

VOLUME I

Vision, Principles & Actions

FINAL DRAFT

CITY OF VANCOUVER | GREENEST CITY

Structure of the Citywide Integrated Rainwater Management Plan

The Citywide Integrated Rainwater Management Plan (IRMP) addresses areas of Vancouver where stormwater is piped directly to either combined sewer or ocean outfalls. Outside of the IRMP study area, two watersheds in Vancouver have remaining surface streams—Still Creek and Musqueam Creek—and are guided by their own integrated stormwater (rainwater) management plans, under separate cover. Stanley Park, which has surface streams, is also excluded from this study area.

Credits

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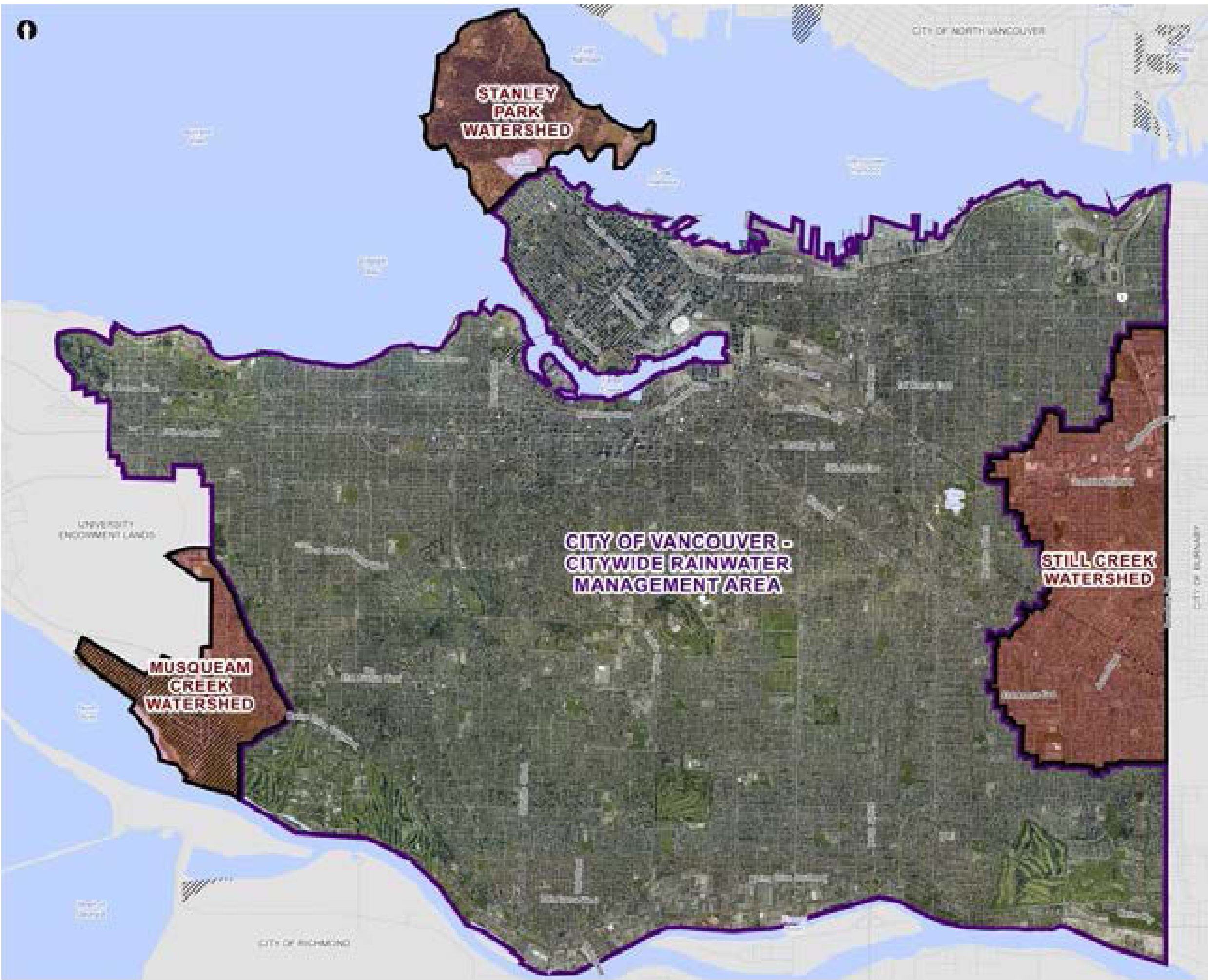
March 2016

Figure I - 1: City of Vancouver - Citywide Rainwater Management Area



The Citywide Integrated Rainwater Management Plan is presented in three volumes:

I. **Vision, Principles and Actions** – a summary of why rainwater management is required, introduction to targets programs to address priorities. (this document)

II. **Best Practice Toolkit** – a guide to common tools to address rainwater management in Vancouver, highlighting their strengths and challenges.

III. **Technical Background Report** (internal) – a detailed record of process, stakeholder input, alternatives considered, technical and financial analysis, program details and action plan.

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VISION FOR THE CITYWIDE IRMP

Vancouver's abundant rainwater is celebrated as a resource:

- To maintain clean water from watersheds to receiving environments.
- To reduce potable water demand;
- To connect people to urban and natural ecosystem functions

1.0 WHY RAINWATER MANAGEMENT?

Links to the Greenest City Action Plan

The City of Vancouver is a leader in sustainability, with an enviable world reputation for innovation. Not resting on this success, the City has established the Greenest City Action Plan (GCAP), with the mission to become the greenest city on earth by the Year 2020.

The three Integrated Stormwater (Rainwater) Management Plans Still, Musqueam and Citywide support the vision and goals of the Greenest City Action Plan. Rainwater management has a relationship with many aspects of GCAP, including:

- **Goal 1**: Green Economy
- **Goal 3**: Green Buildings
- **Goal 6:** Access to Nature
- **Goal 8**: Clean Water

The last Goal—Clean Water— could be refined in GCAP to include the quality of water being released to the environment, which is the primary target of the Citywide IRMP. The stormwater in City pipes flows to sensitive receiving waters including False Creek, Coal Harbour, beaches at English Bay, Kitsilano, Jericho and Spanish Banks, and to the sensitive fisheries of the Fraser River. Supporting salmon, aquatic ecosystems, waterfront enjoyment and beach swimming are all fundamental objectives of the Citywide IRMP.

Supporting Nature's Ecosystems

How the city is designed and operated has a direct effect on rainwater and runoff quality and quantity. Cumulatively, management of the city urban design determines the health of Vancouver's watersheds and receiving waters, including high habitat values along shorelines of the Fraser River, and recovering habitat in restored areas of the central city.

Urban Watershed Health is determined by Urban Design – example shown is Hinge Park and Fraser River in Vancouver.

Stormwater Source Controls, like these infiltration bulges in Vancouver streets, are part of Climate Change Adaptation green infrastructure.

Preparing for Climate Change and Severe Weather

Climate change is predicted to produce wetter winters, and dryer summers, in the Vancouver area. The city has also recently seen summer cloudbursts, which can lead to damage to buildings and utilities. Flooding occurs when intense rainfall overcome the piped system capacity, which has been designed to handle peak flows from historical data that did not anticipate climate change.

Rainwater Management should include actions that reduce impervious areas that create runoff, or redirect stormwater to areas where it can soak in or be stored. These 'stormwater source controls', as shown in the BMP Toolkit (IRMP Volume II), can play a significant role in maintaining water quality and reducing peak flows.

Reduction in peak flows in the piped stormwater system also provides additional capacity to allow for climate-related changes in rainfall patterns.

Rainwater Management should include actions that reduce impervious area, or redirect stormwater to areas where it can soak in or be stored.

Protecting Sensitive Waterbodies

MAINTAINING WATER QUALITY FOR BEACHES

A primary driver in rainwater management in Vancouver is to maintain the water quality of receiving waters. This is particularly important where receiving waters are sensitive, including areas with recreational use, such as beaches along Kitsilano, West End and Jericho, and in False Creek.

Urban stormwater includes many common pollutants: e.g. petroleum hydrocarbons and heavy metals from vehicles, sediment from construction sites, excess nutrients from fertilizer, and bacteria from organic waste. As untreated stormwater is redirected by pipe to the water bodies surrounding Vancouver, the quality of water in these receiving waters may decline compared to today, with potential for increased closures of swimming beaches.

Urban Runoff Carries Pollutants

MAINTAINING WATER QUALITY FOR RECREATION

Water quality is particularly important where receiving waters are confined, including areas with reduced dilution or dispersion of pollutants, such as False Creek or Coal Harbour.

The IRMP and its action plan can help the people of Vancouver reconnect with the watersheds and ecosystems that support them, and connect socially, intellectually and spiritually with each other.

Reducing Combined Sewer Overflows

The volume of water that flows into City sewers is also an issue.

The City was constructed historically with sewers that combine sanitary sewage and stormwater drainage. Combined sewer overflows (CSOs) occur when the volume of rainfall mixing with sewage in the combined sewer overcomes the capacity of the pipe, with the overflow draining to receiving waters such as Burrard Inlet or English Bay.

The City has an established program to convert combined sewers into separated systems of sanitary sewers and storm drains. Already well underway, the program should be completed by Year 2050. When the sewer separation is complete, instead of stormwater currently piped to the regional wastewater treatment plants, there will be new flows of stormwater directly into tidal and estuarine receiving waters around the city.

Although the stormwater outflows will be significantly less polluting than existing combined sewer overflows, the water quality of stormwater remains a concern. Implementation of the best practices for stormwater source control treatment that are recommended in the Action Plan would reduce stormwater flows and improve stormwater quality to meet regional guidelines.

Until such time as separated sewers are completed, there will be continuing combined sewer overflows (CSOs) during periods of heavy rain. These CSOs have impacts on both beach swimming and ecosystems.

Reduction in the volume of stormwater reaching combined sewers in the interim period until sewer separation is complete will reduce the frequency, size and impacts of CSOs.

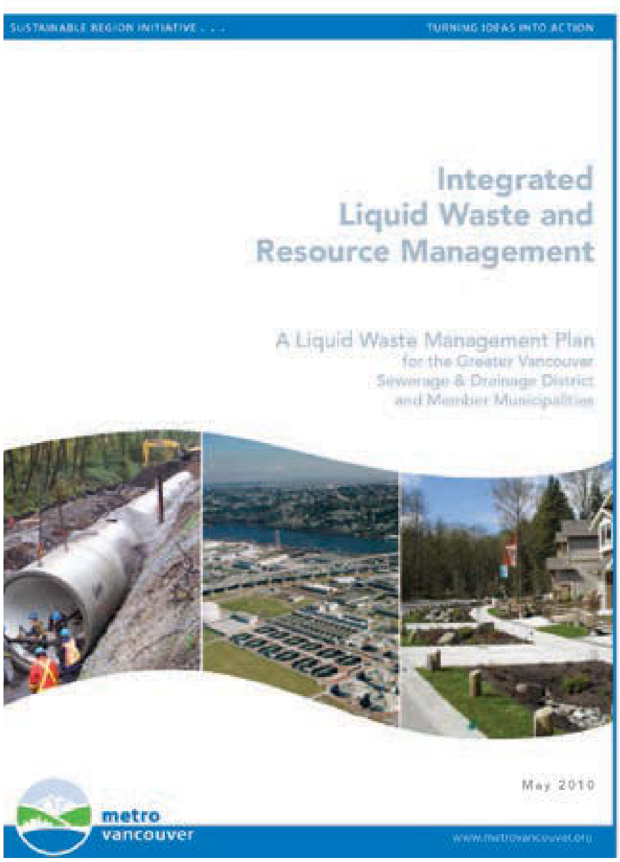
Fraser River and Marine Habitat is at Risk

Meeting Regulatory Requirements

The City needs to meet Water Quality Guidelines that are established under senior levels of government. Environment Canada establishes guidelines for water quality and urban runoff. Fisheries and Oceans Canada establishes requirements for protection of aquatic habitat. The Province of British Columbia, through BC Environment and the Ministry of Health, set and administer requirements for the protection of the environment and public health. These senior government requirements inform a region-specific implementation strategy through the Metro Vancouver Integrated Liquid Waste and Resource Management Plan (ILWRMP). The City of Vancouver and other members of Metro Vancouver are committed to creating and monitoring Integrated Stormwater Management Plans in response to these guidelines and regulations.

This Citywide Integrated Rainwater Management Plan (IRMP) is one of the City of Vancouver's responses to the ILWRMP requirements. The three volumes of the IRMP analyze the issues and opportunities, summarize stakeholder input, and identify programs, tools and adaptation actions customized to the Citywide context and vision.

These documents work together to also meet the needs of senior government regulators for certainty around Vancouver's commitment to sustainable development and redevelopment in its watersheds.



The Metro Vancouver Integrated Liquid Waste and Resource Management Plan provides a region-specific implementation strategy

Honouring Vancouver's Rainfall Resource

Vancouver's First Nations, and early European settlers, lived in economies that depended on the food and timber resources provided by the rainforest and shorelines. Over the 19th and early 20th centuries, Vancouver's development advanced with little regard for the watersheds and watercourses that dissected it. Most streams were culverted, and ravines were filled for development.

Today, only two watersheds remain with surface streams: Still Creek and Musqueam Creek. The City of Vancouver has already created an Integrated Stormwater Management Plan focused on restoration of Still Creek, and is seeing successful return of salmon to that system. The City and Musqueam First Nation are also starting a similar plan for the Musqueam Watershed, to steward and enhance its existing fish populations and biodiversity, as well as manage flooding risks.

The remainder of the city, where streams have been buried underground in pipes, is the subject of this **Citywide Integrated Rainwater Management Plan** (IRMP). The Citywide IRMP has similarities with the objectives and solutions in the Still and Musqueam watersheds, and other coastal BC IRMPs.

But the Citywide study area is also unique, in that all drainage within it is piped, and the entire area has fully developed urban conditions. Vancouver Citywide IRMP issues and solutions require a customized approach. Figure I - 1 on the inside cover illustrates the extent of the Citywide IRMP area.

Rain: Vancouver. The two seem inseparable. Vancouver's abundant rainfall is a key ingredient of its character—the foundation of its coastal forest ecosystems; a part of winter life living here.

Rain Umbrella 01 [cropped] by Al Safrata (CC BY-SA 3.0)

2.0 THE NATURE OF RAINFALL IN VANCOUVER

Rainfall Spectrum in Vancouver

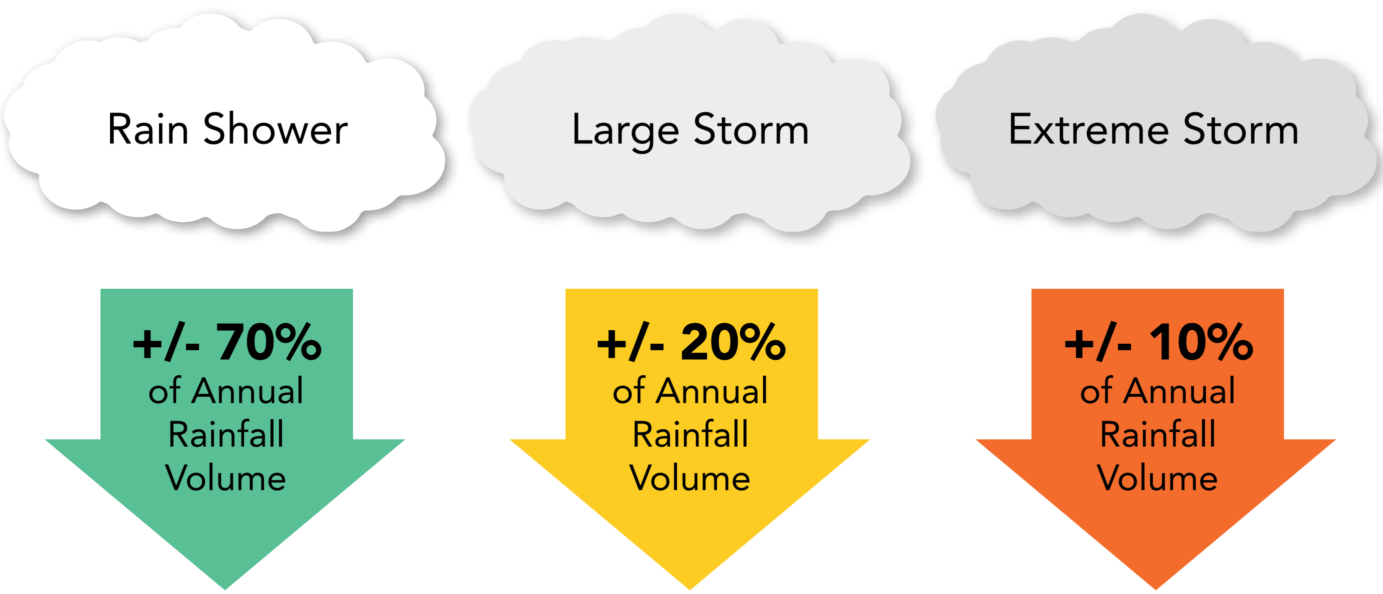
Rainwater Management requires an understanding of the rainfall spectrum.

In South Coast BC, including Vancouver, the great majority (+/-70%) of rainfall volume in an average year falls as light showers to small storms. A further +/-20% is large storms but within the average mean annual rainfall. Only +/-10% of the rainfall volume in an average year is extreme storms that might create widespread flooding. The rainfall distribution varies from year to year (+/-), but figure I - 2 represents averages.

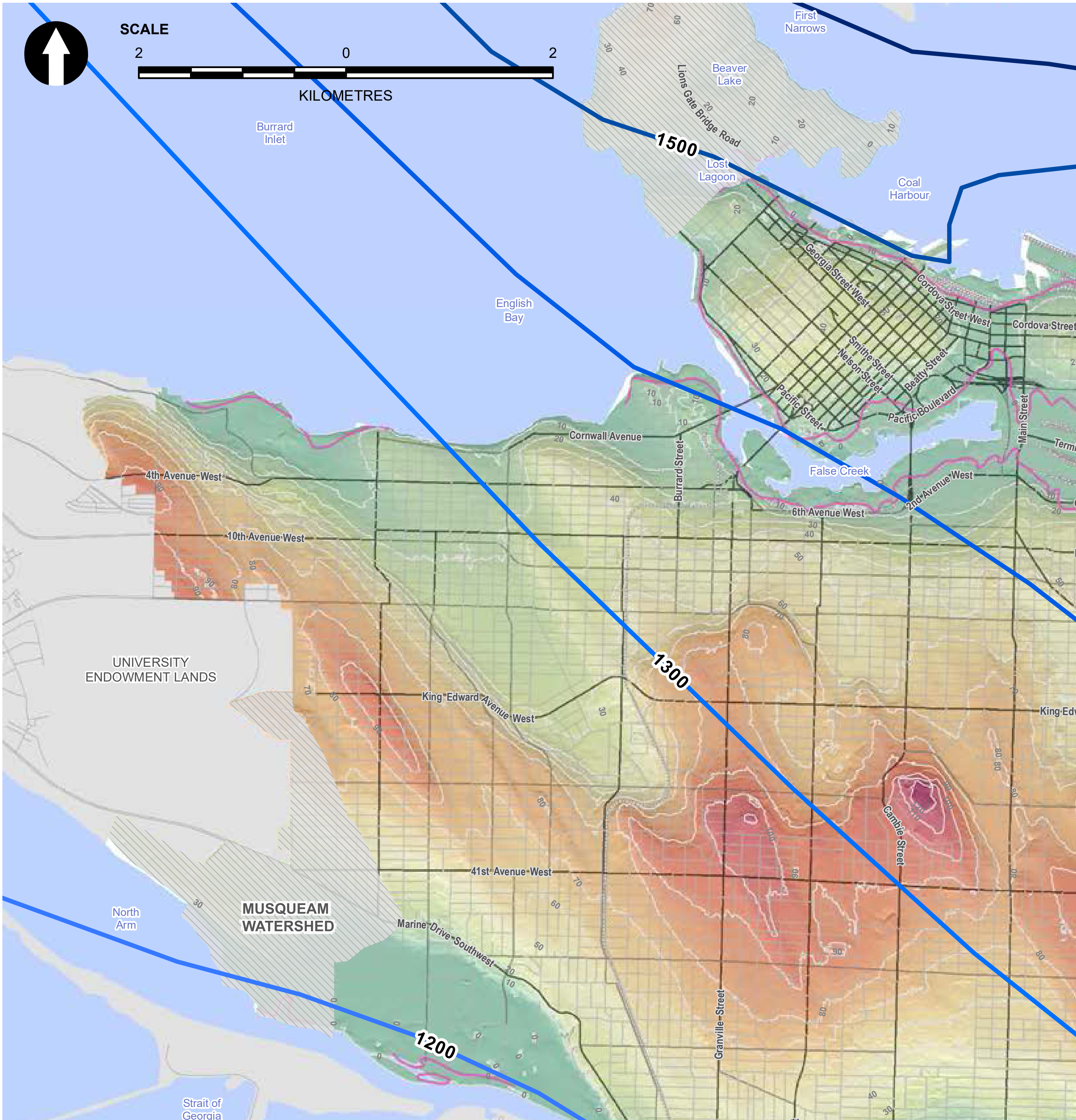
With this insight into rainfall characteristics, Rainwater Management in Vancouver can capture, through infiltration or reuse, the rainfall from drizzle and small storms. Both small and large storms—representing +/-90% of the average annual rainfall volume, can be treated using stormwater source controls (see Volume II) to improve water quality to Metro Vancouver's Monitoring and Adaptive Framework yellow or green standards.

For the rare extreme storm events, conveyance in roadside, gutters and other major overland flow paths is necessary to protect from flood damage.

Figure I - 2: Rainfall Spectrum



*adapted from BC Environment, Stormwater Planning: A Guidebook for British Columbia, 2002



NOTE

1. ISOHYETS DRAWN FROM GVS&DD & AES RAINFALL GAUGES THAT HAD AT LEAST 20 YEARS OF RECORDS DURING THE PERIOD BETWEEN 1961-1990.
2. MAP POLYGONS AND SOURCE DATA FROM CITY OF VANCOUVER OR PUBLISHED SOURCES AS OF YEAR 2013, UNLESS OTHERWISE NOTED

REFERENCE

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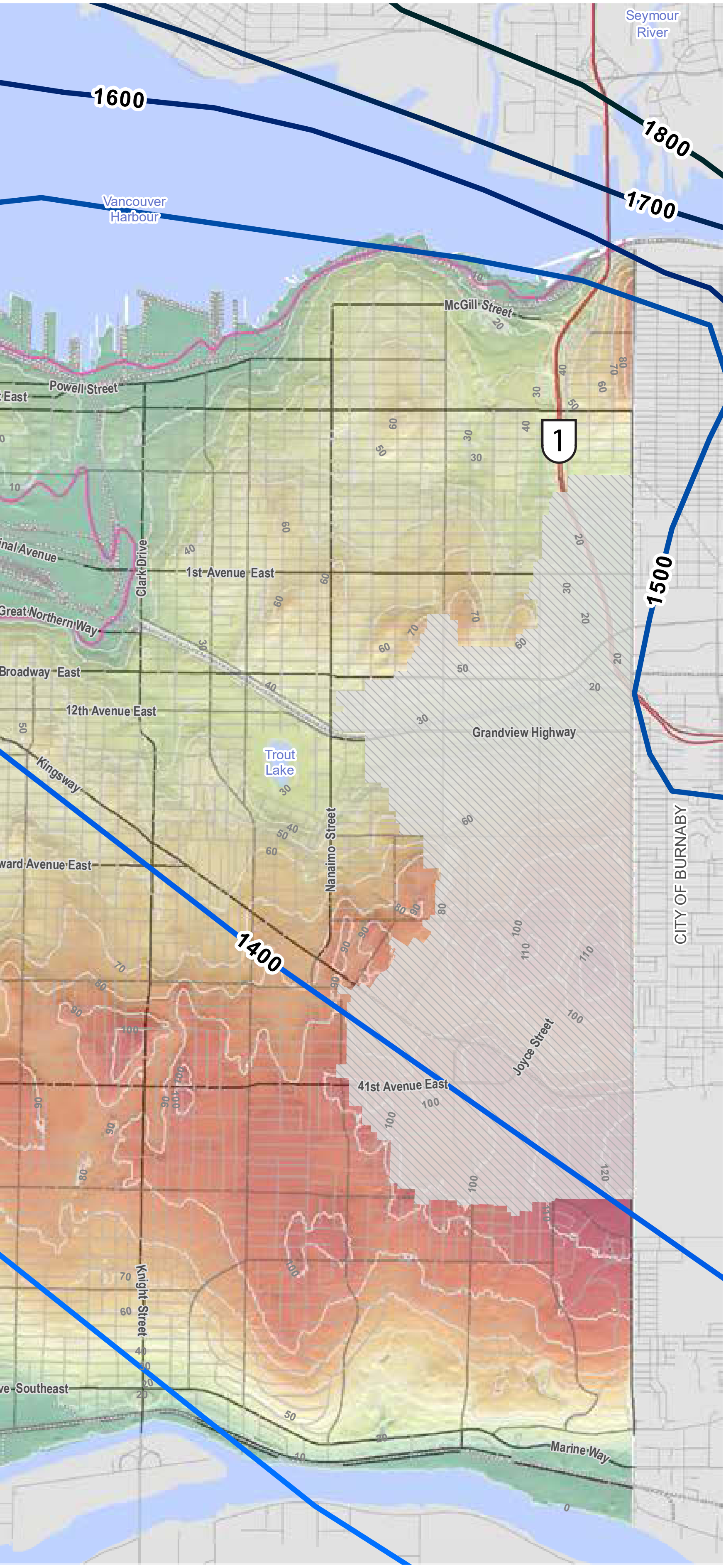
Figure I - 3:

Topography & Areas of Average Annual Precipitation



The pattern of rainfall in Vancouver is influenced by prevailing winds and the effect of the North Shore Mountains that force moisture-laden clouds to rise, cool, and therefore drop their rainfall.

Figure I - 3 shows the increase in average annual rainfall (AAR) from 1200mm AAR near the Fraser River up to 1500mm AAR at Burrard Inlet shoreline. The variation in rainfall and the pattern of drainage to receiving waters may influence sizing of stormwater infrastructure, and priorities for action.

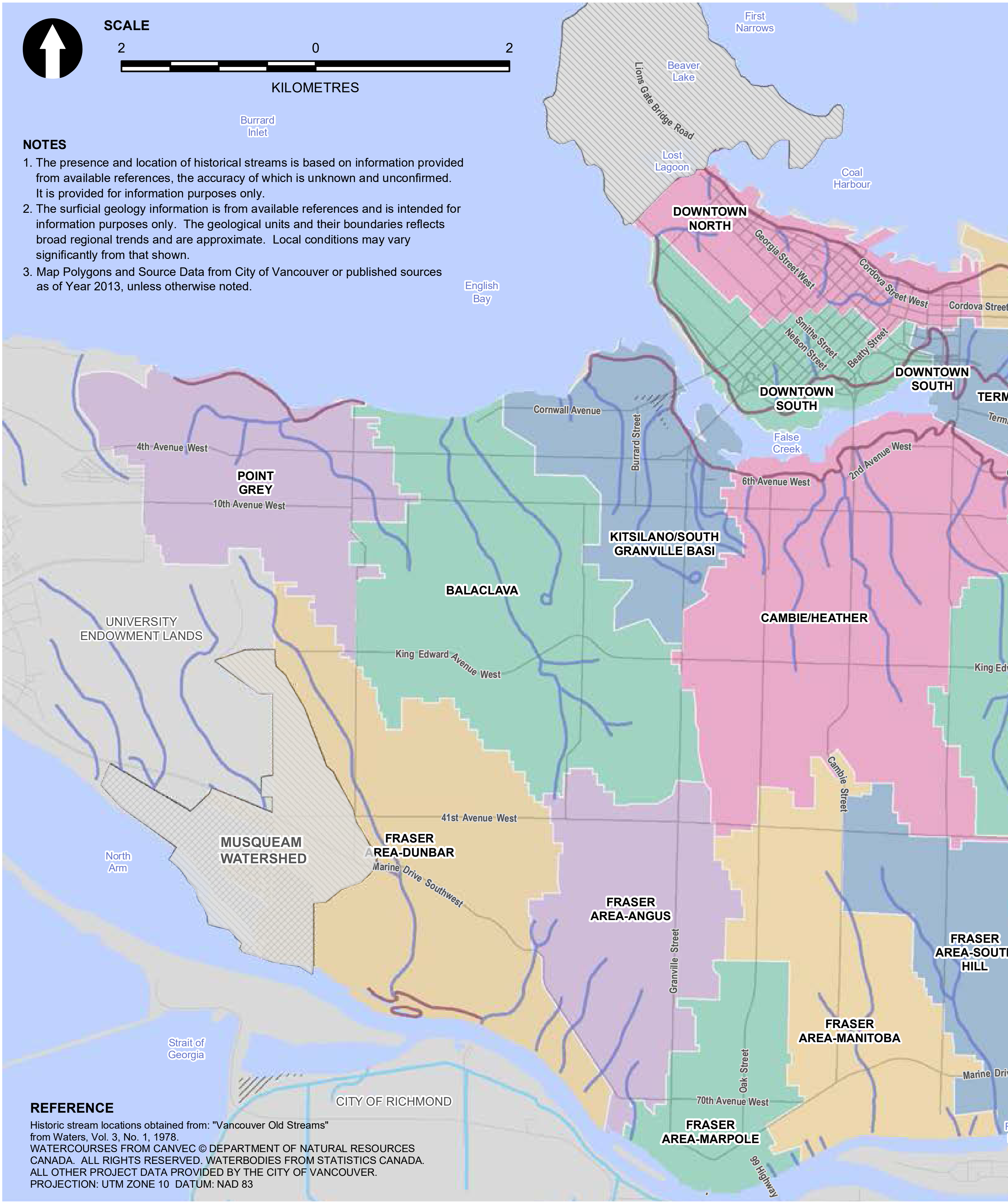
LEGEND

- AREA EXCLUDED FROM STUDY
- HISTORIC SHORELINE
- HIGHWAY
- ARTERIAL ROAD
- SECONDARY ARTERIAL AND COLLECTOR ROAD
- RESIDENTIAL, LEASED AND CLOSED STREET
- RAILWAY
- ELEVATION CONTOUR (10m)
- AVERAGE ANNUAL PRECIPITATION BANDS - ISOHYETS (mm)

ELEVATION (m)

125

0



NOTES

1. The presence and location of historical streams is based on information provided from available references, the accuracy of which is unknown and unconfirmed. It is provided for information purposes only.
2. The surficial geology information is from available references and is intended for information purposes only. The geological units and their boundaries reflects broad regional trends and are approximate. Local conditions may vary significantly from that shown.
3. Map Polygons and Source Data from City of Vancouver or published sources as of Year 2013, unless otherwise noted.

REFERENCE

Historic stream locations obtained from: "Vancouver Old Streams" from Waters, Vol. 3, No. 1, 1978.
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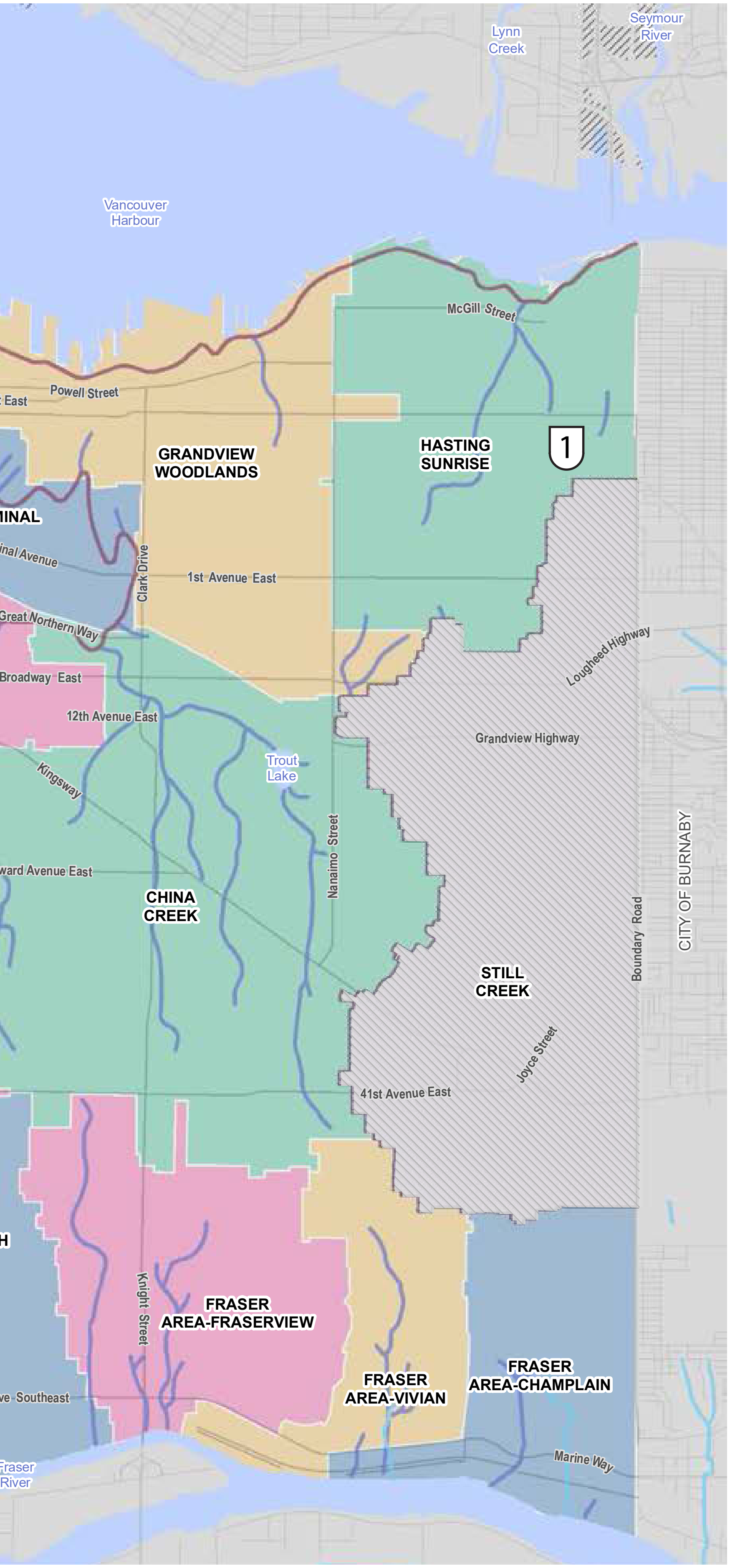
Figure I - 4:

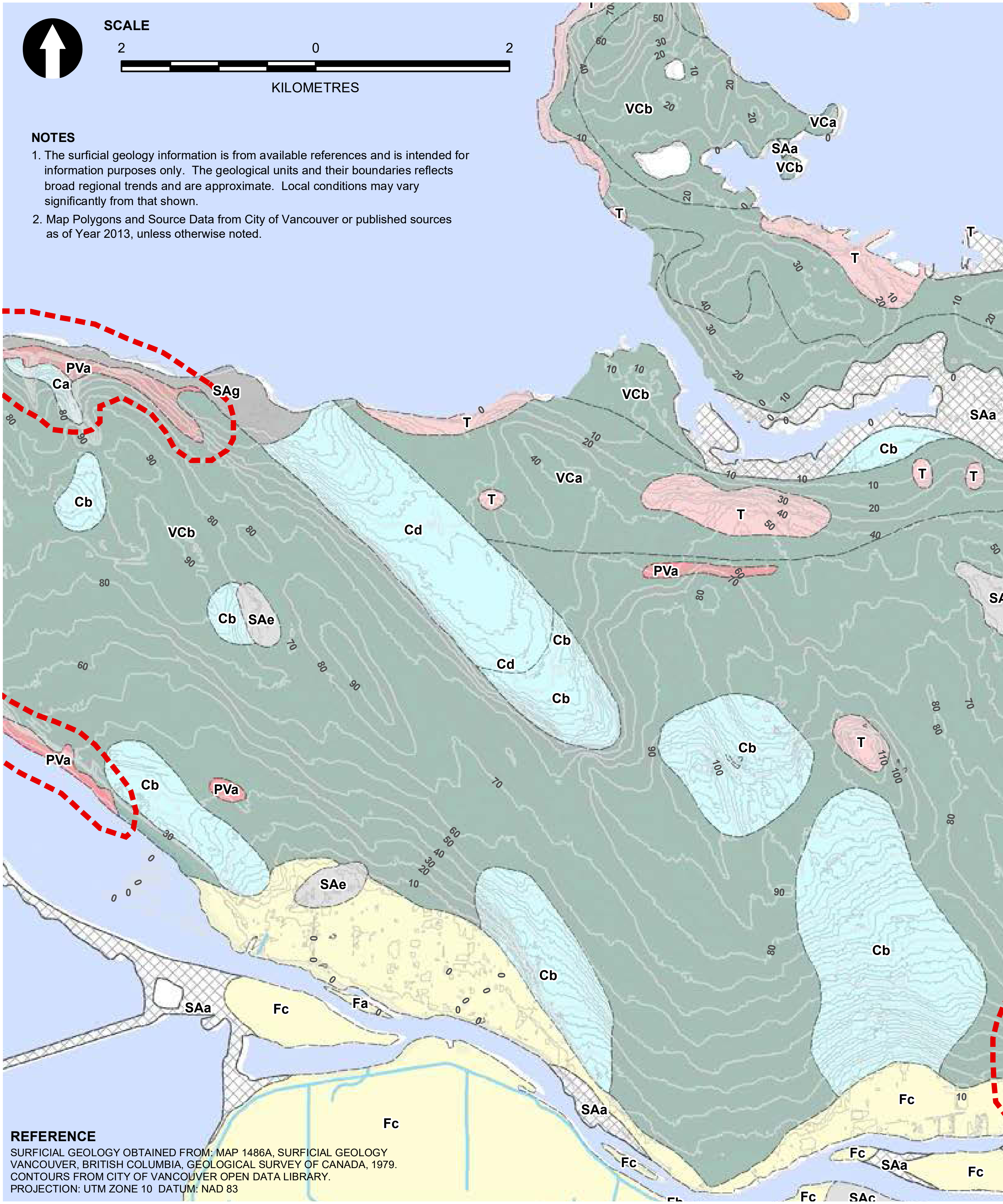
Historical Stream Locations

In the Citywide study area, all of the historical streams shown conceptually on Figure I-4 have been piped and filled. The remaining surface streams and their watersheds (Still and Musqueam) outside the Citywide Study Area are identified. Stanley Park also has surface watercourses, and is outside the study area.



LEGEND

- STORMWATER CATCHMENT AREA (NAME)
- AREA EXCLUDED FROM STUDY
- ROAD
- HISTORIC HIGH WATER MARK
- HISTORICAL STREAM



NOTES

1. The surficial geology information is from available references and is intended for information purposes only. The geological units and their boundaries reflects broad regional trends and are approximate. Local conditions may vary significantly from that shown.
2. Map Polygons and Source Data from City of Vancouver or published sources as of Year 2013, unless otherwise noted.

REFERENCE

SURFICIAL GEOLOGY OBTAINED FROM: MAP 1486A, SURFICIAL GEOLOGY VANCOUVER, BRITISH COLUMBIA, GEOLOGICAL SURVEY OF CANADA, 1979.
CONTOURS FROM CITY OF VANCOUVER OPEN DATA LIBRARY.
PROJECTION: UTM ZONE 10 DATUM: NAD 83

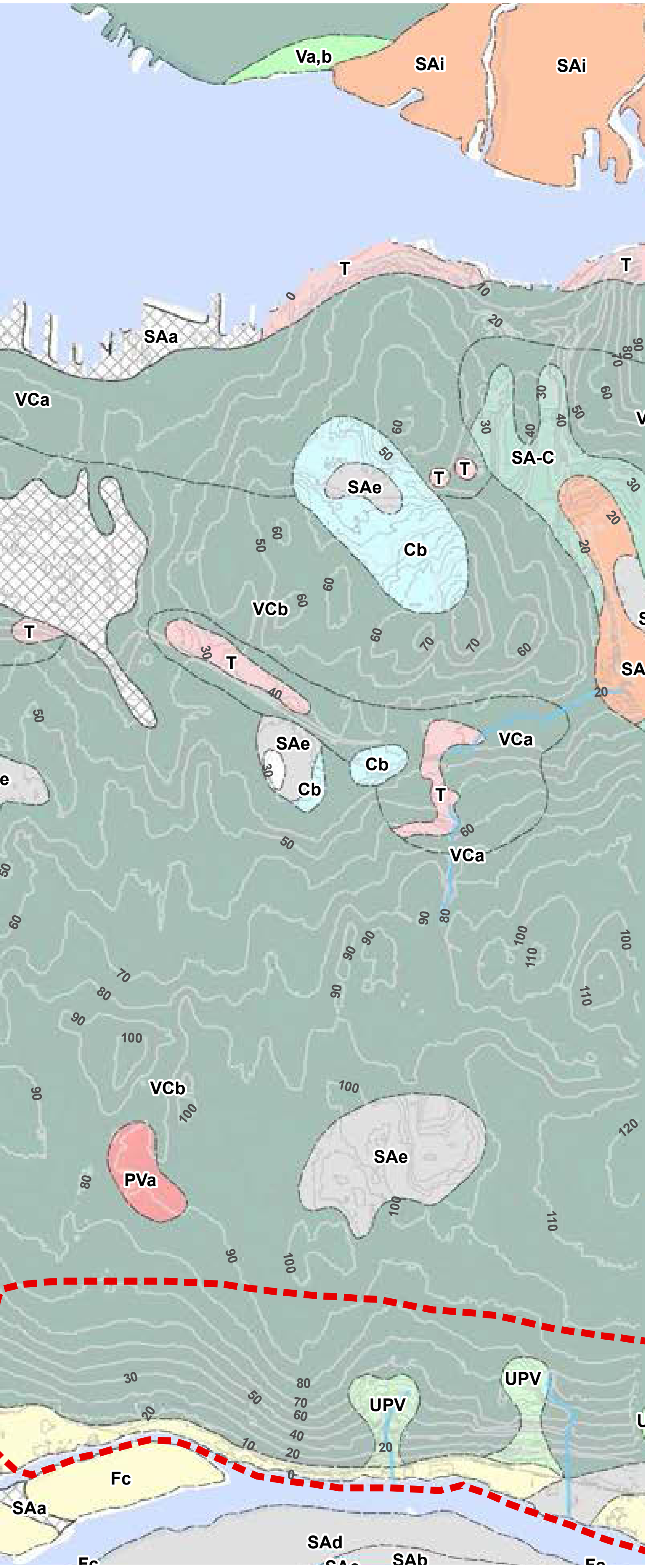


Figure I - 5:

Our Geology and Soils

Figure I - 5 provides general information on the ground conditions (surficial geology) that underlay the City. The City geology has been influenced by glaciers, leaving subsoils that are highly variable. See figure I - 6 for a summary of predominate infiltration potential.

Landfill has also been a significant part of the City history – including major fill areas along Burrard Inlet and at False Creek. Limited areas of the City have steep slopes which could be made less stable by increased groundwater.

LEGEND

SPECIAL INVESTIGATION AREAS - SLOPE STABILITY RISK

WATERCOURSE

ELEVATION CONTOUR (10m)

ELEVATION CONTOUR (2m)

QUATERNARY

POSTGLACIAL

SALISH SEDIMENTS

SAa — Landfill including sand, gravel, till, crushed stone, and refuse

SAb-e — Bog, swamp, and shallow lake deposits: SAb, lowland peat up to 8 m thick overlying Fb,c; SAc, lowland peat up to 1 m thick, underlying Fb (up to 2 m thick); SAd, organic-rich sandy loam to clay loam 15 to 45 cm thick overlying Fd; SAe, upland peat up to 8 m or more thick overlying VC units

SAf,g — Marine shore sediments (beach deposits): SAf, sand to sandy loam up to 2 m thick overlying Fe; SAg, sand to gravel up to 8 m thick

SAh-j — Lowland and mountain stream deltaic, channel fill, and overbank sediments: SAh, lowland stream channel fill and overbank sandy loam to clay loam, also organic sediments: up to 8 m thick; SAi, mountain stream marine deltaic medium to coarse gravel and minor sand up to 15 m or more thick. SAj, mountain stream channel fill sand to gravel up to 8 m thick

FRASER RIVER SEDIMENTS

Fa-e — Deltaic and distributary channel fill sediments overlying and cutting estuarine sediments and overlain in much of the area by overbank sediments: Fa, channel deposits, fine to medium sand and minor silt occurring along present day river channels; Fb, overbank sandy to silt loam normally less than 2 m thick overlying 15 m or more of Fd; Fc, overbank silty to silt clay loam normally less than 2 m thick overlying 15 m or more of Fd; Fd*, deltaic and distributary channel fill (includes tidal flat deposits), 10 to 25 m interbedded fine to medium sand and minor silt beds; may contain organic and fossiliferous material; Fe*, estuarine, fossiliferous, interbedded fine sand to clayey silt (sand content increases from bottom to top of sequence), 10 to 185 m thick

POSTGLACIAL AND PLEISTOCENE

SA-C — Marine shore and fluvial sand up to 8 m thick, Cb in part has been reworked and redeposited by lowland streams (SAh)

PLEISTOCENE

CAPILANO SEDIMENTS

Ca-d — Raised marine, deltaic, and fluvial deposits: Ca, raised marine beach, spit, bar, and lag veneer, poorly sorted sand to gravel (except in bar deposits) up to 10 m thick mantling older sediments and containing fossil marine shell casts up to 175 m above sea level; Cb, raised beach medium to coarse sand 1 to 5 m thick; Cc, raised deltaic and channel fill medium sand to cobble gravel up to 15 m thick deposited by proglacial streams and commonly underlain by silty to silty clay loam; Cd, marine and glaciomarine stony (including till-like deposits) to stoneless silt loam to clay loam with minor sand and silt, normally less than 3 m thick but up to 10 m thick in upland areas

VASHON DRIFT AND CAPILANO SEDIMENTS

VCa,b — Glacial drift including; lodgment and minor flow till, lenses and interbeds of substratified glaciofluvial sand to gravel, and lenses and interbeds of glaciolacustrine laminated stony silt; up to 25 m thick; in most places correlated with Va,b; overlain by glaciomarine and marine deposits similar to Cd, normally less than 3 m but in places up to 10 m thick. Marine derived (Ca) lag gravel normally less than 1 m thick containing marine shell casts has been found mantling till and glaciomarine deposits up to 175 m above sea level; above 175 m till is mantled by bouldery gravel that may be in part ablation till, in part colluvium, and in part marine. VCa, bedrock within 10 m or less of the surface; VCb, bedrock more than 10 m below surface

VASHON DRIFT

Va,b — Till, glaciofluvial, glaciolacustrine, and ice-contact deposits: Va, lodgment till (with sandy loam matrix) and minor flow till containing lenses and interbeds of glaciolacustrine laminated stony silts; Vb, glaciofluvial sandy gravel and gravelly sand outwash and ice-contact deposits

PRE-VASHON DEPOSITS

PVa,b,e-h — Pre-Vashon glacial, nonglacial, and glaciomarine sediments: PVa, Quadra fluvial channel fill and floodplain deposits, crossbedded sand containing minor silt and gravel lenses and interbeds; PVb, Quadra deltaic deposits and crossbedded sand and gravel; PVe, Cowichan Head organic sediments; PVf, Semiahmoo glaciomarine, glaciofluvial sediments and till; PVg, Highbury fluvial, marine, and bog and swamp deposits; PVh, Westlynn till and glaciomarine stony silty clay loam

UNDIVIDED PRE-VASHON DEPOSITS

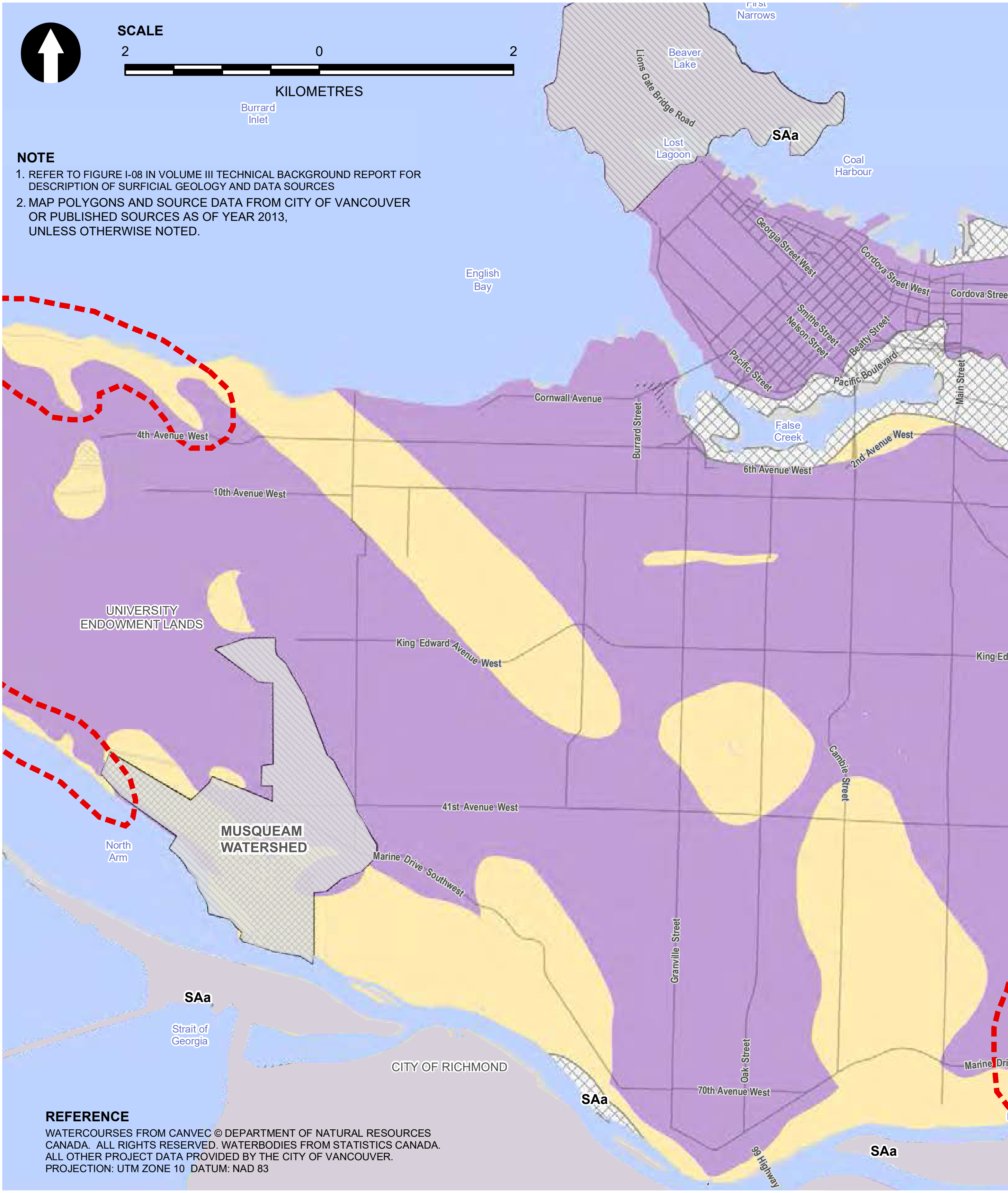
UPV — Till, glaciofluvial, glaciolacustrine, fluvial marine, and organic sediments

TERTIARY

T — Tertiary bedrock including sandstone, siltstone, shale, conglomerate, and minor volcanic rocks; where bedrock is not exposed it is covered by glacial deposits and colluvium

PRE-TERTIARY

PT — Mesozoic bedrock including granitic and associated rock types; where bedrock is not exposed it is covered by glacial deposits and colluvium



NOTE

1. REFER TO FIGURE I-08 IN VOLUME III TECHNICAL BACKGROUND REPORT FOR DESCRIPTION OF SURFICIAL GEOLOGY AND DATA SOURCES
2. MAP POLYGONS AND SOURCE DATA FROM CITY OF VANCOUVER OR PUBLISHED SOURCES AS OF YEAR 2013, UNLESS OTHERWISE NOTED.

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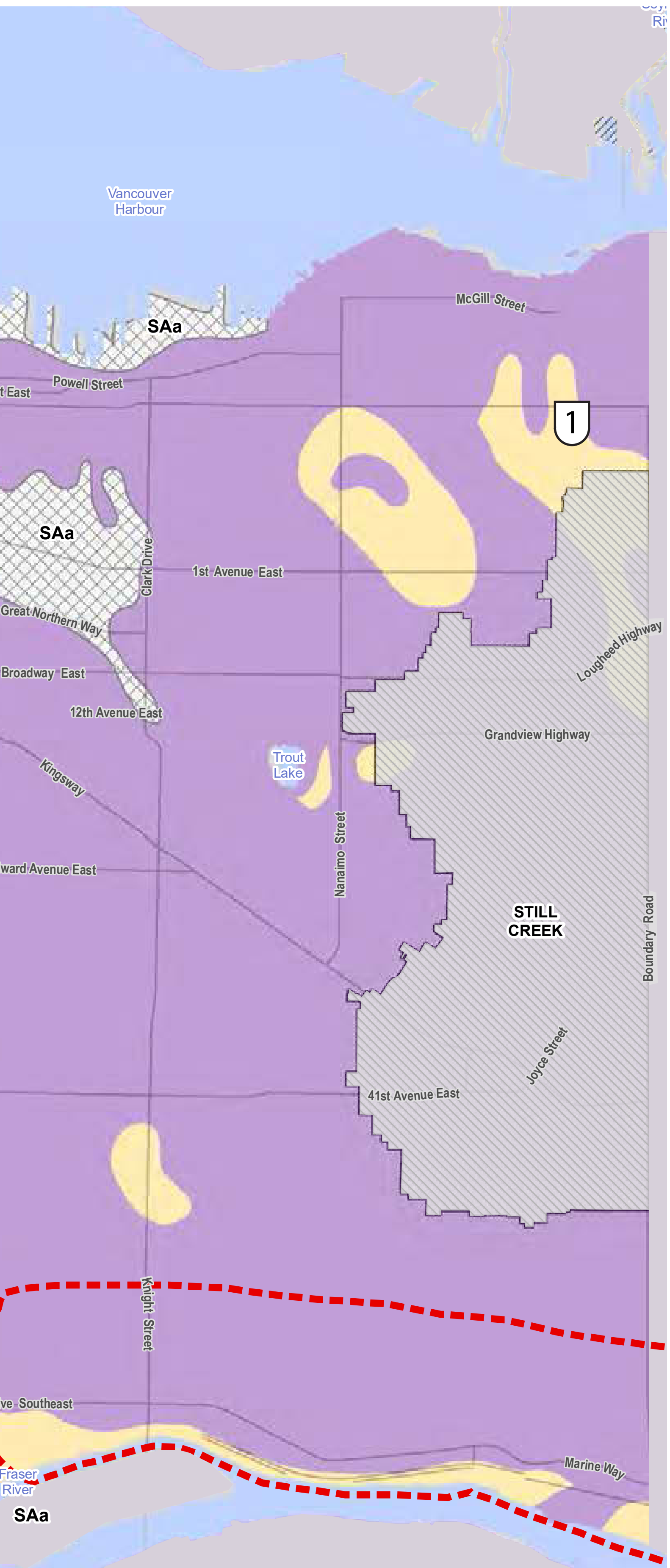


Figure I - 6:

Predominant Infiltration Potential

Most of the study area has predominantly low infiltration potential although some local areas may have moderate subsoil infiltration rates which should be confirmed by local testing. For this study the precautionary principle is used by assuming limited infiltration rates into subsoils (in the range of 1–2mm/hr (average 1.5mm/hr).

However, note that even these low rates of subsoil infiltration—not visible to the naked eye within a short time period – represent 24–48mm of infiltration over a 24 hour period. This slow infiltration is still very relevant to meeting the proposed targets for rainwater capture that are introduced in this report.

Areas planned for concentrated infiltration, and in particular areas of fill or steep slope, should have site-specific investigations of hydrogeology conditions and risks prior to implementing groundwater infiltration practices.

LEGEND

AREA EXCLUDED FROM STUDY

PREDOMINANT INFILTRATION POTENTIAL

PREDOMINANTLY LOW INFILTRATION POTENTIAL

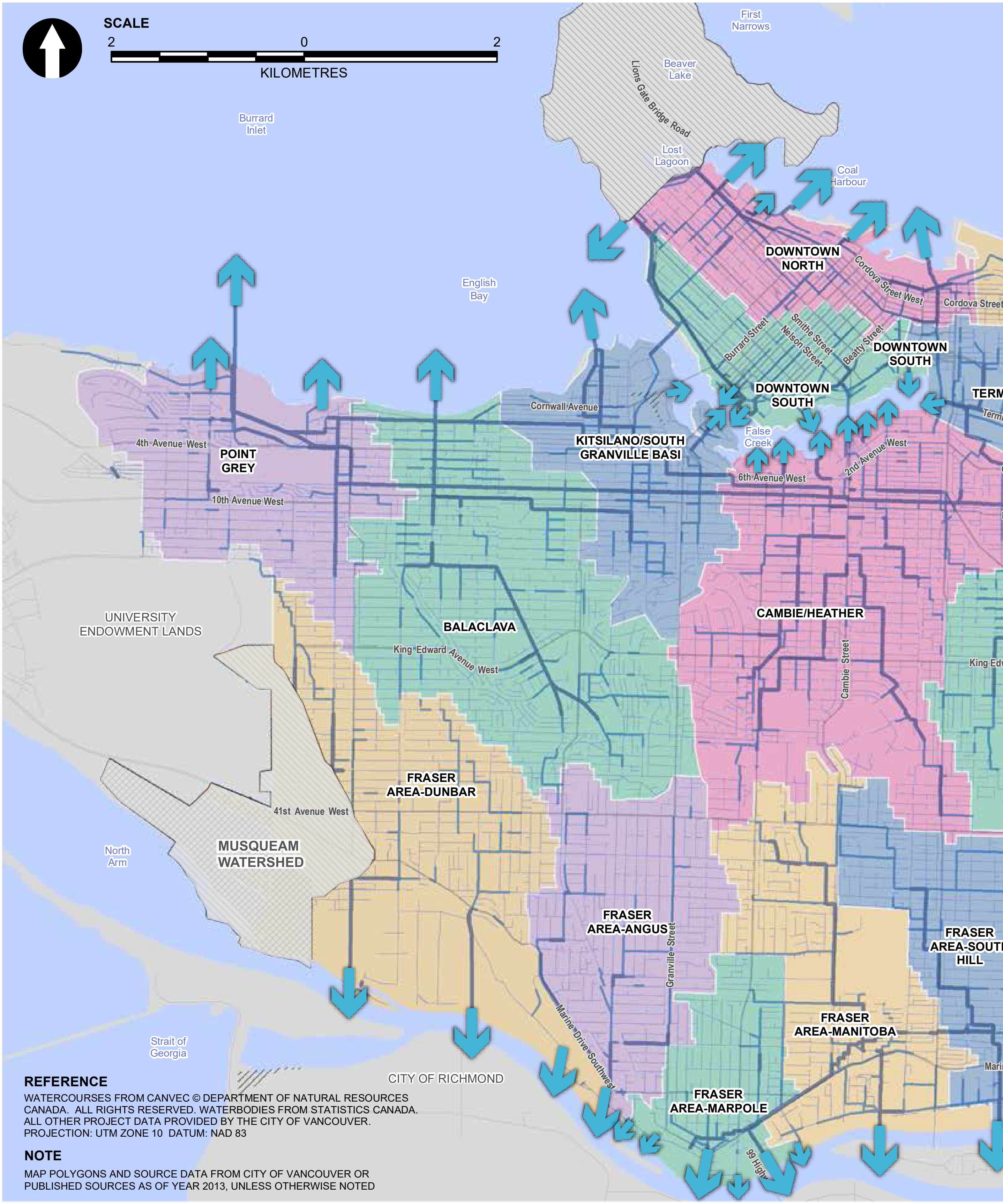
PREDOMINANTLY MODERATE INFILTRATION POTENTIAL

SPECIAL INVESTIGATION AREAS

LANDFILL INCLUDING SAND, GRAVEL, TILL, CRUSHED STONE AND REFUSE*

SLOPE STABILITY RISK

ARTERIAL ROAD



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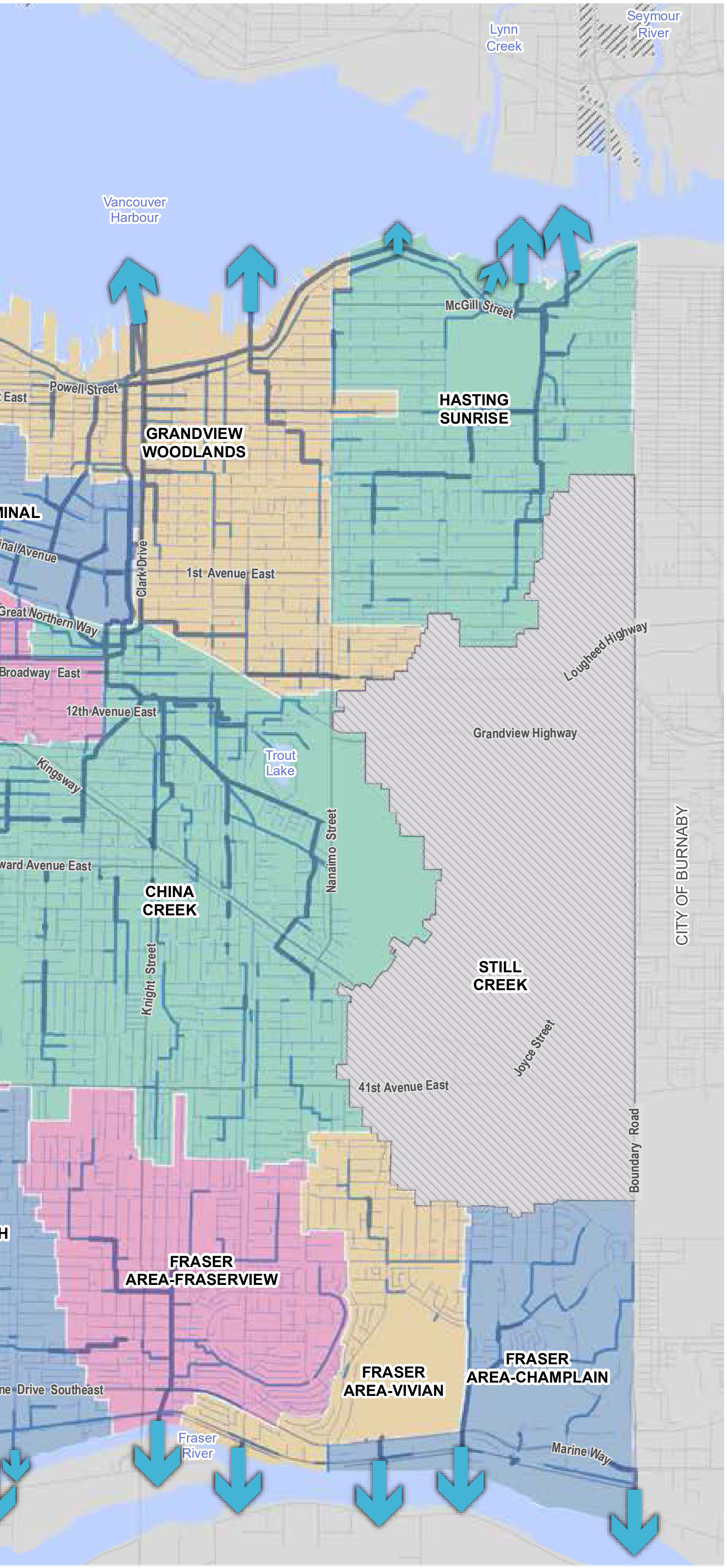


Figure I - 7:

Sewers and Combined Sewer Overflows - Today

Vancouver's piped sewers were developed in the first half of the last century, and at that time it was common to construct combined sewers that received both sanitary (toilet, dish, laundry water) and stormwater (roof, site and pavement drainage). Figure I - 7 shows drainage catchment areas and major sewer pipes, which drain under most weather conditions via Metro Vancouver sewer collectors to wastewater treatment plants and after treatment to the Strait of Georgia.

In extreme storm events, the capacity of existing pipes can be overcome by rainwater, and mixed sanitary and storm water can create combined sewer overflows (CSOs) to some of the existing outfalls shown in Figure I - 7. This brings high diluted, but polluted, water into Burrard Inlet, around English Bay, and to the Fraser River.

LEGEND

STORMWATER CATCHMENT AREA (NAME)

AREA EXCLUDED FROM STUDY

ROAD

SEWER MAIN SIZE (mm)

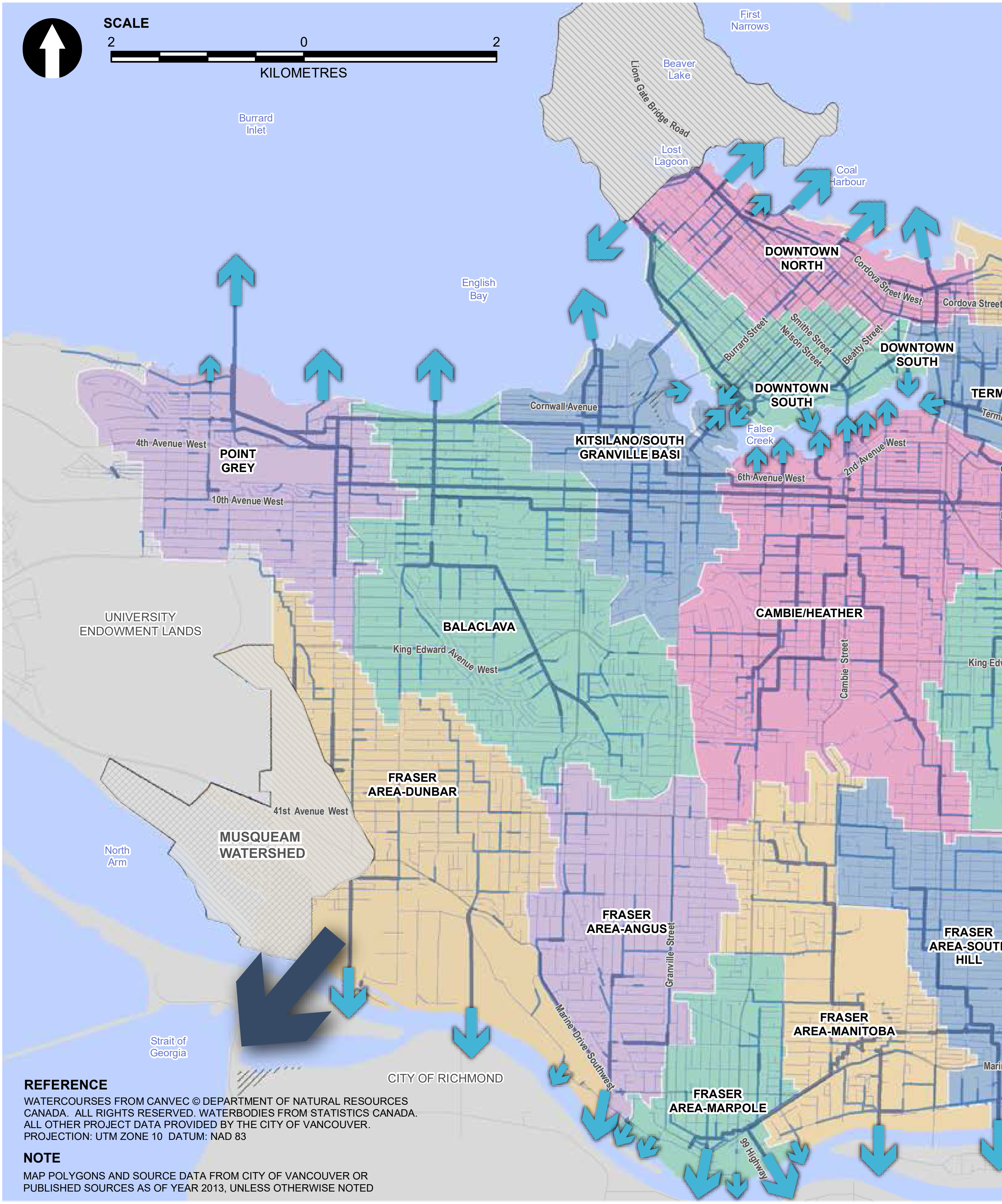
SMALL (0 - 499)

MEDIUM (500 - 999)

LARGE (1,000 - 4,975)

NOW:

COMBINED OR STORMWATER


SCALE
2
0
2
KILOMETRES
First Narrows
Beaver Lake
Lions Gate Bridge Road
Lost Lagoon
Coal Harbour
Burrard Inlet
English Bay
DOWNTOWN NORTH
Cordova Street West
Cordova Street
Burrard Street
Smithe Street
Nelson Street
Beatty Street
DOWNTOWN SOUTH
DOWNTOWN SOUTH
TERM
Cornwall Avenue
KITSILANO/SOUTH GRANVILLE BASI
False Creek
6th Avenue West
2nd Avenue West
4th Avenue West
POINT GREY
10th Avenue West
UNIVERSITY ENDOWMENT LANDS
BALACLAVA
King Edward Avenue West
CAMBIE/HEATHER
Cambie Street
King Edw
FRASER AREA-DUNBAR
41st Avenue West
MUSQUEAM WATERSHED
North Arm
FRASER AREA-ANGUS
Granville Street
FRASER AREA-SOUTH HILL
FRASER AREA-MANITOBA
Strait of Georgia
CITY OF RICHMOND
Marine Drive Southwest
FRASER AREA-MARPOLE
99 Highway
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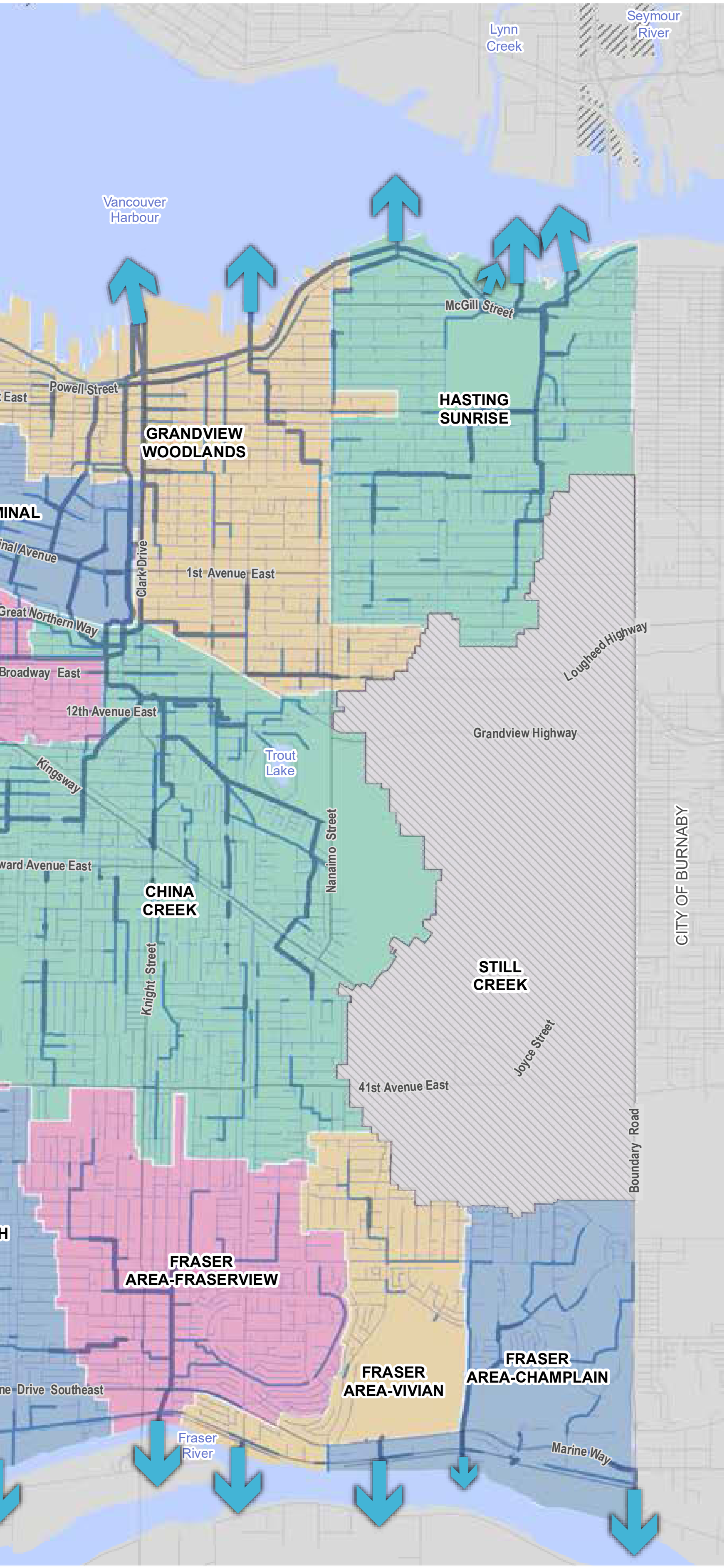


Figure I - 8:

Drainage Areas and Receiving Waters - Tomorrow

To eliminate CSOs and provide more sewer capacity, the City has an established program to separate combined sewers into separated systems of sanitary and storm sewers, with on-going implementation until Year 2050. However, until such time as the sewer separation is completed, there will be continuing combined sewer overflows (CSOs). Reductions in stormwater volume in this interim period will reduce the frequency and size of these CSO events.

Once completed, and with changes in the Metro Vancouver major sewer collectors, the new stormwater system will bring runoff from streets and land uses in the City direct to receiving waters – including False Creek, Coal Harbour and Burrard Inlet, beach areas in English Bay, and the Fraser River. Although the heavy organic pollution from sewage flows has been separated, the remaining stormwater, if untreated, can bring other pollutants such as petroleum hydrocarbons and heavy metals from parking areas to these sensitive receiving waters, with impacts on habitat as well as recreation and waterfront property values.

LEGEND

STORMWATER CATCHMENT AREA (NAME)

AREA EXCLUDED FROM STUDY

ROAD

SEWER MAIN SIZE (mm)

SMALL (0 - 499)

MEDIUM (500 - 999)

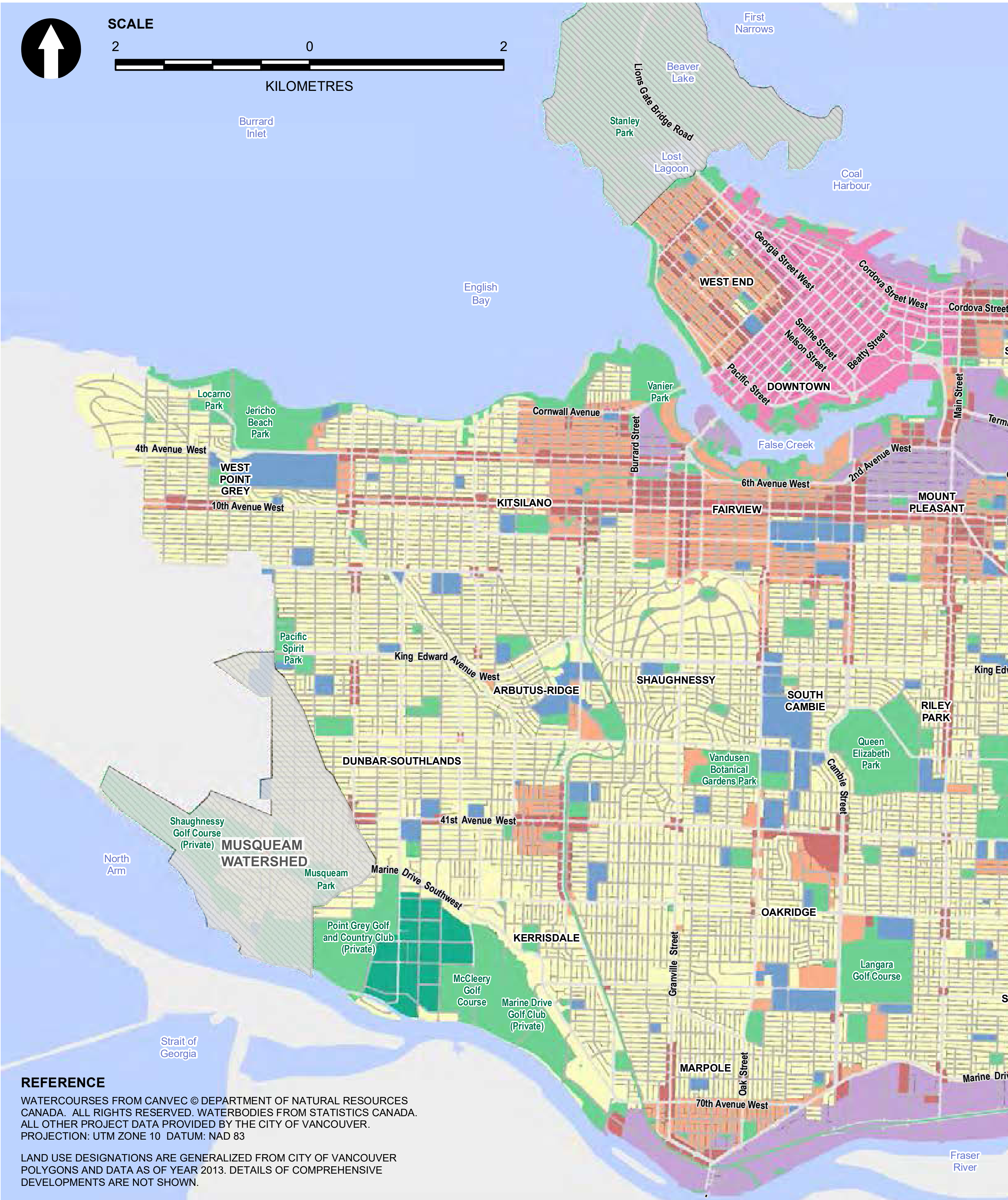
LARGE (1,000 - 4,975)

TOMORROW:

SANITARY ONLY TO TREATMENT PLANT

TOMORROW:

STORMWATER ONLY TO RECEIVING WATERS



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LAND USE DESIGNATIONS ARE GENERALIZED FROM CITY OF VANCOUVER POLYGONS AND DATA AS OF YEAR 2013. DETAILS OF COMPREHENSIVE DEVELOPMENTS ARE NOT SHOWN.

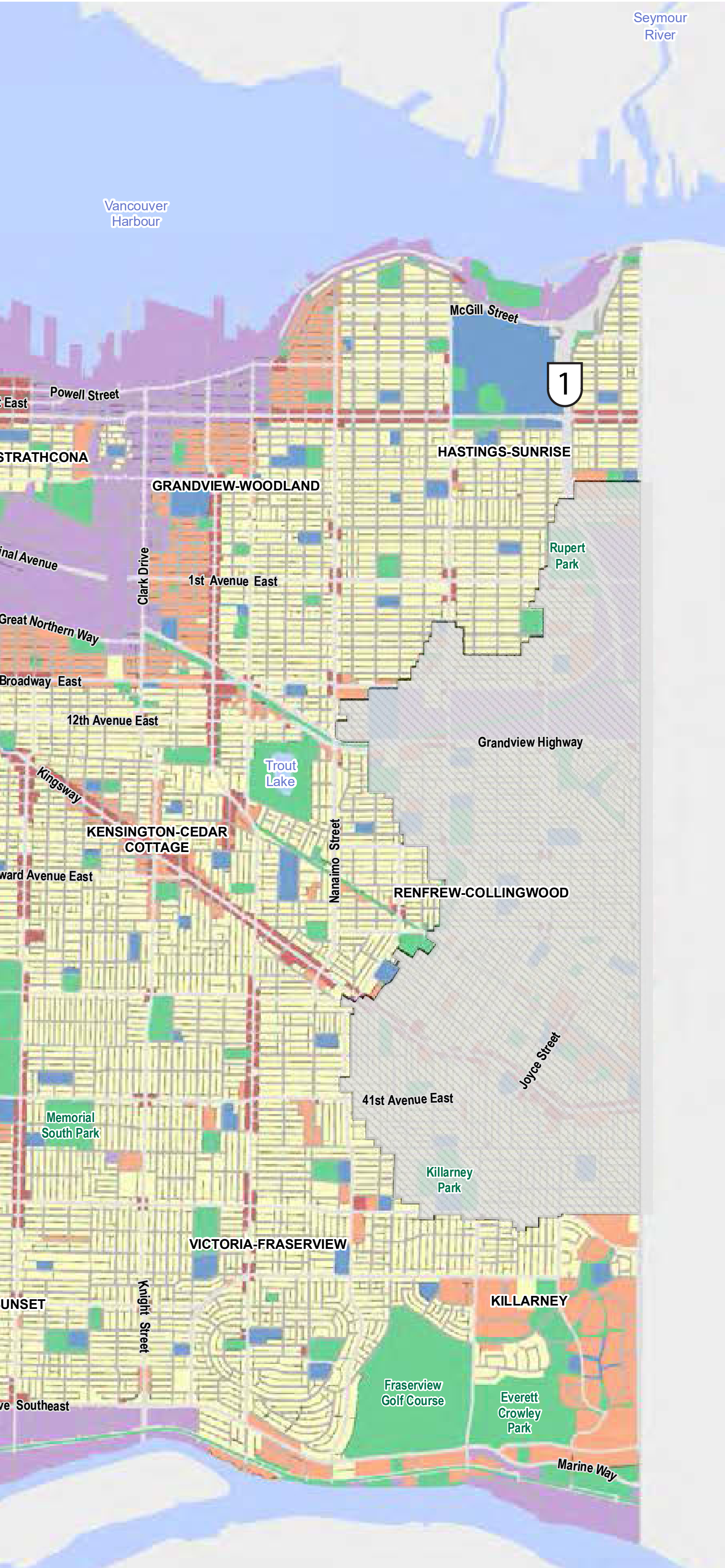


Figure I - 9:

Land Use

The amount of absorbent landscape that soaks up rainfall is directly related to land use designations and zoning, as well as the details of development urban design such as impervious area coverage, green roof or underground parking covered with absorbent landscape.

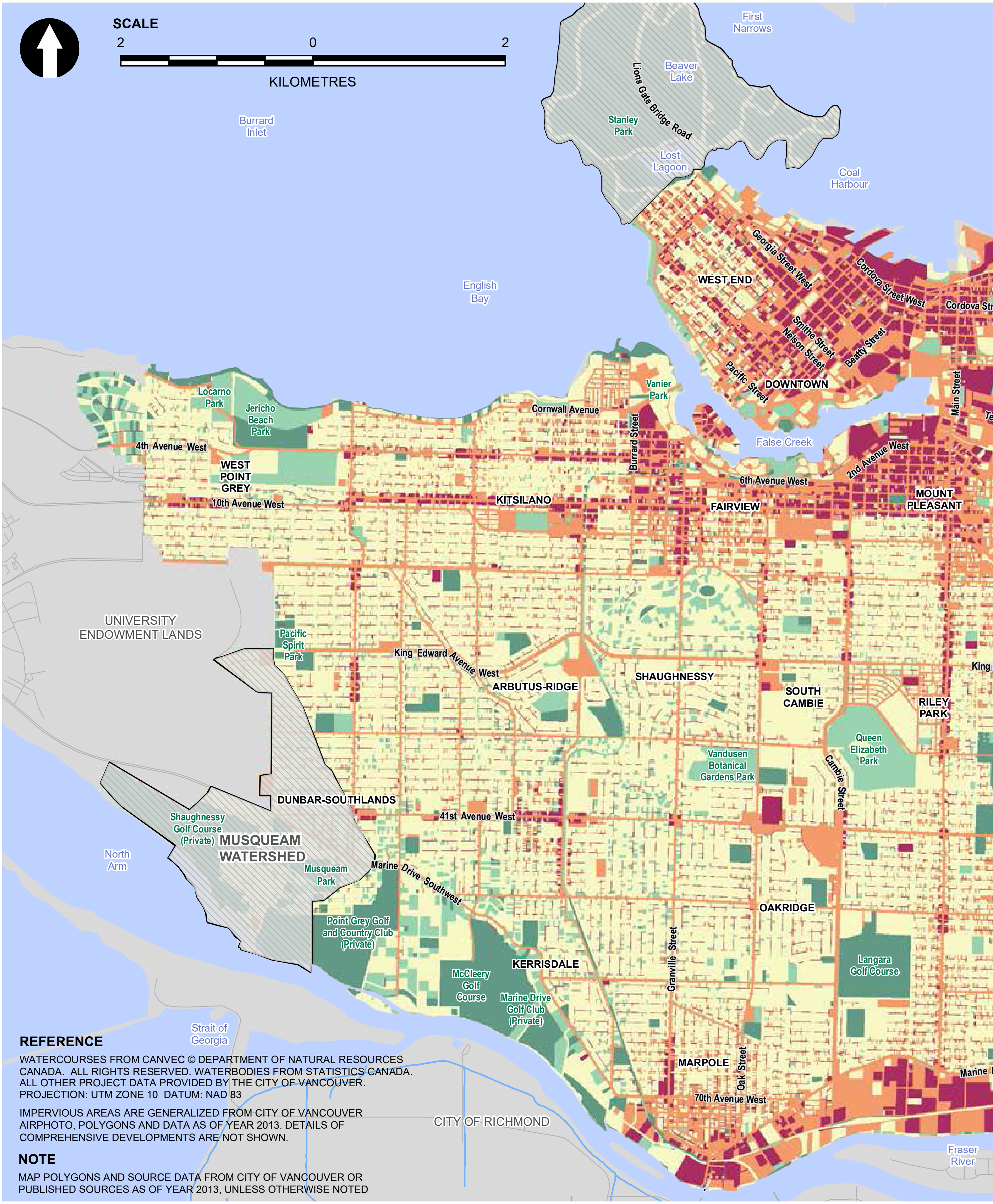
Although there is more potential runoff per hectare from higher density uses - arterial streets, industrial, commercial, and some institutional land uses - the cumulative area of these higher uses is small compared to the area of low density single family uses across the city.

LEGEND

AREA EXCLUDED FROM STUDY

LAND USE TYPOLOGY

- ONE/TWO DWELLING RESIDENTIAL
- MULTIPLE DWELLING RESIDENTIAL
- COMMERCIAL / MIXED USE
- DOWNTOWN MIXED USE
- INDUSTRIAL
- INSTITUTIONAL / AGRICULTURE
- PARK / GREENSPACE
- AGRICULTURE
- ARTERIAL STREET
- LOCAL STREET
- LANEWAY


SCALE
2
0
2
KILOMETRES
Burrard Inlet
First Narrows
Beaver Lake
Lions Gate Bridge Road
Stanley Park
Lost Lagoon
Coal Harbour
English Bay
Georgia Street West
Cordova Street West
Cordova Stre
WEST END
Smithe Street
Nelson Street
Beatty Street
Pacific Street
DOWNTOWN
Main Street
Vanier Park
Cornwall Avenue
Burrard Street
False Creek
2nd Avenue West
6th Avenue West
Locarno Park
Jericho Beach Park
4th Avenue West
WEST POINT GREY
10th Avenue West
KITSILANO
FAIRVIEW
MOUNT PLEASANT
UNIVERSITY ENDOWMENT LANDS
Pacific Spirit Park
King Edward Avenue West
ARBUTUS-RIDGE
SHAUGHNESSY
SOUTH CAMBIE
RILEY PARK
Queen Elizabeth Park
Vandusen Botanical Gardens Park
Cambie Street
DUNBAR-SOUTHLANDS
41st Avenue West
Shaughnessy Golf Course (Private)
MUSQUEAM WATERSHED
Musqueam Park
North Arm
Marine Drive Southwest
OAKRIDGE
Point Grey Golf and Country Club (Private)
KERRISDALE
Granville Street
Langara Golf Course
McCleery Golf Course
Marine Drive Golf Club (Private)
Strait of Georgia
MARPOLE
Oak Street
70th Avenue West
CITY OF RICHMOND
Fraser River
REFERENCE
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NOTE
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Figure I - 10:

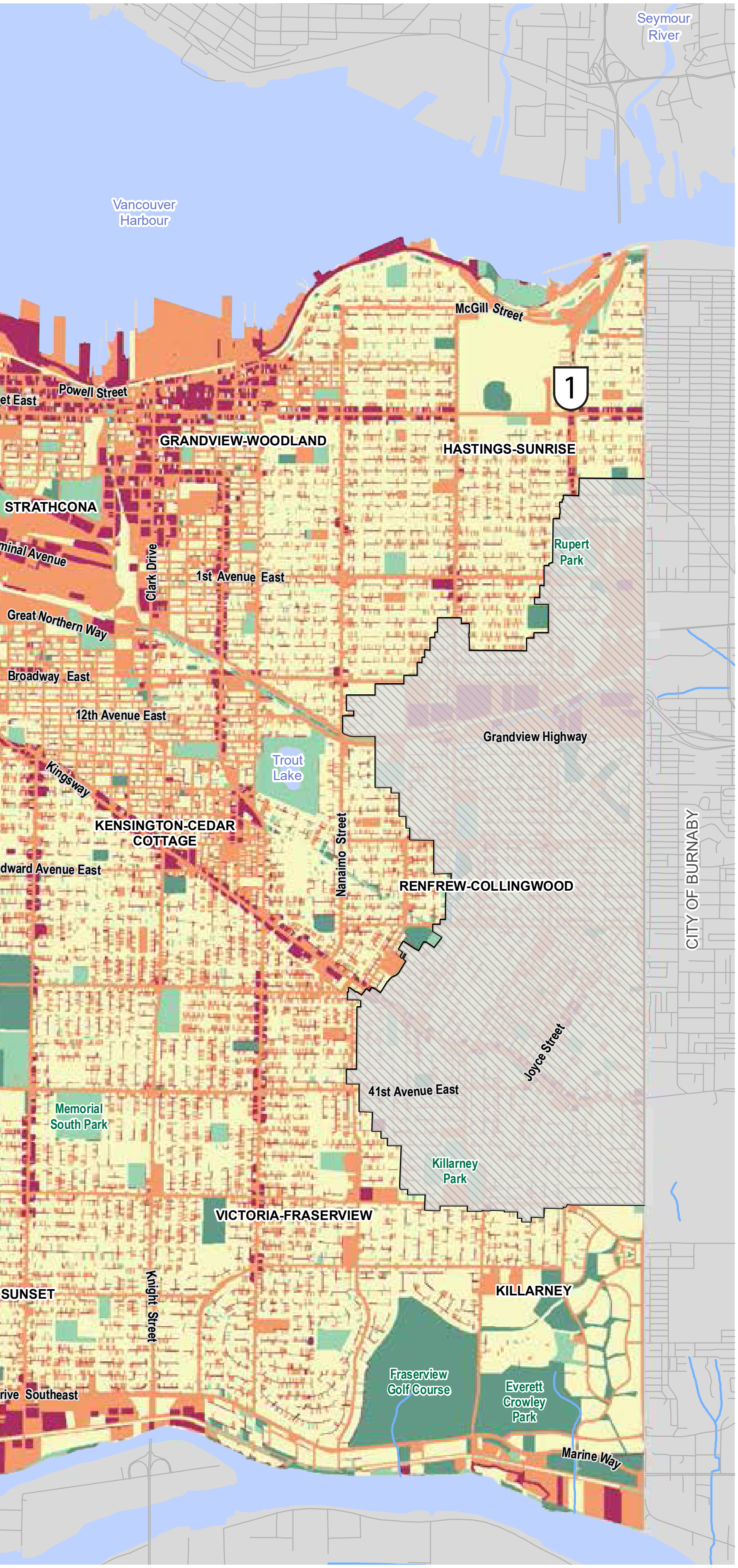
Impervious Areas

The Impervious Surface Area per parcel is the percent of each lot or street right of way that would create runoff – including roof, patios, driveways, parking areas and street travel lanes.

New high-density residential may reduce surface parking and replace it with underground parking with absorbent landscape above the garage, thereby in some cases reducing effective impervious area.

New single family residential in many cases involves greater building and paving coverage than older homes, resulting in an increase in effective impervious area.

Without use of rainwater best management practices or green infrastructure, the majority of rainfall falling in impervious surfaces creates runoff to the sewer system and from there to receiving waters in beaches, bays, rivers or ocean.

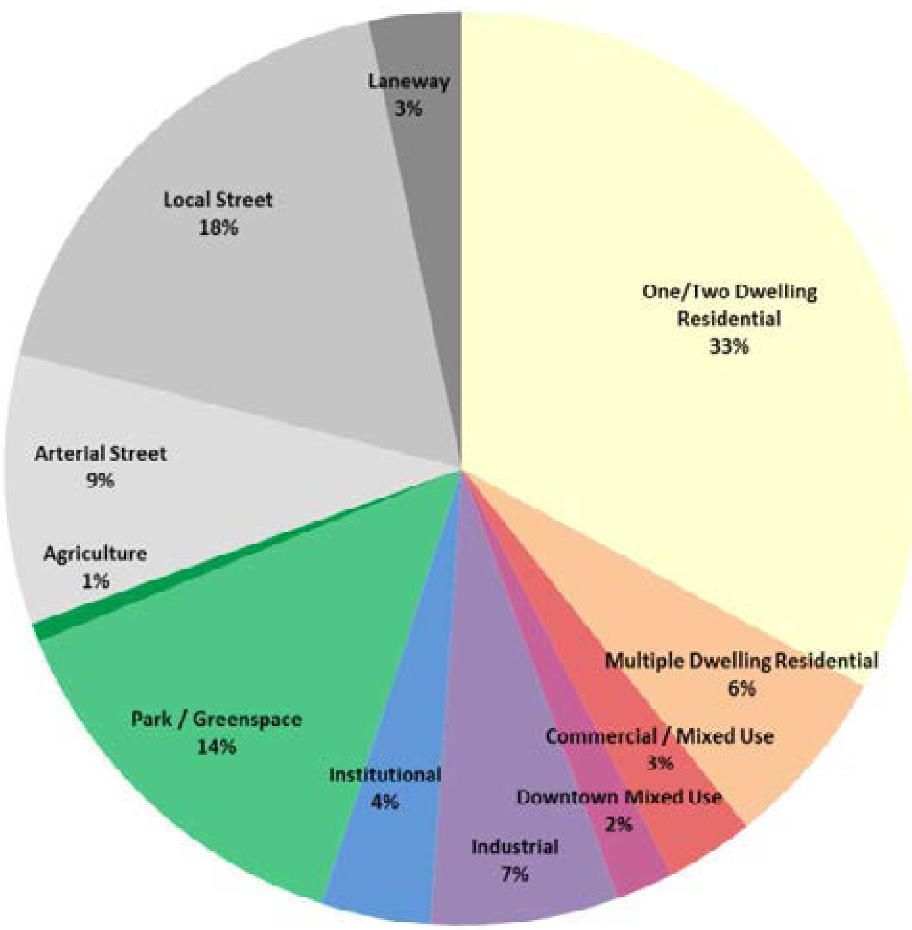


Impervious Areas by Land Use Type

Although higher density areas like City Centre and Fairview show the highest percent impervious area per parcel, it is actually lower density areas (one and two family dwellings and local streets) that provide by far the greatest quantity of impervious area in the city. Figure I-11 illustrates that one/two dwelling residential and local streets and lanes make up more than 50% of the study area. Figure I - 12 shows how this translates into distribution of impervious road, building and site paving across land use typologies. Solutions need to be sought across all land uses in the city.

Figure I - 10 shows graphically the percent of impervious area across the city, as of 2013 (details of comprehensive developments are not shown).

Figure I - 11: Land use percentage of total study area

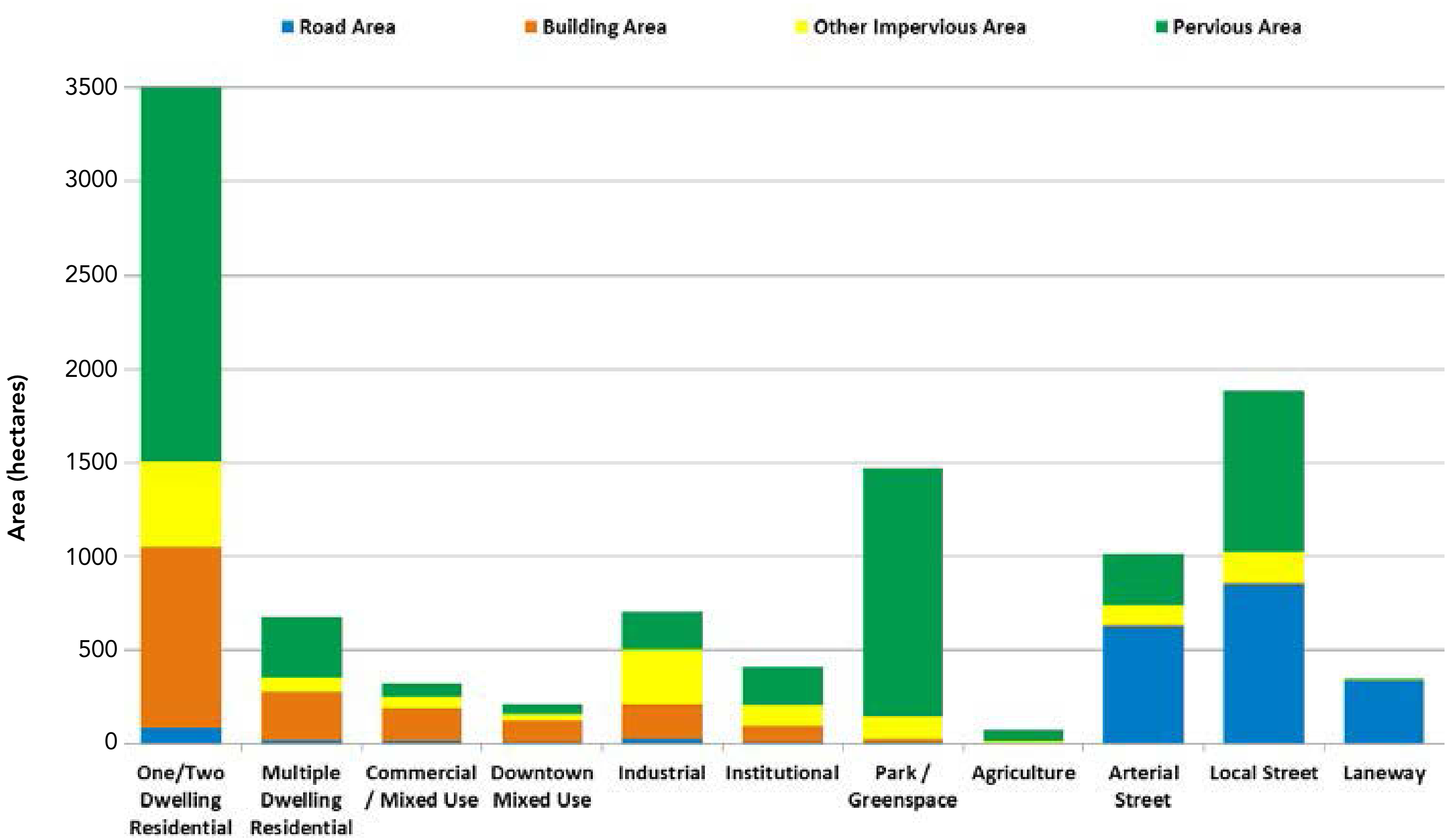


The percent of land use compared to the total Citywide study area is shown in the pie chart (Figure 1-11). About 54% of the study area is One/ Two Family Dwellings, Local Streets, and Laneways. Arterial streets make up 9%. Parks and Agriculture represent 15%. Industrial areas represent 7%, with some of these converting to other uses through comprehensive development. The remainder, in high density, institutional and commercial uses make up only 15% of the total land area.

The bar graph in Figure 1-12 further breaks down each land use type into road and other impervious area, building area, and pervious area. Across the city, it is one/two family residential and streets/lanes that make up the highest total amount of impervious area.

For that reason it is important to include green infrastructure strategies for these low density areas and streets, in addition to high density sites, to reduce the cumulative impact of polluted stormwater on Vancouver's beaches, bays, rivers and other receiving waters.

Figure I - 12: Areas of Land Use Typologies



3.0 WHAT DO WE NEED TO DO DIFFERENTLY?

Treating Rainfall as a Resource

Rainwater in Vancouver should be treated as a resource, as articulated in the Vision for the Citywide IRMP that has been created through stakeholder engagement.

But, like any resource, there is a need for thoughtful management.

The Greening of Land Use and Streets

A long-term focus of this Integrated Rainwater Management Plan is both to minimize runoff volume and to reduce the risks and consequences of pollutants in stormwater runoff.

The focus on rainwater management starts where the rainfall hits the city—in its urban forest, its soils, its streets and land uses.

Without use of rainwater best management practices, the majority of rainfall landing on impervious surfaces—roof, streets, parking areas and other paved surfaces—creates runoff to the sewer system.

Vancouver's future as a Greenest City includes joining leading cities around the world that are mimicking natural ecological systems as the city is gradually reconstructed through building and infrastructure asset life cycles.

With better urban design as we redevelop our buildings and streets when they wear out, we can incorporate Green Infrastructure (GI) approaches to protect our rainwater and water resources.

There are also opportunities to store, treat or infiltrate rainwater and runoff in parks, playing field areas, skateboard bowls, surface parking areas and other civic facilities. Maintaining and increasing the tree canopy of the City also intercepts rainfall and increases evapotranspiration.

To meet objectives, Green Infrastructure will need to be implemented broadly across the City's drainage areas, streets and land uses.

Returning Rainfall to Natural Pathways

Part of Vancouver's Greenest City future is recognizing the role of the urban forest and soils in soaking up, cleaning and slowly releasing rainwater. Minor changes can increase the capacity of existing landscape areas to be more absorbent. New rain gardens and infiltration swales can slow down and treat runoff from streets and parking areas. Pervious paving can be used in select locations to reduce impervious area. Capture and local treatment of roof rainwater can provide water for irrigation, toilet and urinal flushing, and other non-potable uses, and reduce the city's reliance on potable water. These tools are introduced on the following page, and explored in Volume II: BMP Toolkit.

The City and private sector have piloted many of these tools – through the Green Streets program, at the Olympic Village, at new LEED Gold Certification developments, as well as in private residences and lane housing. Review of these pilots is providing insights for improved BMPs.

All of these actions together can help the city avoid water quality problems that have been problematic for many cities around the world. For example, the nutrients in stormwater runoff can cause elevated algae and vegetation growth that, in addition to adversely impacting the receiving environment and aquatic habitat, can result in foul odour due to decay. The results can be aesthetically unappealing – affecting recreation and land values. Further the costs of remediating the excess of nutrients, related excessive plant growth and low oxygen (eutrophication) can be extremely high. Excess bacteria concentration is a common problem in Vancouver's sheltered bays like False Creek, and can cause Health Authorities to impose extended beach closures in English Bay.

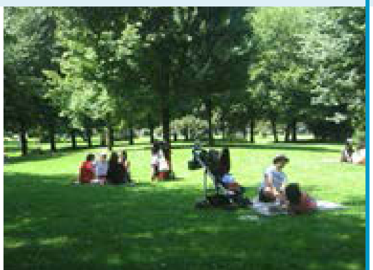
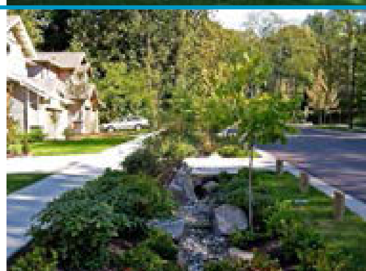
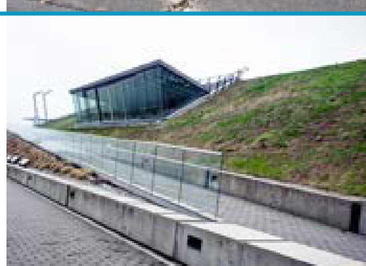
Rainwater management and Green Infrastructure approaches should reduce these risks proactively.

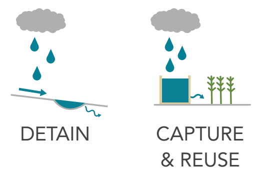
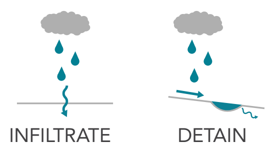
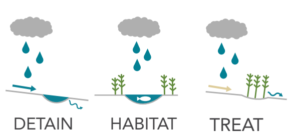
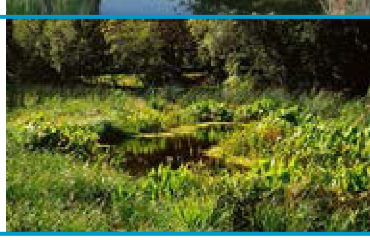
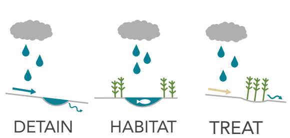
Urban forest (native and planted) as well as urban soils and rain gardens all mimic the evapotranspiration and infiltration that are natural flow pathways for rainwater.

Green Infrastructure Tools for Rainwater Management

The summary matrix below introduces a range of Green Infrastructure practices to improve rainwater management. These tools are in common use in other jurisdictions around Metro Vancouver, the Pacific Northwest, and in developed areas around the world.

For more information on Green Infrastructure, see the BMP Toolkit (IRMP Volume II)

TOOL		IMPACTS ON WATER	BENEFITS
Absorbent Landscapes		INFILTRATE	• intercept and clean rainwater through soil pores, allowing gradual infiltration into subsoils to recharge groundwater
Infiltration Swales		INFILTRATE, TREAT, DETAIN	• reduce runoff volume and increase water quality by capturing, detaining, treating, and conveying stormwater
Rain Gardens & Infiltration Bulges		INFILTRATE, TREAT, DETAIN	• reduce runoff volume and improve water quality by infiltrating, capturing, and filtering stormwater • an overflow conveys extreme rainfall volumes
Pervious Paving		INFILTRATE	• reduce runoff volume and improve water quality by infiltrating and treating stormwater while still providing a hard, drivable surface
Green Roofs		DETAIN, HABITAT, TRANSPIRE	• reduce stormwater peak flows and volume, depending on depth of growing medium • benefit buildings by providing insulation and by reducing the heat island effect • provide urban habitat
Tree Well Structures		INFILTRATE, TREAT, DETAIN, TRANSPIRE	• adequate soil volume will retain excess stormwater and help to remove pollutants from stormwater runoff • support a healthy tree canopy which intercepts rainfall

TOOL		IMPACTS ON WATER	BENEFITS
Rainwater Harvesting			• runoff from roof surfaces can be captured, stored and used for non-potable uses like landscape irrigation, laundry, and toilets, subject to approval of authorities having jurisdiction.
Infiltration Trenches			• reduce the volume and rate of runoff by holding and infiltrating water into subsurface soils • water quality pre-treatment is advisable
Water Quality Structures			• capture petroleum hydrocarbons, coarse grit and coarse sediment • provide some water quality benefits except for soluble nutrients and pollutants
Detention Tanks			• reduce flooding and in-stream erosion by collecting and storing stormwater runoff during a storm event, and releasing it at controlled rates to the downstream drainage system
Daylighted Streams & Channel Improvements			• may provide in-stream detention, water quality improvements, and essential habitat for aquatic life • contribute to the liveability of an area and establish a sense of place if properly designed
Constructed Wetlands			• provide detention, storage, habitat, and treat stormwater runoff through natural processes prior to discharging it into the downstream drainage system

CONSIDERATIONS IN EVALUATING PERFORMANCE

Vancouver's Citywide IRMP is different than many other watershed-based stormwater management plans, in that the Vancouver Citywide study area is entirely serviced with piped stormwater systems. Whereas most IRMPs would aim to protect the water quality and hydrological flow systems of surface streams, the Citywide IRMP is focused on managing piped systems that discharge to tidal or estuarine receiving waters.

In this context, there is a need for the Citywide IRMP to revisit common criteria for evaluating performance of stormwater best management practices (BMPs). Volume II also evaluates the performance of the tools in two sets of criteria: function and cost.

Functional Criteria

- Maximize Water Quality Treatment
- Maximize Volume Control (reduced CSOs)
- Maximize Aesthetic Benefits
- Maximize Biodiversity Benefits
- Maximize Public Education, Culture and Health Values

Cost Criteria

- Minimize Land or Space Cost
- Minimize Material and Construction Cost
- Minimize Maintenance Cost
- Maximize Property Value
- Maximize Longevity

As well as evaluating performance of the tools in isolation, it is also beneficial to know how the tools work together as a system at the City-wide and drainage basin scales (i.e., what is the optimum combination of tools for each land use type?). IRMP Volume III Technical Background Report (internal) provides a full analysis of alternative scenarios that combine tools.

4.0 WHAT DO WE WISH TO ACHIEVE?

It is essential to have a clear understanding of 'what are we trying to achieve?' with implementation of best practices. The following section introduces key principles and customized targets for the Citywide study area, to address both water quality and water volume issues in the watersheds.

Key Principles for Results

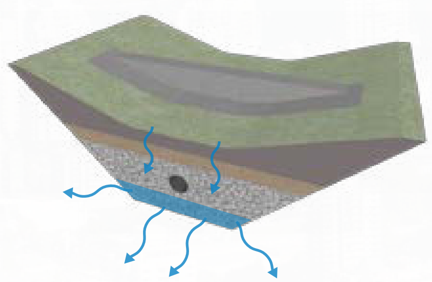
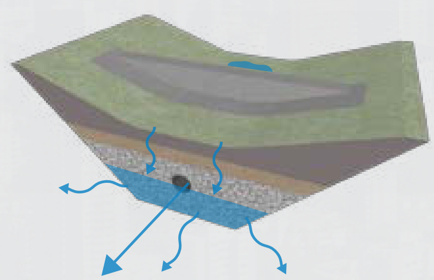
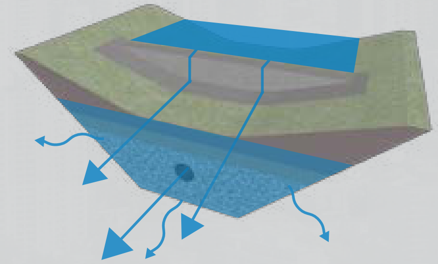
- Reduce Combined Sewer Overflows (CSOs) into Vancouver's tidal and river waters.
- Reduce the demands on capacity for sewage treatment through replacement of combined sewers with separated storm drainage systems and sanitary sewage systems.
- Redirect rainwater into natural pathways, including infiltration to subsoils and aquifers, evaporation, and evapotranspiration through the leaves of plants.
- Allow for reserve capacity in the City's piped drainage system, and constructed watercourses where applicable, to be resilient to changes in precipitation patterns related to climate change.
- Protect water quality in our beaches, bays, rivers and groundwater by using green infrastructure to provide pollution treatment by filtering surface water through soil and organic layers.
- Consider how green infrastructure and installed deep soil/ organic compost layers could also provide healthier landscapes and water conservation benefits.
- Add to the biodiversity, environmental health and urban design diversity of Vancouver by integrating plantings, the urban forest, and constructed wetlands or rain gardens into both private landscapes and city parks, plazas and streets.

Targets: Soak it in! Clean it up! Convey it safely!

The graphic and summary on the following facing pages outline the objectives - expressed as quantitative targets – for the three levels of storm events: showers and small storms, large and extreme storms. The graphic and summary also explain the fundamentals of how green infrastructure can meet these targets.

Rainwater management targets

in Vancouver citywide area

Rain Shower	Large Storm	Extreme Storm
+/- 70% of Annual Rainfall Volume	**+/- 20%** of Annual Rainfall Volume	**+/- 10%** of Annual Rainfall Volume
		
Soak it in!	**Clean it up!**	**Convey it safely!**
First **24mm** per day	Second **24mm** per day	**Remainder**
Capture (infiltrate) or reuse at source	Treat, ideally through surface soils	Provide runoff routes (pipes and/or overflow)

Water Quality Treatment Target

Water Volume Reduction Target

The Water Volume Reduction target is to return the first 24mm of rainfall per day into natural pathways of infiltration through subsoils or evapotranspiration to air - removing this volume from stormwater pipes. The Water Quality Treatment target includes both the first and second 24mm of rainfall a day - to a total of 48mm a day, equal to the 6 month return period. After flowing through treatment soils, some of the treated water quality flows may enter piped drainage through sub-surface perforated drains.

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NORMAL RAINFALL: SOAK IT IN!

- Soak up the first 24mm (1") in a day (24 hrs)
- Includes the common 'drizzle' up to small storms
- Objective is to infiltrate these rainfalls near where they land, providing benefits of water quality and reduced runoff.

HOW GREEN INFRASTRUCTURE WORKS

Even Vancouver's slow-draining subsoils will typically absorb 1mm an hour, or 24 mm over 24 hours.

Good quality topsoil and organic compost will absorb and hold about 10-20% of its volume in rainfall – a 450 mm soil layer would hold at least 45mm, where the moisture would either slowly evaporate or soak into the subsoils.

LARGE STORMS: CLEAN IT UP!

- Clean Up the next 24mm (1"), when combined with the small storms adding up to 48mm in a day (24 hrs).
- Includes large storms that occur once/year in a typical year.
- Objective is to treat for water quality in the runoff from these rainfalls near where they land, as well as to maximize the time available for rainfall to soak into the subsoils.

HOW GREEN INFRASTRUCTURE WORKS

A good topsoil/organic compost mix will typically absorb these volumes (rates of 12mm/hour infiltration into landscape soils are common) and will take out most storm runoff pollutants, including petroleum hydrocarbons, heavy metals from brake linings, sediment from erosion, excess nutrients and bacteria from fertilizers and pet/bird droppings.

A drain rock water reservoir under the topsoil layer would provide underground storage so that the water is given greater time to soak into the subsoils. A perforated underdrain at the top of the drain rock reservoir would take excess water to the City piped drainage system.

EXTREME STORMS: CONVEY IT SAFELY!

- Addresses storm events that are over 48 mm (2") in 24 hours, up to extreme events
- Extreme storms (1 in 10 year, 1 in 100 year return period) can occur at any time, but on average do not happen once/year.
- Objective is to safely convey to outlets the excess runoff through both pipes and in extreme cases by the 'major drainage' system of surface gutters along street edges, channels and overflows.

HOW GREEN INFRASTRUCTURE WORKS

In these larger and extreme storms, the first 48mm are still being treated by green infrastructure as described above.

The runoff from rainfall above 48mm in 24 hours will be carried in pipes, surface routes or channels that minimize the damage to buildings or property.

This type of 'flood conveyance' stormwater management is inherent in all drainage system design, including grey infrastructure systems.

Because these events are rare, water quality is not specifically addressed other than by dilution.

INFORMATION ABOUT VANCOUVER'S CITYWIDE AREA RAINFALL:

Annual Rainfall amounts in a typical year vary from 1200 mm in Southwest Vancouver to 1500mm in Northeast Vancouver. For targets, the larger rainfall amount is used.

For area of Vancouver with 1500mm of rainfall in an average year:

6 month return period storm in 24 hour period = 47.7 mm rainfall (water quality storm)

2 year return period storm in 24 hour period = 66.2 mm rainfall (mean annual rainfall)

Support for These Targets

Targets introduced above follow the intent of guidelines from the federal Department of Fisheries and Oceans, and are adapted from Metro Vancouver Stormwater Source Control guidelines and the MV Integrated Liquid Waste and Resource Management Plan. They also reflect 'aspirational targets' determined by stakeholder input.

The technical wording for targets are listed below, and described in more detail in Volume III: Technical Background (internal). These details include some nuances particular to the Citywide study area conditions.

Water Quality Target:
Treat 90% of the volume of runoff from effective impervious areas, other than roof in low density residential land uses, to the water quality standards - yellow or green - for piped drainage set out in Monitoring and Adaptive Management Framework for Stormwater, Metro Vancouver, 2014. A draft monitoring program is outlined in Volume III of the IRMP.

Water Volume Reduction Target:
Capture a minimum of 50% of the 6-month/24-hour post development volume from effective impervious areas, other than collector/arterial roads in all land uses and either infiltrate to ground, evapotranspirate, or reuse the captured rainfall.

Roof Drainage in Low Density Residential Land Use Areas:
Whereas existing roof drainage in low density residential land uses is required to be piped to the city sewer system, changes to regulations are encouraged to allow either harvest and reuse of this roof drainage, or 'disconnected roof leaders' which direct the roof drainage to on-site absorbent landscape areas. Disconnection of roof drainage should be subject to an approval process, and only in neighbourhoods with foundation drains at buildings. In cases where roof drainage is directed to the ground surface, the water quality target would apply to the roof drainage. This could be met by deep absorbent soils and/or properly sized rain gardens for infiltration of the small and large storm events from the roof and site, with provision for safe conveyance of extreme storm overflow from private property to the public major drainage flow path.

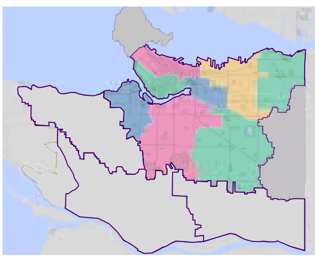
Detention or Rate Control Target:
For developments defined as 'large scale developments', reduce post-development rate and volume to at or below pre-development levels for the 2-year/24-hour precipitation events. Pre-development equals the site's immediate preceding use. Large scale developments should be defined using the same criteria as in the Rezoning Policy for Sustainable Large Developments, City of Vancouver, 2013 which currently has similar requirements.

Like all initiatives, the principle of 'what gets measured - gets done' applies within the Citywide study area. The implementation action plan includes a monitoring and adaptive management strategy, which should complete periodic review of meeting these targets, and allows for adjustment of strategies to ensure the targets are met in a practical and feasible manner.

Rainwater Management Areas and Biodiversity Demonstration Projects

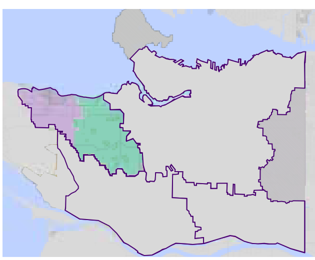
Across the Citywide study area, there are differences in average annual rainfall, in the destination of stormwater runoff to receiving waters, and in the average age of sewer infrastructure. These differences are summarized in the Rainwater Management Areas shown on Figure I-13.

The phasing of on-street green infrastructure should generally follow the pattern of combined sewer separation, with the oldest sewers and those that flow to confined water like False Creek being addressed first. The Rainwater Management areas are a coarse division that follow the principles of integrating green infrastructure at the end of life cycle of existing infrastructure. Individual projects may also respond to servicing issues, development plans and coordination with other infrastructure.



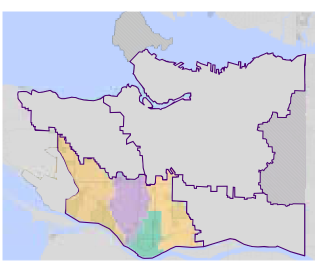
North-East RMA

- Drains to False Creek and Burrard Inlet, older sewers
- Relatively heavy rainfall (1300-1500 mm/yr average)
- Early application of sewer separation and green infrastructure



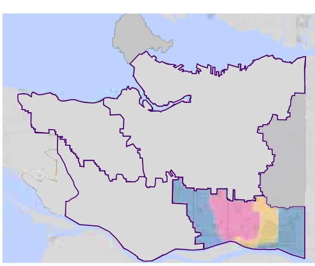
North-West RMA

- Drains to English Bay Beaches, older sewers
- Relatively low rainfall (1200-1300 mm / yr. average)
- Mid-priority application of sewer separation and green infrastructure



South-West RMA

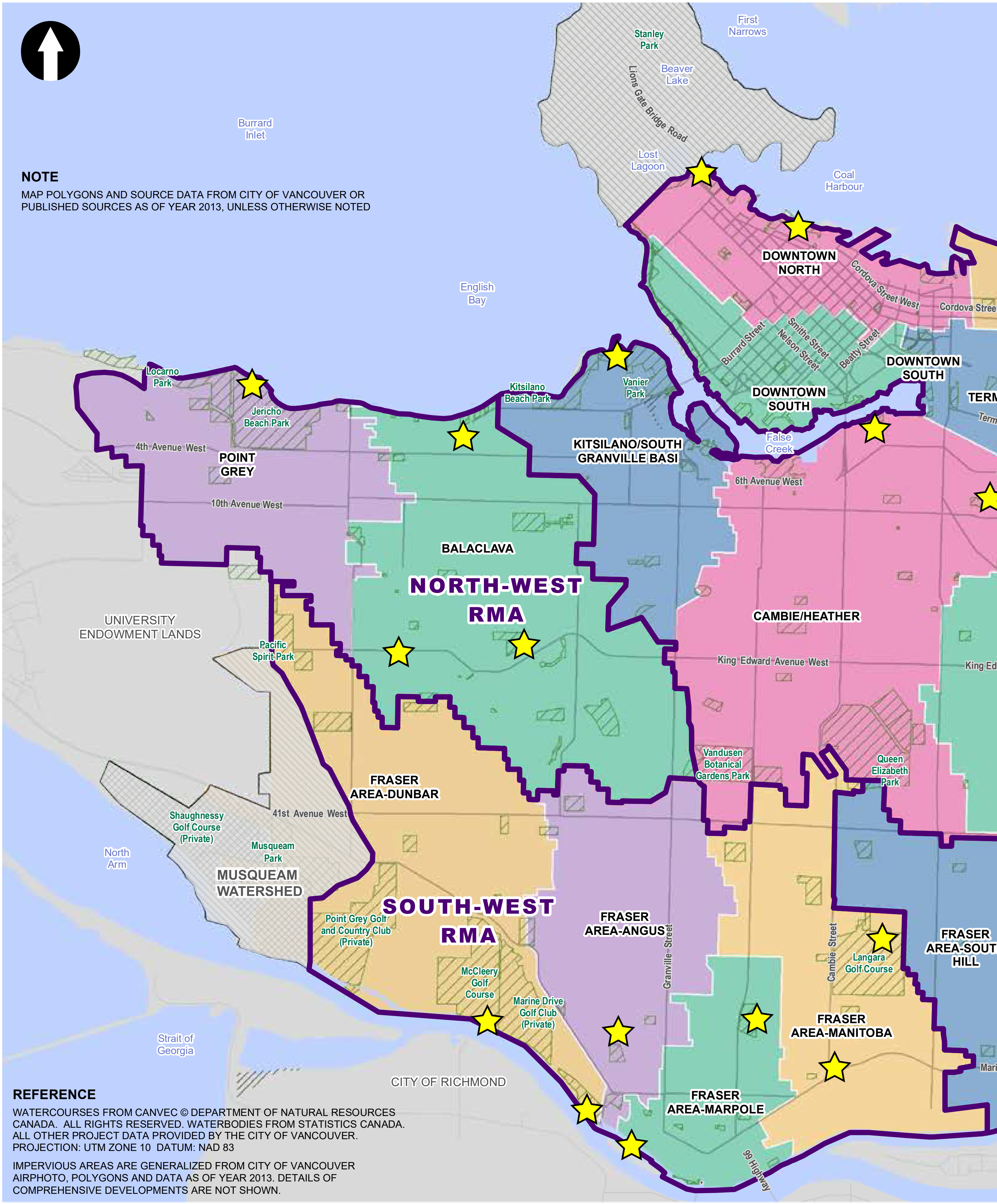
- Drains to Fraser River, newer sewers
- Relatively low rainfall (1200 – 1300 mm / yr. average)
- Later application of sewer separation and green infrastructure



South-East RMA

- Drains to Fraser River, newer sewers
- Relatively heavy rainfall (1300-1500 mm/yr average)
- Later application of sewer separation and green infrastructure

Volume III Technical Background Report (internal) recognizes that larger or custom developments may undertake custom engineering and sizing of green infrastructure to reflect local rainfall and infiltration conditions.



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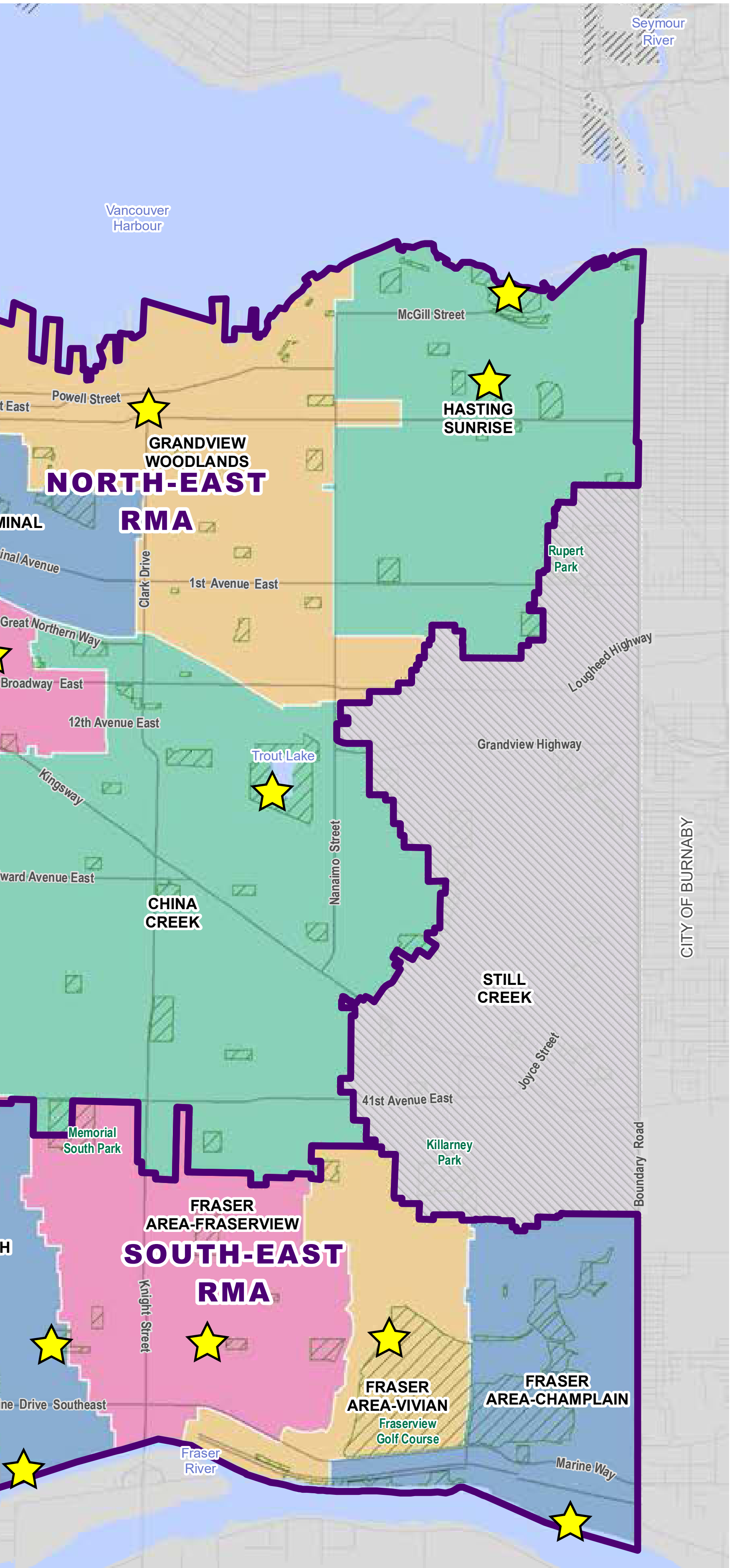


Figure I - 13:

Rainwater Management Areas and Biodiversity Demonstration Projects

An early priority in selected areas should be to create a visible 'water focal point' or biodiversity demonstrations in each watershed - a place where the quality and quantity of water, and the life it supports, can be seen (and monitored / improved).

New focal points are conceptual at this point. Schematic locations of potential Green Infrastructure and Biodiversity Demonstration Projects are shown in Figure I-13, with the intent that widespread BMP adoption would follow across the City.

LEGEND

- RAINWATER MANAGEMENT AREAS (RMA)
- STORMWATER CATCHMENT AREA
- AREA EXCLUDED FROM STUDY
- ARTERIAL ROAD
- BIODIVERSITY DEMONSTRATION PROJECT

Potential new water focus projects / biodiversity demonstration projects

(Examples - subject to priority evaluation)

NORTHEAST RAINWATER MANAGEMENT AREA

Hastings Sunrise

- Playland redevelopment stormwater features, Broughton Park and Hastings Park Creek daylighting to complete Renfrew Creek system.

Grandview Woodlands

- Rain Garden and Pervious Paving Demonstration.

China Creek

- Trout Lake watershed reconnection, treatment wetlands, interpretation, St. George Rainway.

Cambie Heather

- Rainwater Interpretive Route at Olympic Village / Hinge Park (bioswale, pervious paving, green roof, stormwater stream, rainwater reuse, urban tree planting, habitat restoration). Rainwater BMP / biodiversity displays at Queen Elizabeth Park and Van Dusen Gardens. New median infiltration swales along King Edward Ave.

Terminal

- Creekside Park South (Science World) rainwater and climate change interpretive display (including sea level rise)

Downtown South

- Water quality treatment wetland. rainwater re-use features (Georgia Viaduct replacement or parks areas, in cooperation with adjacent developments)

Downtown North

- Coal Harbour rainwater and habitat interpretive display (at unfinished area at east end of Harbour Green Park) – convention centre green roof, rainwater and wastewater treatment and reuse, water edge habitat terraces, light for salmon on waterfront walkways, new visual water and biodiversity display using recycled water source. Pond / wetland stormwater improvements at Devonian Harbour Park. Interpretation of this plus of Lost Lagoon treatment wetland.

Kitsilano South Granville

- Hadden / Vanier Park (Maple and Ogden) treatment wetlands and beach water quality interpretive displays

NORTHWEST RAINWATER MANAGEMENT AREA

Balaclava

- Median infiltration swale demonstration at King Edward Ave., BMP and biodiversity displays at Quilchena Park, Prince of Wales Park, and Trafalgar Park. Tatlow Creek daylighting and park improvements.

Point Grey

- Biodiversity and rainwater enhancements at Jericho Beach Park. Cooperative rainwater and wastewater reuse demonstration and interpretation at future developments. On-going interpretation at Spanish Banks Creek.

SOUTHEAST RAINWATER MANAGEMENT AREA

Champlain

- Habitat biodiversity improvements and water quality interpretation along waterfront walks at East Fraserlands, Riverfront Park, connecting walks and open channel at foot of Boundary Road.

Vivian

- Rainwater BMP showcase near entrances to Fraserview Golf Course Riverfront biodiversity enhancements and interpretation at Gladstone Riverside Park, and at foot of Victoria Drive and Beatrice St. waterfront area.

Fraser View

- Rainwater BMP and biodiversity showcase at Victoria Drive Park / School areas, and at Memorial South Park.

South Hill

- Rainwater BMP showcase at Ross Park / Moberly Park / Schools. BMP Showcase at a volunteer industrial retrofit along the waterfront area.

SOUTHWEST RAINWATER MANAGEMENT AREA

Manitoba

- Biodiversity and rainwater management showcase at Langara Golf Course Biodiversity and rainwater management showcase at 64th and Yukon.

Marpole

- Rainwater BMP showcase at Oak Park, biodiversity and rainwater BMP interpretation at redevelopment of Bus Yard lands.

Angus

- Rainwater BMP and biodiversity displays at Kerrisdale Park and Riverview Park

Dunbar

- Biodiversity and rainwater enhancements and displays at McCleery Golf Course, and at Fraser River Park (joint with Angus watershed)

Everyone Plays a Role – Public and Private

Meeting the goals and targets to protect Vancouver's bays, beaches and biodiversity requires cooperation from all land uses and land managers in the city. Even single family and low density land uses, and local streets, need to play a role, as they represent over 80% of the land area in our watersheds.

Refer to the BMP Tookit (Volume II) for a listing of common practices and their suitability to various land use types. Strategies to meet targets in typical land uses include:

Low Density One/Two Family & Lane Housing

- Eliminate sanitary sewer cross connections into storm sewer.
- Design for zero runoff leaving the site for small or large storms in new homes. Convey runoff from extreme storms to the major drainage path (street or lane).
- Direct roof rainwater to infiltration (subject to an approval process) rather than to piped sewers.
- Provide incentive programs for roof rainwater harvesting and reuse (existing and new homes).

Medium / High Density: Multi-family, Industrial Commercial Institutional

- Meet water quality, volume reduction and detention targets. Allow flexibility to use all Green Infrastructure tools.

Lanes

- Design new homes for no runoff from private parcel to lane.
- Implement regular lane vacuum sweeping and catch basin cleaning in sewer-separated areas, .
- When resurfacing, meet water quality (but not necessarily water volume) targets by installing Green Infrastructure associated with resurfacing.

Local Streets

- Meet water quality and volume reduction targets, but not detention targets.
- Provide flexibility to use several Green Infrastructure tools or combinations.
- Undertake neighbourhood consultation and involvement in design, as well as in operations and maintenance.

Collector / Arterial Streets

- Meet water quality targets, but not water volume reduction or detention targets. Due to space constraints, it may be necessary to consider grey infrastructure for limited water quality treatment.

PRIORITIES AND BENEFITS

The priority in the above actions is reduction of water quality risks to receiving waters, by phasing-in conformance to the Metro Vancouver Monitoring and Adaptive Management Framework (yellow or green standards) that sets out water quality requirements that would apply to the piped drainage in the Citywide area.

The actions should also provide stormwater volume reduction at time of redevelopment through specified practices on local streets, reducing effective impervious area at the site level of one/two family & lane housing, and requiring volume reduction and detention at large High Density Multi Family and Industrial/Commercial/Institutional (MF/ICI) developments.

The volume reduction target should provide additional space (approximately 30%) in storm sewer pipes to accommodate flows that may increase due to more intense rainfall events and climate change.

Until sewer separation is completed, the increased available volume in existing combined sewers would mitigate the tendency towards more frequent or higher volume Combined Sewer Overflows (CSOs).

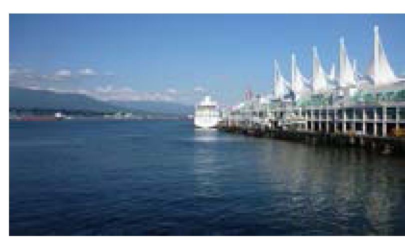
The Action Plan in Section 5.0 of this IRMP introduces the Actions and Priorities to get started on effective implementation.

Some Actions are ongoing, and can continue with renewed committment and focus of City staff. Other actions are new, and will benefit from on-going community engagement, including stewardship groups, the real estate and development community, homeowners and tenants.

Public awareness and outreach programs should be a perennial part of implementation of the IRMP.

Key Implementation Principles for Action

Working with Stakeholders, Key Principles have been noted to guide implementation of the Citywide IRMP.



MULTIPLE BENEFITS AND CONTINUOUS IMPROVEMENT

- Pursue rainwater management solutions that have multiple benefits—that meet many cross-discipline and cross departmental aspirations.
- Ensure that constructed rainwater management solutions are evaluated, and lessons-learned are shared, for continuous improvement.
- Reduce reliance on drinking water supplies to meet non-potable use demands by supporting roof water harvesting and water-conserving absorbent landscape.

CONTEXT SENSITIVE DESIGN

- Recognize that there may be variation in rainwater management solutions among different land use typologies.
- Identify areas of the city that have natural hazards or conditions that would restrict the type of rainwater management technique used (e.g. reduced reliance on infiltration in areas of slope instability, contaminated soils, high water table).
- Support, where possible, the objective of daylighting creeks is supported within the constraints of urban conditions.

SHARED RESPONSIBILITY

- Balance the responsibility to implement rainwater management solutions among private and public sectors, and support community stewardship.
- Continue to show leadership by example, with the City and private sector showcasing projects that demonstrate success in rainwater management.
- Ensure solutions balance capital, operations and maintenance considerations, and anticipate needs for maintenance funds and the role of private property owners in maintenance.

INCREMENTAL ADAPTATION

- Meet water quality and volume reduction targets, but not detention targets.
- Flexibility is provided to use several Green Infrastructure tools or combinations.
- Undertake neighbourhood and stewardship group consultation and involvement in design, as well as in operations and maintenance.
- Implement stormwater source controls into the long-term program of transitioning the combined sewer system into a separated system to reduce CSOs.
- Redevelopment of streets, parks or private lands provide opportunities for incremental rainwater management—leading to significant improvements over time.
- Provide on-going monitoring and periodic implementation refinement to support the Adaptive Management Framework and objectives of Metro Vancouver's Integrated Liquid Waste and Resource Management Plan.
- Adapt existing roles into clear and consistent regulations and requirements, rather than creating new programs or bylaws.

5.0 HOW DO WE START?

Implementing the Citywide IRMP will require a sustained effort among a wide variety of partners in City administration and among stakeholder and groups outside the City staff.

Actions will be incorporated into the City's budgeting processes for capital, operating/maintenance and staffing. Investment and priorities may change from year to year.

Overview of Action Programs

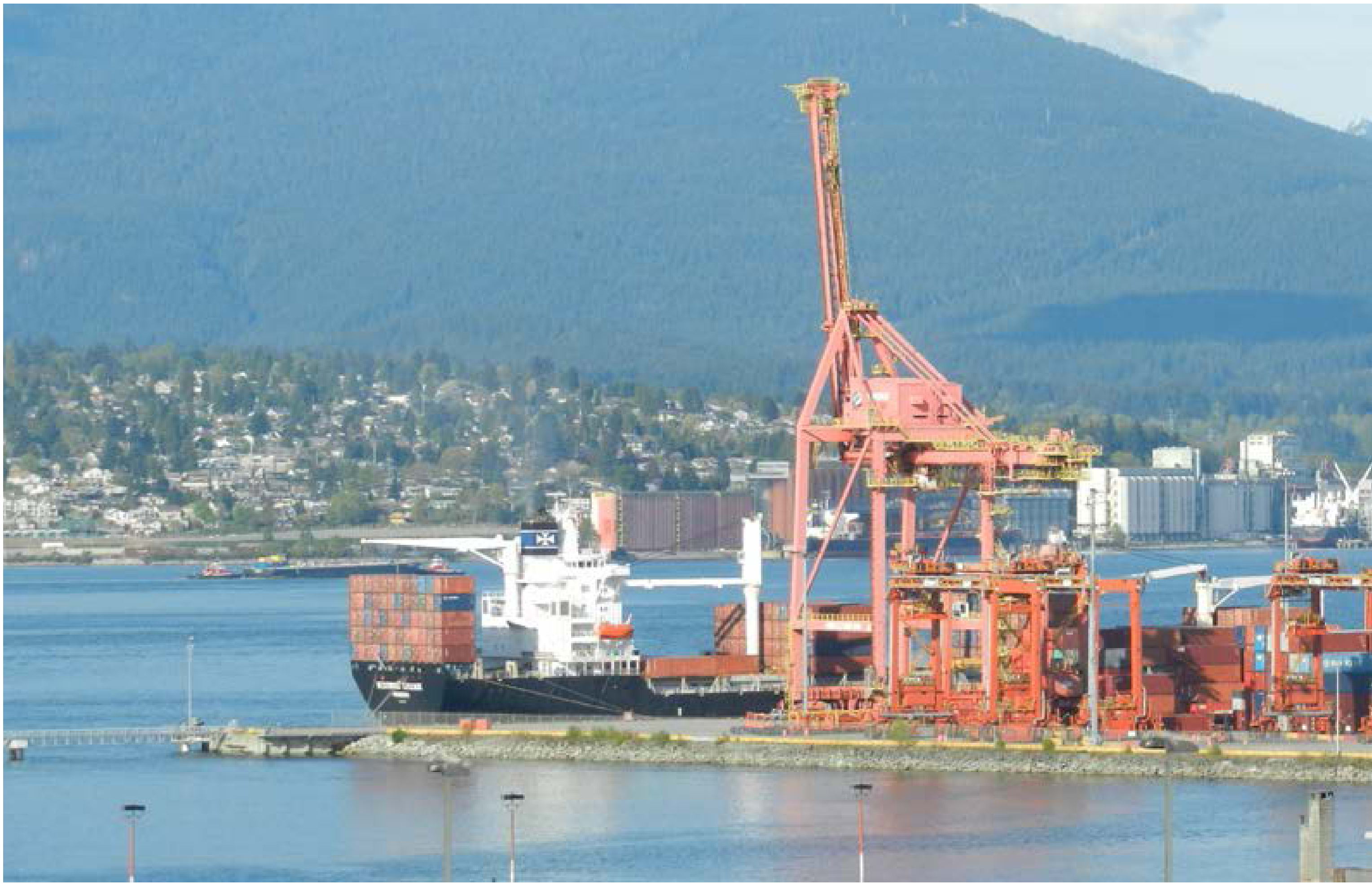
'Action Programs' are recommended to organize the implementation – these are presented as:

I. On-going Existing Actions

II. New Short Term Actions

III. New Sustained Actions

IV. New Longer Term Actions



On-Going Existing Actions

A fundamental issue in pollution abatement is on-going management of the amount of nutrients and bacteria that flow from the stormwater system to receiving waters - as well as sediment, oil and heavy metals that can flow with runoff from surface parking areas.

To minimize these risks, City programs for catch-basin / sump cleaning and sewer cross connection control would be combined to support:

STREET CLEANING

The ongoing program of street sweeping and sidewalk maintenance should continue and be enhanced, to remove sediments and litter such as gum and cigarettes from public spaces. A renewed focus should be placed on fall leaf and water quality cleanup, including citizen programs to encourage timely removal of leaf litter from boulevards, and avoiding the placement of tree or lawn leaf litter on street surfaces where it blocks catch basins and adds excess nutrients to runoff.

CATCH BASIN CLEANING

Catch basin sumps on streets function to remove coarse sediment from runoff before water enters the storm drain pipe. However, when leaves or organic debris and soil accumulate in the catch basins, bacteria can grow and can contribute to the closure of public swimming beaches.

The City should continue and increase regular catch basin cleaning by vacuum truck. It should also continue to remove sediment and oils from 'structural' best practices, like oil/water separators or detention tanks, and require this maintenance on private property.

Oils, sediment, and organics in CBs can generate beach-closing bacteria.

SEWER SEPARATION PROGRAM

The City is well advanced on a major capital investment to replace combined sewers with separate systems of sanitary sewer (human contact water) and storm water (roof and pavement drainage).

The sewer separation program is scheduled to be complete by Year 2015. As it is implemented the size and frequency of combined sewer overflows into Vancouver's bays, beaches and rivers should be reduced.

SEWER CROSS-CONNECTION ELIMINATION PROGRAM

Even after sewer separation in the public street, there are cases on private property where sanitary sewage is running undetected into storm sewers.

This is against City regulations and health best practice. The City should cooperate with private landowners on an on-going investigation and elimination of cross-connections between storm and sanitary systems within buildings or on private land.

MAJOR DEVELOPMENTS RAINWATER MANAGEMENT (SUSTAINABLE LARGE DEVELOPMENTS REZONING POLICY)

The City has an established policy where major rezoning applications are required to provide a Rainwater Management Plan that meets detention and water quality criteria established by the City. This policy should be maintained, and reviewed to ensure that it meets the requirements of the Citywide Integrated Rainwater Management Plan.

New Short Term Actions

WATERSHED PUBLIC AWARENESS OUTREACH PROGRAM (PHASED)

The Watershed Public Awareness and Outreach Program would recognize that urban design and green infrastructure implementation, in each of the city's watersheds, has a direct relationship to the health of the ecosystem of its receiving waters, and on the health of the watershed itself.

The quality of water that is delivered, and to a certain extent its quantity, influence the ability of the watershed and receiving waters to support life and ecosystems—benthic invertebrates (bugs) and insects that are food for aquatic species; clams, mollusks, oysters and other bivalves that are early indicators of pollution and desirable food species; support for the life ecosystems of salmon, herring, trout and other fishes, and for heron, eagles and other birds and mammals that prey on the bounty of the shorelines.

The purpose of the Watershed Public Awareness Outreach Program is to:

- Raise awareness among the public, business, agencies and city staff of the relationship of rainwater and watersheds to local ecosystems and life;
- Provide a vehicle for interested stakeholders within each watershed to focus their efforts;
- Support communication and training among watershed stakeholders, and sharing of green infrastructure and other best practices; Undertake communications and outreach, including multi-media and live training and awareness programs. The focus of these communications would be to help the public, landowners and stakeholders understand the relationship of their actions to watershed and salmon health;
- Provide a constituency in support of applications for outside funding for watershed improvements;
- Allow a role for 'citizen-science' in combination with City-funded science and testing, and a focus for monitoring and adaptive management of the watershed;
- Build a bridge between and support for both the Integrated Rainwater Management Plan and the City's Water Wise, Urban Forest and Biodiversity Program; and
- Share resources to implement adaptive management improvements to improve watershed health.

The City may phase in this 'Watersheds' Program gradually, and expand its depth and breadth in each phase of implementation.

An early priority in selected areas should be to create one or more visible 'water focal points' in each watershed – places where the quality and quantity of water, and the life it supports, can be seen (and monitored / improved). Existing and potential locations for water focal points will be determined on a balance of public land and resources available, potential private sector contributions, community / stakeholder interest, and the potential for the projects to increase community awareness and support.

As well as the environmental benefits, the Watersheds Program is also another means to community and social development in public, school and neighbourhood groups.

DEMONSTRATION PROJECTS AND CAPACITY–BUILDING

Implementation of the Citywide IRMP will require technical knowledge and confidence around design, construction and maintenance of new best practices and technologies. The Capacity-Building Program for Rainwater Management would support:

- Pilot and demonstration projects—these projects provide excellent opportunities to make training and results 'hands-on'. Pilot projects build comfort and confidence among staff and contractors and the skills to implement properly.
- Early projects and capacity building should also showcase 'quick wins' to solidify support.
- Capacity-building should include a review of implementation and enforcement of existing standards and regulations e.g. construction site erosion and sediment control.

Existing Infiltration Bulge in Vancouver

UPDATED ENGINEERING AND BUILDING STANDARDS

The City should bring regulations and procedures into alignment with the IRMP recommendations. Some older city regulations may require exclusive use of 'grey' infrastructure, and require update. The city should add green infrastructure 'city standards' for typical design, sizing and specifications that are well vetted and accepted. Results of pilot projects should inform these new standards.

UPDATED MAINTENANCE STANDARDS AND ROLES

All infrastructure – whether green or grey – requires on-going maintenance. Some parts of the street (notably landscape boulevards) have been maintained by adjacent landowners. Other programs such as the Green Streets program have provided guidance for citizen involvement beyond basic maintenance.

As green infrastructure is contemplated in city streets, plazas and parks, the City should review its maintenance standards and roles, including the role of adjacent properties and the private sector at larger developments. New standards for maintenance and roles should be developed, and funding allocated for the City portion of maintenance responsibilities.
A review of the potential 'social development' opportunities for green infrastructure maintenance should be a part of the review.

UPDATED DEVELOPMENT APPROVAL AND INSPECTION PROCESSES

Like all infrastructure, green infrastructure should function well if properly designed, installed and maintained, and may fail if poorly implemented. The City's approval and inspection processes should encourage proper design and installation of green infrastructure. Implementing requires a careful allocation of people and process to create an efficient and effective development and implementation approval system. The intent should be to fully incorporate green infrastructure reviews into existing review procedures, rather than inventing new administrative systems.

TECHNICAL TRAINING AND STAFF DEVELOPMENT

Both City staff and external contractors have ongoing needs for technical training on green infrastructure. Related training activities should include:

- Internal technical and training materials and staff development.
- External training materials—aimed at increasing the capacity for proper Green Infrastructure and other BMP design and installation on private lands, aimed at the consulting design community, and in contracting installation and maintenance firms, as well as small property owners and homeowners.
- Implementation should also include training of staff that review applications and that provide referrals or informal guidance to applicants.
- Training should also reinforce enforcement of sediment and erosion control during construction on public and private sites.

ORGANIZATIONAL DEVELOPMENT FOR FUNDING AND IMPLEMENTATION

Many aspects of implementing the IRMP should be accommodated as adjustments to existing budgeting, funding and staffing programs. There are, however, some key changes that would benefit from an organizational development approach, including:

- Creation of a Green Infrastructure Team as a focal point for the program;
- Identification of functions that may be accommodated in existing budgets;
- Identification of new service functions that should require allocations of budget and staffing for effective delivery;
- Clarity on roles of City and Park Board departments, staff and consultants/contractors in on-going implementation.

AWARDS AND INCENTIVE PROGRAM

The City should integrate Green Infrastructure recognition into Annual Awards programs to recognize noteworthy investments and awareness-building activities that meet the objectives of the IRMP.

New Sustained Actions

Three new programs should be phased in: Absorbent Sites Program; Surface Parking Treatment Program; and Monitoring and Adaptive Management Program.

ABSORBENT SITES PROGRAM

Over 50% of land area in the City of Vancouver is covered by residential land uses and the adjacent local streets. These residential neighbourhoods occur in two widespread types - low density one and two family homes, and high density or mixed use residential/commercial. The quality and volume of water entering the stormwater system and receiving waters is directly related to the design and maintenance of these places that we live.

Pet waste and over-fertilization of landscape areas can lead to bacteria, aquatic weed and algae problems in receiving waters. Proper depth and quality of absorbent landscape soils can mitigate these risks.

Erosion and sediment control during construction is of paramount importance to water quality in receiving waters

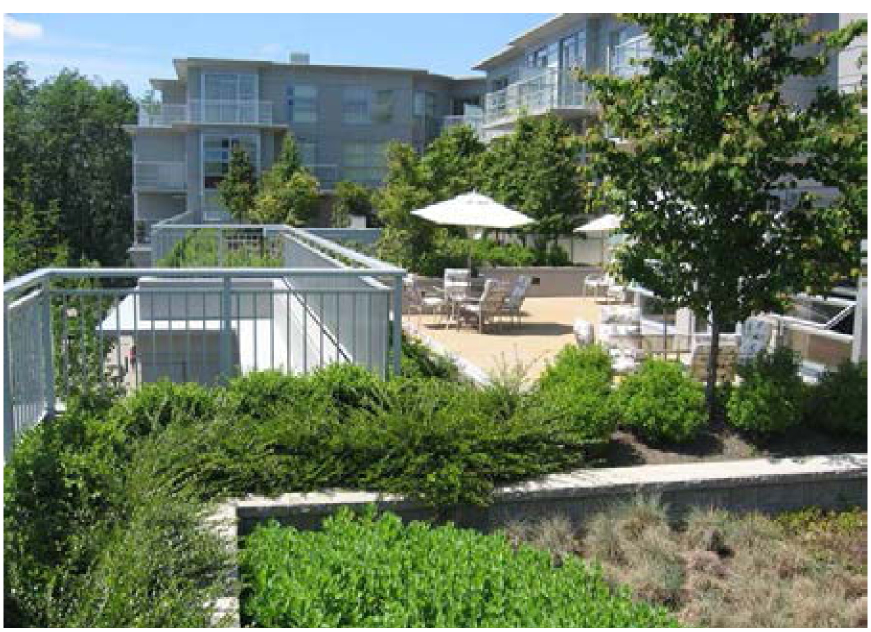
The Absorbent Sites Program provides guidance for rainwater-sensitive site development for private residential lands. The local streets and surface parking concerns are addressed below by the Surface Parking Treatment Program.

The issues with at-grade drainage from housing areas are excess nutrients from over-fertilization, nutrients and bacteria from pet waste, petroleum hydrocarbons and heavy metals from driveways or other surface parking areas, and potential erosion and sediment transport to stormwater from gardening activities, and in particular from construction sites.

The Absorbent Sites Program primary objective is that small storms that land on the at-grade portion of residential landscapes should be absorbed into the underlying subsoils, and large storms should be filtered through surface soils. It is recognized that extreme storms (above the water quality storm) may create some runoff to drain inlets or the fronting street, and provisions for positive drainage for these extreme events should still be made in site and utility planning.

Absorbent Sites can be readily achieved by use of the practices in the BMPs (Vol II). Requirements for Absorbent Sites would be established by design guideline policy or bylaw, and administered at the time of redevelopment through the development or building permit processes.

Single and two-family zones should be encouraged (subject to an approval process) to either harvest roof rainwater for re-use, or disconnect roof rainwater leaders and distribute the roof water to absorbent landscape areas, with an overflow from these absorbent areas for major storm events to the street or piped stormwater system. City exceptions to this requirement should be identified, including areas without foundation drains, or other areas at risk based on hydrogeological investigations. Where landowners otherwise wish an exception to the requirement, approval of the exception should be based on a detailed application form and established criteria.



Absorbent landscape and soils are often installed above parking garages in high density developments.

Medium and High Density residential and mixed-use developments are also required to meet the Absorbent Sites Program requirements. It is anticipated that most of these developments would use the performance application process, and that these requirements would be generally complementary to current best practices such as those encouraged by LEED certification. The Rezoning Policy for Sustainable Large Sites already provides a similar requirement. Refer to the following Roof Rainwater Harvesting and Reuse Program for guidance on roof rainwater reuse.

SURFACE PARKING TREATMENT PROGRAM

Surface Parking is one of the major contributors in urban environments to water quality pollution of receiving waters. The parking areas (even recently paved) show visible droppings of petroleum hydrocarbons, which flow with stormwater into pipes and show up as sheen on surface waters. What are not as visible are heavy metals from brake linings, sediments that are carried into the drains by stormwater, bacteria and other pollutants.

In the Citywide Area, there are two areas of surface parking: on-street, and off-street. All surface parking, whether public or private, contributes to urban water quality issues.

On-street parking is common across Vancouver

Off street surface parking remains a common land use outside the downtown core.

ON STREET SURFACE PARKING TREATMENT

On-street parking areas are perhaps the largest area of surface parking in the study area. Almost every local street is lined with surface parking, usually on both sides. Implementing treatment of water quality associated with on-street parking is a high priority.

The Surface Parking Treatment Program would support an inter-departmental focus to implement water quality treatment on all on-street parking areas. Priority would be given to streets where drainage is now or soon to be flowing into separated storm sewers and to receiving waters.

All BMP tools should be considered for treating water quality from surface parking. IRMP Volume III: Technical Background Report (internal), has compared the life cycle cost and functionality of combinations of tools in a typical Vancouver residential neighbourhood. Based on that analysis, the program envisions the general allocation of tools to be:

Local Streets:

- Four infiltration bulges per block (approximately 90% of locations – see Figure I - 13 Option LS1);
- Two infiltration bulges at the lower portion of a block, with treatment of the upper half of the block provided by pervious paving under parking (approximately 5% of locations);
- Two infiltration bulges, at the lower portion of a block, with treatment of the upper half of the block provided by pervious paving under parking isolated from travel lanes by a gutter that flows to the infiltration bulges (approximately 5% of locations).

Collector and Arterial Streets:

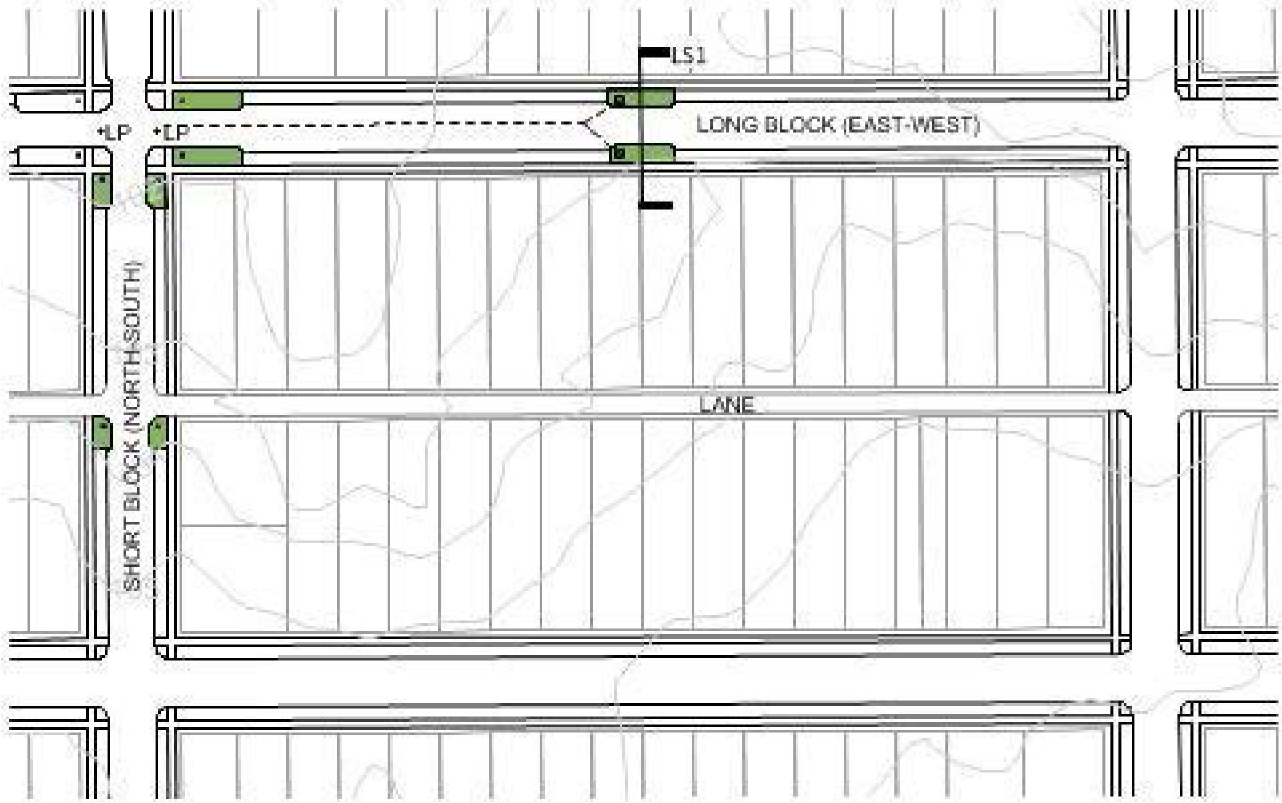
- Membrane-based Water Quality Structures (approximately 90% of locations);
- Localized infiltration bulges or Pervious Paving and Surface Parking (approximately 5% of locations);
- Localized Infiltration into Street Tree Wells (approximately 5% of locations)

Use of water quality structures to treat local streets is discouraged, but may be the only option in certain conditions.

Coordination of technical details with Coastal Health and utility agencies will be required. A review is anticipated of the interface with potable water supply utilities of both natural groundwater and infiltrated runoff.

Guidelines and analysis of these best practices are provided in IRMP Volume II: BMP Toolkit and Volume III: Technical Background Report (internal).

Figure I - 13: Local Street Surface Parking Treatment Option LS1

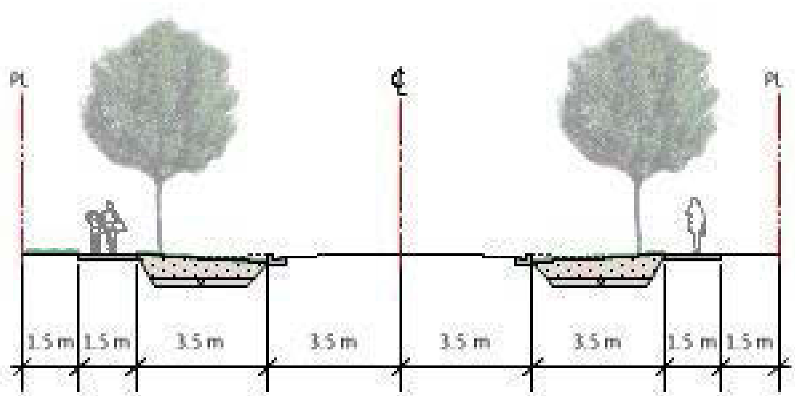


SHORT BLOCK (NORTH-SOUTH)

INFILTRATION BULGE AREA	92 sq.m
PARKING REDUCTION	4 stalls
TREE REMOVAL/REPLACE	4 trees

LONG BLOCK (EAST-WEST)

INFILTRATION BULGE AREA	180 sq.m
PARKING REDUCTION	8 stalls
TREE REMOVAL/REPLACE	4 trees



LOCAL STREET - INFILTRATION BULGES
Scale 1:200

OFF STREET SURFACE PARKING TREATMENT

Off-street parking areas still exist in the Citywide study area. Although their presence is dwindling in the downtown peninsula, they are still a common element along arterial and collector streets (behind or beside commercial buildings), at shopping centres or warehouse areas, at places of worship, and at schools and institutions.

Although this section is intended to address staff parking areas at heavy industrial sites, it should not be applied to industrial yards—which should have their own pollution abatement program.

The preference for treatments of off-street surface parking is similar to that for on-street, although the site plan configuration varies. All BMP tools should be considered for treating water quality from surface parking. However, the program envisions the general allocation of tools to be:

Off-Street Surface Parking:

- Infiltration Swales (Figure I - 14 Small Parking Option PS1)
- Pervious Paving to Parking Bays

Guidelines and analysis of these best practices are provided in IRMP Volume II: BMP Toolkit and Volume III: Technical Background Report (internal).

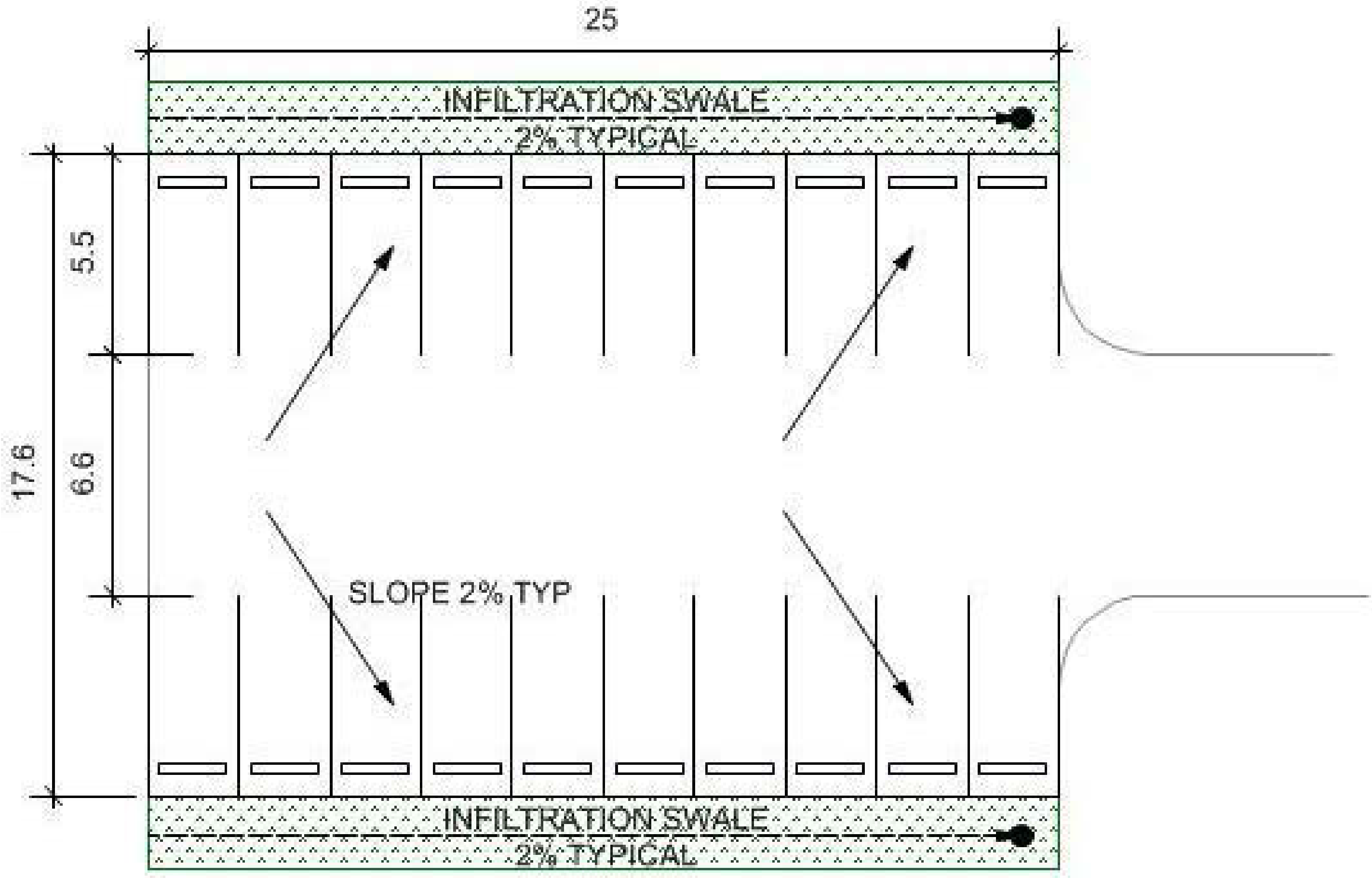
Which of these approaches are chosen for a given off-street parking area is to be determined at the time of development application, or if there is a rezoning application, at the rezoning stage. The development permit process may require landscaped area and tree cover for other purposes, and this requirement, as well as site configuration and space available, should lead to site specific choices.

Use of water quality structures to treat off-street surface parking is discouraged, but may be the only option in certain conditions. Water quality structures (e.g. pretreatment and membrane filtration system) may be appropriate in retrofit surface parking situations where no redevelopment is anticipated for some time, but there is a desire to provide basic water quality treatment.

Where surface parking is an open roof of a parking garage, treatment shall be to a similar performance standard to that provided by the above. Where space is limited, this might be by a water quality structure.

As storm sewer separation progresses, existing off-street parking areas may be connected to new storm sewers that will outfall to sensitive receiving waters. In addition to installed BMPs with new construction, it is therefore important to encourage water quality BMP retrofit of existing off-street surface parking areas prior to final sewer separation. A proposed Surface Parking Treatment Incentive Program could provide a charge on un-treated surface parking areas, with these charges reduced or eliminated as treatment BMPs are installed. A related grants program could provide incentives to early adopters.

Figure I - 14: Small Parking Area Treatment Option PS1



MONITORING AND ADAPTIVE MANAGEMENT PROGRAM

Metro Vancouver's approved Integrated Liquid Waste Resource Management Plan (ILWRMP) requires that municipalities monitor stormwater to assess and report on the effectiveness of ISMP implementation. Metro Vancouver, in consultation with member organizations, has developed a Monitoring and Adaptive Management Framework (MAMF) to monitor watershed health. It is recommended that the City of Vancouver create and maintain a Monitoring and Adaptive Management Program in accordance with the guidelines in the MAMF.

Under the MAMF, there are specific guidelines for piped systems, including monitoring of water quality parameters in every watershed once in every five years, for dissoved oxygen, pH, temperature, conductivity, turbidity, nutrients, E.coli and fecal oliforms, iron, copper, zinc, lead, and cadmium.

Early steps in the Vancouver Citywide Monitoring and Adaptive Management program implementation will include establishing monitoring sites and baseline data, and reviewing that baseline data in context with the water quality performance targets set out in the MAMF. Subject to baseline results, it is recommended that the City adopt the 'Yellow' MAMF ISMP Performance Targets as a minimum, while striving to meet the 'Green' water quality targets.

Additional detail of the proposed monitoring program are provided in IRMP Volume III (internal).

New Longer Term Actions

Two programs that are worthy, but potentially later in the implementation priorities: Absorbent Lanes and Rainwater Harvesting and Reuse.

ABSORBENT LANES PROGRAM

The City of Vancouver has been a leader in showcasing rainwater best practices in its Country Lanes Project.

The use of concrete wheel strips to support heavy waste vehicles, with surrounding absorbent landscape of pervious paving, is an exemplary design. This installation also represents a healthy relationship in involving the neighbourhood and adjacent landowners in pre-design engagement and in on-going maintenance.

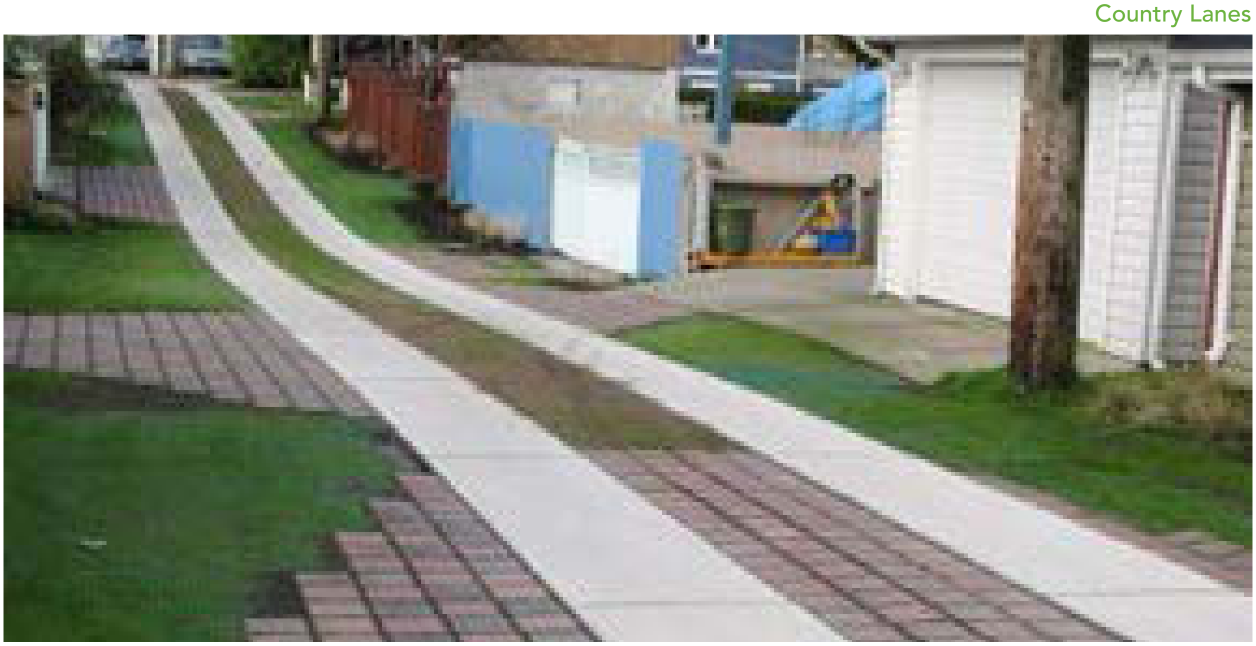
However, lanes in Vancouver generally do not support much surface parking, and it is runoff from surface parking that is a priority for treatment to provide acceptable water quality for receiving waters. For this reason, investment in further Country Lanes projects would be a lower priority in the Citywide area than investing in solutions which treat water from surface parking areas (on-street or off-street).

The Country Lanes approach is important in reducing volume flows, and would reduce CSOs in the combined sewer system in the short term, and provide additional capacity in separate storm sewers in the long term. When other priority projects have been funded, attention could turn to investment in further Country Lane projects, with a determination of what parts of the Citywide system would be most beneficial at that time.

In the meantime, it is important that the amount and quality of runoff from lanes does not deteriorate. The Absorbent Sites program (above) should encourage no runoff during the design minor storm from private lands. Other than in major storms, there should therefore be no runoff from private lands to lanes or streets.

The City of Vancouver has been a leader in showcasing rainwater best practices in its Country Lanes Project.

Country Lanes



ROOF RAINWATER HARVESTING AND REUSE PROGRAM

Rooftop drainage from residential development, is less polluted than at-grade drainage, and should be treated as a resource for reuse where possible.

There are areas of BC (Gulf Islands, Vancouver Island) where use of roof rainwater harvesting and reuse technology is established and growing. There are also several examples of institutional and mixed use buildings in Vancouver that use rainwater harvesting and reuse technology, and in some cases wastewater treatment and reuse (Convention Centre, Olympic Village, UBC, private developments). For general introduction to Rainwater Capture and Reuse, refer to the IRMP Volume II: BMP Toolkit.

There are water conservation advantages in use of roof rainwater harvesting, both in reducing potable water consumption in summer outdoor water use and indoor toilet flushing. Use of the collected rainwater for toilet flushing is also important for a winter 'draw-down' of the water level in the tank in order to provide room for stormwater storage during periods of heavy rain.

Rainwater Harvesting system in a private residential home

Approvals systems for rainwater harvesting and reuse are evolving quickly in Canada and BC, with some concerns remaining in approval authorities about quality control in system installation and operations.

In this context, we recommend a program that encourages, but does not require, roof rainwater harvesting and reuse in the city. Elements would include:

- Motivational information to explain the benefits of rainwater harvesting (videos, pamphlets).
- Technical materials on the issues and guidelines for proper installation and maintenance.
- A focus on design, development and cost optimization for low-cost treatment techniques to reduce health risks and improve aesthetic acceptance of roof rainwater harvesting, in particular for toilet flushing but also as spray irrigation water where human contact may be possible.
- Work on expedited approval procedures between City Building and Plumbing Inspection, as well as with Coastal Health and BC Environment. These approval issues are common to many local governments, and therefore cooperative measures may be appropriate.
- Leadership on pilot installations and monitoring / public familiarization.
- Consideration of using Vancouver's custom building code powers to create a leading 'code' application to guide installation and quality control.

6.0 HOW DO WE ORGANIZE LONG-TERM FUNDING AND IMPLEMENTATION?

A Gradual and Sustained Effort

Meeting the targets for water quality long term, and reducing combined sewer overflows (CSOs) in the short term will take both community effort and financial effort.

The effort should be tied to infrastructure renewal. Although the City is built-out, it is constantly undergoing gradual re-construction as buildings, streets and infrastructure reach the end of their design-life.

At the current rate of redevelopment, a significant portion of Vancouver's single family buildings will be reconstructed by mid-century. The City's sewer separation program will also extend past mid-century before it is complete.
The timeline of implementing the Citywide IRMP is in the same scale – it will require a sustained effort in the range of 50 – 70 years before its recommendations are fully implemented in concert with building and infrastructure renewal.

Funding should vary by year and by the aggressiveness of the program. Based on analysis in IRMP Volume III Technical Background (internal), funding allocation over and above the existing sewer separation program will be required to:

- Support the Capacity-Building Program for staff and stakeholders that design, regulate, approve and deliver rainwater best practices.
- Support pilot projects – design, implementation and monitoring – to act as both training and proof of performance initiatives.
- Fund scientific monitoring as required by the Adaptive Management Framework.
- Provide pooled capital and operating/maintenance funds to allow detail design, construction and targeted maintenance of required stormwater retrofits and best practices on City streets and properties (see IRMP Volume III for maintenance assumptions).
- Fund the detail writing and adoption / phase-in of updated regulatory approaches to promote implementation of rainwater BMPs.
- Receive funds, and disburse grants or reductions in fees, related to stormwater incentive programs, both the Surface Parking Treatment program, and a potential Rainwater Reuse program.

Some of this budget might incorporate and enhance existing City funding e.g. catch-basin cleaning and cleaning of other structural best practices, as well as the sewer cross-connection program.

Short Term Organizational Development and Funding

The 'Phasing and Scheduling Strategy' in Figure I - 15 suggests that a 5 year effort may be necessary to 'start-up and phase-in' the implementation of proposed changes.

In reality, the City is already active in stormwater management. The proposed targets will bring new players, new roles, and a need for new understanding and training as a precedent to on-the-ground action. There are likely to be both education and awareness steps, as well as refined or new regulations and financing mechanisms that need to be put in place.

Figure I - 15: Phasing and Scheduling Strategy

Ongoing Stakeholder Consultation & Public Outreach

1 PHASE A: Immediate and On Going

- Complete detail design of programs, and related financial planning. Confirm Council support.
- Create and staff a new Green Infrastructure (GI) Team.
- Supplement existing street and catch basin cleaning & sewer cross connection programs. Continue rainwater management plans for large rezonings.
- Continue on-going sewer separation program.
- Increase the implementation of Green Infrastructure demonstration and learning in current projects.

2 PHASE B: Remove Barriers, Build Capacity

- Create green infrastructure capacity-building materials like video and web materials that explain, in plain english, the why, what and how of rainwater management.
- Identify priorities for GI demonstration projects, and start off-street implementation.
- Update the City's Engineering Standards to include typical details and design guidelines that ease implementation of best practices.
- Start and maintain a Water Quality Monitoring Adaptive Management program to meet senior agency requirements (all subsequent phases).

Ongoing Stakeholder Consultation & Public Outreach

3

i

PHASE C: Expand Green Infrastructure (GI) into New Non-SF Projects

- Review options for a stormwater utility and for financial incentive programs.
- Require BMP application in new non-single family projects on private land.
- Upscale the amount of GI installations in local streets.
- Continue with public awareness programs and demonstration / capacity building.

ii

PHASE D: Expand Green Infrastructure to New One/Two Family / Lane Housing

- expand GI application to new One/Two Family Housing and Lane Housing, with the familiarity and standards gained in the above three phases now used to expand application or best practices into new construction in low density residential redevelopment.
- Provide SF-specific demonstration and public awareness. programs.

iii

PHASE E: Expand Green Infrastructure to Retrofits

- expand application to retrofits, in recognition that implementing water quality improvements will need to address problems in existing surface parking and building sites.
- Incentive programs, financed by fees on untreated impervious area, are to be considered to speed adoption for retrofits.
- Expand public information and homeowner/small contractor training to facilitate implementation.

4

PHASE F: Long Term Aspirations

- Phase F would introduce incentives and programs for Rainwater Harvesting and Reuse, and for Absorbent Lanes.
- Public awareness programs, water quality monitoring and adaptive management programs would continue to allow fine-tuning.

Beyond Phase F, the programs would be fully active. Continuous improvement to the City's rainwater management is envisioned as a permanent objective, in recognition that full implementation will be achieved only over a building/street asset life cycle, which is in the range of 50 to 100 years (average 75 years).

The following Action Priorities table identifies tasks, roles, and implementation timetables, to be updated from time to time.

1.1 Vancouver IRMP Action Priorities

ACTION	FUNDING	PRIORITY	LEAD AGENCY	RESOURCES (City)
PHASE A: IMMEDIATE AND ONGOING (2016)				S=small M=medium L=large
Implement GI team	Operating	By 2016	Inter-departmental	M
Catch basin cleaning action / awareness	Operating	Ongoing	Eng.:Sewers	S
Cross connection control action / awareness	Operating	Ongoing	Eng.:Sewers	S
Require Green Infrastructure (GI) in large rezonings (cont'd)	Operating	Ongoing	Planning / Eng.	S
Integrate GI demonstration/learning in current projects	Capital & Development	Ongoing	Planning / Eng. / Real Estate / Facilities Management	M
PHASE B: REMOVE BARRIERS, BUILD CAPACITY (2017)				
Green Infrastructure (GI) public awareness (stage one)	Operating	By 2017	GI Team / Communications / Eng.	M
Identify priority areas for street GI implementation	Operating	By 2017	Eng.:Sewers / Streets / Transportation	S
Update Engineering standards to include GI	Operating	By 2017	Eng.:Sewers / Streets	S
Water Quality Monitoring / Adapt to meet regulations	Operating	By 2017	Eng.:Sewers	M
City Off-Street Property GI demo / monitoring projects	Capital / Development	Ongoing	Planning / Real Estate	S
PHASE C: EXPAND GREEN INFRASTRUCTURE INTO NEW NON-SF PROJECTS (2018)				
Review surface parking treatment fee / incentives options	Operating	By 2018	Eng.:Sewers / Planning / Finance	S
Study stormwater utility admin system - future option	Operating	By 2018	Eng.:Sewers / Planning / Finance	S
Street block GI demo / monitoring projects	Capital	Ongoing	Eng:.Sewers /Streets	S
Parks site GI and biodiversity demo / monitoring projects	Capital	Ongoing	Parks / Eng: Sewers	S
Green Infrastructure (GI) public awareness (stage two)	Operating	By 2018	Communications / GI Team	S
Require GI in new MF ICI projects (update regs)	Operating	By 2018	Planning / Dev. Services	M
On-street surface parking treatment integrated with sewer separation	Capital	Ongoing	Eng.:Sewers/streets	L

1.1 Vancouver IRMP Action Priorities (cont'd)

ACTION	FUNDING	PRIORITY	LEAD AGENCY	RESOURCES (City)
PHASE D: EXPAND GREEN INFRASTRUCTURE TO NEW ONE/TWO FAMILY / LANE HOUSING (2019)				S=small M=medium L=large
Green Infrastructure (GI) public awareness (stage three)	Operating	By 2019	GI Team / Communications	S
Private SF GI demo / monitoring projects	Capital / Development	Ongoing	Planning / Dev. Services	S
Require GI in new SF/Duplex projects (update regs.)	Operating	By 2019	Planning / Dev. Services	M
Water Quality Monitoring / Adapt to meet regulations	Operating	Ongoing	Eng.:Sewers	M
On-street surface parking treatment integrated with sewer separation	Capital	Ongoing	Eng.:Sewers/streets	L
PHASE E: EXPAND GREEN INFRASTRUCTURE TO RETROFITS (2020)				
Green Infrastructure (GI) public multimedia (stage four)	Operating	By 2020	GI Team / Communications	S
Private surface parking GI demo / monitoring projects	Capital / Development	Ongoing	Planning / Dev. Services	S
Launch charges/incentives for GI in ex private surface parking	Operating	By 2020	Planning / Dev. Services	M
Water Quality Monitoring / Adapt to meet regulations	Operating	Ongoing	Eng.:Sewers	M
On-street surface parking treatment integrated with sewer separation	Capital	Ongoing	Eng.:Sewers/streets	L
PHASE F: LONG-TERM ASPIRATIONS (beyond 2020)				
Green Infrastructure (GI) public multimedia (stage five)	Operating	By 2021	GI Team / Communications	S
Rainwater capture / reuse demo / monitoring projects	Capital	Ongoing	Eng: Sewers / Planning / Dev. Services	S
Launch incentives for rainwater capture/reuse	Operating	By 2022	Planning / Eng. / Dev. Services	M
Start Absorbent Lanes program	Operating	By 2023	Eng.:Sewers/streets	M
Water Quality Monitoring / Adapt to meet regulations	Operating	Ongoing	Eng.:Sewers	M
On-street surface parking treatment integrated with sewer separation	Capital	Ongoing	Eng.:Sewers/streets	L

Long-term Organizational Development and Funding

It is very important to get started on implementation of the Citywide IRMP Recommendations. Minor Supplements to existing funding can support that beginning.

For a sustained and long-term effort, it is recommended that the following funding strategies be investigated in more detail.

SHIFT TO POLLUTER PAY MODEL

The City is investing heavily in the sewer separation program, and that should support major reductions in the pollution associated with combined sewer overflows.

As stormwater is separated, and as it outfalls directly to the beaches, bays and receiving waters, there will be a reduced, but still signficant amount of pollution that is carried with the stormwater, if it is untreated.

The source of pollution in stormwater is widely spread – it is the surface parking areas, whether on-street or off-street, the manicured landscapes with excess nutrient runoff, the pet and wildlife feces, and sediment from construction operations.

To be fair to the city taxpayer, the costs of such pollution should be allocated to the source of the pollution. It is possible, with implementation of green infrastructure, to have a highly livable and high density city that has very low levels of pollution. The City should move to the principle of 'polluter pay', with both the public and private sector / homeowners contributing in measure to their pollution.

As a corollary, those who are not sources of pollution should pay significantly less than those who are polluting.

STORMWATER UTILITY

Other local governments (e.g. Halifax, Victoria) have implemented a distinct organization to administer stormwater management and funding – a stormwater utility. Similar to a water, energy, or communications utility, this administration would operate on a 'fee for service' basis. It would charge user fees based on a fair allocation of benefits and costs, with the total fees sufficient to make the utility self-sufficient with little or no subsidy from the property tax base.

In the City of Victoria, a primary reason for establishment of a stormwater utility was to provide a system of incentives for stormwater pollution control, financed by changes on untreated impervious area, similar to the parking area pollutions fees described below.

PARKING AREA POLLUTION FEES

An increasingly common approach by other local governments is to establish a fee that is calculated on the area of un-treated surface parking area on a parcel. The fee is calculated based on a combination of aerial imagery and building permit records. Areas of surface parking that have implemented green infrastructure water quality treatment would be exempt from the fee. Some parts of the revenue generated may be used for incentive funding to assist green infrastructure retrofits.

Taken together, this fee and incentive has the effect of encouraging retrofit of green infrastructure water quality treatment into existing surface parking areas. At the same time, it allows that some parcels may not wish to retrofit (e.g. being too small, or being slated for early redevelopment) and they would prefer to simply pay the fee, which in effect funds the implementation of water quality treatment in another location.

These types of fees utilize market forces to encourage change – and are often targeted at existing development, where the regulatory requirements associated with permitting for new development do not apply.

STORMWATER PARCEL TAX

A second approach to funding infrastructure separate from assessment-based property tax is to implement a function-specific parcel tax. These charge a fixed amount per year per parcel. The fee does not vary based on assessed value of the property. In effect, these fees do not penalize large or high value property owners – such as industry or larger commercial. Commonly a parcel tax is a small amount per property, which adds up to a substantial and sustainable fund for a specific purpose – like implementation of stormwater improvements – as opposed to general revenue. In that way the public is certain of the allocation of the tax. The parcel tax may also have a sunset arrangement – where it is set to expire after a stated time period.

As opposed to a stormwater utility or parking area pollution fees, a stormwater parcel tax does not follow the principle of polluter pay.

INTEGRATION WITH CLIMATE CHANGE AND RISK MANAGEMENT PROGRAMS

Climate Change and Risk Management Programs related to sea level rise, storm and flood risk, and drought risk will all require increasing attention and investment by all levels of government and the private sector.

The City of Vancouver's Citywide IRMP implementation should be watchful of how its funding could be integrated into larger risk management programs and senior government grants and incentives. There is much cross-over among objectives of the IRMP and actions that would make the city more resilient to climate change.

ADAPTIVE MANAGEMENT

Just as the water quality aspects of the IRMP should be subject to ongoing monitoring and adaptive management, we recommend that the funding and implementation action plan take a similar approach.

The lifespan of this program implementation should extend through the lifespan of a typical simple building – about 75 years. There will be much change – in technology, in precedents, in public attitudes, in climate – over those years. A review of priorities and programs is advised, at least once every five years.

7.0 WHAT CONSTITUTES SUCCESS?

Vancouver continues to be a world-class city, and it has created attention across the world for its Greenest City Action Plan (GCAP) and related progress. The Integrated Rainwater Management Plan is a key implementation tool for GCAP, and through its actions we expect Vancouver to become increasingly noteworthy for:

- Urban beaches, within walking distance, that support swimming and recreation;
- Urban waters that are alive with fish, amphibians, birds and marine mammals;
- Urban streets and developments that are resilient to climate change;
- A world leading example of livable and sustainable urban design.

To quantify success, this Integrated Rainwater Management Plan includes specific targets and action programs for water quality improvements and stormwater runoff volume reduction.

The proposed Monitoring and Adaptive Management Strategy should be used to measure results on a regular basis, and the associated data will inform IRMP implementation updates to achieve target performance. Reporting on this performance will be important to senior government agencies overseeing the Metro Vancouver Integrated Waste and Resource Management Plan, and to stakeholders and the public.

The IRMP sets out a long term strategy. It's success will require gradual and sustained effort by both City forces and the private sector. The most effective implementation will be through integration of the IRMP best practices into on-going infrastructure and development projects as assets reach the end of their life cycle.

One of the IRMP's greatest challenges, and its greatest success if achieved, will be an improved cross-discipline and public understanding of the design, construction and maintenance of green infrastructure throughout the city's parks, streets, institutions and private land holdings.

Success will be gained through the entire community taking up a role to protect Vancouver's water and watersheds and the quality of life and urban biodiversity that our abundant and valuable rainwater supports.

Assumptions and Limitations

The analysis and recommended actions in this document are based on review of currently available information, and are in accordance with current planning and engineering practice.

Readers should note the following limitations:

I. Maps and quantities shown are based on 'sample areas' that are representative of the pattern of conditions across the study area. Actual total quantities may vary.

II. Where unit costs or quantities are shown, these are approximate 2014 dollars CDN suitable for comparison of options, and based on little or no site information, and therefore only accurate within a range of plus or minus 30% (Class D). No warranty is implied or given on accuracy of quantities or unit costs for any given project.

III. Mapping is based on data and polygons from a variety of sources, and is schematic in nature. No warranty is made as to accuracy of map information.

IV. Infiltration rates discussed are theoretical based on typical rates in assumed soil conditions, sufficient for general option comparison and policy guidance. Users are advised to gain site-specific hydrotechnical advice as a basis for detail design.

V. Where design detail guidelines are provided, the information is intended as an introduction. Readers are guided to the technical reference documents listed as References in IRMP Volume III: Technical Background (internal) for more information. In all cases, it is required that professional site-specific design and construction management advice be sought to customize application of these best practices to a specific site and land use situation.

CITY OF VANCOUVER

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Sustainable Communities