TECHNICAL MEMORANDUM NO. 4

REGIONAL DISTRICT OF KITIMAT-STIKINE
LAKELSE LAKE/JACKPINE FLATS

Stage 1 Liquid Waste Management Plan (LWMP)
Potential Reasons to Change the Status Quo

March
2004
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REGIONAL DISTRICT OF KITIMAT-STIKINE
LAKELSE LAKE/JACKPINE FLATS
STAGE 1 LIQUID WASTE MANAGEMENT PLAN (LWMP)

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1 INTRODUCTION

The previous three technical memoranda included a summarization of the previous background studies that have been done in the area, a discussion of what wastewater treatment is all about and what jurisdictions govern wastewater treatment. It is the intent of this fourth technical memorandum (TM4), to build on the previous three technical memoranda and examine potential reasons to change the current wastewater treatment situation, i.e., the “Status Quo”.

At the present time, with very few exceptions, wastewater treatment in the Lakelse Lake/Jackpine Flats study area is provided by septic tanks and subsurface disposal fields. In some cases, e.g., Mount Layton Hot Springs, secondary treatment and surface water discharge is provided. In TM1, the summary of the background studies, it was shown that there is some evidence, primarily through fecal coliform and phosphorus results, that at least some of these treatment systems, e.g., some septic systems, may not be operating as would have been originally hoped and, as result, there appears to be some contamination of the lake by partially treated wastewater. This could be the result of poorly designed or maintained treatment systems or it may just be that the soil conditions are not appropriate, e.g., the percolation rate is too high and very little, if any, additional treatment is occurring in the soil or the groundwater table is too high and the septic disposal fields can not function as aerobic systems. Whatever the reasons, there are some areas that may have to be considered for a different form of wastewater treatment.

It is intended that TM4 discuss some of the issues and/or reasons for changing the status quo. These topics include:

- Required setbacks from freshwaters
- Location on the flood plain
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POTENTIAL REASONS TO CHANGE THE
STATUS QUO

- High or low soil permeabilities
- Nutrient loading to the lake

These issues are discussed in the following sections.

2 REQUIRED SETBACKS FROM FRESHWATER

The Ministry of Health requires that septic tank disposal fields be located at least 30 m (100 ft) back from the normal high water level. The intent of this requirement is to protect the freshwater from contamination by providing sufficient travel time and adsorption surface between the disposal field and the water so that nutrients, soluble organics and pathogenic microorganisms in the septic tank effluent do not impact the water quality of the receiving body. As shown by the red line on Figure TM4-1, there are several areas in the study area that could potentially have problems meeting this criterion. These include:

- Some of the smaller properties closest to Williams Creek and Sockeye Creek.
- Some of the smaller properties in the Catt Point - Mailbox Point Area.
- Some of the smaller properties in the Mailbox Point west area.

If the required set back could not be met in these areas, the solutions to the problem would include:

- Improving the level of on-site treatment to secondary treatment with disinfection, e.g. UV irradiation followed by ground disposal.
- Collecting the wastewater from the individual septic tanks and piping it to a suitably-sized common disposal field located a sufficient distance away from the water.
- Collecting the wastewater from the individual septic tanks and piping it to a properly-sized secondary or tertiary treatment plant followed by either discharge to the ground (a suitable distance from the water) or UV disinfection and discharge to the Lake (or Creek, as appropriate).

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LOCATION ON THE FLOOD PLAIN

Septic tank systems only function properly when the disposal field is aerobic, i.e., there is air in the disposal field pipes and the soil underneath these pipes is unsaturated, i.e., the pores in the soil are not filled with water. A typical requirement is that the septic tank disposal field be constructed so that the bottom of the perforated pipes is always at least 0.6 m (2 ft) above the water table, even under the worse case scenario. This requirement helps to ensure that aerobic bacteria will help to renovate and treat the septic tank effluent prior to the effluent reaching the groundwater. This in turn helps to prevent issues with contamination of creeks and lakes when the groundwater discharges to them. While this issue is not of much or any concern to the Jackpine Flats area, except to some specific homes built near to Sockeye or Williams Creeks, it is definitely an issue for Lakelse Lake.

As may be seen from the blue, 74 m Elevation, 1-in-200 (1:200) year flood plain line Figure TM4-1, there are several areas around Lakelse Lake that would be inundated during a 1:200 yr flood event. These areas include:

- Some of the area in the subdivisions to the west of Mailbox Point (which are quite flat).
- Some small portions of the Mailbox Point - Catt Point area (most of which is quite steep).
- A considerable portion of the area between Catt Point and Muller Bay.
- The entire north end of the lake (where there are currently no houses - nor are any planned).
- A considerable portion of the area north of the Provincial Park (campground) to Water Lily Bay.
- A large portion of the Provincial Park campground.
- Almost all of the Gainey Point subdivision between Hatchery Creek and the Provincial Park.
- Most of the area along First Street south of Hatchery Creek, all the way down to and including Snow Owl Bay Subdivision.
- The entire south end of the Lake (where there currently no houses nor are any planned).
- A substantial portion of the Squirrel Point subdivision.
Solutions to this flood plain/potential septic system flooding problem would include:

- Requiring that on-site septic systems be built so that the septic tanks and the disposal fields are above the 1:200 flood plain elevation by a sufficient margin, i.e., 0.6 m. This could require the construction of raised-bed/mound-type disposal systems or, if not, moving the entire septic tank and disposal field to higher ground. This in turn could require pumps from the dwelling units to the septic tank.
- Collecting the wastewater from the individual dwelling units and piping it to a suitably-sized and located common septic tank and disposal field system located out of or otherwise above the flood plain.
- Collecting the wastewater from the individual dwelling units and piping it to a properly-sized secondary or tertiary treatment plant located above the flood plain, followed by either discharge to the ground (a suitable height above the flood plain) or UV disinfection and discharge to the Lake (or Creek, as appropriate).

4 HIGH OR LOW SOIL PERMEABILITY

When a septic system is first being considered one of the first things that must be done is to check the percolation rate. This is basically done by constructing a small excavation (pit), filling it with water and then measuring the time it takes for the water level to drop 25 mm (1 inch). The resulting percolation rate is reported as “n” minutes per 25 mm or “n” minutes per 1 inch. Good numbers are in the 10 minute to 30 minute range. In some cases, percolation rates as low as 5 minutes are considered acceptable. Results higher than 30 minutes imply that the soils are too “tight”, i.e., have too much clay or silt, to be useable without clogging and failing over the long term. Rates faster than, say 5 minutes, are an indication that the soils are very permeable and that there may be problems achieving the required treatment of the septic tank effluent before the effluent contacts the ground water. This would be especially true if the groundwater was quite high and close to the bottom of the perforated disposal field distribution pipes but could also be true with very high percolation rates and moderate to deep groundwaters. In either case, the concern would be that without sufficient treatment, the groundwater would be contaminated with pollutants including fecal...
coli forms and nutrients such as phosphorus or nitrates and that these materials will cause health problems.

The main area of concern for high permeabilities is the entire Jackpine Flats area. Recent review of some of the percolation ("perc") test results from that area indicate that natural soils are extremely permeable, e.g., some of the perc test results are "15 seconds" (per inch). Even if the ground water is 10 m down from the surface, this would only be about 390 inches or roughly 98 minutes in the soil before the septic effluent contacts the groundwater. This is a very short time period and very little, if any, treatment will have occurred in that time period. Even the low end of "acceptable", e.g., a 5 minute perc test result and a 0.6 m (2 ft) distance to ground water would provide 120 minutes of contact time in a soil that will be considerably finer grained than a "15 second" perc test soil (likely mostly cobbles with very little sands and gravels), and, as a result, much better treatment than 10 m in a "15 second" soil. As a result, we understand that the local Ministry of Health office requires that the trenches in the Jackpine Flats area are constructed with a material that impedes the initial flow from the perforated pipes and, therefore, more "hang time" and more treatment in the soils. However, even with that, there is still a relatively quick percolation rate beneath this added low permeability layer and, therefore, less renovation of the effluent than would occur in tighter soils.

At the other extreme are soils that are very or too tight, e.g., 30 minute or greater percolation rates. In this case, the length of time in the soil is not so much of a problem, e.g., at least 720 minutes to go 0.6 m (2 ft, 24 inches). However, the potential for future clogging and the resulting flooding of the distribution piping and the loss of aerobic conditions is a concern. We do not know any specific areas within the study area that have this problem but suspect there may be some issues around the edges of Lakelse Lake that may have to be investigated.

The solutions to the high permeability problem (and the resulting lack of treatment of the septic tank effluent) include:

- Modifications to the natural soils in the percolation trenches to slow down the percolation rate and provide adequate time and surface area to provide the required treatment so that the ground water quality is not
impacted by organics and/or fecal-related pathogens (as measured by fecal coliforms).

- Collecting the wastewater from the individual septic tanks and treating it in an on-site secondary or tertiary treatment plant (potentially with UV disinfection) prior to discharging the treated effluent to the ground (via a disposal field).
- Collecting the wastewater from several (or many) individual dwelling units or septic tanks and piping it to a properly-sized secondary or tertiary treatment plant, followed UV disinfection and discharge to the ground (a suitable height above the flood plain) or to the Lake (or a creek, as appropriate).

5 NUTRIENT LOADINGS TO LAKESE LAKE AND/OR ITS TRIBUTARY CREEKS

Concerns have been raised about the possibility that partially treated and/or treated septic tank effluents have been making their way into Lakelse Lake and that these effluents are causing or stimulating the growth of aquatic weeds and/or algae. Of particular concern is the growth of Elodea Canadensis, also known as “Canada Waterweed” (which is different than Eurasian water milfoil, Myriophyllum spicatum) - see reference at:

http://www.extension.umn.edu/distribution/horticulture/DG6955.html

While there is some evidence that Elodea may be related to a combination of silty soils and high dissolved iron concentrations, there are still concerns about nutrients, and especially phosphorus and their impact on the lakes and creeks. On this issue, the BC Water Quality Guidelines (Criteria) - 1998 Edition (http://wlapwww.gov.bc.ca/wat/wq/BCguidelines/nutrients.html) provides some guidance, as shown in Table TM4-1, taken from these BC guidelines.
Table TM4-1
Summary of Water Quality Criteria for Nutrients and Algae

<table>
<thead>
<tr>
<th>Water Use</th>
<th>Phosphorous</th>
<th>Chlorophylla</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drinking Water - lakes</td>
<td>10 µg/L (maximum)</td>
<td>None proposed</td>
</tr>
<tr>
<td>Aquatic Life - streams</td>
<td>None proposed</td>
<td>100 mg/m² (maximum)</td>
</tr>
<tr>
<td>Aquatic Life - lakes</td>
<td>5 to 15 µg/L (inclusive)</td>
<td>None Proposed</td>
</tr>
<tr>
<td>(where salmonids are the predominant fish species)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recreation - streams</td>
<td>None proposed</td>
<td>50 mg/m² (maximum)</td>
</tr>
<tr>
<td>Recreation - lakes</td>
<td>10 µg/L (maximum)</td>
<td>None proposed</td>
</tr>
</tbody>
</table>

As may be seen from Table TM4-1, in terms of phosphorus, 10 µg/L (0.010 mg/L or 10 parts per billion) Total P is the suggested maximum based on drinking water and recreational use of lakes to avoid algae and algae-related taste and odour problems in the drinking water. In terms of aquatic life, when salmonids are predominant (as they are likely to be for this situation), the criteria range is 5 to 15 µg/L Total P.

Based on the work by Kokelj (2003 draft) reported in TM1, the current water quality results for Phosphorus are shown in Figure TM4-2. As may be seen, under the current situation there may be some areas of concern. For example, at the mouth of Williams Creek, at Station 1b, at the north end of the Lake, the Total P concentration in the 2003 sampling program was 0.011 mg/L, i.e., right in the middle of the suggested range. However, since the upstream stations on Sockeye Creek and William Creek (Station 2a, 2b and 1a) where substantially lower, e.g., 0.004 to 0.006 mg/L, it is not clear where the Phosphorus came from. In this case, it may be from something in the Water Lily Bay area, e.g., the Parks' picnic site.

In contrast, the situation at Station 8b, at the mouth of Mountain Creek, is potentially much clearer. The upstream sample, at Station 8a, is to the east of the Highway and away from people. At that point, the phosphorus level is only 0.002 mg/L, well below the criteria in Table TM4-1. However, at Station 8b,
downstream of human activity, the Total P level is 0.012 mg/L, at the high end of the range suggested in Table TM4-1. This would suggest that human activity is the potential likely cause of the higher readings.

Other high Total P values include 0.025 mg/L at the outlet of Eel Creek at Station 14 to the west of Mailbox Point and 0.023 mg/L at the outlet of Provincial Park Creek at Station 4b. There are no upstream values for Station 14, so very little can be said about what is the problem might be. One possibility would be leaking septic systems in the area beside Eel Creek. In the case of the Provincial Park Creek, the upstream value, at Station 4a is already quite high at 0.011 mg/L. Nevertheless, it would appear from the data that some activity from within the Park has added 0.012 mg/L Total P to the creek flow. This could potentially include septic tank systems within the Park.

It should be noted that at Station 17 in the middle of the north end of the Lake and at Station 13 at the outlet of the Lake into Lakelse River, the Total P values are 0.005 mg/L and 0.004 mg/L, respectively. These values are at or below the lower end of the water quality requirements and therefore, in general, the Total P concentrations in Lakelse Lake are not currently a problem.

Based on the above, there are some indications of “hot spots” with respect to total phosphorus. These locations may also correspond to areas of high weed growth. However, the cause and effect correlation is not yet firmly established on this so no conclusions can be drawn as yet. What can be concluded is the Lake may be at the “edge” of a nutrient loading problem if further development in the study area is permitted.

Table TM4-2 presents estimates of the current and potential future number of lots that could be developed in the Jackpine Flats/Lakelse Lake area. On this basis, at about 2 gram of Total P per day, the estimated phosphorus loading to the environment could increase from around 5900 grams per day to about 13,800 grams per day, about 2.3 times as much as currently being discharged. On this basis, it is obvious that if the Total phosphorus concentrations in the Lake are currently in the 0.004 mg/L range, increasing the Total P loading to the environment by 2.3 times would undoubtedly increase the Total P concentrations in the Lake.
To estimate the potential increase in phosphorus concentrations in the Lake, a simple mass balance -equilibrium model was developed. This model assumed that the Lake has an average volume of 108 million m³, the average inflow of 20 m³/s (both values from TM1) contains 5900 grams of Total P (about 0.00341 mg/L) and the Lake is completely (and instantly) mixed. Under these conditions, even starting the Lake out at 0.000 mg/L of Total P at time T=0, equilibrium of 0.00341 mg/L (the inflow concentration) was reached within one year, as shown in Figure TM4-3. Since 0.00341 mg/L is less than the measured average concentration, about 0.004 mg/L, this implies that the average daily loading is actually higher than 5900 grams per day. In fact, in order to achieve a 0.004 mg/L Total P equilibrium, about 6920 grams of Total P per day has to reach the Lake. This is easily possible since textbook (Metcalf and Eddy, Wastewater Engineering, 4th Edition, pg.3-12) values suggest that the per capita Total P in wastewater is more like 3.2 grams (1.2 grams organic-based P and 2.0 gram inorganic-based P) per capita per day. As it turns out, 3.2 grams P per capita or about 9400 grams per day would result in an equilibrium concentration of about 0.0054 mg/L Total P in the Lake. This is quite comparable to the concentration at Sampling Location No. 17, in the middle of the north end of the lake.

In actual fact, the model needs to be more sophisticated than the above. For one thing, there is some absorption of phosphorus onto fine grained soils around the septic tank disposal fields - at least until this absorption capacity is used up. This would help to reduce the loading to the lake and the equilibrium P concentration in the Lake. However, the simplistic model does not recognize that the Lake can stratify in the summer and the actual volume of the upper, warmer, epilimnion layer can be much smaller than the total lake volume, causing the measured P concentrations near the surface of the Lake to be much higher.

In the future, it is possible that two things could occur. The first one is the absorption capacity of the soils around the septic fields will eventually be used up, causing the amount of phosphorus migrating through the soils to the creeks and Lakelse Lake to increase. In addition, as per Table TM4-2, it is possible that the total phosphorus loading to the Lake could increase by two or more times, based on increases in the number of lots that are developed. At 2.0 grams P capita, no soil absorption of P and a completely mixed lake, the equilibrium total P concentration would be in the order of 0.008 mg/L, or just below the middle of the water quality criteria (0.005 to 0.015 mg/L Total P), as shown in Figure TM4-4.

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If the actual Total P generation rate was 3.2 grams, then the equilibrium concentration would be in the 0.013 range, i.e., in the high end of the water quality range. If the upper epilimnion layer had just half of the total Lake volume, then the Total P concentration could increase into the 0.026 range, well above the water quality criteria.

Based on the above theoretical exercise, it is clear that unless something is done in the future to limit the Total Phosphorus loading to Lakelse Lake, there could be problems with excessive algal and/or weed growth, especially in the summer, when the Lake stratifies. Solutions to this problem would include:

- Limiting the number of lots that are developed in both Jackpine Flats and around the Lake.
- Requiring that all on-site treatment systems include phosphorus removal.
- Development of community sewerage areas with common wastewater treatment that includes phosphorus removal prior to discharge to the ground or to the Lake.

These options will be pursued further in subsequent TM’s and/or in Stage 2 of this LWMP.

6 CONCLUSIONS

Based on the above discussions, there are several reasons why it will likely not be possible to continue with the “status quo” wastewater treatment, i.e., mostly on-site septic tank and disposal fields, in the future for the Lakeleese Lake/Jackpine Flats study area. The solutions to the existing and/or potential future problems will include:

- Limiting growth in the area, in general.
- Limiting growth in specific areas, especially in those areas in the flood plain or that have high soil percolation rates.
- Improving on-site treatment in specific areas including everything from improved septic tank disposal fields to on-site tertiary treatment with phosphorus removal.
• Developing community sewerage areas to collect and treat wastewater in some areas in order to protect groundwater and surface waters from pollution, e.g., fecal contamination and/or nutrient loadings.
• Developing community water supplies to replace wells (or the Lake) that have been contaminated by sewage.

These issues will be pursued further in subsequent TM’s and/or in Stage 2 of this LWMP.

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