Shelly Creek Water Balance and Sediment Reduction Plan

Technical Summary

Presented to:

Mid Vancouver Island Habitat Enhancement Society
P.O. Box 935,
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Acknowledgements

The Shelly Creek Water Balance and Sediment Reduction Plan has been completed with the assistance of the following funders:

This report is dedicated to Faye Smith, who was the backbone of stream stewardship in the Oceanside area for the past 30 years. She will be greatly missed.

1. INTRODUCTION

Mr. Jim Dumont has been retained by the Mid Vancouver Island Habitat Enhancement Society (MVIHES) to assist in the assessment of the Shelly Creek watershed. The objectives of the project were:

1) to determine the causes of stream channel erosion in the Shelly Creek watershed, and
2) to determine the water balance for Shelly Creek, and provide a rainwater strategy to restore stream health.

The study is presented in four separate volumes that consist of:

1. **Summary**: which is a very brief description of the issues and mitigation strategies;
2. **Technical Summary**; this document that contains a brief description of the background information and mitigation strategies;
3. **Phase 1**; The detailed collection of information describing the Shelly Creek watershed and the human impacts that have occurred; and
4. **Phase 2**: The detailed description of the stream, the analysis undertaken, and the development of the recommended mitigation strategies.

As indicated above the Technical Summary condenses the information and analysis into a short document suitable for a non-technical audience. Reference to the Phase 1 and the Phase 2 report can provide additional detail concerning the assumptions and analysis.

1.1 Study Area

The Shelly Creek Watershed lies within the Regional District of Nanaimo (RDN) and the City of Parksville as illustrated on **Figure 1-1**. The focus of the study is to examine the biophysical characteristics of the watershed and the negative processes impacting Shelly Creek caused by human development in the watershed.

This Technical Summary will briefly describe important aspects of the information and recommend scientific approaches that will achieve long term stream stability. The current conditions of the watershed and the identified reaches of the steam can be seen of **Figure 1-1**. Land alterations over the past 80 years have included:

- Clearing and ditching for farming
- Ditching for road development and land subdivision
- Logging
- Linear developments (highway, railway, hydro transmission r/w)
- Residential and industrial developments

The watershed has increased in area from 5.21 km^2 to 5.75 km^2 due to ditching and diversions within both the Regional District of Nanaimo and the City of Parksville.

This study has addressed two question that included:

1. **What is causing the stream channel to fill with sediment?**
2. **How can we restore the stream's health?**

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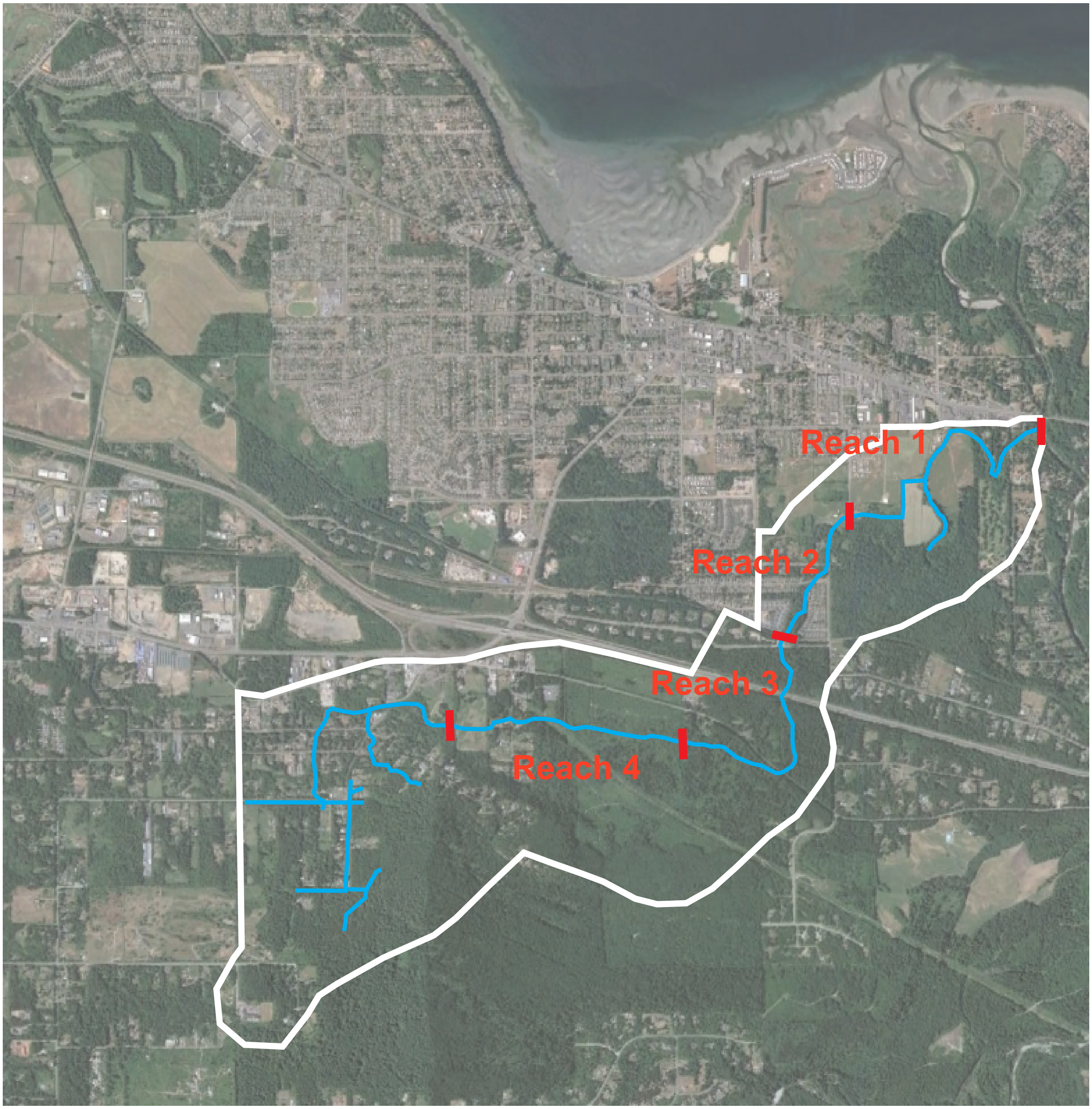

Shelly Creek Watershed
5.21 km^2 521 ha
Stream Reach

Shelly Creek Watershed Plan
Shelly Creek
Figure 1 - 1

2. BACKGROUND INFORMATION

A minimum amount of information is required to undertake a watershed assessment of factors influencing the streams hydrology and to formulate a mitigation plan. A summary of the scientific and recorded information is provided herein.

2.1 Fish and Fish Habitat Assessments

The MVIHES stream stewardship volunteers have been active within the Shelly Creek watershed over the past six years and have completed a number of initiatives that include:

- **Fish Inventory** – by counting Coho smolts in the spring months, MVIHES have documented the productivity of Shelly Creek. Since 2011, MVIHES has helped to coordinate the monitoring of the outward migration of juvenile Coho and Trout into the Englishman River. This was done by installing a smolt trap ~200 m upstream from the confluence with the Englishman River. As many as 8094 Coho smolt have overwintered in Shelly Creek before migrating to the ocean, which shows the importance of the creek to Coho salmon production.

  The 2011 Smolt Trapping Report submitted to DFO offered these observations.

  > "*The large number of smolts found indicates that Shelly Creek offers spawning and rearing habitat within its lower reach. It is also indicated that it is heavily used as overwintering habitat during high water by migrating fish from the Englishman River.*"

  This highlights the importance of the lower reaches of Shelly Creek for the production and survival of salmon in not only the creek but also of the much larger Englishman River watershed.

- **Fish Habitat** - Shelly Creek was subject to an instream fish habitat assessment in summer of 1999 and again in 2014. The Urban Salmon Habitat Program (USHP) methodology was used to allow a comparison of changes to stream habitat conditions over 15 years. The study found the creek's pools between Blower Road and Wildgreen Way have been filled in with sediments as a result of erosion of the creek's stream banks from high (winter) flows. Is was also found that much of the 2 km of creek above Highway 19 has been ditched. This has resulted in significant changes to the available habitat for fish in the Shelly Creek watershed as shown on **Figure 1-1**.

- **Fish Habitat Restoration** - A geomorphic overview was conducted by North West Hydraulics in 2014 who recommended an assessment of the hydrology of the watershed. A habitat enhancement project was completed in summer 2015 downstream of the Blower Road crossing. This included armouring the creek banks downstream of the culvert with rock to prevent further erosion. Weirs were constructed using rock and geotextile cloth to create pools.

The question is whether future restoration will be successful in this unstable stream. Without restoration of the watershed hydrology any instream enhancements and mitigation may not be successful in restoring habitat and fish productivity. For this reason we need to assess the watershed's geology, soils, vegetation, hydrogeology, and land use.

2.2 Geology of the Region

A description of the geology of the region would begin at the base of bedrock geology, overlain by the surficial sediments of various types. Bedrock in the study area consists of dark green Devonian to Jurassic-aged volcanic and metamorphic rocks of the Wrangellia terrain (basement) that are overlain by Upper Cretaceous-aged Nanaimo Group sedimentary rocks as shown on **Figure 2.1**.

2.3 Surficial Geology

The landscape of southern Vancouver Island has been considerably modified by glaciation. The most recent glaciation has resulted in the most extensive surficial deposits. This event began with the advance of glacial ice from the mainland Coast Mountains down the Strait of Georgia approximately 18,000 to 19,000 years ago as this ice sheet crossed the southeastern part of Vancouver Island.

Gravel and soil deposits resulting from the natural processes of colluviation (by gravity) are also widespread while environmentally induced deposits (Ie. organic) are locally important. These deposits lie upon the bedrock and have been either compacted by past glaciation or were directly deposited as the glaciers melted. Collectively these deposits form the parent materials of all the top soils which have formed. The separation of these surficial materials (landforms) was the third level of differentiation in mapping the soils as shown on **Figure 2-1**.

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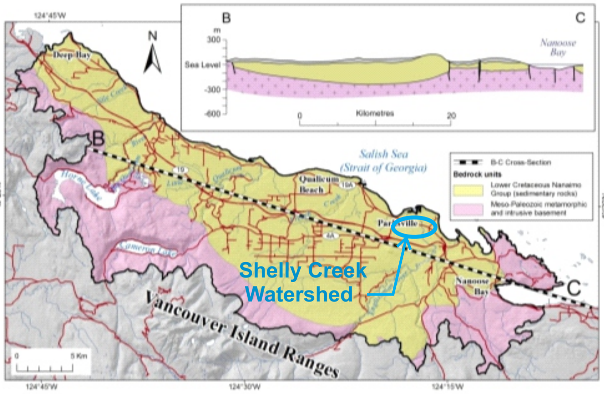
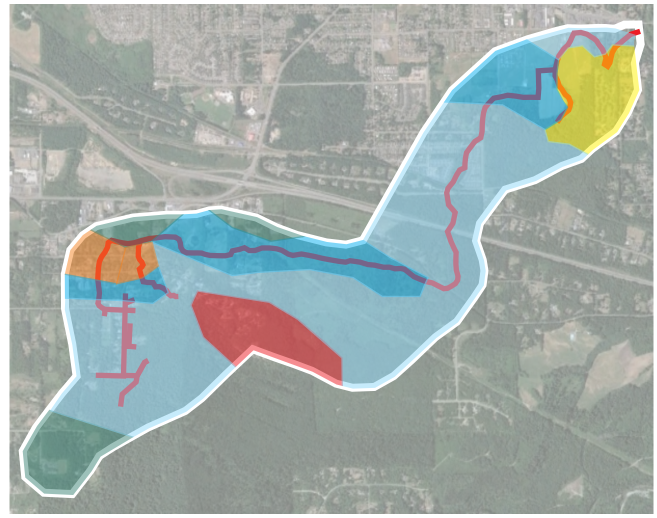
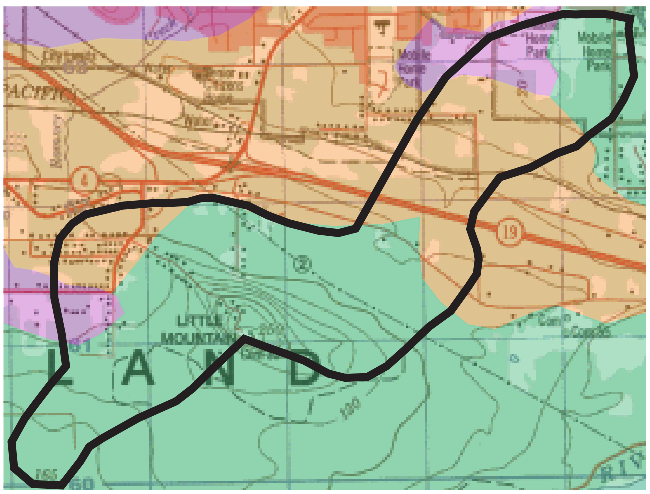


Bedrock Geology

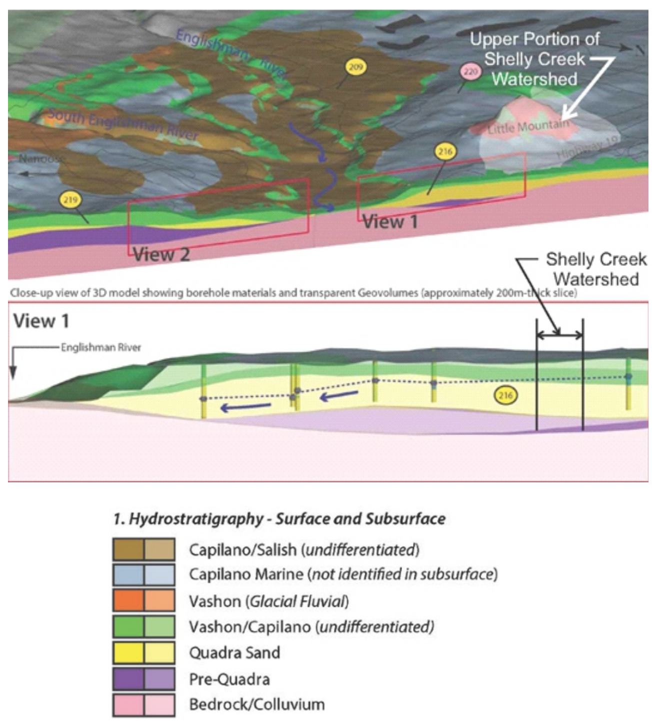


Surficial Geology

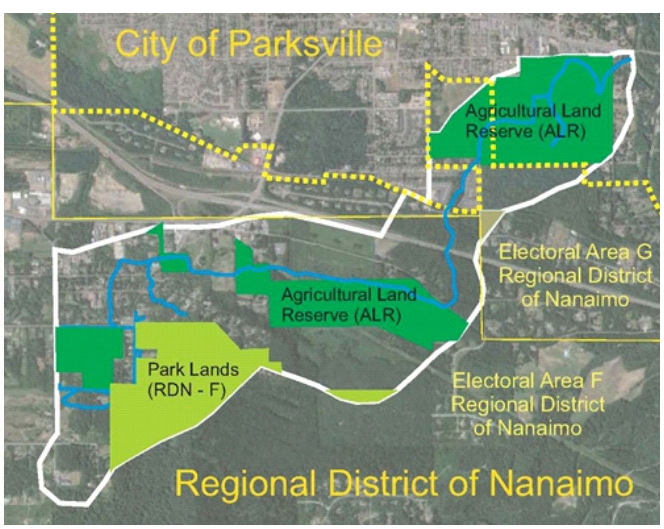


Soil Great Group
- Podzol
- Brunisol
- Gleysol

Surface Soils



Hydrogeology



Land Use

Shelly Creek Watershed Plan

Watershed Components

Figure 2 - 1

2.4 Surface Soils

The shallow surface soils are a mixture of organic material and mineral soil particles. Following the last glaciation and the retreat of the glaciers from the study area there was little or no organic material in the top soil nor was there any vegetation on the ground surface.

The mineral components which now make up the nonorganic portion of the top soils began to change as a result of rainfall, chemical weathering, water leaching, addition of vegetation matter, decomposition of organic matter, and missing by plant and animal populations. Examination of surficial soils is critical to understanding the hydrology of an area because it is the top soil that interacts with the climate and precipitation. The shallow (less than 1 m in depth) soils are most affected and altered by the interaction of both rainwater and biological activity. This is commonly referred to as “top soil”. The surficial soils are modified over time by these factors and their physical and chemical characteristics will be altered from those of the original geological materials. The distribution of surficial soil types can be seen on **Figure 2-1**.

The key conclusion reached when considering the shallow soil information is that concentrated flows of rainwater flowing vertically through unsaturated soil and will not flow vertically to any great depth. A different mechanism of groundwater recharge must be occurring which includes both vertical flow and lateral flow through unsaturated soils.

2.5 Hydrogeology

The surface hydrology of the Shelly Creek Watershed is affected by the flow of water beneath the ground surface and the ability of the soil profile to accept surface water. A ground profile which crosses the Shelly Creek Watershed can be seen on **Figure 2-1**. It is clear that the aquifer water surface is a considerable distance below the ground surface and lies within the Quadra Sand deposit located below the Vashon and Capilano deposits.

The direction of flow of the water contained within the auifer is generally downward toward the Englishman River, and to Shelly Creek where it crosses the piezometric surface (groundwater table). Where the creek crosses the water table springs will occur that allow water to enter the stream and flow within the channel.

The groundwater flowing into the streams is replenished by infiltration and downward movement of precipitation through the surface soils. Within the Shelly Creek watershed annual recharge of the aquifer is limited to approximately 75 to 130 mm or approximately 10% of the total annual precipitation of 1,170 mm that falls upon the watershed.

2.6 Vegetation

The Shelly Creek watershed lies within the Coastal Grand Fir - Western Red Cedar Zone on the south and eastern areas of Vancouver Island. This zone extends from sea level to about 300 m and is characterized by a forest of grand fir and western red cedar on deep, well drained sites. In response to frequent disturbance, coast Douglas-fir is the predominant seral species found on most sites. The Ministry of Environment's Sensitive Ecosystem Inventory identified three unique forest types in the watershed during the original inventory (1997). Logging in the Allsbrook Road area has removed a wooded wetland polygon.

2.7 Land Use

The Shelly Creek watershed has been subjected to a series of human caused alterations, especially during the past 50 years. The original watershed was 521 hectares, and now with diversions, it is now 575 hectares. Future development is restricted by the Official Community Plans created by the City of Parksville and the Regional District of Nanaimo (for the two electoral districts) as shown on **Figure 2-1**. The areas that are highlighted have two significant development constraints which include:

i. The Agricultural Land Reserve which is governed by the British Columbia Land Reserve Council. While the lands are subject to clearing and farming the potential for residential development can be considered to be minimal at this time. Although farming would generally retain the pervious surfaces there would be pressure by the property owners to enhance the drainage and to further alter the hydrology of the areas.
ii. The land use zone identified as Park within Electoral Area F would be subject to the any decisions of the RDN to modify the zoning or the land types and configuration of land surfaces within the area.

The future land use of the watershed is subject to decisions made by the City of Parksville and the RDN.

3. WATER BALANCE IN THE SHELLY CREEK WATERSHED

The activities of man which include logging, road and railway construction, agriculture, land development, and building construction will disrupt the natural hydrologic cycle as shown on **Figure 3-1.** The hydrologic cycle includes precipitation, evaporation, infiltration, uptake and transpiration, subsurface flow, and groundwater flow.

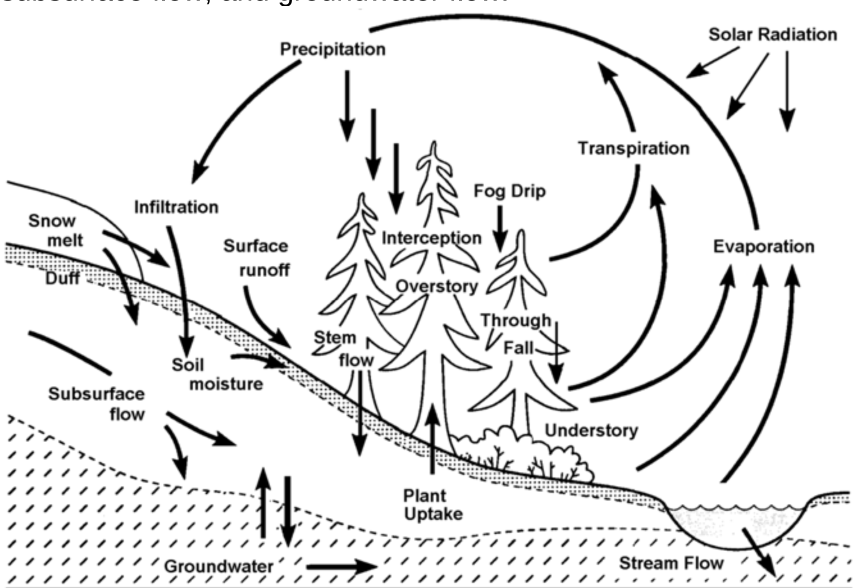


Figure 3-1 Hydrologic Cycle

Development almost universally results in a greater area of imperviousness (due to roads and buildings), and a corresponding reduction in vegetation. This will increase the volume of surface runoff and decrease the moisture captured on the surface (by forests), that evaporates directly back into the atmosphere. **The purpose of constructed drainage works such as ditching, culverts, and storm sewers is to intercept and direct watershed moisture away from the soil and directly to the receiving stream**. Using the existing standards of practice for drainage, as regulated by the BC Ministry of Transportation and Infrastructure, elevated stormwater discharges from developments have resulted in negative impacts to Shelly Creek. **Continuing to use the accepted standard of practice as applied to design of human activities which include municipal engineering and land development will result in further environmental degradation of the watershed and loss of stream productivity.**

The multiple risks resulting from development include:

1. **Increased flood risks** in downstream reaches;
2. **Aquatic habitat damage** and the loss of fisheries resources.
3. **Increased erosion** and property damage; and
4. **Costs** associated with flood damage and repairs to eroded streams.

Rainwater management is utilizing natural precipitation as a resource to maintain or to restore the natural water balance within a watershed. This can provide the most effective method of maintaining or restoring the ecological function of the streams and their productivity. **Rainwater management is a concept that applies a state of the art municipal engineering to achieve the desired objective of restoring Shelly Creek**. In a mixed rural and urban area, such as in the Shelly Creek watershed, the goal of mitigating adverse impacts that resulted from existing drainage improvements and development must be a goal applied to the design and approvals of future alterations within the watershed. Note here that future alterations can be subdivision of land, land development, building construction, road construction, ditching, drainage improvements, or other activities that alter the surface of the watershed.

3.1 Water Balance

Flows in Shelly Creek are comprised of nearly 80% of the total precipitation that falls within the watershed. According to recent reports on hydrogeology in the area, between 2% and 11% of flows come from (groundwater) aquifer discharge. This indicates that the hydrogeology is much more complex than one might initially believe.

The water balance of a watershed encompasses the mass balance and the flow paths of water. The mass balance involves processes that add or subtract water from the watershed and include precipitation in the form of rain and snow, evaporation, transpiration, and stream flow. The flow path is critical to understanding the hydrologic operation of a watershed and these flow paths can be from the atmosphere, return to the atmosphere, flow into the ground, flow through the ground in both saturated and unsaturated conditions, and flows in a stream.

The three flow paths of rainwater exist in a watershed from the point of rainfall until it enters the stream as shown on **Figure 3-2**. The flow paths include:

1. **Surface runoff** where the amount of time water spends on this path is typically in the order of minutes to hours. Where lakes and ponds are a part of the flow path the time could be extended to days.
2. **Interflow** is the system that seasonal with water entering shallow unsaturated soils and typically flowing to the stream within a year.
3. **Deep groundwater** is the flow entering the saturated aquifers where flow duration can be from years to decades depending upon the flow path and porosity of the aquifer.

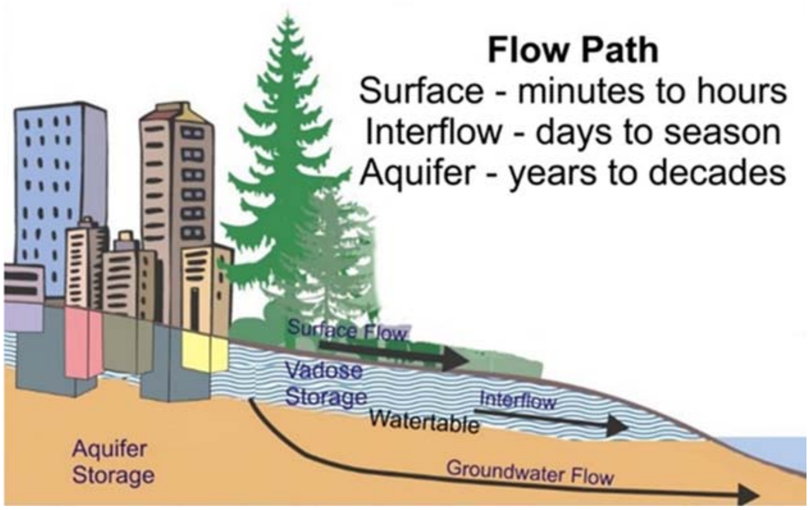


Figure 3-2 Watershed Flow Paths

A summary of the approximate annual water balance in the Shelly Creek Watershed is shown in **Table 3.1**.

Table 3.1 – Annual Water Balance of Shelly Creek Watershed

Flow Path	Total (mm)	Total (%)
Precipitation	**1,170**	**100**
Evaporation and Transpiration	**235**	**20**
Stream Flow	**935**	**80**
Surface Runoff	115	10
Aquifer Recharge / Discharge	120	10
Interflow	700	60

The interflow system has been identified as a critical flow path within the watershed yet it is not well understood. This can be seen as a case of out of sight and out of mind where there is an assumption that any water that infiltrates into the ground will eventually end up in the stream. The interflow system is very shallow, typically less than 1 meter from the ground surface. Flow within the interflow system can readily be intercepted by simply building a road and ditch to improve the drainage of a land parcel. The ditch will allow the interflow to be intercepted and will thus allow the water to be collected and diverted to the stream much quicker than would naturally occur, within a few days rather than over the course of a season. While this does not increase the peak discharge to the stream it does reduce the discharge in Shelly Creek within a few days of dry weather and far sooner in a dry period such as occurs each summer. This demonstrates that the interflow system is very fragile and subject to unintended damage.

3.2 Water Balance Methodology

The Water Balance Methodology is an application of the “State of the Art”, rather than the accepted municipal engineering land development industry “Standard of Practice”. At the center of the **Water Balance Methodology** is the recognition of the different flow paths that rainwater can follow toward a stream and the amount of time it can spend along the way.

The **Water Balance Methodology** addresses the alterations to the land surface and its land use while providing solutions that will maintain the stream health within the developed watershed. The Water Balance Methodology also recognizes the potential change in the paths followed by rainwater in the hydrologic cycle and establishes the methodologies required to protect the stream and the watershed. The Water Balance Methodology uses the understanding of the watershed hydrologic cycle combined with its physical characteristics in a series of calculation processes and computer models to quantitatively arrive at mitigation solutions.

An analytical approach to mitigate the impacts of urban development are required for new developments prior to the impacts being incurred and for existing developed areas where the impacts are already occurring. The calculations, computer modelling are used extensively in the methodology. The intent of the **Water Balance Methodology** is to provide a logical and simple way of assessing potential impacts resulting from urban development and to analytically **demonstrate** the effectiveness of the methods proposed for mitigating the potential impacts. The analysis utilizes standard engineering practice while incorporating scientific knowledge from a wide range of sources not normally considered when undertaking drainage design.

3.3 Impacts and Mitigation

As development occurs, there is a very drastic disruption to the shallow soils as building foundations and underground infrastructure is constructed. Note here that future development can include subdivision of land, land development, road construction, ditching, drainage improvements, installation of underground services, building construction, or other activities that alter the surface of the watershed.

These disruptions result in large alteration of the shallow surficial soils and the interflow system with the greatest impacts occurring in the denser developments where the ground disturbances are contiguous.

The analysis undertaken included a flow duration analysis which compares the discharge rates and the time duration of the flows, or more specifically for how many hours is the discharge larger than a specific flow rate. The information derived by the computer model analysis is complex and requires an extensive review to visually identify critical information. The total picture can be seen on **Figure 3–3** with chart showing results for four development scenarios which include:

1. Natural conditions,
2. Exiting conditions,
3. Possible future conditions if no mitigation works are utilized, and
4. Future conditions with mitigation measures applied.

The information contained in the chart is explained in the text following the chart.

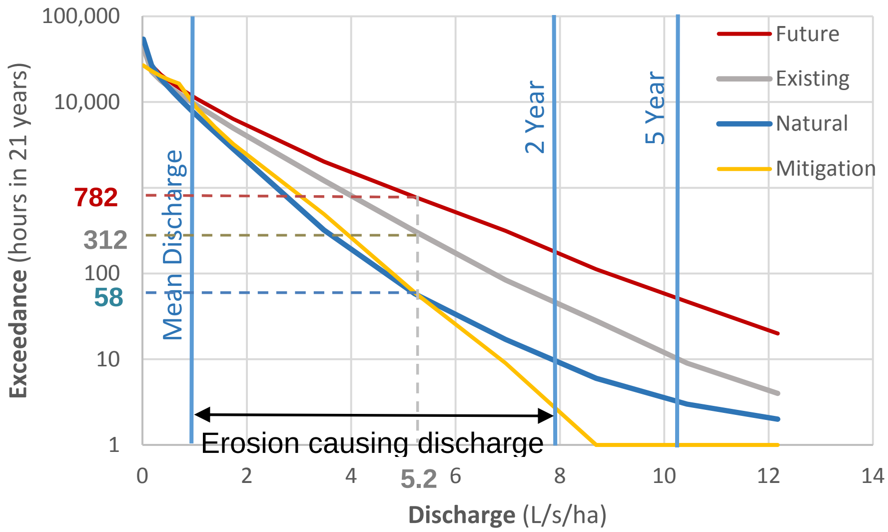


Figure 3-3 Discharge Exceedance

The key conclusions that can be drawn from the chart include:

- The mean discharge for natural watershed condition of the Shelly Creek watershed is approximately 1 L/s/ha and was exceeded for 6,900 hours during the 21 year period. This means the flow was greater than 1 L/s/ha during 6,900 hours and less than 1 L/s/ha for the remaining time during the 184,000 hours in the 21 year period. It would be reasonable to assume that this is a safe discharge which would not result in stream erosion.
- The 2 year return period natural flood discharge of 7.9 L/s/ha was exceeded for just 10 hours during the 21 year period. This leads us to conclude that the discharges that cause the observed stream erosion must be less than the 2 year return period discharge rate. While this discharge rate will cause erosion it very seldom occurs.
- For example the **hours of exceedance** for a discharge rate of **5.2 L/s/ha have increased** over the 21 year period, from the **predevelopment conditions** of **58 hours**. The **existing conditions** to the **312 hours,** and **for future conditions** can be increased to **782 hours.** This indicates a possible **14 fold** increase in the duration of erosion causing discharge rates.
- **We can conclude that the vast majority of stream erosion is caused by discharge rates between the mean discharge and the 2 year return period flood event**. The majority of the stream erosion is caused by watershed flow rates from 1 to 8 L/s/ha. For the 575 ha Shelly Creek watershed this would be equal to discharges into the Englishman River over a range from 575 L/s (0.575 m^3/s) to 4,600 L/s (4.6 m^3/s).

Even under existing conditions the hours of erosion causing discharges have increased by a factor of more than 5 times over the natural conditions. This increase in the flow duration is the cause of the increased steam erosion observed in Shelly Creek.

3.4 Shelly Creek Watershed Targets for Rainwater

The hydrologic aspects of the developed watershed can be described through the use of a suitable continuous simulation model. The simulation of the watershed, plus the retention and the discharge control systems can be added to the computer model as shown on **Figure 3-4**. This graphic describes the physical components and how they interact as precipitation lands upon the catchment (watershed) and passes into the ground or discharges with discharges also returning from the ground. The catchment discharge can be directed to retention systems. The retention system have infiltration to the ground, low flow release plus an overflow to the stream when they are full. The results of analysis of discharges to the stream are described previously.

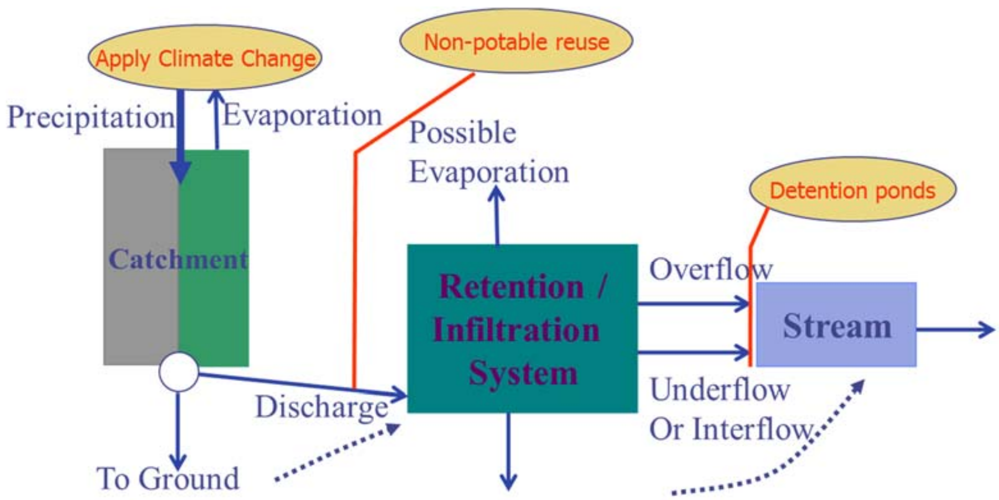


Figure 3-4 Watershed and Rainwater Control System Operation

The objective of Rainwater Management is to mimic the amount of water that was infiltrated to groundwater under natural watershed conditions, provide the interflow connectivity to the stream and to maintain or decrease potential flood risks. This approach provides a level of assurance that:

- Excess water will not be directed to the ground and would avoid potentially adverse impacts of excessive groundwater levels and discharges in areas lower in the watershed.
- Summer flows will be maintained with an operating interflow system.
- Downstream properties will not suffer an increased risk of flooding or flood damages.

The criteria used to measure success would be:

- No increase in magnitude of flood events,
- No increase in the duration of discharge rates to prevent increased stream erosion, and
- No increase in the losses to deep groundwater.

Examination of the process flow chart in **Figure 3-4** leads to the conclusion that there are three physical characteristics of the retention / infiltration systems that can be varied to influence the hydrologic operation of the rainwater control systems. The three physical characteristics include:

1. **Volume of retention** which stores rainwater for controlled release to deep groundwater / aquifer or to the stream through the municipal drainage system;
2. **Infiltration system area** in contact with the subsurface which will allow retained water volumes to infiltrate to deep groundwater / aquifer; and
3. The **base flow release rate** which can be used to augment small stream discharges through release of retained rainwater.

Mitigating the existing and future impacts in the watershed requires a series of rainwater management systems that will reduce the flow duration of the erosion causing stream discharges to their natural values. In the simplest of terms the rainwater management system on-site might be envisioned as a simple rain garden as shown on **Figure 3-5**.

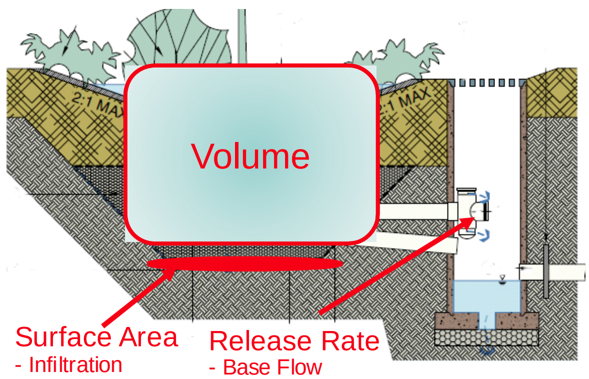


Figure 3-5 **Typical Rain Garden**

The key watershed targets for rainwater management systems include the following:

1. **Retention Volume** 150 m^3/ha of impervious area,
   - For a 100 m^2 house, or patio, or road this equates to a volume of 1.5 m^3
2. **Infiltration Area** 5 m^2 per 100 m^2/ha of impervious area,
3. **Base Flow Release Rate** 1.0 L/s/ha, and
4. **Neighbourhood Detention** 100 m^3 / ha of development with a controlled release rate of 7.9 L/s/ha with an overflow allowed

4. MITIGATION STRATEGIES

Mitigation strategies for the restoration of Shelly Creek must be implemented throughout the watershed and not be restricted to the riparian corridor along the stream. **Without restoration of the hydrology of the watershed any enhancements or stabilization of the stream may not be successful in restoring the productivity of Shelly Creek.** Therefore it is critical that all mitigation activities target the restoration of the hydrology of the Shelly Creek watershed.

The mitigation strategy and any works constructed in the watershed must comply with the rainwater targets for the Shelly Creek watershed to reduce existing stream erosion. Achieving this objective can be accomplished by reducing the duration of erosion causing stream discharges. Restoration of the watershed interflow system can be accomplished over time as opportunities arise through the development and redevelopment processes of the RDN and the City of Parksville.

At this time six opportunities have been identified and are shown on **Figure 4-1** and include:

1. Throughout Shelly Creek Watershed - enforce MOTI guidelines for subdivisions and work with Parksville to adopt similar standards;
2. Throughout the Shelly Creek Watershed – implement the Water Balance Express for all future building permit applications;
3. Infill excavated ditches on certain properties to slow water flows;
4. Creation of off-channel habitat;
5. Maintain and construct new structures as opportunity allows; and
6. Construct works to stabilize channel erosion.

These opportunities can be placed into two broad categories that include:

A. **Implementing Rainwater Management** with opportunities 1 and 2.
B. Implementing **stream channel projects** at specific locations with opportunities 3, 4, 5, and 6.

4.1 Enforce Ministry of Transportation and Infrastructure Design Guidelines

A majority of future subdivision will occur within the RDN where Ministry of Transportation and Infrastructure (MOTI) is the review and approving agency for subdivision and drainage design. The design criteria used for MOTI and subdivision projects were updated and included in the B.C. Ministry of Transportation Supplement to TAC Geometric Design Guide (2007) within Chapter 1010 General Design Guidelines, 1010.03 Requirements for Drainage Designs, subsection Land Development Drainage Design. MOTI should adopt the requirements of this drainage plan for application of the water balance methodology within the Shelly Creek watershed to future subdivisions.

The City of Parksville is required through provincial legislation to establish the drainage criteria that would apply within the City. The City should adopt the requirements of this drainage plan for application of the water balance methodology within the Shelly Creek watershed to future subdivisions.

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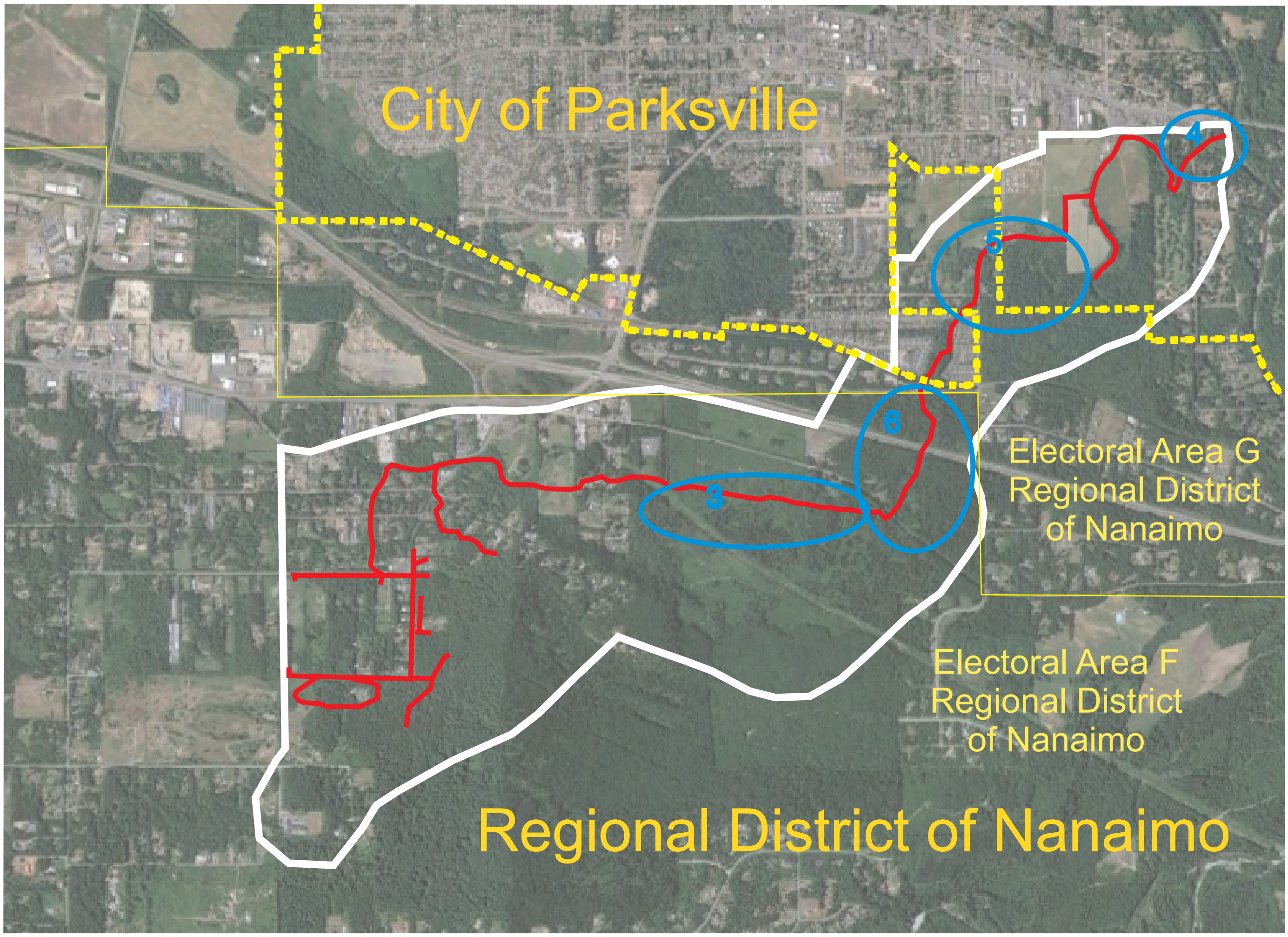

(1) Enhancement Opportunities

1. Throughout Shelly Creek Watershed - enforce MOTI guidelines for subdivisions and work with Parksville to adopt similar standards
2. Throughout the Shelly Creek Watershed - Utilize Water Balance Express for all future building permit applications.
3. Infill excavated ditch
4. Off-Channel Habitat
5. Maintenance and new structures upon opportunity
6. Log Weirs to Stabilize Channel Erosion

Shelly Creek Watershed Plan

Enhancement Opportunities

Figure 4 - 1

4.2 Implement the Water Balance Express

The Water Balance Express for Homeowners has been created by the Partnership for Water Sustainability for British Columbia to provide guidance in restoring site conditions to their natural hydrologic function. The objective is to provide a simple tool that will allow the home owner to return the hydrology of their property to a natural condition. It is intended that the Express be utilized during the on-site construction activities that are regulated through the building permit processes within both the City of Parksville and the Regional District of Nanaimo. These activities would not involve a subdivision and would not be subject to review by MOTI, hence the need for a separate mitigation strategy.

The objective embedded in the Express is to return any disturbed pervious areas to a natural condition with the application of suitable top soil and landscaping that will absorb precipitation. The mitigation of impervious areas such as roofs and driveways, sidewalks, and patios it with the use of rainwater retention that can be in the form of raingardens, infiltration ponds or other landscaping features that contain and slowly release captured rainwater from the impervious surfaces.

Other Regional Districts have versions of the Water Balance Express and can be viewed to see how simple the model is and how decisions can be made. One example as implemented in the Comox Regional District can be tested at this web site: http://comox.waterbalance-express.ca/

Implementing the Water Balance Express will require changes to the administrative processes for building permitting in both the RDN and the City of Parksville. Both organizations will require bylaw amendments, or new bylaws to allow the implementation and ongoing maintenance of rainwater management systems on private property. We anticipate the construction and certification would occur as part of the building permit and construction process.

4.3 Infill Excavated Ditch

The channel through Reach 4 exhibits visual evidence of having been excavated, or enlarged. While this channel flows through a wooded area without risk of direct flood damages the need for enhance drainage can be questioned. Should the property owner agree it would be a simple matter to infill parts, or all of, the channel to restore this area's condition to that of a floodable forest.

Other channels such as roadside ditches can be infilled provided there is sufficient retained capacity for a 1:2 year storm and that water does not overtop the roadway or encroach onto the driving lanes.

4.4 Off-Channel Habitat

The importance of Reach 1 in providing rearing habitat has be reported during the smolt trapping program. The shallow slope of the channel within Reach 1 provides a location for sediment deposition of the material that has been eroded from Reach 2 and Reach 3.

The primary purpose of the off-channel habitat would be to provide aquatic habitat that is not subject to sediment carrying discharges. The off-channel habitat should connect to the main stem at the downstream extent of each habitat section to reduce the sediment load and maintenance requirement for the habitat.

The depth and width of the constructed habitat would be established as part of a design to add the most beneficial habitat characteristics. Only the most downstream end of the off-channel habitat would be connected to the main stream to prevent the sediment from entering and depositing in the new habitat.

4.5 Maintenance and New Structures

The fish habitat survey of Reach 2 provided evidence of a stream reach that is undergoing significant change caused by altered hydrology in the upper portions of the watershed. Resident trout have been observed in the portion of the channel immediately below the upper spring.

Until the upper watershed hydrologic functions are mitigated and returned to normal there is a need to enhance and stabilize Reach 2 with the addition of grade control structures.

4.6 Grade Control - Channel Stabilization

Limited access and steep terrain will increase the costs of stabilizing Reach 3, often referred to as the Canyon Reach. Due to the obvious difficulties the stabilization of this reach through in stream works should only be undertaken if the process of naturalizing the upper watershed cannot be accomplished. There are numerous structures that can be utilized to reduce the erosion in Reach 3 and include:

- rock lined channels or stone chutes,
- a series of rock weirs, and
- a series of log check dams.

The planning process needed for these structures will include conceptual designs to establish comparative cost estimates followed by detailed design to finalize the location, sizing, details, and costs for construction.

5. CORPORATE AUTHORIZATION

This document entitled:

Shelly Creek Water Balance
and
Sediment Reduction Plan

Technical Summary

Client Name:

Mid Vancouver Island Habitat Enhancement Society

Was prepared by:

J.M.K. (Jim) Dumont, P.Eng., P.Ag.

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