the Park wants to show stewardship and improve the level of wastewater treatment. In that case, the best option would be to participate in the RDKS “1st Avenue” treatment system since the effluent quality would be better than the Park-only lagoon-based wastewater treatment system for about the same capital cost.

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