metrovancouver

Iona Island Wastewater Treatment Plant Projects – Conceptual Design

Background Paper

May 2022

Prepared by: Project Delivery

metrovancouver

Together we make our region strong

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1.0 About Metro Vancouver

Metro Vancouver is a diverse organization that plans for and delivers regional-scale utility services. It also regulates air quality, plans for urban growth, manages a regional parks system, and provides affordable housing.

The governance framework under which Metro Vancouver operates consists of four separate legal entities, each with specific legislation. These include:

- The Metro Vancouver Regional District (MVRD)
- The Greater Vancouver Water District (GVWD)
- The Greater Vancouver Sewerage and Drainage District (GVS&DD)
- Metro Vancouver Housing Corporation (MVHC)

The Greater Vancouver Sewerage and Drainage District Board oversees the planning and management of the region's wastewater collection and treatment, including wastewater treatment plant upgrades and expansions.

Vision

Metro Vancouver embraces collaboration and innovation in providing sustainable regional services that contribute to a livable and resilient region and a healthy natural environment for current and future generations.

Mission

Metro Vancouver's mission is framed around three broad roles:

1. Serve as a Regional Federation

Serve as the main political forum for discussion of significant community issues at the regional level and facilitate the collaboration of members in delivering the services best provided at the regional level.

2. Deliver Core Services

Provide regional utility services related to drinking water, liquid waste and solid waste to members. Provide regional services, including parks and affordable housing, directly to residents and act as the local government for Electoral Area A.

3. Plan for the Region

Carry out planning and regulatory responsibilities related to the three utility services as well as air quality and climate change, regional planning, regional parks, Electoral Area A, affordable housing, labour relations, regional economic prosperity, and regional emergency management.

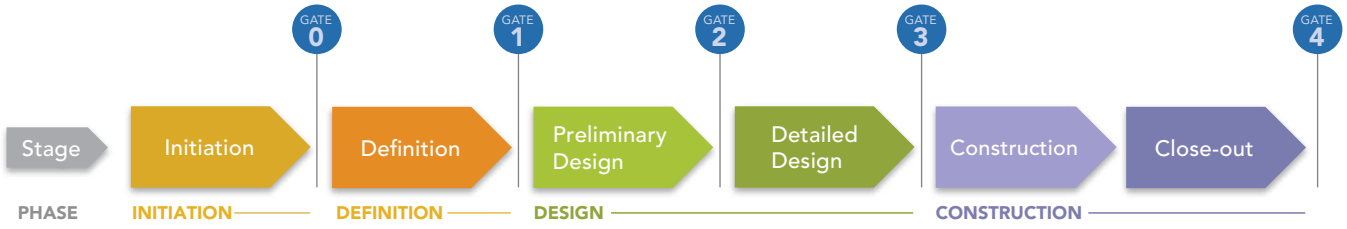
2.0 Introduction

On March 25, 2022, the GVS&DD Board approved the design concept for the Iona Island Wastewater Treatment Plant Projects. The design concept includes tertiary treatment and a range of ecological restoration projects. The treatment plant is being upgraded to meet and exceed provincial and federal regulatory requirements. The upgraded treatment plant will significantly improve the treated wastewater released into the Salish Sea.

The Iona Island Wastewater Treatment Plant Projects are currently in the preliminary design phase.

Key terms in this report:

- **Project definition report (PDR):** The report delivered at the end of the project definition phase that includes a conceptual design together with a project schedule, budget, and recommended delivery strategy.
- **Conceptual design:** Establishes a design basis for the project and a plan for how it will be implemented. The conceptual design is an outcome of the project definition and is documented in the PDR.
- **Preliminary design phase:** Further advances the design following approval of the project definition report. Preliminary design is followed by detailed design.
- **Stage gate:** A process that provides decision makers with the opportunity to make informed decisions at key points through the development and implementation of the project.



Metro Vancouver's Stage Gate Process

3.0 Background

What is wastewater?

Wastewater includes a number of waste products collected from homes and businesses primarily through the sewer system. Wastewater treatment is the process of removing contaminants from the collected wastewater. Treatment processes are designed to remove total suspended solids (TSS) as well as other contaminants and reduce the biological oxygen demand (BOD) of the treated wastewater, or effluent, released to the marine environment.

Iona Island Wastewater Treatment Plant

The Iona Island Wastewater Treatment Plant (IIWWTP or 'the plant') is a primary treatment facility that serves approximately 750,000 residents in the Vancouver Sewerage Area (VSA). The existing treatment facility is one of the last plants on the west coast of North America to provide only primary level wastewater treatment. It is highly vulnerable to both earthquakes and sea level rise. Much of the existing IIWWTP is reaching the end of its service life.

Vancouver Sewerage Area: The Vancouver Sewerage Area treats wastewater from Burnaby, Richmond, Vancouver, Electoral Area A, and UBC.

Place

The Fraser River estuary, where **xʷəyeyət** (Iona Island) and the treatment plant are located, is British Columbia's largest and most threatened estuary. It is one of the most important salmon rivers in the world, providing critical rearing habitat for millions of juvenile salmon. It is also a stopover for millions of birds as they migrate along the Pacific Flyway, and is home to a large variety of ecosystems including the regionally and provincially rare coastal sand dune ecosystem.

The existing plant discharges treated effluent to the Salish Sea through a deep sea outfall. It is located in Richmond, BC, in close proximity to **xʷməθkʷəy̓əm** (Musqueam) Indian Band Reserves #2 and #3 and the Vancouver International Airport (YVR), and is surrounded by Iona Beach Regional Park.

History

The current plant was designed in the 1950s to treat an average dry weather flow of 160 Megalitres per day (ML/d). The plant was commissioned in 1963 and underwent multiple expansions and infrastructure upgrades from 1972 and beyond. Today, the plant treats an average flow of 496 ML/d — more than triple the original capacity.

Regulatory Requirements

Metro Vancouver's 2011 Liquid Waste Management **Plan** (approved by the provincial Minister of Environment), and federal Wastewater Systems Effluent Regulation, legislated in 2012, require that the plant be upgraded to secondary treatment no later than December 31, 2030.

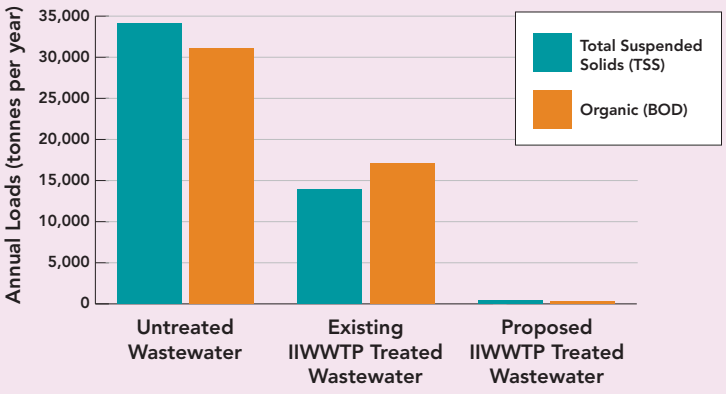
Project Goals

The upgraded plant and related ecological projects are proposed to:

- Improve the level of treatment from primary to tertiary (beyond the regulated secondary treatment requirement) to protect water quality and the marine environment
- Recover sustainable energy and resources from wastewater
- Withstand earthquakes and sea level rise
- Integrate with Iona Beach Regional Park and the surrounding environment
- Restore estuary health and fish habitat, protect bird habitat, and enhance terrestrial and freshwater ecosystems
- Minimize odours
- Connect people to nature
- Integrate **xʷməθkʷəy̓əm** (Musqueam) cultural values and interests

The IIWWTP upgrades will roughly double the treatment efficiency of the plant, removing about 35,000 tonnes of contaminants per year from the effluent discharged to the Salish Sea. The upgraded plant significantly reduces TSS and BOD by over 90% in the treated effluent relative to the existing plant. TSS and BOD are standard measures of contaminants found in wastewater and are key metrics in regulatory requirements for municipal wastewater treatment plants.

Comparing Annual Solids & Organic Discharge



4.0 Project Definition – How We Got Here

A comprehensive study was done in 2008 and 2009 that evaluated alternative options for future upgrading and expansion of the IIWWTP. This included various scenarios for alternate treatment plant locations, including smaller distributed treatment facilities in the VSA as well as other locations near **xʷəyeyət** (Iona Island) for a new centralized plant. The recommendation from the study was to upgrade the primary and secondary treatment processes at the current IIWWTP location.

The project definition phase was initiated in 2018 adopting a multi-disciplinary integrated design process (IDP) supported by public and First Nations engagement. The project definition team did a more recent review in late 2020 of alternate sites for a consolidated treatment plant and confirmed the conclusions of the earlier study. **xʷəyeyət** (Iona Island) remains the recommended location for the WWTP from a cost, risk and schedule perspective.

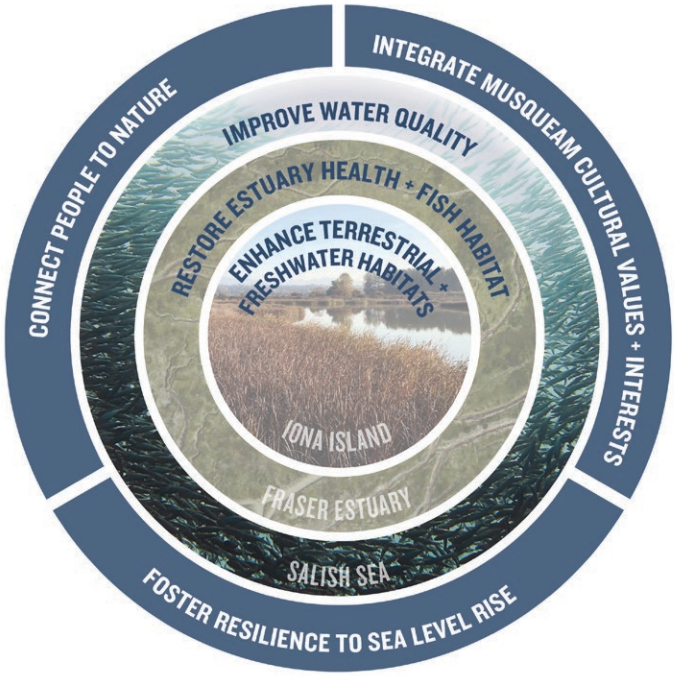
In July 2020, Metro Vancouver's Board of Directors endorsed an initial design concept, which included tertiary level treatment for the new plant, resource recovery opportunities, integration with Iona Beach Regional Park, and a range of ecological projects. With the transition of the projects to Metro Vancouver's new Project Delivery department at that time, the focus shifted to updating the project schedule and cost estimates, which included a more detailed assessment of constructability, risk, and delivery strategy. This identified several challenges, resulting in delayed project completion with significantly higher than previously anticipated estimated costs.

In July 2021, the Board was provided information on these challenges, updated cost estimates and schedule, as well as the work being undertaken to address the identified challenges. This work included value engineering and a comprehensive challenge review of the project definition by a team of independent global experts, tasked with making recommendations to reduce costs and increase value.

In November 2021, the Board endorsed a revised design concept — based on recommendations from the challenge review — addressing the challenges identified and showing a potential capital cost savings of up to 10%. The Board also directed staff to finalize the project definition report for Board approval in March 2022 and to hold a special Board meeting to receive and fully consider project information, including the costs.

In February 2022, a Special Meeting of the GVS&DD Board was held to provide Board members and others with additional information about the projects. A recording of the meeting is available on the Metro Vancouver **website**.

In March 2022, the Board approved the Project Definition Report and design concept for the IIWWTP projects.



5.0 Reconciliation and First Nations Engagement

Metro Vancouver is engaging 14 First Nations on the projects and is working closely with the **xʷməθkʷəy̓əm** (Musqueam) Indian Band, whose primary reserve lands are directly across the Fraser River. Metro Vancouver has incorporated the ecological priorities and interests shared with the design team by **xʷməθkʷəy̓əm** (Musqueam) into the conceptual design.

xʷməθkʷəy̓əm (Musqueam) priorities include:

- Supporting fish and fish habitat
- Designing **xʷəyeyət** (Iona Island) ecosystems that support traditional harvesting
- Breaching the jetties and causeway
- Allowing **xʷməθkʷəy̓əm** (Musqueam) access for traditional resource use, cultural practices, and knowledge transfer
- Ensuring the work plan extends beyond 2034 and considers future generations

Metro Vancouver and **xʷməθkʷəy̓əm** (Musqueam) are working together to identify economic and development opportunities for **xʷməθkʷəy̓əm** (Musqueam) Indian Band and its community members. Metro Vancouver also regularly works with **xʷməθkʷəy̓əm** (Musqueam) to review the projects and multiple permitting requirements.

Reconciliation through Partnership:

- Employment and apprenticeship training opportunities
- Procurement opportunities for Musqueam owned and affiliated businesses
- Involvement in the development of ecological restoration projects
- Developing a relationship agreement with Musqueam (currently underway)

6.0 Public and Stakeholder Engagement

Engagement for the project definition phase began in 2018 and included member jurisdictions, the public, key stakeholders, and First Nations. Most recently, staff provided updates and sought feedback on aspects of the projects that could be revised, based on the work undertaken to address the technical and budgetary challenges.

A summary of all engagement activities was presented to the GVS&DD Board as part of the final project definition report in March 2022 and included information on how Metro Vancouver integrated feedback received to inform the design of the treatment plant and ecological projects.

Public engagement periods during the project definition phase were:

- 2018 to 2019 – Listen & Learn
- 2019 to 2021 – Initial Design Concept
- 2021 – Revised Design Concept

Who we engaged with (2018 – 2021)

7.0 Project Description – Key Components

Implementing upgrades to the plant as required by law provides Metro Vancouver with an opportunity to implement one of Canada's most dynamic and transformative urban sustainability projects. The proposed conceptual design, approved by the Board in March 2022, follows the goals outlined in the **2019-2022 Board Strategic Plan** (page 22) to manage our liquid waste, build resilience, ensure financial sustainability, and foster collaboration and engagement.

The IIWWTP Projects are made up of these key components and features:

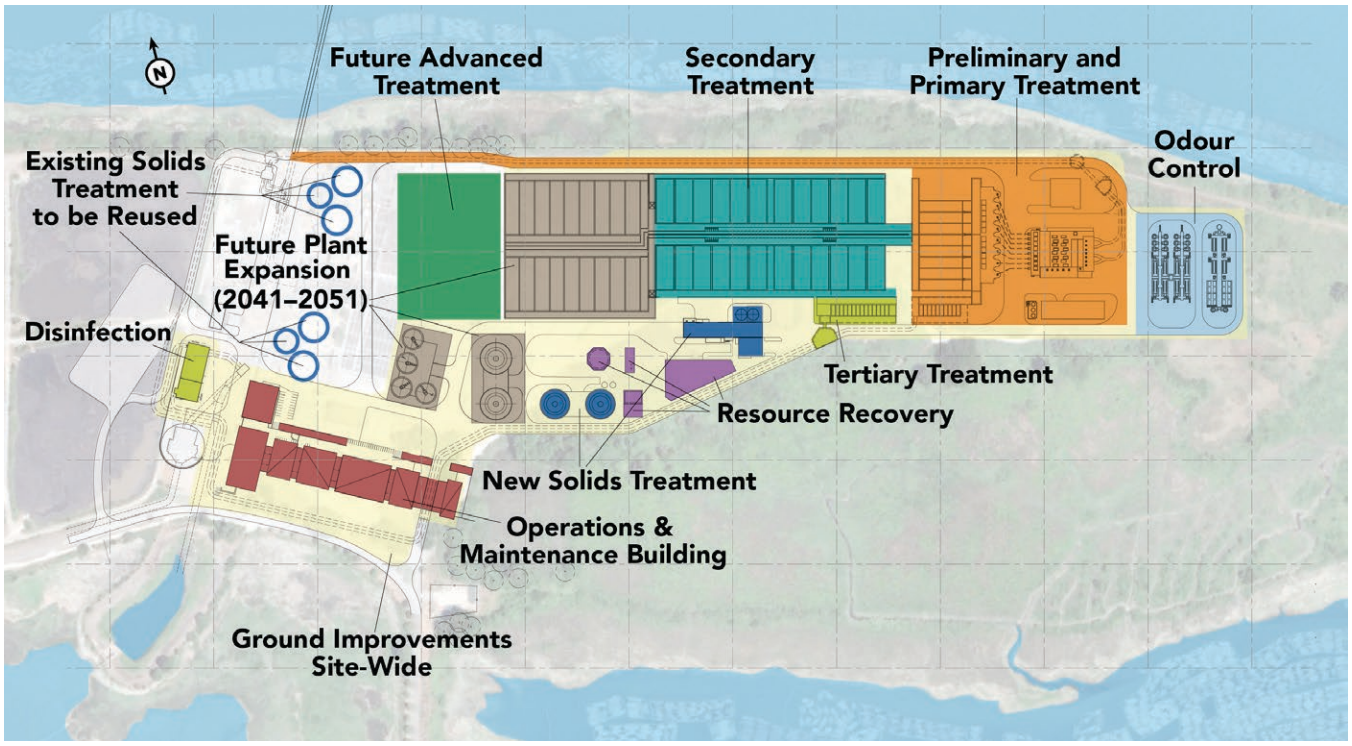
- Early and enabling works
- Ground improvements
- Preliminary and primary treatment
- Secondary treatment
- Tertiary treatment and disinfection
- Solids treatment
- Odour control
- Operations and maintenance building (including regional laboratory and welcome centre)
- Resource recovery opportunities (including biogas generation, reclaimed water distribution, district energy heating, and biosolids beneficial use)
- Future advanced treatment
- Ecological restoration projects (designed to improve water quality, restore fish habitat, improve and protect bird habitat, and enhance terrestrial ecosystems)
- Transportation and utility upgrades
- Integration with Iona Beach Regional Park and surrounding communities

Projects by the Numbers

Concrete Volume: The Iona plant upgrades will require 240,000 m^3 of concrete, which is equivalent to 40,000 truckloads or a 40 m high layer on top of a football field.

Rebar: The construction of the secondary treatment upgrades will require 32,000 tonnes of reinforcing steel bars, which if placed end to end would extend nearly halfway around the earth's equator (18,700 km).

Piles: The conceptual design assumes that over 80,000 tonnes of steel piles will be used to support new structures and tanks constructed for the plant's secondary upgrades.



Proposed WWTP upgrades – key components

Early and Enabling Works

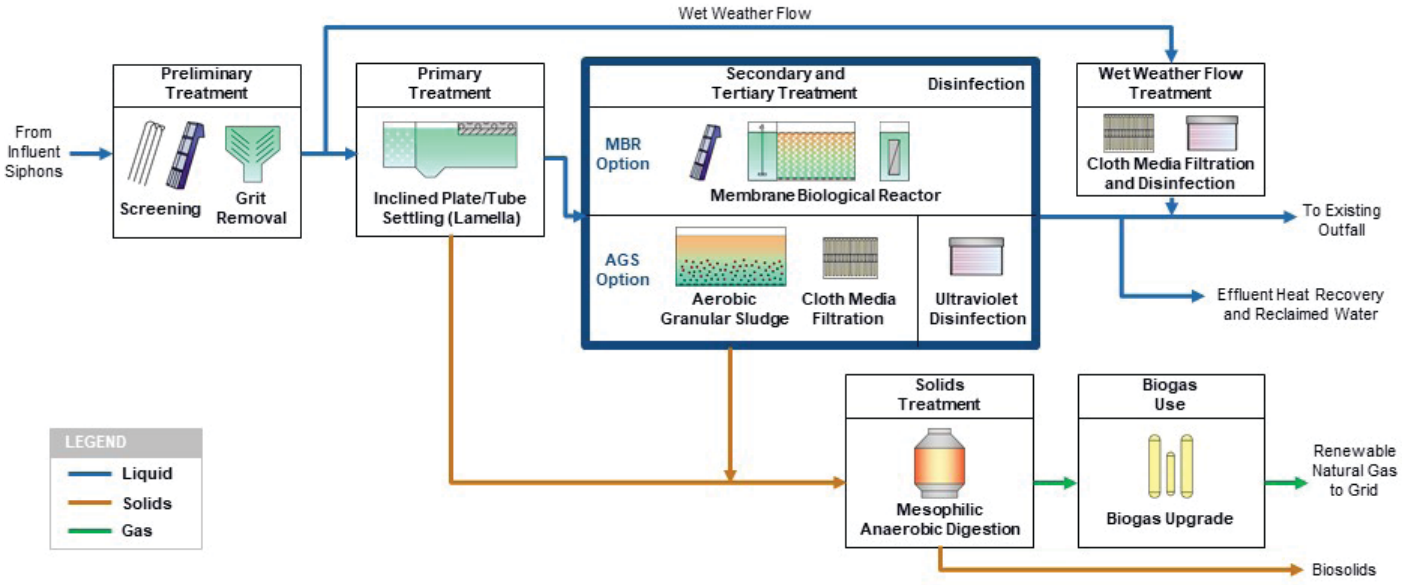
Several early and enabling works projects are required to support the wastewater treatment plant upgrade construction and prepare the site. These include removal of the existing biosolids stockpiles, desludging of the current lagoons, access road upgrades along Ferguson Road and the causeway, a barge berth for materials transportation during construction, and electrical power upgrades for the upgraded plant and construction needs. In addition to being critical for the project schedule, these individual projects also have complex permitting and stakeholder engagement needs.

Ground Improvements

Extensive and costly ground improvements are required across all infrastructure components to support the treatment plant upgrades because of challenging geotechnical conditions in the Fraser River Delta. Ground improvements to meet seismic design considerations include stone columns, site preload, and an underground seismic barrier. Building and tank foundations will also include 60m-deep piles.

These ground improvements allow the wastewater treatment plant to withstand a large magnitude earthquake while also accommodating future sea level rise. The conceptual design shows the ground on which new components will be constructed raised to 6.6 m above sea level, well beyond the level needed to address year 2100 sea level rise projections for the area.

Given the unique nature of the site, ground improvements are estimated to be roughly 20% of total project costs across the following new treatment processes they would support.



Simplified block flow diagram of proposed WWTP treatment processes

Preliminary and Primary Treatment

The existing **xʷəyeyət** (Iona Island) plant has preliminary and primary treatment facilities that are largely past their service life and do not meet current seismic standards. This infrastructure must be replaced and will be built concurrently with the new secondary and tertiary treatment upgrades. Some of the existing plant infrastructure, specifically the solid treatment facilities, will be refurbished and reused to help reduce initial capital costs.

Preliminary treatment includes the screening and pumping of raw untreated wastewater followed by removal of the grit that enters a wastewater treatment plant from the sewer system. The materials removed by the screening process will be washed and trucked to the Metro Vancouver Waste-to-Energy facility and the grit will either be processed for beneficial reuse on-site or hauled to a landfill.

Flows from the preliminary treatment system in excess of two times average dry weather flow will be diverted to cloth media filters for treatment to remove suspended solids and blended with filtered secondary effluent. The use of cloth media filters to treat wet weather flows is a recent innovative development in the industry and offers Metro Vancouver the advantages of a small plant footprint, high treatment efficiency, and low operations and maintenance costs.

Up to two times average dry weather flow from the preliminary treatment system will flow to the primary treatment system, which will be based on lamella clarifier technology. The purpose of primary treatment is to remove organic carbon in the form of suspended solids. Lamella clarifiers employ inclined plates to dramatically increase the surface settling area of the tanks, thereby significantly reducing plant footprint requirements. The primary effluent from the lamella clarifiers will flow to the secondary treatment process and primary sludge will be pumped to a thickening process.

Replacing the existing preliminary and primary treatment components is estimated to be around 34% of the total project costs.

Secondary Treatment

Primary effluent will flow by gravity to the secondary treatment process, which is intended to remove suspended, colloidal, and soluble organic matter carried over in the primary effluent while achieving a minimum of seasonal nitrogen removal. Secondary treatment includes both physical and biological processes that remove more than 90% per cent of BOD and TSS, significantly reducing contaminants in the effluent released into the local environment.

As presented to the GVS&DD Board in November 2021, the flexibility of two potential secondary treatment technologies — either the Membrane Bioreactor (MBR) or Aerobic Granular Sludge (AGS) — will be evaluated further during the next phases of design. Additional due diligence, to help ensure the most cost-effective project is implemented, will include:

- undertaking a comprehensive pilot testing of both the MBR and AGS technologies to evaluate how each performs based on expected operating conditions at the IIWWTP and identify the best technology for the upgrades; and
- further advancing technical and commercial discussions with potential technology vendors.

These steps will help to further refine the design, as well as the expected performance and costs of the wastewater treatment process at the scale of the IIWWTP upgrade.

The construction of new secondary treatment facilities is estimated to be 49% of the total project costs.

Tertiary Treatment and Disinfection

Tertiary treatment involves advanced wastewater treatment processes used to improve effluent quality beyond that achieved by secondary treatment. The type of tertiary treatment used at a treatment plant depends primarily on the receiving water characteristics and the corresponding specific objectives for that plant. Tertiary treatment can be designed to remove additional (i) colloidal solids, (ii) dissolved constituents and, (iii) nutrients such as ammonia-nitrogen and phosphorus.

This higher level of treatment is proposed at the IIWWTP to:

- further remove fine solids particles from the effluent released to the Salish Sea
- further reduce oxygen demand in the Salish Sea, whose deteriorating health is harming southern resident killer whales, and their habitat and food sources
- remove additional contaminants of emerging concern, which are being considered for future regulation by the provincial Ministry of Environment and Climate Change Strategy
- address concerns expressed by **xʷməθkʷəy̓əm** (Musqueam), other First Nations, environmental groups, and residents of Metro Vancouver

The wastewater effluent will be disinfected using ultraviolet (UV) treatment before being pumped to the Salish Sea through the existing deep sea outfall.

The addition of tertiary treatment, including dual use for treating wet weather flows and UV disinfection, accounts for about 3% of total project costs.

Contaminants of Emerging Concern

The existing primary treatment process at the IIWWTP removes minimal persistent organic compounds, such as contaminants of emerging concern (CECs). These are particularly concerning because of their potential impacts on the receiving environment. Secondary treatment processes significantly improve the removal of some CECs by 20–40%.

Solids Treatment

Wastewater plants include treatment of both the liquid wastewater and the treatment of the solids removed from the wastewater, before beneficial reuse and disposal. To reduce capital costs, much of the existing solids treatment facilities at IIWWTP will be refurbished and reused. However, additional solids treatment infrastructure, including two new mesophilic anaerobic digesters, need to be built to treat the additional solids removed from the liquid waste stream by upgrading from primary to secondary and tertiary levels of treatment.

A key planning decision has been to reuse as much of the existing solids treatment infrastructure at IIWWTP as possible to reduce costs and allow for future consideration of new technologies to expand or replace aging solids treatment process units, potentially involving integrating hydrothermal processing which is currently being pilot-tested by Metro Vancouver.

Odour Control

In the conceptual design, odour emissions from the new plant are controlled using prevention, containment, treatment, and dispersion through upgraded odour control treatment systems. These measures will result in a significant reduction in odour experienced by **xʷməθkʷəy̓əm** (Musqueam) community members, Iona Beach Regional Park users, and nearby residents and businesses.

Operations and Maintenance (O&M) Building

The upgraded treatment plant will require roughly double the number of O&M staff as that needed for the existing primary level facilities. The O&M building is the operational centre of the plant, complete with upgraded and expanded electrical, maintenance and instrumentation shops, as well as a new controls system and staff working space. The facility will include a new regional laboratory for analyzing wastewater and treatment plant performance, including new technologies to help improve efficiencies and reduce overall regional laboratory costs. Located near the plant entrance, the building will include a publically accessible space serving as a Welcome Centre, that will also provide an opportunity to showcase **xʷməθkʷəy̓əm** (Musqueam) culture.

Resource Recovery Opportunities

Maximizing resource recovery and opportunities to reduce greenhouse gas emissions are key goals considered throughout the project definition phases.

The conceptual design includes resource recovery opportunities that help support the region's carbon neutrality objectives, including:

- Reclaimed water from the plant could be used for irrigation (e.g. golf courses) or to replenish freshwater wetlands, with opportunities to use nutrients from the plant to meet the ecological needs of the receiving ecosystems.
- Biosolids generated from the wastewater treatment processes could be used as a soil amendment for upland habitat restoration projects, with the potential to use biosolids and reclaimed water for on-site native plant propagation, if deemed feasible.
- Biogas produced in the digestion process would continue to be captured and used at the plant to generate heat and power for the plant operations.

- Biomethane (renewable natural gas), converted from biogas, could be sold to FortisBC and injected into the natural gas grid to avoid the consumption of other higher carbon fossil fuels.
- Excess heat from the treated wastewater could be used as a heat source for offsite district energy facilities. Heat would be supplied to these offsite facilities through an effluent pipeline distribution system that could also serve reclaimed water reuse.

The resource recovery initiatives included in the project cost estimates are about 4% of total project capital costs.

The cost estimate includes resource recovery at the wastewater treatment plant itself and the infrastructure to support a future effluent pipeline distribution system that could be used for both district energy facilities and reclaimed water reuse. Future opportunities and offsite infrastructure (e.g. district energy facilities) are not included in the project cost estimates.

Achieving Carbon Neutrality by 2050

The overall project is projected to result in a net reduction of regional emissions of approximately **5,800 tonnes of CO2 per year.** This is equivalent to removing **almost 1,600 passenger vehicles from the roads for one year or reducing the energy-based emissions from nearly 1,250 homes for one year.**

The reduction is attributed to:

- producing renewable natural gas from biogas processing, which offsets the emissions from biogas flaring
- upgrading the biogas system
- offsite production of electricity for the plant
- residuals hauling
- chemical consumption

Future Advanced Treatment

Future advanced technologies will increase the removal of contaminants of emerging concern (CECs) such as pharmaceuticals and micro-plastics. The new treatment plant will enable the implementation of advanced technologies and future treatment process upgrades to address CECs. The IIWWTP Project has reserved space on the site for technologies that may not be commercially mature at this time, but are projected to be more established when the next plant expansion is required by 2051.

The west side of the site has been reserved for the implementation of future advanced treatment for removal of additional CECs. CECs are facing increased scrutiny from the public, First Nations, and regulators throughout the world and research on these advanced technologies has advanced considerably in recent years.

As an extension of the pilot testing program that will be initiated in 2022 to confirm secondary treatment technology performance and refine design parameters, Metro Vancouver intends to carry out a later advanced treatment pilot testing program. These pilot programs provide opportunities for information sharing between Metro Vancouver, local academic institutions, and global wastewater industry associations.

Ecological Restoration Projects

Existing infrastructure in the Fraser River Estuary — such as the causeway and jetties built as part of the existing treatment plant — has disrupted natural estuary processes. An example is the reduced mixing of fresh and saltwater, which is important for young salmon as they acclimatize to the sea. These juvenile salmon, including Chinook salmon, grow to be an important prey of southern resident killer whales.

Fraser River Estuary Biodiversity at Risk

A recent study found that if we continue with business as usual, two thirds of species within the Fraser River Estuary have less than a 50% probability of persistence over the next 25 years. The study also found that we have the tools — strategic planning, attention to governance, and large-scale investment — "to effectively curtail biodiversity loss, but we must employ them while there is still time to act."

The proposed park and ecological projects will restore estuary health and fish habitat by reconnecting the river and sea through reopening the causeway, creating off-channel habitat, and restoring intertidal wetlands. This will help out-migrating juvenile salmon access critical rearing habitat in Sturgeon Bank more directly, and benefit a diversity of aquatic species. Regenerating and expanding the freshwater wetland complex and restoring uplands areas will enhance native and novel habitats on Iona Island and benefit a diversity of species, notably the large number of birds that use the island as a stopover on their migration route.

Climate Adaptation

By restoring the foreshore and implementing ecosystem-based flood protection strategies, the ecological restoration projects will help the island's tidal habitats keep pace with sea level rise and provide a measure of protection for the plant and island from sea level rise, king tides, and storm waves.

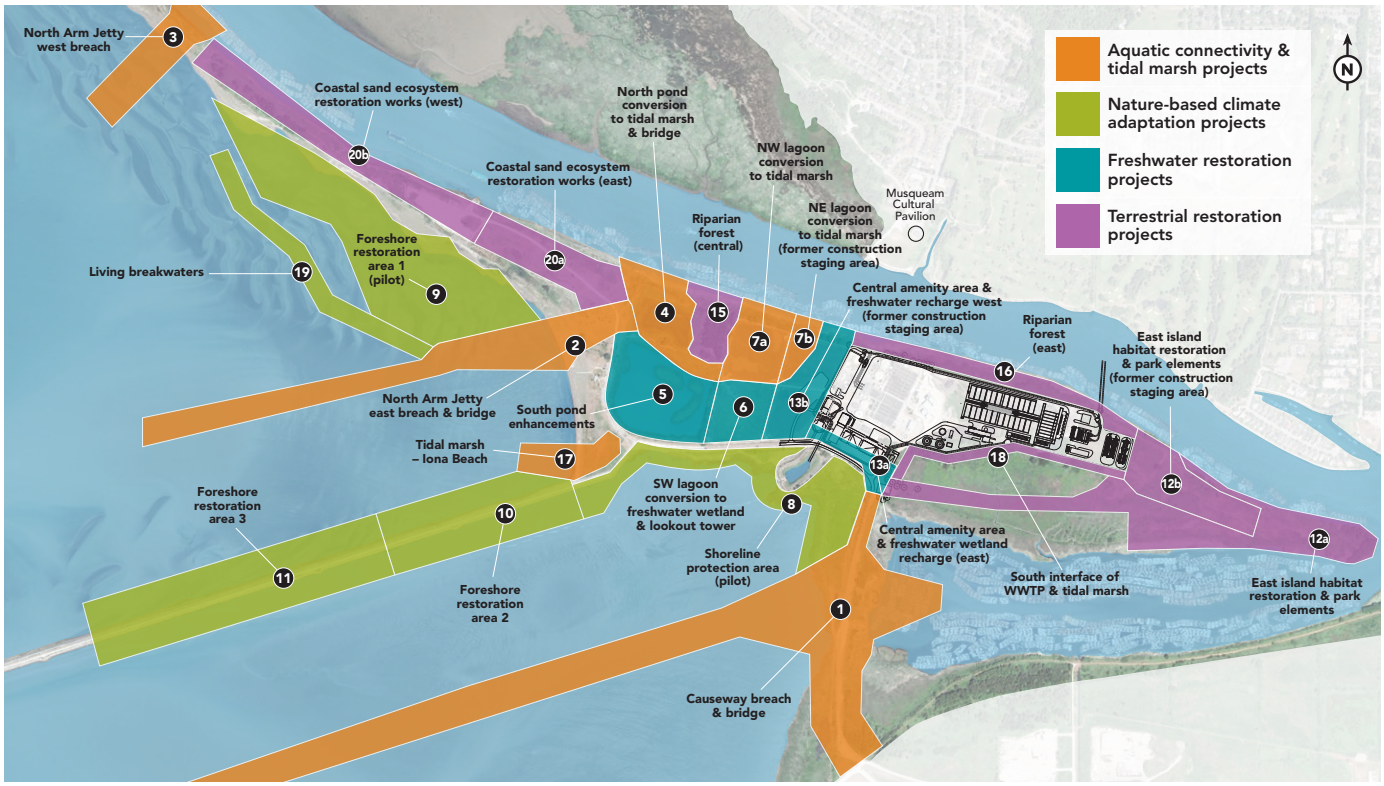
"The Fraser River Basin drains more than a quarter of British Columbia and supports more salmon runs than any other river in the world." (source: Rivershed Society)

Rendering of Iona Beach Regional Park after completion of projects

Iona Beach Regional Park and Community Integration

Iona Beach Regional Park connects more than 400,000 visitors per year to nature while being in close proximity to the city. The projects create increased visitor opportunities for connecting to nature, such as experiencing restored intertidal, freshwater, and coastal sand dune ecosystems.

The proposed ecological restoration projects would support the integration of the wastewater treatment plant with Iona Beach Regional Park and the community, increase park visitor connection to nature, contribute to nature-based climate change adaptation, while restoring the Island's diverse and sensitive ecosystems. The ecological restoration projects to be undertaken before, during, and after the treatment plant construction together make up about 3% of total estimated project costs. These projects also provide environmental compensation required to secure permits and regulatory approvals for the plant construction and are also instrumental in building community support for the IIWWTP upgrades.



Proposed Ecological Restoration Projects

Aquatic connectivity and tidal marsh projects (1, 2, 3, 4, 7a, 7b, 17)

This group of projects re-establishes aquatic connectivity between the Fraser River and Sturgeon Bank by opening several breaches through the north jetty and causeway. This will help out-migrating juvenile salmon acclimatize to salt water conditions and access critical rearing habitat. The existing north pond and northwest sludge lagoon will be restored to tidal marsh providing off-channel habitat for salmon and other aquatic species. Bridges over the causeway and jetty breaches will be designed for climate and seismic resilience, and to provide safe access for visitors, IIWWTP and park staff.

Nature-based climate adaptation projects (8, 9, 10, 11, 19)

This suite of projects aims to provide nature-based flood protection strategies to help **xʷəyeyət**'s (Iona Island's) tidal habitats keep pace with sea-level rise, while providing a measure of flood protection for **xʷəyeyət** (Iona Island) through wave mitigation. Living breakwaters are proposed as a pilot project in the interjetty area to reduce wave energy and retain sediment close to shore, and a thin-layer sediment augmentation pilot in the same area will seek to help tidal habitats keep pace with sea-level rise.

Freshwater restoration projects (5, 6,13a ,13b)

The conceptual design aims to enhance the quality of native and novel habitats on **xʷəyeyət** (Iona Island), including freshwater wetlands. These enhancements will benefit a diversity of species at **xʷəyeyət** (Iona Island), especially the huge numbers of birds that use the island and foreshore as a stopover along their migration route. Freshwater habitat enhancements include: creating deeper water zones and more riparian shading for cooler water temperatures; incorporating nesting, basking and overwintering habitat elements for western painted turtles; and adding an inflow stream of high quality treated effluent from the new IIWWTP. Look out towers, dipping docks and bird blinds will provide improved access for park visitors.

Terrestrial restoration projects (12a, 12b, 15, 16, 18, 20a & 20b)

Through the terrestrial restoration projects, located throughout **xʷəyeyət** (Iona Island), riparian cottonwood forest and the rare coastal sand ecosystems will be expanded by converting invasive-dominated shrub-grassland to these ecologically important habitat types. Cottonwood forest is also nurtured along the north edge of **xʷəyeyət** (Iona Island) to improve riparian habitat and to help screen views of the IIWWTP from the north. Trails and boardwalks will be built to connect park visitors with nature.

Ecological Restoration Projects and Reconciliation

The ecological restoration projects are also part of our work to redress the effect of the plant's construction in the 1960s and on-going operation on the well-being and cultural practices of **xʷməθkʷəy̓əm** (Musqueam). Acknowledging those impacts and beginning to remedy them are part of Metro Vancouver's reconciliation journey with **xʷməθkʷəy̓əm** (Musqueam) and other First Nations.

PHOTO BY MIKE BAIRD

Rendering of Iona Beach Regional Park after completion of projects

8.0 Project Challenges and Considerations

Treating Wastewater from a Combined Sewer System

The IIWWTP needs to be designed to handle higher wet weather flows than most other treatment plants. This is because the Vancouver Sewerage Area (VSA) has a combined sewer system that carries both sanitary and storm water in a single pipe, leading to higher and longer duration flows during wet weather. The City of Vancouver is continuing work on separating their sanitary and drainage systems and is committed to having the bulk of its combined sewers separated by 2050. Once sewer separation is complete, the wet weather VSA flows will be reduced but will be offset by increased sanitary flows and loading from population increases.

The plant is being designed to account for the same flow capacity the existing plant currently treats to avoid increases in combined sewer overflows from the upstream VSA collection system. If the collection system were separated, as other sewage areas in the region are, the upgrade could have been designed with a somewhat lower capacity. However, constructing the plant to treat higher flow rates now does provide the additional capacity needed to handle future increased population growth once the sewer separation is complete and defers the need for future capacity expansions to later.

Designing the plant to handle wet weather flows from the combined sewer system, as compared to what this could be if the system were separated, are in the order of 10% of the total project costs. As noted above, once the collection system is separated, this is offset by future savings in deferring expansions that would have been required for increased population growth.

Site Challenges

Multiple complex projects will need to be completed to upgrade the plant. Constructability challenges at this location include:

- **Accessibility** due to only one single-lane road to access a site that is located in a remote location. Road use must be shared with cyclists and Iona Beach Regional Park users, which presents a significant safety and traffic management challenge.
- **Limited working space** on a constrained site with limited opportunities for staging that could impact safety and productivity.
- **Construction during ongoing plant operations** requiring multiple challenging tie-ins to the existing, aged facilities.
- **Need to minimize impacts** to nearby residents and **xʷməθkʷəy̓əm** (Musqueam) Indian Band, whose primary lands are directly across the North Arm of the Fraser River, while protecting the unique and sensitive ecosystems on **xʷəyeyət** (Iona Island).

Only one single-lane road exists to access Iona Island and the IIWWTP site.

Proposed Secondary Treatment Technology Selection

The conceptual design proposes evaluating two alternate secondary treatment technologies during further phases of design. These are both advanced secondary wastewater technologies that can include or incorporate a tertiary filtration process. Both technologies feature relatively compact footprints (e.g. smaller tanks) that reduce the extent of costly ground improvements.

Membrane Bioreactor (MBR): An advanced wastewater treatment technology that would combine secondary and tertiary treatment. It is a well-established technology that has been implemented at plants around the world, servicing small towns and large municipalities (similar in size to Vancouver) for over 30 years.

Aerobic Granular Sludge (AGS): An advanced secondary wastewater treatment technology that would be combined with cloth media disc-filters (CMF) to provide secondary and tertiary treatment. This is a leading-edge technology that has been implemented at a handful of locations around the world. Many new plants are being designed to accommodate the AGS technology and several large AGS plants are now under construction.

Both technologies:

- Enable construction of additional digesters in parallel with the upgrades to secondary treatment
- Include flexibility to validate performance and costs in next phases, as well as to address potential commercial considerations as part of due-diligence
- Achieve over 97% total suspended solids and biological oxygen demand removal from the influent waste stream on an annual average basis

Location of the Upgraded Plant and Impacts to Regional Park

In general, the upgraded plant will be located on areas of the island that are currently used for the existing primary treatment plant, sludge lagoons, and biosolids stockpile areas. However, the area of the actual treatment process infrastructure will be larger than the existing plant because of the upgrade to secondary/tertiary levels of treatment.

To address some of the earlier challenges identified, including providing space on site for the concurrent construction of the additional solids handling facilities to avoid trucking sludge, the proposed footprint of the plant includes a limited extension (approximately 3 ha) into Metro Vancouver Regional District (MVRD) park land. The land proposed is predominantly overgrown with invasive species. Existing GVS&DD tenure land is available to both the south and west of the proposed layout and use of these lands for the plant upgrades would not have required land tenure changes. However, key considerations in selecting the proposed layout of the plant included:

- avoiding impacts to the sensitive ecosystems and salmon bearing streams to the south of the new plant
- mitigating visual and other impacts to **xʷməθkʷəy̓əm** (Musqueam) Indian Band on the west end of the existing and future plant.

The limited use of park land will be more than offset by land tenure changes that would result in a larger area of GVS&DD land being transferred to the Regional Park, while also achieving the benefits above.

Permitting and Land Tenure

The projects involve multiple, complex permitting, approvals, and land tenure issues. Land tenure impacts the permitting requirements for certain projects and activities and will be considered as part of permit identification process during the preliminary design phase of the project.

Staff are working closely to develop an agreement that ensures a net gain in quality park land on the island. The land tenure transfer also requires provincial approval, which will include Indigenous Nation and public engagement. Required land tenure changes will be presented to MVRD (Board oversight of regional parks) and GVS&DD later this year.

Priority Delivery Activities Underway

Currently, Metro Vancouver is undertaking activities to prepare the site in order to support delivery of a new treatment plant to achieve regulatory compliance as quickly as possible. These activities support the construction of the projects as proposed in the project definition report and conceptual design.

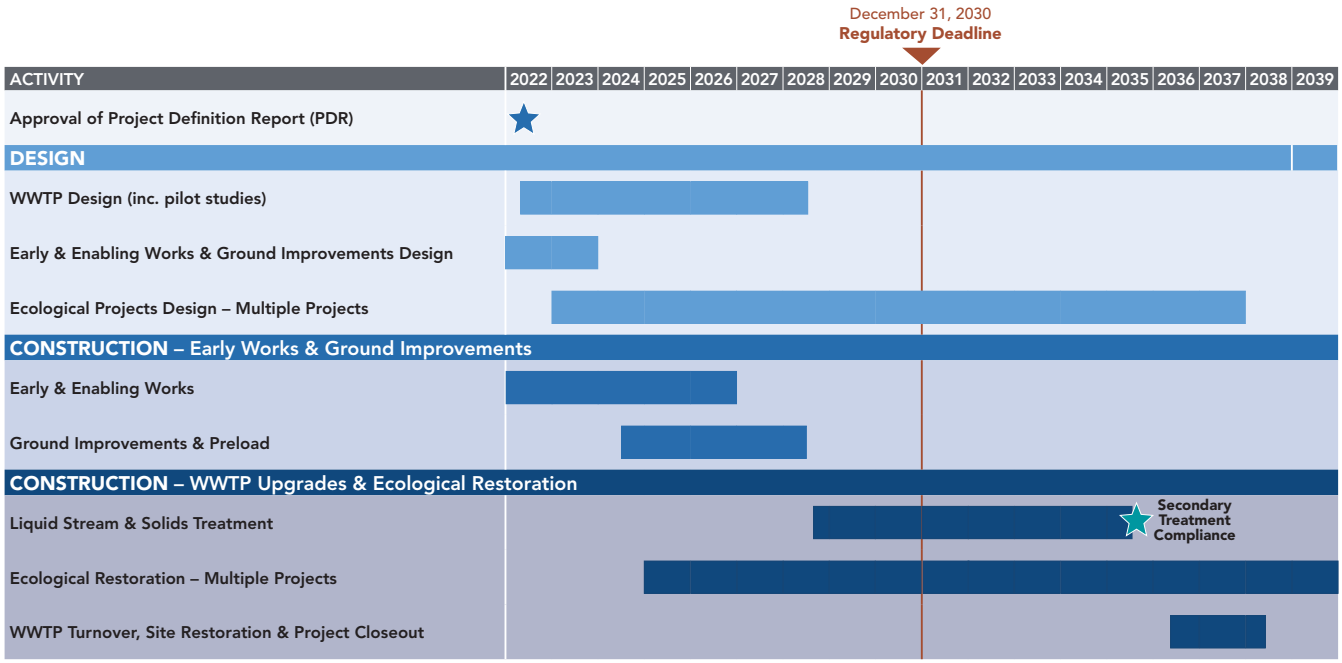
These activities include:

- lagoon cleanout and removal of the biosolids stockpiles
- geotechnical and environmental investigations
- technical studies for ecological restoration projects
- design of a barge berth for materials transportation to accelerate the schedule and mitigate traffic impacts
- planning and preliminary design for access road upgrades, in partnership with YVR, to incorporate safer bicycle and pedestrian pathways

9.0 Project Schedule and Cost Estimates

Schedule Overview

The scale and complexity of the project and the unique nature of the site impact both the timing and duration of construction activities. The estimated project duration (2022–2038) takes these and other challenges into consideration.



Key project delivery activities and milestones

Secondary treatment is anticipated to be operational by mid-2035, which is almost five years after the regulatory deadline of December 31, 2030, and construction is forecast to be complete in 2038.

Before construction of the treatment plant (tanks, buildings, and equipment) can start, several years of intensive work are needed to prepare the site, including cleaning out the sludge lagoons, removing the existing biosolids stockpile, site remediation, and ground improvements. Ground improvement work requires multiple permits and potential land tenure changes. Ground improvements can only begin once the existing biosolids stockpiles are removed and a barge berth is built to allow the extensive volume of materials to be brought into site more efficiently and safely.

Cost Estimate Overview

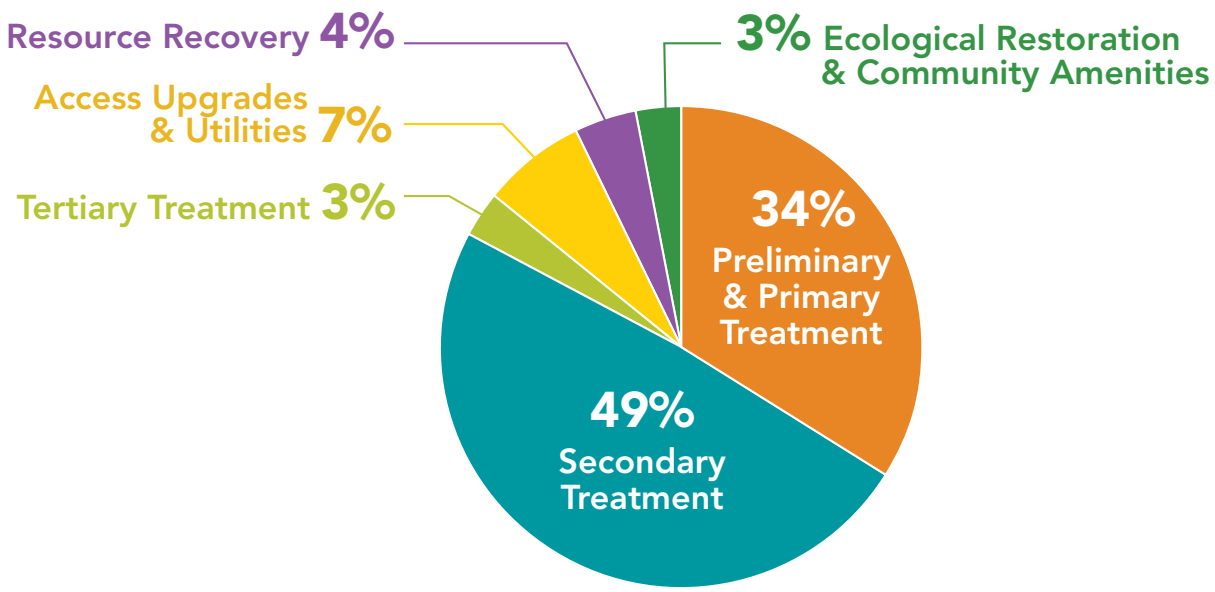
Globally, major infrastructure projects are notorious for going over budget and over time.

Metro Vancouver is working to address these issues by providing a full and realistic cost estimate that explicitly considers risks and escalation and has implemented a Best Practice Project Estimating Framework.

This cost estimating framework includes a rigorous approach to addressing challenges in estimating future costs on large, complex, and lengthy major infrastructure projects, and provides more complete and certain estimates which consider risk, contingency, and escalation of costs over time. Together with a well-developed schedule and sound governance, these are critical factors in setting up major projects for successful delivery.

Using the cost estimating framework, the total estimated cost for the initial July 2020 design concept was:

- $6.7 billion in present value (2021 dollars)
- $10.4 billion when escalation over the duration of the projects and a risk reserve are included



Breakdown of the cost estimate by components

Costs for several common elements of the treatment plant upgrades are included in each of the components in the pie chart above (e.g. ground improvements, reused and new solids treatment , O&M building, and odour control).

Extensive work done to address challenges identified with the initial design concept resulted in a revised design concept, with a potential capital cost savings of up to 10%. In March 2022, the Board approved the design concept and refined cost estimates.

10.0 Project Funding and Financing

Overview

Metro Vancouver is exploring all options for funding and financing the IIWWTP Projects. These include:

- Vigorously pursuing funding and grants from the Government of Canada and Province of BC
- Working with the Municipal Financing Authority (MFA) as our legislated borrower
- Exploring funding opportunities with the Canada Infrastructure Bank (CIB)
- Exploring potential for additional private financing

Metro Vancouver's funding and financing objective is to minimize the annual household impact on regional ratepayers, promote fairness amongst the users paying for the facility, and to ensure that member jurisdictions are able to collect adequate financial resources to meet their own service requirements.

Household Impact Estimate

Currently, Metro Vancouver has modelled funding for the project based on what would come from ratepayers to get a realistic sense of what the household impact could be, under current economic conditions, if no funding is received from other levels of government.

In July 2021, household impact estimates of the IIWWTP Projects for the earlier design concept were calculated based on current policy and legislation, estimated capital cash flows, and operating costs over the life of the project.

Estimated household impact:

- $400–$500 on average per year for Vancouver Sewerage Area households, calculated in in today's dollars
- $60–$115 on average per year for households in other Metro Vancouver sewerage areas

In March 2022, the Board approved the design concept and refined rate impacts.

Efforts to Secure Federal and Provincial Government Funding

Metro Vancouver's current 2022-2026 Financial Plan contains estimated cash flows for the Iona Wastewater Treatment Plant Projects. A significant driver for the replacement of the Iona Plant is the federal and provincial regulatory requirements for secondary treatment. It is critical that local governments are supported in reaching regulatory compliance and Metro Vancouver is seeking co-investment from the federal and provincial governments - with an initial focus on securing equal funding of 1/3 each (Metro Vancouver, Federal, Provincial) for Phase 1 - $750 million over five years.

Should Metro Vancouver be successful in receiving a grant of two thirds for the first phase of work, this would reduce the household impact of the project in Vancouver Sewerage Area by $46 by 2026, and the household impact across the rest of the region by just under $20 by 2026.

Metro Vancouver's Intergovernment Relations Strategy prioritizes securing funding for the Iona Island Wastewater Treatment Plant projects. Significant engagement has been undertaken and will continue to be undertaken with federal and provincial governments and other stakeholders to secure co-investment funding and alleviate the impact on ratepayers in the region.

Other Financing

Due in part to the complex nature of the project as well as potential limitations of traditional financing through the Municipal Finance Authority and the nature of the mandate of the Canada Infrastructure Bank, Metro Vancouver is also exploring working with private financers to deliver on portions of the work that may fit, such as those elements that generate a revenue stream (e.g. waste to energy).

How household impacts are calculated:

The annual household cost estimate is an average based on both capital costs and operating/ maintenance costs, and is calculated on present value basis for the project. Ratepayers will see a gradual increase as costs are spent on the project and actual costs will vary for different properties.

11.0 Accountability and Governance

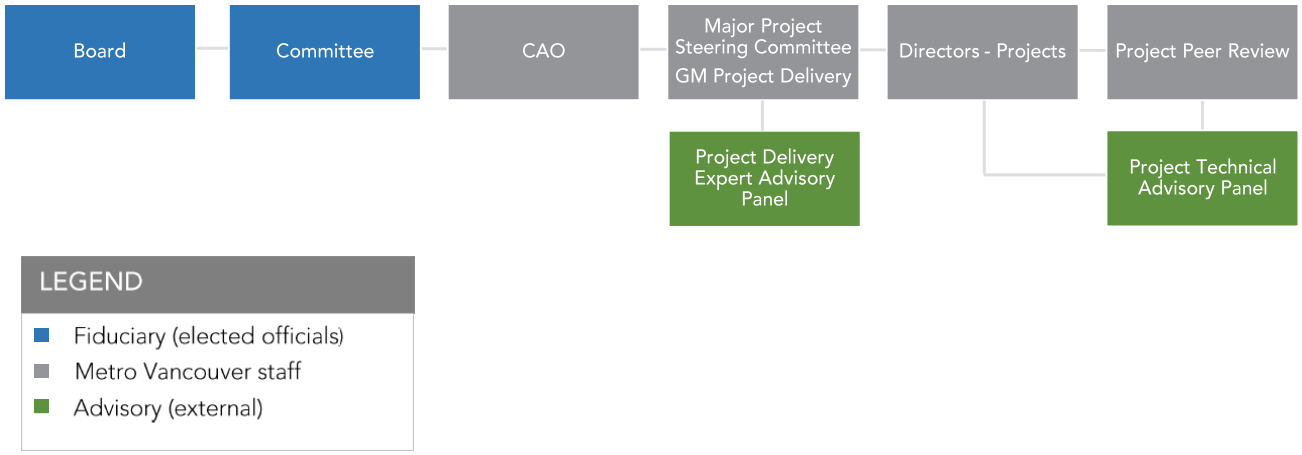
Governance for Major Infrastructure Projects

Good governance enables the right people, to make the right decision, based on the right information, at the right time. To this end, Metro Vancouver has been undertaking significant continuous improvement initiatives to update its project management governance and frameworks to meet the needs of increasingly significant and complex major infrastructure projects.

Delivering major infrastructure projects within the scope and schedule of an original project definition requires significant discipline in the following areas:

- Clarity of vision and unrelenting focus
- Unambiguous accountability and authority
- Extraordinary leadership with experienced and dedicated teams
- High performance culture based on trust and commitment
- High level of transparency
- Consistent political leadership and committed project governance
- Rigorous controls and risk management processes

Current Metro Vancouver Governance Model



Metro Vancouver Governance Initiatives

Metro Vancouver has been implementing enhanced processes to improve project delivery and allow for enhanced governance. Recently introduced processes and frameworks include:

- **Project Management Framework** – Consists of processes, systems, and controls, anchored in project management best practices. (Project Delivery Best Practice Response – Capital Project Governance & Stage Gate Framework – Finance and Intergovernment Committee, May 3, 2021 – Section 5.3 of **PDF**)
- **Best Practice Cost Estimating Framework** – This framework includes a rigorous approach to addressing challenges in estimating future costs on large, complex, and lengthy major infrastructure projects, and provides more complete and realistic estimates which consider risk, contingency, and escalation of costs over time. (Project Delivery Best Practice Response – Project Estimating Framework – Finance and Intergovernment Committee – Nov 6, 2020 – Section 5.2 of **PDF**)
- **Stage Gate Approvals Process** – The stage gate process ensures decision makers have clear opportunities to make informed decisions at key points through the project lifecycle. (Project Delivery Best Practice Response – Capital Project Governance & Stage Gate Framework – Finance and Intergovernment Committee, May 3, 2021 – Section 5.3 of **PDF**)

12.0 Next Steps

The Iona Island Wastewater Treatment Plant Projects have advanced to the preliminary design phase (stage gate 1).

Benefits of WWTP and ecological projects planned on Iona Island

13.0 Glossary

Aerobic Granular Sludge (AGS) — A novel microbial community which allows simultaneous removal of carbon, nitrogen, phosphorus, and other pollutants in a single sludge system.

Biogas — A mixture of gases, primarily consisting of methane and carbon dioxide, produced from raw materials such as agricultural waste, manure, municipal waste, plant material, sewage, green waste, or food waste. It is a renewable energy source.

Biological wastewater treatment process — A treatment process that harnesses the action of bacteria and other microorganisms to clean water. Biological treatments rely on bacteria, nematodes, or other small organisms to break down organic wastes using normal cellular processes.

Biomethane — Also known as renewable natural gas, biomethane is a biogas which has been upgraded to a quality similar to fossil natural gas and having a methane concentration of 90% or greater. By upgrading the quality of methane-based biogas to that of natural gas, it becomes possible to distribute the gas to customers via the existing gas grid within existing appliances. Renewable natural gas is a subset of synthetic natural gas or substitute natural gas (SNG).

Biosolids — Nutrient-rich organic fertilizer and soil conditioner produced from the solids (food and poop) removed in wastewater treatment. Composting takes food and garden waste and through natural biological processes converts these materials into a soil amendment (a material added to a soil to improve its physical properties), or a nutrient rich soil conditioner.

Contaminants of emerging concern (CECs) — A term used by water quality professionals to describe pollutants that have been detected in water bodies that may cause ecological or human health impacts and typically are not regulated under current environmental laws. Sources of these pollutants include agriculture, urban runoff, ordinary household products (such as soaps and disinfectants), and pharmaceuticals that are disposed to sewage treatment plants and subsequently discharged to surface waters.

Effluent — Liquid waste or sewage discharged into a river or the sea.

Major infrastructure project — Major infrastructure projects are by definition very large and costly critical infrastructure investments (typically $1 billion or more), and may be found in all infrastructure sectors. They are usually complex, and almost always involve multiple stakeholders.

Membrane bioreactor (MBR) — The combination of a membrane process like microfiltration or ultrafiltration with a biological wastewater treatment process, the activated sludge process. It is now widely used for municipal and industrial wastewater treatment.

Nitrogen — Nitrogen is a nutrient essential for the growth of all living organisms. However, excessive amounts of nutrients released to the environment by human activities can harm ecosystems and impact human health.

Preload — Preloading is a temporary loading applied at a construction site, to improve subsurface soils primarily by increasing density and horizontal stress.

Project Management Framework — The project management framework consists of processes, systems, and controls, anchored in project management best practices.

Tertiary treatment — Tertiary treatment is an advanced wastewater treatment process used to improve effluent quality beyond that achieved by secondary treatment. The type of tertiary treatment used at a treatment plant depends primarily on the receiving water characteristics and the corresponding specific objectives for that plant. Tertiary treatment can be designed to remove additional (i) colloidal solids, ii) dissolved constituents, and iii) nutrients such as ammonia-nitrogen and phosphorus.

Acronyms:

AGS: Aerobic granular sludge

IIWWTP: Iona Island Wastewater Treatment Plant

MBR: Membrane bioreactor

MR1 / MR2 / MR3: xʷməθkʷəy̓əm (Musqueam) Indian Reserve 1/2/3

VSA: Vancouver Sewerage Area

WWTP: Wastewater Treatment Plant

metrovancouver

Together we make our region strong