



**Biennial Report: 2017-2018 Integrated Liquid
Waste and Resource Management**
**A Liquid Waste Management Plan for the Greater Vancouver
Sewerage & Drainage District and Member Municipalities,
Volume 1: Metro Vancouver Report**

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Volume 1: Metro Vancouver Report

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Abbreviations

AMF	Monitoring and Adaptive Management Framework for Stormwater
BIEAP-FREMP	Burrard Inlet Environmental Action Plan and the Fraser River Environmental Management Plan
BMP	Best management practice
BOD	Biological oxygen demand
CBOD	Carbonaceous biological oxygen demand
CEPA	Canadian Environmental Protection Act
CEPT	Chemically enhanced primary treatment
CCME	Canadian Council of Ministers of Environment
CCTV	Closed circuit television
CSO	Combined sewer overflow
CWS-MMWE	Canada-wide Strategy for the Management of Municipal Wastewater Effluent
DONCE	Discharge out of the normal course events as pertaining to the Fisheries Act
EDO	Effluent discharge objective
EMBC	Emergency Management BC, formerly PEP
EMC	Environmental Monitoring Committee
GHG	Greenhouse gas
GVS&DD	Greater Vancouver Sewerage and Drainage District
GVWD	Greater Vancouver Water District
I&I	Inflow and infiltration
IDZ	Initial dilution zone as defined as boundary for regulatory criteria
ILWRMP	Integrated Liquid Waste and Resource Management: A Liquid Waste Management Plan for the Greater Vancouver Sewerage & Drainage District and Member Municipalities

IPREM	Integrated Partnership for Regional Emergency Management in Metro Vancouver
IRR	Integrated resource recovery
ISMP	Integrated stormwater management plan
IUMAC	Integrated Utilities Management Advisory Committee
LEED	Leadership in Energy and Environmental Design
LWMP	Liquid Waste Management Plan
OC	Operational Certificate (as issued under the BC Environmental Management Act)
OCP	Official Community Plan
PAH	Polycyclic aromatic hydrocarbons
PCB	Polychlorinated biphenyls
PBDE	Polybrominated diphenyl ethers
PEP	Provincial Emergency Program, now Emergency Management BC (EMBC)
RAAC	Regional Administrative Advisory Committee
REAC	Regional Engineering Advisory Committee
REAC-LWSC	Liquid Waste Subcommittee of the Regional Engineering Advisory Committee
RPAC	Regional Planning Advisory Committee
RGS	Regional growth strategy or the Regional Growth Strategy Bylaw
SCADA	Supervisory control and data acquisition
SILG	Stormwater Interagency Liaison Group
SS	Suspended solids
SSO	Sanitary sewer overflow
TSS	Total suspended solids
UEL	University Endowment Lands
WSER	Wastewater Systems Effluent Regulations (under the Fisheries Act)
WWTP	Wastewater treatment plant

Introduction

Background

The updated Liquid Waste Management Plan, titled *Integrated Liquid Waste and Resource Management: A Liquid Waste Management Plan for the Greater Vancouver Sewerage & Drainage District and Member Municipalities*, was adopted by the Metro Vancouver Board and its members in 2010. This Plan was then approved by the Minister of Environment in 2011.

Under this updated Plan, Metro Vancouver and its members provide biennial progress updates on the implementation of the Plan as well as annual updates specific to sanitary sewer overflows and integrated stormwater management plan progress.

This biennial report focusses on implementation progress for the period 2017-2018 and is the fourth biennial report under this Plan. Some actions under this Plan have been completed or are long-term and ongoing. In these instances, the reporting may refer back to a previous biennial report or an interim report for particular details.

Highlights

During 2017 and 2018, Metro Vancouver continued to implement its actions identified in the ILWRMP. Highlights include the following initiatives.

Risk Management

Metro Vancouver has actively been working to identify and mitigate risks to the environment, people and its system. Ongoing planning work, environmental monitoring programs and construction identify and mitigate risks. Two important planning initiatives are the assessment of potential seismic and climate change risks to liquid waste services.

In 2018, the Liquid Waste Services Department completed a study evaluating seismic risks to Metro Vancouver's sewers, pump stations and wastewater treatment plants. Its findings are being used to inform seismic resiliency decisions in project designs and capital planning.

Also in 2018, Metro Vancouver completed its re-evaluation of climate change impacts to rainfall with the findings published in the *Study of the Impacts of Climate Change and Precipitation on Stormwater Management*. This research validates previous Metro Vancouver and recent municipal studies on changing rainfall intensity and identifies challenges related to the adaptation of sewerage and drainage infrastructures that are being explored by both municipal and Metro Vancouver staff. This work supports and links into Metro Vancouver's Climate 2050 initiative and helps Metro Vancouver and members with drainage service planning.

Environmental Monitoring

Metro Vancouver continues to provide environmental monitoring programs that assess wastewater treatment plant performance, ambient environmental quality, recreational water quality, and the occurrence, duration, volume and quality of combined and sanitary sewer overflows and their impact on environments.

Metro Vancouver characterizes the discharge quality of select CSOs that discharge to Burrard Inlet and the Fraser River. Monitored CSO locations are rotated every year or two so that all 15 Metro Vancouver CSO locations are monitored on a five to eight-year cycle. CSO discharges continue to be tested for fecal coliform bacteria, metals, select organics and toxicity to Rainbow Trout. The CSO samples collected during this period were non-toxic to Rainbow Trout.

Inflow and Infiltration Management

To address excessive inflow and infiltration, Metro Vancouver and its member municipalities are exploring strategies to address private-side inflow and infiltration (I&I) management, including linking private lateral condition certification to time of property sale and transfer.

The reduction of I&I is a key component of reducing the long-term likelihood of wet weather sanitary sewer overflows (SSOs) by preventing excessive amounts of rainwater and groundwater from entering sanitary sewer systems. For some areas, with high I&I, interim SSO mitigation is addressed by the construction of wet weather SSO storage. New Metro Vancouver SSO storage tanks in North Surrey and Maple Ridge are anticipated to be completed by 2022 and 2024 respectively.

Combined Sewer Separation

The Cities of Burnaby, New Westminster and Vancouver, along with the University Endowment Lands continue to separate their combined sewers as part of their long-term commitment that will eliminate combined sewerage overflows from Metro Vancouver's outfalls. In 2017 and 2018, 20,242 m of combined sewer were separated at a cost of \$64.8 million.

Also during this period, Metro Vancouver completed combined sewer separation plans for the Heather-Cambie and Canoe Creek Combined Trunk Sewers. These plans serve as conceptual designs and will guide subsequent combined sewer separation work for the municipal and regional systems in their specific catchment areas.

Stormwater Management

Metro Vancouver continues to facilitate the Stormwater Interagency Liaison Group (SILG). Through this forum, municipalities continue to share information on the development and implementation of their integrated stormwater management plans as well as contribute to shared initiatives such as the development of the region-wide baseline for on-site stormwater management. In 2017, the *Region Wide Baseline for On-Site Rainwater Management* was endorsed by the GVS&DD Board for use by its members. This stormwater baseline defines the minimum requirements for on-site stormwater

management for single-family type residential development and may be used by municipalities to supplement their stormwater regulations and ISMPs.

Wastewater Treatment

To meet the environmental protection needs of a growing region, substantial investment is being made in wastewater treatment at four facilities: North Shore WWTP, Iona Island WWTP, Annacis Island WWTP and Northwest Langley WWTP.

Construction of a new North Shore WWTP to replace the Lions Gate WWTP has started. The budget for this work is \$778 million, with \$212.3 million in grant funding from the federal government and \$193 million in grant funding from the provincial government. Once the new secondary level wastewater treatment plant is operational, the existing Lions Gate WWTP will be decommissioned.

In 2018, the indicative design process for upgrade and replacement of the Iona Island WWTP began. When completed in 2020, the design process will determine the treatment technology, general form and anticipated cost of the new wastewater treatment plant that will replace the existing primary treatment plant.

The Annacis WWTP Stage 5 upgrades continue to increase treatment capacity, improve plant reliability and enhance facility resiliency. This work represents a \$685 million investment in expanding the existing plant to meet growing demand and is being completed in two phases. Phase 1 is scheduled to be complete in 2020 and Phase 2 is scheduled to be complete in 2026.

Similarly, the expansion of the Northwest Langley WWTP will relieve growth pressure on Annacis Island WWTP by investing \$1.3 billion in a new Northwest Langley WWTP. This new plant will achieve higher levels of wastewater treatment, have improved long-term resiliency and provide an expanded service area through a new trunk sewer crossing the Fraser River from Maple Ridge.

Research and Collaboration

Metro Vancouver continues to establish new research partnerships with the wastewater treatment technology and process industry and academic institutions – including the University of British Columbia and Thomson Rivers University. Metro Vancouver continues to explore new opportunities and partnerships to support expanded energy and materials recovery from wastewater, including sewer and effluent heat, biogas, biocrude, biosolids, reclaimed water, and nutrients.

Plan Review and Update

The *Integrated Liquid Waste and Resource Management Plan* has an eight-year review and update cycle. The plan was approved by the Minister of Environment in 2011 with its review and update scheduled to occur in 2019. In September 2018, the GVS&DD Board requested that the Minister of Environment and Climate Change Strategy extend the review cycle by two years. This review cycle extension will permit the updated plan to align with the outcomes from key Metro Vancouver initiatives that are currently

underway: The Iona Island WWTP indicative design, Metro Vancouver's *Climate 2050*, and the development of new joint regional-municipal strategies on sewer overflow management and control.

Metro Vancouver

Goal 1: Protect Public Health and the Environment

Strategy 1.1 Reduce liquid wastes at their source

Action 1.1.1 – Review and enhance sewer use bylaws to reduce liquid waste at source, including contaminants identified by the *Canadian Environmental Protection Act (2012)*.

Metro Vancouver continues to regulate the discharge of non-domestic liquid waste from industrial, commercial and institutional sources to sewers through the Sewer Use Bylaw No. 299 and associated bylaws and codes. The Bylaw protects the environment, sewer workers, and sewer infrastructure and is continually being updated to improve the quality of wastewater entering the sewer from non-domestic dischargers.

Hospital Pollution Prevention Plan Bylaw

In 2018, Metro Vancouver adopted a Bylaw to regulate the discharge of wastewater from hospitals in the region. The Bylaw will apply to 18 hospitals across four health authorities in the Metro Vancouver region that meet the definition of ‘hospital’ as defined in section 1 (a) of British Columbia’s Hospital Act.

The main requirement of the Bylaw requires hospitals to develop and submit a Pollution Prevention Plan. The Pollution Prevention Plan shall include specific actions to:

- Prevent the disposal of biomedical waste to the sanitary sewer;
- Manage any ‘silver-rich solutions’ generated through the processing of diagnostic images including X-rays;
- Review any food service kitchens, within the hospital, to ensure the requirements of the *GVS&DD Food Sector Grease Interceptor Bylaw No. 268, 2012* are met;
- Prevent the disposal of unused drugs to the sanitary sewer; and,
- Limit the concentration of formaldehyde to the sanitary sewer to a maximum concentration of 30 mg/L.

These five actions are the core requirements of the Bylaw. In addition, and in keeping with the pollution prevention principle of continuous improvement, hospitals will be required to continuously review their practices across all areas of operation that impact their discharge to the sanitary sewer.

Action 1.1.2 – Develop new regulatory instruments, such as Pollution Prevention Plans to complement existing regulations (2014).

New regulatory instruments have been implemented with the adoption of the Hospital Pollution Prevention Plan Bylaw in 2018.

Action 1.1.3 – Increase resources for permitting and inspection to support and enforce sewer use bylaws (2010).

This action was completed in 2010.

Action 1.1.4 – Investigate the implications of the use of domestic food grinders (2012).

This action was completed in 2012.

Action 1.1.5 – Develop and implement targeted outreach plans to support liquid waste source control programs (Ongoing).

Between November 2017 and February 2018, Metro Vancouver staff visited eight post-secondary institutions representing a cross-section of teaching and research laboratories, fine arts studios and trade shops. Interviews with subject matter experts within the institutions were also conducted. Metro Vancouver staff observed that post-secondary institutions have developed policies and procedures to manage the materials they use as part of teaching and research. As such, there is no need at this time to develop further regulatory measures such as a requirement for Pollution Prevention Plans.

In 2017, Metro Vancouver consulted with representatives from the following commercial operations to develop a *Guide to Managing Wastewater* for each industry:

- Carpet cleaning;
- Automotive repair;
- Commercial vehicle washing; and,
- Swimming pools and ice rinks.

The Guides include practices for safeguarding the wastewater system and the environment, as well as general information on the wastewater system and existing regulations. To support the guides, durable vinyl 11x17 posters were developed that highlight recommended practices to be employed to ensure compliance with existing regulations and to safeguard the wastewater system and the environment.

To acknowledge the work currently being done by post-secondary institutions, staff recommended developing a Wastewater Guide specific to post-secondary institutions to help them better manage wastewater from their research and teaching laboratories, fine arts studios and trade shops. The Guide

will emphasize existing regulatory requirements of the Sewer Use Bylaw as well as non-regulatory pollution prevention practices. The Guide is currently being developed and will be distributed in 2019.

From September through November 2018, large industrial dischargers (operating under waste discharge permits) were invited by Metro Vancouver staff to visit each of the five regional wastewater treatment plants. The events were well attended with a total of 94 people representing over a third of the invited organizations in attendance. Staff explained the wastewater treatment plant processes, the importance of source control, and the biosolids management program. The need for timely notification of any unplanned or unexpected discharges to the sanitary sewer was communicated. Feedback forms were received from the industrial and municipal attendees who recommended that other permit holders attend similar events if offered.

Action 1.1.6 – Develop a template to guide the preparation and implementation of inflow and infiltration management plans as part of broader asset management plans and to support sanitary sewer overflow reduction strategies (2011).

This action was completed in 2011.

Action 1.1.7 – Work with the real estate industry and their regulators, and the municipalities to develop and implement a process for the inspection and certification of private sewer laterals being in good condition as a required component of real estate transactions within Metro Vancouver (2011).

In 2017 and 2018, Metro Vancouver and the REAC Liquid Waste Subcommittee worked to identify the primary challenges in addressing excessive I&I. Controlling private lateral I&I through sewer lateral certification at time-of-sale or property ownership transfer were identified as an option. Another option identified in 2018 was the consideration of dual sewer user fees based on certified and uncertified sewer laterals. These three options are being explored by the REAC Liquid Waste Subcommittee. REAC has requested a preferred strategy be identified by the Subcommittee by December, 2019.

Action 1.1.8 – Develop and implement inflow and infiltration management plans that identify reduction strategies and timelines to ensure wet weather inflow and infiltration are within targeted levels (2012)

No change from the 2015-2016 Biennial Report.

Action 1.1.9 – Work with municipalities to review historical data and adjust, as necessary, the average inflow and infiltration allowance for regional trunk sewers and wastewater treatment plants, and develop associated target allowances for municipal sewer catchments associated with a 1:5 year return frequency storm event for sanitary sewers to a level that ensures environmental economic sustainability (2013)

The review for this action was completed in 2014.

Action 1.1.10 – Review progress in reducing inflow and infiltration every four years (*every 4 years*).

The I&I allowance for regional sewers is 11,200 L/ha·d. Municipalities continue to focus on prioritizing work in areas suspected of having the highest I&I rates: the majority of the I&I in Metro Vancouver’s sewers comes from municipal sewers and private laterals. Municipal I&I programs are reported individually by each municipality in Volume 2, under Action 1.1.18. Municipal I&I estimates provide a better reflection of local I&I rates due to the smaller catchment scales and the normalization of rainfall return periods.

Metro Vancouver rehabilitated and replaced approximately 450 metres of gravity sewers which had the effect of reducing infiltration: the interior of sections of the North Surrey Interceptor, including manholes, were sealed using external chemical grout injection after internal inspections by divers identified signs of infiltration such as cracks in pipes with water leaking into the system noted by the divers.

Recent I&I rates, as measured at Metro Vancouver’s sewer flow meters and wastewater treatment plants for the Fraser Sewerage Area, the Lulu Island West Sewerage Area and North Shore Sewerage Area are shown on Figure 1 to Figure 4 and represent an estimated average I&I rate for their respective upstream catchment¹. Combined sewer catchments are excluded from I&I assessments. Annual variations in I&I rates are due to variations in storm intensity and storm tracking as well as remedial works undertaken by municipalities.

Throughout 2017 and 2018, the REAC Liquid Waste Sub-Committee has been developing a comprehensive report on managing I&I in the Metro Vancouver area. The report is expected to be completed in early 2019.

The impacts of climate change on I&I were evaluated as part of a precipitation change study conducted by the consulting firm GHD in 2018. The Collingwood sanitary sewer catchment area in the Vancouver Sewerage Area was evaluated under future rainfall intensity scenarios. The analysis showed that unless I&I is controlled, rain derived inflow associated with increased rainfall intensity and could lead to more occurrences of I&I induced SSOs; which are not desirable and poses increased risk of SSOs to properties and agricultural lands.

¹ Values used to create these figures are based on annual data starting July and ending the following July.

North Shore Sewerage, Inflow and Infiltration, 2016-2017

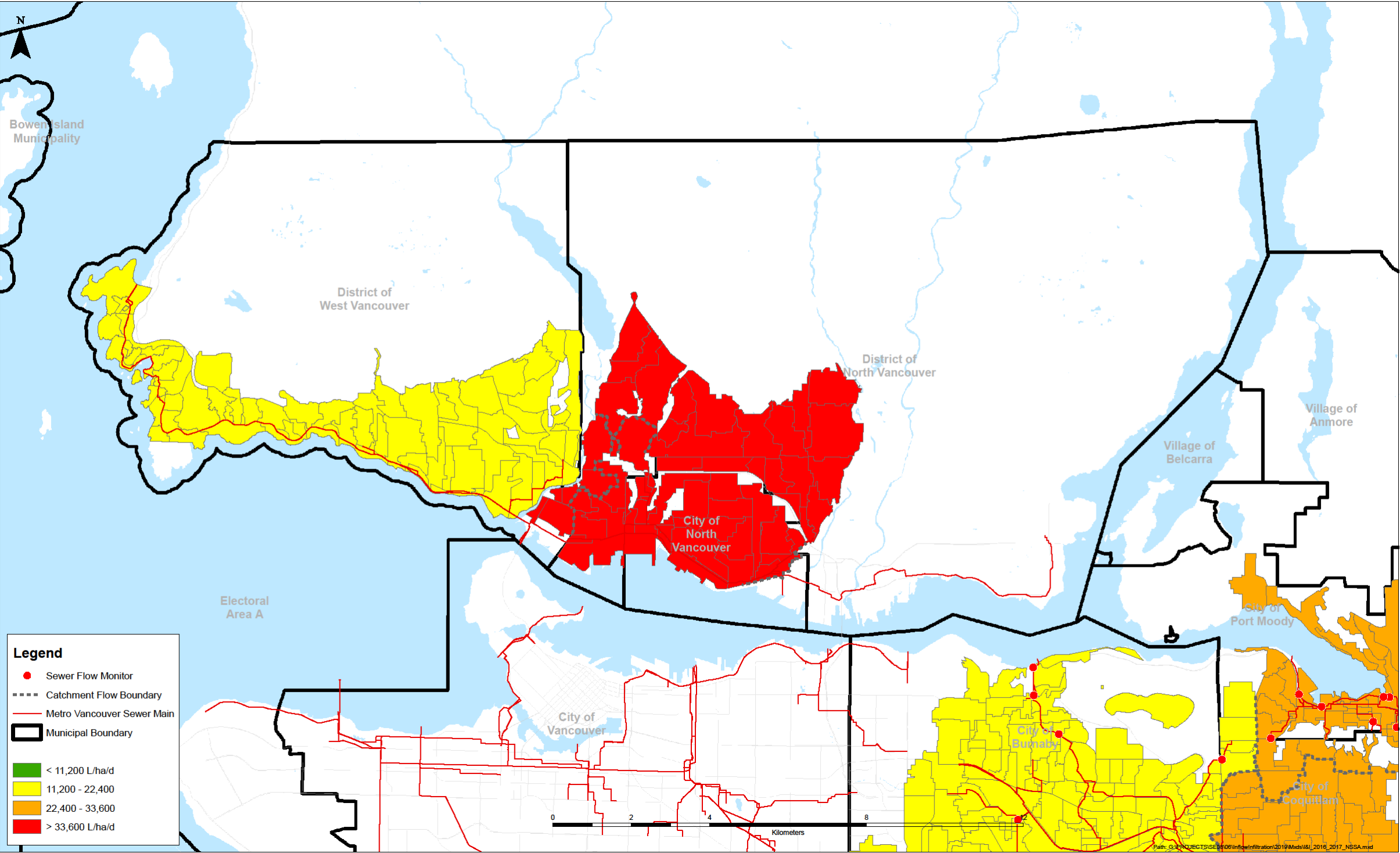


Figure 1 Inflow and Infiltration - North Shore Sewerage Area 2016-2017

North Shore Sewerage, Inflow and Infiltration, 2017-2018

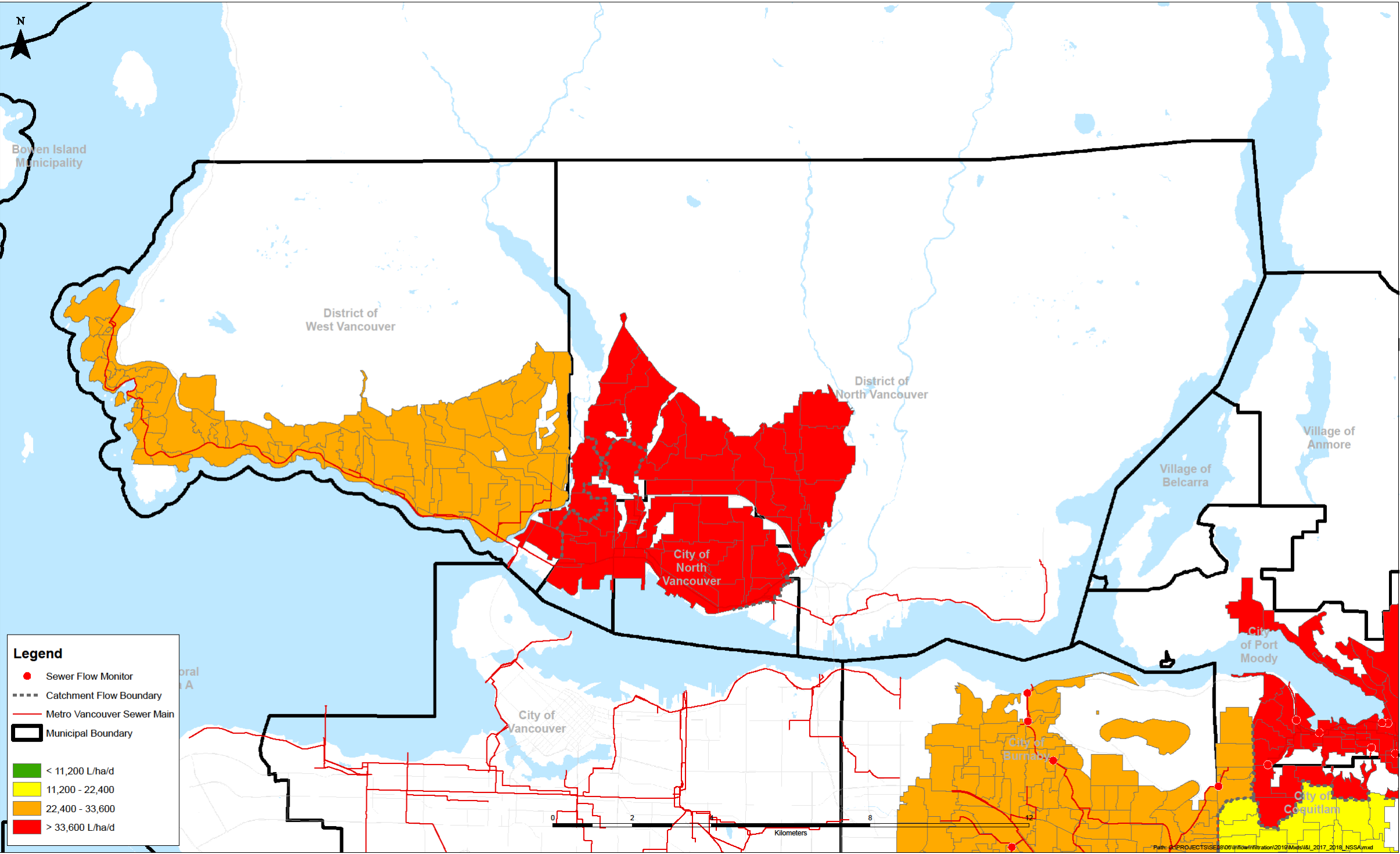


Figure 2 Inflow and Infiltration - North Shore Sewerage Area 2017-2018

Fraser and Lulu Island Sewerage, Inflow and Infiltration, 2016-2017

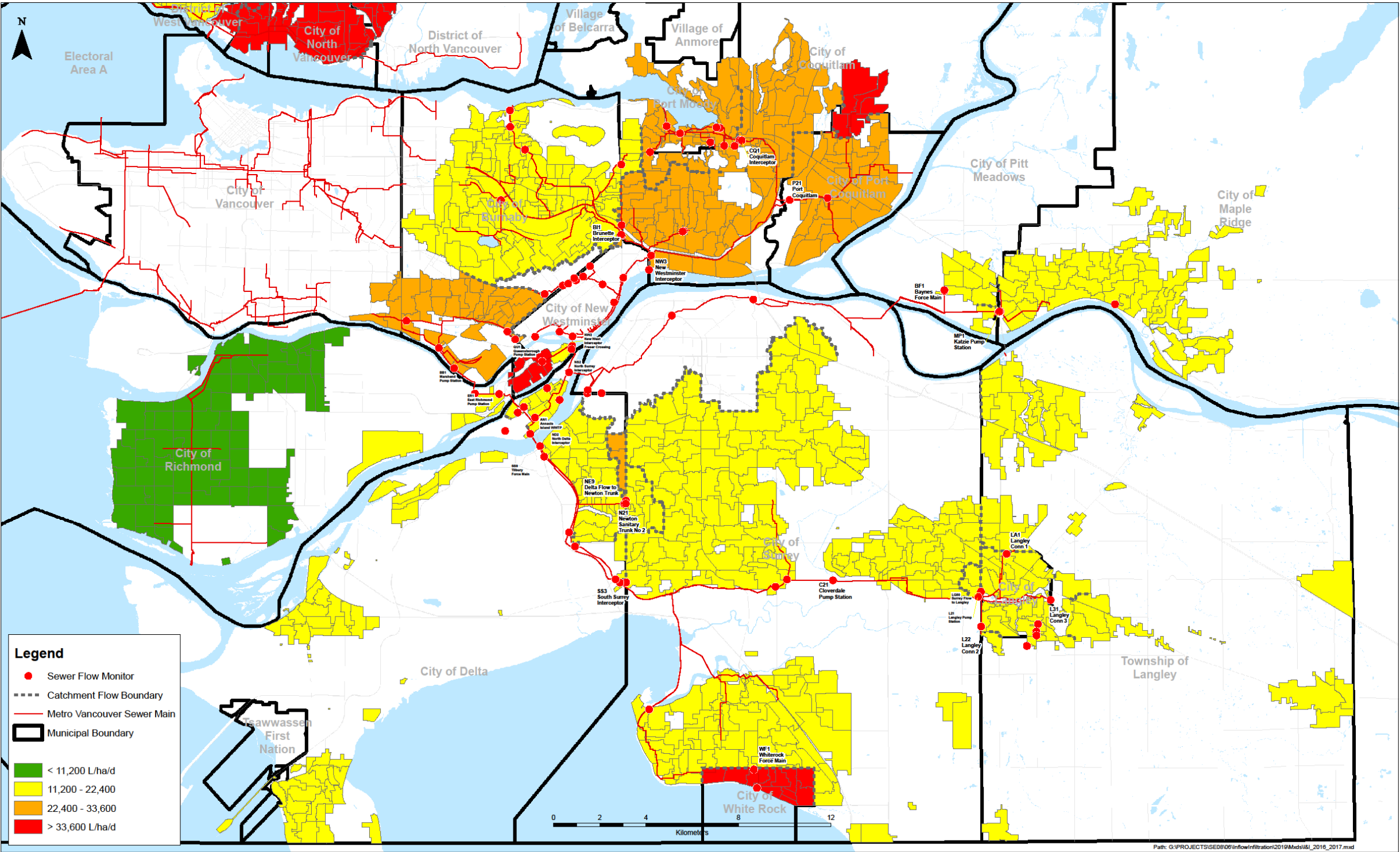


Figure 3 Inflow and Infiltration - Lulu Island West and Fraser Sewerage Areas 2016-2017

Fraser and Lulu Island Sewerage, Inflow and Infiltration, 2017-2018

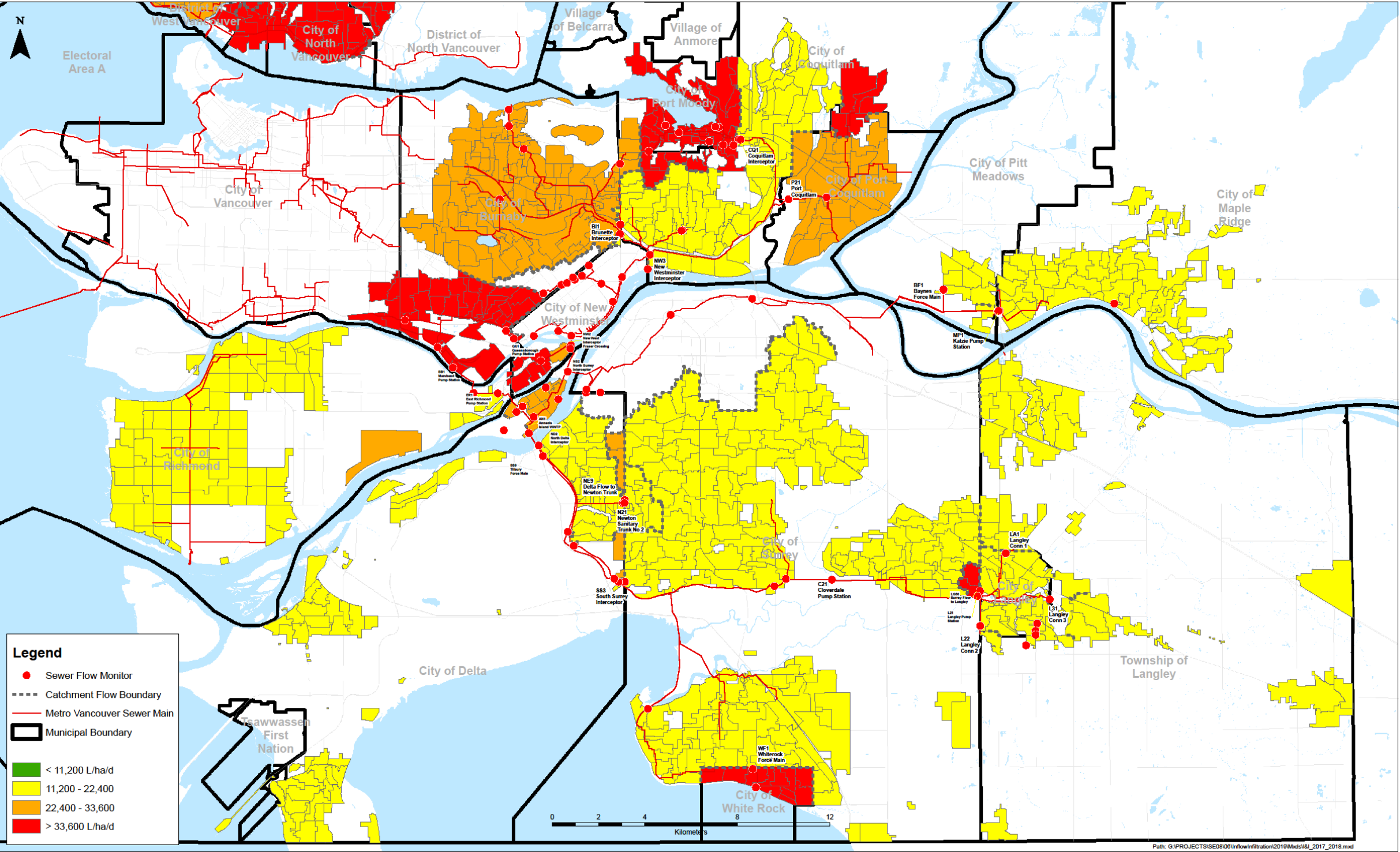


Figure 4 Inflow and Infiltration – Lulu Island West and Fraser Sewerage Areas 2017-2018

Action 1.1.11 – Enhance enforcement of sewer use bylaw prohibition against the unauthorized discharge of rainwater and groundwater to sanitary sewers (2010).

This action was completed in 2010.

Action 1.1.12a – Work with municipalities to facilitate research on watershed-based stormwater management approaches.

Regular bi-monthly meetings of the Stormwater Interagency Liaison Group (SILG) continued through 2017 and 2018. Through SILG, Metro Vancouver continues to facilitate the ongoing exchange of information on stormwater issues, and provide support to its member municipalities on technical matters related to stormwater management. This supports member municipalities in implementing their ILWRMP actions.

In 2017, work on a review of the 2005 *Integrated Stormwater Management Plan Template* (ISMP template) was initiated. The municipalities and Metro Vancouver realized a need to incorporate numerous changes in the regulatory environment, the advancements in the scientific foundation and technical practice of urban stormwater and watershed management that took place over the past twelve years. Some of the notable documents that needed to be considered and incorporated into the new template included the 2011 ILWRMP; the 2012 update to the *Stormwater Source Control Design Guidelines*, and a review of the municipal ISMP processes and implementation experience (*ISMP Lessons Learned*, 2012; *Stormwater Monitoring and Adaptive Management Framework*, 2014; *Region-Wide Baseline for On-Site Stormwater Management*, 2017, etc.). The work is on-going.

Action 1.1.12b – Work with municipalities to identify improvements to stormwater bylaws to include on-site rainwater management requirements.

This action was completed in 2017 with the approval by the GVS&DD Board of the *Region-wide Baseline for On-site Stormwater Management* for use as a guideline by GVS&DD members. A model bylaw for on-site rainwater management is included as part of the guideline.

Action 1.1.12c – Work with municipalities to develop model utility design standards and options for neighbourhood design guidelines.

This action was completed in 2012.

www.metrovancouver.org/services/liquidwaste/LiquidWastePublications/StormwaterSourceControlDesignGuidelines2012.pdf.

Action 1.1.12d – Work with municipalities to establish region wide baseline criteria for on-site rainfall management including variations for localized geology, rainfall and watershed conditions.

See action 1.1.12b.

<http://www.metrovancouver.org/services/liquid-waste/LiquidWastePublications/Region-wideBaselineOnsiteStormwaterManagement-Feb2017.pdf>

Action 1.1.12e – Work with municipalities to establish mechanisms to ensure continued performance of on-site rainwater management systems.

Generalized performance requirements for on-site stormwater management were identified in 2012 as part of the work under Action 1.1.12c.

Following the GVS&DD Board endorsement of the *Region-wide Baseline for On-Site Stormwater Management* in 2017, SILG continued to work to identify specific issues and mechanisms that support the long-term performance of on-site rainwater management systems.

Action 1.1.12f – Work with senior government and industry to develop codes of practice, certification, guidelines and standards which support this plan. (2012)

Source control initiatives related to this action have been implemented as sector specific bylaws, and are summarized under Action 1.1.1 and 1.1.2.

The International Water Services Flushability Group (IWSFG), formed in 2017, released a position statement on non-flushable and flushable products which is now supported by wastewater utilities in 25 countries and over 300 stakeholders. The GVS&DD Board endorsed the International Water Industry Position Statement on Non- flushable and ‘Flushable’ Labelled Products in early 2017.

The Municipal Enforcement Sewer Use Group (MESUG), in partnership with the Canadian Water and Wastewater Association (CWWA), are working to address the non flushable situation in Canada. MESUG and CWWA have made an appeal for funding to support efforts in the development of a Canadian Standard for Flushability and any corresponding work. In September 2017, Metro Vancouver contributed \$10,000 to this effort and the funding is being directed in a two-stage approach:

Immediate (Short-Term):

- Research and final development of ‘flushable’ test methods;
- Retention of formally qualified 3rd party laboratories to confirm reliability of the test methods and confirmation of the wastewater approved pass/fail criteria; and

- Retention of qualified Fiber Analysis testing laboratories to analyze the materials used in ‘flushable’ products that do not biodegrade and contribute to microfiber issues in the aquatic environment.

Long-Term:

- Education and outreach programs; and
- The expense to move the adoption of the standard into an enforceable regulation.

Action 1.1.13 – Decrease liquid waste volumes through complementary initiatives in the Metro Vancouver Drinking Water Management Plan to reduce potable water consumption (*Ongoing*).

Actions in the Metro Vancouver’s *Drinking Water Management Plan* continue to support and implement water conservation strategies that lead to reduced sewage flows. Ongoing efforts include a regional water conservation campaign that encourages water-wise behavioural change through education and outreach initiatives such as the We Love Water website, the Water Wagon, Tap Water Campaign, and lawn sprinkling communications.

Metro Vancouver embarked on a review of the *Water Shortage Response Plan* (WSRP) following the exceptionally hot and dry summer of 2015, which included an in-depth technical review of summer water restriction impacts and a two-phase consultation of proposed changes. In 2017, the Board approved the newly updated WSRP, renamed the *Drinking Water Conservation Plan* (DWCP).

In 2018, the DWCP seasonal Stage 1 watering restrictions were implemented on a region-wide basis for the summer demand period, and a guide was developed to support member jurisdictions in monitoring and enforcement. Through the Water Sustainability Innovation Fund, Metro Vancouver staff completed a densification study called the “Greater Vancouver Water District Assessing Densification Impacts on Water Demands” <http://orbit.qvrd.bc.ca/orbit/llisapi.dll/properties/25058451> that showed the benefits from a water demand perspective of moving towards denser urban housing forms with limited outdoor water use and will embark on a greywater and rainwater demonstration project to showcase existing greywater and rainwater installations in the region. A shortlist of existing buildings with various water reuse systems with 2-3 of them being monitored within this upcoming project. Metro Vancouver is hoping to monitor at least one rainwater system and one greywater system. The final selection of buildings will be dependent on securing an agreement with the building owners and if their reuse systems can be feasibly monitored

Strategy 1.2 Reduce wet weather overflows

Action 1.2.1 – Prohibit the construction of new combined sewer systems other than those functioning as part of a strategy to reduce combined sewer overflows or to manage stormwater quality (*Ongoing*).

Metro Vancouver did not construct any new combined sewer systems during 2017 or 2018.

Action 1.2.2 – Address the Canada-wide Strategy for the Management of Municipal Wastewater Effluent (CWS-MMWE) by working with Burnaby, New Westminster and Vancouver to develop and implement: priorities for sewer separation of catchments tributary to combined sewer outfalls; regional and municipal sequence for trunk and collector sewer separation; strategic use of existing combined sewers to manage rainwater quality runoff; and strategy to separate combined sewer connections from private properties (2014).

Combined sewer separation planning for the Manitoba Combined Sewer Catchment was completed in early 2017. The area lies in South Vancouver and covers the Oakridge-Langara neighbourhoods and extends south to the Fraser River. In addition, combined sewer separation planning was started in 2018 for the Heather-Cambie and Canoe Creek Combined Sewer Catchments. These planning areas lie in Vancouver and extend north of the Manitoba catchment to False Creek and cover the Douglas Park, Fairview and Mount Pleasant neighbourhoods. These last two plans will be completed in early 2019.

A steering committee and working group were formed in late 2018 to ensure the CSO elimination initiatives of the cities of Burnaby, New Westminster, Vancouver and Metro Vancouver are aligned. Objectives for this group include improved clarity on combined sewer lateral separation, defining the context for green infrastructure in CSO elimination, and coordinating sewer separation initiatives.

To support sewer separation planning work, the updated Vancouver Sewerage Area sewer model was calibrated in 2018 and verified for dry weather flow modelling. Wet weather flow calibration is expected to be completed in 2019 and the model will be used to assess combined sewer separation strategies and inform the prioritization of work.

Action 1.2.3 – Replace combined regional trunk sewers with separated sanitary and storm sewers as determined by the plans developed in 1.2.2 (Ongoing).

Replaced combined regional trunk sewers with separated sanitary and storm sewers as determined by the plans developed in 1.2.2.

The Conceptual Design Engineering for the Glenbrook System in New Westminster has been initiated. Construction is currently planned to commence in the late 2020's.

Action 1.2.4 – Work with municipalities to develop and implement municipal –regional sanitary overflow management plans which will: prevent sanitary overflows resulting from heaving rain and snowmelt occurring less than once every five years (for a 24 hour duration event); reduce emergency overflows due to power outages; and identify locations and schedules for appropriate system capacity improvements, wet weather containment, and point treatment and discharge to receiving waters of chronic overflows, including Cloverdale Pump Station, Katzie Pump Station, Lynn Pump Station (2013).

Metro Vancouver continued to support its members in their I&I management planning through work with the REAC LWSC in reviewing strategies for long-term I&I control. The recommendations from this work will be delivered to REAC in early 2019 and are intended to help member municipalities I&I management programs.

With respect to the three priority locations for SSO (Sanitary Sewer Overflow) management planning, Cloverdale Pump Station, Katzie Pump Station and Lynn Branch Siphon, progress is summarized as follows:

North Shore Interceptor - Lynn Branch Siphon

Three wet weather SSOs occurred at Lynn Branch Siphon in 2017 while 6 occurred in 2018. The total estimated volume of SSOs decreased in 2017-2018 (28,400 m³) compared to 2015-2016 (30,100 m³) even though there were 4 more SSO events than in the previous period of 2015-2016. The District of North Vancouver continues its work to reduce I&I from private laterals in the upstream Lynn Valley area. An overview of the District's I&I management work is provided in Volume 2: Municipal Reports under Action 1.1.18.

North Surrey Interceptor – Maple Ridge Section & Port Mann Section

Discharges to locations of reduced environmental sensitivity are preferred if SSOs are unavoidable. To minimize environmental risks to Katzie Slough during wet weather, emergency wet weather overflows are directed to the Fraser River at the 225th Street overflow location.

12 wet weather SSOs occurred at the 225th Street overflow in 2017 and 9 occurred in 2018; the total estimated SSO volume is 144,500 m³ for this period. No SSOs occurred at the Katzie Pump Station during in 2017 or 2018. In contrast, during 2015 and 2016, 1 wet weather SSO occurred at the Katzie Pump Station and 14 wet weather SSOs occurred at the 225th Street overflow, and overall SSO volumes were lower at 62,000 m³. As part of the interim solution to re-occurring wet weather overflows, Metro Vancouver is designing the Golden Ears SSO Storage Project near the Katzie Pump Station. Construction of this overflow containment tank is anticipated to be completed by 2022.

Metro Vancouver continues to experience reoccurring wet weather SSOs on the Port Mann Section of the North Surrey Interceptor at Manhole 48. The reoccurrence of wet weather SSOs increased at this

location with 10 events in 2017 and 7 events in 2018 and resulted in a total 112,400 m³ of overflows. This compares to 2015-2016 when only 8 events occurred and resulted in 14,900 m³ of overflows. To reduce the reoccurrence of SSOs at this location, Metro Vancouver completed repairs to sections of the North Surrey Interceptor to reduce I&I and has started a design of an SSO storage facility as part of a solution that includes reductions in tributary municipal I&I. Construction of this SSO storage facility is anticipated to be complete by 2024.

Furthermore, the Cities of Maple Ridge and Surrey continue with their I&I management work. An overview of this work provided in Volume 2: Municipal Reports under Action 1.1.18.

South Surrey Interceptor – Cloverdale Pump Station

Construction of capacity improvements to the South Surrey Interceptor and operation of the Cloverdale SSO containment tank have prevented SSOs at the Cloverdale Pump Station from occurring since 2013. Ongoing efforts by both upstream and downstream municipalities are required to ensure that wet weather SSOs remain controlled. I&I management reporting for the City of Delta, the City of Langley, Langley Township, the City of Surrey and the City of White Rock are contained in Volume 2 under Action 1.1.18.

Strategy 1.3 Reduce environmental impacts from liquid waste management to a minimum

Action 1.3.1 – Develop and implement operational plans for sewerage and wastewater treatment facilities to ensure infrastructure reliability and optimal performance (*Ongoing*).

Operational data is analyzed for changes in performance, and alarm logic is developed where feasible to allow intervention before failures occur. For example, alarms are based on run times, flow rate and/or vibration that alert operators to potential pump ragging.

The following refers to work completed in 2017 and 2018:

- Design of the back-up power systems for the VSA pump stations continued;
- Water actuated discharge valves were assessed with the intention of replacing them with check valves or electrically actuated discharge valves to improve reliability and reduce potable water use once the above noted power improvements are in place;
- Assessment, review and repair of the North Surrey Interceptor is underway to identify deteriorated sections and complete repairs to minimize exfiltration of sewage during wet weather;
- Initiated a plan to install flow meters at all pump stations to monitor the pump station performance; and,
- Carried out testing at a number of pump stations to identify and improve pump performance.

Action 1.3.2 – Maintain trunk sanitary sewer capacity for dry weather sewerage conveyance levels plus the Metro Vancouver target inflow and infiltration allowance; as necessary upgrade trunk sewer systems to maintain hydraulic grade lines and safe operating levels which have been established based on measured flow (*Ongoing*).

The work is ongoing. Please refer to the 2015-2016 Biennial report.

Action 1.3.3 – Work with municipalities to develop and implement emergency sanitary sewer overflow plans including contingency plans to minimize impacts of unavoidable sanitary sewer overflows resulting from extreme weather, system failures or unusual events (*Ongoing*).

No new work was initiated on this action during 2017-2018. Refer to the 2013-2014 Biennial Report.

Action 1.3.4 – Operate wastewater treatment plants which have secondary level treatment (Annacis Island, Lulu Island, North West Langley wastewater treatment plants) to meet requirements specified in each facility's Operational Certificate as well as the national Wastewater Systems Effluent Regulations including: (a) maximum Carbonaceous Biochemical Oxygen Demand (CBOD₅): 25mg/L (monthly average for Annacis Island and Lulu Island and quarterly average for North West Langley); and (b) maximum Total Suspended Solids (TSS): 25mg/L (monthly average for Annacis Island and Lulu Island and quarterly average for North West Langley)

No change in status or reporting parameters. Harmonization discussions between the governments of BC and Canada have been postponed until further notice.

The following tables summarize WWTP performance with the Operational Certificate parameters. Please refer to the previous Biennial Reports for past performance details.

Table 1 Total WWTP Operational Certificate Exceedances per Year – All Parameters

WWTP	2017	2018
Annacis	0	2
Iona	2	0
Lions Gate	1	0
Lulu	1	1
NW Langley	5	1

Table 2 WWTP Operational Certificate Exceedances per Year – CBOD/BOD

WWTP	2017	2018
Annacis	0	0
Iona	2	0
Lions Gate	0	0
Lulu	0	0
NW Langley	0	0

Table 3 WWTP Operational Certificate Exceedances per Year – TSS

WWTP	2017	2018
Annacis	0	0
Iona	0	0
Lion Gate	0	0
Lulu	0	0
NW Langley	1	0

Table 4 WWTP Operational Certificate Exceedances per Year – Coliform

WWTP	2017	2018
Annacis	0	0
Lion Gate	0	0
Lulu	0	0

Action 1.3.5 - Upgrade or replace Lions Gate (North Shore Sewerage Area) and Iona Island (Vancouver Sewerage Area) wastewater treatment plants to secondary level treatment to meet Canada-wide Strategy for the Management of Municipal Wastewater Effluent (CWS-MMWE) requirements and timelines.

Lions Gate WWTP/North Shore WWTP

On April 5, 2017 Metro Vancouver executed an agreement with Acciona Wastewater Solutions L.P. for the design and construction of the new North Shore Wastewater Treatment Plant (NSWWTP), previously referred to as the Lions Gate Secondary Wastewater Treatment Plant, for \$525 million with a contracted secondary treatment completion date prior to December 31, 2020. Construction began in the summer of 2017. In July 2018, Metro Vancouver executed an agreement with North Shore Conveyance Partners, for \$141 million for the design and construction of the associated conveyance works required to integrate the NSWWTP with the collection system as well as tie-in the NSWWTP into the existing outfall. This work represents all the major capital requirements for the program.

Iona Island WWTP

Metro Vancouver started the Project Definition Phase of the new Iona Island Wastewater Treatment Plant on September 20, 2018. A total of 8 integrated design workshops involving Metro Vancouver and a consulting team are planned, the first of which was completed in October 2018. The second workshop was held in January 2019 to develop the plant design objectives hierarchy and evaluation process. Metro Vancouver will engage various stakeholder groups, including but not limited to: local government staff and elected officials; residential and business neighbours of the plant; First Nations; environmental groups; regulators and other government agencies; recreational users of Iona Beach Regional Park; and commercial and recreational Fraser River users. A series of community workshops are planned throughout the Project Definition Phase and will be scheduled to align with key decision points in the project's Integrated Design Process.

Action 1.3.6 – Maintain interim maximum daily concentration limits for wastewater effluent of 130mg/L BOD₅ at both Lions Gate and Iona Island plants and 130mg/L TSS at Lions Gate and 100mg/L TSS at Iona Island until such a time as secondary treatment is operational, and operate the plants to meet requirements specified in each facility's Operational Certificate (*Ongoing*).

No change from the previous 2015-2016 Biennial Report.

Action 1.3.7 – Assess environmental monitoring results (see Strategy 3.3) to determine whether any actions are required to meet Ministry of Environment/Canada-wide Strategy for the Management of Municipal Wastewater Effluent (CWS-MMWE) requirements (*Ongoing*).

Metro Vancouver is developing Effluent Discharge Objectives (EDOs) in conjunction with major wastewater treatment plant upgrades. Over the past two years, the associated risk assessments for development of EDOs have been completed for the expansion of the Northwest Langley WWTP to a regional plant and a higher level of wastewater treatment, and for the regulatory mandated upgrade of the Iona Island WWTP. These assessments were conducted in accordance with the CCME *Canada-wide Strategy for the Management of Municipal Wastewater Effluent*.

The Northwest Langley plant expansion will incorporate wastewater which currently flows from the Cities of Pitt Meadows and Maple Ridge to the Annacis Island WWTP. The EDO study completed in 2016 had no data from these catchments and is not representative of the future WWTP. In 2017 and 2018, a Key Manhole Monitoring program was conducted to collect data from the expanded catchment and included parameters not included in the 2016 EDO study. In 2018, a preliminary EDO study was completed for the Northwest Langley WWTP expansion based on the 2017 data. The 2018 data is pending and will be used to verify and update the 2018 EDO study.

The Iona Island WWTP EDO assessment identified substances that required additional monitoring in the influent and effluent to determine if the proposed EDOs can be accommodated, or alternatively eliminated from the list. In some instances, historical monitoring has not included a particular substance, or the analytical detection limit used for its quantification was inadequate to assess if an EDO is required. Additional monitoring for those identified substances will be carried out for the Iona Island WWTP in the future.

Action 1.3.8 – Continue odour control programs at wastewater treatment plants and implement odour control programs for targeted facilities in the regional sewer system and for relevant energy and material recovery processes, see Action 3.3.4 (*Ongoing*).

Hydrogen sulphide monitoring in GVS&DD's linear system has been occurring around the region in support of developing future hydrogen sulphide models that will be used to predict where areas of concern are expected to exist. Design occurred in 2017 and construction began in 2018 on one odour control facility, which will be completed in 2019. Design on three other regional site designs occurred in

2017 and 2018 with construction expected to be complete in 2020 for all 3 sites. 3 sites are: SSI-King George Section, West of King George Boulevard; SSI – Hwy 91, Intersection of Hwy 91/10; and SSI- Delta Section, South of River Road.

Hydrogen sulphide monitoring in GVS&DD's linear system has occurred in 2017 and 2018 around the region in support of the development of a hydrogen sulphide model that will be used to predict where areas of concern are expected to exist.

The Highbury Diversion Chamber Rehabilitation project deals with the rehab of diversion chambers and siphon throats #1, 2 and 3. Work completed included: Fabrication and installation of all isolation gates in the chambers and rehabilitation of siphon throat area in chamber #2 using Shotcrete which is just a sprayed on concrete.

The King George Odour control facility is located near the recently completed King George grit chamber, just west of King George Boulevard in Surrey. Metro Vancouver has applied to the City of Surrey for a building permit and a right-of-way agreement; these are required before the work can proceed. It is expected that both the building permit and the right-of-way agreement will be in place by early 2019. Construction may commence in early spring of 2019.

The Highway 91 odour control facility is located near the Highway 91 grit chamber at the Highway 91 and Highway 10 junction in North Delta. The contract for these works was awarded in November 2018.

See Figure 5 on page 27 for the Odour Controls and Complaint mapping

Action 1.3.9- Develop and implement air emissions management programs for standby power generators and biogas production, including assessment of desirability of retrofit and accelerated asset replacement where appropriate (2014).
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Purchases of new or replacement standby generators aim to meet the most stringent emission standards available, with consideration of potential emission reductions and costs. This approach is typically used for purchases of any non-road diesel engines and equipment, and is based on availability of equipment meeting current emission standards. No change to any of the biogas productions systems have been made since the last 2015 - 2016 Biennial Report update.

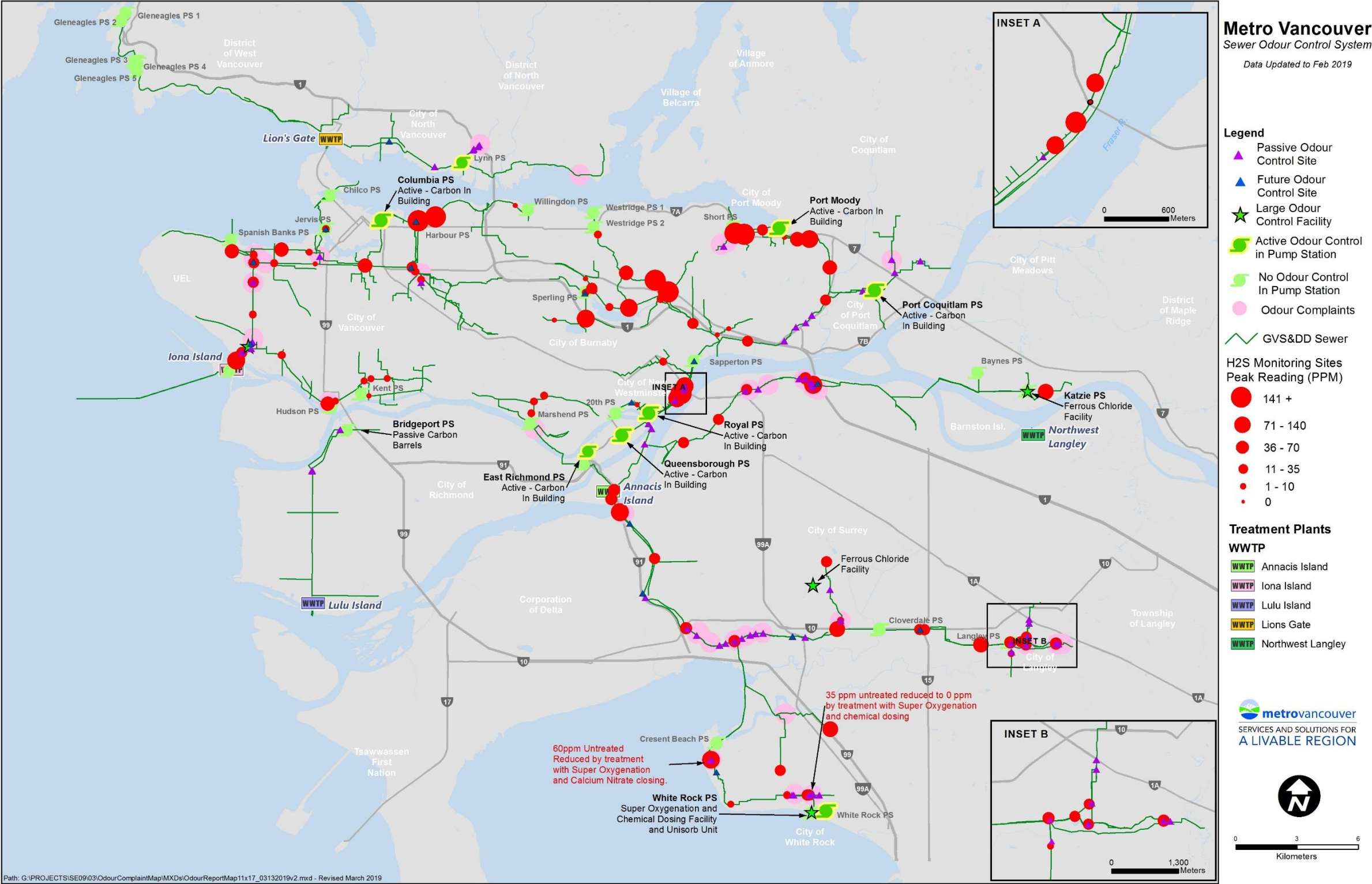


Figure 5 Sewer Odour Controls and Complaints

Action 1.3.10- Develop and implement programs to reduce greenhouse gas emissions from the regional liquid waste management systems to help achieve federal, provincial and Metro Vancouver greenhouse gas targets, see Action 3.3.4 (2015).

Greenhouse gas (GHG) emissions are directly and indirectly produced by the regional liquid waste management system. Direct GHG emissions are from natural gas and digester gas combustion in boilers, engines, and flares at the wastewater treatment plants; from vehicle activity (both corporate vehicles operated by the liquid waste utility and contracted vehicles used for residuals management); and from fugitive methane emissions. Indirect emissions are associated with the electricity used in the liquid waste collections system and at the wastewater treatment plants. The operation and management of the regional liquid waste management system produces approximately 12,415 tonnes of GHGs for this reporting period, including emissions from contracted fuel use for residuals hauling. Promising GHG reduction projects that have been examined and/or pursued in 2017 and 2018 include:

- improved beneficial use of biogas generated at wastewater treatment plants, for use in boilers, for co-generation of heat and power at the plant, or by cleaning and injecting the cleaned biomethane into natural gas pipelines;
- extraction of heat from effluent at the new North Shore WWTP for use in the nearby district energy system owned by Lonsdale Energy Corporation;
- heat extraction from effluent at Iona Island WWTP for use at nearby businesses and municipalities, including the Vancouver Airport Authority;
- heat extraction from effluent at Lulu Island WWTP for similar purposes for use at nearby businesses and municipalities;
- Hydrothermal Processing demonstration project, for implementation at Annacis Island WWTP, and in larger scales for future wastewater treatment facilities, which would produce biocrude that can replace a portion of petroleum feedstock in oil refineries and produce fuels with lower carbon intensity;
- biosolids drying using heat from co-generation engines for use as a low-carbon fuel in cement kilns and other processes;
- use of biosolids in biocovers and biofilters for landfill closure, to reduce fugitive methane emissions; and
- equipment and process control improvements to better utilize natural gas, digester gas, and electricity.

Action 1.3.18 – Include Metro Vancouver and municipalities in the Ministry's processes to review and establish official water uses and official water quality objectives for specific water bodies within Metro Vancouver.

Following the development of the *Burrard Inlet Action Plan: A Tsleil-Waututh Perspective* in 2016, the BC Ministry of Environment and Tsleil-Waututh First Nation jointly initiated a review of Burrard Inlet Water Quality Objectives. Metro Vancouver has been participating in the work of the Water Quality

Roundtable and Technical Working Group since their inception, and has provided a considerable amount of monitoring and other data for this initiative.

Goal 2: Use Liquid Waste as a Resource

Strategy 2.1: Pursue liquid waste resource recovery in an integrated resource recovery context

Action 2.1.1- Assess each sewerage area using an integrated resource recovery business case model that: (a) evaluates opportunities to expand the recovery of energy, nutrients and water from the liquid waste system, specifically: Energy from biogas at wastewater treatment plants including investigating new sludge and wastewater treatment technologies and the co-digestion of other organic wastes such as organics in municipal solid waste, oils and greases, Heat energy from new pump stations, sewer replacement and rehabilitation and major wastewater treatment plant projects, Biodiesel from trucked liquid waste, waste grease and sewer grease, Energy from biosolids and sludge, Nutrients, such as phosphorous from liquid waste and biosolids, Alternatives to potable water for non-drinking purposes, such as rainwater harvesting, greywater reuse and reclaimed treated wastewater, (b) identifies linkages between liquid waste resource recovery opportunities and other systems (solid waste, drinking water, land use/buildings, parks, air quality, energy), (c) develops and evaluates business cases for integrated resource recovery/use opportunities (2012).

Integrated Resource Recovery

The Integrated Resource Recovery (IRR) study for the Lulu Island West Sewerage Area (LSA) was completed in 2017. (Studies for the Vancouver Sewerage Area and North Shore Sewerage Area were completed in 2013 and 2011, respectively.) The study explored opportunities associated with the integrated management of solid and liquid wastes originating within the LSA and resulted in an “IRR Framework”, an overall strategy for developing IRR projects in the LSA, and an “Actions List” defining specific activities to implement the strategy. Two main potential IRR scenarios were identified, one focusing on the development of district energy and water recycling systems at Richmond City Centre and a second involving the development of bioenergy resources and conducting research on agricultural end uses for residuals from the Lulu Island Wastewater Treatment Plant (LIWWTP). The most promising concepts from the evaluation led to the identification of near-term concrete steps. Some of these steps have been already completed, such as the analysis of alternative digestion optimization techniques for LIWWTP and the predesign for a pilot-scale facility for distribution of bulk recycled water completed in 2017 and 2018 respectively. Other initiatives are currently under way, including the BC Biogas Project, to be constructed at LIWWTP in 2019. Additional initiatives, such as the collaboration with local

universities on the microbial activity within wastewater to optimize treatment processes and pilot testing of hydrothermal processing technology will continue.

An IRR study was undertaken as part of the conceptual design for the new Northwest Langley WWTP, which will serve a substantial portion of the Fraser Sewerage Area. A broad range of IRR opportunities were analyzed, and several promising concepts were included in the approved conceptual design, including co-digestion of trucked liquid waste, reclaimed water for onsite and offsite use, grit reuse, biosolids reuse, nutrient recovery, and biogas use. In some cases, space will be reserved for necessary infrastructure, which will be installed later, dependent on the market and incentives for sustainability projects. The larger Fraser Sewerage Area IRR study will begin in 2019.

Co-digestion of Trucked Liquid Waste

A review of Metro Vancouver's Trucked Liquid Waste Program was initiated in 2016 to determine whether to expand co-digestion, move trucked liquid waste facilities to different wastewater treatment plants that may be more convenient for haulers, or other alternative methods of management and recovery of this waste. The review was completed in early 2018 and determined that most high-strength waste suitable for co-digestion was being managed by the private sector at on-farm anaerobic digestion facilities in the Fraser Valley and Washington State. To ensure redundancy, the TLW Program review recommended that the new Northwest Langley WWTP be designed with both domestic and non-domestic TLW facilities, and, that TLW facilities continue to be available at the Iona WWTP. However, the primary finding relevant for the potential for co-digestion at WWTPs is that Metro Vancouver cannot currently compete with the private sector for the types of waste best suited for co-digestion.

Sewer and Effluent Heat Projects

The Sewer Heat Policy, which was approved by Metro Vancouver in 2014, enables municipalities and businesses to evaluate the use of sewer heat, and provides a clear implementation path for promising situations. Municipalities have assessed the potential use of sewer heat in coordination with Metro Vancouver at many locations since the policy was approved. As a result, some projects will not proceed, due to technical or economic challenges.

Sewer Heat Projects

In the reporting period 2017-2018, two applications were received, one from the City of New Westminister for a district energy system extracting heat from a trunk sewer near the Sapperton Pump Station, and one from the City of Vancouver for an expansion project servicing the Southeast False Creek Neighbourhood Energy Utility.

The City of New Westminister (CNW) is planning a District Energy System to serve the Sapperton area, in conjunction with the redevelopment of the Royal Columbian Hospital site. CNW Council had indicated a preference to use sewer heat as an energy source if economically feasible. A revised business case completed in 2018 showed economic challenges and CNW put the project on hold until completion of their 2019 Strategic Planning. The project will be revisited in Spring 2019.

The City of Vancouver (CoV) is planning to increase energy supply at the Southeast False Creek Neighbourhood Energy Utility (SEFC NEU) to supply low carbon energy that will meet growing demand as the system expands to new developments. CoV intends to extract additional sewer heat from a Metro Vancouver trunk sewer or a city sewer to add capacity. In 2017 and 2018, the City carried out further studies to screen options for sewerage diversion to the SEFC NEU plant and developed the design basis for the SEFC NEU expansion. Metro Vancouver's staff has continued to collaborate with CoV to explore the various proposed configurations. Final decision on sewage sourcing is anticipated in March 2019.

Effluent Heat Recovery at the new North Shore Wastewater Treatment Plant (NSWWTP)

In 2017, the business case for effluent heat recovery at the new North Shore WWTP was re-evaluated during negotiations with Lonsdale Energy Corporation (LEC). In October 2017, Metro Vancouver exercised the District Energy Option as part of Acciona Wastewater Solutions LP Proposal for inclusion in the design and construction of the NSWWTP, and executed an agreement with LEC for the sale and purchase of thermal energy recovered from effluent at the NSWWTP. Metro Vancouver agreed to fund the \$17.9 Million of capital for the heat recovery equipment in return for an 84 per cent share of the greenhouse gas reductions that result from LEC's use of effluent heat.

Effluent Heat Recovery at Iona Island Wastewater Treatment Plant

In 2015, based on an opportunity identified in the Vancouver Sewerage Area Integrated Resource Recovery study of 2013, Metro Vancouver undertook a feasibility study in partnership with the Vancouver Airport Authority (YVR) to explore the use of clean energy available from the Iona Island WWTP to supply heat to a district energy system on Sea Island.

The study indicated that such a system may be viable; but that further detailed technical and economic studies were necessary. A subsequently study, undertaken by YVR, explored several heating options including effluent heat recovery concluded that the construction of a geo-exchange field to provide all domestic and international terminal buildings heating loads.

Effluent heat recovery options at Iona Island WWTP will be further explored as part of the design for the new secondary Iona Island WWTP which started in 2018.

Biogas Energy Recovery

Biogas is created through anaerobic digestion processes at the four principal wastewater treatment plants in the region. Some portion of the biogas is beneficially used at all of the plants. The Iona Island and Annacis Island WWTPs co-generate heat and electricity. While the Lulu Island and future North Shore WWTPs will generate heat for plant uses. In all cases, the generated energy allows the plants to meet nearly all of the plants' heating needs, avoiding the use of natural gas and consequent greenhouse gas emissions. The generated electricity reduces the need for additional electricity generation by BC Hydro, providing a complementary green and renewable electricity source. Existing levels of recovered energy are shown in Table 5.

Table 5 Energy Recovered for all 5 Wastewater Treatment Plants 2017-2018

	Biomethane Used	Electricity Self-generated
	GJ	kWh
Wastewater Treatment Plants		
2017	536,226	36,936,606
2018	414,484	13,757,056

Wastewater Biomass to Biocrude – Hydrothermal Processing (HTP)

In 2018, the HTP pilot project became a fully funded partnership involving the Province of BC through its Innovative Clean Energy Fund and Parkland Fuel Corporation’s refinery operations in BC. This multi-year project will initiate with procurement of services in 2019 and operations is expected to commence in 2021. HTP is a resource recovery technology that converts wastewater biomass into biocrude, with minimal solids output. The biocrude can be further co-processed into low-carbon transportation fuels such as biodiesel or biojet fuel.

Preliminary assessments suggest there are significant economic and environmental benefits for HTP compared to anaerobic digestion (AD). These benefits include 10% and 40% lower capital and operational costs, respectively, and a 3-fold increase in GHG reductions. Implementing HTP can lead to the establishment of an advanced biofuels hub and development of highly qualified personnel, which would help to further the technology and establish additional revenue.

Success in the commercialization of HTP will create more sustainable infrastructure, while yielding positive environmental, social and economic outcomes for Metro Vancouver and demonstrating leadership in innovation and sustainability. The expected outcomes and benefits include:

- An updated techno-economic assessment and HTP business case for full-scale implementation;
- Reduced GHG emissions through displacement of fossil fuels with a biocrude that is compatible with current fuel refining infrastructure;
- Cost savings associated with lower capital costs compared with AD; lower net operating costs due to revenue generation from selling biocrude; and reduction of biosolids management costs;
- New solution for solids management; and
- Leverages billions of dollars of infrastructure in the wastewater and petroleum industry.

Phosphorous Recovery

In 2016, Metro Vancouver initiated a phosphorus recovery trial at the Annacis Research Center using centrate from the Annacis Island Wastewater Treatment Plant to better inform Metro Vancouver’s decisions regarding full-scale installation of phosphorus recovery equipment at existing and planned wastewater treatment plants. Physical trials were successfully completed in December 2016. Test results were compiled and documented in 2017. Results demonstrated the capacity and quality of fertilizer that was produced using the Annacis Island Wastewater Plant centrate feed stream, provided evidence of optimized operational settings through testing various configurations, and documented operational requirements and labour and materials needed to effectively operate such a system.

In 2017 and 2018, installation of phosphorus recovery equipment was considered during the conceptual design phase of the Northwest Langley WWTP. The business case for phosphorus recovery at this point is not strong enough to recommend equipment installation during the initial construction of the plant. However; it was recommended that space be allocated at the new plant for such equipment in the future.

Wastewater Research

Metro Vancouver continues to identify priority research needs and to undertake projects capable of contributing to Metro Vancouver's goals by saving money and/or meeting existing and potential future environmental needs more effectively. Some projects are undertaken at the Annacis Research Centre (ARC), and others are tested at other locations. Several projects have been developed in collaboration and with support from other agencies and funders such as NSERC. ARC, which is located next to the Annacis Island Wastewater Treatment Plant, exists to support liquid waste research, training, conferences, and education.

Many research projects took place in 2017 and 2018. Continuing projects included:

- annamox bacteria for ammonia removal;
- methods of detecting contaminants of emerging concern, detecting microplastics to better understand their impacts on aquatic life;
- H₂S mitigation and methods of detecting H₂S in sewer collection systems, granular biomass for improved settling and nutrient removal, genomic analyses, and other privately patented technologies for removing contaminants from wastewater;
- Activities at ARC included trials by private sector firms, by Metro Vancouver, and by the University of British Columbia; and
- Many projects at ARC and elsewhere were undertaken with partners, such as the Vancouver Aquarium.

New projects initiated during 2017 and 2018 include microwave oxidation of wastewater to improve digestion processes and biogas production, techniques to better understand the microbial environment with intent to increase sludge destruction and biogas production, and hydrothermal liquefaction as an alternative means of sludge transformation into biofuels.

Reclaimed Water

Following the completion of the Demand Study for a Reclaimed Water Pilot Facility in 2016, the collaborative partner selected for further consideration was the City of Richmond. In 2017 and 2018, a pre-design basis and operational plan for a Reclaimed Water Demonstration Facility at the Lulu Island Wastewater Treatment Plant were completed with input from the City of Richmond. The objectives of the demonstration facility are:

- To reduce potable water use in municipal operations in the City of Richmond;

- To demonstrate that it is technically possible to meet community water needs using reclaimed water and reduce potable water use, while meeting all regulatory requirements and maintaining public and worker safety;
- To collect evidence of the capital and operating costs, administrative, regulatory, and operational requirements of such a project; and
- To inform potential reclaimed water provision policy development.

A capital cost estimate was prepared for the facility and Metro Vancouver is seeking to confirm commitment to the use of the water in municipal operations by the City of Richmond in the form of a Letter of Interest. If one is received in 2019, the capital budget may be available in 2020 for the construction of such a facility.

Biosolids

Metro Vancouver's biosolids are high in nutrients and organic matter that, when applied to land, can improve soil health, improve water retention capability, increase vegetation growth, and enhance carbon sequestration. In 2017 and 2018 Metro Vancouver's biosolids were used to:

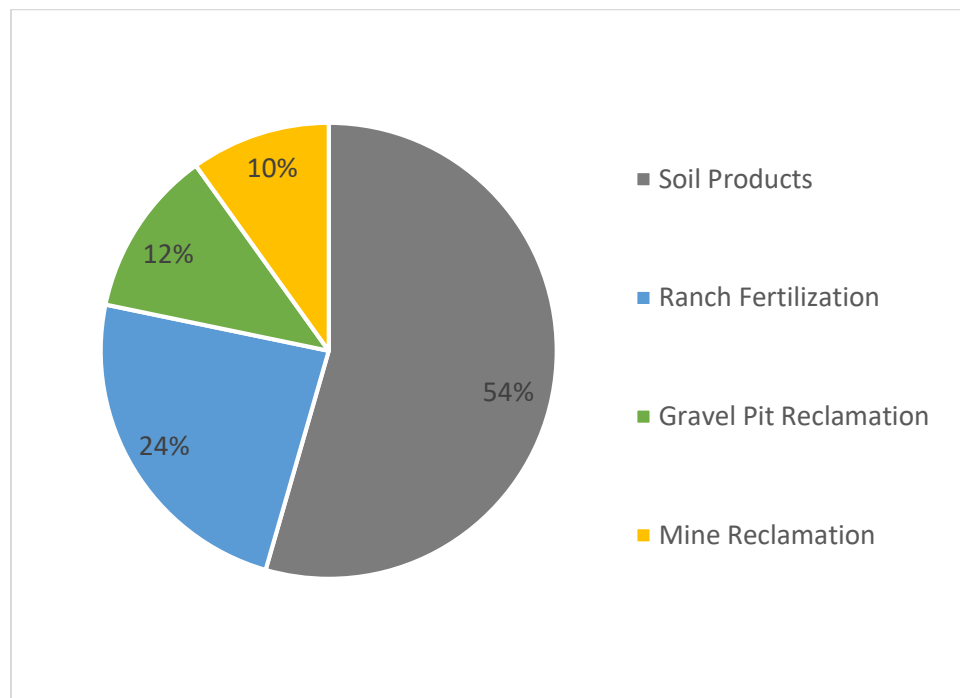
- make fabricated topsoil for local landscaping projects including the restoration of a Regional Park and landscaping of a municipal greenway;
- make fabricated soil for use as a topsoil to reclaim disturbed and degraded lands and to level fields for agricultural use in the BC Interior;
- make a fabricated topsoil for a local nursery;
- fertilize rangeland and hayfields in the BC Interior;
- reclaim mine sites and gravel pits through the provision of nutrients and organic matter to rebuild soil and re-introduce vegetation; and
- construct a landfill biocover that mitigates greenhouse gas emissions by oxidizing methane gas.

Approximately 98 percent of the Organic Matter Recycling Regulation (OMRR) compliant material produced at Metro Vancouver Wastewater Treatment Plants in 2017 and 2018 was used for nutrient recovery beneficial use projects. The remainder was disposed in a secure landfill facility due to road closures during wildfire season. The table and figure below show the amount of biosolids delivered for each type of beneficial use.

Table 6 Metro Vancouver Biosolids Beneficial Uses 2017 -2018

	Soil Products	Ranch Fertilization	Gravel Pit Reclamation	Mine Reclamation	Landfill Reclamation & Biocover Construction
Bulk tonnes delivered	91,822	40,110	19,966	16,697	118

Figure 6 Metro Vancouver Biosolids Beneficial Use Program 2017-2018



Energy from Biosolids

In 2018, Metro Vancouver completed two studies assessing the feasibility of constructing a biosolids dryer and identifying potential markets for a dried biosolids product. These studies indicated that the most feasible option for biosolids drying would be to build a facility near the Northwest Langley Wastewater Treatment Plant that could use biogas from the future solids digesters to offset some of the fuel consumption of the dryer. The dried granules could be marketed both as a component of blended fertilizer products, offsetting the need for mined phosphorous and manufactured urea, as well as a substitute for coal at two local cement kilns.

Action 2.1.2 Implement appropriate business cases based on the results of 2.1.1 (<i>Ongoing</i>).
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Reclaimed Water

For reclaimed water updates please see action 2.1.1

Effluent Heat Recovery at the North Shore Wastewater Treatment Plant

In 2017, Metro Vancouver approved an effluent heat recovery facility at the new North Shore WWTP and entered into an agreement with Lonsdale Energy Corporation (LEC) for sale and purchase of thermal

energy. The heat recovered from effluent will displace the use of natural gas in LEC's district energy system. Metro Vancouver will receive 84 percent of the greenhouse gas reductions that result from LEC's use of effluent heat.

Action 2.1.3- Work with municipalities to adapt plans and infrastructure for long term needs based on the results of 2.1.1 (*Ongoing*).

In 2017 and 2018, Metro Vancouver continued working with the City of Vancouver, the City of New Westminster, the City of Richmond, the City of North Vancouver and the District of North Vancouver to develop plans for the recovery of heat for space heating from Metro Vancouver's trunk sewers and effluent from the new North Shore Wastewater Treatment Plant and Lulu Island Wastewater Treatment Plant. Implementation of these sewer and effluent heat recovery opportunities will take a number of years and the work conducted in the last two years will lay the foundation for these resource recovery opportunities. The effluent heat recovery at the new North Shore WWTP will be the first such project implemented.

As noted in section 2.1.1, following the completion of the Demand Study for a Reclaimed Water Pilot Facility in 2016, the collaborative partner selected for further consideration was the City of Richmond. In 2017 and 2018, a pre-design basis and operational plan for a Reclaimed Water Demonstration Facility at the Lulu Island Wastewater Treatment Plant were completed with input from the City of Richmond. A capital cost estimate was prepared for the facility and Metro Vancouver is seeking to confirm commitment to the use of the water in municipal operations by the City of Richmond in the form of a Letter of Interest.

In 2018, Metro Vancouver completed two studies determining the feasibility of constructing a biosolids dryer and identifying potential markets for a dried biosolids product. These studies indicated that the most feasible option for biosolids drying would be to build a facility near the Northwest Langley Wastewater Treatment Plant that could use biogas from the future solids digesters to offset some of the fuel consumption of the dryer. The dried granules could be marketed both as a component of blended fertilizer products, offsetting the need for mined phosphorous and manufactured urea, as well as a substitute for coal at two local cement kilns.

Goal 3: Effective, affordable and collaborative management

Strategy 3.1: Manage assets and optimize existing sanitary sewerage operations

Action 3.1.1 - Assess the performance and condition of regional sewerage systems by: (a) inspecting regional sanitary sewers on a twenty-year cycle and, (b) maintaining current maps of sewerage inspection, condition, and repairs (*Ongoing*).

Metro Vancouver has an ongoing program to inspect and maintain its wastewater collection and treatment systems under the Operations and Maintenance Department.

Annual wastewater collection video assignments were completed in 2017 and 2018 with 5.6% of Metro Vancouver's overall wastewater collection system inspected in this manner. Sewer condition data obtained from the video inspections has been summarised and added to Metro Vancouver's GIS mapping system to provide visual representation of the wastewater collection system.

Action 3.1.2 - Create incentives to reduce inflow and infiltration by adjusting Tier 1 sewerage cost allocation formulae within each sewerage area from an average dry weather flow basis (25th percentile) to average wet weather flow (75th percentile) with appropriate adjustments for combined sewerage areas. Tier 2 cost allocation would remain unchanged (*2010*).

In 2018, REAC directed its Liquid Waste Subcommittee to examine options that will contribute to improve I&I management. Wet weather cost-allocation options have not been included as part of the subcommittee's work plan as other I&I management strategies, such as private lateral condition certification, are anticipated to be more proactive and achieve better results. Consequently, wet-weather cost-allocation will be revisited in the future if it is deemed to be cost-effectively beneficial in reducing I&I.

Action 3.1.3 - In consultation with municipalities, review Metro Vancouver's safe operating head for regional sewers (*2011*).

This work is ongoing. In addition to the ongoing update of Safe Operating Head (SOH) levels when a specific change occurs, the overall review previously initiated continues in partnership with member municipalities.

Action 3.1.4 - Develop and implement asset management plans targeting a 100 year replacement or rehabilitation cycle for regional sewerage infrastructure (*2013 for plans*).

Metro Vancouver has been managing the regional liquid waste infrastructure using various asset management approaches for several years. The utility is working towards formalizing these work processes and guidelines for asset management.

As noted in the 2013-2014 Biennial Report, replacing infrastructure on a 100-year age-based cycle without understanding the risk to “Levels of Service” is not necessarily the most cost effective or best asset management strategy. Many complex, often competing factors such as capacity (growth), condition, performance, and reliability influence decisions.

Metro Vancouver is currently developing the 30-year capital spending projections including infrastructure renewal to address longer term risks to the services that Liquid Waste Services (LWS) provide.

Metro Vancouver will be developing asset management plans as identified in the Asset Management for Liquid Waste Services policy approved in September 2018.

Current focus is on collecting asset performance and condition information that will be reported in asset management plans. The age of Metro Vancouver’s sewers is shown on Figure 7.

Action 3.1.5 - Update and implement asset management plans for wastewater treatment plants which address risks, including climate change and seismic events, and maintain performance in wet weather (2013).

Metro Vancouver considers risks to the regional WWTPs in its design and facility planning. As an example, through the Project Definition Phase, the new North Shore WWTP will be designed to adapt to the sea level rise due to climate change, and constructed in accordance with the National Building Code of Canada to address risks associated with seismic events. Plant capacity will be sufficient to treat twice the average dry weather flow through secondary treatment components and convey excess flows through primary treatment. The design flows incorporate future reduction in inflow and infiltration by member municipalities.

The risks for the Iona Island WWTP secondary treatment upgrade will be addressed during the Project Definition Phase of the project.

Other projects such as the Annacis Stage 5 Expansion and Northwest Langley Expansion will meet post-disaster requirements per the 2010 National Building Code of Canada and will be capable of withstanding the 1 in 200 design flood event. Projects to improve the reliability of treatment processes including the Annacis Island Cogeneration Backup Power upgrade are also being implemented.

Metro Vancouver will be developing asset management plans as identified in the Asset Management for Liquid Waste Services policy approved in September 2018.

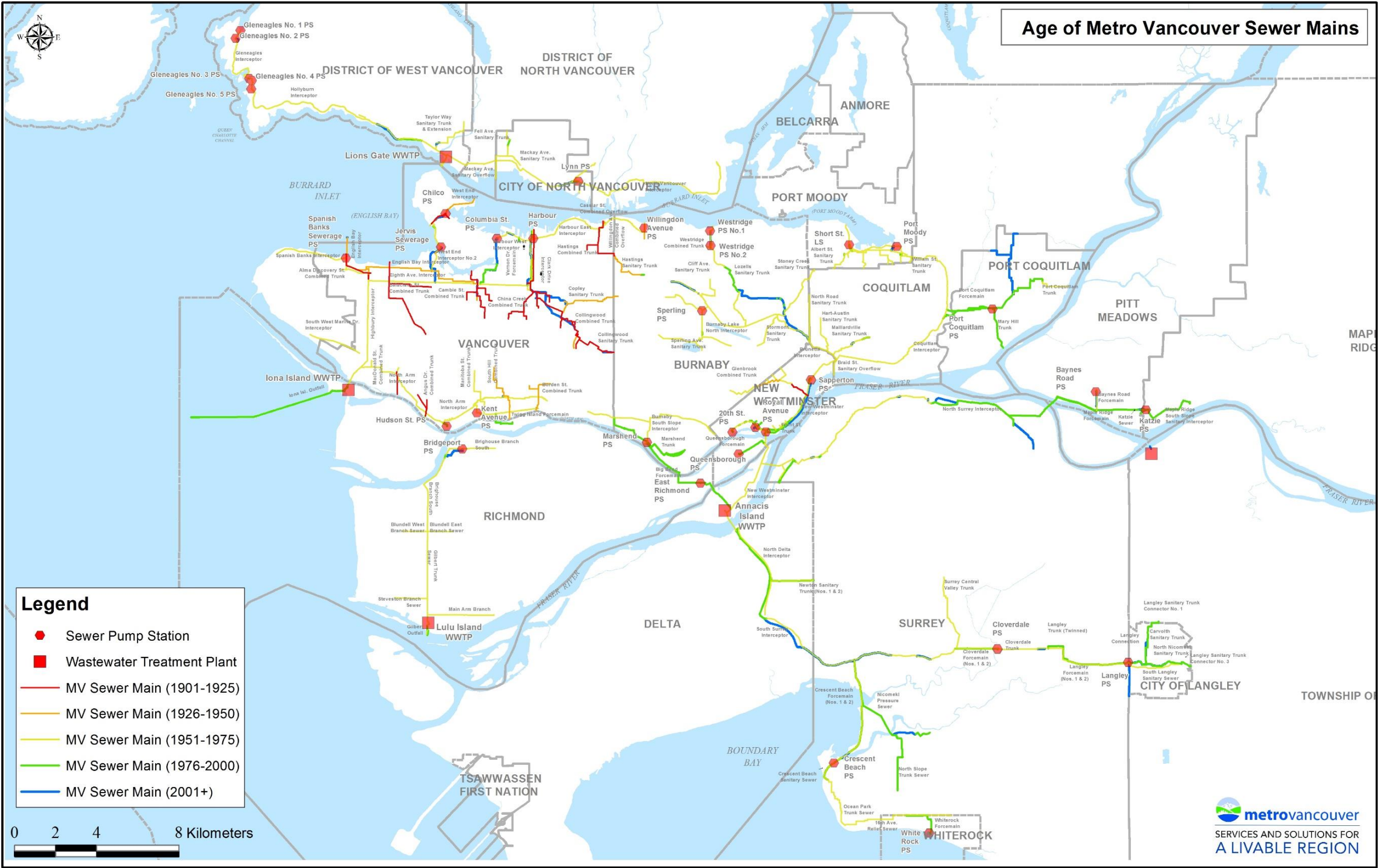


Figure 7 Age of Metro Vancouver Sewers

Strategy 3.2: Use innovative approaches and technologies

Action 3.2.1 - With financial support from provincial and federal governments and the University of British Columbia, develop the Annacis Island Sustainability Academy to support innovative research and demonstration projects in liquid waste management (*Facility by 2011*).

Wastewater Research

The Annacis Research Centre (ARC), which is located next to the Annacis Island Wastewater Treatment Plant, exists to support liquid waste research, training, conferences, and education. Many research projects were underway in 2017 and 2018, including trials by private sector firms, by Metro Vancouver, and by the University of British Columbia. Many projects were undertaken in partnership among these parties and other agencies, such as the Vancouver Aquarium. Projects included techniques for enhancing sludge destruction, annamox bacteria for ammonia removal, methods of detecting contaminants of emerging concern, detecting microplastics to better understand their impacts on aquatic life, H₂S mitigation in sewer collection systems, granular biomass for improved settling and nutrient removal, phosphorus recovery, managing food scraps in wastewater systems, and other privately patented technologies for removing contaminants from wastewater.

Several projects have been developed in collaboration and with support from other agencies and funders such as NSERC. Techniques for enhancing sludge destruction are being explored in collaboration with the University of British Columbia, with additional funding received from NSERC. Methods of detecting contaminants of emerging concern were explored in collaboration with Simon Fraser University. Microplastics concentrations in wastewater are being explored in collaboration with the Vancouver Aquarium. Processes using granular biomass for improved settling and nutrient removal were explored in collaboration with the University of British Columbia and Associated Engineering, with additional funding received from NSERC.

The consultants don't tend to provide detailed descriptions of their research, because it is private and they wish to protect their future commercial potential. Some of them are beginning to expand quickly (like Axine). Several private firms undertook research at ARC during 2017 and 2018, including Axine Water Technologies, Prongineer R&D, Sanzfield Technologies, and Associated Engineering (in partnership with University of British Columbia).

Action 3.2.2 - Collaborate with local and senior governments, academic institutions and industry in research on wastewater treatment technology and stormwater management and associated demonstration projects, training and development of educational toolkits (*Ongoing*).

Metro Vancouver is also engaged in identifying relevant wastewater research, and partnering with outside collaborators capable of innovating in those areas. Some of these initiatives are described below.

High Efficiency Aeration

At many wastewater treatment facilities, mechanical blowers and aeration diffusers supply air as fine bubbles, a system that survey results have shown can consume more than 50% of a treatment facility's total electrical energy demand. Motivated to make a step-change in energy conservation at MV's future treatment plants, the search for improved technologies led to the Perlemax Ltd. proprietary High Efficiency Aeration technology called the fluidic oscillator (FO). The FO produces fine bubbles that have been shown to provide a 50% improvement in oxygen transfer efficiency. At its February 24, 2017 meeting, the GVS&DD Board approved the allocation of funds from the Liquid Waste Sustainability Innovation Fund to a High Efficiency Aeration Demonstration. Perlemax was hired in 2017 to provide a conceptual design for the high efficiency aeration pilot. In 2018, the Water Research Foundation was hired to provide third party validation services. Pilot testing of the FO technology is set to commence in Q3 of 2019, with results documented in Q4 of 2019.

Genomics Approach to Anaerobic Digestion Optimization (GAADO)

At its February 24, 2017 meeting, the GVS&DD Board approved the allocation of funds from the Liquid Waste Sustainability Innovation Fund (SIF) to the GAADO project. The goal of this project is to increase energy generation from existing anaerobic digestion processes used at Metro Vancouver WWTPs. There are two academic teams on this project: i) environmental genomic experts at UBC's Department of Microbiology and Immunology, and ii) anaerobic digestion experts from UBC's School of Engineering, Bioreactor Technology Group. Since project approval in February 2017, the genomics team and Bioreactor Technology Group have leveraged SIF funds to secure four grants from the Natural Sciences and Engineering Research Council totaling over \$700,000.

Work to date involves establishing baseline conditions for existing anaerobic digesters at the Lulu Island WWTP. Preliminary findings show that less than 1% of micro-organisms present are methanogens, those responsible for producing the methane content in biogas. Given the relatively small starting community of methanogens, even a marginal increase in this population should result in a significant increase in methane production. The genomic analysis suggests methane-limiting conditions are present. Work will continue after 2018.

Microwave-enhanced Advanced Oxidation Processes

Anaerobic digestion (AD) at Wastewater Treatment Plants (WWTPs) is a common process to convert municipal sewage sludge into biogas that can be used as a renewable source of energy. Sludge pre-treatment processes can accelerate sludge destruction to increase AD efficiency and biogas production. At its February 24, 2017 meeting, the GVS&DD Board approved the allocation of funds from the Liquid Waste Sustainability Innovation Fund (SIF) to the Microwave-enhanced Advanced Oxidation Process Sludge Destruction Pilot. The process consists of exposing secondary sludge to microwave heating after injection of hydrogen peroxide (H₂O₂). The combination of heat and H₂O₂ increases solids disintegration, making them more available for biogas production. The project is being undertaken in collaboration with academics in the Civil Engineering Department of UBC who patented this process in 2006. They are also receiving NSERC funding for this project.

The first phase of the project includes the design, construction, installation and commissioning of a pilot unit at the Annacis Research Centre (ARC) and will be completed by end of 2019. This first phase will test the process to assess potential for methane recovery, energy consumption and life cycle costs to confirm cost effectiveness of the process. If this first phase is successful, a second phase will be considered to carry out pilot testing at one of Metro Vancouver WWTPs.

Action 3.2.3 - Undertake an annual internal audit of the best practices of one regional liquid waste management sub program and environmental management system to identify opportunities for innovation and improvements (<i>Annually</i>).
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In 2017 and 2018, Metro Vancouver reviewed and updated technical operating and maintenance procedures and critical information for key Liquid Waste Services infrastructure. This included the assessment of training needs, verification and update of equipment lists, capture of knowledge through interviews of experienced staff, review and optimization of operating and maintenance procedures. This work also included the development of technical training resources (on-line self-paced training modules, field guides, updated procedures) and the development of business processes for the ongoing development and upkeep of training materials and instructions for design and construction contractors to ensure that training materials for new facilities meet consistent standards and format.

In 2018, a business process review of the Annual Sewer Pipe Inspection program commenced. Initial work included the assembly of a cross-functional continuous improvement (CI) work team, and training of the work team on continuous improvement principles and practices and the application of these. This CI work team collected and reviewed information on the current “as-is” inspection practices. Program challenges were identified and list of causes and effects gathered. Potential solutions were identified and evaluated. This review will be completed in 2019.

In 2018, a business process review of the Technical Knowledge Management Program commenced, specifically focused on the model adopted for the delivery of technical knowledge. Initial work included staff interviews to collect information regarding the process for developing technical knowledge content

and the processes and tools used to deliver technical knowledge content to staff. This review will be completed in 2019.

Strategy 3.3: Monitor the performance of the liquid waste system and impacts on the receiving environment

Action 3.3.1 - Continue to monitor the ambient environment conditions of relevant water bodies in the region in conformance with the Canada-wide Strategy for the Management of Municipal Wastewater Effluent (CWS-MMWE) requirements, and work with the Ministry of Environment in developing Environmental Quality Objectives (*Ongoing*).

In 2017 and 2018, Metro Vancouver conducted ambient environment monitoring of water bodies that may be influenced by the liquid waste discharges in the region (refer to Ministerial Condition 6 for details). The results of these monitoring programs were shared with the BC Ministry of Environment and Climate Change Strategy with other members of Metro Vancouver's Environmental Monitoring Committee on an ongoing basis. The information that may be pertinent for development of environmental quality objectives was made available to the regulatory agencies mandated with development of Provincial environmental quality objectives.

Action 3.3.2 - Continue to monitor the quality and characteristics of Metro Vancouver's liquid waste point discharge to the environment in conformance with the Canada-wide Strategy for the Management of Municipal Wastewater Effluent (CWS-MMWE) requirements to meet Environmental Discharge Objectives (*Ongoing*).

The Environmental Management and Quality Control Annual Report summarizes the regulatory and process monitoring information through the programs in place at Metro Vancouver. The Annual Report for 2017 is available on Metro Vancouver's website: <http://www.metrovancouver.org/services/liquid-waste/LiquidWastePublications/2017GVSD-EMQCAAnnualReport.pdf>. The 2018 Annual Report is being prepared in the summer of 2019.

Action 3.3.3 - Continue to operate its regional data collection network for sewers, rainfall and streams and use that data to assess the effectiveness of actions taken under this plan (*Ongoing*).

The location of Metro Vancouver's sewer flow meters, stream gauges and rain gauges are shown on Figure 8 to Figure 13.

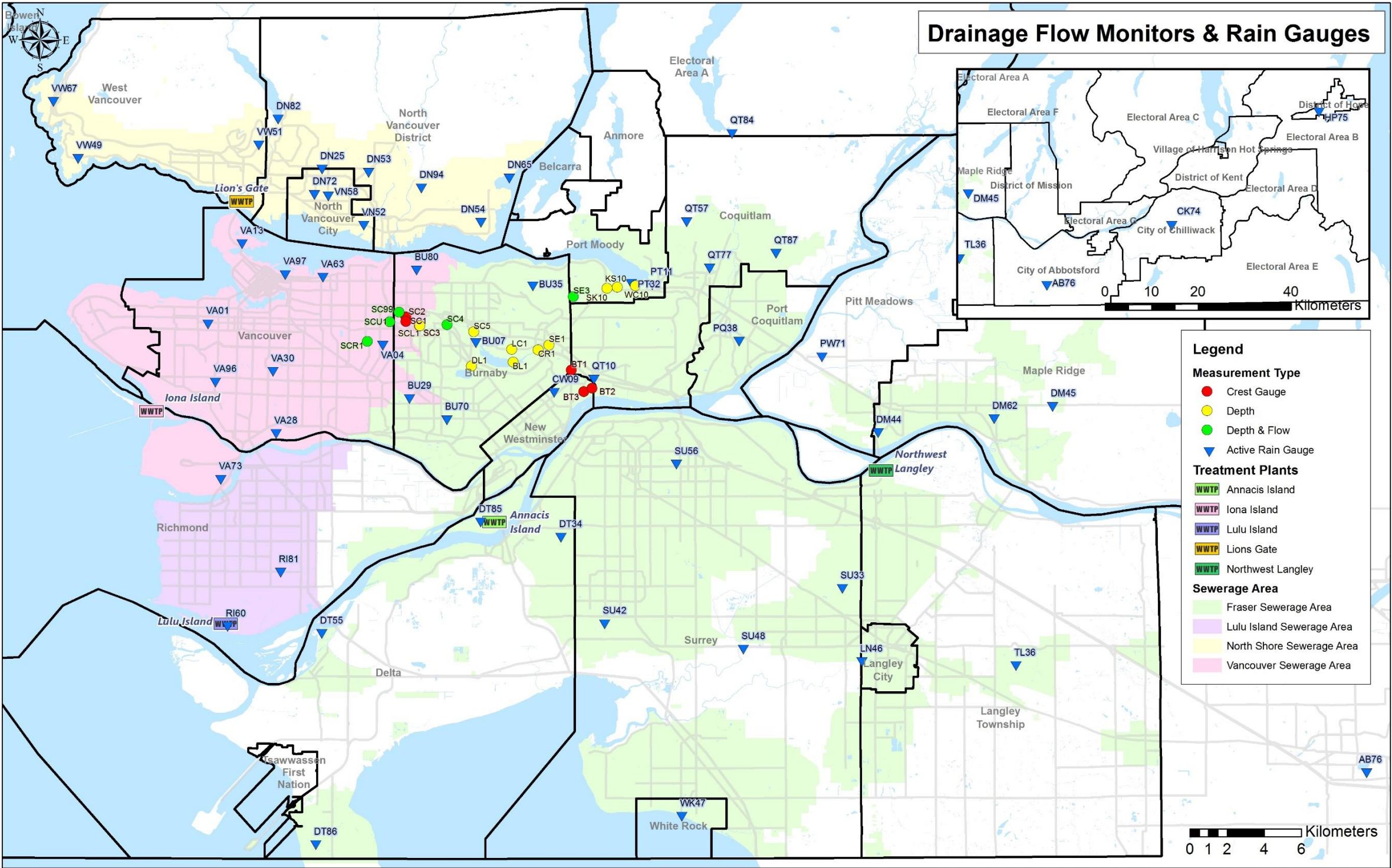


Figure 8 Sewer and Drainage Monitoring Sites – Metro Vancouver Rain Gauge Network

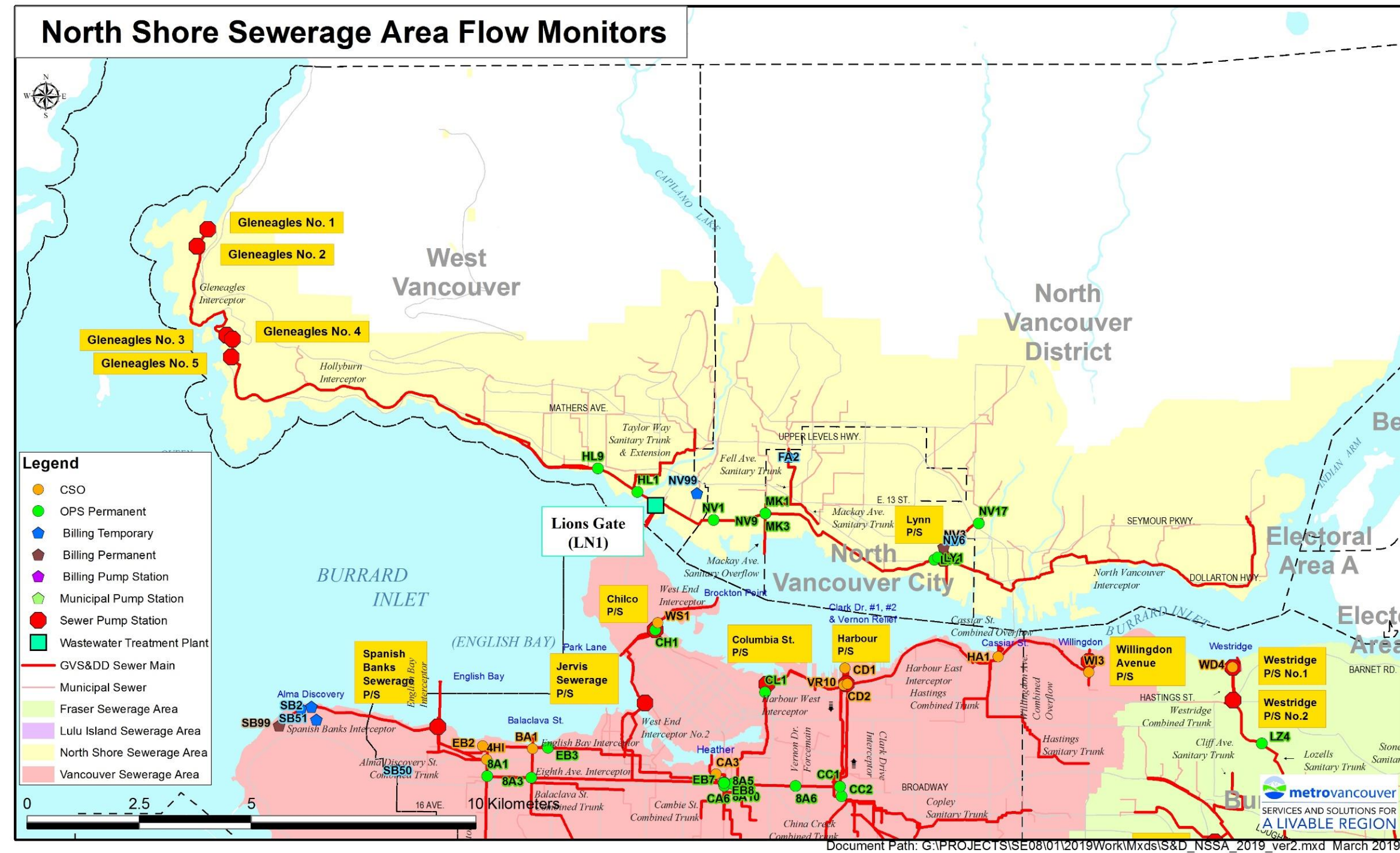


Figure 9 Sewer and Drainage Monitoring Sites - North Shore

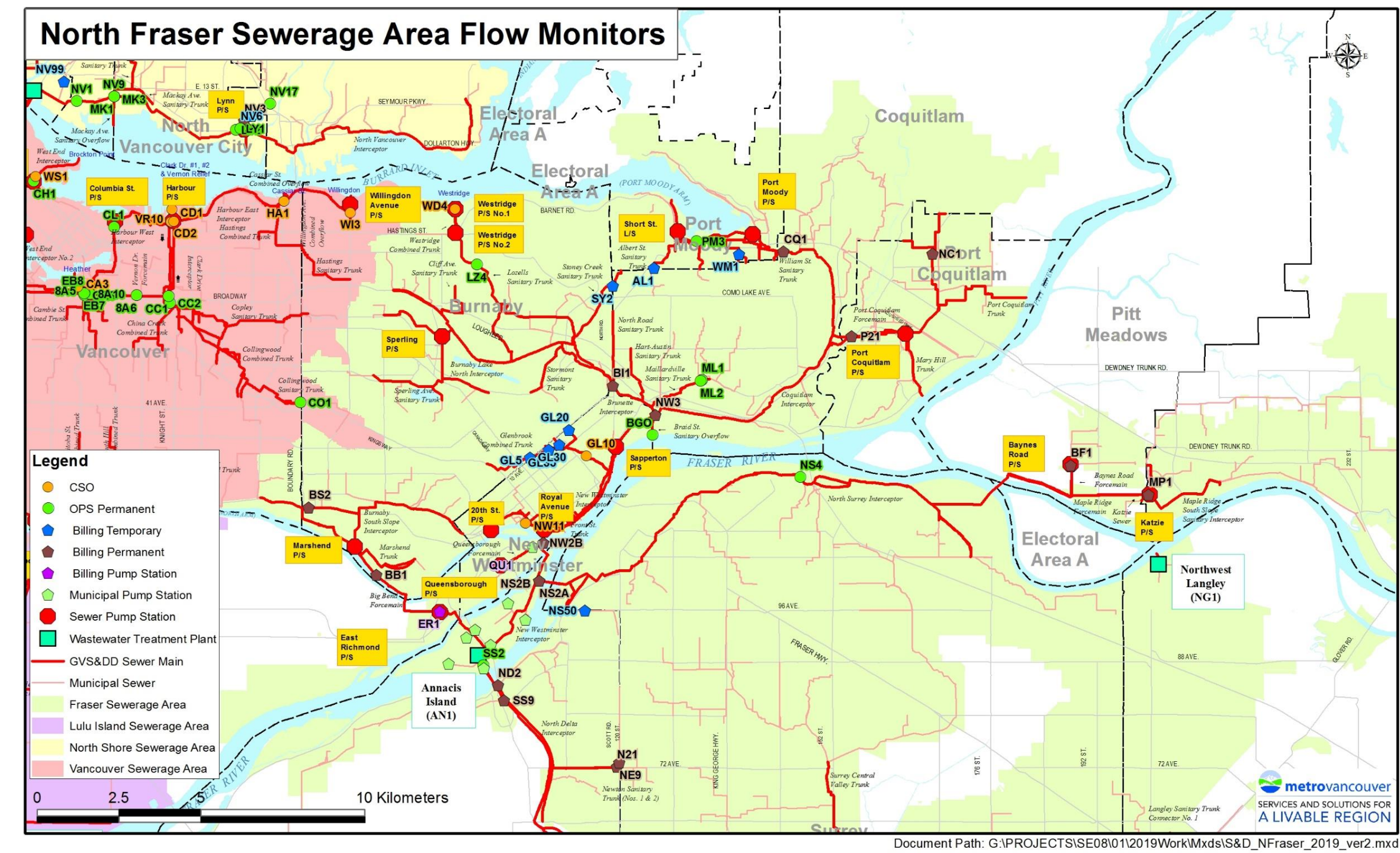


Figure 10 Sewer and Drainage Monitoring Sites – North Fraser

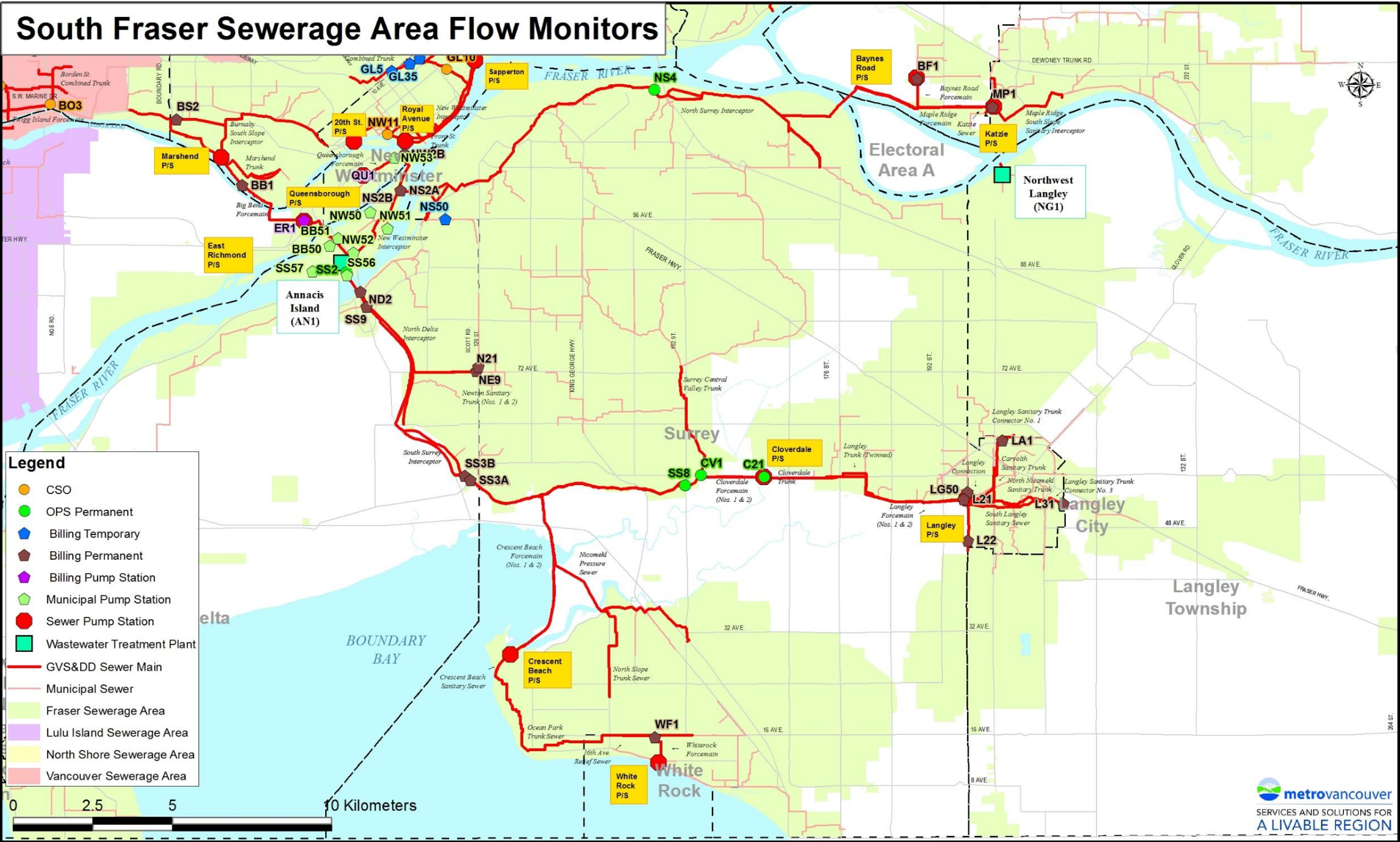


Figure 11 Sewer and Drainage Monitoring Sites – South Fraser

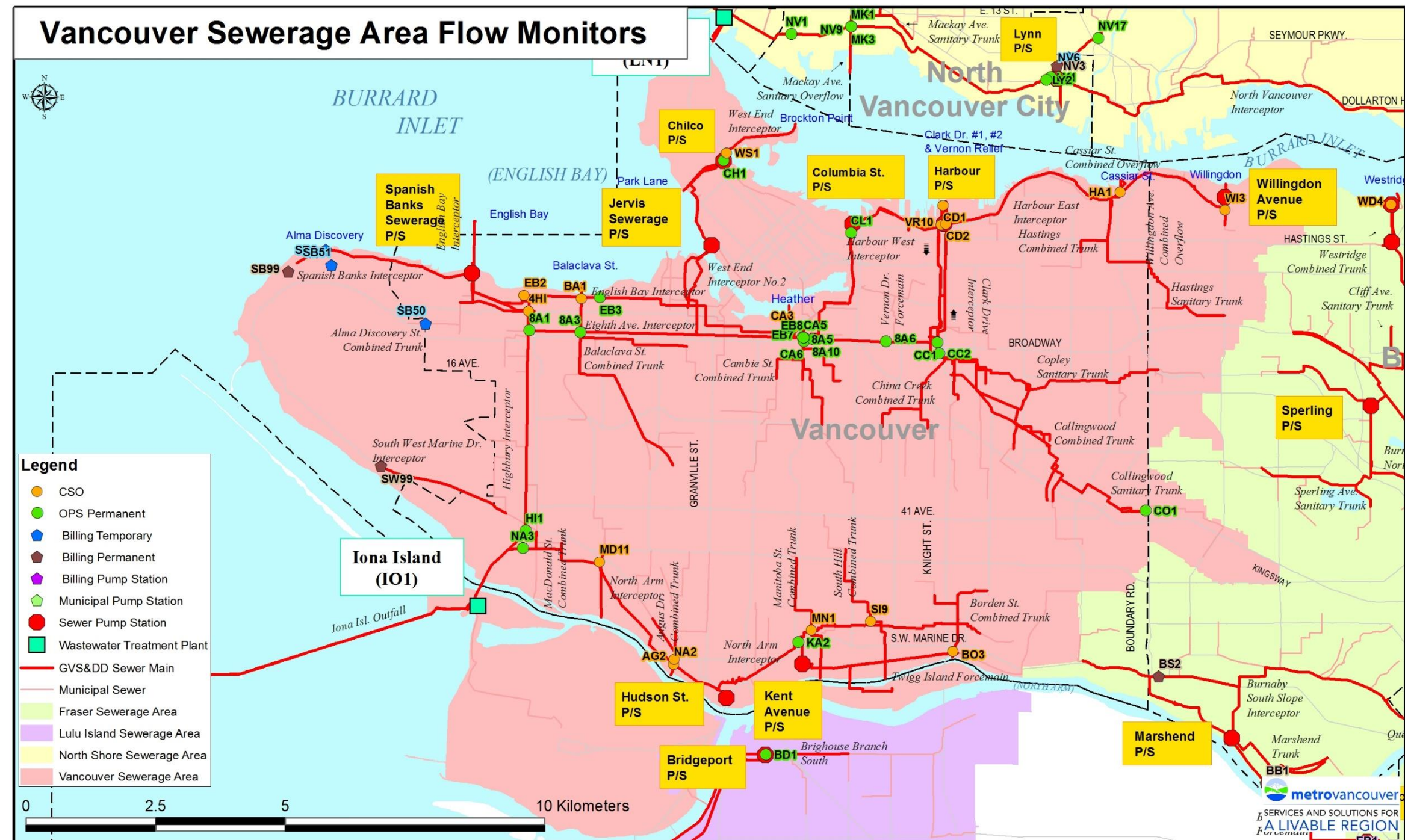


Figure 12 Sewer and Drainage Monitoring Sites - Vancouver

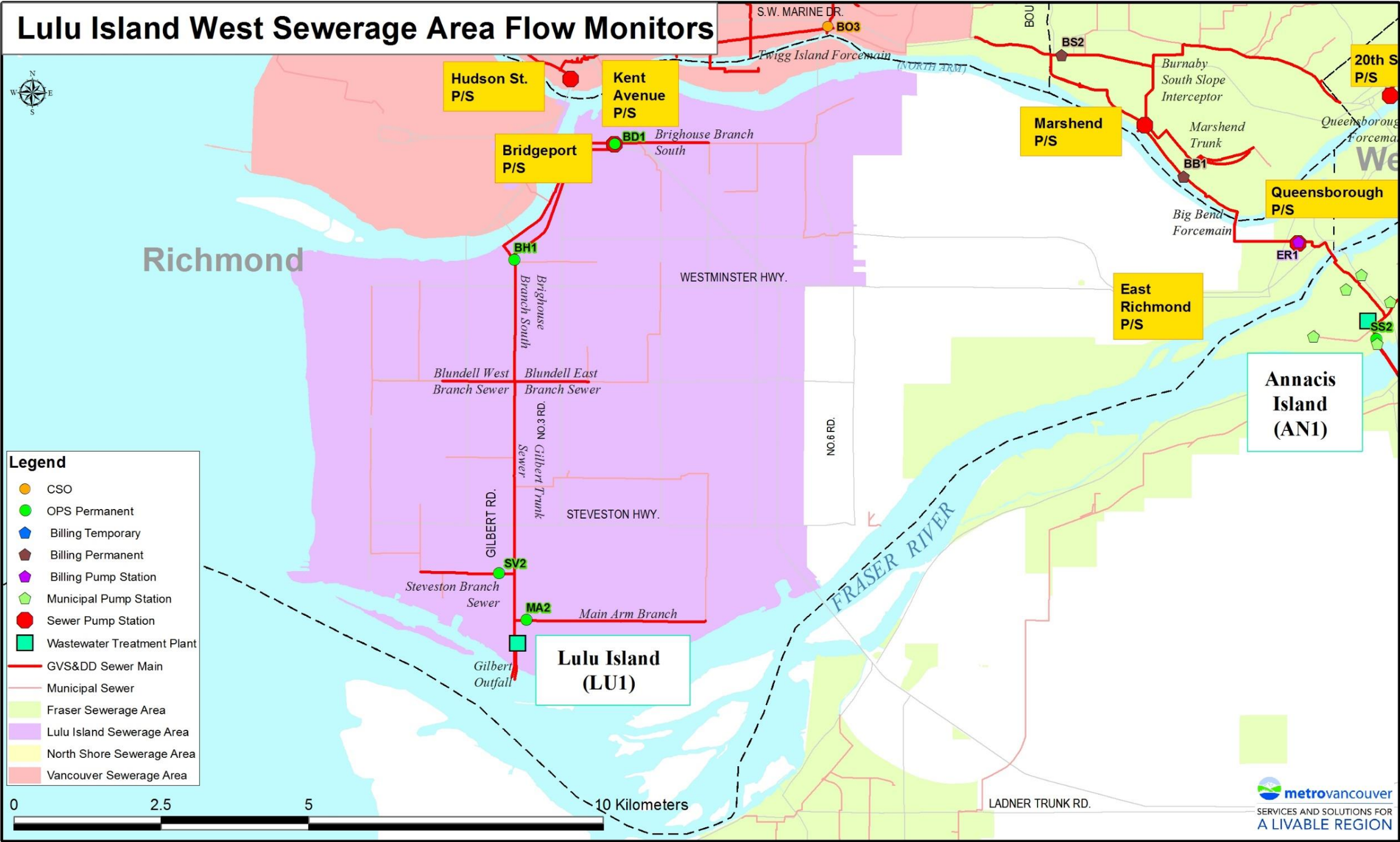


Figure 13 Sewer and Drainage Monitoring Sites – Lulu Island

Action 3.3.4 - In collaboration with municipalities, estimate and document the greenhouse gas emissions and odours associated with the operation of the municipal and regional liquid waste management systems, see Actions 1.3.8, 1.3.10, 1.3.15, and 1.3.17 (2012).

Liquid Waste management-related greenhouse gas emissions and energy use in 2017 and 2018 are shown in Table 7 and Table 8, respectively. Hauling and fleet data is now included.

Table 7 Liquid Waste Greenhouse Gas Emissions 2017-2018 (Tonnes of CO₂e)

Location	2017	2018
Annacis Island WWTP	652	727
Iona Island WWTP	233	393
Lulu Island WWTP	192	184
Lions Gate WWTP	260	260
Northwest Langley WWTP	53	49
Residuals	2,246	4,959
Collections System	251	247
Fleet	844	891
TOTAL	4,730	7,710

Table 8 Estimates of Annual Energy Use (GJ)

Location	Energy Use: Purchased and Self-generated	
	2017	2018
Annacis Island WWTP	419,112	380,598
Iona Island WWTP	226,997	231,871
Lulu Island WWTP	82,520	75,667
Lions Gate WWTP	50,281	52,274
Northwest Langley WWTP	17,876	16,518
Residuals	32,675	70,694
Collections System	84,529	83,237
Fleet	12,526	13,353
TOTAL	926,516	924,212

Action 3.3.5 - Estimate and report on the frequency, location and volume of sewerage overflows from regional combined and sanitary sewers, and where feasible identify and address the probable causes (*Ongoing*).

Metro Vancouver has developed public awareness material and is participating in a national initiative to control the production of pump clogging materials that are being flushed into the sewerage system.

During the 2017-2018 period there were a total of 132 SSOs, 92 wet weather related SSOs and 40 dry weather SSOs. The locations and details of the overflows are provided in Figure 17 through Figure 20, pages 78 to 81 of this report.

Strategy 3.4: Provide resilient infrastructure to address risk and long-term needs

Action 3.4.1 - Design and adapt infrastructure and operations to address identified risks and long-term needs, including risks associated with climate change (*Ongoing*).

Climate Change Risk

In 2018, Metro Vancouver completed a study of the impacts of climate change on precipitation and stormwater in the region. The study considered various sources of uncertainty in future climate projections to develop future rainfall intensity-duration-frequency (IDF) curves to the end of this century for moderate (likely) and high change (conservative) scenarios. Three case studies analyzed the potential effects of the projected future rainfall increases on Metro Vancouver's sewerage and drainage functions. The new future IDF curves are being adopted by Metro Vancouver for planning and design and have been shared with member jurisdictions. The planning and design of the new AIWWTP outfall have taken future sea level rise into account. Similarly, construction of the Highbury Interceptor Air Management Facility will adhere to the local 1:200 future flood construction level. Measures for other facilities will be determined on a case by case basis.

Seismic Risk

Metro Vancouver considers seismic resiliency and the post-disaster performance needs of its wastewater collection and treatment facilities as part of new designs and its facility planning. In 2018, the "Seismic Risk Action Plan for Liquid Waste Services" was completed. This study builds upon previous work and informs the understanding and the consideration of seismic risks in Liquid Waste Services' capital plan process. For example, new Sperling and Sapperton Pump Stations are currently under construction and include seismic upgrades. The Stage 5 expansion at the Annacis Island WWTP is designed as a post seismic disaster structure as per the National Building code of Canada. The North Shore Secondary WWTP and the new Hollyburn Pump Station are also designed as post seismic disaster structures.

Action 3.4.2 - In collaboration with municipalities and the Integrated Partnership for Regional Emergency Management (IPREM), develop emergency management strategies and response plans for municipal and regional wastewater collection and treatment systems, including identifying and maintaining a system of emergency wastewater overflow locations (2015).

Work continued on the development of operational level communications and decision making guideline for regional water and liquid waste services (the regional Utility Operational Coordination Guide or OCG). Review by the Regional Engineers Advisory Committee (REAC) and the Medical Health Authority was completed in 2017. The OCG was tested through an exercise involving the Water Subcommittee of REAC. The OCG was subsequently updated based on feedback from that exercise and adopted by REAC. Final adoption of the OCG by the Regional Administrators Advisory Committee (RAAC) will occur following a large scale exercise involving all Metro Vancouver services and all regional municipalities. Planning for this exercise, scheduled to take place in Fall/Winter 2019, commenced in 2018.

Action 3.4.3 - Ensure liquid waste infrastructure and services are provided in accordance with the Regional Growth Strategy and coordinated with municipal Official Community Plans (Ongoing).

Metro Vancouver 2040: Shaping our Future (Metro 2040), the regional growth strategy, was adopted by the Metro Vancouver Board as Bylaw 1136 on July 29, 2011 following unanimous approval by members. Under *Metro 2040* Strategy 1.1, Contain Urban Development within the Urban Containment Boundary, *Metro 2040* policy is to not extend regional sewerage services into lands designated Rural, Agricultural or Conservation / Recreation unless particular public health or environmental exceptions are met. Procedural guidelines “Metro 2040, Implementation Guideline #7” have been established for Metro Vancouver departments to coordinate the review of sewerage extension applications. This aligns the ILWRMP and GVS&DD servicing with *Metro 2040*. Refer to Figure 14 on page 53.

Strategy 3.5: Use collaborative management to address evolving needs

Action 3.5.1 - Establish a new overarching committee, the Integrated Utility Management Advisory Committee (IUMAC), to advise Metro Vancouver on plan implementation, particularly from the perspectives of integrated planning and resource recovery across utility systems (2010).

Refer to the 2013-2014 Biennial Report.

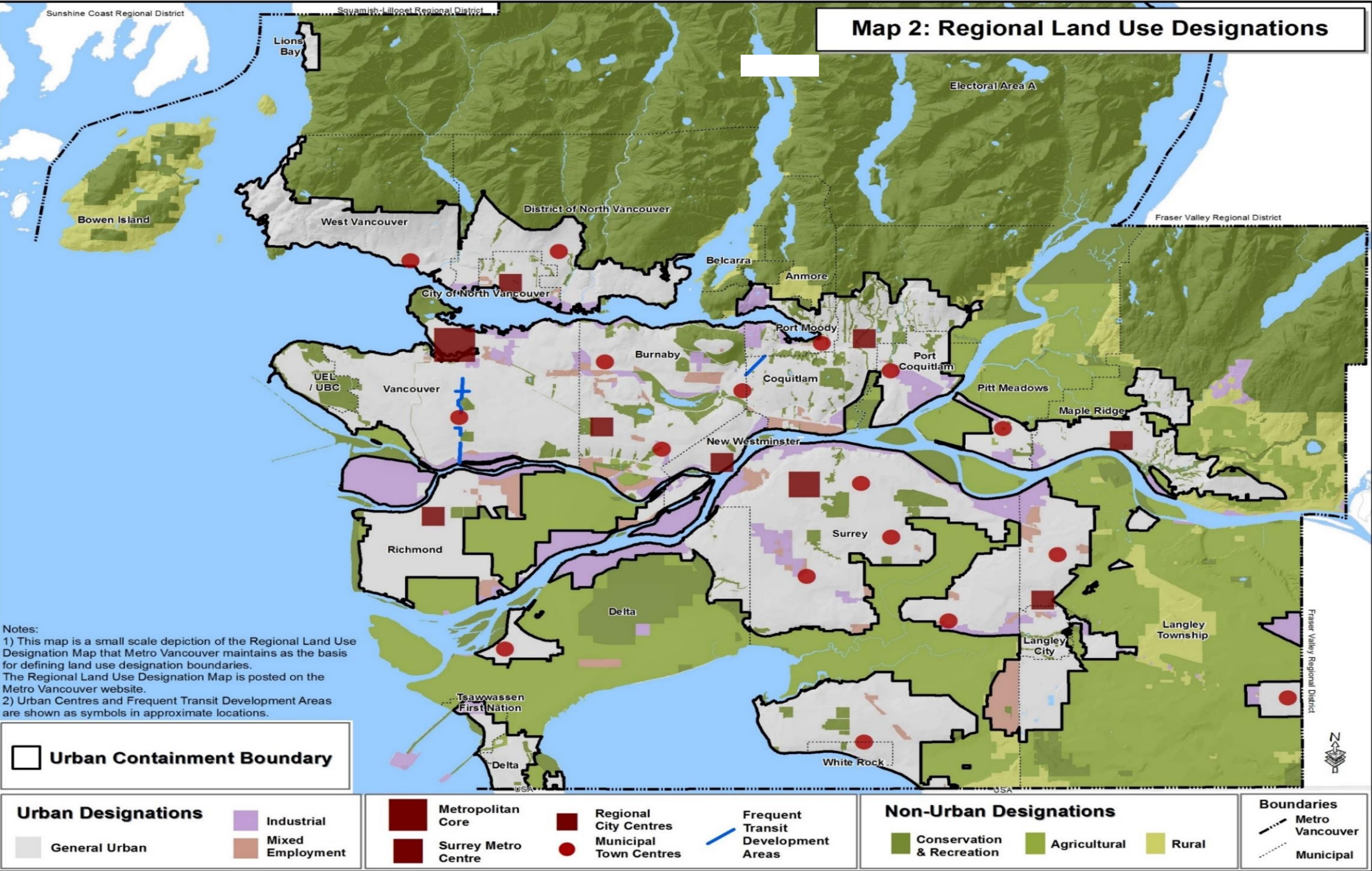


Figure 14 RGS Urban Containment Boundary

Action 3.5.2 - Continue to receive advice from the Environmental Monitoring Committee (EMC) and Stormwater Interagency Liaison Group (SILG) as subcommittees under IUMAC (*Ongoing*).

The EMC and SILG continued to meet regularly in 2017 and 2018. Major EMC activities included discussions associated with:

- The ongoing review of the ambient, receiving environment, and recreational water quality monitoring programs, and the new approaches to environmental monitoring in the region;
- The development of the EDOs associated with the Iona Island WWTP upgrade;
- The impacts of the Wastewater Systems Effluent Regulations on Metro Vancouver;
- The updates on the status of the new North Shore WWTP, and Iona Island WWTP Upgrade;
- Wastewater characterization studies;
- Strategy for Contaminants of Emerging Concern;
- The results of the sediment surveys in the vicinity of the selected CSO outfalls;
- Fraser River Hydrodynamic Model for Effluent Transport and Fraser River salinity monitoring; and
- ILWRMP progress on CSO actions.

Major SILG activities for this reporting period included discussions on:

- Overland drainage and delineation of catchment areas;
- Green infrastructure initiative;
- Land cover, mapping ecosystem services and ecosystem health;
- Advancing MV's sustainability goals and Grow Green initiative;
- Single family residences source control;
- Storm management using biosolids growing medium;
- Stormwater tree trench initiative;
- Rainwater reuse challenges;
- Implementation of the ISMPs, Stormwater Monitoring and Adaptive Management Framework and Region-wide Baseline for On-site Stormwater Management;

- Update to the Integrated Stormwater Management Plans (ISMP) Template and the future update to the Stormwater Source Control Design Guidelines;
- Climate change impacts on precipitation and stormwater; and
- MV's Climate 2050 Discussion Paper.

In 2017, SILG also reviewed its Terms of Reference and elected a new Chair; while in 2018, the group held a workshop to develop a 5-year work plan.

Action 3.5.3 - Use the Burrard Inlet Environmental Action Program and the Fraser River Estuary Management Program Management Committee (BIEAP-FREMP) as the senior level forum for discussion of policy and assessment of the scientific work related to the plan, and for resolving toxicity concerns and any disputes among its members related to implementing the Plan (*Ongoing*).

BIEAP-FREMP was dissolved in March 2013; see previous biennial report for context.

Action 3.5.4 - Biennially produce a progress report on plan implementation for the distribution to the Ministry of Environment that: (a) summarizes progress from the previous two years on plan implementation, for all Metro Vancouver actions, including the status of performance measures, (b) includes summaries and budget estimates for proposed LWMP implementation programs for the subsequent two calendar years (*By July 1st biennially*)

The first biennial report under the ILWRMP, covered the three-year period 2010-2012 to address the transition from the previous LWMP. Subsequent biennial reports under the ILWRM cover the period 2013-2014 and 2015-2016. This is the fourth biennial report under this plan and covers the period 2017-2018. A total of four biennial reports were produced under the previous LWMP that was approved in 2002.

Action 3.5.5 - Hold a public accountability session based on the biennial reports (Actions 3.5.4 and 3.5.8) by making the report available through Metro Vancouver's website and by holding a special meeting of the Metro Vancouver Waste Management Committee to receive public comments and input on the report (*Biennially*).

This action was completed in 2017.

Action 3.5.6 - Report directly to the Ministry of Environment annual progress on integrated stormwater management plan implementation and all occurrences of sanitary sewer overflows (*By March 1st annually*).

The latest annual report under the ILWRMP was submitted to the Ministry of Environment on March 1, 2018 as the Interim Report: 2017. It included a figure showing locations and volumes of all wet weather sanitary sewer overflows and municipal ISMP progress for 2017. The annual reporting for 2018 is included in this biennial report.

Action 3.5.7 – In collaboration with members and the Ministry of Environment, undertake a comprehensive review and update of the Plan on an eight-year cycle (Every eight years).

As the ILWRMP was approved in 2011, the review cycle requires a comprehensive review of the plan in 2019. However, at their September 28, 2018 meeting, the GVS&DD Board resolved that the Minister of Environment and Climate Change Strategy be asked to extend the review cycle by two years to 2021. This will allow the review and updating of the ILWRMP to align with regional initiatives either underway or planned for 2019-2020. These initiatives address the secondary treatment upgrades to the Iona Island Wastewater Treatment Plant, sewer overflow reduction and actions on climate change. The request is with the Ministry of Environment and Climate Change Strategy.

Ministerial Conditions

Ministerial Condition 1 – The ministry supports upgrading to secondary level treatment the Lions Gate Wastewater Treatment Plant by 2020 and Iona Island Wastewater Treatment Plant as soon as possible, but no later than 2030 and not contingent on the availability of senior government funding. The Ministry of Environment is not a funding agency. While I understand the cost of the upgrades is significant, they are necessary to meet current environmental standards. The Ministry will support Metro Vancouver pursuing senior government and alternative funding options, but cannot guarantee any provincial commitment in that regard, nor compromise the Ministry's mandate to protect the environment.

In support of the upgrades to secondary wastewater treatment for the Lions Gate Wastewater Treatment Plant, Metro Vancouver has received \$212.3 million in grant funding from the federal government and \$193 million in grant funding from the provincial government. These funds are being applied to the plant's replacement, the new North Shore Wastewater Treatment Plant, which is currently in the design and construction phase. The total budget for this work is \$778 million which includes construction of the new secondary wastewater treatment plant, conveyance works and decommissioning of the existing Lions Gate plant.

Ministerial Condition 4 - Metro Vancouver must use receiving environmental and effluent monitoring data from combined sewer overflow (CSO) and sanitary sewer overflow (SSO) in the regional system to interpret the overall status of CSOs and SSOs. Metro Vancouver will continue the fate and effects studies on CSOs with the Clark Drive location and other significant sites as determined by the Environmental Management Committee. Metro Vancouver will establish similar studies representative of significant SSO locations, in particular the Cloverdale, Katzie and Lynn locations. The interpretation and assessment should demonstrate whether there has been any improvement or degradation along with any measures taken to address such discharges. Metro Vancouver will report out in the Quality Control Annual Report.

Sanitary Sewer Overflows

In 2017, risk assessments were completed for Braid Street Outfall, Mackay Avenue Outfall and Hollyburn/Bellevue Avenue at 15th Street SSOs. Results are reported in the 2017 EMQC Annual Report, which is available on the Metro Vancouver website: <http://www.metrovancouver.org/services/liquid-waste/LiquidWastePublications/2017GVSD-EMQCAnnualReport.pdf>. This completes the risk assessments for significant SSO sites and as such, annual SSO characterization monitoring has been discontinued.

However, Metro Vancouver continues to conduct receiving environment water quality monitoring following each SSO event. Receiving environment water quality data, observations and impact assessments are provided to regulatory agencies and municipalities in end-of-spill reports that include information on SSO location, date and time (start/end), duration, volume, estimated cause, immediate actions taken to minimize duration of the SSO and mitigate the impact, and planned long-term actions to eliminate it.

Combined Sewer Overflows

The CSO Receiving Environment Monitoring Program includes determination of receiving environment water quality; sediment monitoring, chemical analysis and toxicity testing; and benthic invertebrate community structure assessments. In 2017 and 2018, Metro Vancouver completed receiving environment effects surveys for the Balaclava, Cassiar, Manitoba and Clark Drive CSOs, substantially completed work for the Angus and Glenbrook CSOs and initiated work for English Bay and Borden CSOs. Findings of the Balaclava, Cassiar, Manitoba and Clark Drive CSOs were presented to the EMC and results are reported in the EMQC Annual Reports. The 2017 report is available on the Metro Vancouver website at <http://www.metrovancouver.org/services/liquid-waste/LiquidWastePublications/2017GVSD-EMQCAnnualReport.pdf>. The 2018 report will be posted when complete.

The Angus and Glenbrook CSO report is in preparation, and field work is complete for English Bay and Borden CSOs. Metro Vancouver's CSO discharge monitoring and characterization work is discussed under Ministerial Condition 6.

Ministerial Condition 5 – Metro Vancouver is encouraged to continue to build upon previous studies associated with studying endocrine-disrupting chemicals, persistent organic pollutants and other micro-contaminants found in the wastewater by developing source control initiatives through education (for example, target outreach), regulation and inspection programs.

Please refer to sections 1.1.1 and 1.1.5 of this report.

In 2017, Metro Vancouver provided commentary on the BC Medications Return Program Plan submitted by Health Products Stewardship Association (HSPA) to the Ministry as part of the provincial Extended Producer Responsibility (EPR) program. This commentary sought to ensure that the HSPA was placing emphasis on medications disposed of through the liquid waste (wastewater) system as well as the solid waste system. As used medications are a part of an EPR program, it is essential that the producers take responsibility for ensuring their safe disposal – and for educating the public about their options for disposal.

Ministerial Condition 6 – Metro Vancouver will continue the receiving and ambient monitoring programs specified in the approved 2002 LWMP, including, but not limited to, recreational water quality (beach monitoring); monitoring near the outfalls for all five wastewater treatment plants, including the extensive deep sea monitoring near the Iona Island plant; and CSO effluent quality and monitoring of small urban streams relating to impacts from urbanization and stormwater.

Environmental Monitoring Programs

Metro Vancouver conducts receiving and ambient environment monitoring programs in areas where water quality has the potential to be affected by wastewater and stormwater discharges. The information and data collected from the monitoring work are used to provide baseline environmental quality data, determine whether the discharges meet water quality guidelines and site-specific objectives, develop indicators of environmental change, characterize changes in environmental quality, and evaluate trends within the monitoring areas over time.

Metro Vancouver has established receiving environment monitoring (REM) programs for Iona, Lions Gate and Annacis WWTPs and ambient monitoring programs for the water bodies into which they discharge: the southern portion of the Strait of Georgia, Burrard Inlet and the lower Fraser River, respectively. Although there are no WWTP discharges to Boundary Bay, Metro Vancouver monitors Boundary Bay.

Additional receiving environment programs include recreational water quality monitoring and monitoring in the vicinity of SSO and selected CSO discharge points. In addition, monitoring is done to characterize the discharge quality of combined sewer overflows.

In 2017 and 2018, additional monitoring has also been carried out in support of the Annacis Island and Northwest Langley WWTP upgrades, which will also enhance existing, and provide a basis, for new environmental monitoring programs.

Ambient Environment Monitoring

The Strait of Georgia ambient environment monitoring program is currently being conducted in partnership with the University of British Columbia (UBC) Department of Earth, Ocean and Atmospheric Sciences under a five-year Natural Science and Engineering Research Council of Canada (NSERC) Collaborative Research and Development (CRD) grant awarded in the summer of 2016. The five-year program's objective is to understand the scale of Metro Vancouver's Iona WWTP marine outfall footprints, and pathways, cycling, fate and variability of organics and selected metals.

The Fraser River, Burrard Inlet, and Boundary Bay ambient environment monitoring programs are intended to evaluate the effects of point and non-point source discharges in the Region to receiving water bodies. Each program operates on a five-year cycle and consists of water column monitoring every year, sediment monitoring every two to five years and biota monitoring approximately every five years. A review of each program is carried out on a five-year cycle. Monitoring results are compared to applicable environmental criteria. The plans and results of all monitoring programs are regularly discussed by the Environmental Monitoring Committee.

Metro Vancouver is reviewing its Receiving Environment Monitoring (REM) and ambient monitoring Programs and re-designing these programs to refine/improve sampling methodology as well as to identify efficiencies from conducting them as amalgamated programs. This will allow for a more holistic water body approach, and has already begun for Burrard Inlet in 2018. In Burrard Inlet, the Ambient Monitoring Programs for the water column and sediment quality have been fully incorporated into the Initial Dilution Zone Boundary water column and the Sediment Effects Survey for the Lions Gate REM program, respectively. As the Burrard Inlet-Lions Gate amalgamated environmental monitoring programs are undertaken and evaluated, wider efforts will include similar efforts for the environmental monitoring programs in the Strait of Georgia and the Fraser River. Table 9 outlines the work completed in 2017 and 2018 for Metro Vancouver's receiving and ambient environment monitoring programs.

Table 9 Environmental Monitoring Program

Program	Program Initiation	Ambient Environment Monitoring Programs (component conducted in each year)	
		2017	2018
Strait of Georgia	2004	Water-Iona REM IDZ	Water-Iona REM special study-in progress
		Sediment-Iona REM	Sediment-Iona REM – in progress
		Fish-Iona REM	Contaminant Dispersion and Removal–ambient-
		Contaminant Dispersion and	in progress
		Removal-ambient	

Fraser River	2003	Water-ambient Water-Annacis REM IDZ (winter, summer) Sediment-Northwest Langley - REM Pilot phase 1	Water-ambient Water-Annacis REM IDZ (winter, summer) Sediment-Annacis REM – in progress Fish-Fraser WWTPs REM and ambient amalgamated –in progress Water - Northwest Langley - ambient water (summer) Sediment - Northwest Langley - REM Pilot phase 2 - in progress
Burrard Inlet	2007	Water-Pilot near-field plume study Water-Lions Gate REM IDZ Sediment-Lions Gate REM Fish-ambient and REM amalgamated - in progress	Water-REM and ambient amalgamated – in progress Sediment-REM and ambient amalgamated – in progress

Strait of Georgia Ambient Monitoring

Iona Deep-Sea Outfall Receiving Environment Monitoring Program

Metro Vancouver continued with its annual water-column monitoring of the regulatory initial dilution zone (IDZ) boundary as a component of the overall environmental monitoring program for the Iona Deep-Sea Outfall. The purpose of the monitoring program is to establish compliance with water quality guidelines at the boundary of the IDZ. Currently, there are no site-specific objectives available for the Strait of Georgia, and the BC Water Quality Guidelines apply.

In 2017, all parameters at the IDZ boundary met the applicable water quality guidelines with the exception of dissolved oxygen and total boron. The 30-day average dissolved oxygen concentrations at both the reference area and IDZ boundary were below the minimum guideline of 8 mg/L, which is a reflection of lower oxygen concentrations in deep water rather than a result of the Iona effluent discharge. Total boron concentration in samples from both the IDZ boundary and the reference area were above the guideline, and representative of the coastal marine environment. The Iona effluent boron concentration met the guidelines.

The 2018 IDZ monitoring program was conducted in the form of a special effluent plume characterization study. The 2018 report is in progress.

For sediment, in 2017, water quality near the sediment surface (bottom-water) was within average ranges for coastal marine environments. Sediment chemistry values were mostly below provincial and federal guidelines for the protection of aquatic life. The noted exceedances of metals included arsenic, copper, and nickel; however, these metals were also above guidelines at the prescribed reference sites. Only selected organic substances exceeded guidelines, often with no consistent relationship to the Iona discharge. Sediment biotic indicators of organic enrichment have shown some changes at the near-field stations. As in previous years, the changes in the benthic infaunal community were predominantly driven by the prevalence of opportunistic polychaetes and the absence of one organism sensitive to disturbance at stations close to the outfall. Further monitoring of the area will provide additional

information to help determine significance of these observations, and if they are solely outfall related, are due to short or long-term changes in oceanographic conditions, or due to a combination of these or other factors. The 2018 report is in progress.

Continued effort has been devoted to qualify the underlying circulation and mixing in the Strait and the dispersion of Fraser River fresh water and suspended particles. The surface and near surface water properties (temperature, salinity, chlorophyll) in the southern Strait of Georgia are strongly influenced by the Fraser River plume. Both in and out of plume water properties and timing of the spring bloom established since 2003 have been updated to include the latest data set. Long-term trends of intermediate and deep-water properties (temperature, salinity, dissolved oxygen) of the Strait of Georgia have also been extended using the latest archival data. In general, observed long-term changes are small compared to seasonal and inter-annual variability. Mean temperature rose considerably in 2015 at both intermediate and deep waters. Deep water oxygen levels reached significantly lower levels in early 2015, and may not have returned to normal in 2017, based on long term records from Ocean Networks Canada's (ONC) instrument moorings.

In 2017, Polybrominated Diphenyl Ethers (PBDE) samples were collected in February, May and September at various depths in the southern Strait of Georgia. The dissolved PBDE concentrations for all the congeners measured in the Strait of Georgia are below the federal water quality guidelines for the ambient environment. Measurements so far indicate that Iona outfall is not a major direct point source of dissolved PBDEs. However, similarity of the PBDE congener distribution in particles collected in the Iona plume and in sediment samples suggests that Iona could be one of the sources of particulate. PBDE Samples were also collected in Juan de Fuca Strait for the estimation of export of dissolved PBDE and in the Fraser River for the calculation of dissolved and particulate PBDE input into the strait of Georgia. Modelling continued in 2017 to assess the mass balance and relative importance of Iona outfall on the PBDE load in the Strait of Georgia water. The Polychlorinated Biphenyls (PCB's) seawater concentration data collected so far suggests that they are mainly added in dissolved form from localized legacy contamination or from the atmosphere.

The total cadmium concentration in Iona effluent is found to be similar to the dissolved cadmium concentration in the incoming Pacific water. The measured surface dissolved copper concentrations in the Strait of Georgia in 2017 are comparable with other populated coastal areas, and about 10 times higher than open oceans. Both dissolved cadmium and copper concentrations measured in the water column of the Strait are below the Approved BC Water Quality Guidelines. Despite the increased use of nano-silver as antimicrobial, no silver concentration increase has been observed in Iona effluent. The silver concentrations measured in the strait is very low, about 3 orders of magnitude lower than the Approved BC Water Quality Guidelines. Work is underway to determine trace metal concentrations in pelagic organisms from the Strait of Georgia food web. Initial tests have been conducted to quantify uptake of dissolved silver by marine phytoplankton and zooplankton. The 2018 report is in progress.

Fraser River Ambient Monitoring

Receiving Environment Monitoring Program for Metro Vancouver's Fraser River Wastewater Treatment Plants

Metro Vancouver continued its annual water-column monitoring of the regulatory IDZ boundary as a component of the receiving environment monitoring program for Metro Vancouver's secondary wastewater treatment plants discharging into the lower Fraser River. The objective of this monitoring is to assess compliance with applicable water quality guidelines and site-specific objectives.

Monitoring is focused at the Annacis Island WWTP outfall, as the previous attempts to monitor the receiving environment near the Lulu Island and NW Langley WWTPs were unsuccessful due to the highly transient nature of their outfall discharge plumes. The Annacis effluent discharge rate is substantially greater than either the Lulu Island or Northwest Langley WWTPs; consequently, indicators of potential effects, if present, would likely be detected first in the Annacis Island WWTP receiving environment. A pilot study was undertaken in 2014-2015 at the Lulu Island WWTP outfall and in 2017–2018 a pilot water and sediment study was initiated at the Northwest Langley WWTP outfall.

At the Annacis Island WWTP, water samples are collected in winter during low river flows from within the effluent plume at the boundary of the IDZ as well as three reference stations upstream of the Fraser River trifurcation near the SkyTrain Bridge in New Westminster. In 2017 and 2018, monitoring was also conducted in the late summer to assess the level of effluent disinfection. In 2017, all parameters at the IDZ boundary met the applicable Fraser River objectives, and where comparison with provincial and federal guidelines was possible, the guidelines were met, except for un-ionized ammonia concentrations in several samples collected from the IDZ boundary during three of the five weeks were above the 16-µg/L CCME guideline. However, ammonia concentrations met the corresponding Fraser River Water Quality Objective for total ammonia for all samples in each weekly event. There were no upward or downward temporal trends in water quality at the IDZ boundary of the Annacis Island Outfall. The 2018 report is in progress.

In 2018, a sediment monitoring study was carried out in the Fraser River in the vicinity of the proposed Annacis Island Stage V Outfall. The purpose was to improve the spatial resolution of pre-construction baseline sediment data, collected in 2016 and 2017, in areas surrounding the proposed outfall and to inform design of the post outfall sediment monitoring program. Phase 1 consisted of collecting and characterizing 34 sediment samples (grain size, total organic carbon, and moisture content) in an area 500 m upstream and downstream of the proposed outfall. Grain size distributions were mapped to determine suitable sample locations, representative of sediments near the proposed outfall. Phase 2 consisted of collecting sediment samples from 11 locations, selected in Phase 1, for analyses of phase 1 parameters, as well as bacteria, conventional parameters, metals, and selected organics. Analytical results are pending.

In 2017 and 2018, a two phase sediment monitoring program in the vicinity of the Northwest Langley WWTP collected sediment samples within a zone of probable influence and analyzed for grain size to determine if fine sediment was present. A second survey sampled sediment locations with fine

sediment for additional analyses, and investigated additional locations. Water quality samples were also collected in a grid pattern to determine if the plume could be detected. The report is in progress.

In the summer of 2018, ambient water quality monitoring was conducted at two ambient monitoring sites immediately upstream (McMillan Island- Site 1) and immediately downstream (Barnston Island – Site 2) of the Northwest Langley Wastewater Treatment Plant (WWTP) with the objective to provide high river flow water quality data for studies related to upgrading the Northwest Langley WWTP. The data obtained will also provide pre-construction baseline data. The samples were analyzed for all parameters included in the Fraser River Ambient Monitoring Program, plus total and dissolved organic carbon, total mercury, methylmercury, and hexavalent chromium. The field program also included *in-situ* measurements of temperature, pH, conductivity, salinity, dissolved oxygen and turbidity.

Water quality is monitored annually within one meter below surface at seven sites in the Fraser River within the geographic region of Metro Vancouver. Water samples are collected once a week for five consecutive weeks during the annual low flow period (February-March). Sediments are monitored at seven sites once in five years, and fish tissue and health are monitored approximately once in five years.

2017 and 2018 Fraser River Water Monitoring Results

The water quality and chemistry monitoring results were compared with applicable Fraser River Water Quality Objectives, BC Water Quality Guidelines, or Canadian Council of Ministers of the Environment (CCME) Canadian Environmental Quality Guidelines. Concentrations of all measured Fraser River water quality parameters met the applicable objectives or guidelines in 2017 and 2018, with the exception of total copper and total iron in 2017. 2017 mean concentrations of total copper near Sapperton Bar and Tilbury Island, were above the 30-day average objective, but were equal to the objective within the limits of analytical precision. 2017 total iron concentrations at Barnston Island and Tilbury Island were above the maximum guideline on one sampling day.

Spatial patterns have been relatively consistent over the 16-year period of the Fraser River Ambient Monitoring Program. Average concentrations for specific conductance, total ammonia, nitrate, fecal coliforms, total suspended solids, total phosphorus and total metals (copper, iron, zinc) increased from upstream to downstream.

No statistically significant temporal trends in ambient water quality were observed over the 16 years of ambient water quality monitoring, with the exception of total phosphorous and total copper. Total phosphorus concentration decreased significantly at the mouth of the North Arm near McDonald Slough (Site 7), but not at the other six monitoring stations. There were significant increases in total copper at Sites 1, 3 and 4, but not at Site 2. The lack of clear geographical pattern in copper trends makes it uncertain whether copper concentrations are actually increasing at one or more locations within the lower Fraser River.

For the 2018 Fraser River Fish Survey, the fish tissue program was modified to allow consideration of potential discharge effects, and as such included an REM aspect to the ambient program. In addition to the three sites historically monitored, the combined program now includes two sites downstream of the

Annacis Island and Northwest Langley WWTP outfalls. Five sites were monitored in the autumn of 2018: Upriver Reference, Northwest Langley WWTP exposure, Annacis WWTP exposure, Lulu WWTP exposure, and Downriver Reference (North Arm). The 2018 report is in preparation.

Burrard Inlet Ambient Monitoring

In 2018, Metro Vancouver started reviewing both the Lions Gate Outfall Receiving Environment Monitoring (REM) Program and the Burrard Inlet Ambient Monitoring Program (BIAMP) and will continue to amalgamate and fine-tune the programs in the coming years. The BIAMP was established in 2009 to monitor and assess the spatial and temporal differences in water, sediment, and fish tissue quality within Burrard Inlet. Several changes have already occurred and are outlined below.

Water sampling is done weekly for five consecutive weeks in October-November. Sediment quality is monitored every two to three years at the same seven sites in Burrard Inlet, sediment monitoring is continued in the amalgamated Lions Gate REM program. Fish tissue sampling is conducted every five years.

The Lions Gate REM programs continued through 2017 and 2018 with annual data collection for the IDZ and SES programs. Additionally, the Burrard Inlet Biota Monitoring Program, a portion of the BIAMP, was executed in 2017. Aside from the biota portion, the BIAMP ceased to exist in 2017. Through a detailed program review, components of the BIAMP Water Column and Sediment Monitoring Programs were amalgamated into the existing REM programs. This amalgamation was conducted in order to find efficiencies in sampling activities and data analysis, allowing potential effects of wastewater discharge to be assessed within the regional context of Burrard Inlet.

2017-2018 Burrard Inlet Water Column results:

The Burrard Inlet Ambient Monitoring Program - Water Column monitoring ceased to exist in 2017. Instead, funding for this program was re-allocated to fund a pilot study, conducted in conjunction with UBC's Earth and Ocean Sciences Department. The focus of the pilot study was to refine a new sampling methodology and data analysis techniques for water column monitoring in Burrard Inlet.

The new methodology employed a compact sea carousel integrated with a Conductivity-Temperature-Pressure (CTD) profiler. The previously developed methodology relied upon continuous measurements of Coloured Dissolved Organic Matter (CDOM) to determine plume presence and manually close water bottles based on real-time observations of CDOM and CTD profiles in the field at the initial dilution zone boundary of the Lions Gate outfall.

Review of the collected data found CDOM signatures related to the effluent plume but also found high CDOM values related to freshwater inputs from the Capilano River. Using salinity as a surrogate for freshwater CDOM inputs, a new metric termed CDOM Anomaly was created, allowing remnants of the effluent plume to be detected over 1000 m away from the outfall. However, these measurements could not be used to confirm the plumes presence in real-time.

In 2018, the sampling methods used during the 2017 pilot study were refined and an amalgamated water quality program was executed. The amalgamated program sampled all seven established Ambient Monitoring Program sites while also conducting detailed sampling at the Lions Gate IDZ boundary. All samples were collected on a single day in conjunction with continuous water column profiles. Multiple water grabs were also collected at various depths related to the effluent plume or the observed halocline.

The 2018 report is in preparation.

2017 to 2018 Burrard Inlet Fish and Sediment Monitoring

In September 2017, the third iteration of the Burrard Inlet Fish Biota Monitoring Program was initiated. This program was modified to focus on outfall effects, particularly human health risk. This included changing the timing of sampling from winter to summer, and adding replicate samples of edible English sole muscle tissue chemistry to allow for an assessment of individual variability. The 2017 report is in preparation. The program was executed in September 2017 and the report is in progress.

In 2018, the Burrard Inlet Sediment Monitoring program was absorbed into the larger Lions Gate REM Sediment Effects Survey. Three of the seven sites used in the Burrard Inlet program overlapped with the Lions Gate program; therefore, the four additional Ambient sites were collected during the course of the Lions Gate Sediment Effects Survey. This amalgamation, while ensuring a consistent suite of chemical parameters throughout Burrard Inlet, also allowed for the inclusion of additional analysis including benthic infauna. This is included in the 2018 Lions Gate REM Sediment Effects Survey Report, which is in preparation.

Lions Gate Outfall Receiving Environment Monitoring Program

The receiving environment monitoring program for Lions Gate includes annual water column and sediment effects monitoring.

2017-18 Initial Dilution Zone Boundary

As in prior years, water quality objectives and guidelines were met in 2017 at the Lions Gate initial dilution zone (IDZ) boundary with the exception of boron and dissolved oxygen which are also not met at the reference sites. Further, boron concentrations in the effluent met the guideline, and boron concentrations are typical of the coastal marine environment. Dissolved oxygen concentrations were intermittently below the Burrard Inlet water quality objectives at the IDZ and throughout Burrard Inlet. In terms of organic contaminants, permethrin was estimated to be equal to its CCME guideline on one of the five sampling days. This estimation was based on measured effluent concentrations multiplied by the observed dilution ratio.

The methodology used to monitor compliance with water quality objectives and guidelines at the IDZ boundary changed in 2018. As discussed above regarding the Burrard Inlet Ambient Monitoring Program, the two annual water column programs conducted by Metro Vancouver were amalgamated into a single program. This program, utilizing the previous discussed seacarousel, collected water column profiles and chemistry grabs throughout Burrard Inlet and at the IDZ boundary in November

2018. Sampling occurred five times within November, permitting the calculation of a 5-in-30 long-term average.

The 2018 report is in preparation.

2017/18 Sediment Effects Surveys

The 2017 Lions Gate Sediment Effects Survey showed similar findings to those observed in previous years. Most of the measured parameters were below established guidelines with the exception of Polycyclic Aromatic Hydrocarbons (PAHs). Several metals were consistently above guidelines as well including copper. The concentrations of various contaminants do not appear to be related to the Lions Gate discharge as reference sites to the west of Point Atkinson (outside of Burrard Inlet) consistently exceed guidelines. Furthermore, the patterns in sediment chemistry show no consistent association with changes in the benthic infaunal community.

Spatial patterns in the data remain elusive as confounding factors from the industrial activities within Burrard Inlet, natural runoff from the north shore mountains, and urban runoff from the larger region obscure any potential for effluent-related effects. The 2018 report is in progress.

Boundary Bay Ambient Monitoring

In 2017, a program assessment was completed and in 2018 additional work was conducted relating to two of the 2017 Program Assessment Report recommendations to conduct further review and interpretation of the 2014 biota results.

In 2017 and 2018, water quality was monitored. The 2017 water quality program followed the historical method of monitoring at ten marine sites in two seasons per year. Water sampling was done weekly for five consecutive weeks in July-August during the dry weather and in October-November during the wet weather. In 2018, following the 2017 Program Assessment, modifications of the program in keeping with the report recommendations were planned and are being evaluated with the aim to reduce unnecessary effort while maintaining value in the monitoring program. Water quality analysis is ongoing with reduced sites and frequency. The sediment and biota monitoring program is under review.

Boundary Bay Water Column Results

The analytical results for the 2017 Boundary Bay marine water column samples were compared with the Boundary Bay Water Quality Objectives and BC Water Quality Guidelines. Results generally met the applicable water quality objectives or guidelines, for most parameters. The main exception was boron, which exceeded the BC guideline, as has been the case in all previous years of this study. All boron results were consistent with typical boron concentrations in Canadian coastal marine waters, and as such are of no concern. In addition, 2017, measured levels of copper, chromium (VI) and zinc on at least one occasion did not meet the applicable guidelines or objectives. The 2018 report is under preparation.

Combined Sewer Overflow Monitoring Program

Metro Vancouver monitors for the occurrence, duration and volume of combined sewer overflows at each of its 19 CSO sites at 15 locations, including the addition of the New Westminster CSO Storage Tank's overflow. Overflow water quality is also monitored at select CSO locations and rotated over an approximate five-year cycle. In 2017 and 2018, Metro Vancouver characterized the discharge quality of selected CSOs to Burrard Inlet and the Fraser River. These are summarized by Table 10. Volumetric estimates of CSOs are not indicative of the quantity of sanitary sewage in the overflow, as the overflow volume is primarily stormwater. Metro Vancouver maintains a database on its CSO discharge quality. Targeted monitoring parameters include bacteria, conventional parameters, metals, and selected organics as well as periodic toxicity testing. The CSO samples collected and tested for acute toxicity to rainbow trout were not toxic.

Table 10 Number of Samples Collected at each CSO Location 2017-2018

CSO Location	2017	2018
Chilco / Brockton	1	0
Heather	4	9
Macdonald		
Clark Drive #2	0	5
Manitoba	1	1
Borden	3	0
Angus	1	6
Cassier	4	11
English Bay	0	1
Glenbrook	3	2

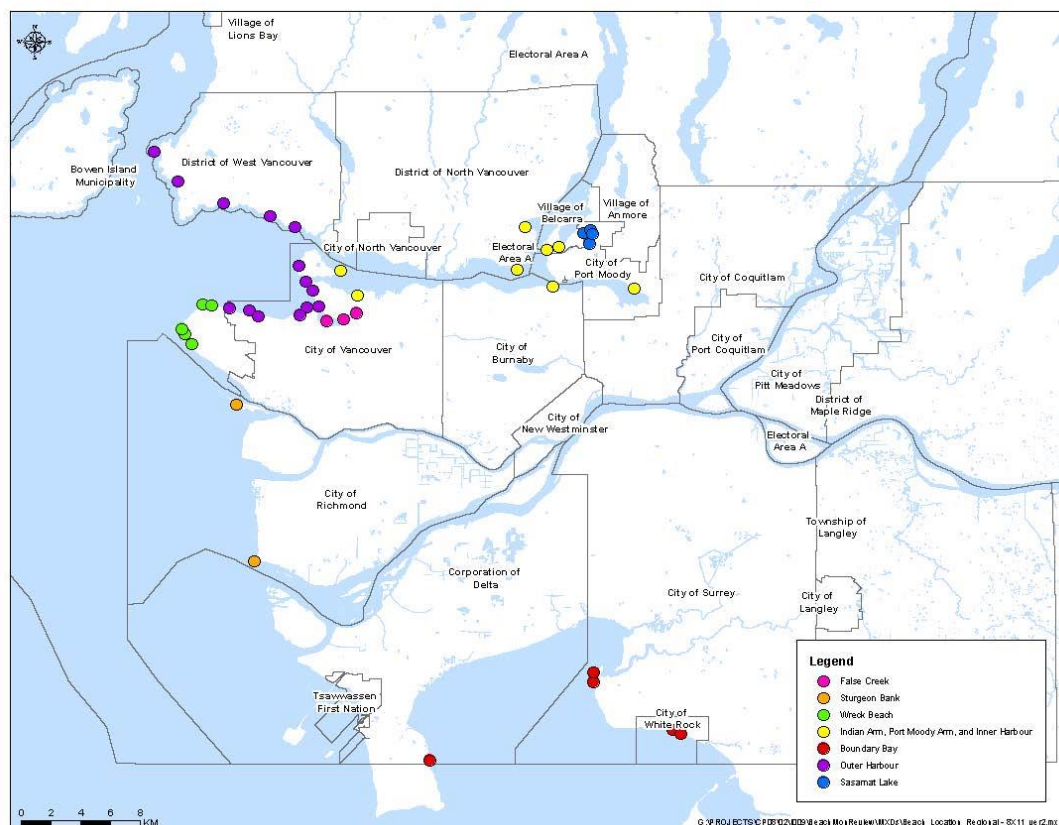
Recreational Water Quality Monitoring Program

Metro Vancouver monitors the bacteriological quality of recreational waters on a weekly basis starting in April and throughout the bathing season from May to September. Both bathing (swimming) and non-bathing beaches are monitored. The 2017 and 2018 program included monitoring of 113 sites at 41 locations (Figure 15). *Escherichia coli* bacteria are used as an indicator of fecal contamination to determine the safety of recreational waters for both primary and secondary contact recreational activities such as swimming, windsurfing, waterskiing, boating and fishing. The weekly results are forwarded to the Health Authorities and Beach Operators. The Health Authorities make the decision regarding the safety of recreational water in the region and the need to post a beach use advisory at a given beach.

The bacteriological quality for primary-contact recreation areas met the applicable Health Canada guidelines for all bathing beaches in 2017. In 2018, bacteriological quality was met for most primary-contact recreation areas with following exceptions: the 30-day geometric mean guideline was exceeded at English Bay (3 days), Kitsilano Beach (9 days), and Sunset Beach (12 days) which resulted in swimming advisory postings that lasted 3 to 7 days. In addition, the single sample maximum guideline was exceeded and swimming advisories were posted at Whytecliff Park, Sandy Cove, Ambleside, Kitsilano

Point, and Jericho Beach for between 2 to 6 days and at Barnet Marine Park for 21 days. For non-bathing beach areas, the monitoring data indicated West and Central False Creek met the working guideline limit for secondary contact activities for the 2017 and 2018 season. False Creek east did not meet the applicable secondary use recreation working guideline in 2018. Bathing beach swimming advisories are summarized in Table 13, on page 84.

Figure 15 Metro Vancouver Recreational Water Quality Monitoring Locations (2017-2018)



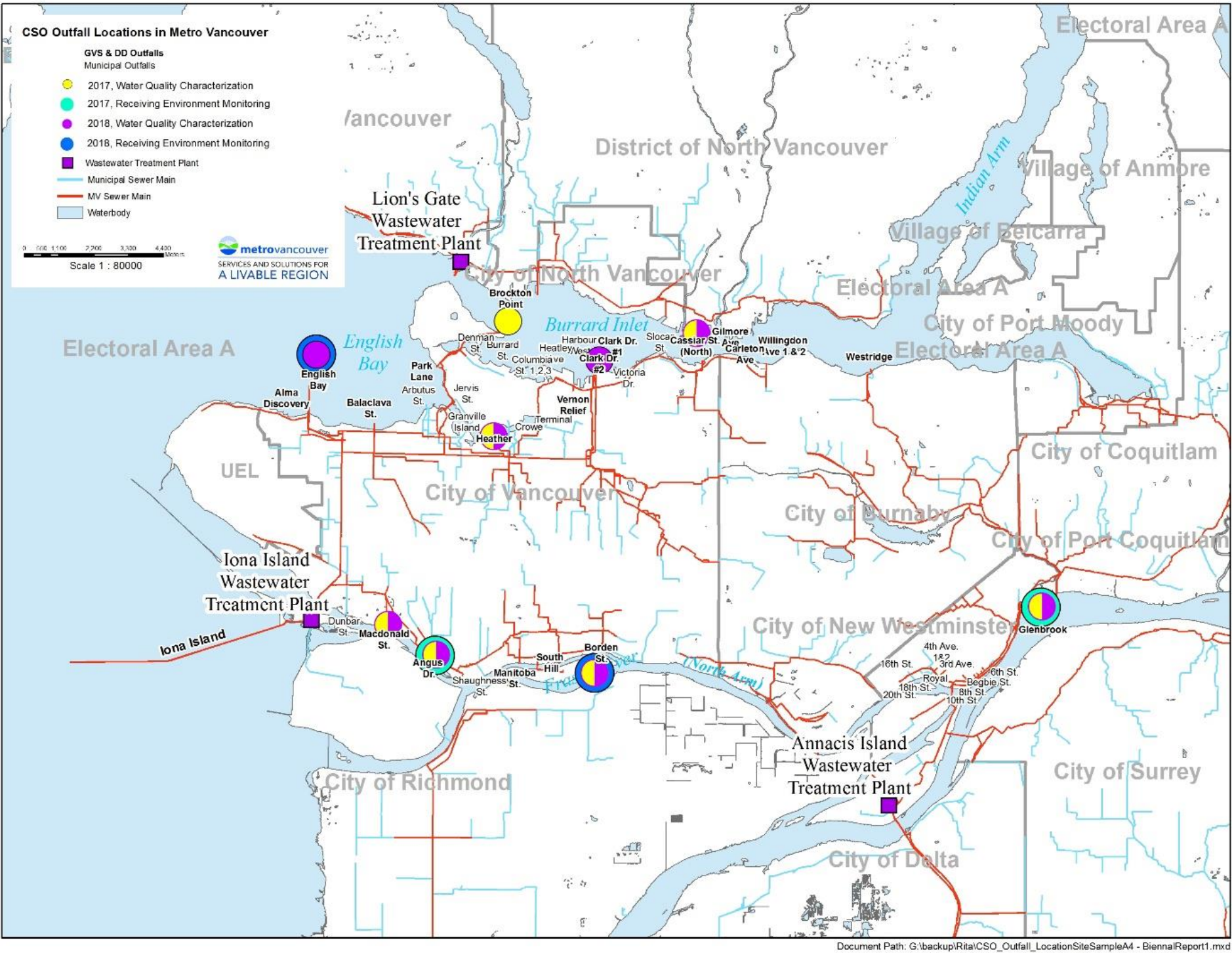


Figure 16 Metro Vancouver CSO Locations (2017-2018)

Ministerial Condition 7 – Member municipalities will, with MV planning and coordination, and to the satisfaction of the Regional Manager, develop a coordinated program to monitor stormwater and assess and report the implementation and effectiveness of Integrated Stormwater Management Plans (ISMPs). The program will use a weight-of-evidence performance measurement approach and will report out in the Biennial Report. The Regional Manager may extend the deadline for completion of ISMP by municipalities from 2014 to 2016 if satisfied that the assessment program could result in improvement of ISMP and protect stream health.

This Ministerial Condition was completed in 2012.

Ministerial Condition 8 – Bypass conditions that occur at wastewater treatment plants will be reported out in the annual quality control report. The report on each activity will include a description of the event, cause, environmental effect and monitoring that occurred and any mitigation measures undertaken to prevent reoccurrence and remediate detrimental environmental effect.

Please refer to the Quality Control Annual Reports available on Metro Vancouver's website:
<http://www.metrovancouver.org/services/liquid-waste/plans-reports/reports/Pages/default.aspx> .

Ministerial Condition 9 – The ILWRM has a goal of protecting public health and the environment. In keeping with this goal and to ensure alignment with other national, provincial and regional initiatives, Metro Vancouver and member municipalities are encouraged to: (a) Have local land use planning consider the direction provided by the ISMPs, (b) Consider how the degree, type and location of land development within a drainage can affect the long-term health of the watershed, (c) Consider how to protect the stream, including the riparian areas that exert an influence on the stream, from long-term cumulative impacts; and (d) Use scenarios and forecasting to systematically consider environmental consequences/benefits of different land use approaches prior to build-out (for example , Alternative Future type approaches).

Metro Vancouver continues to facilitate the SILG and RPAC forums where member municipalities explore options on shared policy and technical issues such as land use planning, land use interactions, and ISMPs.

Ministerial Condition 10 – Metro Vancouver will continue to consult with First Nations during the implementation of the Plan – in particular, engaging, as appropriate, with First Nations likely to be impacted by the secondary upgrades.

Metro Vancouver Regional District has, as one of its strategic directions: “Enhance relationships between Metro Vancouver and other orders of government, First Nations and stakeholders.” In this regard, one of the goals of the regional district is to “advance working relationships with First Nations on shared objectives.” The region is home to 11 First Nations. Another 35 First Nations, Tribal Councils and treaty groups from Vancouver Island to the Fraser Valley have traditional territories and identified interests within the Metro Vancouver region. Metro Vancouver’s Aboriginal Relations staff, as one of the services provided, assess the needs for engaging with First Nations on capital and infrastructure projects on a case-by-case basis and provide advice to staff.

In the last two years, two separate but inter-related policies have been updated by the Metro Vancouver Regional District and its Boards to facilitate working with First Nations on construction and other projects including works related to wastewater treatment plants:

- Information Sharing and Engagement Process with First Nations for Construction Projects; and
- Procurement and Real Property Contracting Authority.

The following provides detailed descriptions of each policy, and explains the process for engaging, as appropriate, with First Nations, and procuring services either directly from local First Nations or from local First Nations’-preferred service providers.

1. INFORMATION SHARING AND ENGAGEMENT PROCESS WITH FIRST NATIONS FOR CONSTRUCTION PROJECTS: A CORPORATE POLICY

In May 2017, the Metro Vancouver Regional District adopted a formal corporate policy to ensure consistency in approach for information sharing and engagement with First Nations for construction projects. The policy applies across all Metro Vancouver Departments. When seeking federal and/or provincial approval for its projects, Metro Vancouver carries out any required Crown procedural aspects of consultation with First Nations. Metro Vancouver staff engage with First Nations in the manner described below under the heading “Crown Regulatory Process.” When federal and/or provincial approval is not required, Metro Vancouver may engage with First Nations using the process described below under the heading “Non-regulatory Engagement Process.”

Project Managers seek input from Aboriginal Relations staff as early as possible in the project timeline in order to review the project, identify initial concerns, receive any information about First Nations to engage, discuss potential procurement opportunities, and receive specific or unique advice about potential impacts related to the nature of the project or its location.

A) CROWN REGULATORY PROCESS

Project Initiation Stage

When a project is initiated, the Project Manager completes a “Considerations for Conducting Archaeological Studies for Construction Projects Form” together with a map of the project area, and provides it to Aboriginal Relations staff.

Aboriginal Relations staff review the form and provide recommendations, which may include a preliminary meeting involving the Project Manager, and staff from Aboriginal Relations, Public Involvement and Purchasing to further discuss the project and any procurement needs. The purpose of this communication is to consider and recommend, as per the Metro Vancouver Board’s *Procurement and Real Property Contracting Authority Policy* (revised in July 2017):

- If any archaeological studies are required for the project;
- If any archaeological companies would be preferred by First Nations based on the project location; and
- If large procurement competitions can be unbundled so that First Nation Entities can participate in the procurement process. This may be applicable if the project area is on or in proximity to First Nations lands.

Preliminary Design Stage

At the preliminary design stage of a construction project within Water Services and Liquid Waste Services, Project Managers:

- Contact Public Involvement Division (PID) staff who will coordinate the First Nations engagement process;
- Consider hiring a professional archaeological consultant to conduct a high-level review of the project site by checking the provincial Remote Access to Archaeological Data (RAAD) system to determine if any known archaeological sites overlap with and/or fall within 50 metres of the project area; and
- Consider hiring a professional archaeological consultant to conduct an Archeological Overview Assessment (AOA) and provide advice with respect to any specific archaeological concerns within the project area, if deemed necessary.

Prior to conducting an AOA, a department General Manager sends a Project Introduction Letter No. 1 to those First Nations whose Consultative Areas include the project site. The letter introduces the project and Project Manager as well as Metro Vancouver’s archaeological and/or other consultant(s), if such consultants have been retained for the project. Public Involvement staff draft letters and Aboriginal Relations staff review/comment on all project letters to First Nations and provide any specific advice, including whether an alternative approach may be necessary. For example, there may be proximal First Nations to a project location that have expressed extraordinary concerns on other projects in the same area. Therefore, a different means of communication may be necessary (e.g. letters from Metro Vancouver’s Chief Administrative Officer; particularly if there are legal, political or other sensitivities). In addition, a different approach may need to be followed with one or more First Nations if it is considered to be more beneficial for Metro Vancouver in its relationships with First Nations including, but not

limited to, large-sized projects such as wastewater treatment plants, or if specific project impacts may be of concern.

The archaeological consultant undertakes a high-level review and/or an AOA of the site to determine if the proposed project site is within an area of low, moderate, or high archaeological potential. If the results indicate that the site is within an area of moderate to high archaeological potential, the consultant will likely recommend an Archaeological Impact Assessment (AIA). A professional archaeologist completes an AIA before or early in the detailed design stage. If a project overlaps with a registered, known archaeological site, the archaeologist may recommend (with direction from the Province) applying for a Site Alteration Permit from the BC Archaeology Branch to alter the archaeological site.

Detailed Design Stage - Engage Using the 3-Step Process

Where an AIA is required to determine if there are artifacts/cultural sites at or near the project site, or when a Site Alteration Permit is required, the following 3-Step Regulatory Process will be implemented to allow time to modify the project design or remove artifacts. Other triggers for the 3-step process may include land tenure (e.g. projects located on Crown land), Crown funding and/or a provincial or federal permit for which First Nation engagement is required.

3-Step Regulatory Process involves:

- Letter No. 2 is signed by the Project Manager and sent by registered mail to the respective Chiefs and Councils of those First Nations potentially affected by the project. The letters describe the project, provide contact information, and specify a deadline for responses. The response deadline allows First Nations at least 45 business days to respond;
- Public Involvement Division (PID) staff make follow-up phone calls to those First Nations who were sent letters to ensure receipt of the letters and to gauge if a response will be provided to Metro Vancouver; and
- Public Involvement Division (PID) staff draft and send a follow-up Letter No. 3, signed by the Project Manager, to those First Nations who were sent the second letter near the end of the deadline for responses as a courtesy reminder.

Public Involvement staff track and record attempts to contact First Nations and comments or requests received from First Nations in the project file. Metro Vancouver's actions and responses to those inquiries will be incorporated by Public Involvement staff into the official First Nations Engagement Report sent to the Provincial Ministry, Federal Department, or Crown Agency issuing the permit(s) or responsible for project approval when the engagement process is complete. Staff then forward the final First Nations Engagement Report to Aboriginal Relations staff for information and tracking. For any requests from First Nations for capacity funding to review Metro Vancouver's project engagement referrals, staff seek advice from Aboriginal Relations staff.

As responses are received from First Nations, Metro Vancouver staff:

- Responds to any technical or policy-related questions and incorporates, where appropriate, First Nations' responses into the project;

- Meets with First Nations to discuss any concerns and, if requested, provides a presentation;
- Follows up on additional requests from First Nations, as required;
- Provides a First Nations Engagement Report to the appropriate Provincial Ministry, Federal Department or Crown agency(ies) on efforts to engage First Nations;
- Proceeds with the project after the established deadline for responses has passed;
- Closes the project's response tracker following completion of the project or phases of the project; and
- Continues to update and to follow up on requests from First Nations.

If no responses are received from First Nations, Metro Vancouver:

- Provides a First Nations Engagement Report on First Nations engagement to the Crown and monitors any further interests, responses, or engagement needs;
- Prepares for the mobilization of the project, such as the start of the project or new phase of the project; and
- Closes the project's response tracker following completion of the project or phase of the project, and files the information for reference purposes.

B) NON-REGULATORY ENGAGEMENT PROCESS

If projects or plans do not trigger any Crown duty to consult with First Nations, then Metro Vancouver will determine if First Nations engagement as set out below is required.

First Nations engagement may be required if:

- An AOA is required for the project area;
- A First Nation property is located either adjacent to or in close proximity to the project site;
- Any First Nation sensitivities are identified; or
- A First Nation interest is publicly known.

Where First Nations engagement is required, the Project Manager contacts Aboriginal Relations to:

- Identify which local First Nations may be affected by the project;
- Send out an initial project notification letter to those First Nations; and
- Follow up on additional requests from First Nations, respond to any technical enquiries, and undertake such measures including: the possible redesign of the project route, changing the timing of proposed activities, commissioning additional archaeological work at or near the project site, or other measures deemed appropriate.

If responses are received from First Nations, Metro Vancouver:

- Responds to any technical or policy-related questions and incorporate, where appropriate, First Nations' responses into the project;
- Meets with First Nations to discuss any concerns and, if requested, provides a presentation;
- Follows up on additional requests from First Nations, as required;
- Closes the project's response tracker following completion of the project or phases of the project; and

- Continues to update First Nations who have responded to Metro Vancouver on the progress of the project, new phases of the project and project completion.

If no responses are received from First Nations, Metro Vancouver staff monitor any further interests, responses and engagement needs, and proceeds with the project.

2. *PROCUREMENT AND REAL PROPERTY CONTRACTING AUTHORITY: A BOARD-AMENDED POLICY*

In July 2017, the Metro Vancouver Regional District Board amended its 2014 policy on *Procurement and Real Property Contracting Authority* to include more opportunities for First Nations' economic development opportunities, including archaeological and environmental studies and monitoring, Indigenous artistic opportunities, civil construction, and other services that may be needed for infrastructure and capital works projects (e.g. clearing and grubbing, security, traffic control) as well as graphic design, catering and other miscellaneous services.

Contracting authority grants designated employees the ability to commit the organization's funds with external vendors, such as First Nation entities. First Nation entities are defined as "any business arrangement in which First Nation individuals and/or First Nation communities have an ownership or other interest, and includes a business entity identified by a First Nation community as its designated business partner."

Clause 7.6(a) of the updated *Procurement and Real Property Contracting Authority* policy states:

"7.6 (a) Where a Metro Vancouver project or activity is located on or in proximity to First Nation Lands, the procurement process may include one or more of the following:

- i. Unbundle large procurement competitions so that First Nation entities can participate in the procurement process; or
- ii. Include provisions in the procurement documents that give preference to a First Nation entity, or a proponent that sub-contracts a portion of the work to a First Nation entity."

Unbundling of large procurement competitions prior to construction or giving preference to a proponent that sub-contracts a portion of the work to a First Nation entity will provide procurement opportunities for First Nations businesses that may not be able to participate in the bidding process under the current policy. For example, archaeological work is often bundled with both geotechnical as well as environmental assessments, resulting in one contract awarded to larger firms that can undertake all three aspects of project work. Some First Nations have their own archaeological consultants, operate independent archaeological companies, or are associated with their trusted archaeological firms. Despite their ability to provide archaeological services, First Nations businesses are unable to compete for the larger procurement competitions, as they may not have the capacity to carry out geotechnical and/or environmental assessments.

The above clause also relates to partnerships that may already exist between a First Nation and other non-First Nation businesses. For example, some First Nations in the region have existing agreements

with construction companies and other industry sector companies that employ and train First Nation members. A proponent wishing to have First Nation involvement can either contact the First Nation directly to solicit participation or contact one of the First Nation's partner companies which will employ that First Nation's members. This reference-based approach can be accommodated under this clause.

The second related clause added to the policy in July 2017 states:

“7.6 (b) Where a Metro Vancouver project or activity is located within a First Nation's Traditional Territory and archaeological work is required, the procurement process will seek the First Nation's input and recommendations for qualified archaeological consultants.”

This clause specifically deals with archaeological work which is especially significant to First Nations who wish to protect their cultural and heritage interests. Some First Nations have their own archaeological consulting firms. Other First Nations wish to utilize their preferred independent archaeological consultants. Still other First Nations may have a business arrangement with its trusted archaeological firm that works exclusively for them. The above clause takes into consideration all of these various arrangements, is respectful of First Nations' input, and does not preclude Metro Vancouver's underlying consideration to seek best value wherever possible.

Performance Measures

Goal 1: Protect Public Health and the Environment

WWTP Compliance

The overall performance of Metro Vancouver's five wastewater treatment plants met most of the Operational Certificate requirements. A review of the effluent monitoring program results showed the percent passing in 2018 was 99.95% and 99.93% in 2017, with an average of 99.94%. Therefore, the requirements listed in the operational certificates were met each year. The few exceptions, for example, were the result of exceeding permitted load limits due to high flows through the plants and power interruption.

Discharges Not Meeting Provincial Water Quality Guidelines

Site-specific water quality objectives and guidelines were largely met at the boundary of the initial dilution zones for Metro Vancouver wastewater treatment plants. For the few exceptions, none could be attributed to the treatment plants.

Sanitary Sewer Overflows

Overflows from sanitary sewers fall into two categories: wet weather overflows due to excessive amounts of rainfall and stormwater entering into sanitary sewers, and dry weather due to reasons other than rainfall or stormwater.

While the Ministry of Environment has set a target for wet weather overflows not to occur for storms associated with a statistical occurrence once every 5 years, high rates of rainwater inflow during and after storms have led to overflows. These are shown in Figure 17 and Figure 18.

The locations and dates of dry weather overflows are shown in Figure 19 and Figure 20. These overflows may be caused by equipment failure, power failure, or unexpected events such as sewer pipe blockage and third party actions.

Combined Sewer Overflows

Combined sewer overflows occur during wet weather when there is insufficient combined sewer capacity to handle additional stormwater inflows. Dry weather overflows from combined sewer systems are reported as sanitary sewer overflows. These wet weather overflows are flow reliefs which redirect the excess combined sewage and stormwater to the receiving environment. Combined sewer overflows are listed in Table 11 and Table 12.

The Cities of Burnaby, New Westminster and Vancouver as well as the University Endowment Lands continue to eliminate their combined sewers and replace them with separate storm sewers and sanitary sewers. This process will eventually result in all sanitary sewage conveyed to the wastewater treatment plants with stormwater redirected away; combined sewer overflows locations will ultimately discharge only stormwater. In the meantime, the characteristics of the combined sewer overflows will continue to slowly transform as there will be decreasing percentages of sanitary sewage mixed with stormwater.

Figure 17 Wet Weather Sanitary Sewer Overflows 2017

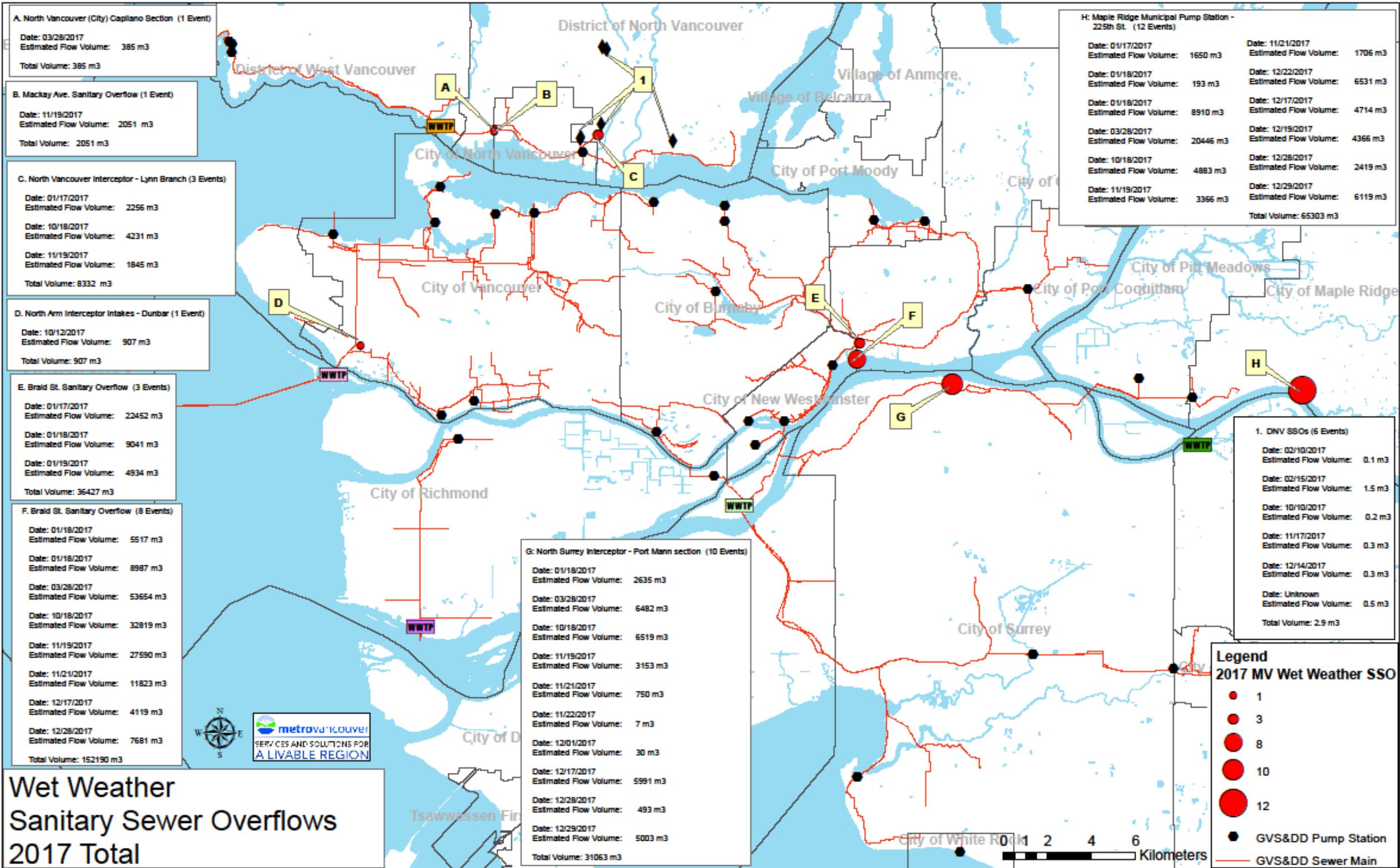


Figure 18 Wet Weather Sanitary Sewer Overflows 2018

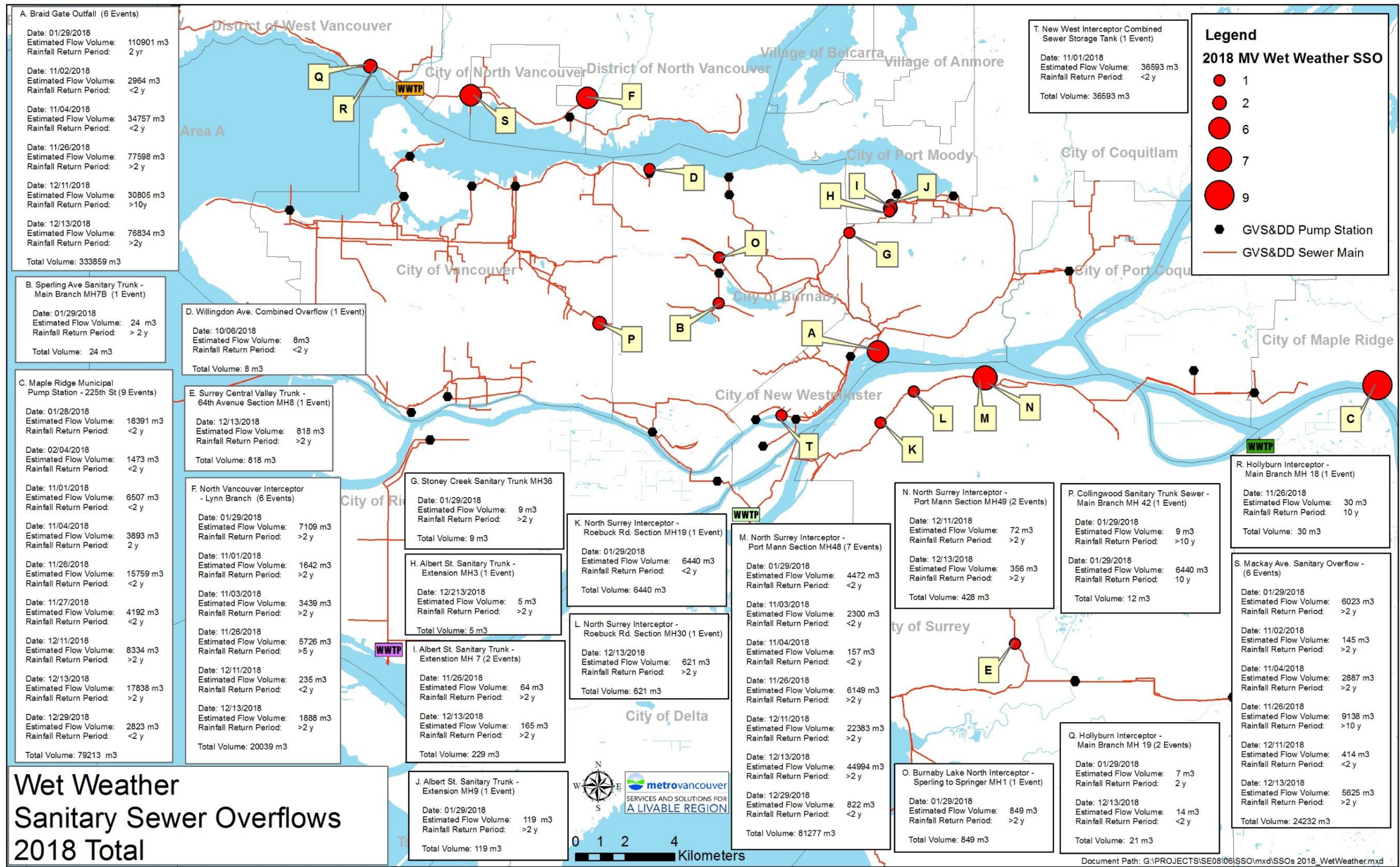


Figure 19 Dry Weather Sanitary Sewer Overflows 2017

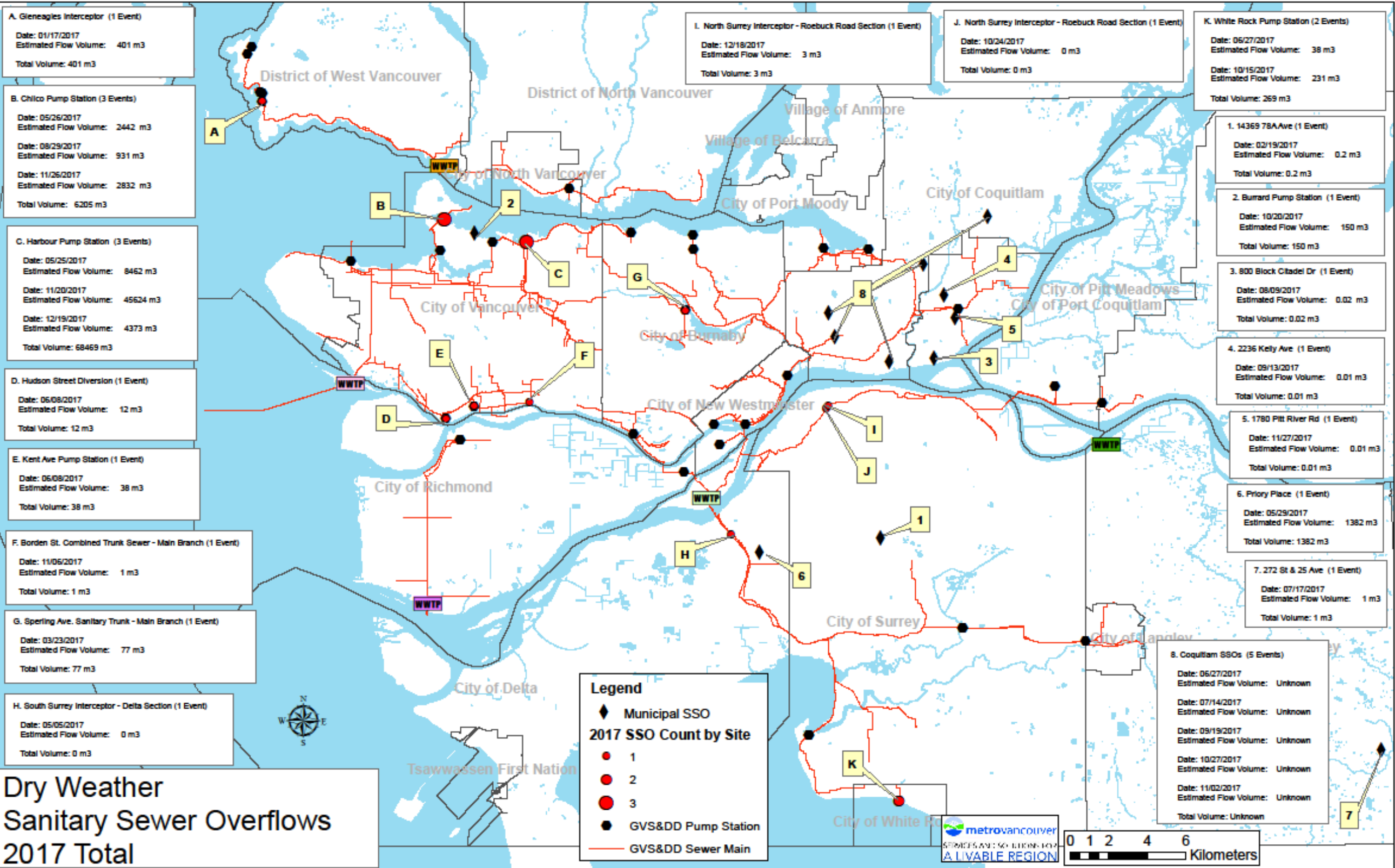


Figure 20 Dry Weather Sanitary Sewer Overflows 2018

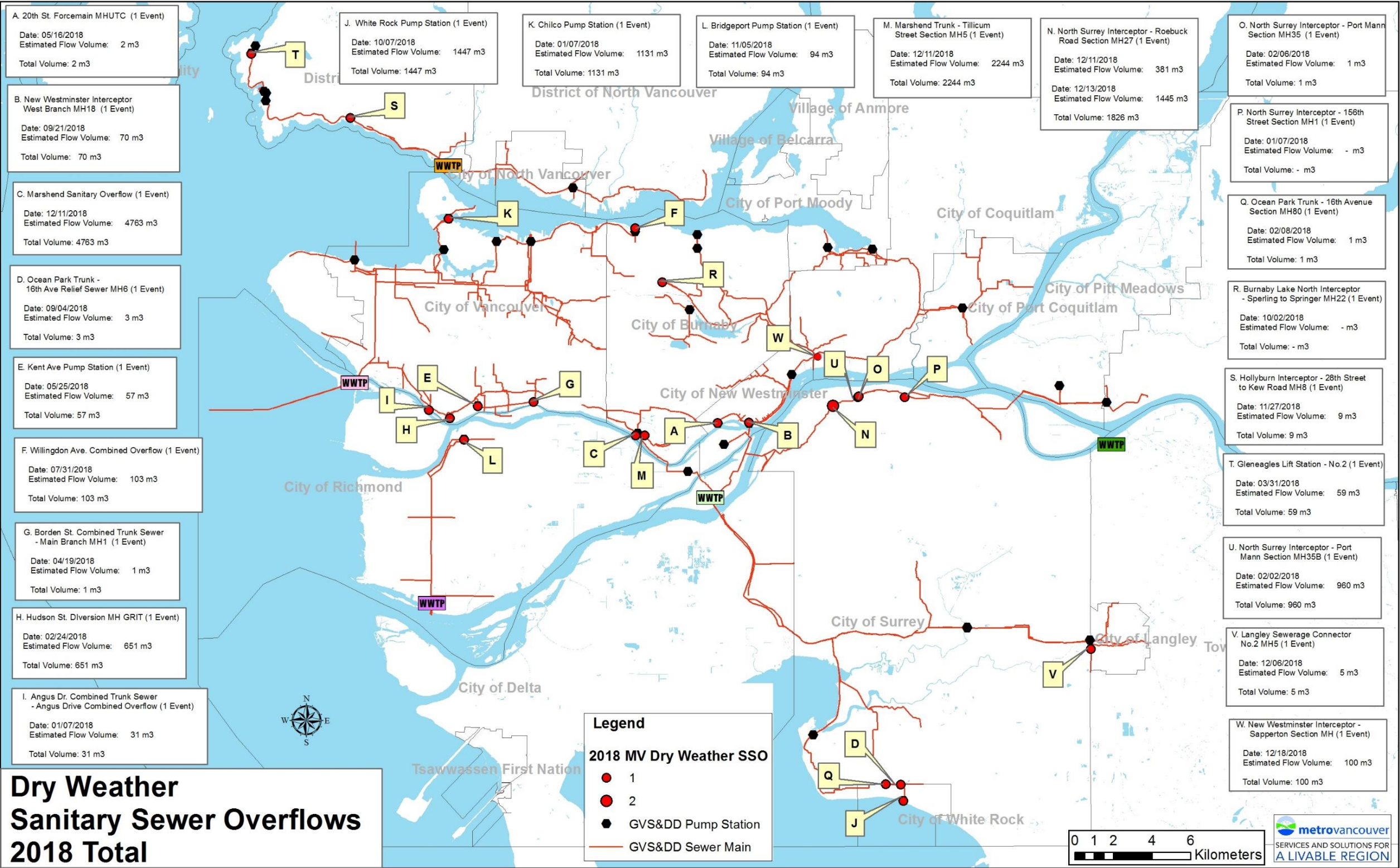


Table 11 GVS&DD CSO Summary 2017

2017 CSO OVERFLOW SUMMARY - WSER RESULTS				
Outfall Site Information		Annual Total		
Name	Site Code	Number Of Days*	Duration (hr)	Total Est. Volume (m³)
Angus Drive **	AG2 & NA2	42	143	1,823,000
Balaclava	BA1	44	140	1,403,000
Borden	BO3	147	1,513	456,000
Chilco / Brockton	CH7	16	48	85,000
Cassiar East	HA1	129	1,247	2,347,000
Cassiar North	HA1	129	1,247	2,347,000
Clark Drive #1	CD1	121	1,292	2,878,000
Clark Drive #2	CD2	89	775	11,268,000
Vernon Drive	VR10	88	455	733,000
English Bay #1	EB2	53	179	290,000
English Bay #2	4HI	43	109	51,000
Glenbrook	GL10	134	1,096	3,057,000
Heather	CA3	80	266	674,000
Macdonald	MD11	6	4	8,000
Manitoba	MN1	66	233	1,652,000
New West. CSO Tank	NW11	27	203	432,000
South Hill	SI9	104	594	1,377,000
Westridge	WD4	311	7,464	1,311,000
Willingdon #1	WI3	151	1,804	546,000
Willingdon #2	WI3	151	1,804	546,000
	Total ***	1,931	20,615	33,283,000
* Number of days during the year that wastewater discharged.				
** The greater of the days and duration, and sum of the discharges from the two monitoring sites.				
*** The Total Estimated Volume does not equal the sum of the values above it due to roundoff error.				

Table 12 GVS&DD CSO Summary 2018

2018 CSO OVERFLOW SUMMARY - WSER RESULTS				
Outfall Site Information		Annual Total		
Name	Site Code	Number Of Days*	Duration (hr)	Total Est. Volume (m³)
Angus Drive **	AG2 & NA2	59	185	3,140,000
Balaclava	BA1	64	220	2,504,000
Borden	BO3	143	1,781	534,000
Chilco / Brookton	CH7	23	97	205,000
Cassiar East	HA1	149	1,892	3,175,000
Cassiar North	HA1	149	1,892	3,175,000
Clark Drive #1	CD1	134	1,455	3,447,000
Clark Drive #2	CD2	103	856	12,540,000
Vernon Drive	VR10	105	581	1,139,000
English Bay #1	EB2	65	187	263,000
English Bay #2	4HI	47	84	32,000
Glenbrook	GL10	134	1,242	3,547,000
Heather	CA3	80	267	854,000
Macdonald	MD11	7	13	36,000
Manitoba	MN1	77	237	1,649,000
New West. CSO Tank	NW11	25	218	416,000
South Hill	SI9	106	671	1,674,000
Westridge	WD4	344	8,256	1,566,000
Willingdon #1	WI3	170	2,350	709,000
Willingdon #2	WI3	170	2,350	709,000
	Total ***	2,154	24,834	41,313,000
* Number of days during the year that wastewater discharged.				
** The greater of the days and duration, and sum of the discharges from the two monitoring sites.				
*** The Total Estimated Volume does not equal the sum of the values above it due to roundoff error.				

Beach Closure Days

Metro Vancouver monitors the bacteriological quality of recreational waters. The monitoring information is shared with local health authorities and others, and is used by the health authorities to determine the need to post notice of beach closures.

Table 13 Beach Closure Days in 2017 and 2018

Year / Beach	Days Guideline was Exceeded	Days Beach was Posted
2017 – Bathing Beaches		
-	-	-
2018 – Bathing Beaches		
Whytecliff	-	2
Sandy Cove	-	2
Ambleside	-	2
English Bay	3	3
Sunset Beach	12	7
Kitsilano Beach	9	6
Kitsilano Point	-	6
Jericho Beach	-	4
Barnet Marine Park	-	21

Goal 2: Use liquid waste as a resource

Energy and Materials Recovery

Metro Vancouver makes use of the biogas generated on-site at its wastewater treatment plants to provide treatment process heating and electricity for the plants.

Table 14 Energy Recovered for all 5 Wastewater Treatment Plants 2010-2018

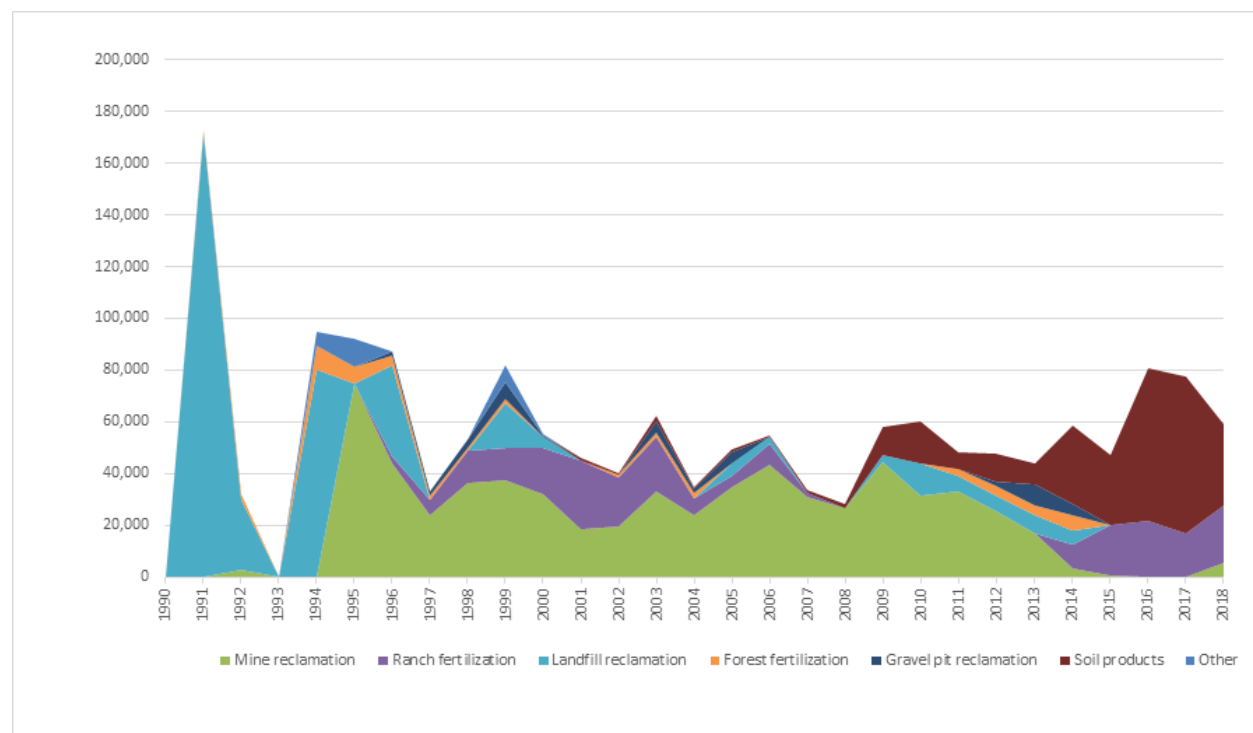
Table 14 provides a summary of the energy recovered. Opportunities to increase biogas production are being explored and are discussed under their respective actions starting on page 31.

Table 14 Energy Recovered for all 5 Wastewater Treatment Plants 2010-2018

Year	Electricity Generated (kWh)	Total Biogas Used (GJ)
2010	39,934,650	247,919
2011	42,108,590	239,773
2012	38,692,239	300,163
2013	40,106,181	424,109
2014	41,317,709	477,732
2015	39,012,898	505,333
2016	41,142,259	522,179
2017	36,936,606	536,226
2018	13,757,056	414,484

Biosolids produced at the wastewater treatment plants are recovered for their nutrients and organic matter for use in land restoration or as components in soil products, refer to Figure 21. Quantities of biosolids generated at the wastewater treatment plants will continue to increase as a result of population growth and treatment process upgrades.

Figure 21 Recycled Biosolids Quantities from 1990 to 2018 (tonnes)



Goal 3: Effective, affordable and collaborative management

Daily Flows at WWTPs with Rainfall

How the sewer system responds to rainfall is indicative of whether there is too much rainwater entering sanitary sewers from cross-connected storm or building foundation drains. In sanitary sewer systems, excessive amounts of stormwater add additional pumping and treatment costs, as well as consume sewer capacity that has been dedicated to serve anticipated population growth. Figure 22 and Figure 23 show how sewage flows change at wastewater treatment plants in response to rainfall. Low flow trends can be seen for all locations for summer months, with sharp response to autumn rainfall.

While high peak flows at the Iona Island WWTP are a normal response to rainfall for its combined sewer system, the sharp peaks in flows at the Annacis Island WWTP indicate that there are still significant amounts of rainwater entering its sanitary sewer system. This is due in part to combined sewers in New Westminster as well as high I&I occurring in some sewers leading to this plant.

Similarly, the peak flows of the Lions Gate WWTP indicate that there are large amounts of I&I entering the North Shore sewers and are a contrast to the limited rainfall responses shown at the Lulu Island and NW Langley WWTPs.

Figure 22 Average 24-hour Flows and Rainfall at WWTPs 2016 and 2017

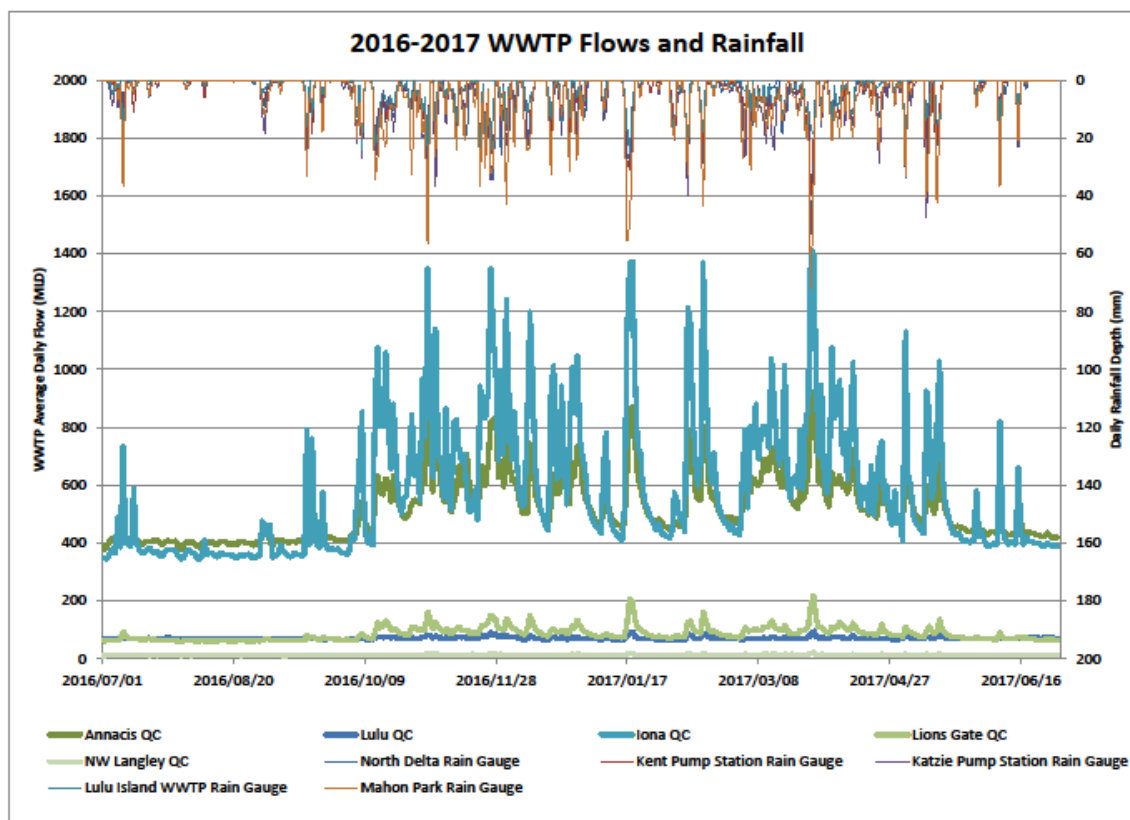
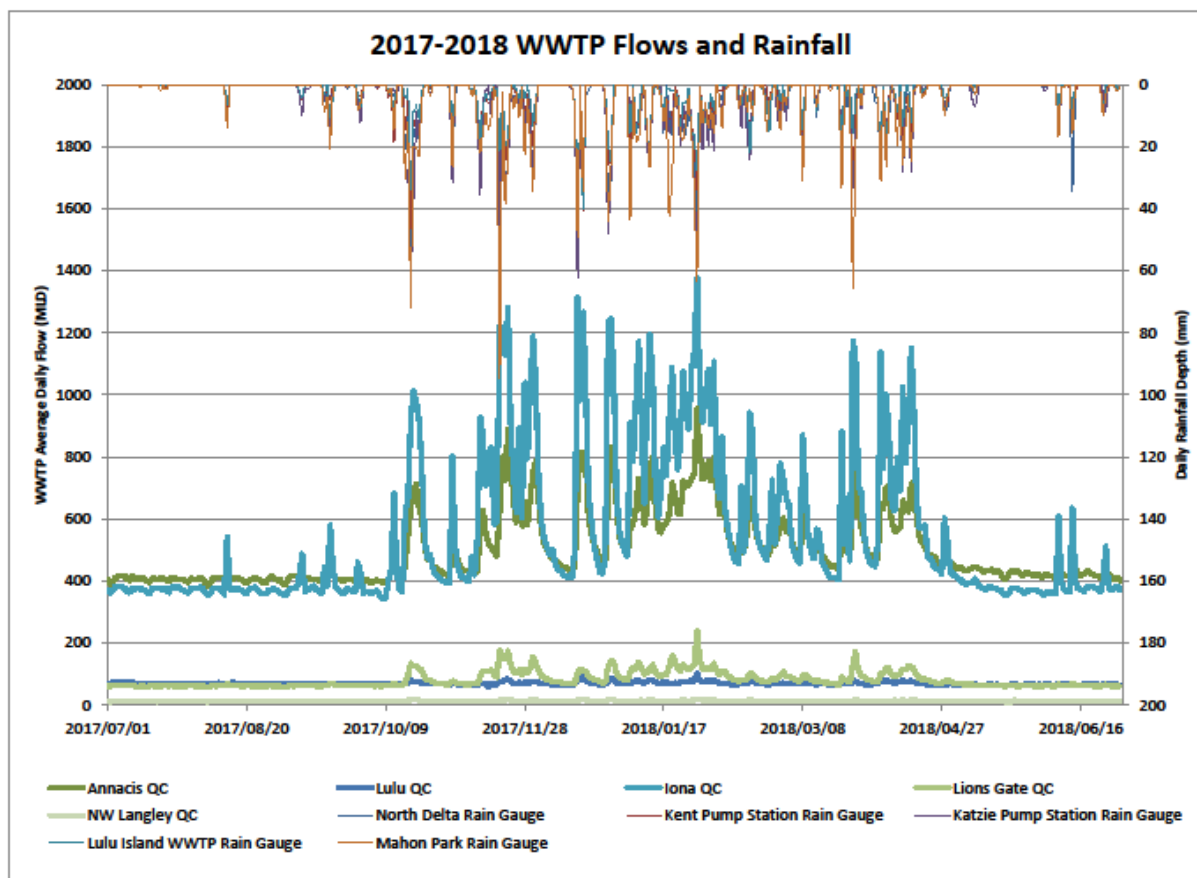


Figure 23 Average 24-hour Flows and Rainfall at WWTPs 2017 and 2018



Wet Weather Peaking Factors at Key Metro Vancouver Monitoring Points

The magnitude of wet weather peaking factors varies with I&I rates and the tributary catchment size (Table 15). Smaller catchments should have greater peaking factors than larger ones. The flow meter locations are shown on Figure 9 to Figure 13 (pp 45-49), and corresponding I&I estimates are shown on Figure 1 to Figure 4 (pp 13-16).

Due to the large catchment sizes, Metro Vancouver has not normalized the I&I estimates around the 1:5-year return period storm. Therefore, the estimates shown are strongly impacted by the differences in rainfall volume and intensity for each reporting period. Consequently, a catchment may move up or down within the I&I grouping categories due to different rainfall patterns. Municipal I&I estimates are considered more reliable as the finer catchment resolution allows for I&I estimates to be normalized to the 1:5-year storm return period. This permits better catchment-to-catchment and before-and-after comparison.

Table 15 Wet Weather Peaking Factors

Meter	Site	Gross Area (Ha)	Ratio PWWF : ADFW*	
			2016-2017	2017-2018
AN1	Annacis Island WWTP Effluent	42224.78	2.45	2.86
BB1	Marshend Pump Station	1478.31	2.24	3.43
BF1	Baynes Pump Station	390.91	2.12	2.15
BI1	Brunette Interceptor	4815.01	2.72	3.57
BS2	Burnaby South Slope Interceptor	216.30	1.59	2.24
C21	Cloverdale Pump Station	4897.37	2.91	2.85
CA6	Cambie Combined Trunk Sewer	257.77	13.71	11.90
CH1	Chilco Pump Station	144.41	3.09	2.32
CL1	Columbia Pump Station	115.80	4.20	4.77
CM7	Crescent Beach Pump Station	60.65	2.87	12.70
CQ1	Coquitlam Interceptor	1290.36	4.47	4.78
EB3	English Bay Interceptor	765.60	7.99	10.44
ER1	East Richmond Pump Station	158.69	1.97	2.56
HL1	Hollyburn Interceptor	2697.44	3.74	5.20
IO1	Iona Island WWTP Effluent	9806.20	3.82	3.96
KA2	Kent Avenue Pump Station	473.44	2.39	2.72
L21	Langley Pump Station	3049.28	2.96	3.30
L22	Langley Connector #2	109.21	7.04	8.71
L31	Langley Connector #3	1254.86	2.60	3.05
LA1	Langley Connector #1	502.62	2.23	2.56
LG50	Surrey flow to Langley Pump Station	106.42	4.05	8.53
LN1	Lions Gate WWTP Effluent	4290.91	4.22	6.36
LU1	Lulu Island WWTP Effluent	4894.66	1.53	2.02
LY1/LY2	Lynn Pump Station	1387.81	3.90	6.56
LZ4	Lozells Sanitary Trunk Sewer	207.30	8.64	9.74
ML2	Maillardville Trunk Sewer Twinning	585.60	4.17	4.24
MP1	Katzie Pump Station	2634.75	2.56	3.14
N21	Newton Sanitary Trunk Sewer No. 2	498.36	1.91	1.68
NA3	North Arm Interceptor	2393.70	6.74	6.06
NC1	North East Coquitlam Trunk Sewer	176.96	2.20	2.52
ND2	North Delta Interceptor	1690.96	2.19	2.28
NE9	Delta Flow to Newton Sanitary Trunk Sewer No. 2	138.39	2.59	2.45
NG1	Northwest Langley WWTP Effluent	1295.16	2.02	2.02
NS2	North Surrey Interceptor	6836.57	3.45	3.68
NV1	North Vancouver Interceptor - Capilano Section	2594.90	3.63	5.11
NV9	North Vancouver Interceptor - City Section	2420.40		5.43
NW2	New Westminster Interceptor	13490.51	3.01	2.89
NW3	New Westminster Interceptor - Sapperton Section	12077.03	3.01	2.45
P21	Port Coquitlam Pump Station	2184.87	2.81	3.69
QU1	Queensborough Pump Station	148.36	2.64	4.09
SS3	South Surrey Interceptor	14986.12	2.18	2.18
SS9	Tilbury Force Main	2580.29	3.53	3.29
WF1	White Rock Pump Station	501.47	4.24	4.42

*Calculated as the max hourly flow on the max flow day divided by the 25th percentile of average daily flows for

Sewer Condition Inspection

Sewer condition inspection is part of an ongoing cycle of asset evaluation and repair. Keeping assets in good repair reduces I&I, lowers pumping and treatment costs, and extends the lifecycle of existing

infrastructure investments. Metro Vancouver's 530 km of sewers represent less than three percent of the region-wide total sewer network.

Table 16 Meters of Sewer Pipe Inspected and Renewed Annually

	Planned (km)	Actual (km)	Rehabilitated (km)
2012	27.5	24.5	0.7
2013	33	31	0
2014	29.7	20.5	0.2
2015	29.7	27.5	0
2016	37	22.4	0.35
2017	26.5	14.4	0.15
2018	26.5	26	0

Integrated Stormwater Management Planning

Integrated stormwater management plans (ISMPs) were initiated under the 2002 LWMP, with members initially given 12 years to complete the development of these plans. From 2002 onwards, Metro Vancouver has worked with the Stormwater Interagency Liaison Group to develop supporting processes and material to help facilitate the ISMP development and implementation.

In 2010, through the updated LWMP, GVS&DD members reaffirmed their commitment to develop ISMPs by the end of 2014, and implement these plans.

In 2014, a Monitoring and Adaptive Management Framework (AMF) was developed to fulfill Ministerial Condition 7, which also allows for the extension of the ISMP completion deadline to 2016.

A summary of ISMP status by location is provided by Figure 24. ISMPs are not required for the entire region; in general, they are not required for watersheds which are 20% or more rural or forested area.

Watershed specific details for ISMP progress are provided by each municipality in Volume 2: Municipal Reports, under Action 3.4.7. In addition, watershed specific summaries were also reported as part of the Interim Report: 2017.

As of the end of 2018, there are 97 ISMPs developed and in implementation phase and 9 ISMPs being developed.

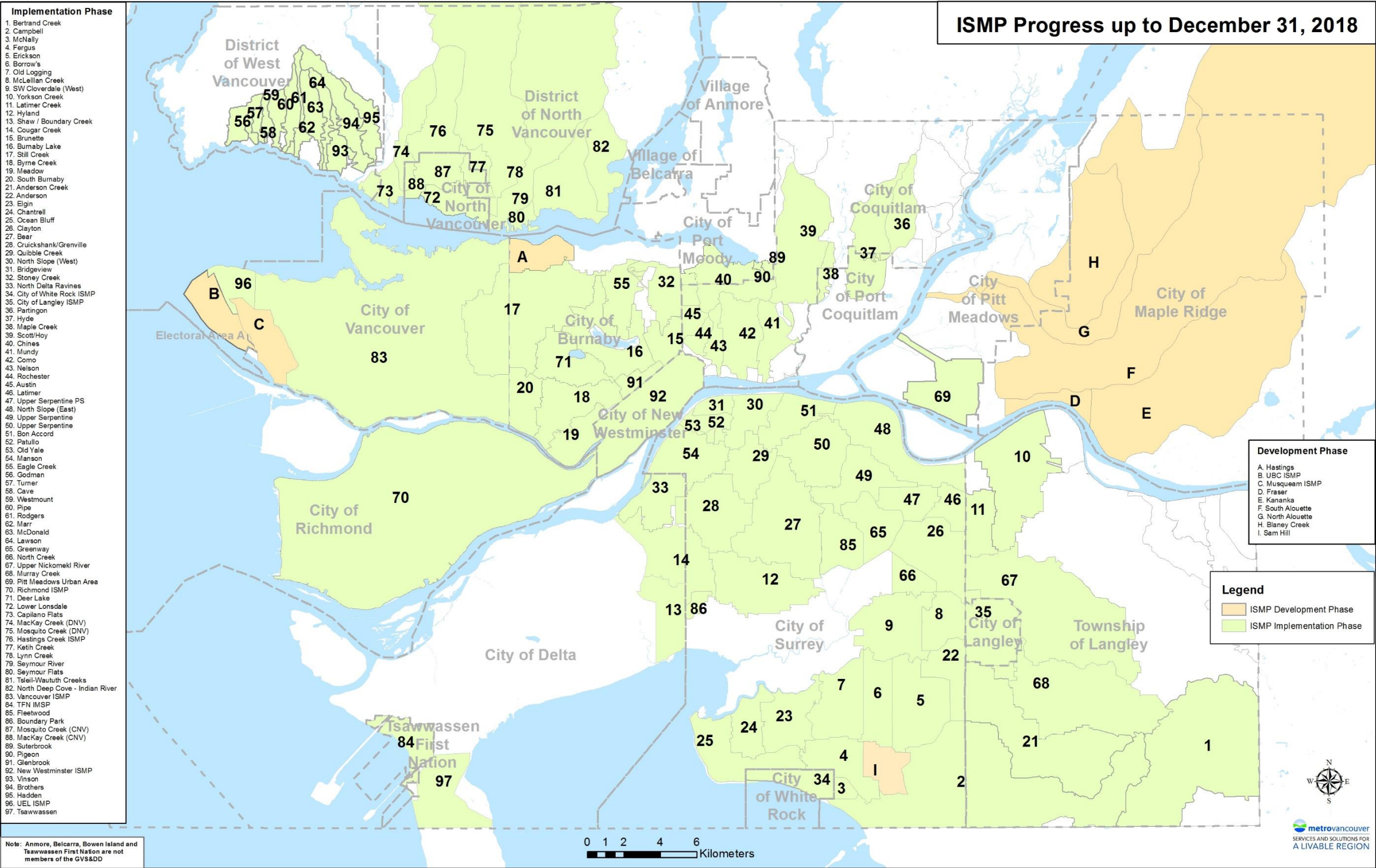


Figure 24 ISMP Status as of December 31, 2018

Financial

A summary of Metro Vancouver's liquid waste budgets is provided in Table 17: details and context are available at:

<http://www.metrovancouver.org/services/financial-services/programs-budget/Pages/default.aspx>

Table 17: Liquid Waste GVS&DD Operating/Capital Budgets (\$ Millions)

	Final Budget	Actual	Final Budget	Actual	Final Budget	Actual	Final Budget
Type of Expenditure / Revenue:	2015	2015	2016	2016	2017	2017	2018
Operations & Maintenance	\$140.8	\$137.1	\$141.1	\$137.5	\$153.5	\$145.0	\$166.6
Debt Service	\$16.1	\$12.4	\$14.7	\$11.9	\$18.0	\$14.2	\$25.6
Contribution to Capital	\$55.8	\$55.8	\$60.3	\$60.3	\$64.8	\$64.8	\$74.7
Total Operating Budget - S&D (Expenditures)	\$212.7	\$205.1	\$216.1	\$209.7	\$236.3	\$224.0	\$266.9
Municipal (S&D) Levy - Liquid Waste	\$192.3	\$192.3	\$200.3	\$200.3	\$213.9	\$213.9	\$232.1
User Fees	\$2.5	\$2.7	\$2.4	\$2.3	\$2.4	\$2.5	\$2.5
Transfer from DCC reserves	\$3.6	\$5.4	\$3.5	\$6.0	\$6.8	\$5.2	\$12.9
BOD-TSS Industrial Charges	\$7.6	\$8.3	\$8.5	\$8.5	\$8.6	\$9.8	\$10.2
Other External Revenues	\$0.8	\$1.2	\$0.2	\$0.9	\$0.2	\$1.1	\$0.2
Other Funds / Reserves / Surplus	\$5.9	\$3.3	\$1.2	\$1.0	\$4.4	\$0.2	\$9.0
subtotal - other revenues/reserves	\$20.4	\$20.9	\$15.8	\$18.7	\$22.4	\$18.8	\$34.8
Total Operating Budget - S&D (Revenues)	\$212.7	\$213.2	\$216.1	\$219.0	\$236.3	232.7	\$266.9
Operational Surplus Sewerage & Drainage	\$7.9		\$9.3	\$9.3		\$8.7	
Sewerage & Drainage Capital - Expenditures	\$92.1	\$115.3	\$126.0	\$118.8	\$163.7	\$167.8	\$354.9

References

Climate and Seismic Risk

CH2M. 2018. Seismic Risk Action Plan for Liquid Waste Services. Commissioned by Metro Vancouver. Burnaby BC: Metro Vancouver.

GHD. 2018. Greater Vancouver Sewerage and Drainage District – Study of the Impacts of Climate Change on Precipitation and Stormwater Management. Waterloo, ON. Metro Vancouver.

Combined Sewer Overflows

ENKON Environmental Limited (ENKON). (2017). Receiving Environment Effects Survey of the Balaclava, Cassiar and Manitoba Combined Sewer Overflows. Commissioned by Metro Vancouver. Burnaby, BC: Metro Vancouver.

ENKON Environmental Limited (2018). *CSO Receiving Environment Monitoring Program: 2016 Clark Drive Effects Survey*. Commissioned by Metro Vancouver. Burnaby, BC: Metro Vancouver.

McElhanney. 2017. Manitoba Street Combined Trunk Sewer Separation Strategy – Final Summary Report. Surrey BC: Metro Vancouver.

Strait of Georgia Monitoring

ENKON Environmental Limited. (2017). Iona Deep-Sea Outfall Receiving Environment Monitoring Program: 2016 Initial Dilution Zone Boundary Monitoring. Final Report Prepared for Metro Vancouver Regional District (GVRD), Burnaby, BC by ENKON Environmental Limited, Surrey, BC.

Pawlowicz, R., Francois R. and Maldonado, M. 2017. *Contaminant Dispersion and Removal in the Strait of Georgia (2016)*. Commissioned by Metro Vancouver. Burnaby, BC: Metro Vancouver.

Pawlowicz, R., Francois R. and Maldonado, M. 2018. *Contaminant Dispersion and Removal in the Strait of Georgia (2017)*. Commissioned by Metro Vancouver. Burnaby, BC: Metro Vancouver.

Burrard Inlet Monitoring

ENKON Environmental Limited (ENKON). (2017). Lions Gate Receiving Environment Monitoring Program, 2016 Initial Dilution Zone Boundary Monitoring. Final Report prepared for Metro Vancouver, Burnaby, BC by ENKON Environmental Limited, Surrey, BC.

ENKON Environmental Limited. 2017. *Burrard Inlet Ambient Monitoring Program - 2016 Water Column Monitoring*. Commissioned by Metro Vancouver. Burnaby, BC: Metro Vancouver.

Fraser River Monitoring

ENKON Environmental Limited. 2017. *Fraser River Ambient Monitoring Program 2017 Water Column Monitoring*. Commissioned by Metro Vancouver. Burnaby, BC: Metro Vancouver.

Smith, A. 2018. Receiving Environment Monitoring Program for Metro Vancouver's Fraser River Wastewater Treatment Plants: 2017 Initial Dilution Zone Boundary Monitoring. Prepared for Metro Vancouver, Burnaby, BC by ENKON Environmental Limited, Surrey, BC.

ENKON Environmental Limited. 2019. *Fraser River Ambient Monitoring Program 2018 Water Column Monitoring*. Commissioned by Metro Vancouver. Burnaby, BC: Metro Vancouver.

Boundary Bay Monitoring

ENKON Environmental Limited. 2017. *Boundary Bay Ambient Monitoring Program 2016 Sediment Monitoring Report*. Commissioned by Metro Vancouver. Burnaby, BC: Metro Vancouver.

Hemmera Envirochem Inc. 2017. *Boundary Bay Assessment and Monitoring Program: Review and Recommendations Based on Monitoring Results from 2009 to 2015*. Commissioned by Metro Vancouver. Burnaby, BC: Metro Vancouver.

Tri-Star Environmental Consulting. 2018. *2016 Boundary Bay Ambient Monitoring Program Water Column Monitoring Report*. Commissioned by Metro Vancouver. Burnaby, BC: Metro Vancouver.

Tri-Star Environmental Consulting. 2018. *2017 Boundary Bay Ambient Monitoring Program Water Column Monitoring Report*. Commissioned by Metro Vancouver. Burnaby, BC: Metro Vancouver

Key Manhole Monitoring

Stantec (2018). *Metro Vancouver Key Manhole Monitoring Program: Fraser Sewerage Area 2014 and 2016 Monitoring Program Report*. Commissioned by Metro Vancouver. Burnaby, BC: Metro Vancouver.

Stantec (2019). *Metro Vancouver Key Manhole Monitoring Program: North Shore Sewerage Area 2013 and 2015 Monitoring Program Report*. Commissioned by Metro Vancouver. Burnaby, BC: Metro Vancouver.

Wastewater Treatment Plant Effluent Discharge Objectives

Tri-Star Environmental Consulting. 2018. Potential Effluent Discharge Objectives for the Proposed Regional Northwest Langley Wastewater Treatment Plant. Commissioned by Metro Vancouver. Burnaby, BC: Metro Vancouver

Tri-Star Environmental Consulting. 2018. Potential Effluent Discharge Objectives for the Iona Island Wastewater Treatment Plant Secondary Upgrade. Commissioned by Metro Vancouver. Burnaby, BC: Metro Vancouver