

Appendix B:

Discussion Papers



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Report

**Regional District of
Nanaimo**

Wastewater Treatment Basics

March 2008

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REPORT

Abbreviations

Wastewater	water contaminated with organic and inorganics based on human activities, as discharged to a sewer system for conveyance to a facility for treatment and disposal/reuse.
Sewage	wastewater (sewage is the older term)
Sewerage System	the wastewater (sewage) collection system
Combined sewer	a pipe system to convey stormwater and wastewater in one pipe
Separate sewer	a dual pipe-system, one for stormwater, one for wastewater
Sanitary wastewater	the wastewater in a non-stormwater collection system
Infiltration	the leakage of groundwater into a sewer system
Inflow	the flow of rainwater or snow melt into a sewer through manholes covers and roof leaders
CSO	combined sewer overflow, wastewater overflow from a combined sewer system
SSO	sanitary sewer overflow, wastewater overflow from a separate sanitary sewer system
BOD	biochemical oxygen demand, a measure of the biodegradability
COD	chemical oxygen demand
TSS	total suspended solids
NH ₃	ammonia gas, dissolved in water
NH ₄ ⁺	ammonium ion, dissolved in water
Preliminary Treatment	the first level of treatment, screening and/or grinding
Primary Treatment	settling of solids, skimming of scum
Secondary Treatment	biological treatment to remove dissolved and colloidal organics

Advanced treatment	additional removal of BOD and TSS
Tertiary Treatment	biological or chemical treatment to remove nutrients, nitrogen (N) and phosphorus (P)
Disinfection	destruction of pathogenic organisms, typically through chlorination or the use of ultraviolet (UV) light irradiation
Grit	the sandy, heavy particulate organics and inorganics that are the first materials to be removed in a large scale treatment plant
Sludge	the materials that settle in a primary clarifier (sedimentation) tank (primary sludge) and secondary clarifier (secondary sludge) prior to treatment, e.g. digestion.
Biosolids	sludges after they have been treated, e.g. after digestion or chemical treatment.

1 Wastewater Sources and Sewer Types

Wastewater contains organic, inorganic, soluble and particulate materials and micro-organisms that are diluted, dissolved and/or suspended in water. The materials come from a wide range of sources including domestic, commercial, institutional, and industrial sources. Most of these materials can be measured in milligrams per litre (mg/L) (or “parts per million” (ppm)) concentrations, either directly or through surrogate parameters. Some of the organics present, including some persistent organics and some endocrine disrupting chemicals, are present in the microgram per litre (parts per billion) or nanogram per litre (parts per trillion) concentration range.

Wastewater is sometimes called sewage. The wastewaters from domestic, commercial, institutional and industrial sources are collectively called sanitary sewage or municipal wastewater. While the “sanitary” part would seem to be a misnomer, it is meant to describe the wastewater from domestic, commercial, institutional and industrial sources that is flowing in a separate collection system, one that does not include stormwater. Sanitary sewage or wastewater is relatively concentrated, when compared to combined sewage which is diluted with rainwater or snow melt and, therefore, is easier to control and treat and, thereby, protect the environment, including drinking water sources, hence the term “sanitary”.

The first wastewater collection systems, e.g. those in Rome, Paris, London, Montreal, New Westminster, parts of Vancouver, parts of Victoria, part of Port Alberni, etc. were single pipe system combined sewers, designed to accommodate stormwater during the rainy season and sanitary wastewater all year round. While such sewers were better than sewage running in open ditches, by today’s standards they create problems when the system cannot handle high rainfall or snow-melt induced flows and there are CSOs.

Even with separate sanitary sewer systems, there is the possibility of SSOs when there is significant rainfall or snow-melt induced infiltration and inflow (I&I). Infiltration is when groundwater leaks into the sewer system through leaky pipe joints or leaky manhole barrels or pipe connections. Inflow is direct inflow of stormwater into the sanitary sewer system, through manhole lids (in flooded intersections), cross-connected catch basins (that should have been connected to the storm sewer system) and roof drain leaders (both commercial buildings and residential buildings) (which is often illegal).

2 Measuring Wastewater Strength

While there are many parameters that could be used to describe the strength of a given wastewater, the most common parameters include the following:

- BOD
- COD
- Total suspended solids (TSS)
- Ammonia nitrogen
- Total inorganic phosphorus
- Fecal coliforms

BOD is basically a bacterial bioassay test that provides an estimate of the biodegradability of the organic content of the wastewater. A known volume, e.g. 10 mL, of the wastewater in question is placed into a 300 mL bottle that is then filled with nutrient-rich dissolved oxygen saturated water and mixed. The stoppered bottle is put away in the dark, in a 20°C incubator for five days. The change in dissolved oxygen content from the start of the test to the end of the test is measured and the results used to calculate the BOD. Typical raw sewage (wastewater) has a BOD in the 180 to 220 mg/L range. Some industries can, without out pre-treatment, discharge wastewaters in the 6000 mg/L range, e.g. a milk processing or fish processing plant. Leachate from a landfill can have BODs from 500 mg/L to 25,000 mg/L depending on the age of the landfill (younger = stronger). If there is no wastewater treatment and very little dilution in the receiving environment, wastewaters can cause the dissolved oxygen levels in the receiving body to drop to the point that fish are unable to survive. As a result, treatment standards usually set effluent BOD requirements. Effluent from a secondary wastewater treatment plant like the French Creek treatment plant needs to be less than 45 mg/L BOD or less, whereas that for a primary treatment plant like the Greater Nanaimo treatment plant on Hammond Bay Road needs to be less than 130 mg/L (dilution helps to prevent problems in this case). The Duke Point secondary treatment plant needs to have an effluent less than 30 mg/L BOD. Advanced secondary treatment plants typically need to have BODs less than 10 mg/L. Such wastewaters can often be reused in beneficial ways.

COD is a much more severe test that uses chemicals, e.g. acids, and heat, to digest and oxidize both organic and inorganic compounds that are in the wastewater. COD should always be greater than BOD for the same sample. Since BOD is a measure of the biodegradability of the wastewater,

the ratio of BOD to COD can help further assess the type of biological treatment that is appropriate. For BOD/COD ratios above 0.7 or 0.8, the wastewater contains very biodegradable materials, indicating that anaerobic treatment should be explored because aerobic treatment would have a very high energy requirement to provide the aeration needed to destroy the BOD-causing compounds. Such high BOD/COD wastes include dairy wastes, fish processing wastewater and, in some cases, landfill leachate. When the BOD/COD ratio is in the 0.4 to 0.6 range, aerobic biological treatment, like that at the French Creek and Duke Point treatment plants, is appropriate. When the BOD/COD ratio is down in the 0.1 range, biological treatment is very unlikely to be of benefit. This is true of some leachates from older landfills.

TSS is a measure of the floating particulate content of the wastewater and, in some ways, is an indicator of the clarity of the wastewater. The test is done by filtering a known volume of the wastewater through a glass fibre filter and then drying the filter in a special drying oven at 103°C and measuring the increase in mass for the given volume of wastewater. Typical municipal wastewaters will have a TSS in the 180 to 220 mg/L range. Settling, as in primary treatment, can remove about 35 to 50% of the influent TSS without additional chemicals. Adding chemicals, e.g. alum, as a coagulant, can increase the removal efficiency in a primary sedimentation tank up to the 60% to 80% range, depending on the wastewater. Effluent requirements for TSS for primary plants are in the range of 100 to 130 mg/L TSS. Effluent requirements for TSS for secondary treatment plants, like the French Creek plant are based on secondary solids from the biological treatment process and must typically be less than 45 mg/L. The Duke Point treatment plant effluent must be less than 30 mg/L. In this case, the lower TSS level reflects the fact that the Duke Point treatment plant has effluent disinfection via UV disinfection, which requires a high clarity effluent in order to be effective.

Ammonia is a wastewater constituent that results from the degradation of proteins. Raw wastewater typically has ammonia concentrations in the 20 to 30 mg/L range, as N, nitrogen. Ammonia in wastewater exists in two states, the ammonium ion NH_4^+N and dissolved ammonia gas, NH_3 . Lower pHs (measure of the strength of the dissolved hydrogen ion, H^+), in the pH 6 to 7 range favour the ammonium ion and higher pHs, say above pH 8, favour the dissolved ammonia gas. The problem is the dissolved ammonia gas, NH_3 , affects fish gills and can cause acute mortality. Environment Canada is developing a new acute mortality fish bioassay test protocol using pH stabilization that will favour treatment plants like the French Creek secondary treatment plant that have effluent pHs in the 7 range and relatively low effluent ammonia concentrations. The same Environment Canada standards will require concentrations of less than 0.019 mg/L (19 parts per billion) ammonia^{-N} at the edge of the initial dilution zone around an ocean (or river) outfall, in order to prevent chronic ammonia toxicity problems in fish.

Phosphorus, P, is nutrient found in most foods and typically is the range of 6 to 10 mg/L as Total P in influent wastewaters. As nutrient, phosphorus can stimulate algae growth, causing the receiving water quality to deteriorate if there is inadequate flushing. The BC Municipal Sewage Regulation requires that discharges to embayed ocean waters have less than 1 mg/L Total P. Fortunately, none of the RDN's treatment plants fit this requirement and are able to discharge without having to

meet any Total P requirement. In contrast, the treatment plants on Okanagan Lake, e.g. Vernon, Kelowna, Westbank, Summerland and Penticton, must remove Total P down to effluent levels in the 0.15 to 0.25 mg/L range using a complicated biological nutrient removal (BNR) process, in order to protect the lake water quality.

Fecal coliforms are a group of bacteria that inhabit gastro-intestinal tracts. As result, they can be used as an indicator of fecal contamination of water and the likelihood of pathogenic micro-organisms being present. When wastewater needs to be disinfected, the standard is based on the number of fecal coliforms per 100 mL. Effluent standards, when disinfection is required, are often in the 200 to 400 fecal coliforms per 100 mL range from an influent fecal coliform concentration of 107 to 108/100 mL

Unless there is a high degree of flushing or dilution, discharge of raw sewage will likely result in some form of environmental problem. This is especially true when the discharge is to fresh water and the background water quality is very high. Without any treatment, the risk of a problem due to oxygen depletion in the receiving water or ammonia toxicity is much higher than with treatment. As a result, there is typically some form of treatment that is required by the regulatory agencies involved, e.g. the Ministry of Environment or Federal Fisheries.

3 Levels of Wastewater Treatment

The levels of wastewater treatment that are available include the following:

- Preliminary (screening to remove gross solids)
- Primary (settling to remove grit and heavier solids, also floatable oils and greases)
- Secondary (to remove soluble and colloidal organics)
- Advanced (to remove specific “problem” chemicals or materials)
- Tertiary (to remove nutrients)

Preliminary treatment is the most basic of treatment types. At best, it includes fine screening to remove gross solids. At worst, it means grinding or macerating to make the gross solids unrecognizable. Preliminary treatment can only be used as the final treatment step when the ocean currents are very strong and the dilution and flushing rate quickly disperse the preliminary treated wastewater. The CRD’s Clover Point and Macaulay Point treatment facilities are examples of preliminary treatment using screening. Tofino is an example of preliminary treatment using grinders. Preliminary treatment is generally no longer acceptable, even in such high energy environments like the Strait of Juan de Fuca. There are no effluent standards for preliminary treatment.

Primary treatment is the next level of treatment, following preliminary treatment. Primary treatment relies on gravity and the differential buoyancy between materials that are heavier than water and materials that are lighter than water. Primary treatment occurs in large tanks with hydraulic retention times in the 2 to 4 hour time frame. During this time, heavy organic and inorganics settle

to the bottom as primary sludge. Congealed oils and greases float to the top as scum. Both primary sludges and scum are removed from the primary settling tank and typically are sent to digestion for further treatment. The Greater Nanaimo Pollution Control Centre (GNPCC) is a primary treatment plant. Primary treatment plants typically must have effluents that are less than 130 mg/L BOD and 130 mg/L TSS. In some cases, additional chemicals are required, in chemically-enhanced primary treatment to achieve these requirements, particularly in the summer months when the levels of wastewater dilution from infiltration and inflow are diminished. GNPCC uses chemically-enhanced primary treatment during some months of the year to meet its discharge permit requirements for BOD and TSS.

Secondary treatment is designed to remove dissolved and colloidal organics, measured as BOD, that remain after preliminary or primary treatment. To do so, the dissolved and colloidal organics need to be converted into a settleable form. This is accomplished by feeding the preliminary or primary treatment effluent into an aerobic liquid environment and allowing naturally occurring bacteria in the wastewater to convert the soluble and colloidal organics to new bacterial cells that can subsequently be settled out and removed from the system. Secondary treatment can use either fixed film biological processes like the trickling filters at French Creek treatment plant or a suspended growth aerobic process like that at the Duke Point treatment plant, the CRD's Saanich Peninsula wastewater treatment plant on Manwaring Road or the Regional District of Comox-Strathcona's Comox Valley treatment plant in Comox. In all cases, the aerobic biological step is followed by secondary sedimentation where the bacterial cells are removed from bulk of the liquid. In the case of the French Creek treatment plant, the trickling filter effluent is first passed through a short retention time suspended growth "solids contact" system to condition the trickling filter biomass to settle better before being sent to secondary sedimentation. The sludge that settles in the secondary clarifiers (sedimentation tanks) is typically sent to some form of digestion in preparation for some type of beneficial reuse. Typical secondary effluent in BC must never exceed 45 mg/L BOD and 45 mg/L TSS.

Advanced secondary treatment plants usually are just concerned with achieving additional BOD and TSS removals so the effluent will not exceed 10 mg/L BOD or 10 mg/L TSS (or 5 turbidity units). This can be accomplished by designing and running a secondary treatment plant to achieve less than 20 mg/L BOD and 20 mg/L TSS and then adding some type of effluent filter, e.g. a sand or cloth filter, to remove particulate BOD and TSS. Alternatively, membrane bioreactors that substitute membrane barriers for sedimentation tanks can be used to make advanced secondary standards. There are several small advanced secondary treatment plants on Vancouver Island, e.g. Sooke Harbour house and the Mt. Washington ski resort both had membrane bioreactors systems followed by UV disinfection.

Tertiary treatment plants are needed whenever the phosphorus levels need to be less than 1.0 mg/L. Typically, in BC this means the treatment plants on Okanagan Lake. These plants use some form of BNR including nitrification and denitrification (conversion of ammonia N to nitrate and then the nitrate to nitrogen gas) and preferential-bacteria excess-phosphorus uptake and removal. As such, BNR plants typically produce effluents with less than 5 mg/L BOD and less than 5 mg/L

TSS as well as very low effluent N and P levels, e.g. less than 0.25 mg/L Total P. In some cases, such plants require the addition of alum and filters to remove particulates and phosphorus precipitates in order to meet the effluent standards. There are no major BNR plants on Vancouver Island.

4 The Need for Levels of Treatment

The current state of wastewater treatment with in the RDN is as follows:

- Greater Nanaimo Pollution Control Centre (GNPCC) – Primary treatment
- French Creek Pollution Control Centre (FCPCC) – Secondary treatment
- Nanoose Pollution Control Centre (NPCC) – Primary treatment
- Duke Point Pollution Control Centre (DPPCC) – Secondary treatment

At this point in time, GNPCC is scheduled to be upgraded to secondary treatment, as is NPCC. Both the FCPCC and DPPCC will likely remain secondary treatment plants. The only foreseeable reason why any of these treatment plants would need to go beyond secondary treatment at some point in the future would be chronic water shortages and a desire to reclaim some of the effluent for non-potable uses, e.g. lawn irrigation.

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REPORT

Discussion Paper No. 1

Draft

**Regional District of
Nanaimo**

**Liquid Waste Management Plan -
Review and Amendments**

Review of Existing Conditions

January 2008

DRAFT DISCUSSION PAPER NO. 1

Regional District of Nanaimo Liquid Waste Management Plan – Review and Amendments

Review of Existing Conditions

Issued: January 31, 2008
Previous Issue: November 28, 2007

The Regional District of Nanaimo (RDN) has an approved Liquid Waste Management Plan (LWMP) that was completed in November 1997. The LWMP is a region-wide, long-range (20 years and beyond), strategy to provide a comprehensive approach to managing liquid waste reduction, treatment, utilization, and disposal. The Environmental Management Act allows municipalities and regional districts to develop LWMP for approval by the Minister of Environment. The LWMP consists of Operational Certificates, which replace waste discharge permits; a strategy to ensure liquid waste disposal conforms to Ministry objectives; an implementation schedule; and measures to accommodate future development. An approved plan, such as the one the RDN has, authorizes the discharge of waste in accordance with Operational Certificates, other provisions of the waste management plan, and the Minister's requirements.

The RDN has retained the services of Associated Engineering for reviewing and amending the existing LWMP to reflect current conditions. As part of this work, several discussion papers on various topics pertaining to the LWMP will be prepared and circulated to the RDN's LWMP Advisory Committee for review and discussion.

This discussion paper, Discussion Paper No. 1, provides an overview of existing service areas for each of the four treatment plants, capacities of the existing treatment plants, effluent quality and flow requirements for each treatment plant as per Operational Certificates or permits, and milestone dates for scheduled treatment plant upgrades.

1 Existing Service Areas and Treatment Plants

Created in 1967, the RDN is comprised of four incorporated municipalities and seven unincorporated electoral areas. The four municipalities consist of:

- City of Nanaimo,
- City of Parksville,
- Town of Qualicum Beach, and
- District of Lantzville.

The seven unincorporated electoral areas are:

- A (Cedar, South Wellington, and Cassidy),
- B (Gabriola, Decourcy, and Mudge Islands),

- C (Extension, Nanaimo Lakes, and East Wellington/Pleasant Valley),
- E (Nanoose Bay),
- F (Coombs, Hilliers, and Errington),
- G (French Creek, San Pareil, and Dashwood), and
- H (Bowser, Qualicum Bay, and Dunsmuir).

The RDN provides a range of services for the municipalities and electoral areas, depending on local needs and interests. The RDN's responsibilities and services include regional and community planning, transit, liquid and solid waste treatment, recreation and parks, building inspection and bylaw enforcement, water and sewer utilities, general administration, and emergency planning. The RDN's Liquid Waste Management Department provides sewer servicing for the Greater Nanaimo, French Creek, Nanoose Bay, and Duke Point Service Areas that serve the urban containment areas within the District. A map of the entire RDN sewer service area and treatment plants is provided in Sketch 1. Local service areas are comprised of areas within the 'sewer benefiting area' that are currently provided with community sewer service. The 'sewer benefiting area' is the area that the wastewater treatment plant is engineered and planned to service.

1.1 Greater Nanaimo Service Area

The Greater Nanaimo Service Area (see Sketch 2) includes the City of Nanaimo Urban Area as defined by the Regional Growth Management Plan and the Lantzville Sewer Local Service Area; and possibly future Village Centres and problem areas in some or all of Electoral Areas 'A', 'B', and 'C'.

Future sewer service in the Greater Nanaimo area will include the currently expanding development in Lantzville and possible addition of the Sandstone Development in southeast Nanaimo.

The wastewater from the Greater Nanaimo Service Area is treated at the Greater Nanaimo Pollution Control Centre (GNPCC). The RDN took over operational responsibility of GNPCC in 1972. The GNPCC provides preliminary and primary treatment of incoming raw wastewater. The treated primary effluent is discharged to the Strait of Georgia through a 2000 m long marine outfall that discharges at a depth of approximately 70 m. In 1988, a Stage II expansion of the GNPCC was commissioned to improve plant efficiencies and support increasing flows due to development. To accommodate future expansion of the GNPCC to secondary treatment, Walley Creek was relocated in 2006 and 2007. According to the LWMP, the GNPCC will need to have secondary treatment by 2015.

1.2 French Creek Service Area

The French Creek Service Area (see Sketch 3) includes the Town of Qualicum Beach, the French Creek Sewer Local Service Area, Surfside, Barclay Crescent, Pacific Shores, and the City of Parksville; and possibly future Village Centres and problem areas in Electoral Areas 'F', 'G', and 'H'.

Potential future sewer service in the French Creek area may include the Church Road Transfer Station and surrounding area, proposed expansion in the Surfside/Dashwood Area, and possibly Madrona, and Wall Beach.

The wastewater from the French Creek Service Area is treated at the French Creek Pollution Control Centre (FCPCC). The FCPCC was originally constructed in 1977 (Stage 1). A major upgrade and expansion completed in 1997 (Stage 2) provides preliminary, primary, and secondary treatment of incoming wastewater. Stage 3 upgrades are currently underway and consist of interim upgrading strategies to prolong the useful life of the existing capital infrastructure to the year 2012. Stages 4 and 5 would involve major facility changes and expansions. Stage 4 implementation is scheduled for Year 2012. The treated effluent is discharged into the Strait of Georgia through a 2075 m long outfall with an additional 78 m long steel diffuser section at a depth of 61 m to ensure rapid and complete mixing. Some of the effluent is diverted to the Morningstar Golf Course for irrigation.

1.3 Nanoose Service Area

The Nanoose Service Area (see Sketch 4) includes the Fairwinds Development, and the Delanice Way, Beachcomber, Dolphin Drive, Garry Oaks, and Red Gap areas.

The wastewater from the Nanoose Service Area is treated at the Nanoose Pollution Control Centre (NPCC). The NPCC provides preliminary and primary treatment of incoming raw wastewater. The treated primary effluent is discharged via an outfall into the Strait of Georgia at a depth of 39 m, and 450 m offshore.

1.4 Duke Point Service Area

The Duke Point Service Area (see Sketch 5) includes the industrial development at Duke Point, and possibly future Village Centres and problem areas within Electoral Area 'A' that require community sewers.

Future sewer service in the Duke Point area will include Cedar Village (sewer servicing currently under construction), and possibly future connection from Cable Bay Lands and First Nations lands (IR 2, 3 and 4).

The wastewater from the Duke Point Service Area is treated at the Duke Point Pollution Control Centre (DPPCC). The DPPCC was originally constructed in 1981 and equipped with rotating biological contactors (RBC) technology. In 1997, the RBC technology was replaced with sequencing batch reactor (SBR) technology. The DPPCC was intended to treat domestic wastewater generated within the industrial park, consistent with the November 1997 Stage 3 LWMP. The RDN commissioned SBR plant in 1998.

The DPPCC provides preliminary and secondary treatment of incoming raw wastewater. The treated effluent is discharged via a shared outfall with West Coast Reduction to the Northumberland Channel at a depth of 43 m, 242 m off shore.

2 Capacities of the Existing Treatment Plants

2.1 Greater Nanaimo Pollution Control Centre

The GNPCC primary treatment plant was designed and constructed to process up to 110,000 m³/day of flows of typical residential strength wastewater based on typical overflow rates. The overflow rate is a measure of the rate at which the wastewater effluent flows through the clarifier (settling tank). A smaller overflow rate means that the wastewater is in the clarifier longer and therefore, there is more time for solids to settle out. A larger overflow rate means that there may not be sufficient time for all solids of a certain diameter to settle out and, as result, the effluent quality may not be as good. Based on an overflow rate of 122 m³/m²-day, with all three clarifiers in service, the theoretical capacity of the GNPCC would be 160,000 m³/day (Associated Engineering, 1999). However, at these higher overflow rates, the removal performance of the primary clarifiers could be expected to drop off dramatically. Fortunately, given the highly diluted influent flow that would occur during peak wet weather flows, typically during winter storm events, the plant would still likely meet the permit BOD and TSS effluent criteria under this extreme condition. However, operating at this level provides no factor of safety, e.g. if one clarifier was out of service at that time, the chances of going out of compliance would increase significantly.

2.2 French Creek Pollution Control Centre

The FCPCC was designed and constructed to process up to a maximum of 16,000 m³/d of typical residential strength wastewater. The FCPCC is currently at “Stage 3” of its development. A number of potential constraints or “bottle necks” exist at the FCPCC. The constraints of these individual unit operations and processes ultimately limit the capacity of the facility to service a larger equivalent population. Associated Engineering, in a December 2006 Report, developed a list of short-term tasks and works that the RDN should implement to help alleviate these constraints. The following list only includes tasks that expand the capacity of unit processes and operations. The replacement of assets due to age or failure has not been included.

- Task 1 - TF/SC Expansion - Completed
- Task 2 - Influent Screens Upgrade - Completed
- Task 3 - Final Effluent Pump Upgrades – Partial completion
- Task 4 - Power Supply Upgrade - Completed
- Task 5 - Grit System Upgrade (2008)
- Task 6 - Increase the Digested Sludge Storage Capacity
- Task 7 - Install Second Waste Biological Sludge (WBS) Drum Thickener
- Task 8 - Implement Short-term Chemical-Enhanced Primary Treatment (CEPT)
- Task 9 - Commission the Fifth ATAD Reactor

- Task 10 – Install the Second Dewatering Centrifuge
- Task 11 - Add Return Biological Sludge (RBS) Pumping Capacity
- Task 12 – Secondary Clarification Expansion

2.3 Nanoose Pollution Control Centre

The NPCC is designed and constructed to process up to 2270 m³/d of wastewater as per discharge permit. A draft Operational Certificate has been prepared.

2.4 Duke Point Pollution Control Centre

The DPPCC plant is designed and constructed to process up to 910 m³/d of typical residential strength wastewater.

2.5 Average Daily Flows

The average daily flow for each treatment plant is provided in the table below.

Treatment Plant	Average Daily Flow (m ³ /day)
Greater Nanaimo Pollution Control Centre	34,380
French Creek Pollution Control Centre	8,485
Duke Point Pollution Control Centre	21
Nanoose Bay Pollution Control Centre	450*

NOTE: *This is an estimated flow based on water use. Daily flows are currently being recalculated.

3 Effluent Quality and Flow Requirements for Each Plant as per the Operational Certificates/Permits

Effluent quality and flow requirements for each treatment plant are outlined in Operational Certificates or permits. Draft Operational Certificates for all four-treatment plants were submitted to the Ministry of Environment on October 29, 2001. Each Operational Certificate outlines maximum and average daily-authorized rates of discharge and the effluent quality characteristics of the discharge from the treatment plant. To date, the Ministry has only approved the Operational Certificate for the Duke Point Pollution Control Centre. The Greater Nanaimo, French Creek, and Nanoose Bay Pollution Control Centers, await approval of their draft Operational Certificates and continue to operate using discharge permits.

The effluent quality and flow requirements as per the Operational Certificates or permits, draft or approved, are described below.

- Greater Nanaimo Pollution Control Centre: Permit issued June 2, 1994. The plant operates according to the permit, which specifies the maximum authorized rate of discharge as 80,870 m³/d. The characteristics of the discharge shall be equivalent or better than: 5-day Biochemical Oxygen Demand – 130 mg/L and Total Suspended Solids - 130 mg/L.

The Draft Operational Certificate, submitted to the Ministry in 2001 for approval, specifies the maximum authorized rate of discharge as 160,000 m³/d. The characteristics of the discharge shall be equivalent or better than: 5-day Biochemical Oxygen Demand – 130 mg/L, Total Suspended Solids - 130 mg/L, and pH - 6-9 pH units.

- French Creek Pollution Control Centre: Permit issued July 10, 1990. The plant operates according to the permit, which specifies the maximum authorized rate of discharge to Strait of Georgia as 16,000 m³/d. The maximum authorized rate of discharge to Morningstar Golf Course is 1,370 m³/d. The characteristics of the discharge to the Strait of Georgia shall be equivalent or better than: 5-day Biochemical Oxygen Demand - 45 mg/L and Total Suspended Solids - 60 mg/L. The characteristics of the discharge to the Morningstar Golf Course shall be equivalent or better than: 5-day Biochemical Oxygen Demand - 20 mg/L and Total Suspended Solids - 30 mg/L.

The Draft Operational Certificate, submitted to the Ministry in 2001 for approval, specifies the maximum authorized rate of discharge to Strait of Georgia as 25,300 m³/d and the maximum authorized rate of discharge to Morningstar Golf Course as 1,370 m³/d. The characteristics of the discharge to the Strait of Georgia shall be equivalent or better than: 5-day Biochemical Oxygen Demand - 45 mg/L, Total Suspended Solids - 45 mg/L, and pH - 6-9 pH units. The characteristics of the discharge to the Morningstar Golf Course shall be equivalent or better than: 5-day Biochemical Oxygen Demand - 20 mg/L, Total Suspended Solids - 30 mg/L, and pH - 6-9 pH units.

- Nanoose Bay Pollution Control Centre: Permit issued March 8, 1988. The plant operates according to the permit, which specifies the maximum authorized rate of as 2,270 m³/d. The characteristics of the discharge shall be equivalent or better than: 5-day Biochemical Oxygen Demand - 100 mg/L and Total Suspended Solids - 100 mg/L.

The Draft Operational Certificate, submitted to the Ministry in 2001 for approval, specifies the maximum authorized rate of discharge as 2,260 m³/d. The characteristics of the discharge shall be equivalent or better than: 5-day Biochemical Oxygen Demand – 130 mg/L, Total Suspended Solids - 130 mg/L, and pH - 6-9 pH units.

- Duke Point Pollution Control Centre: Operational Certificate ME-05989, approved August 12, 2004.

The maximum authorized rate of discharge is 1,800 m³/d. The characteristics of the discharge shall be equivalent or better than: 5-day Biochemical Oxygen Demand - 30 mg/L, Total Suspended Solids - 30mg/L, and pH - 6-9 pH units, and Fecal Coliform Bacteria - 1000 colonies/100 mL.

4 Milestone Dates for Scheduled Upgrades

On-going operational and capacity requirements necessitate upgrades at the four treatment plants and pump stations, which convey wastewater to the treatment plants. Scheduled upgrades at each of the treatment plants, complete with year of implementation, are provided below.

Greater Nanaimo

Projects

- GNPCC - New Operations Building: Construction (2008)
- GNPCC - Gravity Thickeners (two sludge thickeners will increase digester capacity): Design (2007), Construction (2007/2008)
- Departure Bay Pump Station - Upgrade: Design and Construction (2008/2009/2010)
- GNPCC- Cogeneration Field Test: (2008/2009)
- GNPCC- Replace Non-potable Water Lines: Construction (2008)
- GNPCC - Stand-by Generator (2008)
- GNPCC - Third Digester: Design (2008), Construction (2009/2010)
- GNPCC - Existing Operations Building Internal Renovations (2009)
- GNPCC - Sedimentation Tank Expansion (4th primary sedimentation tank): Preliminary Design (2009), Construction (2010)
- GNPCC – Upgrade Scum Pumping Equipment: Upgrade (2010)
- GNPCC - Digester #2 Upgrade: Detailed Design (2009), Upgrade (2010)
- GNPCC - Outfall Expansion – Land Section: Preliminary Design (2009), Construction (2010)
- GNPCC - Modify Outfall Diffuser: Design and Construction (2010)
- GNPCC - Secondary Treatment Upgrades: Preliminary Design (2011), Detailed Design (2012), Construction (2013)
- Departure Bay Pump Station - Upgrade – Stage 2: Upgrade (2012)
- GNPCC – Cogeneration Facility: Upgrade (2013)

Studies

- Treatment Plant Annual Report (on-going)
- GNPCC - Wastewater Characterization Program: (2007)
- GNPCC - Liquid Waste Management Review and Amendments: (2007/2008)
- GNPCC - Secondary Treatment Geophysical Study: (2008)

- GNPCC - Secondary Treatment Upgrades, Stage III: Process Alternatives and Layout Study (2008), Process Selection (2010)

French Creek

Projects

- FCPCC – Dewatering Building Odour Control: Technology Review and Pilot Test (2008)
- FCPCC – Grit Channel Expansion: Upgrade (2007/2008)
- FCPCC – Skimming System Upgrade: Preliminary Design (2007), Design and Construction (2008)
- FCPCC – Morningstar Creek Bank Protection: Stage 1 (2007), Stage 2 (2008), Stage 3 (2009)
- FCPCC – Second Waste Biological Sludge (WBS) Drum Thickener: Conceptual Design (2007), Install (2009)
- FCPCC – Hauled Waste Receiving Upgrade: Preliminary Design (2007), Design and Construction (2010)
- FCPCC – Pave Road to Septage Area: (2008)
- Lee Road Pump Station – Electrical Upgrade: Upgrade (2008)
- Lee Road Pump Station – Odour Control: (2008)
- FCPCC – Washroom and Change Area Renovation: Preliminary Design (2008), Design and Construction (2009)
- FCPCC – Add RBS Pumping Capacity: Preliminary Design (2008), Construction (2009)
- FCPCC – Odour Control Upgrade: Trickling Filter Odour Control (2008), Dewatering Odour Control (2009)
- FCPCC – Secondary Treatment Ventilation Upgrade: Preliminary Design (2006), Stages 2 and 3 Upgrades (2009)
- FCPCC – Add Effluent Pumping Capacity: Preliminary Design (2006), Upgrade (2009)
- FCPCC – 5th ATAD (5th ATAD to be commissioned, actually is the 2nd ATAD): Design and Construction (2009)
- FCPCC – Stage 3 Phase 2 - Solids Contact Tank Expansion: Preliminary Design (2009), Design and Construction (2010)
- FCPCC - Additional Secondary Clarifier: Preliminary Design (2009), Design and Construction (2010)
- FCPCC – Expand Sludge Dewatering System (Second Centrifuge): Preliminary Design (2009), Design and Construction (2010)
- FCPCC – Replace Trickling Filter Down Pipes With PVC: Design and Construction (2009)
- FCPCC – Implement Chemically Enhanced Primary Treatment (CEPT): Implement (2009)
- Hall Road Pump Station – Odour Control: Implement (2009)
- Parksville Sanitary Sewer Overflow Tank: Preliminary Design (2009), Design and Construction (2010)
- FCPCC – Stage 4 Expansion: Preliminary Design (2010)

- Bay Avenue Pump Station - Odour Control: (2010)
- Qualicum Interceptor / Pump Station Upgrades: Stage 1 Upgrade (2011), Stage 2 Upgrade (2012), Stage 3 Upgrade (2013), Stage 4 Upgrade (2014), Stage 5 Upgrade (2015), Stage 6 Upgrade (2016)
- FCPCC – Stage 4 Expansion: Construction (2012)

Studies

- Treatment Plant Annual Report (on-going)
- FCPCC – Liquid Waste Management Plan – Review and Amendments: (2007/2008)
- Qualicum Interceptor: Wet Weather Flow Analysis (2008), Dynamic Model (2009)
- FCPCC – Stage 4 Expansion: Process Selection (2009)
- Qualicum Interceptor / Pump Station Upgrade: Feasibility Study (2010)

Duke Point

Projects

- DPPCC – Pump Upgrade: Preliminary Design (2008), Upgrade (2009)
- Several residential areas around the Cedar Secondary School region may connect to the treatment plant over the next several years.
- As flows increase, a second pair of Sequencing Batch Reactor basins may need to be added.

Studies

- Treatment Plant Annual Report (on-going)

Nanoose Bay

Projects

- NPCC - Odour Control: Preliminary Design (2007), Implement (2008)
- Nanoose Pump Station No. 1 – Genset: Design and Construction (2008)
- Nanoose – SCADA Strategy for NPCC and Pump Station: Preliminary Design (2008)
- NPCC – Inlet Screen: Design and Construction (2008)
- Nanoose Pump Station No. 6 – Genset: Design and Construction (2010)
- NPCC – Secondary Treatment Upgrade and Expansion: Preliminary Design (2012), Upgrade and Expansion (2013)

Studies

- Treatment Plant Annual Report (on-going)

5 Summary

The RDN has an approved LWMP that was completed in November 1997. The LWMP provides a comprehensive approach to managing liquid waste reduction, treatment, utilization, and disposal. An approved plan, such as the one the RDN has, authorizes the discharge of waste in accordance with Operational Certificates, other provisions of the waste management plan, and the Minister's requirements.

Currently the RDN is in the process of reviewing and amending the existing LWMP to reflect current conditions. This discussion paper reviewed existing service areas for each of the four treatment plants, capacities of the existing treatment plants, effluent quality and flow requirements for each treatment plant as per Operational Certificates or permits, and milestone dates for scheduled treatment plant upgrades to meet on-going operational and capacity requirements.

Draft Operational Certificates for all four-treatment plants were prepared by Associated Engineering and submitted to the Ministry of Environment on October 29, 2001. To date, the Ministry of Environment has only approved the Operational Certificate for the Duke Point Pollution Control Centre. The Greater Nanaimo, French Creek, and Nanoose Bay Pollution Control Centers continue to operate using permits.

6 References

- 1 Associated Engineering. Report: Greater Nanaimo Pollution Control Centre Performance Audit. March 1999.
- 2 Associated Engineering. Report: Duke Point WWTP Expansion Assessment Study. November 2000.
- 3 Associated Engineering. Report: French Creek Pollution Control Centre Performance Evaluation and Upgrading Plan Update. December 2006.
- 4 Regional District of Nanaimo. Website: <http://www.rdn.bc.ca>
- 5 Associated Engineering. Budget Management Spreadsheets. October 2007.

Draft Discussion Paper No. 2



Regional District of Nanaimo

Liquid Waste Management Plan - Review and Amendments

On-site Treatment Issues

March 2008

Regional District of Nanaimo Liquid Waste Management Plan – Review and Amendments

On-site Treatment Issues

Issued: March 25, 2008

Previous Issue: March 19, 2008

1 Background

The Regional District of Nanaimo (RDN) has an approved 1997 Liquid Waste Management Plan (LWMP) that is currently being reviewed to determine if amendments to the plan are required at this time. As part of this work, discussion papers are being developed and circulated to the Liquid Waste Advisory Committee for discussion and comments. This discussion paper covers aspects of on-site wastewater treatment.

Within the RDN, there are many residences, some multifamily developments, some commercial establishments and some institutions that are not on a sewer system. As a result, they are on some type of on-site treatment system. In most cases, on-site treatment means a septic tank and disposal field (“Type 1” treatment). In some cases, on-site treatment means a small mechanical-biological packaged treatment plant and disposal field (“Type 2” treatment). In rare cases, on-site treatment means an advanced mechanical-biological packaged treatment plants (“Type 3” treatment) that produce very high quality effluents. (Further details of Type 1, 2 and 3 systems are found in Appendix A). Also, in rare cases, on-site “treatment” really isn’t treatment at all, but a holding tank for pump and haul while waiting for a sewer connection or because of poor soil or high groundwater issues. Overall, there are approximately 12,000 on-site systems within the RDN. With numbers of this magnitude, on-site treatment warrants some discussion within this LWMP review.

Previously, under the 1997 LWMP, with respect to on-site treatment, the RDN committed to the following:

- “The RDN will proactively and cooperatively work with the Central Vancouver Island Health Region to monitor and to assess sewage system requirements and develop solutions for failed on-site systems that are under Ministry of Health jurisdiction.”
- “The RDN, in consultation with stakeholders and the Central Vancouver Island Health Region, will investigate alternate minimum standards for on-site systems to supplement existing Ministry of Health sewage disposal regulations.”

With 12,000 on-site systems within the RDN, even if the 2008 situation was the same as the 1997 situation, there would still be a potential need for the RDN to be involved with the control and

operation of on-site treatment systems. However, with the 2005 Sewerage System Regulation, the situation did change significantly with respect to responsibilities towards on-site treatment systems. Since 2005, the Ministry of Health, i.e. the Vancouver Island Health Authority (VIHA) is no longer actively involved in approval or monitoring on-site systems. As a result, Regional Districts and some District Municipalities within BC have had to or have elected to take on more responsibilities to ensure that there are no major problems with the on-site systems within their jurisdiction. Therefore, the issue of on-site wastewater treatment systems needs to be reviewed within the context of the overall LWMP review.

The questions that need to be answered or discussed in this discussion paper include:

- How does the new Health Act regulation differ from the old one with regard to on-site systems?
- Who approves on-site systems?
- What are the different types of on-site systems?
- What is the purpose of holding tanks and pump and haul?
- How can the maintenance of on-site systems be ensured so there aren't problems now and in the future?

This discussion paper will provide an overview of the new British Columbia Ministry of Health Sewerage System Regulation; Type 1, 2 and 3 wastewater treatment systems, including holding tanks; RDN policies regarding on-site treatment including Type 1 and 2 systems; on-site treatment system management options; and proposed RDN on-site sewage disposal system educational program.

2 Sewerage System Regulation

The British Columbia Sewerage System Regulation under the Health Act applies to the construction and maintenance of holding tanks, sewerage systems that serve single family residences or duplexes, and sewerage systems with a combined design daily flow of less than 22,700 L that serve a single parcel or one or more parcels or strata lots (BC Health Act, 2004).

When the 1997 LWMP was developed, on-site wastewater treatment systems fell under the 1985 Health Act and the associated Sewage Disposal Regulation. Under the Act and the regulation of the day, the Ministry of Health was responsible for the approval, inspection and monitoring of on-site sewage systems. At some point in time, this level of responsibility eventually became unmanageable for the remaining Ministry of Health staff. With the mandate by the Provincial Government to reduce regulations in the early 2000's, the Ministry of Health was directed to develop a new, more streamlined and less prescriptive, Sewerage System Regulation.

Under the British Columbia Health Act, the new Sewerage System Regulation was approved on July 6, 2004 and came into effect May 31, 2005. The Sewerage System Regulation applies to the construction and maintenance of the following:

- (a) holding tanks,
- (b) sewerage systems that serves a single family residence or a duplex,
- (c) sewerage systems or combination of sewerage systems with a combined design daily domestic sewage flow of less than 22,700 litres that serves structures on a single parcel, and
- (d) a combination of sewerage systems with a combined design daily domestic sewage flow of less than 22,700 litres that serves structures on one or more parcels or strata lots or on a shared interest and discharges to ground.

For context, the Ministry of Environment has jurisdiction over wastewater treatment and disposal for any wastewater flows that are greater than 22,700 litres per day or for any wastewater flows that are discharged to surface waters. For this reason, in the past, there have been numerous strata subdivisions developed around 16 homes and a common septic tank and disposal field system because the theoretical flow was just below the 22,700 litre per day threshold, resulting in Ministry of Health jurisdiction.

In general, the intent of the new Sewerage System Regulation is to have all new on-site systems designed, installed, and maintained better than they would have been under the previous regulation. This new regulation is a non-prescriptive, outcome-based, industry-driven, approach. The new regulation has shifted resources, costs, and responsibility from the Ministry of Health, e.g. VIHA, to property owners and industry professionals. The Ministry of Health no longer approves new on-site systems but does accept and file the registrations of the new systems. Registered practitioners and/or qualified professionals are now responsible for planning, installing, registering and maintaining the on-site wastewater systems.

To assist these registered practitioners and/or qualified professionals, the Ministry of Health has issued a Sewerage System Standard Practice Manual, now into its second version. This Standard Practice Manual provides detailed guidance on most aspects of on-site system design, installation and maintenance. The Standard Practice Manual has extensive information about Type 1 (septic tank and disposal field) systems, but less information about Type 2 and Type 3 mechanical-aerobic biological systems that must be designed by qualified professionals, typically Professional Engineers.

Although VIHA may not be as involved with new systems as it was before, VIHA's roles and responsibilities under the new regulation continue to include the authority to inspect and take corrective action to alleviate health hazards related to onsite wastewater systems. If a health hazard exists or a system is likely to cause a health hazard, the Health Officer has the authority to hold liable the owner of the system and/ or the registered practitioner or professional that designed, installed, or was contracted to maintain the system. While existing on-site systems installed prior to May 31, 2005, do not have to comply with the new regulation, if any significant alteration or repair is to be made to an existing system, i.e. adding a bedroom to a house, relocating a tank for a garage, replacing a failed/ruined system, etc., the alterations or repairs have to comply with the new

regulation. Otherwise, for systems older than May 31, 2005, unless they fail and the failure is reported, no one is required to actively ensure that they are operating correctly.

Due to the transfer of overall liability onto the registered practitioner, professional, and property owner, the RDN may want to ensure that existing systems, systems constructed prior to May 31, 2005 which are not regulated by the new regulation, are operated and maintained in a safe and effective manner and according to the established LWMP. It is likely that some of the older systems within the 12,000 systems within the RDN may not be operated and maintained properly. This could potentially impact human health and the environment. With VIHA not required to monitor any on-site systems, there is a void that the RDN might have to fill with respect to managing the on-site systems and ensuring that they are in proper working order and are not causing any issues, e.g. failed septic systems contaminating surface or ground water supplies.

It may be beneficial for the RDN to develop a collective program with VIHA to investigate and remedy non-compliant/failed septic systems. A public education program covering location, construction, and care and maintenance of on-site sewerage systems for all owners - regardless of whether their systems are new or existing, can further protect the environment. Since it is likely that some existing wastewater treatment systems are not functioning correctly, a public education program would ensure that owners are informed to make decisions to safeguard surface and groundwater sources and the surrounding environment from non-compliant, non-maintained systems. To this end, the RDN has developed an education program that has been approved and scheduled for implementation in 2008. This is discussed further in Section 6.

To further assist the RDN in complying with its LWMP goals, the RDN may want to develop and implement a management program to monitor and address non-compliant systems. As such, it may be appropriate for the RDN to review and revise, if required, the current zoning bylaws in order to protect the environment from poorly sited systems by preventing development in areas with known or likely on-site treatment problems unless there is a sewer system. Additionally, the RDN may want to develop formal procedures to identify non-compliant/failed septic systems and implement measures to amend these systems such as mandating replacement of the existing septic tank system, upgrading the level of treatment, or connection to a municipal treatment system.

3 Holding Tanks and Their Role in Liquid Waste Management

The 2005 Sewerage System Regulation regulates the construction and maintenance of holding tanks. According to the regulation, holding tanks are defined as “a watertight container for holding domestic sewage until the domestic sewage is removed for treatment.” More generally, holding tanks are tanks that are connected to the plumbing system of the house or commercial establishment. They are different from septic tanks in that, in theory, there is no discharge from holding tanks other than through removal by a “pump and haul” contractor using a vacuum-type pumping truck. In contrast, a septic system includes a tank, wherein solids settle and oil and grease scum floats, and a perforated pipe effluent disposal system. While septic tanks are pumped

out every two to four years to remove the settled solids and scum, holding tanks have to be pumped out every time they are full, which could be a matter of days, depending on the size of tank and usage.

Holding tank pump outs would likely cost in the multiple of \$100's per pump out and many \$1,000's per year. As a result, owning and operating a holding tank can be very expensive. Therefore, holding tanks are usually the option of last resort when no other sewage disposal means are available, e.g. on-site septic systems or connection to a wastewater collection system.

A typical valid reason for using a holding tank is when a residential-sized lot, one too small for a septic tank and disposal field system is developed in anticipation of connection to a sewer system, but for some reason, the sewer system development is delayed. Similarly, the sewer system could be in place but the capacity of the wastewater treatment plant has been reached and, until the capacity is expanded, no further sewer connections are permitted. In such cases, the intent of the holding tank would be to bridge the need for service for a few months, but not on a permanent basis. It should also be noted that in the latter example, when the treatment plant capacity has been reached, the pumped out holding tank contents cannot be discharged at that treatment plant and must be hauled to another treatment plant.

Often, people have no idea of the volume of wastewater that they generate (or will generate) or the total cost of using a holding tank for wastewater disposal. Even when people are presented with the facts about wastewater generation and their likely costs, they often tend not to believe the information and still desire to use a holding tank. This is likely because their only other option is not being able to occupy their often newly-built home.

Once the homeowner is into the holding tank situation and they begin to experience the real cost of using a holding tank, there may be temptation for the homeowner to let the tank overflow, i.e. spill raw sewage to the ground, without the benefit of pre-treatment or distributed disposal as in a septic tank system. As a result, some jurisdictions do not allow the use of holding tanks, given past experiences with some people succumbing to the temptation to dispose of the wastewater from the tanks improperly or illegally because of economic pressures.

Although not allowing holding tanks might seem harsh to the individual homeowners, the real intent is to protect their public health and economic interests. This prevents the homeowner being faced with repetitive orders to dispose of the wastewater properly and legally, the possible declaration of a residence unfit for human habitation, or the inability to sell a property which is not attractive to potential purchasers because of the cost of sewage disposal. Instead, whenever possible, the property owner should provide an appropriately sized and designed on-site sewage disposal system or a connection to a sanitary sewer system should be used.

While the wholesale approval of permanent holding tanks is suggested above to be less than wise, there are reasons for approval of a temporary sewage holding tank under certain conditions. For example, if a permit has been issued for an on-site sewage disposal system, the local health

authority might permit the installation and use of the septic tank as a holding tank until soil conditions permit the installation of the absorption field. Another situation would be if the owner has written verification from the sewer utility that a sanitary sewer system connection will be available to the property within one year. In this case, the approving agency could issue approval for the use of a temporary holding tank until connection to the sewer is secured. Finally, a temporary sewage-holding tank may be used to eliminate the discharge from a failing on-site sewage disposal system until a new on-site system has been constructed, or connection to sanitary sewer is secured. In fact, in some cases, it is recommended that local health officers immediately require "pump and haul" as the first action whenever a sewage discharge from a failed septic system has been documented.

Holding tanks and "pump and haul" does exist within the RDN, particularly in the Horne Lake area where soil and groundwater issues make on-site disposal systems difficult to impossible. Under existing RDN bylaws, the RDN provides a function for holding tanks within the District. Lower "pump and haul" sewage disposal rates are provided for properties within the Pump and Haul Service Areas. The Horne Lake Pump and Haul Service Area has been established in response to historic problems with on-site systems in the Horne Lake area. Outside of the Horne Lake area, individuals must apply to be included in the Pump and Haul Service Area. To be included in the Pump and Haul Service Area, the following requirements must be met:

- The parcel is greater than 700 m².
- The parcel is for existing uses and the disposal system has failed, or the parcel is currently vacant and will only be used for the construction of a single family residence
- The parcel cannot be further subdivided or stratified according to existing zoning or a restrictive covenant.
- A community sewer system is not available.
- A holding tank permit has been obtained.
- The parcel will not facilitate development of any additional units on the property.
- The development conforms to zoning bylaws.

The Pump and Haul function is not available in Electoral Area A or C (except for defined properties in Area C).

4 RDN Policies Regarding On-site Treatment Systems and Lot Sizes

The RDN has policies in place regarding on-site wastewater treatment including where on-site waste disposal is supported. These "policies" include the LWMP, the Regional Growth Strategy (RGS), official community plans (OCPs) and on-site wastewater treatment-related bylaws.

The RDN enforces minimum lot size requirements using bylaws. The Land Use and Subdivision Bylaw No. 500, 1987 (RDN, 1987) and the Zoning and Subdivision Bylaw No. 1285, 2002 (RDN, 2002) set out lot size requirements depending on the location of the property and whether a community water and/or sewer system is in place. Generally, minimum lot sizes in unserviced areas are larger than the minimum lot sizes in serviced areas. One reason for the larger lot sizes in

unserved areas is to ensure that new lots have sufficient area to install on-site wastewater treatment systems. Typically, Type 1 systems - on-site septic tank and disposal fields, are used. However, these types of systems require suitable soils and percolation rates for effective treatment. If such parameters are not met, Type 2 systems, which are small packaged mechanical wastewater treatment systems, can be used to achieve higher quality effluent prior to discharge to ground. (Refer to Appendix A for more details on Type 1, 2 and 3 systems).

The RDN also has bylaws to regulate areas that may use holding tanks and as a result may use pump and haul services. The Pump and Haul Local Service Establishment Bylaw No. 975, establishes a local service area within the RDN for the purpose of collection, conveyance, treatment and disposal of sewage from holding tanks. In addition to Bylaw No. 975, Bylaw No. 988 regulates the discharge of trucked liquid wastes, including wastes from holding tanks and septic tanks, to RDN septage disposal facilities.

There are also two bylaws related to the Horne Lake Pump and Haul Local Service Areas. The first of these two bylaws is No. 1217, the Horne Lake Pump and Haul Local Service Establishment Bylaw that establishes the specific area for holding tanks in a defined portion of Electoral Area H. The second bylaw is No. 1218, the Horne Lake Service Area Sewage Disposal Regulation Bylaw which establishes a local service for the collection, conveyance, treatment and disposal of sewage within parts of Horne Lake Pump and Haul Service Area.

There is also Bylaw 1224, Sewage Disposal Regulation Bylaw from December 2000 that establishes a local service for the collection, conveyance, treatment and disposal of sewage from holding tanks within a defined portion of the RDN.

Bylaws 500, 975, 988, 1217, 1218, 1224 and 1285 are discussed in further detail in Appendix B.

5 On-site Wastewater System Management Options

All on-site wastewater treatment systems require regular inspection and maintenance to operate effectively. The manner in which an on-site treatment system is taken care of will influence how long the system will last, how well it functions, and how well the environment is protected. In order for homeowners to avoid the inconvenience and cost associated with the repair or replacement of a prematurely failed on-site system, the treatment system should be regularly inspected and maintained to help the system perform well for many years. Typically, the frequency for septic tank clean outs and system inspections is in the two to five year time frame.

Under the new Sewerage System Regulation, VIHA is not going to actively inspect on-site systems. While the newer systems, developed under the new regulations, are supposed to have a regular inspection and maintenance program, the older systems developed before May 31, 2005 have no such requirement. As a result, the RDN may elect to ensure that the on-site systems within its jurisdiction are actively and regularly inspected and maintained.

Three management programs are available to the RDN that can ensure on-site systems are regularly inspected and maintained. They include the following options:

- Privately-owned and maintained on-site systems and privately-operated inspection program.
- Privately-owned and maintained on-site systems and publicly-operated inspection program.
- Publicly-owned and maintained on-site systems and publicly-operated inspection program.

These options will be discussed in greater detail in the following sections.

5.1 Privately-Owned and Maintained On-site Systems and Privately-Operated Inspection Program

This management program would involve renewable operating licences. Under this management program, the RDN would issue licences upon proof of performance monitoring, pumping, or service by a qualified person. The licence would authorize the owner of the system to use the on-site system for a specified period, as long as the conditions on the licence were met.

If the system were not performing properly, the licence would not be issued until the problems are corrected. Property owners would be responsible for contracting and paying a specialist qualified by an industry association, e.g. the BC On-site Sewage System Association (BCOSSA), for the inspections. In addition, owners would pay a fee for the operating licence and would assume all costs associated with pump-outs, repairs, upgrades, or replacement of systems. At the end of the licensing period, the licence may be renewed based on the property owner paying a renewal fee and submitting an inspection report prepared by a qualified person indicating the system is performing properly.

Under this management program, the RDN's involvement would be enacted under a Regional District bylaw and would include:

- Development of licence conditions and reporting requirements,
- Mailings of licence requirements and application forms (possibly in a phased schedule),
- Receiving payments,
- Maintaining a database and file system,
- Enforcement activities (for failure to obtain licence, spot-checks on inspectors), and
- Licence renewals.

A public information program, i.e., educational pamphlets, advertising, and open houses would be used to initiate the program. Letters would be mailed to property owners explaining the program requirements, deadlines, fees, and penalties. The property owner would then be required to retain a qualified person to conduct an inspection of their system, typically once every three years, and prepare a report detailing the inspection results. The RDN would be required to determine the degree of the inspection. The inspections could include the following:

- A description of the on-site treatment and disposal system, including age of the system and number of occupants it normally serves.
- Uncovering the septic tank to measure the scum, sludge, and liquid level in the tank.
- Inspection of the general condition of the tank, outlets, distribution box, etc.
- Inspection of all mechanical parts, including pumps, valves, etc.
- A general site evaluation documenting evidence of any malfunction including lush vegetation, saturated ground surface, seepage, etc.
- A dye test, to assess leakage, at the discretion of the inspector.

Septic tank pump-outs would be required on a regular frequency, e.g. every three years, and possibly more frequently, depending on the occupancy of the residence. The property owner would then submit the inspection report with a licence application. If the property owner's system were non-compliant, there would be provisions for submitting the report with a plan and schedule to bring the system into compliance and a completion report.

Property access issues would not be an issue under this management concept because the property owner would be responsible for contracting the pump out and inspection. The RDN could also enact a bylaw permitting RDN staff to access private property to conduct spot checks of the inspection reports.

Disadvantages of this type of program include the following:

- Difficulty issuing permits if there are incomplete records of the system.
- Property owner has to take the responsibility to get an inspection done and submit an application.

One way to help ensure that the inspection is completed regularly would be to charge the property owner approximately one-third of the pump-out and inspection cost each year, plus an administration fee, on their annual property tax bill. Once the pump out and inspections were completed, the property owner would submit the inspection report and subsequently be given a rebate for the cost of the pump-out and inspection, less the administrative fees.

5.2 Privately-Owned and Maintained On-site Systems and Publicly-Operated Inspection Program

This "Private-Public" management program is similar to the first "Private-Private" one but differs on one big point: the RDN would provide the systematic inspection of on-site systems. These inspections would be conducted by either RDN staff or an inspection company under contract to the RDN. System deficiencies would be noted and the property owner would be responsible for hiring a qualified person to complete any required maintenance or repairs. The property owners would be charged a service fee for the inspection and would assume all costs associated with required repairs, upgrades, or system replacement.

The RDN would be involved in:

- Developing the permit conditions and reporting requirements,
- Carrying out or contracting out the pump outs and inspections,
- Mailing licences, or development of correction orders,
- Receiving payments,
- Maintaining files and a database,
- Enforcing compliance, and
- Renewing permits.

The main drawback with this management program is opposition from residents toward RDN-authorized inspectors entering their property. This may be resolved by enacting a bylaw providing inspectors with the right to access private property for the sole purpose of conducting an inspection of the on-site wastewater treatment system.

Another drawback with this type of management scenario is the timing of fee collection for the licence. For this option, there is no obvious trigger, such as the submission of a licence application. This issue could be addressed by sending an invoice after an inspection takes place. However, if the system is in non-compliance, the property owner may be disgruntled and less likely to pay the inspection fee. A better way to resolve this issue would likely be to put the inspection fee directly on the annual property tax notice.

5.3 Publicly-Owned and Maintained On-site Systems and Publicly-Operated Inspection Program

Under this management program, the RDN would be regarded as the septic system “owner”. As “owner” the RDN would be responsible for the installation, upgrading, and management of all on-site systems within the Regional District by agreement to operate and maintain systems with access by easement. The RDN would pay for all inspections (typically once every three to five years), repairs, upgrades, and scheduled maintenance. To recover costs, the RDN would charge user fees. The property owner would pay fees to cover the cost of the treatment and disposal system and an annual operation fee.

The main drawback of this type of management program is the overall risk and high cost associated with transferring responsibility of inspecting, maintaining, and upgrading on-site systems from individual property owners, to the RDN.

The small community of Port Maitland, Nova Scotia, is trying this type of management program. Port Maitland uses a publicly-owned and publicly-managed program to manage the wastewater generated by 135 households and several businesses. The community voted to establish a Wastewater Management District. The Wastewater Management District installed four cluster

systems and some private systems, as well as upgraded 31 individual systems. Port Maitland has experienced the following problems with this management program:

- General population believes that they can manage their own systems at a less expensive cost.
- Port Maitland must remediate contaminated properties.
- Even though there was a resident education program, improper disposal of wastes is a common occurrence likely due to the loss of individual ownership, i.e. they don't care about the system anymore. This has resulted in expensive repairs, which are charged back to the user through higher taxes.
- Port Maitland is responsible for the disposal of waste they have no control over, i.e., pump-out and disposal of contaminated waste.

Taken as a whole, this "Public-Public" septic system management model is very problematic and cannot be recommended for the RDN situation.

5.4 Summary of Management Options

In order to ensure that the 12,000 on-site treatment systems are functioning properly, the RDN will likely need to implement an on-site wastewater treatment system management program. Three different management programs were discussed in the previous sections. Only the Private-Private and Private-Public options are viable. The fundamental differences between the management programs are the delegation of responsibilities for inspection and maintenance; ownership of the systems (i.e., the property owner or the RDN); and whom the on-site system inspector is employed by (i.e., the property owner or the RDN).

No matter which program is selected, the following are required to ensure the management program is successful:

- An education program for on-site system users.
- Inspection and maintenance of on-site systems at regular intervals.
- A record of each on-site system, in a database and its condition, pump-out history, etc.

It should be noted that the CRD had to include on-site management as part of its LWMP. After considering the management options, the CRD has opted for the Private-Private on-site system management option for Saanich, Colwood, Langford and View Royal, i.e. the municipalities with septic systems in their Core Area Liquid Waste Management Plan area. A bylaw will require owners of a basic septic tank and disposal field (Type 1 system) to pump out their tanks by the end of 2010 and every five years thereafter. Owners of a package treatment plant (Type 2 or 3 system) will be required to have their system maintained by a professional by the end of 2009 and annually thereafter to ensure it continues to function properly and does not cause or contribute to a health hazard. The homeowners will have to keep their receipts and send them in to the CRD as proof of compliance. Those who have pumped out their tanks since 2007 or later, and who can show proof

to the CRD, will be able to pump five years from their last pump-out date. An annual parcel tax of approximately \$25 to \$30 will be charged to owners of on-site sewage systems to administer the program. This fee is intended to cover maintenance of a database to keep track of where systems are, new installations and connections to sanitary sewer. It will also include notification to homeowners when their due-date is approaching and follow up enforcement costs with those who are not complying.

Reference: <http://www.crd.bc.ca/wastewater/septic/onsite.htm>

6 RDN's Approved On-site Treatment Educational Program

The RDN currently estimates that there are 12,000 individual private on-site septic systems in operation in the Regional District. On-site systems require proper operation and maintenance to ensure they are in good working order. Systems, which are not properly operated or maintained, may fail due to a variety of reasons and as such, may potentially threaten human health and the environment.

The RDN will be implementing an on-site sewage disposal system educational program to help prevent septic system failures, and minimize the impacts of the failures that do occur. By educating homeowners about septic system regulations, homeowner responsibilities under the regulations, private on-site systems, how the systems operate, required system maintenance, and signs of system failure, homeowners can become informed and capable of making important decisions regarding their systems. As such, homeowners can avoid costly repairs to their system, while preventing health and environmental damage from occurring.

The approved RDN education program will consist of mail outs, an article in Regional Perspectives (an RDN publication), as well as information provided at public information meetings / workshops, and pollution control centre open houses. The program will be fully developed in 2008.

7 Conclusions

This discussion paper set out to answer or discuss the following questions:

- How does the new Health Act regulation differ from the old one with regard to on-site systems?
- Who approves on-site systems?
- What are the different types of on-site systems?
- What is the purpose of holding tanks and pump and haul?
- How can the maintenance of on-site systems be ensured so there aren't problems now and in the future?

This discussion paper has hopefully provided readers with answers to these questions.

The 2005 Health Act Sewerage System regulation eliminated the Ministry of Health as the approval agency for on-site systems by shifting the responsibility for design, installation and maintenance to qualified professionals and registered practitioners. While the Ministry of Health still has the powers to step in and inspect systems and order their repair, they are very unlikely to do so unless informed of problematic situations. This leaves a significant need for inspection of older, pre-May 2005 systems, as well as new systems, in order to find and eliminate potential problems.

Types 1, 2 and 3 on-site treatment systems were discussed with more detailed information provided in Appendix A.

Holding tanks and pump and haul were discussed and were shown to have a role when connection to a sewer system will be made within a year or where there are very poor soils or groundwater problems. Bylaws related to on-site systems, including pump and haul holding tanks, and related lots sizes, within the RDN were briefly discussed. More detailed bylaw information is provided in Appendix B.

This discussion paper has also provided information on management programs for on-site systems. These programs included a privately-owned and maintained system and privately-operated (Private-Private) inspection program, a privately-owned and maintained system and publicly-operated (Private-Public) inspection program, and a publicly-owned and maintained systems and publicly-operated (Public-Public) inspection program. It was noted that the CRD has recently opted to go with a Private-Private program to ensure the continued safe operation of on-site systems in its jurisdiction.

The RDN is planning the implementation of an educational program regarding on-site sewage disposal systems. The RDN currently estimates 12,000 individual private on-site septic systems in operation in the Regional District. The educational program is a proactive step by the RDN to help prevent septic system failures, and minimize the impacts to human health and the environment from the failures that do occur. This does not necessarily preclude the need for a more active management program such as that adopted by the CRD.

8 References

- .1 BC Health Act. Sewerage System Regulation 326/2004. Available at: www.qp.gov.bc.ca/statreg/reg/H/Health/326_2004.htm
- .2 Regional District of Nanaimo. Liquid Waste Management Plan (Stage 3 Report), November 1997. Available at: www.rdn.bc.ca/cms/wpattachments/wpID1131atID1130.pdf
- .3 Regional District of Nanaimo. Memorandum: On-Site Sewage Disposal System Education Program. June 2007.

- .4 Regional District of Nanaimo. Land Use and Subdivision Bylaw No. 500. 1987. Available at: www.rdn.bc.ca/cms.asp?wpID=262
- .5 Regional District of Nanaimo. Zoning and Subdivision Bylaw No. 1285. 2002. Available at: www.rdn.bc.ca/cms.asp?wpID=262
- .6 Regional District of Nanaimo. Trucked Liquid Waste Bylaw No. 988. 1995.
- .7 Regional District of Nanaimo. Pump and Haul Local Service Establishment Bylaw No. 975. 1995.

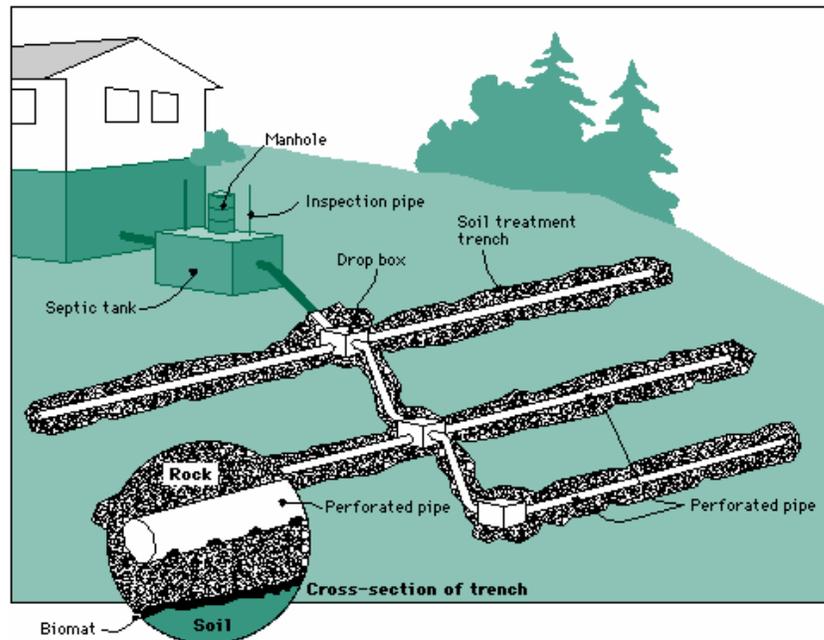
APPENDIX A - TYPES OF ON-SITE TREATMENT

Under the new 2005 Sewerage System Regulation, there are three types of on-site treatment, Type 1, Type 2 and Type 3. The following sections describe these treatment types.

A.1 Type 1 Systems

According to the Sewerage System Regulation, a Type 1 system consists of treatment by septic tank only. A properly functioning septic system receives all the wastewater created from household use (including toilets, showers, sinks, dishwasher, washing machine, etc.), treats the wastewater to a primary level, and returns the treated effluent to the groundwater. A conventional septic system is composed of a septic tank and a soil filter called an absorption field.

Figure A-1
Septic Tank and Absorption Field



The purpose of the septic tank is to separate liquid from solids and to provide some breakdown of organic matter in the wastewater. A septic tank is a buried, watertight container made from concrete, polyethylene or fibreglass. The size of the septic tank will depend upon the size of the house (number of bedrooms) and household water use.

As wastewater from the house enters the septic tank, its velocity slows, allowing heavier solids to settle to the bottom and lighter materials to float to the surface. The accumulation of settled solids at the bottom of the tank is called “sludge” while the lighter solids (greases and fats), which form a mass on the surface, is called “scum”. Anaerobic bacteria, which are always present in wastewater, digest some of the organic solids in the tank. Clarified wastewater in the middle of the tank flows by displacement into the leaching bed for further treatment in the soil layer.

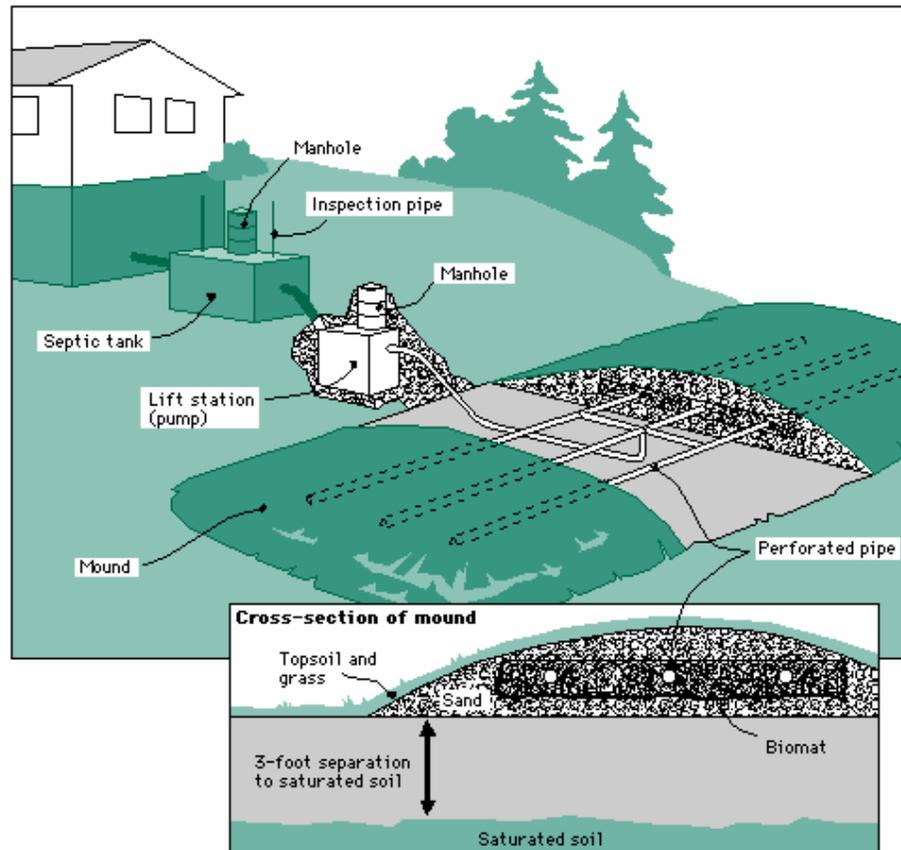
The partially treated wastewater from the septic tank flows into the absorption field. The absorption field is typically a network of perforated plastic distribution pipes laid in sandy-gravel trenches over a layer of soil. Typically, the soil layer must be a minimum depth above the ground water table or a restrictive layer such as bedrock or clay, and have a certain permeability (absorptive capacity). Conducting a percolation test can test the soil permeability. A percolation test determines the absorption rate of soil by observing how quickly a known volume of water dissipates into the subsoil of a drilled hole of known surface area. In general, sandy soil will absorb more water than soil with a high concentration of clay or where the water table is close to the surface.

Older septic systems may have been constructed with clay tiles instead of plastic pipes, while new systems may use plastic chambers to replace the gravel trenches and perforated piping. The actual size, design and layout of the absorption field is based upon the volume of sewage generated, the absorptive capacity of the underlying soils, and the depth to the high groundwater table or limiting/ restrictive layer. Wastewater can flow by gravity from the septic tank to the distribution pipes, or where required, can be collected in a pump chamber and pumped to a absorption field at a higher elevation.

The absorption field is a soil filter, which uses natural processes to treat the wastewater from the septic tank. Contaminants in the wastewater include solid and dissolved organic matter (carbon compounds), nutrients (nitrogen and phosphorus), beneficial bacteria and fungi, and harmful bacteria and viruses. A slime layer of bacteria, called a “biomat” layer, forms at the bottom and sidewalls of each distribution trench; and it is in this layer where much of the treatment occurs. The soil bacteria, which perform the treatment, require oxygen to function, therefore; the absorption field must be installed in soils that are not saturated by surface water run-off or a high groundwater table, and should not be paved or covered over with hard surfaces.

The absorption field soil must be the right type to retain the wastewater long enough for treatment to occur, while at the same time allowing the wastewater to infiltrate into the ground. In cases where there is a sufficient separation from either the high groundwater table or bedrock, the network of drainage piping is installed directly in the native soil or in imported sand if the permeability of the native soil is not suitable. This is called a conventional system. In cases where the high groundwater table or bedrock is close to the surface, the absorption field must be raised so that there is sufficient unsaturated soil under the drainage piping. This is called a raised bed system or a mound system.

Figure A-2
Raised Bed or Mound System



A.2 Type 2 Systems

Type 2 systems are on-site secondary wastewater treatment systems that produce effluent consistently containing less than 45 mg/L of total suspended solids and having a 5-day biochemical oxygen demand of less than 45 mg/L. Type 2 systems are generally used where site conditions make it impractical or even impossible to install a conventional septic system such as: high groundwater table, bedrock, poor soil conditions (i.e. clay, silt, till) or inability to meet the setback distances from surface water, wells or property boundary lines.

In these cases, an aerobic treatment technology is often used. These treatment technologies are proven technologies used to treat the wastewater to a higher level (secondary and tertiary) than a septic tank, permitting the treated effluent to be discharged into a much smaller area than is required for treatment by a conventional absorption field.

Aerobic treatment technologies typically have three components: a settling tank (this may be smaller than a conventional septic tank), the aerobic treatment unit, which removes much of organic matter from the wastewater, and a dispersal system, which is often a small absorption field.

Aerobic treatment technologies rely on aerobic micro-organisms to break down the organic matter in the wastewater. In order to optimize treatment, the treatment units either include a material to support the growth of micro-organisms (called attached growth media), or a continuous mixer or aerator to keep micro-organisms in suspension (called suspended growth). Many technologies utilize either an air pump or blower to provide oxygen to the micro-organisms, while some technologies are designed as “trickling filters”, where effluent is dosed onto an unsaturated media and the micro-organisms use the oxygen in the air, which surrounds the media.

The treated effluent is typically discharged into a small absorption field, although there are alternative methods in some jurisdictions including pressure distribution systems near the soil surface or even discharge to surface waters.

A.3 Type 3 Systems

Type 3 systems are advanced secondary treatment systems that can meet an effluent standard of less than 10 mg/L BOD, 10 mg/L TSS and less than 400 fecal coliform forming units per 100 mL. The treatment process would either include Type 2 treatment followed by some type of fabric or sand filter or a membrane bioreactor, both followed by disinfection (either chlorination/ dechlorination or ultraviolet (UV) irradiation). The effluent from such systems would be very clean and clear. Type 3 treatment systems are relatively expensive to build and operate. Type 3 treatment systems would typically only be used in very unique situations with a sensitive receiving environment or a high water table that would make a Type 1 or Type 2 system impossible.

APPENDIX B - RDN BYLAWS THAT AFFECT ON-SITE TREATMENT

B.1 Land Use and Subdivision Bylaw No. 500, 1987

The RDN's Land Use and Subdivision Bylaw No. 500, 1987 provides land use regulations for properties within all Electoral Areas except Electoral Area 'B' (Gabriola Island) and 'F' (Errington, Coombs, Whiskey Creek & Hilliers). Under Bylaw 500, minimum parcel sizes for new lots created through subdivision have been established for Electoral Areas 'A', 'C', 'E', 'G', and 'H'. Minimum lot sizes vary depending on location and whether the lot is serviced by a community water system and/or a community sewer system. Generally, smaller lots are permitted if both community water and sewer is available. If no services are available, then the minimum lot size for subdivision is generally larger.

Section 4.7 of Bylaw 500 specifies that a parcel not served by a community sewer system must obtain the approval of the jurisdictional authority and they must be satisfied as to the sewage disposal capability of the parcel. The RDN has no approval authority for on-site sewage disposals systems.

With respect to new community sewer systems, to service new subdivisions that will be connected to an RDN trunk sewage main, they must be constructed and installed at the expense of the owner of the land being subdivided and be carried out in accordance with the standards and specifications set out in Schedule '4D' of Bylaw 500 (RDN, 1987).

The overall Planning function for Electoral Area 'B' (Gabriola Island) is administered by the Islands Trust.

B.2 Zoning and Subdivision Bylaw No. 1285, 2002

RDN's Zoning and Subdivision Bylaw No. 1285, 2002 provides zoning and subdivision regulations for properties within Electoral Area 'F' (Errington, Coombs, Whiskey Creek & Hilliers). Bylaw No. 1285 specifies minimum lot sizes depending on land use. With one exception, the minimum parcel size for all new lots in Electoral Area F is 1 ha or larger and on-site sewage disposal is currently the only available form of sewage disposal.

Similar to Bylaw 500, where a lot is proposed and not served by a community sewer system, the jurisdictional authority must be satisfied with the sewage disposal capability of the lot.

The Area F OCP and the RGS only permit the establishment of a community sewer system to service lands within the designated village centres within the urban containment boundary. Bylaw 1285 includes the following requirement for new community sewer systems:

- Any community sewer system, or part thereof, provided within the subdivision, to service the subdivision, or to connect the community sewage collection system within the subdivision to a trunk sewer main is to be designed, constructed, and installed at the expense of the owner of the land being subdivided.

B.3 Pump and Haul Local Service Establishment Bylaw No. 975

RDN Bylaw 975, adopted in December 1995, establishes a local service area within the RDN for the purpose of collection, conveyance, treatment and disposal of sewage from holding tanks within a defined portion of the Regional District. The boundaries of the local service area are the boundaries of the parcels established in Schedule A of the bylaw. Schedule A includes parcels in the following areas: Electoral Areas B, C (defined properties), E, F, G, H, City of Nanaimo, and District of Lantzville.

B.4 Trucked Liquid Waste Bylaw No. 988

RDN Bylaw No. 988, adopted in December 1995, regulates the discharge of trucked liquid waste into septage disposal facilities operated by the RDN. Bylaw No. 988 oversees septage disposal facilities and has the power to acquire, construct, maintain, operate, and regulate these facilities. Schedule A of Bylaw No. 988 lists prohibited wastes, which include amongst others flammable or explosive waste, biomedical waste, and corrosive wastes. Schedule B to Bylaw 988 indicates approved septage receiving facilities. Schedule C sets out required fees, while Schedule D sets out rules for use of the septage disposal facilities.

B.5 Horne Lake Pump and Haul Local Service Establishment Bylaw No. 1217

RDN Bylaw 1217, adopted in November 2001, establishes a local service area within the RDN for the purpose of collection, conveyance, treatment and disposal of sewage from holding tanks within a defined portion of Electoral Area H. The boundaries of the local service area are the boundaries of the parcels established in Schedule A of the bylaw.

B.6 Horne Lake Service Area Sewage Disposal Regulation Bylaw No. 1218

RDN Bylaw 1218, adopted in December 2001, establishes a local service for the collection, conveyance, treatment and disposal of sewage within parts of Horne Lake Pump and Haul Service Area. Schedule A to this bylaw is the holding tank disposal permit application form. Schedule B to this bylaw sets out fees.

B.7 Sewage Disposal Regulation Bylaw No. 1224

RDN Bylaw 1224, adopted in December 2000, establishes a local service for the collection, conveyance, treatment and disposal of sewage from holding tanks within a defined portion of the RDN. Schedule A is the holding tank disposal permit application form.

Regional District of Nanaimo

Policies Regarding New Communities and Developer Installed Treatment Plants

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1 Background

The Regional District of Nanaimo (RDN) is undertaking a review of its Liquid Waste Management Plan (LWMP) to determine if amendments to the plan are required at this time. As part of this work, discussion papers are being developed and circulated to the RDN Liquid Waste Advisory Committee for their input and comments. Previous discussion papers have reviewed existing conditions and on-site treatment issues. This discussion paper takes a look at policies regarding new communities and developer-installed treatment plants. These treatment plants are more commonly known as package wastewater treatment plants.

1.1 Package Wastewater Treatment Plants and Regulatory Requirements

A package wastewater treatment plant is a pre-fabricated or pre-built wastewater treatment plant, which uses a process involving energy, and mechanical, biological, chemical, or physical treatment of the wastewater to reduce the following wastewater constituents:

- biological oxygen demand,
- suspended solids,
- nitrogen,
- bacteria, and
- other wastewater constituents.

Package treatment plants typically provide a secondary level of treatment and are smaller than conventional treatment plants. Package treatment plants are privately owned, and serve specific uses or new housing developments, rather than entire cities or regional districts.

In 1996, the RDN Board requested the Ministries of Health and Environment cease approval of package treatment plants for strata and other private developments within the RDN, except where the application had first been referred to the RDN for review and approval. The RDN passed this resolution because it was concerned about the following:

- Package treatment plants may be approved on a site-by-site basis with no assessment of the cumulative impact of such approvals.
- Package treatment plant approval might conflict with the RDN's strategy to provide community sewer service.

- Package treatment plant approval may conflict with the RDN's capital plans to provide community sewer service.
- The inadequacy of bonds required for package treatment plants.
- The insufficiency of measures to monitor and maintain package treatment plants.

The RDN's request to the Ministries of Health and Environment was not accommodated. As such, properties are able to utilize package treatment plants based on applicable provincial legislation e.g. the Ministry of Environment's Municipal Sewage Regulation (MSR), which does not recognize individual local government policies. Properties currently using packaged treatment plants continue to use them based on the legislation governing them. However, the current legislation does not establish a government body responsible for monitoring the ongoing operation and maintenance, but imposes this responsibility on the owners of these systems.

In 2005, the provincial government passed the new Sewerage System Regulation under the Health Act, which amends the process by which independent residential septic systems and package treatment systems with daily flows of less than 22,700 litres/day are approved. The regulation is locally administered by Vancouver Island Health Authority and applies to developments such as new homes on existing lots, strata developments with multiple units, new residential subdivisions (under approximately 20 lots), new subdivision lots, and other sources generating less than 22,700 litres/day of domestic sewage. The regulation requires that "authorized persons" approve and inspect treatment systems, including both conventional septic fields and package treatment plants.

Under the Ministry of Environment's regulations, the MSR applies to management of wastewater treatment systems larger than 22,700 litres/day or any systems that discharge to surface water. Larger single-family subdivisions, strata developments over about 16 units and non-residential developments fall under this category. The MSR registration process generally requires more effort and expense compared to applying for a permit under the Health Act. A registration under the MSR effectively becomes a contract with the provincial government. It specifies the required level of wastewater treatment and other compliance items such as submitting regular monitoring results. The Ministry does not inspect the facility or monitor the effluent on a regular basis but has the ability to audit. If the audit found that the proponent was not fulfilling the requirements of the approved MSR registration, penalties could result.

1.2 Objectives of Discussion Paper 3

This discussion paper will provide an overview of RDN policies regarding developer installed package treatment plants, implications of package treatment plants on the RDN's Regional Growth Strategy (RGS), and administrative issues the RDN should consider regarding ownership and operation of developer installed package treatment plants.

It is the intent of this discussion paper to answer or discuss the following questions:

- Should the RDN enter into ownership, operation, and maintenance of package treatment systems?
- To what degree should the RDN be involved in the operation and maintenance of package treatment systems acquired (i.e. RDN staff or contracted out)?
- What standards of wastewater treatment should be established?
- Which wastewater treatment technologies should be acceptable for use?
- What is the acceptable minimum size of the package treatment system?
- When a developer constructs a package treatment system, should there be a requirement to provide additional treatment plant capacity for servicing of adjacent existing homes?

2 RDN Policies Regarding Developer Installed Package Treatment Plants

The RDN provides a range of services for the municipalities and electoral areas, depending on local needs and interests. Private individual on-site systems and packaged treatment plants service most properties outside of these existing service areas. The RDN's Environmental Services Department has received requests to takeover newly constructed packaged treatment plants located outside the urban containment areas. To date, such requests have been turned down since the RDN's RGS does not allow the RDN services to extend outside urban containment areas, unless it is to mitigate problem areas (i.e. failed on-site septic tank systems). The RDN Board made a motion to develop a policy, as part of the Liquid Waste Management Plan Review, regarding the acquisition of new package treatment systems within the RDN's Urban Containment Boundary.

The RDN's RGS is an initiative adopted in January 1997 and reviewed in 2001-2002 to respond to concerns about the impacts of growth in the region. The RGS has the following goals:

- **GOAL 1: STRONG URBAN CONTAINMENT:** To limit sprawl and focus development within well defined urban containment boundaries.
- **GOAL 2: NODAL STRUCTURE:** To encourage mixed-use communities that includes places to live, work, learn, play, shop and access services.
- **GOAL 3: RURAL INTEGRITY:** To protect and strengthen the region's rural economy and lifestyle.
- **GOAL 4: ENVIRONMENTAL PROTECTION:** To protect the environment and minimize ecological damage related to growth and development.
- **GOAL 5: IMPROVED MOBILITY:** To improve and diversify mobility options within the region – increasing transportation efficiency and reducing dependency on the automobile.

- **GOAL 6: VIBRANT AND SUSTAINABLE ECONOMY:** To support strategic economic development and to link commercial and industrial strategies to the land use and rural and environmental protection priorities of the region.
- **GOAL 7: EFFICIENT SERVICES:** To provide cost efficient services and infrastructure where urban development is intended, and to provide services in other areas where the service is needed to address environmental or public health issues and the provision of the service will not result in additional development.
- **GOAL 8: COOPERATION AMONG JURISDICTIONS:** To facilitate an understanding of and commitment to the goals of growth management among all levels of government, the public, and key private and voluntary sector partners.

The approval, operation, and maintenance of package wastewater treatment plants may result in development, which is not consistent with the RGS land use or servicing strategies, and or a development that may threaten the environment. As such, the following items have been implemented in the LWMP as a result of the RGS:

- Services will not be extended outside of Urban Containment Boundaries, Village Centres, and Present Status Lands (lands outside the Urban Containment Boundary where the present zoning may continue to control the development potential of the land) except where existing developments threaten public health or the environment.
- Servicing decisions will be linked to the land use elements of the RGS and local official community plans.
- Servicing decisions of the LWMP will be consistent with the goals of growth management.

3 Implications of the RGS on the LWMP and Package Treatment Plants

The RDN's LWMP supports the goals, policies and guidelines of the RGS. It also supports efficient use and management of services and resources as well as cooperation among jurisdictions. There are specific initiatives within the LWMP that pertain to rural areas, including the RGS's goal to exclude rural areas from urban type development. The LWMP should anticipate the sewer servicing needs of future village centres, identify areas with failing septic systems and other potential problems, and provide solutions to address these problems.

The demand for community sewer services outside the Urban Containment Boundaries impact the RDN because existing capital plans and servicing areas were not created to include these areas. Providing services outside the Urban Containment Boundary could facilitate more intensive development than intended by the RGS. In some instances, packaged treatment plants enable development to occur in areas that may not have otherwise occurred with standard septic systems.

This also impacts the rural character of unincorporated areas and may result in unplanned impacts such as increased traffic congestion, noise, and odours. However, if rural development in the RDN is inevitable, small-scale collection and treatment systems, such as packaged treatment plants based on conventional or new technologies, may provide more cost-effective alternatives to individual on-site systems, or community wastewater treatment plants.

Achieving the RGS goals of supporting development within the established village centres may require a flexible servicing approach. If these facilities were operated by the RDN and served more than one parcel they would be considered a community sewer system. As the package treatment systems are modular, it should be possible to have new development serviced by an existing package treatment system provided that the expansion of the package treatment system is planned for and land and receiving environment requirements can be accommodated. In that way, each new development pays for upgrades and rather than a package treatment system on each parcel or for each development, a reduced number of package treatment systems to serve a village centre may be possible.

This approach would be predicated on the basis that a land base is available for package treatment plant expansion and disposal capacity (to land, to surface water, etc) for the treated wastewater is available for future development. New developments that receive sewer servicing from existing package treatment systems must pay for the portion of capacity that is used; a capital charge bylaw or latecomers fee would need to be established for these developments.

If a rezoning is required the RDN has the option of requiring that a community amenity be provided in the form of extra capacity in the package treatment system or installation of infrastructure to connect some of the existing adjacent property owners. For areas outside of the Urban Containment Boundary, community sewer services are not supported except in cases where there is an environmental or health concern, but not to facilitate new development.

4 Issues Regarding Ownership and Operation of Developer Installed Package Treatment Plants

The ownership and operation of developer-installed package treatment plants present issues that require resolution prior to consideration and adaptation. This section will explore issues pertaining to recommended package treatment plant requirements including bonding requirements, staffing requirements, and type of treatment system and minimum size.

4.1 Bonding Requirements

If the RDN assumes ownership of a developer installed package treatment systems, the developer avoids the Ministry of Environment's financial security requirements under the MSR registration process. In addition, RDN ownership may allow the developer to avoid stratifying the development to create an ongoing management entity for the treatment facility. Avoiding Ministry security

requirements and the ability to market fee simple properties (vs. strata properties) may provide significant financial benefit to the developer.

If the RDN were to take over developer installed package treatment systems, bonding requirements must be established. Maintenance bonds should be required to guarantee the performance of a package treatment plant after it is constructed and before it is taken over by the RDN. The role of a maintenance bond is to protect the RDN against design defects and/or failures in workmanship, and to guarantee facilities constructed are adequately maintained during the commissioning period. Maintenance bonds are often valid for a limited time, at which time the responsibility for facility upkeep must be transferred to either a private party or local government, i.e. the RDN. Due to the limited time frame of maintenance bonds, they are often not a solution to ensure long-term maintenance. As such, the RDN may wish to explore longer-term security options.

4.2 Staffing Requirements

Many package treatment systems end up failing due to factors such as inappropriate management, lack of maintenance, and insufficient funds to meet operation and maintenance requirements. The RDN is not currently staffed to take on additional wastewater systems, so supplementary resources would be required.

The staffing requirements to operate and maintain the package treatment plants will vary by the number of package treatment plants the RDN decides to operate, the complexity of the treatment plants, and the capabilities of the current staff in meeting the operational and maintenance demands.

Staff requirements are estimated at approximately one full-time employee for every two to four systems, depending on their size, technology and location.

In addition to staffing there will also be vehicle, equipment, office, etc. requirements, as well as administrative responsibility related to the establishment of service areas, obtaining provincial approvals and reviewing developer's proposals. These tasks would require additional planning and engineering resources.

Another operational and maintenance option available to the RDN is to contract the operation and maintenance of the package treatment plants to an outside company through a contract or agreement. This alternative would alleviate the need to hire additional staff and would essentially put the responsibility of operating and maintaining various types of package treatment plants on the private owner(s) and/or developers through the contractor. Corix and EPCOR are two examples of companies that provide contract wastewater treatment operation in BC.

4.3 Recommended Package Treatment Plant Requirements

If the RDN were to take over the operation and maintenance of package treatment plants, it is in the best interest of the RDN to ensure that the package treatment systems are of an approved standard. Standardizing the package plants to one or two types of treatment processes would alleviate the time and effort required from operators in learning how the different types of systems work. Systems that are designed correctly, simple to operate, and affordable to maintain can be successful at providing the necessary level of effluent treatment.

Typically, package treatment plants can produce an effluent with a biochemical oxygen demand (BOD) of less than 45 mg/L and total suspended solids (TSS) of less than 45 mg/L. Some more sophisticated (and expensive) packaged treatment plants can produce effluent with biochemical oxygen demand of less than 10 mg/L and total suspended solids of less than 10 mg/L. The quality of effluent required is related to the disposal site characteristics or the intent to reuse the effluent in a beneficial manner. The “10/10” BOD/TSS quality of effluent is more likely to be acceptable for reuse whereas the “45/45” BOD/TSS quality is not suitable for direct reuse.

There is a wide variety of choice when it comes to treatment processes, with the various processes offering different advantages and disadvantages. The key in selecting a treatment system is recognizing system requirements and having a plan in place that will ensure long-term operation and maintenance of the system. For the system to be cost-effective and also provide acceptable wastewater treatment, the following factors must be addressed before selecting a package treatment system:

1. The receiving environment to which the effluent will be discharged (to ground, or into surface waters).
2. The type of collector sewer used.
3. The estimated volume of flow.
4. Site characteristics (including the land footprint and projected future use, soil type, topography).
5. System reliability and monitoring.
6. System maintenance and personnel requirements.
7. Adaptability to changes in system operation.
8. The potential for effluent to impact fish bearing streams.
9. Management of residuals e.g. sludges.

To discourage development in areas not suitable for conventional on-site wastewater treatment and disposal systems, package systems used for treating individual homes, i.e., rotating biological contactor (RBC) serving five person flows, would not be recommended for take over. The recommended minimum package sewage treatment system size to be accepted by the RDN, if it chose to take over private treatment systems, would be a system designed for 16 lots or more. This number is based on the breakpoint value of 22.7 m³/day between the Waste Management

Act's Municipal Sewage Regulation (MSR) and the Health Act's Sewerage System Regulation. The MSR applies to all flows greater than 22.7 m³/day or any effluent discharged to surface water. Flows of 22.7 m³/day are equivalent to approximately 16, three-bedroom homes. Private firms such as Corix and EPCOR have concluded that package treatment systems servicing less than about 60 dwelling units (homes) may not be economically viable. As such, we recommend a range of approximately 16 to 60 homes for package treatment systems to be accepted by the RDN. It should be noted that this range depends on site conditions and other parameters that would need to be assessed prior to making a final decision on how to proceed.

Once the abovementioned factors are identified, the type of package wastewater treatment process can be selected. There are several treatment processes that may be used for a package system. The suitability of the treatment process for a particular application depends on the factors mentioned above. Recommended treatment processes include:

- Activated sludge/extended aeration,
- Sequencing batch reactor,
- Rotating biological contactor,
- Moving bed biological reactors, and
- Membrane bioreactors.

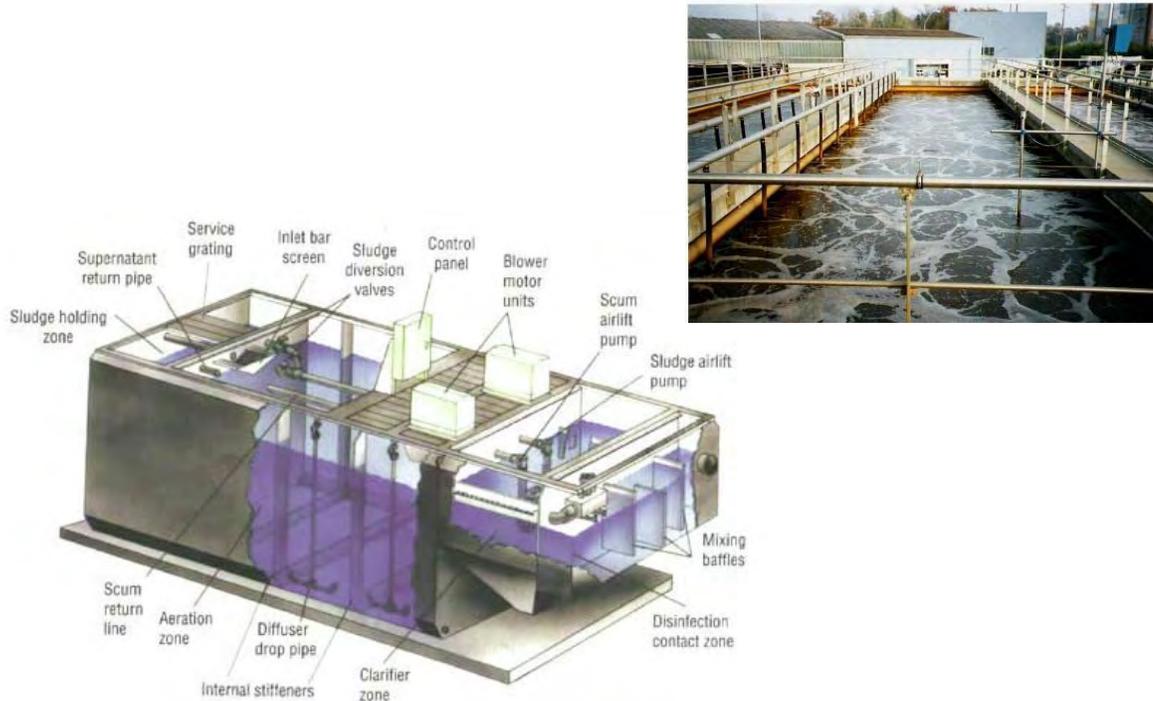
Descriptions of these treatment processes are provided below.

4.3.1 Activated Sludge/Extended Aeration

The activated sludge process, shown in Figure 1, is a biological treatment process. Raw screened wastewater is added to the activated sludge, and the mixture is aerated and agitated. After a certain amount of time, the activated sludge settles by sedimentation and is either disposed of (wasted) or reused (returned to the aeration tank).

A basic activated sludge process consists of several interrelated components: an aeration tank where the biological reactions occur; an aeration source, i.e. blowers and diffusers, that provides oxygen and mixing; a tank, known as the clarifier, where the solids settle and are separated from treated wastewater; and a means of collecting the solids either to return them to the aeration tank, (return activated sludge), or to remove them from the process (waste activated sludge).

Figure 1
Activated Sludge Process



Aerobic bacteria thrive as they travel through the aeration tank. They multiply rapidly with sufficient food and oxygen. By the time the waste reaches the end of the tank (between four to eight hours), the bacteria have used most of the organic matter to produce new cells. The organisms settle to the bottom of the clarifier tank, separating from the clearer water. This sludge is pumped back to the aeration tank as return activated sludge where it is mixed with the incoming wastewater. Excess biological growth is removed from the system as waste activated sludge. The relatively clear liquid above the sludge, the supernatant from the clarifier, is sent on for discharge or further treatment, e.g. filtration and/or ultraviolet disinfection, as required.

The extended aeration activated sludge process is a modified version of the activated sludge process described above. The extended aeration activated sludge process is designed to provide a much longer aeration period, e.g. 18 to 24 hours, for low organic loadings, thereby reducing the amount of sludge being wasted and requiring disposal. Air may be supplied by mechanical or diffused aeration. Mixing is by aeration or mechanical means.

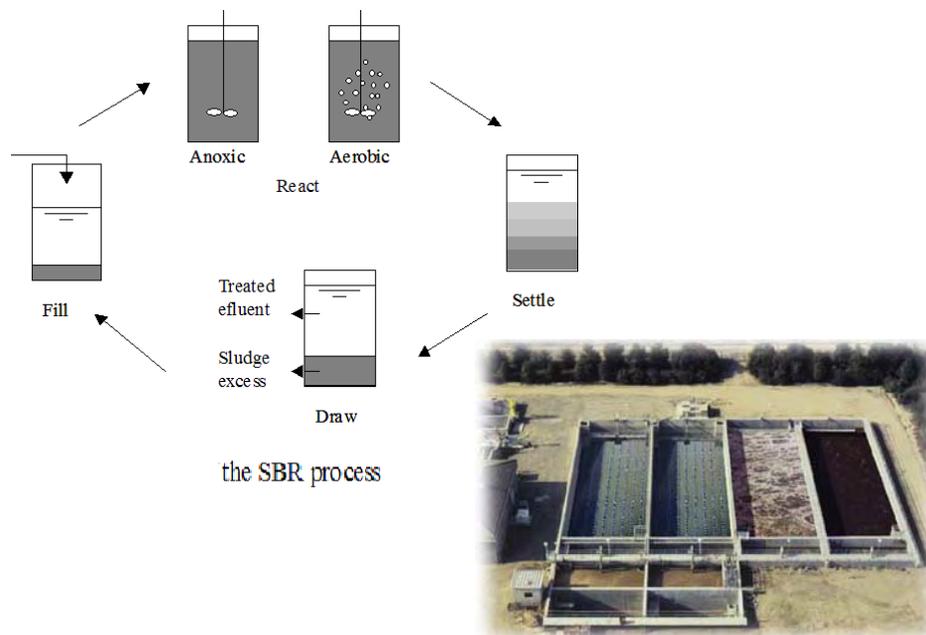
This process operates at a high solids retention time resulting in a condition where nitrification may occur. The micro-organisms compete for the remaining food and oxygen. This highly competitive situation results in a highly treated effluent with relatively low solids

production. The extended aeration process can accept periodic (intermittent) loadings without upsetting the system. The downsides include the potential for filamentous bacteria that make settling difficult, and therefore, can cause the process to fail to meet its discharge permit requirements.

4.3.2 Sequencing Batch Reactor

The process sequence for a sequencing batch reactor is a type of activated sludge process that involves a fill and draw activated sludge treatment system, where aeration and sedimentation/clarification are carried out sequentially in the same tank. The sequencing batch reactor process, shown in Figure 2, involves a series of five steps. The steps are as follows: (1) fill, (2) react (aeration), (3) settle (sedimentation), (4) draw (decant), and (5) idle.

Figure 2
Sequencing Batch Reactor Process



Sludge wasting in the sequencing batch reactor process typically occurs during the settle or idle steps. There is no need for a return activated sludge system because both aeration and settling occur in the same tank. Therefore, no sludge is lost in the reaction step, and no sludge has to be returned from the clarifier to maintain the sludge concentration in the aeration chamber. All wastewater that can be treated by conventional activated sludge process can be treated with the sequencing batch reactor. Filamentous bacteria, again, can be a problem, in some cases. The Duke Point Pollution Control Centre is a sequencing batch reactor treatment plant.

4.3.3 Rotating Biological Contactors

RBCs are made up of a series of closely spaced circular disks, such as those shown in Figure 3. The disks are partially submerged in wastewater and rotated slowly through it. The rotation of the disks and subsequent exposure to oxygen allows organisms to multiply and form a thin layer of biomass on the disks. As the disks rotate, they allow biomass to make contact with organic material in the wastewater and subsequently oxygen in the atmosphere. The rotating action also allows the biomass to maintain an aerobic condition. This large, active population of biomass causes the biological degradation of organic pollutants found in wastewater. Excess biomass shears off at a steady rate and is then carried through the rotating biological contactor system for removal in a clarifier (settling tank). The settled solids are wasted to a sludge treatment system, e.g. an aerobic digester.

The RBC process is quite reliable due to the large amount of biomass present (low food to micro-organisms ratio). The low food to micro-organisms ratio also allows the process to withstand hydraulic and organic surges. Energy costs are lower than for other aerobic treatment systems. Potential problems include mechanical failures of the disc support structures and drive failures.

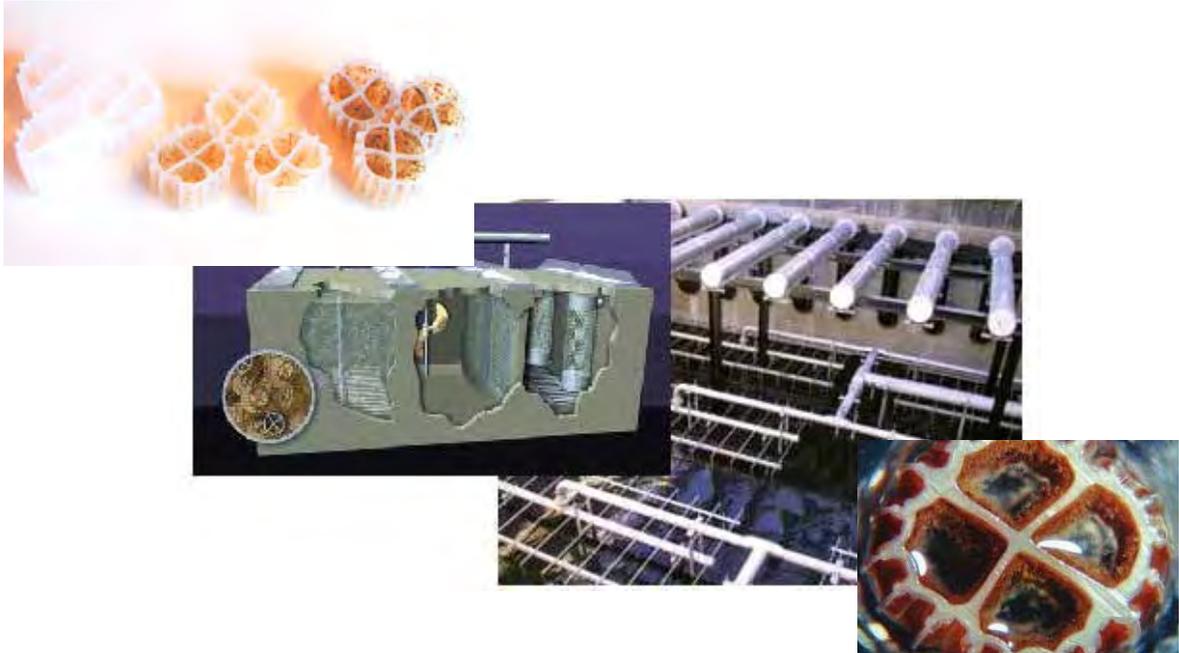
Figure 3
Rotating Biological Contactors



4.3.4 Moving Bed Bioreactors

The moving bed bioreactor process is an attached growth aeration process that uses a plastic ring media to optimize biomass growth within a fluidised bed. Figure 4 provides a schematic of the moving bed biological reactor. The biomass retained on a suspended plastic media provides effective treatment for the effluent. The media are kept in motion by coarse bubble aeration. The air introduced into the tank provides mixing and turnover of the media within the reactor. The media are physically separated from the flow going to the clarifier. Sludge treatment is similar to the rotating biological contactor process.

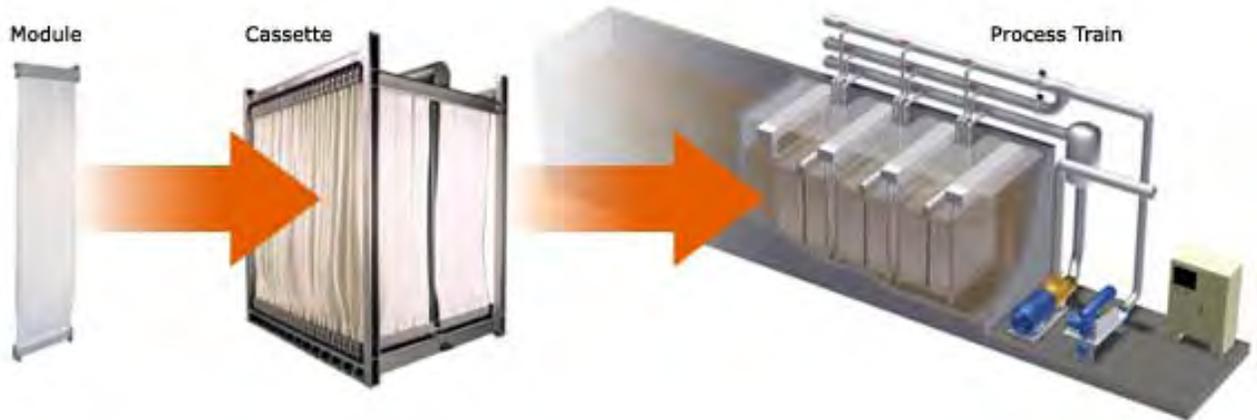
Figure 4
Moving Bed Biological Reactor



4.3.5 Membrane Bioreactors

A membrane bioreactor characterized by a suspended growth of biomass, similar to the activated sludge process but with a micro- or ultra-filtration membrane system that rejects particles and the biomass in the mixed liquor. Membrane bioreactors are composed of two primary parts, the biological unit responsible for the biodegradation of the waste compounds and the membrane filter (see Figure 5) for the physical separation of the treated water from mixed liquor.

Figure 5
Membrane Bioreactor



The membrane system replaces the traditional gravity sedimentation unit in the activated sludge process. The turbidity and suspended solids concentration of the effluent is far lower than in conventional treatment, e.g. less than 5 mg/L BOD and less than 5 mg/L TSS. Virtually all of the biomass is retained as activated sludge. Excess biological growth leaves the membrane bioreactor system as waste activated sludge. Due to the high quality of effluent produced and the higher cost of achieving that quality, membrane bioreactors are typically only used when there are water reuse applications either in place or planned.

Membrane bioreactors are also likely the best type of wastewater treatment for removal of endocrine disrupting chemicals and personal pharmaceutical care products because of the relatively long sludge ages in the membrane bioreactor process.

4.3.6 Treatment Technology Comparison

Table 1 provides a basic comparison of the different treatment technologies, based on capital cost, O&M costs, achievable effluent quality, and modular capabilities.

Table 1
Package Wastewater Treatment Technology Comparison

	Capital Cost	O&M Costs	Achievable Effluent Quality	Modular Capabilities
Activated Sludge/Extended Aeration	Low	Low-medium	<30 BOD/<30 TSS	Good – addition parallel units
Sequencing Batch Reactor	Low-medium	Low	<20 BOD/<20 TSS	Good - addition tankage in pairs
Rotating Biological Contactor	Lowest	Lowest	<45 BOD/<45 TSS	Good - addition parallel units
Moving Bed Biological Reactors	Medium-high	Medium	<20 BOD/<20 TSS	Good - addition additional tanks
Membrane Bioreactors	Highest	Highest	<10 BOD/<10 TSS	Good - addition more cassettes and/or more tanks

5 Summary

The RDN has policies in its LWMP to protect the integrity of the Region with regards to connection of new subdivisions and developer-installed package treatment plants. The RDN's LWMP supports the goals of the RDN's RGS by protecting rural areas from urban type development through the use of initiatives. This discussion paper has discussed RDN policies regarding new communities and developer-installed package treatment plants. It also discussed the implications of package treatment plants on the RDN's RGS and administrative issues the RDN should consider regarding ownership and operation of developer-installed package treatment plants.

Package treatment plants acquired and operated by the RDN could provide greater control and flexibility for servicing the Electoral Areas urban containment boundaries. However, this discussion paper identified several issues pertaining to the RDN taking ownership of privately-owned package sewage treatment systems inside the Urban Containment Boundary that would need to be addressed prior to considering and implementing policy changes.

6 References

Regional District of Nanaimo. Memorandum from Sean De Pol to John Finnie: Package Sewage Treatment Systems Review, January 24, 2008.

Regional District of Nanaimo. Environmental Services. Liquid Waste Management Plan – Stage 3 Report. November 1997. Available:

<http://www.rdn.bc.ca/cms/wpattachments/wpID1131atID1130.pdf>

Regional District of Nanaimo. Growth Management Plan Review: Issues Associated With the Plan's Land Use and Servicing Strategies. December 2001. Available:

<http://www.rdn.bc.ca/cms/wpattachments/wpID497atID440.pdf>

Regional District of Nanaimo. Regional Growth Strategy. January 1997. Available:

<http://www.rdn.bc.ca/cms/wpattachments/wpID436atID413.pdf>

DISCUSSION PAPER NO. 4

Regional District of Nanaimo Liquid Waste Management Plan Review and Amendments

Current Flows and Loads, Effluent Quality, and Treatment Plant Capacities

Issued: October 23, 2008
Previous Issue: September 18, 2008

1 Background

The Regional District of Nanaimo (RDN) is undertaking a review of its Liquid Waste Management Plan to determine if amendments to the plan are required at this time. As part of this work, discussion papers are being developed and circulated to the RDN Liquid Waste Advisory Committee for their input and comments. Previous discussion papers have reviewed existing conditions, on-site treatment issues, and policies regarding new communities and developer-installed treatment plants.

The purpose of this discussion paper is to compare existing wastewater flows to established wastewater treatment plant (WWTP) capacity, compare actual effluent quality to required effluent quality in permits or operational certificates, review remaining treatment plant capacity for additional service connections, and assess the need to increase capacity sooner than previously established milestones.

As presented in Discussion Paper No. 1 “Review of Existing Conditions” (Associated Engineering, 2007), the RDN’s Liquid Waste Management Department provides sewer servicing for the Greater Nanaimo, French Creek, Nanoose, and Duke Point Service Areas that serve the urban containment areas within the District. Wastewater is treated for each of these service areas by the Greater Nanaimo Pollution Control Centre (GNPCC), French Creek Pollution Control Centre (FCPCC), Nanoose Pollution Control Centre (NPCC), and Duke Point Pollution Control Centre (DPPCC), respectively.

Effluent quality and flow requirements for each treatment plant are outlined in operational certificates or permits. Draft operational certificates for all four of the District’s WWTPs were submitted to the Ministry of Environment (MoE) on October 29, 2001. Each operational certificate outlines maximum and average daily-authorized rates of discharge and the effluent quality characteristics of the discharge from the treatment plant. To date, the MoE has only approved the operational certificate for the DPPCC. The GNPCC, FCPCC, and NPCC await approval of their draft operational certificates and continue to operate under discharge permits.

2 Approach

The approach of this discussion paper was to assess the state of the District's four WWTPs with respect to current and future service provisions. For this study, influent and effluent quality data were provided by the RDN for 2005 through July 2008 for the GNPCC, FCPC, and DPPCC. Influent and effluent quality data were provided by the RDN for 2005 through June 2008 for the NPCC.

This discussion paper is organized by treatment facility and begins with an overview of the service areas for each WWTP, followed by a quantitative assessment of WWTP capacity and effluent quality. WWTP capacity was examined by comparing wastewater flows and calculated influent biochemical oxygen demand (BOD) loading and total suspended solids (TSS) loading for each WWTP. These flow and loading values were compared to discharge permits and/or operating certificates and relevant design criteria obtained from existing studies for each facility. Effluent quality was evaluated to determine plant performance and the potential for expansion of service area connections via a comparison of effluent BOD and TSS concentrations to the discharge characteristics outlined in the discharge permits and/or operating certificates for each WWTP.

3 Greater Nanaimo Pollution Control Centre

3.1 Service Area

The GNPCC provides preliminary and primary treatment of incoming raw wastewater from the Greater Nanaimo Service Area, which includes the City of Nanaimo Urban Area as defined by the Regional Growth Management Plan and the Lantzville Sewer Local Service Area; and possibly future Village Centres and problem areas in some or all of Electoral Area 'C'. Future sewer service in the Greater Nanaimo area could include the currently expanding development in Lantzville, First Nations lands (IR 2, 3, and 4), and the Sandstone Development in southeast Nanaimo.

3.2 Capacity Assessment

Previously in Discussion Paper No. 1, it was stated that the GNPCC was designed and constructed to process up to a maximum of 110,000 m³/d of flows of typical residential strength wastewater based on typical overflow rates. Based on a review of the effluent data, such flows might be optimistic unless upgrades are implemented. Current wastewater flows and influent BOD and TSS loading for 2005 to July 2008 are presented graphically in Figure 1, Figure 2, and Figure 3. A statistical summary of GNPCC influent and effluent quality is presented in Table 1.

Table 1
GNPCC Influent and Effluent Statistical Summary 2005 to July 2008

Statistical Parameter	Flow (m ³ /d)	Influent BOD Loading (kg/d)	Influent TSS Loading (kg/d)	Effluent BOD Concentration (mg/L)	Effluent TSS Concentration (mg/L)
Average	32,840	6,102	8,141	92	72
Minimum	25,100	1,553	159	17	22
Maximum	120,800	20,476	27,425	148	237
90 th Percentile	41,500	8,038	10,600	95	69

Design criteria for the GNPCC were inferred from the “Greater Nanaimo Water Pollution Control Centre Pre-design Stage III Expansion Phase 1 Report Draft No. 4” (Dayton & Knight, 1997). GNPCC wastewater flows are generally in compliance with dry weather design flow criteria. Peak flows are also generally below discharge permit requirements of 80,870 m³/d, with occasional exceedances resulting from significant wet weather events, i.e. December 3, 2007 and January 18 to 19, 2005. Influent BOD and TSS loadings are approaching and frequently exceeding the Stage 2 design criteria. BOD and TSS influent loadings shown in Figures 2 and 3, respectively, suggest that without facility upgrades, additional connections to the service area in the future could significantly affect overall treatment performance.

3.3 Effluent Quality

The discharge permit for the GNPCC was issued June 2, 1994. The plant operates according to the permit, which specifies the maximum authorized rate of discharge as 80,870 m³/d. The characteristics of the discharge shall be equivalent to or better than: 5-day BOD - 130 mg/L and TSS - 130 mg/L. The Draft Operational Certificate, submitted to the MoE for approval in 2001, specifies the maximum authorized rate of discharge as 160,000 m³/d. The characteristics of the discharge shall be equivalent to or better than: 5-day BOD - 130 mg/L, TSS - 130 mg/L, and pH - 6-9 pH units. The preamble for the Draft Operational Certificate specifies that the GNPCC will be required to upgrade to full secondary treatment by 2015.

Comparisons of GNPCC effluent BOD and TSS concentrations to discharge permit and draft operational certificate values for 2005 through July 2008 are presented in Figure 4 and Figure 5.

Effluent BOD and TSS concentrations for the GNPCC are typically in compliance for the discharge permit and draft operational certificate. A distinct cyclical trend in BOD and TSS concentrations is clearly shown in Figures 4 and 5 for effluent BOD and TSS, respectively. This trend, which is more pronounced for GNPCC effluent TSS concentrations, is a result of seasonal variations in wet

weather flow characterized by the climate in the Pacific Northwest. In general, more concentrated wastewater is observed during the drier summer months whereas less concentrated wastewater is observed during the winter months when stormwater dilutes the wastewater. To improve the TSS effluent quality during the summer months at GNPCC, chemically enhanced primary treatment or CEPT is used to enhance removal of suspended material from the effluent via settling.

Although GNPCC effluent quality is generally in compliance with discharge permits, BOD and TSS concentrations are relatively high in the summer months compared to the winter months. Additional connections and population growth increases within the Greater Nanaimo Service Area suggest that enhancements in treatment capacity of the GNPCC will be required.

3.4 Summary

- GNPCC wastewater flows are generally in compliance with Stage 2 design criteria and discharge permits during dry weather flow. During wet weather events, discharge permit requirements are occasionally exceeded.
- GNPCC influent BOD and TSS loadings have approached the design criteria, with frequent exceedances of these criteria.
- GNPCC effluent BOD and TSS concentrations are generally in compliance with discharge permit requirements. Effluent BOD and TSS concentrations are approaching these limits, with the potential for more frequent exceedances, particularly during the summer months when wastewater is more concentrated.
- Wet weather wastewater flows are approaching permit requirements and influent BOD and TSS loadings are approaching (and in many instances are exceeding) plant design criteria demonstrating that the plant is approaching the limits of its current design. Interim treatment solutions have been implemented to maintain effluent BOD and TSS permit requirements; without upgrades to the facility, additional service connections will not be accommodated without increased potential to compromise the effluent quality. Continued use of CEPT is recommended until such upgrades are implemented.
- Upgrading to secondary treatment should occur no later than 2015.

4 French Creek Pollution Control Centre

4.1 Service Area

The FCPCCC provides preliminary, primary, and secondary treatment of incoming wastewater from the French Creek Service Area. The French Creek Service Area includes the Town of Qualicum Beach, the French Creek Sewer Local Service Area, Surfside, Barclay Crescent, Pacific Shores, and the City of Parksville, and possibly future Village Centres and problem areas in Electoral Areas 'F', 'G', and 'H'. Potential future sewer service in the French Creek area may include the Church Road Transfer Station and surrounding area, proposed expansion in the Surfside/Dashwood Area, and possibly Coombs Village Area, Madrona, and Wall Beach.

4.2 Capacity Assessment

The FCPCC was designed and constructed to process up to a maximum daily flow of 16,000 m³/d of typical residential strength wastewater. The FCPCC is currently at “Stage 3” of its development. “Stage 3” is an improvement on Stage 2 and is an interim step between Stage 2 and Stage 4. However, “Stage 3” is not as elaborate as had been originally envisioned by Dayton & Knight in 1993.

Wastewater flows and influent BOD and TSS loading for 2005 to July 2008 are presented graphically in Figure 6, Figure 7, and Figure 8, respectively. A statistical summary of FCPCC influent and effluent quality is presented in Table 2.

Table 2
FCPCC Influent and Effluent Statistical Summary 2005 to July 2008

Statistical Parameter	Flow (m ³ /d)	Influent BOD Loading (kg/d)	Influent TSS Loading (kg/d)	Effluent BOD Concentration (mg/L)	Effluent TSS Concentration (mg/L)
Average	9,090	1,569	2,860	9	22
Minimum	6,330	775	903	2	5
Maximum	18,872	4,374	9,963	37	96
90 th Percentile	10,727	2,087	3,849	14	36

Design criteria for the FCPCC were based on Stage 2 design flows and loads (Dayton & Knight, 1993). FCPCC wastewater flows currently exceed the Stage 2 average annual flow design criteria. These wastewater flows generally do not exceed the discharge permit, but occasional exceedances resulted from significant wet weather events, i.e. December 3, 2007 and January 19, 2005. Influent BOD loadings are generally above the Stage 2 design criteria, while influent TSS loadings are well-above the Stage 2 design criteria. Wastewater flows and TSS loading results suggest that additional connections made to the service area in the future could further affect overall treatment performance. Stage 3 upgrades to FCPCC are currently on-going, which consist of interim upgrading strategies to prolong the useful life of the existing Stage 2 capital infrastructure.

4.3 Effluent Quality

The discharge permit for the FCPCC was issued July 10, 1990. The plant operates according to the permit, which specifies the maximum authorized rate of discharge to Strait of Georgia as 16,000 m³/d. The maximum authorized rate of discharge to Morningstar Golf Course is 1,370 m³/d. The characteristics of the discharge to the Strait of Georgia shall be equivalent to or better than:

5-day BOD - 45 mg/L and TSS - 60 mg/L. The characteristics of the discharge to the Morningstar Golf Course shall be equivalent to or better than: 5-day BOD - 20 mg/L and TSS - 30 mg/L. The Draft Operational Certificate, submitted to the MoE in 2001 for approval, specifies the maximum authorized rate of discharge to Strait of Georgia as 25,300 m³/d and the maximum authorized rate of discharge to Morningstar Golf Course as 1,370 m³/d. The characteristics of the discharge to the Strait of Georgia shall be equivalent to or better than: 5-day BOD - 45 mg/L, TSS - 45 mg/L, and pH - 6-9 pH units. The characteristics of the discharge to the Morningstar Golf Course shall be equivalent to or better than: 5-day BOD - 20 mg/L, TSS - 30 mg/L, and pH - 6-9 pH units.

Comparisons of FCPCC effluent BOD and TSS concentrations to discharge permit and draft operational certificate values for 2005 through July 2008 are presented in Figure 9 and Figure 10, respectively.

Effluent BOD and TSS concentrations for the FCPCC are in general compliance for the discharge permit and draft operational certificate, with values typically below the Morningstar Golf Course effluent requirements. Effluent BOD concentrations were consistently below the permit requirements for the Strait of Georgia. Effluent TSS concentrations exceeded the allowable discharge permit for the Strait of Georgia for a short period in September and October 2007, during aeration upgrades to the solids contact tanks. Stage 3 interim facility upgrades are currently in progress, with Stages 4 and 5 consisting of major facility changes and upgrades recommended for completion by 2012 and 2025, respectively (Associated Engineering, 2006).

Additional connections and population growth increases within the French Creek Service Area could impact the treatment capacity of the FCPCC unless something significant is done to decrease wet weather flows, i.e., infiltration and inflow (I&I) reduction, and reduce influent TSS. In the interim, stress testing of the trickling filter/solids contact tanks could be used to estimate remaining potential capacity.

4.4 Summary

- FCPCC wastewater flows currently exceed the Stage 2 design criteria, but are within discharge permit requirements. Improvements to Stage 2 have been made to help accommodate this situation.
- FCPCC influent BOD and TSS loadings currently exceed the Stage 2 design criteria.
- FCPCC effluent BOD and TSS concentrations are generally in compliance with discharge permit requirements.
- Wastewater flows, influent BOD and TSS loadings demonstrate that additional connections from the French Creek Service Area are becoming less feasible. Recent facility upgrades have improved effluent quality but additional service connections could place additional hydraulic stress on the treatment system.
- Reduction of I&I and influent TSS is required.
- Stress testing of the trickling filter/solids contact tanks could be used to estimate remaining potential capacity.

- Planning for the 2012 Stage 4 upgrades should not be delayed.

5 Nanoose Pollution Control Centre

5.1 Service Area

The NPCC provides preliminary and primary treatment of incoming raw wastewater from the Nanoose Service Area. The Nanoose Service Area includes the Fairwinds Development, and the Delanice Way, Beachcomber, Dolphin Drive, Garry Oaks, and Red Gap areas. Other future areas, to be identified in the Official Community Plan (OCP) updating process, may be included in the future.

5.2 Capacity Assessment

The NPCC was designed and constructed to process up to 2,270 m³/d of wastewater as per discharge permit. Wastewater flows and influent BOD and TSS loading for 2005 to July 2008 are presented graphically in Figure 11, Figure 12, and Figure 13. A statistical summary of GNPCC influent and effluent quality is presented in Table 3.

Table 3
NPCC Influent and Effluent Statistical Summary 2005 to June 2008

Statistical Parameter	Flow (m ³ /d)	Influent BOD Loading (kg/d)	Influent TSS Loading (kg/d)	Effluent BOD Concentration (mg/L)	Effluent TSS Concentration (mg/L)
Average	247	62	70	89	70
Minimum	104	5	15	46	23
Maximum	554	352	308	162	114
90 th Percentile	297	108	109	129	97

Design criteria for the NPCC were based on the “Optimization of the Nanoose Bay Water Pollution Control Centre” (Associated Engineering, 2002). NPCC wastewater flows are well below the design criteria and permit requirements. Influent BOD and TSS loadings are generally below the design criteria, with more frequent exceedances observed during the end of 2007 and 2008 monitoring period. Given the relatively low flows to NPCC, the BOD and TSS loadings are more frequently exceeding the design criteria for the plant. The BOD and TSS influent loading results suggest that additional connections to the service area could significantly affect overall treatment performance unless some improvements are made.

5.3 Effluent Quality

The discharge permit for the NPCC was issued March 8, 1988. The plant operates according to the permit, which specifies the maximum authorized rate of discharge as 2,270 m³/d. The characteristics of the discharge shall be equivalent to or better than: 5-day BOD - 100 mg/L and TSS - 100 mg/L. The Draft Operational Certificate, submitted to the MoE in 2001 for approval, specifies the maximum authorized rate of discharge as 2,260 m³/d. The characteristics of the discharge shall be equivalent to or better than: 5-day BOD - 130 mg/L, TSS - 130 mg/L, and pH - 6-9 pH units.

Comparisons of NPCC effluent BOD and TSS concentrations to discharge permit and draft operational certificate values for 2005 through June 2008 are presented in Figure 14 and Figure 15, respectively.

Effluent BOD concentrations for the NPCC are generally in compliance with the discharge permit, with more frequent discharge permit exceedances observed in 2008. Effluent TSS concentrations for the NPCC are in compliance with the discharge permit. At this time, it is not clear whether or not issues related to an on-site sludge holding tank and its influence on effluent BOD quality have been resolved. It is noted that chemically enhanced treatment using alum and polymer has been implemented recently.

5.4 Summary

- NPCC wastewater flows are currently below design capacity and within the discharge permit requirements.
- Influent BOD and TSS loadings are generally below the design criteria, with more frequent exceedances observed during the end of 2007 and 2008 monitoring period.
- NPCC effluent BOD loadings are generally in compliance with the discharge permit, with more frequent permit exceedances observed in 2008. NPCC effluent TSS loadings are in compliance with the discharge permit.
- Wastewater flows and influent BOD and TSS loadings generally well below design capacity demonstrate that additional connections from the Nanoose Service Area could be accommodated. However, recent observed increases in influent BOD and TSS loadings, particularly loadings above the plant design criteria, must be taken into account if additional connections are to be considered for the NPCC.
- If the influence of the sludge tank cannot be mitigated, it will become increasingly necessary to continue to use enhanced primary treatment or secondary treatment sooner than originally planned.

6 Duke Point Pollution Control Centre

6.1 Duke Point Service Area

The DPPCC provides preliminary and secondary treatment of incoming wastewater from the Duke Point Service Area. The Duke Point Service Area includes the industrial development at Duke Point, and possibly future Village Centres and problem areas within Electoral Area 'A' that require community sewers. Future sewer service in the Duke Point area will include Cedar Village (sewer servicing currently under construction), and possibly future connection from Cable Bay Lands.

6.2 Capacity Assessment

The DPPCC plant is designed and constructed to process up to 910 m³/d of typical residential strength wastewater. Wastewater flows and influent BOD and TSS loading for 2005 to July 2008 are presented graphically in Figure 16, Figure 17, and Figure 18. A statistical summary of DPPCC influent and effluent quality is presented in Table 4.

Table 4
DPPCC Influent and Effluent Statistical Summary 2005 to July 2008

Statistical Parameter	Flow (m ³ /d)	Influent BOD Loading (kg/d)	Influent TSS Loading (kg/d)	Effluent BOD Concentration (mg/L)	Effluent TSS Concentration (mg/L)
Average	19	32	3	17	14
Minimum	6	0.1	0.1	1	1
Maximum	231	1,756	278	854	101
90 th Percentile	29	48	5	23	28

Design criteria for the DPPCC were based on the "Duke Point Water Pollution Control Centre Process Operation and Maintenance Manual" (Goronszy, 1998). DPPCC wastewater flows are well below the design and discharge values. Influent BOD and TSS loadings are also typically well below the design criteria, with only a few values that exceed the design values. DPPCC flow values and influent BOD and TSS loadings well below the design criteria demonstrate that there is capacity at the DPCC for additional connections for the service area.

6.3 Effluent Quality

The operational certificate (ME-05989) for the DPPCC was approved August 12, 2004. The maximum authorized rate of discharge is 1,800 m³/d. The characteristics of the discharge shall be

equivalent to or better than: 5-day BOD - 30 mg/L, TSS - 30mg/L, and pH - 6-9 pH units, and Fecal Coliform Bacteria - 1000 colonies/100 mL.

Comparisons of DPPCC effluent BOD and TSS concentrations to operational certificate values for 2005 through July 2008 are presented in Figure 19 and Figure 20, respectively.

Effluent BOD and TSS concentrations for the DPPCC are generally in compliance with the operational certificate. The operational certificate requirements for BOD and TSS were occasionally exceeded during the study period. These certificate exceedances were likely a consequence of unscheduled upstream industrial wastewater discharges to DPPCC that resulted in the disruption of biological activity, i.e., secondary effluent treatment, at the facility. Impacts to the biological activity would result in the observed increase in BOD and TSS concentrations observed in the DPPCC effluent. It is imperative that such activities do not occur in the future. This might require enforcement of a source control bylaw.

6.4 Summary

- DPPCC wastewater flows are in compliance with the design criteria.
- DPPCC influent BOD and TSS loadings are generally in compliance with the design criteria, with only a few loadings that exceeded these values.
- DPPCC effluent BOD and TSS concentrations are generally in compliance with operational certificate requirements. Occasional exceedances of certificate requirements are the result of a disruption in biological activity caused by upstream industrial discharges.
- Wastewater flows and influent BOD and TSS loadings well below design capacity and high quality effluent BOD and TSS concentrations demonstrate the feasibility for additional connections in the Duke Point Service Area.

7 Overall Summary

Greater Nanaimo Pollution Control Centre

- GNPCC wastewater flows are generally in compliance with Stage 2 design criteria and discharge permits during dry weather flow. During wet weather events, discharge permit requirements are occasionally exceeded.
- GNPCC influent BOD and TSS loadings have approached the design criteria, with frequent exceedances of these criteria.
- GNPCC effluent BOD and TSS concentrations are generally in compliance with discharge permit requirements. Effluent BOD and TSS concentrations are approaching these limits, with the potential for more frequent exceedances, particularly during the summer months when wastewater is more concentrated.
- Wet weather wastewater flows are approaching permit requirements and influent BOD and TSS loadings are approaching (and in many instances are exceeding) plant design criteria demonstrating that the plant is approaching the limits of its current design. Interim treatment solutions have been implemented to maintain effluent BOD and TSS permit

requirements; without upgrades to the facility, additional service connections will not be accommodated without increased potential to compromise the effluent quality. Continued use of CEPT is recommended until such upgrades are implemented.

- Upgrading to secondary treatment should occur no later than 2015.

French Creek Pollution Control Centre

- FCPCC wastewater flows currently exceed the Stage 2 design criteria, but are within discharge permit requirements. Improvements to Stage 2 have been made to help accommodate this situation.
- FCPCC influent BOD and TSS loadings currently exceed the Stage 2 design criteria.
- FCPCC effluent BOD and TSS concentrations are generally in compliance with discharge permit requirements.
- Wastewater flows, influent BOD and TSS loadings demonstrate that additional connections from the French Creek Service Area are becoming less feasible. Recent facility upgrades have improved effluent quality but additional service connections could place additional hydraulic stress on the treatment system.
- Reduction of I&I and influent TSS is required.
- Stress testing of the trickling filter/solids contact tanks could be used to estimate remaining potential capacity.
- Planning for the 2012 Stage 4 upgrades should not be delayed.

Nanoose Pollution Control Centre

- NPCC wastewater flows are currently below design capacity and within the discharge permit requirements.
- Influent BOD and TSS loadings are generally below the design criteria, with more frequent exceedances observed during the end of 2007 and 2008 monitoring period.
- NPCC effluent BOD loadings are generally in compliance with the discharge permit, with more frequent permit exceedances observed in 2008. NPCC effluent TSS loadings are in compliance with the discharge permit.
- Wastewater flows and influent BOD and TSS loadings generally well below design capacity demonstrate that additional connections from the Nanoose Service Area could be accommodated. However, recent observed increases in influent BOD and TSS loadings, particularly loadings above the plant design criteria, must be taken into account if additional connections are to be considered for the NPCC.
- If the influence of the sludge tank cannot be mitigated, it will become increasingly necessary to continue to use enhanced primary treatment or secondary treatment sooner than originally planned.

Duke Point Pollution Control Centre

- DPPCC wastewater flows are in compliance with the design criteria.
- DPPCC influent BOD and TSS loadings are generally in compliance with the design criteria, with only a few loadings that exceeded these values.

- DPPCC effluent BOD and TSS concentrations are generally in compliance with operational certificate requirements. Occasional exceedances of certificate requirements are the result of a disruption in biological activity caused by upstream industrial discharges.
- Wastewater flows and influent BOD and TSS loadings well below design capacity and high quality effluent BOD and TSS concentrations demonstrate the feasibility for additional connections in the Duke Point Service Area.

8 Final Summary

- GNPCC needs to continue to use CEPT as needed and move to secondary treatment on the existing 2015 schedule.
- FCPCC is approaching capacity, planning for Stage 4 upgrades and improvements for 2012 should proceed.
- NPCC should continue to implement CEPT or consider a move towards secondary treatment.
- DPPCC is likely fine for many years if industrial discharges are kept in compliance and there are not substantial increases to the DPPCC service area / population.

9 References

- 1 Associated Engineering. Discussion Paper No. 1: Review of Existing Conditions. February 2008.
- 2 Dayton & Knight. Report. Greater Nanaimo Water Pollution Control Centre Pre-Design Stage III Expansion Phase I Report. Draft No. 4. May 1997.
- 3 Dayton & Knight. Report. Stage 2 Pre-Design: French Creek Water Pollution Control Centre – Phase 2 Report. January 1993.
- 4 Associated Engineering. Report. French Creek Pollution Control Centre Performance Evaluation and Upgrading Plan Update. December 2006.
- 5 Associated Engineering. Report. Optimization of the Nanoose Bay Water Pollution Control Centre. January 2002.
- 6 Goronszy, M. C. Manual. Duke Point Water Pollution Control Centre Process Operation and Maintenance Manual. February 1998.



ENVIRONMENTAL SERVICES

LIQUID WASTE MANAGEMENT PLAN REVIEW AND AMENDMENT DISCUSSION PAPER #5

SOURCE CONTROL PROGRAM



August 2008

1.0 Background

The Regional District of Nanaimo (RDN) is reviewing the 1997 Liquid Waste Management Plan (LWMP) to determine if amendments to the plan are required. As part of the review, discussion papers have been prepared and submitted to the Liquid Waste Advisory Committee for comment and discussion.

The LWMP review offers a unique opportunity to re-evaluate the source control program at the RDN. Options include abandoning the program, maintaining status quo, or making a series of improvements to render the program more effective and/or rigorous. The objective of the paper is to provide material for discussion in order to answer the following question:

What changes, if any, should be made to the RDN's source control program?

This discussion paper provides an overview of the components of a source control program, the RDN's current program, a case study of the program at the Capital Regional District and concludes with recommendations for the RDN's future program.

In effect, the RDN's source control program should work to improve the quality of influent, effluent and biosolids while reducing the resources (energy, chemical and financial) required to treat wastewater. Furthermore, a source control program supports the Liquid Waste Department's environmental mandate and ISO 14001 Environmental Management System.

2.0 Source Control Programs

Source control programs are recognized as an economical and effective way to influence the quantity and quality of wastewater to be treated. At its core, a source control program is a pollution prevention strategy that works to reduce or eliminate contaminants that enter the wastewater stream. It can be a suite of practices, methods, and/or technologies targeted at industry, institutions, businesses and households who discharge wastewater into the sanitary sewer system. It is widely accepted that the general goals of a source control program are to¹:

1. Protect the environment.
2. Protect the health and safety of workers and the public.
3. Protect existing infrastructure and the wastewater treatment process.
4. Protect the quality of biosolids.

Generally, to achieve these goals, a source control program focuses on 2 elements:

¹ For example, see: Natural Resources Canada. March 2003. Wastewater Source Control: A Best Practice By The National Guide To Sustainable Municipal Infrastructure. National Guide to Sustainable Municipal Infrastructure. Issue No.10. Chapter 2: pp. 2-4.
Or, Capital Regional District. 2008. Source Control Program Goals. Available at:
<http://www.crd.bc.ca/wastewater/sourcecontrol/goals.htm>

1. A *sewer use bylaw* that regulates how the sewer system may be used.
2. An *education component* designed to generate awareness about the proper uses of the sanitary sewer system.

Regulations Governing Source Control Programs

Although source control is considered an aspect of the LWMP in the Ministry of Environment's guidelines for the development of LWMPs², there are no strict provincial requirements for the design, implementation or operation of a municipal source control program.

However, in S.20(3) of the *Municipal Sewage Regulation*³, the Ministry of Environment states that a municipality cannot accept discharge of non-domestic waste into the municipal sewage collection system unless the municipality has a source control bylaw, or the equivalent, in place. A source control bylaw must include provisions for pre-treatment of industrial, commercial and institutional discharges into the sewer system. It must also contain pre-treatment requirements to ensure that the final discharge of effluent meets pre-determined standards and that the quality of biosolids meet the requirements of any authorization given under the *Municipal Sewage Regulation*. Further, under reporting requirements (S.28(7a)) an update of the previous year's achievements relating to source control should be reported in the annual monitoring report.

Quantifying Success of a Source Control Program

The first step in developing a source control program is the identification of contaminants that adversely affect the quality of influent, effluent and biosolids. Commonly, measures of BOD₅⁴, TSS⁵, pH, metal content (eg. Mercury) and quantities of oils and grease, can determine the success of a source control program. Success is measured by a quantifiable decrease in the quantity and quality of contaminants entering and processed in the wastewater stream. Often the effects of a targeted education campaign, or outreach effort, are correlated with the perceptible decrease in a particular contaminant.

Further, a bylaw serves as a regulatory tool that sets parameters around sewer use, penalties for misuse, and instances where discharge into the municipal sewer system requires a permit or authorization. In some jurisdictions, an annual evaluation of permits/authorizations granted, rates of compliance, and number of fines issued is also used to gauge success.

² See: Government of British Columbia, Ministry of the Environment. 2008. Guidelines for Developing a Liquid Waste Management Plan. Available online at: <http://www.env.gov.bc.ca/epd/epdpa/mpp/gfdalwmp.html>

³ Government of British Columbia, Ministry of the Environment. 2006. Municipal Sewage Regulation. http://www.qp.gov.bc.ca/statreg/reg/E/EnvMgmt/129_99.htm

⁴ BOD₅: Biochemical Oxygen Demand is a measure of the quantity of oxygen consumed by microorganisms to break down organic matter in water. A high BOD means that there will be less oxygen and results in contamination of the receiving environment.

⁵ TSS: Total Suspended Solids are solid pollutants that would be captured on a fine filter paper. High concentrations can cause problems for aquatic life.

3.0 RDN's Programs and Commitments

The RDN covers an area of approximately 2,035 km² with a population of roughly 138,630 people. Between 2001 and 2006 the Region grew by 9.1%⁶. The sewer service population currently is 83,661 for Greater Nanaimo and 24,483 for French Creek. It is anticipated that the RDN's population will continue to increase, in all areas, by an average of 2% per year into the future.

Relative to other jurisdictions, the RDN has little in the way of heavy industry. Levels of metals, as well as the quality of influent, effluent and biosolids, are consistently within and below permit levels. As the 2007 monitoring report for the French Creek Pollution Control Centre illustrates, BOD₅ levels were well below the permit level of 45 mg/L for discharges to the Georgia Strait and below the limit of 20mg/L for the Morningstar Golf Course. In 2007 the average annual reduction from influent to effluent was 95% for BOD₅ and 92% for TSS. Low levels of Aluminum, Barium, Boron, Iron, Manganese, and Zinc were detected in effluent but these were attributed to naturally occurring levels in the municipal water supply. Finally, independent testing shows that influent levels of oil and grease were 17 mg/L but was <2 in effluent. Biosolids quality continued to meet the Ministry of Environment standards for class 'A' biosolids.⁷

Similarly, the 2007 monitoring report for the Greater Nanaimo Pollution Control Centre shows that average daily BOD₅ levels were 86 mg/L, below permit levels of 130 mg/L. Likewise TSS averaged 73 mg/L, below permit levels of 130 mg/L. The average annual reduction from influent to effluent was 54% for BOD₅ and 74% for TSS. Independent testing shows that influent levels of oil and grease was 34 mg/L. Biosolids generated by GNPCC contained concentrations of metals and fecal coliforms but still met the standards for Class "B" biosolids. However, volatile and semi-volatile compounds (4) were detected in effluent samples.⁸

Taken together, numbers from French Creek and Greater Nanaimo indicate relatively low levels of contaminants in influent, effluent and biosolids. Regardless, source control commitments were made in the 1997 LWMP. From this several source control strategies have been implemented.

Source Control Program Highlights 1997-2008

In the 1997 LWMP the following commitments were made:

1. Preparation and adoption of a district sewer use bylaw.
2. Development of an educational program to support the bylaw designed for rural and urban residents, both at home and in work places.

As a first step, the LWMP recommended that a cost benefit study be used to evaluate and prioritize objectives for the RDN's source control program. Results from this study suggested that the implementation of a source control program would yield the following benefits for the RDN:

⁶ Statistics Canada. 2008. Community Profiles. Available online at: statscan.ca

⁷ Regional District of Nanaimo, Liquid Waste Management. 2007. French Creek Pollution Control Centre Annual Monitoring Report.

⁸ Regional District of Nanaimo, Liquid Waste Management. 2007. Greater Nanaimo Pollution Control Centre Annual Monitoring Report.

- Reduced sewer maintenance costs and prevention of maintenance problems,
- Reduced treatment plant operation costs and prevention of plant upsets,
- Protection and improvement of effluent and biosolids quality,
- Protection and improvement of receiving environment quality,
- Prevention of public/worker health and safety concerns near sewers and in the treatment plants,
- Cost savings for individual operations due to lower water/energy/materials consumption, product recovery, etc.
- Tax savings as a result of 'user pay' approach (i.e. high strength waste surcharge fees), and
- Equitable treatment of businesses with respect to sewer discharge requirements.⁹

In 1998 the RDN contracted a firm to investigate an inventory model for non-domestic discharges to the sewer collection system in the French Creek area. Outcomes of this study identified contaminants discharged into the sewer system from 5 particular sectors: automotive, metal industries, printing and photoprocessing, food manufacturing, and drycleaners. This study recommended that an analysis of sewer discharge be undertaken in order to determine the most effective regulatory and education programs for wastewater contaminant reduction.

Bylaw No. 1225

On March 12th, 2002, the current sewer use Bylaw was introduced and subsequently adopted. The Bylaw places limits on the release of conventional contaminants (BOD₅, oil and grease, TSS), organic contaminants (such as polycyclic aromatic hydrocarbons (PAHs)), inorganic contaminants (metals), food waste, radioactive waste, pH waste, dyes, and other restricted wastes (such as Polychlorinated biphenyls (PCBs)) into the sewer system¹⁰. It also defines the powers of the manager to issue permits and authorizations, sets out requirements for the monitoring of discharges and maintenance of discharge records, and outlines possible consequences in instances of non-compliance. The Bylaw also includes an "Application for Waste Discharge Permit". Contravention of the Bylaw can result in a fine that does not exceed \$10,000, that may be imposed for each day on or during which an offence occurs or continues to occur. However, the strength of the Bylaw is undermined by the lack of enforcement capacity of the Liquid Waste Department to enforce instances of non-compliance using, for example ticketing or a Bylaw Enforcement Officer. Despite this, in 2008, two permits were issued under the Bylaw.

Education/Outreach

In 2001, an outreach and educational campaign directed at dentists resulted in a discernable decrease in the mercury levels in the wastewater stream. Between 2003 and 2007 there was a 71% reduction in mercury concentration in biosolids and a 95.5% reduction in mercury in effluent.

⁹ Cielanga, N. 2000. Memorandum to Dennis Trudeau. Correspondence within Regional District of Nanaimo.

¹⁰ Regional District of Nanaimo. 2002. Bylaw No. 1225: A Bylaw to Regulate the Discharge of Waste Into All Sewers Connected to Sewage Facilities Operated by the Regional District of Nanaimo. Available at: <http://www.rdn.bc.ca/cms/wpattachments/wpID1162atID1491.pdf>

Beginning in 2003, pamphlets were created to promote responsible residential sewer use. Materials developed included the pamphlets "Garburators – Why Not to Use", "Food Services Sewer Discharge Requirements" and "Business Sector's Guide to Responsible Wastewater Reduction". Each pamphlet describes aspects of wastewater processing, effects of improper sewer use and outlines alternatives. The 2007 Annual Monitoring Report for both French Creek and Greater Nanaimo facilities states that these pamphlets were mailed to all food services providers in the District.

These outreach campaigns have been complimented by open houses at the French Creek and Greater Nanaimo facilities. These have allowed the public to develop first hand knowledge of the wastewater processing systems and the effects of sewer use in the RDN. The next open house will be held in October or November of this year.

Education and outreach programs at the RDN are continually reviewed and updated. For example, the Liquid Waste Department's website has a link to a page that describes source control as a means to protect the environment and sewer infrastructure¹¹. This site links to the page "Be Sewer Smart At Home!" that outlines responsible sewer use for residential users, including tips as to what should not be put down the drain¹². Included on both sites is contact information for local hazardous waste disposal sites. Finally, in preparation is a water use awareness outreach program through the Utility Department's Water Smart program and a Septic Education Program, designed for rural communities, that is being developed by the Liquid Waste Department.

Taken together, the Bylaw and current source control initiatives form a firm foundation for a source control program at the RDN. Recognizing that there exists concerns about the marine environment at outfall sites and taking into consideration future demands on the system and the need to preserve current and future infrastructure, the RDN is in an excellent position to adapt and integrate elements from other jurisdictions/municipalities to enhance the effectiveness of their source control program.

4.0 Case Study: CRD

A regional scan suggests few other jurisdictions have adopted pro-active source control programs, with the exception being the Capital Regional District (CRD) and, in some respects, Metro Vancouver. Although the size of other regional districts precludes the need to develop rigorous source control programs, the RDN, as a mid-sized district, has the opportunity to evaluate and adopt aspects of the CRD's program that are most suited to the needs of the facilities and population in the RDN.

The CRD is considered to have one of the most progressive source control programs in the province. Though the CRD operates five wastewater treatment facilities, the two facilities that serve the core area (Clover Point and Macaulay Point) have only preliminary treatment that screen objects larger than 6 millimeters prior to discharge, through outfall, into the Strait of Juan De Fuca. Consequently, the CRD has developed a rigorous source control program. Although the CRD's program relies on two distinct components - regulation and education/outreach - emphasis is placed on a comprehensive system of regulation, enforcement and monitoring. The impetus for the development of this program was driven by the need to protect the effluent and biosolids quality at the Saanich Peninsula Wastewater Treatment Plant, a secondary treatment facility.

¹¹ See: Regional District of Nanaimo, Liquid Waste Department. 2008. Source Control. Available at: <http://www.rdn.bc.ca/cms.asp?wpID=1161>

¹² See: Regional District of Nanaimo, Liquid Waste Department. 2008. Be Sewer Smart At Home. Available through: www.rdn.bc.ca.

Regulatory Tools

The CRD's regulatory program evolved out of a sewer use bylaw adopted in 1994 and has developed into a system based on codes of practice, authorizations, and permits targeted at industrial, commercial, and business users.

Codes of practice (COPs) are regulatory documents with mandatory sanitary sewer discharge standards for specific industrial, institutional, or commercial sectors¹³. Included among the codes are requirements of the installation of works, such as grease traps in the food sector. Currently, three compliance officers inspect 20% of the approximately 2,200 permitted businesses per year, representing 11 sectors¹⁴. Drawbacks of the COP system include the limited physical and fiscal capacity for compliance officers to follow up on businesses that are not in compliance and/or in support of businesses in transition to compliance. However, in 2007 CRD compliance officers completed 630 primary business inspections and 729 repeat inspections¹⁵.

Within the CRD 88 authorizations were issued under the Sewer Use Bylaw, "in cases where overall contaminant loads to sanitary sewer are low or where discharges are predicted to have a minimal impact on collection and treatment systems and/or the receiving environment"¹⁶. Authorizations were issued to regulate unusual discharges or "small groups of similar operations, such as ship and boat waste facilities, laundromats and sani-dumps¹⁷". These are tailored to the specific outputs of a particular business and do not necessarily require self-monitoring requirements. There is, at minimum, a periodic check on the quality of effluent discharged with reported restrictions on waste generation or on site handling. In 2007, 45 inspections were carried out with a near total level of compliance.

There have been 30-40 active temporary permits issued to businesses within the CRD. These are site-specific documents that outline requirements for wastewater treatment, effluent quality, monitoring and reporting. These are issued to operations that discharge significant non-domestic wastewater flows that are greater than 10 m³/day or wastewater with high loads of chemical contaminants or restricted wastes¹⁸. Permits require self-monitoring and reporting, preparation of compliance letters, meetings and regular phone contact with permittees, as well as site inspections.

Of potential interest for the RDN is the outreach effort made to include businesses in the planning and implementation of COPs, authorizations and permits. The CRD developed relationships with professional associations and groups within 11 sectors of their economy.

¹³ See: Capital Regional District. 2008. Codes of Practice. Available at: <http://www.crd.bc.ca/wastewater/sourcecontrol/codespractice.htm>

¹⁴ Capital Regional District. 2008. Regional Source Control Program Annual Report 2007. Available online at: <http://www.crd.bc.ca/wastewater/sourcecontrol/documents/sc2006annualreport.pdf>

¹⁵ Capital Regional District. 2007. CRD Regional Source Control Program Annual Report 2007. Available online at: <http://www.crd.bc.ca/wastewater/sourcecontrol/documents/sc2006annualreport.pdf>

¹⁶ Ibid. Pp. 6.

¹⁷ Ibid.

¹⁸ Ibid.

Compliance remains relatively high although there have been some instances (6) in which court action has resulted from non-compliance.

Education and Outreach

The CRD's source control program also has an outreach component targeted at either residential or commercial/industrial/business users. For the latter, guidebooks have been developed and are continuously updated to summarize regulations, COP guidelines and best practices. For residential users, education/outreach has targeted 3 activities: release of fats, oils, and greases, detergent use, as well as a pharmaceutical return program. To this end, education campaigns have distributed detergent scoops, organized pharmaceutical round-up programs and have featured community displays at appropriate venues.

The combined impact of the CRD's source control program has yielded tangible results, particularly with respect to installation of works and reduction of key contaminants. However, the program has some drawbacks particularly in terms of enforcement and monitoring. Not only has the issuance of tickets related to breaches of COPs lead to some dissension and court action, the monitoring schedule and follow up on non-compliance reports cannot be adequately maintained. Additionally, high turnover in business and the emergence of new businesses has further complicated efforts to enforce compliance.

Though the regulatory aspects of this program generate revenue of \$120,000 (2007) in permittee fees, source control at the CRD has a budget of over a million dollars and requires 7.5 full time staff.¹⁹ Although this is a resource intensive program, the focus on monitoring/enforcement is, in comparison, an aspect that is absent from the RDN's source control program relative to the sewer use bylaw.

Metro Vancouver and Public Outreach

Comparatively, few other jurisdictions, save Metro Vancouver, have such a rigorous source control program. This can be attributed to the time and budget intensive nature of regulation-based source control programs. However, it should be noted that Metro Vancouver, in their March 2006 LWMP Biennial Report reiterate a commitment to their focus on source control programs. Included among these were the development of peak discharge limits and fees for industry (targeted at BOD₅ and TSS), reduction in demand for treatment capacity (development of 10 Strategies to Improve Eco-Efficiency guidelines), and an increase in the number of workshops delivered for their education program. The latter education program is focused on developing educational tools for elementary and secondary teachers and students. This education program was also complimented by four outreach programs targeted at residential sewer use and proper disposal of household hazardous waste. These were developed in consultation with community stakeholders, including the BC Landscape and Nurseries Association and the Recycling Council of BC.²⁰ Further, as part of their LWMP and the 6 commitments laid out therein, Metro Vancouver has recently (as of February 27th, 2008) committed to "provide resilient infrastructure to address risks and long term needs" including collaboration with members of its municipalities.

5.0 Recommendations

¹⁹ Numbers obtained from personal communications with Chris Robins, Acting Supervisor of the Regional Source Control Program

²⁰ Metro Vancouver. 2006. Liquid Waste Management Plan Biennial Report. Available online at: <http://public.metrovancouver.org/about/publications/Publications/LWMPBiennialReport2006-Part2.pdf>

Given the size of the RDN, current and future demands on sewer infrastructure, existing outreach programs and programs in other jurisdictions, only minor improvements need to be made with respect to the RDN's source control program. At its core the RDN has an excellent foundation for a source control program. The objectives of the program continue to focus on the reduction of contaminants in influent, effluent and biosolids through education, outreach, and regulation through the Bylaw with measurable success. In addition to the recommendations below, efforts should continue to focus on education through the website.

The three recommendations made here seek to maximize existing relationships through the development of partnerships with other departments at the RDN, other regional governments, and others within the district. Indeed, the RDN can benefit from the knowledge, expertise, and experience of other programs in neighbouring jurisdictions.

Co-Partnerships with Other Departments Within the RDN

In 2007, for example, the Solid and Liquid Waste Departments worked together on an initiative designed to minimize the amount of organic waste entering the waste stream. Similar efforts that serve the goals of other departments in the RDN, particularly with the Solid Waste Department, should continue to be pursued. Not only is this economical in terms of resource sharing, it also serves to target key populations at one time, without engendering 'consumer fatigue' with regard to waste reduction messages.

Further, as several communities in the RDN are working to review or develop their Official Community Plans there are ample opportunities for the Liquid Waste Department to participate at community meetings. It is through these venues that community needs can be assessed and addressed vis-à-vis wastewater disposal. In addition, key source control messages can be imparted through presentations and one-on-one dialogue with community members. There also exists tremendous opportunity for communication about the bylaw and proper sewer use through the RDN's Regional Perspectives newsletter.

Finally, there exists opportunities to assess the possibility of using the RDN's bylaw enforcement resources, on an as needed basis.

Resources dedicated towards the creation of partnerships with other departments at the RDN would require minimal effort and could result in innovative resource sharing.

Partnerships With Other Municipalities/Jurisdictions

Throughout the year the Liquid Waste Department is in conversation with other technologists/coordinators/managers at other liquid waste departments across Canada and in the US, but in particular with those in our region. As such, there exists a network of individuals with whom information is exchanged and ideas are formed. It has been suggested that knowledge sharing regarding compliance, enforcement, and permitting could be invaluable in developing a streamlined and consistent approach to source control bylaws. Not only would this result in the identification of problems in the RDN, it could also make more collaborative use of municipal and regional sewer use bylaws.

Knowledge sharing with other municipalities and in other jurisdictions could enhance the effectiveness and outcomes of the RDNs source control program. This could also be useful for developing and coordinating educational campaigns with municipalities both inside and outside the RDN.

Communication and potential partnerships, on an informal and formal basis, would require minimal effort and budgeting, save for organization of and travel to meetings.

Partnerships With Others Within our District

In the interest of ensuring that the RDN's source control program meets the needs of the members of the community the RDN should, where possible, explore working with others in our district. Possibilities include professional associations, schools, non-profit and non-governmental organizations, or others with interest in contributing to inter/intra community outreach. Having linkages to the community helps to bolster the effectiveness of Bylaw compliance and sewer use through targeted messaging while also helping to determine suitable frequencies for education/outreach programs.

Taken in total it is estimated that the total expenditures related to the development and implementation of these three recommendations would require no more than 12-15% of 1 FTE (Liquid Waste Coordinator) and a budget of roughly \$15,000 for the revamping of source control outreach materials and for meetings with others within and outside of the RDN.

Conclusions

A source control program will improve the quality of our influent, effluent and biosolids, while reducing the resources (energy, chemical, and financial) required to treat wastewater. Furthermore, a Source Control Program supports the Liquid Waste Department's environmental mandate and ISO 14001 Environmental Management System at the RDN. However, the LWMP affords the opportunity to determine if and how the RDN's source control program should be either abandoned or improved.

This discussion paper provided an overview of the key components of a source control program. Through regulation (bylaw) and outreach (education) source control programs seek to decrease the levels of contaminants entering the wastewater stream. They also work to:

1. Protect the environment.
2. Protect the health and safety of workers and the public.
3. Protect existing infrastructure and the wastewater treatment process.
4. Protect the quality of biosolids.

As this discussion paper has shown, the RDN currently has an excellent foundation for a source control program, with both Bylaw and education/outreach components. However, the program can be rendered more effective through partnerships with other departments at the RDN, with other municipalities and jurisdictions, and with members of our community.

Regional District of Nanaimo Liquid Waste Management Plan Review and Amendments

Options for Secondary Treatment Processes

Issued: October 23, 2008

Previous Issue: None

1 Introduction

Currently, the Regional District of Nanaimo (RDN) has four pollution control centres (PCCs). Two of these PCCs are primary treatment plants that will have to be upgraded to secondary treatment in the future and two are secondary treatment plants that will have to be expanded at some point, perhaps using the same technologies or a different technology. The primary treatment plants include the Greater Nanaimo Pollution Control Centre (GNPCC) and the Nanoose Pollution Control Centre (NPCC). The secondary treatment plants include the French Creek Pollution Control Centre (FCPCC) and the Duke Point Pollution Control Centre (DPPCC).

The purpose of this document is to review the optional secondary treatment processes that might be used at these or other RDN plants in the future. Some of this information has been previously covered as a technical memorandum, "GNPCC Stage 3 Expansion, Technical Memorandum No. 5, Process Alternatives", issued by Associated Engineering October 1, 2003. In addition, as part of the Liquid Waste Management Plan (LWMP) review process there was also a "Wastewater Treatment Primer" document that was created and issued to the LWMP review committee members as a reference. Some of this information was also presented in Discussion Paper 3 in the context of developer-installed packaged treatment plants. Information from these documents has been updated and/or expanded, as required, below.

Secondary treatment needs to be discussed in context. Preliminary treatment, which includes screening and grit removal, takes out large and easy to settle materials. Primary treatment, also called primary sedimentation or clarification, removes less easy to settle inorganics and some of the non-soluble organics, leaving a portion of the non-soluble organics and most of the soluble organics in the wastewater. Secondary treatment removes soluble and insoluble organic matter that is in primary treatment effluent. Without secondary treatment, there is some risk that the degradation of the organics in the receiving environment (rivers, lakes or the ocean) could cause the depletion of the dissolved oxygen in the receiving environment to the point that fish can no longer survive in that area. Secondary treatment also helps to remove contaminants of emerging concern such as some endocrine disrupting chemicals (EDCs) and pharmaceuticals and personal care products (PPCPs). It also helps to manage the creation of nitrous oxide from proteins and ammonia, which is about 330 times more potent as a greenhouse gas than carbon dioxide.

2 Regulatory Requirements

Based on the RDN being coastal, with all of the treatment plants discharging to the marine environment, the British Columbia Ministry of Environment, based on the Municipal Sewage Regulation, would establish the criteria for an Operational Certificate under the LWMP. This Operational Certificate would likely require the RDN to treat its wastewater to the levels defined and summarized in Table 1.

Table 1
Summary of Regulatory Treatment Requirements for Secondary Treatment
Where the Dilution in the Outfall is > 40:1

Parameter	Compliance Criteria ¹
Biochemical Oxygen Demand (BOD ₅)	45 mg/L Maximum
Total Suspended Solids (TSS)	45 mg/L Maximum
Fecal Coliforms	Not applicable
Turbidity	Not applicable (at this time)
Nitrogen	Not applicable (at this time) – based on ammonia toxicity at the edge of the initial dilution zone

¹ Note: Lower operational objectives would be required to consistently meet the compliance criteria, which in some cases are maximum or “never-to-exceed” values.

The values in Table 1 would require “secondary” treatment of the wastewater. The Municipal Sewage Regulation requirements in Table 1 are “never-to-exceed” values for single samples. In contrast, the up-coming compliance criteria for BOD₅ and TSS from the Canadian Council of Ministers of the Environment’s (CCME’s) Canada-Wide strategy process would likely be more stringent than the above numbers, but would be based on “average” values over a certain period of time, e.g. less than 30 mg/L BOD and less than 30 mg/L TSS on a 30-day running average. Regardless, the target values for treatment design and operation are normally set on a lower level than the above numbers, e.g. less than 20 mg/L BOD and 20 mg/L TSS.

The need for disinfection is based on water contact recreation needs and shellfish harvesting. At present, only the DPPCC has any disinfection. Disinfection for the other treatment plants is not required by the regulations at the moment. If any recreational activities or shellfish harvesting is to be considered in the future, treatment specifically targeting a reduction in pathogenic organisms would be required.

3 Secondary Treatment

Secondary treatment requires the removal of soluble and insoluble organics from the preliminary or primary treatment effluent. This discussion of secondary treatment includes biological treatment, settling, and separation and disinfection.

3.1 Biological Processes

Biological treatment works by providing an environment in which non-pathogenic bacteria can be cultivated in a safe and stable manner. These bacteria grow and multiply by consuming the soluble organics in the primary effluent and by hydrolyzing the non-soluble organics in the primary effluent and converting both sources of soluble organics to new cell mass. This new cell mass is then separated from the secondary effluent via sedimentation or some type of filter.

Within biological treatment there are three options: suspended growth processes, fixed growth processes and hybrid processes (a combination of suspended and fixed growth processes). The following sections discuss these options.

3.1.1 Suspended Growth Biological Processes

Suspended growth processes are biological treatment processes in which microorganisms (bacteria, fungi, rotifers, protozoa, and algae) responsible for wastewater treatment are maintained in suspension within the liquid. Suspended growth processes are a type of process often considered “secondary” wastewater treatment.

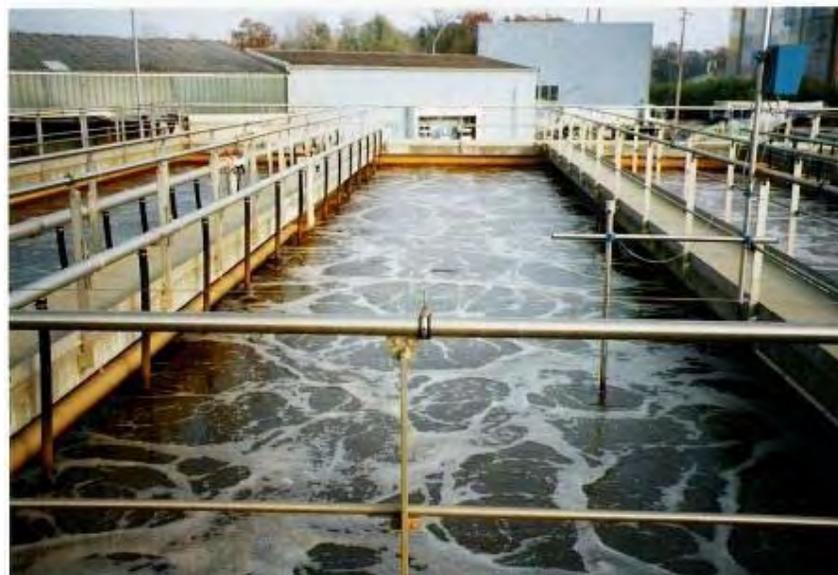
Suspended growth processes, which include activated sludge, sequencing batch reactors (SBRs), and membrane bioreactors, among others, are described below.

Activated Sludge

The activated sludge process involves the production of an activated mass of microorganisms capable of stabilizing wastewater in an aerobic (presence of oxygen) environment. Wastewater is introduced into a tank where the microorganisms are maintained in suspension through aeration and/or mixing. The contents in the reactor are referred to as “mixed liquor”. An aerobic environment is maintained by adding dissolved oxygen into the tank using diffused aeration or mechanical aeration to force air (21% oxygen) into the mixed liquor. As shown in Figure 1, the aeration also keeps the “mixed liquor” well mixed. After a set time period, the mixture is sent to a settling tank or a membrane filtration system where the bacterial cells are separated from the treated wastewater. The majority of the separated microbial solids are returned to the aeration tanks as return activated sludge in order to maintain a certain concentration of mixed liquor suspended solids (MLSS), e.g. 2500 mg/L. A smaller portion of the separated microbial solids is wasted from the system (e.g. to a digestion system) as waste activated sludge in

order to maintain the MLSS concentration and the mean cell residence time or solids retention time (SRT). The latter is typically kept at less than four days if nitrification (oxygen-consuming conversion of ammonia to nitrate) is to be avoided. If the SRT is too long, the MLSS concentration will be high and there will be a tendency to develop nitrification (and the resulting increase in energy demands from the aeration system) and/or filamentous bacteria (which do not settle well, causing potential effluent quality and operational issues).

Figure 1
An Activated Sludge Aeration Tank



In some cases, activated sludge can be augmented with anaerobic and anoxic tanks and various recirculation lines to produce biological nutrient removal (BNR) of both phosphorous and nitrogen. As an added bonus of the BNR process, BNR plants typically have high quality effluent, e.g. less than 10 mg/L BOD and less than 10 mg/L TSS. Such high levels of treatment are typically not needed in the RDN context because of the discharge to open marine waters. BNR is typically used where the discharge is to inland freshwater rivers or lakes, e.g. all the major treatment plants on Lake Okanagan are BNR plants. The only reason for BNR in a marine discharge situation is if there are concerns about the greenhouse gas implications (nitrous oxide) of discharging nitrogen to the ocean. At the present time, there is only speculation on this point and no firm conclusions.

Activated sludge systems can be based on aeration with air, i.e. air activated sludge in open tanks, or oxygen activated sludge in closed (covered) tanks.

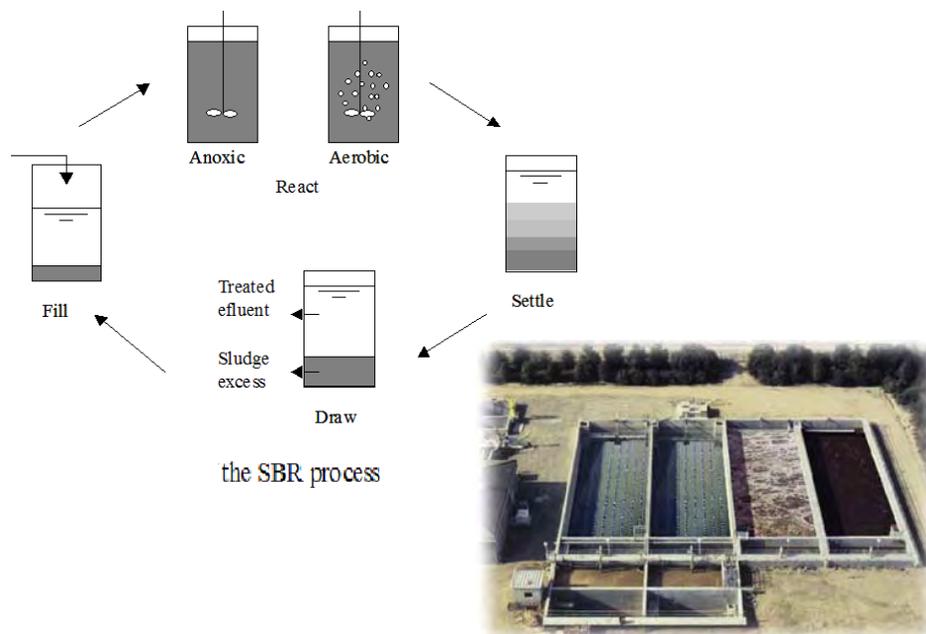
Activated sludge systems have some capacity to remove EDCs and PPCPs, particularly at longer sludge ages (SRTs).

Activated sludge is a well known process and despite some potential issues, is a reasonably robust treatment system. The downsides of the activated sludge process include the energy requirements for the aeration and the need for clarifiers or additional tankage for the separation of the solids.

Sequencing Batch Reactors

The SBR process is a type of suspended growth activated sludge treatment. SBRs can provide both high quality effluent and provide the possibility of biological nutrient removal. The main difference between an SBR and a conventional activated sludge treatment process is that after the preliminary treatment (screening and grit removal) processes, all of the wastewater treatment processes occur in one tank. These SBR tanks are each equipped with both an aeration system and a means to settle the solids and decant off treated liquid. A schematic of the SBR process is shown in Figure 2.

Figure 2
The Sequencing Batch Reactor Treatment Process
(Showing a Schematic Operating Cycle and a Four-Tank System)



There are several variations of the SBR process. One of the more common variants is the Intermittent Cycle Extended Aeration System. The Intermittent Cycle Extended Aeration System has a small pre-react chamber at the influent end of the SBR tank and a baffle wall

that forces the influent to the bottom of the tank. This feature and the addition of making the SBR tank somewhat longer allows for continuous loading of raw screened influent to all the SBR tanks (e.g. one or more tanks) in the process. This permits much simpler operation of the SBR. This is the type of SBR that is at the DPPCC.

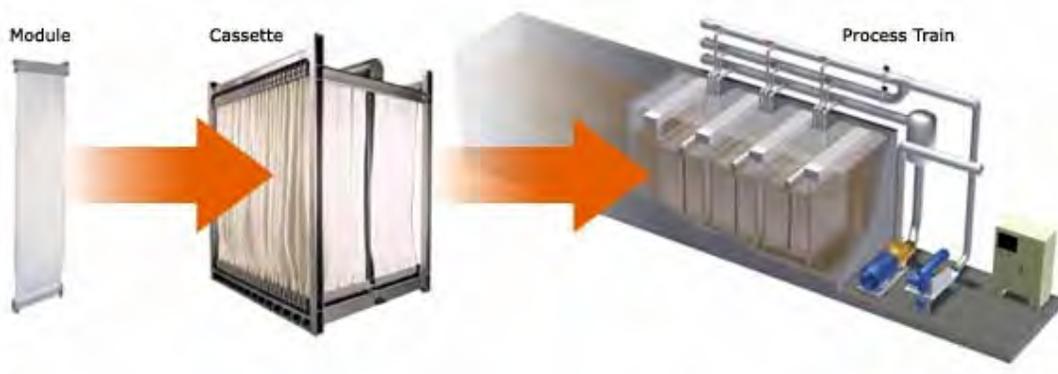
SBRs have some capacity to biologically remove nutrients as in the BNR process. However, if nutrient removal was a requirement, it would likely be better to design and operate a conventional activated sludge-based BNR process plant. SBRs, like activated sludge systems, have some capacity to remove EDCs and PPCPs, particularly at longer sludge ages (SRTs).

SBRs are most often used to treat smaller flows, e.g. under 5000 m³/day. However, there are larger SBR installations in the world, e.g. Dublin, Ireland. That said, at the larger flows, the SBR process may not be cost competitive with other processes, including conventional activated sludge systems.

Membrane Bioreactors

Membrane bioreactors (MBRs) also use a single tank system similar to the SBR process. However, rather than have a decanter and an intermittent cycle, the membrane bioreactor process eliminates the need for either a clarifier or a decanter to separate the biological solids from the purified effluent. Instead, a membrane system is used to provide a physical barrier between the biomass and the effluent. A pressure gradient provided by either gravity on the aeration side of the membrane or a vacuum on the effluent side of the membrane is used to provide the driving force across the membrane. Figure 3 presents a graphical representation of an MBR treatment plant.

Figure 3
The Membrane Bioreactor Process



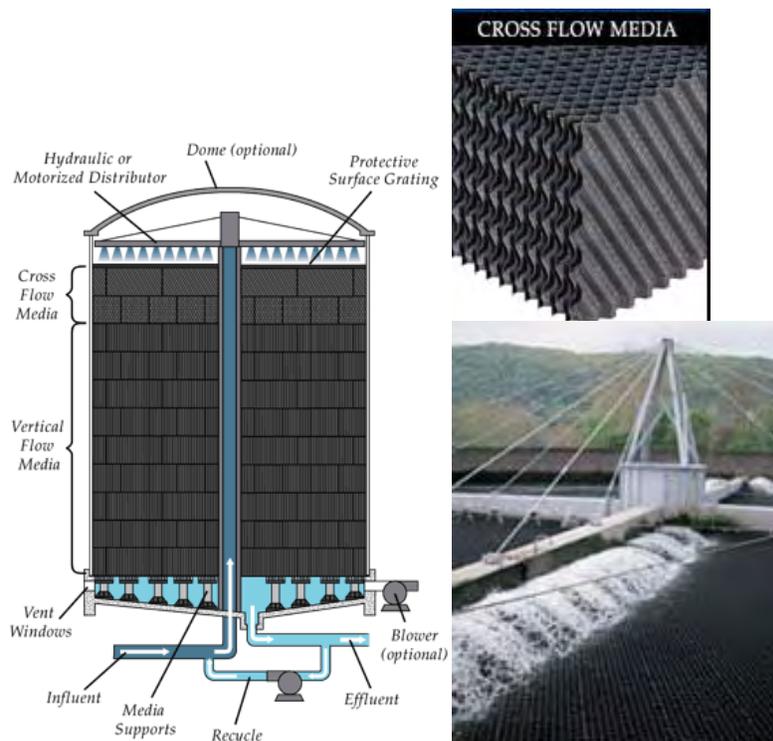
MBRs can produce the highest quality effluent currently possible with “conventional” treatment, i.e. less than 10 mg/L BOD and TSS is usually a given and in many cases, the effluent is less than 5 mg/L BOD and TSS. As an added bonus, the membrane pore sizes typically exclude both bacteria and viruses so the effluent quality is very good even prior to disinfection. MBRs are also likely to have long sludge ages (SRTs) and, as a result, are most likely to be capable of removing EDCs and PPCPs. The downside to MBRs is the additional equipment and energy required to make the process work. To some degree, this is mitigated by the elimination of the need for secondary sedimentation that conventional activated sludge requires.

MBRs have good capacity to biologically remove nutrients as in the activated sludge-based BNR process, provided the required anaerobic and anoxic tanks are added to the system.

3.1.2 Fixed Film Biological Processes

Fixed film processes are a type of “secondary” wastewater treatment. Fixed film processes, also referred to as attached growth process, are essentially biological treatment processes in which the microorganisms responsible for treating the wastewater are attached to some type of medium such as rocks, plastic materials, etc. Fixed film processes include trickling filters and rotating biological contactors (RBCs). These processes are described below.

Figure 4 - Trickling Filter Basics



Trickling Filters

Trickling filters consist of a media bed of highly permeable material such as rock or plastic on to which microorganisms are attached. As shown in Figure 4, wastewater is percolated or trickled down onto this media bed. Treatment occurs when the wastewater comes in contact with the rock or plastic media and microorganisms begin to degrade the organic material in the wastewater, converting the soluble and non-soluble organics to new cell mass that eventually sloughs off the media.

The depth of the media bed depends on the type of material used and the size and shape of the tank. While rock was an early popular media, it had a poor specific area, i.e. low m^2/m^3 rating. Today, it is very common for trickling

filters to be based around corrugated plastic sheets that have been thermally and/or chemically welded to form media blocks that are then stacked in the filter structure. An underdrain system is used to collect the treated wastewater effluent and any biological solids that have become detached from the media bed. This effluent is directed to secondary sedimentation basins or clarifiers.

In contrast to the activated sludge process, the solids from a trickling filters system secondary clarifiers are not recirculated back into the trickling filter like return activated sludge is returned to the activated sludge aeration basin. However, in some cases, the effluent from the trickling filter secondary clarifiers is recirculated back to the trickling filter, either for additional treatment or to improve the wetting rate, i.e. the flow over the media that is required to keep the media wet and to continuously shear off excess growth. The solids from the trickling filter clarifiers are wasted to a sludge handling system that typically includes some form of digestion to produce biosolids.

Trickling filters do provide a robust form of secondary treatment in that they are not as easy to upset as suspended growth systems can be. However, one problem that they do have is the sloughed solids do not settle as well as activated sludge mixed liquor does. This results in a poorer quality effluent (higher BOD and TSS) than activated sludge effluent. This can also mean that effluent disinfection becomes more difficult, either because of increased chemical dosages for chlorination or lamp fouling and/or light penetration for ultraviolet (UV) disinfection.

Trickling filters can be included in a BNR process train if biological nutrient removal was required. However, making them work in a BNR process is more difficult than a conventional activated sludge-based BNR process.

Trickling filters are not as good as the suspended growth systems for EDC and PPCP removal, likely because the effective sludge age is much shorter for a trickling filter than most activated sludge systems and much shorter than that for an MBR system.

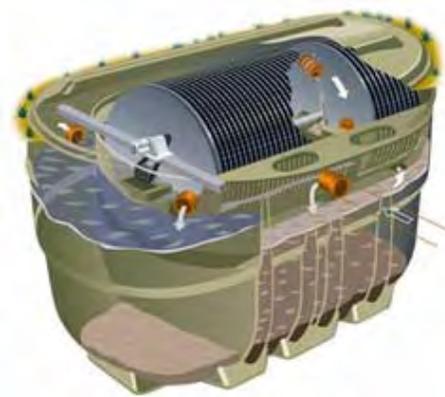
Trickling filters do not absolutely need forced airflow through the media but they will function better and more consistently if there is forced airflow. If forced airflow is used, it is best drawn downwards through the trickling filter rather than blown upwards through it. Upward flow tends to strip odour compounds from the primary treatment effluent leading to the need for odour control. Downward flow tends to result in the odour compounds being treated within the trickling filter by the biofilm.

Rotating Biological Contactors

RBCs are a fixed-film secondary treatment process in which the biology is virtually identical to that of the trickling filter. The only change instead of the media sitting passively and the primary effluent trickled over it as in the trickling filter process, with an RBC, the media

rotates through the wastewater. RBCs consist of a series of closely spaced circular disks, which are submerged in wastewater and rotated slowly through it. In the RBC process, microorganisms become attached to the disk surfaces and form a “slime” layer (much the same as a trickling filter). The rotation of the disks provides the microorganisms with food in the form of the organic material present in the wastewater and also oxygen present in the atmosphere. The rotation of the disks affects oxygen transfer and maintains the microorganisms in an aerobic condition. Figure 5 shows the general RBC process in a small scale (packaged plant) application.

Figure 5
Schematic View of a Small Scale RBC



Like trickling filters, RBCs provide a robust form of secondary treatment in that they are not as easy to upset as suspended growth systems can be. However, as with trickling filters, the sloughed solids from the RBC media do not settle as well as activated sludge mixed liquor does. This results in a poorer quality effluent (higher BOD and TSS) than activated sludge effluent. This can also mean that effluent disinfection becomes more difficult, either because of increased chemical dosages for chlorination or lamp fouling and/or light penetration for UV disinfection.

RBCs are potentially capable of being incorporated into some form of biological nutrient removal scheme, but rarely are because of their niche in smaller treatment plants. RBCs are similar to trickling filters for EDC and PPCP removal, i.e. not as good as activated sludge and MBR systems.

RBCs are relatively easy to maintain since they typically do not require additional aeration and the only electric motors are relatively low horsepower used to rotate the shafts through the wastewater. Based on economics, RBCs are typically more suited to smaller treatment plant installations. The original DPPCC was based on an RBC. NPCC is of a size and effluent quality requirement that would be suitable for an RBC installation.

3.1.3 Hybrid Biological Systems

Hybrid wastewater treatment systems consist of two or more treatment processes, e.g. trickling filters and a form of activated sludge, which are combined to achieve an overall level of treatment that is better than using a single treatment process alone. Hybrid system processes are a type of “secondary” wastewater treatment.

Examples of hybrid systems include trickling filter/solids contact, integrated fixed film activated sludge, and moving bed biofilm reactor. These processes are described below.

Trickling Filter/Solids Contact

Trickling filters typically shed or slough small amounts of biological solids from the biofilm on the plastic media on a constant basis. In some situations, these biological solids are very difficult to settle because they are small in size and light in mass. As a result, on their own, trickling filters do not have high quality effluent because of the higher TSS. To aid the settling of these solids, in the trickling filter/solids contact (TF/SC) process, the trickling filter process is followed by a short retention time (e.g. one hour) activated sludge aeration tank. This additional step improves the settleability of the solids and therefore, improves the clarity of the effluent.

The solids contact tank used in the TF/SC process is followed by a clarifier and, like the activated sludge system, a portion of the settled solids from the clarifier are recirculated back to the solids contact aeration tank. However, the sludge age (SRT) is kept very short, e.g. one day, and as a result, most of the solids are wasted to the sludge digestion system.

TF/SC systems can be incorporated into BNR nutrient removal but this is rare. It is typically easier to just have an activated sludge-based BNR process if you need biological nutrient removal. While the TF/SC process likely removes more EDCs and PPCPs than a straight trickling filter system, the improvement is very small and does not approach even that of a short (four-day) conventional activated sludge system.

The FCPCCC currently uses the TF/SC process and it has been shown to be reasonably robust for BOD and TSS removal. Issues with airflow direction (upwards) in the FCPCCC trickling have lead to odour control problems that still need to be fully resolved. There are plans developing to do this by reversing the airflow through the trickling filter.

Integrated Fixed-Film Activated Sludge

The integrated fixed-film activated sludge (IFAS) process is a variation of the conventional activated sludge process in which more biomass is added to the system in the form of biofilms grown on suspended plastic media. In this process, synthetic materials, i.e., polyethylene, foam, or polyvinyl chloride are used within the activated sludge tank to

provide additional surface area for the growth of microorganisms to treat the wastewater. These synthetic materials are often suspended within the activated sludge mixed liquor. In some cases, the additional fixed film media is fixed firmly in place within the aeration tank. In either case, this approach enhances the activated sludge process by increasing the concentration of microorganisms. As such, the IFAS media can be used to retrofit an existing activated sludge tank so it can be loaded higher than it could be previously. Alternatively, the IFAS media can be used to reduce the size of the activated sludge aeration tank that is required.

The IFAS process would have better EDC and PPCP removal capabilities than an activated sludge plant because of the greater biomass involved and also the longer overall sludge retention time (SRT).

Moving Bed Biofilm Reactor: The moving bed biofilm reactor (MBBR), such as that developed by Kaldnes®, is an example of an integrated fixed-film activated sludge (IFAS) process. In this process, small polyethylene cylinders, i.e., approximately 10 mm in diameter and 7 mm in height are suspended within an aerated or non-aerated activated sludge basin. Air or mixing is applied to the tank to keep the cylinders in circulation. The use of these cylinders increases the surface area for growth of biological organisms. A screening system is used to keep the plastic media and its attached biological growth in the activated sludge aeration tank. Typically for this process, a clarifier follows the aeration tank to settle out biological solids.

Figure 6 shows some of the characteristics of an MBBR process (including the media with biofilm, the aeration tank and the separation screens) (images courtesy of Veolia – Kaldnes)

Figure 6
Moving Bed Biofilm Reactor



The MBBR process would have better EDC and PPCP removal capabilities than an activated sludge plant because of the greater biomass involved and also the longer overall sludge retention time (SRT).

Biological Aerated Filters

Biological Aerated Filters (BAF) process combines BOD removal and physical solids separation in a single structure. In one BAF configuration of the process has primary effluent flowing downward through a bed of granular media while the bed is aerated. In another BAF configuration, the primary effluent flow is upwards as is the aeration. In either case, the granular media supports attached biofilm, which oxidizes soluble and particulate organic matter. The media also filters out the solids, leaving a clear effluent. The filter is regularly backwashed to remove excess solids; backwash solids are typically returned to the primary sedimentation tanks for thickening and removal. Figure 7 illustrates some of the aspects of the BAF process.

Figure 7
Schematic Representation of the BAF Process

(courtesy of Infilco Degremont)

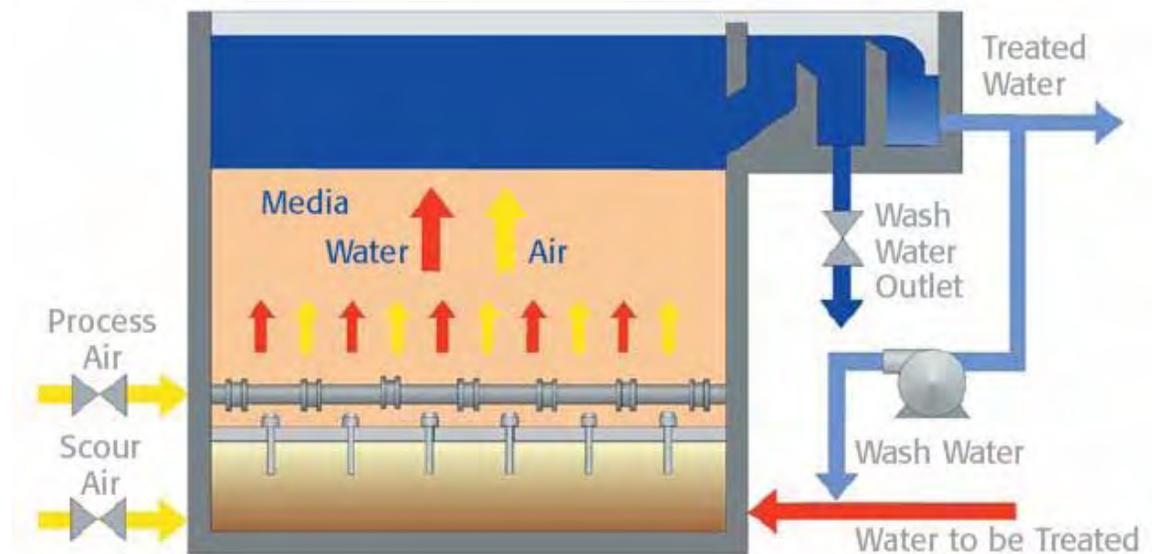
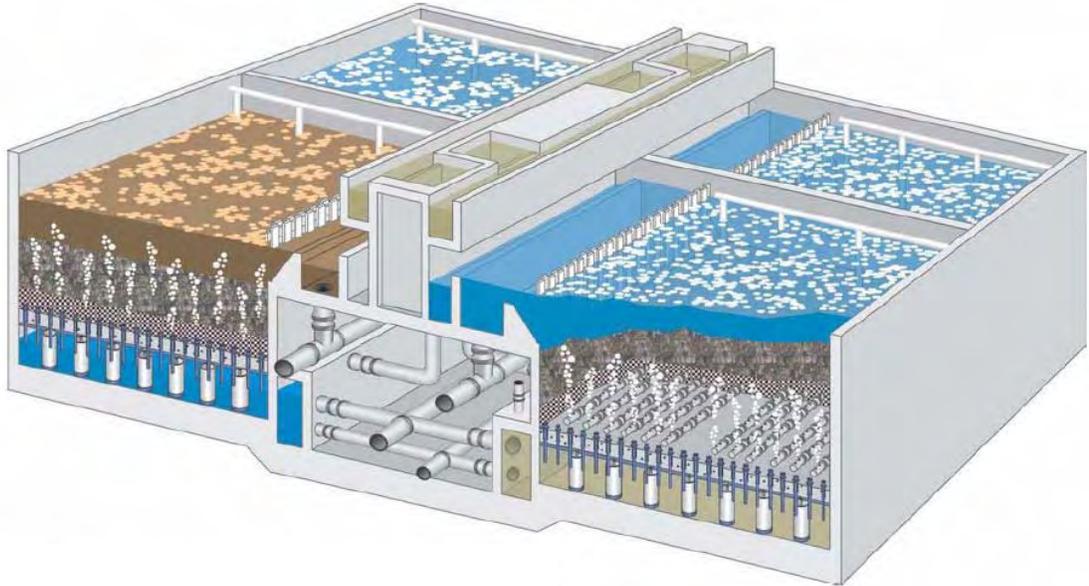


Figure 7 - Continued



BAFs typically have relatively short sludge ages (SRT) and as such, are similar to trickling filters in their relatively poor capabilities of removing EDCs and PPCPs.

3.1.4 Nitrification

Nitrification is the conversion of ammonia (NH_4^+) to nitrate (NO_3^-). If nitrification is not required to meet effluent criteria, i.e. an ammonia limit in the receiving body, it is often avoided because it consumes oxygen and alkalinity. The additional oxygen costs money through additional capital and operating costs associated with larger or more aeration blowers in a suspended growth system or additional trickling filter media for a fixed film system. Depletion of alkalinity can potentially significantly decrease the effluent pH to well below pH 6, whereas typical effluent criteria discharge pH's are not less than 6.5 (and not more than 8.5). One way to get back some of the oxygen and alkalinity is to biologically denitrify by recirculating aeration tank or trickling filter effluent back to a new tank, an "anoxic" tank, located before the aeration system (or trickling filter). In this situation, another group of bacteria convert the NO_3^- to N_2 gas and, in doing so, liberate some oxygen and bicarbonate (HCO_3^-) that help to replace at least some of the oxygen and alkalinity consumed in the original nitrification step.

As stated earlier, typically, for ocean discharges, the need for nitrification has been seen to be very low. However, with the growing interest in greenhouse gases this may change. The reason for this is one product of the conversion of ammonia to nitrate is nitrous oxide, which is about 330 times more potent on a mass basis than carbon dioxide. Since ammonia that is discharged to the environment could end up, at least partially, as nitrous

oxide in the natural environment, i.e. the ocean, it might be better to control the nitrous oxide generation by controlling the nitrification within the treatment plant. At present, there is no legislation that requires nitrification (and denitrification) for greenhouse gas control reasons.

3.1.5 Summary of Optional Secondary Treatment Processes

Table 1 summarizes the optional secondary treatment processes that could be available for expansion or upgrading of the RDN's treatment plants.

Table 1
Comparison of the Optional Secondary Treatment Processes

Process Option	Capital Cost	O&M Costs	Achievable Effluent Quality	Comments
Activated Sludge (AS)	Medium	Medium-high	<20 BOD/<20 TSS	Well known process; significant footprint requirements because of clarifiers
Sequencing Batch Reactor (SBR)	Low-medium	Low	<20 BOD/<20 TSS	Size limitations. Suitable for DPPCC and NPCC, but likely not for GNPCC or FCPCC
Membrane Bioreactors (MBR)	Highest	Highest	<10 BOD/<10 TSS	Best effluent quality but not necessarily needed for marine discharge. Good EDC and PPCP removal. Smaller footprint than conventional AS.
Trickling Filters (TF)	Medium	Medium-low	<45 BOD/<45 TSS	Effluent quality is not as good as AS or MBRs, poorer EDC and PPCP removal than AS and MBRs
Rotating Biological Contactors (RBCs)	Medium-high	Lowest	<45 BOD/<45 TSS	Suitable for NPCC, but not FCPCC or GNPCC. Not good for EDC and PPCP removal.

Process Option	Capital Cost	O&M Costs	Achievable Effluent Quality	Comments
Trickling Filter/Solids Contact (TF/SC)	Medium-high	Medium	<20 BOD/<20 TSS	Well known to RDN staff via FCPCC. Some issues with odour control. Not good for EDC and PPCP removal.
IFAS/ Moving Bed Biological Reactors (MBBR)	Medium-high	Medium	<20 BOD/<20 TSS	Good for upgrading or new plants to keep footprint down. Better EDC and PPCP removal than either AS or TF
Biological Aerated Filter (BAFs)	Medium-high	Medium-high	<30 BOD/<30 TSS	Small footprint. Not particularly good at EDC or PPCP removal.

Based on the above, the most likely processes for upgrading or expansion of the existing treatment plants would be as follows:

- FCPCC - TF/SC, Activated Sludge, IFAS/MBBR, BAF (if there are footprint issues), MBR if there is demand for reclaimed water
- GNPCC - TF/SC, Activated Sludge, IFAS/MBBR, BAF (if there are footprint issues), MBR if there is demand for reclaimed water
- NPCC - RBC following existing primary treatment plant, SBR (perhaps using existing tankage), MBR if there is a demand for reclaimed water for effluent use (toilet flushing, lawn and golf course watering, etc.)
- DPPCC – SBR, IFAS/MBBR to make further use of the existing tankage, MBR if there is demand for reclaimed water

Drivers for the final process selection will be the need for nitrification, the need for EDC and PPCP removal, cost and the need for reclaimed water.

3.2 Secondary Clarification

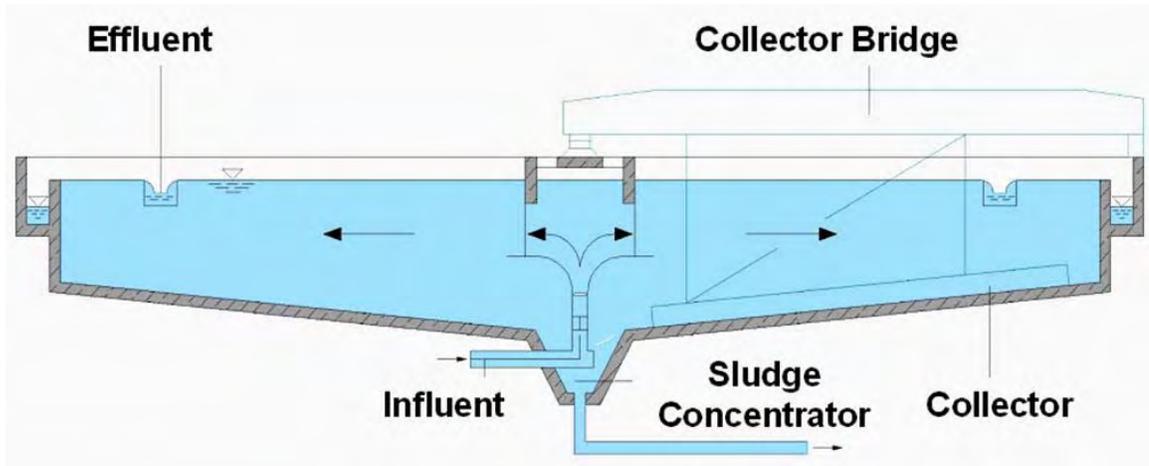
Following most suspended growth and fixed-film secondary treatment processes, it is usually necessary to have clarifiers to separate the biomass from the liquid effluent. Only the SBR, BAF and MBR processes do not require a separate secondary clarification step.

The following conventional and newer technology, e.g. AS, TF, TF/SC, MBBRs and RBCs, solids separation processes would have to be considered for future upgrades of the FCPCC, GNPCC

and, potentially, the NPCC. FCPCC has secondary sedimentation in the form of rectangular clarifiers that were converted from an older abandoned treatment process. The options include:

- *Circular Clarifiers* - Circular clarifiers have become the industry standard for biomass separation in larger treatment facilities. Clarifiers are often designed with purpose-built, centre well flocculation zones, which provide re-flocculation of sheared and dispersed biomass, thus enhancing clarifier suspended solids removal efficiency. Large clarifiers are often outfitted with inboard weirs and effluent launders, to avoid drawing water into the launders that originates near the outside walls, an area that often contains high solids concentrations. Finally, clarifier performance is largely influenced by the ability of the sludge withdrawal system to remove settled solids from the bottom of the clarifier. The most recent sludge scraper designs include a curved scraper blade, with the blade height decreasing as the blade extends from the centre of the clarifier to the outer wall. In addition, suction-based sludge withdrawal systems can increase allowable clarifier peak solids loading rates, while still providing acceptable solids separation efficiency.

Figure 8
A Schematic of a Circular Secondary Clarifier



- *Rectangular Secondary Clarifiers* - In North America, primary clarifiers are most often rectangular and secondary clarifiers are most often circular. One reason for this is the better flow distribution and flocculation that is possible with circular clarifiers. The other is the better likelihood of longer effluent weir lengths and lower approach velocities with circular clarifiers. However, this is not a firm rule as long as attention is paid to the flow distribution system, e.g. addition of inlet baffles in a rectangular secondary clarifier, and having sufficient length of effluent weirs to minimize upflow velocities and suspended solids carry-over. For example, the FCPCC has rectangular secondary clarifiers. A better example (because of the larger size) is the City of Edmonton's Gold Bar WWTP, which has rectangular

secondary clarifiers as a result of a need to keep the footprint as small as possible - this permits common walls that are not possible with circular clarifiers. A photo of the City of Edmonton secondary clarifiers is shown in Figure 9.

Figure 9
City of Edmonton Rectangular Secondary Clarifiers



- *Membrane Filtration* - In a biological treatment system, membrane filtration units can provide biomass separation, replacing traditional secondary clarifiers. Membrane filtration units can be incorporated directly into suspended-growth bioreactors, creating what are termed MBRs. Alternately, the filtration units can be situated in a separate tank located adjacent to the bioreactor. In this configuration, membrane filtration can theoretically be used to provide solids separation for any sort of suspended-growth, fixed-growth, or hybrid secondary treatment system.

As a matter of interest, the City of Edmonton supplies reclaimed water to the petrochemical industry in nearby Strathcona County by treating their secondary treatment effluent with membrane filtration to further improve the effluent quality (eliminating more suspended solids).

3.3 Effluent Disinfection

Generally, there are two conventional approaches for effluent disinfection at wastewater treatment facilities:

- UV irradiation
- Chlorination / Dechlorination

At present, only the DPPCC has to disinfect its effluent and, when it does so, it uses UV light. In general, the trend has been away from chlorination/dechlorination because of issues with handling chemicals and on-going improvements in UV lamp efficiency. It is anticipated that if disinfection was required at the other three RDN wastewater treatment facilities in the future, UV would be the method of choice. That said, UV does not work well with primary effluent and therefore would only be used at GNPCC or NPCC once those plants were upgraded to secondary treatment.

3.4 Additional Considerations

In secondary treatment process evaluations, the RDN will take a number of factors into consideration. Evaluations will consider energy consumption, capital costs, and overall operation and maintenance costs associated with the treatment technology. Further, the effectiveness of the treatment technology to reduce and / or remove levels of EDCs and PPCPs will be considered. Treatment technology evaluations will also identify opportunities for integrated resource management, such as wastewater heat recovery and water reuse (to be discussed further in Discussion Paper No. 8).

4 Summary

This discussion paper has identified that when primary treatment is no longer acceptable at GNPCC and NPCC, the required level of treatment will be secondary treatment. However, if there is demand for reclaimed water or there are concerns about EDCs and PPCPs in the effluent, additional measures, including membrane bioreactors might be needed. Another potential concern is the need for nitrification, not so much for ammonia removal, but more for control over the processes that convert ammonia to nitrate and other products, including nitrous oxide, which in itself is a potent greenhouse gas.

Based on the discussion of the optional secondary treatment processes, the most likely processes for upgrading or expansion of the existing treatment plants would be as follows:

- FCPCC - TF/SC, Activated Sludge, IFAS/MBBR, BAF (if there are footprint issues), MBR if there is demand for reclaimed water
- GNPCC - TF/SC, Activated Sludge, IFAS/MBBR, BAF (if there are footprint issues), MBR if there is demand for reclaimed water

- NPCC - RBC following existing primary treatment plant, SBR (perhaps using existing tankage), MBR if there is a demand for reclaimed water for effluent use (toilet flushing, lawn and golf course watering, etc.)
- DPPCC – SBR, IFAS/MBBR to make further use of the existing tankage, MBR if there is demand for reclaimed water

When the secondary processes are added or expanded, if secondary clarifiers are needed, they could either be circular or rectangular, depending on space availability. Effluent disinfection, if deemed necessary in the future, would most likely be UV irradiation. Additional factors such as energy consumption, capital costs, operation and maintenance costs, EDCs and PPCP reduction and/or removal and opportunities for integrated resource management, will also be considered by the RDN in the secondary treatment process evaluations.

Regional District of Nanaimo Liquid Waste Management Plan Review and Amendments

Cost Estimates for Upgrading/Expanding Treatment Capacity

Issued: November 26, 2008

Previous Issue: None

1 Introduction

The Regional District of Nanaimo (RDN) is undertaking a review of its Liquid Waste Management Plan to determine if amendments to the plan are required at this time. As part of this work, discussion papers are being developed and circulated to the RDN Liquid Waste Advisory Committee for their input and comments. Previous discussion papers have reviewed existing conditions; on-site treatment issues; policies regarding new communities and developer-installed treatment plants; and current flows and loads, effluent quality, and treatment plant capacities.

The purpose of this discussion paper is to update capital and operation and maintenance (O&M) costs for upgrades / expansions of treatment capacity for RDN's existing wastewater treatment facilities, based on previously completed studies. This discussion paper will also provide a revised timeline and cash flow, where applicable, for treatment facility upgrades and expansions.

As presented in Discussion Paper 6 "Options for Secondary Treatment Processes", the RDN has four pollution control centres (PCCs). Two of these PCCs are primary treatment plants that will have to be upgraded to secondary treatment in the future and two are secondary treatment plants that will have to be expanded at some point, perhaps using the same technologies or a different technology. The primary treatment plants include the Greater Nanaimo Pollution Control Centre (GNPCC) and the Nanoose Pollution Control Centre (NPCC). The secondary treatment plants include the French Creek Pollution Control Centre (FCPCC) and the Duke Point Pollution Control Centre (DPPCC).

The updated cost estimates for secondary treatment upgrades to RDN PCCs presented in this discussion paper do not account for potential opportunities for integrated resource management that may be included as part of the upgrades. Information related to integrated resource management strategies will be presented in a subsequent discussion paper, Discussion Paper No. 8.

2 Approach

The capital cost estimates for PCC upgrades were based on previous studies. Capital costs were updated based on consideration of various price/cost indices and was uniformly applied to all relevant costs. Operations and maintenance costs are based on a fixed percentage of the capital

cost, 4% of capital, intended to cover equipment maintenance and repair costs, chemical costs, electrical costs and additional staffing costs.

3 Greater Nanaimo Pollution Control Centre

A detailed capital cost assessment and upgrading plan for GNPCC was outlined in the report titled “Greater Nanaimo Pollution Control Centre Stage 3 Expansion – Process Alternatives and Layouts” (Associated Engineering, 2003) (the report) and, in particular, Appendix J - Technical Memorandum No. 9 – Development Plan and Cost Estimates (Issued October 1, 2003). The purpose of this section of this discussion paper is to update this previous cost estimate based on a number of factors.

3.1 Staged Upgrading Items

Upgrading of the existing GNPCC has been and will be done in stages. The initial upgrade stage is Stage 3. Stage 4 would be the secondary treatment upgrade and Stage 5 would be future expansion of the secondary treatment plant. Some aspects of Stage 3 have already be implemented, others have are partially completed or still need to be completed. Some upgrades could occur in either Stage 3 or Stage 4. Others could occur in Stage 4 or Stage 5. This list of items for the various stages of upgrade include the following:

Stage 3 – Primary Upgrading and Expansion

- Twin outfall land section
- Chemically-enhanced primary treatment – summer operation (on-going)
- Third digester
- Odour control upgrades (partially completed)

Stage 3 or Stage 4 – Upgrading and Expansion

- New headworks (Screens, grit tanks, etc)
- New Operations building (being completed)
- New biosolids dewatering facility (if needed)
- Cogeneration – Stage 1
- Construct 4th primary clarifier
- Construct new electrical power distribution building

Stage 4 – Secondary Upgrading

- Construct secondary treatment trains including secondary clarifiers
- Construct UV disinfection system (if required)
- Construct 4th digester to accommodate increase solids loadings
- Expand gravity thickening facility for primary sludge

- Construct dissolved air flotation (DAF) system for secondary sludge
- Expand existing sludge heating capacity
- Construct new flow monitoring facility
- Modify outfall diffuser
- Expand odour control facilities

Stage 4 or 5 – Upgrading and Expansion

- Expand headworks – add third screen
- Cogeneration – Stage 2 – to deal with increased gas production and energy demands

Stage 5 – Secondary Expansion

- Expand secondary treatment process
- Expand primary and secondary sludge thickening capacity
- Expand biosolids dewatering capacity

3.2 Previous Cost Estimates

The previous cost estimate developed in the report (Associated Engineering 2003) was expressed in 2002 dollars, the ENR Construction Cost Index (CCI); at the time of the cost estimates was 6500. A summary of the estimates from the 2003 GNPCCC report is as follows:

Stage	Amount (2002 \$)
Stage 3 – Primary Treatment, Upgrading and Expansion	\$7,500,000
Stage 3 or 4	\$10,600,000
Stage 4 – Secondary Treatment Upgrading	\$26,400,000
Stage 4 or 5	\$4,100,000
Stage 5 – Secondary Treatment Expansion	\$9,100,000
Total Development Plan	\$57,700,000

3.3 Revised Cost Estimate

3.3.1 Approach

The approach taken in updating the 2003 estimate can be summarized as follows:

- .1 The cost estimates were updated to August 2008.

- .2 Construction Value was updated using STATSCAN Table 327-0039 - Price indexes of non-residential building construction, industrial structures for Vancouver, B.C. (1)
- .3 For work that has been completed, these have been removed from the updated cost estimates.
- .4 Cost estimates reflect revisions to previous cost estimates due to subsequent design activities. In particular co-generation, digestion and primary sludge thickening costs.
- .5 The allowance for Engineering, Contingencies and other factors increased by 10% to reflect additional soft costs such as geotechnical, environmental, regulatory, administration and permitting costs. The total allowance included for these items is 40%.

Note that the STATSCAN values were taken in lieu of the more common Engineering News Record Construction Cost Index (ENR CCI) since the STATSCAN index best reflected the market conditions experienced in BC since 2003. A comparison of the two indices is provided on the following table (for information purposes ENR CCI Values have also been presented for the cities of Toronto and Seattle.)

Index	STATSCAN Table 327-0039	ENR- CCI (North America)	ENR – CCI (Seattle)	ENR – CCI (Toronto)
Index Value 2002	108.3	6500	7560	8100
Index Value August 2008	189.5	8362	8762	9555
Total Increase (%)	75 %	29 %	16 %	18 %
Average Year to Year Annual Increase (%)	9.8 %	4.3 %	2.5 %	2.8 %

Based on the above, the previous construction cost estimates were increased by 75% (by multiplying them by 1.75) and then the resulting product was multiplied by 1.4 to take into account contingencies and engineering. Additional amounts, not included here, would have to be added to account for RDN project financing costs. O&M costs are estimated, at this level of accuracy, to be approximately 4% of capital, which is intended to cover future equipment repairs, chemical use, electrical use, and staffing.

3.3.2 The Revised Estimate

Based on the above approach, a summary of the updated costs estimates to August 2008 follows:

Stage	Original Amount (2002 \$)	Updated Amount (2008 \$)	Estimated O&M Cost (2008 \$)
Stage 3 – Primary Treatment, Upgrading and Expansion	\$7,500,000	\$11,450,000	\$460,000
Stage 3 or 4	\$10,600,000	\$17,750,000	\$710,000
Stage 4 – Secondary Treatment Upgrading	\$26,400,000	\$55,700,000	\$2,230,000
Stage 4 or 5	\$4,100,000	\$1,150,000	\$46,000
Stage 5 – Secondary Treatment Expansion	\$9,100,000	\$17,300,000	\$692,000
Total Development Plan	\$57,700,000	\$103,350,000	\$4,138,000

3.3.3 Summary of GNPCC Cost Updates

Based on the previously prepared cost estimates, we have updated the estimated costs for upgrading the GNPCC to reflect escalated costs to August 2008. The revised estimate considers projects already completed as well as revised values due to subsequent capital projects and engineering studies carried out since the preparation of the original estimate. In addition, the allowance for engineering, contingencies and other factors has been increased from 30% for most items to 40%. It should be noted that costs from 2008 will escalate from now until the time of construction. As a result, as time progresses, future cost estimates and forecasts will be required.

3.4 Cash Flow Requirement for GNPCC Upgrades

Based on the above, the cash flow requirements for the GNPCC facility upgrades would likely be as follows:

Stage	Updated Amount	Year(s) for Implementation
Stage 3 – Primary Treatment, Upgrading and Expansion	\$11,450,000	2009 to 2012
Stage 3 or 4	\$17,750,000	2009 to 2017
Stage 4 – Secondary Treatment Upgrading	\$55,700,000	2013 to 2017 with secondary trains in by 2015
Stage 4 or 5	\$1,150,000	2020 to 2028
Stage 5 – Secondary Treatment Expansion	\$17,300,000	2029 to 2032
Total Development Plan	\$103,350,000	

4 French Creek Pollution Control Centre

The FCPCC currently operates with primary treatment followed by trickling-filter solids contact (TF/SC) secondary treatment, including secondary clarification. While treatment processes other than TF/SC might be selected for the next expansion of the treatment plant, the estimated costs for expansion of the secondary process are currently based on the TF/SC process. These costs were most recently updated in 2006.

The Stage 4 expansion, scheduled to occur in 2011, would include the following:

- Two new trickling filter bays located immediately beside and to the north of the current trickling filter, additional solids contact system improvements
- Two new secondary clarifiers located to the north of Morningstar Creek.
- A new cycled biological sludge (RBS) pump station to return solids from the new secondary clarifiers to the solids contact tanks.
- Retrofitting of some of the existing secondary clarifiers into primary clarifiers, e.g. No. 1 secondary would be converted to No. 4 primary.
- Expansion of the ATAD sludge digestion system (tanks already in place).
- Improvements to the effluent pumping system.

4.1 Previous Cost Estimates

Previous cost estimates for future upgrades at the FCPCC were most recently presented in a December 2006 upgrades report entitled “Performance Evaluation and Upgrading Plan Update”. Some of the cost items included in that report have since been implemented or are in the process of being implemented. Of those that remain, the major ones that remain include those in the table below:

FCPCC Upgrade Item	Amount (2006)
Implement Short-term chemically-enhanced primary treatment	\$590,000
Commission Fifth ATAD digester	\$250,000
Install second dewatering centrifuge	\$550,000
Add RBS pumping capacity	\$130,000
Stage 3 – Phase 2 – secondary treatment optimization and new secondary clarifier	\$2,090,000
Stage 4 – TF/SC Plant Expansion No.1 (including outfall)	\$28,000,000
Total Development Plan	\$ 31,610,000

4.2 Revised Cost Estimates

Based on the work to update the GNPCC cost estimates, we have again used the STATSCAN index as the basis for the cost increases. In this case, the indices of concern are the 2006 value 151.9 and the latest 2008 value, 189.5, an increase factor of about 24.75%. Since the 2006 FCPCC cost estimates already included approximately 40% for engineering and contingencies, no further cost increase factors will be used to update the 2006 estimates to 2008 dollars. The results of the 24.75% cost increase factor and the 4% O&M cost estimate are shown in the following table:

FCPCC Upgrade Item	Estimated Cost (2006 \$)	Estimated Cost (2008 \$)	Estimated O&M Cost (2008 \$)
Implement short-term chemically-enhanced primary treatment (CEPT)	\$590,000	\$740,000	\$30,000
Commission fifth ATAD digester	\$250,000	\$315,000	\$13,000
Install second dewatering centrifuge	\$550,000	\$690,000	\$28,000
Add RBS pumping capacity	\$130,000	\$165,000	\$7,000
Stage 3 – Phase 2 – secondary treatment optimization and new secondary clarifier	\$2,090,000	\$2,610,000	\$105,000
Stage 4 – TF/SC Plant Expansion No.1 (c/w outfall)	\$28,000,000	\$34,910,000	\$1,400,000
Total Development Plan	\$31,610,000	\$39,430,000	\$1,583,000

4.3 Cash Flow for Major Upgrades

FCPCC Upgrade Item	Estimated Cost (2008 \$)	Year(s) for implementation
Implement short-term chemically-enhanced primary treatment (CEPT)	\$740,000	2009 or as needed
Commission fifth ATAD digester	\$315,000	2010 or as needed
Install second dewatering centrifuge	\$690,000	2009
Add RBS pumping capacity	\$165,000	Only if needed
Stage 3 – Phase 2 – secondary treatment optimization and new secondary clarifier	\$2,610,000	May not be needed if CEPT is successful
Stage 4 – Secondary Treatment Plant Expansion No.1 (c/w outfall)	\$34,910,000	2010-2012
Total Development Plan	\$39,430,000	

5 Nanoose Pollution Control Centre

The NPCC is a small primary treatment facility designed to accommodate a service population of 1,500 persons, with a current service population of approximately 800 residents. The RDN committed, through the 1997 Liquid Waste Management Plan, to upgrade the NPCC liquid-stream treatment process to include secondary treatment when the service population for NPCC reaches 6,000 persons. In 1997, it was likely assumed that this population would be reached before 2010 through growth and potential trunk sewer expansions to Madrona, Wall Beach, Delanice Way, Beachcomber, Red Gap and Garry Oak (Reference: pg. 16 and Table 4.1 of the LWMP). As a result, in the 1997 LWMP, this population-triggered upgrade was scheduled for the 2005-2010 period. In reality, the extensions of the trunk sewer system were not made and the growth in the service populations from 500 in 1997 to 800 recently, has been much slower than had been anticipated. On this basis, there is merit in extending the 2010 date for the upgrading of Nanoose to secondary treatment to something more realistic. This is especially true in light of the relatively low service population and the cost of upgrading to secondary treatment that would have to be borne by this population.

Class D capital cost estimates for secondary treatment upgrades for the NPCC were developed (Associated Engineering, 2006). At that time, it was arbitrarily assumed that the RDN would have

secondary treatment operational at NPCC by 2012, independent of service populations. The capital cost estimate and operations and maintenance costs for secondary treatment upgrades were developed using the following assumptions:

- All new works would be related to secondary treatment and/or the significantly increased treatment capacity.
- Primary treatment would be decommissioned, rather than maintained and expanded.
- Ultraviolet-based effluent disinfection system.
- Treatment system would not include ammonia removal at this time.
- Solids-stream handling systems that would include aerobic solids digestion and mechanical dewatering.
- Effluent outfall was excluded from the cost analysis.

Cost estimates included engineering and construction costs and contingency allowances. Cost estimates were developed based on similarly sized facilities located in southwestern British Columbia. The developed capital cost estimate for the secondary treatment facility was \$10,400,000 in 2006 dollars. Similar to the capital cost estimate, the operations and maintenance cost was developed using data from similar and recently constructed treatment facilities. The anticipated O&M cost, assuming a 6,000 person service population is in place would be about \$400,000 per year in 2006 dollars. Based on the FCPC discussions in Section 4, the factor to increase these previous 2006 cost estimates to 2008 is approximately 24.75%, which would bring the new cost estimates for NPCC upgrades to approximately \$12,975,000 for capital cost and \$ 500,000 for O&M costs.

Based on the current service population (approximately 800 persons), with an average of a three-person household, the capital cost of this upgrade would be approximately \$48,600 per household, well above a reasonable level of affordability. Based on this cost, unless additional service population is added very quickly, upgrading the NPCC by 2010 would be unacceptably financially onerous on the specified service area population. While the 6000 person trigger population might be too far in the future, it would appear that for the NPCC, some date between a 2010 implementation date and the 6000 person population would be more appropriate than 2010.

6 Duke Point Pollution Control Centre

DPPCC is a secondary treatment facility consisting of two sequencing batch reactors. The DPPCC is currently the only RDN's facility with a Ministry of Environment approved operational certificate.

As presented in Discussion Paper No. 5 (Associated Engineering, 2008), the DPPCC is generally well below its current design capacity.

The current estimated cost to twin the DPPCC is approximately \$ 4.7 million.

The timing of such an upgrade depends entirely on the increase to the connected sewered population. At this point, it is not clear when such an increase in capacity would be needed.

7 Future Staffing Requirements

Moving to secondary treatment at the GNPCC and expanding the FCPCC will likely require an increase in staff. At present there is one Operations Supervisor for all plants plus 11 staff at GNPCC (1 Chief Operator, 4 Operator Level 3s, 4 Operator Level 2s, and 2 Operators-in-Training) and 9 staff at FCPCC (1 Chief Operator, 2 Operator Level 3s, 4 Operator Level 2s and 2 Operators-In-Training). In a September 8, 2008 memorandum to the RDN on future staffing levels, Associated Engineering, estimated future staffing levels for GNPCC and FCPCC based on data from a Water Environment Federation survey of 110 wastewater treatment plants regarding their staffing levels (WEF, 1998). The data were examined in two different ways: straight numbers and numbers broken down to staff per 1000 m³/day. The results were the upgrade to secondary treatment at GNPCC could require up to a total of 29 operational staff depending on the process selected, the level of weekend staffing and the degree to which the future plant will be automated. For the FCPCC, the initial 2012-13 expansion would require a total of 10 staff (an increase of one) with the future 2025 expansion requiring an additional 3 staff, for a total of 13.

The above estimates are based on a 7 day per week operation and include additional duties, such as maintenance of the RDN pump stations and attending the DPPCC and NPCC. If the plant is left unstaffed over the weekend or if the staff did not do pump stations, staffing levels could be lower. For example, the Comox Valley Pollution Control Centre (CVPCC) serving Courtenay and Comox and area is a secondary treatment plant that is only staffed Monday to Friday. The CVPCC has average flows in the range of 15,000 m³/day (about the same as the future FCPCC expansion flows). They currently have one Chief operator, 6 Level 3 operators, and one Level 2 operator at the treatment plant, plus two more staff at their biosolids composting operation, for a total of 10 staff. They are planning on adding one additional staff in the near future.

Another comparable example for future staffing requirements is the City of Abbotsford's JAMES PCC. The JAMES plant is a TF/SC plant like FCPCC but the flow are significantly higher, e.g. average flows of 65,000 m³/day, which is the upper range of the future upgraded GNPCC. The JAMES plant is currently staffed by 1 plant manager, 8 operators, 2 millwrights, 1 electrician and 1 lab staff, for a total of 13. The plant manager indicated that this level is reflective of the fact that they do not staff the plant on the weekend, they do not do any pump station maintenance and, perhaps most importantly, the TF/SC process is not as staff intensive as some other wastewater treatment processes like activated sludge.

Based on the above the future level of staffing needs to be a consideration of part of the GNPCC secondary process selection. In addition, policies on weekend staffing and levels of automation will have to be considered during the preliminary design of the future treatment plant.

8 Summary

Previous cost estimates for GNPCC, FCPCC, NPCC and DPPCC have been updated using STATSCAN construction related indices and, in some cases, increases to the engineering and contingency allowances from 30% to 40%. These updated costs have then been summarized and dates associated with their likely implementation have been assigned. For the GNPCC, the amounts are significant, especially when secondary treatment is implemented starting in 2013. The costs for the FCPCC are also significant and are primarily related to the expansion of the secondary treatment process. The cost to upgrade the NPCC to secondary are shown to be too high to be affordable for the current small connected population. On this basis, it is suggested that the original NPCC secondary treatment implementation date of 2010 was based on an assumed need to service 6000 people, not the current 800 connected people and, as a result, the implementation date should be extended beyond 2010. DPPCC currently has so much excess capacity that the timing of secondary expansion is completely unknown and dependent on decisions to expand the sewer service area.

Future staffing level requirements were reviewed. FCPCC will likely need to increase its staff from 9 persons to approximately 13 with future expansions. GNPCC will likely also have to increase its staff levels from the current 11 to upwards of 29. This latter level is significant and could be reduced by selecting less personnel-intense treatment processes as well as limiting staffing to five days per week and increasing the level of plant automation.

9 References

Associated Engineering. 2003. Greater Nanaimo Water Pollution Control Centre Stage 3 Expansion – Process Alternatives and Layouts. Regional District of Nanaimo, Nanaimo, British Columbia.

Associated Engineering. 2006. Secondary Treatment Brief. Memo from L. Pickard to S. De Pol, July 27, 2006.

Associated Engineering, December 2006, Performance Evaluation and Upgrading Plan Update, Regional District of Nanaimo, Nanaimo, British Columbia.

Associated Engineering. 2008. Discussion Paper No. 5: Current Flows and Loads, Effluent Quality, and Treatment Plant Capacities. Regional District of Nanaimo, Nanaimo, British Columbia.

Water Environment Federation (WEF) 1998, Design of Municipal Wastewater Treatment Plants - MOP 8, 4th Edition.

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Discussion Paper

Date: April 20, 2009
To: Sean De Pol, RDN – Manager, Wastewater Services
From: David Lycon, AECOM – Senior Wastewater Engineer
Project Number: 111660 (03)
Subject: Integrated Resource Management Opportunities for the Regional District of Nanaimo

Distribution: RDN – Lindsay Dalton
AECOM – Will Wawrychuk, Catherine Dallaire, File

draft for discussion

1. Introduction

As the Regional District of Nanaimo (RDN) Liquid Waste Advisory Committee reviews the Liquid Waste Management Plan (LWMP), the wastewater industry is undergoing a paradigm shift. Increasingly municipalities are considering options that will allow them to reduce the energy they consume and optimize the resources they can recover from the treatment of their wastewater. In B.C., the provincial government is encouraging municipalities and regional districts such as the RDN to take into consideration such options.

This discussion paper includes a review of the Province's view on Integrated Resource Management (IRM), or Integrated Resource Recovery (IRR) as it is sometimes referred to. They are interested in ways by which valuable resources can be recovered both from the solid and liquid components of wastewater. This paper will further summarize the relevance of each opportunity to the RDN's main wastewater treatment plants (Greater Nanaimo Pollution Control Centre and French Creek Pollution Control Centre). Each relevant opportunity will be further scrutinized as the process selection exercise for each plant is developed.

1.1 Wastewater Solids

Solids in wastewater treatment processes represent a significant potential source of resource recovery (Table 1). The solids are referred to as either *sludge* or *biosolids*. The term *sludge* refers to the solids prior to treatment for beneficial use, where *biosolids* refers to solids after treatment.

Table 1. Resources Recoverable from Wastewater Treatment Solids¹

Type of Recovered Product	Use of Product
Methane	Electricity, Heat, Fuel
Gases	Electricity, Heat
Oil, fat, greases	Bio-Diesel, methane
Phosphorus	Fertilizer
Nitrogen	Fertilizer
Metals	Coagulants
Inorganic material	Building material
Organic compounds	Organic acid production
Inoculum	Bio-Hydrogen gas production
Crystal proteins, spores	Bio-pesticides production

This list of examples serves to show the direction the wastewater industry is taking. Some of the technologies listed in the table are still not proven to be viable in the North American context. This discussion paper will focus on the resource recovery options that represent the most promising opportunities for the RDN.

1.2 Liquid Component of Wastewater

The liquid component of wastewater, specifically treated wastewater called effluent, holds water that can be reused for irrigation and heat. The heat stored in a wastewater treatment plant's effluent comes in part from the residential and commercial hot water heaters used across the Regional District, and from within the plant's treatment processes themselves. The hot water used for domestic and commercial purposes is sent down the drain at a relatively high temperature which means with thermal energy/heat that can be recovered and reused. The recovered waste heat from the effluent can be reused for space and domestic water heating.

Depending on the level of treatment and intended use, the effluent can also be used as source of raw water, replacing the requirement for potable water from the Regional District's network. While a desirable practice, it is not always viewed as a priority given the Province's climate and availability of raw water sources.

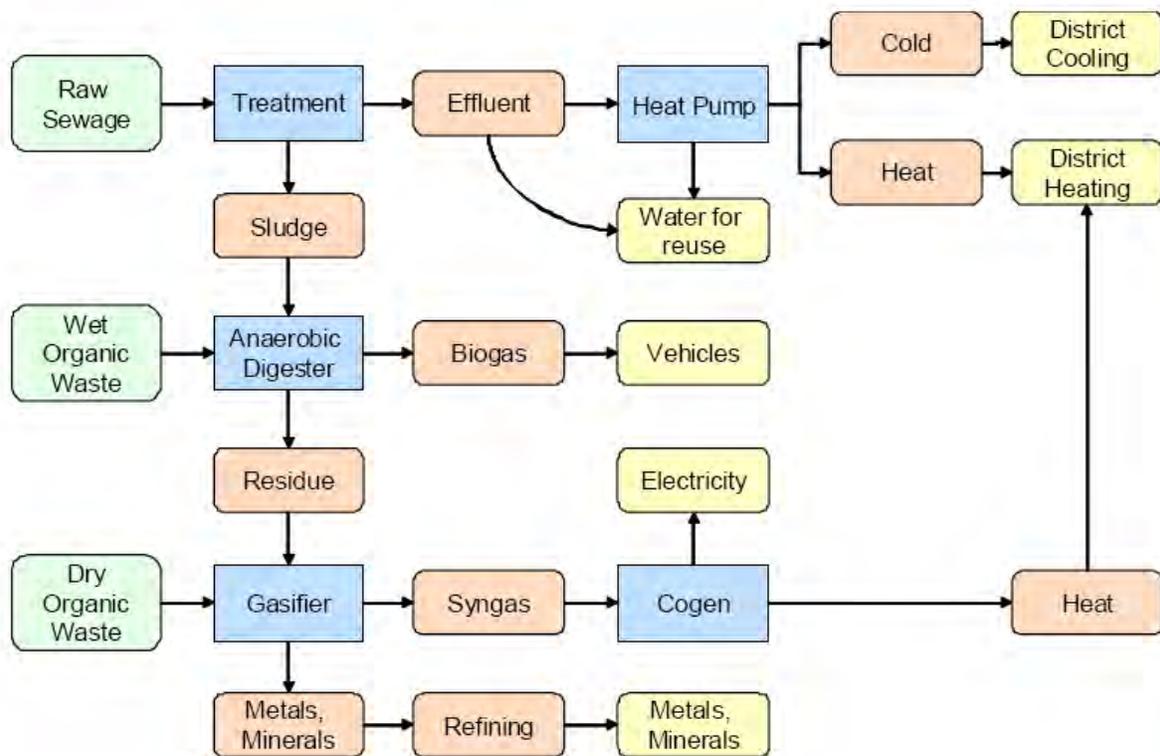
2. Supporting Provincial Policy

In February 2008 the Ministry of Community Services published the Phase I Study Report on IRM "Resources from Waste". The IRM approach sees the amalgamation of the three urban waste management streams for wastewater, stormwater and solid waste. It aims to create a more sustainable and integrated approach to wastewater management and resource recovery, and has the following main characteristics:

¹ Table1 was developed by the Water Environment Research Foundation (WERF) in a state of science report on recoverable resources from sludge.

- It promotes smaller localized facilities for the treatment of wastewater to reduce pumping needs and the ensuing greenhouse gas emissions from energy use;
- The capture of energy (Figure 1) by the combination of municipal organic solid waste and sludge to increase biogas production;
- The re-use of treated wastewater at a tertiary level for irrigation, commercial and industrial consumption, or for groundwater recharge; and
- It is driven by the highest and best use, and value business case.

Figure 1. Resource Recovery Pathway



Beyond being environmentally focused, a principle that was adopted when the IRM was developed is that in future infrastructure planning net revenues generated from recovered resources should be placed as a priority before engineering options, design and costs. This presents a new business case approach, similar to the private sector's, for assessing the most viable method for waste management.

The IRM approach itself coincides with many existing provincial policies including:

- The Climate Action Plan to reduce GHG emissions in the province by 33% below 2007 levels by 2020;

- The Climate Action Charter of which the RDN is a signatory;
- The Energy Plan which aims to reduce GHG emission from energy production; and
- The Bio-Energy Strategy which aims that by 2020 bio-fuel be equal to 50% of renewable fuels produced in the province.

As the Regional District considers sustainable approaches in the review of its LWMP, it aligns itself with the goals of the Province. This is an alignment that has benefited other communities as they have received infrastructure grants to implement said goals.

3. Recoverable Resources

3.1 Methane (Biogas)

In wastewater treatment plants methane gas is produced and collected within anaerobic digesters. The gas is produced by bacteria as they decompose the volatile organic material present in the sludge. The gas in turn can be used to generate electricity, heat and/or fuel. The practice of anaerobic digestion has been common in wastewater treatment plants for a number of years, but it is only over the past 10 to 15 years that recovery of the methane has become more of an area of interest.

3.1.1 Anaerobic Digestion

Anaerobic digestion involves the decomposition of the volatile organic matter and sulfate in sludge by bacteria in the absence of oxygen. In stabilizing concentrated sludge, anaerobic digestion produces gas that contains approximately 65-70% of methane (CH₄) by volume, 25-30% carbon dioxide (CO₂), and small amounts of nitrogen (N₂), hydrogen (H₂), hydrogen sulfide (H₂S), water vapor, and other trace gases. The extent of methane production and sludge stabilization depends on temperature and providing sufficient residence time to allow significant destruction of the organics to occur by the bacteria.

Temperature is important in determining the rate of digestion, as biochemical reaction rates increase with temperature. Most anaerobic digestion systems, including Greater Nanaimo's, are designed to operate with bacteria in the mesophilic range, between 30 and 38°C. Other systems are designed for operation with bacteria in the thermophilic temperature range of 50 to 57°C.

Thermophilic digestion is much faster than mesophilic digestion because of the higher temperature, and subsequent higher reaction rate. Advantages cited for thermophilic digestion include increased solids destruction capability, improved dewatering, and increased bacterial destruction. Disadvantages are higher energy requirements for heating, poorer-quality supernatant containing larger quantities of dissolved solids, odours, and less process stability.

The IRM favours anaerobic digestion in the thermophilic range since it produces higher methane yields, but there are other opportunities for enhancing the performance of anaerobic digesters. This is primarily accomplished by increasing the residence time of sludge in the digester. Residence time of sludge is defined by:

- Solids retention time, the average time the solids are held in the digestion process; and
- The hydraulic retention time, the average time the liquid is held in the digestion process.

Concentrating the feed sludge going into the digester or thickening a portion of the digesting sludge can increase the solids retention time and reduce the hydraulic retention time. In short, thickened sludge contains more organic food for the bacteria to convert into biogas and less water that takes up valuable digester space. The Regional District is already familiar with this practice as they have recently implemented gravity thickeners for the primary sludge feed into the digesters at the Greater Nanaimo Pollution Control Centre (GNPCC).

3.1.2 Co-Generation of Electricity & Heat

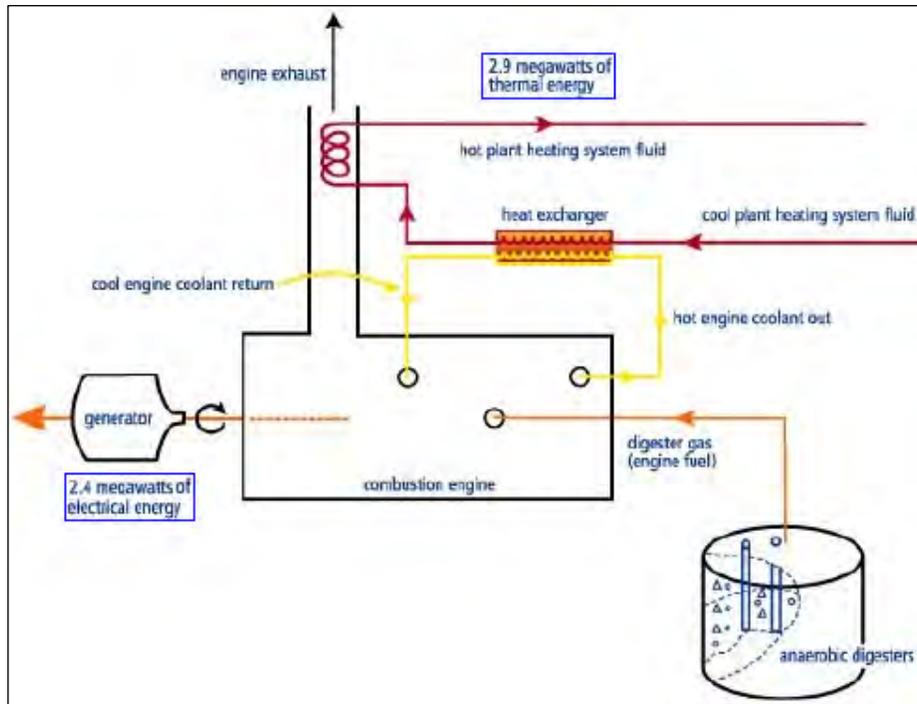
Methane gas at standard temperature and pressure (20°C and 1 atm) has a lower end heating value of 36 MJ/m³. Because digester gas is only 65% methane the lower end heating value of digester gas is approximately 23 MJ/m³. By comparison natural gas which is a mixture of methane, propane and butane has a lower end heating value of 38 MJ/m³. Nonetheless, digester gas is highly flammable and can be used as fuel for cogeneration of heat and electricity.

Cogeneration has a long history in Canada with the first plants being built for radar sites in the Arctic in the 1960s. There are several industrial and municipal installations where surplus power, over and above that required for plant purposes, is sold to local electric utilities. According to Environment Canada, cogeneration could supply more than 20% of the country's current electricity needs.

Before cogeneration processes are installed, wastewater treatment plants typically use the digester gas for building and process heating purposes. In the warm summer months this heat demand decreases and the excess digester gas is flared. Cogeneration processes can put to good use the excess biogas by producing electricity with internal combustion engines that drive generators and recover the heat produced in gas combustion. The overall energy recovery efficiency is reported to be 75-85%.

As an example, the City of Ottawa does this at its Robert O. Pickard Environmental Centre. The cogeneration facility at the Pickard Centre converts 32% of the available energy in the digester gas to electricity and 48% to heat. This electrical power (2.4 megawatts) and thermal energy (2.9 megawatts) reflects enough electric power to supply 2,000 homes and enough heat for 400 homes. The cogeneration plant was built at a cost of \$4.5 million, which in turn saves Ottawa taxpayers \$650,000 annually on the purchase of electricity. At the Pickard Centre, digester gas from the anaerobic digesters is piped and burned by three continually running combustion engines located in the cogeneration facility. The digester gas serves as fuel for the engines that drive the generators, producing the electricity. A schematic of the overall process is illustrated below in Figure 2.

Figure 2. Typical Wastewater Treatment Plant Co-Generation Facility



As illustrated above in Figure 2, heat generated from the gas combustion is captured and utilized in two ways:

- Circulating coolant runs through cavities in each engine body and is warmed to approximately 120°C. The hot coolant is then channelled to a heat exchanger where the heat is transferred to the plant heating system; and
- Exhaust gas runs through a heat exchanger. The heat recovered in this process is also transferred to the plant heating system.

3.1.3 Co-Digestion of Biosolids & Municipal Solid Waste

The IRM model promotes the practice of mixing organic kitchen waste with wastewater treatment plant sludge for increased biogas production by digesters. The combined anaerobic digestion of sludge and municipal organic solid waste is a proven technology. This practice has been put into full scale operation in Sweden. However, according to a study performed by Gartner Lee (now AECOM) for the RDN, the anaerobic digestion of organic solid waste although technically viable is not economically viable in the North American context.

Recently it was recommended by AECOM in a draft Technical Memorandum (February 16, 2009) that the opportunity for co-digestion of organic solid waste and wastewater treatment plant sludge not be considered further by the RDN. The reasons being that:

- Based upon their Solid Waste Management Plan, the RDN is moving towards a cost-effective, timely, and sustainable diversion of organic waste from its solid waste stream;
- Adding the element of co-digestion would require a significant investment for larger digester(s) which may not be able to be sited at the GNPCC; and
- Creating an end use for the surplus biogas would increase the required infrastructure investment.

3.1.4 End Uses for Biogas

Biogas from anaerobic digestion can potentially be sold back to natural gas utilities and reformed to hydrogen or into liquid fuels such as ethanol. According to the IRM, the best use for biogas would be to displace gasoline or diesel for transportation. However these options for biogas do not represent the most promising opportunities for the RDN at present given the size and location of its wastewater treatment plants.

3.2 Compost

Composting is a viable method for sludge stabilization and resource recovery after it has been dewatered. Most composting operations are aerobic and consist of the following steps:

- Preprocessing - the mixing of dewatered sludge with an amendment material and/or a bulking agent;
- High-rate decomposition by micro-organisms (bacteria, actinomycetes and fungi) and aeration of the mixed biosolids/amendment pile either by the addition of air, by mechanical turning or both;
- Recovery of the amendment and or bulking agent (if applicable);
- Further curing and storage, which allows for additional stabilization and cooling of the compost;
- Postprocessing, screening for the removal of non-biodegradable material (if applicable); and
- Final disposition.

This practice is becoming increasingly common in response to an anticipated shortage of landfill space in many communities. In addition to leaving space at the landfill composting sludge creates a fertilizer superior to commercial chemical fertilizers, or can be used as cover for landfill completion. It contains plant nutrients such as phosphorus and nitrogen which are released over a long period of time and the humus quality of the compost helps to retain water and nutrients.

The RDN is already familiar with biosolids diversion from their Regional landfill. Biosolids from the two pollution control centers were diverted from the landfill and are being successfully used for land reclamation. Biosolids from both the GNPCC and FCPCC are managed by Vancouver Island University and are used as part of a Forest Fertilization Project on their woodlot. The university has forest sites which lack soil nutrients that have strongly benefited from the application of biosolids. According to the University's website (<http://www.viu.ca/forestry/biosolids/index.asp>), the project which began in 1992 has seen increases in tree growth from 50% to 400%. Trees treated with

biosolids also appear healthier; needles and buds are longer, greener and more numerous. It serves as an example that the health of forests can be improved in an ecologically sensible way.

3.3 Phosphorus

Wastewater contains an important component of fertilizer, phosphorus. If discharged to the environment in excess it can cause the depletion of water resources by eutrophication. Eutrophication is the enrichment of water bodies with nutrients such as phosphorus and nitrogen which causes growth of algae beyond the carrying capacity of the ecosystem. This leads to the decline of animal and other plant populations because of decreased light in the water column and increased CO₂ concentrations.

Luckily, phosphorus can be recovered from sludge and increasingly there is reason to do so as the reserves held in the Earth's crust are limited and depleting because of increasing global demand. In an article published in 2004, Helmut Kroiss of the Vienna University of Technology wrote: *"The conclusion is that phosphorus is the most valuable compound in sewage sludge from the sustainability point of view but also in regard to the economic value. The recovery of phosphorus can become a vital resource for food production of the global population in the foreseeable future."*

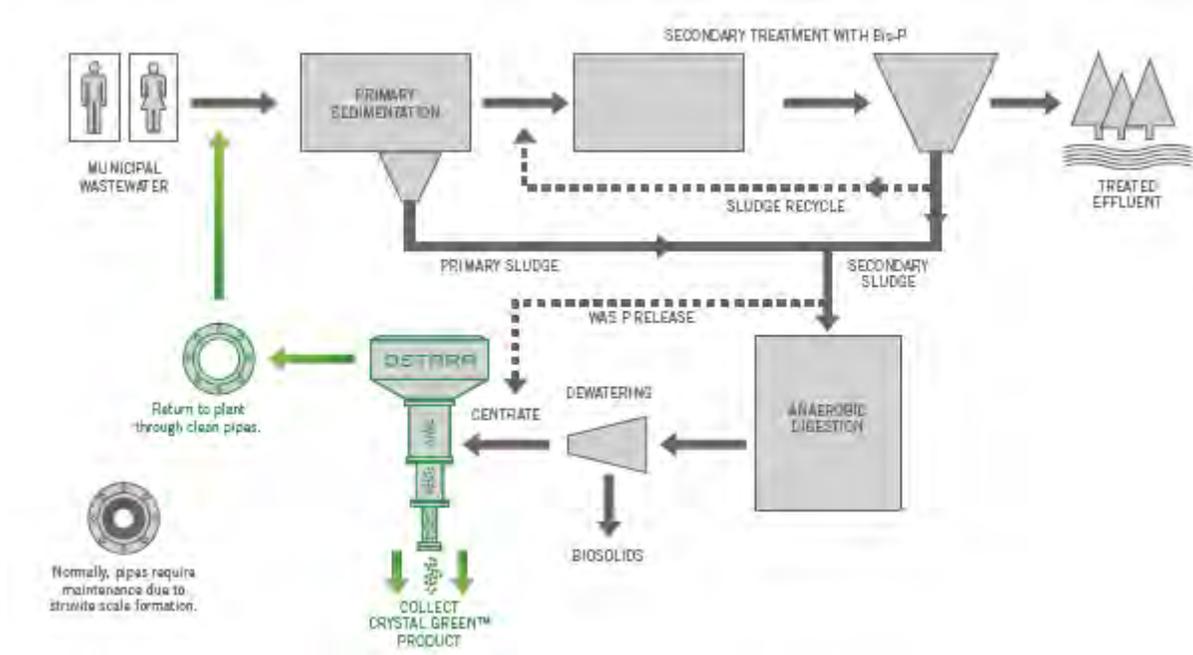
3.3.1 Struvite

Phosphorus can be recovered chemically and biologically. An innovative process was developed to recover phosphorus from sludge (75 to 80%) at the University of British Columbia and commercialized by Ostara Nutrient Recovery Technologies Inc. of Vancouver. The process recovers phosphorus in the form of struvite (crystalline magnesium ammonium phosphate). In its commercial form the Ostara process by-product is referred to as Crystal Green™. Unlike most fertilizers, Crystal Green™ dissolves slowly over a nine-month period and therefore is environmentally safe because it does not leach into the water table, or run off the surface of the ground. It is currently used in agriculture, horticulture and silviculture.



The Ostara process requires the centrate from dewatered anaerobically digested sludge. The centrate is usually returned to the beginning of the treatment process for further treatment. By undergoing the Ostara treatment process, the centrate returns to the head of the plant with less nutrients which increases plant capacity and reduces the scaling of pipes due struvite accumulation. Figure 3 provides a basic level overview of how this process fits into the overall wastewater treatment plant process.

Figure 3. Nutrient Recovery and Struvite Mitigation



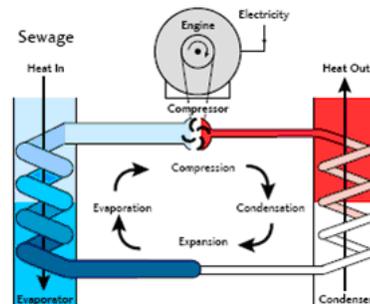
There are Canadian wastewater treatment plants that have implemented the technology. The City of Penticton and Metro Vancouver did so at a pilot scale and the Goldbar plant in Edmonton became the first commercial-scale producer of this product following a successful pilot study. It produces approximately 500 kg/d of Crystal Green™ by treating the effluent of a city of 700,000 people.

3.4 Effluent Heat

Much of the energy that is used to heat potable water by its users for domestic and commercial use is wasted to the sewer and then to the environment via the treatment plant's effluent. Municipal wastewater heat is an advantageous source of community energy for water and space heating. It is stable and available in substantial quantities. The heat contained in 10°C to 20°C effluent can be safely captured and increased to a useable temperature as high as 65°C with the use of heat pump technology.

3.4.1 Heat Pump

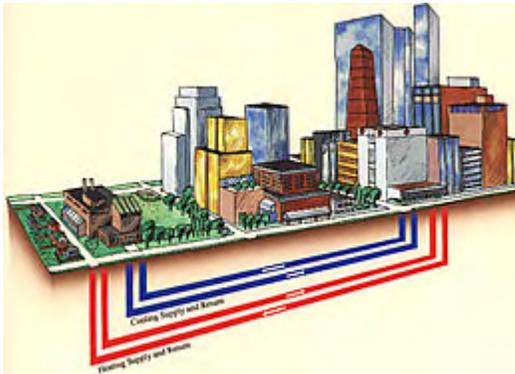
The heat pump is a proven technology that operates in a fashion similar to a refrigerator by transferring thermal energy from a low temperature source and making it available at a higher temperature. It is highly efficient; for the same electricity input into the compressor motor, heat pumps provide three times the heat of a conventional electric heating system.



3.4.2 District Heating Systems

The upgraded effluent heat can be used within the wastewater treatment plant or distributed to residential, institutional and commercial users by means of a district heating system (DHS), also known as district energy system. Although wastewater heat is the main source of energy, back up boilers are always included for peak demand during the coldest days of the year. There are two types of DHS, low temperature and high temperature network systems.

3.4.2.1 Low temperature networks



Low temperature networks are best for cases in which the pipeline must extend more than one kilometre from the utility to the customers. The temperature of the water that circulates from the utility to the user ranges usually from 10 to 20°C. According to SuisseEnergie, less expensive non-insulated pipes can be used since heat losses to the ground are small because of the small temperature difference between the ground and the water in the pipe.

With a low temperature network, each building connected to the DHS must consequently have its own heat pump system to increase the low-grade heat to usable temperatures. This allows each building to have a heat pump system that provides usable temperatures specific to their heating system temperature requirements.

3.4.2.2 High temperature networks

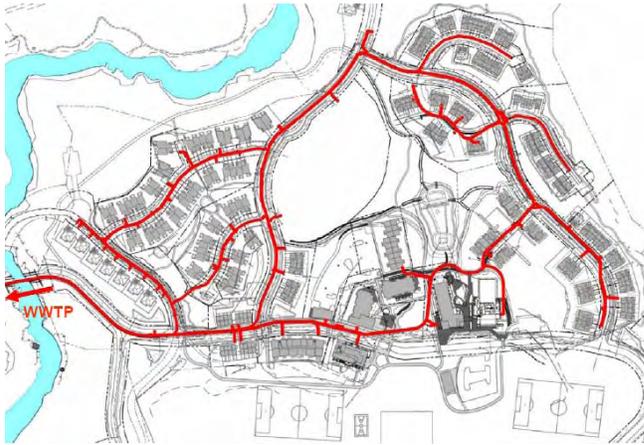
High temperature networks are best when customers are close to the utility. An advantage of centralized heat generation at the utility is that heat transfer units are easier to maintain and rates are easier to set. The advantage to the customer is that they can use the space normally required for heating systems in their buildings for other purposes, if a back-up heating system is not required.

3.4.3 Examples in Canada

The countries with the most knowledge, technology and experience with wastewater heat recovery are Switzerland and Japan. Although the majority of wastewater heat recovery projects are found in Switzerland, Sweden, Japan and the United States, a few can be found in BC, as described below.

3.4.3.1 Athlete Village, Whistler

The wastewater heat recovery project in the Resort Municipality of Whistler (RMOW) is a part of the preparations for the 2010 Olympics. A low temperature DHS will serve to heat the Athlete Village/Cheakamus Legacy Neighbourhood; it will provide over 90 percent of the heating and up to 75 percent of the domestic hot water heating requirements for the village. The Whistler 2020 Development Corporation, a subsidiary of the municipality, is in charge of the planning, construction and operation of the village.



Heat exchangers at the WWTP will transfer the heat contained in the effluent to water contained in the DHS closed loop piping network. The addition of the heat exchangers to the WWTP comes at the convenient time when the plant is undergoing a major capacity upgrade. The pipe network will extend more than a kilometre from the plant to and across the village.

The housing units vary from townhouses to four story apartment buildings. Each building in the village will have a heat pump system to transfer the energy from the DHS pipe network to the building's space and water heating system. This DHS will have a low temperature heat network. The heat pumps will be sold with the housing units and owned by the building owner. Peak energy demands will be covered by electric heating.

The Municipality will remain the owner and operator of the DHS. When the project is completed, a Municipal department will then run the DHS from the WWTP. The DHS in Whistler will not be regulated by the British Columbia Utilities Commission. The rates will be based on operating, maintenance and replacement costs.

3.4.3.2 Okanagan College, Kelowna

The first Canadian DHS wastewater heat recovery project was completed during the upgrade of the Okanagan College heating system in 2003. The upgrade was mostly focused on the College's heat generation system which at the time consisted of two boilers with over a decade of operating time. A feasibility study recommended recovered effluent heat and high efficiency boilers to cover peak loads as a heat sources.

The effluent temperature at the WWTP varies between 12°C and 22°C. The effluent is pumped from a WWTP discharge chamber through a 500m long 200mm diameter PVC pipe to the central plant on campus. The effluent is circulated through a heat pump and is then returned to the WWTP discharge chamber at a lower temperature. The City of Kelowna agreed to the use of the effluent as long as no heat is rejected in the discharge by the campus. Maximum allowable discharge temperatures into Okanagan Lake are imposed on the City by Fisheries Canada.

The heat pump increases the temperature of the warm water that flows in the campus heat distribution network by 50°C to 55°C as it circulates through the heat pump. Two new high efficiency boilers were installed to supplement the heating requirement and two of the previous boilers were kept as additional back-up sources.

For a portion of the year, the heat provided by the heat pump is enough to cover the campus' needs. Peter Csandl, Manager of Operations and Energy Services, confirmed that when the heat demand increases during the cold season, the reclaimed heat is directed solely to the trades and health

buildings, approximately 100,000 square feet. At this time the boilers provide heat for the remaining buildings on campus.

Construction took a year to complete and the heating system was operational in 2004. The existing closed loop heat distribution network on campus made the heat source upgrade to wastewater more feasible. The Community Energy Association (CEA) reported that the upgrade cost approximately \$1.5 million to complete with annual savings of \$100,000. Although 15 years is a long cost recovery period for stakeholders envisaging a similar project, the cost benefit over the entire life cycle of the project is substantial. The college received funding from Natural Resources Canada's Energy Innovators Initiative and Aquila Networks Canada.

3.4.4 Benefits of District Heating

The magnitude of a DHS permits the cost effective installation of highly efficient heating technologies since incorporating low emission technologies or renewable energies is not often economically feasible for individual facilities. As a centralized thermal source, DHS also reduces the number of greenhouse gas emitters in a community. Other benefits associated with DHS community energy projects include:

- They offer the possibility of diversifying energy sources and securing the energy supply for an area; and
- They are an opportunity for job creation in the energy sector and keep energy dollars in the local economy (Community Energy Association 2007).

3.5 Water

The major pathways of water reuse include irrigation, industrial use, surface water replenishment and groundwater recharge for which case studies abound. The best case scenario for the RDN depends on the potential users in close proximity to the plants. Despite advances in treatment technology and growing water re-use, environmental and health concerns remain.

3.5.1 Re-use methods

The re-use of wastewater for agricultural purposes is the largest current use of reclaimed water. In North America, California is the largest user with an average daily consumption of 1,100,000 m³ for agricultural purposes alone (nearly 50% of total re-use). The second most important use of water is for landscape irrigation of parks, playgrounds and golf courses.

Groundwater recharge can be performed by direct injection of water into the aquifer. This however requires the injected water to be highly treated so it does not contaminate the groundwater. It is the method of groundwater recharge that has proven effective in creating freshwater barriers in coastal aquifers against the intrusion of saltwater from the sea.

Groundwater recharge can also be done by surface spreading. It is the simplest, oldest and most widely used method of groundwater recharge. It is the most favoured method of recharge because it allows efficient use of space and requires relatively low maintenance.

3.5.2 Environmental & Health Concerns

Despite the existence of technically proven advanced wastewater treatment processes, long term safety of reclaimed water and the impact on the environment are still difficult to quantify for the wastewater industry. There are a variety of constituents of concern from an environmental and health perspective that are found in wastewater. These are listed in the following table.

Table 2. Constituent of Concern for Effluent Re-use

Classification	Constituent
Conventional Those constituents measured in mg/L that have served as the basis for the design of most conventional wastewater treatment plants. These are also the constituents that fall under the guidelines associated with the <i>B.C. Municipal Sewage Regulation (MSR)</i> .	Total suspended solids
	Colloidal solids
	Biochemical oxygen demand (BOD)
	Chemical oxygen demand (COD)
	Total organic carbon (TOC)
	Ammonia
	Nitrate
	Phosphorus
	Bacteria
	Protozoan cysts and oocysts
Non-Conventional Those constituents that may have to be removed or reduced using advanced wastewater treatment processes.	Refractory organics
	Volatile organic compounds
	Surfactants
	Metals
	Total dissolved solids
Emerging Those classes of compounds measured in the micro- or nanograms/L range that may pose long-term health concerns and environmental problems.	Prescription and non-prescription drugs
	Home care products
	Veterinary and human antibiotics
	Industrial and household products
	Sex and steroidal hormones
	Other endocrine disrupters

For most of the emerging compounds listed in the table, there is little or no information concerning health or environmental effects. Some however are known to have acute or chronic health effects depending on their concentrations.

4. IRM Opportunities Relative to the RDN's WWTPs

Not all of the IRM opportunities discussed above necessarily have merit in the RDN's context. The following sections represent a list and discussion of the opportunities that could prove feasible at either the GNPCC and/or the FCPCC. These opportunities will need to be further refined once the process selection for each of the treatment plants is further defined. The intent is to develop an

appropriate secondary treatment process for both the GNPCC secondary treatment upgrade and the FCPCC secondary treatment expansion projects. This overall process selection project will be initiated in the coming month. As such, the identification of IRM opportunities for the RDN will likewise be finalized in October 2009 to allow for inclusion with grant documentation to the Ministry of Community Services.

4.1 GNPCC

Based on an initial assessment of the opportunities noted above, four appear to have potential for the GNPCC. These include:

- Struvite recovery;
- Effluent water re-use;
- Heat recovery from effluent; and
- Enhanced biogas recovery and utilization.

4.1.1 Struvite Recovery

With the implementation of secondary treatment at the GNPCC, there will likely be a blended sludge stream feeding the anaerobic digesters, consisting of both primary and secondary sludge. It is this combined sludge stream in treatment plants that leads to the formation of struvite from the centrate generated from the dewatering of the digested sludge. As noted above, there is a benefit to the recovery of this stream both in the production of a high grade fertilizer byproduct and in the elimination from the process piping of a stream that will eventually create a nuisance build up. A determination will have to be made early on in the design process as to whether this is an economical opportunity based on the size of the treatment plant and its corresponding production of centrate from the digested sludge.

4.1.2 Effluent Water Re-use

It may be challenging to develop a business/technical case for water re-use in conjunction with the upgrade to the GNPCC. Aside from internal re-use, external re-use may not have an end-user within a reasonable distance of the treatment plant. Typically effluent re-use in the Province is geared towards irrigation of golf courses and municipal parks. As they are unlimited public use facilities, these applications also require a high level of treatment/disinfection. It will have to be further determined if such an end-user exists in relative close proximity to the GNPCC.

4.1.3 Heat Recovery from Effluent

This represents perhaps the most viable of the four identified IRM opportunities. The potential for heat from effluent use both internally and externally should be examined in more detail prior to the submission of any grant application for IRM-related funds. The heat pump technology could also be applied to older existing buildings at the GNPCC where current unit heaters may be nearing the end of their lifecycle.

4.1.4 Enhanced Biogas Recovery and Utilization

With the addition of secondary sludge into the anaerobic digestion process, there is a potential for greater production of biogas due to an increase in the volatile component of the feedstock. The

GNPCC already utilizes its digester gas in boilers for digester related process heating, and is currently in the early implementation stages for a co-generation facility. The development of the design for Digester 3 will help in the process of establishing biogas quantity projections. This in turn will allow for the development of a firm utilization strategy prior to the submission of any grant application for IRM-related funds for co-generation.

4.2 FCPCC

Based on an initial assessment of the opportunities noted above, three appear to have potential for the FCPCC. These include:

- Effluent water re-use;
- Heat recovery from effluent;
- Biosolids composting; and
- Enhanced biogas recovery and utilization.

4.2.1 Effluent Water Re-use

The FCPCC already has a current effluent re-use strategy with its provision of seasonal irrigation water to the adjacent Morningstar Golf Course. As noted above for the GNPCC, effluent re-use is dependant upon having end users in nearby proximity to the treatment plant. Aside from the golf course, other end-users would have to be identified to determine if expansion of this system within the IRM context would be feasible.

4.2.2 Heat Recovery from Effluent

This opportunity may be developed with the planned secondary expansion, as this expansion will entail new or expanding buildings to accommodate additional processes and potentially, additional staff. If the opportunity exists to heat these buildings with heat pump energy derived from plant final effluent, it should be determined early in the design process. In addition, district heating opportunities will also be explored prior to submission of any IRM-related funding application.

4.2.3 Biosolids Composting

Composting represents a potential opportunity at the FCPCC if the RDN might consider moving away from ATAD sludge stabilization technology. This has been done at treatment plants in both Whistler and Banff, where the ATAD process was abandoned in favour of either onsite or offsite indoor aerated static pile composting. This process allows for the production of a nutrient rich growing media that can be marketed in bulk for partial cost recovery. However, the RDN may not choose to proceed with this option given the substantial capital that has already been directed towards the odour issues related to the FCPCC ATADs, along with having an already well developed disposal plan (as briefly outlined above in Section 3.2).

4.2.4 Enhanced Biogas Recovery and Utilization

As with the option of composting presented above, biogas recovery and utilization at the FCPCC would require the departure from ATAD technology and the replacement with anaerobic digestion (either mesophilic or thermophilic). Like the GNPCC, the derived digester gas could be used in boilers for digester related process heating, and for co-generation of heat and/or electricity. However,

from a purely economical point of view, anaerobic digestion is not typically seen as feasible for smaller plants such as French Creek. It is often only examined for plants that exceed average annual flows of 25 ML/d; where the FCPCC is currently averaging under 10 ML/d.



WATER & WASTEWATER SERVICES

LIQUID WASTE MANAGEMENT PLAN REVIEW AND AMENDMENT DISCUSSION PAPER

SERVICING RURAL AREAS



JUNE 2009

1.0 BACKGROUND

The Regional District of Nanaimo (RDN) is reviewing the 1997 Liquid Waste Management Plan (LWMP) to identify items that require updating or amendment. As part of the review, discussion papers have been prepared and submitted to the Liquid Waste Advisory Committee (LWAC) for comment and discussion. Through the process it has been demonstrated that wastewater infrastructure in the RDN is the product of time, geography, planning, regulation, and the needs of the RDN's residents. As such, the review process offers a unique opportunity to re-evaluate *Section 3.5 Rural Areas* of the LWMP.

Although various land use plans, population settlement patterns, and environmental conditions have given shape to the existing network of septic systems, collection systems, and treatment plants, the location of wastewater treatment options has also been influenced by property owners. These wastewater treatment options include septic systems, community sewer, and package treatment plants. For the purposes of this paper, community sewer refers to any sewer collection system and treatment plant that is owned and operated by the RDN.

With that in mind, this discussion paper provides an overview of wastewater treatment options for rural areas, as supported by RDN policy. It should be noted that community sewer can facilitate new development in Village Centres and potentially alleviate threats to the environment and human health in areas of existing development with failing on-site systems.

The objective of this paper is to provide points of discussion on 3 wastewater treatment options for rural areas, places that are located inside and outside of the RDN's urban containment boundary. The goal of any strategy discussed in this document is to support the long term health and sustainability of the Region's residents, environment, and economy. The outcome of this discussion will inform the *Section 3.5 Rural Areas* of the LWMP.

This paper begins with an examination of the planning tools used by the RDN to regulate growth and development in the Region. This is followed by discussion of wastewater treatment options that are available to residents in the rural parts of the Electoral Areas and in designated Village Centres. The paper concludes with a proposed future implementation plan for discussion by the LWAC.

2.0 DEFINING "RURAL AREAS"

Although not explicitly defined in the LWMP, section 3.5 implies that rural areas are the RDN's Electoral Areas, places that exist beyond the municipal boundaries of the City of Nanaimo, the District of Lantzville, the City of Parksville, and the Town of Qualicum Beach.

It is anticipated the RDN's population will grow at an average rate of 2% per year, from 144,317 people in 2006 to 231,184 in 2036¹. The majority of this growth will be in existing municipalities, but will also



occur in the Region's Electoral Areas.

Recognizing that growth will occur, the RDN uses the concept of Urban Containment Boundary in the Regional Growth Strategy (RGS) as tool to identify where growth should take place and where it should be discouraged in Electoral Areas². The RGS is a Board-approved strategic plan and policy framework made up of 8 distinct goals that work to enhance the liveability of the Region.

¹ See: Urban Futures. Population and Housing Change in the Nanaimo Region, 2006-2036. Pp. 14. Available at: <http://www.shapingourfuture.ca/resources.asp>

² See: Regional District of Nanaimo Regional Growth Strategy Bylaw No. 1309. Pp. 1. Available at: <http://www.rdn.bc.ca/cms/wpattachments/wpID436atID413.pdf>

Goal 7, 'Efficient Services' states that services - community sewer, for example - will be cost-effective and intentionally located where development is intended, within Village Centres³. Village Centres are determined through the Official Community Plan (OCP) planning process and are to serve as local service centres in the rural areas by supporting a mix of uses and higher densities. Village Centres are also areas that can be considered for community servicing.

Section 3.5 Rural Areas of the LWMP supports the RGS goal of protecting rural areas and intentionally siting services, such as community sewer, in Village Centres. Working within the parameters of the RGS, neither the RDN nor the LWMP support sewer servicing outside the Urban Containment Boundary, except where there are verifiable threats to the environment and/or human health⁴.

Although Village Centres are an integral part of the RDN's 'rural' landscape, the majority of the population in Electoral Areas live outside of these areas. For the foreseeable future, residents outside Village Centres will continue to depend on septic systems.

3.0 SERVICING OPTIONS

As mentioned on page 1, there are 3 types of wastewater treatment options in the RDN: 1) septic systems, including holding tanks; 2) community sewer; and 3) package treatment plants. It should be noted, that the costs associated with the installation, expansion, repair, and maintenance of any wastewater treatment system are borne by property owners that do, or can, benefit from the service.

3.1 SEPTIC SYSTEMS

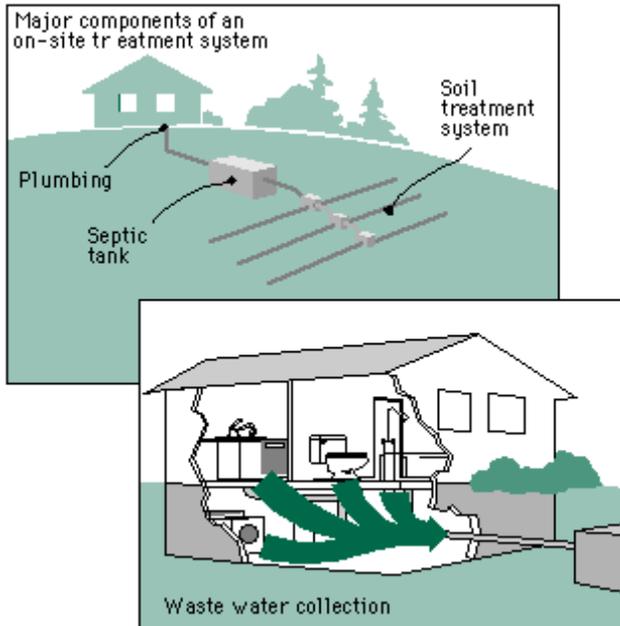
Although there are some portions of Electoral Areas A, C, E, and G that are connected to the larger RDN sewer service, most properties rely on septic systems to service an individual residence/business, or several residences/businesses collectively. It is estimated that there are approximately 12,000 septic systems in the RDN, making septic systems the most prevalent form of sewage treatment in the Electoral Areas. As discussed in the *On-site Treatment Issues Discussion Paper*⁵, these systems are generally privately owned by property owners. Subsequently, residents use a disposal service to

³ See: Regional District of Nanaimo. 2003. Regional Growth Strategy Bylaw No. 1309. Pp. 15. Available at: <http://www.rdn.bc.ca/cms/wpattachments/wpID436atID413.pdf>

⁴ OCP will be explained on pp. 2 but refers to an Official Community Plan.

⁵ See: Associated Engineering, March 2008, "Discussion Paper No. 2: On-site Treatment Issues". Available at: <http://www.rdn.bc.ca/cms/wpattachments/wpID1632atID2235.pdf>

transfer septage to the Chase River Pump Station or the French Creek Pollution Control Centre. Residents also hire an authorized person to perform required maintenance on their septic system. An



'authorized person' is an accredited professional who is authorized through the *Sewerage System Regulation Act* to repair, upgrade, and perform maintenance on an septic system.

It is under this same Regulation, that the Vancouver Island Health Authority (VIHA) has the authority to inspect and take corrective action to alleviate health hazards presented by failed, or failing, septic systems. The LWMP suggests that the RDN will work proactively with VIHA to "monitor and assess sewage system requirements

and develop solutions for failed on-site systems"⁶. To that end, the RDN has an educational program to support new and existing septic systems in the Electoral Areas.

The SepticSmart program is designed to connect septic system owners with basic information about septic system maintenance. Given residents' overwhelmingly positive feedback, the RDN has also recently secured funding to evaluate the feasibility of implementing a mandatory maintenance program designed to ensure that property owners are servicing their septic systems.

3.1.1 *The SepticSmart Program*

The SepticSmart Program provides basic information to property owners about the proper use, maintenance, and servicing of their septic system. It provides tools to enable homeowners to detect and prevent failing systems by underscoring the value of regular maintenance and proper use of the system. The program also makes the link between a failing system and its potential impact on human health and the environment. It follows that the expected outcome of the SepticSmart program is a reduction in the number of failing systems in the RDN.

⁶ See pp. 3-6 of the Regional District of Nanaimo, Liquid Waste Management Plan (Stage 3 Report), November 1997. Available at: <http://www.rdn.bc.ca/cms/wpattachments/wplD1131atID1130.pdf>

The RDN SepticSmart program has been modeled after the Capital Regional District's (CRD) Septic Savvy education program. The CRD has found that workshops and outreach events have proven successful as they allow for direct communication with the owners of septic systems.

The RDN's SepticSmart Program has been created with this in mind and currently includes:

1. A brochure;
2. A SepticSmart Residential Household Information Kit;
3. A public workshop presentation; and
4. A web-based component.



At each of the workshop sessions, a VIHA representative is available to answer property owner questions. More recently, an expert has been contracted to give a portion of the presentation, as well as to answer more detailed questions. As of June 2009, 350 people have attended 4 workshops, 650 information kits have been distributed, and feedback has been overwhelmingly positive.

3.1.2 Mandatory Septic Maintenance Program (Proposed)

VIHA is responsible for issuing permits for on-site wastewater systems and enforcing the *Sewerage System Regulation Act*, as mentioned on page 5. They recommend that septic tanks be pumped out every 5 years and that Type 2 and 3 systems (package treatment plants) receive annual service by an authorized person.

Failing systems are known to cause many problems, ranging from malodour to the contamination of surface and ground water. Repairs are often costly, but can be avoided through proper maintenance. However, many systems are not adequately maintained and VIHA has no real means to ensure that each system is functioning properly.

In April 2008, the Capital Regional District (CRD) adopted Bylaw 3479 which enables the CRD to enforce mandatory maintenance for onsite septic systems to mitigate system failures. The CRD Bylaw has only been applied within the municipalities in the *Core Area Liquid Waste Management Plan*: Langford, Colwood, Saanich, and View Royal. If the program proves successful, it may be extended to 3 Electoral Areas: Juan de Fuca, Salt Spring, and the Southern Gulf Islands Electoral Areas.

Although it will be phased in gradually, the CRD Bylaw requires the owners of Type 1 septic systems (basic septic tank and disposal fields) to pump out their tanks by the end of 2010 and every five years thereafter. Homeowners must keep their receipts as proof of compliance.

To administer the program, the CRD created an annual parcel tax of \$25. This fee covers the cost of a database to track compliance, map individual septic systems, create records of new installations, and monitor decommissioning of septic systems when homes eventually connect to the sewer. When maintenance is due, the program also provides notification to property owners and the potential cost for non-compliance.

The RDN is considering implementing a similar mandatory maintenance program. To that end, the RDN has been granted \$10,000 from the Ministry of Community Development to evaluate the feasibility of developing and implementing a mandatory maintenance program. A study of this kind would examine the general causes of failed systems, cost assessments related to the drafting of a bylaw, the development of a framework of requirements, and administrative and staffing needs for the implementation and execution of a monitoring program. This study will work to support the RDN's SepticSmart education program.

3.2 COMMUNITY SEWER

As discussed on page 3, community sewer can direct growth and support increased population densities in Village Centres. With community sewer, Village Centres can potentially support the population densities required to make them socially and economically diverse. For example, the Area E OCP states that "under the current zoning, the provision of community sewer and water services may enable a higher level of development in some areas of Nanoose Bay"⁷. On page 1, community sewer was defined as any sewer collection system and treatment plant that is owned and operated by the RDN.⁸

In the RDN, the extension of existing sewer infrastructure or the location of community sewer is generally determined by an OCP and by property owners. For example, the Area E OCP states that new sewer connections: "...[require] a policy framework and proposed consultation and decision making

⁷ Available At: <http://www.rdn.bc.ca/cms/wpattachments/wplD1125atID1041.pdf>

⁸ Electoral Area 'G' Official Community Plan Bylaw 1540. 2008. Plan. pp. 118. Available at: <http://www.rdn.bc.ca/cms.asp?wplD=1722>

process to allow the community and RDN Board decide how future community sewer...⁹. Additionally, RDN plans determine the extent of sewer service areas. Servicing is only possible where an area has first been designated for community sewer, or for health and environmental reasons.



Under the current LWMP all sewer systems are based on a user pay principle, through the establishment of a sewer service area¹⁰. A sewer service area is a geographically bounded area, recognized by bylaw, within which properties may be connected to a particular treatment plant via a particular collection system network.

All RDN sewer service areas come into being through public assent, by means of a referendum, petition, or counter-petition process.

3.2.1 Sewer Servicing Study

A sewer servicing study identifies and evaluates opportunities and options for servicing a particular area. This type of study assesses environmental conditions, defines treatment options, and identifies suitable types of infrastructure and potential locations for that infrastructure. A study also provides cost estimates for various options. The intent of these studies is to provide property owners and RDN staff with enough information to make an informed decision about whether or not to proceed with community sewer in a given area. Information from a sewer servicing study can also be used in the public assent process and is, generally, presented by the RDN to property owners at an open house

3.2.2 Sewer Service Area & Fees

There are geographic considerations that also factor into sewer connections. In some places, such as Cedar Village, it may be more financially feasible to pay for an upgrade to the Duke Point Pollution

⁹ <http://www.rdn.bc.ca/cms/wpattachments/wplD1125atID1041.pdf>.. Section V, pp. 7.

¹⁰ See pp. 3.7 in Regional District of Nanaimo Liquid Waste Management Plan (Stage 3 Report), November 1997. Available at: <http://www.rdn.bc.ca/cms/wpattachments/wplD1131atID1130.pdf>

Control Centre and install a collection system, than build a new treatment plant. However, in Area H it could be more practical to build a small a treatment plant, as well as a new collection system.

The cost of providing community sewer is based on a user pay principle. This means that those who benefit from sewer service pay for it. All connections share equally in the cost of constructing, maintaining, and upgrading a wastewater collection system and treatment plant. There is little opportunity for grants unless a region wide bylaw is passed limiting all lots outside of Village Centres to a 1 hectare minimum, or through a region-wide soils suitability analysis¹¹. Regardless, the costs of providing sewer servicing are captured through the designation of a local sewer service area.

The fees paid by property owners who are connected to the sewer system include capital charges, parcel taxes, and user fees. A capital charge is assessed for properties within a service and allows a property owner to 'buy into' the capacity of an existing service. Within a sewer service area all properties pay a parcel tax to cover the capital cost of the system, as these properties are, or could be, connected to the sewer service. User fees are also charged once a property is connected.

The cost to provide sewer servicing will be borne equally among those who benefit from the service. However, it is anticipated that a portion of the cost of expanding a sewer service area will be paid by developers through development cost charges (DCCs). Capital charges will apply to existing development and property owners that are newly brought into a service area.

3.3 PROPOSED FUTURE IMPLEMENTATION PROCESS FOR VILLAGE CENTRES

If sewer servicing in Village Centres is supported by the LWMP, the RDN will develop an implementation plan that consists of meetings with different types of property owners in Village Centres and Electoral Areas.

For the purposes of this paper, there are two types of local property owners who can initiate or influence sewer servicing in a Village Centre. The first are existing property owners who own one or more parcels of land within the Village Centre and reflect the current sewer servicing needs of the existing

¹¹ See for example: Canada-British Columbia Building Canada Fund – Communities Component. February 2009. Category Specific Supplement Wastewater. Available at: <http://www.th.gov.bc.ca/BCFCC/documents/wastewater.pdf> . Pp. 16.

population. The second are property owners who own large parcels or multiple lots that can be subdivided and who represent future residents and sewer servicing needs for a growing Village Centre and Electoral Area.

Though distinct, both types of property owners can request the creation of a sewer service area via the public assent process.

3.3.1 Proposed Implementation Plan : Meetings With Current Property Owners

It is proposed that the RDN will host meetings with residents of an Electoral Area, in Village Centres (as they are identified in OCPs). The intent of these meetings is to assess the community's interest in community sewer and their willingness to pay for a sewer servicing study to assess the options and costs for establishing a sewer service area, or for the extension of existing infrastructure.

Meetings of this kind will serve 2 purposes: 1) They will be used to gauge the community's interests in pursuing sewer servicing in the Village Centres or Electoral Area generally; and 2) They will provide baseline information for future sewer servicing studies should property owners reject sewer servicing, or should a new Village Centre, with potential for sewer servicing, be created in an Electoral Area.

Once a servicing study has been supported by the community and developed by a consultant, the RDN will present the study findings to property owners for their consideration. Property owners will have a specified length of time to evaluate the study and express their interest in pursuing a public assent process.

3.3.2 Proposed Implementation Plan: Meetings With Developers

Owners of large, subdividable parcels, or multiple properties in the same area, are considered developers and represent future property owners, residents, and possibly community sewer in Village Centres and Electoral Areas. Developers can facilitate the design and construction of sewer infrastructure within a UCB, mitigating some of the costs for existing property owners.

The RDN will evaluate existing land ownership against the development potential of a Village Centre as it is expressed in the relevant OCP. In instances where there exists potential for development, or an expression of interest in development through subdivision application, the RDN will meet with the property owner(s) to discuss mutually beneficial sewer servicing opportunities. Should the property

owner(s) be interested in pursuing sewer servicing, the RDN and property owner(s) will jointly contract a sewer servicing feasibility study. If the property owner(s) wishes to continue with the design and construction of sewer related infrastructure, the public assent process will be initiated.

The intent of meetings with property owner(s) with large parcels, or multiple properties with potential to be subdivided, is to encourage density in the Village Centre, as described in an Electoral Area's OCP. It is expected these owners will be willing to pay a portion of the cost for sewer servicing to a Village Centre.

3.4 PACKAGE TREATMENT PLANTS

Achieving RGS goals of nodal development within the established Village Centres may be achieved through a variety of approaches. Like other types of wastewater servicing, package treatment plants (PTP) located in Village Centres could encourage development in these areas and support strong urban containment, a nodal structure, rural integrity, and efficient services.



Following current policy, any PTP system will be designed, constructed, and maintained at the expense of the users. There are many types of innovative systems available to property owners. However, all package treatment plants must be suited to the environmental conditions of a site and will require regular maintenance and upgrades. The basic criteria for selecting a package treatment plant should also consider the following:

1. the discharge environment;
2. type of collection system;
3. flow volume;
4. site and footprint;
5. reliability of the system and its monitoring requirements;
6. operational and maintenance requirements, costs, and personnel;
7. the capacity of the system to adapt to technological change.

For a greater discussion on PTPs in the RDN please see *Discussion Paper No. 3: Policies Regarding New Communities and Developer Installed Treatment Plants*¹². The RDN, as part of the LWMP Review, will determine whether to approve and manage PTPs in the future. Currently, Ministry of Environment (MOE) and Vancouver Island Health Authority (VIHA) approve systems, dependent on their size.

4.0 CONCLUSIONS

Various land use plans, population settlement patterns, environmental conditions, and changing technologies have given shape to the existing network of septic systems, collection systems, and treatment plants. With that in mind, this discussion paper provides an overview of wastewater treatment options for rural areas, as they are supported by RDN policy. For the purposes of this paper, wastewater treatment options include septic systems, community sewer, and package treatment plants.

The objective of this paper was to provide points of discussion on 3 wastewater treatment options for areas located inside and outside Village Centres. The outcome of this discussion will inform *Section 3.5 Rural Areas* of the LWMP.

This paper began with an overview of the planning tools deployed by the RDN to regulate growth and development in the Region. It was concluded that LWMP supports the goals of urban containment in the RGS.

This was followed by a discussion of wastewater treatment options available to both rural and urbanizing areas (Village Centres) in the Electoral Areas. It was demonstrated that:

- 1) Septic systems are currently the most prevalent form of wastewater treatment in Electoral Areas in the RDN. As such, the RDN has developed the SepticSmart program and will undertake a study to consider the feasibility of implementing a mandatory septic maintenance program.

¹² Available at <http://www.rdn.bc.ca/cms/wpattachments/wpID1632atID2374.pdf>

- 2) Community sewer is generally determined by property owners through a public assent process. Property owners will pay for sewer servicing on a user pay basis. However, sewer servicing will be limited to Village Centres, or in cases where there are verifiable threats to human health and/or the environment.

- 3) Package treatment plants are a third wastewater treatment option available to property owners in the RDN. Although there are many innovative options, all systems will be based on a user pay principle and require that property owners consider installation, maintenance, and upgrade costs, as well as the environment in which their system will be located.

The paper concluded with a proposed future implementation plan for discussion by the Liquid Waste Advisory Committee.

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Date: August 26, 2009
To: Sean De Pol, RDN – Manager, Wastewater Services
From: Andy Bell, AECOM – Infrastructure Engineer
Project Number: 113488 (03)
Subject: Volume Reduction in Sanitary Sewers

Distribution: RDN – Lindsay Dalton, Sean De Pol
AECOM – Will Wawrychuk, Scott Neuman, File

1. Introduction

The Regional District of Nanaimo (RDN) is in the process of updating sections 3.2 and 3.3 of its 1997 Liquid Waste Management Plan (LWMP) that refer to the reduction of flow into sanitary sewers and stormwater management initiatives. The goal of the plan's update is to create a LWMP that sets out appropriate wastewater management strategies and their implementation, for now and the future.

AECOM has prepared this discussion paper to assist the RDN's Liquid Waste Advisory Committee (LWAC) with the LWMP update.

2. Volume Reduction in Sanitary Sewers

2.1 Introduction

In complying with the Ministry of Environment's long-term goal of achieving zero pollution, the RDN recognizes the various benefits of reducing sewage flow, inflow and infiltration (I&I) in their sanitary sewer network. Such benefits include the increased operational stability of pollution control centres, the reduction of sanitary sewage overflows and the potential for both capital and operational economic savings (deferment of new infrastructure and reduced power, chemical and potentially labour costs).

BC's Municipal Sewage Regulation specifically recognizes the impact of I&I on a sewer system, stating in Part 17, Schedule 1 (see appendix 1) that inflow and infiltration be controlled as follows:

"The discharger must ensure that no person allows I&I so that the maximum average daily flow exceeds 2.0 times ADWF¹ to occur during storm or snowmelt events with less than a 5-year return period".

Although allowances to this rule are permissible (by implementation of reduction strategies or cost benefit analysis as set out by the discharger's Liquid Waste Management Plan), it is a realistic target for the RDN and local municipalities to aim at.

2.2 RDN Infrastructure

The Ministry of Environment's Guidelines for Developing a Liquid Waste Management Plan requires that municipalities (incorporated cities, towns, villages and regional, municipal and improvement districts) reduce the impact of their liquid waste on the environment by complying with operational certificates issued under the LWMP. It also requires a commitment to control and minimize sanitary overflows from sewers and pumping stations and investigate I&I control options to reduce hydraulic loads on treatment plants.

The RDN owns and operates four Pollution Control Centres (PCCs) and associated trunk sewers, 19 pump stations and a number of small sanitary collection systems. It does not own any stormwater sewers, or related infrastructure. Stormwater infrastructure is owned by the MoT (Ministry of Transport & Infrastructure) or local governments.

The most significant local and communities discharging to the four pollution control centres are listed in the table below.

¹ ADWF (Average Dry Weather Flow) is a measure of sewer flow during periods of no rainfall. Refer to appendix for additional details.

Table 1. RDN Pollution Control Centres Inflows

Pollution Control Centre	Community Served
Greater Nanaimo (GNPCC)	The Greater Nanaimo Service Area* The District of Lantzville**
French Creek (FCPCC)	The Town of Qualicum Beach The City of Parksville The Surfside Sanitary Sewer Service Area*** French Creek Sewer Service Area*** The Barclay Crescent Sewer Service Area*** The Pacific Shores Sanitary Sewer Service Area***
Nanoose (NPCC)	The Fairwinds Sanitary Sewer Service Area***
Duke Point (DPPCC)	Duke Point Service area*

*Collection system operated by the City of Nanaimo

**Only a small area of Lantzville has recently received sewer services

*** Collection system operated by the RDN

As a trunk system operator, the RDN is heavily dependant on its service area municipalities to meet its own operational commitments, as the majority of I&I sources are located within collection, not trunk, systems. Thus, any reduction strategy should be strongly aligned with the objectives of collection system operators.

Flow meters are used to record flows from the Town of Qualicum Beach and the City of Parksville prior to them reaching the FCPCC, while Greater Nanaimo flows are measured at the GNPCC. Flow measurement is considered accurate to + or – 5% and is used for billing each municipality, except for the District of Lantzville that is currently billed by the number of connections in their system.

2.3 Understanding Inflow and Infiltration

2.3.1 Defining Sanitary Sewer Flows

Sanitary sewer flow is derived from sewage that enters the system via buildings and other permitted service connections and I&I of ground, surface and extraneous water sources. For the purpose of discussion, these terms are defined as follows:

Wastewater

Water contaminated with organics and inorganics based on human activities, as discharged to a sewer system for conveyance to a facility for treatment and disposal/reuse².

Note: Wastewater originates from a building's toilets, sinks, floor drains and similar sources, as well as any other permitted source (for example, from an industrial process). It excludes rainwater,

² Taken from the District's LWMP glossary

groundwater and water from extraneous sources. Wastewater sewage may also be defined as baseflow that, depending on the local community, is typically constant in volume. Reducing baseflow reduces the cost of pumping and treating sewage.

Inflow

Water discharged to a sanitary sewer system, including service connections, from such sources as roof leaders; cellar, yard or area drains; foundation drains; drainage from springs and swampy areas; manhole covers; interconnections from stormwater sewers; surface runoff and street wash waters or drainage³.

Note: Inflow is rainfall dependant. During a storm, inflow is often the cause of peak flows that overwhelm pump and treatment facilities and cause sanitary overflows. Reducing peak flows can prevent overflows, promote stable operation of treatment facilities, avoid short term capital investment and reduce operational and maintenance costs.

Infiltration

Water entering a sewer system, including building sewers, from the ground through such means as defective pipes, pipe joints, connections or manhole walls⁴.

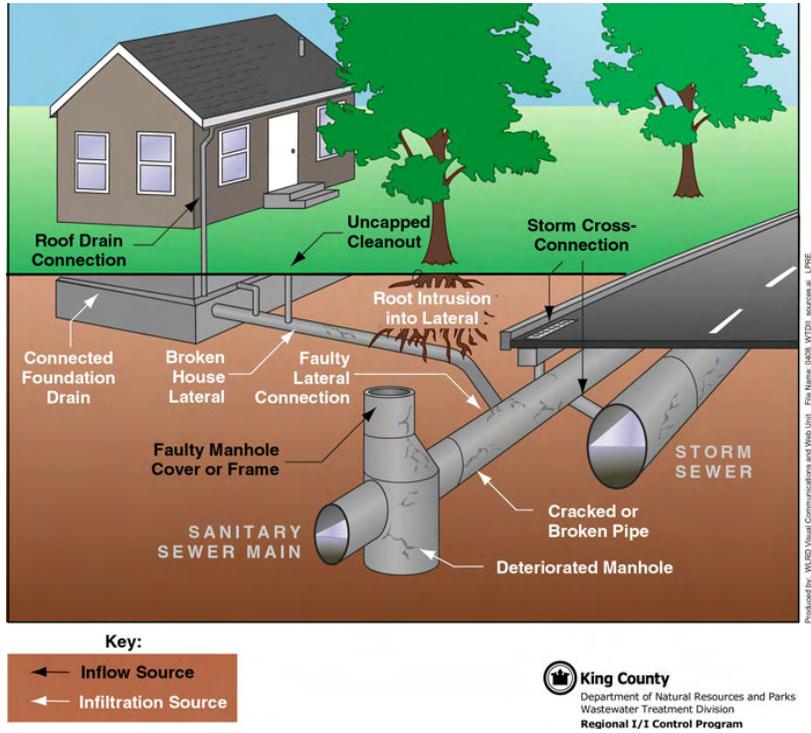
Note: Infiltration is both rainfall and groundwater dependant, as rainfall can elevate groundwater levels to submerge susceptible sewers. Infiltration can therefore increase base and peak flow in a sewer.

The figure below identifies many sources related to inflow and infiltration (I&I).

³ *The National Guide to Sustainable Municipal Infrastructure's 2003 guide: Infiltration/Inflow Control/Reduction for Wastewater Collection Systems*

⁴ *The National Guide to Sustainable Municipal Infrastructure's 2003 guide: Infiltration/Inflow Control/Reduction for Wastewater Collection Systems*

Figure 1 Common Sources of I&I



I&I has proved a difficult issue for many local governments to deal with. For example, a significant source of I&I arises from private properties – either from poor plumbing or from legal and non-legal connections from stormwater collection systems into sanitary mains. Toronto based studies have in fact indicated that over 50% of I&I can come from private properties. Prominent areas of I&I often include those where older houses exist (pre 1970's) that may have been permitted to connect drainage from their property into sanitary sewer systems.

Each flow type previously described can be managed to reduce the total flow of water in a sewer. Management of these flows is often best addressed using a cost benefit approach to ensure that money spent brings best value to the community.

2.3.2 Problems and Costs Associated with Inflow and Infiltration

Excessive I&I is a problem because it reduces sewer and sewage treatment facility capacities, can cause pollution events at overflow chambers, manholes (for example, a surcharged manhole spill into a street and subsequently into storm sewers that lead to watercourses), basements etc, and in extreme cases can result in sinkholes. I&I is costly to communities in a number of ways:

1. The cost of sewage treatment is often based on flows/volumes, meaning that once extraneous water gets mixed in with sanitary flows communities pay unnecessary charges this service – thus reducing I&I volume to achieve an annual 5% in flows could save a community 5% of its total wastewater service charge.

2. It reduces sewer and treatment facility conveyance and processing capacities and can lead to unnecessary or premature capital construction projects to provide greater capacity, which also have associated operational and maintenance (O&M) costs.
3. Pollution events cost money to clean up and can have far reaching social and environmental consequences, which also have a financial element.
4. In certain soil conditions, infiltration can lead to the loss of solid particles and the formation of voids or sinkholes – with sometimes disastrous consequences.

An extreme example of a sinkhole is shown below, which was caused by a watermain burst that scoured soil into a damaged sewer, forming a void under the road.

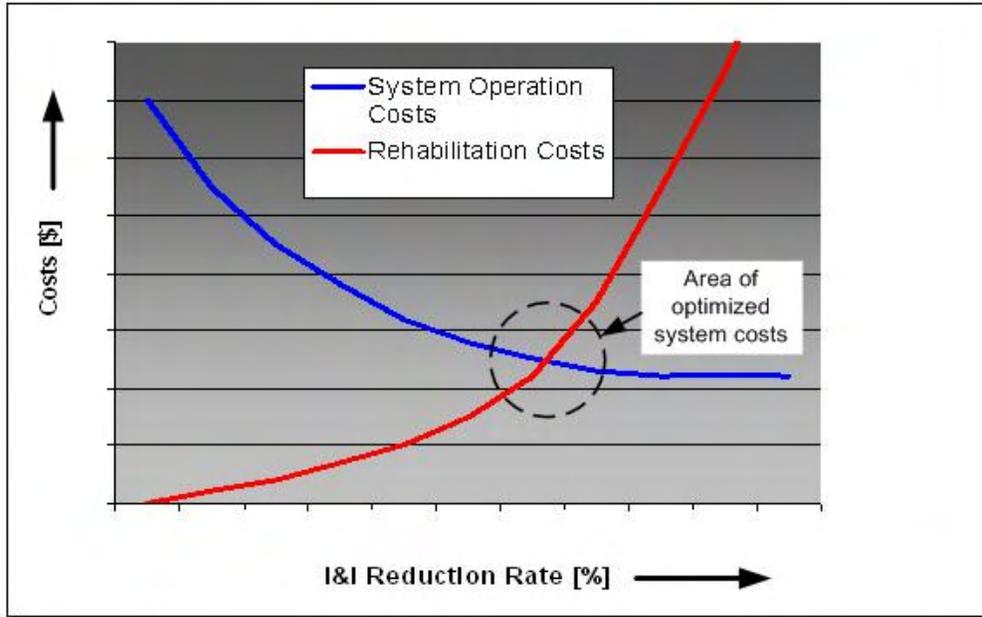
Figure 2. A sink hole caused by a watermain break adjacent to a poorly maintained sewer



It is not economically feasible, nor is it necessary, to eliminate all I&I into a sewer system. Thus, a cost benefit analysis between the cost of implementing I&I mitigation measures and the benefits of doing so should always be considered. Such benefits may include the delay of capital expansion projects at pollution control centers (and the O&M costs they incur), the reduction of treatment charges to a community and the reduction of sewer overflow events (which could eliminate or delay the need for new capital infrastructure that would otherwise be needed to prevent such events).

The figure below depicts a simplified view of I&I reduction economics. It shows that the cost required to reduce I&I increases disproportionately as higher reduction rates are obtained.

Figure 3. Inflow and Infiltration Economics



2.3.3 I&I Identification

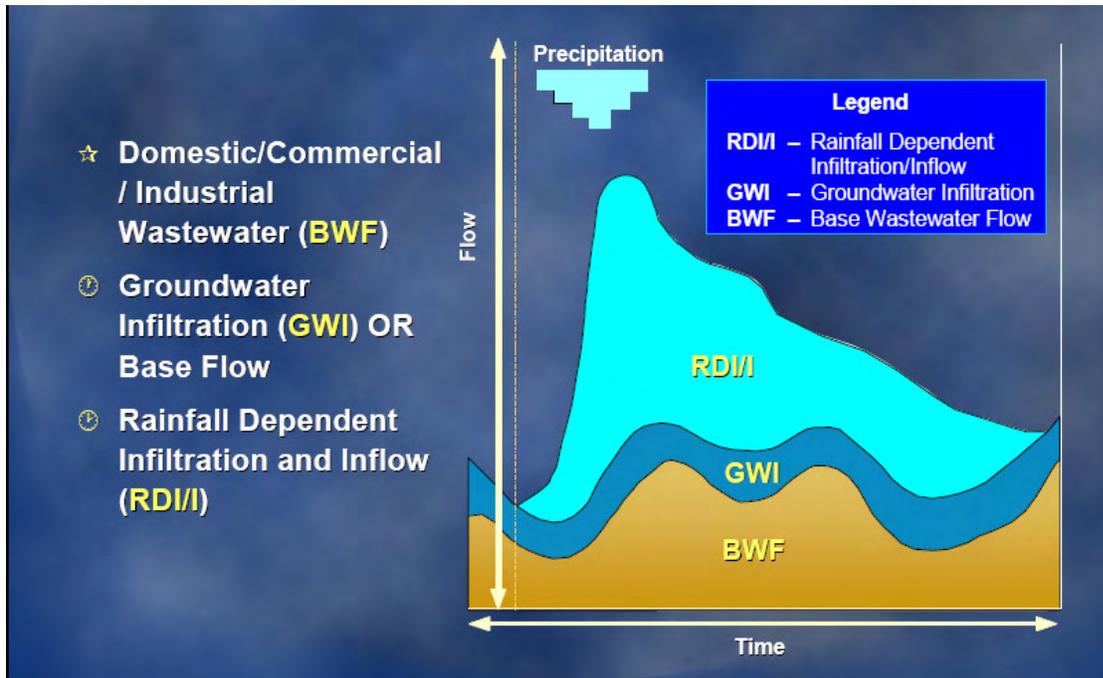
Inflow to a sewer system is easily identified through correlating elevated sewage system flows with periods of wet weather (either in collection sewers or treatment facilities). This may include the observation of overflow events throughout the sewer collection system.

Conversely, infiltration is more difficult to identify as it is related to groundwater flowing into the system, typically through defects – and can occur during both wet and dry weather periods. Its occurrence typically depends on the height of the groundwater table, seasonal variations, and soil permeability.

Identifying the source of I&I problems can be costly in itself and requires a strategic approach to determine the biggest “bang for your buck”. The approach initially involves a modeling and flow monitoring program that starts at the system level and drills down to greater detail as areas and sub areas with I&I are identified. This approach will assist in distinguishing between inflow from rainfall or infiltration from ground and extraneous water sources. Figure 4 presents a visual interpretation of flow within a sewer during and after a rainfall event. Here, large rainfall flow (RDI/I) is seen to enter sewers very quickly while groundwater (GWI) is more consistent over time, and wastewater flow (BWF) varies diurnally.

This type of study has already been completed for the Greater Nanaimo trunk sewer system, which will be discussed in subsequent sections of this paper.

Figure 4. Sewer flow Components



With the approximate location and type of I&I identified, specific sources of I&I can be systematically investigated.

2.3.4 Inflow Investigation

Inflow from the downspouts of buildings, road drains, lawn drains, leaking manhole covers are most simply and cost effectively identified using vapour tests (also called smoke tests). This process involves isolating a section of sewer and blowing a non-toxic, visible vapour into it and observing locations vapour is escaping, as shown in figure 5.

Figure 5. Vapour escaping from a road drain



Figure 6. Vapour escaping from abandoned services



Another simple way of identifying inflow is by dye tests. This involves the application of dyed water at each potential inflow source with the observation at strategic manhole points to see if the source is connected to the sewer. Dye tests are sometimes used to confirm the results of vapour tests prior to the commencement of disconnection work.

Figure 7. Dye is observed in a manhole downstream of an inflow source



2.3.5 Infiltration Investigation

Closed Circuit Television (CCTV) inspection involves the use of robotic closed circuit cameras mounted on portable platforms that move down a sewer to visually inspect sewers and identify defects where infiltration can occur. Common sewer pipe defects include cracks, leaking joints, holes and even collapsed sections, which can be exacerbated by the ingress of tree roots. It also enables identification of unknown connections that could be a source of water inflow. However, due to the relatively high cost of CCTV inspection, it is usually used to identify infiltration rather than inflow sources.

The following two figures show the application of CCTV equipment for investigation of main line sewers plus lateral connections.

Figure 8. CCTV equipment deployed into a sewer

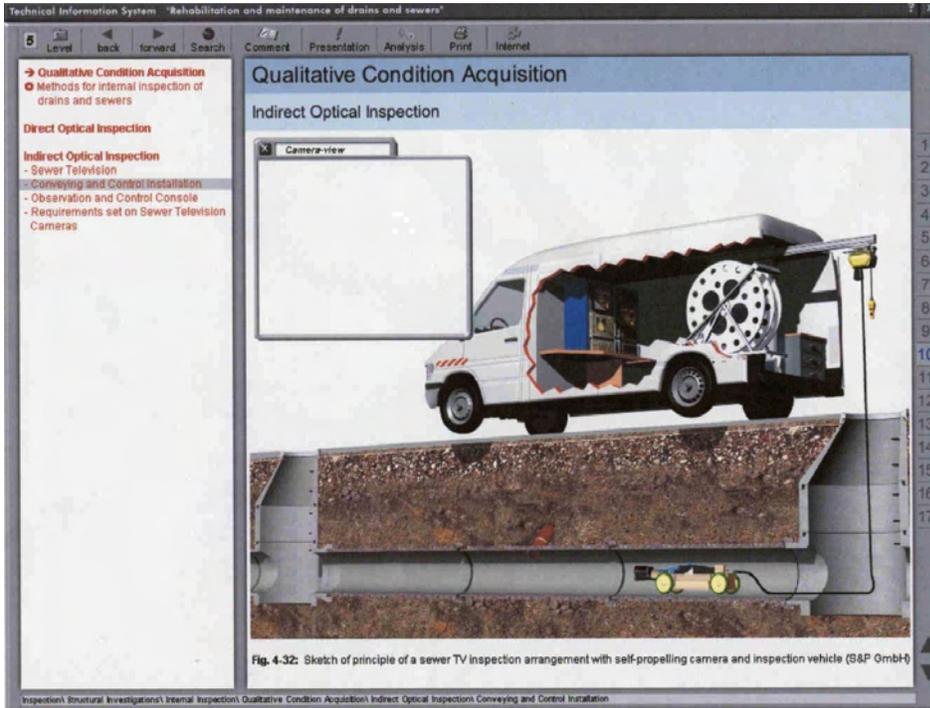
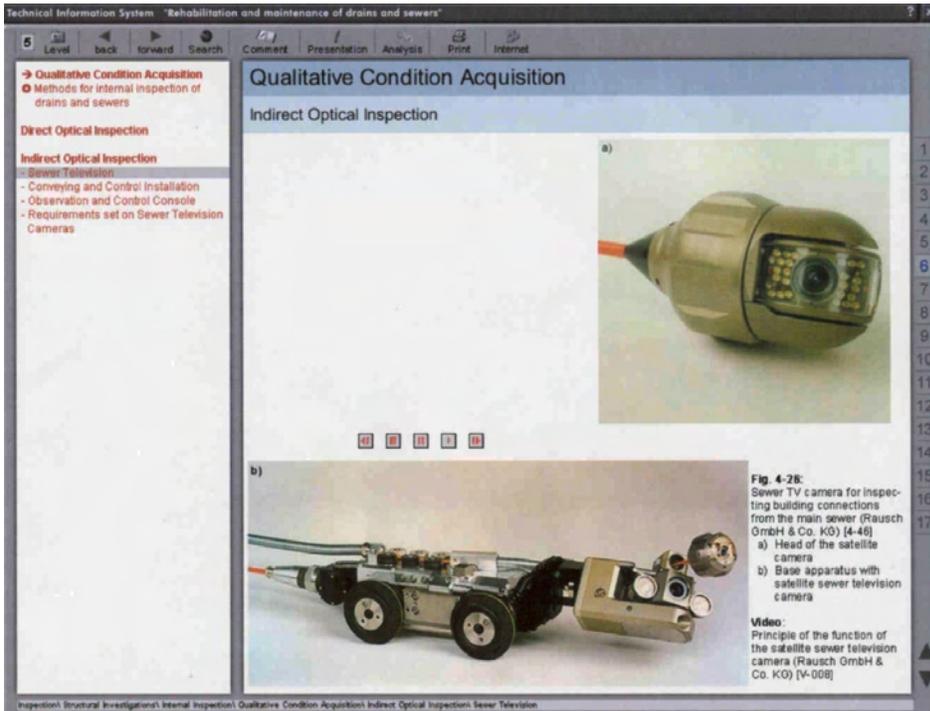


Figure 9. CCTV equipment used for service lateral inspections



The following two figures show example results from a CCTV survey, the first shows a sewer in almost perfect condition where infiltration is unlikely to occur and the second shows a sewer collapsing where infiltration is highly likely.

Figure 10. A sewer in almost perfect condition where infiltration is unlikely to occur



Figure 11. A sewer is collapsing and is highly likely have infiltration issues



Manhole inspection is another important part of identifying infiltration. Based on similar condition assessment principles to pipes, manhole should be visually inspected to identify cracks and holes that allow infiltration of groundwater, an example of which is shown below.

Figure 12. Significant infiltration of water into a damaged manhole.



2.3.6 Mitigation of Inflow and Infiltration

I&I mitigation techniques vary with their source. The following two tables summarise a number of typical I&I sources, corresponding mitigation techniques responsible parties. It should be noted that many sources of infiltration occur on private, typically older, property. Local governments across North America are reducing I&I from private property in a variety of ways that includes education campaigns, incentives and tariffs. Some governments have gone as far establishing stormwater utilities that, alongside the management of surface rainwater, aim to control sanitary sewer inflows.

Table 2. Inflow Sources into Sanitary Sewers and their Mitigation Techniques

Inflow Source (responsibly)	Mitigation technique
Roof leaders/downspouts (property owners)	Disconnect from sanitary sewer and re-route to a: <ul style="list-style-type: none"> - Buried/surface soak-away (to be located away from sanitary sewers), - rain-barrel, - splash pad to a vegetated area ,or a - storm sewer* Where feasible a green roof may be appropriate to help mitigate this source (incorporates soil beds and plants to store and utilize rainfall)
Yard/area drains (property owners)	Disconnect from sanitary sewer and re-route to a: <ul style="list-style-type: none"> - buried/surface soak-away, - storm sewer*
Cellar drains/sumps that are also connected to foundation drains (property owners)	Disconnect from sanitary sewer and re-route to a: <ul style="list-style-type: none"> - buried/surface soak-away (see note above), - rain-barrel, - vegetated area ,or a Note that cellar drains can contain pollutants and should not discharge directly to a storm sewer
Foundation drains (property owners)	Disconnect foundation drains and weeping tiles from sanitary sewer and using a sump pump re-route to a: <ul style="list-style-type: none"> - buried/surface soak-away, - rain-barrel, - vegetated area ,or - storm sewer* Note that overflows from soak-aways to storm drains may be required
Manhole covers (property owners – if on private property - & local gov't)	Stop the inflow of water through manhole covers by: <ul style="list-style-type: none"> - Replacing existing covers with sealed covers - Using manhole pans (plastic or steel pans that fit beneath an existing cover to form a seal) - Resetting manhole frames (lift the manhole frame and cover to road or soil grade to prevent ponding on the covers surface).
Cross connections (property owners & local gov't)	Remove cross connections between sanitary and storm sewers
Catch basins (local gov't)	Where feasible: <ul style="list-style-type: none"> - Discharge catchbasins to exfiltration structure - Remove catchbasins, curbs and gutters and create roadside ditches
Drainage of swampy areas (property owners & local gov't)	Reconsider the reasons for draining such areas and strategies for removing water
Uncapped sewer cleanouts (property owners & local gov't)	Sanitary service lateral cleanouts (located on all sanitary services) should always be capped.

*Many communities now recognize that containing stormwater locally is an effective strategy for inflow management. Reducing or better managing flows running off of impervious areas - driveways, parking areas, walkways, patios etc. – can help to reduce inflow. However, rainwater redirected below ground must be kept away from sewer pipes with infiltration problems, otherwise inflow may be transferred from one point to another.

Table 3. Infiltration Sources into Sanitary Sewers and their Mitigation Techniques

Infiltration Source	Mitigation technique
Unstable Mains (local gov't)	Replace structurally unstable or collapsed mains with new mains using: <ul style="list-style-type: none"> - open trench construction (traditional mainline sewer or lateral installation), - pipe bursting, (pipe is burst into fragments and a new pipe is pulled into its place), and - pipe reaming (pipes are reamed into fragments that are removed as a new pipe is pulled in to replace the old). Both pipe bursting and reaming require dig down operations to restore services.
Defective Mains (local gov't)	Rehabilitate defective pipes using: <ul style="list-style-type: none"> - Cured-in-Place pipe (fabric liner with a liquid resin inflated in the pipe and cured in place. Spot repairs and laterals can be sealed in this way) - Chemical grouting (pressure inject grout into crack and surrounding soil to form a seal). - Sliplining (new pipe inserted into old one and grouted into place, numerous variations of this technique exist) - Mechanical Joint seals (rubber seals placed by hand in larger diameter sewers, held in place by stainless steel bands)
Defective/Unstable Lateral (property owners & local gov't)	Replace or reline using cured-in-place techniques
Abandoned Lateral (property owners & local gov't)	Cut and permanently cap as close to the sewermain as possible.
Unstable Manhole (property owners – if on private property - & local gov't)	Replace structurally unstable, leaking manholes
Defective Manhole (property owners – if on private property - & local gov't)	Rehabilitate defective but structurally sound manholes by: <ul style="list-style-type: none"> - Repointing (repoint brickwork, solution only good where low pressure flows exist) - Grout injection (resin or chemical grout injected through the manhole wall to form a seal on its outer side) - Spray systems (spray the entire manhole interior with cement or polymer grout) - Lining (insert a preformed, cast or poured-in-place liner)

In combination with implementing I&I mitigation techniques, it is prudent to educate property owners against planting trees and shrubs over sewer laterals, as roots from larger plants can structurally damage a sewer lateral, causing infiltration potential.

2.3.7 Public Education/Outreach

Through its Team Watersmart initiative, the RDN already strives to educate its community on a range of water conservation issues that include the use of rain barrels on roof leaders to reduce reliance on potable water. The same initiative could therefore be used to educate on I&I issues relevant to property owners.

2.3.8 Funding

Funding to reduce I&I can come from various sources, for various stages of a project. Recent and currently grants opportunities include:

1. Infrastructure Planning Grant Program – Ministry of Community & Rural Development

Available until July 29, 2009, this fund provided up to \$10k towards the comprehensive planning of projects and initiatives aimed at sustaining a communities infrastructure and environmental health.

2. Green Municipal Fund Waterways Projects – Federation of Canadian Municipalities

Available until March 31, 2010, this fund provides up to \$400k per project (\$4million total per applicant) towards projects that improve wastewater effluent quality. It is notable that the City of Victoria received \$3million of grant funding from the Green Municipalities Fund for its current James Bay I&I Pilot, which will study trenchless rehabilitation approaches to see which has the greatest ability to prevent rain and groundwater from entering the sanitary sewer system.

3. The Ministry of Community & Rural Development has recently offered numerous other grants that may have been applicable to I&I and related projects in the RDN. These funds are now fully allocated; however, similar types of funds are likely to become available in the future. Examples of allocated programs include:

- B.C.s Community Water Improvement Program
- Building Canada Fund
- Canada/B.C. Infrastructure Program
- Canada/B.C. Municipal Rural Infrastructure Fund

2.3.9 Experience from the National Water and Wastewater Benchmarking Initiative

In February 2008, The National Water and Wastewater Benchmarking Initiative circulated a survey to its I&I task force members to collect information on a range of I&I topics. Topics included I&I causes, investigation and mitigation resources, stakeholder communication, program reduction details,

programs successfulness, legal issues and more. Ten surveys were returned, a roll-up of which is presented as Appendix 2.

The RDN may find certain aspects of this survey useful to their own activities as it describes the types of problems Cities have, the level of resources being applied to solve problems, descriptions of flow monitoring and inspection programs and additional information that may help I&I mitigation planning.

2.4 Inflow and Infiltration in RDN Trunk Systems

2.4.1 System Integrity

A discussion with Bob Swanson, RDN's Wastewater Operations Supervisor, about the RDN's trunk system suggests that the system currently has no notable I&I problems, and that I&I from the City of Nanaimo has been significantly reduced in the last 5-10 years. He noted that CCTV work has been done in areas that were perceived to have problems, such as the 60" Departure Bay sewer that runs below sea level; however, only minor leaks have ever been found. Smoke testing has been used to identify and rectify cross connection and other issues such as leaking manhole lids, which have been rectified.

2.4.2 Rainfall Response

Storm flows in a trunk sewer are mainly the result of the collection system's storm response.

Typically, the RDN's trunk sewers perform well during regular intensity storm events (for example, events that occur less than once in every five years. In such events, the systems are able to convey wastewater and I&I volumes to the treatment plants without overflowing. However, in extreme storm events such as the 1 in 100 year event on December 3, 2007, where a combined storm and snow thaw event caused high levels of I&I in many of the regions sanitary sewers, the RDN's trunk sewers can be partially overwhelmed.

Data from a report detailing the December 3rd event⁵ is used below to indicate the magnitude of treatment plant flows received that day. The table below compares December 3rd flows to each plant's Average Dry Weather Flow (ADWF). Due to the magnitude and nature of the event, it is unsurprising that flows were over double the ADWF⁶, which BC's Municipal Sewage Regulation states should not exceed 2.0 x ADWF in less than a 5-year return period. However, it does serve to highlight each system's reactivity to high rainfall events.

⁵ Nadine Schwager RDN, *Wet Weather Report for December 3rd, 2007*

⁶ ADWF estimated from RDN records as the average flow from the driest month of each year during 2006 to 2008.

Table 4. December 3rd flows to PCCs

Pollution Control Centre	ADWF (m ³)	Dec 3 rd Flow (m ³)	Flow ratio
Greater Nanaimo (GNPCC)	27422	120800	4.4
French Creek (FCPCC)	7558	18,872	2.5
Nanoose (NPCC)	257	NA*	NA
Duke Point (DPPCC)	14	231**	17.0

*NPCC is a small plant permitted to accept 2270 m³/d

**DPPCC is a small plant permitted to accept 910m³/d

Greater Nanaimo Trunk System

The RDN has hydraulically modelled its trunk sewers and pump stations in the Greater Nanaimo Service Area, as recently as June 2008⁷. The model used data from both the City of Nanaimo and the RDN's sewer flow meters and rain gauges in the area. A report about the model concludes that at the peak of a 5 year storm event overflows are expected to occur at two overflow structures due to flows overwhelming the Departure Bay Pump Station. However, at this time the model is believed to be overly conservative as these structures have not been observed to spill in a 1 in 5 year storm event (model accuracy is being addressed).

A December 3, 2007 report stated the systems observed response to the 1 in 100 year event:

- On December 4th, there was an approximate 60% increase in TSS at GNPCC in both influent and effluent.
- Wellington Pump Station saw an increase in flow on December 3rd of about 60% above the day before. However, it did not back up during the wet weather event.
- Chase River Pump Station saw an increase in flow of about 260% above a typical December day. However, it did not back up during the wet weather event.
- Departure Bay Pump Station saw an increase in flow of about 210% over the previous day. DBPS was unable to keep up with the flow, allowing the interceptor to surcharge. The outfall at Brechin Point was estimated to overflow for approximately 4 hours.
- During inspection of the interceptor manholes along Departure Bay Beach during low tide on December 3, sewage was observed to spill out of a hole in the 2" vent line at manhole #10.
- The outfall vent in Morningside Park overflowed onto the ground (it should be noted that this vent has been decommissioned).

From the above information and discussion with RDN operations staff, it is concluded that the Greater Nanaimo sanitary collection and trunk sewer systems significantly react to extreme rainfall events (for example 1 in 100 year), to the point where RDN pump stations become partially overwhelmed, and

⁷ RDN Wet Weather Flow Management Phase 3 Update for the Greater Nanaimo Service Area

the quality of treatment plant effluent is affected. Collection and trunk systems also react strongly to lesser events (1 in 5 year).

It is noted in the Wet Weather Flow Management Update that future increases of leachate flow from the RDN landfill could significantly impact Departure Bay Pump Station capacity.

It is noted that the landfill's sump is considered as the largest point source of rainwater inflow into the Greater Nanaimo trunk system. The RDN's Solids Waste department is currently working on ways to manage the site to reduce this flow.

French Creek Trunk System

Modelling of the French Creek Service area is underway but not complete. However, the December 3, 2007 report stated that:

- At Bay Ave, the station ran with 3 pumps (firm pumping capacity) during most of the day.
- Hall Road Pump Station kept up with the flow with 1 pump.
- Lee Road Pump Station had all 3 pumps on for the day and was losing ground until early afternoon.

There was no comment about how the plant coped with flow that day.

It is noted that several trunk system manholes frames and covers have been replaced/sealed in this area to reduce I&I over the last 5 years.

Duke Point Trunk System

The Duke Point PCC is reported to have little infiltration flow, which is attributed to the areas low water table and a relatively compact sewer network⁸. The same report states that storm events have increased daily flow volumes at the plant to five times those observed during dry weather, which judging by the information in table 3 is conservative (a caveat in the hydraulic report noted the potential for storm flow readings to be exaggerated due to flume ragging).

Nanoose Trunk System

No capacity information has been reviewed for the Nanoose Service Area.

2.5 Inflow and Infiltration in Local Collection Systems

The operators of collection systems that feed into the RDN's trunk sewer networks were contacted to discuss I&I issues and remediation initiatives. Key points for each collection system are noted below:

⁸ RDN Duke Point Pollution Control Centre Hydraulic Capacity Assessment 2007

City of Nanaimo – Doris Fournier, Municipal Infrastructure Engineer

- Monitoring practiced since 2000. However, problems with data loggers and plugged up weirs caused weeks or months of data to be lost.
- New data loggers and more reliable measurement devices are currently being installed throughout the city that will report SCADA (Supervisory Control And Data Acquisition) systems.
- CCTV cameras have been purchased to inspect sewers and service connections.
- Approximately 15km of strategically selected sewers and manholes are to be inspected each year. Short and long term improvement plans being created using CCTV results.
- In 2010 \$450k of relining work (approx 650m of pipe) for mains and services is expected.
- Certain catchments have high I&I rates. Older areas of the Chase River catchment have some “Harewood wye’s” installed immediately off the main pipeline. These devices have an inspection wye which was capped. In most instances, the caps have corroded and failed leaving the inspection end of the wye open for groundwater infiltration or direct inflow. The number of services employing the Harewood wye are unknown. These are repaired whenever operations has the opportunity. Their locations are also being identified using CCTV inspection so specific mitigation projects can be implemented.
- Work has also been done to reduce I&I at manholes.
- Generally some work has been done, but much more is being planned.

In addition to the above information, the City of Nanaimo provided the RDN flow readings taken during the December storm event. This data identifies high rates of I&I at a number of stations. Such data is essential for determining where mitigation efforts should be applied.

Table 5. City of Nanaimo Collection System Flow Data, December 4th 2007

fms #	site location	4-Dec-2007			average readings (may-dec)			% increase
		time	level (cm)	flow (lps)	time	level (cm)	flow (lps)	
fms #1	Buttertubs	13:21	54.978	171.73	-	36.631	96.06	178.8%
	Buttertubs 2	13:23	19.337	34.45	-	11.992	15.15	227.4%
fms #2	Esplanade	14:07	17.234	31.31	-	7.961	7.38	424.3%
fms #4	Westdale	12:45	8.519	9.32	-	11.507	10.09	92.4%
fms #5	Townsite	<i>no reading available</i>			-	14.44	20.13	0.0%
fms #8	Departure Bay	12:55	28.013	77.77	-	21.653	54.91	141.6%
fms #12	7th Street	13:39	22.725	59.11	-	10.791	15.17	389.7%
fms #13	Park Ave	13:31	20.749	24.61	-	9.959	7.45	330.3%
fms #15	Stirling Ave	13:46	48.031	154.83	-	22.267	49.11	315.3%
fms #16	Maki Rd	14:00	33.708	68.52	-	17.607	28.07	244.1%

The District of Lantzville - No discussion held

- It is noted that the District is only just starting to connect to the local RDN trunk systems, such that current and future I&I flows should be negligible.

The Town of Qualicum Beach – Allan Cameron, Public Works Superintendent

- Smoke testing is performed in the fall to identify inflow sources
- Manhole lids have been bolted
- Manhole barrels are now being power grouted (equipment purchased)
- 1.8km of CCTV inspection completed this year. Services with suspected I&I problems are being located
- No relining has been performed. Pipes are all PVC and relatively new (less than 33 years old) and no sewer degradation is noted.
- Some cross connections have been found and disconnected – 4 or 5 noted in the Chartwell area

The City of Parksville – Mike Squire, Manager of Engineering

- A flow meter and weather station has been installed to report on I&I flows.
- Based on a 5 year return period, current I&I is estimated at 11,300 l/ha/d
- Manhole lids have been bolted
- Leaking manholes are being injected with epoxy
- \$90k of CCTV inspection completed on critical sewers last year which didn't indicate any significant problems
- Smoke testing has been completed in two of the City's older catchments
- The Foreshore area that is subject to tidal influence and high groundwater is known to have I&I problems
- Rathrevor Park, the responsibility of BC Parks, is believed to have stormwater sewers that connect into Parksville's collection system

RDN Collection Systems – Norm Burow, Chief Operator, Utilities

The RDN operate a number of collection systems including the:

Surfside Sanitary Sewer Service Area

French Creek Sewer Service Area

Barclay Crescent Sewer Service Area

Pacific Shores Sanitary Sewer Service Area

Fairwinds Sanitary Sewer Service Area

- Smoke testing has been done in most areas; the Morningstar area being the notable exception
- Some storm cross connections have been fixed, as have minor leaks in manhole structure
- CCTV inspection used primarily for operational problems as opposed to I&I investigation

2.6 Reducing Inflow and Infiltration Volume in the RDN

2.6.1 High level Analysis

The most cost effective way of addressing high I&I volumes within a sewer network is to identify the issues it is causing and quantify and cost the different options that could be used to mitigate them, so that cost benefit analysis can be performed.

For example, in the Greater Nanaimo area, lack of capacity at the Departure Bay Pump Station has been identified as cause of sewage overflows within its catchments. Estimation of volumes spilled and a future acceptable spill volume will allow for the development of whole life cost estimates for:

- adding in-line or off-line storm flow storage
- increasing pump station and downstream infrastructure capacity
- I&I reduction projects

It is unclear if cost estimates can be made for I&I reduction projects that will deliver a targeted level of reduction. In this example, of course, it will require input from the City of Nanaimo. However, the City of Nanaimo is making great strides into improving its understanding of I&I issues (see section 2.5), suggesting that this level of analysis may be possible.

2.6.2 Detailed Analysis and Goal Setting

Sanitary Sewer Overflow Monitoring

The RDN is learning a lot about its system through flow monitoring. Although, current sanitary overflow monitoring does not provide detailed estimates of spill duration and volume⁹. Such information is important when making decisions about I&I's cost implication to the community. It is therefore recommended that a sewer overflow monitoring program is created that records the frequency and extent of sewer overflows at all RDN and municipal sanitary overflows.

Workshops

It is clear from section 2.5 that, to various extents, RDN and municipal collection system managers are identifying their I&I problems and are taking steps to mitigate them, as set fourth in the 1997 LWMP. Steps taken include a number of mitigation techniques described in tables 2&3 (section 2.3.6). However, it appears from modelling and actual storm events that excessive I&I still occurs. It is therefore suggested that to build on this a series of workshop sessions are hosted for system operators to meet and discuss I&I problems, initiatives and successes.

⁹ See Appendix 3, *Liquid Waste Department Operating Procedures: Wet Weather – Monitoring Requirements*

Workshop sessions should have a clear purpose, articulate problems, identify strategies and set defined goals for all stakeholders. As inflow is typically the result of surface water run-off, the RDN and other municipalities' planning departments should have involvement in such workshops, as planners have the opportunity to manage stormwater flows.

It is recommended that the RDN should base workshops using the following type of approach:

- Define the problems that I&I is causing in each RDN trunk system, articulating regulatory commitments related to the issue as well as the financial, social and environmental risks posed, identifying high priority target areas (as indicated in 2.6.1)
- List all:
 - RDN investigation and mitigation work carried out in the last 10 years in its trunk and collection systems
 - known issues that are inside of the RDN's control and how and when they will be mitigated
 - known issues that are outside of RDN's control that require assistance from collection operators
- Request that each collection system operator lists:
 - work done in the last 10 years to investigate or mitigate I&I
 - known issues that are inside of their control and how and when they will mitigate them
 - known issues that are outside of their control (for example, I&I into Parksville's system from Rath Trevor Park) such that an action plan is created to solve the issue, which the RDN can choose to assist with as is appropriate
- Identify what mitigation techniques are working and which are not.
- Identify additional mitigation techniques that could be used (see tables 2 & 3, section 2.3.6)
- Identify how departments outside of wastewater operations can reduce inflow into sewers by redevelopment of existing impermeable areas and more consideration of the issue in future developments (include planners and engineers).
- Identify high priority areas for I&I investigation and agree on a strategy for implementation.
- Create an I&I mitigation action plan based on all information discussed, with well defined targets and timelines (goals) for both the RDN and all system operators

Hosting such a workshop will clarify to all stakeholders how their system's I&I problems affect the RDN, as well as promoting collaboration and knowledge share/learning between all stakeholders.

Preparing thoroughly for a workshop is essential to show to all stakeholders that the RDN is committed to reducing I&I and has the knowledge to strategically approach the problem. It will also make a productive outcome far more likely. Advanced preparation is expected from stakeholders.

Follow up workshops should be held to check progress against goals.

2.7 Managing sewage

The RDN wishes to reduce sewage flow as well as I&I in their system. As permitted sewage flow (as defined in section 2.2.1) is typically generated from the use of potable water within homes or buildings. The RDN's existing Watersmart programs educate on indoor water conservation and provide education literature on:

- Low flow toilet retrofits: replacing high volume flush toilets with more efficient low volume flush toilets.
- Low flow showerheads and faucet aerators: replacing less efficient showerheads and faucets with low-flow showerheads and faucet aerators.
- Clothes washers: replacing clothes washers with higher efficiency models.

The use of low flush toilet rebate programs are being considered in the RDN's local water service areas, and are already offered by the City of Nanaimo, the Town of Qualicum Beach, the City of Parksville and the District of Lantzville. Extending such programs to include free water reduction kits, such as the one below, may be a way of reducing water use in homes where the resident has no motivation to replace toilets and plumbing fittings. Such kits typically include faucet aerators, cistern water displacement bags, a low flow showerhead and dye capsules for leak testing.

Figure 13. Residential water reduction kit



Future provincial legislation will require new buildings to use water efficient plumbing fixtures as well purple pipe systems, which are designed to harvest rainwater and flows from lightly contaminated sources such as sinks and bathtubs (commonly referred to as greywater). However, as legislation will not be applied to existing properties it will have no affect on reducing current sewer flows.

Retrofitting existing properties with systems to collect greywater from inside of properties is not considered to be economically viable in B.C at this time due to the low cost of potable water.

Appendix 1: Extract from BC's Municipal Sewage Regulation, Item 17, Schedule 1.

MUNICIPAL SEWAGE REGULATION

[includes amendments up to B.C. Reg. 305/2007, October 5, 2007]

Average Dry Weather Flow or ADWF means the daily municipal sewage flow to a sewage facility that occurs after an extended period of dry weather such that the inflow and infiltration has been minimized to the greatest extent practicable and is calculated by dividing the total flow to the sewage facility during the dry weather period by the number of days in that period;

Inflow and infiltration

17 (1) The discharger must ensure that no person allows inflow and infiltration so that the maximum average daily flow exceeds 2.0 times ADWF to occur during storm or snowmelt events with less than a 5-year return period, unless

(a) if 2.0 times ADWF is exceeded at the treatment plant and for municipal sewage collection systems for which the contributory population to the treatment plant is equivalent to or exceeds 10 000 persons, the discharger addresses how I/I can be reduced as part of a liquid waste management plan, or

(b) if 2.0 times ADWF is exceeded at the treatment plant and for municipal sewage collection systems for which the contributory population equivalent to the treatment plant is less than 10 000 persons, the discharger either develops a liquid waste management plan or conducts a study and develops and implements measures that are developed in either the liquid waste management plan or the study such that I/I is reduced.

(2) Despite subcondition (1), if reductions below 2.0 times ADWF are not possible or cost effective based on a cost/benefit analysis, the discharger must

(a) provide full secondary treatment for the entire flow at all times, or

(b) undertake all of the following:

(i) provide at least primary treatment for flows greater than 2.0 times the ADWF;

(ii) utilize the full secondary treatment capacity of the treatment facility;

(iii) combine the primary and secondary effluent prior to discharge;

(iv) maintain a minimum receiving environment to discharge dilution ratio of 40:1;

(v) if disinfection is required, provide adequate excess disinfection capacity to ensure disinfection of the entire discharge flow.

Appendix 2: Results from Inflow and Infiltration Task Force Survey

Inflow and Infiltration Process Task Force Initial Program Comparison Survey Results

2/15/2008

City Name	Question 1: Please identify the wastewater collection problems that your I&I program is being designed to respond to.				Question 2: Please identify the wastewater treatment problems that your I&I program is being designed to respond to.			Question 3: Of the problems in Question 1 & 2, which are the most important, and why. Please explain:	Question 4: What was the trigger in your municipality that identified that you had an I&I problem in need of attention?
	Premature replacement through loss of capacity	SSO or CSO	Basement Flooding	Other, please specify	Premature expansion through loss of capacity	Bypass or overflows	Other, please specify		
City of Saskatoon			✓			✓		Basement flooding. One major incident in 2005 and two in 2007.	Basement flooding from large rain events.
Region of Peel			✓			✓		Basement flooding is most important because of the impact on residents	Areas with historical records of basement flooding
City of Victoria	✓	✓			✓	✓		1. L.W.M.P. mandates from province 2. Capacity and overflows tie in together for environmental reasons.	-L.W.M.P for the core area municipalities. -sewer pipe capacities for new developments with higher densities. -system (pipe) age & material
City of Calgary	✓	✓	✓			✓		Basement flooding (sewage back-up) is currently the biggest problem. Major storms in 2005 and 2007 resulted in nearly 1000 cases of sewage back-up.	Extreme rainfall in June 2005 resulted in extensive sewage back-ups (780), SSO's (3), lift station overflows (3), and treatment plant bypasses (3).
City of Chilliwack	✓	✓			✓			Question 2 - The cost to upgrade the WWTP.	No specific event.
Region of Halton	✓		✓	Reduce strains to pump stations & treatment plants		✓	Upsets at WWTPs, O&M cost reduction	Basement flooding, along with bypass and overflows are most important because these are reportable. Also, to confirm I/I rates used for design is an important task for us.	Significant basement flooding which occurred in May 2000 as a result of substantial rainfall.
Regional Municipality of York	✓	✓	✓	To reduce loads on treatment plants	✓	✓	To reduce loads on treatment plants	Capacity issues and treatment plant loads are most important for use. However, basement flooding and SSO is the most important for our local municipalities.	We noticed large responses at our treatment plants, pumping stations, and metering locations following a rain event. We also saw evidence of I&I in some of our wastewater modeling exercises.
Metro Vancouver		✓				✓		Both are important because they result in untreated wastewater to the environment.	Documented SSO's, and monitored flows with peak to dry weather flow ratio in excess of 2.
City of London		✓	✓			✓		Both are important.	Provincial ministry
District of Maple Ridge	✓			Optimal capacity use and Cost reduction			Not applicable	Cost reduction in volumetric charges is important	Differences of dry and wet weather flow as identified in the Master Sanitary Plan prepared by Earth Tech in 2000

Inflow and Infiltration Process Task Force Initial Program Comparison Survey Results

2/15/2008

City Name	Question 5: Briefly describe the resources that you have allocated to deal with your I&I program (approximate staffing, and annual funding expenditures)	Question 6: Does your Council understand the significance of I&I on the performance of your wastewater collection system and/or treatment plant(s)?	Question 6: Additional Comment	Question 7: Do you communicate resolution options to your customers (i.e. homeowners)?	Question 7: Explain	Question 8: Have you ever, or do you routinely have to resort to bypass pumping to avoid system backup and flooding during wet weather?	Question 9: Do you use real-time or predictive control as a means of maximizing collection system storage to alleviate I&I and mitigate flooding impacts?	Question 9: Additional Comment
City of Saskatoon	\$2.2 million - 4 staff - this includes other basement flooding response and investigation work.	Yes	Communication has been good on this point.	Yes	Sets of public meetings, websites, and brochures have all been used.	Occasionally	No	This is an area we are currently investigating and have funds committed towards.
Region of Peel	130,000 to annual sewer inspection 190,000 to inspection of maintenance chambers I/I studies and remedies is 700,000 annually 5,000,000 to repair and replacement 20 operations and 5 studies staff	Yes	We get calls even before a rain event from Councillors	Yes	downspout disconnect no grease down the drain limit water use during storms use of rain barrels	Almost Never	Yes	Use geotivity real time monitoring
City of Victoria	-staff of one -approx. annual funding of \$250,000 for investigations related works -I&I targeted rehab work yet to be done.	Yes	In process of informing council of issues related to I&I and it's potential impact on system capacities & future developments.	No		Never	No	
City of Calgary	1 - 2 FTE dedicated to inflow and infiltration program. Three I & I pilot studies planned in 2008. Estimate total cost of the studies is \$500,000.	No		Yes	Water Services staff contact homeowners to resolve problems.	Never	No	
City of Chilliwack	Still in preliminary stages. Have a annual budget of \$60,000. Fully equipped CCTV truck and crew.	No	Council has not been fully addressed in regards to this issue.	Yes	After tests have proven I&I, property owner is advised of repair requirements.	Never	No	
Region of Halton	2 full staff plus a 3 part time staff and one supervisor.	Yes	They understand more as it relates to basement flooding as opposed to impacts to the collection system/treatment facilities.	Yes	We do as it relates to removing private-side sources of I/I to reduce impacts on the wastewater system and prevent basement flooding.	Occasionally	No	This is something that we may want to move to in the future.
Regional Municipality of York	We have allocated staff to manage an inflow and infiltration study and we have retained a engineering consultant for the flow monitoring, investigations, analysis. Funds are allocated for the I&I project through our capital budget.	Yes	Our inflow and infiltration reduction project was approved by council.	No	Not yet, but we will be soon as our current projects approaches this part of our project. Within our project we included public communications such as flyers and a website.	Never	No	Not at this time but current program will address this issue with the development of flow control gates.
Metro Vancouver	Metro Vancouver owns and operates large mains and inspection and repair/replacement is part of our regular annual budget.	Yes	We're currently updating our Liquid Waste Management Plan and have drafted a discussion document for our board and the public that includes the significance of I&I.	Yes	Metro Vancouver's customers are our member municipalities, and we have discussed resolution options during the development of our Liquid Waste Management Plan.	Almost Never	Yes	
City of London	The City of London has a 20 year plan for all sewer works and included in this plan is \$120 M for CSO. We have one engineer working partime on this project using technical staff as required	Yes	Outlined in reports and presentations	Yes	Via bill inserts	Occasionally	Yes	To a minor degree at this time. More in the future.
District of Maple Ridge	No staff allocation. Annual funding (\$12,000 to \$ 65,000) for video inspections and flow monitoring	Yes		Yes	Open houses for remedial work	Never	Yes	

Inflow and Infiltration Process Task Force Initial Program Comparison Survey Results

2/15/2008

City Name	Question 10: Do you have any customers that are connected to your wastewater collection system that are unable to obtain insurance for basement flooding because repeated flood events?	Question 10: Estimated Number	Question 11: Have you had to pay settlement claims related to I&I flooding in the past 5 years?	Question 11: If yes, approximate value and year(s)	Question 12: Do you require backflow prevention valves to be installed on the sewer services for:				Question 13: Have you identified where your I&I is coming from?	Question 13: Degree of confidence?
					All new construction	In redevelopment (or infill development) areas	Only in known problem areas	Additional Comments?		
City of Saskatoon	Yes	Two	Yes	Very minimal in previous five years. There is a possibility of paying settlements from ongoing litigation in events in 2005 and 2007 however.	✓			Backflow retrofit program in place for 2005/07	Yes	High though still under investigation
Region of Peel	Yes	50	Yes	5 claims per year total \$8,000			✓		Yes	weeping tiles, downspouts, foundation drain systems, vandalism, broken pipes, manholes, improper storms connections
City of Victoria	No		No	Not to my knowledge.			✓		Yes	
City of Calgary	Yes	Unknown	No	City has not paid any claims. Most were paid by private insurance.				Not required. Homeowner's discretion.	No	Very low confidence, due to the limited number of flow monitoring sites, large catchment areas, and lack of resources to analyze data.
City of Chilliwack	No		No				✓		Yes	Aging infrastructure, manholes, pipes, cross connections. High water tables, and storm water run off. Degree of confidence 70%
Region of Halton	Yes	Less than 5 known.	No					Responsibility of the Local Municipalities	Yes	Coming largely from private-side stormwater connections and aging infrastructure - high level of confidence in areas that have been extensively studied.
Regional Municipality of York	No	NA. We are a two-tier municipality and our customers are the local municipalities within our region. We do not have this information from our local municipalities.	No	NA. We are a two-tier municipality and our customers are the local municipalities within our region. We do not have this information from our local municipalities.				Not Applicable	Yes	Our past studies have shown where I&I is coming from in some communities. We are currently looking at the whole Region.
Metro Vancouver		NA - our customers are our member municipalities.	No					That's up to each member municipality.	Yes	About 50% of our flow to the treatment plants is I&I, and of that a large percentage is believed to be from private property laterals.
City of London	Yes	Unknown	Yes	Confidential				We do not require backflow preventors	Yes	moderate
District of Maple Ridge	No		No					We don't require back flow prevention	Yes	80%

Inflow and Infiltration Process Task Force Initial Program Comparison Survey Results

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City Name	Question 14: Are the weeping tile (foundation drains) of any of your residential customers connected to your sewage collection system?	Question 14: If yes, please describe circumstances	Question 15: Are you undertaking or have you undertaken any flow monitoring within your collection system to attempt to quantify I&I?	Question 16: If yes to above, please briefly describe your flow monitoring program and its magnitude (permanent and temporary installations and catchment area, etc.	Question 17: Does your CCTV program include:					Question 18: Do you CCTV inspect your collection system post construction as a condition of acceptance?			
					Trunks	Collectors	Laterals	Services	We do not have a CCTV Program	Trunks	Collectors	Laterals	Services
City of Saskatoon	Yes	All homes built from approximately 1965 up to January 1, 2004.	Yes	CITY WIDE 6 real time rain gauges 22 real time sanitary monitors 5 temporary download monitors 3rotated through 35 sites 11 passive peak flow indicators		✓	✓	✓					
Region of Peel	Yes	but not supposed to be	Yes	30 permanent flow monitors on trunk sewers, 30 real time alarmed flow monitors in basement flooding areas	✓	✓				✓	✓	✓	✓
City of Victoria	Yes	Built as separate systems at the turn of the century, drainage bylaws prior to 1950 required storm drain lateral to be connected to storm drain main but allowed, by approval from Director, connections to the sanitary sewer. No records kept of which areas this occurred.	Yes	Permanent monitoring currently on 7 of 11 lift stations forcemains; remaining four to be done this year. temporary installations done thru contracts: 2005/06 = 9 open channel flow meters 2008 = 15 open channel flow meters 9 overflow locations City owned/CRD loaned flow meters 2005/06 = 5 open channel flow meters		✓	✓				✓		
City of Calgary	Yes	Weeping tile connections were permitted prior to 1973, in areas of high groundwater.	Yes	60 permanent flow monitors. Catchment areas 500 – 4000 ha +. Monitoring period May – Sept. Mixture of area – velocity meters and weir type meters. Typically 10-20 temporary flow monitors for special studies. Typical catchment area 200 – 500 ha.	✓	✓	✓			✓	✓	✓	
City of Chilliwack	Yes	Servicing existing homes with sanitary sewer, home owners connecting to system with no City inspection or knowledge.	No		✓	✓	✓			✓	✓	✓	
Region of Halton	Yes	Typically in older homes built prior to 1978.	Yes	106 flow monitoring stations within the collection system and WWTPs (15 temporary). Combination of manually collected information and SCADA collected information.		✓	✓	✓		✓	✓		
Regional Municipality of York	Yes	They are connected on the local municipal sewer system in some areas. This will be under review in our current study.	Yes	Our current flow monitoring includes 120 temporary flow meters and 15 heated rain gauges. Flow meters are placed in areas were problems have been identified and typically in older sewers that are not PVC. Flow meters were placed were the total length of pipe in the catchment was in the 5-7 km range. We will be constantly moving our meters if we do not see any response to a large rain event.	✓					✓			
Metro Vancouver	No	Officially no.	Yes		✓	✓				✓	✓		
City of London		yes, in areas built at certain times	Yes	21 flow monitors temporary and permanent.	✓	✓	✓			✓	✓	✓	
District of Maple Ridge	No		Yes	Temporary flow monitoring: 13 stations Total catchment Area: 3,096 ha	✓	✓	✓			✓	✓	✓	✓

Inflow and Infiltration Process Task Force Initial Program Comparison Survey Results

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City Name	Question 19: Have your municipality's I&I programs and mitigation efforts been a success thus far?	Question 19: Please explain why (or thoughts about why not)	Question 20: Do you subsidize flood prevention programs for any of your customers?						Question 21: Describe your current wastewater collection system design standards for Average Dry Weather Flow, Peak Wet Weather Flow, I&I Allowance (and Return Period)	Question 22: Do your design standards differ by type of development, redevelopment vs infill vs new construction? If so, please describe.
			Backflow preventer installation	Lot grading improvement	Weeping tile disconnection	Sump pump installation	Roof leader disconnection	Other, please specify		
City of Saskatoon	No	Public resistance to backflow upgrades and weeping tile disconnection in private homes. We are supported by Council however.	✓		✓	✓			290 l/capita/day (35/persons/ha) base plus Harmon peaking factor, 0.05 l/s per weeping tile connection (wet weather), 0.08 l/s/ha I/I (wet weather) - NO return period	No
Region of Peel	Yes	We've reduced basement flooding claims and increased are knowledge of system flows		✓		✓	✓		Except for unusual circumstances, the infiltration portion of sewage flow shall be 0.0002 m3/sec/ha for all types of land use. This factor applies to the gross area of all lands. When designing sewers that accept flows from an area greater than twenty five (25) years old, or where evidence indicates, an additional allowance shall be made for foundation drains equal to 0.08 litres/sec/foundation drain (0.00008 m3/sec/drain). Additional allowance for maintenance hole inflow: 0.00028 m3/sec/mh or equivalent of 0.000028 m3/sec/m of sewer length.	Yes
City of Victoria	No	-preliminary investigation stage thus far where we have identified some sources of I&I. -we are planning to undertake an extensive I&I reduction project starting in 2008 and continuing over the next 2-3 years, with an estimated cost of approx. \$3,000,000						no	Large models done by consultants. Peak Design Flow = Domestic Flow + Peaking Factor + I&I Domestic Flow = 225 litres/person/day Peaking Factor = Harmon or Babbit formula I&I = we try to use actual I&I rates (where possible) from flow metered results	No
City of Calgary	Yes	Very limited mitigation efforts undertaken to date. Several storm cross connections were identified and removed as part of one I & I study.						No subsidy programs.	ADWF = population X 380 L/c/day (population based on 55 persons / ha) PDWF = ADWF X Harmon's Peaking Factor (min 2.5) PWWF = PDWF + I & I Allowance of 0.28 L/s/ha Required sewer size based on = PWWF / 0.86 Return Period: Not currently used for sanitary sewer design. Note: Sanitary Sewer Design Standards for Industrial and Commercial lands are under review and new standards may be published in the future.	No
City of Chilliwack	No	Still in preliminary stages. What corrections have been made have had minimal impact.						No, not at this time	ADWF = 410 litres/capita/day PWWF = 3.5 X ADWF I&I Flow Rate = 0.1 litres/sec/hect + ADWF	No
Region of Halton	Yes	The results of these efforts are still premature and there is lots more to do. Still hard to completely quantify the results of our I/I efforts.							With respect to flows, these standards vary from pipe size to pipe size. WRT I/I allowances, ours is 0.286l/sec/ha.	No
Regional Municipality of York	Yes	Our last program identified areas or concern. The local municipalites conducted some rehabilitation. We went back in and monitor and there was definent reduction in I&I.						Not Applicable	Dry weather I&I Allowance - 90 L/ca/d Peak I&I Allowance - 0.2 L/s/h ADWF - 265 l/c/d (res); 160 l/c/d (ICI) Peaking Factor - Harmon	No
Metro Vancouver	No	Municipalities have competing priorities, and the LWMP has only been in place for 5 years.						Municipal area of concern.	ADWF is a function of population PWWF is defined by basic service Our I&I allowance is 11,200 litres per ha per day	No
City of London	Yes	We have not initiated the program.	✓			✓			ADWF=250 I&I allowance=8640 l/ha/d PWWF=N/A Return Period=N/A	No
District of Maple Ridge	Yes	The I&I program has led to creation of capital projects to replace or reline						No	As per MMCD Design Standards. I&I Total Allowance: 11,200 l/ha/day	Type of development: yes Redevelopment vs Infill only if there is a change in land use. New construction: no

Inflow and Infiltration Process Task Force Initial Program Comparison Survey Results

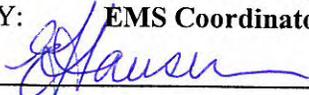
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City Name	Question 23:				Question 24: What is your normal period of highest rainfall? (eg: Nov to Feb)	Question 25: Are you familiar with any research, BMP, or any of your own studies on I & I that you might share with the participants? Please reference these.	Question 26: Please provide your opinion regarding where you would like this Task Force's efforts to be directed over the next few months	Question 27: Contact Information
	Return Period	Duration	Rainfall (mm)	Peak Intensity (mm/hr)				
City of Saskatoon	5 year	1 hour	28.9	28.9	May to September	Familiar with some weeping tile studies from cities of Winnipeg and Regina but I have no specific references.	Provide all of the information from the municipalities in an easily comparable form. It would also be useful to know the specific techniques municipalities are using to seek and control I/I and to share the limitations and successes of those experiences.	Galen Heinrichs, City of Saskatoon, galen.heinrichs@saskatoon.ca, 306 975 7522, , , , ,
Region of Peel					spring and fall	Infraguide OMBI and OCMBP		Jennifer Rose, Region of Peel, jennifer.rose@peelregion.ca, 905-791-7800 x. 4029, , , , ,
City of Victoria	1:25	17 hours over a 24 hour period	104mm	19mm/hr	January to April	-Inflow & Infiltration Management Plan done by consultant for the City. -BMP (National Guide to Sustainable Mun. Infrastructure) -various Capital Regional District studies on I&I. -could share results from proposed I&I reduction project that we will be	-private property I&I related issues -> rehab programs/incentives/strategies -sharing of other cities' experiences and findings. What worked, what didn't and at what costs.	Derk J. Wevers, City of Victoria, BC, dwevers@victoria.ca, 250-361-0552, , , ,
City of Calgary	Design Rainstorms Not Used for Sanitary Design				May, June, and July.	Computer Modeling Studies Completed to Date: Forest Lawn I/I Study – Phase 1 (2005), Glencoe South Calgary I & I Study, Anderson Road Sanitary Study (2007), Fish Creek West Sanitary Study (2007) Possible Future Studies: RDII Calibration Study (Mike Urban model), Use of Radar - Rainfall data in sanitary sewer modeling. BMP's: In 2006, the City installed plastic plugs in sanitary manhole lids in Palliser, Oakridge, Woodbine, and Woodlands communities. The manholes were located in street sags where street flooding may have occurred in June 2005. A consultant recommended plugging the pick holes as a first step after sewage back-ups occurred.	1) More information on how customer complaints are received, tracked, and used to assess system performance. 2) More information on flow monitoring practices (internal / external provider, resources allocated, data storage and ana	Colin R. Hansen, P. Eng. , City of Calgary - Water Resources, colin.hansen@calgary.ca, 403-268-1942, , , , ,
City of Chilliwack					October to March			Jared Brounstein, City of Chilliwack, brounstein@chilliwack.com, 604 793 2754, , , , ,
Region of Halton	n/a	n/a	n/a	n/a	March, April, October	Not at this time.	I/I reduction strategies aimed at basement flood prevention, cost-benefit analysis for remedial works and quantifiable results.	Matt Stefanik/John Duong, Halton Region, Ontario, Matthew.Stefanik@halton.ca, (905) 825-6000 x 7918, , , , ,
Regional Municipality of York	25 years	12 hours	73	18 mm/hr	March to May	King County Regional Infiltration?Inflow Control Study Miami-Dade Infiltration/Exfiltration/Inflow study Current study under way to be shared when finished.	Development of BMP	David Jansma, The Regional Municipality of York, david.jansma@york.ca, 905-830-4444 x5046, , , , ,
Metro Vancouver	5 yr	24 hr			Nov to Mar	Recent I/I study "Study of Effectiveness of I&I Measures" being finalized.	How do we deal with private property laterals in a practical and timely manner?	Ed von Euw, Metro Vancouver, ed.voneuw@metrovancouver.org, 604.436.6900, , , , ,
City of London					Available on Environment Canada Website	No.	Comparison of level of service standards as they related to flood protection for various municipalities. Do they use a specific design storm?	Scott Mathers, City of London, smathers@london.ca, 519-661-2500 x5472, , , , ,
District of Maple Ridge	10 years	Is the calculated Time of Concentration (Tc)		based on calculated Tc	November to February	No	BMP and successful programs	Velimir Stetin, District of Maple Ridge, vstetin@mapleridge.org, 604-467-7495, , , , ,

Appendix 3: Liquid Waste Department Operating Procedures: Wet Weather – Monitoring Requirements

REGIONAL DISTRICT OF NANAIMO
Liquid Waste Department

OPERATING PROCEDURES

SUBJECT: Wet Weather – Monitoring Requirements	PROCEDURE NO.: LWD-OP-10
	PAGE: 1 of 2
EFFECTIVE DATE: January 22, 2009	LAST REVISED: January 22, 2009
APPROVED BY: Manager of Liquid Waste SIGNATURE: 	PREPARED BY: EMS Coordinator SIGNATURE: 

1.0 PURPOSE

- 1.1 To provide operating staff with direction on monitoring requirements during an extreme wet weather event.

2.0 RESPONSIBILITY

- 2.1 It is the responsibility of the Chief Operator to provide this procedure to staff.
- 2.2 It is the responsibility of the staff to read, understand and follow these procedures during an extreme wet weather event.
- 2.3 It is the responsibility of the EMS Coordinator, Environmental Technician and Liquid Waste Manager to assist where necessary to ensure that all areas of the procedure are completed during an event.

3.0 PROCEDURES

- 3.1 The Liquid Waste Coordinator or person designated by the liquid Waste Coordinator is required to monitor weather forecasts and alert the Liquid Waste Manager, Operations Supervisor and Chief Operators of any upcoming weather events that should be monitored.
- 3.2 Greater Nanaimo Pollution Control Centre:
 - 3.2.1 Operator or EMS Coordinator or Environmental Technician are to check:
 - Brechin Point for sewage overflow
 - Millstone Siphon for sewage overflow
 - Departure Bay Beach for leaking manholes
 - 3.2.2 Record individual pump hours and wet well levels every half hour for:
 - Chase River Pump Station
 - Departure Bay Pump Station
 - Wellington Pump Station.

- 3.3 Duke Point Pollution Control Centre:
 - 3.3.1 To be monitored as per normal from Greater Nanaimo Pollution Control Centre.
 - 3.3.2 Operator or Liquid Waste Coordinator or Environmental Technician to check the manhole located in the ditch near the DPPCC for possible ICC infiltration by checking manhole upstream and down stream of this point. ICC is located 931 Maughan Road. (See Attachment I: Map of manhole locations)
- 3.4 French Creek Pollution Control Centre:
 - 3.4.1 Operator or Liquid Waste Coordinator or Environmental Technician to check Surfside for leaking manholes.
 - 3.4.2 Record individual pump hours and wet well levels every half hour for :
 - Hall Road Pumpstation
 - Bay Ave Pumpstation
 - Lee Road Pumpstation
- 3.5 Nanoose Pollution Control Centre:
 - 3.5.1 To be monitored as per normal from French Creek pollution Control Centre.
- 3.6 Observations are to be compiled by the EMS Coordinator and the results to be discussed at the next LWD meeting following a wet weather event to identify any issues that need to be address for future wet weather events.

4.0 ATTACHMENTS

- 4.0 Attachment I: Map of manhole locations near DPPCC

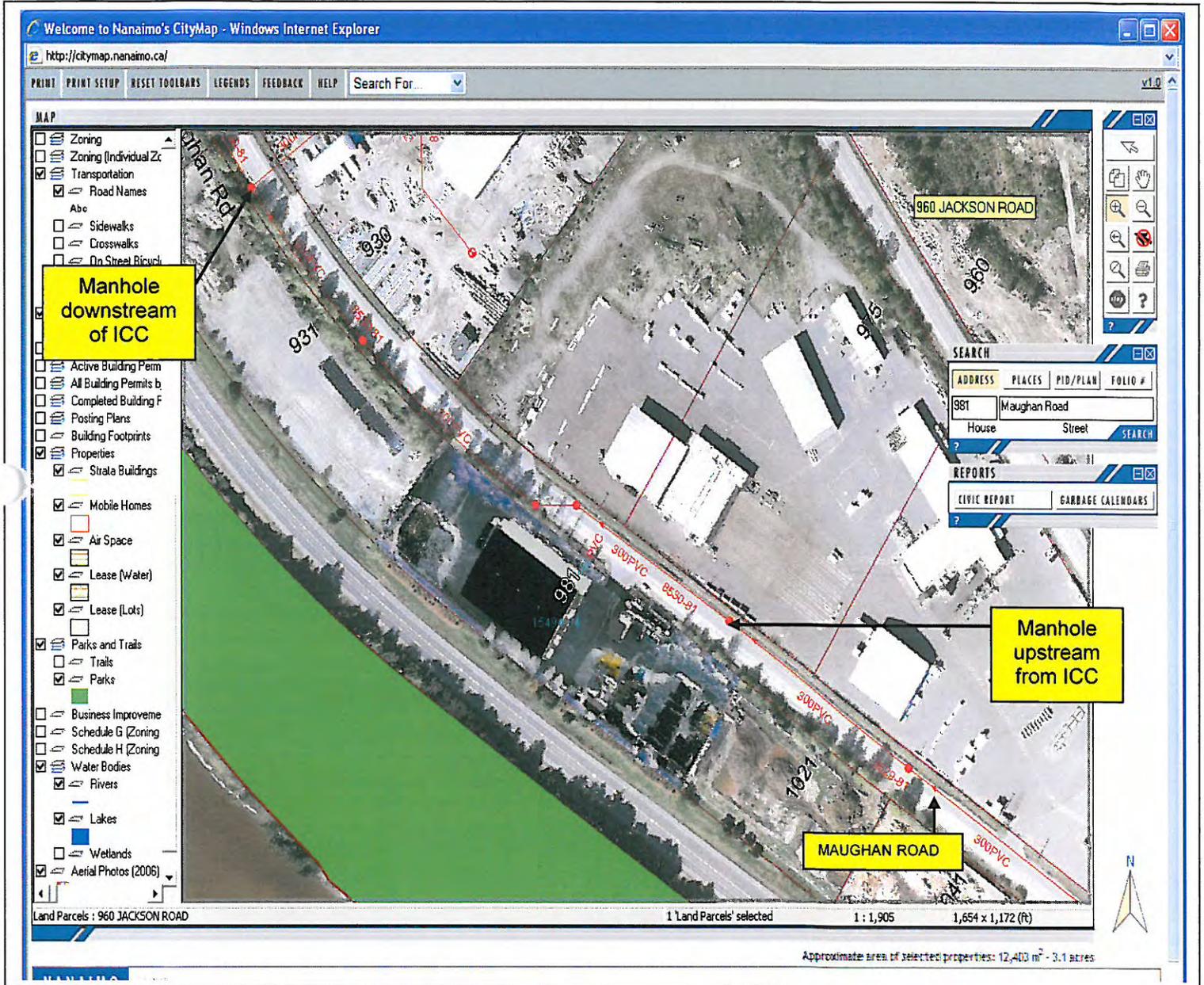
Liquid Waste Department	Page 2 of 2	Prepared by: EMS Coordinator	Last Revised: 22 Jan 2000
Emergency Response Procedures Manual [Wet Weather Monitoring Requirements]		Approved by: Manager of Liquid Waste	



LIQUID WASTE DEPARTMENT



Map of manhole locations near DPPCC (931 Maughan Road)



Liquid Waste Department	Page 1 of 1	Prepared by: EMS Coordinator	Last Revised: 22 Jan 2000
Emergency Response Procedures Manual [Map of manhole locations near DPPCC]		Approved by: Manager of Liquid Waste	

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