# Technical Memorandum

DATE: April 9, 2019

TO: Elizabeth Scott, Deputy Project Director, Capital Regional District

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RE: **2019 Sanitary Model Update and Flow Study**
**Summary of Interim Results – NET/ECI System**
**Our File 283.431**

# 1. Background

The purpose of this Technical Memorandum is to summarize the results of the 2019 Sanitary Model Update and Flow Analysis Study as it relates to the CRD's Northeast Trunk (NET) and East Coast Interceptor (ECI) Systems. More specifically, to review the need for future conveyance system upgrades through to 2045.

## 1.1 2003–2004 Definition of Upgrades Required at Clover Point Catchment

The CRD previously retained Kerr Wood Leidal Associates (KWL) in 2003 to create a hydraulic model for the East Coast Interceptor. The resulting May 2003 report[1] was presented to the CRD's Environment Committee in June 2003[2], and assessed the hydraulic capacity deficiencies in the NET/ECI trunk system based on:

- flow monitoring data (i.e. actual, recorded data) acquired from CRD meters for three winter seasons (1999 to 2002);
- residential population growth (based on CRD's R*egional Growth Strategy*);
- equivalent population from non-residential (ICI) land use *(industrial, commercial and institutional areas)*;
- ICI growth (based on forecast employment growth); and
- wet weather flows (analysis of the flow monitoring data to produce estimates of inflow and infiltration (I&I) of rain and/or groundwater into sanitary sewer systems).

[1] Kerr Wood Leidal Associates Ltd. (May 2003) *Northeast Trunk/East Coast Interceptor Upgrade Capacity Deficiency Study*

[2] Environment Committee (4 June 2003) *Core Area Liquid Waste Management Plan – Northeast Trunk/East Coast Interceptor Upgrading Plan - Capacity Deficiency Study* CRD Staff Report #EES 03-71

The report found that the system was operating as it was originally designed to, but that the Northeast Trunk Sewers and the Currie and Clover Point Pump Stations were significantly undersized to meet the new performance criteria in the Core Area Liquid Waste Management Plan (CALWMP) and the provincial regulations.

## 1.2 2004 NET/ECI Options Study

The CRD along with significant contributions by KWL subsequently prepared a September 2004 report[3] that identified 20 possible solutions to address the capacity deficiencies in the various sections of the NET/ECI trunk system and evaluated eight options in detail. The eight options were evaluated based on technical, social, environmental and financial considerations and the report concluded that the highest ranked option included:

1. Trent Pump Station (High Head) and Forcemain;
2. Currie Road Pump Station Upgrade and Trunk Sewer;
3. Clover Point Pump Station and Outfall Upgrade; and
4. Arbutus Peak Flow Storage Tank.

The report proposed construction of the recommended option in three phases, over the following time periods: 2005-2015; 2015-2030 and 2030-2045.

The executive summary of CRDs September 2004 report was presented to the Trunk Sewer Committee in October 2004[4], and the work in phases 1 and 2 was added to the CALWMP through Amendment No. 4, such that the CALWMP committed the CRD to:

- Intercept and convey all flows up to the 5-year storm through to the Clover Point Pumping Facility for marine locations along the East Coast of Greater Victoria; and
- All flows in excess of the 5-year storm will be permitted to discharge through approved overflow facilities at Finnerty Cove and McMicking Point.

Components of the first phase of work have been completed by CRD (the Trent peak flow pump station and a portion of the forcemain were constructed in 2007 and 2008). The outstanding components of the first phase and all of the second phase were anticipated to be constructed as part of the Seaterra Program and subsequently as part of the Wastewater Treatment Project.

# 2. 2019 ECI Sanitary Computer Model Update – NET/ECI

A significant investment in upgraded flow monitoring (both in terms of technology and number of sites) has been undertaken by the CRD since the 2004 study. This improved data results in more accurate estimates of water usage, ICI buildout, and I&I.

The 2019 model update included the following components:

- sewer loading of residential, industrial, commercial, and institutional sanitary loads;
- sewer response due to rainfall and groundwater influences;

[3] CRD (September 2004) *Northeast Trunk Sewer and East Coast Interceptor Sewer Upgrade Options Study*

[4] Trunk Sewer Committee (6 October 2004) *Northeast Trunk and East Coast Interceptor Sewer Upgrade Options Study* CRD Staff Report #EES 04-85

- population and employment growth scenario development through 2045;
- calibration and verification of the model using actual flow monitoring data;
- hydraulic analysis of each NET/ECI system component;
- identification of hydraulic deficiencies; and
- comparison against 2004 NET/ECI Option Study recommended upgrades.

The following sub-sections highlight key details of the analysis performed and subsequent findings.

## 2.1 Model Loading Development

### Domestic Sanitary Sewer Loading

The 2016 census population was distributed in a Geographic Information System (GIS) analysis to each parcel within the study area, where the existing land use indicated residential use. Overlaying the existing flow catchment boundaries in GIS allowed for the residential population in each flow catchment to be obtained.

An analysis was then carried out to estimate existing per-capita loading rates in the predominantly residential catchments. Based on the analysis of 25 residential catchments with different sizes, it was found that the loading rates in the majority of the catchments range from 119 to 226 L/cap/day, with a population-weighted average value of 159 L/cap/day. Aggressive water conservation efforts in the past 10 years within the CRD have significantly reduced this value from the 225 L/cap/day used in the 2003-2004 study.

An analysis performed by KWL in 2017 indicated that the CRD's 2005 water conservation baseline of 160 L/cap/day (based on 6 L toilets) could be further reduced to 154 L/cap/day (using 4.8 L toilets as specified in the 2012 BC Plumbing Code). Therefore, for modelling existing conditions, the actual sanitary loading rate as observed has been used, with a lower limit of 154 L/cap/day used where the observed value was less.

### Sanitary Peaking Factors

This study analyzed actual sanitary peaking factors (the ratio of peak to average sanitary flow) versus catchment total population equivalents for all flow monitoring catchments. A relationship curve was developed, representing actual peaking factors observed in the CRD. The curve, while slightly conservative, is more representative of actual peaking factors as opposed to traditional design curves used in the past. For purposes of modelling the actual peak flows in the system, this new relationship has been used to calculate catchment peak sanitary flows for model input.

This new peaking factor data is intended for use in identifying capacity deficiencies, by providing a more realistic comparison with actual flows. When sizing future facilities, the use of conservative design values (for example, 80% or 100% of the Harmon curve) is still recommended.

### Inflow and Infiltration Response

Return-period based RDII (Rainfall-Dependent Inflow & Infiltration) rates have been calculated for most flow catchments using the latest flow monitoring data and the RDII Envelope method. The CRD has invested heavily in permanent and temporary flow monitoring stations, using new and improved technologies. This has resulted in more data of better quality, producing superior estimates of I&I compared to previous efforts.

A unit rainfall RDII pattern was also developed by analyzing RDII responses during two sizable storm events in several flow catchments, representing a range of infrastructure conditions. RDII is scaled from 3-month to 100-year return periods, then added to the calculated dry weather flow to produce wet weather flow signals for each storm return period. For modeling purposes, the peak RDII is made to align with the peak dry weather flow, providing for a conservative capacity assessment.

### NET/ECI System Control Logic

As part this analysis, a proposed NET/ECI control logic was developed to coordinate various control valves and pump operation (Humber, Rutland, Currie pump stations, and Arbutus and Penrhyn control valves) to eliminate or prioritize locations of sanitary sewer overflows (SSOs). This control logic has been created and tested in the computer model, with a recommendation for this to be implemented as part of the planned system upgrades.

## 2.2 Model Calibration for Existing Conditions

To confirm that the model can predict the response of the system to actual conditions, the model has been calibrated using existing dry weather flows at several flow meter locations, including Arbutus flume, Trent Pump Station, Currie Pump Station, and Clover Point Pump Station. The comparisons show that the modeled dry weather flows (DWF) closely match the observed DWF, in terms of 24-hour total flow volume, peak dry weather flow, and time to peak. Where differences occur, the model is more conservative than actual conditions.

As previously discussed, the I&I rates for the numerous catchments in the model have been normalized into consistent return-periods. A conservative approach to using the I&I Envelope Methodology, where compensation for less-than-saturated groundwater conditions is applied, has also been used. The modelling approach for wet weather is to use a conservative peak-on-peak approach, where the peak of the dry and wet weather flows are aligned. Therefore, the model is setup to perform an accurate but conservative analysis.

## 2.3 Hydraulic Modeling and Capacity Analyses

Three different development scenarios were developed. The 2021 development scenario reflects the anticipated population levels during the commissioning of the new wastewater treatment plant (WWTP) at McLoughlin Point. A medium-term horizon of 2030 and long-term horizon of 2045 have also been modelled.

- 2021: WWTP Commissioning
- 2030: Medium Term Development
- 2045: Long Term Development

The model was run for 2021, 2030, and 2045 wet weather flow conditions under a range of return period storms (from 3-month to 100-year).

Based on the analysis performed under the 5-year storm for all scenarios up to 2045, it was determined that there is no longer a need to upgrade the Currie Pump Station and forcemain, or undertake twinning of the lower ECI. The planned Trent forcemain extension and a small section of the lower ECI need to be upgraded to handle larger return periods.

Table 1 illustrates the results of the hydraulic capacity assessment performed and assumes that the remaining projects (Trent Forcemain extension, Arbutus Attenuation Tank, and ECI Bushby Street Section) have been constructed.  The amount of storage used in the Arbutus Tank, as well as the peak overflow rate and total estimated volume at each outfall are shown.

**Table 1: 2045 NET/ECI Overflow/Capacity Analysis (with Improvements Completed)**

| Location | | 2-Year | 5-Year | 10-Year | 25-Year | 50-Year | 100-Year |
|---|---|---|---|---|---|---|---|
| Arbutus Tank | | | 2,131 m³ | 4,495 m³ | 5,000+ m³ | 5,000+ m³ | 5,000+ m³ |
| Arbutus (Finnerty) | | | | | 504 L/s 2,759 m³ | 566 L/s 5,540 m³ | 632 L/s 8,910 m³ |
| Bowker | | | | | | | |
| Broom | | | | | | | |
| Currie (McMicking) | | | | | | 427 L/s 2,117 m³ | 552 L/s 4,310 m³ |
| Clover Deep | | 1,559 L/s 33,196 m³ | 2,139 L/s 58,672 m³ | 2,462 L/s 77,332 m³ | 2,500 L/s 99,992 m³ | 2,500 L/s 111,783 m³ | 2,500 L/s 122,876 m³ |
| Clover Short | | | | | 432 L/s 2,447 m³ | 612 L/s 5,149 m³ | 811 L/s 8,652 m³ |

## 2.4 Comparison with Previous Studies

As previously stated, the proposed upgrades to the Currie Pump Station and forcemain, and the proposed ECI twinning project identified in the previous studies, are not required.  This is due to reduced flow estimates compared to the previous studies, and is attributable to:

- Significant water use reduction, supported by numerous sanitary flow measurements and other loading rate studies for the CRD, resulting in lower per-capita sanitary loading rates;
- Differentiating the use of calibrated peaking factors for sanitary flow to identify upgrading requirements, compared to the use of theoretical peaking factors (i.e., 80% or 100% Harmon) for use in actual design flow calculations;
- A far more extensive flow monitoring dataset is now available, with improved accuracy and many more sites with longer periods of record, allowing for more accurate and better spatial estimates of I&I loading; and
- Differentiating calibrated ICI equivalent population projections (for example, in the downtown core, supported by actual flow measurement) compared to projected theoretical ICI loading rates from previous studies (based on ICI land use design densities).

# 3. Future Uncertainties

There are several uncertain factors that can affect the system in the future as discussed below.

## 3.1 Climate Change

The anticipated effect of climate change is that storm events will become more intense when compared to the historical intensity-duration-frequency (IDF) data that the system was designed for. For example, an event that is currently classified as a 10-year return period may become more intense such that it would be the equivalent to a 25-year event today.

The analysis has not progressed to analyzing this in detail, however reviewing Table 1 it is apparent that there is some capacity to accommodate climate change impacts in the system after the planned upgrades are complete. For example, the Arbutus tank is not being fully utilized under the 10-year event, and likewise overflows at the other outfalls are not projected to occur until the 25-year event (with the exception of the Clover Deep outfall). Since these facilities are required to protect up to a 5-year storm, some climate change protection is available. Further, as municipalities work to reduce their I&I levels to meet their CALWMP commitments, additional capacity will be made available.

## 3.2 I&I Growth

It is generally agreed that I&I increases over time as facilities age. In the catchment areas with newer infrastructure in the NET/ECI, this growth can be accommodated by the storage tank at Arbutus, which can be expanded in the future if needed.

The older areas of the NET/ECI have already deteriorated significantly, and I&I from these older areas is not likely to increase considerably further as a result. This should also be offset by future system rehabilitation efforts by the municipalities as they work towards meeting their commitments under the CALWMP.

# 4. Summary

The NET/ECI sanitary system hydraulic model has been updated using the latest census population (2016), extensive flow monitoring data, revised sewer infrastructure information (both existing and planned for construction), traffic zone future populations, and employment projections.

The model has been calibrated to match observed dry weather flows for the existing development conditions, and then future wet weather flow scenarios for 2021, 2030, and 2045.

Based on the analysis performed under the 5-year storm for all development scenarios up to 2045, it was determined that there is no longer a need to upgrade the Currie Pump Station and forcemain, or undertake the lower ECI twinning project. However, the analysis identified that about 270 m of 900 mm dia. new gravity sewer will be needed to partially divert flows from the existing ECI at Bushby St into the planned new gravity section of the new Trent forcemain extension along Dallas Rd.

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## Revision History

| Revision # | Date | Status | Revision Description | Author |
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