The background of the entire page is a close-up photograph of raindrops hitting a dark blue, reflective surface. The impact of the raindrops creates a series of concentric white and light blue ripples that spread outwards. Some small, brownish-orange leaves or debris are scattered across the surface, partially submerged. The overall tone is cool and aquatic.

Improving Integrated Stormwater Service Delivery at the District of Squamish: Summary of Phase 1 Findings and Recommendations

FINAL REPORT – April 10, 2019



SQUAMISH INTEGRATED STORMWATER MANAGEMENT PLAN - PHASE 1
Phase 1 Summary and Recommendations



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EXECUTIVE SUMMARY

Overview of this Plan

What it is

In 2018, the District of Squamish initiated an “Integrated Stormwater Management Plan (ISMP) – Phase 1” process. The purpose was to develop a comprehensive, District-wide plan to guide improvements to how stormwater and stormwater assets are managed. This plan summarizes the key outcomes and recommendations of the Phase 1 process. It will help ensure that public safety and the environment are protected from impacts as the community develops, and that stormwater service delivery is more sustainable over the long term.

Why it is important

The District owns a significant amount of stormwater infrastructure, including both built and natural assets. These assets provide important stormwater services such as flood conveyance, water quality treatment, and erosion prevention; yet, there is a lack of dedicated funding for stormwater service delivery by the District. Furthermore, there are numerous existing stormwater-related issues around the District, such as erosion, potential water quality issues, and localized flooding. New development could create more issues if stormwater-related impacts of development are not mitigated. Therefore, a plan was needed to start to address these gaps.

Desired outcomes

Desired outcomes of the project included recommendations for the following:

- District-wide goals for stormwater levels of service
- Gaps in current asset management and stormwater management practices and how to address them
- Priority catchments that require an ISMP to address issues and threats
- The scope of an Environmental Monitoring Program (EMP) to measure watershed health and evaluate the effectiveness of ISMPs over time
- Common terms of reference (TOR) and a process guide for catchment-specific ISMPs
- A review of the District’s assets, including natural assets, and what they are worth
- A review of current funding levels and how to move towards more sustainable funding levels

How it was developed

The Phase 1 process was led by a multi-disciplinary team at the District, and members of Squamish Nation and the developmental and environmental stewardship communities were involved early in the process. The community was engaged via a public questionnaire once a draft plan was developed to gauge their level of support for the proposed direction outlined in the plan.

Funding for this work was provided by the Union of British Columbia Municipalities (UBCM).



Results and Recommendations

Phase 1 Desired Outcome	Results and Recommendations
District-wide goals for stormwater levels of service	<ol style="list-style-type: none">1. Public stormwater management practices should not result in negative impacts to private property.2. Nuisance flooding in backyards and low-lying areas is expected for minor rain events if it is generated on-site.3. New developments should mitigate on-site and off-site impacts of runoff.4. Public property may be used as a floodway or storage for major storm events as appropriate5. Public and private stormwater management practices should minimize negative impacts to water quality, water quantity, and ecosystem health on a watershed basis, relative to current conditions.6. The District should meet all Federal and Provincial regulations and guidelines for environmental protection.7. Drainage infrastructure is appropriately maintained for its intended function.8. District staff will be available to respond to stormwater management issues, and will respond to issues in order of highest to lowest priority.9. Residents are aware of what to expect in terms of stormwater levels of service.10. Residents know what they can do to help.
Gaps in current asset management and stormwater management practices and how to address them	<p>At the time the Baseline Assessment was conducted, the District's understanding of the current state of its assets was fairly low. Through the Phase 1 process, the asset inventory was greatly improved, and there are opportunities for further improvement.</p> <p>Overall, the quality and quantity of information the District is using to make decisions about stormwater service delivery are fairly low. Many gaps were addressed through the Phase 1 process but there are still opportunities for further improvement.</p> <p>The District does not currently fund stormwater infrastructure at a sustainable level. This is largely due to a gap in the understanding of what level of investment is needed.</p> <p>Like many small communities, the District is currently doing a lot with limited resources. Staff strive to move towards proactive planning and preventative maintenance, but are often occupied with immediate pressures.</p> <p>Many opportunities for improvement that were initially identified in the Baseline Assessment were addressed through the Phase 1 process. Those that could not be addressed during Phase 1, but that should be implemented by the District, are summarized in this plan. Recommendations were made to:</p> <ol style="list-style-type: none">1. Improve the District's understanding of assets2. Improve the District's information used to make decisions3. Improve the District's financial processes and practices4. Improve the capacity and effectiveness of people <p>Recommendations on specific actions to take in these four areas is provided in this plan.</p>



SQUAMISH INTEGRATED STORMWATER MANAGEMENT PLAN - PHASE 1

Phase 1 Summary and Recommendations

Phase 1 Desired Outcome	Results and Recommendations
Priority catchments that require an ISMP to address issues and threats	<p>There are around 15 different watersheds (catchments) that span the District's municipal boundaries. While all of them are important, not all of them require a dedicated plan for managing stormwater.</p> <p>Priority catchments were identified as those that meet the following criteria:</p> <ul style="list-style-type: none">• Those that are currently experiencing issues due to past land use and development activities (as identified by previous studies or as observed by staff)• Those for which future development is anticipated to cover at least 10% of watershed area and could impact watershed health and existing system performance• Those for which an ISMP is recommended, based on the first two criteria, as well as environmental monitoring <p>Priority catchments that require an ISMP include the following:</p> <ol style="list-style-type: none">1. Howe Sound Watershed (2019-2020) – includes the Downtown, Logger's Lane East, North Yards, Dentville, Business Park (and also Valleycliffe, to achieve efficiencies in planning)2. Squamish River East Watershed (2021-2022) – includes Brackendale, North Highlands, and Tantalus Road3. Mamquam River Watershed (2023-2024) – includes Garibaldi Estates and Garibaldi Highlands <p>The cost to develop each ISMP is expected to be about \$150,000.</p>
The scope of an Environmental Monitoring Program (EMP) to measure watershed health and evaluate the effectiveness of ISMPs over time	<p>It is recommended that the District collects baseline environmental data in the priority catchments as part of the process of developing ISMPs. Recommendations for ongoing environmental monitoring will then be made based on the baseline findings.</p> <p>Following is the high-level scope of monitoring that is recommended as part of each priority ISMP:</p> <ol style="list-style-type: none">1. Howe Sound Watershed (2019-2020) – field monitoring for water quality, water level, flow, benthic invertebrates, and desktop analysis and field reconnaissance (\$107,000 over 2 years)2. Squamish River East Watershed (2021-2022) – field monitoring for water quality, flow, benthic invertebrates, and desktop analysis and field reconnaissance (\$43,000 over 2 years)3. Mamquam River Watershed (2023-2024) – field monitoring for water quality and flow, and desktop analysis and field reconnaissance (\$41,000 over 2 years)
Terms of reference (TOR) and a process guide for catchment-specific ISMPs	<p>The ISMP TOR and Process Guide provides direction on the following:</p> <ul style="list-style-type: none">• What ISMPs are and how they will be used at the District• District-wide stormwater service goals as defined in the LOS Framework• Linkages to the District's Environmental Monitoring Program and stormwater AMIP• Desired outcomes of the ISMP planning process and major deliverables• Steps in the planning process and who is involved



SQUAMISH INTEGRATED STORMWATER MANAGEMENT PLAN - PHASE 1

Phase 1 Summary and Recommendations

Phase 1 Desired Outcome	Results and Recommendations
A review of the District's inventory of stormwater assets, including natural assets, and what they are worth	<p>An Asset Management Investment Plan (AMIP) was developed for the District's stormwater assets. The AMIP summarizes the inventory of capital assets, project timing, and funding requirements for long-term asset sustainability.</p> <p>In total, the replacement value of the District of Squamish's built stormwater assets is estimated to be \$133 million, expressed in 2018 dollars. The Expected Percent Remaining Life of 51% overall, for all assets, expresses the relative useful life that can be expected from each asset class. Dike-related infrastructure such as pump stations and flood boxes possess the lowest expected remaining lives, and are considered the greatest risk of inadequate performance or failure. The total average annual lifecycle investment (AALCI) of \$2.3 million represents the annual funding that is required to sustain the District's current stormwater assets over the long term, assuming like-for-like replacement of all assets. Opportunities to reduce the AALCI may exist at greater risk to the District, or by determining alternative renewal or rehabilitation methods on an individual asset basis.</p> <p>In terms of natural assets, the total value of stormwater management services provided by wetlands, forests, and creeks is estimated at over \$380 million. Risks to these natural assets include development and natural hazards. It is recommended that the District:</p> <ol style="list-style-type: none">Includes strategies to protect them when we develop dedicated ISMPs for high-priority watershedsRecognizes and consider their significance in our major community and neighbourhood plansUses land use planning, land acquisition strategies, partnerships, and private property incentives to help protect these areas
A review of current funding levels and approaches, and recommendations to move towards sustainable funding levels	<p>Stormwater is currently funded through General Revenues, and it therefore competes for funding with other major services. The amount dedicated to stormwater annually in the capital budget is negligible. The funding required to sustain <u>current</u> levels of service through the recapitalization of existing District assets (not including natural assets) is approximately \$2.3 million annually. This excludes ongoing operating costs and additional costs required to implement the recommendations from this Phase 1 ISMP.</p> <p>Based on a review of the advantages and disadvantages of various funding mechanisms, and the extent to which funding could be considered in the Phase 1 process, the following are recommended as next steps:</p> <ol style="list-style-type: none">Engage Council to establish funding objectives.Evaluate funding mechanisms on the basis of their ability to meet those funding objectives and select a preferred approach (recognizing that there will be trade-offs between objectives). Funding mechanisms include:<ul style="list-style-type: none">General taxation (status quo)Levy on Property Tax NoticeParcel taxUser feeSeparate stormwater utilityConduct a rate study based on the chosen approach to select a preferred rate that will help the District move towards a more sustainable funding level



Public Support for this Phase 1 ISMP

Squamish Nation and community stakeholders were engaged in a workshop early in the process to develop this ISMP by providing input on stormwater management issues and opportunities for improvement. The community was then engaged via an online questionnaire once a draft ISMP was developed to gauge their level of support for the proposed direction outlined in the plan.

The following is an overview of the online questionnaire:

- The survey was open from March 15 to March 29, 2019
- 21 responses were received
- Almost all respondents strongly agreed or agreed with the direction of the Phase 1 ISMP

Several qualitative suggestions were provided for improvements to the plan, including adjustments to the LOS goal statements. The final Phase 1 ISMP reflects the input provided by respondents. Other suggestions were provided that should be considered as the District decides how to increase funding for stormwater service delivery.



1. INTRODUCTION

Context

The District of Squamish (the District) strives to provide sustainable stormwater services to the community, and to protect public property, the environment, and public safety as the community develops. The District recognizes that asset management and integrated stormwater management, when done well, will support the District in achieving these goals. The District also recognizes that typically, these two management practices and processes are not always well-connected. For example, communities often develop Integrated Stormwater Management Plans (ISMPs) for specific catchments in the absence of big-picture context and a common set of goals. Furthermore, while ISMPs typically identify existing and future deficiencies in infrastructure and new capital investments required to address them, they do not generally involve taking stock of the condition, remaining life, and long-term funding required to sustain the existing infrastructure and natural assets. In short, how ISMPs actually support a community in providing sustainable service delivery is not always considered.

In 2018, the District initiated an “Integrated Stormwater Management Plan – Phase 1” process. The intent behind this initiative was to address the gaps described above by establishing direction for how both types of processes and practices can be strengthened and implemented at the District. The desired outcomes of the project included the following:

- District-wide goals for stormwater levels of service
- Gaps in current asset management and stormwater management practices
- Priority watersheds that require an ISMP to address issues and threats
- Common terms of reference (TOR) and a process guide for catchment-specific ISMPs
- The scope of an Environmental Monitoring Program (EMP) to measure watershed health and evaluate the effectiveness of ISMPs over time
- An inventory and valuation of stormwater assets, including natural assets
- A review of current funding levels and approaches
- Recommendations for improvements to asset management and integrated stormwater management practices based on findings from the above

It was also desired that Squamish Nation and community stakeholders were engaged in the process.

Asset management is an integrated and continuous process that combines the skills, expertise, and activities of people with information about a community’s infrastructure assets and finances, so that decisions are informed by cost, risk, and level of service. Sustainable service delivery is the goal of asset management.

Integrated stormwater management is an integrated and continuous process of managing stormwater through regulations, land use decisions, capital planning, operations, and education and outreach. Integrated stormwater management is about balancing competing objectives such as environmental protection and community development.



SQUAMISH INTEGRATED STORMWATER MANAGEMENT PLAN - PHASE 1

Phase 1 Summary and Recommendations

The process was carried out throughout 2018, and was led by staff from Engineering with support and involvement from Public Works, Planning, Environment, and Finance. Squamish Nation and community stakeholders were engaged early in the process to provide input on issues and opportunities for improvement. The community was engaged via a public online survey once a draft plan was developed to gauge their level of support for the proposed direction outlined in the plan. Input from all those involved in the process is reflected in the outcomes described in this document.

Using this Document

This document summarizes the key findings and recommendations of the Phase 1 process.

Details on the Phase 1 methodology and other information are provided in Attachments A through H, which are useful standalone documents that were prepared throughout the Phase 1 process. These appendices include:

- Appendix A: Level of Service Framework
- Appendix B: Baseline Assessment
- Appendix C: Asset Management Investment Plan
- Appendix D: Natural Assets Valuation
- Appendix E: ISMP Terms of Reference and Process Guide
- Appendix F: Environmental Management Program
- Appendix G: Funding Review
- Appendix H: Public Questionnaire Summary

This summary document should be used by staff along with the attachments to:

- Make improvements to stormwater management and asset management practices
- Guide the development and implementation of ISMPs and environmental monitoring
- Inform the annual budget
- Guide annual departmental work planning
- Inform communications with Council and the public



2. STORMWATER SERVICE GOALS AND INDICATORS

Goals and Indicators

The District has established ten goals for stormwater service delivery. These goals are described in the District's Stormwater Level of Service Framework in **Appendix A**. The LOS Framework also describes indicators for each goal.

The District's goals for stormwater service delivery are listed below.

1. Public stormwater management practices should not result in negative impacts to private property.
2. Nuisance flooding in backyards and low-lying areas is expected for minor rain events if it is generated on-site.
3. New developments should mitigate on-site and off-site impacts of runoff.
4. Public property may be used as a floodway or storage for major storm events as appropriate
5. Public and private stormwater management practices should minimize negative impacts to water quality, water quantity, and ecosystem health on a watershed basis, relative to current conditions.
6. The District should meet all Federal and Provincial regulations and guidelines for environmental protection.
7. Drainage infrastructure is appropriately maintained for its intended function.
8. District staff will be available to respond to stormwater management issues, and will respond to issues in order of highest to lowest priority as follows:
 - a. Issues related to the capacity or performance of public stormwater infrastructure
 - b. Issues relating to impacts to a private building (e.g., crawlspace flooding) caused by failure of the public stormwater system
 - c. Issues relating to flooding of private property (e.g., backyard flooding) caused by failure of the public stormwater system
9. Residents are aware of what to expect in terms of stormwater levels of service.
10. Residents know what they can do to help.

Recommendations

These goals and indicators should be used by the District to:

- Establish common goals for catchment-specific ISMPs so that ISMPs help the District achieve District-wide desired outcomes. Note that this is reflected in the District's ISMP Terms of Reference and Process Guide.



SQUAMISH INTEGRATED STORMWATER MANAGEMENT PLAN - PHASE 1

Phase 1 Summary and Recommendations

- Inform the scope of the District's Environmental Monitoring Program (EMP) and future monitoring and data collection efforts.
- Measure current LOS, set targets for LOS, and monitor progress towards them as part of the process of developing and implementing catchment-specific ISMPs.
- Communicate to customers what they can expect in terms of stormwater service delivery.





3. CURRENT MANAGEMENT PRACTICES: GAPS AND OPPORTUNITIES FOR IMPROVEMENT

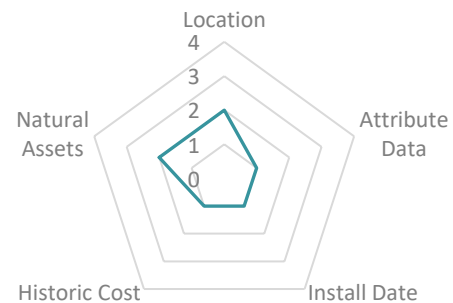
Findings from Baseline Assessment

As part of the Phase 1 process, a Stormwater Service Delivery Baseline Assessment was conducted to identify strengths and challenges with the District's current asset management and stormwater management processes and practices. The assessment also included the identification of stormwater-related issues within the community, which are presented in Section 5. The inventory of management practices and processes was conducted using the AssetSMART 2.0 Self-Assessment Tool. The assessment was informed by a high-level review of relevant District regulations and background information; a review of the District's asset inventory; and interviews with staff from Engineering, Public Works, Planning, and Finance.

The key findings from the assessment are described below. Details of the Baseline Assessment process and findings are documented in **Appendix B**.

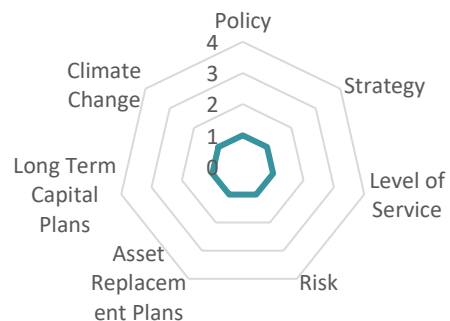
Understanding of Assets

At the time the Baseline Assessment was conducted, the District's understanding of the current state of its assets was fairly low. Through the Phase 1 process, the asset inventory was greatly improved. The District will benefit from improving processes and practices to ensure that new gaps are avoided, and from improving the O&M of its assets. The District has made considerable progress in recent years on identifying and mapping natural assets such as watercourses, and through the Phase 1 process, completed a preliminary valuation of natural assets. The District will benefit from doing more detailed natural asset valuation and risk management through ISMPs.



Information Used to Make Decisions

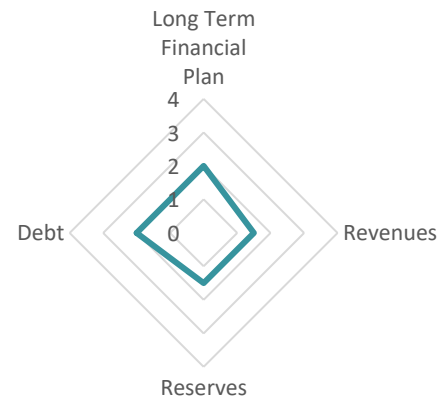
Overall, the quality and quantity of information the District is using to make decisions about stormwater service delivery are fairly low. This is not unusual for small communities. The District will benefit from building its corporate capacity in asset management and stormwater service delivery. The District was able to improve in many of these areas through the Phase 1 process, but opportunities remain for further improvements.





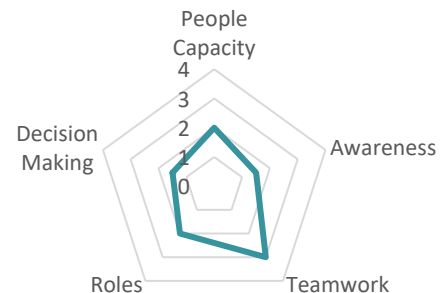
Sustainability of Finances

The District does not currently fund stormwater infrastructure at a sustainable level. This is largely due to a gap in the understanding of what level of investment is needed – a gap which was filled, to a large extent, through the Phase 1 ISMP process. The District will benefit from gaining a stronger understanding of the extent to which services are currently underfunded, and from developing an approach to fully funding service delivery. This is discussed further in the Funding Review in Section 6.



People Capacity and Effectiveness

Like many small communities, the District is currently doing a lot with limited resources. Staff strive to move towards proactive planning and preventative maintenance, but are often occupied with immediate pressures. The District will benefit from leveraging staff awareness and motivation to improve in stormwater service delivery.



Recommendations

Many opportunities for improvement that were initially identified in the Baseline Assessment were addressed through the Phase 1 process. Those that could not be addressed during Phase 1, but that should be implemented by the District, are summarized below:

1. To improve the District's understanding of assets:

- Incorporate natural assets in asset management and stormwater management processes and practices.
- Enforce requirements in the Subdivision and Development Control Bylaw for developers to submit GIS-based asset data post-construction.
- Improve final inspection process and file closure process, and include Public Works in the process.
- Use watercourse mapping and riparian classification information in the development of ISMPs.
- Expand Sensitive Habitat Inventory and Mapping (SHIM) and riparian classification on public land.



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Phase 1 Summary and Recommendations

- f. Expand the inventory and mapping of ditches.
 - g. Develop O&M plans for new and existing infrastructure, including green infrastructure, based on a clear understanding of the function of the infrastructure. Align these plans with environmental permitting requirements.
- 2. To improve the District's information used to make decisions:**
 - a. Develop an up-to-date, clear, relevant corporate Asset Management Strategy that contextualizes stormwater services with other municipal services.
 - b. Assess and document asset risks to inform capital plans and operations.
 - c. Develop ISMPs for priority areas.
 - d. Update the Subdivision and Development Control Bylaw to address challenges/gaps.
 - e. Include considerations for stormwater management in the Zoning Bylaw.
 - f. Develop a process to document and retain knowledge of stormwater system performance and other information and practices.
- 3. To improve the District's financial processes and practices:**
 - a. Develop and make progress towards a full cost-recovery approach to stormwater service delivery.
- 4. To improve the capacity and effectiveness of people:**
 - a. Develop and implement a process to continuously build Council's and public's awareness of stormwater LOS, and issues and risks related to asset management and stormwater management. Connect this to environmental values and risk management so the message resonates.
 - b. Clearly define roles and responsibilities for all asset management- and stormwater management-related activities.
 - c. Develop and implement a knowledge retention strategy.
 - d. Communicate with the public frequently and strategically about asset management and stormwater management through the development of ISMPs and any rate reviews and updates.





4. STORMWATER ASSET INVENTORY AND VALUE

Inventory and Value of Engineered Assets

As part of the Phase 1 process, an Asset Management Investment Plan (AMIP) was prepared for the District's engineered stormwater assets. The AMIP is provided in **Appendix C**. The process to develop the AMIP involved improving the District's asset inventory through a review of as-built drawings and integrating them into the District's GIS system.

The AMIP aims to answer the following core questions:

- What assets does the District own?
- What is the cost to replace these assets?
- What is the age of the assets and what is the estimated remaining service life?
- How much money needs to be invested annually to replace the District's assets?

The AMIP is not a capital plan and it is not meant to replace one. Rather, the AMIP provides a conservative indication of the target sustainable funding level for the replacement of stormwater assets.

A summary of key findings from the asset management review is provided below in Table 1. Details on assumptions and exclusions are provided in the AMIP in **Appendix C**.

Table 1 Summary from the 2018 Asset Management Investment Plan

Asset Category	Quantity of Infrastructure	Expected Percent Remaining Life	AALCI*
Mains	85 km	57%	\$1,024,000
Catch Basin Leads	9 km	71%	\$43,000
Catch Basins	2,200	59%	\$210,000
Manholes	1,300	60%	\$121,000
Culverts	16 km	47%	\$276,000
Inlet/Outlet Structures	35	50%	\$9,000
Pump Stations	6	37%	\$252,000
Flood Boxes	25	26%	\$324,000
Total		51%	\$2,259,000

*AALCI is the Average Annual Lifecycle Investment

In total, the replacement value of the District of Squamish's stormwater assets is estimated to be \$133 million, expressed in 2018 dollars.

The Expected Percent Remaining Life of 51% overall, for all assets, expresses the relative useful life that can be expected from each asset class. Dike-related infrastructure such as pump stations and flood boxes possess the lowest expected remaining lives, and are considered the greatest risk of inadequate performance or failure.

The total AALCI of \$2.3 million represents the annual funding that is required to sustain the District's current stormwater assets over the long term, assuming like-for-like replacement of all assets.



Opportunities to reduce the AALCI may exist at greater risk to the District, or by determining alternative renewal or rehabilitation methods on an individual asset basis.

Inventory and Value of Natural Assets

Natural assets are the naturally occurring resources and ecosystems that provided services that are critical to the functioning of communities. They provide services such as clean air, habitat, climate regulation, water treatment, pollination, recreation, and more. Some natural assets also provide stormwater management services, such as infiltration, treatment, evapotranspiration, and more.

Without the natural assets that provide core services, local governments would require other means to deliver the service – typically relying on engineered (built) infrastructure.

As part of the Phase 1 ISMP process, natural assets were inventoried and valued at a high level, with a focus on natural assets that play a significant role in stormwater management services: wetlands, forests, and creeks. A summary of the inventory of natural assets and their value is provided below in Table 2. Details on assumptions and methodology are provided in **Appendix D**.

Table 2 Summary from the 2018 Natural Assets Valuation

Asset Type	Quantity	Stormwater Services	Replacement Value
Wetland	256 ha	<ul style="list-style-type: none">• Rainwater attenuation (flood protection and erosion prevention)• Stormwater quality treatment	\$77,280,000
Forest	14,580 ha	<ul style="list-style-type: none">• Rainwater attenuation, evapotranspiration, infiltration (flood protection and erosion prevention)	\$57,620,000
Creeks*	116,825 m	<ul style="list-style-type: none">• Rainwater conveyance• Flood protection	\$245,330,000
TOTAL			\$380,230,000

*does not include Squamish, Mamquam, Stawamus, Cheekye, or Cheakamus Rivers

As shown above, the total value of stormwater management services provided by wetlands, forests, and creeks is estimated at over \$380 million. Risks to these natural assets include development and natural hazards.

In the context of managing significant risks to these services, it can be helpful to focus on the value of services provided by natural assets in areas that may experience development. The value of these services is over \$22 million. This value underestimates the true value of these natural assets as it does not account for full lifecycle costs of built replacement infrastructure, the other municipal services these natural assets may provide (e.g. water treatment and aquifer recharge from forests), or the additional services such as recreation, habitat, pollination, air quality, temperature regulation, carbon storage, and others.



Recommendations

For Engineered Assets

The following recommendations for next steps are made based on results from the asset management review that is documented in the AMIP:

1. Present a summary of the AMIP results to Council. Key messages to communicate include the following:
 - The AALCI of \$2.3M is a conservative estimate of the annual “sustainable funding level” that is required to replace the District’s current stormwater assets. It should be viewed as a target, and taxation and/or user fee rates should be structured so that annual funds for replacement of assets move towards this target over time.
 - Annual funds should be allocated to projects according to a risk-based 10-year capital plan.
 - The AALCI estimated in this AMIP is conservatively based on expected percent remaining life of stormwater assets, not their actual condition (insufficient data was available). As condition data becomes available, the AMIP and the AALCI should be refined. Condition data should also be used to develop the risk-based capital plan.
2. Develop and implement a condition assessment program for stormwater assets to inform refinements to the AALCI and to inform the development of a risk-based capital plan.
3. Refine the AALCI over time by:
 - Adjusting the expected percent remaining life based on actual condition assessments
 - Adjusting the assumed useful life of assets based on the District’s experience with various materials locally
 - Adjusting replacement timing based on risk tolerance
 - Investigating alternative methods/technologies for asset renewal or replacement.
4. Update the AMIP as ISMPs are developed and regularly thereafter to capture new assets that have been acquired by the District and to reflect refinements to the process of estimating the AALCI as described above.
5. A funding review was conducted as part of this project, the results of which are provided in Section 6. However, it is worth noting in the context of the AMIP that the setting of taxation and/or user fee rates for stormwater, and the allocation of funding for stormwater, should be considered in the broader context of the District’s funding needs for all types of assets.



For Natural Assets

The following recommendations for next steps are made based on results from the preliminary natural assets valuation:

1. Natural asset inventories and valuations should be further detailed where there are potential risks to specific natural assets. This analysis can be part of a catchment specific ISMP. Details on how to do this are provided in the natural assets valuation in **Appendix D** and also in the ISMP Terms of Reference and Process Guide in **Appendix E**.
2. Recognize the significance, role and function of natural assets in the Official Community Plan (OCP). Through the OCP, provide terms of reference for Area Plans and Neighbourhood Plans that include consideration of natural assets.
3. Ensure that specific Area Plans and Neighbourhood Plans are informed by an understanding of the current role of natural assets and how development may impact the services provided by natural assets. Through area planning, consider scenarios that preserve the function of significant natural assets, reducing overall costs to the District and maintaining community resilience. An example of an approach that may preserve natural asset function and development objectives is density transfer.
4. Include natural assets in the overall asset management process (asset management policy, strategy, and plans), to inform decisions about the construction, renewal, and maintenance of existing engineered assets and new ones.
5. Implement protection strategies for natural assets, throughout land use planning and acquisition strategies, partnerships with neighbouring jurisdictions, private property incentives, operations and maintenance activities, and capital projects.



5. PRIORITY WATERSHEDS THAT REQUIRE AN ISMP AND ENVIRONMENTAL MONITORING

Overview of Watersheds

According to the provincial Freshwater Atlas, approximately 15 watersheds and significant sub-watersheds span the District's municipal boundaries. These watersheds and development areas within them are shown on Figure 1.

Issues and Threats

Stormwater performance issues and threats to watershed health were inventoried by watershed through the Baseline Assessment process, which is documented in **Appendix B**. The intent behind the process was to identify priority watersheds that require an ISMP and environmental monitoring. The process included a review of background studies and engagement with District staff, Squamish Nation, and community stakeholders.

Issues and threats that were considered in the Baseline Assessment included:

- Land use
- Development pressures
- Existing stormwater infrastructure and performance issues
- Watercourses
- Sensitive habitat areas
- Ownership, jurisdiction, and access issues
- Any other issues affecting public or environmental health

Issues and threats to watershed health that were identified in each watershed are summarized on **Appendix B**.

Priority Watersheds

Not all of the watersheds in the District are experiencing the same issues, and not all of them require a comprehensive management response such as an ISMP. Therefore, priority watersheds were identified as those that meet the following criteria:

- Those that are currently experiencing issues due to past land use and development activities (as identified by previous studies or as observed by staff)
- Those for which future development is anticipated to cover at least 10% of watershed area and could impact watershed health and existing system performance
- Those for which an ISMP is recommended, based on the first two criteria, as well as environmental monitoring



SQUAMISH INTEGRATED STORMWATER MANAGEMENT PLAN - PHASE 1

Phase 1 Summary and Recommendations

Table 3 summarizes the priority watersheds for which a catchment-specific ISMP and environmental monitoring are recommended.

Table 3 Priority Watersheds that Require an ISMP and Environmental Monitoring

Watershed	Development/Usage Areas	Sub-Watersheds/Tributaries with Development Potential (>10%)
Howe Sound	<ul style="list-style-type: none">• Downtown• North Yards• Business Park• Dentville• Logger's East	<ul style="list-style-type: none">• Logger's Creek
Mamquam River	<ul style="list-style-type: none">• Garibaldi Estates• Garibaldi Highlands	<ul style="list-style-type: none">• Harris Slough
Stawamus River	<ul style="list-style-type: none">• Valleycliffe• Hospital Hill	<ul style="list-style-type: none">• Little Stawamus
Squamish River – East	<ul style="list-style-type: none">• Brackendale• North Highlands (District Lot 509/510)• Tantalus Road	<ul style="list-style-type: none">• Horse Creek• Dryden Creek• Hop Ranch Creek• Meighan Creek• North Highlands Unnamed creeks

Developing and Implementing ISMPs in Priority Watersheds

As part of the Phase 1 process, an ISMP Terms of Reference and Process Guide, in **Appendix E**, was prepared to guide the development and implementation of ISMPs in these priority watersheds.

ISMPs comprehensively explore the strategic linkages and needs of environment, land use, and infrastructure. They lay out a pathway for the District to achieve the community's vision and service goals through improvements in stormwater management practices, including policies and regulations, capital projects, operations, monitoring and reporting, and funding. They will help the District balance competing objectives around community development, flood protection, and environmental protection and enhancement. ISMPs will be used by the District as part of its broader efforts to improve stormwater service delivery.

The ISMP Terms of Reference and Process Guide provides direction on the following:

- What ISMPs are and how they will be used at the District
- District-wide stormwater service goals as defined in the LOS Framework
- Linkages to the District's Environmental Monitoring Program and stormwater AMIP
- Desired outcomes of the ISMP planning process and major deliverables
- Steps in the planning process and who is involved



Environmental Monitoring in Priority Watersheds

As part of the Phase 1 process, the scope of an Environmental Monitoring Program was established for implementation in these priority watersheds. The Environmental Monitoring Program is described fully in **Appendix F**.

The Environmental Monitoring Program provides direction on the following:

- Purpose of the program
- How data will be used and managed
- Linkages to the District's LOS Framework and ISMPs
- How the recommended scope was established
- The recommended scope
- Implementation phasing and costs

Recommendations

1. Develop and implement an ISMP for priority watersheds (shown in Figure 2) and conduct monitoring in those watersheds according to the following implementation timeline:

Table 4 Implementation Timeline and Costs for ISMPs and Environmental Monitoring

Priority Watershed	Timeline	Actions	Cost
Priority 1: Howe Sound and Stawamus River ISMP <i>Downtown, North Yards, Business Park, Dentville and Logger's East, and Valleycliffe, Hospital Hill</i>	2019	Conduct environmental monitoring of water quality, flow/water level, and B-IBI	\$98,000
	2020	Conduct desktop analysis and field review	\$9,000
		Prepare ISMP	\$150,000
Priority 2: Squamish River East ISMP <i>Brackendale, North Highlands, Tantalus Road</i>	2021	Conduct environmental monitoring of water quality, flow, and B-IBI	\$34,000
	2022	Conduct desktop analysis and field review	\$9,000
		Prepare ISMP	\$150,000
Priority 3: Mamquam River ISMP <i>Garibaldi Estates and Garibaldi Highlands</i>	2023	Conduct environmental monitoring of water quality and flow	\$32,000
	2024	Conduct desktop analysis and field review	\$9,000
		Prepare ISMP	\$150,000

2. Develop and implement ISMPs for priority watersheds using the ISMP Terms of Reference and Process Guide provided in **Appendix E**.



6. FUNDING REVIEW

As previously described, the Phase 1 process included an assessment of current management practices, including finances (see Section 3). Gaps that were identified at the time included the need for an AMIP for stormwater assets, which was developed as part of the Phase 1 process, and the need to develop a full cost recovery approach to stormwater service delivery. To provide guidance on how to do this, a Funding Review was conducted as part of the Phase 1 process and is documented in **Appendix G**. Key takeaways from the Funding Review are summarized below.

Current and Required Funding Levels

Stormwater is currently funded through General Revenues, and it therefore competes for funding with other major services. In the past, the District has not had reliable lifecycle information for its stormwater assets, which has resulted in minimal dedicated annual investment in stormwater assets. The AMIP developed through the Phase 1 process aims to help address this gap.

The funding required to sustain current levels of service through the recapitalization of existing District assets (not including natural assets) is approximately \$2.3 million annually. Assuming stormwater assets are useful for 50% longer than expected, the AALCI is approximately \$1.6 million annually – in other words, stormwater is underfunded even when very conservative estimates are made. The AALCI excludes ongoing operating costs and additional costs required to implement the recommendations from this Phase 1 ISMP. The intent behind reporting this value is simply to communicate the magnitude of the funding gap, which as shown, is significant. This gap will increase with any improvements to service delivery.

Potential Funding Mechanisms

There are several ways to fund stormwater service delivery, including:

- General taxation (status quo)
- Levy on Property Tax Notice
- Parcel tax
- User fee
- Separate stormwater utility

Funding for stormwater improvements may also be provided through development cost charges (DCCs) where applicable, and through senior government grants.

Recommendations

Based on a review of the advantages and disadvantages of each funding mechanism, and the extent to which funding could be considered in the Phase 1 process, the following are recommended as next steps:



SQUAMISH INTEGRATED STORMWATER MANAGEMENT PLAN - PHASE 1

Phase 1 Summary and Recommendations

1. Engage Council to establish funding objectives.
2. Evaluate funding mechanisms on the basis of their ability to meet those funding objectives and select a preferred approach (recognizing that there will be trade-offs between objectives).
3. Conduct a rate study based on the chosen approach to select a preferred rate that will help the District move towards more sustainable funding levels.



7. PUBLIC SUPPORT

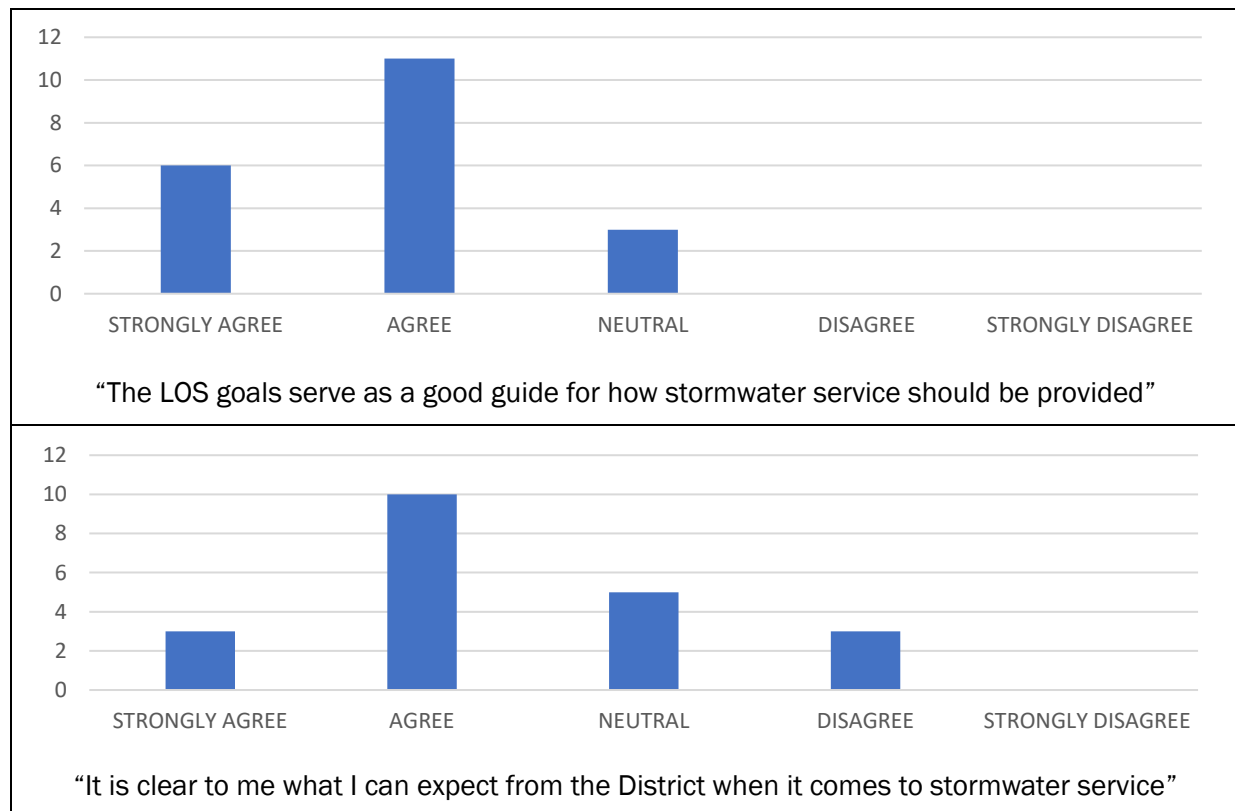
Squamish Nation and community stakeholders were engaged in a workshop early in the process to develop this ISMP by providing input on stormwater management issues and opportunities for improvement. The community was then engaged via an online questionnaire once a draft ISMP was developed to gauge their level of support for the proposed direction outlined in the plan.

The following is an overview of the online questionnaire:

- The survey was open for two weeks, from March 15 to March 29, 2019.
- The survey was advertised via social media channels and e-newsletters.
- The survey was sent directly to Squamish Nation and community stakeholders who participated in the workshop early in the project process.
- Survey participants were provided with information in order to help them respond to questions about their level of support for the plan; this is shown in **Appendix H**.

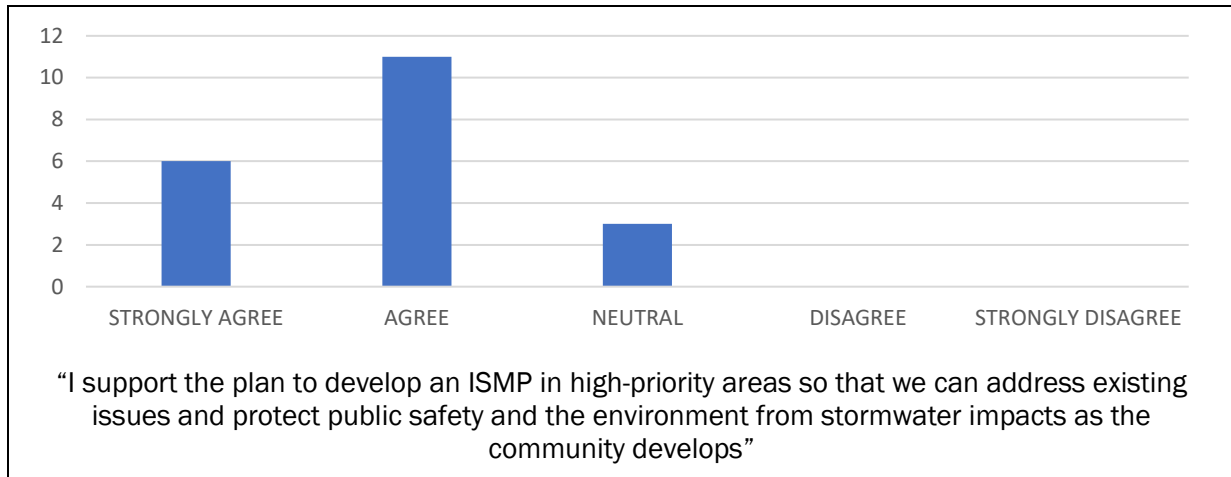
A total of 21 responses to the survey were received. The survey results are summarized in the following sections.

Support for the LOS Goal Statements

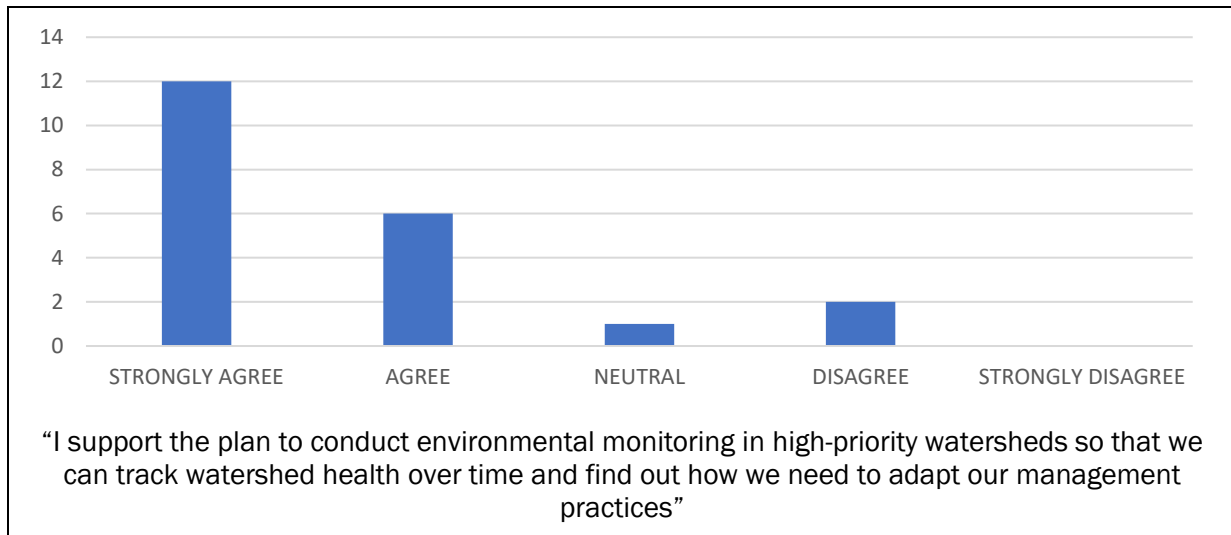




Support for Developing ISMPs in High-Priority Catchments

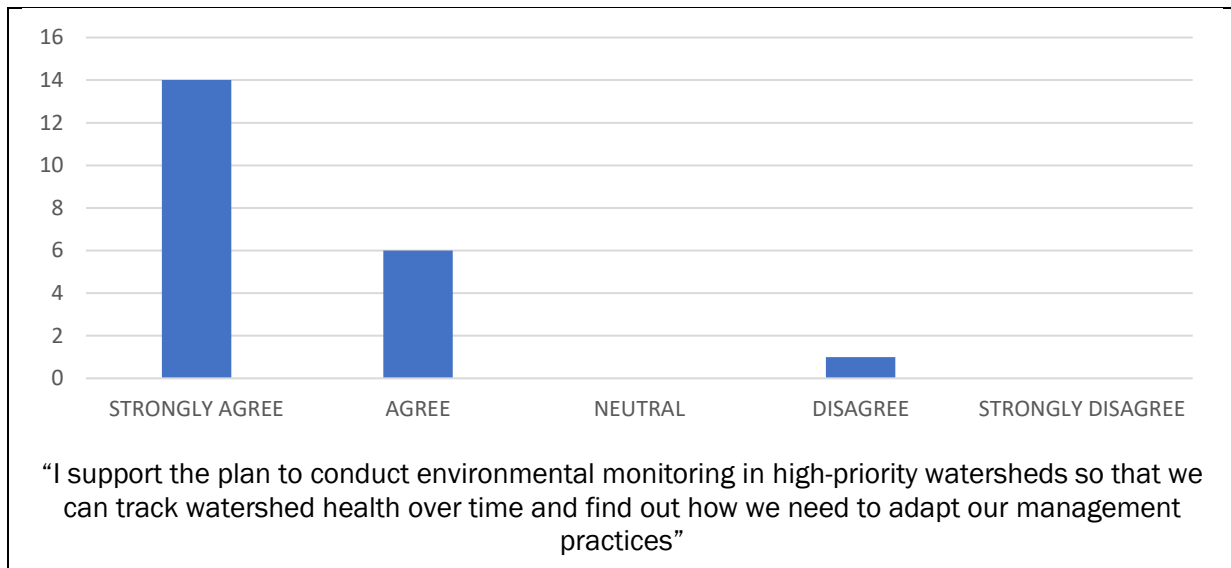


Support for Conducting Environmental Monitoring in High-Priority Catchments

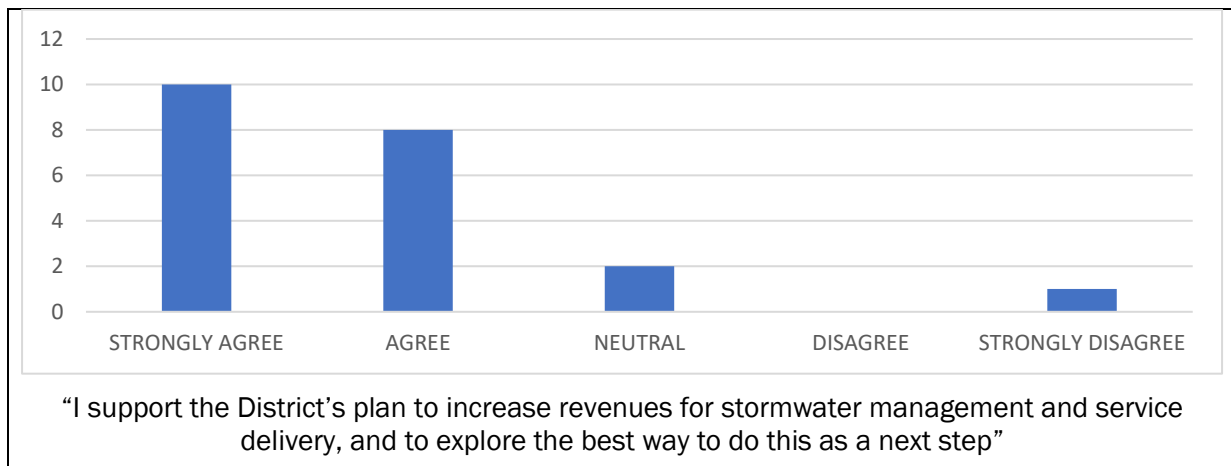




Support for Protecting Natural Assets and Considering Them in Planning Processes

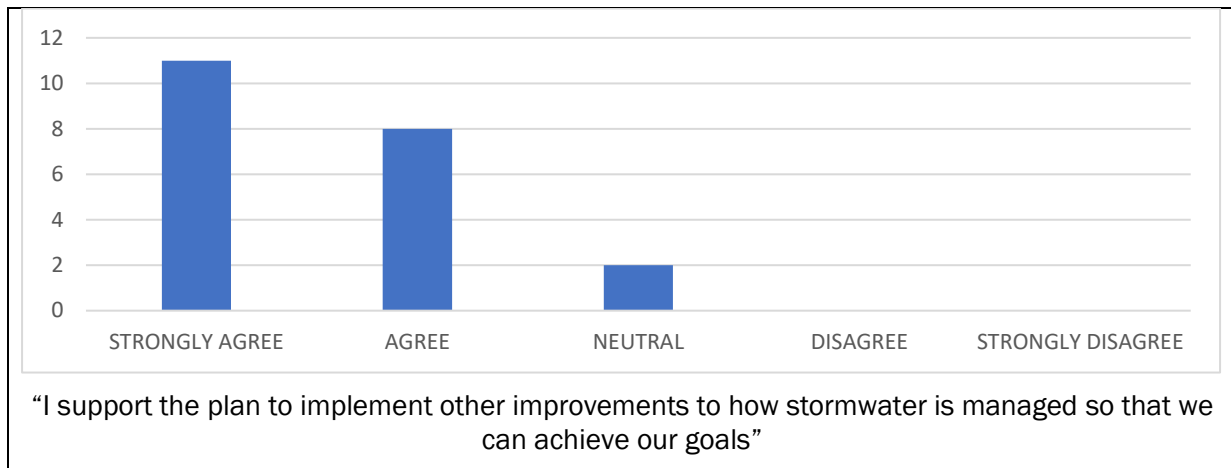


Support for Increasing Revenues for Stormwater Service Delivery



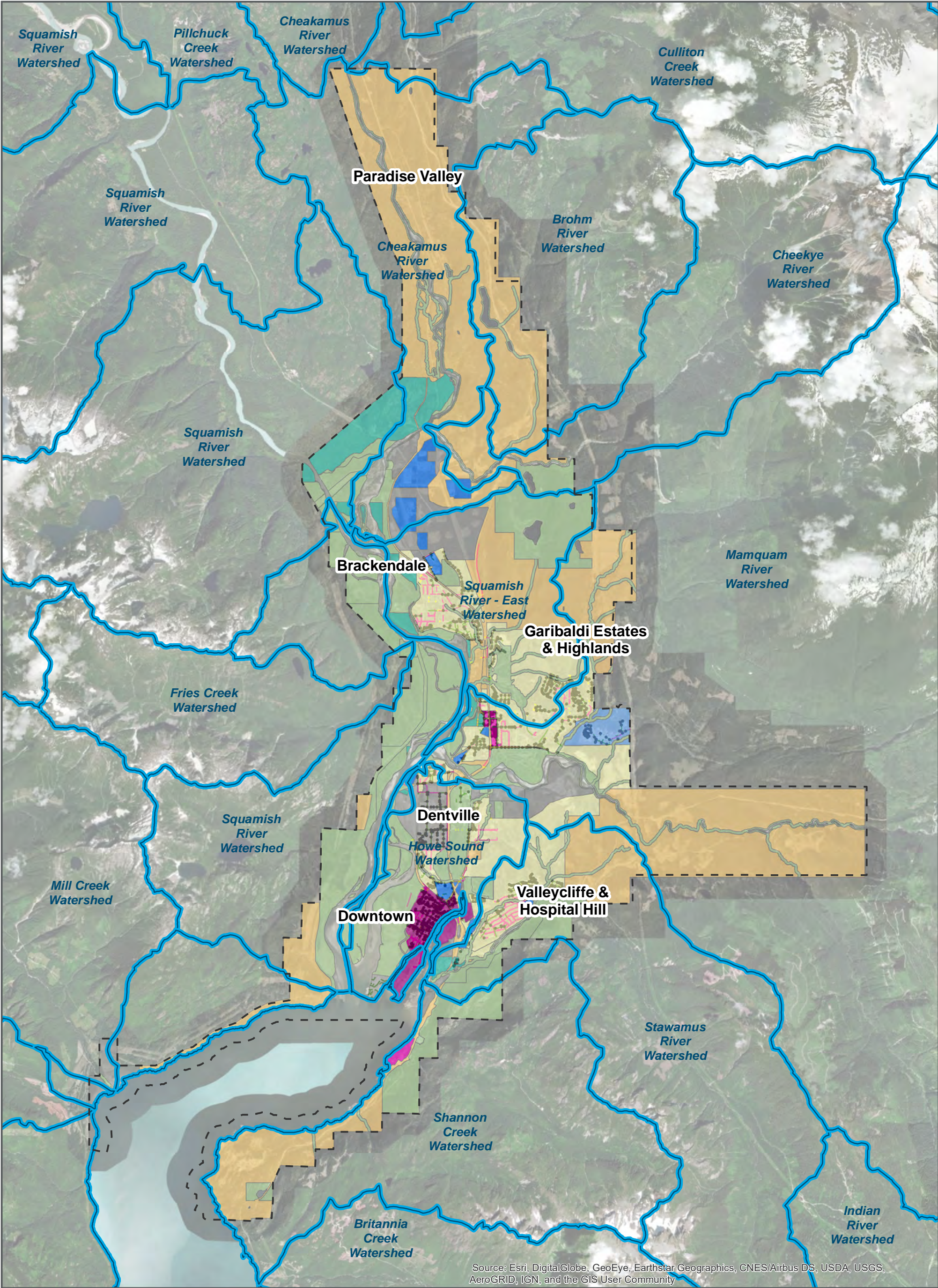


Support for Implementing Other Stormwater Management Improvements

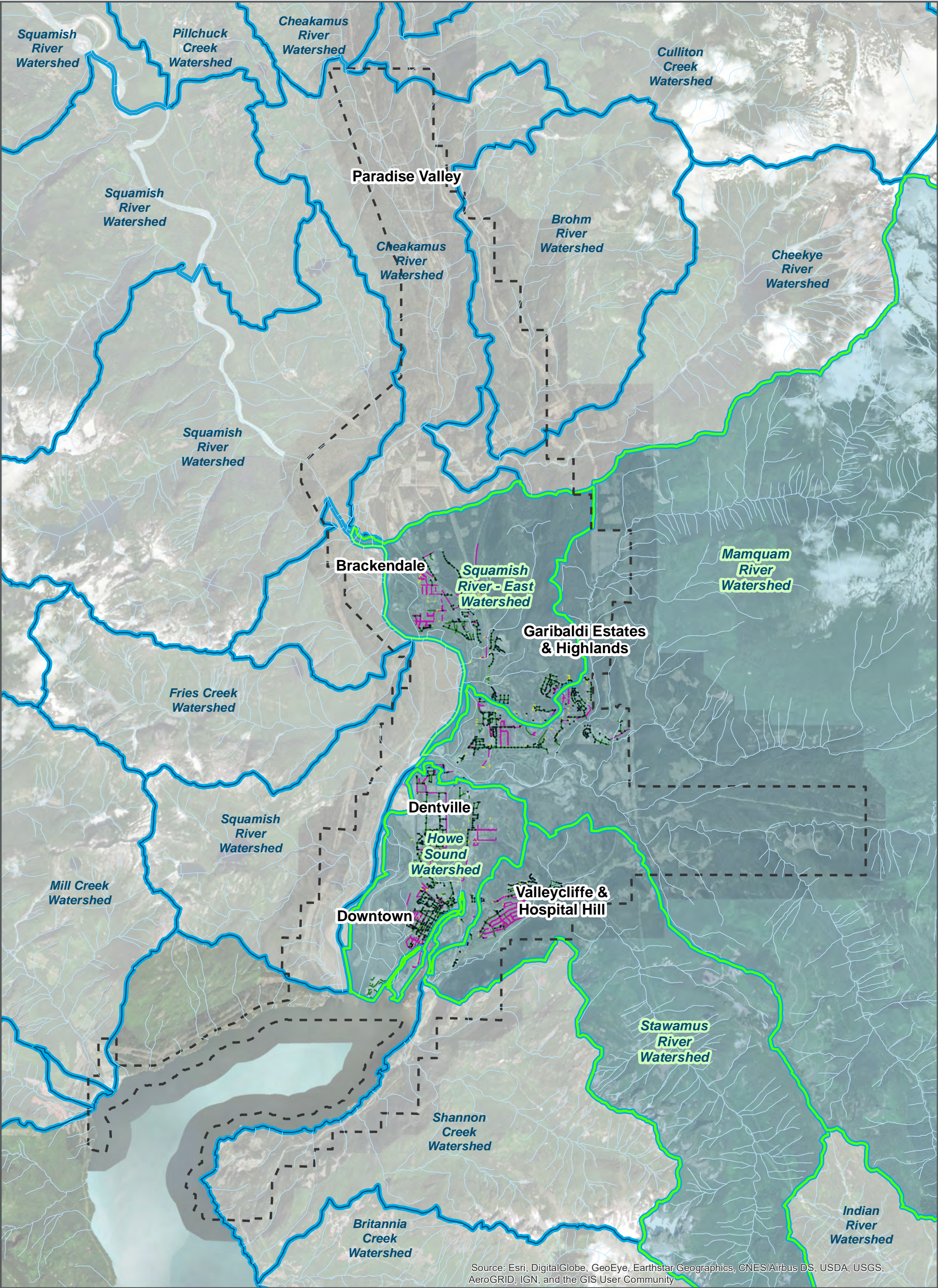


Takeaways

- Respondents generally support the direction of this Phase 1 ISMP.
- A few suggestions were provided for improvements to the draft Phase 1 ISMP, including adjustments to the LOS goal statements. The final Phase 1 ISMP reflects the input provided by respondents.
- Several comments were provided regarding funding for stormwater service delivery. Some respondents expressed a desire for developers to contribute more for building and/or upgrading infrastructure in the community, and for their initial upkeep. Other respondents expressed a desire to see fees for stormwater service commensurate with the property location and runoff generated from the site, both to fairly recover the cost and to incentivise the application of permeable surfaces onsite. These comments should be considered as the District makes decisions on taxation and/or user fee rates for stormwater.
- Communicating with the public frequently and in different ways about stormwater service is important. It will help to continue to build the public’s understanding of what to expect in terms of stormwater service, what the District is doing to maintain and improve stormwater service, and what funding is required.



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Appendix A: Level of Service Framework

DISTRICT OF SQUAMISH INTEGRATED STORMWATER
MANAGEMENT PLAN – PHASE 1

FINAL REPORT – April 10, 2019



Integrated Stormwater Service Delivery Level of Service Framework



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1. INTRODUCTION

The District of Squamish (the District) strives to continuously improve in asset management and integrated stormwater management. This will allow the District to sustainably provide stormwater services to the community, and protect public property, the environment, and public safety as the community develops.

To support these improvement goals, the District developed a Stormwater Level of Service (LOS) Framework (Framework). This document provides a Framework to support the District in further establishing LOS and using LOS as part of its broader approach to stormwater service delivery.

2. OVERVIEW OF LEVELS OF SERVICE

Definition

Level of service (LOS) is a statement of the quality, function, and/or capacity of a service. It can be considered as a service standard that is met through decisions by the service provider about new capital assets, replacement of assets, and ongoing operations and maintenance.

Deciding on the 'Right' Level of Service

The 'right' LOS is based on what customers are willing to pay for the perceived benefits they get from the service. The 'right' LOS strikes a balance between customer expectations and affordability.

Measuring Level of Service

Level of service is measured using indicators that reflect what customers care about. For example, if users of a public transit system care about frequency of service, then LOS can be measured by waiting time between buses.

Indicators can be used to quantify current LOS, to set targets for LOS, and to measure progress towards them. Indicators need to be meaningful and are ideally relatively easy to measure.



3.THE DISTRICT’S STORMWATER LEVEL OF SERVICE FRAMEWORK

The District’s LOS framework defines the following:

- **What customers care about** – as identified by District staff based on their experience with customers.
- **Stormwater service goals** – statements of what customers can expect in terms of stormwater service delivery by the District.
- **Indicators** – what the District can measure to quantify current LOS, to set targets for LOS in specific areas, and to measure whether goals and targets are being met.

This LOS Framework will be used by the District to:

- **Establish District-wide goals for Integrated Stormwater Management Plans (ISMPs).** This is so that catchment-specific ISMPs will be informed by a common set of higher-level goals for service delivery.
- **Quantify the current LOS and set targets for LOS** in specific watersheds, based on what is achievable in each area.
- **Inform the scope of an Environmental Monitoring Plan,** which will be used by the District to measure and track the effectiveness of its integrated stormwater management practices in terms of environmental impacts.

The LOS Framework is summarized on the following page.



SQUAMISH INTEGRATED STORMWATER MANAGEMENT PLAN - PHASE 1

Level of Service Framework

What Customers Care About	Stormwater Service Goals <i>What customers can expect in terms of stormwater service delivery</i>	Indicators <i>How the District can measure current LOS, set targets, and monitor progress</i>
Impacts to private property	1. Public stormwater management practices should not result in negative impacts to private property	<ul style="list-style-type: none"> Number and nature of private property damage complaints
	2. Nuisance flooding in backyards and low-lying areas is expected for minor rain events if it is generated on-site	<ul style="list-style-type: none"> Number and nature of private property damage complaints
	3. New developments should mitigate on-site and off-site impacts of runoff	<ul style="list-style-type: none"> Change in on-site total impervious area; and/or Post-development vs. pre-development flows
Impacts to public property	4. Public property may be used as a floodway or storage for major storm events as appropriate	<ul style="list-style-type: none"> Observed performance in major events Number and nature of complaints
Impacts to the environment	5. Public and private stormwater management practices should minimize negative impacts to water quality, water quantity, and ecosystem health on a watershed basis, relative to current conditions	<ul style="list-style-type: none"> Water quality Flows Benthic index of biological integrity (B-IBI) Percent total impervious area Percent riparian forest integrity Number of erosion/instability sites and their risk level
	6. The District should meet all Federal and Provincial regulations and guidelines for environmental protection	<ul style="list-style-type: none"> Compliance with regulations and guidelines
Condition of infrastructure	7. Drainage infrastructure is appropriately maintained for its intended function	<ul style="list-style-type: none"> Number of complaints regarding condition and odour
District response	8. District staff will be available to respond to stormwater management issues, and will respond to issues in order of highest to lowest priority as follows: <ol style="list-style-type: none"> Issues related to the capacity or performance of public stormwater infrastructure Issues related to impacts to a private building (e.g., crawlspace flooding) caused by failure of the public stormwater system Issues relating to flooding of private property (e.g., backyard flooding) caused by failure of the public stormwater system 	<ul style="list-style-type: none"> Response time
Clarity of Levels of Service	9. Residents are aware of what to expect in terms of stormwater levels of service	<ul style="list-style-type: none"> Number of repeat complaints
	10. Residents know what they can do to help	<ul style="list-style-type: none"> Number of public inquiries

Appendix B: Stormwater Service Delivery Baseline Assessment

DISTRICT OF SQUAMISH INTEGRATED STORMWATER
MANAGEMENT PLAN – PHASE 1

FINAL REPORT – April 10, 2019



Integrated Stormwater Service Delivery Baseline Assessment



SQUAMISH INTEGRATED STORMWATER MANAGEMENT PLAN - PHASE 1
Integrated Stormwater Service Delivery Baseline Maturity Assessment



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Figure 1 Overview of Watersheds and Development Areas

Figure 2 Watersheds Recommended for Integrated Stormwater Management Planning



1. INTRODUCTION

The District of Squamish (the District) strives to continuously improve in asset management and integrated stormwater management. This will allow the District to sustainably provide stormwater services to the community, and protect public property, the environment, and public safety as the community develops.

To support these improvement goals, a Stormwater Service Delivery Baseline Assessment was conducted to identify strengths and challenges with the District's current processes and practices. The Assessment also included the identification of stormwater-related issues within the community. The Assessment was informed by a high-level review of relevant District regulations and background information; a review of the District's asset inventory; and interviews with staff from Engineering, Public Works, Planning, and Finance.

The District will use the results of the Assessment to:

- identify priorities for improvements to processes and practices
- develop an Asset Management Investment Plan (AMIP) for stormwater assets
- identify priority areas for responding to stormwater-related issues, such as through the development of Integrated Stormwater Management Plans (ISMPs)
- inform the development of a stormwater levels of service framework
- inform the development of an environmental monitoring program
- develop terms of reference for ISMPs



2.ASSESSMENT PROCESS AND FRAMEWORK

The following process and framework was used to conduct the Baseline Assessment:

Part 1: Inventory of stormwater-related conditions and issues by watershed

For the purpose of this study, watershed boundaries were delineated according to the Freshwater Atlas. The following parameters were then considered in the inventory of stormwater-related conditions and issues in each watershed:

- Land use
- Development pressures
- Stormwater infrastructure, including ditches
- Known issues with stormwater system performance, age, and/or condition
- Known history of flooding
- Watercourses
- Soil and groundwater
- Sensitive habitat areas
- Ownership, jurisdiction, and access issues

This inventory provided context for an assessment of the District's processes and practices in Part 2.

Part 2: Assessment of strengths and challenges with current processes and practices

Strengths and challenges with the District's current asset management and integrated stormwater management processes and practices were identified. The framework included:

- Assets
- Information
- Finance
- People

This framework is based on *Asset Management for Sustainable Service Delivery: A BC Framework*. The BC Framework establishes a high-level, systematic approach that supports local governments in moving toward sustainable service delivery through an asset management process. Because stormwater service sustainability is key to addressing integrated stormwater management-related issues in the District's watersheds, this is a suitable framework to apply in this case.



3.ASSETS

Assets include both built assets, and natural assets that provide a stormwater management function. It is important for the District to have a strong understanding of what stormwater assets it owns, the value and condition of those assets, levels of service, and risk. This is so that the District can make informed decisions about service delivery, including planning, operations, and funding.

A review of the District's asset inventory was conducted as part of the assessment. Findings of the review are provided in **Attachment A**.

Challenges

- Assets do not have unique ID's assigned
- Significant gaps in key attribute data needed for asset management and hydraulic modelling
- No installation dates or historical costs for majority of assets
- No connectivity between pipes and overland assets (ditches)
- No O&M plan for green infrastructure such as rain gardens or ponds
- District-wide issues with beaver control and vegetation (invasive species and alders) in terms of natural assets

Strengths

- A GIS system exists with locations for approximately 50-60% of drainage infrastructure
- As-built drawings are available (accuracy in some cases is unknown)
- Mapping available for watercourses on public and private land
- Mapping and riparian classification available for ditches primarily on public land
- Interest in better understanding value of natural assets
- Good growing conditions for many types of natural assets
- District is participating in the National Water and Wastewater Benchmarking Initiative

Opportunities to address challenges and leverage strengths

- Address gaps in the asset inventory using as-builts; incorporate them into GIS
- Incorporate natural assets in asset management and stormwater management processes and practices
- Enforce requirements in Subdivision and Development Control Bylaw for developers to submit GIS-based asset data post-construction
- Improve final inspection process and file closure process, and include Public Works in the process. This may require additional staff.
- Use watercourse mapping and riparian classification information in the development of ISMPs
- Expand Sensitive Habitat Inventory and Mapping (SHIM) and riparian classification on public land

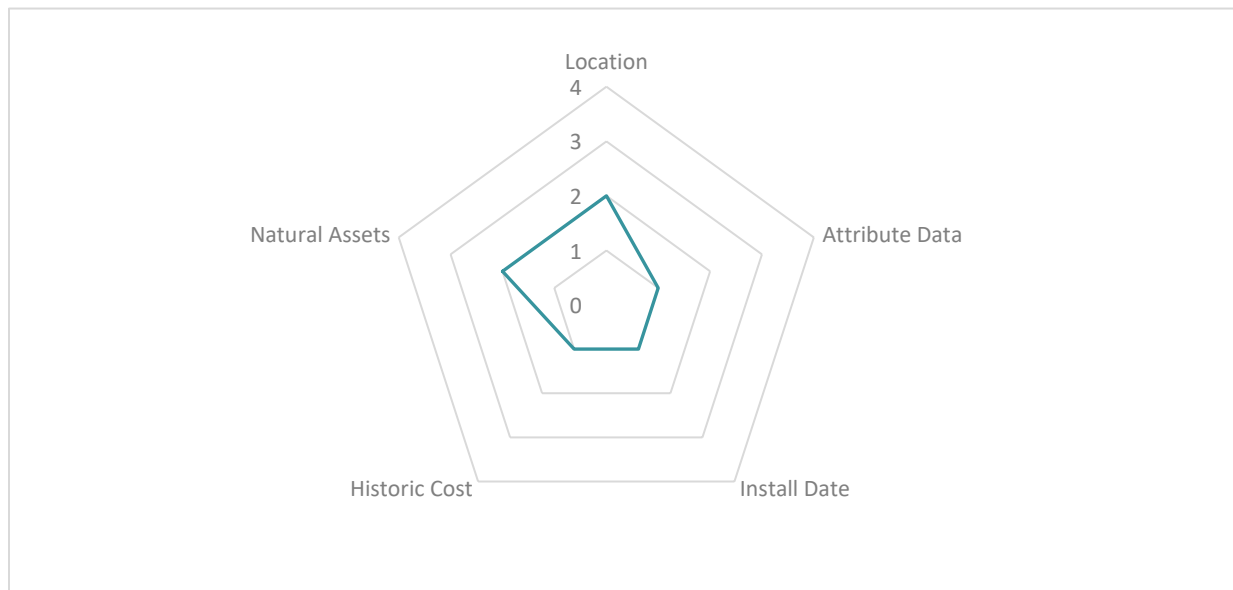


SQUAMISH INTEGRATED STORMWATER MANAGEMENT PLAN - PHASE 1

Integrated Stormwater Service Delivery Baseline Maturity Assessment

- Expand inventory and mapping of ditches
- Develop O&M plans for new and existing infrastructure, including green infrastructure, based on a clear understanding of the function of the infrastructure. Align these plans with environmental permitting requirements.

Summary Statement: Overall, the District's understanding of the current state of its assets is fairly low. The District will benefit from addressing existing gaps in the inventory, and improving processes and practices to ensure that new gaps are avoided. The District will also benefit from improving the O&M of its assets. The District has made considerable progress in recent years on identifying and mapping natural assets such as watercourses and ditches, and will benefit from better understanding the value of these assets.





4. INFORMATION

Information is needed to support decisions that are cost-effective, manage risks, and support long-term service delivery. Information can take many shapes: from policies and regulations that provide legal direction on how to make decisions, to plans that provide strategic direction. It is also important to have information about system performance and watershed health, as this is used to inform management practices, policies, regulations, and plans – all part of the continuous improvement aspect of stormwater service delivery.

Challenges

- No overall strategy or framework in place related to sustainable service delivery goals or objectives for stormwater management
- Levels of Services (LOS) for stormwater are not well understood, used to inform decision-making, or communicated to the public
- Risks related to stormwater assets are not documented or communicated
- Some asset replacement plans exist that identify timing and costs, but they are dated
- No long-term capital plan for stormwater assets
- Impacts of climate change have not been identified or incorporated into plans, stormwater management criteria, or standards
- Existing Drainage Master Plans are dated and generally focused only on capacity issues
- No “big picture” ISMPs or equivalent strategic master plans exist to inform stormwater management plans prepared by developers, or capital plan/budget;
- Subdivision and Development Control Bylaw does not provide clear direction to staff on criteria and standards for stormwater management
- Issues with the drainage system performance are not well documented
- State of watershed health not currently known or used to inform decision-making

Strengths

- A draft Asset Management Policy was recently developed
- Subdivision and Development Control Bylaw was updated in 2015 and provides direction on lot-level stormwater management requirements (but is weak on existing and offsite requirements)
- Stormwater Management Plans are required for new development
- Updated Official Community Plan now in second reading
- Drainage system performance and issue areas are well understood by Public Works staff
- LOS indicators / performance measures are already tracked to an extent as part of the National Water and Wastewater Benchmarking Initiative
- The District’s Asset Management Policy provide direction on potential stormwater LOS indicators



Opportunities to address challenges and leverage strengths

- Develop an up-to-date, clear, relevant corporate AM strategy that contextualizes stormwater services with other municipal services
- Develop clear, relevant, and measurable, LOS for stormwater (and other services)
- Develop an up-to-date AMIP for stormwater (assets and other assets)
- Assess and document risks to inform capital and operations plans
- Develop ISMPs for priority areas
- Update Subdivision and Development Control Bylaw to address challenges/gaps. This includes incorporating climate change into the District's Design Criteria and IDF curves
- Include considerations for stormwater management in Zoning Bylaw
- Develop a process to document and retain knowledge of stormwater system performance and other information and practices
- Develop a process to collect and track data on watershed health and use it to inform management practices
- Develop a framework to inform decisions with competing objectives/priorities (e.g., fisheries objectives with flood protection objectives)

Summary Statement: Overall, the quality and quantity of information the District is using to make decisions about stormwater service delivery are fairly low. This is not unusual for small communities. The District will benefit from building its corporate capacity in asset management and stormwater service delivery. The current project provides a significant opportunity to improve on many of the challenges identified in the assessment.





5. FINANCES

This category refers to the amount of funding dedicated to stormwater service delivery, including new capital, ongoing operations and maintenance of assets, and asset renewal and replacement. It also refers to the manner in which stormwater service delivery revenues are generated. It is considered best practice to fully recover the cost of services, as this can help avoid disruptions in service and risks to public and environmental health and safety.

Challenges

- Aging infrastructure past its service life is a liability
- Financial plan exists but does not reflect the revenue required for the future replacement or rehabilitation of stormwater assets
- Currently only O&M is funded and the occasional capital project
- No linkage between the long-term financial requirements of stormwater assets and the revenue collected
- Stability and availability of stormwater capital funding is a concern to staff

Strengths

- Financial planning guiding principles and policy have been established and implemented
- A five-year financial plan has been developed
- Financial policy exists and is referenced annually
- No debt specifically related to storm water assets, and overall District debt level is reasonable and stable

Opportunities to address challenges and leverage strengths

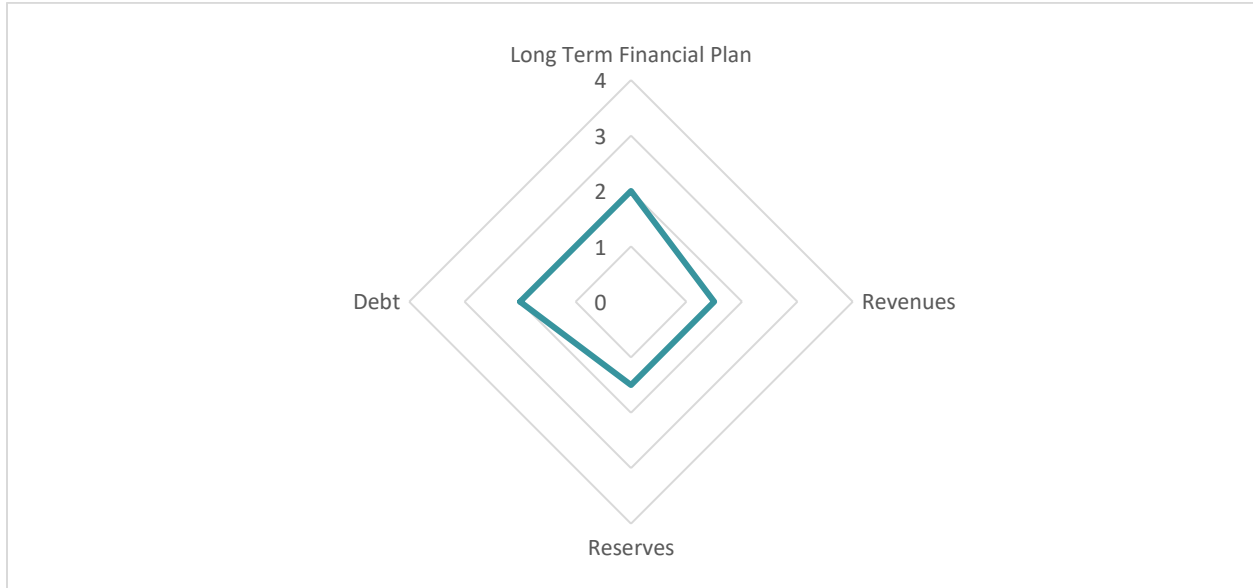
- Develop an asset management investment plan (AMIP) for stormwater assets and other assets
- Develop and make progress towards a full cost recovery approach to stormwater service delivery

Summary Statement: *The District does not currently fund stormwater infrastructure at a sustainable level. This is largely due to a gap in the understanding of what level of investment is needed. The District will benefit from gaining a stronger understanding of the extent to which services are currently underfunded, and from developing an approach to fully funding service delivery. This will be examined further through the Phase 1 ISMP process through the development of an AMIP and by conducted a funding review.*



SQUAMISH INTEGRATED STORMWATER MANAGEMENT PLAN - PHASE 1

Integrated Stormwater Service Delivery Baseline Maturity Assessment





6. PEOPLE

Stormwater service delivery doesn't happen on its own – teams of people working effectively together make it happen. It is therefore important to assess the District's current capacity to provide stormwater service delivery from a 'people' perspective, including roles, decision-making processes, awareness, knowledge and skills, and overall teamwork.

Issues

- Staff have limited time and resources for proactive asset management, proactive stormwater management, and preventative maintenance
- Council's awareness of risks and issues related to stormwater management is low
- Roles and responsibility for asset management planning are not clearly defined

Strengths

- Staff is aware of some of the major issues and risks related to sustainable stormwater management (however, many gaps remain)
- A cross functional team is in place and is able to bridge siloes in the organization
- There is a "green ethic" at the District that aligns with the principles of integrated stormwater management
- Staff is eager to move towards proactive planning, informed decision-making, and preventative maintenance

Opportunities to address challenges and leverage strengths

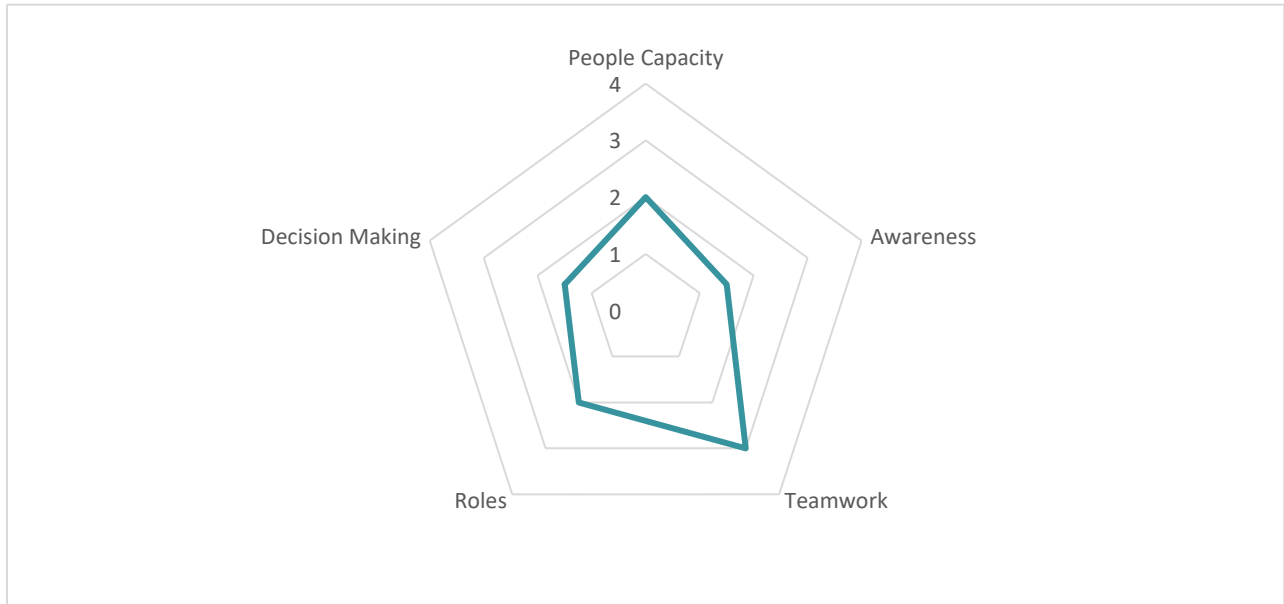
- Develop and implement a process to continuously build Council's and public's awareness of stormwater LOS, and issues and risks related to asset management and stormwater management. Connect this to environmental values and risk management so the message resonates.
- Clearly define roles and responsibilities for all asset management- and stormwater management-related activities
- Develop a knowledge retention strategy
- Communicate with the public frequently and strategically about asset management and stormwater management

Summary Statement: *Like many small communities, the District is currently doing a lot with limited resources. Staff strive to move towards proactive planning and preventative maintenance, but are often occupied with immediate pressures. The District will benefit from leveraging staff awareness and motivation to improve in stormwater service delivery.*



SQUAMISH INTEGRATED STORMWATER MANAGEMENT PLAN - PHASE 1

Integrated Stormwater Service Delivery Baseline Maturity Assessment





7. WATERSHED ISSUES AND PRIORITIES

It is important to inventory watershed-specific issues that may be addressed through integrated stormwater management practices and processes. This is so that decisions on improvements can be prioritized and resources allocated to where they are most needed – whether that be to addressing high-priority District-wide issues through a common approach or implementing improvements to address high-priority issues in a specific area.

Included in the assessment was an inventory of watershed conditions and issues that may affect public and environmental health and safety, and that may be addressed through integrated stormwater management practices and processes. Conditions and issues inventoried were based on information available in the City's GIS database, on previously completed studies, and on input provided by staff during the interviews and a follow-up workshop. Conditions and issues inventoried included:

- Land use
- Development pressures
- Existing stormwater infrastructure and performance issues
- Watercourses
- Sensitive habitat areas
- Ownership, jurisdiction, and access issues
- Any other issues affecting public or environmental health

According to Freshwater Atlas Mapping, a total of 15 watershed span District boundaries, as shown on Figure 1.

District-wide issues include the following:

- SDC Bylaw does not provide clear direction on stormwater management requirements
- Zoning Bylaw does not adequately address infill issues/laneway housing pressures on stormwater system
- Issues with access/ROW
- Beaver control
- Vegetation management
- Limited proactive O&M

Issues by watershed are summarized in Table 1. Priority watersheds for which an ISMP is recommended are shown on Figure 2.



Table 1 Summary of Stormwater Issues and Threats to Watershed Health

Watershed and Usage Areas	Existing Issues	Development Pressures	Sub-watersheds / Tributaries with Development Potential (>10%)	Environmental Monitoring Recommended	ISMP Recommended	Priority Level and Implementation Time Frame
Howe Sound <i>Downtown, North Yards, Business Park, Dentville and Logger's East</i>	<ul style="list-style-type: none"> Flat topography High groundwater Designated flood risk Ditch filling and driveway extensions due to infill development "Stinky Pond" issues including sedimentation, odour, aesthetics Ad-hoc connections by private owners Tidal influence in the Mamquam Blind Channel Gravity-fed drainage Wood stave piping in poor condition Issues with Mamquam Reunion – unknowns regarding capacity, elevations, competing objectives, unclear governance Basement flooding in Dentville Drainage issues in Logger's East area Poor information and understanding on interaction between stormwater storage in Wilson Slough and upstream areas, operation of Wilson Slough floodbox and introduction of water into the catchment via Mamquam Reunion Project. Further information is required to guide operation of intakes and future infrastructure upgrades. 	<ul style="list-style-type: none"> Immediate Downtown Neighbourhood Plan Oceanfront Peninsula Sub-Area Plan Waterfront Landing Sub-Area Plan Business Park Sub-Area Plan Initial work on Logger's East Sub Area Plan (anticipated for 2019 completion) 	<ul style="list-style-type: none"> Logger's Creek 	Yes	Yes	Priority #1 2019-2020
Squamish River – East <i>Brackendale, North Highlands, Tantalus Road</i>	<ul style="list-style-type: none"> Issues are centered around Brackendale (developed area east of Judd Slough) Brackendale is located within the Squamish River floodplain Capacity and reliance of Judd Slough and Dryden Creek pump stations is a major concern Designated flood risk Limited information on stormwater asset condition Ditches and culverts crossing roads/driveways Crawl space flooding Drainage interface with Squamish Nation is not well-understood Outdated Master Drainage Plan (KWL, 1992) 	<ul style="list-style-type: none"> Future Sub-Area Plan for District Lot 509/510 Cheekeye Special Study Area 	<ul style="list-style-type: none"> Horse Creek Dryden Creek Hop Ranch Creek Meighan Creek North Highlands Unnamed creeks 	No	Yes	Priority #2 2021-2022
Mamquam River <i>Garibaldi Estates and Garibaldi Highlands</i>	<ul style="list-style-type: none"> Mamquam River is flashy Limited information on stormwater asset condition Steep, rocky terrain MOTI interface at the highway; downstream impacts to the District Legacy issues from poor implementation of site grading plans Capacity and reliance on Harris Slough Pump Station is a major concern Flooding issues Gravity-fed drainage – no pumps when needed (DCC bylaw identifies need for a pump station, but no development trigger to date) Water quality/runoff from industrial/commercial land uses 	<ul style="list-style-type: none"> Immediate Sea-to-Sky University Sub-Area Plan Future Sub-Area Plans for District Lots 509/510, 513, 514, and 5212 	<ul style="list-style-type: none"> Harris Slough 	Yes	Yes	Priority #3 2022-2023



SQUAMISH INTEGRATED STORMWATER MANAGEMENT PLAN - PHASE 1
Integrated Stormwater Service Delivery Baseline Maturity Assessment

Watershed and Usage Areas	Existing Issues	Development Pressures	Sub-watersheds / Tributaries with Development Potential (>10%)	Environmental Monitoring Recommended	ISMP Recommended	Priority Level and Implementation Time Frame
	<ul style="list-style-type: none">Orange water issueOutdated Master Drainage Plan (KWL, 1994)					
Stawamus River <i>Valleycliffe, Hospital Hill</i>	<ul style="list-style-type: none">Ranges from relatively flat to steep, rocky topographyFilled ditches and resident-built ditches and storm systemsLittle Stawamus River can be flashyOrange water issue	<ul style="list-style-type: none">Long-term development potential past Crumpit WoodsFuture Sub-Area Plan for District Lot 5212	Little Stawamus River	Yes	Yes	Priority #4 – but opportunity to complete as part of Howe Sound/Downtown ISMP
Cheakamus River <i>Paradise Valley</i>	<ul style="list-style-type: none">Designated flood riskLarge flows from Daisy Lake damJurisdictional issues with DFODistrict is unclear of how the fisheries operate	<ul style="list-style-type: none">Limited; mostly ALR and designated high flood risk	None	No	No	Low priority
Shannon Creek <i>Stawamus Chief Provincial Park</i>	<ul style="list-style-type: none">Minimal issues affecting public or environmental health	<ul style="list-style-type: none">None	None	No	No	Low priority
Squamish River – West <i>Undeveloped, limited usage</i>	<ul style="list-style-type: none">Much of the District is at risk of flooding from the Squamish River; however, at a sub-watershed level, issues are relatively limited due to the lack of development pressures on the west side of the Squamish River	<ul style="list-style-type: none">None	None	No	No	Low priority



Priorities

The inventory of issues by watershed was used to identify watersheds that require an Integrated Stormwater Management Plan (ISMP) and environmental monitoring.

Not all of the watersheds in the District are experiencing the same issues, and not all of them require a comprehensive management response such as an ISMP. Therefore, priority watersheds were identified as those that meet the following criteria:

- Those that are currently experiencing issues due to past land use and development activities (as identified by previous studies or as observed by staff)
- Those for which future development is anticipated to cover at least 10% of watershed area and could impact watershed health and existing system performance
- Those for which an ISMP is recommended, based on the first two criteria, as well as environmental monitoring

Appendix C: Stormwater Asset Management Investment Plan

DISTRICT OF SQUAMISH INTEGRATED STORMWATER
MANAGEMENT PLAN – PHASE 1

FINAL REPORT – April 10, 2019



District of Squamish

Stormwater Asset Management Investment Plan



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Executive Summary

The District of Squamish retained Urban Systems to develop an Asset Management Investment Plan (AMIP) for its stormwater infrastructure. The AMIP aims to answer the following core questions:

- What assets does the District own?
- What is the cost to replace these assets?
- What is the age of the assets and what is the estimated remaining service life?
- How much money needs to be invested annually to replace the District's assets?

The AMIP is not a capital plan and it is not meant to replace one. Rather, the AMIP provides a conservative indication of the target sustainable funding level for the replacement of stormwater assets.

The District's stormwater assets were divided into 8 asset categories as summarized below, each of which was assessed for the amount of infrastructure, Expected Percent Remaining Life, and Average Annual Lifecycle Investment (AALCI).

The Expected Percent Remaining Life expresses the relative useful life that can be expected from each asset class. Dike-related infrastructure such as pump stations and flood boxes possess the lowest expected remaining lives, and are considered the greatest risk of inadequate performance or failure.

The total AALCI of approximately \$2.3 million represents the annual funding that is required to sustain the District's current stormwater assets over the long term, assuming like-for-like replacement of all assets in terms of capacity. Opportunities to reduce the AALCI may exist at greater risk to the District, or by determining alternative renewal or rehabilitation methods on an individual asset basis.

Asset Category	Quantity of Infrastructure	Expected Percent Remaining Life	AALCI
Mains	85 km	57%	\$1,024,000
Catch Basin Leads	9 km	71%	\$43,000
Catch Basins	2,200	59%	\$210,000
Manholes	1,300	60%	\$121,000
Culverts	16 km	47%	\$276,000
Inlet/Outlet Structures	35	50%	\$9,000
Pump Stations	6	37%	\$252,000
Flood Boxes	25	26%	\$324,000
Total		51%	\$2,259,000

In total, the replacement value of the District of Squamish's stormwater assets is estimated to be \$133 million, expressed in 2018 dollars.

The following recommendations for next steps are made based on results from the AMIP:

1. Present a summary of the AMIP results to Council. Key messages to communicate include the following:



- The AALCI of \$2.3M is a conservative estimate of the annual “sustainable funding level” that is required to replace the District’s current stormwater assets. It should be viewed as a target, and taxation and/or user fee rates should be structured so that annual funds for replacement of assets move towards this target over time.
 - Annual funds should be allocated to projects according to a risk-based 10-year capital plan.
 - The AALCI estimated in this AMIP is conservatively based on expected percent remaining life of stormwater assets, not their actual condition (insufficient data was available). As condition data becomes available, the AMIP and the AALCI should be refined. Condition data should also be used to develop the risk-based capital plan.
2. Develop and implement a condition assessment program for stormwater assets to inform refinements to the AALCI and to inform the development of a risk-based capital plan.
 3. Refine the AALCI over time by:
 - a. Adjusting the expected percent remaining life based on actual condition assessments
 - b. Adjusting the assumed useful life of assets based on the District’s experience with various materials locally
 - c. Adjusting replacement timing based on risk tolerance
 - d. Investigating alternative methods/technologies for asset renewal or replacement.
 4. Update the AMIP as ISMPs are developed and regularly thereafter to capture new assets that have been acquired by the District and to reflect refinements to the process of estimating the AALCI as described above.
 5. A funding review was conducted as part of this project, the results of which are provided under separate cover. However, it is worth noting in the context of the AMIP that the setting of taxation and/or user fee rates for stormwater, and the allocation of funding for stormwater, should be considered in the broader context of the District’s funding needs for all types of assets.



1. Overview of the AMIP

This Asset Management Investment Plan (AMIP) was developed to determine future investment requirements for the District of Squamish's stormwater infrastructure. The AMIP describes annual investment requirements based on current renewal cost and estimated remaining service lives of the District's assets. The purpose of the AMIP is to support long-term financial planning decisions.

What does the AMIP tell us?

The AMIP aims to answer the following core questions:

- What assets does the District own?
- What is the cost to replace these assets?
- What is the age of the assets and what is the estimated remaining service life?
- How much money needs to be invested annually to replace the District's assets?

The AMIP is not a capital plan and it is not meant to replace one. Rather, the AMIP provides a conservative indication of the target sustainable funding level for the replacement of stormwater assets.

What doesn't the AMIP tell us?

It is important to note that despite its name, the Asset Management Investment Plan is not a tailored maintenance plan, nor a budget or capital plan. It should not be solely relied upon for investment decisions. The AMIP does not consider the District's definition and tolerance of risk, or current and desired levels of service, which are both necessary aspects of capital plans, budgets, and maintenance plans. The AMIP does not consider the optimal replacement or refurbishment method for infrastructure and more detailed review may allow for reduction of costs. The AMIP does not make decisions about infrastructure – it is up to those that make decisions within the District to consider this information when making major investment decisions.

How often should the AMIP be updated?

The AMIP should be kept relevant and useful by updating it approximately every 5 years. This will help ensure that the AMIP continues to support ongoing decisions regarding capital plans and financial operating budgets.

Key Definitions

Average Annual Life Cycle Investment (AALCI): The replacement value of an asset divided by its service life. The summation of this value for all the stormwater infrastructure serves as a tool for assessing the financial capacity of the District for infrastructure investment. For example, an asset valued at \$100 with an expected service life of 10 years would be considered to have an AALCI of \$10.

Infrastructure Backlog: The value of assets that have reached their theoretical service life before 2018 and have not yet been replaced.



Remaining Life: The number of years remaining until an asset reaches its theoretical service life, measured from the year of installation or previous renewal.

Replacement Value: The estimated cost to replace the asset, in 2018 dollars.

Service life (theoretical age): The number of serviceable years an asset is expected to provide.

2. Methodology

2.1 Information Gathering

Urban Systems compiled a stormwater asset inventory using the following:

- GIS data (provided by the District and open source data);
- as-built drawings;
- engineering reports;
- anecdotal information; and
- assumptions where necessary based on local knowledge.

The asset inventory is the foundation of the AMIP, so it is important that the compiled inventory represents the best currently available information. Information was collected throughout the project to address missing data and confirm details of specific assets as needed.

Geographic Information System (GIS) data was collected and compiled to develop the majority of the asset inventory and to support many of the assumptions made to address data gaps. An example of how GIS information helped to fill data gaps was missing culvert installation years, which were assumed to have been installed in the same year as adjacent culverts with known installation years.

It is important to emphasize that inventory development and maintenance is an ongoing process for which there is no “final” version. However, in order to conduct a current asset replacement forecast that complemented the AMIP, the inventory was captured at the current point in time.

2.2 Asset Management Investment Plan Spreadsheet

The AMIP is based on a spreadsheet that is populated with data from the assembled GIS inventory. One of the main AMIP objectives is to forecast a timeline of replacement needs, alongside the overarching strategy which places long-term focus on financial requirements. The AMIP includes a 20-year replacement forecast, which provides planning-level insight into the District’s more imminent replacement requirements. Understanding asset replacement timing can help the District prepare for the end of asset service lives before this happens, rather than approaching replacements on a potentially costly emergency basis.



2.3 Assumptions & Data Gaps

The majority of the AMIP inventory was compiled from the District's GIS database and through correspondence with District staff, but several assumptions were required to fill remaining data gaps in support of providing the most accurate representation of current stormwater assets.

For the purposes of the AMIP, data gaps are considered areas of missing asset information. Based on the collected information, data gaps ultimately included pipe sizes, material, and installation or renewal years. Identifying these data gaps and updating the asset inventory should be a focus of future efforts.

To address current remaining data gaps, the following key assumptions were made:

- Missing pipe material is concrete if installed in 1960s & 1970s, concrete or PVC for 1980s & 1990s, and PVC for 2000s or later (based on distribution of known mains).
- Catch basin leads are PVC for less than 300mm diameter, and concrete for greater.
- Missing culvert material is CMP.
- Pump stations and flood boxes have average service lives of 50 years for all components (the true service lives of each component are likely to vary and be independent, so this is a broad assumption in the absence of detailed cost and condition information).
- Pump stations with no installation year provided (Galbraith and Centennial) were installed in 1974. All pump stations have current replacement value of either \$500,000 or \$3,000,000 as per District input.
- Flood boxes provided from the 1974 flood map were installed in 1974 and have current replacement cost of \$500,000 (typical cost, based on comments by the District).
- Missing data for mains, culverts, catch basins, catch basin leads, and manholes (including material, size, and install year) is identical to nearby assets with known information.



3.AMIP Results

3.1 What Assets Does the District Own?

To develop a useful AMIP, it was necessary to assemble a complete and accurate inventory of the District's stormwater infrastructure, based on available information. Understanding the District's assets not only benefits the AMIP, but is necessary to develop successful asset management strategies moving forward.

Using the information gathering methods previously described, the asset inventory was organized into 10 categories. These categories, and the quantity of infrastructure within each, are as follows:

- **Mains** – Approximately 85 km of mostly PVC or concrete mains, ranging in size from 100 to 2,520 mm diameter
- **Catch Basin Leads** – Approximately 9 km of mostly PVC leads, ranging in size from 100 to 375 mm diameter
- **Catch Basins** – A total of about 2,200 catch basins and lawn drains
- **Manholes** – A total of about 1,300 manholes
- **Culverts** – Approximately 1,400 totalling 16 km of mostly CMP culverts, ranging in size from 150 to 1,800 mm diameter
- **Inlet/Outlet Structures** – A total of 35 structures
- **Pump Stations** – A total of 6 pump stations
- **Flood Boxes** – A total of 25 flood boxes
- **Ditches¹** – Approximately 45 km of grass ditches
- **Ponds¹** – A total of 8 ponds

3.2 What is the Cost to Replace the Assets?

The total replacement value of the District of Squamish's stormwater assets is estimated to be \$133 million, expressed in 2018 dollars. The replacement cost of each asset was determined either through anecdotal estimates provided by the District or using unit costs shown in the AMIP spreadsheet. Included in the costs is a 20% increase to account for engineering and design fees associated with infrastructure replacement and 20% contingency. Figure 1 shows the breakdown of each category's replacement value.

¹ Ditches and Ponds are both District assets, but they have not been included in the AMIP's replacement value or AALCI as their service lives may be extended indefinitely through ongoing maintenance programs.



Total Replacement Value:
\$132,646,000

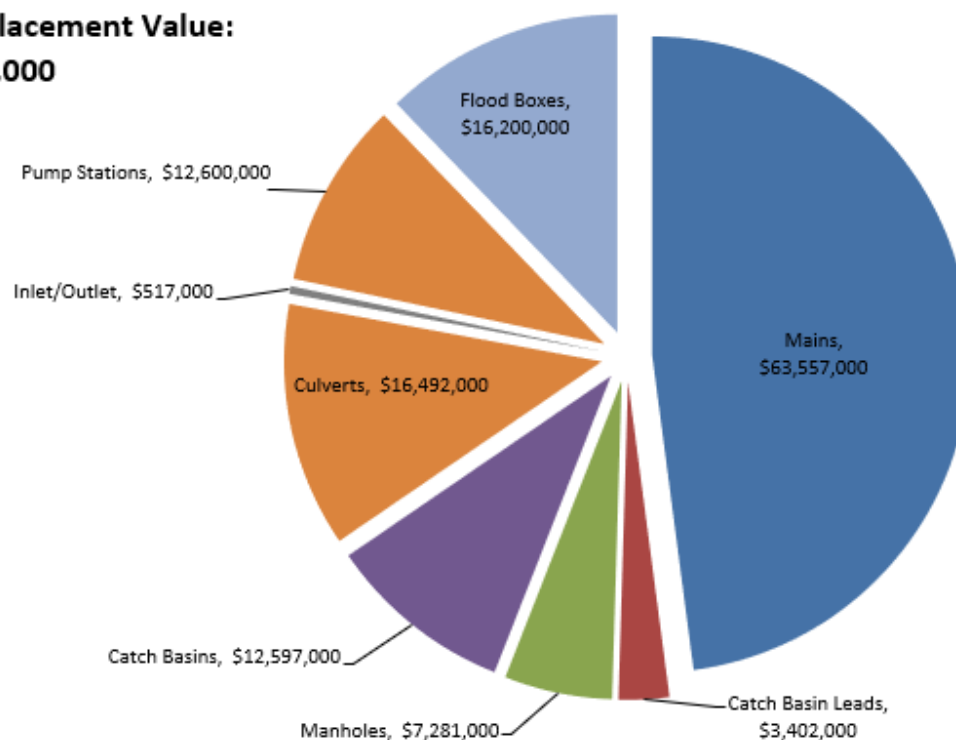


Figure 1 Total Replacement Value for Each Asset Category

The highest-value stormwater asset category is stormwater mains, with 48% of the total replacement value, followed by culverts and flood boxes at 12% each.

The replacement values used in the AMIP and the pie chart above, specifically for underground pipe, assume the most invasive and expensive replacement method of open-cut construction. Rehabilitation methods for underground pipe is challenging to forecast in the current absence of condition information which would be used to evaluate an individual pipe's candidacy for alternative and less expensive rehabilitation methods like pipe relining. Without this information, it is not suitable to apply a universal renewal approach, and therefore the conservative assumption of open-cut construction was used.

3.3 What is the Age of the Assets?

The current age and remaining service life of each asset is impossible to predict from an asset inventory without physical inspection of individual assets. However, typical service lives based on anecdotal information from the District and local industry-standard values were used and are a critical aspect of the AMIP. They are applied to each asset category and material type where necessary to determine timing of overall asset replacement needs based on each asset's installation or renewal date. The service lives applied to each asset are presented in Table 1 below and in the AMIP spreadsheet.



Table 1 Estimated Service Lives

Item	Service Life
Pipe Material	
Asbestos Cement	50
Concrete	50
Cast Iron	50
Corrugated Metal Pipe	60
High Density Polyethylene	80
Polyvinyl Chloride	80
Reinforced Concrete	50
Steel	60
Unknown	30
Assets	
Catch Basin	60
Manhole	60
Lawn Drain	60
Inlet/Outlet/Outfall Structures	60
Flood Boxes	50
Pump Stations	50

Table 2 below summarizes the overall expected remaining life of each asset category based on its overall service life and install or renewal year.

Table 2 Expected Remaining Life for Each Asset Category

Asset Category	Expected Percent Remaining Life	Average Age
Mains	57%	24
Catch Basin Leads	71%	23
Catch Basins	59%	24
Manholes	60%	24
Culverts	47%	35
Inlet/Outlet Structures	50%	29
Pump Stations	37%	37
Flood Boxes	26%	39
Total	51%	

As shown in Table 2, flood boxes and pump stations are the assets that have the least remaining life, with 26% and 37% respectively. This is due to the installation years of assets in these categories, which were typically around 1974 when the Squamish River dike was largely constructed. The highest-value category, stormwater mains, has an overall expected remaining life of 51%.

A key component to understanding the overall age and replacement forecast of the District's assets is the "infrastructure backlog". This represents existing infrastructure that has surpassed its theoretical useful life. As determined through the AMIP, the only asset category with a considerable backlog is stormwater mains, which is not uncommon given the variance in age across thousands of pipes. However, as discussed in the asset ages above, a significant amount of flood box infrastructure, as well as the Galbraith and Centennial pump stations, will be nearing its forecasted replacement in 2024, based on 50 years service lives from 1974. Thus, it is not long before a large value of



infrastructure will be considered backlogged if it is not renewed before the end of its expected service life.

3.4 How Much Money Needs to be Invested Annually?

The AMIP aims to estimate the sustainable funding level: the annual investment that is required to replace the District's existing assets when needed. The two concepts that inform this are the 20-year Asset Replacement Forecast and the Average Annual Life Cycle Investment (AALCI).

The 20-year asset replacement forecast () is a valuable tool to prepare for more immediate infrastructure replacement needs. The District can use this information to identify which assets will soon reach the end of their useful lives, and along with an understanding of risk of failure, the District can plan and prioritize projects and funding to address upcoming needs.



20-Year Asset Replacement Forecast

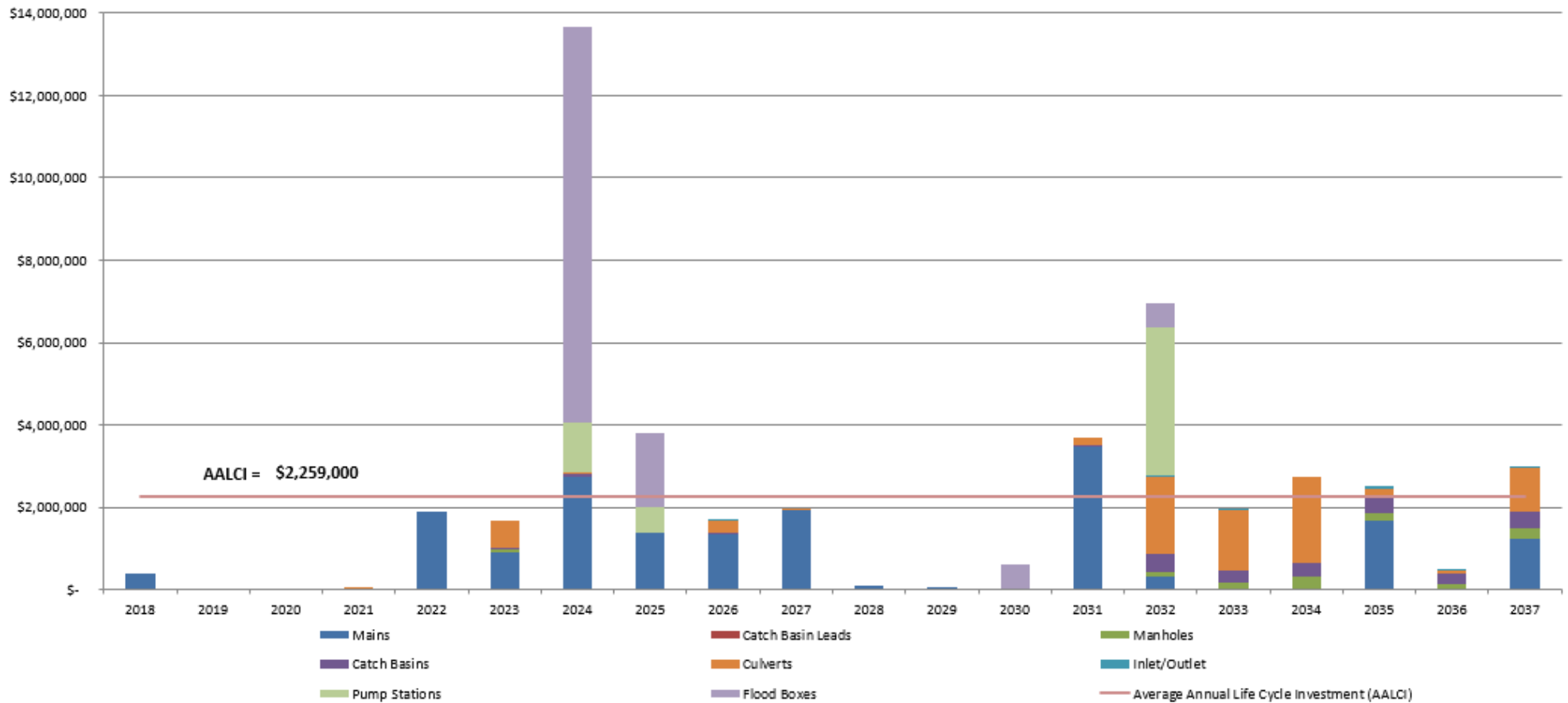


Figure 2 20-Year Asset Replacement Forecast



The 20-year replacement forecast predicts significant replacement needs in the years 2024 and 2032. Similar to the remaining lives, these costs can be attributed to pump stations and flood boxes, many of which were installed with the dike around 1974 (assumed for Galbraith and Centennial pump stations), or subsequently in 1982, and have an estimated service life of 50 years. Note that service lives are an assumed indicator of the asset's condition and replacement timing needs, and not a guaranteed serviceable end date. Older assets will inherently possess a higher probability of inadequate performance or failure. Assessment of past or future conditions assessments could be used to refine service lives, which may be unique to the District due to factors such as geographic location or maintenance practices.

The AALCI is a long-term planning tool that can be used to estimate the ongoing required level of infrastructure investment. This is the conservative funding level for sustaining infrastructure indefinitely and can be used to help ensure that revenue is stable enough to provide consistent support for asset replacement requirements. The AALCI is sensitive to service life changes, so it is important to understand how the investment level could vary based on predicted versus actual years of service. Understanding this sensitivity will help when deciding what investment level is best for the District. The AALCI also assumes replacing "like with like"; it does not consider potential changes in technology or service delivery that could be utilized in the future to adapt to changing circumstances such as climate change, or to better meet servicing needs. For example, the AMIP assumes that all stormwater mains will be replaced with PVC pipe, using open-cut construction. It does not consider other techniques such as cured-in-place pipe lining.

The AALCI for each of Squamish's stormwater asset categories, with service life scenarios, is outlined in Table 3.

Table 3: Average Annual Lifecycle Investment for Each Asset Category

Asset Category	AALCI	AALCI 25% Longer	AALCI 50% Longer
Mains	\$1,024,000	\$819,200	\$682,667
Catch Basin Leads	\$43,000	\$34,400	\$28,667
Catch Basins	\$210,000	\$168,000	\$140,000
Manholes	\$121,000	\$96,800	\$80,667
Culverts	\$276,000	\$220,800	\$184,000
Inlet/Outlet Structures	\$9,000	\$7,200	\$6,000
Pump Stations	\$252,000	\$201,600	\$168,000
Flood Boxes	\$324,000	\$259,200	\$216,000
Total	\$2,259,000	\$1,807,200	\$1,506,000

The majority of the District's AALCI is for replacement needs of mains (45%), flood boxes (14%), and culverts (12%), and the total AALCI for storm assets was estimated to be \$2.3 million.

The District may experience prolonged service from some of its assets, especially those which have already surpassed their useful life but are still functioning (backlogged infrastructure). Assuming that assets will consistently outlast their expected service lives is a risk that may be accepted by the District if it wishes to take a less conservative approach to asset management. The third and fourth columns in Table 3 present an adjusted AALCI based on different levels of risk tolerance in the form of extended service lives, with an AALCI of \$1.8 million if assets last 25% longer than expected, and an AALCI of \$1.5 million if they last 50% longer.



4. Observations & Recommendations

The Asset Management Investment Plan has identified several focus areas within the asset inventory, replacement forecast, and investment requirements of the District's stormwater infrastructure.

Results suggest that the most significant short-term infrastructure needs belong to flood boxes and stormwater mains. This is due to the installation year and useful lives applied to these assets, and the capital that will eventually be required to upgrade or replace them. It should be noted that flood box installation years were generally assumed to be 1974 when the dike was built and were given replacement values based on anecdotal information of a small sample of assets.

On a long-term outlook, the AALCI results suggest that stormwater mains will require the most funding on a continuous basis, at over \$1 million annually assuming unadjusted service lives. To achieve the best results from capital that is allocated to this infrastructure, the District would benefit from an ongoing inspection program to identify specific high-risk mains, culverts, and other storm network infrastructure that should be targeted for renewal or replacement, as well as to refine the service life assumptions used in this assessment.

The iterative process which involves identifying future needs, evaluating assets, and considering the asset replacement forecast will ensure that the AMIP continues to be a valuable tool for asset management decisions.

A complete list of recommendations is as follows:

1. Present a summary of the AMIP results to Council, focusing on key messages.

It is important that Council recognizes the importance of long-term asset management planning, as well as the quantity and value of District infrastructure that is impacted by Council decisions. Key messages to communicate include the following:

- The AALCI of \$2.3M is a conservative estimate of the annual “sustainable funding level” that is required to replace the District's current stormwater assets. It should be viewed as a target, and taxation and/or user fee rates should be structured so that annual funds for replacement of assets move towards this target over time.
- Annual funds should be allocated to projects according to a risk-based 10-year capital plan.
- The AALCI estimated in this AMIP is conservatively based on expected percent remaining life of stormwater assets, not their actual condition (insufficient data was available). As condition data becomes available, the AMIP and the AALCI should be refined. Condition data should also be used to develop the risk-based capital plan.

2. Develop and implement a condition assessment program for stormwater assets to inform refinements to the AALCI and to inform the development of a risk-based capital plan.

It is recommended that the District reviews current inspection practices, and revises or establishes a strategy to identify specific replacement needs.

As shown in the 20-Year Asset Replacement Forecast (Figure 2), there is significant upcoming infrastructure needs belonging to flood boxes, and to a lesser extent, pump stations. This is



due to the installation year and useful lives applied to these assets, and the capital that will be required to upgrade or replace them. Results are based on several assumptions such as installation years of 1974 when the dike was built (assumed for Galbraith and Centennial pump stations) and are subject to change depending on the true condition of individual assets. To obtain a better understanding of this infrastructure, it is recommended that the condition of pump station and flood boxes be evaluated in the near future.

The 20-Year Asset Replacement Forecast suggests a continuous need for main and culvert replacements, with mains generally occurring ahead of culverts. The 20-year total replacement values are \$17.5 million for mains and \$8.0 million for culverts, which combine for a value of \$25.5 million. Closer assessment of this infrastructure, such as through CCTV inspection, would help the District prioritize future replacement projects. Other storm network infrastructure such as catch basins, catch basin leads, and manholes should also be inspected simultaneously, but are not forecasted to have immediate replacement needs.

This District currently follows a sanitary sewer CCTV program in which 10 catchments are CCTV inspected on a 10-year cycle (10% completed per year). Conducting storm sewer inspection concurrently, or through a similar program, may present cost saving opportunities when inspection, maintenance, or replacement projects are interconnected. However, the District should remain vigilant to, and address more isolated issues that may arise outside of the planned inspection cycle.

3. Refine the AALCI over time by:

- **Adjusting the expected percent remaining life based on actual condition assessments**
- **Adjusting the assumed useful life of assets based on the District's experience with various materials locally**
- **Adjusting replacement timing based on risk tolerance**
- **Investigating alternative methods/technologies for asset renewal or replacement.**

The total AALCI of \$2.3 million is considered the conservative funding target for long-term sustainability of the District's current storm water assets. Adjusted AALCIs of \$1.8 million and \$1.5 million may be considered at higher risk to the District, if assets were to collectively provide service 25% or 50% longer, respectively. This is just to meet current service levels. The District should work towards refining the AALCI over time by using a risk assessment process that would inform potential for deferral of replacement for lower-risk assets. The AALCI could also be refined through the investigation and piloting of less invasive and expensive rehabilitation methods such as pipe/culvert relining.

4. Update the AMIP as ISMPs are developed and regularly thereafter to capture new assets that have been acquired by the District and to reflect refinements to the process of estimating the AALCI.

The AMIP is not a "fixed" plan – it is a tool used to estimate and communicate long-term funding requirements to replace existing infrastructure. Therefore, it should be updated annually as part of one of the District's regular asset management processes. The update should reflect new assets that have been added to the District's inventory (either through acquisition or by filling gaps in the inventory), and should include refinements to the AALCI as described above.



5. **Make decisions about taxation rates and/or user fees, and about the allocation of funds for stormwater, with consideration for the broader funding needs for all types of assets.**

A funding review was conducted as part of this project, the results of which are provided under separate cover. However, it is worth noting in the context of the AMIP that the setting of taxation and/or user fee rates for stormwater, and the allocation of funding for stormwater, should be considered in the broader context of the District's funding needs for all types of assets.

Appendix D: Stormwater Natural Assets Valuation

DISTRICT OF SQUAMISH INTEGRATED STORMWATER
MANAGEMENT PLAN – PHASE 1

FINAL REPORT – April 10, 2019



Integrated Stormwater Service Delivery Natural Assets Valuation



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1. INTRODUCTION

Context and Scope

This report summarizes the results of an initial high-level district-wide inventory and valuation of natural assets within the District of Squamish. This work is part of the District's Integrated Stormwater Management Plan (ISMP) – Phase I, and therefore focuses on natural assets that provide services in stormwater management. Future development is one of the primary risks to the performance of natural assets. This work will support the District in creating and evaluating strategies that enable development while meeting the “no net loss” objective of ISMPs.

The intent of this preliminary work is to begin to raise awareness of the value of services provided by natural assets within the District, and to inform an approach for further in-depth consideration of natural assets within catchment specific ISMPs. Although the analysis is high-level, it provides a framework for the approach for more detailed analysis that may be conducted in the future. In addition to using this information in integrated stormwater management planning, it should also be used to inform decisions about land use, development, and servicing.

The District may also consider using this approach to develop an initial inventory and valuation of natural assets that provide services beyond stormwater management, such as water treatment or carbon storage.

Role of Natural Assets in Core Service Delivery

Natural assets are the naturally occurring resources and ecosystems that provide services that are critical to the functioning of our communities. They provide services such as clean air, habitat, climate regulation, water treatment, pollination, recreation, and more. Communities have always intuitively understood the importance of these natural systems, but only in recent years have local governments begun efforts to understand and manage these systems as assets that deliver core services¹.

Natural assets provide core local government services, such as water storage, treatment, rainwater attenuation, and flood protection. Without the natural assets that provide these core services, local governments would require other means to deliver the service – typically relying on engineered infrastructure. Increased reliance on engineered infrastructure in the place of natural assets can lead to higher ongoing costs that include construction, operations, maintenance, renewal, and replacement of infrastructure at end of life. In some cases, engineered infrastructure may also lead to reduced community resilience, as natural assets can be more resilient to wide ranges of loads (for example, precipitation volume and intensities changing with climate change) than engineered infrastructure².

The role of natural assets in providing community resilience is particularly relevant to the District, as the community is vulnerable to a high number of natural hazards such as coastal storm surges, high

¹ For further information on natural assets, refer to resources prepared by the Municipal Natural Asset Initiative, www.mnai.ca.

² Pilot studies conducted by the Municipal Natural Asset Initiative found that the value of services provided by natural assets often increased in a climate change scenario.



flows that breach the dikes, and debris flows. By fully understanding the role of natural assets in core service delivery, risks to these services can be identified and managed to minimize costs and maintaining or enhancing community resilience. The Insurance Bureau of Canada released a report in 2018³ that emphasized that natural assets have a prominent role in flood protection and management. The report states: “As a general “rule of thumb”, in order of preference, the most cost-effective means to mitigate flood losses utilizing natural systems is to:

- (i) retain what you have;
- (ii) restore what you’ve lost;
- (iii) build what you must.”

Strategies and approaches for managing risk include: integrating natural assets within ongoing asset management processes, designating land use and structuring development in ways that maintain natural asset services, shifting land ownership to protect natural assets, providing incentives for private property owners and members of the public to maintain or protect natural assets, monitoring natural assets, running public education programs, and restoration or enhancement projects.

The objectives of managing risks to natural assets are to maintain the important services that natural assets provide, ultimately reducing lifecycle costs, maintaining community resilience, and achieving both development and environmental objectives.

³ Moudrak, N., Feltmate, B., Venema, H., Osman, H. 2018. Combating Canada’s Rising Flood Costs: Natural infrastructure is an underutilized option. Prepared for Insurance Bureau of Canada. Intact Centre on Climate Adaptation, University of Waterloo.



2. PROCESS

Described below is the process that was used to prepare the initial inventory and valuation. This is the same process that can be applied at a smaller scale using more in-depth analysis. Further information about the inventory and valuation methods are in the following section.

1. Identify types of natural assets to be considered.

This project focused on assets that provided services in managing the quality, quantity, and flows of stormwater.

2. Determine the type of services provided by the natural asset, and the quantity of each service.

Services identified should include core municipal services (i.e. services that the local government would need to replace with engineered infrastructure) as well as an acknowledgement of other services that the natural asset provides (i.e. services such as pollination). Determining the quantity of each service will require quantification of the natural assets in a way that relates to the services it provides. For example, the rainwater attenuation services of a forest are related to the area of the forest, so the quantity of the forest is determined in hectares which can be used to estimate the quantity of rainwater attenuation provided by that forest.

3. Identify risks to natural assets.

Managing natural assets requires understanding the primary risks to the natural asset. These may include risks such as development, contamination, or depletion of the asset. Natural risks such as forest fires should also be considered. This project focused on risks related to watershed health and land use.

4. Determine the engineered assets that would be required to provide that service if the natural asset was no longer able to provide it.

The type and capacity of engineered assets required to replace the services provided by a natural asset will depend on attributes of the specific natural asset. Natural asset valuations that are performed on a catchment or site-specific level should assess the engineered infrastructure required to replace the loss of the specific natural asset. This project used assumptions about general impacts to estimate the value on a district-wide basis.

5. Estimate the cost of providing the required engineered assets.

The estimated cost of providing engineered asset replacement serves as a proxy for the value of the service from the natural asset.



3. RESULTS

Inventory

This project focused on natural assets that play a significant role in stormwater management services: wetlands, forests, and creeks.

The District's available geospatial information about environmentally sensitive areas was used to identify the quantity of each of these natural assets within the District's boundaries. The Official Community Plan was used to identify quantities of these natural assets in three different general land use types: currently developed area, greenway and limited use, and other (i.e. currently undeveloped but designated in an area with the potential for development). Land use types were separated for each of the natural assets because each of these areas may have different potential hazards and risk ratings.

Note that although this project focused on stormwater management services, the additional services provided by the natural asset have also been identified for consideration.

Table 1. Inventory of natural assets providing stormwater management services

Natural Asset Type	Quantity	Unit	Stormwater Services Provided	Other core services provided	Risks to service delivery
WETLAND					
Undeveloped, urban area potential for future development	36.2	ha	<ul style="list-style-type: none"> Rainwater attenuation (flood protection and erosion prevention) Stormwater quality treatment 	<ul style="list-style-type: none"> Groundwater flow recharge Climate regulation (carbon storage) Temperature regulation Habitat Recreation Resilience to climate change (changes in precipitation) 	Development
Parks, greenway or limited use	220.1	ha			Natural hazards
TOTAL	256.3	ha			
FOREST					
Undeveloped, Urban area potential for future development	3,008.8	ha	<ul style="list-style-type: none"> Rainwater attenuation, evapotranspiration, infiltration (flood protection and erosion prevention) 	<ul style="list-style-type: none"> Water filtration Groundwater flow recharge Climate regulation (carbon storage) Temperature regulation Air quality Habitat Recreation Tourism Pollination Resilience to climate change (precipitation and increased temperatures) 	Development, natural hazards
Parks, greenway or limited use	11,571.7	ha			Natural hazards (forest fire, invasive species/pests, slides)
TOTAL	14,580.5	ha			



Natural Asset Type	Quantity	Unit	Stormwater Services Provided	Other core services provided	Risks to service delivery
CREEKS					
Creeks (does not include Squamish, Mamquam, Stawamus, Cheekye, Cheakamus Rivers)	116,825	m	<ul style="list-style-type: none">• Rainwater conveyance• Flood protection	<ul style="list-style-type: none">• Habitat• Recreation• Tourism• Temperature regulation• Resilience to climate change (precipitation and increased temperatures)	Natural hazards, development within creekshed
TOTAL	116,825	m			

Valuation

Replacement value method was selected to estimate the financial value of the natural asset. In this method, the value of the service provided by the asset is estimated as the cost of replacing the service with an engineered infrastructure alternative⁴.

There is no single 'right' way of assigning a financial value to nature's services, so it is important to understand the limitations of whatever method is selected and ensure that method aligns with the types of decisions it may inform. In this study, the financial valuation is focused on the provision of stormwater management services. It does not consider the full value of broader ecosystem services, such as habitat, pollination, or carbon storage - or even full value of municipal services (such as drinking water treatment and storage). For example, within this project, forest has been valued for its ability to attenuate rainwater (a stormwater service) but not for the value it provides in providing clean water (drinking water service).

Results of the valuation are provided in Table 2. Assumptions made in the process are summarized following the table.

⁴ Further information about options and approaches for valuation of natural assets can be found in TEEB - The Economics of Ecosystems and Biodiversity for Local and Regional Policy Makers (2010),



Table 2. Value of stormwater services provided by natural assets

Natural Asset Type	Quantity	Unit	Engineered Replacement for Stormwater Services	Cost	Unit	Total Replacement Value
WETLAND						
Undeveloped, urban area potential for future development	36.2	ha	storage and water treatment capacity (assume 0.2m deep of storage in wetland areas).	\$150	\$/m3 for storage capacity services	\$10,920,000
Parks, greenway or limited use	220.1	ha		\$1,503	\$/ha for water treatment services	\$66,360,000
TOTAL	256.3	ha				\$ 77,280,000
FOREST						
Undeveloped, Urban area potential for future development	3,008.8	ha	on-site storage, controls, and conveyance system from downstream site of forest block	\$3,952	\$/ha	\$ 11,890,000
Parks, greenway or limited use	11,571.7	ha				\$45,730,000
TOTAL	14,580.5	ha				\$ 57,620,000
CREEKS						
Creeks (does not include Squamish, Mamquam, Stawamus, Cheekye, Cheakamus Rivers)	116,825	m	conveyance structure (assume 1050mm pipe)	\$2	m*mm	
TOTAL	116,825	m				\$245,330,000
TOTAL VALUE OF SERVICES						\$380.2 million
TOTAL VALUE OF SERVICES IN AREAS WITH POTENTIAL DEVELOPMENT IMPACTS						\$22.8 million



Summary

The total value of stormwater management services provided by wetlands, forests, and creeks is estimated at over \$380 million. However, in the context of managing significant risks to these services, it can be helpful to focus on the value of services provided by natural assets in areas that may experience development. The value of these services is over \$22 million. As discussed previously, this value underestimates the true value of these natural assets as it does not account for full lifecycle costs of built replacement infrastructure, the other municipal services these natural assets may provide (e.g. water treatment and aquifer recharge from forests), or the additional services such as recreation, habitat, pollination, air quality, temperature regulation, carbon storage, and others.

In catchment specific ISMPs, it would be helpful to further refine this analysis by considering specifics such as: the location of natural assets, the quantity of services that are provided by them, and the risks to natural assets (i.e. local land development plans or scenarios).

Assumptions and References

Several general assumptions were made to develop the inventory valuation:

- All individual areas of a natural asset type (e.g. forest, wetland, etc.) provide the same quantity of services per unit, regardless of location. In reality, each individual wetland or forest block will provide different quantities of services based on location, local hydrology, and integration with the existing drainage system.
- Site specific geographical features are not considered (e.g. slopes, ground conditions, depth of various wetland areas, specific type of forest, etc.).
- The impacts of losing natural assets on the downstream existing conveyance system were not considered.
- For valuation purposes, due to information availability, it was assumed that natural asset services would be provided by engineered infrastructure rather than through attempts to mimic natural functions through green infrastructure.

For wetland valuation:

- It was assumed that all wetland areas provide approximately 0.2m depth of storage as well as treatment capacity. Total value is the sum of the storage and treatment services. \$150/m³ is based on recent contract costs for engineered storage capacity. Unit cost for treatment referenced from "Natural Capital in BC's Lower Mainland: Valuing the benefits from nature" by the David Suzuki Foundation and Sara Wilson for the Pacific Parklands Foundation, 2010. Reported value of \$1,283 per ha has been adjusted for 2% annual inflation. Final dollar values have been rounded.

For forest valuation:

- Unit cost referenced from "Natural Capital in BC's Lower Mainland: Valuing the benefits from nature" by the David Suzuki Foundation and Sara Wilson for the Pacific Parklands Foundation, 2010. Reported value of \$1,502/ha reflects a unit cost of constructed storage of \$57/m³ and



has been adjusted to reflect a constructed storage cost of \$150/m³ (\$3,952/ha). Reported value is based on 2yr, 24hr rainfall. Final dollar values are rounded.

For creek valuation:

- It was assumed that a standard size conveyance structure is required for all creeks (1050mm pipe). \$2 per mm m is based on recent estimates for design and construction only, does not include lifecycle costs. Final dollar values are rounded.



4. CONNECTIONS TO PLANNING AND DECISION-MAKING PROCESSES

Process of Integrating Natural Asset Management in Catchment-Specific ISMPs

Natural asset inventories and valuations should be further detailed where there are potential risks to specific natural assets. This analysis can be part of a catchment specific ISMP.

The first task in integrating the management of natural assets in catchment specific ISMPs is to clearly define the objective of the ISMP. What specific decisions will the ISMP be informing? If these decisions may impact the performance of natural assets, proceed with further analysis of discrete natural assets within the catchment.

The process steps for integrating natural assets with an ISMP are the same general steps that were used in this project, but to a finer degree of detail. The steps are:

1. Identify discrete major natural assets within the catchment and the services provided by these assets.
2. Estimate the quantity of each of the services provided by these natural assets.
3. Identify risks to specific natural assets within the catchment (development, environmental spills, loss of forest, climate change, etc.).
4. Determine the value of engineered infrastructure that would be required to replace the service provided by each natural asset. This should include site specific considerations and impacts on downstream existing infrastructure systems.
5. Once the value of the discrete natural asset has been determined by applying replacement method, use this information to evaluate scenarios that achieve the no-net-loss objective for watershed health, including land development and servicing scenarios.

These steps are included in the District's ISMP Terms of Reference (TOR) and Process Guide.

Using Natural Asset Values to Inform Other Plans and Decisions

Beyond integration in integrated stormwater management planning, there are several places where natural assets can be integrated into planning and decision making:

1. Recognize the significance, role and function of natural assets in the Official Community Plan (OCP). Through the OCP, provide terms of reference for Area Plans and Neighbourhood Plans that include consideration of natural assets.
2. Ensure that specific Area Plans and Neighbourhood Plans are informed by an understanding of the current role of natural assets and how development may impact the services provided by natural assets. Through area planning, consider scenarios that preserve the function of significant natural assets, reducing overall costs to the District and maintaining community



resilience. An example of an approach that may preserve natural asset function and development objectives is density transfer.

3. Include natural assets in the overall asset management process (asset management policy, strategy, and plans), to inform decisions about the construction, renewal, and maintenance of existing engineered assets and new ones.
4. Implement protection strategies for natural assets, throughout land use planning and acquisition strategies, partnerships with neighbouring jurisdictions, private property incentives, operations and maintenance activities, and capital projects.

Appendix E: ISMP Terms of Reference and Process Guide

DISTRICT OF SQUAMISH INTEGRATED STORMWATER
MANAGEMENT PLAN – PHASE 1

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Integrated Stormwater Service Delivery ISMP Terms of Reference and Process Guide



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1.INTRODUCTION

The District of Squamish (the District) strives to continuously improve in asset management and integrated stormwater management. This will allow the District to sustainably provide stormwater services to the community, and protect public property, the environment, and public safety as the community develops.

To support these improvement goals, the District will be developing and implementing Integrated Stormwater Management Plans (ISMPs) in priority watersheds over the coming years. This document provides an overview of ISMPs, outlines the desired outcomes of the District's ISMPs, and provides guidance on the process to develop them. It is meant to support the District in developing specific terms of reference / requests for proposal (RFPs) for each of its ISMPs.



2.OVERVIEW OF INTEGRATED STORMWATER MANAGEMENT PLANS

What They Are

Integrated Stormwater Management Plans (ISMPs) comprehensively explore the strategic linkages and needs of environment, land use, and infrastructure. They lay out a pathway for the District to achieve the community's vision and service goals through improvements in stormwater management practices, including policies and regulations, capital projects, operations, monitoring and reporting, and funding. They will help the District balance competing objectives around community development, flood protection, and environmental protection and enhancement. ISMPs will be used by the District as part of its broader efforts to improve stormwater service delivery.

In terms of study area, ISMPs are developed at a watershed level so that issues and opportunities that affect the community and the environment can be assessed holistically. ISMPs are not required in all watersheds – they are typically developed for a single watershed or grouping of watersheds in which the combination of existing issues and development pressures warrants a comprehensive, integrated plan to address them. ISMPs will supersede older Master Drainage Plans (MDPs) in the study areas. Planning in areas in which isolated issues exist and/or in which development pressures are limited can often be guided by more focused solutions such as a MDP, site assessment, feasibility study, or other appropriate solution.

How They Will Be Used at the District

ISMPs are truly integrated in nature and therefore will be used by numerous departments at the District to improve service delivery:

- **Engineering** will use ISMPs to determine capital planning requirements. Staff will also use them to assist with development reviews of available stormwater infrastructure capacity and to determine the stormwater management practices that are required of developers in specific watersheds.
- **Public Works** will use ISMPs to identify critical infrastructure requiring attention in terms of operations and maintenance, and to inform improvements to the District's O&M practices.
- **Environment** will use ISMPs to inform environmental planning and development reviews, and to identify opportunities for environmental improvement for which they will lead implementation.
- **Planning** will use ISMPs as a reference document to note any outstanding issues that may impact planning/land use decisions in specific watersheds. They will identify specific corridors or rights of way that should be preserved or secured through the zoning, development, or subdivision process. ISMPs may also identify unique land use policy or criteria.
- **Finance**, in coordination with the other departments, will use ISMPs to inform potential updates to user fees, taxation, and development cost charges (DCCs) to recover the cost of



necessary improvements to stormwater service delivery. ISMPs will also be referenced as part of the annual budgeting process.

Linkages to the District's Stormwater Level of Service Framework

The District has a Stormwater Level of Service (LOS) Framework. The LOS Framework outlines the following stormwater service goals that describe what customers can expect in terms of service delivery by the District:

- **Service Goal #1:** Public stormwater management practices should not result in negative impacts to private property.
- **Service Goal #2:** Nuisance flooding in backyards and low-lying areas is expected for minor rain events if it is generated on-site.
- **Service Goal #3:** New developments should mitigate on-site and off-site impacts of runoff.
- **Service Goal #4:** Public property may be used as a floodway or storage for major storm events as appropriate.
- **Service Goal #5:** Public and private stormwater management practices should minimize negative impacts to water quality, water quantity, and ecosystem health on a watershed basis, relative to current conditions.
- **Service Goal #6:** The District should meet all Federal and Provincial regulations and guidelines for environmental protection.
- **Service Goal #7:** Drainage infrastructure is appropriately maintained for its intended function.
- **Service Goal #8:** District staff will be available to respond to stormwater management issues on a priority basis.
- **Service Goal #9:** Residents are aware of what to expect in terms of stormwater levels of service.
- **Service Goal #10:** Residents know what they can do to help.

These are the overarching goals that guide stormwater service delivery at the District, and therefore also guide integrated stormwater management planning. The LOS Framework further outlines indicators (parameters) for each of the goals that can be measured and used to quantify current LOS in specific watersheds, to set targets for service in specific watersheds, and to track progress over time.

ISMPs will be the primary tool for setting stormwater service goals and specific targets in each watershed. ISMPs will also describe how service goals will be achieved through policies and regulations, capital projects, operations, and ongoing monitoring and adaptive management.



Linkages to the District's Environmental Monitoring Program

The District is developing an Environmental Monitoring Program (EMP). The EMP outlines the scope of environmental monitoring that the District will carry out to quantify current LOS, to set targets, and to track progress regarding service goals #5 and #6 specifically, which relate to environmental protection. The EMP provides a framework for the monitoring locations, parameters, and frequency that will be undertaken by the District.

ISMPs aim to answer certain questions such as “what are current conditions?” and “what are the potential impacts of development?” The answer to these questions will be informed in part through data collected through the EMP. The EMP is therefore an important component of the District's overall approach to integrated stormwater management planning and service delivery.

Linkages to the District's Asset Management Investment Plan

The District will be developing an Asset Management Investment Plan (AMIP) for stormwater assets through Phase 1 of the ISMP process (to be completed by November 2018). The AMIP will answer the following key questions:

- What assets does the District own?
- What is the cost to replace these assets?
- What is the age of the assets and what is the estimated remaining service life?
- How much money needs to be invested annually to replace the District's assets?

ISMPs will outline recommendations for such things as upgrades to capital assets and changes in operational activities, which would impact the District's asset inventory and ultimately the long-term cost of stormwater service delivery. Therefore, the ISMPs will speak to impacts on the District's AMIP and will provide direction on what to update in the AMIP financial model so that the AMIP remains up-to-date and useful to the District.

Linkages to the District's Integrated Flood Hazard Management Plan

The District's Integrated Flood Hazard Management Plan (IFHMP) identifies community-supported options for flood risk management while promoting sustainable development opportunities. The IFHMP carried out hazard and consequence assessments for the community's most important flood risk areas. The IFHMP modelled floods on local rivers and identified areas that may be at risk from river flooding and identified options for mitigating the risks.

The IFHMP focused on the impacts of river flooding and coastal hazards, but not on the contribution of urban stormwater flows and groundwater to potential flood scenarios. The role of ISMPs is to address urban stormwater impacts. In this way, ISMPs should consider and complement, but not replace, the District's IFHMP.



3. DESIRED OUTCOMES

Desired Outcomes of Planning Process

The District aims to develop ISMPs that are practical and achievable, and that help achieve the District's stormwater service goals. Therefore, the following are the District's desired outcomes of the ISMP planning processes:

- An understanding of current watershed conditions and watershed health, and the hydrologic/hydraulic performance of the District's stormwater system.
- An understanding of the potential unmitigated impacts of climate change and future land use conditions on system performance and watershed health.
- Targets for stormwater service goals in each watershed that are suitable for the conditions.
- A plan to achieve the District's stormwater service goals and to address the current and future unmitigated issues related to stormwater system capacity, stream flows, water quality, and watershed health. The plan is to include:
 - **Recommendations for new and upgraded capital stormwater infrastructure projects over a 20-year period**, with Class D cost estimates, to manage both frequent and infrequent, extreme storm events. The plan must be prioritized based on level of risk the issue presents to public and private property, the environment, and the sustainability of District finances.
 - **Establishment of clear, implementable stormwater management requirements for developers.** Recommendations must be enforceable by the District, and be suitable to the unique conditions of each watershed. Stormwater requirements should be firm but flexible enough so that if site-specific conditions, such as infiltration rates, vary from those assumed in the ISMP, the overarching service goals can still be met. Requirements should be very clear for developers as to what they need to do to rezone, subdivide and get development/building permits. Guidelines should be easy to understand and minimize different interpretations by different parties.
 - Recommendations for improvements to District O&M practices.
 - **Recommendations for education and outreach** with stakeholders, and joint activities with community groups and other authorities
 - **Recommendations for implementation of measures to enhance watershed health** (i.e., that go beyond the District's basic stormwater service goals of minimizing impacts to the environment). This includes such things as recommendations for restoration of aquatic habitat.

All recommendations in the ISMP must:

- Be clearly defined and include clear rationale and a statement of the service goals they help achieve



- Account for projected changes in precipitation due to climate change, and include full consideration of impacts to the District's stormwater asset management plan and municipal budgets
- Include a game plan for how they should be implemented, including phasing if needed.

Section 4 provides details on the planning process, and what to include in the scope of the ISMPs.

Major Deliverables

The following are the major deliverables that are to come from each ISMP planning process:

- Current Conditions and Issues Report
- Future Conditions and Unmitigated Issues Report
- Management Options Report
- Prioritized capital plan
- Final ISMP as a succinct, executive summary-style document summarizing the previous components
- Monitoring and Adaptive Management Plan
- A one- to two-page summary for developers, including guidelines for requirements in the watershed(s)



4. PLANNING PROCESS

The following sections provide guidance on how to achieve the desired outcomes of the ISMP planning process previously described.

General

General Process

The following questions should be answered through the process to develop the ISMP:

- What are current conditions and issues regarding stormwater system performance and the environment?
- What are potential future conditions (including climate change, growth, and ongoing deterioration of assets), and what may be the unmitigated impacts of those conditions to system performance and the environment?
- What are the potential management options to address current and future issues, and what is the preferred option based on an assessment of the costs and benefits?
- What are the specific targets for service in the watershed and what plan will the District implement to achieve them?
- How will the District monitor implementation of the ISMP and progress towards goals?

Project Team

Because ISMPs will be used by numerous departments, the planning process will be led by a dedicated project leader (likely from Engineering) and a project steering committee involving representation from Public Works, Planning, Environment, and Finance. Communications staff will be engaged at key points as well to advise on how external stakeholders are involved.

First Nations Involvement

The District of Squamish is located within the unceded traditional territory of Squamish Nation. Squamish Nation should therefore be involved in the ISMP planning process on a government-to-government basis with the District.

The District will invite Squamish Nation to be involved in planning each ISMP; the engagement process that is carried out will ultimately depend on how Squamish Nation chooses to participate. For budgeting purposes, the District should assume that up to three meetings will take place with Squamish Nation through the planning process.

External Stakeholder Involvement

Stakeholders are the individuals and groups that have an interest in, and may be impacted by, the outcomes of the ISMP planning process. They should therefore be involved in some way in the planning process.



External stakeholders (including, but not limited to, the general public, developers, environmental stewardship groups, resident associations, and recreational groups) should be involved at an “inform” level on the International Association of Public Participation (IAP2) participation spectrum. For budgeting purposes, the District should assume that an online survey and two stakeholder workshops will be part of the planning process.

Council Involvement

Council will ultimately decide whether to endorse or adopt the ISMP and to approve the budget required to do so, which will have significant implications on staff ability to implement the ISMPs. Therefore, Council should be involved at key points in the process to develop the ISMPs. For the purpose of budgeting, at least one presentation to Council should be included in the process to develop the ISMP. Depending on the extent to which Council prefers to inform such plans, some communities include a representative from Council on the project steering committee and/or in stakeholder workshops.

Duration

Numerous variables will impact the time it takes to develop an ISMP, including staff availability, other planning processes, First Nation and stakeholder availability, and availability of data. However, in general, the process to develop an ISMP is typically 12-18 months.

Cost

The cost of an ISMP ultimately depends on its unique scope, and particularly the extent of technical analysis, field work, and degree to which stakeholders are engaged. It is also influenced by the level of detail the District seeks in terms of cost estimates for capital project recommendations. ISMPs typically range between \$150,000 and \$300,000 to complete, including monitoring. For planning purposes, we suggest budgeting \$200,000 each.

Available Background Information

The following datasets, studies, and background information are available to support each ISMP planning process. Each ISMP TOR should reference only relevant documents/information.

- All documents developed as part of the ISMP Phase 1 (Urban Systems, 2018/2019)
- Brackendale Master Drainage Plan (Kerr Wood Leidal, 1992)
- Central Squamish Drainage Study (Steffen, Robertson, and Kirsten, 1995)
- Integrated Flood Hazard Management Plan (KWL et. al, 2017)
- Mamquam Blind Channel Rewatering Design (Hay & Company, 2001)
- Master Drainage Plan for Garibaldi (Kerr Wood Leidal, 1994)
- National Water and Wastewater Benchmarking Initiative Report (AECOM, 2016)
- Optimization of the 3rd Avenue Tide Gate Operations (TetraTech EBA, 2014)
- Performance of Drainage Pump Stations in October 2003 Flood (Draft Report) (Kerr Wood Leidal, 2005)



- Squamish Downtown Drainage Study (Hay & Company, 2004)
- Squamish Industrial Park – Development of Stormwater Management Strategy (Phase 2 Draft Report) (Kerr Wood Leidal, 2005)
- Stawamus River and Mashiter Creek Watershed Assessment (Kathy M. Baur, 1994)
- Stormwater asset inventory (GIS database and as-builts)
- Watercourse Mapping and Classification
- LiDAR
- Orthophotograph
- Historical aerial photographs from 1999, 2005, 2009, 2013, and 2016
- Customer complaints logs

Assessment of Current Conditions

Objective:

- Understand current conditions in the study area, including land use, stormwater system performance, watershed health, and related issues

Key Technical Activities:

- Review background information (desktop)
- Capacity assessment of the stormwater network using hydrologic/hydraulic modelling
- Conduct field assessments
- Characterize and summarize current conditions and issues

Additional notes:

- The inventory of available information should include:
 - Current land use
 - Soil and groundwater conditions
 - Detailed inventory of infrastructure systems
 - Asset (infrastructure) condition
 - Inventory and valuation of natural assets
 - Capacity deficiencies or issues with system performance
 - Indicators of watershed health as defined in the District's EMP



- At a minimum, the hydrologic/hydraulic analysis should be conducted to assess the performance of the stormwater system under the following design events:
 - 1:100-year events for pump stations and the major system
 - 1:10 year events for conveyance capacity in the minor system
 - Where stream erosion or impact to summer groundwater baseflow are of concern, continuous simulation with groundwater analysis may be warranted.
- Each ISMP should provide further investigation into watershed-specific issues that were documented in the Stormwater Service Delivery Baseline Assessment that was conducted as part of the Phase 1 ISMP process (Urban Systems, 2018)

Key Outputs:

- Draft and final Current Conditions and Issues Report

Assessment of Future Conditions and Unmitigated Issues

Objective:

- Understand future conditions in the study area, including land use, stormwater system performance, watershed health, and related issues

Key Technical Activities:

- Future capacity assessment of the stormwater network using hydrologic/hydraulic modelling, accounting for impacts of climate change and land use
- Characterize future conditions and issues

Additional notes:

- The future conditions assessment should consider the following:
 - Future land use, based on the District's Land Use Plan, applicable Area Plans and/or Sub-Area Plans, and active development applications
 - Climate change projections (precipitation, temperature, sea level rise)
 - Capacity deficiencies or issues with system performance
 - Impacts of land use changes and climate change on the indicators of watershed health as defined in the District's EMP
 - Risks to natural assets
- The hydrologic/hydraulic analysis should be conducted to assess the performance of the stormwater system under the same design events that were applied in the assessment of current conditions, but both with and without an allowance for climate change



- Where stream erosion may be an issue, conduct flow-exceedance-frequency, or Stream Erosion Index (SEI), analysis

Key Outputs:

- Draft and final Future Conditions and Unmitigated Issues Report

Evaluation of Management Options and Trade-Offs

Objectives:

- Identify the specific targets for service to be achieved in each watershed and the preferred option(s) to achieve them and to address the current and future unmitigated issues

Key Technical Activities:

- Identify potential options to address the current and future issues identified and to achieve watershed-specific targets for stormwater service
- Analyze the stormwater management options to determine their expected impacts
- Evaluate the costs, benefits, and trade-offs between the potential options
- Affirm issues to be addressed
- Identify the District's capacity for change and implementation
- Review implementation funding mechanisms
- Identify the preferred option and the watershed-specific targets to be achieved for each service goal through that approach

Note that for efficiency, the analysis of options to determine their expected impacts on system performance and watershed health may be done along with the Future Conditions Assessment by including "future stormwater controls" in the analysis.

Key Outputs:

- Draft and final Management Options Report

Integrated Stormwater Management Plan

Objectives:

- Determine priorities
- Outline the 20-year plan to achieve the watershed-specific targets for service and to address current and future issues.
- Develop plan to monitor implementation of the ISMP and progress towards goals



Key Technical Activities:

- Identify division of responsibility between the District and land owners / developers.
- Present the 20-year capital plan in 5-year increments
- Specify tailored policy or criteria that should be included in the Subdivision and Development Control Bylaw
- Prepare stormwater management guidelines for developers to support interpretation of policy/criteria
- Summarize recommendations for education and outreach, and additional measures to improve/enhance watershed health
- Prepare monitoring and adaptive management plan
- Specify funding strategy

Key Outputs:

- Draft and final ISMP, including capital plan
- Draft and final monitoring and adaptive management plan
- Draft and final summary for developers
- Presentation to staff and Council

Guidance on Considering Natural Assets Through ISMPs

From the Stormwater Natural Assets Valuation (Urban Systems, 2019):

1. Identify discrete major natural assets within the catchment and the services provided by these assets.
2. Estimate the quantity of each of the services provided by these natural assets.
3. Identify risks to specific natural assets within the catchment (development, environmental spills, loss of forest, climate change, etc.).
4. Determine the value of engineered infrastructure that would be required to replace the service provided by each natural asset. This should include site specific considerations and impacts on downstream existing infrastructure systems.
5. Once the value of the discrete natural asset has been determined by applying replacement method, use this information to evaluate scenarios that achieve the no-net-loss objective for watershed health, including land development and servicing scenarios.



6.IMPLEMENTING THE PLANS

Common Implementation Challenges

Many communities struggle with implementation of their ISMPs for a variety of reasons, such as:

- The ISMP is not affordable for the community
- Phasing of projects and other management strategies is unclear
- Division of responsibilities is unclear
- Management strategies do not get translated into actual policies and bylaws
- Staff and/or developers are unclear of what is required
- Staff do not enforce policies and bylaws

Ongoing Actions to Support Implementation

If the District follows the general outline and process that is described above, many of these challenges should be avoided. Additionally, it is essential that everyone within the District who will use the ISMP to inform their decisions is *actively involved* in developing the ISMP.

Additionally, to support implementation, ISMPs should be reviewed as part of the following regular organizational processes:

- The District's annual capital planning and budgeting process, collaboratively between Engineering, Public Works, Planning, Environment, and Finance.
- Any updates to District regulations such as the Zoning Bylaw, Subdivision and Development Control Bylaw, and Official Community Plan
- The development of Area Plans, Sub-Area Plans, or Neighbourhood Plans
- Any review of the District's DCC Bylaw
- Any review of rates, fees, or other charges
- Annual departmental work planning processes

Finally, ISMPs are to be considered living documents that should be reviewed and updated in response to changing climatic conditions and development pressures, and based on the results of the District's environmental monitoring program. The 'monitoring and adaptive management' component of ISMPs will provide direction to the District on how to do this.

Appendix F: Environmental Monitoring Program

DISTRICT OF SQUAMISH INTEGRATED STORMWATER
MANAGEMENT PLAN – PHASE 1

FINAL REPORT – April 10, 2019



Integrated Stormwater Service Delivery Environmental Monitoring Program



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1. INTRODUCTION

Purpose of this Document

The District of Squamish (the District) strives to continuously improve in asset management and integrated stormwater management. This will allow the District to sustainably provide stormwater services to the community, and protect public property, the environment, and public safety as the community develops.

To support these improvement goals, the District is establishing an Environmental Monitoring Program (EMP). This document describes the purpose of the EMP, how the scope was developed, recommendations on scope, and guidance on phasing given the cost to implement the EMP. The information in this document is meant to support the District with capital planning and budgeting and in phasing the implementation of catchment-specific Integrated Stormwater Management Plans (ISMPs).

Purpose of the Environmental Monitoring Program

The District currently has limited information on the health of its watersheds as measured by quantifiable data. Environmental stewardship groups have been active in the community for many years and have been monitoring data such as fisheries and water quality to various extents. However, there remains a lack of a comprehensive database of information that can be used to inform decisions about stormwater service delivery so that it supports community growth and also protects public and private property and the environment. The purpose of the EMP is to help fill this gap.

How the Data will be Used

How the data will be used informs the entire scope of the EMP. Data that is generated through the EMP will be used by the District as part of its broader integrated stormwater management practices to:

1. Establish a baseline understanding of watershed health and infrastructure performance, and confirmation of issues
2. Understand the influence that development and integrated stormwater management practices may have on watershed health
3. Establish performance targets
4. Inform decisions about integrated stormwater management practices that are required in various parts of the District to meet those targets
5. Track changes over time and inform decisions about adjustments to management practices (typically referred to as “adaptive management” practices)

This document describes the scope of baseline data that will be collected as part of the development of catchment-specific ISMPs, in support of the first four objectives. Based on the results of the baseline monitoring, recommendations will be made for ongoing monitoring that will help the District track changes over time and inform decisions about adaptive management practices.



How the Data will be Managed

Data will be collected and managed by staff within Engineering, in coordination with Environment. If any monitoring and reporting services are contracted out, the District will request the raw data and, if applicable, laboratory results for inclusion in its own monitoring database.

There is an opportunity to integrate the monitoring data into the District's GIS system: much like how as-built drawings can be accessed in the GIS system via the asset inventory, the District could select a monitoring location and access data and reports relevant to that site. This will require minimal effort to set up and will enable ease of access to the data moving forward.

Linkages to the District's Stormwater Level of Service Framework

The District has a Stormwater Level of Service (LOS) Framework. The LOS Framework outlines high-level stormwater service goals that describe what customers can expect in terms of service delivery by the District. The goals are informed by what customers care about, such as impacts to private and public property, condition of infrastructure, District response time, and impacts to the environment.

The District has defined two service goals that relate to impacts to the environment:

- **Goal #5:** Public and private stormwater management practices aim to minimize negative impacts to water quality, water quantity, and ecosystem health on a watershed basis, relative to current conditions.
- **Goal #6:** The District aims to meet all Federal and Provincial regulations and guidelines for environmental protection.

The LOS Framework further outlines indicators for each of the goals that can be measured and used to quantify current LOS, set targets, and monitor progress over time.

This EMP provides further detail on the indicators that will be monitored, where, and over what time frame.

Linkages to the District's Integrated Stormwater Management Plans

The District aims to develop Integrated Stormwater Management Plans (ISMPs) for priority watersheds as part of an improved approach to stormwater service delivery in the District. ISMPs will be the primary tool for setting stormwater service goals and specific targets in each watershed, using the indicators described in the Stormwater LOS Framework and in the EMP. ISMPs will also describe how the goals will be achieved through policies and regulations regarding development practices; through new capital projects and upgrades; and through operations.

Baseline environmental monitoring will be conducted as part of the development of each catchment-specific ISMP. Based on the results of the baseline monitoring, recommendations will be made for ongoing monitoring, including monitoring location, parameters, and frequency.



2. APPROACH TO ESTABLISHING SCOPE

General Approach

The highest-value monitoring program will be one that maximizes the usefulness of the data to the District, and minimizes cost – recognizing that there are trade-offs between these objectives. To balance the trade-offs between usefulness of the data and the costs to implement monitoring, the following is the recommended general approach for the EMP:

- Monitor only high-priority watersheds
- Use Metro Vancouver's Monitoring and Adaptive Management Framework as a general guide for identifying indicators and monitoring locations, and for collecting data
- Collect baseline data as part of the development of catchment-specific ISMPs – frequency of ongoing monitoring will be determined and costed based on the baseline results

Rationale

It is important that the District collects useful information that is meaningful and not misleading. It is also important that the District focuses its efforts on indicators that can be influenced through integrated stormwater management practices. The District does not currently have a comprehensive monitoring program; therefore, any monitoring will require an increase in the capital and operating budget. A key consideration in developing the EMP is the cost of the program and available resources.

The primary components of the cost of an EMP include:

- Staff time
- Equipment purchase (for long-term monitoring) versus rental (for short-term monitoring)
- Site accessibility and installation requirements
- Laboratory analysis
- Maintenance and data management
- Professional fees, if the District does not carry out all activities in-house

The biggest cost drivers are:

- Type and number of monitoring parameters and locations
- Frequency and duration of monitoring

Prudent control of these variables is important to minimize cost of the program while maximizing usefulness of the data.

The following sections describe the scope of the EMP based on this general approach.



3. RECOMMENDED SCOPE

Which Watersheds Should Be Included in the EMP

Table 1 describes the watersheds in which monitoring of one or more indicators is recommended. These are also shown on Figure 1.

Table 1 High-Priority Watersheds Where Monitoring Should be Conducted

Watershed	Development/Usage Areas	Sub-Watersheds/Tributaries with Development Potential (>10%)
Howe Sound	<ul style="list-style-type: none"> Downtown North Yards Business Park Dentville Logger's East 	<ul style="list-style-type: none"> Logger's Creek
Mamquam River	<ul style="list-style-type: none"> Garibaldi Estates Garibaldi Highlands 	<ul style="list-style-type: none"> Harris Slough
Stawamus River	<ul style="list-style-type: none"> Valleycliffe Hospital Hill 	<ul style="list-style-type: none"> Little Stawamus
Squamish River – East	<ul style="list-style-type: none"> Brackendale North Highlands (District Lot 509/510) Tantalus Road 	<ul style="list-style-type: none"> Horse Creek Dryden Creek Hop Ranch Creek Meighan Creek North Highlands Unnamed creeks

Rationale

According to the provincial Freshwater Atlas, approximately 15 watersheds and significant sub-watersheds span the District's municipal boundaries. The District need not monitor each of these watersheds in order to capture useful data for the purposes of the EMP. Rather, to balance usefulness of data with cost, the District should focus its efforts on gathering information from watersheds that meet the following criteria:

- Those that are currently experiencing issues due to past land use and development activities (as identified by previous studies or as observed by staff)
- Those for which future development is anticipated to cover at least 10% of watershed area and could impact watershed health and existing system performance
- Those for which an ISMP is recommended, based on the first two criteria
- Specific sub-watersheds/tributaries that have similar characteristics as others of interest, so that one area can be taken as representative of others, thereby minimizing monitoring efforts

In the spring of 2018, an Integrated Stormwater Service Delivery Baseline Assessment was conducted as part of Phase 1 of the District's ISMP process (Urban Systems, 2018). Through the Baseline



Assessment, watersheds were mapped according to the provincial Freshwater Atlas, and stormwater issues and other watershed characteristics were inventoried across the District. Based on the issues identified in these watersheds, the watersheds were then grouped according to whether they warranted an ISMP and environmental monitoring, or whether other strategies were suitable to address the issues.

Watersheds listed in Table 2 were also considered in the Baseline Assessment. However, given the nature of the issues and the limited development potential in these areas, an ISMP is not recommended at this time and so resources are best directed to higher-priority areas.

Table 2 Low-Priority Watersheds for Which Monitoring is Not Currently Recommended

Watershed	Development/Usage Areas	Sub-Watersheds/Tributaries
Shannon Creek	<ul style="list-style-type: none">Stawamus Chief Provincial Park	<ul style="list-style-type: none">n/a
Squamish River – West	<ul style="list-style-type: none">n/a	<ul style="list-style-type: none">Fries CreekMill CreekMonmouth Creek
Cheakamus River	<ul style="list-style-type: none">BrackendaleParadise ValleyAlice Lake Provincial Park	<ul style="list-style-type: none">Brohm RiverCheekeye River

What Data Should Be Collected, When, and How

Table 3 on page 10 summarizes the data that should be collected in high-priority areas.

Rationale

The indicators and data collection method described in Table 3 are based on Metro Vancouver's Monitoring and Adaptive Management Framework (MAMF)¹. As a condition of the BC Minister of Environment's approval of Metro Vancouver's Integrated Liquid Waste Management Plan, developed the MAMF for assessing watershed health and the effectiveness of ISMPs. The MAMF was developed by a technical committee comprised of members from Metro Vancouver, member municipalities, and the Ministry of Environment. The MAMF provides an approach for:

- Monitoring watershed health
- Tracking ISMP implementation and effectiveness
- Identifying impacts/threats to watershed health
- Selecting adaptive management practices
- Tracking the effectiveness of adaptive management practices
- Reporting out on all components list above

¹ Available online at http://www.metrovancouver.org/services/liquid-waste/LiquidWastePublications/Monitoring_Adaptive_Management_Framework_for_Stormwater.pdf



The District is not a member municipality of Metro Vancouver and is not required to use the MAMF as a framework for its EMP. However, the MAMF serves as a useful guide for establishing the District's EMP because it was developed for the same purposes and to balance the competing objectives of maximizing usefulness of the data and minimizing cost.

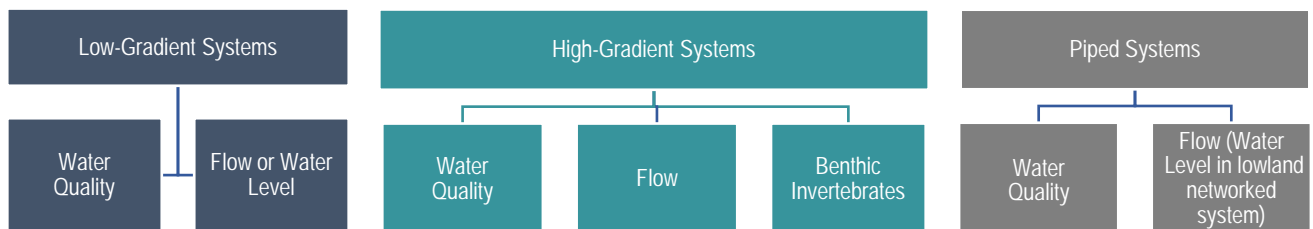
The MAMF provides guidance on the collection of:

- water quality data
- flow data
- benthic invertebrates data.

The standard approach in the MAMF was adapted to suit the District's objectives for the EMP by adding the following indicators of watershed health. They are typically included as part of a baseline assessment of watershed conditions for the purpose of developing ISMPs:

- Water level data in the lowland networked piped system
- Land-based indicators of watershed health, including percent total impervious area (%TIA), percent riparian forest integrity (%RFI), tree canopy (%), and erosion
- Climate-based parameters that influence watershed health and system performance, including air temperature and precipitation
- Wildlife and vegetation-based indicators of watershed health, including fisheries and habitat

In terms of where monitoring is conducted, the MAMF sets out an approach to monitoring flow, water quality, and benthic invertebrates based on the type of drainage system and whether it is high-gradient, low-gradient, or a piped system². This is to account for variations in natural conditions and monitoring techniques, and to balance the costs and benefits of data collection.



² High-gradient systems are natural watercourses with gradients greater than 1%. Low-gradient systems are natural watercourses, ditches, and canals less than 1% gradient.

Table 3 Indicators, Sampling Method, and Location for Baseline Data Collection

Indicator	Method	Sequencing with ISMP Development	Area or Candidate Location	Rationale and Additional Comments
Land				
Total impervious area (TIA) (%)	Desktop analysis	<ul style="list-style-type: none">Can collect during ISMP development	<ul style="list-style-type: none">Calculated for the entire watershed	<ul style="list-style-type: none">TIA is an indicator of how much runoff and pollutants a given study area may generate. It is also a cursory indicator of water quality and therefore of watershed health.It can be readily calculated at any time through GIS analysis – no advance data collection required to develop ISMPs.Typically reported on a sub-watershed basis and for the entire watershed.Note that effective impervious area (EIA), defined as the area directly connected to the stormwater system, may also be measured and, when accurate, it is a more useful indicator. However, it is more difficult to measure as it requires more advanced inventories of the stormwater system and is often determined through calibration of a hydrologic/hydraulic model of the system. Given the nature of development and stormwater management practices in the District, TIA is a realistic and suitable indicator at this time when used in combination with additional parameters.
Tree Canopy (%)	Desktop analysis	<ul style="list-style-type: none">Can collect during ISMP development	<ul style="list-style-type: none">Calculated for the entire watershed	<ul style="list-style-type: none">Tree canopy supports natural watershed processes. It reduces anthropogenic influences on runoff and recharge, water temperature, and overland pollutant transport.Tree canopy is calculated for the entire watershed. It can be readily calculated at any time through GIS analysis – no advance data collection required to develop ISMPs.Typically reported on a sub-watershed basis and for the entire watershed.
Riparian forest integrity (RFI) (%)	Desktop analysis	<ul style="list-style-type: none">Can collect during ISMP development	<ul style="list-style-type: none">Calculated as the percent riparian cover within a 30-metre buffer of watercourses	<ul style="list-style-type: none">Riparian areas have an array of influences on watershed health, including intercepting and moderating runoff, providing shade and buffering temperature extremes (which can also reduce certain toxicities), filtering pollutants in surface or subsurface runoff, providing woody debris to stream channels that enhances aquatic food webs, and stabilizing banks and floodplains.RFI can be readily calculated at any time through GIS analysis – no advance data collection required to develop ISMPs.Typically reported on a sub-watershed basis and for the entire watershed.
Erosion	Desktop analysis and field verification	<ul style="list-style-type: none">Can collect during ISMP development	<ul style="list-style-type: none">Watershed-wide desktop review and field review in high-priority areas. Preliminary locations are listed belowLogger’s Creek (Howe Sound watershed)Little Stawamus (Stawamus watershed)Meighan Creek (Squamish East watershed)	<ul style="list-style-type: none">Erosion is a natural process but it also occurs when a watercourse experiences changes in flows due to additional, unmitigated runoff from development. The intent of this review is to identify problematic erosion only.Erosion leads to deposition and turbidity, which in turn may impact water quality and fish spawning. Erosion may also contribute to land loss and be a threat to property located near the erosion sites.High-priority areas should be identified first from a review of background information and desktop analysis. A field assessment should then be focused on these areas, versus doing a walkabout of the entire watershed. No advance data collection required.
Climate				
Air temperature and precipitation	Desktop analysis	<ul style="list-style-type: none">Can collect during ISMP development	<ul style="list-style-type: none">Calculated for the entire watershed	<ul style="list-style-type: none">Air temperature and precipitation data can be correlated with water quality and streamflow to determine how a watershed reacts to weather.Data can be gathered at any time using Environment Canada weather station data and District rainfall gauges. No advance data collection required.
Water Quality				
Temperature pH Conductivity Turbidity	In situ field reading with appropriate instruments	<ul style="list-style-type: none">Collect in advance of ISMP development	<ul style="list-style-type: none">Logger’s Creek and 2 locations in the piped network (Howe Sound watershed)Little Stawamus (Stawamus watershed)Outlet to Harris Slough (Mamquam Watershed)Meighan Creek (Squamish East watershed)	<ul style="list-style-type: none">Water quality is a primary indicator of watershed health.Stormwater is a significant source of a wide range of pollutants including metals, nutrients, bacteria, and suspended solids that may impact fisheries and aspects of ecological health. Specific pollutants in a given water sample will depend on upstream land use; therefore, the parameters selected for inclusion in a water quality assessment should be focused on those that may be influenced by the specific type of development in that watershed, and on those that may be influenced through integrated stormwater management practices.Requires approximately one year to collect data: data should be collected twice during the year (wet season and dry season) with five samples taken during each season over 5 consecutive weeks.Data should be collected in watercourses at a point that is downstream of development.Data should be collected in the lowland piped network at an outlet downstream of developmentNote that typically, samples should be analysed for iron, copper, lead, zinc, and cadmium at a minimum. However, laboratories typically provide a package for the analysis of metals, so the District may choose to expand the indicators. This is also true for other indicators – the District may choose to include hardness, alkalinity, total suspended solids, etc. based on laboratory packages.
Nitrate (as nitrogen)	Field sample collected and submitted for analysis at an accredited laboratory			
Microbiological Parameters (E. coli, faecal coliforms)				
Metals (iron, copper, lead, zinc, and cadmium)				

Indicator	Method	Sequencing with ISMP Development	Area or Candidate Location	Rationale and Additional Comments
Water Quantity				
Streamflow parameters	Hydrometric gauging station installed in culverts or storm sewer	<ul style="list-style-type: none"> Collect in advance of ISMP development 	<ul style="list-style-type: none"> Logger's Creek (Howe Sound watershed) Little Stawamus (Stawamus watershed) Outlet to Harris Slough (Mamquam Watershed) Meighan Creek (Squamish East watershed) 	<ul style="list-style-type: none"> Streamflow monitoring is used to calibrate hydrologic/hydraulic models used to assess current capacity of the stormwater network and impacts on capacity due to changes in flows from climate change and land use changes/development activities. Wet-weather flow data is required for infrastructure sizing. Dry-weather data is important for measuring base flows, which are important for watershed health. Requires approximately one year of continuous data collection. For watercourses, monitoring stations should be set up downstream of development and in an existing culvert to mitigate costs and challenges of open-channel monitoring. Flow in storm sewers should be measured at a location to capture a sufficient sample of development at a location hydraulically suitable.
Water Level	Water level meters installed in lowland pipes	<ul style="list-style-type: none"> Collect in advance of ISMP development 	<ul style="list-style-type: none"> 2 locations in piped network (Howe Sound watershed) 	<ul style="list-style-type: none"> Water level data is suitable for understanding the performance of a networked lowland stormwater system prone to surcharge/backwater (system heavily constrained by grade and where water may flow in multiple directions, particularly one governed by downstream boundaries such as the ocean tide). When coupled with asset condition information, water level is a more cost-effective indicator of system performance than installing flow gauge stations. Note that data from pump stations will also be useful for understanding system performance and for calibrating models.
Ecosystem Health				
B-IBI (benthic index of biotic integrity)	Field collection of samples and analysis at an accredited laboratory	<ul style="list-style-type: none"> Collect in advance of ISMP development 	<ul style="list-style-type: none"> Little Stawamus (Stawamus watershed) Meighan Creek (Squamish East watershed) 	<ul style="list-style-type: none"> Benthic invertebrate species and assemblages/communities can be utilized to evaluate surface water quality and aquatic habitat attributes to understand general water quality and habitat conditions. B-IBI is an indicator of watershed health. The type of benthic invertebrates used to calculate B-IBI are only found in rocky/gravelly substrate. Samples are only collected in high-gradient streams with a suitable substrate. Benthic invertebrate samples are typically collected in late summer or early fall. If selected streams are typically dry at this time of year, samples may be collected in spring following the vegetation bud-out period.
Fisheries Inventory and Habitat	Desktop analysis and field verification	<ul style="list-style-type: none"> Can collect during ISMP development 	<ul style="list-style-type: none"> Inventory of all streams in the watershed 	<ul style="list-style-type: none"> Fish species abundance and diversity and fish habitat are indicators of watershed health. Changes in streamflow characteristics and water quality as a result of development within a watershed can negatively impact fish populations. Identification of physical barriers that may prevent migration of fish and that would provide an opportunity for improvement if resolved.

Note that sediment quality is sometimes included in monitoring programs for the purpose of testing for metals and polyaromatic hydrocarbons (PAH). Typically, sediment monitoring would only be conducted in a highly urbanized area where sediments need to be dredged to restore system capacity and the sampling information informs whether the material is considered hazardous. This is likely not a high-value indicator to monitor within the District at this time, so it is excluded from the scope of the EMP.



4. IMPLEMENTATION: PHASING AND COSTS

This section provides direction on implementation of the overall program described in the previous section, including direction on phasing and costs to support capital planning and budgeting. Recommendations on phasing are based on which watersheds are highest-priority for developing ISMPs.

Priority 1: Implement Over 2019-2020

Recommendation

Initiate monitoring in the Howe Sound watershed and Stawamus River watershed in 2019 so that an ISMP can be prepared for these watersheds in 2020.

Rationale

- The highest-priority watershed is the Howe Sound watershed, which includes the existing areas of the Downtown and Dentville. These areas have a history of known issues as indicated by past studies and staff knowledge, as well as immediate development pressures. An Area Plan is in development for Loggers Creek.
- Development pressures in the Stawamus River watershed are longer-term but an ISMP is still recommended. The District will achieve efficiencies in cost by developing an ISMP that covers both watersheds as part of a single planning process.
- Monitoring in these watersheds should be initiated within the next year to inform the rest of the ISMP planning process, as it may take up to a year to collect meaningful data.

Program Summary

Table 4 summarizes the monitoring that is recommended as part of the Howe Sound and Stawamus River ISMP process.

Table 4 Recommended Monitoring in the Howe Sound and Stawamus River Watersheds

Area or Candidate Location	Indicators	Comments
Watershed-wide	<ul style="list-style-type: none">• TIA• RFI• Tree canopy• Climate• Fisheries and habitat	<ul style="list-style-type: none">• Water quality data within the piped network should be collected at the downstream outlet from a developed area.• Water quality data should be collected within Logger's Creek and Little Stawamus at the most suitable downstream location.• Flow data for Logger's Creek and Little Stawamus should be collected at a culvert crossing.• Explore partnerships with DFO and Squamish River Watershed Society for data collection and/or sharing.
Little Stawamus River	<ul style="list-style-type: none">• Water quality• Flow• B-IBI• Erosion	
Logger's Creek	<ul style="list-style-type: none">• Water quality• Flow• Erosion	



Area or Candidate Location	Indicators	Comments
1 other location in the lowland piped network	<ul style="list-style-type: none"> Water quality Water level 	

Cost Estimate

The Class D cost estimate to implement monitoring as part of the Howe Sound and Stawamus River ISMP is summarized in Table 5. Costs include effort to collect and analyse data; interpretation of data and reporting on overall baseline conditions would be conducted as part of the development of ISMPs.

Table 5 Cost Estimate for Howe Sound / Stawamus River Monitoring Program

Component	Class D Cost	Assumptions
Year 1		
Flow monitoring	\$60,000	<ul style="list-style-type: none"> 2 locations Equipment installed and operated by a professional service provider over a period of 12 months at \$2,500/month (upper end of range of service providers) Includes equipment, supplies, labour, discharge measurements, development of stage-discharge curve Installed in a culvert or pipe (no open channel gauging stations)
Water level monitoring	\$13,000	<ul style="list-style-type: none"> 1 location Equipment installed and operated by a professional service provider over a period of 5 months (wet weather data collection only) at \$2,500/month (upper end of range of service providers) Installed in a pipe
Water quality monitoring	\$23,000	<ul style="list-style-type: none"> 3 locations District staff purchase the monitoring equipment required to collect in-situ water quality data at a one-time cost of \$6,500 District staff collect water quality samples Training would be provided for District staff to collect in-situ water quality data at a one-time cost of \$10,000, which is significantly less costly than contracting sample collection to professional service providers Samples would be submitted to an accredited laboratory and analyzed for indicators of interest. Includes lab costs.
Benthic invertebrates monitoring	\$2,000	<ul style="list-style-type: none"> 1 location Sample collected by a professional service provider and submitted for analysis at an accredited laboratory. Includes labour and lab costs.
Year 1 Total	\$98,000	
Year 2		
TIA, RFI, tree canopy, and climate	\$4,000	<ul style="list-style-type: none"> Desktop analysis conducted by a consultant
Fisheries and habitat	\$2,500	<ul style="list-style-type: none"> Desktop analysis and one-day field review conducted by a consultant
Erosion	\$2,500	<ul style="list-style-type: none"> Desktop analysis and one-day field review conducted by a consultant
Year 2 Total	\$9,000	



Component	Class D Cost	Assumptions
TOTAL	\$107,000	<ul style="list-style-type: none"> In addition to remainder of ISMP costs

Priority 2: Implement Over 2021-2022

Recommendation

Initiate monitoring in the Squamish River East watershed in 2021 so that an ISMP can be prepared in 2022.

Rationale

- The Squamish River East watershed includes the Garibaldi Estates, which is anticipated to undergo greenfield development, as well as the existing developed area of Brackendale, which has a history of known issues.
- Monitoring in this area should be initiated once the Howe Sound/Stawamus River ISMP is completed. Monitoring may take up to a year to collect meaningful data.

Program Summary

Table 6 summarizes the monitoring that is recommended as part of the Squamish River East ISMP process.

Table 6 Recommended Monitoring in Squamish River East Watershed

Area or Candidate Location	Indicators	Comments
Watershed-wide	<ul style="list-style-type: none"> TIA RFI Tree canopy Climate Fisheries and habitat 	<ul style="list-style-type: none"> Water quality data should be collected within Meighan Creek at the most suitable downstream location. Flow data for Meighan Creek should be collected at a culvert crossing. Explore partnerships with DFO and Squamish River Watershed Society for data collection and/or sharing.
Meighan Creek	<ul style="list-style-type: none"> Water quality Erosion Flow B-IBI 	

Note that according to District staff, existing data may be available from the Eagle Run pump station in Brackendale to understand system performance and to calibrate models developed for the area.

Cost Estimate

The Class D cost estimate to implement monitoring as part of the Squamish River East ISMP is summarized in Table 7. Costs include effort to collect and analyse data; interpretation of data and reporting on overall baseline conditions would be conducted as part of the development of ISMPs.



Table 7 Cost Estimate for Squamish River East Monitoring Program

Component	Class D Cost	Assumptions
Year 1		
Flow monitoring	\$30,000	<ul style="list-style-type: none"> 1 location Equipment installed and operated by a professional service provider over a period of 12 months at \$2,500/month (upper end of range of service providers) Includes equipment, supplies, labour, discharge measurements, development of stage-discharge curve Installed in a culvert or pipe (no open channel gauging stations)
Water quality monitoring	\$2,000	<ul style="list-style-type: none"> 1 location District staff collect water quality samples District staff have already purchased the monitoring equipment required to collect in-situ water quality data Samples would be submitted to an accredited laboratory and analyzed for indicators of interest. Includes lab costs.
Benthic invertebrates monitoring	\$2,000	<ul style="list-style-type: none"> 1 location Sample collected by a professional service provider and submitted for analysis at an accredited laboratory. Includes labour and lab costs.
<i>Year 1 Total</i>	<i>\$34,000</i>	
Year 2		
TIA, RFI, tree canopy, and climate	\$4,000	<ul style="list-style-type: none"> Desktop analysis conducted by a consultant
Fisheries and habitat	\$2,500	<ul style="list-style-type: none"> Desktop analysis and one-day field review conducted by a consultant
Erosion	\$2,500	<ul style="list-style-type: none"> Desktop analysis and one-day field review conducted by a consultant
<i>Year 2 Total</i>	<i>\$9,000</i>	
TOTAL	\$43,000	<ul style="list-style-type: none"> In addition to remainder of ISMP costs

Priority 3: Implement Over 2023-2024

Recommendation

Initiate monitoring in the Mamquam River watershed in 2023 so that an ISMP can be prepared in 2024.

Rationale

- The Mamquam River watershed is very large and development is primarily limited to the lower reaches of the mainstem. Runoff from most of the developed area discharges into Harris Slough. There is a history of issues in the area and some upstream development is anticipated.
- Monitoring in this area should be initiated once ISMPs for the other priority watersheds is completed. Monitoring may take up to a year to collect meaningful data.



Program Summary

Table 8 summarizes the monitoring that is recommended as part of the Mamquam River ISMP process.

Table 8 Recommended Monitoring in the Mamquam River Watershed

Area or Candidate Location	Indicators	Comments
Watershed-wide	<ul style="list-style-type: none"> TIA RFI Tree canopy Climate Fisheries and habitat Erosion 	<ul style="list-style-type: none"> Water quality data should be from the piped network at the outlet to Harris Slough. Flow data should be collected at a suitable downstream outlet. Desktop analysis of erosion and then field review in areas of concern. Explore partnerships with DFO and Squamish River Watershed Society for data collection and/or sharing.
Harris Slough	<ul style="list-style-type: none"> Water quality Flow 	

Cost Estimate

The Class D cost estimate to implement monitoring is summarized in Table 9.

Table 9 Cost Estimate for Squamish River East Monitoring Program

Component	Class D Cost	Assumptions
Year 1		
Flow monitoring	\$30,000	<ul style="list-style-type: none"> 1 location Equipment installed and operated by a professional service provider over a period of 12 months at \$2,500/month (upper end of range of service providers) Includes equipment, supplies, labour, discharge measurements, development of stage-discharge curve Installed in a culvert or pipe (no open channel gauging stations)
Water quality monitoring	\$2,000	<ul style="list-style-type: none"> 1 location District staff collect water quality samples District staff have already purchased the monitoring equipment required to collect in-situ water quality data Samples would be submitted to an accredited laboratory and analyzed for indicators of interest. Includes lab costs.
<i>Year 1 Total</i>	<i>\$32,000</i>	
Year 2		
TIA, RFI, tree canopy, and climate	\$4,000	<ul style="list-style-type: none"> Desktop analysis conducted by a consultant
Fisheries and habitat	\$2,500	<ul style="list-style-type: none"> Desktop analysis and one-day field review conducted by a consultant
Erosion monitoring	\$2,500	<ul style="list-style-type: none"> Desktop analysis and one-day field review conducted by a consultant
<i>Year 2 Total</i>	<i>\$9,000</i>	
TOTAL	\$41,000	<ul style="list-style-type: none"> In addition to remainder of ISMP costs

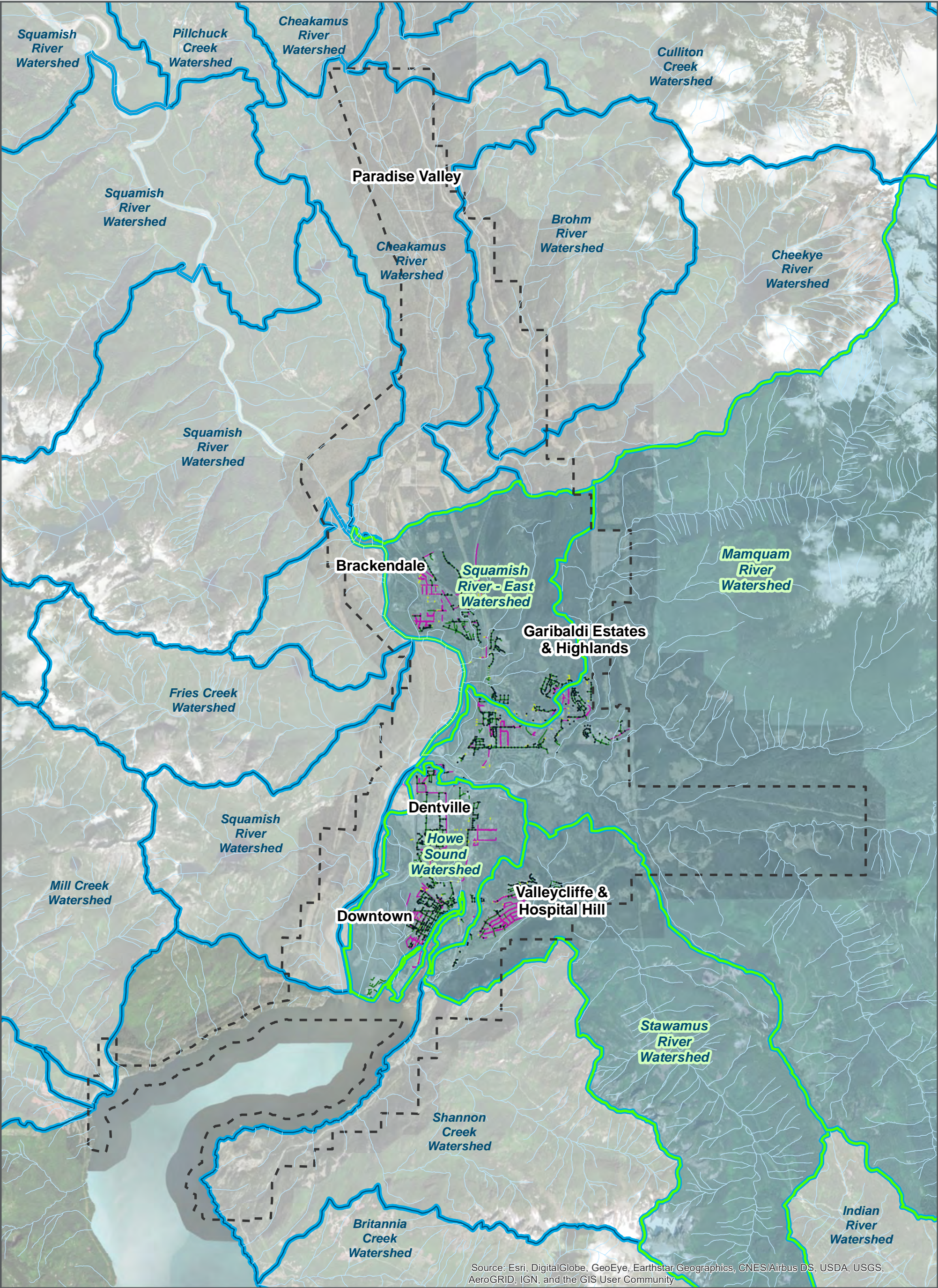


Summary

The following figure summarizes the recommended approach to conducting monitoring as part of the development of catchment-specific ISMPs.

	2019	2020	2021	2022	2023	2024
Priority 1 Howe Sound / Stawamus River ISMP	Water Quality Flow/Level B-IBI \$98,000	Desktop analysis Field review \$9,000				
	Prepare ISMP					
		Priority 2 Squamish River East ISMP	Water Quality Flow B-IBI \$34,000	Desktop analysis Field review \$9,000		
			Prepare ISMP			
				Priority 2 Mamquam River ISMP	Water Quality Flow \$32,000	Desktop analysis Field review \$9,000
					Prepare ISMP	

Figure 2 Summary of Recommended Program Phasing



<div><div>URBANSYSTEMS</div><div><div>Project #:</div><div>1928.0025.01</div></div><div><div>Author:</div><div>SQ</div></div><div><div>Checked:</div><div>BD</div></div><div><div>Status:</div><div>~DRAFT~</div></div><div><div>Revision:</div><div>A</div></div><div><div>Date:</div><div>2018 / 12 / 12</div></div></div>	<div><div><div>01,0002,0003,000</div><div>Meters</div></div><div><div>Coordinate System:</div><div>NAD 1983 UTM Zone 10N</div></div><div><div>Data Sources:</div><div>- Data provided by District of Squamish (2018) and DataBC (2018)</div></div><div><div>The accuracy and completeness of information shown on this drawing is not guaranteed. It will be the responsibility of the user of the information shown on this drawing to locate and establish the precise location of all existing information whether shown or not.</div></div></div>	<div><div><div><div></div><div>Recommended Watersheds for Stormwater Management</div></div><div><div></div><div>District of Squamish Municipal Boundary</div></div><div><div></div><div>Freshwater Atlas Watersheds</div></div><div><div></div><div>Manhole</div></div><div><div></div><div>Gravity Main</div></div><div><div></div><div>Culvert</div></div><div><div></div><div>Open Drain (Ditch)</div></div></div></div>	<div><div><div><div></div><div>SQUAMISH</div><div>HARDWIRED for ADVENTURE</div></div><div><div>Phase 1 ISMP - EMP Watersheds Recommended for Environmental Monitoring</div><div>FIGURE 1</div></div></div></div>
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Appendix G: Stormwater Service Funding Review

DISTRICT OF SQUAMISH INTEGRATED STORMWATER
MANAGEMENT PLAN – PHASE 1

FINAL REPORT – April 10, 2019



Integrated Stormwater Service Delivery Funding Review



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1. INTRODUCTION

The District of Squamish (the District) strives to continuously improve in asset management and integrated stormwater management. This will allow the District to sustainably provide stormwater services to the community, and protect public property, the environment, and public safety as the community develops.

To support these improvement goals, the District conducted a funding review of its stormwater services. This document describes the results of the funding review, and it aims to support the District in deciding on potential funding mechanisms to adjust and/or introduce to cover the cost of service provision.

2. CURRENT CONTEXT AND FUNDING NEEDS

Background

As part of the process to establish the Phase 1 Integrated Stormwater Management Plan (ISMP), a baseline assessment of current stormwater and asset management practices was conducted. Among other considerations, the assessment considered the District's finances; specifically, the current state of the District's funding dedicated to stormwater service delivery. The assessment also considered the manner in which stormwater service delivery revenues are generated. This is because it is considered best practice to fully recover the cost of service delivery, as this can help avoid disruption in service and risks to public and environmental health and safety.

The following challenges, strengths, and opportunities for improvement were identified from the assessment:

Financial strengths:

- Financial planning guiding principles and policy have been established and implemented
- A financial plan has been developed and long-term projections are also used
- Financial policy exists and is referenced annually
- No debt specifically related to stormwater assets, and overall District debt level is reasonable and stable

Financial challenges:

- Aging infrastructure past its service life is a liability
- Financial plan does not reflect the revenue required for the future replacement or rehabilitation of stormwater assets due to a lack of accurate life cycle information



SQUAMISH INTEGRATED STORMWATER MANAGEMENT PLAN - PHASE 1

Funding Review

- Lack of a consistent and adequate funding stream for stormwater infrastructure
- Currently only O&M is funded and the occasional capital project due to lack of a long-term capital plan for stormwater infrastructure
- Stability and availability of stormwater capital funding is a concern to staff

Opportunities for improvement:

- Develop an asset management investment plan (AMIP) for stormwater assets
- Identify and implement a funding stream for stormwater infrastructure
- Develop a full cost recovery approach to stormwater service delivery

An AMIP was developed as part of the Phase 1 ISMP process. At the time of developing this document, the AMIP was in draft form. The following sections describe the funding needs that were identified in the draft AMIP.

Current Funding Levels and Mechanisms

Stormwater is currently funded through General Revenues, and it therefore competes for funding with other major services. In the past, the District has not had reliable lifecycle information for its stormwater assets, which has resulted in minimal dedicated annual investment in stormwater assets.

Funding Required to Provide Current Level of Service

The AMIP summarizes, among other information, the inventory of capital assets, replacement costs, and average annual lifecycle investment (AALCI) for capital assets. The AALCI represents the annual funding that is required to sustain the District's current stormwater assets at current service levels over a long-term basis.

As shown in Table 1 below, the District owns a diverse inventory of stormwater assets with a total replacement value of approximately \$133 million (in 2018 dollars). The AALCI is approximately \$2.3 million annually, just for recapitalization of existing District assets.

Table 1 Summary of Key Information in the Stormwater Asset Management Investment Plan (2018)

Asset Category	Quantity of Infrastructure	Replacement Value (2018 dollars)	AALCI (2018 dollars)
Mains	85 km	\$63,600,000	\$1,024,000
Catch Basin Leads	9 km	\$3,400,000	\$43,000
Catch Basins	2,200	\$12,500,000	\$210,000
Manholes	1,300	\$7,300,000	\$121,000
Culverts	16 km	\$16,500,000	\$276,000
Inlet/Outlet Structures	35	\$500,000	\$9,000
Pump Stations	6	\$12,600,000	\$252,000
Flood Boxes	25	\$16,200,000	\$324,000
Total		\$132,600,000	\$2,259,000



As of 2018, there are 9,735 parcels of land in the District (including 8,531 residential parcels). An AALCI of approximately \$2.3 million equates to just over \$235 per parcel per year for all parcels to sustainably maintain current service levels provided by existing District assets. This per-parcel estimate does not reflect considerations such as equity or principles regarding user-pay.

It should be noted that this amount would only apply to the recapitalization costs and would not cover ongoing O&M requirements, environmental monitoring, the cost of developing and implementing ISMPs, or any new capital infrastructure or operating programs that arise from those ISMPs. As indicated by the current funding levels and the funding requirements to maintain current levels of service, there is a significant funding shortfall that will increase with any improvements to service.

3.POTENTIAL FUNDING MECHANISMS

Potential Mechanisms

There are several different ways to fund stormwater service delivery: general property taxation, levy on property tax notice, user fees, and through a dedicated utility. Table 2 provides a summary of each funding mechanism, considerations (advantages and disadvantages) for each, and an indication of communities that use each mechanism.

General Taxation (Status Quo)

Description	<ul style="list-style-type: none">• Stormwater operating and capital are funded through general property tax, similar to Roads, Parks, Fire, etc.• Funds are allocated annually at Council's discretion.• Revenues flow through the General Fund. Ideally, revenues flow into a dedicated stormwater reserve.• The majority of communities in British Columbia use this method.
Legislative Authority	<ul style="list-style-type: none">• Community Charter Section 197 (Ad Valorem Tax / assessment-based)• Tax rates must be outlined in the financial plan and must be based on assessed value of land and improvements.• Bylaw may establish for each property class a single rate or a separate revenue to be raised for different purposes but the relationships between the different property class rates must be the same for all purposes.
Advantages	<ul style="list-style-type: none">• Easy to understand (no change to current approach)• Can partition between property classes.
Disadvantages	<ul style="list-style-type: none">• Council can change funding allocation at any time.• May require a significant increase in total property taxes.• Stormwater competes with more visible services for funding, and as a result is often significantly under-funded.



	<ul style="list-style-type: none">No connection between amount paid and the actual “use” of the service.
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Levy on Property Tax Notice

Description	<ul style="list-style-type: none">Stormwater is funded as a distinct levy on the property tax notice. This is generally done on a flat rate basis, but could also be calculated on an ad valorem (assessment) basis.Revenue is “ear-marked” for stormwaterThe City of Port Moody successfully uses this approach
Legislative Authority	<ul style="list-style-type: none">Community Charter section 197, as described above.
Advantages	<ul style="list-style-type: none">Easy to understand and administerTransparentAccountability for how funds are spent
Disadvantages	<ul style="list-style-type: none">May require a significant increase in total property taxes.No connection between amount paid and the actual “use” of the service.

Parcel Tax

Description	<ul style="list-style-type: none">Tax paid per parcel or for unit of taxable area or taxable frontage.Implemented through a bylaw that states the purpose for which the tax is imposed.Requires the maintenance of a property tax roll.Revenue is “ear marked” for stormwaterThe City of Surrey uses this approach
Legislative Authority	<ul style="list-style-type: none">Community Charter section 200Council may, by bylaw, impose a parcel tax for all or part of a service. It must state the service for which the tax is imposed and the duration for which the fee will be imposed.The municipality must make available to the public upon request a report outlining how the amounts or rates were determined.
Advantages	<ul style="list-style-type: none">Easy to understand and administer.Some connection between charge and the use of the service (if based on parcel area or frontage, assuming larger areas contribute more runoff).Provides a revenue stream specifically purposed for stormwater through a bylaw.
Disadvantages	<ul style="list-style-type: none">May require a significant increase in total property taxes.No connection between amount paid and the actual “use” of the service in the case of a straight parcel tax.



User Fee

Description	<ul style="list-style-type: none">• Dedicated fees collected from users.• Fees may be set a variety of ways, depending on what is important to the municipality – for example, if equity is a primary objective, the fees may be reflective of impervious area on each property.• Fees may be collected through existing utility bills, such as water or sewer.• The City of White Rock uses a user fee approach to billing.
Legislative Authority	<ul style="list-style-type: none">• Community Charter section 194.• The municipality may impose a fee for all or part of service of the municipality.• The fee can be based on many factors specific in the bylaw and different rates and levels of fees can be set based on different factors.• The municipality must make available to the public upon request a report outlining how the amounts or rates were determined.
Advantages	<ul style="list-style-type: none">• Provides a revenue stream specifically purposed for stormwater.• Is not included in total property taxes.• Potentially some degree of connection between the charge and the use of the service (if based on impervious area).
Disadvantages	<ul style="list-style-type: none">• Depending on the basis the user fee is calculated on, it could be difficult for customers to understand and support.• Depending on how the fee is calculated, there could be significant effort to establish the fee, invoice the change, and support customer queries.• Customers may oppose an additional fee and view it as “another tax”.

Any of the funding mechanisms above could be implemented within the General Fund or alternatively within a separate stormwater utility. A stormwater utility would require the establishment of a new fund to segregate and track all revenues and expenses related to stormwater capital and operations. This would be very similar to the District’s existing water and sewer utilities. Although popular in the United States, stormwater utilities are not commonly implemented in Canada due to their overall complexity and additional effort to administer.

Additional funding mechanisms – though unsustainable in terms of full cost recovery – include development cost charges (DCCs) and grant programs.

Development cost charges – DCCs are another funding mechanism available to municipalities, but they can only be applied to capital projects (not operations) and they must be used to help pay for growth-driven infrastructure (new infrastructure or growth-driven upgrades to existing infrastructure), and other capital projects that are required because of growth: for example, studies/plans required to address growth (including ISMPs), land acquisition, etc.

Grants – provincial and federal grants are used by communities to help cover the cost of isolated capital projects (versus ongoing regular operations). In applying for grants, the District should consider the amount it is required to contribute (often there is a cost-sharing requirement) and its capacity for implementation.



Considerations for Establishing Funding Mechanisms and Setting Rates

There are two key considerations to take into account when deciding on a funding mechanism and the specific rate that will be implemented:

1. The District's objectives for funding

A primary consideration in deciding on funding and rate setting is the specific objective(s) the municipality aims to achieve through its approach. Best practices call for the setting of objectives first, and then evaluating funding mechanisms on their ability to meet these objectives. Common objectives for funding and rate setting include:

- Fairness / equity
- Administrative requirements
- Ease of understanding
- Full cost recovery

The District will need to decide what its specific objectives are and then decide on the funding mechanism that best meets these objectives, recognizing that there will be trade-offs between objectives.

2. The public's and Council's understanding and support

Regardless of the funding mechanism, any additional cost to taxpayers/ratepayers is typically initially met with resistance. However, this can be overcome by thoughtfully communicating information to the public and Council and engaging them in the decision as to which funding mechanism and rate is most appropriate. Representatives from Finance and Engineering play key roles in the communication and engagement process, as both departments have valuable perspectives on the matter. A useful framework for communicating options to support a decision is as follows:

- Explain the "why": clearly explain the need for funding and the risks of not increasing funding further at all (regardless of funding mechanism).
- Outline the "how": describe the options for funding mechanisms that are available to the District and the advantages/disadvantages of each, given the District's objectives.
- State the "what": state what the financial impact would be to taxpayers/ratepayers under each option. For example, to increase funding through General Taxation, state what the percent and absolute increase would be for taxpayers over what they are currently paying. As another example, to increase funding through a user fee, state what the user fee would be.



4.RECOMMENDATIONS

It is recommended that the District follows these general steps to decide on its funding mechanism and rates:

1. Engage Council to establish funding objectives.
2. Decide on an appropriate funding mechanism based on its ability to meet these objectives, given the trade-offs between objectives.
3. Based on the preferred funding approach, determine cost implications to various customer groups and engage Council and the public to support a decision.

Appendix H: Public Survey Infographic

DISTRICT OF SQUAMISH INTEGRATED STORMWATER
MANAGEMENT PLAN – PHASE 1

FINAL REPORT – April 10, 2019

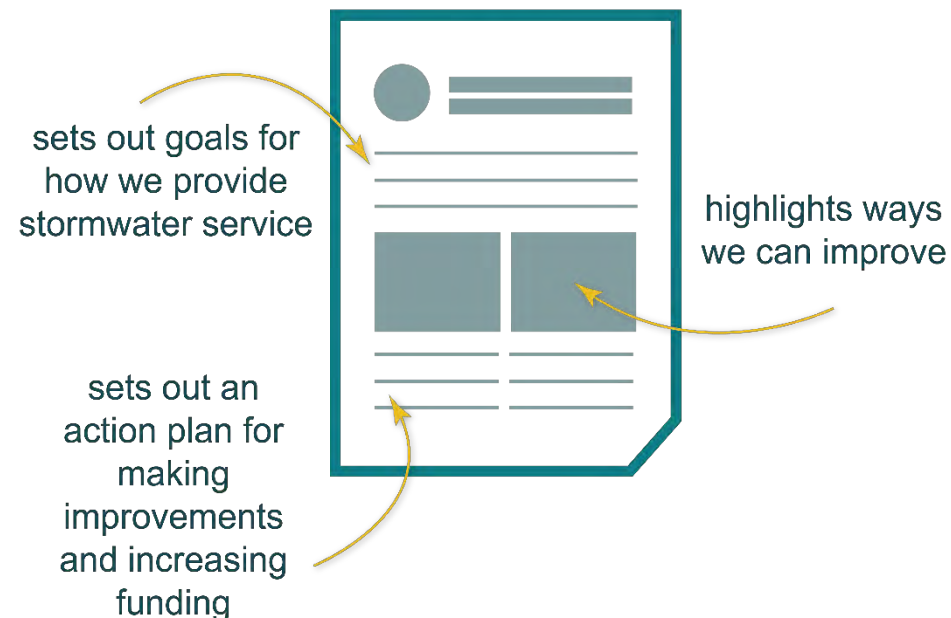
WHY WE NEED A PLAN



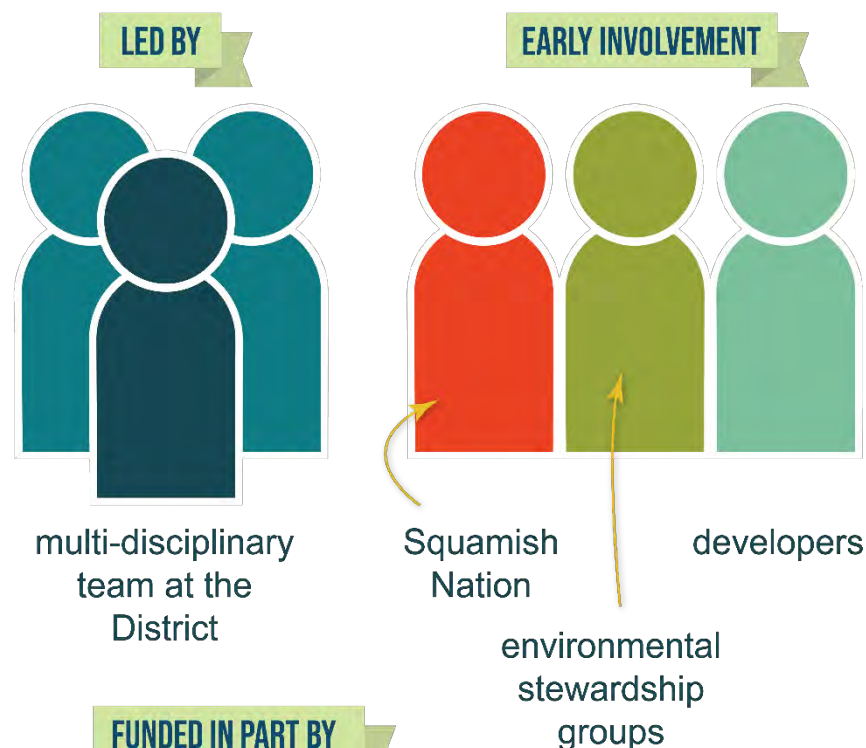
public safety and the environment need to be protected from stormwater impacts



WHAT THE PLAN DOES



WHO HAS BEEN INVOLVED



Union of BC Municipalities

THE GOALS

1. Public stormwater management practices should not result in negative impacts to private property
2. Nuisance flooding in backyards and low-lying areas is expected for minor rain events if it is generated on-site
3. New developments should mitigate on-site and off-site impacts of runoff
4. Public property may be used as a floodway or storage for major storm events as appropriate
5. Public and private stormwater management practices aim to minimize negative impacts to water quality, water quantity, and ecosystem health on a watershed basis, relative to current conditions
6. The District aims to meet all Federal and Provincial regulations and guidelines for environmental protection
7. Drainage infrastructure is appropriately maintained for its intended function
8. District staff will be available to respond to stormwater management issues, and will respond to issues in order of highest to lowest priority as follows:
 - a. Issues related to the capacity or performance of public stormwater infrastructure
 - b. Issues resulting in impacts to a private building (e.g., crawlspace flooding)
 - c. Issues relating to flooding of private property (e.g., backyard flooding)
9. Residents are aware of what to expect in terms of stormwater levels of service
10. Residents know what they can do to help

PRIORITY WATERSHEDS

We plan to develop dedicated ISMPs for the following areas:

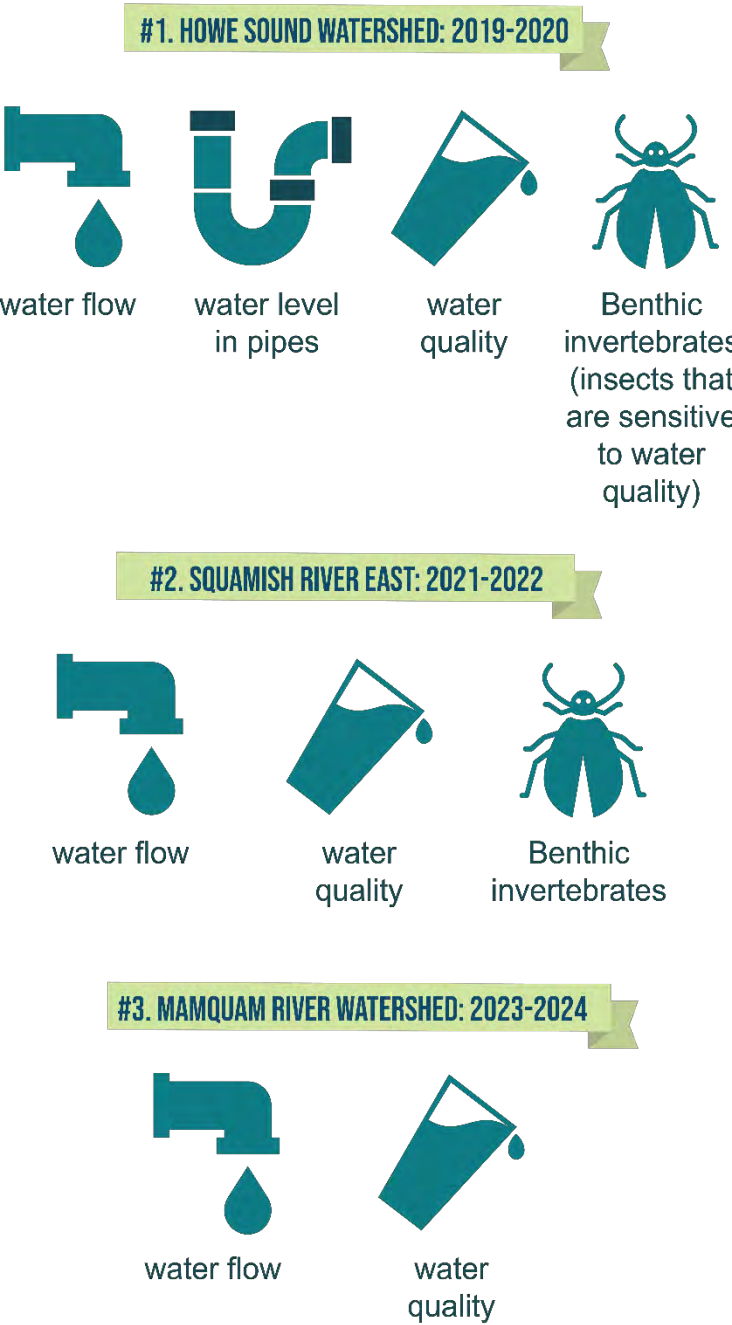


The cost to develop each ISMP is expected to be about

\$150,000

THE MONITORING PROGRAM

We plan to monitor indicators like water quality, stream and pipe flow, and other environmental factors that tell us how healthy the watershed is. Monitoring programs would be implemented in the high-priority watersheds as we prepare dedicated ISMPs.



From 2019-2024, the average cost per year to conduct baseline environmental monitoring in each watershed is expected to be about

\$32,000

OUR NATURAL ASSETS

There are a lot of natural assets within the District that provide important stormwater services like treating and conveying stormwater, offering flood and erosion protection, and increasing infiltration.

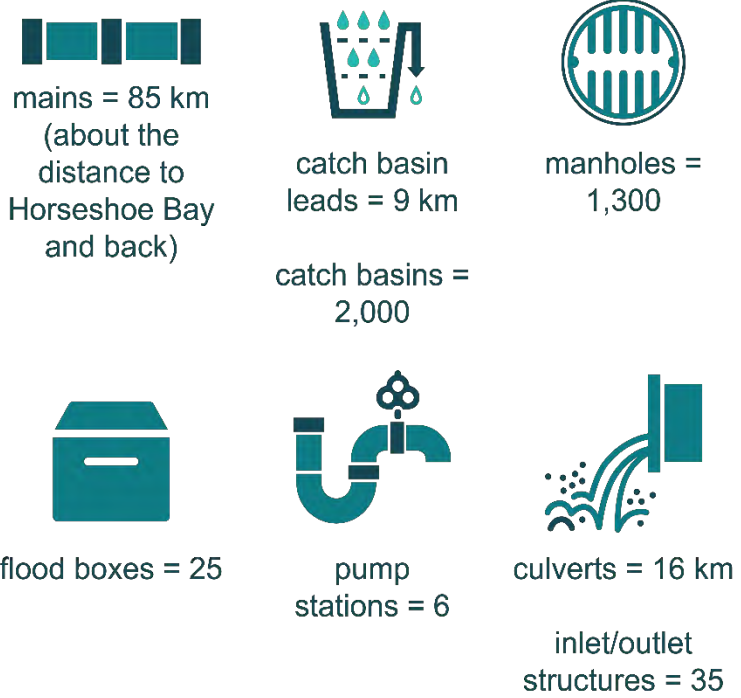


High-level estimates show that the value of the stormwater services provided by these natural assets is over

\$380 MILLION

WHY WE NEED MORE FUNDING

Historically, there has been no dedicated funding for stormwater management and stormwater infrastructure in the capital budget. However, the District owns and maintains a lot of stormwater infrastructure.



It will take about \$2.3 million annually to cover the replacement cost of infrastructure when it is needed. This doesn't include the cost to operate and maintain this infrastructure, and it doesn't include any costs of our diking system.

stormwater infrastructure in the District is, on average, at about 50% of its useful life, and we need funds in place to replace them at the end of their life

\$2.3 MILLION