Memo

Stantec

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Reference: CRD Core Area Wastewater Management Program – Design Flows and Loads

1.0 Introduction

The Capital Regional District (CRD) is currently in the process of planning for secondary wastewater treatment. The selection of appropriate design flows is an important element of the Core Area Wastewater Treatment Program (CAWTP). The CRD has already completed a comprehensive assessment of existing and future design flows for the CAWTP. The Discussion Paper 033-DP-2 as prepared by KWL, CH2MHill, and Associated Engineering in September 2008 and updated in January 2009 outlined the methodology and summarized the design flows for each of the sewerage catchment areas in the program. As the Discussion Paper is very comprehensive, this memo serves to provide a synopsis of the information detailed in the Discussion Paper and also includes BOD and TSS load projections, which are the governing factors for sizing of secondary wastewater treatment facilities.

2.0 Description of Wastewater Treatment Plan

Table 1 provides a brief overview of the proposed configuration for a wastewater treatment system for the Core Area based on the revised Option $1A^{Prime}$.

Table 1. Description of Revised Option 1A^{Prime}

Component	Description
Saanich East – North Oak Bay	• 12,000 m3 of storage for wet weather flows in excess 2 X ADWF
Clover Point	• No wet weather flow plant at Clover Point • Pump 3 X ADWF to plant at McLoughlin Point
McLoughlin Point / Macaulay Point	Treatment plant at McLoughlin Point site: • Primary treatment for up to 4 x ADWF from Macaulay and 3 x ADWF from Clover • BAF secondary tratment plant for flows up to 2 x ADWF • ADWF of 107.8 ML/d
West Shore Plant	• No plant initially • Capacity for West Shore included in McLoughlin Point plant
Biosolids Processing	A biosolids processing and resource recovery facility at Hartland landfill for all biosolids produced at the McLoughlin Plant
Process for biosolids stabilization	Thermophilic anaerobic digestion at Hartland Landfill
Outfalls	• Twin Macaulay outfall • Future outfall in the West Shore
Future Capacity Expansion Opportunity	Build West Shore plant(s)

3.0 Existing Design Flows and Proposed System Configuration

Under the original plan for wastewater treatment, Option 1A, four treatment facilities were proposed. One facility at Clover Point was to be a wet weather treatment facility. It is now proposed to amend Option 1A to eliminate the wet weather flow plant at Clover Point and to pump 3 x ADWF to the central treatment facility at McLoughlin Point. It is also proposed to eliminate the wastewater treatment plant at Saanich East and to install a 12,000 m3 storage tank to handle wet weather in excess of 2 X ADWF. Sufficient treatment capacity can be provided at the McLoughlin Plant to accommodate the initial wastewater treatment needs of the West Shore which enables deferring construction of a West Shore plant for 10 to 15 years.

The historical flow information for Clover and Macaulay catchment areas serving the proposed plants for the past four years was provided by the CRD and is tabulated below:

Table 2. Historical Flows (ML/d)

Catchment Area	Year 2006		Year 2007		Year 2008		Year 2009	
	ADWF	PWWF	ADWF	PWWF	ADWF	PWWF	ADWF	PWWF
Clover Point	54.5	185	53.6	178	44.6	132	42.9	173
Macaulay Point	40.6	123	40.8	130	39.4	85	39.4	145

The historical flow data for Clover Point include the flows from Saanich East while the Macaulay Point flow data include the flows from the West Shore. The PWWF for Clover in year 2009 shows a spike flow of 173 ML/d in January 2009, which is abnormal. The normal PWWF in the rest of year 2009 is only 94 ML/d.

Regulatory Requirements

New treatment facilities must meet the requirements of the Municipal Sewage Regulation and must also satisfy Federal regulations. Secondary treatment must be provided for flows up to 2 x ADWF. Primary treatment must be provided for flows in excess of 2 times ADWF. For the CRD, it is proposed that that flows up to 3 times ADWF at Clover Point and flows up to 4 times ADWF at Macaulay Point be provided with primary treatment. As discussed in a separate memorandum, this should cover the majority of the peak wet weather flow events currently experienced in the CRD sewerage system.

Appendix 1 to Schedule 7 of the MSR specifies redundancy requirements for the various process units within a wastewater treatment plant. For facilities the size of the CRD, multiple process trains must be provided such that the plant can meet operating certificate effluent requirements at all times. For the secondary process units the remaining capacity with the largest unit out of service or train out of service must be capable of treating 75% of the design maximum flow.

4.0 Population Projections

Table 3 shows the existing and projected sewered residential population and equivalent population for the institutional, commercial and industrial (ICI) sectors up to 2030 for each municipality for a low and a high rate of growth of 1.3% and 2.1% respectively. The total population is the total population equivalent, which is the sum of the residential population and the ICI population equivalent (as a number of full time residential population equivalents for industrial, commercial, and institutional activities). The population projections were prepared by the CRD based on projections carried out by the Province through BC STATS using PEOPLE software and on the basis of Regional planning documents.

As indicated in Table 3, the projected total equivalent population for the year 2030 is 493,474 persons based on a high rate of growth. Using a low rate of growth, the projected sewered equivalent population in 2030 is 436,032 persons. It should be noted that the actual residential population is lower than the numbers outlined in Table 3 because industrial, commericial and institutional users are converted to population equivalents to estimate flows. This is a common practice in the design of sewerage systems.

Table 3. Sewered Equivalent Population Projections – Year 2030

Municipality	2008/2009	2030 – Low Rate of Growth @ 1.3%	2030 – High Rate of Growth @ 2.1%
Saanich	137,430	149,892	166,513
Victoria	114,539	122,669	141,734
View Royal	12,257	17,418	22,972
Oak Bay	21,674	22,173	26,304
Esquimalt	25,295	29,601	26,866
Colwood	8,933	35,526	34,548
Langford	20,964	58,753	74,737
TOTALS	**341,093**	**436,032**	**493,474**

In **Tables 4 and 5**, the projected population is apportioned in the catchment areas for the proposed wastewater treatment plants. Tables 3 and 4 also extend the population projections to 2065. Projected populations for years 2030 and 2065 will be used for design flow projections as the timeframe is considered to be reasonable for staging of construction.

Table 4. Design Sewered Population Equivalents – Low Rate of Growth

Catchment Area	Year 2030	Year 2065
East Saanich	47,642	56,952
Clover Point	122,018	135,086
Macaulay Point	176,925	220,648
West Shore	89,447	169,314
Total	**436,032**	**582,000**

Table 5. Design Sewered Population Equivalents – High Rate of Growth

Catchment Area	Year 2030	Year 2065
East Saanich	53,900	63,500
Clover Point	138,100	150,600
Macaulay Point	200,200	246,000
West Shore	101,200	188,800
Total	**493,400**	**648,900**

As indicated in Table 5, the total connected **sewered equivalent** population in the Core Area is expected to increase to approximately 493,400 by year 2030 and to 650,000 by year 2065 with the high rate of growth.

Historically the region has grown at a rate of 1% per year. Using the historical rate of growth, the projected equivalent population in 2030 would be 416,000 persons in 2030 and 535,000 persons in 2065.

The expected rate of growth in the Macaulay catchment is much greater than that in the Clover catchment. The growth potential in the Clover catchment area is through infill and densification while the Macaulay catchment still has more room for expansion.

For West Shore communities, significant developments are planned in the City of Langford and City of Colwood in the coming years. It should be noted that the sewered equivalent population projections for the West Shore is based on servicing all current developments with sanitary sewers by 2030.

5.0 Project Design Flows and Loads

The projected flows were developed based on the following approaches assuming that water conservation initiatives are implemented in the future through use of low flow fixtures. CRD has already embarked on this program over the last 5 years and have noticed a reduction in water consumption.

5.1 ADWF (Average Dry Weather Flow):

ADWF consists of two main components: BSF and GWI_{summer}.

- BSF (Dry Weather Base Sanitary Flow): The per capita equivalent BSF in the projected areas is currently averages 206 L/d/capita. With water

conservation and fixture reduction, the per capita equivalent value could be reduced to 195 L/d/capita in year 2030 and to 184 L/d/capita in year 2065.

- GWI (Ground Water Infiltration): It represents leakage of ground water into the sewer system through cracked pipe or pipe joints. Older sewer systems typically have higher GWI rates than newer sewer systems. GWI_{summer} represents ground water that infiltrates into the collection system during the driest months of the year.

Typically, GWI increases with time as a sewer system deteriorates due to age. A considerable investment would be required for the CRD to reduce the GWI as the core system is getting older. The summer groundwater infiltration is estimated as 70% of the sewage flow at 4:00 AM. Using this approach, the following groundwater infiltration rates have been estimated:

- Clover Point catchment area, which includes Saanich East: 3,900 L/ha/day. This has been apportioned into a lower rate of 2,100 L/ha/day for Saanich East and a higher 3,946 L/ha/day for the balance of the Clover Point area.

- Macaulay Point catchment area, which includes the West Shore: 1,900 L/ha.day.

Table 6. McLoughlin Point WWTP Design Flows

Item	2030		2065	
	Flow (ML/d)	Action	Flow (ML/d)	Action
Design ADWF	107.8	On-site Secondary	107.8	On-site Secondary
Total design flow of 2 x ADWF	215.6	On-site Secondary	215.6	On-site Secondary
2 x ADWF – 3 x ADWF (from Clover)	51.9	On-site primary only	51.9	On-site primary only
2 x ADWF – 4 x ADWF (from Macaulay)	111.7	On-site primary only	111.7	On-site primary only
Wet Weather Flow (Total)	163.6	On-site primary only	163.6	On-site primary only
>4 x ADWF(tributary)	≅20[1]	Screening to outfall	≅0[1]	Screening to outfall
Filtration for Reuse	6		6	
Biosolids		Pump to digesters at Hartland		Pump to digesters at Hartland

Notes on Table 8:

1. Based on effective I&I reduction program

5.2 Peak Wet Weather Flow

PWWF is estimated as PDWF (Peak Dry Weather Flow) plus I&I (inflow and infiltration).

PDWF is the product of ADWF and PF (peaking factor). Usually, 80% of the calculated value from Harmon equation is applied. The exception is that 100% of the Harmon equation value was used for peak flow estimate along the ECI (East Coast Interceptor) and has been confirmed by flow monitoring results.

I&I (inflow and infiltration) for wet weather flows is the sum of RDI&I (rainfall dependent inflow and infiltration) and GWI_{winter} where GWI_{winter} is the ground water that infiltrates into the collection system during the wettest months of the year.

Wet weather flows are typically based on storm events. The magnitude of storm events varies based on the frequency of their return periods. The methodology used in the Discussion Paper 033-DP-2 is termed as the "I&I Envelope", which uses a series of flow monitored storm events, including 2, 5, 10, 25, 50 and 100 years, to develop a correlation between the amount of rainfall that occurs and the magnitude of I&I that shows up at a given site. A return period of 5-Year and a 6-Hour rainfall duration were selected for best correlation of return period. The projected flows (ADWF) for the catchments as shown in the Appendices of Discussion Paper 033-DP-2 are summarized and tabulated above for comparison with the design flows used in the cost estimate. The 5 year return period is a regulatory requirement under the MSR.

5.3 Wastewater Design Loads

The secondary wastewater treatment plants should also be designed to handle the organic and suspended solids loading. The organic loading governs the sizing the of secondary treatment and biosolids processes while hydraulic flows govern the sizing of components such as headworks, primary treatment and outfalls. These loadings are measured as biochemical oxygen demand (BOD_5) and total suspended solids (TSS). For preliminary design, the total quantity of the organic and suspended solids loading for each plant is determined using the design flow (ADWF) with a solids loading factor of 1.3 to account for the load increase during the storm events and maximum month loading conditions. The BOD_5 and TSS concentrations in the storm water are greatly reduced. The solids loading factor could range from 1.1 to 1.4 x ADWF depending on the characteristics of the catchment area and ICI contributions. The increases in flow during the wet weather conditions would mainly affect the hydraulic capacity

of the wastewater treatment facility. The primary and secondary treatment facilities have been designed to handle the wet weather flow hydraulically at 4 x ADWF and 2 x ADWF, respectively.

The following values were used for all catchment areas for calculating the design loads:

- ADWF BOD_5: 240 mg/L
- ADWF TSS: 195 mg/L
- Primary clarification efficiency for TSS removal: 55%
- Primary clarification efficiency for BOD_5 removal: 30%
- Net yield factor for conversion of primary effluent to secondary solids: 0.8
- Biosolids Loading Factor applied for increase in loads that occur at flows above ADWF conditions: 1.3

The selected design wastewater treatment concentrations and the biosolids loading factor of 1.3 appear to be consistent with the preliminary results of the wastewater sampling characterization program, which started in the fall of 2008. The preliminary results of this program are summarized in **Table 7**.

Table 7. Preliminary Results of Wastewater Characterization Study

Location	Wet Weather Flow		Dry Weather Flow	
	BOD (mg/L)	TSS (mg/L)	BOD (mg/L)	TSS (mg/L)
Penhryn Booster Station (Saanich East)	150	144	n.a.	n.a.
Clover Point	162	160	259	226
Macaulay Point	168	176	319	341
Craigflower Pump Station (West Shore)	193	261	n.a.	n.a.

n.a: Not available – dry weather sampling to take place in late spring and summer of 2010

The wastewater at the McLoughlin Point plant will be a blend of wastewater from Clover and Macaulay catchment areas. The preliminary wastewater characterization study indicates that during a two week dry weather period in July 2009, the BOD of the blended wastewater was 290 mg/L. This preliminary

result correlates well with the proposed maximum month BOD for the year 2030 of 312 mg/L (1.3 x 240 mg/L).

It is proposed to continue the wastewater characterization study for at least another year in order to gather sufficient data to confirm the design loading for the proposed plants.

These above parameters are in fact lower than many communities in British Columbia mainly due to the I&I impacts from older sewers in Greater Victoria.

The design flows used in the calculations for biosolids loads are ADWF for year 2030. The process design BOD and TSS for all plant sites were computed and summarized in **Table 8**. Table 10 also shows the loadings and biosolids (sludge) production.

Table 8. Year 2030 Design Loads

Plant	Process Design BOD at 1.3 x ADWF (kg/day)	Process Design TSS at 1.3 x ADWF (kg/day)	Biosolids Production at 1.3 x ADWF (kg/day)
McLoughlin Point	33,634	27,327	33,865

6.0 Potential Treatment Plant Staging Opportunities

Staging of construction has been considered in the construction of the CRD wastewater treatment plants. Other than the addition of a West Shore plant(s), there does not appear to be significant opportunities for staging at other locations. The following is suggested for staging of each of the plants:

- McLoughlin Point Plant - Because of the site constraints it recommended to build concrete tankage to reach the maximum site utilization which corresponds to a flow of 107.8 ML/day. As the flows from both the West Shore and the central portion of the Core Area increase, additional capacity can be obtained by building plant(s) on the West Shore to obtain additional capacity.

The date when a plant will be required to service the West Shore depends on population growth. Figure 1 shows the plant capacity for the McLoughlin Point plant. With the high rate of growth, the capacity of the plant will be reached in 2018. Using a low rate of growth, a plant on the West Shore would be required by approximatley 2028. With the historical rate of growth, a plant on the West Shore would not be required until 2032.

7.0 Conclusions

Based on the assessments that have been completed with respect to design flows and loads for the CRD Wastewater Treatment Progran, the following can be concluded:

1. A review of the selected design flows for the various catchments serving the CRD has been completed. The 2030 design flows and load projections provide little additional capacity over current loading conditions and are in fact considered a very aggressive design with no conservatism. The flows have been calculated assuming that fixture replacement continues to be implemented and the I&I reduction programs continue. The difference between 2030 and 2065 design flow for the McLoughlin Point plant is minimal and future capacity will come from the implementation of water conservation efforts, reductions in I&I, source control and constructing plant(s) in West Shore.
2. A review of ongoing wastewater characterization completed by the CRD indicates the selected design parameters for BOD and TSS loading used in the planning work to date are reasonable for the purpose of secondary treatment process sizing.
3. In assessing existing flow records for the last 4 years based on measured flows at Clover Point, Macaulay Point and other locations within the Core Area system, the selected design flows are considered aggressive and will require that the CRD continues with water conservation and I&I reduction initiatives. The CRD is already committed to these initiatives and they are part of the recent Liquid Waste Management Plan Amendment No.7.

Figure 1
Serviced Population and Capacity of Secondary Treatment Plants